3.3.4 Debris Rack Criteria

Debris racks are commonly used to exclude large debris from entering fish passage facilities. Debris rack openings should be a minimum of 8 inches clear, or 12 inches clear if adult Chinook are present. NMFS criteria state that approach velocity should be less than 1.5 ft/s. Debris racks should be sloped at 1:5 or flatter to assists with manual cleaning. In systems with coarse floating debris, debris booms or other provisions must be incorporated into the debris rack design (NMFS 2011).

3.3.5 Fish Trapping and Holding Criteria

If the design requires trapping, holding, and handling of fish then the following criteria applies:

- Holding Pool Volume – Fish holding pools must be sized to provide a minimum volume of 0.25 cubic feet per pound of fish. For holding durations greater than 72 hours, holding pool volumes should be increased by a factor of three. The maximum daily fish return, or number of fish expected to be trapped before fish are removed, is used to determine the required trap capacity (NMFS 2011).
- Temperature – Water temperatures must be less than 50° F. If temperatures exceed this threshold, the poundage of fish held should be reduced 5 percent for each degree above 50° F (NMFS 2011). It should be noted however that this criteria would require a variance to sufficiently accommodate water temperatures typically experienced by such fish species in the Tuolumne River. As an example, Mokelumne River juveniles collected for transport are held in water temperatures of approximately 70° F (18 C).
- Dissolved Oxygen – Must be maintained between 6 and 7 parts per million (NMFS 2011).
- Water Supply – A minimum of 0.67 gallons per minute per adult fish must be supplied to the holding pool (NMFS 2011).
- Handling – Fish must be handled with extreme care, use of nets should be minimized or eliminated. Fish should be anesthetized before being handled and only be handled by individuals trained to safely handle fish (NMFS 2011).
- Frequency of Removal – Fish must not remain in traps for more than a day. Traps may have to be cleared more often to prevent crowding or adverse water quality (NMFS 2011).
- Adult Jumping Provisions – Fish may be injured by jumping, and provisions must be included in the holding pool design to minimize adult jumping. Provisions can include: freeboard of 5 feet or more; covering of the holding pool to create a darkened environment; use of netting over the pool; or sprinklers above the holding pool (NMFS 2011).
- Segregation of fish – Specific criteria for segregating different species and life stages of fish are established on a site-specific basis. This could include picket panels, screens, and other materials to limit certain sizes of fish holding in pools.

3.3.6 Juvenile Salmonid Upstream Passage Criteria

Juvenile upstream passage will not be considered as part of this Fish Passage Facilities Alternatives Assessment.

3.4 Other Factors That Require Further Consideration

There are a number of remaining factors that require careful consideration when siting, selecting and formulating fish passage alternatives for both adult and juvenile life stages of target fish species. The following list summarizes additional considerations that should be evaluated prior to subsequent phases of alternative development.

- Confirmation of Target Species – The target species must still be agreed upon. None of the three potential target anadromous species currently occur above Don Pedro Reservoir. The viability, funding, or planning of such reintroduction is unknown at this time and therefore the inclusion of these three target species into the Fish Passage Facilities Alternatives Assessment is speculative. Further discussion and concurrence with the LPs is necessary to finalize target species.
- Migration Timing for Various Life Stages – The migration timing of target fish species has a significant influence on the applicability and selection of potentially viable fish passage facilities alternatives. Information on the seasonal timing of adult and juvenile passage would be required for all three of the potential target fish species for use in the engineering feasibility study. Currently, assumptions regarding these factors are only available through other regional data sources where populations of these species currently exist. Input from the LPs is required to finalize assumptions regarding these potential future populations and their various characteristics.
- Population Size and Peak Run Values – The number of fish to be passed has a significant impact on the size and configuration of facility components. At the time this TM No. 1 was prepared, there is no known or assumed population numbers or objectives set forth for the upper Tuolumne River relative to the target species assumed to be reintroduced. Information on the availability of suitable habitat and potential carrying capacity for all relevant life stages of target species (e.g., adult spawning, juvenile rearing, etc.) in the reintroduction reach will be necessary to inform potential population goals and specific facility design characteristics.
- Suitability of Reservoir Passage – Reservoirs foster slow and deep hydraulic conditions which provide habitat for predators of outmigrating juvenile fish. The potential for predation on target species and its effect on escapement objectives should be evaluated prior to final determination of facility siting and technology selection. The applicability of reservoir passage will be evaluated if fish passage alternatives requiring reservoir passage are selected for further development.
- Suitability of Reservoir Water Quality– In addition to predation, reservoir water quality (temperature and dissolved oxygen levels, etc.) can have a detrimental impact on both adult and juvenile life stages. Water quality, the potential residence time for fish in the reservoir, and any potential detrimental effects of such adverse conditions will be evaluated if alternatives requiring reservoir passage are selected for further development.

- Water Supply – All upstream fish passage facilities require operational flow and fish attraction flow to successfully guide fish to a facility entrance and to support fish handling systems. The source of the supplied water will need to be of a unique temperature and water quality that attracts fish to a facility entrance and sufficiently maintains their health when in a holding facility prior to transport. The source and type of water required will be evaluated further as the alternative evaluation and design development moves forward.
- Power Supply – Virtually all fish passage technology options of the magnitude required for this project will require some level of electrical power supply to operate measurement, automated control, monitoring, lighting, pumping, and other miscellaneous systems. The accessibility to power supply for each potential location should be evaluated prior to final determination of facility siting and technology selection.
- Reservoir Recreation – Don Pedro Reservoir fosters a high level of sport fishing, boat touring, and aquatic activities. Fish passage facilities present within the reservoir may interfere with such public activities and in some cases may become a safety hazard. Careful consideration of both safety and interference with existing recreational opportunities should be considered if the design process moves forward.

4.0 NEXT STEPS IN THE DEVELOPMENT OF THE FISH PASSAGE FACILITIES ALTERNATIVES ASSESSMENT

This is the first of two TMs being prepared as part of the Fish Passage Facilities Alternatives Assessment. The purpose of the interim TMs being developed is to move forward with LP participation, identify information needs, establish the linkage of certain biological and ecological criteria to the engineering design process, obtain input and feedback in a collaborative process, and to establish when information will be available to support the feasibility assessment of alternative fish passage facilities.

Providing fish passage facilities for the reintroduction of anadromous salmonids to the upper Tuolumne River watershed would be a significant and costly undertaking. The feasibility study of fish passage facilities is one component of the investigation of the potential reintroduction of anadromous species, an investigation which must consider a host of issues ranging from engineering and regulatory guidance (e.g., ESA considerations, experimental designation, etc.) to biological objectives and ecological feasibility (e.g., upstream habitat suitability, estimated carrying capacity and adult and juvenile abundance estimates, seasonal and interannual environmental conditions, etc.). Economic feasibility and potential impacts to other resources (e.g., recreation, existing fisheries, etc.) must also be determined. As such, implementing a collaborative process to collect needed information at the appropriate level of detail is critical to supporting the study process and ensuring the information produced is accurate and can be used to inform future decision making.

The assessment of potential fish passage and reintroduction to the upper watershed requires information on a number of factors that currently have high uncertainty and require agreements among the LPs. Examples of such factors include but are not limited to seasonal timing of adult and juvenile migration, target species to consider in the assessment and their source, escapement goals, and expected adult and juvenile abundance. Although all of these factors require careful consideration, certain ones are needed to directly support the development of facility alternatives for both upstream and downstream passage. Examples include:

- target species identification and source,
- life stages proposed for collection at each type of facility,
- migration timing of these species specific to the Tuolumne River,
- environmental conditions associated with adult and juvenile collection, handling, transport, and release, and
- population goals and expected peak return numbers (linked to habitat availability, suitability, and carrying capacity).

The review of materials in advance of the September 17 workshop is encouraged. Please come prepared to provide input and pertinent discussion to information needs to further the study program.

5.0 REFERENCES

Bell, M. 1991. Fisheries Handbook of Engineering Requirements and Biological Criteria. U.S. Army Crops of Engineers, North Pacific Division, Portland, Oregon.

California Department of Fish and Game (CDFG). 2000. Fish Screening Criteria.

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Tuolumne River Technical Advisory Committee (TRTAC). 2000. Habitat Restoration Plan for the Lower Tuolumne River Corridor.

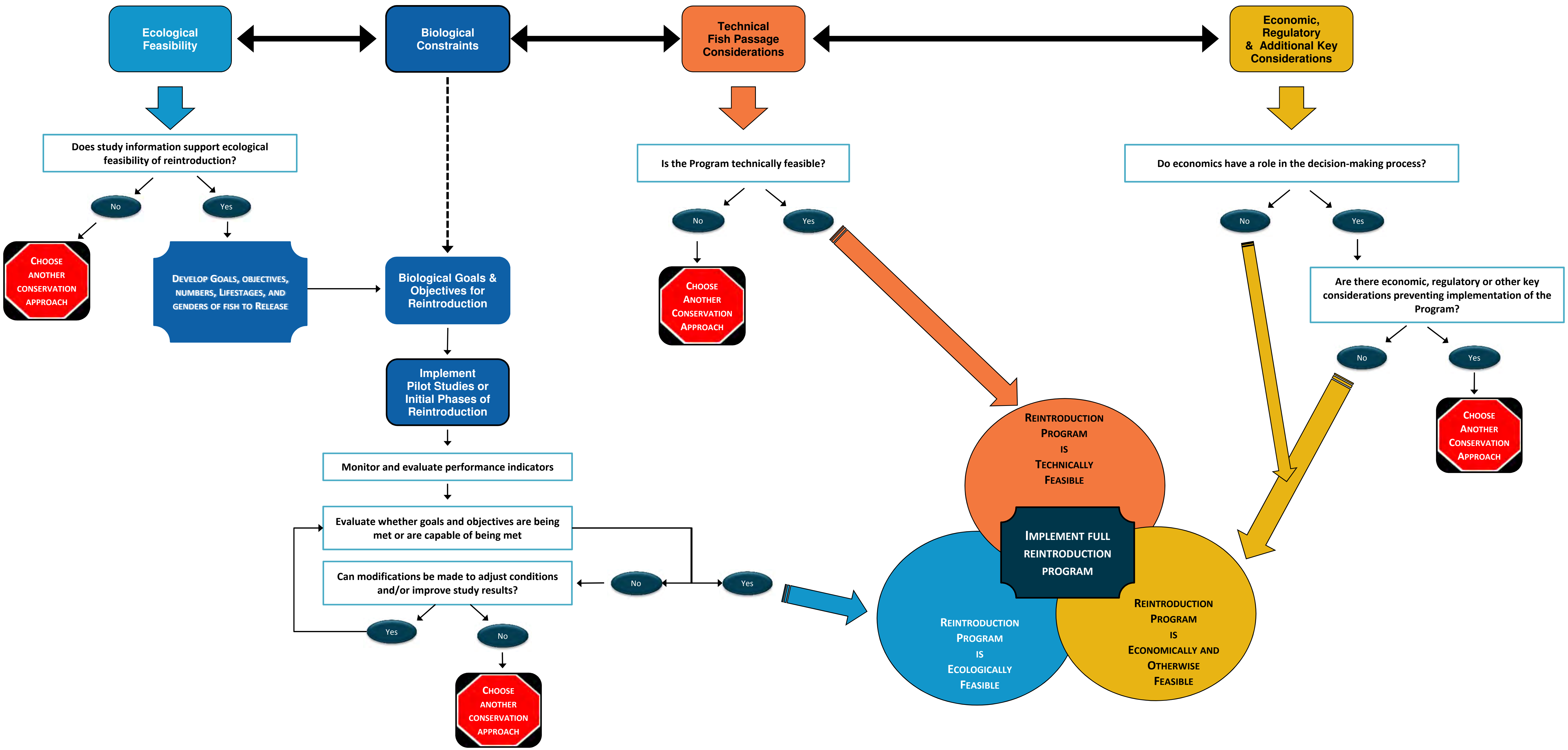
Turlock Irrigation District and Modesto Irrigation District (TID/MID). 2010. FERC - 2009 Lower Tuolumne River Annual Report.

_____. 2013a. Don Pedro Project Operations/Water Balance Model. Attachment B – Model Description and User's Guide, Addendum 1 Base Case Description (W&AR-02). May 5, 2013.

_____. 2013b. Don Pedro Project FERC No. 2299 Draft License Application. Transmittal Letter Exhibits A Through H. Prepared November 2013.

_____. 2013c. Salmonid Population Information Integration and Synthesis Study Report (W&AR-05). Attachment to Don Pedro Hydroelectric Project Draft License Application. December 2013.

TUOLUMNE RIVER FISH REINTRODUCTION DECISION-MAKING FRAMEWORK



From: Staples, Rose
Sent: Thursday, September 10, 2015 1:26 PM
Cc: Staples, Rose
Subject: La Grange: Comments for Licensing Website - Link to NMFS Documentary

La Grange Licensing Participants,

At the La Grange Fish Passage Assessment Workshop No. 1, held on May 20, 2015, the Districts stated they would provide a way for licensing participants to submit comments on the La Grange Licensing Website and would make available a link to the NMFS fish passage documentary.

In an effort to complete these two action items, the Districts have revised the homepage of the La Grange Licensing Website to state the following:

> TID and MID wish to foster a collaborative licensing process. Please email any comments you wish to be shared with all licensing participants to Rose.Staples@hdrinc.com. All comments will be uploaded to the DOCUMENTS section of the website. All comments will also be recorded in the La Grange Hydroelectric Project Licensing Consultation Record, which the Districts will file with FERC as part of the license application.

By this email, the Districts make available a link to the NMFS fish passage documentary. The documentary, entitled "Rights of Passage: Taking Action to Restore Listed Anadromous Fish," may be viewed here: https://vimeo.com/75552829.

Rose Staples, CAP-OM, MOS
Executive Assistant

HDR
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D 207-239-3857
rose.staples@hdrinc.com

hdrinc.com/follow-us

From: Le, Bao
Sent: Monday, September 14, 2015 2:29 PM
To: John Wooster - NOAA Federal
Cc: Devine, John; Borovansky, Jenna; Deason, Jesse
Subject: RE: Upcoming Fish Passage Workshop #2 - engineering participation

Follow Up Flag: Follow up
Flag Status: Completed

Hi John.

I wanted to follow back up on this string as in discussions with our temperature modeler (Mike Deas), he would definitely see a use for processed, QC'd LiDAR whenever it is available for the purposes of his work. So when LiDAR is available, please let us know.

As discussed in previous email, the habitat evaluation study appears like it may have to wait and analysis of this as part of the tasks identified in the RSP may be delayed and we can state as such.

We can discuss more this week if you'll be at the meeting.

Thanks, Bao

From: John Wooster - NOAA Federal [mailto:john.wooster@noaa.gov]
Sent: Tuesday, September 01, 2015 1:22 PM
To: Le, Bao
Cc: Devine, John; Borovansky, Jenna; Deason, Jesse
Subject: Re: Upcoming Fish Passage Workshop #2 - engineering participation

Hi Bao:

In regards to your question below, are you asking about the availability of the LIDAR data itself, or about the analyses being conducted with the LIDAR being used as a basis for habitat input?

The LIDAR data itself should be ready by 2016, if not sooner. The actual habitat analyses being completed is a moving target, and has a temperature component to it, so I don't expect that to be finalized until temperature data / models are completed to provide a thermal suitability overlay....

John

On Mon, Aug 24, 2015 at 11:31 AM, Le, Bao <ChiBao.Le@hdrinc.com> wrote:

Thanks, John. Anything that can be done would be much appreciated.

While I have your attention, I wanted to circle back about the availability of the LIDAR assessment NMFS is conducting. Last we spoke, the availability of this information for review had been revised from this fall to next spring (2016). If you recall, we have an element in our Revised Study Plan that includes review this information. I wanted to circle back to double check on its status of availability so we can characterize this element appropriately when it comes time for reporting in the Initial Study Report.

Bao

From: John Wooster - NOAA Federal [mailto:john.wooster@noaa.gov]
Sent: Monday, August 24, 2015 11:18 AM
To: Le, Bao
Cc: Devine, John; Borovansky, Jenna; Deason, Jesse
Subject: Re: Upcoming Fish Passage Workshop #2 - engineering participation

At a minimum I will get review of your materials that you provide. I will look into getting an engineer to be present, but it is probably an uphill battle because we are on travel restrictions until the end of the federal fiscal year (September 30), and all travel requests for the remainder of the year were due awhile ago for approval.

-John

On Mon, Aug 24, 2015 at 8:06 AM, Le, Bao <ChiBao.Le@hdrinc.com> wrote:

Hi John.

As we complete the development of materials (i.e., Technical Memorandum #1) for the upcoming fish passage workshop #2, it appears that it would be valuable to have a fish passage engineer participate by phone or in person given the number of items that may require input from NMFS, as the lead entity. This would ensure a more productive discussion at the workshop. I apologize for this change of course and hope someone can be available. If this is not possible, at the very minimum I'd strongly encourage an agency fish passage engineer review the materials and provide you with feedback that you can present for discussion at the meeting. We are targeting September 3rd for distribution of workshop materials (i.e., 2 weeks in advance of the meeting).

Please let me know if you have any questions.

Thanks, Bao

Bao Le

Senior Fisheries Biologist

HDR

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John Wooster
Hydrologist
NOAA Fisheries West Coast Region
U.S. Department of Commerce
john.wooster@noaa.gov

From: Staples, Rose
Sent: Thursday, September 17, 2015 7:29 AM
Cc: Staples, Rose
Subject: La Grange Workshop No. 2 Handouts

Follow Up Flag: Follow up
Flag Status: Completed

La Grange Licensing Participants,

I have uploaded to the www.lagrange-licensing.com website the HANDOUTS to be used at today's Fish Passage Facilities Assessment Workshop No 2, being held at the MID Offices in Modesto beginning at 9:00 a.m. Click on the CALENDAR Tab; then click on the workshop announcement under today's date. The handouts are attached to the workshop announcement.

There are 12 handouts. If you print them out, please note that the Decision Tree files are formatted to print 11 x 17—but if your printer automatically defaults to standard 8 ½ x 11 size print, you will need to change the print setting to be 11 x 17.

Agenda
Decision Tree-Biological
Decision Tree-Ecological
Decision Tree-EconReg
Decision Tree-Integrated
Decision Tree-Overview
Decision Tree-TechlPassage
Lower Tuolumne River-Map (11 x 17)
Project Aerial
Upper Tuolumne River-Map (11 x 17)
Slides–Fish Facilities
Slides-Introduction

If you have any difficulty locating the workshop handouts, please let me know at rose.staples@hdrinc.com.

Thank you.

Rose Staples, CAP-OM, MOS
Executive Assistant

HDR
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Portland ME 04103
D 207-239-3857
rose.staples@hdrinc.com

hdrinc.com/follow-us

From: Staples, Rose
Sent: Friday, September 18, 2015 11:51 AM
Cc: Staples, Rose
Subject: Historic Articles Mentioned at Workshop No 2 Uploaded to Licensing Website

Follow Up Flag: Follow up
Flag Status: Flagged

La Grange Licensing Participants,

Peter Drekmeier with the Tuolumne River Trust has forwarded to us the "historic articles" mentioned yesterday at the La Grange Fish Passage Facilities Assessment Workshop No. 2—and I have just finished combining the pieces into one pdf document and uploading it to the La Grange Licensing Website www.lagrange-licensing.com.

If you have any difficulties locating and/or accessing the document, please let me know. Thank you.

Rose Staples, CAP-OM, MOS
Executive Assistant

HDR
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Portland ME 04103
D 207-239-3857
rose.staples@hdrinc.com

hdrinc.com/follow-us

From: Peter Drekmeier [mailto:peter@tuolumne.org]
Sent: Thursday, September 17, 2015 8:00 PM
To: Byrd, Larry; Devine, John; John Holland
Subject: Historic Salmon Articles

Gentlemen,

Nice seeing you this morning.

I'm following up on the historic articles that reference salmon in the upper Tuolumne. Attached are a few things. The first is a summary prepared by Bob Hackamack. The second is the actual article from the Tuolumne Independent, and the third is the front page of the edition the article appeared in.

I hope these are helpful.

-Peter

Bob Hackamack's summary was as an attached document; the second and third items were inserted here in the text of the email. They have been removed and given their own pages, so that the scanned images could be rotated and enlarged for easier viewing.

–Rose Staples 09/18/2015

Peter Drekmeier
Policy Director
312 Sutter St., #402, San Francisco, CA 94108
peter@tuolumne.org | www.tuolumne.org
(415) 882-7252

Tuolumne River Trust

Editor: I have presented the texts I copied as close to the actual pages appearance in quotation marks as I can including Font, but not type size. Please take care how you change margins at sides, top and bottom. Bob H

A number of sources of historical data on salmon in the Tuolumne River are relevant to La Grange Dam licensing:

"THE TUOLUMNE INDEPENDENT SONORA, TUOLUMNE CAL. SEPT 15, 1883. NUMBER 24.
Published every Saturday Morning by DUCHOW BROTHERS."

Two years of this newspaper are at the Tuolumne County Museum Archive in Sonora CA. In the Sept 15 issue the INDEPENDENT wrote on the fifth page, top of the second column:

"We Want a Fish-Ladder.—Considerable complaint is manifested, from time to time, regarding the dam that retards the fish from ascending the Tuolumne at La Grange. This dam is thrown across the river from bank to bank, 40 feet high, and one hundred feet wide, and belongs to the La Grange Hydraulic Mining Company in operation near by. The worthless fish-ladder that was put in, some two years ago, washed out. It was impossible for salmon to go up—nothing but very small fish. The ladder was put in about 200 feet below the dam, and the little fish that ascended were compelled to go into a by-ditch before getting into the river above. We are informed that the water at the foot of the dam is now literally alive with salmon trying to ascend the river—and sometimes jumping twenty to thirty feet into the air in the vain endeavor to get over. This is the time of year for them to hunt the head waters of steams for spawning purposes, and after passing this dam there is no further obstruction offered. A man by name of Wheaton, who resides in San Francisco, owns the property, and the Fish Commissioner should see to it at once that a proper fish-ladder is put in the stream where the water *flows over* the dam, and no toy arrangement in a by-ditch as heretofore."

The second source of salmon information is from "Land, Water and Power A History of the Turlock Irrigation District 1887-1987" by Alan M. Paterson", published by Arthur H Clark Company, Spokane, WA, in 2004, now in its third printing. A copy of Mr. Paterson's book was purchased recently at the TID central offices. Pertinent salmon information begins at chapter and page:

"New Don Pedro 319"

"Before Wheaton dam blocked the Tuolumne, salmon spawned above La Grange, perhaps as far upstream as Wards Ferry. In the right conditions of water temperature, depth and velocity the salmon scooped out the gravel of the riverbed to make their nests, or redds, and deposited their eggs. The eggs hatched in late winter or early spring and the young salmon went down to the sea with the spring freshets. The effect of Wheaton's dam was described in 1877.

> Immense quantities of salmon have been prevented from reaching their breeding grounds further up the stream in consequence, and much indignation is expressed regarding the obstruction. The ranchers and others have been taking wagon loads of salmon from the river below the dam during several months past, killing the fish with clubs as they passed over the riffles. The Fishery Commissioners should compel the construction of a fish ladder to the dam, as the law requires.[15]

Although the salmon did spawn in the stretch of the river below La Grange, M. A. Wheaton was twice brought before the courts for failing to provide a fish ladder. The last time in 1889, his attorneys included C. C. Wright and P. J. Hazen, and the jury delivered a rapid verdict of not guilty.[16] Illegal salmon "fences" in the San Joaquin River erected by poachers impeded the annual migration in some years, but around the turn of the century, more determined enforcement of the fish and game laws reduced the practice and there were reports of thousands of salmon at La Grange Dam. Salmon were commonly caught with spears, and some people were said to be gathering great numbers of fish to be salted down.[17]

Until 1940 there seem to have been no estimates of how many salmon spawned in the gravel riffles above Waterford, and the number varied considerably from year to year. Salmon numbers between 1940 and 1960 ranged from a high of 130,000 fish in 1944 to a low of 3,000 in 1951, although after 1944 there were only four years of 45,000 fish or more, and none above 61,000.[18] The salmon run on the San Joaquin River itself was eliminated by the construction of Friant Dam in the mid-1940s, and runs in San Joaquin tributaries like the Tuolumne may have suffered as well.[19] As early as 1946, the California Department of Fish and Game (DFG), in commenting on a federal water development report recognized that more dams and additional diversions from valley rivers could endanger the salmon population. To save the salmon the department recommended that controlled minimum flows be required to provide enough water for migration and spawning. On the Tuolumne River the 1946 report recommended flows below La Grange Dam ranging from at least 750 second–feet during the spawning season, down to 100 second-feet in the late spring and summer.[20]"

"CHAPTER 13-FOOTNOTES"

"[15] *Modesto Herald,* Dec. 27, 1877

[16] *Modesto Daily* Evening News, June 6, 7, 1886, Oct 24, 28, 1889.

[17] *Stanislaus County Weekly News,* Dec. 18, 1903, Dec 2, 1904.

[18] Fall-Run Chinook Salmon Stocks in the Tuolumne River, 1940-," (ca. 1970), in Meikle files, vol. 1970, item 56.

[19] Author interview with Tim Ford, June 24, 1985.

[20] U.S. Dept of the Inter., *Central Valley Basin,* Sen. Doc. 113, 81st. Cong., 1st. Sess. (1949), p 413."

end

nne Independent.

SS FOR TUOLUMNE CO.

r. 16th—Columbia and Sono . Collection for orphans, in

T. Phillips, Rector.

Service in Columbia, next Sab nd at 7:30 p. m., in Sonora.
A. H. Cross.

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friends of T. J. Witt will n that in July last the State ion, at Sacramento, issued ploma. He has also had) per month as teacher. his month Mr. Witt was tice in the Supreme Court. s that he owes Tuolumne ese acknowledgments of r.

Public School opens a week nday, Sept. 24th. Same re, with the exception that Kenzie takes the place of

We Want a Fish Ladder.—Considerable complaint is manifested, from time to time, regarding the dam that retards the fish from ascending the Tuolumne at La Grange. This dam is thrown across the river from bank to bank, 40 feet high, and one hundred feet wide, and belongs to the La Grange Hydraulic Mining Company in operation near by. The worthless fish-ladder that was put in, some two years ago, washed out. It was impossible for salmon to go up—nothing but very small fish. The ladder was put in about 200 feet below the dam, and the little fish that ascended were compelled to go into a by-ditch before getting into the river above. We are informed that the water at the foot of the dam is now literally alive with salmon trying to ascend the river—and sometimes jumping twenty or thirty feet into the air in the vain endeavor to get over. This is the time of year for them to hunt the head waters of streams for spawning purposes, and after passing this dam there is no further obstruction offered. A man by the name of Wheaton, who resides in San Francisco, owns the property, and the Fish Commissioner should see to it at once that a proper fish ladder is put in the stream where the water *flows over* the dam, and no toy arrangement in a by-ditch as heretofore.

— Ah Kuen was arrested on the 12th inst. for keeping an opium den, at the Tigre, and on the 14th was fined $20 by Justice Cooper. At the time Marshal Keeffe kicked

Pops.

Dave Levy is about t "Old Tuolumne" quartz below Summit Pass, nor A small portion of the paid down. Our honest this will be the making of mine....M. B. Harriman surfeiting with delights of turned. The Judge gaine day....In the way of Sears has just finished pa on the school house. He tract for a number of fine San Francisco....Hattie gone a-herding sheep.... gossip at Bald Mountain got our measure. For his will state, that we do n against neighbors or oth those who do. When it to exist by such means, we establishment and lose th by the local papers, that Goods' firms have evider business, and wiped out B. Brescia, comes to the stock of fine Dry Goods, cheaper than that class before been sold in Sono that the public call and as to prices. Give him is opposite Divoll's mi the corner. Those out of shopping here, will save on Brescia....The bla

THE TUOLUMNE INDEPENDENT.

An Independent Newspaper, Devoted to Local Affairs, the Interests of Tuolumne County, and to Miscellaneous, Family Reading.

VOLUME XII. SONORA, TUOLUMNE COUNTY, CAL., SEPT. 15, 1883. NUMBER 24.

The Tuolumne Independent

What to Wear to the Photographer's

Tried Her Own Remedy

On Sep 18, 2015, at 9:08 AM, Devine, John wrote:

Thanks Peter. We'll upload these to the LG website too. And let folks know they are there.

John Devine, P.E.
D 207-775-4495 **M** 207-776-2206

hdrinc.com/follow-us

From: Peter Drekmeier [mailto:peter@tuolumne.org]
Sent: Thursday, September 17, 2015 8:00 PM
To: byrdnest@wildblue.net; Devine, John; John Holland
Subject: Historic Salmon Articles

Gentlemen,

Nice seeing you this morning.

I'm following up on the historic articles that reference salmon in the upper Tuolumne. Attached are a few things. The first is a summary prepared by Bob Hackamack. The second is the actual article from the Tuolumne Independent, and the third is the front page of the edition the article appeared in.

I hope these are helpful.

-Peter

<image001.jpg>

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<image003.png>

Peter Drekmeier
Policy Director
312 Sutter St., #402, San Francisco, CA 94108
peter@tuolumne.org | www.tuolumne.org
(415) 882-7252

From: Le, Bao
Sent: Wednesday, September 30, 2015 5:07 PM
To: John Wooster - NOAA Federal
Cc: Borovansky, Jenna; Deason, Jesse; Devine, John
Subject: La Grange Project - Follow Up Items
Attachments: tailrace.jpg; arisinwater2.jpg; 20822490184_2ed996a9c5_o.jpeg; 21445186535_38fea14624_o.jpeg

Follow Up Flag: Follow up
Flag Status: Completed

Hi John.

Good to see you at the last workshop. Sorry I did not have a chance to catch up with you during the break or after the meeting. I wanted to follow up/share a few items related to the project.

1. The counting weirs and the ARIS unit have been installed and both of these studies appear to be underway. I've attached a few pictures in case you're interested.
2. Per our previous discussions, it does not appear that NMFS' habitat study using the LiDAR will be available to review and report on in the ISR. This is fine but I just want to confirm this is the case so we can note it in our reporting.
3. Related to the LiDAR, I spoke with Mike Deas, our temperature modeler and he has said that he would welcome having the LiDAR prior to the actual habitat study when it is available. This would support his model development. Please let me know when this might be available to share with him.
4. Regarding temperature data being collected in the Upper Tuolumne River, there had been previous discussions regarding sharing final data. I'd like to follow up and identify when data might be available. We're also working on our last download in October and could have information to share after that time period.
5. Now that the Draft Tube Study is under way, the FERC approved study plan identifies the need to analyze footage for a 5-week period during the fall-run Chinook spawning period and five additional 3-day sampling periods after the fall Chinook season (i.e., January to April/May). We plan to use data from the Fish Passage Assessment (weir study) to identify these sampling periods but please let us know if you have any additional input here.

Let me know if you have any questions regarding the above or would like to discuss by phone.

Thanks,
Bao

Bao Le
Senior Fisheries Biologist

HDR
1001 SW 5th Avenue, Suite 1800
Portland, OR 97204-1134
D 971.202.1722 **M** 503.309.9423
bao.le@hdrinc.com

hdrinc.com/follow-us

Images attached to Bao Le's 9-30-2015 email to John Wooster

Images attached to Bao Le's 9-30-2015 email to John Wooster

From: Le, Bao
Sent: Thursday, October 01, 2015 2:53 PM
To: Vaughn, Gary D -FS; dfoote@fs.fed.us
Cc: Stanley, Robert N -FS; Borovansky, Jenna; Deason, Jesse; Vertucci, Charles
Subject: Fieldwork Notification - Water Temperature Monitoring Download/Maintenance - October 27-30

Hi Dusty and Debbie.

HDR staff are planning to download data and conduct maintenance on all temperature and stage recording equipment covered under our Special Use Permit for the Upper Tuolumne River Temperature Monitoring Program. Staff plan to conduct field activities on USFS lands from October 27-30, 2015 and will be travelling by vehicle and accessing deployment locations by foot. Staff will be working in the mainstem and South Fork Tuolumne rivers, the Clavey River, the upper North Fork Tuolumne River (non BLM locations), and the Cherry Creek watershed. I had two additional questions:

1. Vehicle/foot access to the Clavey River confluence is difficult and recreational boating flows are typically completed by this time of year. Is it possible to utilize helicopter to access this location? Our hope is that might be acceptable with the expected decrease in recreational use.

2. We're currently working with Jim Eicher for approval to access loggers on BLM lands at/around the NF Tuolumne River confluence. Similar to the Clavey River confluence, access by foot to the north side of the mainstem Tuolumne River at this location appears challenging. Currently, our most viable access alternative may be the Mohican Mine Trail however this puts us on the south side of the mainstem and would require wading or swimming across the river. This poses some safety concern at this time of year. This may work fine but if you or your staff were aware of any other access alternatives that might be worth considering, we'd appreciate it.

Please advise regarding the above. If you have any questions please let us know.

Thanks, Bao

Bao Le
Senior Fisheries Biologist

HDR
1001 SW 5th Avenue, Suite 1800
Portland, OR 97204-1134
D 971.202.1722 **M** 503.309.9423
bao.le@hdrinc.com

hdrinc.com/follow-us

From: John Wooster - NOAA Federal [mailto:john.wooster@noaa.gov]
Sent: Monday, October 05, 2015 3:21 PM
To: Le, Bao
Subject: Re: La Grange Project - Follow Up Items

Hi Bao:

1. Thanks for the pictures. Yes, I think using the weir to inform when to sample is appropriate to determine sample timing. However, deciding when is enough fish to trigger starting the 5 weeks could be challenging. How "real time" is your weir data going to be available?

2. Yes, I do not think the habitat study will be complete by the time of your ISR, mainly because a thermal suitability component will not be done.

3. The raw LiDAR should be available (although haven't confirmed this), more or less now, I just need to touch base with the Science Center on getting it from them.

4. I am heading out tomorrow to finish downloading my loggers. I've downloaded about half of mine, and should be finished by the end of the week. I'll need a little time to put the data into shape, but I should be ready to share/swap mid to late October. But let's try and make that happen sooner than later, as getting the data is important for models / analyses, etc...

5. see #1

-JW

On Wed, Sep 30, 2015 at 5:06 PM, Le, Bao <ChiBao.Le@hdrinc.com> wrote:

Hi John.

Good to see you at the last workshop. Sorry I did not have a chance to catch up with you during the break or after the meeting. I wanted to follow up/share a few items related to the project.

1. The counting weirs and the ARIS unit have been installed and both of these studies appear to be underway. I've attached a few pictures in case you're interested.

2. Per our previous discussions, it does not appear that NMFS' habitat study using the LiDAR will be available to review and report on in the ISR. This is fine but I just want to confirm this is the case so we can note it in our reporting.

3. Related to the LiDAR, I spoke with Mike Deas, our temperature modeler and he has said that he would welcome having the LiDAR prior to the actual habitat study when it is available. This would support his model development. Please let me know when this might be available to share with him.

4. Regarding temperature data being collected in the Upper Tuolumne River, there had been previous discussions regarding sharing final data. I'd like to follow up and identify when data might be available. We're also working on our last download in October and could have information to share after that time period.

5. Now that the Draft Tube Study is under way, the FERC approved study plan identifies the need to analyze footage for a 5-week period during the fall-run Chinook spawning period and five additional 3-day sampling periods after the fall Chinook season (i.e., January to April/May). We plan to use data from the Fish Passage Assessment (weir study) to identify these sampling periods but please let us know if you have any additional input here.

Let me know if you have any questions regarding the above or would like to discuss by phone.

Thanks,

Bao

Bao Le

Senior Fisheries Biologist

HDR

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bao.le@hdrinc.com

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--
John Wooster
Hydrologist
NOAA Fisheries West Coast Region
U.S. Department of Commerce
john.wooster@noaa.gov

NOAA FISHERIES West Coast Region

From: Steve E. Boyd
Sent: Thursday, October 01, 2015 4:12 PM
To: 'James Eicher (jeicher@blm.gov)'
Subject: Access Approval Request

Jim

Based on your work schedule that you shared with me earlier, I wanted to get these to you ASAP. I will drop them in the mail tomorrow.

Thanks for all your help.

Steve

WATER & POWER
Serving Central California since 1887

(209) 883.8300 • www.tid.com

333 East Canal Drive • P.O. Box 949 • Turlock, CA 95381-0949

Bureau of Land Management
James Eicher
Associate Field Manger
Mother Lode Field Office
5152 Hillsdale Circle
El Dorado Hills, CA 95762

October 1, 2015

Dear Mr. Eicher

Thank you for the call today. I appreciate your understanding of the need to retrieve the temperature data that is stored in the data loggers installed in the Tuolumne River, a portion of which is on BLM land. As you are aware, HDR is the lead consultant for TID and MID for the FERC relicensing of New Don Pedro and licensing of La Grange.

Please find their attached letter indicating the days, the location and proposed route to gain access to the loggers. Per our discussion a helicopter will not be used. We are requesting your approval to enter BLM lands in order to reach those data loggers.

The letters are being submitted via email in order to best meet your schedule and hard copies will follow in the mail.

Please call me if you have any questions.

Sincerely

Steve Boyd
Director of Water Resources and Regulatory Affairs
Turlock Irrigation District

October 1, 2015

Jim Eicher, Associate Field Manager
Bureau of Land Management – Mother Lode Field Office
5152 Hillsdale Circle
El Dorado Hills, CA 95762

Subject: La Grange Hydroelectric Project Temperature Study – summary of proposed North Fork Tuolumne River temperature monitoring equipment download and maintenance activities

Dear Jim,

In June 2015, HDR, on behalf of the Turlock and Modesto Irrigation Districts (collectively, the "Districts"), installed water temperature and stage monitoring equipment on Bureau of Land Management (BLM) land to support the development of a temperature model for the La Grange Hydroelectric Project Federal Energy Regulatory Commission Licensing process. Equipment was deployed at two locations; the mainstem Tuolumne River just upstream of the North Fork Tuolumne River confluence and the North Fork Tuolumne River at approximately river mile 0.1. In order to download data and service monitoring equipment prior to the winter, HDR plans to visit these two locations as part of an October 27-30, 2015 field effort. Access, download and maintenance activities at this location are expected to take one full day. These locations will be accessed by vehicle and foot. Access will likely be via the Mohican Mine Trail however additional research is required to confirm the safest and most feasible alternative. Helicopter will not be used to access the site. In 2016, additional download and maintenance visits to this location are planned. Monitoring activities are expected to be complete by November 2016.

Please feel free to contact me if you have any questions or concerns.

Sincerely,

Bao Le
HDR – *Senior Fisheries Biologist*
503-309-9423

From: Vaughn, Gary D -FS <gdvaughn@fs.fed.us>
Sent: Wednesday, October 07, 2015 6:22 PM
To: Le, Bao
Cc: Borovansky, Jenna; Deason, Jesse; Vertucci, Charles; Foote, Debra -FS; Junette, Jim -FS
Subject: RE: Fieldwork Notification - Water Temperature Monitoring Download/Maintenance - October 27-30
Attachments: 34_STF_TRANS11x17_2013_TUOLUMNE.pdf

Follow Up Flag: Follow up
Flag Status: Completed

Bao,

Thanks for informing us of the upcoming work. According to the Tuolumne Wild & Scenic River Management Plan, aircraft landings are prohibited within the congressional Wild & Scenic boundary except for emergencies only. This is not only due to its potential impacts to recreation users, but also a safety and impacts to wildlife concern. We have found that packable/inflatable floatation devices like inner tubes, stand-up paddle boards, or inflatable kayaks are light enough to carry in and out of the canyon and get across. For the North Fork location, once you have authorization from the BLM, you may be able to use the 1N02 road and trails 16E13 and 16E13B along the top of Paper Cabin Ridge (see R16E T1N Sec 20, 21, 29-25, and 32) to access the confluence. This route is closed to public motorized use so you would need to get a permit from the Mi-Wok District to utilize this road with a motor vehicle. I will check with our Special Use Permit Administrator on whether we can issue you motorized access to the road through and amendment to the permit our District has issued you. I do not know the condition of these routes but know that they were utilized during the 2013 Rim Fire as fuel breaks. The trail is not evident from the confluence.

Thanks,

Dusty Vaughn
Public Service Program Leader
Forest Service
Stanislaus National Forest, Groveland Ranger District
p: 209-962-7825 x525
f: 209-962-7412
gdvaughn@fs.fed.us
24545 State Highway 120
Groveland, CA 95321
www.fs.fed.us

Caring for the land and serving people

From: Le, Bao [mailto:ChiBao.Le@hdrinc.com]
Sent: Thursday, October 01, 2015 2:53 PM
To: Vaughn, Gary D -FS; Foote, Debra -FS
Cc: Stanley, Robert N -FS; Borovansky, Jenna; Deason, Jesse; Vertucci, Charles
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Thanks, Bao

Bao Le
Senior Fisheries Biologist

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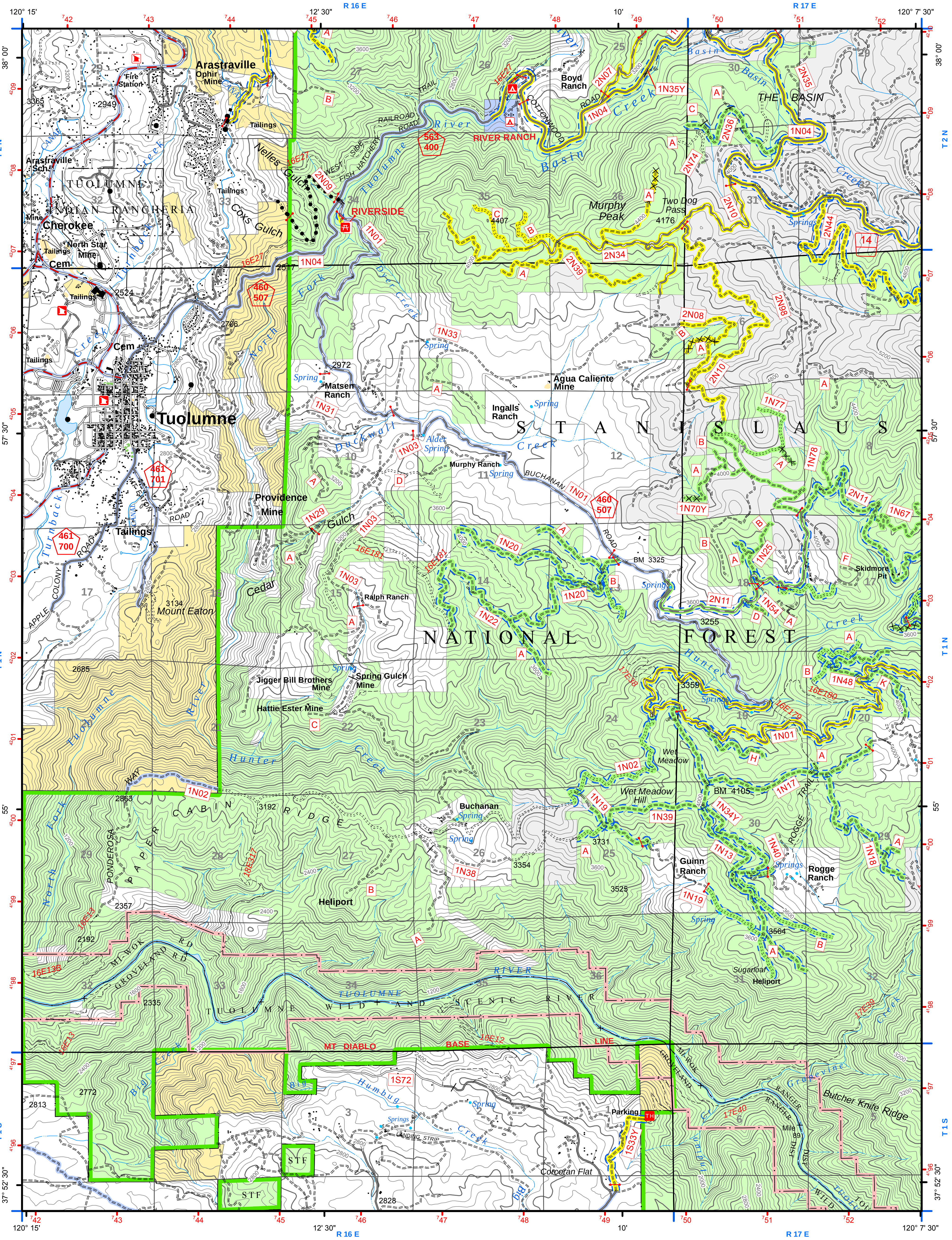
STANISLAUS NATIONAL FOREST TRANSPORTATION SYSTEM - 2013



LEGEND

ROADS AND TRAILS
- HIGHWAY, PRIMARY
- HIGHWAY, SECONDARY
- ROAD, SURFACE UNKNOWN
- ROAD, PAVED
- ROAD, GRAVEL
- ROAD, DIRT, IMPROVED
- ROAD, DIRT, UNIMPROVED
- TRAIL

Note: Former Road Numbers Shown in Grey on map for roads that have been converted to trails.

VEHICLE DESIGNATIONS
- ALL TYPES ALLOWED
- HIGHWAY LEGAL ONLY
- 4WD & HIGHWAY LEGAL
- ATV & MOTORCYCLE
- MOTORCYCLE
- OTHER PUBLIC ROAD
- CLOSED PENDING MITIGATION
- ADMIN USE ONLY
- NOT DRIVEABLE (2012)
- OPEN YEARROUND**

** All other routes open April 15 - Dec. 15

Ownership
- PRIVATE
- PRIVATE - SPI
- STANISLAUS NF
- OTHER NATIONAL FOREST
- NATIONAL PARK; NATL MONU.
- BUREAU OF RECLAMATION
- ARMY CORP OF ENGINEERS
- BLM
- STATE
- LOCAL GOVERNMENT
- FISH AND WILDLIFE SERVICE
- MILITARY

0 0.25 0.5 1 Miles

Contour Interval = 80 feet

UTM COORDINATES - ZONE 10, NAD 83

LAT-LONG COORDINATES - NAD 83

TUOLUMNE

11/12/2013

United States Department of the Interior

BUREAU OF LAND MANAGEMENT
Mother Lode Field Office
5152 Hillsdale Circle
El Dorado Hills, CA 95762
www.blm.gov/ca/motherlode

Mr. Steven Boyd
Turlock Irrigation District
333 East Canal Drive
Turlock, CA 95380

FERC No. 14581
CA018.14

Re: Letter of Authorization To the "Districts" To collect water temperature logger data on BLM land and waters within the Wild and Scenic Tuolumne and North Fork Tuolumne Rivers

Dear Mr. Boyd:

A request has been made by your authorized agent John Devine from HDR Inc., Senior Vice President Hydropower Services to seek authorization from BLM Mother Lode Field Office to collect water temperature data from water temperature loggers which were installed on BLM land and waters within the Wild and Scenic Tuolumne and North Fork Tuolumne Rivers this past year. BLM is currently reviewing the unauthorized installation of the temperature loggers placed by HDR on behalf of Turlock and Modesto Irrigation Districts. BLM will be responding to the unauthorized installation of these loggers shortly but in the meantime BLM will allow the Districts through HDR to enter BLM land to download the temperature data from the loggers that were installed.

This Letter of Authorization allows the Districts and your agent HDR to cross BLM land in order to download and collect water temperature data. At no time will the Districts or your agents HDR be allowed to enter BLM land that is within the Wild and Scenic River boundary by motorized vehicles of any kind, or by helicopters. Using Mohican Mine road and trail is allowed as long as the vehicles are outside of the Wild and Scenic boundary. Once inside the Wild and Scenic boundary access must be by non-motorized methods. This authorization is good for one time in order to retrieve the stored water temperature data. BLM will follow up with a trespass and permit for any further data collection purposes.

Please inform Jim Eicher when you are going to utilize the BLM lands to retrieve the water temperature data. If you have any questions concerning this Letter of Authorization please contact Jim Eicher Associate Field Manager at 916-941-3103.

Sincerely,

William S. Haigh
Field Manager

From: Le, Bao
Sent: Thursday, October 08, 2015 9:53 PM
To: John Wooster - NOAA Federal
Cc: Borovansky, Jenna; Deason, Jesse
Subject: RE: La Grange Project - Follow Up Items

Follow Up Flag: Follow up
Flag Status: Completed

Hi John.

See below in red.

Thanks, Bao
From: John Wooster - NOAA Federal [mailto:john.wooster@noaa.gov]
Sent: Monday, October 05, 2015 3:21 PM
To: Le, Bao
Subject: Re: La Grange Project - Follow Up Items

Hi Bao:

1. Thanks for the pictures. Yes, I think using the weir to inform when to sample is appropriate to determine sample timing. However, deciding when is enough fish to trigger starting the 5 weeks could be challenging. How "real time" is your weir data going to be available? The weir video footage will likely be reviewed on a weekly basis however, note that we're actually sampling footage with the ARIS over the entire study period but per the study plan are only required to evaluate a 5-week period for adult fall Chinook. As such, we can review the weir footage after the run is done and then choose the 5-week period retroactively as we'll have the footage available.

2. Yes, I do not think the habitat study will be complete by the time of your ISR, mainly because a thermal suitability component will not be done. Thanks for the update. We'll note this in the ISR.

3. The raw LiDAR should be available (although haven't confirmed this), more or less now, I just need to touch base with the Science Center on getting it from them. That'd be great. Please let me know when that might be available to share with Mike Deas for development of his temperature model.

4. I am heading out tomorrow to finish downloading my loggers. I've downloaded about half of mine, and should be finished by the end of the week. I'll need a little time to put the data into shape, but I should be ready to share/swap mid to late October. But let's try and make that happen sooner than later, as getting the data is important for models / analyses, etc...Chuck Vertucci, our field lead, is planning his downloads and maintenance at the end of October. I'll check in with him regarding his planned QC process and when it might be available to share.

5. see #1

-JW

On Wed, Sep 30, 2015 at 5:06 PM, Le, Bao <ChiBao.Le@hdrinc.com> wrote:

Hi John.

Good to see you at the last workshop. Sorry I did not have a chance to catch up with you during the break or after the meeting. I wanted to follow up/share a few items related to the project.

1. The counting weirs and the ARIS unit have been installed and both of these studies appear to be underway. I've attached a few pictures in case you're interested.

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Let me know if you have any questions regarding the above or would like to discuss by phone.

Thanks,

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Bao Le

Senior Fisheries Biologist

HDR

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--
John Wooster
Hydrologist
NOAA Fisheries West Coast Region
U.S. Department of Commerce
john.wooster@noaa.gov

NOAA FISHERIES West Coast Region

From:	Le, Bao
Sent:	Thursday, October 08, 2015 9:46 PM
To:	Vaughn, Gary D -FS
Cc:	Borovansky, Jenna; Deason, Jesse; Vertucci, Charles; Foote, Debra -FS; Junette, Jim -FS
Subject:	RE: Fieldwork Notification - Water Temperature Monitoring Download/Maintenance - October 27-30
Follow Up Flag:	Follow up
Flag Status:	Completed

Thanks for the feedback, Dusty.

I've passed this information along to Chuck Vertucci, our field lead. He noted that he had previously done some research on the suggested route without any luck. Regardless, if we access by vehicle/foot, it's looking like a long day each into the Clavey and NF Tuolumne River confluence locations. One alternative we thought of was floating to these two locations. We reached out to Marty (Sierra Mac) to investigate this possibility and he had said that although they are done with commercial trips for the season, they would be willing to do a one day trip (provided flows are adequate). It would be 2 people and a guide utilizing a small raft that would allow for navigation at lower flows. It would be a long day but he estimated that we would have 3hrs of stop time to do our work at the NF and Clavey confluence locations. I wanted to follow up with you to ask about whether this approach would require a permit or additional USFS approvals?

Please advise.

Bao

From: Vaughn, Gary D -FS [mailto:gdvaughn@fs.fed.us]
Sent: Wednesday, October 07, 2015 6:22 PM
To: Le, Bao
Cc: Borovansky, Jenna; Deason, Jesse; Vertucci, Charles; Foote, Debra -FS; Junette, Jim -FS
Subject: RE: Fieldwork Notification - Water Temperature Monitoring Download/Maintenance - October 27-30

Bao,

Thanks for informing us of the upcoming work. According to the Tuolumne Wild & Scenic River Management Plan, aircraft landings are prohibited within the congressional Wild & Scenic boundary except for emergencies only. This is not only due to its potential impacts to recreation users, but also a safety and impacts to wildlife concern. We have found that packable/inflatable floatation devices like inner tubes, stand-up paddle boards, or inflatable kayaks are light enough to carry in and out of the canyon and get across. For the North Fork location, once you have authorization from the BLM, you may be able to use the 1N02 road and trails 16E13 and 16E13B along the top of Paper Cabin Ridge (see R16E T1N Sec 20, 21, 29-25, and 32) to access the confluence. This route is closed to public motorized use so you would need to get a permit from the Mi-Wok District to utilize this road with a motor vehicle. I will check with our Special Use Permit Administrator on whether we can issue you motorized access to the road through and amendment to the permit our District has issued you. I do not know the condition of these routes but know that they were utilized during the 2013 Rim Fire as fuel breaks. The trail is not evident from the confluence.

Thanks,

Dusty Vaughn
Public Service Program Leader
Forest Service
Stanislaus National Forest, Groveland Ranger District
p: 209-962-7825 x525

f: 209-962-7412
gdvaughn@fs.fed.us
24545 State Highway 120
Groveland, CA 95321
www.fs.fed.us

Caring for the land and serving people

From: Le, Bao [mailto:ChiBao.Le@hdrinc.com]
Sent: Thursday, October 01, 2015 2:53 PM
To: Vaughn, Gary D -FS; Foote, Debra -FS
Cc: Stanley, Robert N -FS; Borovansky, Jenna; Deason, Jesse; Vertucci, Charles
Subject: Fieldwork Notification - Water Temperature Monitoring Download/Maintenance - October 27-30

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Please advise regarding the above. If you have any questions please let us know.

Thanks, Bao

Bao Le
Senior Fisheries Biologist

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D 971.202.1722 **M** 503.309.9423
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From: Vaughn, Gary D -FS <gdvaughn@fs.fed.us>
Sent: Friday, October 09, 2015 2:30 PM
To: Le, Bao
Cc: Borovansky, Jenna; Deason, Jesse; Vertucci, Charles; Foote, Debra -FS
Subject: RE: Fieldwork Notification - Water Temperature Monitoring Download/Maintenance - October 27-30

Affirmative – you can conduct the proposed float and activities.

Thanks!

Dusty Vaughn
Public Service Program Leader
Forest Service
Stanislaus National Forest, Groveland Ranger District
p: 209-962-7825 x525
f: 209-962-7412
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Groveland, CA 95321
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Caring for the land and serving people

From: Le, Bao [mailto:ChiBao.Le@hdrinc.com]
Sent: Friday, October 09, 2015 1:16 PM
To: Vaughn, Gary D -FS
Cc: Borovansky, Jenna; Deason, Jesse; Vertucci, Charles
Subject: RE: Fieldwork Notification - Water Temperature Monitoring Download/Maintenance - October 27-30

Hi Dusty.

Thanks for taking time to chat with me about our proposed float on October 20 or 21 to download temperature/stage recorders at the Clavey River confluence. Per our discussion, our existing USFS special use permit will allow us to conduct the float and this activity and nothing more is required. If you could, please confirm that this is correct.

Thanks again for your assistance.

Bao

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Sent: Wednesday, October 07, 2015 6:22 PM
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Cc: Borovansky, Jenna; Deason, Jesse; Vertucci, Charles; Foote, Debra -FS; Junette, Jim -FS
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1. Vehicle/foot access to the Clavey River confluence is difficult and recreational boating flows are typically completed by this time of year. Is it possible to utilize helicopter to access this location? Our hope is that might be acceptable with the expected decrease in recreational use.

2. We're currently working with Jim Eicher for approval to access loggers on BLM lands at/around the NF Tuolumne River confluence. Similar to the Clavey River confluence, access by foot to the north side of the mainstem Tuolumne River at this location appears challenging. Currently, our most viable access alternative may be the Mohican Mine Trail however this puts us on the south side of the mainstem and would require wading or swimming across the river. This poses some safety concern at this time of year. This may work fine but if you or your staff were aware of any other access alternatives that might be worth considering, we'd appreciate it.

Please advise regarding the above. If you have any questions please let us know.

Thanks, Bao

Bao Le
Senior Fisheries Biologist
HDR
1001 SW 5th Avenue, Suite 1800
Portland, OR 97204-1134
D 971.202.1722 **M** 503.309.9423
bao.le@hdrinc.com

hdrinc.com/follow-us

From: Staples, Rose
Sent: Monday, October 19, 2015 1:16 PM
To: Armstrong, George ; Ayala, Mike; DeLano, Lee; Dias, Ray; Engstrom, Tom; Grasso, Rob; Jamar, Alicia; Ketscher, Bill; McBride, Toby; Stine, Phil; Alves, Jim; Amerine, Bill; Asay, Lynette; Barnes, James; Barnes, Peter; Barrera, Linda; Bartoo, Andrea; Beeco, Adam; Blake, Martin; Bond, Jack; Borovansky, Jenna; Boucher, Allison; Bowes, Stephen; Bowman, Art; Brenneman, Beth; Buckley, John; Buckley, Mark; Burke, Steve; Burt, Charles; Byrd, Larry 1; Byrd, Larry 2; Byrd, Tim; Cadagan, Jerry; Carlin, Michael; Carr, Adrianne; Cartisano, Angela; Charles, Cindy; Cooke, Michael; Cowan, Jeffrey; Cox, Stanley Rob; Cranston, Peggy; Cremeen, Rebecca; Damin Nicole; Day, Kevin; Deason, Jesse; Denean; Derwin, Maryann Moise; Devine, John; Drake, Emerson; Drekmeier, Peter; Edmondson, Steve; Eicher, James; Fargo, James; Ferranti, Annee; Ferrari, Chandra; Fleming, Mike; Fuller, Reba; Ganteinbein, Julie; Gard, Mark; Gorman, Elaine; Grader, Zeke; Groves, Catherine J; Gutierrez, Monica; Hackamack, Robert; Hastreiter, James; Hatch, Jenny; Hayden, Ann; Hellam, Anita; Heyne, Tim; Holley, Thomas; Holm, Lisa; Horn, Jeff; Horn, Timi; Hudelson, Bill; Hughes, Noah; Hughes, Robert; Hume, Noah; Hurley, Michael; Jackson, Zac; Jennings, William; Johnson, Brian; Johnston, William ; Jones, Christy; Jsansley; Keating, Janice; Kempton, Kathryn; Kiley, Keith; Kinney, Teresa; Koepele, Patrick; Le, Bao; Levin, Ellen; Linkard, David; Loy, Carin; Lwenya, Roselynn; Lyons, Bill; Madden, Dan; Marko, Paul; Martin, Michael; Mathiesen, Lloyd; McDaniel, Dan; McDonnell, Marty; Mein Janis; Metcalf, Nathan; Mills John; Morningstar Pope, Rhonda; Moses, Matt; Murphey, Gretchen; Murray, Shana; O'Brien, Jennifer; Orvis, Tom; Ott, Bob; Ott, Chris; Pool, Richard; Puccini, Stephen; Ramirez, Tim; Rea, Maria; Reed, Rhonda; Reynolds, Garner; Richardson, Daniel; Richardson, Kevin; Riggs T; Romano, David O; Roos-Collins, Richard; Rosekrans, Spreck; Roseman, Jesse; Rothert, Steve; Sandkulla, Nicole; Saunders, Jenan; Schutte, Allison; Sears, William; Shakal, Sarah; Shelton, John; Shipley, Robert; Shutes, Chris; Sill, Todd; Simsiman, Theresa; Slay, Ron; Smith, Jim; Staples, Rose; Stapley, Garth; Steindorf, Dave; Steiner, Dan; Stone, Vicki; Stork, Ron; Taylor, Mary Jane; Terpstra, Thomas; TeVelde, George; Thompson, Larry; Tmberliner; Ulibarri, Nicola; Verkuil, Colette; Vierra, Chris; Villalobos, Amber; Wantuck, Richard; Ward, Walt; Welch, Steve; Wenger, Jack; Wesselman, Eric; Wetzel, Jeff; Wheeler, Dan; Wheeler, Dave; Wheeler, Douglas; Wilcox, Scott; Williamson, Harry; Willy, Allison; Wilson, Bryan; Winchell, Frank; Wooster, John; Yoshiyama, Ron; Zipser, Wayne; Armstrong, George ; Brennan, Sherri - TC Board of Supervisors; Ferguson, Bob - Zephyr Whitewater; Grasso, Rob; Gray, John L - TC Board of Supervisors; Hanvelt, Randall - TC Board of Supervisors; Neubacher, Don; Rodefer, Karl - TC Board of Supervisors; Royce, Evan - TC Board of Supervisors; Russell, Carol (carussell@tid.org); Sierra Pacific Forest Products; Stearn, Ron - Mayor of Sonora; Tuolumne Chamber of Commerce; Vaughn, Dusty; White Water Voyages
Subject: La Grange Workshop No. 3 to be held Nov 19 in Modesto

Follow Up Flag: Follow up
Flag Status: Completed

Please save the date of Thursday, **November 19, 2015** for the La Grange Fish Passage Facilities Assessment Workshop No. 3, to be held at the MID Offices in Modesto. The Workshop will start at 10 am and will wrap up by noon. More details to follow closer to the date.

Rose Staples, CAP-OM, MOS
Executive Assistant

HDR
970 Baxter Boulevard Suite 301
Portland ME 04103
D 207-239-3857
rose.staples@hdrinc.com

hdrinc.com/follow-us

From: Staples, Rose
Sent: Monday, October 26, 2015 1:24 PM
Cc: Staples, Rose
Subject: Time Extension for La Grange Workshop No 2 Comments on Tech Memo 1 and Proposed Reintroduction Decision Framework

At the La Grange Fish Passage Facilities Assessment Workshop No. 2 held on September 17, 2015, licensing participants agreed to provide comments/input on the following items by Friday, October 23:

- Technical Memorandum No. 1 and identified information gaps
- Proposed reintroduction decision framework

No comments or input has yet been received. The Districts request that licensing participants submit any comments on the above to Rose.Staples@hdrinc.com by this Friday, October 30, 2015. The items listed above may be found here on the La Grange Project Licensing Website.

Thank you!

Rose Staples, CAP-OM, MOS
Executive Assistant

HDR
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D 207-239-3857
rose.staples@hdrinc.com

hdrinc.com/follow-us

From: Staples, Rose
Sent: Tuesday, October 27, 2015 6:44 AM
Cc: Staples, Rose
Subject: La Grange Licensing Newsletter - Issue No. 1

The Districts' first *La Grange Licensing Newsletter* (Issue No 1) has been uploaded to the www.lagrange-licensing.com website under the DOCUMENTS tab. If you have any difficulty locating and/or accessing the document, please let me know at Rose.Staples@hdrinc.com. Thank you.

Rose Staples, CAP-OM, MOS
Executive Assistant

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rose.staples@hdrinc.com

hdrinc.com/follow-us

From: Staples, Rose
Sent: Wednesday, October 28, 2015 11:58 AM
Cc: Staples, Rose
Subject: La Grange Fish Passage Workshop No 2 Meeting Notes - Presentations - Handouts on Website

Follow Up Flag: Follow up
Flag Status: Completed

The Districts have uploaded to the La Grange licensing website (www.lagrange-licensing.com), in the DOCUMENTS section, the meeting notes and materials from the September 17, 2015 La Grange Fish Passage Facilities Assessment Workshop No. 2.

If you have any difficulties locating / accessing this document, please let me know at Rose.Staples@hdrinc.com. Thank you.

Rose Staples, CAP-OM, MOS
Executive Assistant

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From: "Murphey, Gretchen@Wildlife" <Gretchen.Murphey@wildlife.ca.gov>
Date: November 3, 2015 at 7:04:37 AM PST
To: "guignard, jason@fishbio.com" <jasonguignard@fishbio.com>
Cc: "Tsao, Steve@Wildlife" <Steve.Tsao@wildlife.ca.gov>
Subject: Re: La Grange weir operations

You will need to contact permits for a solution to your bass problem.

Gretchen Murphey
Environmental Scientist
Cell (209) 617-1093
Office (209) 853-2533 ex 3#
Sent from my iPhone

On Nov 2, 2015, at 3:22 PM, Jason Guignard <jasonguignard@fishbio.com> wrote:

> Hi Gretchen,
>
> I just left you a voicemail at the office, but wanted to follow up with an email as I imagine you are out in the field these days.
>
> After consulting with the Districts, we would like to request written authorization to address the potential predation risk associated with striped bass observed at the La Grange Weir site. Our SCP amendment for the lower Tuolumne weir includes a condition that would allow for removal/relocation if the Department considers the weir to be stacking predatory fish. Our La Grange weir permit does not include this condition, likely because striped bass were not expected to be encountered at this upstream location.
>
> While the La Grange weir does not appear to be stacking predatory fish, we do have concerns regarding predation risk associated with striped bass near the sampling site at present and in the future. Based on some preliminary video review, we have identified 1 or 2 striped bass passing upstream and downstream of the weir on an almost daily basis. On some nights, we have also recorded attempted predation events on juvenile fish within the fish passage chute by these striped bass.
>
> Please advise on how we should move forward with obtaining authorization to modify our La Grange weir permit to include this removal/relocation condition from our lower Tuolumne weir permit so we may address this potential predation risk.
>
> Thanks,
> Jason
>
> Jason Guignard
> Fisheries Biologist
>
> ***FISHBIO***
> jasonguignard@fishbio.com
> O: (209) 847-6300
> C: (209) 840-9019
> www.fishbio.com

From: Staples, Rose
Sent: Thursday, November 05, 2015 2:02 PM
Cc: Staples, Rose
Subject: La Grange Workshop No 3 AGENDA
Attachments: LaGrange_Nov19 WorkshopNo3_Agenda.pdf

La Grange Licensing Participants,

Please find attached the Agenda for Workshop No. 3 to be held on Thursday, November 19, 2015 from 10:00 am to 12:00 pm at Modesto Irrigation District. The primary purpose of Workshop No. 3 is to come to agreement on adopting the fish reintroduction/fish passage decision framework discussed at Workshop No. 2. The goal of the reintroduction decision framework is to ensure that all relevant issues related to fish passage and fish reintroduction on the Tuolumne River are identified and examined within a collaborative process.

Materials presented at Workshop No. 2 and Meeting Notes from the workshop are available here on the La Grange Project Licensing website (www.lagrange-licensing.com). Please contact me at Rose.Staples@hdrinc.com if you have difficulty accessing this file.

Thank you.

Rose Staples, CAP-OM, MOS
Executive Assistant

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MID Modesto Irrigation District
The Power to Grow

La Grange Hydroelectric Project
Fish Passage Assessment Study
Workshop No. 3

Thursday, November 19, 10:00 am to 12:00 pm
MID Office, 1231 11th Street, Modesto, California
Conference Line: 1-866-583-7984, Passcode: 814-0607
Join Lync Meeting https://meet.hdrinc.com/jesse.deason/8DZ4VNVN

Workshop Objectives:

1. Discuss and amend the Conceptual Tuolumne River Reintroduction/Fish Passage Evaluation Framework (Reintroduction Decision Framework or Framework) including participant comments and potential implementation concepts.
2. Gain consensus on pursuit of Reintroduction Decision Framework.
3. Discuss potential Framework implementation methods, schedule and opportunities for collaboration.

TIME	TOPIC
10:00 am – 10:10 am	Introduction of Participants (All)
10:10 am – 10:30 am	Opening Statements (All) Summary review of Tuolumne River Anadromous Fish Passage Facilities Assessment Collaborative (Districts) Review agenda, workshop objectives, and action items from previous meeting (Districts)
10:30 am – 11:30 am	Conceptual Tuolumne River Reintroduction Decision Framework (All) a. Summary review of the Reintroduction Decision Framework b. Participant comments on Framework, preferences and potential process implementation concepts c. Decision regarding Reintroduction Decision Framework implementation
11:30 am – 12:00 pm	Next Steps (All) a. Schedule: Further opportunities for collaboration and incorporation of feedback b. Action Items

From: Staples, Rose
Sent: Wednesday, November 18, 2015 1:07 PM
To: John Buckley
Subject: RE: question for Rose about La Grange Workshop No 3 AGENDA

Thank you for asking. Thursday's workshop is indeed a PUBLIC meeting; and all are welcome to attend. As other licensing participants may get the same inquiries, I may send out a general announcement later today. Thank you.

Rose Staples, CAP-OM, MOS
D 207-239-3857

hdrinc.com/follow-us

From: John Buckley [mailto:johnb@cserc.org]
Sent: Tuesday, November 17, 2015 6:14 PM
To: Staples, Rose
Subject: Re: question for Rose about La Grange Workshop No 3 AGENDA

From John Buckley
CSERC

Hi, Rose:

A reporter from a Tuolumne County newspaper contacted me to ask whether or not there was an upcoming PUBLIC meeting concerning fish reintroduction/fish passage for the Tuolumne River.

Obviously I am planning to attend the meeting on Thursday and know that is the topic. But I am not clear in terms of the relicensing process agreements as to whether this Thursday's meeting is fully open to the interested public (including a newspaper reporter) or whether this is instead intended to be part of the ongoing settlement negotiations informational meetings that are NOT open to the public.

My understanding is that Thursday's 10 a.m. -12 p.m. meeting is indeed open to the public and thus to the reporter. Is that accurate?

If so I will have him contact you to ensure that you know he is planning to attend.

John Buckley
CSERC

On Nov 5, 2015, at 2:01 PM, Staples, Rose <Rose.Staples@hdrinc.com> wrote:

La Grange Licensing Participants,

Please find attached the Agenda for Workshop No. 3 to be held on Thursday, November 19, 2015 from 10:00 am to 12:00 pm at Modesto Irrigation District. The primary purpose of Workshop No. 3 is to come to agreement on adopting the fish reintroduction/fish passage decision framework discussed at Workshop No. 2. The goal of the reintroduction decision framework is to ensure that all relevant issues related to fish passage and fish reintroduction on the Tuolumne River are identified and examined within a collaborative process.

Materials presented at Workshop No. 2 and Meeting Notes from the workshop are available here on the La Grange Project Licensing website (www.lagrange-licensing.com). Please contact me at Rose.Staples@hdrinc.com if you have difficulty accessing this file.

Thank you.

Rose Staples, CAP-OM, MOS
Executive Assistant

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970 Baxter Boulevard Suite 301
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rose.staples@hdrinc.com

hdrinc.com/follow-us

<LaGrange_Nov19 WorkshopNo3_Agenda.pdf>

From: Staples, Rose
Sent: Wednesday, November 18, 2015 5:23 PM
Cc: Staples, Rose
Subject: La Grange Workshop No 3 Handouts On Licensing Website

La Grange Licensing Participants,

The handouts to be used during the November 19, 2015 La Grange Fish Passage Facilities Assessment Workshop No. 3 are now available for viewing on the La Grange licensing website: www.lagrange-licensing.com. I have combined all the handouts into one file, which is attached to the November 19 Workshop announcement on the CALENDAR tab--and it is also the first document in the listing under the DOCUMENTS tab.

If you have any difficulty locating and/or accessing the handouts, please contact me at Rose.Staples@hdrinc.com.

Thank you.

Rose Staples, CAP-OM, MOS
Executive Assistant

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hdrinc.com/follow-us

From: Staples, Rose
Sent: Wednesday, November 18, 2015 11:36 AM
To: Armstrong, George ; Ayala, Mike; DeLano, Lee; Dias, Ray; Engstrom, Tom; Grasso, Rob; Jamar, Alicia; Ketscher, Bill; McBride, Toby; Stine, Phil; Zanker, Allen; Bahls, Amanda; Bragg, Carolyn; Brennan, Sherri - TC Board of Supervisors; Ferguson, Bob - Zephyr Whitewater; Gray, John - TC Board of Supervisors; Hanvelt, Randall - TC Board of Supervisors; Neubacher, Don; O'Connor, David; Rodefer, Karl - TC Board of Supervisors; Royce, Evan - TC Board of Supervisors; Russell, Carol (carussell@tid.org); Sierra Pacific Forest Products; Stearn, Ron - Mayor of Sonora; Tuolumne Chamber of Commerce; Vaughn, Dusty; White Water Voyages; Alves, Jim; Amerine, Bill; Asay, Lynette; Barnes, Peter; Barrera, Linda; Beeco, Adam; Blake, Martin; Bond, Jack; Borovansky, Jenna; Boucher, Allison; Bowes, Stephen; Bowman, Art; Brenneman, Beth; Buckley, John; Buckley, Mark; Burke, Steve; Burt, Charles; Byrd, Larry 1; Byrd, Larry 2; Byrd, Tim; Cadagan, Jerry; Carlin, Michael; Carr, Adrianne; Cartisano, Angela; Charles, Cindy; Cooke, Michael; Cowan, Jeffrey; Cox, Stanley Rob; Cranston, Peggy; Cremeen, Rebecca; Damin Nicole; Day, Kevin; Deason, Jesse; Denean; Derwin, Maryann Moise; Devine, John; Drake, Emerson; Drekmeier, Peter; Edmondson, Steve; Eicher, James; Fargo, James; Ferranti, Annee; Ferrari, Chandra; Fleming, Mike; Fuller, Reba; Ganteinbein, Julie; Gard, Mark; Gorman, Elaine; Grader, Zeke; Groves, Catherine J; Gutierrez, Monica; Hackamack, Robert; Hastreiter, James; Hatch, Jenny; Hayden, Ann; Hellam, Anita; Heyne, Tim; Holley, Thomas; Holm, Lisa; Horn, Jeff; Horn, Timi; Hudelson, Bill; Hughes, Noah; Hughes, Robert; Hume, Noah; Hurley, Michael; Jackson, Zac; Jennings, William; Johnson, Brian; Johnston, William ; Jones, Christy; Jsansley; Keating, Janice; Kempton, Kathryn; Kiley, Keith; Kinney, Teresa; Koepele, Patrick; Le, Bao; Leigh Bartoo (aondrea_bartoo@fws.gov); Levin, Ellen; Linkard, David; Loy, Carin; Lwenya, Roselynn; Lyons, Bill; Madden, Dan; Marko, Paul; Martin, Michael; Mathiesen, Lloyd; McDaniel, Dan; McDonnell, Marty; Mein Janis; Metcalf, Nathan; Mills John; Morningstar Pope, Rhonda; Moses, Matt; Murphey, Gretchen; Murray, Shana; O'Brien, Jennifer; Orvis, Tom; Ott, Bob; Ott, Chris; Pool, Richard; Puccini, Stephen; Ramirez, Tim; Rea, Maria; Reed, Rhonda; Reynolds, Garner; Richardson, Daniel; Richardson, Kevin; Riggs T; Romano, David O; Roos-Collins, Richard; Rosekrans, Spreck; Roseman, Jesse; Rothert, Steve; Sandkulla, Nicole; Saunders, Jenan; Schutte, Allison; Sears, William; Shakal, Sarah; Shelton, John; Shipley, Robert; Shutes, Chris; Sill, Todd; Simsiman, Theresa; Slay, Ron; Smith, Jim; Staples, Rose; Stapley, Garth; Steindorf, Dave; Steiner, Dan; Stone, Vicki; Stork, Ron; Taylor, Mary Jane; Terpstra, Thomas; TeVelde, George; Thompson, Larry; Tmberliner; Ulibarri, Nicola; Verkuil, Colette; Vierra, Chris; Wantuck, Richard; Ward, Walt; Welch, Steve; Wenger, Jack; Wesselman, Eric; Wetzel, Jeff; Wheeler, Dan; Wheeler, Dave; Wilcox, Scott; Williamson, Harry; Willy, Allison; Wilson, Bryan; Winchell, Frank; Wooster, John; Yoshiyama, Ron; Zipser, Wayne
Subject: La Grange Workshop No 3 Being Held on Thursday November 19
Attachments: LaGrange_Nov19 WorkshopNo3_Agenda.pdf

Follow Up Flag: Follow up
Flag Status: Flagged

La Grange Licensing Participants,

The question has been asked of me if tomorrow's La Grange Workshop No. 3 is open to the public. In case you receive similar queries, please be assured that the workshop is indeed open to the public and all are welcome to attend and participate.

Details on the workshop are in the agenda attached.

Thank you.

Rose Staples, CAP-OM, MOS
Executive Assistant

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970 Baxter Boulevard Suite 301
Portland ME 04103
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rose.staples@hdrinc.com

hdrinc.com/follow-us

La Grange Hydroelectric Project
Fish Passage Assessment Study
Workshop No. 3

Thursday, November 19, 10:00 am to 12:00 pm
MID Office, 1231 11th Street, Modesto, California
Conference Line: 1-866-583-7984, Passcode: 814-0607
Join Lync Meeting https://meet.hdrinc.com/jesse.deason/8DZ4VNVN

Workshop Objectives:

1. Discuss and amend the Conceptual Tuolumne River Reintroduction/Fish Passage Evaluation Framework (Reintroduction Decision Framework or Framework) including participant comments and potential implementation concepts.
2. Gain consensus on pursuit of Reintroduction Decision Framework.
3. Discuss potential Framework implementation methods, schedule and opportunities for collaboration.

TIME	TOPIC
10:00 am – 10:10 am	Introduction of Participants (All)
10:10 am – 10:30 am	Opening Statements (All) Summary review of Tuolumne River Anadromous Fish Passage Facilities Assessment Collaborative (Districts) Review agenda, workshop objectives, and action items from previous meeting (Districts)
10:30 am – 11:30 am	Conceptual Tuolumne River Reintroduction Decision Framework (All) a. Summary review of the Reintroduction Decision Framework b. Participant comments on Framework, preferences and potential process implementation concepts c. Decision regarding Reintroduction Decision Framework implementation
11:30 am – 12:00 pm	Next Steps (All) a. Schedule: Further opportunities for collaboration and incorporation of feedback b. Action Items

From: Staples, Rose
Sent: Wednesday, December 02, 2015 1:43 PM
Cc: Staples, Rose
Subject: E-Filing LaGrange Request for Waiver of Regulations-Approval of Study Report Meeting Date
Attachments: P-14581_LaGrange_ReqWaiverReg-ApprvlISRMtgDt_151202.pdf

Licensing Participants,

The Districts have e-filed with FERC today the attached request for waiver of regulations and approval of the Initial Study Report Meeting date of February 25, 2016 for La Grange. A copy of this document is also available on FERC's E-Library as well as on the La Grange licensing website www.lagrange-licensing.com under the DOCUMENTS tab.

Rose Staples, CAP-OM, MOS
Executive Assistant

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970 Baxter Boulevard Suite 301
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D 207-239-3857
rose.staples@hdrinc.com

hdrinc.com/follow-us

December 2, 2015
Via Electronic Filing

FERC Project No. 14581
Tuolumne River - California

Kimberly D. Bose, Secretary
Federal Energy Regulatory Commission
888 First Street NE
Washington, DC 20426

Subject: La Grange Hydroelectric Project, FERC Project No. 14581
Request for Waiver of Regulations and Approval of ISR Meeting Date

Dear Secretary Bose:

On September 5, 2014, the Federal Energy Regulatory Commission ("FERC" or "Commission") issued Scoping Document 2 ("SD2") for the La Grange Hydroelectric Project, FERC No. 14581, owned jointly by Turlock Irrigation District and Modesto Irrigation District (collectively, the "Districts") and located on the Tuolumne River in California. SD2 states the Districts must file the La Grange Hydroelectric Project Initial Study Report ("ISR") by February 2, 2016. Pursuant to §5.15(c)(2) of the Commission's regulations, the Districts must hold the ISR Meeting within 15 days of filing the ISR; therefore, if the Districts file the ISR on February 2, 2016, the ISR Meeting must be held on or before February 17, 2016 (i.e., within 15 days of February 2, 2016). The ISR Meeting Summary would then be due to be filed with FERC by March 3, 2016.

The Districts respectfully request a waiver from §5.15(c)(2) and propose to hold the ISR Meeting on February 25, 2016. On November 19, 2015, the Districts held Workshop No. 3 for the La Grange Project's Fish Passage Facilities Alternatives Assessment study and discussed with licensing participants the possibility of requesting a waiver from §5.15(c)(2) and holding the meeting on February 25, 2016. A broad group of interested parties present at the Workshop, including representatives from the National Marine Fisheries Service, California Department of Fish and Wildlife, U.S. Fish and Wildlife Service, and Conservation Groups, confirmed their schedules would accommodate having the ISR Meeting on February 25, 2016. No licensing participant in attendance at Workshop No. 3 objected to holding the ISR Meeting on this date.

Therefore, the Districts respectfully request that FERC approve the ISR Meeting date of Thursday, February 25, 2016. The Districts would maintain March 3, 2016 as the filing date for the ISR Meeting Summary. If you have any questions about this request, please contact the undersigned at the addresses or telephone numbers listed below.

Sincerely,

Steve Boyd
Turlock Irrigation District
P.O. Box 949
Turlock, CA 95381
(209) 883-8364
seboyd@tid.org

Greg Dias
Modesto Irrigation District
P.O. Box 4060
Modesto, CA 95352
(209) 526-7566
gregd@mid.org

cc: La Grange Licensing Participant email group

From: Staples, Rose
Sent: Monday, December 07, 2015 3:32 PM
Cc: Staples, Rose
Subject: Districts File with FERC Request for Revised DLA and FLA Schedule

Licensing Participants,

The Districts have e-filed with FERC a request for a revised schedule for the filing of the La Grange Draft License Application (DLA) and the Final License Application (FLA). A copy of the letter has been uploaded to the licensing website (www.lagrange-licensing.com) and should also be available some time tomorrow on FERC's E-Library. If you have any difficulty locating/accessing the document, please let me know at rose.staples@hdrinc.com. Thank you.

Rose Staples, CAP-OM, MOS
Executive Assistant

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Modesto Irrigation District
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December 7, 2015
Via Electronic Filing

FERC Project No. 14581
Tuolumne River - California

Kimberly D. Bose, Secretary
Federal Energy Regulatory Commission
888 First Street NE
Washington, DC 20426

Subject: La Grange Hydroelectric Project, FERC Project No. 14581
Request for Revised Schedule for Filing Draft and Final License Application

Dear Secretary Bose:

On September 5, 2014, the Federal Energy Regulatory Commission ("FERC" or "Commission") issued Scoping Document 2 ("SD2") for the La Grange Hydroelectric Project, FERC No. 14581, owned jointly by Turlock Irrigation District and Modesto Irrigation District (collectively, the "Districts") and located on the Tuolumne River in California. SD2 provides a schedule which establishes deadlines for the pre-filing process. According to this schedule, the Districts must file the Draft License Application ("DLA") and Final License Application ("FLA") by January 18, 2016, and June 16, 2016, respectively.

On February 2, 2015, the Commission released the Study Plan Determination ("SPD") for the La Grange Hydroelectric Project, approving or approving with modifications six studies. As proposed on January 5, 2015, in the Districts' Revised Study Plan ("RSP"), and approved by FERC in the SPD, schedules for three of these six studies – the Fish Passage Facilities Alternatives Assessment, the Fish Passage Barrier Assessment, and the Fish Habitat and Stranding Assessment below La Grange Diversion Dam Study – anticipate two calendar years of study. In particular, the FERC-approved schedules for these three studies include data collection activities through calendar year 2016, with results to be reported in the Updated Study Report ("USR") due to be filed by the Districts in February 2017. In addition to these FERC-approved studies, the Districts have elected to complete the Upper Tuolumne River Basin Habitat Assessment as described in the Fish Passage Assessment Study Plan in the RSP, given the study's importance for assessing the need for fish passage. The Upper Tuolumne River Basin Habitat Assessment also anticipates two calendar years of study activities (2015/2016), with results being reported in the USR. Even further, FERC's SPD acknowledges the potential need for a study of reservoir migration survival if the results of the Fish Passage Facilities Alternatives Assessment, scheduled to be reported in the USR, indicate the most feasible passage concept would require anadromous fish to migrate through the Don Pedro or La

Grange impoundments. The survival study would take place in 2017, with report issuance about December 2017.

Given the schedules for the three FERC-approved studies described above, as well as the schedule for the Upper Tuolumne River Basin Habitat Assessment, data necessary for and relevant to assessing the need for fish passage facilities at the La Grange Hydroelectric Project will be unavailable for inclusion in the DLA and FLA as currently scheduled in SD2. As part of the upcoming Initial Study Report consultation process, the Districts will develop, in collaboration with licensing participants, a detailed schedule for completing the ongoing two years of study as well as any new studies to be completed under the La Grange Hydroelectric Project licensing process. Also, as provided by FERC's regulations governing the Integrated Licensing Process, licensing participants have the opportunity to request additional studies as part of the ISR process (§5.15(c)(6)). By the schedule in SD2, the FERC Director's determination on disputes and requested amendments to studies would not occur until June 1, 2016. Given the schedule of activities related to the completion of studies for the La Grange proceeding, it is not possible for the Districts to prepare and file a meaningful FLA by June 16, 2016.

The Districts do not intend to file a DLA or FLA in accordance with the schedule contained in SD2; therefore, we respectfully request that FERC prepare a revised schedule for filing the DLA and FLA that considers the full scope of studies underway, potential for additional studies, and anticipated availability of study results.

If you have any questions about this request, please contact the undersigned at the addresses or telephone numbers listed below.

Steve Boyd
Turlock Irrigation District
P.O. Box 949
Turlock, CA 95381
(209) 883-8364
seboyd@tid.org

Greg Dias
Modesto Irrigation District
P.O. Box 4060
Modesto, CA 95352
(209) 526-7566
gregd@mid.org

cc: La Grange Licensing Participant Email Group
Mr. Jim Hastreiter, FERC

From: Staples, Rose
Sent: Friday, December 18, 2015 10:54 AM
Cc: Staples, Rose
Subject: La Grange Workshop No. 3 Meeting Notes and Handouts Uploaded to Website

Follow Up Flag: Follow up
Flag Status: Completed

Licensing Participants,

The Districts have uploaded to the licensing website today (www.lagrange-licensing.com) the notes and handouts from the November 19, 2015 Workshop No. 3. The documents have been combined into one file and it can be found at the top of the Documents listing (under the DOCUMENT TAB) and as an attachment to the November 19 workshop announcement on the CALENDAR. If you have any difficulty locating and/or accessing the document, please contact rose.staples@hdrinc.com. Thank you.

Rose Staples, CAP-OM, MOS
Executive Assistant

HDR
970 Baxter Boulevard Suite 301
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From: Staples, Rose
Sent: Wednesday, January 06, 2016 4:16 PM
Cc: Staples, Rose
Subject: Jan 27-SAVE THE DATE for La Grange Meeting

Licensing Participants,

Welcome to 2016!

Just a reminder that at Workshop No. 3 held on November 19, we set the date for our next meeting/workshop to be **Wednesday, January 27** at the MID Offices in Modesto.

Additional details (time, agenda) will be forthcoming shortly; but we wanted to confirm the date on your calendar.

Thank you—and Happy New Year.

Rose Staples, CAP-OM, MOS
Executive Assistant

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From: Staples, Rose
Sent: Thursday, January 21, 2016 10:21 AM
Cc: Staples, Rose
Subject: Corrected AGENDA for La Grange January 27 2016 Workshop No 4
Attachments: LG Workshop No 4 AGENDA_160121.pdf

Follow Up Flag: Follow up
Flag Status: Completed

NOTE: Workshop No. 4 will be held January 27, 2016!! The following message and the attached agenda have been updated from "2015" to "2016"!

Licensing Participants,

Please find attached the AGENDA for the La Grange Workshop No. 4 to be held on January 27, **2016** from 9:00 a.m. to Noon at the MID Offices in Modesto. Copies of additional materials to be shared at Workshop No 4 will be forwarded later this week.

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La Grange Hydroelectric Project
Reintroduction/Fish Passage Assessment Framework
Workshop No. 4

Wednesday, January 27, 2016 -- 9:00 am to 12:00 pm
MID Office, 1231 11th Street, Modesto, California
Conference Line: 1-866-583-7984; Passcode: 814-0607
Join Lync Meeting: https://meet.hdrinc.com/jenna.borovansky/3D64F0F5

Meeting Objectives:

1. Discuss and approve the proposed Upper Tuolumne River Reintroduction/Fish Passage Assessment Framework (Reintroduction Framework) goals and schedule.
2. Present and discuss existing information, information needs, and potential preliminary studies for 2016.

TIME	TOPIC
9:00 am – 9:10 am	Introduction of Participants (All)
9:10 am – 9:30 am	Opening Remarks (All) Review Agenda and Meeting Objectives (All) Overview of Upper Tuolumne River Reintroduction Framework (Districts)
9:30 am – 10:00 am	Reintroduction Assessment Framework Goals and Schedule (All) a. Proposed goals by year (2016-2017) b. Summary of 2016 proposed schedule, meetings, and potential use of a technical subcommittee c. Discuss and decide: -Assessment Framework goals, schedule and meetings -Use of a technical subcommittee
10:00 am – 10:45 am	Potential 2016 Studies and Discussion of Biological Goals and Objectives of the Reintroduction Program (All) a. Potential 2016 studies discussion b. Schedule for identifying reintroduction program biological goals and objectives
10:45 am – 11:00 am	Break
11:00 am – 11:45 am	Upper Tuolumne River: Existing Information and Information Gaps Discussion (Districts) a. NMFS studies – schedule of availability b. Barriers, temperature, habitat, and hydrology summaries c. Other information
11:45 am – 12:00 pm	Next Steps (All) a. Schedule b. Action items

From:	Staples, Rose
Sent:	Friday, January 22, 2016 3:29 PM
Cc:	Staples, Rose
Subject:	La Grange Licensing Newsletter Issue No 2
Follow Up Flag:	Follow up
Flag Status:	Completed

Licensing Participants,

A copy of the latest issue of the La Grange Licensing Newsletter has been uploaded to the La Grange licensing website (www.lagrange-licensing.com) in the DOCUMENTS folder. If you have any difficulty locating and/or downloading the document, please contact me at Rose.Staples@hdrinc.com. Thank you.

Rose Staples, CAP-OM, MOS
Executive Assistant

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From: Staples, Rose
Sent: Friday, January 29, 2016 7:29 AM
Cc: Staples, Rose
Subject: La Grange Technical Subcommittee
Attachments: KeyReintroStudies_abstracts_toLPs_rev_160128.pdf

Follow Up Flag: Follow up
Flag Status: Completed

La Grange Licensing Participants,

The Districts would like to thank everyone who participated in Wednesday's La Grange Workshop No 4.

As mentioned at the workshop, if you are interested in participating on the technical subcommittee, please email Rose Staples at rose.staples@hdrinc.com by Tuesday, February 2, 2016.

The first technical subcommittee conference call with be held on Tuesday, February 16, 2016 at 11:00 a.m. (Pacific). Conference call number, agenda, and associated materials will be forthcoming closer to the date.

If you will not be participating on the technical subcommittee but have written comments or thoughts on possible studies (see attached list), please email them to Rose Staples at rose.staples@hdrinc.com by Friday, February 5, 2016.

Per an action item captured at the workshop, Steve Edmonson (NMFS) has provided the following link regarding the Klamath economic studies:
http://klamathrestoration.gov/keep-me-informed/secretarial-determination/role-of-science/secretarial-determination-studies

Thank you.

Rose Staples, CAP-OM, MOS
Executive Assistant

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Information Needs and Potential Studies to Inform Reintroduction Assessment Framework
For Discussion and Review by Collaborative Group

Framework Category	Studies	On-going and Potential Studies for 2016[1]	Cost Estimate	Schedule for Draft Report
Ecological	Limiting Factors Analysis and Carrying Capacity		$340,000	December 2017
Ecological	Reservoir Transit Study		$500,000	
Ecological	Interactions with Existing Aquatic Communities		$250,000	
Ecological	Source Population Assessment		NMFS lead?	
Ecological	Method of Colonization		$60,000	
Ecological	Genetics Assessment of Existing and Source Populations (NMFS has study on-going)	X	NMFS lead	April 2017
Biological	Habitat Typing and Characterization[2]	P	$240,000	Nov/Dec 2016
Biological	Upstream Migration Barriers	X	$220,000	Nov/Dec 2016
Biological	Instream Flow – Habitat Assessment: PHABSIM		$300,000[3]	
Biological	Water Temperature Monitoring and Modeling	X	$350,000	Nov/Dec 2016
Biological	Spawning Gravel Study	P	$140,000	Nov/Dec 2016
Biological	Macroinvertebrate Study		$220,000	
Biological	Swim Tunnel Study of Upper River *O. mykiss*		$450,000	
Economic, Regulatory, and Other Key Considerations	Regulatory Evaluation of Reintroduction (ESA Status, BLM/USFS Management Plans, Wild and Scenic, etc)	P	$50,000	October 2016
Economic, Regulatory, and Other Key Considerations	Socioeconomic Scoping and Issues Identification/ Preliminary Evaluation of Impacts on Tuolumne River Uses/Users	P	$50,000	October 2016
Economic, Regulatory, and Other Key Considerations	Hatchery Practices Review, including current Don Pedro related practices.		$50,000	

<u>Draft Study Abstracts</u>

<u>Limiting Factors Analysis and Carrying Capacity</u>

A limiting factors analysis (LFA) is a useful tool to identify and fill information gaps related to physical and biological factors controlling population dynamics of one or more target species. This type of analysis has been used extensively in California and the Pacific Northwest to identify habitat conditions, ecological interactions, and other factors that constrain salmonid population production potential. The LFA proposed herein would test hypotheses regarding potential factors that that could limit the ability of the upper Tuolumne River to support viable populations of reintroduced Chinook salmon and O. mykiss. The data analyzed and synthesized as part of a LFA can also include an analysis of carrying capacity, to determine the number of individuals of each freshwater life stage that can be supported by the available habitat. The results of a LFA provide valuable insight into possible effects of current or historical riverine habitat conditions on salmonid populations (or reintroduced populations), allowing managers evaluate

[1] X = Ongoing study; P = Potential additional 2016 study for consideration by collaborative group
[2] Habitat typing and characterization study proposal does not explicitly include habitat components being collected by NMFS; however, the NMFS data should be discussed in overall Assessment Framework.
[3] The geographic scope and amount of available information needs to be confirmed to refine scope and cost estimate.

reintroduction potential, focus future management activities, help prioritize actions, and/or refine the current understanding of limitations of the ecosystem.

Reservoir Transit Study

As detailed in FERC's study plan determination, if the fish passage facilities assessment indicate that the most feasible concept alternative for fish passage would involve either upstream or downstream passage through the project reservoirs (i.e., La Grange or Don Pedro reservoirs), a study would be required to evaluate the technical and biological feasibility of upstream (adults) or downstream (juvenile) movement of anadromous fish (as appropriate) through the project's reservoirs. Until feasible concept alternatives have been selected, the scope of this study cannot be accurately identified.

Interactions with Existing Aquatic Communities

Evaluating potential interactions with existing species in the target area is a factor that can impact reintroduction success. This constraint includes predatory and competitive interactions with other species and populations. Often times, habitat in target areas have changed from historic conditions. Consequently, aquatic communities present in target reintroduction areas may be comprised of non-native species or native invaders that have filled these available niches. Furthermore, intraspecific competition is possible if a population of the target species is already present in the target reach (i.e., *O. mykiss*). This assessment would identify the potential interactions of target reintroduction species with the existing aquatic community in the target reach and characterize the potential risks/benefits to the reintroduction program.

Source Population Assessment

Consideration of genetic and ecological characteristics of a source population is important to assessing the probability of a successful reintroduction. Ecological factors such as life history, morphological, and behavioral traits compatible with the target area will increase the probability of a successful reintroduction. Source populations that are genetically similar to the historic population may also maximize the benefits and reduce the risks of reintroduction. This assessment would identify factors that should be considered when identifying viable source populations, potential sources, associated pros and cons of each, and constraints of utilizing each source, if any.

Method of Colonization Assessment

Colonization approaches (i.e., natural, transplants, and hatchery releases) differ in the effects on the parameters that are used to assess the success or failure of a reintroduction. Method of colonization also has implications for the infrastructure and operations needed to support a reintroduction program. As such, identifying early in the process the lowest-risk strategy for colonization will be a critical component of assessing risks, constraints, and benefits of any reintroduction program.

Genetics Assessment of Existing and Source Populations

NMFS is conducting a study of the upper river *O. mykiss* fishery genetics. Request a schedule and information update for the group.

Habitat Typing and Characterization

Habitat mapping quantifies the type, amount, and location of river habitat types available to reintroduced anadromous salmonids of all life stages. Habitat mapping would be conducted in the field and remotely using standardized methodologies. The frequency and area of each habitat type (e.g., pool, riffle, run) would be tabulated and where potential holding pools for spring-run salmon occur, the size, depth, and vertical thermal profile of the pools will be measured to determine possible holding capacity, stratification of the pools (if any), and thermal suitability. Additional (remote) mapping tasks will include assessments of channel gradient, width, habitat areas, etc. This baseline information provides the template for many other evaluations and is critical for assessing the feasibility of reintroduction. For example, data on habitat type, area, and distribution are required to assess potential Chinook salmon and steelhead adult holding capacity, spawning habitat potential, and juvenile rearing capacity.

Upstream Migration Barriers

Little information exists to reliably assess the current quantity and quality of suitable habitat for the adult, egg, fry and juvenile life stages of anadromous salmonid species that may be considered for reintroduction in the Upper Tuolumne River watershed (i.e., above the Don Pedro Project). Prior to assessing the quality/suitability of habitat for target species, an assessment of barriers (both complete and partial) to upstream anadromous salmonid migration must first be conducted to identify the quantity of habitat that is accessible. This assessment would utilize relevant prior studies, desktop analyses, and field surveys to characterize and document the physical structure of barriers in the mainstem Tuloumne River and its tributaries upstream of the Don Pedro Project Boundary. Note that this study was requested by NMFS but per FERC's determination, was not required to be conducted by the Districts as part of the La Grange licensing process. However, to more fully support licensing participants in their development of information to supplement fish passage and reintroduction assessments, and to foster collaboration among all parties, the Districts have opted to conduct an upstream migration barriers assessment.

Instream Flow – Habitat Assessment: PHABSIM

Hydraulic models such as the Physical Habitat Simulation (PHABSIM) system are widely used and accepted tools used to produce quantitative estimates of the amount (quantity and quality) of habitat available to fish at a range of stream flows. Using measured physical channel characteristics for representative habitat types or reaches, PHABSIM modeling incorporates habitat suitability relationships for the target fish species and life stage to produce estimates of weighted usable area (WUA) in relation to stream flow. Results of PHABSIM modeling can be combined with data from habitat mapping and water temperature modeling to provide estimates of habitat availability and suitability for target species and associated life stages throughout the project area at a range of flows. Additionally, the analysis would include an evaluation of the effect of fluctuating flows on habitat value, due to the frequent peaking operations in the upper Tuolumne River. This could be evaluated by comparing habitat values on a small time-step using the high and low flows within the fluctuation range. Water temperature data would also be overlaid with the PHABSIM results to evaluate how the total amount of habitat is affected by thermal rather than physical habitat conditions.

Water Temperature Monitoring and Modeling

The assessment of suitable habitat quality for the adult, egg, fry and juvenile life stages of anadromous salmonid species that may be considered for reintroduction in the Upper Tuolumne River watershed (i.e., above the Don Pedro Project) is dependent upon both physical and thermal characteristics. This study would use existing and additional data to characterize the thermal regimes of the upper Tuolumne River and tributaries from the Don Pedro Project Boundary to CCSF's Early Intake to characterize locations where temperatures may be suitable for anadromous salmonid species considered for reintroduction. The study would include the development of a computer model to simulate existing thermal conditions in the study area. Note that this study was requested by NMFS but per FERC's determination, was not required to be conducted by the Districts as part of the La Grange licensing process. However, to more fully support licensing participants in their development of information to supplement fish passage and reintroduction assessments, and to foster collaboration among all parties, the Districts have opted to conduct an upstream migration barriers assessment.

<u>Spawning Gravel Study</u>

Spawning gravel mapping quantifies the amount, location, and suitability of gravel available for spawning by reintroduced anadromous salmonids. In a confined, high gradient river channel dominated by large substrates (boulder, cobble, bedrock) like the upper Tuolumne River, spawning gravel distribution is typically patchy and overall abundance may be low. Initial evaluation of aerial photographs and an on-river reconnaissance survey indicate this is may be the case in portions of the Tuolumne River between Wards Ferry and Early Intake. Because successful spawning and fry production are dependent on the abundance and suitability of accessible spawning gravel, spawning gravel mapping is a critical component for assessing the feasibility of reintroduction. This information is a key part of any evaluation of the factors likely to limit production and viability of an existing or reintroduced salmonid population (i.e., a limiting factors or carrying capacity analysis).

<u>Macroinvertebrate Study</u>

Drifting and benthic macroinvertebrates (BMI) are the primary food source for rearing salmonids in fresh water habitats. Growth of juvenile anadromous salmonids during their freshwater rearing period is critical for their survival during outmigration and ocean phases, as well as to the overall viability of the population. Studies have shown a strong relationship between the size at which juvenile salmon and steelhead migrate to the ocean and the probability that they return to fresh water to spawn. Macroinvertebrate sampling provides a measure of food availability during this important life history period. Information on macroinvertebrate prey resource availability is therefore a key component of any evaluation of the factors likely to limit production and viability of an existing or reintroduced salmonid population (i.e., a limiting factors analysis).

<u>Swim Tunnel Study of Upper River O. mykiss</u>

Thermal acclimation among fish species dates back to the 1940's and since 2001, thermal adaptation at the population level and among a wide variety of fish species has been convincingly supported in the peer-reviewed scientific literature. Included in this evidence base are salmon and trout species. The objective of this study would be to determine the thermal performance of the subadult *O. mykiss* population inhabiting the upper Tuolumne River to assess any local adjustments in thermal performance. The study would test the hypothesis that the *O.mykiss* population in the Upper Tuolumne River (i.e., above the Don Pedro Project Reservoir) is locally adjusted to relatively warm thermal conditions that may exist during the summer. Results of the study would be used to support habitat suitability and temperature modeling assessments.

<u>Hatchery Practices Review, including current Don Pedro related practices</u>

Assessing historic and current hatchery practices in the upper Tuolumne River will be necessary to evaluate potential risks to reintroduction. Risks include but are not limited to evolutionary (homogenization or reduced fitness), ecological (competition, predation, etc.) and disease issues. Results of the review will identify past and current hatchery practices in the reintroduction area as well as connected areas (i.e., Don Pedro Reservoir), potential risks of past/present hatchery programs to a reintroduction program, and recommendations to address identified risks.

<u>Regulatory Evaluation of Reintroduction</u>

The Upper Tuolumne River watershed spans several land management agencies' jurisdictions and there are management plans and regulations in place based on established resource management objectives (e.g., Wild and Scenic Management Plan, Forest Plan, BLM Management Plan). The compatibility of the potential reintroduction of *O.mykiss* and/or spring run Chinook will be evaluated relative to these current management objectives. The potential reintroduction of Endangered Species Act (ESA) listed species may overlay additional management objectives and a new regulatory framework in the upper Tuolumne River. This evaluation will include compiling and reviewing all relevant and potentially relevant existing management plans for the upper Tuolumne River and the Don Pedro Reservoir. In addition, applicable recovery plans and ESA regulations and potential population status classifications for the reintroduced species will be summarized. Responsible resource management agencies will be contacted to determine the most recent guidance documents for the study area.

Socioeconomic Scoping and Issue Identification/Preliminary Evaluation of Impacts on Tuolumne River Uses/Users

Current management of the Don Pedro Reservoir and upper Tuolumne River supports a wide range of resources, uses, and users. The upper watershed includes the Tuolumne Wild & Scenic River segment managed for several outstanding resource values and is utilized by commercial and private recreational boaters. Other uses include the City and County of San Francisco's Hetch Hetchy Project operations, private timber practices, and a recreational fishery. Don Pedro Reservoir has an active house boating and recreational fishery; county government and businesses rely upon the economic activities supported by the upper watershed. This evaluation will conduct a comprehensive survey of uses in the upper watershed and identify potential issues for consideration in the reintroduction assessment. A literature survey and review of existing information from the Don Pedro Recreation Agency, county and federal land management agencies and other sources will be conducted. Surveys and/or focus groups will be used to verify and expand upon available information on the multiple existing uses of the watershed that could be impacted by a fish reintroduction program.

From: Staples, Rose
Sent: Tuesday, February 02, 2016 12:41 PM
Cc: Staples, Rose
Subject: La Grange ISR - FERC Acceptance for Filing

Follow Up Flag: Follow up
Flag Status: Completed

To La Grange Licensing Participants

Today the Districts e-filed the La Grange Initial Study Report, a copy of which is available on FERC's E-Library (www.ferc.gov) and which will shortly be in the DOCUMENTS section of the La Grange licensing website (www.lagrange-licensing.com).

If you have any difficulties in locating and/or downloading the 10 documents that make up the ISR filing, please let me know.

Thank you.

Rose Staples, CAP-OM, MOS
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-----Original Message-----
From: eFiling@ferc.gov [mailto:eFiling@ferc.gov]
Sent: Tuesday, February 02, 2016 3:29 PM
To: Staples, Rose; eFilingAcceptance@ferc.gov
Subject: FERC Acceptance for Filing in P-14581-000

Acceptance for Filing

The FERC Office of the Secretary has accepted the following electronic submission for filing (Acceptance for filing does not constitute approval of any application or self-certifying notice):

-Accession No.: 201602025207

-Docket(s) No.: P-14581-000

-Filed By: Turlock Irrigation District and Modesto Irrigation District -Signed By: Steve Boyd, Greg Dias -Filing Type: ILP Initial or Updated Study Report -Filing Desc: ILP Initial Study Report of Turlock Irrigation District and Modesto Irrigation District under P-14581 La Grange.

-Submission Date/Time: 2/2/2016 2:32:46 PM -Filed Date: 2/2/2016 2:32:46 PM
Your submission is now part of the record for the above Docket(s) and available in FERC's eLibrary system at:

http://elibrary.ferc.gov/idmws/file_list.asp?accession_num=20160202-5207

If you would like to receive e-mail notification when additional documents are added to the above docket(s), you can eSubscribe by docket at:

https://ferconline.ferc.gov/eSubscription.aspx

Thank you again for using the FERC Electronic Filing System. If you need to contact us for any reason:

E-Mail: efiling@ferc.gov mailto:efiling@ferc.gov (do not send filings to this address) Voice Mail: 202-502-8258.

From:	Le, Bao
Sent:	Wednesday, February 03, 2016 5:12 PM
To:	John Wooster - NOAA Federal
Cc:	Borovansky, Jenna; Deason, Jesse; mike.deas@watercourseinc.com
Subject:	RE: Temperature Data Swap and LiDAR
Follow Up Flag:	Follow up
Flag Status:	Completed

Hi John.

See below in red.

Let me know if you have any questions.

Thanks, Bao

From: John Wooster - NOAA Federal [mailto:john.wooster@noaa.gov]
Sent: Wednesday, February 03, 2016 12:38 PM
To: Le, Bao
Cc: Borovansky, Jenna; Deason, Jesse; mike.deas@watercourseinc.com
Subject: Re: Temperature Data Swap and LiDAR

Bao:

I received the LiDAR data this morning. I can't email files over about 25 MB. I have the data on my Google Drive. I am going to invite you and Mike to share the folder, you should be able to link directly in without installing any additional software, click on the file (the file preview will fail) but you should then be able to start to download. There is also a data description / quasi meta data in there from the vendor. Let me know if it doesn't work.

As for water temp data, when you say "We remove loggers that go dry from the data set", I believe you mean you remove the portion of that loggers record that is dry (not the entire logger record), but wanted to double check....that’s correct. We remove just the air temperature portion.

How would you like to handle the logger(s) that go wet/dry on a daily basis with the whitewater release? I see two options: just remove the portion of the record where there is daily wet/dry cycles, or transmit the portion of each day where there is water temp readings (longer than you might think given a 4 hour whitewater release because it takes quite awhile for the pools to fully recede)..... We can sympathize with the deployment challenges of that reach reach given the whitewater releases. We think the data is useful and the second option preserves some important temperature information that would be lost if the daily wet/dry cycles were removed (option 1). Is it difficult to discern the transition between water temperatures and air temperatures and vice versa since a partially inundated logger might be hard to interpret? If so, perhaps a conservative approach would be to trim the data set a little more to ensure air temperatures do not creep into the data set. Thoughts?

Thanks,

John

On Wed, Feb 3, 2016 at 8:40 AM, Le, Bao <ChiBao.Le@hdrinc.com> wrote:

Thanks for the info, John. See responses below and let me know what you think.

Bao

From: John Wooster - NOAA Federal [mailto:john.wooster@noaa.gov]
Sent: Tuesday, February 02, 2016 1:43 PM
To: Le, Bao
Cc: Borovansky, Jenna; Deason, Jesse; mike.deas@watercourseinc.com
Subject: Re: Temperature Data Swap and LiDAR

Hi Bao:

Yes the LiDAR is ready to share, and it is processed. It is the bathymetry (derived from the hyper spec images) that is still being worked out - and still could be a few months out. Eventually those two data sets will be stitched together. But if you want the LiDAR now (everything above water surface), we could make that happen in a matter of days. I was told the LiDAR is only about a 5 GB file, so we could probably do that over a dropbox / Google Drive exchange. Let me know if you want that now, and I can probably have it within a matter of days from Science Center (I'm not actually holding it at the moment, but they did tell me last week it was ready).....That would be great if we could get the LiDAR above water surface for now. When the bathymetry is available, if we could acquire that as well, it'd be much appreciated. My email can accept 5 GB attachments.

My temp data is more or less ready to exchange - I did have one logger in the mainstem that I didn't get deep enough that would dessicate when they shut the water off after whitewater release and inundate with the whitewater pulse (that's what happens when you install loggers while rafting down the river and the water is up), so I still need to process that one. We had a similar issue with our mainstem logger above the Clavey and NF confluence locations – we installed in the early summer prior to rafting flows (down low and deep) and then as we got into late fall/winter, were unsure we could access them again with water rising. So these two locations have overwintered without a download. And our upper Clavey logger eventually went dry as well because we installed it when flows were up and couldn't safely get into the middle of the thalweg. I saw in August that at least your NF Tuolumne logger went dry, and I think your lower Clavey if memory serves correct. How would you like to handle the data from loggers that go dry? We remove loggers that go dry from the dataset. Are you deleting the records that are air temperature (i.e., when it goes dry)? Yes. Are you separating the data into two different columns - one for water temp, one for air temp (that is my preferred, as sometimes it is useful to have the air temp data)? Or one column of data, and one column of water vs air qualifier? Let me know what you have done and I will follow suit.... We did not manage air temp data in any way because we do not know if the logger is sitting in a puddle of water partly submerged and partly exposed, under a rock, in the baking sun, etc. The logger was not deployed as an air temperature monitoring station, which would require its own deployment protocol (somewhat different than a water temperature logger deployment).

Let's shoot to exchange temp data this coming Monday. I can probably transmit mine over email, or a couple of emails. Also could do that over Google Drive, as well. Let's work this week on how to exchange the larger files next Monday. As noted above, I can accept pretty large files. What's the case on your end and what's your preference? Using any file transfer software (that isn't currently on my laptop) will require that I get IT involved on this end to approve and download those programs. But I can get it going this week.

-John

On Tue, Feb 2, 2016 at 9:54 AM, Le, Bao <ChiBao.Le@hdrinc.com> wrote:

Hi John.

This has been on my plate for a while so I apologize for not getting back to you on exchanging data sooner. We've been through the process of temperature data QC and believe it is now available to share. As discussed previously, we'd like to also get NMFS' temperature data in the Upper Tuolumne River. Let's discuss a way in which we can swap that data here soon.

Also, you had mentioned that you would have LiDAR (although not completely processed) available to share as well. In discussions with Mike Deas, our temperature modeler, he thought this would still be useful for his purposes so if we could acquire these data also, that'd be great. I've cc'd him here.

Let me know if you have any questions.

Thanks,

Bao

Bao Le

Senior Fisheries Biologist

HDR

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John Wooster
Hydrologist
NOAA Fisheries West Coast Region
U.S. Department of Commerce
john.wooster@noaa.gov

NOAA FISHERIES
West Coast Region

From: Le, Bao
Sent: Thursday, February 04, 2016 5:58 PM
To: Eicher, James
Cc: Devine, John; Staples, Rose; Deason, Jesse
Subject: RE: Upper Tuolumne River Reintroduction Assessment Framework - Invitation to participate in the technical subcommittee
Follow Up Flag: Follow up
Flag Status: Completed

You bet, Jim.

I will add your name to the participant list so that you can receive emails regarding upcoming conference calls and materials. If you are interested in talking more prior to these calls, please let me know and we can set something up to bring you up to speed.

Thanks, Bao

From: Eicher, James [mailto:jeicher@blm.gov]
Sent: Thursday, February 04, 2016 5:56 PM
To: Le, Bao
Subject: Re: Upper Tuolumne River Reintroduction Assessment Framework - Invitation to participate in the technical subcommittee

Thank you Bao I am interested in understanding this process so please include me in this discussion.

Jim

On Thu, Feb 4, 2016 at 4:06 PM, Le, Bao <ChiBao.Le@hdrinc.com> wrote:

Hi Jim.

As part of the La Grange Licensing Process, the Districts and Licensing Participants (LPs) are implementing a Reintroduction Assessment Framework intended to evaluate the feasibility of reintroducing anadromous salmonids into the Upper Tuolumne River. The process is intended to integrate biological/ecological, fish passage engineering, and economic/regulatory and other key considerations into a structured reintroduction evaluation. We began the process in January 2016 and as part of this process, we are convening a technical subcommittee to address technical elements such as identifying information gaps, developing studies, etc. Since this technical subcommittee will be developing studies that will occur in the Upper Tuolumne River (as early as this summer), we wanted to extend an invite to both the USFS and the BLM to participate. Given BLM's regulatory authority in the upper watershed, your participation and input would be valuable from a variety of perspectives including permit coordination.

If you or any of your staff are interested in participating, we'd welcome it. We're mindful of everyone's busy schedules and as such, technical subcommittee conference calls will generally be short (i.e., 2 hours) and only when needed.

Please let me know if you have any questions.

Thanks,

Bao

Bao Le

Senior Fisheries Biologist

HDR

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Portland, OR 97204-1134
D 971.202.1722 **M** 503.309.9423
bao.le@hdrinc.com

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From: John Wooster - NOAA Federal <john.wooster@noaa.gov>
Sent: Thursday, February 04, 2016 10:07 AM
To: Le, Bao
Cc: Borovansky, Jenna; Deason, Jesse; mike.deas@watercourseinc.com
Subject: Re: Temperature Data Swap and LiDAR

Follow Up Flag: Follow up
Flag Status: Completed

I agree with your approach below, transmit the portion of the daily record that has water temp readings and trim the record aggressively to make sure we are in a zone of full inundation. While the discontinuous record will make it tough to run some stats and probably calibrate your model too, the data may help you validate once the model is built or at least get some insight if things further downstream aren't lining out as expected....

-JW

On Wed, Feb 3, 2016 at 5:11 PM, Le, Bao <ChiBao.Le@hdrinc.com> wrote:

Hi John.

See below in red.

Let me know if you have any questions.

Thanks, Bao

From: John Wooster - NOAA Federal [mailto:john.wooster@noaa.gov]
Sent: Wednesday, February 03, 2016 12:38 PM
To: Le, Bao
Cc: Borovansky, Jenna; Deason, Jesse; mike.deas@watercourseinc.com
Subject: Re: Temperature Data Swap and LiDAR

Bao:

I received the LiDAR data this morning. I can't email files over about 25 MB. I have the data on my Google Drive. I am going to invite you and Mike to share the folder, you should be able to link directly in without installing any additional software, click on the file (the file preview will fail) but you should then be able to start to download. There is also a data description / quasi meta data in there from the vendor. Let me know if it doesn't work.

As for water temp data, when you say "We remove loggers that go dry from the data set", I believe you mean you remove the portion of that loggers record that is dry (not the entire logger record), but wanted to double check....that's correct. We remove just the air temperature portion.

How would you like to handle the logger(s) that go wet/dry on a daily basis with the whitewater release? I see two options: just remove the portion of the record where there is daily wet/dry cycles, or transmit the portion of each day where there is water temp readings (longer than you might think given a 4 hour whitewater release because it takes quite awhile for the pools to fully recede)..... We can sympathize with the deployment challenges of that reach reach given the whitewater releases. We think the data is useful and the second option preserves some important temperature information that would be lost if the daily wet/dry cycles were removed (option 1). Is it difficult to discern the transition between water temperatures and air temperatures and vice versa since a partially inundated logger might be hard to interpret? If so, perhaps a conservative approach would be to trim the data set a little more to ensure air temperatures do not creep into the data set. Thoughts?

Thanks,

John

On Wed, Feb 3, 2016 at 8:40 AM, Le, Bao <ChiBao.Le@hdrinc.com> wrote:

Thanks for the info, John. See responses below and let me know what you think.

Bao

From: John Wooster - NOAA Federal [mailto:john.wooster@noaa.gov]
Sent: Tuesday, February 02, 2016 1:43 PM
To: Le, Bao
Cc: Borovansky, Jenna; Deason, Jesse; mike.deas@watercourseinc.com
Subject: Re: Temperature Data Swap and LiDAR

Hi Bao:

Yes the LiDAR is ready to share, and it is processed. It is the bathymetry (derived from the hyper spec images) that is still being worked out - and still could be a few months out. Eventually those two data sets will be stitched together. But if you want the LiDAR now (everything above water surface), we could make that happen in a matter of days. I was told the LiDAR is only about a 5 GB file, so we could probably do that over a dropbox / Google Drive exchange. Let me know if you want that now, and I can probably have it within a matter of days from Science Center (I'm not actually holding it at the moment, but they did tell me last week it was ready).....That would be great if we could get the LiDAR above water surface for now. When the bathymetry is available, if we could acquire that as well, it'd be much appreciated. My email can accept 5 GB attachments.

My temp data is more or less ready to exchange - I did have one logger in the mainstem that I didn't get deep enough that would dessicate when they shut the water off after whitewater release and inundate with the whitewater pulse (that's what happens when you install loggers while rafting down the river and the water is up), so I still need to process that one. We had a similar issue with our mainstem logger above the Clavey and NF confluence locations – we installed in the early summer prior to rafting flows (down low and deep) and then as we got into late fall/winter, were unsure we could access them again with water rising. So these two locations have overwintered without a download. And our upper Clavey logger eventually went dry as well because we installed it when flows were up and couldn't safely get into the middle of the thalweg. I saw in August that at least your NF Tuolumne logger went dry, and I think your lower Clavey if memory serves correct. How would you like to handle the data from loggers that go dry? We remove loggers that go dry from the dataset. Are you deleting the records that are air temperature (i.e., when it goes dry)? Yes. Are you separating the data into two different columns - one for water temp, one for air temp (that is my preferred, as sometimes it is useful to have the air temp data)? Or one column of data, and one column of water vs air qualifier? Let me know what you have done and I will follow suit.... We did not manage air temp data in any way because we do not know if the logger is sitting in a puddle of water partly submerged and partly exposed, under a rock, in the baking sun, etc. The logger was not deployed as an air temperature monitoring station, which would require its own deployment protocol (somewhat different than a water temperature logger deployment).

Let's shoot to exchange temp data this coming Monday. I can probably transmit mine over email, or a couple of emails. Also could do that over Google Drive, as well. Let's work this week on how to exchange the larger files next Monday. As noted above, I can accept pretty large files. What's the case on your end and what's your preference? Using any file transfer software (that isn't currently on my laptop) will require that I get IT involved on this end to approve and download those programs. But I can get it going this week.

-John

On Tue, Feb 2, 2016 at 9:54 AM, Le, Bao <ChiBao.Le@hdrinc.com> wrote:

Hi John.

This has been on my plate for a while so I apologize for not getting back to you on exchanging data sooner. We've been through the process of temperature data QC and believe it is now available to share. As discussed previously, we'd like to also get NMFS' temperature data in the Upper Tuolumne River. Let's discuss a way in which we can swap that data here soon.

Also, you had mentioned that you would have LiDAR (although not completely processed) available to share as well. In discussions with Mike Deas, our temperature modeler, he thought this would still be useful for his purposes so if we could acquire these data also, that'd be great. I've cc'd him here.

Let me know if you have any questions.

Thanks,

Bao

Bao Le

Senior Fisheries Biologist

HDR

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--

John Wooster
Hydrologist
NOAA Fisheries West Coast Region
U.S. Department of Commerce
john.wooster@noaa.gov

From: Deason, Jesse
Sent: Monday, February 08, 2016 8:19 AM
To: Deason, Jesse
Subject: FW: Upper Tuolumne River Reintroduction Assessment Framework - Invitation to participate in the technical subcommittee

From: "Vaughn, Gary D -FS" <gdvaughn@fs.fed.us>
Date: February 6, 2016 at 3:53:36 PM PST
To: "Le, Bao" <ChiBao.Le@hdrinc.com>
Subject: RE: Upper Tuolumne River Reintroduction Assessment Framework - Invitation to participate in the technical subcommittee

Thanks Bao – I have forwarded your e-mail on to our Resource program including Steve Holdeman, our aquatics biologist. Hopefully you will be hearing back from one of us soon.

Dusty Vaughn
Public Service Program Leader
Forest Service
Stanislaus National Forest, Groveland Ranger District
p: 209-962-7825 x525
f: 209-962-7412
gdvaughn@fs.fed.us
24545 State Highway 120
Groveland, CA 95321
www.fs.fed.us
Caring for the land and serving people

From: Le, Bao [mailto:ChiBao.Le@hdrinc.com]
Sent: Thursday, February 04, 2016 4:04 PM
To: Vaughn, Gary D -FS <gdvaughn@fs.fed.us>
Cc: Borovansky, Jenna <Jenna.Borovansky@hdrinc.com>; Deason, Jesse <Jesse.Deason@hdrinc.com>
Subject: Upper Tuolumne River Reintroduction Assessment Framework - Invitation to participate in the technical subcommittee

Hi Dusty.

As part of the La Grange Licensing Process, the Districts and Licensing Participants (LPs) are implementing a Reintroduction Assessment Framework intended to evaluate the feasibility of reintroducing anadromous salmonids into the Upper Tuolumne River. The process is intended to integrate biological/ecological, fish passage engineering, and economic/regulatory and other key considerations into a structured reintroduction evaluation. We began the process in January 2016 and as part of this process, we are convening a technical subcommittee to address technical elements such as identifying information gaps, developing studies, etc. Since this technical subcommittee will be developing studies that will occur in the Upper Tuolumne River (as early as this summer), we wanted to extend an invite to both the USFS and the BLM to participate. Given your regulatory authority in the upper watershed, your participation and input would be valuable from a variety of perspectives including permit coordination.

If you or any of your staff are interested in participating, we'd welcome it. We're mindful of everyone's busy schedules and as such, technical subcommittee conference calls will generally be short (i.e., 2 hours) and only when needed.

Please let me know if you have any questions.

Thanks,
Bao

Bao Le
Senior Fisheries Biologist

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From: Deason, Jesse
Sent: Thursday, February 11, 2016 9:00 AM
To: Deason, Jesse
Subject: FW: Upper Tuolumne River Reintroduction Assessment Framework - Invitation to participate in the technical subcommittee

---

From: Holdeman, Steven J -FS [mailto:sholdeman@fs.fed.us]
Sent: Tuesday, February 09, 2016 1:28 PM
To: Le, Bao
Subject: FW: Upper Tuolumne River Reintroduction Assessment Framework - Invitation to participate in the technical subcommittee

Hi there, Bao.

I'm the fisheries biologist for the Stanislaus NF and would like to be informed when you all are having a meeting. Also, I would like to receive any information coming from the work you all are conducting in the Upper Tuolumne River watershed. I'm somewhat ashamed to say this, but I generally have very little idea where you all are at this stage of the relicensing process because I have been committed to doing post-Rim Fire work on the forest. My work in that area has slowed to the point where I can entertain additional interests, including this part of the La Grange/Don Pedro relicensing.

Thank you for including us in this effort, and I look forward to communication in the future.

Steven J. Holdeman
Forest Aquatic Biologist

Forest Service
Stanislaus National Forest, Supervisor's Office

p: 209-532-3671 x311
sholdeman@fs.fed.us

19777 Greenley Road
Sonora, CA 95370
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From: Vaughn, Gary D -FS
Sent: Friday, February 05, 2016 1:34 PM
To: Junette, Jim -FS; Jow, Michael -FS; Holdeman, Steven J -FS
Subject: FW: Upper Tuolumne River Reintroduction Assessment Framework - Invitation to participate in the technical subcommittee

All – please see below and let me know if anyone is available to assist with these studies and resulting framework.

Thanks,

Dusty Vaughn
Public Service Program Leader
Forest Service
Stanislaus National Forest, Groveland Ranger District
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f: 209-962-7412
gdvaughn@fs.fed.us
24545 State Highway 120
Groveland, CA 95321
www.fs.fed.us

Caring for the land and serving people

From: Le, Bao [mailto:ChiBao.Le@hdrinc.com]
Sent: Thursday, February 04, 2016 4:04 PM
To: Vaughn, Gary D -FS <gdvaughn@fs.fed.us>
Cc: Borovansky, Jenna <Jenna.Borovansky@hdrinc.com>; Deason, Jesse <Jesse.Deason@hdrinc.com>
Subject: Upper Tuolumne River Reintroduction Assessment Framework - Invitation to participate in the technical subcommittee

Hi Dusty.

As part of the La Grange Licensing Process, the Districts and Licensing Participants (LPs) are implementing a Reintroduction Assessment Framework intended to evaluate the feasibility of reintroducing anadromous salmonids into the Upper Tuolumne River. The process is intended to integrate biological/ecological, fish passage engineering, and economic/regulatory and other key considerations into a structured reintroduction evaluation. We began the process in January 2016 and as part of this process, we are convening a technical subcommittee to address technical elements such as identifying information gaps, developing studies, etc. Since this technical subcommittee will be developing studies that will occur in the Upper Tuolumne River (as early as this summer), we wanted to extend an invite to both the USFS and the BLM to participate. Given your regulatory authority in the upper watershed, your participation and input would be valuable from a variety of perspectives including permit coordination.

If you or any of your staff are interested in participating, we'd welcome it. We're mindful of everyone's busy schedules and as such, technical subcommittee conference calls will generally be short (i.e., 2 hours) and only when needed.

Please let me know if you have any questions.

Thanks,
Bao

Bao Le
Senior Fisheries Biologist

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From: Staples, Rose
Sent: Thursday, February 11, 2016 3:18 PM
To: Devine, John; Borovansky, Jenna; Deason, Jesse; Le, Bao
Subject: Call Today from Lonnie Moore

Lonnie Moore, who recently emailed me asking to be added to the La Grange Licensing email group, called today and his questions basically were, not necessarily in this order—*along with my responses*. He said he was new to the process, the January workshop having been his first involvement.

- Did I work for HDR? *Yes*
- What did the initials HDR stand for? *Henningson Durham & Richardson*
- What did HDR do? Law firm? *No, Consulting – Engineering Architecture Permitting Relicensing/Licensing*
- Was I in the main office? *I work in the Portland Maine office; HDR's headquarters is in Omaha NE, and we have offices all over the country*
- Was I involved in a lot of projects of this type? *I work on several relicensing/licensing projects*
- What was the name of the individual from HDR leading the discussion as he missed getting a business card from him? *John Devine*
- What was the timeline for the notes from the January workshop being available *I said they were in the process of being compiled; that the Districts had not released any notes yet, other than the material posted on the website*

Rose Staples, CAP-OM, MOS
Executive Assistant

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D 207-239-3857
rose.staples@hdrinc.com

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From: Le, Bao
Sent: Friday, February 12, 2016 10:30 AM
To: jeicher@blm.gov
Cc: Borovansky, Jenna; Deason, Jesse; Staples, Rose
Subject: Upper Tuolumne River Reintroduction Assessment Framework - Technical Subcommittee

Good morning, Jim.

We're excited to have your participation in the technical subcommittee. Thank you for taking the time. Later today, you'll receive information and materials regarding the upcoming technical subcommittee conference call next week but be aware that this process has been ongoing for about a year. As such, there are materials from a number of workshops that have occurred in 2015 in case you wanted to dig into the background and get up to speed.

The documents are on the www.lagrange-licensing.com website; the notes and materials used at previous workshops are filed, in date sequence, under the DOCUMENTS tab on the website--and the advance materials used at the most recent workshop (January 27) are attached to the meeting date announcement on the website calendar under the CALENDAR tab. It might be a bit overwhelming so if you have any questions related to navigating the website to acquire relevant materials, please contact either Rose Staples or Jesse Deason, both cc'd here. And as always, if you have any questions or want to get up to speed via phone, please don't hesitate to call me.

Thanks, Bao

Bao Le
Senior Fisheries Biologist

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From: Staples, Rose
Sent: Friday, February 12, 2016 11:09 AM
Cc: Staples, Rose
Subject: Agenda for La Grange Initial Study Report Meeting Feb 25
Attachments: LG_ISRMeeting_Agenda.pdf

Follow Up Flag: Follow up
Flag Status: Completed

La Grange Licensing Participants,

Please find attached the AGENDA for the upcoming February 25, 2016 La Grange Project *INITIAL STUDY REPORT MEETING*, to be held from 9:00 a.m. to 1:00 p.m. at the Doubletree Hotel in Modesto.

Thank you.

Rose Staples, CAP-OM, MOS
Executive Assistant

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TID WATER & POWER
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La Grange Hydroelectric Project (FERC No. 14581)
Initial Study Report Meeting

Thursday, February 25, 2016, 9:00 am to 1:00 pm
Hilton DoubleTree Hotel, 1150 Ninth Street, Modesto, California
Conference Line: 1-866-583-7984, Passcode: 814-0607
Join Skype Meeting: https://meet.hdrinc.com/jenna.borovansky/3D64F0F5

TIME	TOPIC
9:00 am	Opening – Review Agenda and Purpose of the Meeting
9:15 am	Status of Cultural Resources Study and Recreation Access and Safety Assessment
9:25 am	Effects of the Project and Related Activities on the Losses of Marine-Derived Nutrients in the Tuolumne River
9:40 am	Topographic Survey Downstream of La Grange Diversion Dam
9:55 am	Salmonid Habitat Mapping Downstream of La Grange Diversion Dam
10:10 am	La Grange Diversion Dam Fish Barrier Assessment
10:25 am	Fish Presence and Stranding Assessment Downstream of La Grange Diversion Dam
10:40 am	Investigation of Fish Attraction to La Grange Powerhouse Draft Tubes
11:00 am	Break
11:15 am	Historical Flow Records for Five Discharge Structures at the La Grange Project
11:30 am	Upper Tuolumne River Basin Water Temperature Monitoring and Modeling Study
11:50 am	Upper Tuolumne River Basin Fish Migration Barriers Study
12:15 pm	Fish Passage Facilities Alternatives Assessment
12:55 pm	Next Steps in the ISR Process
1:00 pm	Meeting Adjourns

From: Staples, Rose
Sent: Friday, February 12, 2016 12:35 PM
Cc: Staples, Rose
Subject: La Grange Technical Subcommittee Call Feb 16

La Grange Licensing Participants,

FYI that we have today forwarded to the members of the Technical Subcommittee an agenda and other advance material for the subcommittee conference call scheduled for February 16th. Copies of these documents have been uploaded to the www.lagrange-licensing.com website as attachments to the February 16 conference call announcement on the website CALENDAR.

Rose Staples, CAP-OM, MOS
D 207-239-3857

hdrinc.com/follow-us

From: Staples, Rose
Sent: Friday, February 12, 2016 3:00 PM
Cc: Staples, Rose; Le, Bao
Subject: Advance Materials for La Grange Technical Subcommittee Call Feb 16

La Grange Technical Subcommittee participants:

Please find attached materials for the first Upper Tuolumne River Reintroduction Assessment Framework Technical Subcommittee conference call scheduled for Tuesday, February 16th from 11am-1pm. Call-in number is 866-583-7984, passcode 8140607.

Materials attached include:

1. Agenda – note that the primary objectives of the call include decisions on 2016 studies to support the Reintroduction Assessment Framework and decisions on an approach and schedule for the development of reintroduction program goals.

2. Potential Reintroduction Studies List and Abstracts – an updated list of potential reintroduction studies to support identification of the 2016 study program.

Thank you for your participation.

Rose Staples, CAP-OM, MOS
Executive Assistant

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From: Staples, Rose
Sent: Friday, February 12, 2016 3:00 PM
Cc: Staples, Rose; Le, Bao
Subject: Advance Materials for La Grange Technical Subcommittee Call Feb 16

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Please find attached materials for the first Upper Tuolumne River Reintroduction Assessment Framework Technical Subcommittee conference call scheduled for Tuesday, February 16th from 11am-1pm. Call-in number is 866-583-7984, passcode 8140607.

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2. Potential Reintroduction Studies List and Abstracts – an updated list of potential reintroduction studies to support identification of the 2016 study program.

Thank you for your participation.

Rose Staples, CAP-OM, MOS
Executive Assistant

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La Grange Hydroelectric Project
Reintroduction/Fish Passage Assessment Framework
Technical Subcommittee Conference Call

Tuesday, February 16, 11:00 am to 1:00 pm
Conference Line: 1-866-583-7984; Passcode: 814-0607

Meeting Objectives:

1. Identify and decide on 2016 studies for the Upper Tuolumne River Reintroduction/Fish Passage Assessment Framework (Reintroduction Framework).
2. Prepare schedule for study plan development of identified 2016 studies.
3. Identify and decide on a schedule for the development of reintroduction program goals.

TIME	TOPIC
11:00 am – 11:10 am	Introduction of Participants (All) Review Agenda and Meeting Objectives (Districts)
11:10 am – 12:20 pm	2016 Studies to Support Reintroduction Framework (All) a. General studies list b. Discuss feedback/comments from Workshop #4 c. Updates on studies in progress d. Discuss and decide: - 2016 studies -Study plan development schedule for 2016 studies
12:20 pm – 12:50 pm	Reintroduction Program Goals to Support Reintroduction Framework (All) a. Purpose of development of program goals (i.e., metrics for success) in the Reintroduction Framework b. Relationship to Recovery Plan c. Discuss and decide: - Development schedule - Participants
12:50 pm – 1:00 pm	Next Steps (All) a. Schedule next call and agenda topics (e.g., review 2016 draft study plans, etc.) b. Action items

Potential Studies to Inform Reintroduction Assessment Framework For Discussion and Review by Technical Subcommittee

Framework Category	Studies	On-going and Potential Studies for 2016[1]	Cost Estimate	Schedule for Draft Report
Ecological	Limiting Factors Analysis and Carrying Capacity		$340,000	December 2017
Ecological	Reservoir Transit Study		$500,000	
Ecological	Interactions with Existing Aquatic Communities		$250,000	
Ecological	Source Population Assessment		NMFS lead?	
Ecological	Method of Colonization		$60,000	
Ecological	Genetics Assessment of Existing and Source Populations (NMFS has study on-going)	X	NMFS lead	April 2017
Ecological	Climate Change Assessment (proposed by NMFS)		NMFS lead?	
Biological	Habitat Typing and Characterization[2]	P	$240,000	Nov/Dec 2016
Biological	Upstream Migration Barriers	X	$220,000	Nov/Dec 2016
Biological	Instream Flow – Habitat Assessment: PHABSIM		$300,000[3]	
Biological	Water Temperature Monitoring and Modeling	X	$350,000	Nov/Dec 2016
Biological	Spawning Gravel Study	P	$140,000	Nov/Dec 2016
Biological	Macroinvertebrate Study		$220,000	
Biological	Swim Tunnel Study of Upper River *O. mykiss*		$450,000	
Economic, Regulatory, and Other Key Considerations	Regulatory Evaluation of Reintroduction (ESA Status, BLM/USFS Management Plans, Wild and Scenic, etc)	P	$50,000	October 2016
Economic, Regulatory, and Other Key Considerations	Socioeconomic Scoping and Issues Identification/ Preliminary Evaluation of Impacts on Tuolumne River Uses/Users	P	$50,000	October 2016
Economic, Regulatory, and Other Key Considerations	Hatchery Practices Review, including current Don Pedro related practices.		$50,000	

Draft Study Abstracts

Limiting Factors Analysis and Carrying Capacity

A limiting factors analysis (LFA) is a useful tool to identify and fill information gaps related to physical and biological factors controlling population dynamics of one or more target species. This type of analysis has been used extensively in California and the Pacific Northwest to identify habitat conditions, ecological interactions, and other factors that constrain salmonid population production potential. The LFA proposed herein would test hypotheses regarding potential factors that that could limit the ability of the upper Tuolumne River to support viable populations of reintroduced Chinook salmon and O. mykiss. The data analyzed and synthesized as part of a LFA can also include an analysis of carrying capacity, to determine the number of individuals of each freshwater life stage that can be supported by the available habitat. The results of a LFA provide valuable insight into possible effects of current or historical riverine habitat

[1] X = Ongoing study; P = Proposed additional 2016 study for consideration by collaborative group

[2] Habitat typing and characterization study proposal does not explicitly include habitat components being collected by NMFS; however, the NMFS data should be discussed in overall Assessment Framework.

[3] The geographic scope and amount of available information needs to be confirmed to refine scope and cost estimate.

conditions on salmonid populations (or reintroduced populations), allowing managers evaluate reintroduction potential, focus future management activities, help prioritize actions, and/or refine the current understanding of limitations of the ecosystem.

Reservoir Transit Study

As detailed in FERC's study plan determination, if the fish passage facilities assessment indicate that the most feasible concept alternative for fish passage would involve either upstream or downstream passage through the project reservoirs (i.e., La Grange or Don Pedro reservoirs), a study would be required to evaluate the technical and biological feasibility of upstream (adults) or downstream (juvenile) movement of anadromous fish (as appropriate) through the project's reservoirs. Until feasible concept alternatives have been selected, the scope of this study cannot be accurately identified.

Interactions with Existing Aquatic Communities

Evaluating potential interactions with existing species in the target area is a factor that can impact reintroduction success. This constraint includes predatory and competitive interactions with other species and populations. Often times, habitat in target areas have changed from historic conditions. Consequently, aquatic communities present in target reintroduction areas may be comprised of non-native species or native invaders that have filled these available niches. Furthermore, intraspecific competition is possible if a population of the target species is already present in the target reach (i.e., *O. mykiss*). This assessment would identify the potential interactions of target reintroduction species with the existing aquatic community in the target reach and characterize the potential risks/benefits to the reintroduction program.

Source Population Assessment

Consideration of genetic and ecological characteristics of a source population is important to assessing the probability of a successful reintroduction. Ecological factors such as life history, morphological, and behavioral traits compatible with the target area will increase the probability of a successful reintroduction. Source populations that are genetically similar to the historic population may also maximize the benefits and reduce the risks of reintroduction. This assessment would identify factors that should be considered when identifying viable source populations, potential sources, associated pros and cons of each, and constraints of utilizing each source, if any.

Method of Colonization Assessment

Colonization approaches (i.e., natural, transplants, and hatchery releases) differ in the effects on the parameters that are used to assess the success or failure of a reintroduction. Method of colonization also has implications for the infrastructure and operations needed to support a reintroduction program. As such, identifying early in the process the lowest-risk strategy for colonization will be a critical component of assessing risks, constraints, and benefits of any reintroduction program.

Genetics Assessment of Existing and Source Populations

NMFS is conducting a study of the upper river *O. mykiss* fishery genetics. Request a schedule and information update for the group.

Climate Change Assessment

At the January 27th, 2016 Upper Tuolumne River Reintroduction Assessment Framework Workshop #4, NMFS requested that a climate change assessment be added to this potential studies list. An action item was noted at this workshop for NMFS to develop an abstract.

Habitat Typing and Characterization

Habitat mapping quantifies the type, amount, and location of river habitat types available to reintroduced anadromous salmonids of all life stages. Habitat mapping would be conducted in the field and remotely using standardized methodologies. The frequency and area of each habitat type (e.g., pool, riffle, run) would be tabulated and where potential holding pools for spring-run salmon occur, the size, depth, and vertical thermal profile of the pools will be measured to determine possible holding capacity, stratification of the pools (if any), and thermal suitability. Additional (remote) mapping tasks will include assessments of channel gradient, width, habitat areas, etc. This baseline information provides the template for many other evaluations and is critical for assessing the feasibility of reintroduction. For example, data on habitat type, area, and distribution are required to assess potential Chinook salmon and steelhead adult holding capacity, spawning habitat potential, and juvenile rearing capacity.

Upstream Migration Barriers

Little information exists to reliably assess the current quantity and quality of suitable habitat for the adult, egg, fry and juvenile life stages of anadromous salmonid species that may be considered for reintroduction in the Upper Tuolumne River watershed (i.e., above the Don Pedro Project). Prior to assessing the quality/suitability of habitat for target species, an assessment of barriers (both complete and partial) to upstream anadromous salmonid migration must first be conducted to identify the quantity of habitat that is accessible. This assessment would utilize relevant prior studies, desktop analyses, and field surveys to characterize and document the physical structure of barriers in the mainstem Tuloumne River and its tributaries upstream of the Don Pedro Project Boundary. Note that this study was requested by NMFS but per FERC's determination, was not required to be conducted by the Districts as part of the La Grange licensing process. However, to more fully support licensing participants in their development of information to supplement fish passage and reintroduction assessments, and to foster collaboration among all parties, the Districts have opted to conduct an upstream migration barriers assessment.

Instream Flow – Habitat Assessment: PHABSIM

Hydraulic models such as the Physical Habitat Simulation (PHABSIM) system are widely used and accepted tools used to produce quantitative estimates of the amount (quantity and quality) of habitat available to fish at a range of stream flows. Using measured physical channel characteristics for representative habitat types or reaches, PHABSIM modeling incorporates habitat suitability relationships for the target fish species and life stage to produce estimates of weighted usable area (WUA) in relation to stream flow. Results of PHABSIM modeling can be combined with data from habitat mapping and water temperature modeling to provide estimates of habitat availability and suitability for target species and associated life stages throughout the project area at a range of flows. Additionally, the analysis would include an evaluation of the effect of fluctuating flows on habitat value, due to the frequent peaking operations in the upper Tuolumne River. This could be evaluated by comparing habitat values on a small time-step using the high and low flows within the fluctuation range. Water temperature data would also be overlaid with the PHABSIM results to evaluate how the total amount of habitat is affected by thermal rather than physical habitat conditions.

Water Temperature Monitoring and Modeling

The assessment of suitable habitat quality for the adult, egg, fry and juvenile life stages of anadromous salmonid species that may be considered for reintroduction in the Upper Tuolumne River watershed (i.e., above the Don Pedro Project) is dependent upon both physical and thermal characteristics. This study would use existing and additional data to characterize the thermal regimes of the upper Tuolumne River and tributaries from the Don Pedro Project Boundary to CCSF's Early Intake to characterize locations where temperatures may be suitable for anadromous salmonid species considered for reintroduction. The study would include the development of a computer model to simulate existing thermal conditions in the study area. Note that this study was requested by NMFS but per FERC's determination, was not required to be conducted by the Districts as part of the La Grange licensing process. However, to more fully support licensing participants in their development of information to supplement fish passage and reintroduction assessments, and to foster collaboration among all parties, the Districts have opted to conduct an upstream migration barriers assessment.

Spawning Gravel Study

Spawning gravel mapping quantifies the amount, location, and suitability of gravel available for spawning by reintroduced anadromous salmonids. In a confined, high gradient river channel dominated by large substrates (boulder, cobble, bedrock) like the upper Tuolumne River, spawning gravel distribution is typically patchy and overall abundance may be low. Initial evaluation of aerial photographs and an on-river reconnaissance survey indicate this is may be the case in portions of the Tuolumne River between Wards Ferry and Early Intake. Because successful spawning and fry production are dependent on the abundance and suitability of accessible spawning gravel, spawning gravel mapping is a critical component for assessing the feasibility of reintroduction. This information is a key part of any evaluation of the factors likely to limit production and viability of an existing or reintroduced salmonid population (i.e., a limiting factors or carrying capacity analysis).

Macroinvertebrate Study

Drifting and benthic macroinvertebrates (BMI) are the primary food source for rearing salmonids in fresh water habitats. Growth of juvenile anadromous salmonids during their freshwater rearing period is critical for their survival during outmigration and ocean phases, as well as to the overall viability of the population. Studies have shown a strong relationship between the size at which juvenile salmon and steelhead migrate to the ocean and the probability that they return to fresh water to spawn. Macroinvertebrate sampling provides a measure of food availability during this important life history period. Information on macroinvertebrate prey resource availability is therefore a key component of any evaluation of the factors likely to limit production and viability of an existing or reintroduced salmonid population (i.e., a limiting factors analysis).

Swim Tunnel Study of Upper River O. mykiss

Thermal acclimation among fish species dates back to the 1940's and since 2001, thermal adaptation at the population level and among a wide variety of fish species has been convincingly supported in the peer-reviewed scientific literature. Included in this evidence base are salmon and trout species. The objective of this study would be to determine the thermal performance of the subadult *O. mykiss* population inhabiting the upper Tuolumne River to assess any local adjustments in thermal performance. The study would test the hypothesis that the *O.mykiss* population in the Upper Tuolumne River (i.e., above the Don Pedro Project Reservoir) is locally adjusted to relatively warm thermal conditions that may exist during the summer. Results of the study would be used to support habitat suitability and temperature modeling assessments.

Hatchery Practices Review, including current Don Pedro related practices

Assessing historic and current hatchery practices in the upper Tuolumne River will be necessary to evaluate potential risks to reintroduction. Risks include but are not limited to evolutionary (homogenization or reduced fitness), ecological (competition, predation, etc.) and disease issues. Results of the review will identify past and current hatchery practices in the reintroduction area as well as connected areas (i.e., Don Pedro Reservoir), potential risks of past/present hatchery programs to a reintroduction program, and recommendations to address identified risks.

Regulatory Evaluation of Reintroduction

The Upper Tuolumne River watershed spans several land management agencies' jurisdictions and there are management plans and regulations in place based on established resource management objectives (e.g., Wild and Scenic Management Plan, Forest Plan, BLM Management Plan). The compatibility of the potential reintroduction of *O.mykiss* and/or spring run Chinook will be evaluated relative to these current management objectives. The potential reintroduction of Endangered Species Act (ESA) listed species may overlay additional management objectives and a new regulatory framework in the upper Tuolumne River. This evaluation will include compiling and reviewing all relevant and potentially relevant existing management plans for the upper Tuolumne River and the Don Pedro Reservoir. In addition, applicable recovery plans and ESA regulations and potential population status classifications for the reintroduced species will be summarized. Responsible resource management agencies will be contacted to determine the most recent guidance documents for the study area.

Socioeconomic Scoping and Issue Identification/Preliminary Evaluation of Impacts on Tuolumne River Uses/Users

Current management of the Don Pedro Reservoir and upper Tuolumne River supports a wide range of resources, uses, and users. The upper watershed includes the Tuolumne Wild & Scenic River segment managed for several outstanding resource values and is utilized by commercial and private recreational boaters. Other uses include the City and County of San Francisco's Hetch Hetchy Project operations, private timber practices, and a recreational fishery. Don Pedro Reservoir has an active house boating and recreational fishery; county government and businesses rely upon the economic activities supported by the upper watershed. This evaluation will conduct a comprehensive survey of uses in the upper watershed and identify potential issues for consideration in the reintroduction assessment. A literature survey and review of existing information from the Don Pedro Recreation Agency, county and federal land management agencies and other sources will be conducted. Surveys and/or focus groups will be used to verify and expand upon available information on the multiple existing uses of the watershed that could be impacted by a fish reintroduction program.

From: Le, Bao
Sent: Friday, February 12, 2016 12:06 PM
To: John Wooster - NOAA Federal
Cc: Deason, Jesse
Subject: FW: Advance Materials for La Grange Technical Subcommittee Call Feb 16

Hi John.

Related the materials above, I wanted to give you a "head's up" regarding two items:

1. Climate change abstract action item – if you are able to provide something in advance of the meeting to help participants understand the scope of this potential study, that would be great – we will distribute. If this is not possible, input at the meeting about what NMFS is thinking with regard to the scope/objectives of this request would be much appreciated.

2. Genetics Study update – in the agenda, there is a brief topic for in-progress study updates. It would be great if NMFS could be ready to provide some updated information on the study including objectives, preliminary results, next steps, etc.

Let me know if you have any questions.

Have a good weekend,
Bao

From: Staples, Rose
Sent: Friday, February 12, 2016 12:00 PM
Cc: Staples, Rose; Le, Bao
Subject: Advance Materials for La Grange Technical Subcommittee Call Feb 16

La Grange Technical Subcommittee participants:

Please find attached materials for the first Upper Tuolumne River Reintroduction Assessment Framework Technical Subcommittee conference call scheduled for Tuesday, February 16th from 11am-1pm. Call-in number is 866-583-7984, passcode 8140607.

Materials attached include:

1. Agenda – note that the primary objectives of the call include decisions on 2016 studies to support the Reintroduction Assessment Framework and decisions on an approach and schedule for the development of reintroduction program goals.

2. Potential Reintroduction Studies List and Abstracts – an updated list of potential reintroduction studies to support identification of the 2016 study program.

Thank you for your participation.

Rose Staples, CAP-OM, MOS
Executive Assistant

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From: Le, Bao
Sent: Friday, February 12, 2016 10:28 AM
To: Holdeman, Steven J -FS
Cc: Deason, Jesse; Borovansky, Jenna; Staples, Rose
Subject: RE: Upper Tuolumne River Reintroduction Assessment Framework - Invitation to participate in the technical subcommittee

Hi Steve.

Sorry for the delayed response. We're excited to have USFS participation. Thank you for making the time. Later today, you'll receive information and materials regarding the upcoming technical subcommittee conference call next week but be aware that this process has been ongoing for about a year. As such, there are materials from a number of workshops that have occurred in 2015 in case you wanted to dig into the background and get up to speed. The documents are on the www.lagrange-licensing.com website; the notes and materials used at previous workshops are filed, in date sequence, under the DOCUMENTS tab on the website--and the advance materials used at the most recent workshop (January 27) are attached to the meeting date announcement on the website calendar under the CALENDAR tab. It might be a bit overwhelming so if you have any questions related to navigating the website to acquire relevant materials, please contact either Rose Staples or Jesse Deason, both cc'd here. And as always, if you have any questions or want to get up to speed via phone, please don't hesitate to call me.

Thanks, Bao

From: Holdeman, Steven J -FS [mailto:sholdeman@fs.fed.us]
Sent: Tuesday, February 09, 2016 1:28 PM
To: Le, Bao
Subject: FW: Upper Tuolumne River Reintroduction Assessment Framework - Invitation to participate in the technical subcommittee

Hi there, Bao.

I'm the fisheries biologist for the Stanislaus NF and would like to be informed when you all are having a meeting. Also, I would like to receive any information coming from the work you all are conducting in the Upper Tuolumne River watershed. I'm somewhat ashamed to say this, but I generally have very little idea where you all are at this stage of the relicensing process because I have been committed to doing post-Rim Fire work on the forest. My work in that area has slowed to the point where I can entertain additional interests, including this part of the La Grange/Don Pedro relicensing.

Thank you for including us in this effort, and I look forward to communication in the future.

Steven J. Holdeman
Forest Aquatic Biologist

Forest Service
Stanislaus National Forest, Supervisor's Office

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Caring for the land and serving people

From: Vaughn, Gary D -FS
Sent: Friday, February 05, 2016 1:34 PM
To: Junette, Jim -FS; Jow, Michael -FS; Holdeman, Steven J -FS
Subject: FW: Upper Tuolumne River Reintroduction Assessment Framework - Invitation to participate in the technical subcommittee

All – please see below and let me know if anyone is available to assist with these studies and resulting framework.

Thanks,

Dusty Vaughn
Public Service Program Leader
Forest Service
Stanislaus National Forest, Groveland Ranger District
p: 209-962-7825 x525
f: 209-962-7412
gdvaughn@fs.fed.us
24545 State Highway 120
Groveland, CA 95321
www.fs.fed.us

Caring for the land and serving people

From: Le, Bao [mailto:ChiBao.Le@hdrinc.com]
Sent: Thursday, February 04, 2016 4:04 PM
To: Vaughn, Gary D -FS <gdvaughn@fs.fed.us>
Cc: Borovansky, Jenna <Jenna.Borovansky@hdrinc.com>; Deason, Jesse <Jesse.Deason@hdrinc.com>
Subject: Upper Tuolumne River Reintroduction Assessment Framework - Invitation to participate in the technical subcommittee

Hi Dusty.

As part of the La Grange Licensing Process, the Districts and Licensing Participants (LPs) are implementing a Reintroduction Assessment Framework intended to evaluate the feasibility of reintroducing anadromous salmonids into the Upper Tuolumne River. The process is intended to integrate biological/ecological, fish passage engineering, and economic/regulatory and other key considerations into a structured reintroduction evaluation. We began the process in January 2016 and as part of this process, we are convening a technical subcommittee to address technical elements such as identifying information gaps, developing studies, etc. Since this technical subcommittee will be developing studies that will occur in the Upper Tuolumne River (as early as this summer), we wanted to extend an invite to both the USFS and the BLM to participate. Given your regulatory authority in the upper watershed, your participation and input would be valuable from a variety of perspectives including permit coordination.

If you or any of your staff are interested in participating, we'd welcome it. We're mindful of everyone's busy schedules and as such, technical subcommittee conference calls will generally be short (i.e., 2 hours) and only when needed.

Please let me know if you have any questions.

Thanks,
Bao

Bao Le

Senior Fisheries Biologist

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From: John Wooster - NOAA Federal <john.wooster@noaa.gov>
Sent: Tuesday, February 16, 2016 4:16 PM
To: Le, Bao
Cc: Deason, Jesse
Subject: Re: FW: Advance Materials for La Grange Technical Subcommittee Call Feb 16
Attachments: Pearse_Garza_2015.pdf

Bao:

Attached is the paper I was talking about today related to genetics.

-John

On Fri, Feb 12, 2016 at 12:05 PM, Le, Bao <ChiBao.Le@hdrinc.com> wrote:

Hi John.

Related the materials above, I wanted to give you a "head's up" regarding two items:

1. Climate change abstract action item – if you are able to provide something in advance of the meeting to help participants understand the scope of this potential study, that would be great – we will distribute. If this is not possible, input at the meeting about what NMFS is thinking with regard to the scope/objectives of this request would be much appreciated.

2. Genetics Study update – in the agenda, there is a brief topic for in-progress study updates. It would be great if NMFS could be ready to provide some updated information on the study including objectives, preliminary results, next steps, etc.

Let me know if you have any questions.

Have a good weekend,

Bao

From: Staples, Rose
Sent: Friday, February 12, 2016 12:00 PM
Cc: Staples, Rose; Le, Bao
Subject: Advance Materials for La Grange Technical Subcommittee Call Feb 16

La Grange Technical Subcommittee participants:

Please find attached materials for the first Upper Tuolumne River Reintroduction Assessment Framework Technical Subcommittee conference call scheduled for Tuesday, February 16th from 11am-1pm. Call-in number is 866-583-7984, passcode 8140607.

Materials attached include:

1. Agenda – note that the primary objectives of the call include decisions on 2016 studies to support the Reintroduction Assessment Framework and decisions on an approach and schedule for the development of reintroduction program goals.
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Thank you for your participation.

Rose Staples, CAP-OM, MOS

Executive Assistant

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John Wooster
Hydrologist
NOAA Fisheries West Coast Region

U.S. Department of Commerce
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Title:

You Can't Unscramble an Egg: Population Genetic Structure of *Oncorhynchus mykiss* in the California Central Valley Inferred from Combined Microsatellite and Single Nucleotide Polymorphism Data

Journal Issue:

San Francisco Estuary and Watershed Science, 13(4)

Author:

Pearse, Devon E., Southwest Fisheries Science Center, National Marine Fisheries Service, Santa Cruz, CA
Garza, John Carlos, Southwest Fisheries Science Center, National Marine Fisheries Service, Santa Cruz, CA

Publication Date:

2015

Permalink:

http://escholarship.org/uc/item/8dk7m218

Acknowledgements:

We thank Vanessa Apkenas, Anthony Clemento, Cheryl Dean, Celeste Gallardo, Libby Gilbert–Horvath, Andres Martinez, and Edith Martinez for assistance in the laboratory, and Sara John and Alicia Abadía–Cardoso for help with the analysis and figures. The sam

Keywords:

Evolution, genetics, adaptation, steelhead, trout, Central Valley

Local Identifier:

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Abstract:

doi: http://dx.doi.org/10.15447/sfews.2015v13iss4art3

Steelhead/rainbow trout (*Oncorhynchus mykiss*) are found in all of the major tributaries of the Sacramento and San Joaquin rivers, which flow through California's Central Valley and enter the ocean through San Francisco Bay and the Golden Gate. This river system is heavily affected by water development, agriculture, and invasive species, and salmon and trout hatchery propagation has been occurring for over 100 years. We collected genotype data for 18 highly variable microsatellite loci and 95 single nucleotide polymorphisms (SNPs) from more than 1,900 fish from Central Valley drainages to analyze genetic diversity, population structure, differentiation between populations above and below dams, and the relationship of Central Valley *O. mykiss* populations to coastal California steelhead. In addition, we evaluate introgression by both hatchery rainbow trout strains, which have primarily native Central Valley ancestry, and imported coastal steelhead stocks. In contrast to patterns typical of coastal steelhead, Central Valley *O. mykiss* above and below dams within the same tributary were not found to be each others' closest relatives, and we found no relationship between genetic and geographic distance among below-barrier populations. While introgression by hatchery rainbow trout strains does not appear to be widespread among above-barrier populations, steelhead in the American River and some neighboring tributaries have been introgressed by coastal steelhead. Together, these results demonstrate that the ancestral population genetic structure that existed among Central Valley tributaries has been significantly altered in contemporary populations. Future conservation, restoration, and mitigation efforts should take this into account when working to meet recovery planning goals.

DECEMBER 2015

SAN FRANCISCO ESTUARY & WATERSHED SCIENCE

Sponsored by the Delta Science Program and the UC Davis John Muir Institute of the Environment

You Can't Unscramble an Egg: Population Genetic Structure of *Oncorhynchus mykiss* in the California Central Valley Inferred from Combined Microsatellite and Single Nucleotide Polymorphism Data

Devon E. Pearse*[1] and John Carlos Garza[1]

Volume 13, Issue 4 | Article 3

doi: *http://dx.doi.org/10.15447/sfews.2015v13iss4art3*

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1 Fisheries Ecology Division, Southwest Fisheries Science Center, National Marine Fisheries Service, Santa Cruz, CA 95060 USA and University of California, Santa Cruz, CA 95060 USA

KEY WORDS

Evolution, genetics, adaptation, steelhead, trout, Central Valley.

ABSTRACT

Steelhead/rainbow trout (*Oncorhynchus mykiss*) are found in all of the major tributaries of the Sacramento and San Joaquin rivers, which flow through California's Central Valley and enter the ocean through San Francisco Bay and the Golden Gate. This river system is heavily affected by water development, agriculture, and invasive species, and salmon and trout hatchery propagation has been occurring for over 100 years. We collected genotype data for 18 highly variable microsatellite loci and 95 single nucleotide polymorphisms (SNPs) from more than 1,900 fish from Central Valley drainages to analyze genetic diversity, population structure, differentiation between populations above and below dams, and the relationship of Central Valley *O. mykiss* populations to coastal California steelhead. In addition, we evaluate introgression by both hatchery rainbow trout strains, which have primarily native Central Valley ancestry, and imported coastal steelhead stocks. In contrast to patterns typical of coastal steelhead, Central Valley *O. mykiss* above and below dams within the same tributary were not found to be each others' closest relatives, and we found no relationship between genetic and geographic distance among below-barrier populations. While introgression by hatchery rainbow trout strains does not appear to be widespread among above-barrier populations, steelhead in the American River and some neighboring tributaries have been introgressed by coastal steelhead. Together, these results demonstrate that the ancestral population genetic structure that existed among Central Valley tributaries has been significantly altered in contemporary populations. Future conservation, restoration, and mitigation efforts should take this into account when working to meet recovery planning goals.

INTRODUCTION

The Central Valley of California supports both Chinook salmon (*Oncorhynchus tshawytscha*) and fish from the species *O. mykiss*, commonly known as steelhead (anadromous life history) or rainbow trout (resident life history). Tributary rivers from the west slope of the Sierra Nevada mountain range and east slopes of the coastal mountain ranges feed into the north-flowing San Joaquin and the south-flowing Sacramento rivers, which converge in the San Francisco Bay/Delta region before finally exiting to the Pacific ocean. The watershed has been severely affected by the construction of many dams, which block movement by anadromous fish and effectively divide nearly every major tributary into separate above-barrier and below-barrier reaches. In addition, much of the flow in the system is diverted for agricultural and domestic uses through an extensive system of levees and aqueducts. Together, these effects have severely modified and reduced the habitat available to anadromous fishes (Lindley et al. 2006).

Populations of steelhead in California are divided into six Distinct Population Segments (DPSs) for management purposes; five on the coast and one in the Central Valley (Busby et al. 1996). Importantly, these DPSs specifically include only anadromous life-history fish that spawn below impassable barriers to migration; *O. mykiss* isolated above natural or artificial barriers to fish passage are excluded from the DPS and, consequently, from protection under the U.S. Endangered Species Act (ESA; Federal Register 2006). The California Central Valley Steelhead DPS also includes fish produced by two of the four artificial propagation programs in the Central Valley—the Feather River Fish and Coleman National Fish hatcheries—but not those spawned at the Nimbus or Mokelumne River hatcheries. This DPS was listed as "Threatened" under the ESA in 1998 and this status was reaffirmed in 2006 (Federal Register 2006).

Hatchery rainbow trout have been heavily stocked in the reservoirs above nearly all of the Central Valley dams for more than 100 years (Busack and Gall 1980; California HSRG 2012). These captive hatchery trout broodstock strains were domesticated from diverse geographic and phylogenetic sources, but many originated from fish collected from streams that drain into the Central Valley (Needham and Behnke 1962; Leitritz 1970). Similarly, steelhead and other anadromous salmonids have been propagated at several hatcheries in the Central Valley since the late 1800s, and four Central Valley hatcheries (Coleman, Feather, Nimbus, and Mokelumne), currently release approximately 1.5 million yearlings annually (Brown 2005; California HSRG 2012). For both steelhead and hatchery trout strains, it has been common practice to move eggs among hatcheries within the Central Valley and to import eggs from outside sources (Leitritz 1970; California HSRG 2012). Nimbus Hatchery on the American River has been a substantial producer of steelhead in the Central Valley since 1955 (Leitritz 1970) and, for many years, imported eggs from coastal steelhead sources, primarily the Eel and Mad rivers (California HSRG 2012). However, the extent to which such interbasin transfers have influenced population structure of *O. mykiss* in the Central Valley has not been carefully evaluated.

Numerous genetic analyses of salmonid population structure in California have relied on microsatellite markers, because such multi-locus data can identify population genetic structure at both larger scales (Aguilar and Garza 2006; Clemento et al. 2009; Garza et al. 2014) and at relatively fine ones (Deiner et al. 2007; Pearse et al. 2007, 2009; Kinziger et al. 2013), including within the Central Valley (Banks et al. 2000; Nielsen et al. 2005). Recently, another class of genetic markers, single nucleotide polymorphisms (SNPs), has been used increasingly in population genetics and has proven useful in assessments of population structure (Morin et al. 2004), introgressive hybridization (Stephens et al. 2009; Finger et al. 2011), and pedigree reconstruction (Abadía–Cardoso et al. 2013). Though microsatellites and SNPs each have advantages and disadvantages in terms of cost, genotyping errors, polymorphism, etc., when a large number of both types of loci is available, this combination provides the most statistical power for understanding population genetic relationships (Narum et al. 2008).

Here we attempt to "unscramble" the population genetic structure of Central Valley *O. mykiss* using a combination of more than 100 microsatellite and SNP loci on a comprehensive set of Central Valley trout and steelhead populations. We compare these data with genotypes from a representative set of hatchery trout strains and coastal California steelhead populations (Aguilar and Garza 2006; Pearse et al.

2007, 2009; Clemento et al. 2009; Garza et al. 2014). Analysis of this combined dataset provides insight into the the historical relationships of Central Valley *O. mykiss*, as well as the relationships of Central Valley populations with those from other parts of California.

METHODS

Sampling

Samples were taken from populations of *O. mykiss* at one or more locations in 15 tributary sub-basins of the Sacramento and San Joaquin rivers that drain the Central Valley (Figure 1; Table 1), including locations both above and below barriers to anadromy in most tributaries. Most fish were captured using either electrofishing or hook-and-line capture techniques. Small pieces of caudal fin tissue were then excised and preserved through desiccation on blotter paper. Fish sampled in multiple years in the same location were combined for analysis, after verifying that they were taken from the same underlying population. These groups of fish are all referred to as populations for convenience and without additional assumptions about the biological details underlying this designation.

Genetic Data Collection

Nucleic acid extraction and microsatellite and SNP genotyping followed Arciniega et al. (2016). Genotypic data from 18 microsatellite loci were collected for all samples. This set of loci has been used in numerous previous studies of *O. mykiss* in California (Aguilar and Garza 2006; Deiner et al. 2007; Pearse et al. 2007, 2009, 2011a; Garza et al. 2014). All samples were also genotyped with the panel of 96 SNP loci used by Abadía–Cardoso et al. (2013). The 96 SNPs include 95 loci from Aguilar and Garza (2008), Campbell et al. (2009), and Abadía–Cardoso et al. (2011), as well as an assay that includes a Y–chromosome marker developed by Brunelli et al. (2008) that identifies gender. All 96 loci were genotyped using 5′ nuclease TaqMan assays (Applied Biosystems) on 96.96 Dynamic Genotyping Arrays in the EP1 Genotyping System (Fluidigm Corporation). Two negative controls were included in each array and genotypes were called using Fluidigm SNP Genotyping Analysis Software v3.1.1.

Data Analysis

We combined the microsatellite and SNP data collected from the Central Valley *O. mykiss* populations with previously collected data from coastal California steelhead populations and hatchery trout strains commonly stocked in California. In analyzing these data, we first removed from most analyses three SNP loci that have been shown to be influenced by selection on life-history patterns in *O. mykiss* (Pearse et al. 2014). Two of these loci in particular, *SH121006-131* and *SH114448-87*, are in strong linkage disequilibrium (LD) with a genomic region on chromosome Omy5 that was recently found to be associated with resident and anadromous life-history in coastal California steelhead populations (Pearse et al. 2014). These two loci were analyzed separately to evaluate patterns of LD between them in Central Valley populations using the R package genetics (Warnes and Leisch 2005). Finally, we removed three microsatellite loci (*OtsG401*, *Omy27*, and *Ots1b*) and two SNP loci (*SH127645-308* and *SH128996-481*) for which at least one of the population samples was not genotyped. Together, these removals left a total of 105 loci (15 microsatellites and 90 SNP loci), and we conducted all further population genetic analyses on this combined dataset. The gender identification locus was also excluded from the population genetic analyses.

We calculated expected heterozygosity (Nei 1987), observed heterozygosity, and number of alleles for each sample population, and estimated allelic richness (AR) with the rarefaction method in the program HP-Rare (Kalinowski 2005) based on a sample of 25 gene copies. We quantified pairwise differentiation between all populations with F_{ST}, using Weir and Cockerham's (1984) estimator, and assessed significance by the permutation algorithm in the genetix software package (Belkhir et al. 2004) with 100 replicates. We used a Mantel test implemented in the program *ISOLDE* of the GenePop software package (Raymond and Rousset 1995) to evaluate the correlation between genetic and geographic distance

http://dx.doi.org/10.15447/sfews.2015v13iss4art3

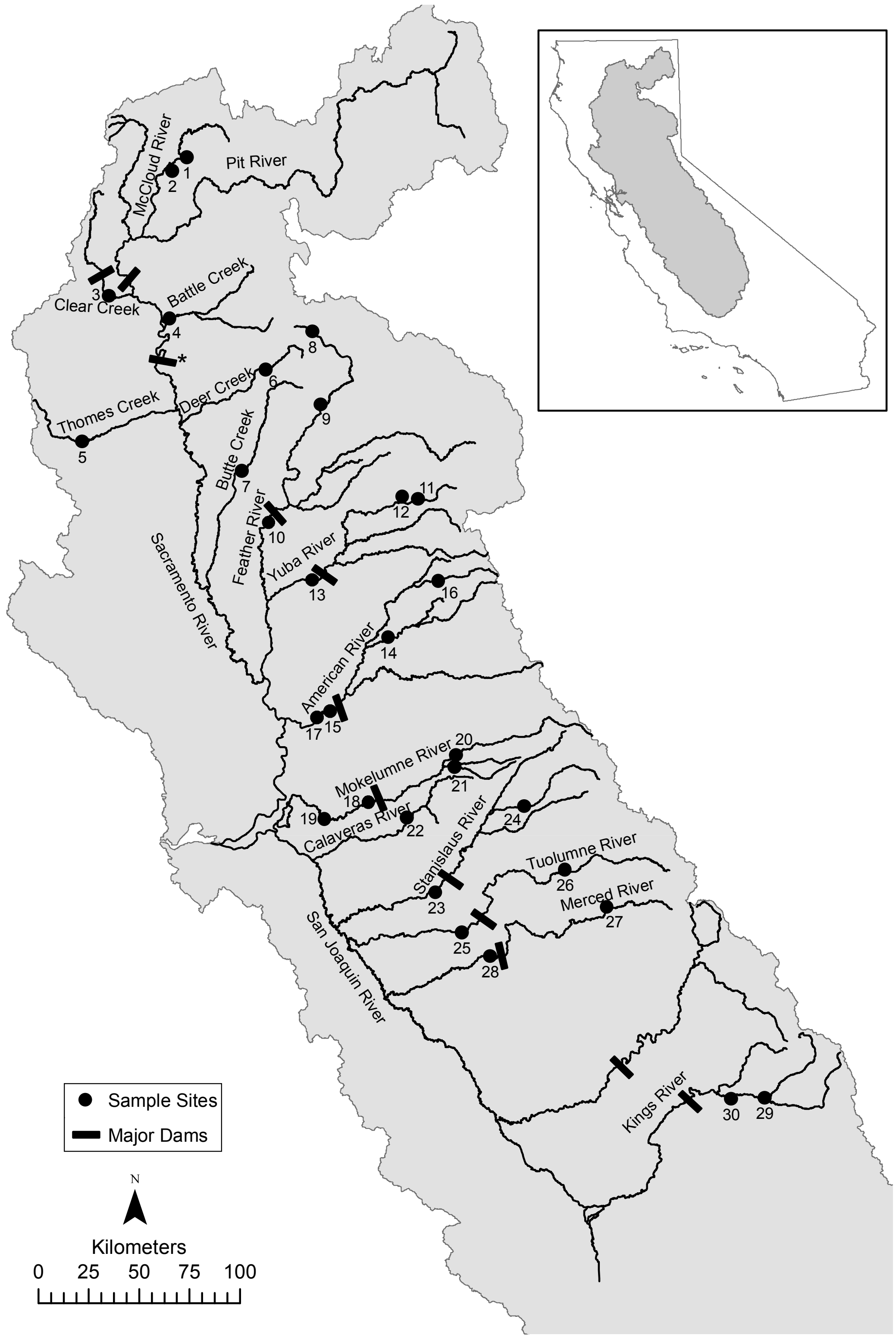

Figure 1 Map showing Central Valley of California, including major barrier dams and rivers tributary to the Sacramento-San Joaquin system. Sample sites are numbered as in Table 1.

Table 1 Population samples used in the present study, organized by region (coastal versus Central Valley), and listed north to south. Within each basin, population samples are grouped with respect to location above and below major dams, or at hatcheries. For each population, number of samples (N), expected and observed heterozygosities (He and Ho), microsatellite and SNP allelic richness (AR), proportion genetically self-assigned, and linkage disequilibrium (r^2) between two SNP loci located on chromosome Omy5.

Population	Area	N	He	Ho	AR (micros)	AR (SNPs)	% Self	r^2(Omy5)
North Coast								
Smith R.	Coastal	32	0.38	0.37	7.99	1.89	93.8	0.99
Klamath R. (Blue Ck.)	Coastal	32	0.39	0.37	8.64	1.93	96.9	0.93
Klamath R. (Hunter Ck.)	Coastal	28	0.39	0.39	6.68	1.92	85.7	0.79
Redwood Ck. (Lost Man Ck.)	Coastal	31	0.42	0.39	8.27	1.94	87.1	1.00
Mad R.	Coastal	31	0.39	0.41	6.77	1.94	74.2	1.00
Eel R. (Hollow Tree Ck.)	Coastal	28	0.39	0.39	7.04	1.91	71.4	1.00
Eel R. (Lawrence Ck.)	Coastal	30	0.41	0.40	7.50	1.94	90.0	0.74
Mattole R.	Coastal	31	0.39	0.40	6.36	1.92	93.5	1.00
Noyo R.	Coastal	31	0.41	0.42	7.62	1.96	93.5	0.82
Gualala R.	Coastal	29	0.43	0.45	6.65	1.98	86.2	1.00
Redwood Ck. (Marin Co.)	Coastal	30	0.44	0.44	7.28	1.98	83.3	0.86
Miller Ck. (Marin Co.)	Coastal	31	0.39	0.41	5.66	1.94	100.0	1.00
Central Valley								
1. McCloud R. (Butcherknife Ck.)	Above	21	0.21	0.21	3.75	1.61	100.0	—
2. McCloud R. (Claiborne Ck.)	Above	33	0.37	0.37	6.00	1.88	97.0	—
3. Clear Ck.	Below	94	0.39	0.37	8.00	1.96	93.6	0.12
4. Battle Ck.	Below	94	0.41	0.40	8.43	1.97	71.3	0.25
5. Thomes Ck.	Below	51	0.37	0.36	6.25	1.92	100.0	1.00
6. Deer Ck.	Below	45	0.42	0.43	8.64	1.98	71.1	0.40
7. Butte Ck.	Below	47	0.40	0.39	7.99	1.95	87.2	0.91
8. Feather R. (Above Lake Almanor)	Above	16	0.29	0.27	6.23	1.86	100.0	1.00
9. Feather R. (Chips Creek)	Above	31	0.37	0.36	7.49	1.91	90.3	0.49
10. Feather River Hatchery	Hatchery	30	0.41	0.40	7.01	1.96	33.3	0.17
11. Yuba R. (Upper)	Above	26	0.43	0.43	6.85	1.98	84.6	1.00
12. Yuba R. (Pauley Ck.)	Above	25	0.35	0.33	5.71	1.85	92.0	--
13. Yuba R.	Below	90	0.45	0.44	7.80	1.99	87.8	0.68
14. American R. (MF)	Above	58	0.42	0.40	7.58	1.97	91.4	0.93
15. American R.	Below	19	0.43	0.44	7.18	1.98	42.1	0.25
16. American R. (NF)	Above	49	0.38	0.38	6.29	1.92	93.9	0.64
17. Nimbus Hatchery	Hatchery	98	0.43	0.42	7.53	1.97	86.2	0.39
18. Mokelumne Hatchery	Hatchery	162	0.41	0.40	7.31	1.97	77.8	0.09
19. Mokelumne R.	Below	63	0.43	0.42	7.61	1.98	74.6	0.36
20. Mokelumne R. (North Fork)	Above	51	0.38	0.38	7.63	1.94	80.4	0.84
21. Mokelumne R. (South Fork)	Above	49	0.36	0.36	6.84	1.93	91.8	0.65
22. Calaveras R.	Below	47	0.41	0.41	6.91	1.96	95.7	0.13
23. Stanislaus R	Below	80	0.44	0.44	7.66	1.99	91.3	0.26
24. Stanislaus R. (Upper)	Above	52	0.37	0.37	7.02	1.94	95.7	0.75
25. Tuolumne R.	Below	112	0.43	0.43	6.62	1.97	95.5	0.64
26. Tuolumne R. (Upper)	Above	47	0.39	0.36	7.28	1.93	91.5	0.87
27. Merced R. (Upper)	Above	35	0.36	0.32	6.04	1.92	90.5	0.41
28. Merced R.	Below	83	0.34	0.32	5.71	1.90	51.8	0.22
29. Kings R. (Deer Cove Ck.)	Above	33	0.38	0.37	4.70	1.95	90.9	0.32
30. Kings R. (Mill Flat Ck.)	Above	26	0.41	0.42	6.94	1.98	92.3	0.82
South Coast								
San Francisquito R.	Coastal	24	0.39	0.41	5.34	1.91	100.0	1.00
San Lorenzo R.	Coastal	32	0.42	0.43	5.80	1.97	71.9	1.00
Carmel R.	Coastal	32	0.42	0.42	6.96	1.97	96.9	0.68
Big Sur R.	Coastal	31	0.43	0.43	6.97	1.97	77.4	1.00
Hatchery trout strains								
Kamloops	Trout	47	0.29	0.28	5.51	1.75	100.0	—
Mt. Shasta	Trout	92	0.35	0.35	4.26	1.84	98.9	0.01
Eagle	Trout	47	0.30	0.29	4.35	1.83	87.2	1.00
Coleman	Trout	47	0.37	0.37	5.04	1.91	100.0	0.19
Moccasin	Trout	47	0.30	0.30	4.72	1.78	100.0	0.11
All CV		1,667					84.7	
All samples		2,430					86.9	

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for the naturally spawning populations below barriers, using river distances separating the confluences of each major tributary along the mainstem of the Sacramento–San Joaquin River system.

We used two individual-based assignment methods to evaluate both recent gene flow among populations and to identify hatchery rainbow trout individuals among the naturally spawning populations. The first analysis, implemented in the model-based clustering program *structure* (version 2.2; Pritchard et al. 2000), was used to fractionally assign the genome of individual fish to a hypothesized number of genetic clusters, K, in the dataset and to identify population associations. This analysis did not use information about *a priori* population designations, so it truly assigns the ancestry of each individual fish without regard to its origin. We evaluated the data using a range of values of $K=2-14$ to qualitatively document consistent patterns of population association. The second assignment analysis, implemented in the program *gsi_sim* (Anderson et al. 2008), uses the population genotype data as references to assign each individual fish to its most likely population of origin based on the method of Rannala and Mountain (1997). This approach evaluates the likelihood of assignment of each individual to every population, providing an evaluation of the composition of each population sample.

We constructed phylogeographic trees based on matrices of Cavalli–Sforza and Edwards' (1967) chord distance using the software package PHYLIP (v. 3.69c; Felsenstein 2005). This genetic distance was chosen because of its accuracy and ability to reliably recover the correct topology for phylogeographic trees (Takezaki and Nei 1996; Felsenstein 2003). We used the neighbor-joining algorithm (Saitou and Nei 1987) to determine tree topology, and derived a consensus tree from 1,000 bootstrap samples of the distance matrix with the CONSENSE program of PHYLIP. Finally, we conducted a correspondence analysis (CA) on the full dataset to qualitatively evaluate population relationships in the absence of a constrained tree structure. This analysis was conducted using the R-based software package *adegenet 1.3-4* (Jombart 2008; Jombart and Ahmed 2011).

RESULTS

Individual-Based Analysis

The final dataset contained genotypes of 2,430 individuals from 51 sample groups, including 1,667 fish from Central Valley populations. Model-based assignments from the program *structure* over the range of K-values employed clearly identified hatchery rainbow trout sampled among the naturally spawned fish (Figure 2). This analysis was used to identify 14 hatchery-origin rainbow trout in the Upper Merced population sample, six in the Upper Stanislaus, and 11 sampled at Nimbus Hatchery. The large number of hatchery trout identified in the Upper Merced River (14 of 35, 40%) were all sampled on the same day, separately from the rest of the fish in that population sample, and likely represent a distinct group of planted hatchery trout. Hatchery rainbow trout identified with structure were removed from the dataset in all subsequent analyses, with the exception of fish in the Lower Merced River sample, which had a strong and uniform hatchery influence, so no individuals could be singled out for removal.

Individual assignment tests provided high accuracy of self-assignment to Central Valley *O. mykiss* populations. The overall accuracy of assignment to population of origin was 84.7% (Table 1). Assignment accuracy for individual populations ranged from 100% for the McCloud R.–Butcherknife Ck., Thomes Creek, and the Feather River-above-Lake-Almanor samples to 33% for the Feather River Hatchery stock, in which many fish assigned to the Mokelumne Hatchery, and vice versa. Similarly, a substantial number of individuals cross-assigned between the American River and Nimbus Fish Hatchery samples, reflecting the strong similarities between these groups of fish.

Population Genetic Diversity

Allelic richness within populations was strongly correlated for microsatellite and SNP loci ($r^2=0.453$, $p<0.001$; Table 1). For the microsatellite loci, allelic richness ranged from a low of 3.75 (McCloud R.–Butcherknife Ck.) to a high of 8.64 (Deer Ck.). Since these SNPs have a maximum of two alleles, their allelic richness ranged from 1.6 (McCloud R.–

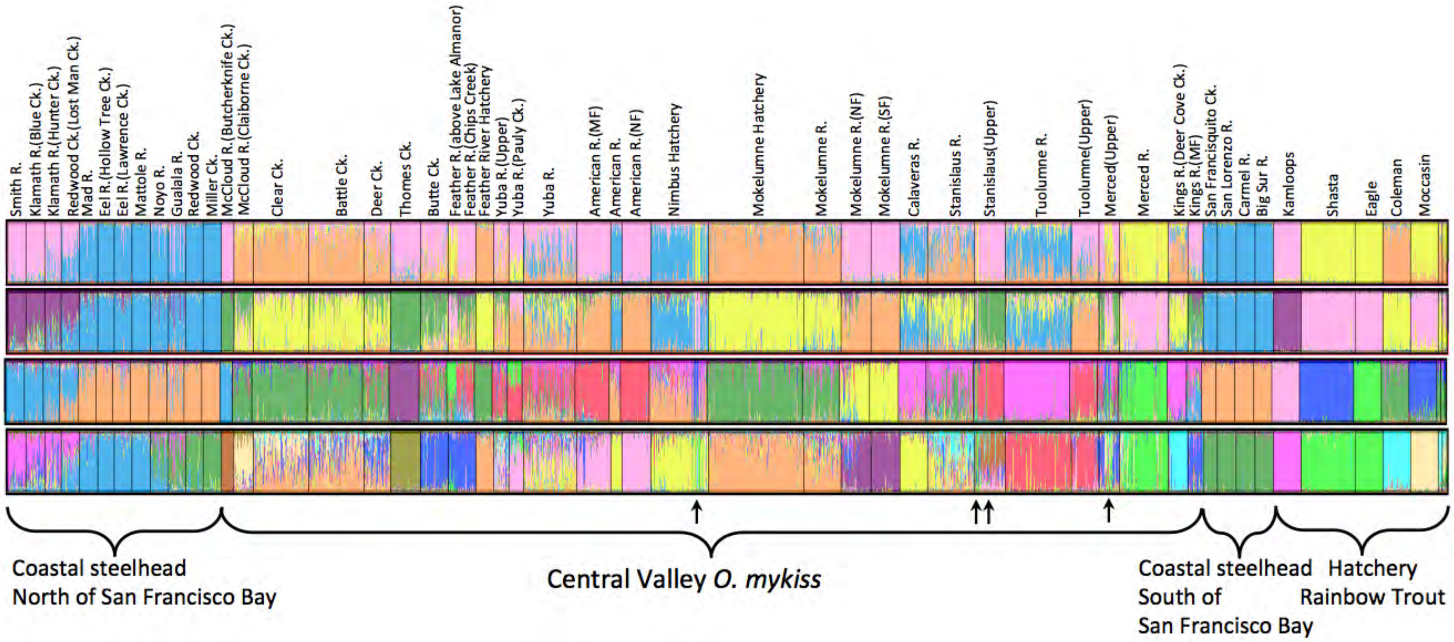

Figure 2 Graphical results of model-based clustering method implemented in structure (Pritchard et al. 2000) for a hypothesized number of genetic clusters, K, of 4, 6, 10 and 14. This analysis fractionally assigns each individual to the set of genetic clusters without prior consideration of geographic or population information, providing an unbiased assessment of individual ancestry. Arrows show hatchery trout identified and removed from other analyses.

Butcherknife Ck.) to >1.9 (many populations; Table 1). For both marker types, the range of allelic richness values observed in Central Valley populations encompassed the full range seen in coastal *O. mykiss* populations (Table 1). Observed heterozygosity across all loci ranged from a low of 0.212 in the McCloud R.–Butcherknife Creek population to 0.443 in the lower American, Stanislaus, and Yuba rivers (Table 1). Both microsatellite allelic richness and observed heterozygosity were signficantly lower in the populations above dams than those in sites below dams (AR: 6.42 vs. 7.40, *t*-test, $p<0.05$. Ho: 0.355 vs. 0.401; *t*-test, $p<0.05$), while the five hatchery trout strains had the lowest average values for any of the groups for both genetic diversity measures (Table 1). Finally, unlike the strong LD between the two SNP loci on chromosome Omy5 that was observed in coastal *O. mykiss* populations (mean $r^2=0.92$, range = 0.68 to 1.00), the strength of LD between these two SNP loci varied widely among Central Valley populations (mean $r^2=0.54$, range = 0.09 to 1.00; Table 1). Nonetheless, as in coastal populations, the mean frequency of alleles associated with anadromy at these adaptive loci was significantly higher in Central Valley below-barrier populations than above-barrier ones (0.48 vs. 0.17; *t*-test, $p<0.01$), consistent with the influence of dams on life-history variation (Pearse et al. 2014).

Population Structure

We examined pairwise values of FST, the standardized variance in allele frequencies between populations, for patterns of population structure. All pairwise FST values were significantly greater than zero based on permutation tests, with the highest values found between above-barrier populations (0.34, McCloud R., Butcherknife Ck. and Yuba River–Upper) and the lowest values involving below-barrier hatchery populations (0.005, Feather River Hatchery and Mokelumne Hatchery; 0.01, Nimbus Hatchery and American River) and below-barrier natural populations (0.015, Battle and Deer creeks). Notably, the lower

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Merced River sample was very similar to Eagle Lake trout, based on F_{ST} (0.012) and other analyses (see below). Mean pairwise F_{ST} values were significantly greater among above-barrier (0.15) than below-barrier populations (0.07; t-test, $p<0.001$), and for SNP loci (0.13) than for microsatellites (0.10; t-test, $p<0.001$). Despite the potential for both historical and current gene flow, there was no significant isolation by distance among the 12 natural below-barrier samples ($r^2=0.029$, $p>0.05$).

Phylogeographic trees were created for Central Valley populations only (Figure 3) and also with coastal California steelhead included (Figure 4). We also constructed trees using the microsatellite and SNP data separately, and with the hatchery rainbow trout strains included and excluded (data not shown). Regardless of which populations were included, there were only minor differences in the relationships inferred in the different trees, and all the major, statistically significant, relationships were consistent with the trees shown in Figures 3 and 4. In general, the phylogeographic trees did not cluster populations by basin of origin, with little or no statistical support for most internal branching relationships. We found strong bootstrap support primarily for nodes joining pairs of population samples above the same barrier dam. For example, the relationships between the two upper American River populations—American-NF and American-MF, and the two upper Mokelumne River populations, Mokelumne-NF and Mokelumne-SF—were both strongly supported in all trees (Figures 3 and 4). There was also a well-supported association between the Upper Yuba (Pauley Creek), Upper Feather River (both samples), Eagle Lake hatchery strain, and Lower Merced River samples, which consistently clustered, even when Eagle Lake was excluded from the analysis. Among the below-barrier populations, the American River–Lower and Nimbus

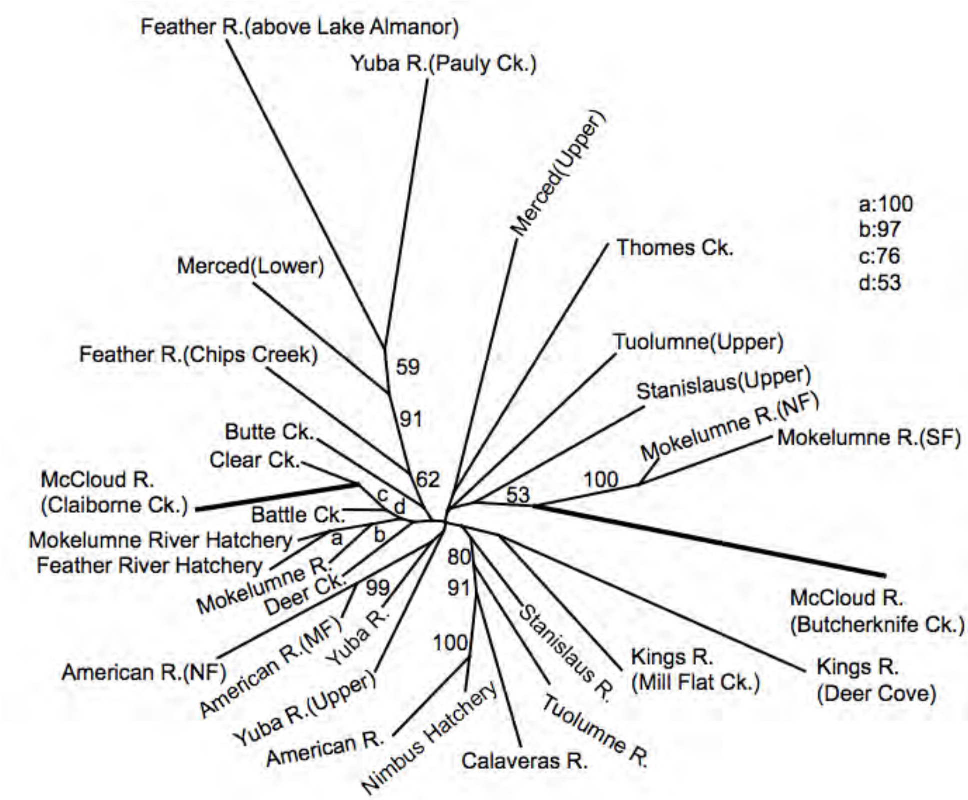

Figure 3 Neighbor-joining network showing only Central Valley *O. mykiss* populations, constructed with chord distances and original sub-basin groupings. Thick lines for McCloud populations shown at half length for display purposes. Bootstrap consensus values from 1000 bootstrap replicates shown. Only bootstrap values above 50% are reported.

Hatchery samples were closely associated with strong bootstrap support in all trees, as were the Mokelumne River, Mokelumne River Hatchery, and Feather River Hatchery samples (Figures 3 and 4).

The phylogeographic analysis that included coastal California steelhead populations revealed that, in general, Central Valley *O. mykiss* populations, both above and below dams, are more closely related to each other than to coastal populations outside of the Central Valley. Similarly, all of the hatchery strains cluster with the Central Valley populations in those analyses, as expected, given that most strains of hatchery rainbow trout used in California were domesticated from Sacramento River tributary populations (Busack and Gall 1980). The reduced LD between the two Omy5 loci in the hatchery trout strains is also consistent with their Sacramento River basin origins (Table 1). In addition, the American River–Lower and Nimbus Hatchery samples fall in a position intermediate between the coastal steelhead populations and the rest of the Central Valley, consistent with the founding of the current Nimbus Hatchery stock with eggs imported from coastal populations, primarily the Eel and Mad rivers. Finally, correspondence analysis displayed the same general relationships among Central Valley and coastal *O. mykiss* populations as the phylogenetic analysis, without the constraints of a tree (Figure 5).

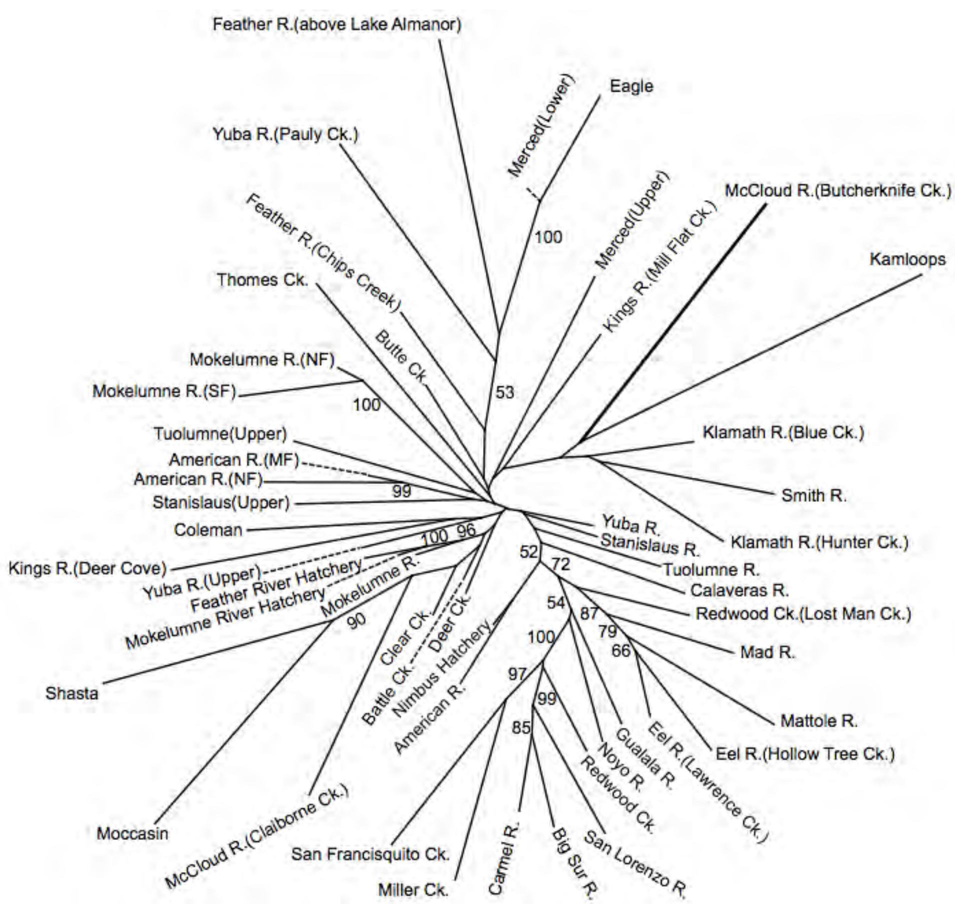

Figure 4 Neighbor-joining network of coastal and Central Valley *O. mykiss* populations constructed with chord distances and original sub-basin groupings. The thick line for McCloud R. (Butcherknife Ck.) is shown at half scale, and dotted lines connect names to branch tips for display purposes. Bootstrap consensus values from 1000 bootstrap replicates shown. Only bootstrap values above 50% are reported.

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Figure 5 Correspondence analysis, showing population relationships on the first two axes of differentiation. Coastal steelhead populations that are not contained in the oval shown are labeled individually.

DISCUSSION

In contrast with the patterns typically found in natural populations, genetic analysis of Central Valley *O. mykiss* populations with more than 100 markers found a general lack of geographically associated population structure. This likely reflects more than a century of habitat modification and stocking/hatchery practices that together have altered the historical genetic relationships among *O. mykiss* populations in at least three ways. First, unlike the close relationships typically found between coastal *O. mykiss* populations above and below barriers within the same watershed (Clemento et al. 2009; Pearse et al. 2009), Central Valley populations separated by dams are usually not each other's closest relatives. Second, the relationships among below-barrier Central Valley populations do not fit a pattern of isolation-by-distance, as has been found among *O. mykiss* and other salmonid populations both within and among watersheds (Primmer et al. 2006; Palstra et al. 2007; Pearse et al. 2007; Pearse et al. 2011b; Garza et al. 2014), as well as in a recent study of Central Valley giant gartersnakes (*Thamnophis gigas*) inhabiting the same geographic area (Wood et al. 2015). Finally, some below-barrier Central Valley *O. mykiss* populations, particularly in the lower American River, are clearly derived primarily from populations from the northern California steelhead DPS, presumably though past importation of eggs from the Eel and Mad rivers. Like scrambling an egg, these genetic effects are largely irreversible, and future management must take them into account while recognizing that the historical relationships cannot be completely restored. However, such genetic effects are also not static, making efforts to use science-based recovery planning essential for the restoration of the adaptive potential of *O. mykiss* populations in the Central Valley (Meek et al. 2014).

Our results are largely concordant with previous genetic studies of Central Valley *O. mykiss* (e.g., Nielsen et al. 2005). However, the increased power of the combined microsatellite and SNP data used in the present study, as well as the inclusion of multiple stocks of hatchery rainbow trout and population samples above barriers to anadromy, offer increased resolution, especially given the complementary characteristics of these two types of marker (Narum et al. 2008). Nonetheless, unlike the well-supported relationships and strong isolation by distance found among coastal populations, there was only weak statistical support for most phylogenetic relationships among Central Valley *O. mykiss* populations. Thus, the lack of strong population structure found in this study likely represents an accurate depiction of the current population genetic relationships among Central Valley *O. mykiss* populations, while also showing that the overall genetic distinction between coastal and Central Valley DPS *O. mykiss* remains. Moreover, the majority of the genetic diversity found among the Central Valley steelhead/rainbow trout populations studied here was found at the level of the individual sample sites, all of which were significantly differentiated, contributing to high rates of self-assignment for most populations (Table 1). Accurate population self-assignments are useful because they indicate that the underlying genetic data can be used as a reference baseline for genetic stock identification techniques to determine basin and tributary of origin for individual fish in management or forensic applications (e.g., Seeb et al. 2007).

As noted above, one salient result of the present study is that populations above and below barrier dams in the same basins are not closely related in most of the major tributaries. Instead many of the above-barrier populations appear to be more genetically similar to each other than to any of the below-barrier populations, a pattern also observed by Nielsen et al. (2005). However, that study did not evaluate relationships between Central Valley trout and hatchery rainbow trout, leaving uncertainty about the phylogenetic origin of the above-barrier populations (Lindley et al. 2006). In the present study, most above-barrier populations are clearly genetically distinct from the hatchery trout strains, supporting the hypothesis that hatchery rainbow trout stocked in the reservoirs and elsewhere above dams in the region have not replaced the native *O. mykiss* populations that residualized following dam construction. Thus, our results suggest that native *O. mykiss* dominate the existing populations represented above the dams, as has been documented in coastal California basins (Clemento et al. 2009). However, it should be noted that detecting the influence of hatchery strains

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is complicated by the close relationship of most hatchery trout strains to their Central Valley origins, and substantial past introgression by hatchery trout into some or all above-barrier populations can not be completely ruled out.

In several sub-basins, we sampled and analyzed multiple above-barrier populations and the results were not all consistent. For example, in the Kings River, samples from Deer Cove and Mill Flat creeks both showed some similarity to hatchery trout strains, and the two populations were closely associated in some, but not all, analyses. On the other hand, pairs of samples from different tributaries above Folsom and Pardee dams, in the American and Mokelumne rivers, respectively, were closely related in all analyses. Pairwise FST values were very low, 0.03 and 0.04 between the middle and north forks of the American River and north and south forks of the Mokelumne River, respectively, and both pairs also cluster with high confidence in all phylogeographic analyses, indicating a common genetic ancestry and/or recent gene flow between them.

Artificial propagation of *O. mykiss* began in the Central Valley with the establishment of the Baird Station on the McCloud River in 1872. Since then, millions of juvenile fish have been released annually in Central Valley rivers, streams, lakes and reservoirs (Leitritz 1970). This massive propagation and stocking effort, much of it sparsely documented, significantly complicates efforts to disentangle historical population structure. Based on individual genotypic assignments, few hatchery trout were found amongst the population samples, with almost all identified hatchery trout sampled in three locations (Upper Stanislaus River, Upper Merced River, and Nimbus Hatchery). However, two populations showed significant associations with one or more hatchery trout strains. The population from Deer Cove Creek on the Kings River clustered with hatchery strains in some analyses, suggesting likely hatchery trout ancestry, even though no hatchery trout were identified individually. More strikingly, the sample from the Lower Merced River associated strongly with the Eagle Lake hatchery trout strain in both phylogenetic and correspondence analyses, as well as containing a significant number of individuals that assigned to the Eagle Lake strain. Thus it appears that the fish sampled in the Lower Merced River are almost exclusively descended from this hatchery trout strain.

Introgression of hatchery rainbow trout into natural steelhead / rainbow trout populations and hatchery production is potentially detrimental, because of their reduced genetic variation, history of hatchery selection, and potential for a genetic predisposition against anadromy. Here, among the 31 sampled adults that entered Nimbus Fish Hatchery in 2005–2006, nine were identified as hatchery rainbow trout (Garza and Pearse 2008). These individuals were generally smaller than the steelhead, but there was significant overlap in the size distributions, suggesting that such fish might be mistaken for small steelhead and incorporated into the broodstock. However, a separate genetic analysis of steelhead broodstock from all four Central Valley steelhead hatcheries from 2011–2013 identified the presence of fewer than 10 hatchery rainbow trout among the more than 7,000 adult spawners assayed (four at Nimbus among >1,100 spawners; Vendrami et al., unpublished data, see “Notes”). In addition, recent changes in California state hatchery protocols call for stocking only sterile, triploid, trout in waters where they may come into contact with naturally spawning steelhead (Fish and Game Code Chpt. 7.2, §1725–1730; see *http://www.leginfo.ca.gov/.html/fgc_table_of_contents.html*). Thus, it is unlikely that the incorporation of hatchery trout into broodstock of Central Valley steelhead hatchery programs is a widespread or ongoing problem.

Steelhead propagation and hatchery practices have directly affected the population structure of *O. mykiss* below barriers in the Central Valley in several ways. First, after the collapse of the steelhead program at Mokelumne Hatchery, the broodstock was replaced with fish from Feather River Hatchery, and these two populations are now extremely similar genetically, despite being geographically separated by >100 km. Similarly, Nimbus Hatchery on the American River has been a substantial producer of steelhead in the Central Valley since 1955 (Leitritz 1970) and, during the first several decades of operation, broodstock was imported periodically from coastal steelhead populations, including the Eel, Mad and Russian rivers (Lee and Chilton 2007). The effects of this out-of-basin stocking are apparent in both individual and population analyses, in which the Nimbus and American–Lower populations are intermediate between the coastal steelhead populations and all other Central Valley populations. Notably, the closest relationship of the American River populations outside of the Central Valley is to fish from Northern California, in the group that includes the Eel and Mad rivers, rather than to more geographically proximate populations in San Francisco Bay (e.g., Los Trancos, Miller Creek, Redwood Creek; Figures 3 and 4). The clustering of other Central Valley below-barrier populations with Nimbus and American River samples, particularly those from the Calaveras and Tuolumne Rivers, indicates that introgression of natural populations by fish with coastal steelhead ancestry has occurred through straying / migration of Nimbus Hatchery steelhead. Conversely, individual assignment tests and the reduced LD between the two Omy5 loci show that the *O. mykiss* now propagated at Nimbus Hatchery have diverged significantly from their coastal steelhead origins, likely through interbreeding with native Central Valley fish.

CONCLUSION

Our genetic results indicate small population sizes and reduced genetic diversity in above-barrier populations relative to below-barrier populations, consistent with the decreased connectivity and lost influx of new genes through migration after dam construction, factors that can contribute to population extirpation (Srikwan and Woodruff 2000). Facilitating fish migration across barriers is one way to mitigate such effects, and might also counteract adaptation of above-barrier populations in response to the strong selection against anadromy in these populations (Pearse et al. 2014). However, re-establishing connectivity of above-barrier populations trout with steelhead populations below dams should be carefully monitored because the consequences of such integration are not known, and could range from beneficial increases in genetic diversity and effective size, to negative changes in life history of the below-barrier populations, decreased fitness of hybrids, and adverse ecological interactions such as competition or direct predation.

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From: Le, Bao
Sent: Wednesday, February 17, 2016 2:16 PM
To: John Wooster - NOAA Federal
Cc: Deason, Jesse
Subject: RE: FW: Advance Materials for La Grange Technical Subcommittee Call Feb 16

Thanks for the paper and your participation on yesterday's call, John.

I will send this over to Rose and make sure it is distributed to tech subcommittee members and is posted on the website.

Bao

From: John Wooster - NOAA Federal [mailto:john.wooster@noaa.gov]
Sent: Tuesday, February 16, 2016 4:16 PM
To: Le, Bao
Cc: Deason, Jesse
Subject: Re: FW: Advance Materials for La Grange Technical Subcommittee Call Feb 16

Bao:

Attached is the paper I was talking about today related to genetics.

-John

On Fri, Feb 12, 2016 at 12:05 PM, Le, Bao <ChiBao.Le@hdrinc.com> wrote:

Hi John.

Related the materials above, I wanted to give you a "head's up" regarding two items:

1. Climate change abstract action item – if you are able to provide something in advance of the meeting to help participants understand the scope of this potential study, that would be great – we will distribute. If this is not possible, input at the meeting about what NMFS is thinking with regard to the scope/objectives of this request would be much appreciated.
2. Genetics Study update – in the agenda, there is a brief topic for in-progress study updates. It would be great if NMFS could be ready to provide some updated information on the study including objectives, preliminary results, next steps, etc.

Let me know if you have any questions.

Have a good weekend,

Bao

From: Staples, Rose
Sent: Friday, February 12, 2016 12:00 PM
Cc: Staples, Rose; Le, Bao
Subject: Advance Materials for La Grange Technical Subcommittee Call Feb 16

La Grange Technical Subcommittee participants:

Please find attached materials for the first Upper Tuolumne River Reintroduction Assessment Framework Technical Subcommittee conference call scheduled for Tuesday, February 16th from 11am-1pm. Call-in number is 866-583-7984, passcode 8140607.

Materials attached include:

1. Agenda – note that the primary objectives of the call include decisions on 2016 studies to support the Reintroduction Assessment Framework and decisions on an approach and schedule for the development of reintroduction program goals.
2. Potential Reintroduction Studies List and Abstracts – an updated list of potential reintroduction studies to support identification of the 2016 study program.

Thank you for your participation.

Rose Staples, CAP-OM, MOS

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John Wooster
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From: Staples, Rose
Sent: Wednesday, February 17, 2016 12:48 PM
Cc: Staples, Rose; Deason, Jesse
Subject: Article Shared by Gretchen Murphey, CDFW in regards to La Grange fish passage
Attachments: Evidence of Landlocked Chinook Salmon Populations in California.pdf

Gretchen Murphey, Environmental Scientist Tuolumne River, California Department of Fish and Wildlife, as an action item from the
La Grange Technical Committee conference call yesterday, has forwarded to me the attached article (*Evidence of Landlocked Chinook Salmon Populations in California)* and asked that I share it with you all. A copy of it will also be added to the DOCUMENTS section of the licensing website (www.lagrange-licensing.com). Thank you.

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Evidence of Landlocked Chinook Salmon Populations in California

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MANAGEMENT BRIEF

Evidence of Landlocked Chinook Salmon Populations in California

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Abstract
Natural reproduction of adfluvial Chinook Salmon *Oncorhynchus tshawytscha* has been documented in their native and introduced range but not in California, the southern end of their native range. A combination of anecdotal evidence and survey data suggests that successful spawning by Chinook Salmon reared in California reservoirs could be common. The planted juveniles are often from different basins and are genetically distinguishable from local salmon populations below reservoirs. Consequently, the possibility of behavioral and genetic interactions may lead to complications of restoration efforts via trap and haul programs. The full extent of this phenomenon needs to be documented before trap and haul programs are initiated to reintroduce salmon above reservoirs.

Chinook Salmon *Oncorhynchus tshawytscha* are anadromous, with native populations distributed throughout rivers and streams of the Pacific Coast. This includes central California, Canada, Alaska, Russia, and northern Japan (Moyle 2002). Self-sustaining landlocked populations are rare or absent in their native range, although such populations have become established through introductions in the Laurentian Great Lakes (Lever 1996; Crawford 2001; Landsman et al. 2011), in Lake Coeur D'Alene in Idaho (NPCC 2004), Lake Chelan and Lake Cushman in Washington (Quinn and Myers 2005), Lake Puyehue in Chile (Soto et al. 2007; Correa and Gross 2008), Green Peter Reservoir in Oregon (Romer and Monzyk 2014), and several lakes in New Zealand (Graynoth 1999; Quinn et al. 2001). Fish in these populations are adfluvial spawners and complete their entire life histories in freshwater. Landlocked reproducing populations have not been recorded from California, at the southern end of their range, although juvenile fall-run Chinook Salmon from hatcheries have been planted in reservoirs for decades to support sport fisheries. It was assumed that these fish would grow to harvestable size in reservoirs but no reproduction would take place. For example, in New Don Pedro Reservoir (Tuolumne River), hatchery Chinook Salmon have been planted periodically starting in 1982 (Turlock and Modesto Irrigation Districts 2011; Table 1). Here we provide evidence of spawning by adfluvial Chinook Salmon in six California reservoirs: New Don Pedro, Folsom, Trinity, Almanor, Pine Flat, and Shasta reservoirs (Figure 1).

STUDY AREAS

New Don Pedro Reservoir. —New Don Pedro Reservoir is a multipurpose reservoir located on the main stem of the Tuolumne River, in Tuolumne County, California. The reservoir has a maximum capacity of 2.50 × 10^9 m^3 and is California's 6th largest reservoir in terms of storage. The reservoir has a

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TABLE 1. Juvenile Chinook Salmon stocking records from New Don Pedro, Folsom, Trinity, Almanor, Pine Flat, and Shasta reservoirs. All fish are diploid fish from the Iron Gate Hatchery, located on the Klamath River, unless otherwise noted.

	Number of Chinook Salmon smolts stocked each year													
Reservoir	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
New Don Pedro	125,376[a]	177,900	0	100,000	100,440	70,015	91,000	93,995	100,006	100,000	129,980	99,997	0	90,035[c]
Folsom	0	100,800	0	0	73,470	117,800[b]	0	0	0	0	0	0	0	99,990[c]
Trinity	0	9,940	32,775	25,025	0	25,530	25,004	60,030	33,908	0	0	31,075	0	44,800
Almanor	163,800[a]	100,008	0	176,100	60,420	43,560	60,270	59,994	33,792	60,000	65,030	59,993	0	53,985[c]
Pine Flat	125,250[a]	75,000	0	75,400	0	54,978	56,940	75,072	0	75,000	75,020	74,999	100,000	74,991
Shasta	36,720	48,843	50,500	67,182	54,270	72,982	56,745	46,100	53,350	87,840	94,500	0	0	12,338[c]

[a]Fish from Nimbus Fish Hatchery on the American River.
[b]Fish from Feather River Hatchery.
[c]Sterile, triploid fish; M. Clifford, California Department of Fish and Wildlife, unpublished data.

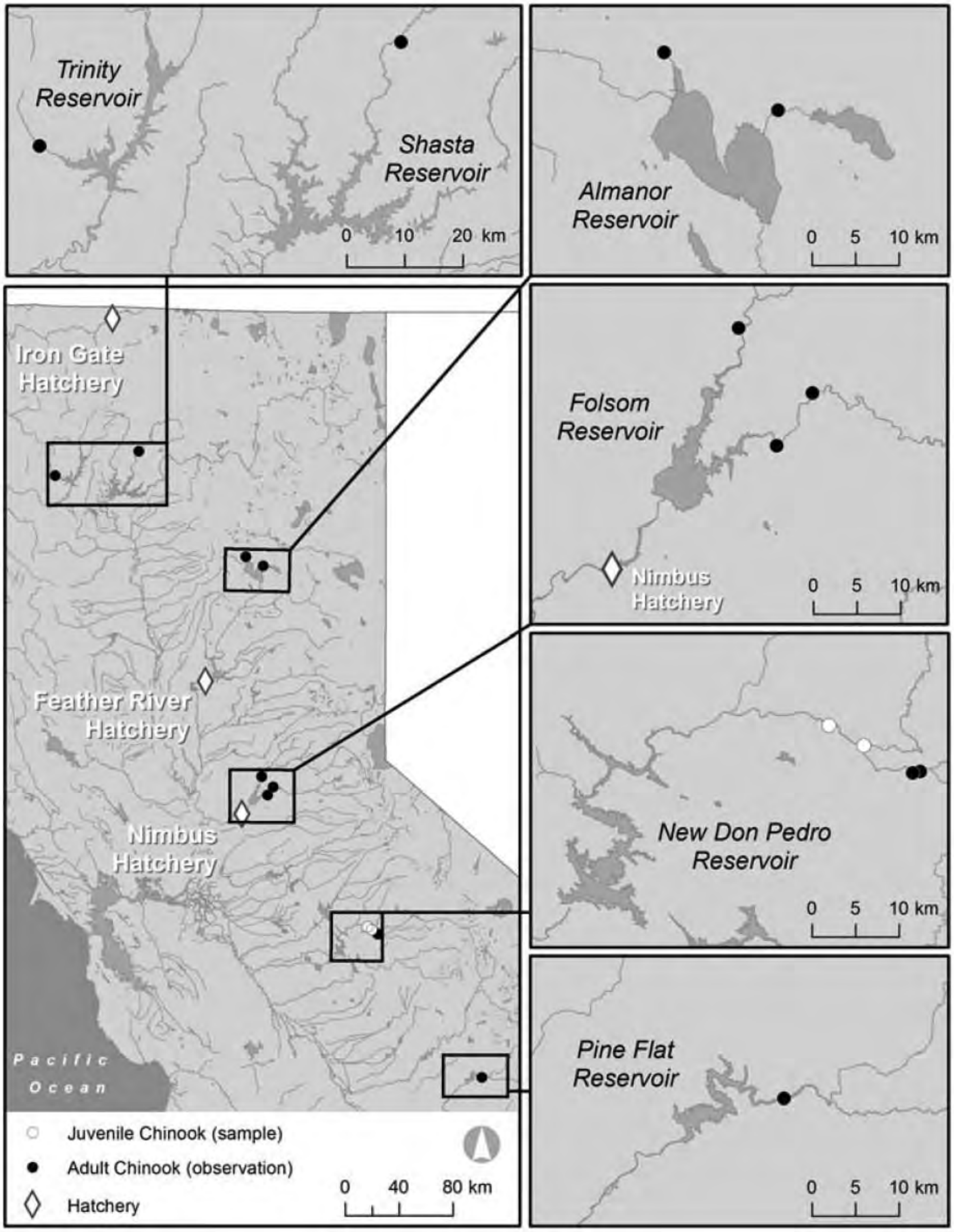

FIGURE 1. Map of California with locations of hatcheries, reservoirs, and observational data.

surface area of roughly 53 km^2 and a maximum water height of 253 m. The reservoir's main purpose is to store water for agricultural, industrial, and municipal uses, as well as for flood management. The reservoir also provides recreational and environmental flows, in addition to hydroelectric power generation (Turlock and Modesto Irrigation Districts 2011). New Don Pedro Reservoir has been regularly stocked with juvenile Chinook Salmon, quite heavily in some years (Table 1). These

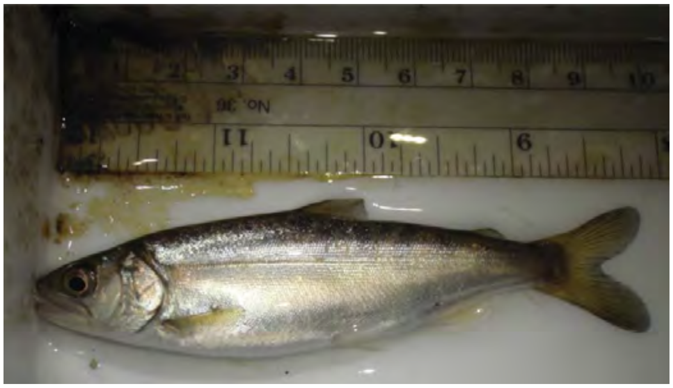

FIGURE 2. A juvenile Chinook Salmon, about 9 cm FL, from the Tuolumne River above New Don Pedro Reservoir, May 18, 2012.

juveniles are fall-run Chinook from Iron Gate Hatchery on the Klamath River (M. Clifford, California Department of Fish and Wildlife [CDFW], personal communication). New Don Pedro Dam is impassible for salmon migrating upstream. However, prior to construction in the late 1870s of LaGrange Dam, located downstream of New Don Pedro Dam, Chinook Salmon presumably used the upstream region for spawning and rearing (Yoshiyama et al. 1998).

Eight Chinook Salmon juveniles were collected in the Tuolumne River above the reservoir in 2012. Sampling was conducted after sundown with a 30-ft bag seine and was landed on gravel bars. On May 18, 2012, six of the fish were collected on the downstream end of a gravel bar directly across from where Indian Creek meets the Tuolumne River (37°53′04″N, 120°09′10″W), about 14 km above the reservoir. On June 19 and 20, 2012, two juveniles were collected on the left bank above the confluence of the Tuolumne River and the Clavey River (37°51′49″N, 120°07′00″W). All fish appeared to be in good condition and ranged in length from 65 to 100 mm fork length (FL; Figure 2). The collected fish were silvery bright, which suggests they were smolts moving downstream to the reservoir. In October 2009, three adult Chinook Salmon in spawning colors were observed around Lumsden campground (37°50′13″N, 120°03′31″W; 37°50′08″N, 120°03′58″W), about 8 km upstream from where the smolts were collected. All fish observed were between 250 and 450 mm standard length (Weaver and Mehalick 2009).

Folsom Reservoir.—Folsom Reservoir is located just below the confluence of the North and South Fork of the American River in Placer, Sacramento, and El Dorado counties, California. The reservoir is California's 9th largest reservoir with a capacity of 1.20×10^9 m^3 and a surface area of 46 km^2. The main functions of the reservoir are to generate hydropower, provide flood protection, provide recreational and environmental flows, and enhance water quality downstream (U.S. Department of the Interior and U.S. Bureau of Reclamation 2012). Folsom Reservoir has been periodically stocked with fish from Iron Gate Fish Hatchery, located on the Klamath River, and from Nimbus Fish Hatchery, located on the American River, just downstream of the reservoir. The most recent stocking of reproductively viable fish took place in 2006, with 117,800 American River Chinook Salmon juveniles being released (Table 1; Clifford, unpublished data).

California Department of Fish and Wildlife biologists conducted snorkel surveys of the South Fork American River on October 4 and 21 2010, in response to reports from fisherman catching small adult Chinook Salmon in Folsom Reservoir, 4 years since the last known stocking event. The snorkel survey confirmed the presence of Chinook Salmon in significant numbers; 106 salmon were observed over 10 km of the South Fork of the American River. Roughly 66% of Chinook Salmon surveyed were $>$ 450 mm standard length; the rest of the fish ranged from 305 to 450 mm standard length. A single redd was observed in the uppermost reach of the survey. In addition, gravid females were collected during 2009 and 2010 CDFW electrofishing surveys in the North Fork and South Fork of the American River (J. Rowan and K. Thomas, 2010 file memorandum to the CDFW, on snorkel survey and electrofishing data). This strongly suggests that there have been at least 2 years in which these Chinook Salmon spawned in numbers great enough to sustain a small population in freshwater.

Trinity Reservoir.—Trinity Reservoir is located on the Trinity River, in Trinity County. The reservoir has a maximum capacity of 3.02×10^9 m^3 and a surface area of 63 km^2. The main function of the reservoir is to produce hydroelectric power and to act as water storage. Trinity Reservoir is stocked with juvenile Chinook Salmon from Iron Gate Hatchery on the Klamath River (Clifford, personal communication; Table 1).

Spawning Chinook Salmon were observed in Stuart's Fork of the Trinity River in October 2011 and November 2012. Observed fish had spawning colors and appeared to be ready to spawn. Males had developed kypes and females appeared to be gravid (J. Muegge, recreational fisherman, personal communication). In addition, on November 15, 2012, fish exhibiting spawning behavior, several carcasses, and about 24 redds were observed in a 3.5 km reach of the Stuart's Fork (B. Aguilar, CDFW, personal communication).

Other reservoirs.—Adult Chinook Salmon have also been observed above Almanor Reservoir around Hamilton Branch (J. Rowan, unpublished observations). Photos of inland Chinook Salmon in spawning colors were taken recently in Last Chance Creek above Almanor Reservoir (M. Fish, CDFW, personal communication). A pair of Chinook Salmon on a redd in Kings River above Pine Flat Reservoir was observed in 1986 (K. Murphy, CDFW, personal communication). Healey and Rode (1994) reported seven adult Chinook Salmon passing through a weir on the McCloud River above Shasta Reservoir in 1986, the only year the weir was working. Authors noted that fish appeared to be in prespawning condition. Additionally, Moyle (2002) reported observations of adult Chinook Salmon in streams above Shasta and Almanor reservoirs.

DISCUSSION

While the evidence we present here is limited to observational data, we have confirmed that spawning by land-locked Chinook Salmon occurs in several California reservoirs. Given that the observations are all of fish in rivers once used by anadromous fishes, occurrence of natural spawning above reservoirs should not be too surprising, especially given the high frequency of planting of juvenile Chinook Salmon in reservoirs. Determining if these populations are self-sustaining is an important next step. The only population that we can say has been maintaining itself is the Folsom Reservoir population. The reservoir had received Chinook Salmon juveniles 4 years prior to sampling by CDFW, which observed numerous adult salmon migrating to rivers, a single redd and gravid females. This strongly suggests that Chinook Salmon have reproduced naturally in great enough numbers to sustain a small recreational fishery. This sets Folsom Reservoir apart from New Don Pedro in particular, which has received constant stocking on an annual basis. Thus, the spawning runs from Folsom Reservoir indicate that a self-sustaining population can become established.

In 2014, a program of planting sterile triploid juvenile Chinook Salmon was initiated for New Don Pedro and Folsom reservoirs, providing an opportunity to discover or confirm whether the existing populations are reproducing themselves (Clifford, personal communication). Trapping adult salmon below dams and trucking them to upstream spawning areas, followed by capture of juveniles and trucking them to downstream areas, is being proposed as a conservation strategy for Central Valley Chinook Salmon. Surveys of possible spawning and rearing areas for Chinook Salmon of reservoir origin could provide insights into the potential for success of this strategy, as an indication of the extent and quality of spawning and rearing habitat. Such surveys could also indicate the potential for behavioral and genetic interactions between “natural” and planted fish. This is important because most salmon planted in Central Valley reservoirs originate from the Klamath River and are genetically distinguishable from other California Chinook Salmon (Waples et al. 2004). In a trap-and-haul operation, it can be difficult to distinguish between juveniles of different origins, including hybrids.

ACKNOWLEDGMENTS

We thank Bernard Aguilar, Mark Clifford, Maxfield Fish, John Muegge, and Kyle Murphy for information regarding spawning activity of adfluvial Chinook Salmon in California. Our special thanks to Amber Manfree for providing a site map. We also thank the California Department of Fish and Wildlife for the contribution of data.

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Deason, Jesse

From: Staples, Rose
Sent: Thursday, February 18, 2016 12:06 PM
Cc: Staples, Rose; Deason, Jesse; Le, Bao
Subject: Doodle Poll March Conf Call Date - Formation of New Subgroup

Two Items!

Doodle survey of availability for dates in March for the next Technical Committee conference call
*I want to say THANK YOU to all of you who have already accessed the Doodle Poll link and noted the dates you are available—and to encourage the remaining members of the committee to respond (*http://doodle.com/poll/h26mtizmpdwb3x36). *The dates in question are March 14, March 16, March 18, March 21, and March 22 (11:00 a.m. to 1:00 p.m.).*

Technical Committee Subgroup on the development of reintroduction program goals
An action item from Tuesday's (Feb 16) Technical Committee conference call is the formation of a subgroup of the committee to participate in the development of reintroduction program goals. Committee members who are interested in participating as part of this subgroup should email me at rose.staples@hdrinc.com by Wednesday, February 24th. So far, I have three members: Ron Yoshiyama, Lonnie Moore, and Chuck Hanson.

Thank you.

Rose Staples, CAP-OM, MOS
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Deason, Jesse

From:	Staples, Rose
Sent:	Thursday, February 18, 2016 11:27 AM
Cc:	Staples, Rose; Deason, Jesse
Subject:	Paper Shared by John Woo0ster, NOAA, in regards to Genetics
Attachments:	Pearse_Garza_2015.pdf

La Grange Licensing Participants,

John Wooster, Hydrologist, NOAA Fisheries West Coast Region, as an action item from the La Grange Technical Committee conference call on Tuesday, has forwarded the attached paper on genetics and asked that it be shared with you all. A copy of it will also be added to the DOCUMENTS section of the licensing website (www.lagrange-licensing.com). Thank you.

Rose Staples, CAP-OM, MOS
Executive Assistant

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Title:

You Can't Unscramble an Egg: Population Genetic Structure of *Oncorhynchus mykiss* in the California Central Valley Inferred from Combined Microsatellite and Single Nucleotide Polymorphism Data

Journal Issue:

San Francisco Estuary and Watershed Science, 13(4)

Author:

Pearse, Devon E., Southwest Fisheries Science Center, National Marine Fisheries Service, Santa Cruz, CA
Garza, John Carlos, Southwest Fisheries Science Center, National Marine Fisheries Service, Santa Cruz, CA

Publication Date:

2015

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http://escholarship.org/uc/item/8dk7m218

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Steelhead/rainbow trout (*Oncorhynchus mykiss*) are found in all of the major tributaries of the Sacramento and San Joaquin rivers, which flow through California's Central Valley and enter the ocean through San Francisco Bay and the Golden Gate. This river system is heavily affected by water development, agriculture, and invasive species, and salmon and trout hatchery propagation has been occurring for over 100 years. We collected genotype data for 18 highly variable microsatellite loci and 95 single nucleotide polymorphisms (SNPs) from more than 1,900 fish from Central Valley drainages to analyze genetic diversity, population structure, differentiation between populations above and below dams, and the relationship of Central Valley *O. mykiss* populations to coastal California steelhead. In addition, we evaluate introgression by both hatchery rainbow trout strains, which have primarily native Central Valley ancestry, and imported coastal steelhead stocks. In contrast to patterns typical of coastal steelhead, Central Valley *O. mykiss* above and below dams within the same tributary were not found to be each others' closest relatives, and we found no relationship between genetic and geographic distance among below-barrier populations. While introgression by hatchery rainbow trout strains does not appear to be widespread among above-barrier populations, steelhead in the American River and some neighboring tributaries have been introgressed by coastal steelhead. Together, these results demonstrate that the ancestral population genetic structure that existed among Central Valley tributaries has been significantly altered in contemporary populations. Future conservation, restoration, and mitigation efforts should take this into account when working to meet recovery planning goals.

DECEMBER 2015

SAN FRANCISCO ESTUARY & WATERSHED SCIENCE

Sponsored by the Delta Science Program and the UC Davis John Muir Institute of the Environment

You Can't Unscramble an Egg: Population Genetic Structure of *Oncorhynchus mykiss* in the California Central Valley Inferred from Combined Microsatellite and Single Nucleotide Polymorphism Data

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KEY WORDS

Evolution, genetics, adaptation, steelhead, trout, Central Valley.

ABSTRACT

Steelhead/rainbow trout (*Oncorhynchus mykiss*) are found in all of the major tributaries of the Sacramento and San Joaquin rivers, which flow through California's Central Valley and enter the ocean through San Francisco Bay and the Golden Gate. This river system is heavily affected by water development, agriculture, and invasive species, and salmon and trout hatchery propagation has been occurring for over 100 years. We collected genotype data for 18 highly variable microsatellite loci and 95 single nucleotide polymorphisms (SNPs) from more than 1,900 fish from Central Valley drainages to analyze genetic diversity, population structure, differentiation between populations above and below dams, and the relationship of Central Valley *O. mykiss* populations to coastal California steelhead. In addition, we evaluate introgression by both hatchery rainbow trout strains, which have primarily native Central Valley ancestry, and imported coastal steelhead stocks. In contrast to patterns typical of coastal steelhead, Central Valley *O. mykiss* above and below dams within the same tributary were not found to be each others' closest relatives, and we found no relationship between genetic and geographic distance among below-barrier populations. While introgression by hatchery rainbow trout strains does not appear to be widespread among above-barrier populations, steelhead in the American River and some neighboring tributaries have been introgressed by coastal steelhead. Together, these results demonstrate that the ancestral population genetic structure that existed among Central Valley tributaries has been significantly altered in contemporary populations. Future conservation, restoration, and mitigation efforts should take this into account when working to meet recovery planning goals.

INTRODUCTION

The Central Valley of California supports both Chinook salmon (*Oncorhynchus tshawytscha*) and fish from the species *O. mykiss*, commonly known as steelhead (anadromous life history) or rainbow trout (resident life history). Tributary rivers from the west slope of the Sierra Nevada mountain range and east slopes of the coastal mountain ranges feed into the north-flowing San Joaquin and the south-flowing Sacramento rivers, which converge in the San Francisco Bay/Delta region before finally exiting to the Pacific ocean. The watershed has been severely affected by the construction of many dams, which block movement by anadromous fish and effectively divide nearly every major tributary into separate above-barrier and below-barrier reaches. In addition, much of the flow in the system is diverted for agricultural and domestic uses through an extensive system of levees and aqueducts. Together, these effects have severely modified and reduced the habitat available to anadromous fishes (Lindley et al. 2006).

Populations of steelhead in California are divided into six Distinct Population Segments (DPSs) for management purposes; five on the coast and one in the Central Valley (Busby et al. 1996). Importantly, these DPSs specifically include only anadromous life-history fish that spawn below impassable barriers to migration; *O. mykiss* isolated above natural or artificial barriers to fish passage are excluded from the DPS and, consequently, from protection under the U.S. Endangered Species Act (ESA; Federal Register 2006). The California Central Valley Steelhead DPS also includes fish produced by two of the four artificial propagation programs in the Central Valley—the Feather River Fish and Coleman National Fish hatcheries—but not those spawned at the Nimbus or Mokelumne River hatcheries. This DPS was listed as "Threatened" under the ESA in 1998 and this status was reaffirmed in 2006 (Federal Register 2006).

Hatchery rainbow trout have been heavily stocked in the reservoirs above nearly all of the Central Valley dams for more than 100 years (Busack and Gall 1980; California HSRG 2012). These captive hatchery trout broodstock strains were domesticated from diverse geographic and phylogenetic sources, but many originated from fish collected from streams that drain into the Central Valley (Needham and Behnke 1962; Leitritz 1970). Similarly, steelhead and other anadromous salmonids have been propagated at several hatcheries in the Central Valley since the late 1800s, and four Central Valley hatcheries (Coleman, Feather, Nimbus, and Mokelumne), currently release approximately 1.5 million yearlings annually (Brown 2005; California HSRG 2012). For both steelhead and hatchery trout strains, it has been common practice to move eggs among hatcheries within the Central Valley and to import eggs from outside sources (Leitritz 1970; California HSRG 2012). Nimbus Hatchery on the American River has been a substantial producer of steelhead in the Central Valley since 1955 (Leitritz 1970) and, for many years, imported eggs from coastal steelhead sources, primarily the Eel and Mad rivers (California HSRG 2012). However, the extent to which such interbasin transfers have influenced population structure of *O. mykiss* in the Central Valley has not been carefully evaluated.

Numerous genetic analyses of salmonid population structure in California have relied on microsatellite markers, because such multi-locus data can identify population genetic structure at both larger scales (Aguilar and Garza 2006; Clemento et al. 2009; Garza et al. 2014) and at relatively fine ones (Deiner et al. 2007; Pearse et al. 2007, 2009; Kinziger et al. 2013), including within the Central Valley (Banks et al. 2000; Nielsen et al. 2005). Recently, another class of genetic markers, single nucleotide polymorphisms (SNPs), has been used increasingly in population genetics and has proven useful in assessments of population structure (Morin et al. 2004), introgressive hybridization (Stephens et al. 2009; Finger et al. 2011), and pedigree reconstruction (Abadía–Cardoso et al. 2013). Though microsatellites and SNPs each have advantages and disadvantages in terms of cost, genotyping errors, polymorphism, etc., when a large number of both types of loci is available, this combination provides the most statistical power for understanding population genetic relationships (Narum et al. 2008).

Here we attempt to "unscramble" the population genetic structure of Central Valley *O. mykiss* using a combination of more than 100 microsatellite and SNP loci on a comprehensive set of Central Valley trout and steelhead populations. We compare these data with genotypes from a representative set of hatchery trout strains and coastal California steelhead populations (Aguilar and Garza 2006; Pearse et al.

2007, 2009; Clemento et al. 2009; Garza et al. 2014). Analysis of this combined dataset provides insight into the the historical relationships of Central Valley *O. mykiss*, as well as the relationships of Central Valley populations with those from other parts of California.

METHODS

Sampling

Samples were taken from populations of *O. mykiss* at one or more locations in 15 tributary sub-basins of the Sacramento and San Joaquin rivers that drain the Central Valley (Figure 1; Table 1), including locations both above and below barriers to anadromy in most tributaries. Most fish were captured using either electrofishing or hook-and-line capture techniques. Small pieces of caudal fin tissue were then excised and preserved through desiccation on blotter paper. Fish sampled in multiple years in the same location were combined for analysis, after verifying that they were taken from the same underlying population. These groups of fish are all referred to as populations for convenience and without additional assumptions about the biological details underlying this designation.

Genetic Data Collection

Nucleic acid extraction and microsatellite and SNP genotyping followed Arciniega et al. (2016). Genotypic data from 18 microsatellite loci were collected for all samples. This set of loci has been used in numerous previous studies of *O. mykiss* in California (Aguilar and Garza 2006; Deiner et al. 2007; Pearse et al. 2007, 2009, 2011a; Garza et al. 2014). All samples were also genotyped with the panel of 96 SNP loci used by Abadía–Cardoso et al. (2013). The 96 SNPs include 95 loci from Aguilar and Garza (2008), Campbell et al. (2009), and Abadía–Cardoso et al. (2011), as well as an assay that includes a Y–chromosome marker developed by Brunelli et al. (2008) that identifies gender. All 96 loci were genotyped using 5′ nuclease TaqMan assays (Applied Biosystems) on 96.96 Dynamic Genotyping Arrays in the EP1 Genotyping System (Fluidigm Corporation). Two negative controls were included in each array and genotypes were called using Fluidigm SNP Genotyping Analysis Software v3.1.1.

Data Analysis

We combined the microsatellite and SNP data collected from the Central Valley *O. mykiss* populations with previously collected data from coastal California steelhead populations and hatchery trout strains commonly stocked in California. In analyzing these data, we first removed from most analyses three SNP loci that have been shown to be influenced by selection on life-history patterns in *O. mykiss* (Pearse et al. 2014). Two of these loci in particular, *SH121006-131* and *SH114448-87*, are in strong linkage disequilibrium (LD) with a genomic region on chromosome Omy5 that was recently found to be associated with resident and anadromous life-history in coastal California steelhead populations (Pearse et al. 2014). These two loci were analyzed separately to evaluate patterns of LD between them in Central Valley populations using the R package genetics (Warnes and Leisch 2005). Finally, we removed three microsatellite loci (*OtsG401*, *Omy27*, and *Ots1b*) and two SNP loci (*SH127645-308* and *SH128996-481*) for which at least one of the population samples was not genotyped. Together, these removals left a total of 105 loci (15 microsatellites and 90 SNP loci), and we conducted all further population genetic analyses on this combined dataset. The gender identification locus was also excluded from the population genetic analyses.

We calculated expected heterozygosity (Nei 1987), observed heterozygosity, and number of alleles for each sample population, and estimated allelic richness (A_R) with the rarefaction method in the program HP-Rare (Kalinowski 2005) based on a sample of 25 gene copies. We quantified pairwise differentiation between all populations with F_{ST}, using Weir and Cockerham's (1984) estimator, and assessed significance by the permutation algorithm in the genetix software package (Belkhir et al. 2004) with 100 replicates. We used a Mantel test implemented in the program *ISOLDE* of the GenePop software package (Raymond and Rousset 1995) to evaluate the correlation between genetic and geographic distance

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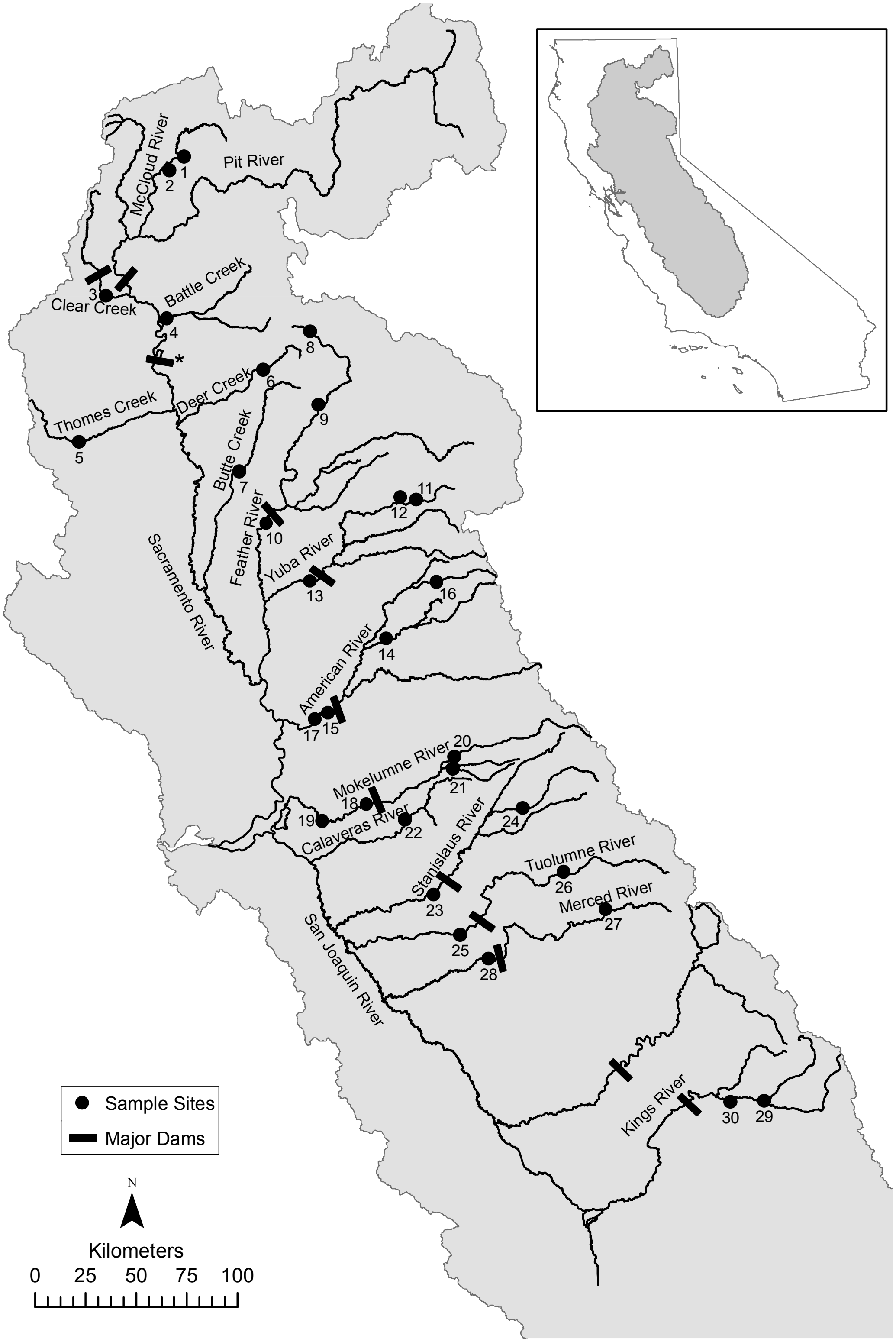

Figure 1 Map showing Central Valley of California, including major barrier dams and rivers tributary to the Sacramento-San Joaquin system. Sample sites are numbered as in Table 1.

Table 1 Population samples used in the present study, organized by region (coastal versus Central Valley), and listed north to south. Within each basin, population samples are grouped with respect to location above and below major dams, or at hatcheries. For each population, number of samples (N), expected and observed heterozygosities (He and Ho), microsatellite and SNP allelic richness (AR), proportion genetically self-assigned, and linkage disequilibrium (r^2) between two SNP loci located on chromosome Omy5.

Population	Area	N	He	Ho	AR (micros)	AR (SNPs)	% Self	r^2(Omy5)
North Coast								
Smith R.	Coastal	32	0.38	0.37	7.99	1.89	93.8	0.99
Klamath R. (Blue Ck.)	Coastal	32	0.39	0.37	8.64	1.93	96.9	0.93
Klamath R. (Hunter Ck.)	Coastal	28	0.39	0.39	6.68	1.92	85.7	0.79
Redwood Ck. (Lost Man Ck.)	Coastal	31	0.42	0.39	8.27	1.94	87.1	1.00
Mad R.	Coastal	31	0.39	0.41	6.77	1.94	74.2	1.00
Eel R. (Hollow Tree Ck.)	Coastal	28	0.39	0.39	7.04	1.91	71.4	1.00
Eel R. (Lawrence Ck.)	Coastal	30	0.41	0.40	7.50	1.94	90.0	0.74
Mattole R.	Coastal	31	0.39	0.40	6.36	1.92	93.5	1.00
Noyo R.	Coastal	31	0.41	0.42	7.62	1.96	93.5	0.82
Gualala R.	Coastal	29	0.43	0.45	6.65	1.98	86.2	1.00
Redwood Ck. (Marin Co.)	Coastal	30	0.44	0.44	7.28	1.98	83.3	0.86
Miller Ck. (Marin Co.)	Coastal	31	0.39	0.41	5.66	1.94	100.0	1.00
Central Valley								
1. McCloud R. (Butcherknife Ck.)	Above	21	0.21	0.21	3.75	1.61	100.0	—
2. McCloud R. (Claiborne Ck.)	Above	33	0.37	0.37	6.00	1.88	97.0	—
3. Clear Ck.	Below	94	0.39	0.37	8.00	1.96	93.6	0.12
4. Battle Ck.	Below	94	0.41	0.40	8.43	1.97	71.3	0.25
5. Thomes Ck.	Below	51	0.37	0.36	6.25	1.92	100.0	1.00
6. Deer Ck.	Below	45	0.42	0.43	8.64	1.98	71.1	0.40
7. Butte Ck.	Below	47	0.40	0.39	7.99	1.95	87.2	0.91
8. Feather R. (Above Lake Almanor)	Above	16	0.29	0.27	6.23	1.86	100.0	1.00
9. Feather R. (Chips Creek)	Above	31	0.37	0.36	7.49	1.91	90.3	0.49
10. Feather River Hatchery	Hatchery	30	0.41	0.40	7.01	1.96	33.3	0.17
11. Yuba R. (Upper)	Above	26	0.43	0.43	6.85	1.98	84.6	1.00
12. Yuba R. (Pauley Ck.)	Above	25	0.35	0.33	5.71	1.85	92.0	--
13. Yuba R.	Below	90	0.45	0.44	7.80	1.99	87.8	0.68
14. American R. (MF)	Above	58	0.42	0.40	7.58	1.97	91.4	0.93
15. American R.	Below	19	0.43	0.44	7.18	1.98	42.1	0.25
16. American R. (NF)	Above	49	0.38	0.38	6.29	1.92	93.9	0.64
17. Nimbus Hatchery	Hatchery	98	0.43	0.42	7.53	1.97	86.2	0.39
18. Mokelumne Hatchery	Hatchery	162	0.41	0.40	7.31	1.97	77.8	0.09
19. Mokelumne R.	Below	63	0.43	0.42	7.61	1.98	74.6	0.36
20. Mokelumne R. (North Fork)	Above	51	0.38	0.38	7.63	1.94	80.4	0.84
21. Mokelumne R. (South Fork)	Above	49	0.36	0.36	6.84	1.93	91.8	0.65
22. Calaveras R.	Below	47	0.41	0.41	6.91	1.96	95.7	0.13
23. Stanislaus R	Below	80	0.44	0.44	7.66	1.99	91.3	0.26
24. Stanislaus R. (Upper)	Above	52	0.37	0.37	7.02	1.94	95.7	0.75
25. Tuolumne R.	Below	112	0.43	0.43	6.62	1.97	95.5	0.64
26. Tuolumne R. (Upper)	Above	47	0.39	0.36	7.28	1.93	91.5	0.87
27. Merced R. (Upper)	Above	35	0.36	0.32	6.04	1.92	90.5	0.41
28. Merced R.	Below	83	0.34	0.32	5.71	1.90	51.8	0.22
29. Kings R. (Deer Cove Ck.)	Above	33	0.38	0.37	4.70	1.95	90.9	0.32
30. Kings R. (Mill Flat Ck.)	Above	26	0.41	0.42	6.94	1.98	92.3	0.82
South Coast								
San Francisquito R.	Coastal	24	0.39	0.41	5.34	1.91	100.0	1.00
San Lorenzo R.	Coastal	32	0.42	0.43	5.80	1.97	71.9	1.00
Carmel R.	Coastal	32	0.42	0.42	6.96	1.97	96.9	0.68
Big Sur R.	Coastal	31	0.43	0.43	6.97	1.97	77.4	1.00
Hatchery trout strains								
Kamloops	Trout	47	0.29	0.28	5.51	1.75	100.0	—
Mt. Shasta	Trout	92	0.35	0.35	4.26	1.84	98.9	0.01
Eagle	Trout	47	0.30	0.29	4.35	1.83	87.2	1.00
Coleman	Trout	47	0.37	0.37	5.04	1.91	100.0	0.19
Moccasin	Trout	47	0.30	0.30	4.72	1.78	100.0	0.11
All CV		1,667					84.7	
All samples		2,430					86.9	

http://dx.doi.org/10.15447/sfews.2015v13iss4art3

for the naturally spawning populations below barriers, using river distances separating the confluences of each major tributary along the mainstem of the Sacramento–San Joaquin River system.

We used two individual-based assignment methods to evaluate both recent gene flow among populations and to identify hatchery rainbow trout individuals among the naturally spawning populations. The first analysis, implemented in the model-based clustering program *structure* (version 2.2; Pritchard et al. 2000), was used to fractionally assign the genome of individual fish to a hypothesized number of genetic clusters, *K*, in the dataset and to identify population associations. This analysis did not use information about *a priori* population designations, so it truly assigns the ancestry of each individual fish without regard to its origin. We evaluated the data using a range of values of $K=2–14$ to qualitatively document consistent patterns of population association. The second assignment analysis, implemented in the program *gsi_sim* (Anderson et al. 2008), uses the population genotype data as references to assign each individual fish to its most likely population of origin based on the method of Rannala and Mountain (1997). This approach evaluates the likelihood of assignment of each individual to every population, providing an evaluation of the composition of each population sample.

We constructed phylogeographic trees based on matrices of Cavalli–Sforza and Edwards' (1967) chord distance using the software package PHYLIP (v. 3.69c; Felsenstein 2005). This genetic distance was chosen because of its accuracy and ability to reliably recover the correct topology for phylogeographic trees (Takezaki and Nei 1996; Felsenstein 2003). We used the neighbor-joining algorithm (Saitou and Nei 1987) to determine tree topology, and derived a consensus tree from 1,000 bootstrap samples of the distance matrix with the CONSENSE program of PHYLIP. Finally, we conducted a correspondence analysis (CA) on the full dataset to qualitatively evaluate population relationships in the absence of a constrained tree structure. This analysis was conducted using the R-based software package *adegenet 1.3-4* (Jombart 2008; Jombart and Ahmed 2011).

RESULTS

Individual-Based Analysis

The final dataset contained genotypes of 2,430 individuals from 51 sample groups, including 1,667 fish from Central Valley populations. Model-based assignments from the program *structure* over the range of *K*-values employed clearly identified hatchery rainbow trout sampled among the naturally spawned fish (Figure 2). This analysis was used to identify 14 hatchery-origin rainbow trout in the Upper Merced population sample, six in the Upper Stanislaus, and 11 sampled at Nimbus Hatchery. The large number of hatchery trout identified in the Upper Merced River (14 of 35, 40%) were all sampled on the same day, separately from the rest of the fish in that population sample, and likely represent a distinct group of planted hatchery trout. Hatchery rainbow trout identified with structure were removed from the dataset in all subsequent analyses, with the exception of fish in the Lower Merced River sample, which had a strong and uniform hatchery influence, so no individuals could be singled out for removal.

Individual assignment tests provided high accuracy of self-assignment to Central Valley *O. mykiss* populations. The overall accuracy of assignment to population of origin was 84.7% (Table 1). Assignment accuracy for individual populations ranged from 100% for the McCloud R.–Butcherknife Ck., Thomes Creek, and the Feather River-above-Lake-Almanor samples to 33% for the Feather River Hatchery stock, in which many fish assigned to the Mokelumne Hatchery, and vice versa. Similarly, a substantial number of individuals cross-assigned between the American River and Nimbus Fish Hatchery samples, reflecting the strong similarities between these groups of fish.

Population Genetic Diversity

Allelic richness within populations was strongly correlated for microsatellite and SNP loci ($r^2=0.453$, $p<0.001$; Table 1). For the microsatellite loci, allelic richness ranged from a low of 3.75 (McCloud R.–Butcherknife Ck.) to a high of 8.64 (Deer Ck.). Since these SNPs have a maximum of two alleles, their allelic richness ranged from 1.6 (McCloud R.–

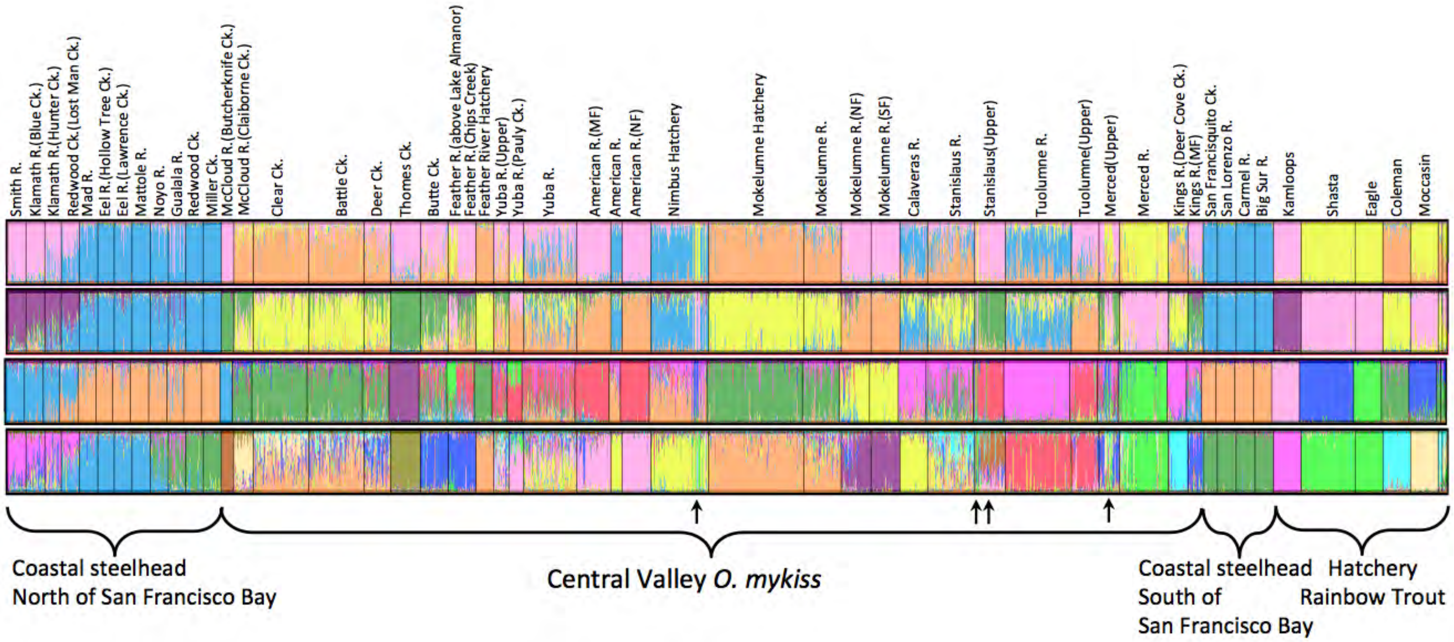

Figure 2 Graphical results of model-based clustering method implemented in structure (Pritchard et al. 2000) for a hypothesized number of genetic clusters, K, of 4, 6, 10 and 14. This analysis fractionally assigns each individual to the set of genetic clusters without prior consideration of geographic or population information, providing an unbiased assessment of individual ancestry. Arrows show hatchery trout identified and removed from other analyses.

Butcherknife Ck.) to >1.9 (many populations; Table 1). For both marker types, the range of allelic richness values observed in Central Valley populations encompassed the full range seen in coastal *O. mykiss* populations (Table 1). Observed heterozygosity across all loci ranged from a low of 0.212 in the McCloud R.–Butcherknife Creek population to 0.443 in the lower American, Stanislaus, and Yuba rivers (Table 1). Both microsatellite allelic richness and observed heterozygosity were signficantly lower in the populations above dams than those in sites below dams (AR: 6.42 vs. 7.40, *t*-test, $p<0.05$. Ho: 0.355 vs. 0.401; *t*-test, $p<0.05$), while the five hatchery trout strains had the lowest average values for any of the groups for both genetic diversity measures (Table 1). Finally, unlike the strong LD between the two SNP loci on chromosome Omy5 that was observed in coastal *O. mykiss* populations (mean $r^2=0.92$, range = 0.68 to 1.00), the strength of LD between these two SNP loci varied widely among Central Valley populations (mean $r^2=0.54$, range = 0.09 to 1.00; Table 1). Nonetheless, as in coastal populations, the mean frequency of alleles associated with anadromy at these adaptive loci was significantly higher in Central Valley below-barrier populations than above-barrier ones (0.48 vs. 0.17; *t*-test, $p<0.01$), consistent with the influence of dams on life-history variation (Pearse et al. 2014).

Population Structure

We examined pairwise values of FST, the standardized variance in allele frequencies between populations, for patterns of population structure. All pairwise FST values were significantly greater than zero based on permutation tests, with the highest values found between above-barrier populations (0.34, McCloud R., Butcherknife Ck. and Yuba River–Upper) and the lowest values involving below-barrier hatchery populations (0.005, Feather River Hatchery and Mokelumne Hatchery; 0.01, Nimbus Hatchery and American River) and below-barrier natural populations (0.015, Battle and Deer creeks). Notably, the lower

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Merced River sample was very similar to Eagle Lake trout, based on F_{ST} (0.012) and other analyses (see below). Mean pairwise F_{ST} values were significantly greater among above-barrier (0.15) than below-barrier populations (0.07; t-test, $p<0.001$), and for SNP loci (0.13) than for microsatellites (0.10; t-test, $p<0.001$). Despite the potential for both historical and current gene flow, there was no significant isolation by distance among the 12 natural below-barrier samples ($r^2=0.029$, $p>0.05$).

Phylogeographic trees were created for Central Valley populations only (Figure 3) and also with coastal California steelhead included (Figure 4). We also constructed trees using the microsatellite and SNP data separately, and with the hatchery rainbow trout strains included and excluded (data not shown). Regardless of which populations were included, there were only minor differences in the relationships inferred in the different trees, and all the major, statistically significant, relationships were consistent with the trees shown in Figures 3 and 4. In general, the phylogeographic trees did not cluster populations by basin of origin, with little or no statistical support for most internal branching relationships. We found strong bootstrap support primarily for nodes joining pairs of population samples above the same barrier dam. For example, the relationships between the two upper American River populations—American-NF and American-MF, and the two upper Mokelumne River populations, Mokelumne-NF and Mokelumne-SF—were both strongly supported in all trees (Figures 3 and 4). There was also a well-supported association between the Upper Yuba (Pauley Creek), Upper Feather River (both samples), Eagle Lake hatchery strain, and Lower Merced River samples, which consistently clustered, even when Eagle Lake was excluded from the analysis. Among the below-barrier populations, the American River–Lower and Nimbus

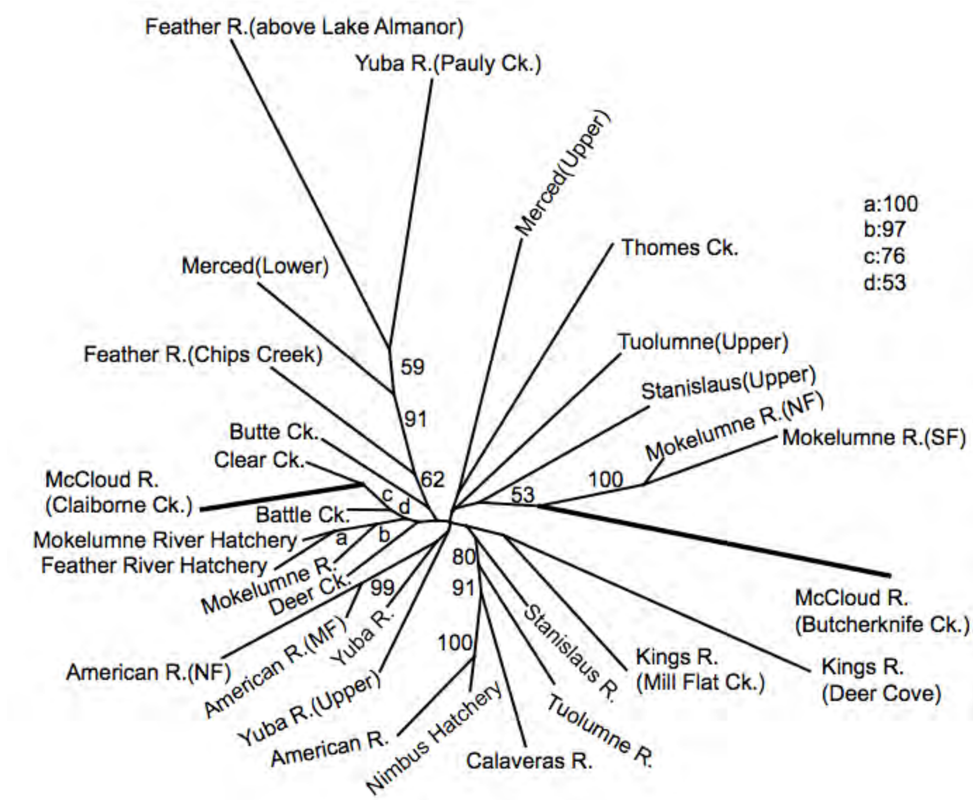

Figure 3 Neighbor-joining network showing only Central Valley *O. mykiss* populations, constructed with chord distances and original sub-basin groupings. Thick lines for McCloud populations shown at half length for display purposes. Bootstrap consensus values from 1000 bootstrap replicates shown. Only bootstrap values above 50% are reported.

Hatchery samples were closely associated with strong bootstrap support in all trees, as were the Mokelumne River, Mokelumne River Hatchery, and Feather River Hatchery samples (Figures 3 and 4).

The phylogeographic analysis that included coastal California steelhead populations revealed that, in general, Central Valley *O. mykiss* populations, both above and below dams, are more closely related to each other than to coastal populations outside of the Central Valley. Similarly, all of the hatchery strains cluster with the Central Valley populations in those analyses, as expected, given that most strains of hatchery rainbow trout used in California were domesticated from Sacramento River tributary populations (Busack and Gall 1980). The reduced LD between the two Omy5 loci in the hatchery trout strains is also consistent with their Sacramento River basin origins (Table 1). In addition, the American River–Lower and Nimbus Hatchery samples fall in a position intermediate between the coastal steelhead populations and the rest of the Central Valley, consistent with the founding of the current Nimbus Hatchery stock with eggs imported from coastal populations, primarily the Eel and Mad rivers. Finally, correspondence analysis displayed the same general relationships among Central Valley and coastal *O. mykiss* populations as the phylogenetic analysis, without the constraints of a tree (Figure 5).

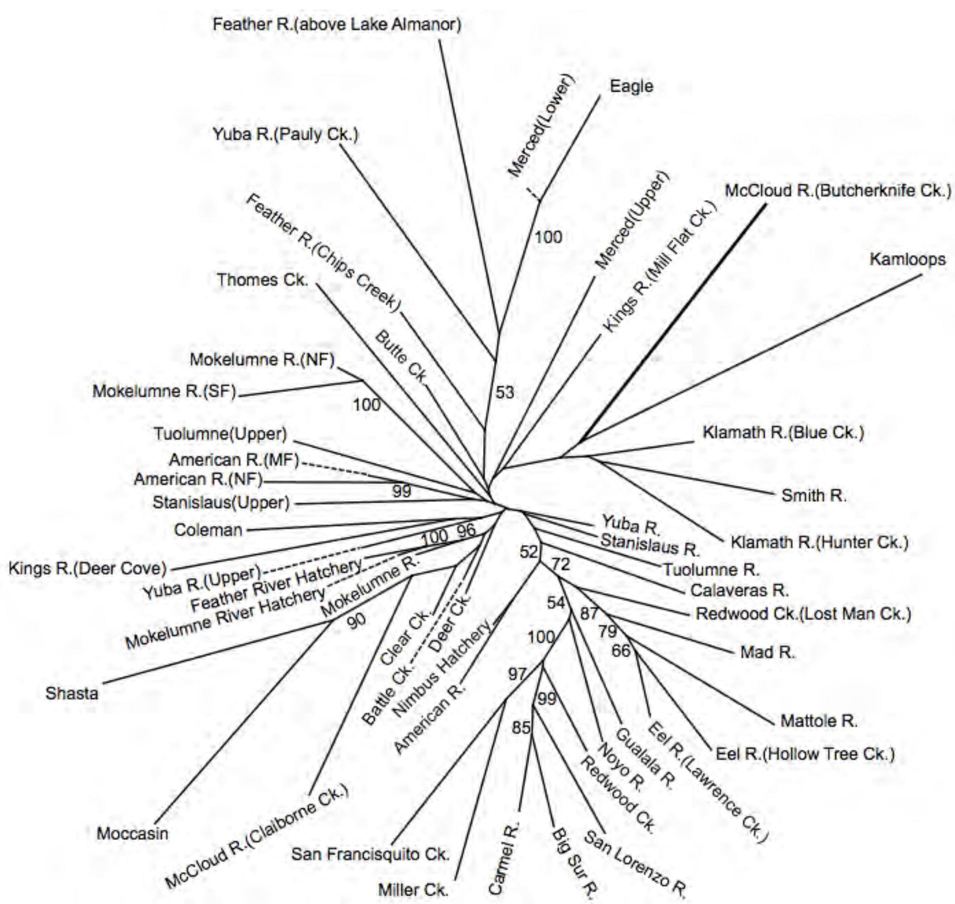

Figure 4 Neighbor-joining network of coastal and Central Valley *O. mykiss* populations constructed with chord distances and original sub-basin groupings. The thick line for McCloud R. (Butcherknife Ck.) is shown at half scale, and dotted lines connect names to branch tips for display purposes. Bootstrap consensus values from 1000 bootstrap replicates shown. Only bootstrap values above 50% are reported.

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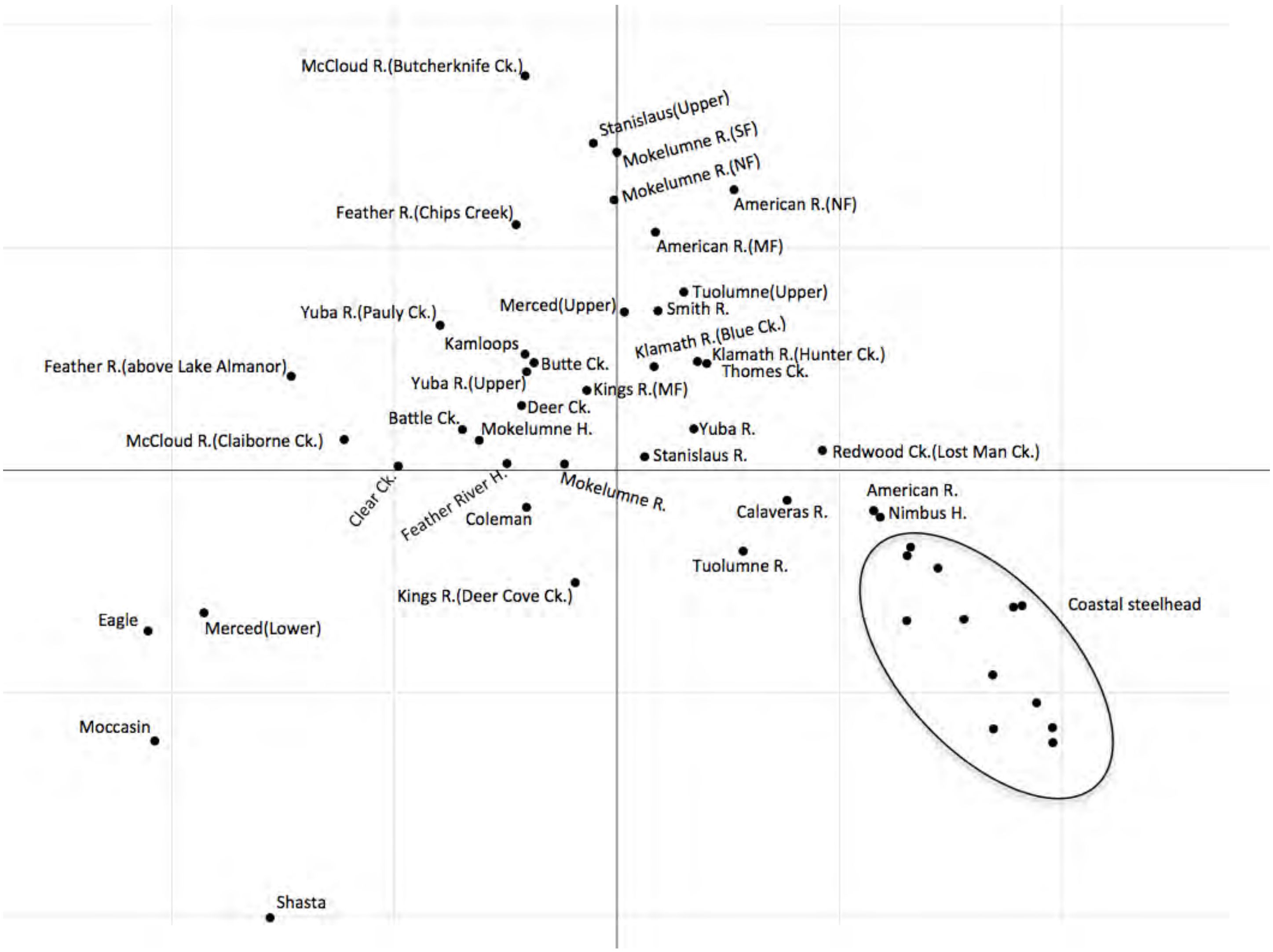

Figure 5 Correspondence analysis, showing population relationships on the first two axes of differentiation. Coastal steelhead populations that are not contained in the oval shown are labeled individually.

DISCUSSION

In contrast with the patterns typically found in natural populations, genetic analysis of Central Valley *O. mykiss* populations with more than 100 markers found a general lack of geographically associated population structure. This likely reflects more than a century of habitat modification and stocking/hatchery practices that together have altered the historical genetic relationships among *O. mykiss* populations in at least three ways. First, unlike the close relationships typically found between coastal *O. mykiss* populations above and below barriers within the same watershed (Clemento et al. 2009; Pearse et al. 2009), Central Valley populations separated by dams are usually not each other's closest relatives. Second, the relationships among below-barrier Central Valley populations do not fit a pattern of isolation-by-distance, as has been found among *O. mykiss* and other salmonid populations both within and among watersheds (Primmer et al. 2006; Palstra et al. 2007; Pearse et al. 2007; Pearse et al. 2011b; Garza et al. 2014), as well as in a recent study of Central Valley giant gartersnakes (*Thamnophis gigas*) inhabiting the same geographic area (Wood et al. 2015). Finally, some below-barrier Central Valley *O. mykiss* populations, particularly in the lower American River, are clearly derived primarily from populations from the northern California steelhead DPS, presumably though past importation of eggs from the Eel and Mad rivers. Like scrambling an egg, these genetic effects are largely irreversible, and future management must take them into account while recognizing that the historical relationships cannot be completely restored. However, such genetic effects are also not static, making efforts to use science-based recovery planning essential for the restoration of the adaptive potential of *O. mykiss* populations in the Central Valley (Meek et al. 2014).

Our results are largely concordant with previous genetic studies of Central Valley *O. mykiss* (e.g., Nielsen et al. 2005). However, the increased power of the combined microsatellite and SNP data used in the present study, as well as the inclusion of multiple stocks of hatchery rainbow trout and population samples above barriers to anadromy, offer increased resolution, especially given the complementary characteristics of these two types of marker (Narum et al. 2008). Nonetheless, unlike the well-supported relationships and strong isolation by distance found among coastal populations, there was only weak statistical support for most phylogenetic relationships among Central Valley *O. mykiss* populations. Thus, the lack of strong population structure found in this study likely represents an accurate depiction of the current population genetic relationships among Central Valley *O. mykiss* populations, while also showing that the overall genetic distinction between coastal and Central Valley DPS *O. mykiss* remains. Moreover, the majority of the genetic diversity found among the Central Valley steelhead / rainbow trout populations studied here was found at the level of the individual sample sites, all of which were significantly differentiated, contributing to high rates of self-assignment for most populations (Table 1). Accurate population self-assignments are useful because they indicate that the underlying genetic data can be used as a reference baseline for genetic stock identification techniques to determine basin and tributary of origin for individual fish in management or forensic applications (e.g., Seeb et al. 2007).

As noted above, one salient result of the present study is that populations above and below barrier dams in the same basins are not closely related in most of the major tributaries. Instead many of the above-barrier populations appear to be more genetically similar to each other than to any of the below-barrier populations, a pattern also observed by Nielsen et al. (2005). However, that study did not evaluate relationships between Central Valley trout and hatchery rainbow trout, leaving uncertainty about the phylogenetic origin of the above-barrier populations (Lindley et al. 2006). In the present study, most above-barrier populations are clearly genetically distinct from the hatchery trout strains, supporting the hypothesis that hatchery rainbow trout stocked in the reservoirs and elsewhere above dams in the region have not replaced the native *O. mykiss* populations that residualized following dam construction. Thus, our results suggest that native *O. mykiss* dominate the existing populations represented above the dams, as has been documented in coastal California basins (Clemento et al. 2009). However, it should be noted that detecting the influence of hatchery strains

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is complicated by the close relationship of most hatchery trout strains to their Central Valley origins, and substantial past introgression by hatchery trout into some or all above-barrier populations can not be completely ruled out.

In several sub-basins, we sampled and analyzed multiple above-barrier populations and the results were not all consistent. For example, in the Kings River, samples from Deer Cove and Mill Flat creeks both showed some similarity to hatchery trout strains, and the two populations were closely associated in some, but not all, analyses. On the other hand, pairs of samples from different tributaries above Folsom and Pardee dams, in the American and Mokelumne rivers, respectively, were closely related in all analyses. Pairwise FST values were very low, 0.03 and 0.04 between the middle and north forks of the American River and north and south forks of the Mokelumne River, respectively, and both pairs also cluster with high confidence in all phylogeographic analyses, indicating a common genetic ancestry and/or recent gene flow between them.

Artificial propagation of *O. mykiss* began in the Central Valley with the establishment of the Baird Station on the McCloud River in 1872. Since then, millions of juvenile fish have been released annually in Central Valley rivers, streams, lakes and reservoirs (Leitritz 1970). This massive propagation and stocking effort, much of it sparsely documented, significantly complicates efforts to disentangle historical population structure. Based on individual genotypic assignments, few hatchery trout were found amongst the population samples, with almost all identified hatchery trout sampled in three locations (Upper Stanislaus River, Upper Merced River, and Nimbus Hatchery). However, two populations showed significant associations with one or more hatchery trout strains. The population from Deer Cove Creek on the Kings River clustered with hatchery strains in some analyses, suggesting likely hatchery trout ancestry, even though no hatchery trout were identified individually. More strikingly, the sample from the Lower Merced River associated strongly with the Eagle Lake hatchery trout strain in both phylogenetic and correspondence analyses, as well as containing a significant number of individuals that assigned to the Eagle Lake strain. Thus it appears that the fish sampled in the Lower Merced River are almost exclusively descended from this hatchery trout strain.

Introgression of hatchery rainbow trout into natural steelhead / rainbow trout populations and hatchery production is potentially detrimental, because of their reduced genetic variation, history of hatchery selection, and potential for a genetic predisposition against anadromy. Here, among the 31 sampled adults that entered Nimbus Fish Hatchery in 2005–2006, nine were identified as hatchery rainbow trout (Garza and Pearse 2008). These individuals were generally smaller than the steelhead, but there was significant overlap in the size distributions, suggesting that such fish might be mistaken for small steelhead and incorporated into the broodstock. However, a separate genetic analysis of steelhead broodstock from all four Central Valley steelhead hatcheries from 2011–2013 identified the presence of fewer than 10 hatchery rainbow trout among the more than 7,000 adult spawners assayed (four at Nimbus among >1,100 spawners; Vendrami et al., unpublished data, see "Notes"). In addition, recent changes in California state hatchery protocols call for stocking only sterile, triploid, trout in waters where they may come into contact with naturally spawning steelhead (Fish and Game Code Chpt. 7.2, §1725–1730; see *http://www.leginfo.ca.gov/.html/fgc_table_of_contents.html*). Thus, it is unlikely that the incorporation of hatchery trout into broodstock of Central Valley steelhead hatchery programs is a widespread or ongoing problem.

Steelhead propagation and hatchery practices have directly affected the population structure of *O. mykiss* below barriers in the Central Valley in several ways. First, after the collapse of the steelhead program at Mokelumne Hatchery, the broodstock was replaced with fish from Feather River Hatchery, and these two populations are now extremely similar genetically, despite being geographically separated by >100 km. Similarly, Nimbus Hatchery on the American River has been a substantial producer of steelhead in the Central Valley since 1955 (Leitritz 1970) and, during the first several decades of operation, broodstock was imported periodically from coastal steelhead populations, including the Eel, Mad and Russian rivers (Lee and Chilton 2007). The effects of this out-of-basin stocking are apparent in both individual and population analyses, in which the Nimbus and American–Lower populations are intermediate between the coastal steelhead populations and all other Central Valley populations. Notably, the closest relationship of the American River populations outside of the Central Valley is to fish from Northern California, in the group that includes the Eel and Mad rivers, rather than to more geographically proximate populations in San Francisco Bay (e.g., Los Trancos, Miller Creek, Redwood Creek; Figures 3 and 4). The clustering of other Central Valley below-barrier populations with Nimbus and American River samples, particularly those from the Calaveras and Tuolumne Rivers, indicates that introgression of natural populations by fish with coastal steelhead ancestry has occurred through straying / migration of Nimbus Hatchery steelhead. Conversely, individual assignment tests and the reduced LD between the two Omy5 loci show that the *O. mykiss* now propagated at Nimbus Hatchery have diverged significantly from their coastal steelhead origins, likely through interbreeding with native Central Valley fish.

CONCLUSION

Our genetic results indicate small population sizes and reduced genetic diversity in above-barrier populations relative to below-barrier populations, consistent with the decreased connectivity and lost influx of new genes through migration after dam construction, factors that can contribute to population extirpation (Srikwan and Woodruff 2000). Facilitating fish migration across barriers is one way to mitigate such effects, and might also counteract adaptation of above-barrier populations in response to the strong selection against anadromy in these populations (Pearse et al. 2014). However, re-establishing connectivity of above-barrier populations trout with steelhead populations below dams should be carefully monitored because the consequences of such integration are not known, and could range from beneficial increases in genetic diversity and effective size, to negative changes in life history of the below-barrier populations, decreased fitness of hybrids, and adverse ecological interactions such as competition or direct predation.

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NOTES

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From: Lonnie Moore [mailto:lmoorenorcal@gmail.com]
Sent: Thursday, February 18, 2016 12:11 PM
To: Le, Bao
Subject: Re: Todays Tech Committee Call: Quick Question

Hi Bao!

Thanks for the info response and good words! I certainly hope to be more valuable in the future as I gain some knowledge, understand the current positions and processes, and better comprehend the "histories" of the project and issues.

Just because I'm old enough to appreciate a good telephone call, compared to an e-mail...where are you located (city/time zone). I promise not to call too often or talk for too long!! Also, is there a better time of your work day, to try to reach you?

Thanks,
Lonnie

On Wed, Feb 17, 2016 at 2:18 PM, Le, Bao <ChiBao.Le@hdrinc.com> wrote:

Hi Lonnie.

We very much appreciate your participation. The name of the gentleman was John Devine. He works for HDR and is a consultant to the Districts. He serves as the PM for the La Grange Licensing process.

Let me know if you have any questions.

Thanks, Bao

From: Lonnie Moore [mailto:lmoorenorcal@gmail.com]
Sent: Tuesday, February 16, 2016 4:31 PM
To: Le, Bao
Subject: Todays Tech Committee Call: Quick Question

Hi Bao,

Thanks for leading the group today!

One question though, could you tell me the name and organization of the gentleman that was speaking "against" the inclusion/consideration of Fall Run salmon.

Just curious, as I don't know the the folks names, org, or their voices, and I missed his name on the call.

Thanks,

Lonnie

--

Lonnie Moore

Consultant

Office: 209-551-5958

Mobile: 209-247-3991

lmoorenorcal@gmail.com

--

Lonnie Moore
Consultant
Office: 209-551-5958
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lmoorenorcal@gmail.com

From: Mike Deas <Mike.Deas@watercourseinc.com>
Sent: Friday, February 19, 2016 5:27 PM
To: John Wooster - NOAA Fe...
Cc: Le, Bao; Deason, Jesse; Borovansky, Jenna; Peggy Basdekas
Subject: RE: Temperature Data Swap and LiDAR

John,
Let me know how and when you would like to proceed with the data exchange. Thank you,
Mike

From: Le, Bao [mailto:ChiBao.Le@hdrinc.com]
Sent: Thursday, February 04, 2016 10:14 AM
To: Mike Deas
Subject: FW: Temperature Data Swap and LiDAR

Hey Mike.

If you're ok with John's response below, I think the next step is to facilitate data exchange. If it's ok, I would direct John to coordinate with you on the best way to go about this. Please let me know if this is ok.

Thanks, Bao

From: John Wooster - NOAA Federal [mailto:john.wooster@noaa.gov]
Sent: Thursday, February 04, 2016 10:07 AM
To: Le, Bao
Cc: Borovansky, Jenna; Deason, Jesse; mike.deas@watercourseinc.com
Subject: Re: Temperature Data Swap and LiDAR

I agree with your approach below, transmit the portion of the daily record that has water temp readings and trim the record aggressively to make sure we are in a zone of full inundation. While the discontinuous record will make it tough to run some stats and probably calibrate your model too, the data may help you validate once the model is built or at least get some insight if things further downstream aren't lining out as expected....

-JW

On Wed, Feb 3, 2016 at 5:11 PM, Le, Bao <ChiBao.Le@hdrinc.com> wrote:

Hi John.

See below in red.

Let me know if you have any questions.

Thanks, Bao

From: John Wooster - NOAA Federal [mailto:john.wooster@noaa.gov]
Sent: Wednesday, February 03, 2016 12:38 PM
To: Le, Bao
Cc: Borovansky, Jenna; Deason, Jesse; mike.deas@watercourseinc.com
Subject: Re: Temperature Data Swap and LiDAR

Bao:

I received the LiDAR data this morning. I can't email files over about 25 MB. I have the data on my Google Drive. I am going to invite you and Mike to share the folder, you should be able to link directly in without installing any additional software, click on the file (the file preview will fail) but you should then be able to start to download. There is also a data description / quasi meta data in there from the vendor. Let me know if it doesn't work.

As for water temp data, when you say "We remove loggers that go dry from the data set", I believe you mean you remove the portion of that loggers record that is dry (not the entire logger record), but wanted to double check....that’s correct. We remove just the air temperature portion.

How would you like to handle the logger(s) that go wet/dry on a daily basis with the whitewater release? I see two options: just remove the portion of the record where there is daily wet/dry cycles, or transmit the portion of each day where there is water temp readings (longer than you might think given a 4 hour whitewater release because it takes quite awhile for the pools to fully recede)..... We can sympathize with the deployment challenges of that reach reach given the whitewater releases. We think the data is useful and the second option preserves some important temperature information that would be lost if the daily wet/dry cycles were removed (option 1). Is it difficult to discern the transition between water temperatures and air temperatures and vice versa since a partially inundated logger might be hard to interpret? If so, perhaps a conservative approach would be to trim the data set a little more to ensure air temperatures do not creep into the data set. Thoughts?

Thanks,

John

On Wed, Feb 3, 2016 at 8:40 AM, Le, Bao <ChiBao.Le@hdrinc.com> wrote:

Thanks for the info, John. See responses below and let me know what you think.

Bao

From: John Wooster - NOAA Federal [mailto:john.wooster@noaa.gov]
Sent: Tuesday, February 02, 2016 1:43 PM
To: Le, Bao
Cc: Borovansky, Jenna; Deason, Jesse; mike.deas@watercourseinc.com
Subject: Re: Temperature Data Swap and LiDAR

Hi Bao:

Yes the LiDAR is ready to share, and it is processed. It is the bathymetry (derived from the hyper spec images) that is still being worked out - and still could be a few months out. Eventually those two data sets will be stitched together. But if you want the LiDAR now (everything above water surface), we could make that happen in a matter of days. I was told the LiDAR is only about a 5 GB file, so we could probably do that over a dropbox / Google Drive exchange. Let me know if you want that now, and I can probably have it within a matter of days from Science Center (I'm not actually holding it at the moment, but they did tell me last week it was ready).....That would be great if we could get the LiDAR above water surface for now. When the bathymetry is available, if we could acquire that as well, it'd be much appreciated. My email can accept 5 GB attachments.

My temp data is more or less ready to exchange - I did have one logger in the mainstem that I didn't get deep enough that would dessicate when they shut the water off after whitewater release and inundate with the whitewater pulse (that's what happens when you install loggers while rafting down the river and the water is up), so I still need to process that one. We had a similar issue with our mainstem logger above the Clavey and NF confluence locations – we installed in the early summer prior to rafting flows (down low and deep) and then as we got into late fall/winter, were unsure we could access them again with water rising. So these two locations have overwintered without a download. And our upper Clavey logger eventually went dry as well because we installed it when flows were up and couldn't safely get into the middle of the thalweg. I saw in August that at least your NF Tuolumne logger went dry, and I think your lower Clavey if memory serves correct. How would you like to handle the data from loggers that go dry? We remove loggers that go dry from the dataset. Are you deleting the records that are air temperature (i.e., when it goes dry)? Yes. Are you separating the data into two different columns - one for water temp, one for air temp (that is my preferred, as sometimes it is useful to have the air temp data)? Or one column of data, and one column of water vs air qualifier? Let me know what you have done and I will follow suit.... We did not manage air temp data in any way because we do not know if the logger is sitting in a puddle of water partly submerged and partly exposed, under a rock, in the baking sun, etc. The logger was not deployed as an air temperature monitoring station, which would require its own deployment protocol (somewhat different than a water temperature logger deployment).

Let's shoot to exchange temp data this coming Monday. I can probably transmit mine over email, or a couple of emails. Also could do that over Google Drive, as well. Let's work this week on how to exchange the larger files next Monday. As noted above, I can accept pretty large files. What's the case on your end and what's your preference? Using any file transfer software (that isn't currently on my laptop) will require that I get IT involved on this end to approve and download those programs. But I can get it going this week.

-John

On Tue, Feb 2, 2016 at 9:54 AM, Le, Bao <ChiBao.Le@hdrinc.com> wrote:

Hi John.

This has been on my plate for a while so I apologize for not getting back to you on exchanging data sooner. We've been through the process of temperature data QC and believe it is now available to share. As discussed previously, we'd like to also get NMFS' temperature data in the Upper Tuolumne River. Let's discuss a way in which we can swap that data here soon.

Also, you had mentioned that you would have LiDAR (although not completely processed) available to share as well. In discussions with Mike Deas, our temperature modeler, he thought this would still be useful for his purposes so if we could acquire these data also, that'd be great. I've cc'd him here.

Let me know if you have any questions.

Thanks,

Bao

Bao Le

Senior Fisheries Biologist

HDR

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--

John Wooster
Hydrologist
NOAA Fisheries West Coast Region
U.S. Department of Commerce
john.wooster@noaa.gov

From: Staples, Rose
Sent: Wednesday, February 24, 2016 2:02 PM
Cc: Staples, Rose; Deason, Jesse
Subject: ISR Meeting Presentations on La Grange Licensing Website

The PowerPoint presentations that will be used during the February 25, 2016 La Grange Initial Study Report (ISR) Meeting, being held at the Doubletree Hotel (1150 Ninth Street) in Modesto from 9:00 a.m. to 1:00 p.m., have been uploaded to the www.lagrange-licensing.com website, in the DOCUMENTS section as well as attachments to the meeting date on the website CALENDAR. A copy of the ISR Meeting agenda can also be found in both those locations.

If you have any difficulties locating and/or accessing the documents, please let me know at rose.staples@hdrinc.com. Thank you.

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From: Mike Deas <Mike.Deas@watercourseinc.com>
Sent: Thursday, February 25, 2016 11:23 AM
To: John Wooster - NOAA Federal
Cc: Chris Shutes; Le, Bao; Deason, Jesse; Borovansky, Jenna
Subject: Re: Some clarification on water temp slides

John, thank you for the clarifying information. More to come as we complete the field work.
Mike

Sent from my iPhone

On Feb 25, 2016, at 11:05 AM, John Wooster - NOAA Federal <john.wooster@noaa.gov> wrote:

> Chris:
>
> In relation to a couple of your questions:
> Slide 9: During June 2015 one of the two units at Holm Powerhouse was offline for the entire month for repair and/or maint.... On July 1 both units came back online, more or less doubling release during whitewater window.
>
> Comparing slide 7 and 9: Not only are they different years, but different monitoring points, slide 7 is 2009 and historic data from CCSF / DFW, and slide 9 show the District's current monitoring stations. You do bring up some good points here to explore further, as it would appear there are some pointed differences in temps as to whether you are on the mainstem above/below Cherry conf, in Cherry above/below Holm powerhouse, etc...
>
> -JW
>
> --
> **John Wooster**
> *Hydrologist*
> *NOAA Fisheries West Coast Region*
> *U.S. Department of Commerce*
> john.wooster@noaa.gov

From: Staples, Rose
Sent: Friday, February 26, 2016 4:26 PM
Cc: Staples, Rose; Deason, Jesse; Le, Bao
Subject: March 2016 Technical Committee Conference Call Scheduled

To members of the Technical Committee,

Thank you all who responded to my recent Doodle Poll query about your availability for the March call—it greatly assisted us in making the final date selection.

The next Upper Tuolumne River Reintroduction Assessment Framework Technical Committee conference call will be held on Friday, March 18th from 10:00 a.m. to Noon. Call-in information and other details will be forthcoming closer to the date.

Thank you.

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From: Barnes, Peter@Waterboards [mailto:Peter.Barnes@waterboards.ca.gov]
Sent: Friday, February 26, 2016 12:43 PM
To: Devine, John
Subject: La Grange and Don Pedro Tribal Consultation

John,

Can you please include the State Water Board in any consultation regarding tribes and/or cultural resources? Recent changes to state legislation and State Water Board policy require us to meet certain tribal consultation requirements during the CEQA process. Thank you.

Sincerely,

Peter Barnes
Engineering Geologist
Water Quality Certification Program
Division of Water Rights
State Water Resources Control Board
Phone: (916) 445-9989
Email: Peter.Barnes@waterboards.ca.gov

From: Staples, Rose
Sent: Thursday, March 03, 2016 2:52 PM
Cc: Staples, Rose; Deason, Jesse; Le, Bao
Subject: Districts E-File La Grange ISR Meeting Summary with FERC Today

The Districts have e-filed the La Grange Initial Study Report Meeting Summary with FERC today. A copy of the document should be available on FERC's E-Library at www.ferc.gov tomorrow. In addition, a copy of the document has been uploaded to the licensing website www.lagrange-licensing.com as an attachment to today's date on the CALENDAR as well as in the DOCUMENTS section of the website. If you have any difficulties locating and/or accessing the document, please let me know at rose.staples@hdrinc.com. Thank you.

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From: Staples, Rose
Sent: Thursday, March 03, 2016 3:19 PM
Cc: Staples, Rose; Deason, Jesse; Le, Bao
Subject: La Grange Workshop No 4 Notes Available on Licensing Website

La Grange Licensing Participants,

The notes from the January 27, 2016 La Grange Workshop No. 4 have been uploaded to the La Grange licensing website (www.lagrange-licensing.com) in the DOCUMENTS section. If you have any difficulty locating and/or accessing the document, please let me know at rose.staples@hdrinc.com. Thank you.

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From: Staples, Rose
Sent: Monday, March 07, 2016 1:27 PM
Cc: Staples, Rose; Deason, Jesse; Le, Bao
Subject: La Grange Workshop No 5 Scheduled for April 13, 2016

La Grange Licensing Participants,

The Districts have scheduled the La Grange Reintroduction Assessment Framework Workshop No. 5 for Wednesday, April 13, 2016 from 10:00 a.m. to Noon in the Boardroom at Turlock Irrigation District, located at 333 E Canal Drive in Turlock. Further details, including an agenda, will be sent closer to the workshop date.

Thank you.

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From: Staples, Rose
Sent: Monday, March 07, 2016 4:17 PM
Cc: Staples, Rose; Deason, Jesse; Le, Bao
Subject: Participation on Technical Committee Subgroup for Development of Reintroduction Program Goals

Members of the La Grange Reintroduction Assessment Framework Technical Committee,

To date I have five committee members (Chuck Hanson, Ellen Levin, Lonnie Moore, William Sears, and Ron Yoshiyama), along with Paul Bratovich with HDR, who have expressed interest in participating on the Technical Committee's subgroup for the development of reintroduction program goals. .

If you are also interested, please do email me at Rose.Staples@hdrinc.com by Thursday, March 10. Thank you.

Rose Staples, CAP-OM, MOS
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From: Le, Bao
Sent: Monday, March 14, 2016 7:27 PM
To: jeicher@blm.gov
Cc: Devine, John; Borovansky, Jenna; Deason, Jesse; Warnock, Cory
Subject: Upper Tuolumne River studies – permitting and approvals

Hi Jim.

As you know, the Districts in collaboration with stakeholders will be conducting both existing (i.e., temperature monitoring and migration barriers assessment) and new (spawning gravel, habitat typing, etc.) studies in the Upper Tuolumne River this year to support the La Grange Project licensing process and the Upper Tuolumne River Reintroduction Assessment Framework. Currently, we're in the process of scoping the level of field effort required for each study so that we can develop the most efficient field program to address the needs of multiple studies that will be occurring at the same time. Once we have a clear understanding of our 2016 field program (targeting early April), we'd like to meet (in person or by phone) to coordinate on getting the required permits and/or approvals in place to support this work.

Let me know if you have any questions.

Thanks,
Bao

Bao Le
Senior Fisheries Biologist

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From: Staples, Rose
Sent: Friday, March 11, 2016 2:04 PM
To: 'Bowes, Stephen'
Subject: RE: Districts E-File La Grange ISR Meeting Summary with FERC Today

The La Grange Proposed Study Plan was e-filed with FERC on October 5, 2014; the Revised Study Plan was e-filed on January 5, 2015. Two other Study Plans were developed: Draft Tube was e-filed on June 11, 2015; the Fish Migration Barriers Component was e-filed on September 18, 2015. All these documents can be found in a date sequential listing under the DOCUMENTS tab of the
La Grange licensing website www.lagrange-licensing.com.

Rose Staples, CAP-OM, MOS
D 207-239-3857

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From: Bowes, Stephen [mailto:stephen_bowes@nps.gov]
Sent: Friday, March 11, 2016 11:44 AM
To: Staples, Rose
Subject: Re: Districts E-File La Grange ISR Meeting Summary with FERC Today

also I'm curious when the study plans were filed. Thanks

Stephen M. Bowes
Hydropower Assistance Program
National Park Service
333 Bush Street, Suite 500
San Francisco, CA 94104
Phone: 415-623-2321
Fax: 415-623-2387

On Wed, Mar 9, 2016 at 2:01 PM, Staples, Rose <Rose.Staples@hdrinc.com> wrote:

Thank you; let me see what I can find out for you as to upcoming milestones, now that the Initial Study Report for La Grange was filed with FERC on February 2.

Rose Staples, CAP-OM, MOS

D 207-239-3857

hdrinc.com/follow-us

From: Bowes, Stephen [mailto:stephen_bowes@nps.gov]
Sent: Wednesday, March 09, 2016 4:55 PM
To: Staples, Rose
Subject: Re: Districts E-File La Grange ISR Meeting Summary with FERC Today

I'm just trying to figure out where this relisensing is at and what are the next milestones. I'm very involved in the Don Pedro re-lisensings and am trying to figure out how this one might over-lap with some of the things we are talking about in Don Pedro.

Stephen M. Bowes
Hydropower Assistance Program
National Park Service
333 Bush Street, Suite 500
San Francisco, CA 94104
Phone: 415-623-2321
Fax: 415-623-2387

On Wed, Mar 9, 2016 at 1:51 PM, Staples, Rose <Rose.Staples@hdrinc.com> wrote:

Could you clarify for me the question? A particular study report other than what was filed with FERC earlier?

Rose Staples, CAP-OM, MOS

D 207-239-3857

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From: Bowes, Stephen [mailto:stephen_bowes@nps.gov]
Sent: Wednesday, March 09, 2016 4:46 PM
To: Staples, Rose
Subject: Re: Districts E-File La Grange ISR Meeting Summary with FERC Today

Hi Rose,

when do you anticipate the ISRs will be done?

Stephen M. Bowes
Hydropower Assistance Program
National Park Service
333 Bush Street, Suite 500
San Francisco, CA 94104
Phone: 415-623-2321
Fax: 415-623-2387

On Thu, Mar 3, 2016 at 2:52 PM, Staples, Rose <Rose.Staples@hdrinc.com> wrote:

The Districts have e-filed the La Grange Initial Study Report Meeting Summary with FERC today. A copy of the document should be available on FERC's E-Library at www.ferc.gov tomorrow. In addition, a copy of the document has been uploaded to the licensing website www.lagrange-licensing.com as an attachment to today's date on the CALENDAR as well as in the DOCUMENTS section of the website. If you have any difficulties locating and/or accessing the document, please let me know at rose.staples@hdrinc.com. Thank you.

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From:	Le, Bao
Sent:	Monday, March 14, 2016 7:30 PM
To:	Vaughn, Gary D -FS; Holdeman, Steven J -FS
Cc:	Devine, John; Borovansky, Jenna; Deason, Jesse; Warnock, Cory
Subject:	Upper Tuolumne River studies – permitting and approvals

Hi Dusty and Steven,

As you know, the Districts in collaboration with stakeholders will be conducting both existing (i.e., temperature monitoring and migration barriers assessment) and new (spawning gravel, habitat typing, etc.) studies in the Upper Tuolumne River this year to support the La Grange Project licensing process and the Upper Tuolumne River Reintroduction Assessment Framework. Currently, we're in the process of scoping the level of field effort required for each study so that we can develop the most efficient field program to address the needs of multiple studies that will be occurring at the same time. Once we have a clear understanding of our 2016 field program (targeting early April), we'd like to meet (in person or by phone) to coordinate on getting the required permits and/or approvals (in addition to those already in place) to support this work.

Let me know if you have any questions.

Thanks,
Bao

Bao Le
Senior Fisheries Biologist

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From: Staples, Rose
Sent: Tuesday, March 15, 2016 1:43 PM
To: Bratovich, Paul; Hanson, Chuck; Koepele, Patrick; Levin, Ellen; marcomorenopr@gmail.com; Moore, Lonnie; Sears, William; Yoshiyama, Ron
Cc: Deason, Jesse; Le, Bao
Subject: Availability for First Technical Committee REINTRODUCTION GOALS SUBGROUP Conference Call

Please use the link below to advise your availability for either April 1 (10:00 am to Noon) or April 8 (10:00 am to Noon) for the first conference call of the La Grange Technical Committee's Reintroduction Goals Subgroup. Thank you.

http://doodle.com/poll/wyx9f79an8vi2h3p

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From: Staples, Rose
Sent: Wednesday, March 16, 2016 1:32 PM
To: Barnes, Peter; Buckley, John; Byrd, Larry; Carr, Adrianne; Edmondson, Steve; Eicher, James; Hanson, Chuck; Holdeman, Steven; Holley, Thomas; Jackson, Zach; Koepele, Patrick; Levin, Ellen; marcomorenopr@gmail.com; Moore, Lonnie; Murphey, Gretchen; Sears, William; Shipman, Jennifer Carlson ; Shutes, Chris; Wilcox, Scott; Wooster, John; Yoshiyama, Ron
Cc: Deason, Jesse; Staples, Rose; Le, Bao
Subject: March 18 Technical Committee Conference Call Agenda and Draft Study Plans

The AGENDA / CONFERENCE CALL-IN INFORMATION for the March 18, 2016 La Grange Reintroduction Assessment Framework Technical Committee Conference Call as well as five draft study plans which will be discussed on the call have been uploaded to the La Grange licensing website at www.lagrange-licensing.com.) You can access these documents both in the DOCUMENTS section of the website and as attachments to the call notice on the CALENDAR. If you have any difficulties locating and/or accessing these documents, please let me know at rose.staples@hdrinc.com.

Final comments on the five draft study plans will need to be sent to me at rose.staples@hdrinc.com by Tuesday, March 29, 2016.

Thank you.

Rose Staples, CAP-OM, MOS
Executive Assistant

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From:	Staples, Rose
Sent:	Monday, March 21, 2016 10:20 AM
Cc:	Deason, Jesse; Staples, Rose; Le, Bao
Subject:	FW: Technical Committee Subgroup Conference Call Scheduled for April 1 2016

To the La Grange Licensing Participants,

The following advisory was sent today to the members of the Technical Committee's Reintroduction Goals Subgroup that their first conference call has been scheduled for Friday, April 1, 2016 from 10:00 a.m. to Noon.

Summary of Upcoming Events

April 1	10:00 am to Noon	Technical Committee's Reintroduction Goals Supgroup	866-583-7984 / Code 8140607
April 13	10:00 am to Noon	Workshop No 5, TID Offices (333 E Canal Drive, Turlock)	

Rose Staples, CAP-OM, MOS
D 207-239-3857

hdrinc.com/follow-us

From: Staples, Rose
Sent: Monday, March 21, 2016 1:07 PM
Cc: Deason, Jesse; Staples, Rose (Rose.Staples@hdrinc.com); Le, Bao
Subject: Technical Committee Subgroup Conference Call Scheduled for April 1 2016

To members of the Technical Committee's Subgroup,

Thank you all for responding to the Doodle Poll regarding availability.

The first Reintroduction Goals Subgroup conference call will be on Friday, April 1, from 10:00 am to 12:00 pm. Here is the conference call-in information:

- Phone number: 866-583-7984
- Code: 8140607

The following individuals have volunteered to participate on the Reintroduction Goals Subgroup: (1) Mr. Paul Bratovich; (2) Mr. Chuck Hanson; (3) Mr. Patrick Koepele; (4) Ms. Ellen Levin; (5) Mr. Lonnie Moore; (6) Mr. Marco Moreno; (7) Mr. Bill Sears; and (8) Mr. Ron Yoshiyama. Thank you for volunteering your time to participate.

Rose Staples, CAP-OM, MOS
Executive Assistant

HDR
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Portland ME 04103
D 207-239-3857
rose.staples@hdrinc.com

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From: Staples, Rose
Sent: Friday, March 18, 2016 3:37 PM
Cc: Devine, John; Deason, Jesse; Le, Bao; Staples, Rose
Subject: CDFW Tuolumne River Summary Report 2009 uploaded to website

As an action item from today's Technical Committee conference call, please be advised that the CDFW Tuolumne River Summary Report 2009 (identifying Chinook salmon near Lumsden area of the upper Tuolumne River), as provided by Tom Holley with NOAA, has been uploaded to the La Grange licensing website (www.lagrange-licensing.com) in the DOCUMENTS section.

Rose Staples, CAP-OM, MOS
Executive Assistant

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rose.staples@hdrinc.com

hdrinc.com/follow-us

From: Staples, Rose
Sent: Tuesday, March 22, 2016 10:42 AM
Cc: Deason, Jesse; Le, Bao; Staples, Rose
Subject: Link to LTR Riparian Information and Synthesis Study Report

On the March 18, 2016 Technical Committee conference call, the Districts volunteered to send out a link to the *Lower Tuolumne River Riparian Information and Synthesis Study Report* (W&AR-19). Please find below a link to where you may view and download the study report.

http://www.donpedro-relicensing.com/Documents/P-2299-075_68_DP_FLA_AttC_StudyRept_W-AR-19_140428.pdf

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Telephone Record

Date:	Tuesday, March 22, 2016		
Project:	La Grange Licensing	Project No:	273222
Call to:	Voice Mail Message Left for Rose Staples this afternoon	Phone No:	
Call from:	Lonnie Moore, LP	Phone No:	209-551-5958
Subject:	Seeking contact information HDR / Fellow Participants		

Action:

Mr. Moore advised he was seeking whether there was a list somewhere of contact information for those involved with the La Grange licensing (i.e. HDR staff and other participants).

From: Staples, Rose
Sent: Wednesday, March 23, 2016 11:40 AM
To: Moore, Lonnie
Subject: Query

Got your voice mail messages from yesterday and today. Have forwarded your request to the Districts; will get back to you as soon as possible. Thank you.

Rose Staples, CAP-OM, MOS
Executive Assistant

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rose.staples@hdrinc.com

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From: John Buckley
Sent: Thursday, March 24, 2016 9:21 AM
To: Staples, Rose
Cc: Deason, Jesse; Le, Bao; William Sears; Patrick Koepele
Subject: Re: Technical Committee Subgroup Conference Call Scheduled for April 1 2016

Rose:

Due to my extremely overbooked schedule, I am not asking to formally be listed on the Technical Committee Reintroduction Goals Sub-Group, but I am intending to participate in all calls when my schedule allows (mostly listening in to be best informed) and I do intend to participate in the upcoming call next week on April 1st. I will call in using the number and code you provided.

John Buckley
CSERC

On Mar 21, 2016, at 10:19 AM, Staples, Rose <Rose.Staples@hdrinc.com> wrote:

To the La Grange Licensing Participants,

The following advisory was sent today to the members of the Technical Committee's Reintroduction Goals Subgroup that their first conference call has been scheduled for Friday, April 1, 2016 from 10:00 a.m. to Noon.

Summary of Upcoming Events

April 1	10:00 am to Noon	Technical Committee's Reintroduction Goals Supgroup	866-583-7984 / Code 8140607
April 13	10:00 am to Noon	Workshop No 5, TID Offices (333 E Canal Drive, Turlock)	

Rose Staples, CAP-OM, MOS
D 207-239-3857

hdrinc.com/follow-us

From: Staples, Rose
Sent: Monday, March 21, 2016 1:07 PM
Cc: Deason, Jesse; Staples, Rose (Rose.Staples@hdrinc.com); Le, Bao
Subject: Technical Committee Subgroup Conference Call Scheduled for April 1 2016

To members of the Technical Committee's Subgroup,

Thank you all for responding to the Doodle Poll regarding availability.

The first Reintroduction Goals Subgroup conference call will be on Friday, April 1, from 10:00 am to 12:00 pm. Here is the conference call-in information:

- Phone number: 866-583-7984
- Code: 8140607

The following individuals have volunteered to participate on the Reintroduction Goals Subgroup: (1) Mr. Paul Bratovich; (2) Mr. Chuck Hanson; (3) Mr. Patrick Koepele; (4) Ms. Ellen Levin; (5) Mr. Lonnie Moore; (6) Mr. Marco Moreno; (7) Mr. Bill Sears; and (8) Mr. Ron Yoshiyama. Thank you for volunteering your time to participate.

Rose Staples, CAP-OM, MOS
Executive Assistant

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From: Staples, Rose
Sent: Monday, March 28, 2016 4:35 PM
Cc: Deason, Jesse; Le, Bao; Staples, Rose
Subject: Changes in La Grange Draft Study Plans Review Schedule and Meeting Dates

La Grange Licensing Participants:

At the Technical Committee meeting on March 18, committee members noted that it may be difficult to provide a full review of the proposed 2016 study plans by March 29, as requested by the Districts, since Initial Study Report comments are also due in the same timeframe.

In consideration of these other licensing activities overlapping with release of the draft 2016 study plans, the Districts have revised the upcoming schedule for study plan review to allow more time for the Technical Committee to review and provide feedback on the draft study plans provided.

In addition, as the Districts have considered the logistics of the field efforts associated with the proposed 2016 studies, in conjunction with the effort that will be required to complete other potential studies that were proposed for 2017, the Districts have decided to initiate the study planning and field effort in support of a completing a PHABSIM study in 2016. Later this week, the Districts will be providing a draft study plan for this PHABSIM effort for Technical Committee review.

In order to provide adequate time for Technical Committee review of all the draft study plans prior to Workshop No. 5, the schedule for upcoming meetings has been revised.

Revised study plan review/comment schedule
- April 22 (extended from March 29) – Technical Committee comments on draft study plans
- May 3 – Districts' study teams provide revised study plans to Technical Committee for final review
- May 6 – Technical Committee final comments/approval of study plans to Districts
- May 10 – Districts provide final study plans and comments to Plenary Group for review (to be discussed at May 19 Workshop No. 5)

Please note on your calendars the revised meeting schedule
- April 1 (cancelled) - Reintroduction Goals Subcommittee Conference Call
- April 13 (new date) – Reintroduction Goals Subcommittee (Conference Call, 10 am – Noon)
- April 13 (cancelled) – Workshop No. 5/Plenary Group Meeting in Turlock
- May 19, 10 am – Noon (new date) – Workshop No. 5/Plenary Group Meeting, location TBD

Please contact me at Rose.Staples@hdrinc.com if you have questions on any of the changes above.

Thank you.

Rose Staples, CAP-OM, MOS
Executive Assistant

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From: Staples, Rose
Sent: Thursday, March 31, 2016 4:52 PM
Cc: Le, Bao; Deason, Jesse; Staples, Rose
Subject: LG TECHNICAL COMMITEE FEB 2016 CONF CALL FINAL NOTES UPLOADED TO WEBSITE

La Grange Licensing Participants,

The FINAL notes from the February 16, 2016 Upper Tuolumne River Reintroduction Framework Technical Committee conference call has been uploaded to the licensing website www.lagrange-licensing.com under the DOCUMENTS section and also as an attachment to the February 16 meeting date.

Please note that on March 18, the Districts had provided to the Technical Committee DRAFT notes from the February 16 meeting and requested that the Technical Committee provide any comments on the meeting notes by March 25. No comments were received; therefore, these FINAL notes are the same as the draft notes originally provided on March 18.

Thank you.

Rose Staples, CAP-OM, MOS
Executive Assistant

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From: Staples, Rose
Sent: Thursday, March 31, 2016 12:29 PM
Cc: Le, Bao; Deason, Jesse; Staples, Rose
Subject: Reminder La Grange Reintroduction Goals Subcommittee April 1 Call Moved to April 13

Just in case you missed my first advisory, I wanted to let you all know that the ***La Grange Reintroduction Goals Subcommittee call*** has been **moved** from April 1 (10:00 to Noon) to the new date of ***Wednesday, April 13th* (from 10:00 to Noon)***. Call-in number will be forwarded closer to the date. Thank you.

P.S.: And yes, Workshop No. 5, originally scheduled for the April 13 date/time has been moved to Thursday, May 19 from 10:00 to Noon. Again, more details closer to the date, including location.

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Executive Assistant

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From: Staples, Rose
Sent: Sunday, April 03, 2016 4:36 PM
Cc: Deason, Jesse; Le, Bao; Staples, Rose
Subject: FW: Draft Notes Mar 18 Technical Committee Conf Call Available For Review

La Grange Licensing Participants,

As you can see by the following message, the draft notes from the March 18, 2016 Technical Committee conference call have been uploaded to the licensing website (www.lagrange-licensing.com) for review by the Committee members—and are available for general viewing in both the DOCUMENTS and CALENDAR sections of the website. Thank you.

Rose Staples, CAP-OM, MOS
D 207-239-3857

hdrinc.com/follow-us

From: Staples, Rose
Sent: Sunday, April 03, 2016 7:18 PM
Cc: Deason, Jesse; Le, Bao; Staples, Rose
Subject: Draft Notes Mar 18 Technical Committee Conf Call Available For Review

Members of the La Grange Technical Committee,

The DRAFT NOTES* from the March 18, 2016 Technical Committee conference call has been uploaded to the licensing website www.lagrange-licensing.com in the DOCUMENTS section and also as an attachment to the CALENDAR March 18 meeting date. Please provide any comments on the meeting notes to me at Rose.Staples@hdrinc.com by Monday, April 11, 2016. The Districts will incorporate any comments received and produce a final version of the meeting notes, which will be posted to the La Grange Project Licensing Website.

In addition, an email will be sent to the La Grange Project licensing email list stating that the meeting notes are available online.

If you have any difficulties locating and/or accessing the document, please let me know. Thank you.

*Note: The documents referenced as "Attachment A" in the draft notes (meeting agenda and draft study plans) were previously uploaded to the above referenced sections of the licensing website.

Rose Staples, CAP-OM, MOS
Executive Assistant

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From: Staples, Rose
Sent: Monday, April 04, 2016 7:30 AM
To: Moore, Lonnie
Subject: Request for La Grange Licensing Participants Email Group Listing

We have discussed your request with the Districts and, at the same time, reviewed the La Grange licensing communication guidelines (Section 2.3, La Grange Preliminary Application Document [PAD]).

If we have your permission to release your email address to the rest of the La Grange Licensing Participants, we can then forward your request on to them so they can email you direct with their contact information if they so choose.

Thank you.

Rose Staples, CAP-OM, MOS
Executive Assistant

HDR
970 Baxter Boulevard Suite 301
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rose.staples@hdrinc.com

hdrinc.com/follow-us

From: Staples, Rose
Sent: Wednesday, April 06, 2016 8:27 AM
Cc: Deason, Jesse; Le, Bao; Staples, Rose
Subject: Request for La Grange Licensing Participants Email Contact Information

La Grange Licensing Participants,

We have received a request for the La Grange licensing participants' group individual email addresses from Mr. Lonnie Moore,
La Grange licensing participant and member of the Technical Committee and the Reintroduction Goals Subgroup.

We discussed his request with the Districts and, at the same time, reviewed the La Grange licensing communication guidelines (Section 2.3, La Grange Preliminary Application Document [PAD]) about not publishing participants' email addresses.

Therefore, while we are not releasing the list in its entirety to Mr. Moore, we are (with his permission) reprinting his contact information below, so that you can individually email him your email contact information, if you so choose:

> Mr. Lonnie Moore
> Modesto, CA
> Affiliation: Concerned Citizen
> E-Mail: lmoorenorcal@gmail.com
> Cell Phone: 209-247-3991
>
> "My desire is only to make communications easier and timely. I will not share anyone's shared information without their permission."

Thank you.

Rose Staples, CAP-OM, MOS
Executive Assistant

HDR
970 Baxter Boulevard Suite 301
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rose.staples@hdrinc.com

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From: Staples, Rose
Sent: Thursday, April 07, 2016 5:49 PM
Cc: Deason, Jesse; Le, Bao; Staples, Rose
Subject: FW: La Grange Reintroduction Goals Subcommittee Conference Call April 13

La Grange Licensing Participants,

FYI that we have today forwarded to the members of the La Grange Reintroduction Goals Subcommittee notification that the AGENDA and discussion material for the subcommittee conference call, scheduled for April 13 from 10:00 a.m. to Noon, have been uploaded to the www.lagrange-licensing.com website.

Rose Staples, CAP-OM, MOS
D 207-239-3857

hdrinc.com/follow-us

From: Staples, Rose
Sent: Thursday, April 07, 2016 8:40 PM
Cc: Deason, Jesse; Le, Bao; Staples, Rose (Rose.Staples@hdrinc.com)
Subject: La Grange Reintroduction Goals Subcommittee Conference Call April 13

Reintroduction Goals Subcommittee members,

Following up on our email notification of March 31st regarding the new date of ***April 13 (10:00 a.m. to Noon) for the La Grange Reintroduction Goals Subcommittee conference call***, we have uploaded these documents to the www.lagrange-licensing.com website (as attachments to the meeting date announcement):

1. AGENDA, with call-in number
2. Article from the *North American Journal of Fisheries Management* titled "Planning Pacific Salmon and Steelhead Reintroductions Aimed at Long-Term Viability and Recovery" by Anderson et al

The above referenced article was developed by NMFS and other agencies and tribes in the Pacific Northwest and discusses the importance of careful evaluation and planning of reintroduction programs. It deals specifically with ESA-listed salmonids. Of particular interest should be the section starting on page 75, which discusses planning concepts, goals, etc.—all of which are relevant to the discussion.

In addition, we are also providing a link to NMFS's Recovery Plan: http://www.westcoast.fisheries.noaa.gov/publications/recovery_planning/salmon_steelhead/domains/california_central_valley/final_recovery_plan_07-11-2014.pdf

If you have any difficulties locating and/or accessing these documents, please let me know. Thank you.

Rose Staples, CAP-OM, MOS
Executive Assistant

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rose.staples@hdrinc.com

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From: Staples, Rose
Sent: Thursday, April 07, 2016 6:47 PM
Cc: Deason, Jesse; Le, Bao; Staples, Rose
Subject: Start Time Correction for La Grange Technical Committee Conference Call April 18

PLEASE NOTE TIME CORRECTION FOR THE START OF THE APRIL 18TH CONFERENCE CALL: 11:00 A.M.

La Grange Licensing Participants,

FYI that we have today forwarded to the members of the Technical Committee notification that the next committee conference call has been scheduled for April 18 from ~~**10:00 a.m. to Noon**~~. **11:00 a.m. to Noon.**

Rose Staples, CAP-OM, MOS
D 207-239-3857

hdrinc.com/follow-us

From: Staples, Rose
Sent: Thursday, April 07, 2016 6:25 PM
Cc: Deason, Jesse; Staples, Rose (Rose.Staples@hdrinc.com); Le, Bao
Subject: La Grange Technical Committee Conf Call Scheduled for April 18

Technical Committee members,

The next ***Upper Tuolumne River Reintroduction Assessment Framework Technical Committee*** conference call will be held on ***Monday, April 18 from 11:00 a.m. to Noon***.

The purpose of this conference call will be to review the new PHABSIM draft study plan (which the Districts will distribute prior to this call) and to provide an opportunity for Technical Committee members to ask questions about and get clarification on the study plans, which were previously distributed and are available on the La Grange Project Licensing Website
(www.lagrange-licensing.com).

Please find below the conference call information for this April 18 call:

- Conference Line: 866-583-7984
- Passcode: 8140607

Thank you.

Rose Staples, CAP-OM, MOS
Executive Assistant

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970 Baxter Boulevard Suite 301
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Rose Staples, CAP-OM,
MOS *Executive Assistant*

HDR

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rose.staples@hdrinc.com

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From: Staples, Rose
Sent: Friday, April 08, 2016 3:48 PM
To: Peter Drekmeier
Subject: RE: Fish Passage Workshop

Thank you for the alert. The change in workshop date was included in an email of March 28th which addressed several changes, including that one—but I can see how it might get missed. I will do a separate email as a reminder to all the participants. Thank you

Rose Staples, CAP-OM, MOS
D 207-239-3857

hdrinc.com/follow-us

From: Peter Drekmeier [mailto:peter@tuolumne.org]
Sent: Friday, April 08, 2016 5:49 PM
To: Staples, Rose
Subject: Fish Passage Workshop

Hi Rose,

I noticed on the licensing website that next week's fish passage workshop has been rescheduled for May 19. Is this correct? If so, I think people would appreciate an email update (if one hasn't already gone out that I missed).

Thanks.

-Peter

Tuolumne River Trust

Peter Drekmeier
Policy Director
312 Sutter St., #402, San Francisco, CA 94108
peter@tuolumne.org | www.tuolumne.org
(415) 882-7252

From: Staples, Rose
Sent: Friday, April 08, 2016 4:54 PM
Cc: Deason, Jesse; Le, Bao; Staples, Rose
Subject: La Grange Workshop 5 Rescheduled for May 19

As announced on March 28th, the La Grange Workshop No. 5 has been rescheduled from April 13th to **Thursday, May 19, 2016** (10:00 a.m. to Noon). Additional details, including location, will be forthcoming closer to the date. Thank you.

Rose Staples, CAP-OM, MOS
Executive Assistant

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rose.staples@hdrinc.com

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From: John Buckley [mailto:johnb@cserc.org]
Sent: Tuesday, April 12, 2016 5:30 PM
To: Staples, Rose
Subject: Re: La Grange Draft UTR Instream Flow Study Plan for April 18 Discussion

Rose:

Thanks for e-mailing the notice of the Technical Committee and for notifying of the opportunity to review and print out the Upper Tuolumne River flow study plan. I have skimmed over it and appreciate the chance to review the information.

I will NOT be able to participate in the Technical Committee call next Monday, so this is simply to let you know.

Thanks

John Buckley
Central Sierra Environmental Resource Center

On Apr 12, 2016, at 11:57 AM, Staples, Rose <Rose.Staples@hdrinc.com> wrote:

La Grange Technical Committee members,

The draft Upper Tuolumne River Instream Flow Study Plan has been uploaded to the La Grange Project Licensing Website www.lagrange-licensing.com in the DOCUMENTS section and is ready for Technical Committee review and comment. The Districts will review this new study plan, as well as answer any questions about the other upper river study plans, on the next Technical Committee call, which is scheduled for ***11:00 am to 12:00 pm on Monday, April 18***.

Please find below the conference call information for this April 18 call:

- Conference Line: 866-583-7984
- Passcode: 8140607

If you have any difficulties locating and/or accessing this draft study plan, please let me know at rose.staples@hdrinc.com. Thank you.

Rose Staples, CAP-OM, MOS
Executive Assistant

HDR
970 Baxter Boulevard Suite 301
Portland ME 04103
D 207-239-3857
rose.staples@hdrinc.com

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From: Staples, Rose
Sent: Tuesday, April 12, 2016 12:20 PM
Cc: Deason, Jesse; Le, Bao; Staples, Rose
Subject: FW: La Grange Draft UTR Instream Flow Study Plan for April 18 Discussion

La Grange Licensing Participants,

FYI that we have today forwarded to the members of the Technical Committee notification that the draft Upper Tuolumne River Instream Flow Study Plan has been uploaded to the La Grange Licensing Website (www.lagrange-licensing.com), in the DOCUMENTS section.

Rose Staples, CAP-OM, MOS
D 207-239-3857

hdrinc.com/follow-us

From: Staples, Rose
Sent: Tuesday, April 12, 2016 2:58 PM
Cc: Deason, Jesse; Le, Bao; Staples, Rose
Subject: La Grange Draft UTR Instream Flow Study Plan for April 18 Discussion

La Grange Technical Committee members,

The draft Upper Tuolumne River Instream Flow Study Plan has been uploaded to the La Grange Project Licensing Website www.lagrange-licensing.com in the DOCUMENTS section and is ready for Technical Committee review and comment. The Districts will review this new study plan, as well as answer any questions about the other upper river study plans, on the next Technical Committee call, which is scheduled for ***11:00 am to 12:00 pm on Monday, April 18***.

Please find below the conference call information for this April 18 call:

- Conference Line: 866-583-7984
- Passcode: 8140607

If you have any difficulties locating and/or accessing this draft study plan, please let me know at rose.staples@hdrinc.com. Thank you.

Rose Staples, CAP-OM, MOS
Executive Assistant

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rose.staples@hdrinc.com

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From: Staples, Rose
Sent: Tuesday, April 12, 2016 12:36 PM
Cc: Deason, Jesse; Staples, Rose
Subject: La Grange Recreation Access and Safety Assessment Study Site Visit Scheduled for June 30

As part of the La Grange Hydroelectric Project ***Recreation Access and Safety Assessment*** study, the Districts will be conducting a site visit with licensing participants. This site visit will take place on Thursday, **June 30, 2016**. Additional details will be provided as the date approaches.

Thank you.

Rose Staples, CAP-OM, MOS
Executive Assistant

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rose.staples@hdrinc.com

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From: Staples, Rose
Sent: Friday, April 15, 2016 3:45 PM
Cc: Deason, Jesse; Le, Bao; Staples, Rose
Subject: FW: La Grange Draft Study Plan Comments Extension - April 18 Technical Committee Call Info

La Grange Licensing Participants,

FYI that we have today forwarded to the members of the Technical Committee notification that the deadline for comments on the draft upper river study plans has been extended from April 22 to the new due date of April 29. We also included a reminder that the next Technical Committee conference call is scheduled for Monday, April 18.

Thank you.

Rose Staples, CAP-OM, MOS
D 207-239-3857

hdrinc.com/follow-us

From: Staples, Rose
Sent: Friday, April 15, 2016 6:33 PM
Cc: Deason, Jesse; Le, Bao; Staples, Rose
Subject: La Grange Draft Study Plan Comments Extension - April 18 Technical Committee Call Info

Members of the Tuolumne River Reintroduction Assessment Framework Technical Committee,

The current deadline for comments on the draft upper river study plans (available on the La Grange Licensing Website www.lagrange-licensing.com under DOCUMENTS and as attachments to the April 18 conference call notification) is Friday, April 22. The Districts have extended the comment deadline by one week. Comments are now due by ***Friday, April 29***. Please submit your comments to Rose Staples at rose.staples@hdrinc.com.

As a reminder, the next Technical Committee call is scheduled for ***Monday, April 18, from 11:00 am to 12:00 pm.*** On this call, the Districts will be reviewing the draft Upper Tuolumne River Instream Flow Study Plan and answering any questions Technical Committee members may have about the other upper river study plans. Please find below the conference call information for this call:

- Conference Line: 866-583-7984
- Passcode: 8140607

Thank you.

Rose Staples, CAP-OM, MOS
Executive Assistant

HDR
970 Baxter Boulevard Suite 301
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rose.staples@hdrinc.com

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From: Staples, Rose
Sent: Friday, April 15, 2016 2:13 PM
Cc: Deason, Jesse; Le, Bao; Staples, Rose
Subject: La Grange - Final Notes from March 18 2016 Technical Committee Conference Call

La Grange Licensing Participants,

The FINAL notes from the March 18, 2016 Upper Tuolumne River Reintroduction Framework Technical Committee conference call has been uploaded to the licensing website www.lagrange-licensing.com under the DOCUMENTS section and also as an attachment to the March 18 meeting date.

Please note that on April 3, the Districts provided to the Technical Committee DRAFT notes from the March 18 meeting and requested that the Technical Committee provide any comments on the meeting notes by April 11. No comments were received; therefore, these FINAL notes are the same as the draft notes originally provided on April 3.

Thank you.

Rose Staples, CAP-OM, MOS
Executive Assistant

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From: Larry Byrd [mailto:byrdnest@wildblue.net]
Sent: Sunday, April 17, 2016 1:38 PM
To: Staples, Rose
Subject: Re: La Grange Draft Study Plan Comments Extension - April 18 Technical Committee Call Info

I'll be there for April 18th call

On Apr 15, 2016, at 3:33 PM, Staples, Rose <Rose.Staples@hdrinc.com> wrote:

Members of the Tuolumne River Reintroduction Assessment Framework Technical Committee,

The current deadline for comments on the draft upper river study plans (available on the La Grange Licensing Website www.lagrange-licensing.com under DOCUMENTS and as attachments to the April 18 conference call notification) is Friday, April 22. The Districts have extended the comment deadline by one week. Comments are now due by ***Friday, April 29***. Please submit your comments to Rose Staples at rose.staples@hdrinc.com.

As a reminder, the next Technical Committee call is scheduled for ***Monday, April 18, from 11:00 am to 12:00 pm.*** On this call, the Districts will be reviewing the draft Upper Tuolumne River Instream Flow Study Plan and answering any questions Technical Committee members may have about the other upper river study plans. Please find below the conference call information for this call:

- Conference Line: 866-583-7984
- Passcode: 8140607

Thank you.

Rose Staples, CAP-OM, MOS
Executive Assistant

HDR
970 Baxter Boulevard Suite 301
Portland ME 04103
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rose.staples@hdrinc.com

hdrinc.com/follow-us

From:	Deason, Jesse
Sent:	Monday, April 18, 2016 10:22 AM
To:	Le, Bao; Lonnie Moore (lmoorenorcal@gmail.com)
Cc:	Devine, John
Subject:	RE: Anderson et al.

Hi Lonnie,

Information on the Don Pedro Project relicensing studies is available online here:

http://www.donpedro-relicensing.com/documents.aspx

To find specific study reports, I suggest you click on the link above and then follow these instructions:

1. Click on ILP Activity: Final License Application (75)
2. Click on Documents: Final (75)

This will bring up a list of pdfs, including pdfs of the study reports. Please let me or Rose (rose.staples@hdrinc.com) know if you are looking for something in particular and are unable to find it.

Regards,

Jesse

Jesse Deason
D 206.826.4744 **M** 781.249.2452

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From: Le, Bao
Sent: Friday, April 15, 2016 2:23 PM
To: Lonnie Moore (lmoorenorcal@gmail.com)
Cc: Deason, Jesse; Devine, John
Subject: Anderson et al.

Hi Lonnie.

Great to talk with you today. Per our catch up discussion on the Reintroduction Goals Subcommittee call, attached is the Anderson et al. paper.

Jesse, if you could send a link to Lonnie for information for the Don Pedro Licensing studies, he requested that and I figured you had a better handle on that than I.

Thanks,
Bao

Bao Le
Senior Fisheries Biologist

HDR
1001 SW 5th Avenue, Suite 1800
Portland, OR 97204-1134
D 971.202.1722 **M** 503.309.9423
bao.le@hdrinc.com

hdrinc.com/follow-us

PHONE CALL MEMORANDUM

Topic	Background information on FERC regulations
Date	April 18, 2016
From	Mr. Lonnie Moore (citizen)
To	Ms. Jesse Deason (HDR)
Summary of Discussion	Mr. Moore called Ms. Deason as a follow up to the email Ms. Deason had sent him earlier in the day with directions on how to locate Don Pedro relicensing study reports. Mr. Moore called asking about how to find information on how the reintroduction work the Districts are completing is related to what the Districts must complete or produce under FERC statute. Ms. Deason suggested Mr. Moore review the Integrated Licensing Process regulations at Title 18, Part 5, as well as FERC's Scoping Document 2 and Study Plan Determination, both of which are available on the La Grange Project licensing website.

From: Le, Bao
Sent: Tuesday, April 19, 2016 4:26 PM
To: Mike Deas; John Wooster - NOAA Fe...
Cc: Deason, Jesse; Borovansky, Jenna; Peggy Basdekas; Devine, John; Borovansky, Jenna
Subject: RE: Temperature Data Swap and LiDAR

Hi John.

In addition to a swap of temperature data, I wanted to touch base on the progress made on the LiDAR and hyperspectral dataset. Last we spoke, more work was being done on the dataset. The Instream Flow Study we're now planning to conduct will likely have a need for the LiDAR and hyperspectral information. Can you provide us with an update of where this is at and if something updated would be available to inform the Instream Flow Study? As I understand it, the temperature modeling would also likely benefit from updated LiDAR information.

Also, we reviewed the technical data report you supplied earlier this year and there were a few questions. Jarvis Caldwell has worked with Quantum Spatial in the past and was hoping to follow up with them regarding these questions. Please let us know if that would be ok.

Thanks, Bao

From: Mike Deas [mailto:Mike.Deas@watercourseinc.com]
Sent: Tuesday, April 19, 2016 11:50 AM
To: John Wooster - NOAA Fe...
Cc: Le, Bao; Deason, Jesse; Borovansky, Jenna; Peggy Basdekas
Subject: RE: Temperature Data Swap and LiDAR

John,
Just following up with you on the temperature data exchange. Let me know if you would like to discuss this or have any questions or comments. Thank you,
Mike

From: Mike Deas
Sent: Friday, February 19, 2016 5:27 PM
To: 'John Wooster - NOAA Fe...'
Cc: Bao Le (bao.le@hdrinc.com); Deason, Jesse (Jesse.Deason@hdrinc.com); Borovansky, Jenna (Jenna.Borovansky@hdrinc.com); Peggy Basdekas
Subject: RE: Temperature Data Swap and LiDAR

John,
Let me know how and when you would like to proceed with the data exchange. Thank you,
Mike

From: Le, Bao [mailto:ChiBao.Le@hdrinc.com]
Sent: Thursday, February 04, 2016 10:14 AM
To: Mike Deas
Subject: FW: Temperature Data Swap and LiDAR

Hey Mike.

If you're ok with John's response below, I think the next step is to facilitate data exchange. If it's ok, I would direct John to coordinate with you on the best way to go about this. Please let me know if this is ok.

Thanks, Bao

From: John Wooster - NOAA Federal [mailto:john.wooster@noaa.gov]
Sent: Thursday, February 04, 2016 10:07 AM
To: Le, Bao
Cc: Borovansky, Jenna; Deason, Jesse; mike.deas@watercourseinc.com
Subject: Re: Temperature Data Swap and LiDAR

I agree with your approach below, transmit the portion of the daily record that has water temp readings and trim the record aggressively to make sure we are in a zone of full inundation. While the discontinuous record will make it tough to run some stats and probably calibrate your model too, the data may help you validate once the model is built or at least get some insight if things further downstream aren't lining out as expected....

-JW

On Wed, Feb 3, 2016 at 5:11 PM, Le, Bao <ChiBao.Le@hdrinc.com> wrote:

Hi John.

See below in red.

Let me know if you have any questions.

Thanks, Bao

From: John Wooster - NOAA Federal [mailto:john.wooster@noaa.gov]
Sent: Wednesday, February 03, 2016 12:38 PM
To: Le, Bao
Cc: Borovansky, Jenna; Deason, Jesse; mike.deas@watercourseinc.com
Subject: Re: Temperature Data Swap and LiDAR

Bao:

I received the LiDAR data this morning. I can't email files over about 25 MB. I have the data on my Google Drive. I am going to invite you and Mike to share the folder, you should be able to link directly in without installing any additional software, click on the file (the file preview will fail) but you should then be able to start to download. There is also a data description / quasi meta data in there from the vendor. Let me know if it doesn't work.

As for water temp data, when you say "We remove loggers that go dry from the data set", I believe you mean you remove the portion of that loggers record that is dry (not the entire logger record), but wanted to double check....that's correct. We remove just the air temperature portion.

How would you like to handle the logger(s) that go wet/dry on a daily basis with the whitewater release? I see two options: just remove the portion of the record where there is daily wet/dry cycles, or transmit the portion of each day where there is water temp readings (longer than you might think given a 4 hour whitewater release because it takes quite awhile for the pools to fully recede)..... We can sympathize with the deployment challenges of that reach reach given the whitewater releases. We think the data is useful and the second option preserves some important temperature information that would be lost if the daily wet/dry cycles were removed (option 1). Is it difficult to discern the transition between water temperatures and air temperatures and vice versa since a partially inundated logger might be hard to interpret? If so, perhaps a conservative approach would be to trim the data set a little more to ensure air temperatures do not creep into the data set. Thoughts?

Thanks,

John

On Wed, Feb 3, 2016 at 8:40 AM, Le, Bao <ChiBao.Le@hdrinc.com> wrote:

Thanks for the info, John. See responses below and let me know what you think.

Bao

From: John Wooster - NOAA Federal [mailto:john.wooster@noaa.gov]
Sent: Tuesday, February 02, 2016 1:43 PM
To: Le, Bao
Cc: Borovansky, Jenna; Deason, Jesse; mike.deas@watercourseinc.com
Subject: Re: Temperature Data Swap and LiDAR

Hi Bao:

Yes the LiDAR is ready to share, and it is processed. It is the bathymetry (derived from the hyper spec images) that is still being worked out - and still could be a few months out. Eventually those two data sets will be stitched together. But if you want the LiDAR now (everything above water surface), we could make that happen in a matter of days. I was told the LiDAR is only about a 5 GB file, so we could probably do that over a dropbox / Google Drive exchange. Let me know if you want that now, and I can probably have it within a matter of days from Science Center (I'm not actually holding it at the moment, but they did tell me last week it was ready).....That would be great if we could get the LiDAR above water surface for now. When the bathymetry is available, if we could acquire that as well, it'd be much appreciated. My email can accept 5 GB attachments.

My temp data is more or less ready to exchange - I did have one logger in the mainstem that I didn't get deep enough that would dessicate when they shut the water off after whitewater release and inundate with the whitewater pulse (that's what happens when you install loggers while rafting down the river and the water is up), so I still need to process that one. We had a similar issue with our mainstem logger above the Clavey and NF confluence locations – we installed in the early summer prior to rafting flows (down low and deep) and then as we got into late fall/winter, were unsure we could access them again with water rising. So these two locations have overwintered without a download. And our upper Clavey logger eventually went dry as well because we installed it when flows were up and couldn't safely get into the middle of the thalweg. I saw in August that at least your NF Tuolumne logger went dry, and I think your lower Clavey if memory serves correct. How would you like to handle the data from loggers that go dry? We remove loggers that go dry from the dataset. Are you deleting the records that are air temperature (i.e., when it goes dry)? Yes. Are you separating the data into two different columns - one for water temp, one for air temp (that is my preferred, as sometimes it is useful to have the air temp data)? Or one column of data, and one column of water vs air qualifier? Let me know what you have done and I will follow suit.... We did not manage air temp data in any way because we do not know if the logger is sitting in a puddle of water partly submerged and partly exposed, under a rock, in the baking sun, etc. The logger was not deployed as an air temperature monitoring station, which would require its own deployment protocol (somewhat different than a water temperature logger deployment).

Let's shoot to exchange temp data this coming Monday. I can probably transmit mine over email, or a couple of emails. Also could do that over Google Drive, as well. Let's work this week on how to exchange the larger files next Monday. As noted above, I can accept pretty large files. What's the case on your end and what's your preference? Using any file transfer software (that isn't currently on my laptop) will require that I get IT involved on this end to approve and download those programs. But I can get it going this week.

-John

On Tue, Feb 2, 2016 at 9:54 AM, Le, Bao <ChiBao.Le@hdrinc.com> wrote:

Hi John.

This has been on my plate for a while so I apologize for not getting back to you on exchanging data sooner. We've been through the process of temperature data QC and believe it is now available to share. As discussed previously, we'd like to also get NMFS' temperature data in the Upper Tuolumne River. Let's discuss a way in which we can swap that data here soon.

Also, you had mentioned that you would have LiDAR (although not completely processed) available to share as well. In discussions with Mike Deas, our temperature modeler, he thought this would still be useful for his purposes so if we could acquire these data also, that'd be great. I've cc'd him here.

Let me know if you have any questions.

Thanks,

Bao

Bao Le

Senior Fisheries Biologist

HDR

1001 SW 5th Avenue, Suite 1800
Portland, OR 97204-1134
D 971.202.1722 **M** 503.309.9423
bao.le@hdrinc.com

hdrinc.com/follow-us

--

John Wooster
Hydrologist
NOAA Fisheries West Coast Region
U.S. Department of Commerce
john.wooster@noaa.gov

From: Staples, Rose
Sent: Tuesday, April 19, 2016 11:10 AM
Cc: Deason, Jesse; Le, Bao; Staples, Rose
Subject: FW: TM Lower McCloud River HSC Development Uploaded to La Grange Website

La Grange Licensing Participants,

The following message was sent to the La Grange Technical Committee today regarding the uploading of the Technical Memo: Lower McCloud River HSC Development to the La Grange website.

Rose Staples, CAP-OM, MOS
D 207-239-3857

hdrinc.com/follow-us

From: Staples, Rose
Sent: Tuesday, April 19, 2016 11:19 AM
Cc: Deason, Jesse; Le, Bao; Staples, Rose
Subject: TM Lower McCloud River HSC Development Uploaded to La Grange Website

Technical Committee members,

As an action item from yesterday's Upper Tuolumne River Reintroduction Assessment Framework Technical Committee conference call, please be advised that *Technical Memo: Lower McCloud River HSC Development (TM-79)* has been uploaded to the La Grange licensing website (www.lagrange-licensing.com) in the DOCUMENTS section.

Rose Staples, CAP-OM, MOS
Executive Assistant

HDR
970 Baxter Boulevard Suite 301
Portland ME 04103
D 207-239-3857
rose.staples@hdrinc.com

hdrinc.com/follow-us

PHONE CALL MEMORANDUM

Topic	Follow up to Reintroduction Goals Subcommittee call held on April 13, 2016
Date	April 21, 2016
From	Mr. Bao Le (HDR)
To	Mr. Chris Shutes (California Sportfishing Protection Alliance)
Summary of Discussion	Mr. Shutes asked how Mr. Le thought differing opinions on making progress on the fish passage engineering component of the fish passage alternatives assessment might be resolved. This topic was again discussed on the Reintroduction Goals Subcommittee conference call on April 13, 2016. Mr. Shutes said he thought his suggestion for everybody to provide their ideas was possible but that Mr. Steve Edmondson (National Marine Fisheries Service) had noted that he thought the Districts should develop an approach first and then let others comment as was typical in FERC processes. Mr. Le told Mr. Shutes that he had interpreted this discussion differently and had heard the development of one pagers and this discussion being associated with the development of reintroduction goals; not necessarily related to information needs to push the engineering component forward although Mr. Le said he could have been mistaken. Mr. Le and Mr. Shutes discussed differences of opinion on the sequence that was required to re-engage the engineering. Mr. Le described NMFS' interest in conducting this component in parallel with the assessment framework while the Districts felt that in the absence of addressing the information gaps described in TM1, this would result in speculative designs contrary to good engineering practice. Mr. Le also noted that the information gaps identified in TM 1 were typically the responsibility of the agencies that have jurisdiction over the species of interest. As such, the Districts would like this input to come from the agencies and have a solid, scientific foundation. Mr. Le noted that this topic had been tabled at the meeting with the intent of considering further how to move the discussion forward outside of the reintroduction goals subcommittee. Mr. Shutes was appreciative of this and noted that he had read the stakeholder letters filed with FERC today. Mr. Shutes thought these might be poorly received by NMFS and worried that it might create more challenges to communication and collaboration moving forward. Mr. Shutes encouraged the Districts to consider reaching out to NMFS sooner rather than later to discuss the issue of fish passage engineering and determine if there might be a path forward. Mr. Shutes worried that in light of these letters, too long of a break in the communication might not be productive at this time.

From: Le, Bao
Sent: Friday, April 22, 2016 11:48 AM
To: Lonnie Moore
Cc: Deason, Jesse; Devine, John
Subject: RE: Study Plan Comments - Due Today!

Hi Lonnie.

Comments to the study plans (yes, there are 6) are due on April 29th. The comment deadline was extended per email communication from Rose Staples. These would be any additional comments beyond verbal comments made on the Tech Committee call and they should be in writing. I'd say to be safe, if you made verbal comments, you should re-state those again in your written comments, if any.

With regard to actual due date for the "Goals" input, I think where we landed on the subcommittee call was that the Districts would take into consideration NMFS request that only the Districts provide a first draft of reintroduction goals for comment as opposed to collecting input from all participants. This is still being discussed internally and I hope we can come to some resolution soon.

Thanks, Bao

From: Lonnie Moore [mailto:lmoorenorcal@gmail.com]
Sent: Friday, April 22, 2016 11:05 AM
To: Le, Bao
Subject: Study Plan Comments - Due Today!

Hi Bao,

I just wanted to be sure that comments to the six (6) draft study plans are due today, and that these comments are to the study plans we originally received in March, and for which we already had a conference call comment session?

So, then my understanding is that this would essentially be written comments, as opposed to the verbal comments/discussion on the earlier Tech Committee call?

Also, is there an actual due date for the "Goals" input we discussed last week?

Thanks,
Lonnie

--
Lonnie Moore
Consultant
Office: 209-551-5958
Mobile: 209-247-3991
lmoorenorcal@gmail.com

From: John Wooster - NOAA Federal <john.wooster@noaa.gov>
Sent: Monday, April 25, 2016 2:27 PM
To: Mike Deas
Cc: Le, Bao; Deason, Jesse; Borovansky, Jenna; Peggy Basdekas; Devine, John
Subject: Re: Temperature Data Swap and LiDAR

That's perfect, today has not gone as planned for me either and am sitting in meetings, will be back at me desktop in a few hours to send you my data.

John

On Mon, Apr 25, 2016 at 2:17 PM, Mike Deas <Mike.Deas@watercourseinc.com> wrote:

John, Here is the data. I agree that we should talk about the metadata surrounding these data. Are you around tomorrow? I have a meeting filled afternoon. I have a call at 1-2 tomorrow, but that is all at this moment.

Mike

From: John Wooster - NOAA Federal [mailto:john.wooster@noaa.gov]
Sent: Monday, April 25, 2016 10:15 AM
To: Mike Deas
Cc: Le, Bao; Deason, Jesse; Borovansky, Jenna; Peggy Basdekas; Devine, John
Subject: Re: Temperature Data Swap and LiDAR

I am fine with DSS or Excel, doesn't matter, mine is in excel....

I am in meetings today until about 2 PM - are you around after that? I mostly want to verbally walk you through any issues (i.e. logger going dry) I had with each station once you have the data.

Thanks

John

On Fri, Apr 22, 2016 at 2:49 PM, Mike Deas <Mike.Deas@watercourseinc.com> wrote:

John – can you use the data in DSS or would you like it in excel? Thanks,

Mike

From: John Wooster - NOAA Federal [mailto:john.wooster@noaa.gov]
Sent: Friday, April 22, 2016 1:09 PM
To: Le, Bao
Cc: Mike Deas; Deason, Jesse; Borovansky, Jenna; Peggy Basdekas; Devine, John
Subject: Re: Temperature Data Swap and LiDAR

I left my loggers in. During download in October, I was able to move one of my problematic loggers to deep in thalweg (the one at RD 1N01 on Clavey). However, I was not able to move the logger that goes dry most days when they shut off whitewater release - mainstem T, just upstream of Clavey confluence. That one might be a lost cause other than spot measurements when flow is up.

John

On Thu, Apr 21, 2016 at 5:27 PM, Le, Bao <ChiBao.Le@hdrinc.com> wrote:

Hi John.

To follow up on your email below, please see my responses in red.

Also, regarding temperature data, are you still collecting data this year as well. I don't recall whether you pulled loggers last fall or kept them out there to collect this spring/summer as well?

Thanks, Bao

From: Mike Deas [mailto:Mike.Deas@watercourseinc.com]
Sent: Thursday, April 21, 2016 11:44 AM
To: John Wooster - NOAA Federal
Cc: Le, Bao; Deason, Jesse; Borovansky, Jenna; Peggy Basdekas; Devine, John
Subject: Re: Temperature Data Swap and LiDAR

John, thank you. I am out of the office today and can communicate the data to you tomorrow.

Mike.

Sent from my iPhone

On Apr 21, 2016, at 10:30 AM, John Wooster - NOAA Federal <john.wooster@noaa.gov> wrote:

> Hi Bao and Mike:
>
> I'll complete the temperature data transfer this afternoon with Mike, I'm in meetings until 1 PM.
>
> Regarding contacting Quantum Spatial, I don't foresee this being an issue, but I had/have nothing to do with the contracting or working with those folks. I would like a chance to run it by the Science Center folks who were involved as a courtesy, good practice, particularly if we are going to ask for additional work products prior to them giving final deliverables. Note, if your questions center around the hyperspec images, the more appropriate person to contact may be the professor from Wyoming that supplied the actual camera, as his shop has handled the post processing of the images. Note sure Quantum did much more than fly the images, and probably georectify them. As I understand it, we don't have any questions for Quantum Spatial that will result in additional development of work products. I think some clarification on the metadata, flight times, etc. is all that is needed. My sense is that this would be pretty brief.
>
> As for "updated LiDAR", the LiDAR I gave you was a final product. But I think what you mean is the bathymetry derived from the hyperspec images, and preferably that data stitched with the LIDAR in the form of a DEM or DTM. I don't have a date on when that work is going to be finished (it wasn't at the time I got the LiDAR data). That being said, I do know that the project was supposed to be moving from deriving habitat units to calculating production in early June, which would imply that a final DEM would have been made by that point. I'll ask for more detail when I run the idea of contacting Quantum by them. You're correct. Apologize for continual use of the wrong terminology. Curious as to the availability of the LiDAR updated with bathymetry stitched in the form of a DEM or DTM.
>
> Regards,
>
> John
>
> On Tue, Apr 19, 2016 at 4:26 PM, Le, Bao <ChiBao.Le@hdrinc.com> wrote:

Hi John.

In addition to a swap of temperature data, I wanted to touch base on the progress made on the LiDAR and hyperspectral dataset. Last we spoke, more work was being done on the dataset. The Instream Flow Study we're now planning to conduct will likely have a need for the LiDAR and hyperspectral information. Can you provide us with an update of where this is at and if something updated would be available to inform the Instream Flow Study? As I understand it, the temperature modeling would also likely benefit from updated LiDAR information.

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Thanks, Bao

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Sent: Tuesday, April 19, 2016 11:50 AM
To: John Wooster - NOAA Fe...
Cc: Le, Bao; Deason, Jesse; Borovansky, Jenna; Peggy Basdekas
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John,

Just following up with you on the temperature data exchange. Let me know if you would like to discuss this or have any questions or comments. Thank you,

Mike

From: Mike Deas
Sent: Friday, February 19, 2016 5:27 PM
To: 'John Wooster - NOAA Fe...'
Cc: Bao Le (bao.le@hdrinc.com); Deason, Jesse (Jesse.Deason@hdrinc.com); Borovansky, Jenna (Jenna.Borovansky@hdrinc.com); Peggy Basdekas
Subject: RE: Temperature Data Swap and LiDAR

John,

Let me know how and when you would like to proceed with the data exchange. Thank you,

Mike

From: Le, Bao [mailto:ChiBao.Le@hdrinc.com]
Sent: Thursday, February 04, 2016 10:14 AM
To: Mike Deas
Subject: FW: Temperature Data Swap and LiDAR

Hey Mike.

If you're ok with John's response below, I think the next step is to facilitate data exchange. If it's ok, I would direct John to coordinate with you on the best way to go about this. Please let me know if this is ok.

Thanks, Bao

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Sent: Thursday, February 04, 2016 10:07 AM
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As for water temp data, when you say "We remove loggers that go dry from the data set", I believe you mean you remove the portion of that loggers record that is dry (not the entire logger record), but wanted to double check....that’s correct. We remove just the air temperature portion.

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Thanks,

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Thanks for the info, John. See responses below and let me know what you think.

Bao

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Subject: Re: Temperature Data Swap and LiDAR

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Yes the LiDAR is ready to share, and it is processed. It is the bathymetry (derived from the hyper spec images) that is still being worked out - and still could be a few months out. Eventually those two data sets will be stitched together. But if you want the LiDAR now (everything above water surface), we could make that happen in a matter of days. I was told the LiDAR is only about a 5 GB file, so we could probably do that over a dropbox / Google Drive exchange. Let me know if you want that now, and I can probably have it within a matter of days from Science Center (I'm not actually holding it at the moment, but they did tell me last week it

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have overwintered without a download. And our upper Clavey logger eventually went dry as well because we installed it when flows were up and couldn't safely get into the middle of the thalweg. I saw in August that at least your NF Tuolumne logger went dry, and I think your lower Clavey if memory serves correct. How would you like to handle the data from loggers that go dry? We remove loggers that go dry from the dataset. Are you deleting the records that are air temperature (i.e., when it goes dry)? Yes. Are you separating the data into two different columns - one for water temp, one for air temp (that is my preferred, as sometimes it is useful to have the air temp data)? Or one column of data, and one column of water vs air qualifier? Let me know what you have done and I will follow suit.... We did not manage air temp data in any way because we do not know if the logger is sitting in a puddle of water partly submerged and partly exposed, under a rock, in the baking sun, etc. The logger was not deployed as an air temperature monitoring station, which would require its own deployment protocol (somewhat different than a water temperature logger deployment).

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-John

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Hi John.

This has been on my plate for a while so I apologize for not getting back to you on exchanging data sooner. We've been through the process of temperature data QC and believe it is now available to share. As discussed previously, we'd like to also get NMFS' temperature data in the Upper Tuolumne River. Let's discuss a way in which we can swap that data here soon.

Also, you had mentioned that you would have LiDAR (although not completely processed) available to share as well. In discussions with Mike Deas, our temperature modeler, he thought this would still be useful for his purposes so if we could acquire these data also, that'd be great. I've cc'd him here.

Let me know if you have any questions.

Thanks,

Bao

Bao Le

Senior Fisheries Biologist

HDR

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D 971.202.1722 M 503.309.9423
bao.le@hdrinc.com

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--

John Wooster
Hydrologist
NOAA Fisheries West Coast Region
U.S. Department of Commerce
john.wooster@noaa.gov

<image001.jpg>

From: John Wooster - NOAA Federal [mailto:john.wooster@noaa.gov]
Sent: Tuesday, April 26, 2016 11:08 AM
To: Mike Deas
Subject: Re: Temperature Data Swap and LiDAR

Updated file, with longer Upper T ID4 record.

On Tue, Apr 26, 2016 at 7:44 AM, Mike Deas <Mike.Deas@watercourseinc.com> wrote:

John,

what is the best number to reach you at?

Mike

From: John Wooster - NOAA Federal [john.wooster@noaa.gov]
Sent: Tuesday, April 26, 2016 7:21 AM
To: Mike Deas
Subject: Re: Temperature Data Swap and LiDAR

11 AM should work, here is my data

thanks

John

On Tue, Apr 26, 2016 at 7:14 AM, Mike Deas <Mike.Deas@watercourseinc.com> wrote:

John,

I just realized I have something at 2;30. How about 11:00 a.m.?

Mike

From: John Wooster - NOAA Federal [john.wooster@noaa.gov]
Sent: Monday, April 25, 2016 6:44 PM
To: Mike Deas
Subject: Re: Temperature Data Swap and LiDAR

On the train home tonight I was reviewing my data and I found an error in the logic I had written for a macro to chop out data for my one logger that goes dry all the time, I worked the whole ride home trying to manually adjust, but I am now off the train and need to go home. I'll pick it up again tonight, and get it out before I turn in so we can discuss tomorrow. Sorry

John

On Mon, Apr 25, 2016 at 2:17 PM, Mike Deas <Mike.Deas@watercourseinc.com> wrote:

John, Here is the data. I agree that we should talk about the metadata surrounding these data. Are you around tomorrow? I have a meeting filled afternoon. I have a call at 1-2 tomorrow, but that is all at this moment.

Mike

From: John Wooster - NOAA Federal [mailto:john.wooster@noaa.gov]
Sent: Monday, April 25, 2016 10:15 AM
To: Mike Deas
Cc: Le, Bao; Deason, Jesse; Borovansky, Jenna; Peggy Basdekas; Devine, John
Subject: Re: Temperature Data Swap and LiDAR

I am fine with DSS or Excel, doesn't matter, mine is in excel....

I am in meetings today until about 2 PM - are you around after that? I mostly want to verbally walk you through any issues (i.e. logger going dry) I had with each station once you have the data.

Thanks

John

On Fri, Apr 22, 2016 at 2:49 PM, Mike Deas <Mike.Deas@watercourseinc.com> wrote:

John – can you use the data in DSS or would you like it in excel? Thanks,

Mike

From: John Wooster - NOAA Federal [mailto:john.wooster@noaa.gov]
Sent: Friday, April 22, 2016 1:09 PM
To: Le, Bao
Cc: Mike Deas; Deason, Jesse; Borovansky, Jenna; Peggy Basdekas; Devine, John
Subject: Re: Temperature Data Swap and LiDAR

I left my loggers in. During download in October, I was able to move one of my problematic loggers to deep in thalweg (the one at RD 1N01 on Clavey). However, I was not able to move the logger that goes dry most days when they shut off whitewater release - mainstem T, just upstream of Clavey confluence. That one might be a lost cause other than spot measurements when flow is up.

John

On Thu, Apr 21, 2016 at 5:27 PM, Le, Bao <ChiBao.Le@hdrinc.com> wrote:

Hi John.

To follow up on your email below, please see my responses in red.

Also, regarding temperature data, are you still collecting data this year as well. I don't recall whether you pulled loggers last fall or kept them out there to collect this spring/summer as well?

Thanks, Bao

From: Mike Deas [mailto:Mike.Deas@watercourseinc.com]
Sent: Thursday, April 21, 2016 11:44 AM
To: John Wooster - NOAA Federal
Cc: Le, Bao; Deason, Jesse; Borovansky, Jenna; Peggy Basdekas; Devine, John
Subject: Re: Temperature Data Swap and LiDAR

John, thank you. I am out of the office today and can communicate the data to you tomorrow.

Mike.

Sent from my iPhone

On Apr 21, 2016, at 10:30 AM, John Wooster - NOAA Federal <john.wooster@noaa.gov> wrote:

Hi Bao and Mike:

I'll complete the temperature data transfer this afternoon with Mike, I'm in meetings until 1 PM.

Regarding contacting Quantum Spatial, I don't foresee this being an issue, but I had/have nothing to do with the contracting or working with those folks. I would like a chance to run it by the Science Center folks who were involved as a courtesy, good practice, particularly if we are going to ask for additional work products prior to them giving final deliverables. Note, if your questions center around the hyperspec images, the more appropriate person to contact may be the professor from Wyoming that supplied the actual camera, as his shop has handled the post processing of the images. Note sure Quantum did much more than fly the images, and probably georectify them. As I understand it, we don't have any questions for Quantum Spatial that will result in additional development of work products. I think some clarification on the metadata, flight times, etc. is all that is needed. My sense is that this would be pretty brief.

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Regards,

John

On Tue, Apr 19, 2016 at 4:26 PM, Le, Bao <ChiBao.Le@hdrinc.com> wrote:

Hi John.

In addition to a swap of temperature data, I wanted to touch base on the progress made on the LiDAR and hyperspectral dataset. Last we spoke, more work was being done on the dataset. The Instream Flow Study we're now planning to conduct will likely have a need for the LiDAR and hyperspectral information. Can you provide us with an update of where this is at and if something updated would be available to inform the Instream Flow Study? As I understand it, the temperature modeling would also likely benefit from updated LiDAR information.

Also, we reviewed the technical data report you supplied earlier this year and there were a few questions. Jarvis Caldwell has worked with Quantum Spatial in the past and was hoping to follow up with them regarding these questions. Please let us know if that would be ok.

Thanks, Bao

From: Mike Deas [mailto:Mike.Deas@watercourseinc.com]
Sent: Tuesday, April 19, 2016 11:50 AM
To: John Wooster - NOAA Fe...
Cc: Le, Bao; Deason, Jesse; Borovansky, Jenna; Peggy Basdekas
Subject: RE: Temperature Data Swap and LiDAR

John,

Just following up with you on the temperature data exchange. Let me know if you would like to discuss this or have any questions or comments. Thank you,

Mike

From: Mike Deas
Sent: Friday, February 19, 2016 5:27 PM
To: 'John Wooster - NOAA Fe...'
Cc: Bao Le (bao.le@hdrinc.com); Deason, Jesse (Jesse.Deason@hdrinc.com); Borovansky, Jenna (Jenna.Borovansky@hdrinc.com); Peggy Basdekas
Subject: RE: Temperature Data Swap and LiDAR

John,

Let me know how and when you would like to proceed with the data exchange. Thank you,

Mike

From: Le, Bao [mailto:ChiBao.Le@hdrinc.com]
Sent: Thursday, February 04, 2016 10:14 AM
To: Mike Deas
Subject: FW: Temperature Data Swap and LiDAR

Hey Mike.

If you're ok with John's response below, I think the next step is to facilitate data exchange. If it's ok, I would direct John to coordinate with you on the best way to go about this. Please let me know if this is ok.

Thanks, Bao

From: John Wooster - NOAA Federal [mailto:john.wooster@noaa.gov]
Sent: Thursday, February 04, 2016 10:07 AM
To: Le, Bao
Cc: Borovansky, Jenna; Deason, Jesse; mike.deas@watercourseinc.com
Subject: Re: Temperature Data Swap and LiDAR

I agree with your approach below, transmit the portion of the daily record that has water temp readings and trim the record aggressively to make sure we are in a zone of full inundation. While the discontinuous record will make it tough to run some stats and probably calibrate your model too, the data may help you validate once the model is built or at least get some insight if things further downstream aren't lining out as expected....

-JW

On Wed, Feb 3, 2016 at 5:11 PM, Le, Bao <ChiBao.Le@hdrinc.com> wrote:

Hi John.

See below in red.

Let me know if you have any questions.

Thanks, Bao

From: John Wooster - NOAA Federal [mailto:john.wooster@noaa.gov]
Sent: Wednesday, February 03, 2016 12:38 PM
To: Le, Bao
Cc: Borovansky, Jenna; Deason, Jesse; mike.deas@watercourseinc.com
Subject: Re: Temperature Data Swap and LiDAR

Bao:

I received the LiDAR data this morning. I can't email files over about 25 MB. I have the data on my Google Drive. I am going to invite you and Mike to share the folder, you should be able to link directly in without installing any additional software, click on the file (the file preview will fail) but you should then be able to start to download. There is also a data description / quasi meta data in there from the vendor. Let me know if it doesn't work.

As for water temp data, when you say "We remove loggers that go dry from the data set", I believe you mean you remove the portion of that loggers record that is dry (not the entire logger record), but wanted to double check....that's correct. We remove just the air temperature portion.

How would you like to handle the logger(s) that go wet/dry on a daily basis with the whitewater release? I see two options: just remove the portion of the record where there is daily wet/dry cycles, or transmit the portion of each day where there is water temp readings (longer than you might think given a 4 hour whitewater release because it takes quite awhile for the pools to fully recede)..... We can sympathize with the deployment challenges of that reach reach given the whitewater releases. We think the data is useful and the second option preserves some important temperature information that would be lost if the daily wet/dry cycles were removed (option 1). Is it difficult to discern the transition between water temperatures and air temperatures and vice versa since a partially inundated logger might be hard to interpret? If so, perhaps a conservative approach would be to trim the data set a little more to ensure air temperatures do not creep into the data set. Thoughts?

Thanks,

John

On Wed, Feb 3, 2016 at 8:40 AM, Le, Bao <ChiBao.Le@hdrinc.com> wrote:

Thanks for the info, John. See responses below and let me know what you think.

Bao

From: John Wooster - NOAA Federal [mailto:john.wooster@noaa.gov]
Sent: Tuesday, February 02, 2016 1:43 PM
To: Le, Bao
Cc: Borovansky, Jenna; Deason, Jesse; mike.deas@watercourseinc.com
Subject: Re: Temperature Data Swap and LiDAR

Hi Bao:

Yes the LiDAR is ready to share, and it is processed. It is the bathymetry (derived from the hyper spec images) that is still being worked out - and still could be a few months out. Eventually those two data sets will be stitched together. But if you want the LiDAR now (everything above water surface), we could make that happen in a matter of days. I was told the LiDAR is only about a 5 GB file, so we could probably do that over a dropbox / Google Drive exchange. Let me know if you want that now, and I can probably have it within a matter of days from Science Center (I'm not actually holding it at the moment, but they did tell me last week it was ready).....That would be great if we could get the LiDAR above water surface for now. When the bathymetry is available, if we could acquire that as well, it'd be much appreciated. My email can accept 5 GB attachments.

My temp data is more or less ready to exchange - I did have one logger in the mainstem that I didn't get deep enough that would dessicate when they shut the water off after whitewater release and inundate with the whitewater pulse (that's what happens when you install loggers while rafting down the river and the water is up), so I still need to process that one. We had a similar issue with our mainstem logger above the Clavey and NF confluence locations – we installed in the early summer prior to rafting flows (down low and deep) and then as we got into late fall/winter, were unsure we could access them again with water rising. So these two locations have overwintered without a download. And our upper Clavey logger eventually went dry as well because we installed it when flows were up and couldn't safely get into the middle of the thalweg. I saw in August that at least your NF Tuolumne logger went dry, and I think your lower Clavey if memory serves correct. How would you like to handle the data from loggers that go dry? We remove loggers that go dry from the dataset. Are you deleting the records that are air temperature (i.e., when it goes dry)? Yes. Are you separating the data into two different columns - one for water temp, one for air temp (that is my preferred, as sometimes it is useful to have the air temp data)? Or one column of data, and one column of water vs air qualifier? Let me know what you have done and I will follow suit.... We did not manage air temp data in any way because we do not know if the logger is sitting in a puddle of water partly submerged and partly exposed, under a rock, in the baking sun, etc. The logger was not deployed as an air temperature monitoring station, which would require its own deployment protocol (somewhat different than a water temperature logger deployment).

Let's shoot to exchange temp data this coming Monday. I can probably transmit mine over email, or a couple of emails. Also could do that over Google Drive, as well. Let's work this week on how to exchange the larger files next Monday. As noted above, I can accept pretty large files. What's the case on your end and what's your preference? Using any file transfer software (that isn't currently on my laptop) will require that I get IT involved on this end to approve and download those programs. But I can get it going this week.

-John

On Tue, Feb 2, 2016 at 9:54 AM, Le, Bao <ChiBao.Le@hdrinc.com> wrote:

Hi John.

This has been on my plate for a while so I apologize for not getting back to you on exchanging data sooner. We've been through the process of temperature data QC and believe it is now available to share. As discussed previously, we'd like to also get NMFS' temperature data in the Upper Tuolumne River. Let's discuss a way in which we can swap that data here soon.

Also, you had mentioned that you would have LiDAR (although not completely processed) available to share as well. In discussions with Mike Deas, our temperature modeler, he thought this would still be useful for his purposes so if we could acquire these data also, that'd be great. I've cc'd him here.

Let me know if you have any questions.

Thanks,

Bao

Bao Le

Senior Fisheries Biologist

HDR

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hdrinc.com/follow-us

--

John Wooster
Hydrologist
NOAA Fisheries West Coast Region
U.S. Department of Commerce
john.wooster@noaa.gov

<image001.jpg>

From: Le, Bao
Sent: Wednesday, April 27, 2016 12:08 PM
To: jeicher@blm.gov
Cc: Devine, John; Deason, Jesse
Subject: 2016 Upper Tuolumne River Reintroduction Assessment Studies - BLM permitting/approval

Hi Jim.

As you know, we're working through the Upper Tuolumne River Reintroduction Assessment Framework in collaboration with interested licensing participants. One component of this framework is to identify additional information that would be collected through a suite of 2016 field studies. With more clarity around the 2016 field program (as well as the need to complete the existing barrier study survey at the North Fork), we're hoping we could have a brief conference call with you and any other BLM staff to discuss the permitting/approval process. Would you and others be available next week to discuss?

Please let me know.

Best regards,
Bao

Bao Le
Senior Fisheries Biologist

HDR
1001 SW 5th Avenue, Suite 1800
Portland, OR 97204-1134
D 971.202.1722 **M** 503.309.9423
bao.le@hdrinc.com

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From: Le, Bao
Sent: Thursday, April 28, 2016 4:10 PM
To: Holdeman, Steven J -FS; Vaughn, Gary D -FS; Foote, Debra -FS
Cc: Warnock, Cory; Neal, Morgan; Deason, Jesse
Subject: RE: 2016 Upper Tuolumne River Reintroduction Assessment Studies - USFS permitting/approvals

Thanks, Steve.

At a minimum, we want to make sure we can accommodate your agency's permitting lead as well. I believe that would be Debra? As soon as we get some feedback on availability, we'll identify a day and time and do our best to work around Thursday.

Bao

From: Holdeman, Steven J -FS [mailto:sholdeman@fs.fed.us]
Sent: Thursday, April 28, 2016 3:59 PM
To: Le, Bao; Vaughn, Gary D -FS; Foote, Debra -FS
Cc: Warnock, Cory; Neal, Morgan; Deason, Jesse
Subject: RE: 2016 Upper Tuolumne River Reintroduction Assessment Studies - USFS permitting/approvals

Yes, I plan on being here all week, though I do have a field day with USFWS scheduled for Thursday, all day.

Steven J. Holdeman
Forest Aquatic Biologist
Forest Service
Stanislaus National Forest, Supervisor's Office
p: 209-532-3671 x311
sholdeman@fs.fed.us
19777 Greenley Road
Sonora, CA 95370
www.fs.fed.us
Caring for the land and serving people

From: Le, Bao [mailto:ChiBao.Le@hdrinc.com]
Sent: Wednesday, April 27, 2016 12:02 PM
To: Vaughn, Gary D -FS <gdvaughn@fs.fed.us>; Foote, Debra -FS <dfoote@fs.fed.us>; Holdeman, Steven J -FS <sholdeman@fs.fed.us>
Cc: Warnock, Cory <Cory.Warnock@hdrinc.com>; Neal, Morgan <Morgan.Neal@hdrinc.com>; Deason, Jesse <Jesse.Deason@hdrinc.com>
Subject: 2016 Upper Tuolumne River Reintroduction Assessment Studies - USFS permitting/approvals

Hi Dusty, Debra, and Steve.

With more clarity around the 2016 study program for the Upper Tuolumne River Reintroduction Assessment Framework, we're hoping it is possible to get the appropriate USFS staff on the phone to discuss permitting questions, application development, schedule, and approval. Would folks be available the middle of next week to discuss via conference call?

Please let me know.

Best regards,
Bao

Bao Le
Senior Fisheries Biologist

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Portland, OR 97204-1134
D 971.202.1722 **M** 503.309.9423
bao.le@hdrinc.com

hdrinc.com/follow-us

From: Le, Bao
Sent: Friday, April 29, 2016 1:12 PM
To: John Wooster - NOAA Federal
Cc: Mike Deas; Deason, Jesse; Borovansky, Jenna; Peggy Basdekas; Devine, John
Subject: RE: Temperature Data Swap and LiDAR

Understood. Thanks for your help, John.

Have a good weekend,
Bao

From: John Wooster - NOAA Federal [mailto:john.wooster@noaa.gov]
Sent: Friday, April 29, 2016 12:59 PM
To: Le, Bao
Cc: Mike Deas; Deason, Jesse; Borovansky, Jenna; Peggy Basdekas; Devine, John
Subject: Re: Temperature Data Swap and LiDAR

Hi Bao:

I heard back from the Science Center, they are fine with you contacting Quantum - just know there is no longer an active account for any charges related to those flights.

You can try contacting Tucker Selko, who was the project manager for the MT LiDAR. His email is:

tselko@quantumspatial.com

Regards,

John

On Thu, Apr 21, 2016 at 5:27 PM, Le, Bao <ChiBao.Le@hdrinc.com> wrote:

Hi John.

To follow up on your email below, please see my responses in red.

Also, regarding temperature data, are you still collecting data this year as well. I don't recall whether you pulled loggers last fall or kept them out there to collect this spring/summer as well?

Thanks, Bao

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Sent: Thursday, April 21, 2016 11:44 AM
To: John Wooster - NOAA Federal
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To: 'John Wooster - NOAA Fe...'
Cc: Bao Le (bao.le@hdrinc.com); Deason, Jesse (Jesse.Deason@hdrinc.com); Borovansky, Jenna

(Jenna.Borovansky@hdrinc.com); Peggy Basdekas
Subject: RE: Temperature Data Swap and LiDAR

John,

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Mike

From: Le, Bao [mailto:ChiBao.Le@hdrinc.com]
Sent: Thursday, February 04, 2016 10:14 AM
To: Mike Deas
Subject: FW: Temperature Data Swap and LiDAR

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Hi Bao:

Yes the LiDAR is ready to share, and it is processed. It is the bathymetry (derived from the hyper spec images) that is still being worked out - and still could be a few months out. Eventually those two data sets will be stitched together. But if you want the LiDAR now (everything above water surface), we could make that happen in a matter of days. I was told the LiDAR is only about a 5 GB file, so we could probably do that over a dropbox / Google Drive exchange. Let me know if you want that now, and I can probably have it within a matter of days from Science Center (I'm not actually holding it at the moment, but they did tell me last week it was ready).....That would be great if we could get the LiDAR above water surface for now. When the bathymetry is available, if we could acquire that as well, it'd be much appreciated. My email can accept 5 GB attachments.

My temp data is more or less ready to exchange - I did have one logger in the mainstem that I didn't get deep enough that would dessicate when they shut the water off after whitewater release and inundate with the whitewater pulse (that's what happens when you install loggers while rafting down the river and the water is up), so I still need to process that one. We had a similar issue with our mainstem logger above the Clavey and NF confluence locations – we installed in the early summer prior to rafting flows (down low and deep) and then as we got into late fall/winter, were unsure we could access them again with water rising. So these two locations have overwintered without a download. And our upper Clavey logger eventually went dry as well because we installed it when flows were up and couldn't safely get into the middle of the thalweg. I saw in August that at least your NF Tuolumne logger went dry, and I think your lower Clavey if memory serves correct. How would you like to handle the data from loggers that go dry? We remove loggers that go dry from the dataset. Are you deleting the records that are air temperature (i.e., when it goes dry)? Yes. Are you separating the data into two different columns - one for water temp, one for air temp (that is my preferred, as sometimes it is useful to have the air temp data)? Or one column of data, and one column of water vs air qualifier? Let me know what you have done and I will follow suit.... We did not manage air temp data in any way because we do not know if the logger is sitting in a puddle of water partly submerged and partly exposed, under a rock, in the baking sun, etc. The logger was not deployed as an air temperature monitoring station, which would require its own deployment protocol (somewhat different than a water temperature logger deployment).

Let's shoot to exchange temp data this coming Monday. I can probably transmit mine over email, or a couple of emails. Also could do that over Google Drive, as well. Let's work this week on how to exchange the larger files next Monday. As noted above, I can accept pretty large files. What's the case on your end and what's your preference? Using any file transfer software (that isn't currently on my laptop) will require that I get IT involved on this end to approve and download those programs. But I can get it going this week.

-John

On Tue, Feb 2, 2016 at 9:54 AM, Le, Bao <ChiBao.Le@hdrinc.com> wrote:

Hi John.

This has been on my plate for a while so I apologize for not getting back to you on exchanging data sooner. We've been through the process of temperature data QC and believe it is now available to share. As discussed previously, we'd like to also get NMFS' temperature data in the Upper Tuolumne River. Let's discuss a way in which we can swap that data here soon.

Also, you had mentioned that you would have LiDAR (although not completely processed) available to share as well. In discussions with Mike Deas, our temperature modeler, he thought this would still be useful for his purposes so if we could acquire these data also, that'd be great. I've cc'd him here.

Let me know if you have any questions.

Thanks,

Bao

Bao Le

Senior Fisheries Biologist

HDR

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John Wooster
Hydrologist
NOAA Fisheries West Coast Region
U.S. Department of Commerce
john.wooster@noaa.gov

<image001.jpg>

From: Staples, Rose
Sent: Monday, May 02, 2016 2:01 PM
Cc: Deason, Jesse; Staples, Rose
Subject: Districts File with FERC Today their Response to Comments Received on La Grange Initial Study Report

The Districts e-filed with FERC today their response to comments received on the La Grange Initial Study Report (ISR) and their request for FERC to adopt the proposed pre-filing schedule. A copy of the document has been uploaded to the DOCUMENTS section of the La Grange licensing website (www.lagrange-licensing.com) – and it is also available for viewing on FERC's E-Library at www.ferc.gov.

Rose Staples, CAP-OM, MOS
Executive Assistant

HDR
970 Baxter Boulevard Suite 301
Portland ME 04103
D 207-239-3857
rose.staples@hdrinc.com

hdrinc.com/follow-us

From: Lonnie Moore [mailto:lmoorenorcal@gmail.com]
Sent: Monday, May 02, 2016 5:26 PM
To: Staples, Rose
Subject: Comments to Six (6) Draft Study Plans of La Grange Technical Committee - L Moore 02May16

Hi Rose,

Attached please find my comments to the document "Comments to Six (6) Draft Study Plans of La Grange Technical Committee - L Moore 02May16".

While I know this is a few days late, I have spoken to Bao Le, and he suggested I go ahead anyway. I understand the comments may or may not be included in the plan revisions.

Thank you very much,
Lonnie

--
Lonnie Moore
Consultant
Office: 209-551-5958
Mobile: 209-247-3991
lmoorenorcal@gmail.com

Comments to Six (6) Draft Study Plans of La Grange Technical Committee

Lonnie Moore
May 02, 2016 (Late)

1. **Draft Study Plan: "Upper Tuolumne River Habitat Mapping and Macro-invertebrate Assessment" – March 2016**

   Comments: (1) Ensure that an adequate/equal study of the Lower Tuolumne River (Below Le Grange Dam) exists or is included in this, or a separate, study.

2. **Draft Study Plan: "Socioeconomic Scoping Study" – March 2016**

   Comments: (1) It should be noted that, until either a single "fish passage" operation proposal/plan exists…all possible operations would need to be included in this scoping study (?).

3. **Draft Study Plan: "Regulatory Context for Reintroduction" – March 2016**

   Comments: (1) The "fall-run Chinook" salmon should be included in "Section 3.0 Study Goals", second to the last bullet statement (Also replace in other plans where appropriate).

4. **Draft Study Plan: "Upper Tuolumne River Chinook Salmon and Steelhead Spawning Gravel Mapping Study" – March 2016**

   Comments: None

5. **Draft Study Plan: "Hatchery and Stocking Practices Review" – March 2016**

   Comments: None

6. **Draft Study Plan: "Upper Tuolumne River Instream Flow Study" – March 2016**

   Comments: None.

PHONE CALL MEMORANDUM

Topic	Submitting comments on the draft upper river study plans past the comment due date
Date	May 2, 2016
From	Mr. Lonnie Moore
To	Mr. Bao Le, HDR
Summary of Discussion	Mr. Moore called Mr. Le to discuss submitting comments on the draft upper river study plans. Mr. Moore acknowledged that his comments would be late, as the comment deadline was April 29, but that he had been running late. Mr. Le noted the Districts are trying to follow a tight schedule to produce and circulate final study plans to the Plenary Group in advance of Workshop No. 5, scheduled for May 19. Mr. Le said the Districts would still like to see his comments if they can be submitted by close of business today. Mr. Le said the Districts will do their best to address his comments, but that he could not guarantee his comments would be addressed. Mr. Moore said he appreciates that.

Comments to Six (6) Draft Study Plans of La Grange Technical Committee

Lonnie Moore
May 02, 2016 (Late)

1. **Draft Study Plan: "Upper Tuolumne River Habitat Mapping and Macro-invertebrate Assessment" – March 2016**

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4. **Draft Study Plan: "Upper Tuolumne River Chinook Salmon and Steelhead Spawning Gravel Mapping Study" – March 2016**

   Comments: None

5. **Draft Study Plan: "Hatchery and Stocking Practices Review" – March 2016**

   Comments: None

6. **Draft Study Plan: "Upper Tuolumne River Instream Flow Study" – March 2016**

   Comments: None.

From: Le, Bao
Sent: Tuesday, May 03, 2016 3:40 PM
To: dfoote@fs.fed.us; Holdeman, Steven J -FS
Cc: Warnock, Cory; Deason, Jesse
Subject: Permitting Call

Debbie and Steve.

Thanks for taking the time to speak with us today. It was really valuable in getting us informed about permitting needs and process. As discussed, you'll follow up with Dusty on the following items:

1. Use of a drone at Lumsden Falls this fall to collect additional survey level information for the barrier assessment. We'll have our fish passage engineer provide more detail on the scope of that effort and why it may be preferred over a traditional survey to help facilitate regional level decision making.
2. Installation of a trail camera on the Clavey River at the total barrier at approximate RM 2.0. As discussed, this is likely not an issue but we just want to confirm we're ok to do this on one of our float trips this summer.
3. The possibility of extended trips greater than 5 days (i.e., 7 or 8 day trips).

On our end, we'll provide a preliminary list of needed raft trips to support the three new field studies and approximate dates so that you can start to plan for how this fits in with the limits for private use permits. Note though that these might change after our May 13th field planning meeting. No matter what, we'll bring things to current for the application submittal the week of May 16th.

Thanks again and please don't hesitate to email or call with questions. We look forward to working closely with you over the next month.

Best regards,
Bao

Bao Le
Senior Fisheries Biologist

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From:	Vertucci, Charles
Sent:	Tuesday, May 03, 2016 4:10 PM
To:	Foote, Debra -FS (dfoote@fs.fed.us)
Cc:	Le, Bao; Borovansky, Jenna; Warnock, Cory; Neal, Morgan; Deason, Jesse
Subject:	Existing USFS permit for LaGrange water temperature monitoring
Attachments:	Turlock Irrigation District HDR.DOCX; Attachment A__SF 299_TID.pdf

Greetings Debbie,

We're getting ready to continue our water temperature monitoring program that was permitted by the Forest last year (permit attached). In the permit application, we stated that access would be by foot or by white water boating (in areas where foot access is unavailable). We also described in the Attachments that there would be two visits using whitewater boating in 2016 (Table 1 of Attachment A).

I wanted to confirm that our current permit is sufficient for the work scheduled, including two three-day rafting trips (currently planned for June and October). We plan to notify the Forest of all field activities related to this permit prior to fieldwork per discussions with Dusty and Bob last year.

This is a separate Study and permit from those you've been discussing with Bao but it seems like the appropriate time to confirm the work under this existing permit as we move into the field season.

I'd be happy to answer any additional questions regarding this work at your convenience. Thank you,

Chuck

Charles Vertucci
Senior Aquatic and Water Resources Scientist
Hydropower Services

HDR
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Sacramento, CA 95833
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charles.vertucci@hdrinc.com

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Attachment A for Forest Service SF-299
Filed by Turlock and Modesto Irrigation Districts
and HDR, Inc.
April 1, 2015

7. **Project Description**

The Turlock Irrigation District (TID) and Modesto Irrigation District (MID) (collectively, the Districts) own the La Grange Diversion Dam (LGDD) located on the Tuolumne River in Stanislaus County, California. Currently the Districts are working through the Federal Energy Regulatory Commission (FERC) licensing process with the end goal to file an application for a license. As part of the process the Districts, at the request of federal fish and wildlife agencies (NMFS, USFWS, and CDFW) have agreed to complete a series of studies including a Fish Passage Assessment study which was submitted to FERC as part of the Revised Study Plan document on January 5, 2015.

HDR Engineering, Inc. has been retained by the Districts to complete portions of the Fish Passage Assessment including the water temperature monitoring task described below.

Water Temperature Monitoring

Schedule and Access

Loggers are proposed to be installed at a total of 10 locations (Table 2) in early April 2015, if conditions allow and checked periodically throughout the monitoring period. Loggers will be removed or prepared to overwinter in late October or early November 2015. The same schedule will be repeated in 2016 (Table 1).

Access to logger installations will occur along existing Forest Service or other public roads. Staff will park safely at a point nearest the desired location and navigate to the river channel. Care will be taken to use any existing trails or traverse areas that will cause little impact to the land.

If areas are deemed too difficult to access on foot, they will be visited by white water boating or helicopter. In the case of boating, HDR will hire a guide with all necessary Forest Service permits to navigate them to areas of the Tuolumne River. For helicopter access (North Fork confluence, Indian Creek confluence and Clavey confluence), all safety elements will be observed and landing areas near logger installations will be within the high water line of the river, usually on a large gravel bar. The Forest Service would be notified of the fly date(s).

HDR will limit the visits to each location in order to provide the least impact while ensuring the collection of necessary data (Table 1).

Table 1. Schedule of field visits for 2015 and 2016 include general access.

Month	Vehicle/Hike Access	Helicopter/WW Boat Access
2015		
March/April (installation)	X	X
May	--	--
June	X	--
July	--	X
August	X	--
September	--	--
October/November (removal	X	X
2016		
March/April (installation)	X	X
May	--	--
June	X	--
July	--	--
August	X	--
September	--	--
October/November (removal	X	X

X = monitoring required by method described.

-- = monitoring not required.

Installation Equipment and locations

HDR staff proposes to install Onset ProV2 water temperature recorders in durable housings (Figure 1) in the Upper Tuolumne River (Table 2, Attachment B maps). Duplicate loggers will be installed in order provide the best chance for a continuous data set. Loggers will be installed during low flow (i.e. non-boating flows) in order to capture both high and low river flows. All monitoring locations will be documented with photographs and GPS coordinates. Each recorder will be placed in the active channel and secured by a removable steel cable or chain tethered to a stable root mass, boulder, or man-made structure such that the recorder is secured in the channel during high-flow periods. The recorder will be installed in the channel thalweg, and the housing and cable will be disguised as much as possible while ensuring the ability to retrieve the unit for future downloads.

HDR staff proposes to install Onset U20 Level loggers in durable housings in the identified tributaries (Table 2, see separate map). Duplicate loggers will be installed in order provide the best chance for a continuous data set. Loggers will be installed during low flow (i.e. before or after spring run-off) in order to capture both high and low river flows. All monitoring locations will be documented with photographs and GPS coordinates. At tributary locations where stage recorders are installed, semi-permanent housings will be affixed to large boulders or bedrock to ensure the level logger does not move (Figure 2). The water surface elevation and depth of the logger will be noted at the time of installation. A flow measurement will also be collected anytime a stage recorder is installed or downloaded using standard USGS methods.

Figure 1. Photograph of normal water temperature recorder housing. Approximate size is 4-6 inches with 2-8 feet of associated cabling.

Table 2. Locations to install and monitor water temperature and/or stage.

Logger Location	River Mile	Latitude	Longitude	Data value for model
Tuolumne River				
TR near Indian Creek	TR 88.2	TBD	TBD	Provides temperatures longitudinally along the main stem river, including above major tributaries.
TR above Clavey River	TR 91.1	TBD	TBD	
TR above South Fork	TR 97.0	TBD	TBD	
TR below Early Intake	TR 105.2	TBD	TBD	
Tributaries				
North Fork at RM8 Bridge	NF 8.0	TBD	TBD	Provides tributary water temperatures and flow at multiple locations in order to build flow and temperature data sets for model input
Clavey above TR	CR 0.1	TBD	TBD	
Clavey at Gage 11283500	CR 8.4	TBD	TBD	
South Fork above TR	SF 0.1	TBD	TBD	
Cherry Cr. above TR	CC 0.6	TBD	TBD	
Cherry Cr. above Powerhouse	CC 1.2	TBD	TBD	

Figure 2. Example of level logger installation. Bolted (removable) to boulder or bedrock.

13a. Describe other alternative routes and modes considered.

Locations of water temperature loggers were selected based on the data needed to build a complete and accurate water temperature model for the La Grange Project. Locations generally are at tributary confluences with the Tuolumne River and areas of hydrologic interest.

Additionally, much of the upper Tuolumne River watershed is very difficult terrain to access, and locations for installation were also selected with this in mind.

Travel onto the Stanislaus National Forest (SNF) is required because the desired monitoring locations occur on SNF lands and all of the vehicular access will occur via established roadways.

16. Effects on the local population

This project will have no effect on the local population. All installations are small and intentionally installed out of the way and hidden. Installation and maintenance of the loggers will be completed by two staff traveling in a standard vehicle and hiking on foot with minimal equipment.

If a helicopter is used at select locations (North Fork confluence, Indian Creek confluence and Clavey confluence), it will be to access areas not easily available to the general public. If there are people present (most likely white water boaters), care will be taken to avoid disturbing them (including visiting the sites during non-boating days or returning to the site at a different time, if possible).

17. Effects on the local environment

This study will have little to no effect to the local environment. The installations are small and made of materials not harmful to local soil and water. Loggers will be installed using existing large boulders and bedrock, so no changes to the soil or stream channel will occur. Anchors may be placed into large boulders and bedrock but will be removed at the end of the study.

The visual impact is minimal since all installations are small and will be intentionally placed out of the way and hidden.

Increases in noise would only occur if and when (three one day trips, at most) a helicopter is used to access certain areas (North Fork confluence, Indian Creek confluence and Clavey confluence).

Authorization ID: GRO1122
Contact Name: TURLOCK IRRIGATION DISTRICT
Expiration Date: 12/31/2017
Use Code: 422

FS-2700-4 (V. 01/2014)
OMB 0596-0082

U.S. DEPARTMENT OF AGRICULTURE
FOREST SERVICE
SPECIAL USE PERMIT
Authority: ORGANIC ADMINISTRATION ACT June4, 1897

TURLOCK IRRIGATION DISTRICT of 333 EAST CANAL DRIVE TURLOCK CA 95380 (hereinafter "the holder") is authorized to use or occupy National Forest System lands in the Stanislaus National Forest, subject to the terms and conditions of this special use permit (the permit).

This permit covers less than 1 acre in the Stanislaus National Forest, ("the permit area"), as shown on the map(s) attached as Appendix A. This permit issued for the purpose of:

Installing, monitoring, and maintaining water temperature recorders at 10 locations. Each recorder will be placed in the active channel and secured by a removable steel cable or chain tethered to a stable root mass, boulder, or man-made structure such that the recorder is secured in the channel during high-flow periods. The recorder will be installed in the channel thalweg, and the housing and cable will be disguised as much as possible while ensuring the ability to retrieve the unit for future downloads.

TERMS AND CONDITIONS

I. GENERAL TERMS

A. AUTHORITY. This permit is issued pursuant to **ORGANIC ADMINISTRATION ACT June4, 1897** and 36 CFR Part 251, Subpart B, as amended, and is subject to their provisions.

B. AUTHORIZED OFFICER. The authorized officer is the Forest or Grassland Supervisor or a subordinate officer with delegated authority.

C. TERM. This permit shall expire at midnight on 12/31/2016, 1 year and 8 months from the date of issuance.

D. RENEWAL. This permit is not renewable. Prior to expiration of this permit, the holder may apply for a new permit that would renew the use and occupancy authorized by this permit. Applications for a new permit must be submitted at least 6 months prior to expiration of this permit. Renewal of the use and occupancy authorized by this permit shall be at the sole discretion of the authorized officer. At a minimum, before renewing the use and occupancy authorized by this permit, the authorized officer shall require that (1) the use and occupancy to be authorized by the new permit

is consistent with the standards and guidelines in the applicable land management plan; (2) the type of use and occupancy to be authorized by the new permit is the same as the type of use and occupancy authorized by this permit; and (3) the holder is in compliance with all the terms of this permit. The authorized officer may prescribe new terms and conditions when a new permit is issued.

E. AMENDMENT. This permit may be amended in whole or in part by the Forest Service when, at the discretion of the authorized officer, such action is deemed necessary or desirable to incorporate new terms that may be required by law, regulation, directive, the applicable forest land and resource management plan, or projects and activities implementing a land management plan pursuant to 36 CFR Part 215.

F. COMPLIANCE WITH LAWS, REGULATIONS, AND OTHER LEGAL REQUIREMENTS. In exercising the rights and privileges granted by this permit, the holder shall comply with all present and future federal laws and regulations and all present and future state, county, and municipal laws, regulations, and other legal requirements that apply to the permit area, to the extent they do not conflict with federal law, regulation, or policy. The Forest Service assumes no responsibility for enforcing laws, regulations, and other legal requirements that fall under the jurisdiction of other governmental entities.

G. NON-EXCLUSIVE USE. The use or occupancy authorized by this permit is not exclusive. The Forest Service reserves the right of access to the permit area, including a continuing right of physical entry to the permit area for inspection, monitoring, or any other purpose consistent with any right or obligation of the United States under any law or regulation. The Forest Service reserves the right to allow others to use the permit area in any way that is not inconsistent with the holder's rights and privileges under this permit, after consultation with all parties involved. Except for any restrictions that the holder and the authorized officer agree are necessary to protect the installation and operation of authorized temporary improvements, the lands and waters covered by this permit shall remain open to the public for all lawful purposes.

H. ASSIGNABILITY. This permit is not assignable or transferable.

II. IMPROVEMENTS

A. LIMITATIONS ON USE. Nothing in this permit gives or implies permission to build or maintain any structure or facility or to conduct any activity, unless specifically authorized by this permit. Any use not specifically authorized by this permit must be proposed in accordance with 36 CFR 251.54. Approval of such a proposal through issuance of a new permit or permit amendment is at the sole discretion of the authorized officer.

B. PLANS. All plans for development, layout, construction, reconstruction, or alteration of improvements in the permit area, as well as revisions to those plans must be prepared by a professional engineer, architect, landscape architect, or other qualified professional based on federal employment standards acceptable to the authorized officer. These plans and plan revisions must have written approval from the authorized officer before they are implemented. The authorized officer may require the holder to furnish as-built plans, maps, or surveys upon completion of the work.

C. <u>CONSTRUCTION</u>. Any construction authorized by this permit shall commence by NA and shall be completed by NA.

III. <u>OPERATIONS</u>.

A. <u>PERIOD OF USE</u>. Use or occupancy of the permit area shall be exercised at least 3 months each year.

B. <u>CONDITION OF OPERATIONS</u>. The holder shall maintain the authorized improvements and permit area to standards of repair, orderliness, neatness, sanitation, and safety acceptable to the authorized officer and consistent with other provisions of this permit. Standards are subject to periodic change by the authorized officer when deemed necessary to meet statutory, regulatory, or policy requirements or to protect national forest resources. The holder shall comply with inspection requirements deemed appropriate by the authorized officer.

C. <u>INSPECTION BY THE FOREST SERVICE</u>. The Forest Service shall monitor the holder's operations and reserves the right to inspect the permit area and transmission facilities at any time for compliance with the terms of this permit. The holder's obligations under this permit are not contingent upon any duty of the Forest Service to inspect the permit area or transmission facilities. A failure by the Forest Service or other governmental officials to inspect is not a justification for noncompliance with any of the terms and conditions of this permit.

IV. <u>RIGHTS AND LIABILITIES</u>

A. <u>LEGAL EFFECT OF THE PERMIT</u>. This permit, which is revocable and terminable, is not a contract or a lease, but rather a federal license. The benefits and requirements conferred by this authorization are reviewable solely under the procedures set forth in 36 CFR 251, Subpart C and 5 U.S.C. 704. This permit does not constitute a contract for purposes of the Contract Disputes Act, 41 U.S.C. 601. The permit is not real property, does not convey any interest in real property, and may not be used as collateral for a loan.

B. <u>VALID OUTSTANDING RIGHTS</u>. This permit is subject to all valid outstanding rights. Valid outstanding rights include those derived under mining and mineral leasing laws of the United States. The United States is not liable to the holder for the exercise of any such right.

C. <u>ABSENCE OF THIRD-PARTY BENEFICIARY RIGHTS</u>. The parties to this permit do not intend to confer any rights on any third party as a beneficiary under this permit.

D. <u>SERVICES NOT PROVIDED</u>. This permit does not provide for the furnishing of road or trail maintenance, water, fire protection, search and rescue, or any other such service by a government agency, utility, association, or individual.

E. <u>RISK OF LOSS</u>. The holder assumes all risk of loss associated with use or occupancy of the permit area, including but not limited to theft, vandalism, fire and any fire-fighting activities (including prescribed burns), avalanches, rising waters, winds, falling limbs or trees, and other forces of nature. If authorized temporary improvements in the permit area are destroyed or substantially

damaged, the authorized officer shall conduct an analysis to determine whether the improvements can be safely occupied in the future and whether rebuilding should be allowed. If rebuilding is not allowed, the permit shall terminate.

F. DAMAGE TO UNITED STATES PROPERTY. The holder has an affirmative duty to protect from damage the land, property, and other interests of the United States. Damage includes but is not limited to fire suppression costs, damage to government-owned improvements covered by this permit, and all costs and damages associated with or resulting from the release or threatened release of a hazardous material occurring during or as a result of activities of the holder or the holder's heirs, assigns, agents, employees, contractors, or lessees on, or related to, the lands, property, and other interests covered by this permit. For purposes of clause IV.F and section V, "hazardous material" shall mean (a) any hazardous substance under section 101(14) of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), 42 U.S.C. § 9601(14); (b) any pollutant or contaminant under section 101(33) of CERCLA, 42 U.S.C. § 9601(33); (c) any petroleum product or its derivative, including fuel oil, and waste oils; and (d) any hazardous substance, extremely hazardous substance, toxic substance, hazardous waste, ignitable, reactive or corrosive materials, pollutant, contaminant, element, compound, mixture, solution or substance that may pose a present or potential hazard to human health or the environment under any applicable environmental laws.

1. The holder shall avoid damaging or contaminating the environment, including but not limited to the soil, vegetation (such as trees, shrubs, and grass), surface water, and groundwater, during the holder's use or occupancy of the permit area. If the environment or any government property covered by this permit becomes damaged during the holder's use or occupancy of the permit area, the holder shall immediately repair the damage or replace the damaged items to the satisfaction of the authorized officer and at no expense to the United States.

2. The holder shall be liable for all injury, loss, or damage, including fire suppression, prevention and control of the spread of invasive species, or other costs in connection with rehabilitation or restoration of natural resources associated with the use or occupancy authorized by this permit. Compensation shall include but not be limited to the value of resources damaged or destroyed, the costs of restoration, cleanup, or other mitigation, fire suppression or other types of abatement costs, and all administrative, legal (including attorney's fees), and other costs. Such costs may be deducted from a performance bond required under clause IV.I.

3. The holder shall be liable for damage caused by use of the holder or the holder's heirs, assigns, agents, employees, contractors, or lessees to all roads and trails of the United States to the same extent as provided under clause IV.F.1, except that liability shall not include reasonable and ordinary wear and tear.

G. HEALTH, SAFETY, AND ENVIRONMENTAL PROTECTION. The holder shall promptly abate as completely as possible and in compliance with all applicable laws and regulations any activity or condition arising out of or relating to the authorized use or occupancy that causes or threatens to cause a hazard to public health or the safety of the holder's employees or agents or harm to the environment (including areas of vegetation or timber, fish or other wildlife populations, their habitats, or any other natural resources). The holder shall prevent impacts to the environment and cultural resources by implementing actions identified in the operating plan to prevent establishment

and spread of invasive species. The holder shall immediately notify the authorized officer of all serious accidents that occur in connection with such activities. The responsibility to protect the health and safety of all persons affected by the use or occupancy authorized by this permit is solely that of the holder. The Forest Service has no duty under the terms of this permit to inspect the permit area or operations and activities of the holder for hazardous conditions or compliance with health and safety standards.

H. INDEMNIFICATION OF THE UNITED STATES. The holder shall indemnify, defend, and hold harmless the United States for any costs, damages, claims, liabilities, and judgments arising from past, present, and future acts or omissions of the holder in connection with the use or occupancy authorized by this permit. This indemnification provision includes but is not limited to acts and omissions of the holder or the holder's heirs, assigns, agents, employees, contractors, or lessees in connection with the use or occupancy authorized by this permit which result in (1) violations of any laws and regulations which are now or which may in the future become applicable, and including but not limited to those environmental laws listed in clause V.A of this permit; (2) judgments, claims, demands, penalties, or fees assessed against the United States; (3) costs, expenses, and damages incurred by the United States; or (4) the release or threatened release of any solid waste, hazardous waste, hazardous materials, pollutant, contaminant, oil in any form, or petroleum product into the environment. The authorized officer may prescribe terms that allow the holder to replace, repair, restore, or otherwise undertake necessary curative actions to mitigate damages in addition to or as an alternative to monetary indemnification.

V. RESOURCE PROTECTION

A. COMPLIANCE WITH ENVIRONMENTAL LAWS. The holder shall in connection with the use or occupancy authorized by this permit comply with all applicable federal, state, and local environmental laws and regulations, including but not limited to those established pursuant to the Resource Conservation and Recovery Act, as amended, 42 U.S.C. 6901 et seq., the Federal Water Pollution Control Act, as amended, 33 U.S.C. 1251 et seq., the Oil Pollution Act, as amended, 33 U.S.C. 2701 et seq., the Clean Air Act, as amended, 42 U.S.C. 7401 et seq., CERCLA, as amended, 42 U.S.C. 9601 et seq., the Toxic Substances Control Act, as amended, 15 U.S.C. 2601 et seq., the Federal Insecticide, Fungicide, and Rodenticide Act, as amended, 7 U.S.C. 136 et seq., and the Safe Drinking Water Act, as amended, 42 U.S.C. 300f et seq.

B. VANDALISM. The holder shall take reasonable measures to prevent and discourage vandalism and disorderly conduct and when necessary shall contact the appropriate law enforcement officer.

C. PESTICIDE USE. Pesticides may not be used outside of buildings to control undesirable woody and herbaceous vegetation (including aquatic plants), insects, rodents, fish, and other pests and weeds without prior written approval from the authorized officer. A request for approval of planned uses of pesticides shall be submitted annually by the holder on the due date established by the authorized officer. The report shall cover a 12-month period of planned use beginning 3 months after the reporting date. Information essential for review shall be provided in the form specified. Exceptions to this schedule may be allowed, subject to emergency request and approval, only when unexpected outbreaks of pests or weeds require control measures that were not anticipated at the time an annual report was submitted. Only those materials registered by the U.S. Environmental

Protection Agency for the specific purpose planned shall be considered for use on National Forest System lands. Label instructions and all applicable laws and regulations shall be strictly followed in the application of pesticides and disposal of excess materials and containers.

D. ARCHAEOLOGICAL-PALEONTOLOGICAL DISCOVERIES. The holder shall immediately notify the authorized officer of all antiquities or other objects of historic or scientific interest, including but not limited to historic or prehistoric ruins, fossils, or artifacts discovered in connection with the use and occupancy authorized by this permit. The holder shall leave these discoveries intact and in place until directed otherwise by the authorized officer. Protective and mitigative measures specified by the authorized officer shall be the responsibility of the holder.

E. NATIVE AMERICAN GRAVES PROTECTION AND REPATRIATION. In accordance with 25 U.S.C. 3002(d) and 43 CFR 10.4, if the holder inadvertently discovers human remains, funerary objects, sacred objects, or objects of cultural patrimony on National Forest System lands, the holder shall immediately cease work in the area of the discovery and shall make a reasonable effort to protect and secure the items. The holder shall immediately notify the authorized officer by telephone of the discovery and shall follow up with written confirmation of the discovery. The activity that resulted in the inadvertent discovery may not resume until 30 days after the authorized officer certifies receipt of the written confirmation, if resumption of the activity is otherwise lawful, or at any time if a binding written agreement has been executed between the Forest Service and the affiliated Indian tribes that adopts a recovery plan for the human remains and objects.

F. PROTECTION OF HABITAT OF THREATENED, ENDANGERED, AND SENSITIVE SPECIES. The location of sites within the permit area needing special measures for protection of plants or animals listed as threatened or endangered under the Endangered Species Act (ESA) of 1973, 16 U.S.C. 1531 et seq., as amended, or identified as sensitive or otherwise requiring special protection by the Regional Forester under Forest Service Manual (FSM) 2670, pursuant to consultation conducted under section 7 of the ESA, may be shown on the ground or on a separate map. The map shall be attached to this permit as an appendix. The holder shall take any protective and mitigative measures specified by the authorized officer. If protective and mitigative measures prove inadequate, if other sites within the permit area containing threatened, endangered, or sensitive species or species otherwise requiring special protection are discovered, or if new species are listed as threatened or endangered under the ESA or identified as sensitive or otherwise requiring special protection by the Regional Forester under the FSM, the authorized officer may specify additional protective and mitigative measures. Discovery of these sites by the holder or the Forest Service shall be promptly reported to the other party.

G. CONSENT TO STORE HAZARDOUS MATERIALS. The holder shall not store any hazardous materials at the site without prior written approval from the authorized officer. This approval shall not be unreasonably withheld. If the authorized officer provides approval, this permit shall include, or in the case of approval provided after this permit is issued, shall be amended to include specific terms addressing the storage of hazardous materials, including the specific type of materials to be stored, the volume, the type of storage, and a spill plan. Such terms shall be proposed by the holder and are subject to approval by the authorized officer.

H. CLEANUP AND REMEDIATION

1. The holder shall immediately notify all appropriate response authorities, including the National Response Center and the authorized officer or the authorized officer's designated representative, of any oil discharge or of the release of a hazardous material in the permit area in an amount greater than or equal to its reportable quantity, in accordance with 33 CFR Part 153, Subpart B, and 40 CFR Part 302. For the purposes of this requirement, "oil" is as defined by section 311(a)(1) of the Clean Water Act, 33 U.S.C. 1321(a)(1). The holder shall immediately notify the authorized officer or the authorized officer's designated representative of any release or threatened release of any hazardous material in or near the permit area which may be harmful to public health or welfare or which may adversely affect natural resources on federal lands.

2. Except with respect to any federally permitted release as that term is defined under Section 101(10) of CERCLA, 42 U.S.C. 9601(10), the holder shall clean up or otherwise remediate any release, threat of release, or discharge of hazardous materials that occurs either in the permit area or in connection with the holder's activities in the permit area, regardless of whether those activities are authorized under this permit. The holder shall perform cleanup or remediation immediately upon discovery of the release, threat of release, or discharge of hazardous materials. The holder shall perform the cleanup or remediation to the satisfaction of the authorized officer and at no expense to the United States. Upon revocation or termination of this permit, the holder shall deliver the site to the Forest Service free and clear of contamination.

I. CERTIFICATION UPON REVOCATION OR TERMINATION. If the holder uses or stores hazardous materials at the site, upon revocation or termination of this permit the holder shall provide the Forest Service with a report certified by a professional or professionals acceptable to the Forest Service that the permit area is uncontaminated by the presence of hazardous materials and that there has not been a release or discharge of hazardous materials upon the permit area, into surface water at or near the permit area, or into groundwater below the permit area during the term of the permit. This certification requirement may be waived by the authorized officer when the Forest Service determines that the risks posed by the hazardous material are minimal. If a release or discharge has occurred, the professional or professionals shall document and certify that the release or discharge has been fully remediated and that the permit area is in compliance with all federal, state, and local laws and regulations.

VI. LAND USE FEE AND ACCOUNTING ISSUES

A. LAND USE FEES. The use or occupancy authorized by this permit is exempt from a land use fee or the land use fee has been waived in full pursuant to 36 CFR 251.57 and Forest Service Handbook 2709.11, Chapter 30.

VII. REVOCATION, SUSPENSION, AND TERMINATION

A. REVOCATION AND SUSPENSION. The authorized officer may revoke or suspend this permit in whole or in part:

1. For noncompliance with federal, state, or local law.

2. For noncompliance with the terms of this permit.

3. For abandonment or other failure of the holder to exercise the privileges granted.

4. With the consent of the holder.

5. For specific and compelling reasons in the public interest.

Prior to revocation or suspension, other than immediate suspension under clause VII.B, the authorized officer shall give the holder written notice of the grounds for revocation or suspension. In the case of revocation or suspension based on clause VII.A.1, 2, or 3, the authorized officer shall give the holder a reasonable time, typically not to exceed 90 days, to cure any noncompliance.

B. IMMEDIATE SUSPENSION. The authorized officer may immediately suspend this permit in whole or in part when necessary to protect public health or safety or the environment. The suspension decision shall be in writing. The holder may request an on-site review with the authorized officer's supervisor of the adverse conditions prompting the suspension. The authorized officer's supervisor shall grant this request within 48 hours. Following the on-site review, the authorized officer's supervisor shall promptly affirm, modify, or cancel the suspension.

C. APPEALS AND REMEDIES. Written decisions by the authorized officer relating to administration of this permit are subject to administrative appeal pursuant to 36 CFR Part 214 as amended. Revocation or suspension of this permit shall not give rise to any claim for damages by the holder against the Forest Service.

D. TERMINATION. This permit shall terminate when by its terms a fixed or agreed upon condition, event, or time occurs without any action by the authorized officer. Examples include but are not limited to expiration of the permit by its terms on a specified date and termination upon change of control of the business entity. Termination of this permit shall not require notice, a decision document, or any environmental analysis or other documentation. Termination of this permit is not subject to administrative appeal and shall not give rise to any claim for damages by the holder against the Forest Service.

E. RIGHTS AND RESPONSIBILITIES UPON REVOCATION OR TERMINATION WITHOUT RENEWAL. Upon revocation or termination of this permit without renewal of the authorized use, the holder shall remove all structures and improvements, except those owned by the United States, within a reasonable period prescribed by the authorized officer and shall restore the site to the satisfaction of the authorized officer. If the holder fails to remove all structures and improvements within the prescribed period, they shall become the property of the United States and may be sold, destroyed, or otherwise disposed of without any liability to the United States. However, the holder shall remain liable for all costs associated with their removal, including costs of sale and impoundment, cleanup, and restoration of the site.

VIII. MISCELLANEOUS PROVISIONS

A. MEMBERS OF CONGRESS. No member of or delegate to Congress or resident commissioner shall benefit from this permit either directly or indirectly, except to the extent the authorized use provides a general benefit to a corporation.

B. CURRENT ADDRESSES. The holder and the Forest Service shall keep each other informed of current mailing addresses, including those necessary for billing and payment of land use fees.

C. SUPERIOR CLAUSES. If there is a conflict between any of the preceding printed clauses and any of the following clauses, the preceding printed clauses shall control.

THIS PERMIT IS ACCEPTED SUBJECT TO ALL ITS TERMS AND CONDITIONS.

BEFORE ANY PERMIT IS ISSUED TO AN ENTITY, DOCUMENTATION MUST BE PROVIDED TO THE AUTHORIZED OFFICER OF THE AUTHORITY OF THE SIGNATORY FOR THE ENTITY TO BIND IT TO THE TERMS AND CONDITIONS OF THE PERMIT.

ACCEPTED:

____

Steve Boyd, Licensing Coordinator DATE

APPROVED:

____

Jim Junette, District Ranger DATE

According to the Paperwork Reduction Act of 1995, an agency may not conduct or sponsor, and a person is not required to respond to a collection of information unless it displays a valid OMB control number. The valid OMB control number for this information collection is 0596-0082. The time required to complete this information collection is estimated to average one hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information.

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From: Staples, Rose
Sent: Wednesday, May 04, 2016 2:46 PM
Cc: Deason, Jesse; Le, Bao; Staples, Rose
Subject: FW: Six Revised La Grange Study Plans Available for Final Review by Technical Committee

La Grange Licensing Participants,

The following email was sent today to the members of the La Grange Reintroduction/Fish Passage Assessment Framework Technical Committee regarding six revised La Grange Study Plans.

As noted below, the Districts will upload to the website next week the final study plans for discussion at Workshop No. 5, which will be held on Thursday, May 19, 2016 at MID.

Rose Staples, CAP-OM, MOS
D 207-239-3857

hdrinc.com/follow-us

From: Staples, Rose
Sent: Wednesday, May 04, 2016 5:34 PM
Cc: Deason, Jesse; Le, Bao; Staples, Rose (Rose.Staples@hdrinc.com)
Subject: Six Revised La Grange Study Plans Available for Final Review by Technical Committee

Technical Committee Members,

On March 16, 2016 the following study plans were provided to the Reintroduction/Fish Passage Assessment Framework Technical Committee for your review and comment:

(1) *Upper Tuolumne River Habitat Mapping and Macroinvertebrate Assessment Study Plan*
(2) *Hatchery and Stocking Practices Review Study Plan*
(3) *Regulatory Context for Reintroduction Study Plan*
(4) *Socioeconomic Scoping Study Plan*
(5) *Upper Tuolumne River Chinook Salmon and Steelhead Spawning Gravel Mapping Study Plan.*

On April 12, 2016 the *Upper Tuolumne River Instream Flow Study Plan* was sent to the Technical Committee for review and comment.

The Districts requested comments on the study plans by April 29, 2016. Comments on the study plans were received from members of the Technical Committee on the March 18, 2016 and April 18, 2016 Technical Committee conference calls. No other comments were received by April 29, 2016. Mr. Lonnie Moore provided comments on Monday, May 1, 2016 and the Districts respond to Mr. Moore's comments in the table below.

Table 1. Districts' Responses to Comments from Mr. Lonnie Moore

No.	Comment (paraphrased)	Districts' Response
1	Regarding the upper Tuolumne River Habitat Mapping and Macroinvertebrate Assessment, ensure that adequate/equal study of the Lower Tuolumne River (Below Le Grange Dam) exists or is included in this, or a separate, study.	Studies completed for the Don Pedro Project relicensing proceeding, including the *O. mykiss* Habitat Survey (W&AR-12) and the Lower Tuolumne River Riparian Information and Synthesis Study (W&AR-19), adequately characterize habitat in the lower Tuolumne River. Further study is unnecessary.

2	Regarding the Socioeconomic Scoping Study, it should be noted that, until either a single “fish passage” operation proposal/plan exists…all possible operations would need to be included in this scoping study.	Given that no fish passage facility alternatives have yet been identified, the Districts agree that the Socioeconomic Scoping Study should be broad enough to consider all activities and current uses in the study area that could be affected by any type of fish passage facility.
3	Regarding the Regulatory Context for Reintroduction Study Plan, add fall-run Chinook salmon to Section 3.0 Study Goals in the second to the last bullet statement. Also make this change in the other study plans, where appropriate.	The Districts will make this change to the Regulatory Context for Reintroduction Study Plan. It is not necessary to make this change in the other study plans since fall-run Chinook are already addressed in these plans.

The Districts have revised the study plans to address comments received on the March 18, 2016 and April 18, 2016 Technical Committee conference calls and to address Mr. Moore’s comment about the Regulatory Context for Reintroduction Study Plan. In addition, minor edits have been made to refine the study plans.

Revised study plans are available on the La Grange Project Licensing Website (www.lagrange-licensing.com) under the DOCUMENTS tab. Please provide any final comments on the study plans by Friday, May 6, 2016 by emailing them to me at Rose.Staples@hdrinc.com. Next week, the Districts will send final study plans to the Plenary Group for discussion at Workshop No. 5, which will be held on Thursday, May 19, 2016 at MID. The Districts appreciate the time and effort devoted by the Technical Committee to the review of the study plans.

Thank you.

Rose Staples, CAP-OM, MOS
Executive Assistant

HDR
970 Baxter Boulevard Suite 301
Portland ME 04103
D 207-239-3857
rose.staples@hdrinc.com

hdrinc.com/follow-us

From: Staples, Rose
Sent: Thursday, May 05, 2016 4:09 PM
To: 'Bartoo, Aondrea'
Subject: RE: La Grange meeting May 19

Leigh, the following items most probably will be the areas of discussion at the May 19th workshop, which is being held from 10:00 a.m. to Noon:

1. Discuss and seek approval of the study plans for the 2016 field studies. The study plans are currently undergoing final review by the Technical Committee and are expected to be uploaded to the La Grange website sometime next week, at which time I will be sending everyone a notification.

2. Provide an update and discuss the next steps for the reintroduction goals subcommittee.

3. Discussion of how to approach the development of spring-run Chinook and steelhead temperature suitability criteria.

Rose Staples, CAP-OM, MOS
D 207-239-3857

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From: Bartoo, Aondrea [mailto:aondrea_bartoo@fws.gov]
Sent: Wednesday, May 04, 2016 4:44 PM
To: Staples, Rose
Subject: La Grange meeting May 19

I'm receiving requests for other meetings on this day. Can you tell me if any potential agenda items have been developed for the La Grange meeting? I'm going to need to prioritize.

Thanks for your help!

--
A. Leigh Bartoo
Fish and Wildlife Biologist
Bay-Delta Fish and Wildlife Office
U.S. Fish and Wildlife Service
650 Capitol Mall, 8-300

Sacramento, CA 95814
916-930-5621

From: Staples, Rose
Sent: Friday, May 06, 2016 1:27 PM
Cc: Deason, Jesse; Le, Bao; Staples, Rose
Subject: La Grange Reintroduction Assessment Framework Workshop No 5 Agenda for May 19
Attachments: LG Reintro Framework Mtg_Agenda_20160519_Final.pdf

Licensing Participants,

Attached is the agenda for the Upper Tuolumne River Reintroduction Assessment Framework Workshop Meeting No. 5 which will be held on Thursday May 19, 2016 from 10:00 a.m. to Noon at the MID Offices in Modesto. The agenda has also been uploaded to the www.lagrange-licensing.com website as an attachment to the workshop date under the CALENDAR tab.

Proposed 2016 study plans to be considered at the meeting for approval will be uploaded to the website next week.

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La Grange Hydroelectric Project
Reintroduction/Fish Passage Assessment Framework
Plenary Group - Meeting No. 5

Thursday, May 19, 10:00 am to 12:00 pm
MID Office, 1231 11th Street, Modesto, California
Conference Line: 1-866-583-7984; Passcode: 814-0607
Join Lync Meeting: https://meet.hdrinc.com/jenna.borovansky/3D64F0F5

Meeting Objectives:

1. Discuss and seek approval of the field studies planned for 2016.
2. Progress update on the Reintroduction Goals Subcommittee activities.
3. Introduce development of temperature criteria.

TIME	TOPIC
10:00 am – 10:10 am	Introduction of Participants (All)
10:10 am – 10:30 am	Opening Remarks (All) Review Agenda and Meeting Objectives (All) Overview of Activities (since the January 27, 2016, Workshop No. 4) (Districts/All)
10:30 am – 11:15 am	Reintroduction Assessment Framework 2016 Study Program (All) Summary and Discussion of the following 2016 studies: a. Habitat Mapping and Macroinvertebrate Assessment b. Spawning Gravel Mapping Study c. Instream Flow Study d. Regulatory Context for Reintroduction Assessment e. Socioeconomic Scoping Study f. Hatchery and Stocking Practices Review
11:15 am – 11:30 am	Reintroduction Goals Subcommittee – Progress Update (All)
11:30 am – 11:50 am	Water Temperature Criteria (All) a. Introductory discussion – collaborative development of suitable criteria
11:50 am – 12:00 pm	Next Steps (All) a. Schedule for Workshop No. 6 b. Action items

From: Le, Bao
Sent: Monday, May 09, 2016 2:54 PM
To: Holdeman, Steven J -FS; Foote, Debra -FS; Vaughn, Gary D -FS
Cc: Warnock, Cory; Deason, Jesse; Borovansky, Jenna; Neal, Morgan
Subject: RE: Upper Tuolumne River Reintroduction Assessment Framework 2016 Field Program - Preliminary Details

Hi Steve.

I'll try and clarify…. the Instream Flow Study is being conducted as a collaborative between HDR and Stillwater. There are three sites for the study and each site has a raft trip associated with it. The first trip will be a partnership between both firms where field leads for the ubsequent two sites will work together at this initial site (August 15 trip). The interim week before the 29th is to "compare notes" and coordinate before both teams will conduct the remaining two sites concurrently the week of the 29th. Let me know if you have questions.

Thanks, Bao

From: Holdeman, Steven J -FS [mailto:sholdeman@fs.fed.us]
Sent: Monday, May 09, 2016 2:45 PM
To: Le, Bao; Foote, Debra -FS; Vaughn, Gary D -FS
Cc: Warnock, Cory; Deason, Jesse; Borovansky, Jenna; Neal, Morgan
Subject: RE: Upper Tuolumne River Reintroduction Assessment Framework 2016 Field Program - Preliminary Details

Two of the trips under item 5 are scheduled for the same week, Aug. 29.

Steven J. Holdeman
Forest Aquatic Biologist
Forest Service
Stanislaus National Forest, Supervisor's Office
p: 209-532-3671 x311
sholdeman@fs.fed.us
19777 Greenley Road
Sonora, CA 95370
www.fs.fed.us
Caring for the land and serving people

From: Le, Bao [mailto:ChiBao.Le@hdrinc.com]
Sent: Monday, May 09, 2016 8:36 AM
To: Foote, Debra -FS <dfoote@fs.fed.us>; Vaughn, Gary D -FS <gdvaughn@fs.fed.us>; Holdeman, Steven J -FS <sholdeman@fs.fed.us>
Cc: Warnock, Cory <Cory.Warnock@hdrinc.com>; Deason, Jesse <Jesse.Deason@hdrinc.com>; Borovansky, Jenna <Jenna.Borovansky@hdrinc.com>; Neal, Morgan <Morgan.Neal@hdrinc.com>
Subject: Upper Tuolumne River Reintroduction Assessment Framework 2016 Field Program - Preliminary Details

Good morning, Debbie et al.

Per our discussion last week, please find attached a summary of relevant permitting details for our upcoming field season. Please note, the details of numbers of raft trips, days, etc. have been informed by detailed discussions with our field leads and we feel pretty good about the levels of effort scoped here. That said, the dates of the earliest raft trips are best considered preliminary at this time since ideally, data collection would occur under an expected flow regime and currently, the timing of when spring run-off flows will subside is not known. So we're doing our best to adaptively manage start of the field season and will let you know if/how things change as soon as we know. We have a field logistics meeting at the end of this week and plan to have an application to you the following week.

Please don't hesitate to reach out should you have any questions.

Thanks,
Bao

Bao Le
Senior Fisheries Biologist

HDR
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Portland, OR 97204-1134
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1. **<u>Barrier Assessments – continue second year of migration barrier surveys (already permitted with one 5-day trip)</u>**
   - **<u>Overview</u>**
     i. **Permit already acquired from USFS in 2015 (for 2 year study)**
     ii. **Schedule – 5- day float tentatively planned for week of July 11th**
     iii. **Total # of days on the river – 5**
     iv. **Total # of rafts needed – 2**
     v. **Total # of staff/raft guides – 5-7 per trip**
     vi. **Additional Notes: Awaiting USFS feedback on drone use at Lumsden (for vehicle trip) and installation of trail camera at the Clavey.**

2. **<u>Temperature Logger Downloads/Flow Measurements</u>**
   - **<u>Overview</u>**
     i. **Permit already acquired from USFS in 2015 (for 2 year study)**
     ii. **Schedule – 2 trips during study season**
        1. **3-day float tentatively planned for the week of June 13th**
        2. **3-day float tentatively planned for the week of October 3rd**
     iii. **Total # of days on the river – 6**
     iv. **Total # of rafts needed 4 (2/trip)**
     v. **Total # of staff/raft guides – 4-5 per trip**
     vi. **Additional Notes: Awaiting USFS confirmation on approved/existing raft permit for this work.**

3. **<u>Habitat Typing and Macroinvertebrates</u>**
   - **<u>Overview</u>**
     i. **Schedule – 2 trips during study season**
        1. **3-day float tentatively planned for the week of June 13th**
        2. **7-day float tentatively planned for the week of June 20th**
     ii. **Total # of days on the river – 10**
     iii. **Total # of rafts needed – 4 (2/trip)**
     iv. **Total # of staff/raft guides – 5-6 per trip**
     v. **Additional Notes: Temporary instream equipment used for macroinvertebrate sampling. All equipment will only be used while on-site.**

4. **<u>Spawning Gravel Study</u>**
   - **<u>Overview</u>**
     i. **Schedule – 3 trips during study season**
        1. **5-day float tentatively planned for the week of June 20th**
        2. **7-day float tentatively planned for the week of July 4th**
        3. **5-day float tentatively planned for the week of August 1st**
     ii. **Total # of days on the river – 17**
     iii. **Total # of rafts needed – 6 (2/trip)**
     iv. **Total # of staff/raft guides – 4-5 per trip**
     v. **Additional Notes: Temporary instream equipment may be used for permeability work (Trip #3). All equipment will only be used while on-site.**

5. **<u>Instream Flow Study</u>**

- **Overview**

    i. **Schedule – 3 trips during study season**

        1. **7-day float tentatively planned for the week of August 15th**
        2. **7-day float tentatively planned for the week of August 29th**
        3. **7-day float tentatively planned for the week of August 29th**

    ii. **Total # of days on the river – 21**

    iii. **Total # of rafts needed – 6 (2/trip)**

    iv. **Total # of staff/raft guides – 7-8 per trip**

    v. **Additional Notes:**

        1. **Rafting scheme currently under development. The current thinking is that as opposed to other studies where rafting guides/cooks stay with the study effort, the guides would likely transport the team to the appropriate location and then come back at the end of the week and pick them up.**
        2. **Temporary instream stage recording equipment will be installed at the upstream and downstream ends of the reach. All equipment will only be used while on-site.**

From: Staples, Rose
Sent: Tuesday, May 10, 2016 12:52 PM
Cc: Deason, Jesse; Le, Bao; Staples, Rose
Subject: La Grange Reintroduction Assessment Framework Workshop No 5 Agenda/Materials for May 19

La Grange Licensing Participants,

In preparation for next week's ***Upper Tuolumne River Reintroduction Assessment Framework (Framework) Workshop Meeting No. 5*** (which will be held on Thursday May 19, 2016 from 10:00 a.m. to Noon at the MID Offices in Modesto), the agenda and six revised draft study plans have been uploaded to the www.lagrange-licensing.com website **as attachments to the workshop date under the CALENDAR tab.**

The six revised draft study plans were developed collaboratively by the Framework's Technical Committee and represents new studies to be implemented in 2016 in support of the reintroduction assessment process. We will seek approval of these study plans at the May 19 meeting.

Rose Staples, CAP-OM, MOS
Executive Assistant

HDR
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Portland ME 04103
D 207-239-3857
rose.staples@hdrinc.com

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From: Le, Bao
Sent: Tuesday, May 10, 2016 12:56 PM
To: John Wooster - NOAA Federal
Cc: Mike Deas; Deason, Jesse; Borovansky, Jenna; Peggy Basdekas; Devine, John; Warnock, Cory
Subject: RE: Temperature Data Swap and LiDAR

Thanks John, for the update. That sounds like a lot of work.

On our end, we're continuing to coordinate with our field leads on needs, etc. so we'll ping them and see if they have specific reaches in mind where the below process/info would be of value to inform their study planning and get back to you. I'll defer to Mike Deas about any questions or needs he might have as it relates to supporting his temperature model development. If you could keep us in the loop about when someone is in place and when a schedule is available, that'd be great.

Bao

From: John Wooster - NOAA Federal [mailto:john.wooster@noaa.gov]
Sent: Monday, May 09, 2016 5:14 PM
To: Le, Bao
Cc: Mike Deas; Deason, Jesse; Borovansky, Jenna; Peggy Basdekas; Devine, John
Subject: Re: Temperature Data Swap and LiDAR

Hi Bao:

Finally was able to have a call with the necessary folks, and the upshot is things do not look good to see the bathymetry data anytime soon. The person that was handling a lot of the manual air photo processing is no longer available and someone new needs to be hired / found. The computer workflow to retrieve / correlate the images to depths is complete, and now someone needs to finish processing every individual image, I don't know how many there are, but there are a lot (something like close to 100 miles of coverage on the Tuolumne including tribs, and a similar amount on the Merced). From there the the depth data from each image needs to be stitched together, and then that data into the LiDAR. I think the best bet to possibly have some data useful for you this field season is to potentially intercept the process above after the depth data for each image has been calculated, put in a request for some specific reaches and see if they can't get us that focused data - and not have to wait for all the stitching of the data together.

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Sent: Friday, April 29, 2016 12:59 PM
To: Le, Bao
Cc: Mike Deas; Deason, Jesse; Borovansky, Jenna; Peggy Basdekas; Devine, John
Subject: Re: Temperature Data Swap and LiDAR

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tselko@quantumspatial.com

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Sent: Thursday, April 21, 2016 11:44 AM
To: John Wooster - NOAA Federal
Cc: Le, Bao; Deason, Jesse; Borovansky, Jenna; Peggy Basdekas; Devine, John
Subject: Re: Temperature Data Swap and LiDAR

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Mike.

Sent from my iPhone

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Cc: Bao Le (bao.le@hdrinc.com); Deason, Jesse (Jesse.Deason@hdrinc.com); Borovansky, Jenna (Jenna.Borovansky@hdrinc.com); Peggy Basdekas
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From: Le, Bao [mailto:ChiBao.Le@hdrinc.com]
Sent: Thursday, February 04, 2016 10:14 AM
To: Mike Deas
Subject: FW: Temperature Data Swap and LiDAR

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Sent: Thursday, February 04, 2016 10:07 AM
To: Le, Bao
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Subject: Re: Temperature Data Swap and LiDAR

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Sent: Wednesday, February 03, 2016 12:38 PM
To: Le, Bao
Cc: Borovansky, Jenna; Deason, Jesse; mike.deas@watercourseinc.com
Subject: Re: Temperature Data Swap and LiDAR

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To: Le, Bao
Cc: Borovansky, Jenna; Deason, Jesse; mike.deas@watercourseinc.com
Subject: Re: Temperature Data Swap and LiDAR

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-John

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This has been on my plate for a while so I apologize for not getting back to you on exchanging data sooner. We've been through the process of temperature data QC and believe it is now available to share. As discussed previously, we'd like to also get NMFS' temperature data in the Upper Tuolumne River. Let's discuss a way in which we can swap that data here soon.

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Let me know if you have any questions.

Thanks,

Bao

Bao Le

Senior Fisheries Biologist

HDR

1001 SW 5th Avenue, Suite 1800
Portland, OR 97204-1134
D 971.202.1722 **M** 503.309.9423
bao.le@hdrinc.com

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John Wooster
Hydrologist
NOAA Fisheries West Coast Region
U.S. Department of Commerce
john.wooster@noaa.gov

From: John Wooster - NOAA Federal <john.wooster@noaa.gov>
Sent: Friday, May 13, 2016 11:13 AM
To: Le, Bao
Cc: Mike Deas; Deason, Jesse; Borovansky, Jenna; Peggy Basdekas; Devine, John; Olden, Randy
Subject: Re: Temperature Data Swap and LiDAR

In short, I don't know, but I would think so. I don't have them, the Science Center does. Nor have I seen an example to speak to whether they would be particularly helpful for you. I just sent an email to the person running the habitat studies, and received a bounce back that he is out of the office until May 23. While I suspect there is a good chance Lee will email me back before then, I'm guessing it is a long shot to have someone bundle them up in a distributable package and put them on a hard drive (I think the images in total are about 1 TB) before then.

I'll update as soon as I know more.

-John

On Fri, May 13, 2016 at 10:38 AM, Le, Bao <ChiBao.Le@hdrinc.com> wrote:

Hi John.

We've been trying to identify and acquire the necessary imagery to inform planning for the habitat studies this summer. Stillwater, who is conducting the spawning gravel mapping study, could really use the hyperspectral imagery to inform their desktop site sampling/planning in advance of getting out into the field in mid-late June. Are we able to get that information? I've also cc'd Randy Olden, our GIS lead, in case he has anything to add or if I've mischaracterized anything?

Thanks, Bao

From: John Wooster - NOAA Federal [mailto:john.wooster@noaa.gov]
Sent: Monday, May 09, 2016 5:14 PM
To: Le, Bao
Cc: Mike Deas; Deason, Jesse; Borovansky, Jenna; Peggy Basdekas; Devine, John
Subject: Re: Temperature Data Swap and LiDAR

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Cc: Bao Le (bao.le@hdrinc.com); Deason, Jesse (Jesse.Deason@hdrinc.com); Borovansky, Jenna (Jenna.Borovansky@hdrinc.com); Peggy Basdekas
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John Wooster
Hydrologist
NOAA Fisheries West Coast Region
U.S. Department of Commerce
john.wooster@noaa.gov

<image001.jpg>

PHONE CALL MEMORANDUM

Topic	Permit for 2016 studies
Date	May 13, 2016
From	Mr. Steve Boyd, Turlock Irrigation District
To	Mr. Jim Eicher, Bureau of Land Management
Summary of Discussion	Mr. Boyd called Mr. Eicher and left a voicemail about discussing permitting for the Districts' 2016 studies in the upper Tuolumne River.

From: Le, Bao
Sent: Monday, May 16, 2016 3:13 PM
To: John Wooster - NOAA Federal
Cc: Mike Deas; Deason, Jesse; Borovansky, Jenna; Peggy Basdekas; Devine, John; Olden, Randy
Subject: RE: Temperature Data Swap and LiDAR

Thanks for the update, John.

Let me circle back with staff here and see what their thoughts are on usability, level of effort, schedule after May 23rd, etc.

Bao

From: John Wooster - NOAA Federal [mailto:john.wooster@noaa.gov]
Sent: Monday, May 16, 2016 2:23 PM
To: Le, Bao
Cc: Mike Deas; Deason, Jesse; Borovansky, Jenna; Peggy Basdekas; Devine, John; Olden, Randy
Subject: Re: Temperature Data Swap and LiDAR

Bao et al.

I received an email reply from the Science Center in regards to the hyperspec images, I've pasted it below. Sounds like the upshot is there is some question as to the utility for you, and not much progress can be made until May 23.... Let me know how you would like to proceed.

-John

Hi John,

I think they'd be better off just downloading the latest NAIP imagery. The hyperspectral imagery consists of 48-band image cubes (.pix extension) that can only be read in ENVI. The tiles aren't mosaicked due to the file sizes so it'd take some work for them to make useable maps.

I'm out of the office until May 23 but let's follow up then.

Thanks,

Lee

On Fri, May 13, 2016 at 11:12 AM, John Wooster - NOAA Federal <john.wooster@noaa.gov> wrote:
In short, I don't know, but I would think so. I don't have them, the Science Center does. Nor have I seen an example to speak to whether they would be particularly helpful for you. I just sent an email to the person running the habitat studies, and received a bounce back that he is out of the office until May 23. While I suspect there is a good chance Lee will email me back before then, I'm guessing it is a long shot to have someone bundle them up in a distributable package and put them on a hard drive (I think the images in total are about 1 TB) before then.

I'll update as soon as I know more.

-John

On Fri, May 13, 2016 at 10:38 AM, Le, Bao <ChiBao.Le@hdrinc.com> wrote:

Hi John.

We've been trying to identify and acquire the necessary imagery to inform planning for the habitat studies this summer. Stillwater, who is conducting the spawning gravel mapping study, could really use the hyperspectral imagery to inform their desktop site sampling/planning in advance of getting out into the field in mid-late June. Are we able to get that information? I've also cc'd Randy Olden, our GIS lead, in case he has anything to add or if I've mischaracterized anything?

Thanks, Bao

From: John Wooster - NOAA Federal [mailto:john.wooster@noaa.gov]
Sent: Monday, May 09, 2016 5:14 PM
To: Le, Bao
Cc: Mike Deas; Deason, Jesse; Borovansky, Jenna; Peggy Basdekas; Devine, John
Subject: Re: Temperature Data Swap and LiDAR

Hi Bao:

Finally was able to have a call with the necessary folks, and the upshot is things do not look good to see the bathymetry data anytime soon. The person that was handling a lot of the manual air photo processing is no longer available and someone new needs to be hired / found. The computer workflow to retrieve / correlate the images to depths is complete, and now someone needs to finish processing every individual image, I don't know how many there are, but there are a lot (something like close to 100 miles of coverage on the Tuolumne including tribs, and a similar amount on the Merced). From there the the depth data from each image needs to be stitched together, and then that data into the LiDAR. I think the best bet to possibly have some data useful for you this field season is to potentially intercept the process above after the depth data for each image has been calculated, put in a request for some specific reaches and see if they can't get us that focused data - and not have to wait for all the stitching of the data together.

I didn't get dates for anything being complete because that is contingent on getting someone in place to finish out the work - a process I don't have a hand in on any level....

Regards,

-John

On Tue, May 3, 2016 at 12:27 PM, Le, Bao <ChiBao.Le@hdrinc.com> wrote:

Hi John.

I also wanted to circle back regarding the availability of the LiDAR with the bathymetry stitched into it. A few study leads have noted that this information would be useful in supporting their studies. Have you heard back from the Science Center as to when that would be available?

Thanks again for your help,

Bao

From: John Wooster - NOAA Federal [mailto:john.wooster@noaa.gov]
Sent: Friday, April 29, 2016 12:59 PM
To: Le, Bao
Cc: Mike Deas; Deason, Jesse; Borovansky, Jenna; Peggy Basdekas; Devine, John
Subject: Re: Temperature Data Swap and LiDAR

Hi Bao:

I heard back from the Science Center, they are fine with you contacting Quantum - just know there is no longer an active account for any charges related to those flights.

You can try contacting Tucker Selko, who was the project manager for the MT LiDAR. His email is:

tselko@quantumspatial.com

Regards,

John

On Thu, Apr 21, 2016 at 5:27 PM, Le, Bao <ChiBao.Le@hdrinc.com> wrote:

Hi John.

To follow up on your email below, please see my responses in red.

Also, regarding temperature data, are you still collecting data this year as well. I don't recall whether you pulled loggers last fall or kept them out there to collect this spring/summer as well?

Thanks, Bao

From: Mike Deas [mailto:Mike.Deas@watercourseinc.com]
Sent: Thursday, April 21, 2016 11:44 AM
To: John Wooster - NOAA Federal
Cc: Le, Bao; Deason, Jesse; Borovansky, Jenna; Peggy Basdekas; Devine, John
Subject: Re: Temperature Data Swap and LiDAR

John, thank you. I am out of the office today and can communicate the data to you tomorrow.

Mike.

Sent from my iPhone

On Apr 21, 2016, at 10:30 AM, John Wooster - NOAA Federal <john.wooster@noaa.gov> wrote:

> Hi Bao and Mike:
>
> I'll complete the temperature data transfer this afternoon with Mike, I'm in meetings until 1 PM.
>
> Regarding contacting Quantum Spatial, I don't foresee this being an issue, but I had/have nothing to do with the contracting or working with those folks. I would like a chance to run it by the Science Center folks who were involved as a courtesy, good practice, particularly if we are going to ask for additional work products prior to them giving final deliverables. Note, if your questions center around the hyperspec images, the more appropriate person to contact may be the professor from Wyoming that supplied the actual camera, as his shop has handled the post

processing of the images. Note sure Quantum did much more than fly the images, and probably georectify them. As I understand it, we don't have any questions for Quantum Spatial that will result in additional development of work products. I think some clarification on the metadata, flight times, etc. is all that is needed. My sense is that this would be pretty brief.

As for "updated LiDAR", the LiDAR I gave you was a final product. But I think what you mean is the bathymetry derived from the hyperspec images, and preferably that data stitched with the LIDAR in the form of a DEM or DTM. I don't have a date on when that work is going to be finished (it wasn't at the time I got the LiDAR data). That being said, I do know that the project was supposed to be moving from deriving habitat units to calculating production in early June, which would imply that a final DEM would have been made by that point. I'll ask for more detail when I run the idea of contacting Quantum by them. You're correct. Apologize for continual use of the wrong terminology. Curious as to the availability of the LiDAR updated with bathymetry stitched in the form of a DEM or DTM.

Regards,

John

On Tue, Apr 19, 2016 at 4:26 PM, Le, Bao <ChiBao.Le@hdrinc.com> wrote:

Hi John.

In addition to a swap of temperature data, I wanted to touch base on the progress made on the LiDAR and hyperspectral dataset. Last we spoke, more work was being done on the dataset. The Instream Flow Study we're now planning to conduct will likely have a need for the LiDAR and hyperspectral information. Can you provide us with an update of where this is at and if something updated would be available to inform the Instream Flow Study? As I understand it, the temperature modeling would also likely benefit from updated LiDAR information.

Also, we reviewed the technical data report you supplied earlier this year and there were a few questions. Jarvis Caldwell has worked with Quantum Spatial in the past and was hoping to follow up with them regarding these questions. Please let us know if that would be ok.

Thanks, Bao

From: Mike Deas [mailto:Mike.Deas@watercourseinc.com]
Sent: Tuesday, April 19, 2016 11:50 AM
To: John Wooster - NOAA Fe...
Cc: Le, Bao; Deason, Jesse; Borovansky, Jenna; Peggy Basdekas
Subject: RE: Temperature Data Swap and LiDAR

John,

Just following up with you on the temperature data exchange. Let me know if you would like to discuss this or have any questions or comments. Thank you,

Mike

From: Mike Deas
Sent: Friday, February 19, 2016 5:27 PM
To: 'John Wooster - NOAA Fe...'
Cc: Bao Le (bao.le@hdrinc.com); Deason, Jesse (Jesse.Deason@hdrinc.com); Borovansky, Jenna (Jenna.Borovansky@hdrinc.com); Peggy Basdekas
Subject: RE: Temperature Data Swap and LiDAR

John,

Let me know how and when you would like to proceed with the data exchange. Thank you,

Mike

From: Le, Bao [mailto:ChiBao.Le@hdrinc.com]
Sent: Thursday, February 04, 2016 10:14 AM
To: Mike Deas
Subject: FW: Temperature Data Swap and LiDAR

Hey Mike.

If you're ok with John's response below, I think the next step is to facilitate data exchange. If it's ok, I would direct John to coordinate with you on the best way to go about this. Please let me know if this is ok.

Thanks, Bao

From: John Wooster - NOAA Federal [mailto:john.wooster@noaa.gov]
Sent: Thursday, February 04, 2016 10:07 AM
To: Le, Bao
Cc: Borovansky, Jenna; Deason, Jesse; mike.deas@watercourseinc.com
Subject: Re: Temperature Data Swap and LiDAR

I agree with your approach below, transmit the portion of the daily record that has water temp readings and trim the record aggressively to make sure we are in a zone of full inundation. While the discontinuous record will make it tough to run some stats and probably calibrate your model too, the data may help you validate once the model is built or at least get some insight if things further downstream aren't lining out as expected....

-JW

On Wed, Feb 3, 2016 at 5:11 PM, Le, Bao <ChiBao.Le@hdrinc.com> wrote:

Hi John.

See below in red.

Let me know if you have any questions.

Thanks, Bao

From: John Wooster - NOAA Federal [mailto:john.wooster@noaa.gov]
Sent: Wednesday, February 03, 2016 12:38 PM
To: Le, Bao
Cc: Borovansky, Jenna; Deason, Jesse; mike.deas@watercourseinc.com
Subject: Re: Temperature Data Swap and LiDAR

Bao:

I received the LiDAR data this morning. I can't email files over about 25 MB. I have the data on my Google Drive. I am going to invite you and Mike to share the folder, you should be able to link directly in without installing any additional software, click on the file (the file preview will fail) but you should then be able to start to download. There is also a data description / quasi meta data in there from the vendor. Let me know if it doesn't work.

As for water temp data, when you say "We remove loggers that go dry from the data set", I believe you mean you remove the portion of that loggers record that is dry (not the entire logger record), but wanted to double check....that's correct. We remove just the air temperature portion.

How would you like to handle the logger(s) that go wet/dry on a daily basis with the whitewater release? I see two options: just remove the portion of the record where there is daily wet/dry cycles, or transmit the portion of each day where there is water temp readings (longer than you might think given a 4 hour whitewater release because it takes quite awhile for the pools to fully recede)..... We can sympathize with the deployment challenges of that reach reach given the whitewater releases. We think the data is useful and the second option preserves some important temperature information that would be lost if the daily wet/dry cycles were removed (option 1). Is it difficult to discern the transition between water temperatures and air temperatures and vice versa since a partially inundated logger might be hard to interpret? If so, perhaps a conservative approach would be to trim the data set a little more to ensure air temperatures do not creep into the data set. Thoughts?

Thanks,

John

On Wed, Feb 3, 2016 at 8:40 AM, Le, Bao <ChiBao.Le@hdrinc.com> wrote:

Thanks for the info, John. See responses below and let me know what you think.

Bao

From: John Wooster - NOAA Federal [mailto:john.wooster@noaa.gov]
Sent: Tuesday, February 02, 2016 1:43 PM
To: Le, Bao
Cc: Borovansky, Jenna; Deason, Jesse; mike.deas@watercourseinc.com
Subject: Re: Temperature Data Swap and LiDAR

Hi Bao:

Yes the LiDAR is ready to share, and it is processed. It is the bathymetry (derived from the hyper spec images) that is still being worked out - and still could be a few months out. Eventually those two data sets will be stitched together. But if you want the LiDAR now (everything above water surface), we could make that happen in a matter of days. I was told the LiDAR is only about a 5 GB file, so we could probably do that over a dropbox / Google Drive exchange. Let me know if you want that now, and I can probably have it within a matter of days from Science Center (I'm not actually holding it at the moment, but they did tell me last week it was ready).....That would be great if we could get the LiDAR above water surface for now. When the bathymetry is available, if we could acquire that as well, it'd be much appreciated. My email can accept 5 GB attachments.

My temp data is more or less ready to exchange - I did have one logger in the mainstem that I didn't get deep enough that would dessicate when they shut the water off after whitewater release and inundate with the whitewater pulse (that's what happens when you install loggers while rafting down the river and the water is up), so I still need to process that one. We had a similar issue with our mainstem logger above the Clavey and NF confluence locations – we installed in the early summer prior to rafting flows (down low and deep) and then as we got into late fall/winter, were unsure we could access them again with water rising. So these two locations have overwintered without a download. And our upper Clavey logger eventually went dry as well because we installed it when flows were up and couldn't safely get into the middle of the thalweg. I saw in August that at least your NF Tuolumne logger went dry, and I think your lower Clavey if memory serves correct. How would you like to handle the data from loggers that go dry? We remove loggers that go dry from the dataset. Are you deleting the records that are air temperature (i.e., when it goes dry)? Yes. Are you separating the data into two different columns - one for water temp, one for air temp (that is my preferred, as sometimes it is useful to have the air temp data)? Or one column of data, and one column of water vs air qualifier? Let me know what you have done and I will follow suit.... We did not manage air temp data in any way because we do not know if the logger is sitting in a puddle of water partly submerged and partly exposed, under a rock, in the baking sun, etc. The logger was not deployed as an air temperature monitoring station, which would require its own deployment protocol (somewhat different than a water temperature logger deployment).

Let's shoot to exchange temp data this coming Monday. I can probably transmit mine over email, or a couple of emails. Also could do that over Google Drive, as well. Let's work this week on how to exchange the larger files next Monday. As noted above, I can accept pretty large files. What's the case on your end and what's your preference? Using any file transfer software (that isn't currently on my laptop) will require that I get IT involved on this end to approve and download those programs. But I can get it going this week.

-John

On Tue, Feb 2, 2016 at 9:54 AM, Le, Bao <ChiBao.Le@hdrinc.com> wrote:

Hi John.

This has been on my plate for a while so I apologize for not getting back to you on exchanging data sooner. We've been through the process of temperature data QC and believe it is now available to share. As discussed previously, we'd like to also get NMFS' temperature data in the Upper Tuolumne River. Let's discuss a way in which we can swap that data here soon.

Also, you had mentioned that you would have LiDAR (although not completely processed) available to share as well. In discussions with Mike Deas, our temperature modeler, he thought this would still be useful for his purposes so if we could acquire these data also, that'd be great. I've cc'd him here.

Let me know if you have any questions.

Thanks,

Bao

Bao Le

Senior Fisheries Biologist

HDR

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John Wooster
Hydrologist
NOAA Fisheries West Coast Region
U.S. Department of Commerce
john.wooster@noaa.gov

NOAA FISHERIES West Coast Region

From: Eicher, James
Sent: Tuesday, May 17, 2016 6:52 PM
To: Steve E. Boyd
Subject: BLM approvals of studies.

Hi Steve sorry we didn't connect today but I am going to be gone till May 27th. If you need authorization from BLM please contact William Haigh Field Manager. You can touch base with him by email whaigh@blm,gov or 916 941-3102. If it can wait till I get back then send me your requests and I will take care of it then. As you are aware, the Districts must get proper authorization prior to placing anything on BLM. If this involves any possible disturbance on water flow and or it is within the bed or bank of the Wild and Scenic river a Section 7 determination will need to be conducted by BLM.

Take Care
Jim

From: Staples, Rose
Sent: Tuesday, May 17, 2016 5:54 PM
Cc: Deason, Jesse; Le, Bao; Staples, Rose
Subject: FW: Draft Notes April 13 Reintroduction Goals Subcommittee Call Available for Review on Licensing Website

La Grange Licensing Participants,

As you can see by the following message, the draft notes from the April 13, 2016 Reintroduction Goals Subcommittee conference call has been uploaded to the La Grange licensing website www.lagrange-licensing.com for review by the Subcommittee members—and is also available for general viewing in both the DOCUMENTS and CALENDAR (meeting date) sections of the website.

Rose Staples, CAP-OM, MOS
D 207-239-3857

hdrinc.com/follow-us

From: Staples, Rose
Sent: Tuesday, May 17, 2016 8:33 PM
Cc: Deason, Jesse; Le, Bao; Staples, Rose (Rose.Staples@hdrinc.com)
Subject: Draft Notes April 13 Reintroduction Goals Subcommittee Call Available for Review on Licensing Website

Reintroduction Goals Subcommittee,

The DRAFT NOTES from the April 13, 2016 Reintroduction Goals Subcommittee call has been uploaded to the licensing website www.lagrange-licensing.com in the DOCUMENTS section and also as an attachment to the April 13 meeting date. Please provide any comments on the meeting notes by Wednesday, June 1. The Districts will incorporate any comments received and then post a final version of the meeting notes to the La Grange Project Licensing Website.

In addition, this email will also be forwarded to the La Grange Project licensing email list stating that the draft meeting notes are available online.

If you have any difficulties locating and/or accessing the document, please let me know. Thank you.

Rose Staples, CAP-OM, MOS
Executive Assistant

HDR
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rose.staples@hdrinc.com

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From: Staples, Rose
Sent: Tuesday, May 17, 2016 5:42 PM
Cc: Deason, Jesse; Le, Bao; Staples, Rose
Subject: FW: Draft Notes April 18 Technical Committee Call Available For Review On Licensing Website

La Grange Licensing Participants,

As you can see by the following message, the draft notes from the April 18, 2016 Technical Committee conference call has been uploaded to the La Grange licensing website www.lagrange-licensing.com for review by the Committee members—and is also available for general viewing in both the DOCUMENTS and CALENDAR (meeting date) sections of the website.

Rose Staples, CAP-OM, MOS
D 207-239-3857

hdrinc.com/follow-us

From: Staples, Rose
Sent: Tuesday, May 17, 2016 8:34 PM
Cc: Deason, Jesse; Le, Bao; Staples, Rose (Rose.Staples@hdrinc.com)
Subject: Draft Notes April 18 Technical Committee Call Available For Review On Licensing Website

Technical Committee,

DRAFT NOTES from the April 18, 2016 Technical Committee call has been uploaded to the licensing website www.lagrange-licensing.com in the DOCUMENTS section and also as an attachment to the April 18 meeting date. Please provide any comments on the meeting notes by Wednesday, June 1. The Districts will incorporate any comments received and then post a final version of the meeting notes to the La Grange Project Licensing Website.

In addition, this email will also be forwarded to the La Grange Project licensing email list stating that the draft meeting notes are available online.

If you have any difficulties locating and/or accessing the document, please let me know. Thank you.

Rose Staples, CAP-OM, MOS
Executive Assistant

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From: Staples, Rose
Sent: Tuesday, May 17, 2016 5:50 PM
Cc: Le, Bao; Deason, Jesse; Staples, Rose
Subject: Draft Notes April 13 Reintroduction Goals Subcommittee Call Available for Review on Licensing Website

Correction to the subject: Draft Notes ***April 13*** Reintroduction Goals Subcommittee Call Available for Review on Licensing Website.
The correct date went out to the rest of the La Grange licensing email group.

Rose Staples, CAP-OM, MOS
D 207-239-3857

hdrinc.com/follow-us

From: Staples, Rose
Sent: Tuesday, May 17, 2016 8:33 PM
Cc: Deason, Jesse; Le, Bao; Staples, Rose
Subject: Draft Notes April 13 ~~18~~ Reintroduction Goals Subcommittee Call Available for Review on Licensing Website

Reintroduction Goals Subcommittee,

The DRAFT NOTES from the April 13, 2016 Reintroduction Goals Subcommittee call has been uploaded to the licensing website www.lagrange-licensing.com in the DOCUMENTS section and also as an attachment to the April 13 meeting date. Please provide any comments on the meeting notes by Wednesday, June 1. The Districts will incorporate any comments received and then post a final version of the meeting notes to the La Grange Project Licensing Website.

In addition, this email will also be forwarded to the La Grange Project licensing email list stating that the draft meeting notes are available online.

If you have any difficulties locating and/or accessing the document, please let me know. Thank you.

Rose Staples, CAP-OM, MOS
Executive Assistant

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From: Staples, Rose
Sent: Tuesday, May 17, 2016 6:14 PM
Cc: Le, Bao; Deason, Jesse; Staples, Rose
Subject: Reminder - La Grange Workshop No 5 - May 19, 2016 - MID Offices Modesto

Draft study plans referenced can be viewed and downloaded from the DOCUMENTS section of the La Grange licensing website www.lagrange-licensing.com.

Rose Staples, CAP-OM, MOS
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La Grange Hydroelectric Project
Reintroduction/Fish Passage Assessment Framework
Plenary Group - Meeting No. 5

Thursday, May 19, 10:00 am to 12:00 pm
MID Office, 1231 11th Street, Modesto, California
Conference Line: 1-866-583-7984; Passcode: 814-0607
Join Lync Meeting: https://meet.hdrinc.com/jenna.borovansky/3D64F0F5

Meeting Objectives:

1. Discuss and seek approval of the field studies planned for 2016.
2. Progress update on the Reintroduction Goals Subcommittee activities.
3. Introduce development of temperature criteria.

TIME	TOPIC
10:00 am – 10:10 am	Introduction of Participants (All)
10:10 am – 10:30 am	Opening Remarks (All) Review Agenda and Meeting Objectives (All) Overview of Activities (since the January 27, 2016, Workshop No. 4) (Districts/All)
10:30 am – 11:15 am	Reintroduction Assessment Framework 2016 Study Program (All) Summary and Discussion of the following 2016 studies: a. Habitat Mapping and Macroinvertebrate Assessment b. Spawning Gravel Mapping Study c. Instream Flow Study d. Regulatory Context for Reintroduction Assessment e. Socioeconomic Scoping Study f. Hatchery and Stocking Practices Review
11:15 am – 11:30 am	Reintroduction Goals Subcommittee – Progress Update (All)
11:30 am – 11:50 am	Water Temperature Criteria (All) a. Introductory discussion – collaborative development of suitable criteria
11:50 am – 12:00 pm	Next Steps (All) a. Schedule for Workshop No. 6 b. Action items

From: Staples, Rose
Sent: Wednesday, May 18, 2016 8:38 PM
To: 'Leon, Abimael@Wildlife'
Subject: RE: Request to be added to the FERC (TID/MID) mailing list

I have added your email address to both my Don Pedro Relicensing and La Grange Licensing email groups. Hopefully you are already aware of the two websites (www.donpedro-relicensing.com and www.lagrange-licensing.com) as well as the fact that there is a La Grange Workshop No. 5 being held tomorrow (10:00 a.m. to Noon) at the MID Offices in Modesto. Workshop agenda and advance materials are on the La Grange website under the DOCUMENTS and the CALENDAR TAB for May 19.

Thank you.

Rose Staples, CAP-OM, MOS
D 207-239-3857

hdrinc.com/follow-us

From: Leon, Abimael@Wildlife [mailto:Abimael.Leon@wildlife.ca.gov]
Sent: Wednesday, May 18, 2016 8:09 PM
To: Staples, Rose
Subject: Request to be added to the FERC (TID/MID) mailing list

Hello Rose,

I would like to be included on the mailing list for the Tuolumne FERC meetings (TID/MID). I will be overseeing and leading FERC licensing and review activities for FERC projects undergoing review within the California Department of Fish and Wildlife – Central Region (Region 4), among other responsibilities.

Thanks,

--
Abimael (Abi) **León**

Senior Environmental Scientist (Specialist)
California Department of Fish and Wildlife
Central Region (Region 4)
Ecosystem Conservation Division
Habitat Conservation Planning Branch
Environmental Planning and Review
1130 East Shaw Avenue,
Fresno, CA 93710
Office: (559)243-4014 ext.251
E-mail: Abimael.Leon@wildlife.ca.gov
www.wildlife.ca.gov
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Abimael (Abi) **León**
Senior Environmental Scientist (Specialist)
California Department of Fish and Wildlife
Central Region (Region 4)
Ecosystem Conservation Division
Habitat Conservation Planning Branch
Environmental Planning and Review
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Fresno, CA 93710
Office: (559)243-4014 ext.251
E-mail: Abimael.Leon@wildlife.ca.gov
www.wildlife.ca.gov
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PHONE CALL MEMORANDUM

Topic	Permit for 2016 studies
Date	May 20, 2016
From	Mr. Steve Boyd, Turlock Irrigation District
To	Mr. Bill Haigh, Bureau of Land Management
Summary of Discussion	Mr. Boyd called Mr. Haigh and left a voicemail about discussing permitting for the Districts' 2016 studies in the upper Tuolumne River.

From: Staples, Rose
Sent: Monday, May 23, 2016 3:09 PM
To: Wooster, John
Subject: Two CDs in Response to NMFS Request for Data Being Sent Today

Per NMFS' request, the Districts have prepared two CD data packages:

(A) The first CD includes: (1) a shapefile depicting point LiDAR measurements of the island area between the lower Tuolumne River main channel below the La Grange Diversion Dam and the powerhouse tailrace channel, (2) a shapefile with survey points, (3) a shapefile with longitudinal profile routed line features that represent the thalweg of each surveyed channel, (4) a shapefile with all survey points utilized to develop the profile graphic included in the technical memo, and (5) a table summarizing depths by habitat unit and profile charts that show the water depth data.

(B) The second CD includes spreadsheets that provide hourly flow data for La Grange powerhouse Units 1 and 2, TID sluice gates 1 and 2, the sum of flows at the MID hillside discharge and Portal 1, and the La Grange Diversion Dam spillway. The hourly flow data is for the period of January 2005 through October 2015. The Districts' May 2 ISR comment response letter states flow data would also be provided for years 2003 and 2004; however, this statement was incorrect as spreadsheets for these two years do not exist. The Districts regret the error.

These two CDs are being sent to you today via FEDEX 2nd Day. The CDs should arrive at your office by Wednesday, May 25.

Rose Staples, CAP-OM, MOS
Executive Assistant

HDR
970 Baxter Boulevard Suite 301
Portland ME 04103
D 207-239-3857
rose.staples@hdrinc.com

hdrinc.com/follow-us

From: Greg Dias [mailto:Greg.Dias@mid.org]
Sent: Tuesday, May 24, 2016 11:19 AM
To: 'John Wooster - NOAA Federal'
Cc: Le, Bao; Devine, John; seboyd@tid.org
Subject: RE: Follow up on offer to help

Hi John,
Thank you for taking up this action item so quickly and your offer to reach out to the Science Center's lead for the data processing. Bao Le has noted that you and he have discussed this subject matter and a possible path forward. I understand that HDR i) is currently evaluating team resources to identify who is capable and available to be involved in this work, ii) has not yet identified a timeline for when the data would be of most value for planning field studies but they agree that it's likely in the next month to month and a half, and iii) is discussing needs with each study lead to better understand circumstances and possible benefits from this work.

To help HDR in their evaluation, would it be possible to have the Science Center's lead provide a more detailed summary update of the dataset, its size, and the objective of the imaging process along with its current status?

As this is specialized work, please directly contact Bao for detailed discussions concerning these matters.

Thanks,
Greg

From: John Wooster - NOAA Federal [mailto:john.wooster@noaa.gov]
Sent: Monday, May 23, 2016 12:35 PM
To: Greg Dias
Cc: Le, Bao; Devine, John; seboyd@tid.org
Subject: Follow up on offer to help

Hi Greg:

Thank you for your offer at last week's meeting to help out with processing the hyperspectral imaging. The Science Center lead for the Project returns to the office today, so I am going to reach out to him this afternoon to see when we can discuss further. I wanted to follow up with you and Steve to see if you had any additional information you might want to give me before I present the idea to the Science Center (probably sometime tomorrow).....

I know that information needs to be completed for you in a timely enough manner to help you this summer. Any additional timeline information you could provide would be useful. As far as I can tell, you are trying to get into the field as soon as flows drop enough, which seems likely to be in late June early July. But I also think you want the data before then to maybe help pick study sites...

A primary question that comes to my mind is, do you have a definite idea of where the additional work/help would take place? In other words, are you thinking that there would be a transition of all the workflow (images, computer code, whatever else is needed, etc) to a different location (such as a District office, or a consultant's office) or are you thinking of trying to get someone to work onsite in Lee's lab to work alongside him? Lee works out a research center / office on the UC Santa Barbara campus.

Regards,

John

--
John Wooster
Hydrologist
NOAA Fisheries West Coast Region
U.S. Department of Commerce
john.wooster@noaa.gov

From: Reba Fuller [mailto:rfuller@mewuk.com]
Sent: Tuesday, May 03, 2016 6:23 AM
To: Risse, Danielle
Subject: Ethnographer

Greetings Danielle, Dottie is a mentor to me, she and I worked on a NAGPRA Project and she is great. So my recommendation would be Dorothea Theodoratus. In my opinion the others can't hold a candle to her! When do you expect to start survey? It appears that we'll have another busy summer, R

From: Risse, Danielle
Sent: Monday, May 02, 2016 3:16 PM
To: 'rfuller@mewuk.com'; 'nayala@tcouncil.com'; 'mmotola@chukchansitribe.net'; 'mmotola@chukchansi-nsn.gov'; 'Miwuk43_1@hotmail.com'; 'tmtc@mlode.com'; 'vstone@mewuk.com'; 'mralston@CRTribal.com'; 'denean@buenavistatribe.com'; 'roselynn@buenavistatribe.com'; 'rhonda@buenavistatribe.com'; 'dmiwuk@aol.com'; 'office@cvmt.net'; 'canutes@verison.net'; 'chairman@tulerivertribe-nsn.gov'; 'neil.peyron@tulerivertribe-nsn.gov'; 'Darrel.cruz@washoetribe.us'
Cc: Boyd, Steve; Greg Dias (Greg.Dias@mid.org); Anna Brathwaite (Anna.Brathwaite@mid.org); Borovansky, Jenna; Devine, John (John.Devine@hdrinc.com); Deason, Jesse; Mackey, Monica; 'Godwin, Arthur F'; 'William Paris (bparis@olaughlinparis.com)'
Subject: La Grange Hydroelectric Project FERC Licensing, Cultural Resources Study - Ethnographer Selection

La Grange Hydroelectric Project FERC Licensing – TCP Investigation and Ethnographer Selection

The Turlock Irrigation District and Modesto Irrigation District (collectively, the Districts) own the La Grange Hydroelectric Project (the Project) located on the Tuolumne River in Stanislaus County, California. The Districts are preparing an application for federal license with the Federal Energy Regulatory Commission (FERC) for the Project.

HDR Engineering, Inc. (HDR) has been contracted by the Districts to help them with licensing the Project with FERC. The Cultural Resources Study to be implemented by HDR as part of licensing efforts includes a Traditional Cultural Properties (TCP) investigation to be completed in partial compliance with Section 106 of the National Historic Preservation Act. This email serves as the Districts' effort to coordinate with Native American tribal participants to select an ethnographer for the TCP investigation.

Attached for your review are resumes from the prospective ethnographers. Please note that the Whiteman, McBride, and Theodoratus resumes represent a team under a company called Northwest Cultural Resource Consultants (the company statement of qualifications is also attached). Clinton Blount and Giorgio Curti are individual ethnographers.

Please review these resumes and provide feedback no later than **Friday, May 16, 2016** so that the Districts can take your input into advisement for selecting an ethnographer for the TCP investigation. Any feedback you wish to provide should be sent to Danielle Risse, HDR Senior Cultural Resources Specialist, at Danielle.Risse@hdrinc.com, or at 2379 Gateway Oaks Drive, Suite 200, Sacramento, Ca 95833.

If you have questions or would like additional information regarding this communication, please contact Danielle Risse of HDR Engineering, Inc., at (916) 679-8796. We look forward to working with you throughout the La Grange Hydroelectric Project FERC licensing process.

This email was sent on behalf of the Districts by:

Danielle Risse, M.A.
Senior Cultural Resources Specialist, Hydropower Services

HDR
2379 Gateway Oaks Drive, Suite 200
Sacramento, CA 95833
D 916-679-8796 **M** 916-679-8700
danielle.risse@hdrinc.com

hdrinc.com/follow-us

From: Staples, Rose
Sent: Wednesday, May 25, 2016 6:22 AM
To: John Buckley
Subject: RE: FERC meetings

You are correct!

1. No meeting scheduled for Thursday May 26th.
2. The next scheduled session is the DPRSG session on June 9th.

Thank you for checking.

Rose Staples, CAP-OM, MOS
D 207-239-3857

hdrinc.com/follow-us

From: John Buckley [mailto:johnb@cserc.org]
Sent: Tuesday, May 24, 2016 7:09 PM
To: Staples, Rose
Subject: Re: FERC meetings

Rose:

At one point I penciled in a possible TID/MID FERC meeting for this coming Thursday (May 26th), but I see no notice of any scheduled meeting.

Am I correct that the next scheduled session is a DPRSG negotiation session on June 9th, and nothing prior to that time for the Don Pedro/LaGrange FERC process?

John Buckley
CSERC
johnb@cserc.org

On May 17, 2016, at 6:14 PM, Staples, Rose <Rose.Staples@hdrinc.com> wrote:

Draft study plans referenced can be viewed and downloaded from the DOCUMENTS section of the La Grange licensing website www.lagrange-licensing.com.

<image002.jpg>

Rose Staples, CAP-OM, MOS
Executive Assistant

HDR
970 Baxter Boulevard Suite 301
Portland ME 04103
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PHONE CALL MEMORANDUM

Topic	Districts' offer to provide technical assistance processing bathymetry data
Date	May 25, 2016
From	Mr. John Wooster (National Marine Fisheries Service [NMFS])
To	Mr. Bao Le (HDR)
Summary of Discussion	Mr. Wooster called Mr. Le to discuss the Districts' offer to provide assistance with processing data for the NMFS Upper Tuolumne Habitat and Carrying Capacity Study. Mr. Wooster said he discussed the Districts' offer with the NMFS study team working on the study. Mr. Wooster said if the Districts provided a staff person to assist on the study, the study team would want to ensure this person has the right qualifications. In addition, the staff person would be required to work on-site with the study team at UC Santa Barbara. Mr. Wooster said given that the staff person would first need to be brought up to speed and perhaps trained, and there is quite a bit of data to process, the assignment could last for several months. Mr. Wooster said the NMFS study team was amenable to providing the hyperspectral data to the Districts, if the Districts provided a hard drive on which to load the data. Mr. Le thanked Mr. Wooster for the call and said he would relay this information to the Districts.

From: Staples, Rose
Sent: Friday, May 27, 2016 8:19 AM
To: 'Buckley, John'
Subject: Response to La Grange ISR Meeting Query Regarding Cherry Creek Flows During Study Fieldwork

During the La Grange Project Initial Study Report meeting held on February 25, 2016, you asked what the flows in Cherry Creek were when the *Upper Tuolumne River Basin Fish Migration Barriers Study* Cherry Creek fieldwork was completed. Following the meeting, the Districts confirmed that flows in Cherry Creek during the fieldwork were approximately 13 cfs as recorded by USGS Gage 11278300.

Rose Staples, CAP-OM, MOS
Executive Assistant

HDR
970 Baxter Boulevard Suite 301
Portland ME 04103
D 207-239-3857
rose.staples@hdrinc.com

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From: John Buckley [mailto:johnb@cserc.org]
Sent: Friday, May 27, 2016 11:23 AM
To: Staples, Rose
Subject: Re: Response to La Grange ISR Meeting Query Regarding Cherry Creek Flows During Study Fieldwork

Thanks… surprisingly low flow level, but unlikely to alter the outcome of the study…

John
CSERC

On May 27, 2016, at 8:19 AM, Staples, Rose <Rose.Staples@hdrinc.com> wrote:

During the La Grange Project Initial Study Report meeting held on February 25, 2016, you asked what the flows in Cherry Creek were when the *Upper Tuolumne River Basin Fish Migration Barriers Study* Cherry Creek fieldwork was completed. Following the meeting, the Districts confirmed that flows in Cherry Creek during the fieldwork were approximately 13 cfs as recorded by USGS Gage 11278300.

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Executive Assistant

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rose.staples@hdrinc.com

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From: Staples, Rose
Sent: Friday, May 27, 2016 8:51 AM
Cc: Deason, Jesse; Le, Bao; Staples, Rose
Subject: FW: Response to La Grange ISR Meeting Query Regarding Cherry Creek Flows During Study Fieldwork

The Districts have responded today to John Buckley's question from the February 2016 La Grange Initial Study Report (ISR) Meeting with the following emailed message.

Rose Staples, CAP-OM, MOS
D 207-239-3857

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From: Staples, Rose
Sent: Friday, May 27, 2016 11:19 AM
To: 'Buckley, John'
Subject: Response to La Grange ISR Meeting Query Regarding Cherry Creek Flows During Study Fieldwork

During the La Grange Project Initial Study Report meeting held on February 25, 2016, you asked what the flows in Cherry Creek were when the *Upper Tuolumne River Basin Fish Migration Barriers Study* Cherry Creek fieldwork was completed. Following the meeting, the Districts confirmed that flows in Cherry Creek during the fieldwork were approximately 13 cfs as recorded by USGS Gage 11278300.

Rose Staples, CAP-OM, MOS
Executive Assistant

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From: Le, Bao
Sent: Friday, May 27, 2016 9:27 AM
To: John Wooster - NOAA Federal
Cc: Devine, John; Prescott, Thomas; Olden, Randy; Deason, Jesse; Borovansky, Jenna
Subject: RE: hyperspectral data request

Will do. We'll send a 1 TB hard drive to the address below and ensure that there is return postage (not a worry, I remember these challenges). I think it would be prudent to have imagery for the tribs as well. We can likely have something in the mail next week.

Thanks again, Bao

From: John Wooster - NOAA Federal [mailto:john.wooster@noaa.gov]
Sent: Friday, May 27, 2016 9:23 AM
To: Le, Bao
Cc: Devine, John; Prescott, Thomas; Olden, Randy; Deason, Jesse; Borovansky, Jenna
Subject: Re: hyperspectral data requested

Bao:

Please send the hard drive to Lee at the address below, as well as some kind of prepaid means to get the hard drive back to you (sorry, the amount of time and layers of people it takes for a government employee to deal with billing even a $10 charge is just too burdensome)....

Also please confirm that you want images for all the tribs (Clavey, Cherry, Eleanor, etc...), I suspect you do, but if not, don't want to spend the time.

Lee Harrison
Earth Research Institute
6716 Ellison Hall
University of California
Santa Barbara, CA 93106
Phone: 805.407.2632

Regards,

John

On Fri, May 27, 2016 at 8:48 AM, Le, Bao <ChiBao.Le@hdrinc.com> wrote:

Hi John.

Thanks for taking time to discuss hyperspectral data needs and possibilities earlier this week. Regarding my two action items:

1. We continue to discuss resources and availability of technical staff to assist Lee with hyperspectral data processing to bathymetry. Not much to share here yet but I'll circle back when discussions progress and I know more.

2.   Per your offer, we would like to acquire the hyperspectral data from Lee to see if it has value in supporting the 2016 field planning effort As discussed, we can send Lee a hard drive so that he can load up data and any other necessary files. If you could facilitate this and provide us the address, requirements, etc., that would be great. I've cc'd both Randy Olden (GIS manager in Sacramento) and Tom Prescott (LiDAR Program Coordinator) and will work with both of them to figure out where the data should be sent.

Let me know if you have any questions.

Bao

Bao Le

Senior Fisheries Biologist

HDR

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--
John Wooster
Hydrologist
NOAA Fisheries West Coast Region
U.S. Department of Commerce
john.wooster@noaa.gov

From: Le, Bao
Sent: Thursday, June 02, 2016 3:08 PM
To: Tucker Selko
Cc: Warnock, Cory; Borovansky, Jenna; Deason, Jesse
Subject: RE: NMFS LiDAR and hyspectral imagery - questions

Hi Tucker.

Just following upon this last email.

Let me know if you have any questions.

Thanks, Bao

From: Le, Bao
Sent: Wednesday, May 25, 2016 8:35 AM
To: 'Tucker Selko'
Cc: Warnock, Cory; Borovansky, Jenna; Olden, Randy; Prescott, Thomas; 'Devine, John'
Subject: RE: NMFS LiDAR and hyspectral imagery - questions

Hi Tucker.

Attached are our questions regarding the LiDAR/hyperspectral information. Note that there are a few questions that lead into the actual analysis of the data. We were not sure where your activities ended and NMFS' activities began so we figured it safer to include these as a discussion item. Please take some time to look them over and let me know your availability for a quick call next week.

Thanks again for your assistance,
Bao

From: Tucker Selko [mailto:tselko@quantumspatial.com]
Sent: Tuesday, May 17, 2016 2:20 PM
To: Le, Bao
Cc: Warnock, Cory; Borovansky, Jenna
Subject: Re: NMFS LiDAR and hyspectral imagery - questions

Hi, Bao. Thank you for reaching out to me on this.

I can certainly put you in touch with the right people to address your questions. Please do send a list of questions. I can use this list to determine who the right folks are.

All the best,

On Tue, May 17, 2016 at 11:28 AM, Le, Bao <ChiBao.Le@hdrinc.com> wrote:

Hi Tucker.

My name is Bao Le and I've been in contact with John Wooster at NMFS regarding imagery that you flew for them on the Merced and Tuolumne rivers. We're using this LiDAR to inform some additional studies we'll be conducting in the reach this summer and we had a few questions related to the information. We asked John and the Science Center if it would be ok to make contact with our questions and he provided your contact information. Would you be available for a quick call in the next couple of weeks to talk through a few questions we have? We could send our list of questions in advance of the call also. Please let me know.

Thanks, Bao

Bao Le

Senior Fisheries Biologist

HDR

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--
Tucker Selko MS PMP
Project Manager
Quantum Spatial Corvallis
517 SW 2nd Street, Suite 400, Corvallis, OR 97333
P: (541) 752-1204

LiDAR/Hyperspectral Data Questions for Quantum Spatial:

1. The technical report that accompanies the data is general (weekly) with regards to flight times of the Tuolumne and Merced rivers. Is it possible to get the exact flight dates/times for the different reaches of the Tuolumne River?
2. Were ground measurements collected concurrent with or close to the time of the aerial data collection? If so, do you know at what frequency?
3. Was a flat field correction adequate for this study? Why was the empirical line method not used?
4. Did riffles or river turbulence present challenges or special adjustments in order to penetrate the water surface and obtain bathymetry data?
5. What is the expected accuracy of bathymetric data? Would accuracy vary with hydraulic condition of the river (pool, glide, riffle, cascade)?
6. Was there glint in the data and if so how was this dealt with?
7. Was it possible to clearly distinguish sediment sizes in riffles?

From: John Wooster - NOAA Federal <john.wooster@noaa.gov>
Sent: Friday, June 03, 2016 10:07 AM
To: Le, Bao
Cc: Borovansky, Jenna; Deason, Jesse; Devine, John
Subject: Re: 5/19 Plenary Group Meeting Action Item

The sediment pictures do not have any direct link to the hyperspec images. The hyperspec images are only being used to produce the bathymetry in the channel.

The sediment pictures, once processed, were intended to give kind of a river longitudinal characterization of the size distribution of sediment deposits.

We had discussed potentially building a sediment transport model, which would use the size distributions from the pictures for calibration, and any model would be built off of LiDAR/hyperspec derived channel geometry. While I have not had any discussion about this in a long time, I am fairly certain this idea is a long ways off, if at all at this point. First and foremost priority is to get the bathymetry done.

-John

On Fri, Jun 3, 2016 at 9:51 AM, Le, Bao <ChiBao.Le@hdrinc.com> wrote:

Thanks, John.

Were these pictures taken at all of the ground truthed locations? My presumption is that these pictures were used to help validate the hyperspectral/LiDAR for use in the habitat mapping exercise. Is that true? Jay Stallman would like to try and use these data to compliment his spawning gravel study field planning but we're trying to figure out whether the hyperspectral data, either as is or processed in some manner, would be valuable to support that.

From: John Wooster - NOAA Federal [mailto:john.wooster@noaa.gov]
Sent: Friday, June 03, 2016 9:45 AM
To: Le, Bao
Cc: Borovansky, Jenna; Deason, Jesse; Devine, John
Subject: Re: 5/19 Plenary Group Meeting Action Item

Bao:

During the meeting it seemed to complicated to go into detail about what the pictures we took look like. So I am attaching an example now (this isn't from the Tuolumne), as you will see the photos aren't obliques that will give you much perspective, but rather zoomed in planform sub-samples of various substrate patches. The photos are designed to be used as input into computer automated measurement routines that can process images into grain size distributions.

Take a look at the photo and gauge your interest. Also, see my other email about your other request, and then let's reconvene, so I can have a comprehensive list of what to ask the Science Center for.

-John

On Thu, Jun 2, 2016 at 12:50 PM, Le, Bao <ChiBao.Le@hdrinc.com> wrote:

Hi John.

I wanted to follow up on an action item regarding the photographs taken from suspended cameras during the August 2014 field work. Per discussions at the meeting, we concluded that these could be helpful for study planning. Are you able to check on what exists and if it could be made available to the study team?

On another note, Tom Prescott (HDR) has provided a 3TB hard drive to Lee Harrison so hopefully that data transfer is in progress or near complete. Also, we continue to try and assess availability of qualified staff for a detail to assist Lee. Stay tuned.

Thanks, Bao

Bao Le

Senior Fisheries Biologist

HDR

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--

John Wooster
Hydrologist
NOAA Fisheries West Coast Region
U.S. Department of Commerce
john.wooster@noaa.gov

From: Le, Bao
Sent: Friday, June 03, 2016 10:10 AM
To: John Wooster - NOAA Federal
Cc: Warnock, Cory; Deason, Jesse
Subject: RE: NMFS LiDAR - Ground Truth Information

Yep. I'll do that shortly. Thanks.

From: John Wooster - NOAA Federal [mailto:john.wooster@noaa.gov]
Sent: Friday, June 03, 2016 10:09 AM
To: Le, Bao
Cc: Warnock, Cory; Deason, Jesse
Subject: Re: NMFS LiDAR - Ground Truth Information

Confirmed for 1 PM, I'll assume you'll provide a call-in #.

-John

On Fri, Jun 3, 2016 at 9:57 AM, Le, Bao <ChiBao.Le@hdrinc.com> wrote:

Can we do 1pm? I'll set up a brief call. I'd like to include our hyperspectral guy so he can explain what he's thinking as that would be more productive than me as the messenger. Thanks.

From: John Wooster - NOAA Federal [mailto:john.wooster@noaa.gov]
Sent: Friday, June 03, 2016 9:47 AM
To: Le, Bao
Cc: Warnock, Cory; Deason, Jesse
Subject: Re: NMFS LiDAR - Ground Truth Information

Fairly open from 11 to 2....

On Fri, Jun 3, 2016 at 9:40 AM, Le, Bao <ChiBao.Le@hdrinc.com> wrote:

What's your availability today?

From: John Wooster - NOAA Federal [mailto:john.wooster@noaa.gov]
Sent: Friday, June 03, 2016 9:33 AM
To: Le, Bao
Cc: Warnock, Cory; Deason, Jesse
Subject: Re: NMFS LiDAR - Ground Truth Information

Hmmm, I think we might have some confusion of terms here. You aren't going to be able to do anything with the hyperspec images other than use them as images, so I think we should chat on the phone so I can understand exactly what you want to do and which data you might need for it.

John

On Fri, Jun 3, 2016 at 9:05 AM, Le, Bao <ChiBao.Le@hdrinc.com> wrote:

Hi John.

In order to process the hyperspectral data to support the spawning gravel study field planning effort, it'd be great if we could get the ground truthing data to build our substrate correlations for the outputs. Do you know if that is being sent with the hyperspectral data Lee is sending? If not, can you provide? Please advise.

Thanks,

Bao

Bao Le

Senior Fisheries Biologist

HDR

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Portland, OR 97204-1134
D 971.202.1722 **M** 503.309.9423
bao.le@hdrinc.com

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--

John Wooster
Hydrologist
NOAA Fisheries West Coast Region
U.S. Department of Commerce

--

John Wooster
Hydrologist
NOAA Fisheries West Coast Region
U.S. Department of Commerce
john.wooster@noaa.gov

From: Le, Bao
Sent: Friday, June 03, 2016 4:44 PM
To: dfoote@fs.fed.us; Vaughn, Gary D -FS; Holdeman, Steven J -FS
Cc: jeicher@blm.gov; Borovansky, Jenna; Deason, Jesse; Warnock, Cory; Neal, Morgan
Subject: Upper Tuolumne River 2016 New Studies - Permit Application
Attachments: Attachment A__SF 299_Upper TR 2016 Studies.pdf; Attachment B_StudyPlans.pdf; USFS SF-299 Permit Application Upper TR Studies 2016.pdf

Hi Debbie,

Please find attached our final programmatic permit application for the 2016 Upper Tuolumne River studies. Based upon updated flow information our schedule for conducting the majority of study activities has shifted to later in the summer (July and August) versus mid-June as originally planned. The attached permit application has been revised based upon planning activities over the last few weeks and represents our current best assessment of timing of activities. That said, these studies are reliant on flows being conducive to quality data collection and as such may need to shift slightly as we move forward. Similar to last year, we will keep you in the loop regarding deviations from the proposed schedule in addition to providing advanced notice of any permitted field work. The first planned field effort will be the last week of June so hopefully the permitting process can accommodate this schedule. Please let me know if you have any questions during your review.

Per our discussion today, I will coordinate with Dusty regarding possible modifications/amendments to our existing temperature study and barrier study permits while you are on leave. Now that are new studies permit application has been submitted, we'll quickly turn our attention to amending these permits.

Jim, I've cc'd you to keep you in the loop. I look forward to discussing BLM permitting needs and approvals in the near future.

Thank you again for your assistance and support. It's very much appreciated.

Bao

Bao Le
Senior Fisheries Biologist

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STANDARD FORM 299 (6/99)
Prescribed by DOI/USDA/DOT
P.L. 96-487 and Federal
Register Notice 5-22-95

APPLICATION FOR TRANSPORTATION AND UTILITY SYSTEMS AND FACILITIES ON FEDERAL LANDS

FORM APPROVED
OMB NO. 0596-0082

FOR AGENCY USE ONLY
Application Number

Date Filed

NOTE: Before completing and filing the application, the applicant should completely review this package and schedule a preapplication meeting with representatives of the agency responsible for processing the application. Each agency may have specific and unique requirements to be met in preparing and processing the application. Many times, with the help of the agency representative, the application can be completed at the preapplication meeting.

1. Name and address of applicant *(include zip code)*
Turlock Irrigation District
Modesto Irrigation District
(Attachment A)

2. Name, title, and address of authorized agent if different from item 1 *(include zip code)*
HDR
2379 Gateway Oaks Dr #200
Sacramento,CA 95835

3. Telephone (area code)
Applicant
209-883-8364
Authorized Agent
971-202-1722

4. As applicant are you? *(check one)*
a. ☐ Individual
b. ☐ Corporation*
c. ☐ Partnership/Association*
d. ☐ State Government/State Agency
e. ☒ Local Government
f. ☐ Federal Agency

* *If checked, complete supplemental page*

5. Specify what application is for: *(check one)*
a. ☒ New authorization
b. ☐ Renewing existing authorization No.
c. ☐ Amend existing authorization No.
d. ☐ Assign existing authorization No.
e. ☐ Existing use for which no authorization has been received *
f. ☐ Other*

* *If checked, provide details under item 7*

6. If an individual, or partnership are you a citizen(s) of the United States? ☐ Yes ☐ No

7. Project description (describe in detail): (a) Type of system or facility, *(e.g., canal, pipeline, road);* (b) related structures and facilities; (c) physical specifications *(Length, width, grading, etc.*); (d) term of years needed: (e) time of year of use or operation; (f) Volume or amount of product to be transported; (g) duration and timing of construction; and (h) temporary work areas needed for construction *(Attach additional sheets, if additional space is needed.)*

As part of the La Grange Hydroelectric licensing, Turlock and Modesto Irrigation Districts and their consultant, HDR Inc. propose several boat based studies on the Tuolumne River within the Stanislaus National Forest. See Attachment A for study summaries and Attachment B for detailed study plans.

8. Attach a map covering area and show location of project proposal

9. State or Local government approval: ☒ Attached ☐ Applied for ☒ Not Required

10. Nonreturnable application fee: ☐ Attached ☐ Not required

11. Does project cross international boundary or affect international waterways? ☐ Yes ☒ No *(if "yes," indicate on map)*

12. Give statement of your technical and financial capability to construct, operate, maintain, and terminate system for which authorization is being requested.

The Districts have hired qualified biologists to help them execute each study they have proposed to complete. Consultant biologists have completed similar fisheries habitat studies in the Merced, lower Tuolumne, Stanislaus, and Yuba Rivers, in addition to various coastal California streams. Study leads have extensive expertise in conducting habitat mapping, substrate mapping, invertebrate sampling, and instream flow assessments in various riverine environments.

13a. Describe other reasonable alternative routes and modes considered.

No other reasonable alternative routes exist that allow for the completion of the study objectives. The rugged terrain and limited access points demand the use of whitewater boat transportation.

b. Why were these alternatives not selected?

n/a

c. Give explanation as to why it is necessary to cross Federal Lands.

The study sites are located within the Stanislaus National Forest (SNF). Travel onto the SNF will be on established roadways and within the upper Tuolumne River Watershed.

14. List authorizations and pending applications filed for similar projects which may provide information to the authorizing agency. *(Specify number, date, code, or name)*

Authorization ID: GRO1122 and GRO 1128

15. Provide statement of need for project, including the economic feasibility and items such as: (a) cost of proposal (construction, operation, and

maintenance); (b) estimated cost of next best alternative; and (c) expected public benefits.

This work is part of the FERC Licensing of the La Grange Hydroelectric Project. Information resulting from the proposed studies will be used to help assess the potential for Chinook salmon and steelhead reintroduction to the upper Tuolumne River basin. Refer to Attachment A for additional information.

16. Describe probable effects on the population in the area, including the social and economic aspects, and the rural lifestyles.

The proposed studies would not have any reasonable foreseeable impacts on the local population. All measurements will be taken with hand held equipment. Overnight camping will occur at locations along the upper Tuolumne River that are not located adjcent to established camping areas.

17. Describe likely environmental effects that the proposed project will have on: (a) air quality; (b) visual impact; (c) surface and ground water quality and quantity; (d) the control or structural change on any stream or other body of water; (e) existing noise levels; and (f) the surface of the land, including vegetation, permafrost, soil, and soil stability.

This project will not result in substantial effects on the local environment. See Attachment A for more detail.

18. Describe the probable effects that the proposed project will have on (a) populations of fish, plantlife, wildlife, and marine life, including threatened and endangered species; and (b) marine mammals, including hunting, capturing, collecting, or killing these animals.

The proposed studies are not anticipated to have substantial effects on the local flora or fauna. Refer to Attachment A for additional detail.

19. State whether any hazardous material, as defined in this paragraph, will be used, produced, transported or stored on or within the right-of-way or any of the right-of-way facilities, or used in the construction, operation, maintenance or termination of the right-of-way or any of its facilities. "Hazardous material" means any substance, pollutant or contaminant that is listed as hazardous under the Comprehensive Environmental Response, Compensation, and Liability Act of 1980, as amended, 42 U.S.C. 9601 et seq., and its regulations. The definition of hazardous substances under CERCLA includes any "hazardous waste" as defined in the Resource Conservation and Recovery Act of 1976 (RCRA), as amended, 42 U.S.C. 6901 et seq., and its regulations. The term hazardous materials also includes any nuclear or byproduct material as defined by the Atomic Energy Act of 1954, as amended, 42 U.S.C. 2011 et seq. The term does not include petroleum, including crude oil or any fraction thereof that is not otherwise specifically listed or designated as a hazardous substance under CERCIA Section 101(14), 42 U.S.C. 9601(14), nor does the term include natural gas.

No hazardous materials will be produced, transported or stored during the course of the proposed studies.

20. Name all the Department(s)/Agency(ies) where this application is being filed.

Stanislaus National Forest, USFS.

I HEREBY CERTIFY, That I am of legal age and authorized to do business in the State and that I have personally examined the information contained in the application and believe that the information submitted is correct to the best of my knowledge.

Signature of Applicant	Date
Turlock Irrigation District Modesto Irrigation District	June 3, 2016

Title 18, U.S.C. Section 1001, makes it a crime for any person knowingly and willfully to make to any department or agency of the United States any false, fictitious, or fraudulent statements or representations as to any matter within its jurisdiction.

Attachment A for Forest Service SF-299
Filed by Turlock and Modesto Irrigation Districts
and HDR, Inc.
June 2, 2016

Names and Addresses of Applicants

Turlock Irrigation District
P.O. Box 949
Turlock, CA 95381-0949

Modesto Irrigation District
P.O. Box 4060
Modesto, CA 95352-4060

Project Description

The Turlock Irrigation District (TID) and Modesto Irrigation District (MID) (collectively, the Districts) own the La Grange Diversion Dam (LGDD) located on the Tuolumne River in Stanislaus County, California. Currently the Districts are working through the Federal Energy Regulatory Commission (FERC) licensing process with the end goal to file an application for a license. As part of the process the Districts, at the request of federal fish and wildlife agencies (NMFS, USFWS, and CDFW) have volunteered to complete a series of studies to evaluate ecological considerations related to the potential reintroduction of anadromous salmonids to the upper Tuolumne River.

Three primary studies are the subject of this permit: (1) Upper Tuolumne River Salmon and Steelhead Spawning Gravel Mapping; (2) Upper Tuolumne River Habitat Mapping and Macroinvertebrate Assessment; and (3) Upper Tuolumne River Instream Flow Study. These studies are described in more detail below. Complete study plans are included in **Attachment B** to this permit application. References for citations included in this Attachment also are included in Attachment B.

Draft Rafting Schedule and Staffing for Proposed Studies

1. Spawning Gravel Study
    - i. Schedule – 4 trips during study season
        1. 2-day float tentatively planned for the week of June 27th
        2. 7-day float tentatively planned for the week of July 18th
        3. 7-day float tentatively planned for the week of August 1st
        4. 5-day float tentatively planned for the week of August 22nd
    - ii. Total # of days on the river – 21
    - iii. Total # of rafts needed – 7 (1 for week of June 27th trip, and 2/trip for all other trips)

iv. Total # of staff/raft guides – 5-10 per trip

2. <u>Habitat Mapping and Macroinvertebrate Assessment</u>
    i. Schedule – 2 trips during study season
        1. 7-day float tentatively planned for the week of July 18th
        2. 5-day float tentatively planned for the week of July 25th
    ii. Total # of days on the river – 12
    iii. Total # of rafts needed – 4 (2/trip)
    iv. Total # of staff/raft guides – 5-10 per trip

3. <u>Instream Flow Study</u>
    i. Schedule – 3 trips during study season
        1. 7-day float tentatively planned for the week of August 15th
        2. 7-day float tentatively planned for the week of August 29th
        3. 7-day float tentatively planned for the week of August 29th
    ii. Total # of days on the river – 21
    iii. Total # of rafts needed – 15 (5/trip)
    iv. Total # of staff/raft guides – 10-15 per trip

Spawning Gravel Mapping

Goals and Objectives

The goal of this study is to assess the quantity and quality of spawning gravel for anadromous salmonids in the upper Tuolumne River. Study objectives include the following:

- Map the distribution of potentially suitable spawning substrate available for Central Valley spring-run Chinook salmon and Central Valley steelhead in the upper Tuolumne River;
- Assess the quality of potentially suitable spawning substrates based on substrate size characteristics, angularity/roundness, sorting, embeddedness, and permeability measured in a statistically representative sample of gravel patches; and
- Quantify the amount of potentially suitable spawning gravel.

Methods

The study area includes the approximately 26.5-mile reach of the mainstem Tuolumne River from Wards Ferry Bridge (RM 78.5) to Early Intake (RM 105) (**Figure 1**).

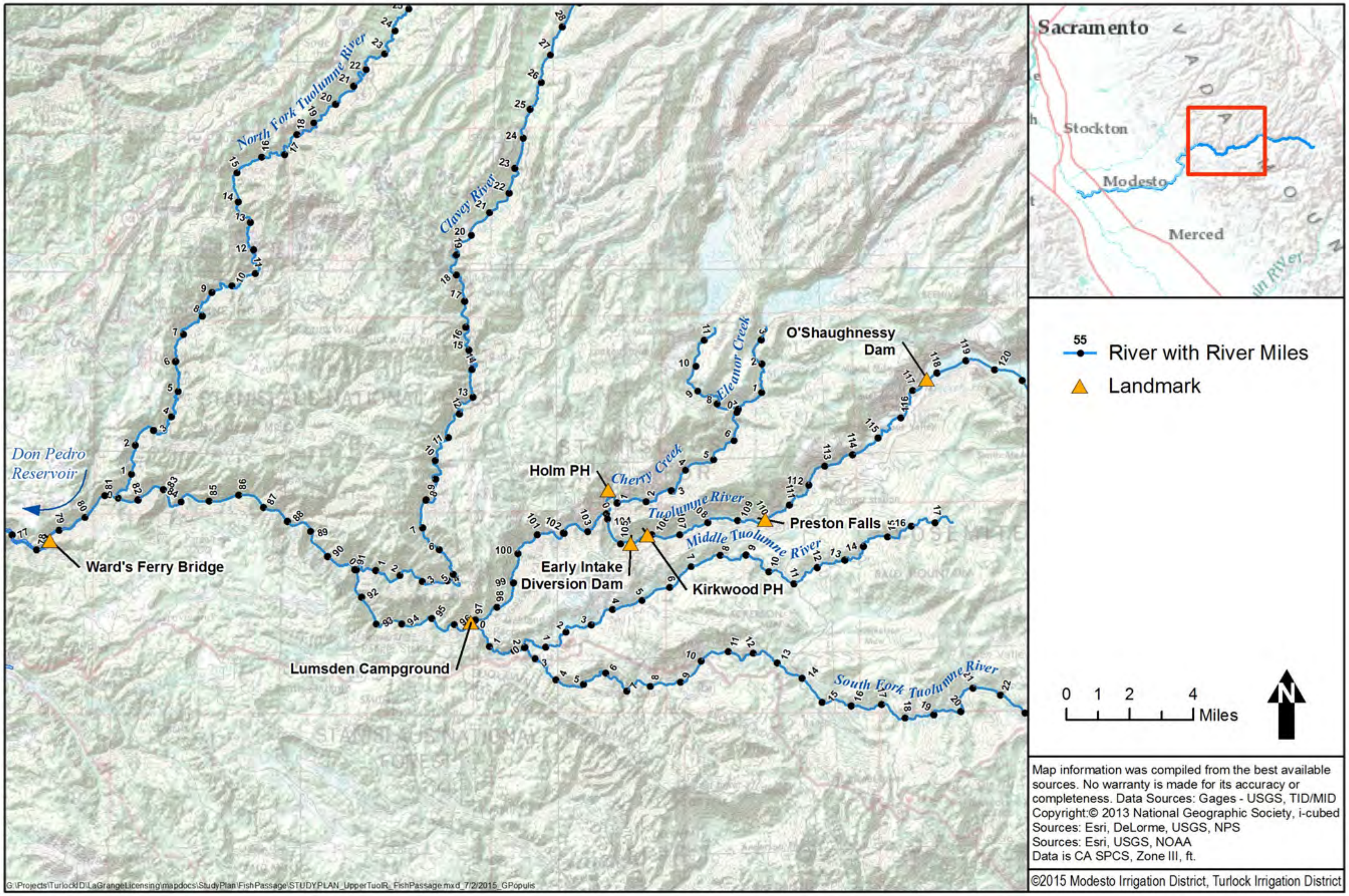

Figure 1. Overview map of the upper Tuolumne River Watershed with notable rivers, tributaries and features.

The spawning gravel study will include desktop activities to delineate gravel patches in a Geographic Information System (GIS) to inform field staff as to the approximate distribution of gravel deposits and the most efficient process for locating and mapping those deposits prior to entering the field. Field mapping criteria and protocols will be refined following this initial desktop analysis, as needed and in consultation with appropriate agency technical staff.

Potentially suitable spawning substrate patches will then be delineated in the field on map tiles, using high resolution orthorectified areal imagery (e.g., 8-13-2007 photography and mapbook) and preliminary gravel polygons from desktop mapping as the base. Field delineation of potentially suitable spawning substrate patches will be performed by a two-person crew using an inflatable raft to access the study reach. The crew will stop frequently to locate and investigate preliminary gravel polygons from desktop mapping and any other deposits that appear to meet the mapping criteria. Inflatable kayaks may also be used to navigate through unwadable map areas. To the extent possible, mapping will be performed during low flow conditions to optimize visibility of potentially suitable spawning substrates.

Species-specific spawning substrate size criteria (e.g., D_{50} particle size and other grain characteristics) will be developed prior to the field effort based on relevant values reported in the scientific literature. Wolman (1954) pebble counts will be conducted in selected areas using methods developed by Bunte and Abt (2001) to calibrate visual estimates of grain size parameters. Mapping criteria will also include a minimum "mappable" patch size.

In addition to the mapping criteria described above, characteristics informing spawning habitat quality will be collected for each patch. These will include parameters such as additional substrate size characteristics (e.g., D_{16}, D_{84}), angularity/roundness, sorting, and embeddedness. A qualitative scoring (1–10) for overall suitability will also be determined for each patch.

Substrate permeability will be collected at select patches to characterize incubation conditions and estimate predicted survival-to-emergence. Since collecting substrate permeability is labor intensive, and can be highly variable between and among patches, a sampling plan for the study reach will be developed based on the results of spawning gravel mapping effort. The sampling plan will outline an approach for characterizing the permeability of spawning gravel map units throughout the study reach, and provide field sampling protocols. Sampling locations will be determined, in part, by accessibility and field crew safety, and may be constrained by boat and crew safety considerations as determined by the commercial boatman.

Potentially suitable spawning substrate patches delineated on field tiles will be digitized using GIS, and area estimates for each patch will be calculated. The quantity and quality of potentially suitable spawning substrate patches will be summarized in tabular format.

Staffing and Schedule

The proposed spawning gravel study includes 4 rafting trips representing a total of 21 days on the river:

- 2-day float tentatively planned for the week of June 27th
- 7-day float tentatively planned for the week of July 18th

- 7-day float tentatively planned for the week of August 1st
- 5-day float tentatively planned for the week of August 22nd

Each proposed trip will include 5-10 field staff and commercial rafting guides.

Upper Tuolumne River Habitat Mapping and Macroinvertebrate Assessment

Habitat Mapping

Goals and Objectives

The goal of this study is to develop information on habitat distribution, abundance and quality in the upper Tuolumne River in order to inform the estimation of potential anadromous salmonid population size and development of fish passage engineering alternatives. Study objectives include the following:

- Document the number, size and distribution of mesohabitats available in the upper Tuolumne River;
- Collect detailed data on habitat attributes in representative reaches of the upper Tuolumne River;
- Document potential pool holding habitat for over-summering adult Chinook salmon; and

Methods

Habitat mapping will quantify the type, amount, and location of habitat types available to potentially reintroduced anadromous salmonids during their riverine life stages (adult holding/spawning, incubation and rearing). Habitat mapping will be conducted in the field and remotely using standardized methodologies. The frequency and area of each habitat type (e.g., pool, riffle, run) will be tabulated and where potential holding pools for adult Chinook occur, the size and depth of the pools will be measured to determine possible holding capacity. Additional mapping tasks will include assessments of channel gradient, width, habitat areas, etc. Habitat mapping will consist of mapping all mesohabitat units between Early Intake (RM 105) and the upstream limit of the Don Pedro Project (approximately RM 81), and collecting detailed habitat data in a sub-set of the mapped mesohabitat units.

Habitat units will be identified visually by a raft-based survey crew and mapped on pre-existing high resolution color aerial photographs. Boundaries of mesohabitat units will also be georeferenced in the field with a handheld GPS unit.

Mapped habitats will be digitized and added to the project GIS layer for mapping, as well as for quantitative and spatial analysis. Color maps will be created to depict the type and location of habitats throughout the study area and in relation to important features such as tributaries, potential passage barriers, access points, and water temperature monitoring locations. The frequency and area of each habitat type (e.g., pool, riffle, run) will also be tabulated.

Additional (remote) mapping tasks will include assessments of channel gradient, width, habitat areas, etc. following the CDFW Level III habitat typing methodology (CDFG 2010). Methods will be similar to habitat typing conducted in the lower Tuolumne River (TID/MID 2013). Sampling units selected for detailed habitat measurements will encompass approximately 10 to 20 percent of the study reach, as recommended in CDFG (2010). The habitat typing field effort will consist of a team of three biologists surveying the river by raft. The study area will be divided into seven sampling reaches, based on length of river rafted daily (two reaches from Early Intake to Lumsden and five reaches from Lumsden to Wards Ferry). Within each individual sampling reach, a one mile section will be randomly selected for habitat typing. Prior to the field assessment, the team will use maps and existing aerial photographs to delineate the specific reaches to be surveyed. Refer to Appendix B for the additional detail on the Habitat Mapping study.

<u>Macroinvertebrate Assessment</u>

Goals and Objectives

The goal of this study is to develop formation on macroinvertebrate prey resource availability in order to inform an evaluation of the factors affecting production and viability of an existing or introduced salmonid population. Study objectives include the following:

- Collect and analyze macroinvertebrate drift samples to determine whether the taxonomic composition and density of drift is consistent with other regional systems currently supporting healthy salmonid populations; and
- Collect and analyze benthic macroinvertebrate samples from the substrate to develop metrics for bioassessment and comparison with similar streams and data sets.

Methods

The study area for macroinvertebrate sampling within the upper mainstem of the Tuolumne River is from RM 81 to Lumsden Bridge (RM 98). The location and number of sampling sites and sampling frequency will represent the seasonal variability of macroinvertebrate populations and related seasonal variability of food resources for stream-dwelling salmonids during the primary salmonid rearing and growth period (spring-fall), as well as the variability of physical habitat characteristics in each study reach.

<u>Number of sites</u>
Depending on opportunities encountered during stream habitat mapping, drift and benthic macroinvertebrate samples will be collected at five sites, equating to approximately one site per 3.5 river miles.

Locations

Drift sampling will occur in the vicinity of Lumsden and at four additional downstream locations corresponding to locations selected for overnight camping during each five-day (four-night) rafting trip. Drift samples will be collected in riffle or run habitats selected opportunistically in the vicinity of overnight camping locations along each study reach. Benthic macroinvertebrate sampling will occur at suitable riffles initially identified in the office using aerial photographs and verified in the field. One composite sample will be collected daily from a suitable riffle or combination of suitable fast-water habitat types during the five-day raft-based sampling.

Macroinvertebrate sampling will be conducted daily during the five-day raft-based sampling effort. Drift sampling in late summer (September) will characterize food resources available to rearing juvenile anadromous salmonids prior to overwintering. Spring sampling may also occur if scheduling allows in conjunction with other field efforts.

Drift sampling will begin each afternoon by 1700 hours and proceed until approximately 2000 hours. Benthic macroinvertebrate samples will be collected once per day during the raftbased sampling effort, typically during mid-day or as determined by the location of suitable sampling riffles and logistics of the habitat mapping study.

Sampling Protocols

Drift samples will be collected using stationary nets with rigid rectangular openings and tapered, nylon mesh bags with a collection jar fitted at the downstream end – similar to drift nets used by other researchers (Brittain and Eikeland 1988), including the 1987–1988 drift studies in the lower Tuolumne River (Stillwater Sciences 2010). All drift nets will be identical, with a mesh size small enough to capture small invertebrates such as immature chironomids that may be important salmonid prey, while also large enough to minimize clogging (e.g., 250–500 μ). There is no standard mesh size for drift nets, with mesh size instead chosen according to study objectives, and to represent a compromise between filtration efficiency and clogging (Svendsen et al. 2004).

At each sampling location two transects will be selected perpendicular to the river and two drift nets will be placed at each transect: one near shore and one in the thalweg or as close to the thalweg as water depth and velocity will safely allow. Each drift net will be anchored in the water column using steel (e.g., rebar stakes or fence posts) driven into the stream bed, with the bottom of the net at least 10 cm above the river bottom and the top of the net at least 4–5 cm above the water surface. This vertical net placement ensures capture of terrestrial-origin organisms originating from outside the stream (Leung et al. 2009), which may be an important diet component for anadromous salmonids (Tiffan et al. 2014, Leung et al. 2009, Rundio and Lindley 2008) while avoiding capture of organisms crawling on the substrate. During sampling, the drift nets will be attended by one or more field crew members to monitor for approaching rafts or other safety hazards. If needed, field personnel will verbally warn rafters of the potential hazard and assist rafts in avoiding the nets.

Drift nets will be deployed for three hours each day (1700–2000 hours). The width and depth of the submerged portion of each net will be measured upon installation to calculate the effective net area (i.e., the area being sampled). Water velocity will be measured at the midpoint of each net mouth immediately after net installation, at the midpoint of sampling (after 1.5 hours), and immediately before retrieving the net.

After removing each drift net from the water, the contents will be carefully washed to the end of the net and into the collection bottle using river water. The bottle will then be removed and all contents will be transferred to a sample container, labeled, and preserved with 95% ethanol for later processing.

Benthic sampling will be conducted using a modified version of the targeted riffle composite (TRC) method described in the California State Water Resources Control Board Surface Water Ambient Monitoring Program (SWAMP) Bioassessment Standard Operating Procedure (Ode 2007).

Due to site access constraints and non-wadeability in most habitat types, a modified version of the SWAMP protocol will be used to select riffles or other suitable fast-water habitat types for TRC sampling. Whereas the SWAMP protocol specifies that habitats (riffles or other fast-water habitats) for TRC sampling should be selected randomly from a pre-established reach 250 meters in length, riffles sampled for this study will instead be selected randomly from among all potentially wadeable riffles that are accessed during the habitat mapping study and were initially identified in the office by examining high-resolution color aerial photographs of the study reaches. Using the office-based method, a total of five riffles will be selected for sampling.

In the field, riffles initially selected for benthic sampling will be evaluated individually as they are encountered during the rafting trip to determine whether substrate, depth, and velocity are suitable for sampling, and if they can be sampled safely. A riffle will be deemed suitable if it has enough gravel or cobble substrate to allow collection of up to eight non-overlapping benthic samples in areas that can be safely accessed on foot by a two-person field crew (i.e., depth and velocity do not prohibit safe access and sampling). If a riffle initially chosen for TRC sampling is unsuitable, the crew will proceed to the next suitable riffle. Ideally, a total of five riffles or other fast-water habitats will be sampled in the study reach using the TRC method. At each riffle selected for TRC sampling, physical habitat and water chemistry data will be collected following the SWAMP protocol for the “basic” level of effort (Ode 2007). These data include GPS coordinates and photographs of the site, water temperature, pH, dissolved oxygen, specific conductance, channel width, riparian canopy cover, bank stability, and channel gradient

The TRC approach specifies collection of benthic samples at eight riffles within each 250 meter sampling reach (Ode 2007). However, preliminary examination of aerial photographs indicates that the riffles in the upper Tuolumne River are relatively infrequent and widely spaced, thus selection of a 250 meter sampling reach containing multiple riffles will likely be infeasible. A modified approach will therefore be used, which will entail collection of eight benthic samples per riffle. If additional suitable riffles or other suitable fast-water habitat types (e.g., run or pool tail) are located in close proximity to a riffle that has been selected for TRC sampling and can be safely accessed on foot, the required eight samples will be collected at locations distributed randomly among the suitable habitats. Sampling locations in each riffle or combination of fast-water habitat types at each site will be selected randomly using a digital stopwatch or random number chart, as described in Ode (2007). Samples will be collected using a standard D-frame kick net with 500-µ mesh. At each sampling location, a 0.09 m^2 (1 ft^2) area of bottom substrate will be sampled immediately upstream of the net following methods described in Ode (2007). All eight samples collected at each site (riffle or combination of fast-water habitats) will be combined into a single composite sample for the site, preserved in 95% ethanol, and labeled for laboratory processing.

Staffing and Schedule

The proposed habitat mapping and invertebrate assessment study includes 2 rafting trips representing a total of 10 days on the river:

- 7-day float tentatively planned for the week of July 18th
- 5-day float tentatively planned for the week of July 25th

Each proposed trip will include 5-10 field staff and commercial rafting guides.

Instream Flow Study

Goals and Objectives

The goal of this study is to assess instream flow-related habitat conditions for anadromous salmonids in the upper Tuolumne River. Objectives of the study are to develop topographical and channel cover model input data, develop stage-discharge rating curves, and use modeling tools to develop weighted usable area relationships with flow.

Methods

The study area may include the approximately 26.5-mile reach of the mainstem Tuolumne River from Wards Ferry Bridge (RM 78.5) to Early Intake (RM 105) (Figure 1). Specific study sites will be defined based on results from the habitat-related studies being conducted during the summer of 2016. Three sites will be surveyed to develop information necessary to model weighted usable area for anadromous salmonids, as summarized below.

- Develop topographic surface, bed roughness, and channel cover model input data
- Create base computational mesh
- Develop upstream and downstream stage-discharge rating curves
- Compile WSE and depth/velocity validation data
- Create River2D input file for initial model runs. Model calibration and validation for two discharges (e.g. estimated to be approximately 200 cfs and 1200 cfs.)
- Model simulations
- Develop tabular and graphical WUA summary output from final model runs

Specific field data collection methodologies are described in Attachment B.

Staffing and Schedule

The proposed instream flow study includes 3 rafting trips representing a total of 21 days on the river:

- 7-day float tentatively planned for the week of August 15th
- 7-day float tentatively planned for the week of August 29th
- 7-day float tentatively planned for the week of August 29th

Each proposed trip will include 10-15 field staff and commercial rafting guides.

Safety Planning for All Proposed Studies

A safety plan will be completed by the Applicant's consultants for the proposed studies to ensure the safety of the field staff and other recreational rafters on the upper Tuolumne River during implementation of the field program. The plan will include standardized safety protocols that have been used by the Applicant's consultants in similar types of studies on rivers including the Tuolumne, Merced, Stanislaus and Yuba. The safety plan will include detailed information on daily "tailgate meetings", call in/call out and other communication procedures, water and boat safety, emergency protocols, and safety of other recreationists on the river. An approved safety plan will be on file prior to the start of the field program and relevant safety information will be in the possession of crews while conducting field work. In addition, all field staff will follow standard safety guidelines required by the commercial rafting guides.

Additional Information for Permit Application Questions

15.

The cost of proposed studies is minimal compared to the overall cost of the ongoing Licensing effort. The Districts have allotted sufficient funds for the completion of all studies involved in the Licensing effort. The purpose of these surveys is to characterize the extent and quality of the available habitat to anadromous salmonid species. Results of the proposed studies will provide valuable and essential ecological information related to the potential feasibility of reintroducing anadromous salmonids into the upper Tuolumne River Watershed. Results of the studies will be available to the public.

17.

The proposed studies are not anticipated to affect air quality, aesthetics, surface and ground water quality and quantity, the control on any stream or body of water, or surface of the land. Equipment to be used for this study does not create noise above that of normal hand held electronic appliances (i.e., laser range finders, GPS units, total stations, etc.). Elevated noise levels would be restricted to noise levels associated with commercial rafting-related operations.

Temporary instream equipment will be used for the spawning gravel and macroinvertebrate studies, but equipment will only be used at discrete sampling locations and will not be left in the water after completion of sampling activities. If needed, field personnel will verbally warn rafters of any potential hazards in the river and assist rafts in avoiding any instream equipment.

Installation of some pieces of equipment will be required in the mainstem upper Tuolumne River for the instream flow study, as described below.

Transducers will be temporarily installed in the upper Tuolumne River. A transducer housing will be attached to galvanized angle iron (2 inch x 2 inch, lengths not to exceed 36 inches) with hose clamps and bolted to bedrock or large boulders on the margins of the channel. Non-corrosive materials (galvanized or stainless) will be used to prevent any staining of the substrate. Removable plastic anchors requiring a small (5/16 of an inch or less) hole will be used to anchor the angle iron in order to minimize impacts of the installation. Transducers will be placed on the margin of the channel in discrete locations out of the normal view of downstream traffic to protect the aesthetic integrity of the site. All materials related to the installation will be removed upon completion of data collection.

At each of the three study sites, a minimum of three and maximum of six domed 2-inch monuments would be installed and would remain permanently. They will be installed in bedrock and require a ½ inch hole and epoxy to anchor them in place.

In order to minimize the potential for spreading aquatic invasive species during the course of all proposed studies, the California Department of Fish and Wildlife Aquatic Invasive Species Decontamination Protocol (https://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=43333) will be followed.

18.

The proposed studies are not anticipated to have any probable effects on populations of fish or wildlife. The macroinvertebrate sampling study will result in the disturbance and collection of a limited number of invertebrates at limited locations. However, standardized sampling protocols will be followed, and the study is not expected to have any notable effect on the macroinvertebrate community in the upper Tuolumne River. The results of the study will provide valuable and critical information related to the suitability of the upper Tuolumne River for potential anadromous fish reintroduction efforts, and study results will be made available to the public.

REVISED DRAFT STUDY PLAN

TURLOCK IRRIGATION DISTRICT
AND
MODESTO IRRIGATION DISTRICT

LA GRANGE HYDROELECTRIC PROJECT
FERC NO. 14581

Upper Tuolumne River Chinook Salmon and Steelhead Spawning Gravel Mapping Study

May 2016

1.0 BACKGROUND

As part of the La Grange Hydroelectric Project licensing proceeding, the Districts are undertaking the Fish Passage Facilities Alternatives Assessment (Fish Passage Assessment), the goal of which is to identify and develop concept-level alternatives for upstream and downstream passage of Chinook salmon and steelhead at the La Grange and Don Pedro dams. In September 2015, the Districts provided to licensing participants Technical Memorandum No. 1, which identified a number of information gaps critical to informing the biological and associated engineering basis of conceptual design for the Fish Passage Assessment. In November 2015, licensing participants adopted a plan to implement the Upper Tuolumne River Reintroduction Assessment Framework (Framework) intended to develop the information needed to undertake and complete the Fish Passage Assessment and to assess the overall feasibility of reintroducing anadromous salmonids into the upper Tuolumne River (TID/MID 2016). As part of implementing the Framework, a number of environmental studies are planned.

The Upper Tuolumne River Chinook Salmon and Steelhead Spawning Gravel Mapping Study is one of several studies to be implemented in 2016 in support of the Framework. Information collected during this study will be used to characterize the distribution, quantity, and quality of suitable Chinook salmon and steelhead spawning gravel in the upper Tuolumne River.

2.0 STUDY AREA

The study area for mapping Chinook salmon and steelhead spawning gravel in the upper Tuolumne River includes the approximately 24-mile reach from the upstream limit of the Don Pedro Project (approximately RM 81) to Early Intake (approximately RM 105).

3.0 STUDY GOALS

Successful Chinook salmon and steelhead spawning and fry production are dependent on the abundance and quality of suitable spawning gravel. Information on the amount, distribution, and quality of spawning gravel are critical components in estimating habitat carrying capacity and assessing limiting factors. Limited information is available to describe the distribution, quantity, and quality of spawning gravel in the upper Tuolumne River. The goal of this study is to characterize the distribution, quantity, and quality of suitable Chinook salmon and steelhead spawning gravel in the upper Tuolumne River.

The study objectives are:

- map the distribution of potentially suitable spawning gravel available for Chinook salmon and steelhead in the upper Tuolumne River;
- quantify the amount of suitable spawning gravel in the reach between RM 81 and RM 105; and
- assess the quality of potentially suitable spawning gravel based on gravel size characteristics, sorting, angularity, embeddedness, substrate depth, and permeability measured in a representative sample of gravel patches.

Study results will help inform the feasibility of introducing Chinook salmon and steelhead into the upper Tuolumne River.

4.0 STUDY METHODS

4.1 Spawning Gravel Mapping

Probable locations of gravel patches will initially be delineated in a Geographic Information System (GIS) using recent LIDAR, the best available aerial photography, and other existing information from prior mapping efforts and studies. This desktop mapping step will inform field staff as to the approximate distribution of gravel deposits and the most efficient logistical process for locating and mapping those deposits in the field. Field mapping criteria and protocols will be consistent with studies in the lower Tuolumne River (TID/MID 1992, 2013), and will be refined following this initial desktop analysis, as needed.

Potentially suitable spawning gravel patches will then be delineated in the field on map tiles from high resolution orthorectified aerial imagery (e.g., 8-13-2007 photography and mapbook). A laser range finder will be used to measure the approximate dimensions of each gravel patch, if necessary to support the delineation of patch areas on field tiles. Each patch will be assigned a unique ID. Field delineation of potentially suitable spawning gravel patches will be performed by a two-person crew using whitewater raft support to access the study reach. The crew will stop frequently to locate and investigate preliminary gravel polygons obtained from desktop mapping and any other deposits that appear to meet the mapping criteria. Inflatable kayaks may also be used to navigate unwadable areas requiring investigation. To the extent feasible, mapping will be performed during low or off-peak flow conditions to optimize visibility of potentially suitable spawning gravels. Supplemental access to limited portions of the study reach are available at vehicle road crossings and by foot, depending on terrain and river flow.

4.1.1 Gravel Particle Size Criteria

Species-specific particle size criteria that will be used to delineate potentially suitable spawning gravel for Chinook salmon and steelhead in the upper Tuolumne River study reach are summarized in Table 1.0. Patches with substantially different surface particle size characteristics will be separately delineated. Chinook salmon typically spawn in substrates with a D_{50} of 11–78 mm (0.42–3.0 in) (Platts et al. 1979, as cited in Kondolf and Wolman 1993, Chambers et al. 1954, 1955, as cited in Kondolf and Wolman 1993). Steelhead typically spawn in substrates with a D_{50} of 10–46 mm (0.4–1.8 in.) (Barnhart 1991, Kondolf and Wolman 1993). Wolman (1954) pebble counts will be conducted in selected areas to calibrate visual estimates of grain size parameters using methods developed by Bunte and Abt (2001). These preliminary particle size criteria, based on D_{50} reported in the literature, may be refined in coordination with the Technical Committee prior to the field effort.

4.1.2 Minimum Gravel Patch Size Criteria

Minimum patch size criteria for mapping potentially suitable spawning gravel will be determined prior to the field effort based on a combination of (1) the minimum area required for a spawning Chinook salmon or steelhead pair and (2) the scale and resolution of available imagery used as a base for field mapping tiles. The minimum spawning area generally identified for Chinook salmon is approximately 12 m^2 (Healy 1991, Bjorn and Reiser 1991, Ward and Kier 1999). Steelhead typically defend a redd only during the period of active spawning, and therefore the area required for a spawning steelhead pair is approximately equal to the disturbed area of the redd. . For mapping purposes, we will initially assume that a minimum patch size of approximately 6 m^2 is required for a steelhead pair to build and defend a redd (Bjornn and Reiser 1991; Orcutt et al. 1968). Preliminary minimum patch size criteria for mapping potentially suitable spawning gravel will be refined prior to field mapping based on review of available spawning patch information from the lower Tuolumne River and other relevant Central Valley river systems.

Table 1.0 Preliminary particle size and minimum patch size criteria for mapping potential spawning gravel for Chinook salmon and steelhead in the upper Tuolumne River.

Species	Gravel D_{50} mm (in.)	Minimum Patch Size Required for Spawning, m^2 (ft^2)	References
Chinook salmon	10–78 (0.4–3)	12 (130)	Platts et al. 1979, Chambers et al. 1954, 1955, all as cited in Kondolf and Wolman 1993; Healy 1991, Bjorn and Reiser 1991, Ward and Kier 1999
Steelhead	10–46 (0.4–2)	6 (65)	Barnhart 1991, Kondolf and Wolman 1993, Bjornn and Reiser 1991, Orcutt et al. 1968

Note: D_{50} – diameter of particle (in millimeters) at which 50 percent of the sample is smaller (*e.g.*, median).

4.2 Spawning Gravel Quality

In addition to the particle size and minimum patch size criteria described above, measurements and observations of the quality of gravel patches will be collected in the field to inform spawning habitat quality. These will include additional gravel particle size parameters (e.g., D_{16}, D_{84}); characterization of particle sorting, angularity, and embeddedness; an estimate of the average substrate depth (where feasible); and measurements of permeability.

4.2.1 Field Observations of Gravel Quality

Sorting describes the homogeneity of surficial particles within a patch. Spawning salmonids prefer substrates that are relatively well sorted. The degree of sorting will be visually estimated using the comparison chart in Compton (1985). Angular grains tend to pack more tightly than rounded particles and are more likely to slow intragravel flow. More loosely packed and rounded particles also increase a fish's ability to dislodge the substrate during redd construction. The degree of particle angularity within a patch will be visually estimated based on the comparison chart in Powers (1989). Substrate embeddedness describes the presence of fine sediment in the gravel interstices. Substrate embeddedness is measured by selecting a random sample of coarse surface particles within the patch and measuring the percent of the particle that is surrounded or buried by fine sediment (fines and sands <2 mm) (Burns and Edwards 1985). Embeddedness measurements will be conducted concurrent with pebble counts and/or during permeability sampling. The substrate depth required for redd construction and egg deposition likely depends on the size of the spawning female and on particle size characteristics, as well as flow depth and velocity. Chinook salmon egg pocket depths range from 8 to 51 cm (3 to 20 in), with an average of 22 cm (8.5 in) (Burner 1951). Steelhead egg pocket depths range from 15 to 28 cm (6 to 11 in), with an average of 21 cm (8.4 in) (Briggs 1953). Substrate depth will be estimated from exposure of bedrock and boulder framework and by probing with a Silvey rod.

4.2.2 Gravel Permeability

Gravel permeability will be collected to characterize incubation conditions and estimate predicted survival-to-emergence. The quality of spawning gravel will be assessed by measuring streambed permeability at select patches following the methods of Barnard and McBain (1994). Gravel inflow rate (ml/sec), which is an index of intragravel permeability (cm/hr), will be measured using a steel standpipe adapted from the Terhune Mark VI standpipe design (Terhume 1958; Barnard and McBain 1994). At select gravel patches, the standpipe will be driven into the gravel to an approximate depth of 30 cm (12 inches) using a protective end cap and sledge hammer. A battery powered peristaltic pump (e.g., IP Masterflex brand pump or equivalent) will be used to create a 2.5 cm head differential in the standpipe and the rate at which water is drawn from the pipe will be measured. While maintaining this constant pressure head, water will be drawn through the perforations in the standpipe buried in the gravel, and a stopwatch will be used to measure the time required to collect a volume of water.

Gravel permeability can be highly variable within and between patches in a reach. Therefore, a sampling plan will be developed based on the results of the spawning gravel mapping effort. The sampling plan will outline an approach and provide field protocols for characterizing the permeability of potential spawning patches throughout the study reach. The approach will generally rely on assigning patches to a morphologic unit (e.g., pool tail) and sampling from consistently similar positions within a morphologic unit. Sampling will occur in the morphological unit(s) that best exhibit the effects of fine sediment supply on spawning gravel quality and that have the highest potential value to spawning Chinook and steelhead. Permeability sampling results may be stratified by subreach, as appropriate. Desktop and field-based mapping of potentially suitable spawning gravel patches will inform an appropriate system for delineating morphological units, appropriate permeability sampling locations within those units, and appropriate delineation of any subreaches useful in extrapolating permeability sampling results.

4.2.3 Gravel Quality Ranking

When a gravel patch is identified as potentially suitable based on minimum area and particle size criteria, a qualitative ranking of overall suitability from 1 (poor) to 10 (good) will be assigned to the patch based on an overall assessment of the following physical characteristics (substrate particle size, sorting, angularity, embeddedness, gravel depth, permeability, and patch location and size). A separate ranking will be assigned for spawning gravel patches potentially suitable for Chinook salmon and steelhead. Although reliable rankings rely heavily on the professional judgment and personal experience of the survey participants, this ranking will allow comparison of patch quality. Rankings will be summarized as follows: 1–3= low suitability, 4–7= medium suitability, and 8–10= high suitability.

4.3 Data Processing and Analysis

Potentially suitable spawning gravel patches delineated on field tiles will be digitized using GIS, and area estimates for each patch will be calculated. The quantity and quality of potentially suitable spawning gravel patches will be summarized in tabular format.

Results to be reported include the following:

- shapefiles with polygons of potentially suitable spawning gravel patches and associated patch attributes;
- a database of attributes for each mapped gravel patch (i.e., measured and/or estimated particle size parameters, sorting, angularity, embeddedness, estimated mean depth [where feasible], associated channel morphological feature, and quality score);
- mean, minimum and maximum gravel inflow rates (ml/sec) as an index of intragravel permeability (cm/hr) for each sample site, presented by river mile location; and
- derived mean permeability (cm/hr) by river mile.

5.0 STUDY SCHEDULE

The anticipated schedule is to conduct the initial office-based analysis in May-June 2016, with subsequent field surveys in August/September 2016 for gravel mapping and gravel quality assessments. Mapping of potentially suitable spawning gravel will occur over two separate five-day field trips. Permeability sampling will occur over one three-day field trip to be conducted after the gravel mapping is completed. A draft report will be provided to the Technical Committee in November 2016 with a final report to be included in the February 2017 Updated Study Report.

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REVISED DRAFT STUDY PLAN

TURLOCK IRRIGATION DISTRICT
AND
MODESTO IRRIGATION DISTRICT

LA GRANGE HYDROELECTRIC PROJECT
FERC NO. 14581

Upper Tuolumne River Habitat Mapping and Macroinvertebrate Assessment

May 2016

1.0 BACKGROUND

As part of the La Grange Hydroelectric Project licensing proceeding, the Districts are undertaking the Fish Passage Facilities Alternatives Assessment (Fish Passage Assessment), the goal of which is to identify and develop concept-level alternatives for upstream and downstream passage of Chinook salmon and steelhead at the La Grange and Don Pedro dams. In September 2015, the Districts provided to licensing participants Technical Memorandum No. 1, which identified a number of information gaps critical to informing the biological and associated engineering basis of conceptual design for the Fish Passage Assessment. In November 2015, licensing participants adopted a plan to implement the Upper Tuolumne River Reintroduction Assessment Framework (Framework) intended to develop the information needed to undertake and complete the Fish Passage Assessment and to assess the overall feasibility of reintroducing anadromous salmonids into the upper Tuolumne River (TID/MID 2016). As part of implementing the Framework, a number of environmental studies are planned.

The Upper Tuolumne River Habitat Mapping and Macroinvertebrate Assessment is one of several studies to be implemented in 2016 in support of the Framework. Information collected during this study will be used to characterize habitat distribution, abundance, and quality in the upper Tuolumne River.

2.0 STUDY AREA

The study area will include the mainstem of the upper Tuolumne River from the upstream limit of the Don Pedro Project (approximately RM 81) to Early Intake (approximately RM 105).

3.0 STUDY GOALS

The primary goal of this study is to provide information on habitat distribution, abundance, and quality in the upper Tuolumne River. This information will inform evaluations in the Framework and is critical for assessing the feasibility of anadromous salmonid reintroduction, estimating potential population size and developing engineering alternatives for the upper Tuolumne River. Specific objectives include:

- documenting the number, size and distribution of mesohabitats available in the upper Tuolumne River;
- collecting detailed data on habitat attributes in representative reaches of the upper Tuolumne River;

- documenting potential pool holding habitat for over-summering adult Chinook salmon; and
- collecting drift and substrate samples of macroinvertebrates (salmonid prey organisms).

4.0 STUDY METHODS

For this assessment, habitat mapping will quantify the type, amount, and location of habitat types available to potentially reintroduced anadromous salmonids during their riverine life stages (adult holding/spawning, incubation and rearing). Habitat mapping will be conducted in the field and remotely using standardized methodologies. The frequency and area of each habitat type (e.g., pool, riffle, run) will be tabulated and where potential holding pools for adult Chinook occur, the size and depth of the pools will be measured to determine possible holding capacity. Additional mapping tasks will include assessments of channel gradient, width, habitat areas, etc.

Habitat mapping will consist of mapping all mesohabitat units between Early Intake (RM 105) and the upstream limit of the Don Pedro Project (approximately RM 81), and collecting detailed habitat data in a sub-set of the mapped mesohabitat units.

4.1 Task 1. Mesohabitat Mapping

Reconnaissance level mapping in the summer of 2015 consisted of mesohabitat classifications (Table 1.0) for portions of the reach between Lumsden (Merals Pool at RM 96) and approximately RM 81. In 2016, habitat mapping will be extended up to Early Intake (RM 105), and gaps in mapping between RM 96 and approximately RM 81 will be comprehensively assessed to obtain a more complete dataset. Habitat units will be identified visually by a boat-based survey crew and mapped on pre-existing high-resolution color aerial photographs. Boundaries of mesohabitat units will also be geo-referenced in the field with a handheld GPS unit.

Table 1.0 Mesohabitat mapping units and criteria for the mainstem Tuolumne River.

Mesohabitat types	Definitions/ Criteria
Deep Pool	>6 ft max depth
Shallow Pool	<6 ft max depth
Glide/ Pool tail	Typically in the downstream portion of a pool with negative bed slope where converging flow approaches the riffle crest. Wide, shallow, flat bottom with little to no surface agitation. Substrate type is typically smaller than riffle, but coarser than pool and often provides best salmonid spawning habitat.
Run	Long, smoothly flowing reaches, flat or concave bottom, and deeper than riffles with less surface agitation. Higher velocities than pools.
Boulder Garden/Pocket Water	Moderate to low gradient riffles, runs, and glides with numerous large boulders/obstructions that create scour pockets and eddies with near zero velocity. Often no clear thalweg present due to multiple flow paths.
Cascade/ Chute	>10% gradient, and with air entrainment (particularly in cascades), very large boulders and/or bedrock. Consisting of alternating small waterfalls and can have shallow pools in middle and margin of channel at low flows.
High Gradient Riffle	>4% gradient. Substrate is usually large boulder and bedrock (>24”)
Low Gradient Riffle	<4% gradient. Substrate is usually small boulder and large cobble(6-24”)
Side Channel	Contains < 20% of total flow. Connected at top and bottom to main channel at low flow.
Backwater	Low to zero velocities. Only connected to main channel from one end.

Mapped habitats will be digitized and added to the project GIS layer for mapping, as well as for quantitative and spatial analysis. Color maps will be created to depict the type and location of habitats throughout the study area and in relation to important features such as tributaries, potential passage barriers, access points, and water temperature monitoring locations. The frequency and area of each habitat type (e.g., pool, riffle, run) will also be tabulated.

4.2 Task 2. Habitat Inventory Mapping

Additional (remote) mapping tasks will include assessments of channel gradient, width, habitat areas, etc. following the CDFW Level III habitat typing methodology (CDFG 2010). Methods will be similar to habitat typing conducted in the lower Tuolumne River (TID/MID 2013). Sampling units selected for detailed habitat measurements will encompass approximately 10 to 20 percent of the study reach, as recommended in CDFG (2010). The habitat typing field effort will consist of a team of three biologists surveying the river by raft. The study area will be divided into seven sampling reaches, based on length of river rafted daily (two reaches from Early Intake to Lumsden and five reaches from Lumsden to Wards Ferry). Within each individual sampling reach, a one mile section will be randomly selected for habitat typing. Prior to the field assessment, the team will use maps and existing aerial photographs to delineate the specific reaches to be surveyed.

A suite of measurements consistent with the Level III CDFW criteria (Table 2.0) will be made within each mesohabitat type along each of the selected one-mile reaches. Data will be recorded on standardized datasheets to ensure all data are collected in a consistent manner. A photograph of each and GPS coordinates will be recorded at the bottom of each habitat unit. Unit length and width will be measured with a laser range finder. Depths will be measured using a stadia rod or handheld depth finder. Large woody debris (LWD) count will include a count of LWD pieces with a diameter greater than one foot and a length between six and twenty feet, as well as pieces greater than twenty feet in length, within the bankfull width. Percent total canopy will be measured using a spherical densiometer at the upstream end of each habitat unit in the center of the wetted channel, as well as general observations of riparian habitat. The remaining habitat parameters including substrate composition, substrate embeddedness, shelter complexity, and bank composition types will be visually estimated. Within each sampling reach, stream gradient will also be measured using a hand level over a distance of at least 20 bankfull channel widths. In addition, the size and depth of each pool will be collected throughout the study reach to help quantify the amount of potential Chinook salmon adult holding habitat.

Table 2.0 List of data collected as part of Level III CDFW habitat mapping.

Data	Description
Form Number	Sequential numbering
Date	Date of survey
Stream Name	As identified on USGS (U.S. Geological Survey) quadrangle
Legal	Township, Range, and Section
Surveyors	Names of surveyors
Latitude/Longitude	Degrees, Minutes, Seconds from a handheld GPS
Quadrant	7.5 USGS quadrangle where survey occurred
Reach	Reach name or river mile range
Habitat Unit Number	The habitat unit identification number
Time	Recorded for each new data sheet start time
Water Temperature	Recorded to nearest degree Celsius
Air Temperature	Recorded to nearest degree Celsius
Flow Measurement	Available from USGS monitoring stations
Mean Length	Measurement in feet of habitat unit
Mean Width	Measurement in feet of habitat unit wetted width
Mean Depth	Measurement in feet of habitat unit

Data	Description
Maximum Depth	Measurement in feet of habitat unit
Bankfull Width	Measurement in feet of channel width at bankfull discharge
Bankfull Depth	Averaged unit depth in feet at bankfull discharge
Depth Pool Tail Crest	Maximum thalweg depth at pool tail crest in feet
Pool Tail Embeddedness	Percentage in 25% interval ranges
Pool Tail Substrate	Dominant substrate: silt, sand, gravel, small cobble, large cobble, boulder, bedrock
Large Woody Debris Count	Count of LWD within wetted width and within bankfull width
Shelter Value	Assigned categorical value: 0 (none), 1 (low), 2 (medium), or 3 (high) according to complexity of the shelter.
Percent Unit Covered	Percent of the unit occupied
Substrate Composition	Composed of dominant and subdominant substrate: silt, sand, gravel, small cobble, large cobble, boulder, bedrock
Percent Exposed Substrate	Percent of substrate above water
Percent Total Canopy	Percent of canopy covering the stream
Percent Hardwood Trees	Percent of canopy composed of hardwood trees
Percent Coniferous Trees	Percent of canopy composed of coniferous trees

Results to be reported include the following:

- Ground-mapped habitat units
  - Total number of habitat units, by type
  - Total length of habitat units, by type
  - Number of habitat units (frequency)
  - Average width of habitat units, by type
  - Number and relative frequency of dominant instream cover types
  - Reach summary data (e.g., average bankfull width and depth, LWD density (within wetted and bankfull))
- Pool holding habitat
  - Total number of pools identified as potential holding habitat (and the criteria of determination)
  - Average and maximum pool depth
  - Percentage of pools with ≥ 5% cover
  - Map showing the suitable holding pools in each 1-mile sampled reach of the upper Tuolumne River
- Tributary mapping data and reconnaissance level mainstem Upper Tuolumne River habitat data collected in 2015

4.3 Task 3. Macroinvertebrate Assessment

If time and logistics allow as the final field schedule is developed, a macroinvertebrate assessment will be conducted following the methods outlined below.

4.3.1 Study Goals

Drifting and benthic macroinvertebrates typically comprise the primary food source for rearing salmonids in fresh water habitats (Allan 1978, Fausch 1984, Harvey and Railsback 2014). Information on macroinvertebrate prey resource availability is a component of an evaluation of the factors affecting production and viability of an existing or introduced salmonid population. The density and taxonomic composition of drifting macroinvertebrates can provide a relative measure of food availability for drift-feeding salmonids. To provide a relative measure of food availability for salmonids within the water column, a literature search of similar streams and macroinvertebrate studies in the region (Sierra foothill region) will be conducted. Substrate sampling for benthic macroinvertebrates will provide data that can be used in a standardized bioassessment approach to evaluate the potential for physical habitat impairment. The objectives of the macroinvertebrate assessment are to:

- collect and analyze macroinvertebrate drift samples to determine whether the taxonomic composition and density of drift is consistent with other regional systems currently supporting healthy salmonid populations; and
- collect and analyze benthic macroinvertebrate samples from the substrate to develop metrics for bioassessment and comparison with similar streams and data sets.

4.3.2 Study Methods

4.3.2.1 Sampling Site Selection

The study area for macroinvertebrate sampling within the upper mainstem of the Tuolumne River is from RM 81 to Early Intake (RM 105). The location and number of sampling sites and sampling frequency will represent the seasonal variability of macroinvertebrate populations and related seasonal variability of food resources for stream-dwelling salmonids during the primary salmonid rearing and growth period (spring-fall), as well as the variability of physical habitat characteristics in each study reach.

<u>Number of sites</u>
Depending on opportunities encountered during stream habitat mapping, drift and benthic macroinvertebrate samples will be collected at seven sites, equating to approximately one site per 3.5 river miles.

<u>Locations</u>
Drift sampling will occur at seven sites, based on length of river rafted daily (two sites from Early Intake to Lumsden and five sites from Lumsden to Wards Ferry) at sites selected near overnight camping locations during each rafting trip. Drift samples will be collected in riffle or run habitats and be selected based on suitable depth, velocity, substrate, and accessibility/safety considerations, with two sites per location and two replicates (net placements) per site.

Benthic macroinvertebrate sampling will occur at suitable riffles initially identified in the office using aerial photographs and verified in the field. One composite sample will be collected daily from a suitable riffle or combination of suitable fast-water habitat types during the seven-day raft-based sampling.

<u>Sample timing and frequency</u>
Macroinvertebrate sampling will be conducted daily during the raft-based habitat mapping effort. Drift sampling in early summer (June) will characterize food resources available to rearing juvenile anadromous salmonids. In many temperate streams, aquatic macroinvertebrate diversity and abundance peak during spring and summer and are reduced in late summer and fall. Peak feeding and growth by rearing salmonids occur when prey availability and water temperatures are relatively high, maximizing net energy gain (Rundio and Lindley 2008, Stillwater Sciences 2007, Wurtsbaugh and Davis 1977). Exact sampling dates for this study may be adjusted within the general seasonal period to coincide with other sampling efforts in order to maximize efficiency and accommodate river flow levels. However, macroinvertebrate sampling should not occur during periods of very high flows or when river discharge is changing rapidly due to safety and access concerns and the potential effects of flow fluctuations on invertebrate drift (Brittain and Eikland 1988).

Drift sampling will begin each afternoon by 1700 hours and proceed until approximately 2000 hours. This sample timing is intended to collect drifting macroinvertebrates during the daily period when feeding activity is often greatest for juvenile Chinook salmon and trout (Sagar and Glova 1988, Johnson 2008) and to avoid pre-dawn and post-dusk peaks in drifting macroinvertebrates that may not be available to drift-feeding salmonids at low light levels. The timing and duration of drift sampling can be adjusted if needed to accommodate rafting safety concerns or logistical constraints. All drift sampling should occur during the peak afternoon-evening feeding period and have the same start and end time.

The timing of the benthic macroinvertebrate sampling is not seasonally dependent, but will be coincident with the drift sampling effort to maximize efficiency and reduce the amount of field sampling time required for the study. Benthic macroinvertebrate samples will be collected once per day during the raft-based sampling effort, typically during mid-day or as determined by the location of suitable sampling riffles and logistics of the habitat mapping study.

4.3.2.2 Sampling Protocols

Invertebrate drift sampling
Drift samples will be collected using stationary nets with rigid rectangular openings and tapered, nylon mesh bags with a collection jar fitted at the downstream end – similar to drift nets used by other researchers (Brittain and Eikeland 1988), including the 1987–1988 drift studies in the lower Tuolumne River (Stillwater Sciences 2010). All drift nets will be identical, with a mesh size small enough to capture small invertebrates such as immature chironomids that may be important salmonid prey, while also large enough to minimize clogging (e.g., 250–500 µ). There is no standard mesh size for drift nets, with mesh size instead chosen according to study objectives, and to represent a compromise between filtration efficiency and clogging (Svendsen et al. 2004).

At each sampling location two transects will be selected perpendicular to the river and two drift nets will be placed at each transect: one near shore and one in the thalweg or as close to the thalweg as water depth and velocity will safely allow. Each drift net will be anchored in the water column using steel (e.g., rebar stakes or fence posts) driven into the stream bed, with the bottom of the net at least 10 cm above the river bottom and the top of the net at least 4–5 cm above the water surface. This vertical net placement ensures capture of terrestrial-origin organisms originating from outside the stream (Leung et al. 2009), which may be an important diet component for anadromous salmonids (Tiffan et al. 2014, Leung et al. 2009, Rundio and Lindley 2008) while avoiding capture of organisms crawling on the substrate. Because drift composition is not uniform across the channel (Waters 1969), placement of near-shore and mid-channel drift nets allows sampling of each portion of the channel to represent potential differences in taxonomic composition, origin (aquatic vs. terrestrial), density, or other factors. The safety of approaching rafts will be considered during the selection of transect locations, and each drift net will be clearly marked with a buoy. During sampling, the drift nets will be attended by one or more field crew members to monitor for approaching rafts or other safety hazards. If needed, field personnel will verbally warn rafters of the potential hazard and assist rafts in avoiding the nets.

Drift nets will be deployed for three hours each day (1700–2000 hours). The width and depth of the submerged portion of each net will be measured upon installation to calculate the effective net area (i.e., the area being sampled). Water velocity will be measured at the midpoint of each net mouth immediately after net installation, at the midpoint of sampling (after 1.5 hours), and immediately before retrieving the net. The three velocity values will be used to calculate the average water velocity at the mouth of each net during sampling, and the average velocity will be multiplied by the sampled area to determine the total volume of water passing through each net during the sampling event. Because net clogging during sampling can gradually reduce the velocity of water passing through the net, an average of several water velocities measured over the course of sampling provides a more accurate measure of volume than a single velocity measure.

After removing each drift net from the water, the contents will be carefully washed to the end of the net and into the collection bottle using river water. The bottle will then be removed and all contents will be transferred to a sample container, labeled, and preserved with 95% ethanol for later processing.

Benthic sampling

Benthic sampling will be conducted using a modified version of the targeted riffle composite (TRC) method described in the California State Water Resources Control Board Surface Water Ambient Monitoring Program (SWAMP) Bioassessment Standard Operating Procedure (Ode 2007). The TRC has been widely used in California by state and federal water resource agencies, is consistent with the methods of EPA's Environmental Monitoring and Assessment Program (EMAP) (Peck et al. 2006), and has been adopted as the standard riffle protocol for bioassessment in California (Ode 2007). A similar methodology, the former California Stream Bioassessment Protocol (CSBP) and later the California Monitoring and Assessment Program (CMAP), produced comparable results and was used for the Districts' benthic macroinvertebrate sampling program in the lower Tuolumne River from 2001–2005 and from 2007–2009 (Stillwater Sciences 2010). The SWAMP TRC method was recently used to collect benthic macroinvertebrate samples in the upper Merced River as part of the Merced River Alliance Biological Monitoring and Assessment project (Stillwater Sciences 2008).

Due to site access constraints and non-wadeability in most habitat types, a modified version of the SWAMP protocol will be used to select riffles or other suitable fast-water habitat types for TRC sampling. Whereas the SWAMP protocol specifies that habitats (riffles or other fast-water habitats) for TRC sampling should be selected randomly from a pre-established reach 250 meters in length, riffles sampled for this study will instead be selected randomly from among all potentially wadeable riffles that are accessed during the habitat mapping study and were initially identified in the office by examining high-resolution color aerial photographs of the study reaches. During field sampling, the field crew will carry a set of the aerial photographs with potential sampling riffles identified, to enable identification of alternative sampling riffles if needed. Using the office-based method, a total of seven riffles will be selected for sampling. Riffles selected for sampling will be spaced sufficiently to enable sampling of an average of one riffle per day during the raft-based field effort.

In the field, riffles initially selected for benthic sampling will be evaluated individually as they are encountered during the rafting trip to determine whether substrate, depth, and velocity are suitable for sampling, and if they can be sampled safely. A riffle will be deemed suitable if it has enough gravel or cobble substrate to allow collection of up to eight non-overlapping benthic samples in areas that can be safely accessed on foot by a two-person field crew (i.e., depth and velocity do not prohibit safe access and sampling). If a riffle initially chosen for TRC sampling is unsuitable, the crew will proceed to the next suitable riffle. Ideally, a total of five riffles or other fast-water habitats will be sampled in the study reach using the TRC method. At each riffle selected for TRC sampling, physical habitat and water chemistry data will be collected following the SWAMP protocol for the "basic" level of effort (Ode 2007). These data include GPS coordinates and photographs of the site, water temperature, pH, dissolved oxygen, specific conductance, channel width, riparian canopy cover, bank stability, and channel gradient.

The TRC approach specifies collection of benthic samples at eight riffles within each 250 meter sampling reach (Ode 2007). However, preliminary examination of aerial photographs indicates that the riffles in the upper Tuolumne River are relatively infrequent and widely spaced, thus selection of a 250 meter sampling reach containing multiple riffles will likely be infeasible. A modified approach will therefore be used, which will entail collection of eight benthic samples per riffle. If additional suitable riffles or other suitable fast-water habitat types (e.g., run or pool tail) are located in close proximity to a riffle that has been selected for TRC sampling and can be safely accessed on foot, the required eight samples will be collected at locations distributed randomly among the suitable habitats. Sampling locations in each riffle or combination of fast-water habitat types at each site will be selected randomly using a digital stopwatch or random number chart, as described in Ode (2007). Samples will be collected using a standard D-frame kick net with 500-μ mesh. At each sampling location, a 0.09 m^2 (1 ft^2) area of bottom substrate will be sampled immediately upstream of the net following methods described in Ode (2007). All eight samples collected at each site (riffle or combination of fast-water habitats) will be combined into a single composite sample for the site, preserved in 95% ethanol, and labeled for laboratory processing.

4.3.2.3 Analysis and Reporting

All macroinvertebrate samples will be processed in the laboratory following standardized methods and the data will be entered into a database. Processing will enumerate and identify organisms to the taxonomic level necessary to calculate commonly reported biological metrics (numerical attributes of biotic assemblages) for each sample site from the benthic samples (i.e., TRC samples) and identify the diversity and abundance of primary salmonid prey items in the drift. Benthic macroinvertebrate metrics may include those calculated for benthic macroinvertebrate samples collected in the lower Tuolumne River from 2000–2005 and 2007–2009 (Stillwater Sciences 2010). Laboratory analysis of drift samples will also include length measurement of individual organisms, to allow calculation of biomass at a later date, if desired, to provide a relative measure of energy content and available fish food resources. Results will be included in a technical report that evaluates the adequacy of the macroinvertebrate prey resources to support healthy populations of juvenile anadromous salmonids, as indicated by comparison of the taxonomic composition and relative abundance (drift density) of the upper Tuolumne River macroinvertebrate drift samples with drift samples from other salmonid streams.

5.0 STUDY SCHEDULE

The study will be completed during the summer and fall of 2016; a detailed field schedule will be developed in conjunction with other field studies.

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REVISED DRAFT STUDY PLAN

TURLOCK IRRIGATION DISTRICT
AND
MODESTO IRRIGATION DISTRICT

LA GRANGE HYDROELECTRIC PROJECT
FERC NO. 14581

Upper Tuolumne River Instream Flow Study

May 2016

1.0 BACKGROUND

As part of the La Grange Hydroelectric Project licensing proceeding, the Districts are undertaking the Fish Passage Facilities Alternatives Assessment (Fish Passage Assessment), the goal of which is to identify and develop concept-level alternatives for upstream and downstream passage of Chinook salmon and steelhead at the La Grange and Don Pedro dams. In September 2015, the Districts provided to licensing participants Technical Memorandum No. 1, which identified a number of information gaps critical to informing the biological and associated engineering basis of conceptual design for the Fish Passage Assessment. In November 2015, licensing participants adopted a plan to implement the Upper Tuolumne River Reintroduction Assessment Framework (Framework) intended to develop the information needed to undertake and complete the Fish Passage Assessment and to assess the overall feasibility of reintroducing anadromous salmonids into the upper Tuolumne River (TID/MID 2016). As part of implementing the Framework, a number of environmental studies are planned.

The Upper Tuolumne River Instream Flow Study is one of several studies to be implemented in 2016 in support of the Framework. Information collected during this study will be used to evaluate existing aquatic habitat and provide quantifiable metrics of aquatic habitat suitability in the upper Tuolumne River.

2.0 STUDY AREA

The study area for the Instream Flow Study is the main stem of the Tuolumne River extending from the upstream end of the Don Pedro Project (RM 81 +/-) to Early Intake (RM 105).

3.0 STUDY GOALS

The goals of this study are (1) to model existing aquatic habitat for spring-run and fall-run Chinook salmon (*Oncorhynchus tshawytscha*) and steelhead (O. *mykiss*); (2) to evaluate the existing aquatic habitat over a representative range of observed water years and operations of the City and County of San Francisco's Holm powerhouse; and (3) to provide quantifiable metrics of aquatic habitat suitability in the context of potential reintroduction of Chinook salmon and steelhead.

4.0 STUDY METHODS

The following instream flow study methods are consistent with normal and customary 2-dimensional (2D) instream flow methodologies, and will provide data that are comparable to data collected and used at other salmonid-bearing streams and rivers in California and elsewhere.

The study will be performed in five steps: (1) reach and site selection; (2) field data collection; (3) hydraulic modeling; (4) aquatic habitat modeling; and (5) report preparation. Each of these steps is described below.

Step 1 – Reach and Site Selection

The establishment of study reaches and the location of a study site within each reach will be based on five primary sources of information: (1) upper Tuolumne River geomorphology; (2) watershed hydrology; (3) habitat mapping study results; (4) spawning gravel mapping study results; and (5) existing aerial imagery. Based on current information, it is expected that two or three study sites will be selected throughout the study area.

Reach segmentation in the study area will be based on geomorphic characteristics (e.g., gradient, channel width, substrate composition) and hydrologic contributions (e.g., accretion, percent contribution to overall streamflow from tributaries, effects of hydropower peaking). Based on these characteristics and results from detailed mesohabitat mapping and gravel surveys, one or more study sites will be selected in each reach. Lastly, study site selection will focus on selecting both low gradient mesohabitats (pool, run and low gradient riffle) and likely short high gradient transition mesohabitats (e.g., high gradient riffle, cascade).

Study sites will be selected of a sufficient size and habitat composition to adequately characterize, and be indicative of, the range of habitat attributes (e.g., spawning, rearing and holding) documented through previous and concurrent field data gathering efforts conducted as part of the Framework. The final length of each site will be dependent on the geomorphic characteristics and lengths of mesohabitats contained within the selected study location. The number and types of mesohabitats selected will also depend on the length and variability of mapped units in the vicinity.

While study sites will initially be developed using field and aerial imagery data sources, final site selection may also be influenced by (1) proximity to camping locations, an important logistical consideration in this remote river canyon, and (2) safety considerations, which are influenced by gradient, channel configuration, hydraulic conditions, and availability of downstream recovery/safety zones.

Step 2 – Field Data Collection

Given the remoteness and limited access to the upper Tuolumne River, field data collection at each site will be completed in one continuous five to seven day period. It is anticipated that most of the out-of-water topography will be developed using airborne Light Detection and Ranging (LiDAR) data collected by NMFS in 2015 along the upper Tuolumne River. Before use, the LiDAR data will be evaluated by a remote sensing expert for quality and study utility.

Additional topographic data will be collected using a variety of methods depending on site conditions. Initially, LiDAR coverage will be evaluated and used to describe the majority of each study site not submerged at the time of the data collection. The remaining in-water and out-of-water topographic data collection will be completed utilizing a number of survey techniques. Given the steep nature of the canyon, standard Real Time Kinematic (RTK) Global Positioning System (GPS) survey will likely not be practical. Therefore, the primary survey instruments used will be Robotic Total Stations (RTS), surveyed into a RTK GPS network. The RTS units will be used for topographic surveys conducted on foot and for single beam bathymetric surveys conducted to collect unwadable in-channel topography. Depending on river conditions and safety considerations during each survey, a variety of manned and unmanned craft may be used for bathymetric data collection. Field staff will record all relevant survey information into predefined survey log sheets throughout each survey day.

After each data collection period, the RTK static GPS data files collected by the base station will be submitted to the National Oceanic and Atmospheric Administration's (NOAA) Online Positioning User Service (OPUS). OPUS returns a position corrected and mapped into the high accuracy National Spatial Reference System (NSRS). Using Trimble Business Center software, the OPUS-corrected position will then used to correct the network of RTS collected points from each survey instrument.

Habitat modeling for certain lifestages will require that substrate classification be consistent with habitat suitability criteria (HSC). Once final HSC are defined for this study, substrate classification tables and codes will be developed for use in the field. Similarly, and if applicable, cover types will correspond to cover codes defined in HSC selected for each species.

Prior to field work, detailed substrate information from the *Upper Tuolumne River Chinook Salmon and Steelhead Spawning Gravel Mapping Study* will be reviewed and, as appropriate, used for field reference. Additionally, if aerial photos are of suitable resolution, preliminary substrate polygons will be digitized throughout each model domain. In the field, crews will use an iPad loaded with aerial photos and GIS mapping software to either validate and refine the desktop delineation or develop substrate polygons and cover features throughout each study site.

Water surface elevations (WSE), discharges, and calibration depths and velocities will be collected throughout each study site at two calibration flows. The final measured flows will ultimately depend on the hydropower peaking operations and the duration of stable flows observed at each study site. Flow stability for data collection and modeling purposes is defined as a 'steady' discharge that results in minimal fluctuation in stage (e.g., no more than +/- 0.05 ft) for a long enough duration to measure discharge, WSEs, depths and velocities throughout the study site. It is anticipated that target flows will range from approximately 200 cfs to 1,200 cfs but will be dictated by upstream hydropeaking operations during each survey period. Based on these targets, hydraulic-habitat relationships modeled in each study site will extend from approximately 50 cfs to 2,000 cfs. The final range will be determined by the overall quality of site specific rating curves and model performance.

WSE's will be surveyed using a RTS in approximately 50 locations throughout the wetted channel for each calibration flow. In addition, spatially referenced depth and velocity validation data will be collected in at approximately 50 locations by an acoustic Doppler current profiler (ADCP) or manual velocity meter depending on location and hydraulic condition. Spot velocities depths and WSE measurements will span the entire longitudinal profile of model site.

Study site discharge measurements will be made using a combination of manual velocity meters and an ADCP mounted on an OceanSciences™ trimaran or similar vessel. ADCP measurements will follow standard USGS procedures (Mueller and Wagner 2009) for measuring discharge.

On-site rating curves will be developed using a combination of stage and discharge measurements and stage recording pressure transducers. At a minimum, three stage and discharge measurements will be made at each site. To supplement these data, stage recorders, which also record temperature, will be deployed at the top and bottom of the each study site to passively record stage over the data collection period. Stage recorders may also be deployed at various locations throughout the site to monitor the rate of stage change at specific mesohabitats. To relate WSE to discharge, the WSE will be measured directly above each installed logger at the time of deployment and again when the units are retrieved. A barometric pressure transducer will also be installed at the site to compensate for changes in atmospheric pressure. For validation purposes, WSEs will be measured during calibration flow surveys in the vicinity of each recorder. In addition to providing stage data for rating curve development, stage and temperature data from the recorders will be used to inform habitat and peaking analyses, discussed in Step 5 below.

Study site photographs will be collected to document site conditions during each survey. A representative collection of site photos, arranged by calibration survey flow will provided in a report attachment.

Step 3 – Hydraulic Modeling

Surface and Mesh Development

Hydraulic modeling for the study site will use River2D (Steffler and Blackburn 2002). The River2D model uses the finite element method to solve the basic equations of vertically averaged 2D flow incorporating mass and momentum conservation in the two horizontal dimensions (Steffler and Blackburn 2002).

The main input parameters for the River2D model include channel surface topography, bed roughness (in the form of an effective roughness height), and upstream and downstream hydraulic boundary conditions (i.e., water levels and discharge). Accurate topography is the primary variable that allows for the development of a well calibrated model.

Topographic surfaces will be constructed by combining the total station survey data, RTS and RTK GPS standard survey data, bathymetric data, and the LiDAR ground return data. In order to increase the definition in areas of topographic gradient and variability, breaklines will be defined within the topographic surface. Breaklines enforce the topographic surface to ‘snap’ to the entire length of the line and are used to define features with large vertical gradient changes, such as cascades, toe of slopes, and boulders.

Before entering the data into the River2D model, topographic data from the site will be reviewed for errors in ArcMap and ArcScene. Triangulated Irregular Networks (TINs) will be developed to visualize the data in two and three dimensions

Mesh development will follow procedures outlined in the R2D_Mesh User’s Manual (Waddle and Steffler 2002). When building a computational mesh, it is important to optimize for computational performance without sacrificing mesh quality. Using the topographic surface nodes to define the mesh is not recommended as the computational requirements for such a model exceed the limits of the software and currently available computer hardware. Instead, a low density uniform mesh is developed and then refined using a variety of techniques.

As recommended by the R2D_Mesh User’s Manual, a balance between mesh density and computational burden will be addressed in part by applying a procedure called ‘wet refinement’ which places nodes at the centroid of each mesh element. This process ensures the appropriate mesh density in wetted areas only, while limiting mesh density in dry areas.

Another method used to refine the mesh is to review mesh-generated elevation contours as compared to bed elevation contours at an interval of 0.82-foot with a goal of close contour approximation. Since the topographic points and mesh nodes are not in the same location, the contours will not be exactly the same. Therefore, to increase contour agreement, additional nodes may be added in topographically complex areas. To achieve the appropriate mesh density over all simulation flows, the mesh will be iteratively refined in the context of the full range of possible wetted areas.

A third method used to refine the mesh will be to identify large elevation differences between topographic data points and the interpolated elevation of each mesh triangle. Most often, large elevation differences exist in areas of high gradient (e.g., cascade) or significant localized topographic relief (e.g., cliff or vertical bank). Mesh triangles that exceed a 0.82-ft difference threshold are highlighted yellow in the mesh development software and further refined until the difference is no longer detected.

QI is a mesh quality index where a value of 1.0 represents a mesh comprised of perfect equilateral triangles. The goal minimum triangle quality index (QI) for each computational mesh is 0.15. Low QI values (i.e., <0.10) do not necessarily compromise model quality, but will increase computational run times. Tools in the mesh development software are used to improve geometry to achieve the minimum goal QI value.

One initial base mesh used for model calibration will be used for all simulation runs. However, it will be necessary to make small changes if model run time errors (i.e., eddy shedding velocity oscillation, extremely high velocity, or Froude number) occur.

Model Calibration

Model parameters such as bed roughness (Ks, in the form of an effective roughness height), substrate transmissivity (tr) and eddy viscosity can be adjusted during model calibration to reflect field conditions. A stage-wise approach with target criteria for model performance will be used to guide calibration. The specific stages and criteria are discussed below.

For the initial hydraulic model, hydraulic calibration tests will be conducted using the target calibration flows of 200 cfs and 1,200 cfs. Bed roughness (Ks) and transmissivity (tr) will be varied as necessary to match observed WSEs and wetted area. As part of normal calibration, Ks and tr values are incrementally adjusted through an integrative sensitivity analysis until modeled WSEs calibrate well to observed WSEs. In addition to the WSE comparisons, velocity and depth predictions will be compared to field measured data to evaluate changes made to Ks.

The term "Ks" is scientific notation for bed roughness factor (in meters) and the term refers to gradation of material in the river. Compared to traditional one-dimensional models, where many two-dimensional effects are abstracted into the resistance factor, the 2D resistance term accounts only for the direct bed shear (Steffler and Blackburn 2002). Ks is iteratively varied as necessary to match observed water surface elevations using the default transmissivity of tr = 0.1. In general, the initial Ks value entered is 1-3 times the grain size documented during field data collection. Multiple regional Ks values (i.e., heterogeneous substrate material and/or large elevation changes) may be selected for each study site based on model performance.

Groundwater transmissivity (tr) is a user-defined variable which corresponds to groundwater flow and the relationship to surface flow. The default value is 0.1 which ensures that groundwater discharge is negligible. Because subsurface flow through gravel or cobble may be present at the study site, it may be necessary to modify the default value of tr to aid in the wetting and drying function throughout the model domain.

The target criterion for mean error in WSE between simulated versus observed data is, to a large extent, based on the accuracy of the survey equipment used to measure WSE. It is also important to recognize the influence of highly heterogeneous or high gradient topography (e.g., cascades and high gradient riffles) habitats on differences between field data and model data. Given the expected range of site characteristics in the upper Tuolumne River an average of 0.10 ft difference between simulated and observed WSE will be targeted.

Similarly, no specific target calibration criteria exist for velocity or depth parameters as these variables are greatly influenced by the differences in topographic detail between the field conditions, initial bed file detail, and the final bed detail resulting from the interpolated mesh. Using professional judgment and standard industry practice, velocity and depth variables are reviewed for reasonableness and significant errors in depth (i.e., > 0.33 ft mean error) and velocity (i.e., > 0.5 fps mean error) are evaluated. For all sets of model calibration variables, the correlation coefficient (r) and the coefficient of determination (r2) (i.e., percent of variance in an indicator variable explained by a factor and the measure of the proportion of variance of model results, respectively) will be calculated. In general, coefficients greater than 0.7 are expected while coefficient of determination values for velocity magnitude are expected to be within a range of 0.4 and 0.8 (Pasternack 2011).

Flow field velocity vectors (i.e., the direction and magnitude) are used to evaluate velocity prediction reasonableness during the calibration process but are otherwise not incorporated into the statistical review process.

Model convergence for a given hydraulic simulation is achieved and accepted when the inflow (Qin) equals outflow (Qout) and the solution change is nominal. Solution change is the relative change in the solution variable over the last time step. Specific criteria thresholds do not exist for these parameters and are largely based on the magnitude of the simulation discharge and the professional judgment of the modeler. The target solution change goal will be 0.0001. This target value is consistent with recommendations made in the River2D User's Manual (Steffler and Blackburn 2002).

Step 4 – Aquatic Habitat Modeling

Habitat Suitability Criteria

HSC define the range of microhabitat variables that are suitable for a particular species and lifestage of interest. HSC provide the biological criteria input to the River2D model which combines the physical habitat data and the habitat suitability criteria into a site-wide habitat suitability index (i.e., Weighted Usable Area or WUA) over a range of simulation flows. Variables typically defined with HSC include depth, velocity, instream cover and bottom substrate. HSC values range from 0.0 to 1.0, indicating habitat conditions that are unsuitable to optimal, respectively. WUA is defined as the sum of stream surface area within a nodal area model domain or stream reach, weighted by multiplying area by habitat suitability variables, most often velocity, depth, and substrate or cover, which range from 0.0 to 1.0 each.

Spring-run Chinook salmon HSC information compiled for the McCloud River, a tributary of the Sacramento River, will be used for habitat modeling. The HSC were recently developed for use in a PHABSIM study assessing potential habitat availability related to the reintroduction of Chinook salmon upstream of Shasta Lake (PG&E 2011). The PHABSIM study was conducted for PG&E's McCloud Pit Hydroelectric Project (FERC No. 2106) (PG&E 2012). Using the best available HSC information and professional judgment, composite curves were developed for spawning, fry and juvenile lifestages. Holding HSC were not developed in the process. Holding habitat will be evaluated in the *Upper Tuolumne River Habitat Mapping and Macroinvertebrate Assessment.* Model results from this study may, however, inform the suitability of holding habitat. Spring-run periodicity information will rely upon information provided in Technical Memorandum No. 1 (TID/MID 2015).

Steelhead and fall-run Chinook salmon HSC information developed for the lower Tuolumne River instream flow study (Stillwater Sciences 2013) will be used to model habitat suitability in this study. Spawning and juvenile lifestages will be modeled. The Districts note that the lower Tuolumne River HSC may require some modification to appropriately be used in the upper Tuolumne River channel. Modifications to HSC will be made by a regional HSC expert familiar with the proposed curves and any changes will be thoroughly documented in the final report. Periodicity information for these species will rely upon information provided in Technical Memorandum No. 1 (TID/MID 2015).

Model Simulation

Approximately 18 discharges will be simulated for each study site resulting in an expected flow range of 50 cfs to 2,000 cfs. Habitat suitability and WUA for all fish species and lifestages will be calculated for each simulation flow. In order to calculate habitat suitability, four data inputs are required: a fish preference file (i.e., HSC), a channel index, depth, and velocity. A fish preference file is loaded into River2D as a text file. Depth and velocity values are provided from the model once a simulation has converged and is at a steady state. Channel index files are a River2D model file equivalent to a substrate and/or cover map of the entire study site. Substrate may only be applicable to the spawning lifestages and possibly fry/juvenile lifestages (as a cover component) but will depend on the HSC used.

For this study, the habitat suitability calculation will use the standard triple product function which multiplies depth, velocity, and channel index suitability together at each model node. Channel index interpolation will be defined using discrete node selection (i.e., nearest node rather than a continuous linear interpolation of the channel index values from surrounding nodes). Discrete node selection is typically applied to substrate classifications such that the original substrate code value is maintained. If cover codes are defined for the proposed HSC, continuous interpolation will be applied to cover indices where a gradient of cover may be best described by the interpolation function.

Hydropeaking Analysis – Habitat Persistence

It is of particular importance to evaluate and understand the potential effect of hydropeaking operations on the habitat utilized by various lifestages of aquatic organisms. For example, an area with suitable depth, velocity and substrate for spawning adults at one flow may become unsuitable as flows rise or recede over a large range of hydropeaking operations. At some point, if redds were developed at a high flow, they may become dewatered at lower flows. Similarly, it is important to understand the spatial and temporal distribution of habitat for fry and juvenile salmonids. Suitable rearing habitat at one flow may quickly become unsuitable and shift in location when flows rapidly increase or decrease. These analyses are often termed habitat effectiveness, or habitat persistence. These terms relate to the temporal and spatial change in habitat suitability and distribution under changing flow conditions.

Within each model domain, regions of special interest (e.g., spawning gravel patches) will be identified. The areas of interest (AOI) will be areas that could provide suitable spawning and rearing habitat under a range of flow conditions. Polygons representing the AOI regions will be digitized in ArcGIS in order to extract data from model nodes in the computational mesh.

Relying on information generated from each of the model simulation runs, model parameters such as suitability, WSE, velocity and depth will be extracted at each model node such that changes in each parameter, per unit discharge, can be calculated and evaluated. These analyses will be conducted using Geographic Information System (GIS) and spreadsheet tools.

Effects on aquatic habitat from daily changes in power plant operation will be modeled for time periods specified by species and lifestage periodicity and will be initially conducted at 15-minute to 1-hr time intervals using data collected at each site by stage recorders. Additional longer duration analyses will focus on weekly or monthly time steps and rely on hydrologic time series data from representative water years (e.g., dry, normal and wet). Results for the selected AOI regions in each model domain will be reported in both tabular and spatial form.

Step 5 – Reporting

A detailed technical memorandum will be provided that includes the following sections: (1) Study Goals and Objectives; (2) Methods; (3) Results; (4) Discussion; and (5) Description of Variances from the study plan, if any. A number of report attachments will include, but not be limited to, additional data such as representative site photographs and, habitat suitability maps. Models and interactive spreadsheets will be made available on CD.

5.0 STUDY SCHEDULE

Final study sites will be selected once data from habitat mapping and spawning gravel surveys are completed and data evaluated. Field data collection is anticipated to commence in the fall of 2016. Hydraulic and habitat modeling and associated analyses will be conducted in the fall of 2016 and winter of 2017. A progress report will be included in the February 2017 Updated Study Report.

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Turlock Irrigation District and Modesto Irrigation District (TID/MID). 2015. Fish Passage Facilities Alternatives Assessment, Technical Memorandum No. 1 – Existing Site Considerations and Design Criteria. La Grange Hydroelectric Project FERC No. 14581. September 2015.

TID/MID. 2016. Fish Passage Facilities Alternatives Assessment Progress Report. Prepared by HDR, Inc. Appendix to La Grange Hydroelectric Project Initial Study Report. February 2016.

Waddle, T. and Steffler, P. 2002. R2D_Mesh. Mesh Generation Program for River2D Two Dimensional Depth Averaged Finite Element. Introduction to Mesh Generation and User's Manual. U.S. Geological Survey.

PHONE CALL MEMORANDUM

Topic	NMFS LiDAR ground truth information
Date	June 3, 2016
From	Mr. John Wooster, NMFS
To	Mr. Bao Le, NMFS
Summary of Discussion	The purpose of this call was to discuss hyperspectral data and the availability of ground truthing data for substrate. Mr. Wooster noted that the ground truthing exercise was strictly associated with confirming depths for bathymetry and that no substrate data was collected in concert with the hyperspectral imagery data collection. Mr. Wooster said that they took some plan size images of substrate and that these could be useful to ground truth hyperspectral although the geo-referenced locations of these substrate photos is not of a high resolution. Furthermore, the photos have not been processed for grain size which could be problematic. Mr. Wooster said he would follow up with the NMFS Science Center to inquire more about these data and their applicability for supporting hyperspectral data use for field planning efforts associated with the upcoming spawning gravel survey.

From: Risse, Danielle
Sent: Wednesday, June 08, 2016 5:49 PM
To: [redacted]
Cc: [redacted]
Subject: RE: La Grange Hydroelectric Project FERC Licensing, Cultural Resources Study - Cultural Work Group Kick-Off Meeting Invitation
Attachments: LaGrange_CulturalTribalKickOff_Agenda.pdf

Attachment is now attached.

From: Risse, Danielle
Sent: Wednesday, June 08, 2016 5:44 PM
To: [redacted]
Subject: La Grange Hydroelectric Project FERC Licensing, Cultural Resources Study - Cultural Work Group Kick-Off Meeting Invitation

La Grange Hydroelectric Project FERC Licensing – Cultural Work Group Kick-Off Meeting Invitation

The Turlock Irrigation District and Modesto Irrigation District (collectively, the Districts) are currently in the licensing process for the La Grange Hydroelectric Project (the Project) with the Federal Energy Regulatory Commission (FERC). The Project is located on the Tuolumne River in Stanislaus and Tuolumne counties, California. As a part of the Incensing process, a Cultural Resources Study Plan was approved by FERC, and the Districts will be completing the approved study this summer.

On behalf of the Districts, HDR Engineering, Inc. (HDR) is inviting cultural resources licensing participants to a kick-off meeting, scheduled for Monday, June 27th from 1pm to 3pm at Modesto Irrigation District Offices located at 1231 11th St, Modesto, CA. If you cannot attend in person, we will have the following conference line open during the meeting so you can participate via phone: 866-583-7984, code 6164399.

The goal of the meeting is to provide you with the Project description, review the licensing schedule, provide a brief overview of the Section 106 consultation process, and discuss the Cultural Resources Study to be completed as part of the licensing effort. Attached is the meeting agenda for your review. The Districts have retained Northwest Cultural Resource Consultants (ethnographers Jennifer Whiteman, Dorothea Theodoratus, and Kathleen McBride) to implement the traditional cultural properties investigation that is part of the Cultural Resources Study, and Ms. Whiteman and Ms. Theodoratus will participate in the June 27th meeting.

If you have questions or would like additional information regarding this meeting, please contact Danielle Risse of HDR at (916) 679-8796. We look forward to working with you throughout the La Grange Hydroelectric Project FERC licensing process.

This email was sent on behalf of the Districts by:

Danielle Risse, M.A.
Senior Cultural Resources Specialist, Hydropower Services

HDR
2379 Gateway Oaks Drive, Suite 200
Sacramento, CA 95833
D 916-679-8796 **M** 916-679-8700
danielle.risse@hdrinc.com

hdrinc.com/follow-us

Agenda

Project:	La Grange Hydroelectric Project FERC Licensing
Subject:	Cultural Resources Study Kick-Off Meeting
Date:	Monday, June 27, 2016 — Time: 1:00 pm – 3:00 pm
Location:	Modesto Irrigation District Offices, 1231 11th St, Modesto, CA

I. Welcome and Introductions .... 1:00 pm

II. Review purpose of meeting .... 1:10 pm

a. The purpose of the meeting is to discuss the Project description, review the licensing schedule, provide a brief overview of the Section 106 consultation process, and discuss the Cultural Resources Study to be completed as part of the licensing effort.

III. Project description .... 1:20 pm

IV. Licensing schedule .... 1:40 pm

V. Section 106 consultation processes .... 1:55 pm

VI. Discussion of Cultural Resources Study .... 2:10 pm

VII. Path Forward .... 2:45 pm

VIII. Meeting Adjournment .... 3:00 pm

From: Le, Bao
Sent: Wednesday, June 08, 2016 8:35 AM
To: Lonnie Moore
Cc: Deason, Jesse
Subject: RE: Introduction Goals Meeting and Action Items

Hi Lonnie.

I apologize for the delay in getting back to you but things have been extremely busy with planning for the 2016 Assessment Framework field program. The Districts also view the development of draft goals as extremely important and per NMFS request at the April 13, 2016 goals subcommittee meeting, are taking on the responsibility of developing a first draft statement to share with the subcommittee to facilitate further discussion. We'll have something available as soon as we can and appreciate your patience on this matter.

Thanks, Bao

From: Lonnie Moore [mailto:lmoorenorcal@gmail.com]
Sent: Friday, June 03, 2016 11:12 AM
To: Le, Bao
Subject: Re: Introduction Goals Meeting and Action Items

Hi Bao,

I am very interested in all the Action Items. However, currently the most significant seems to be the draft "goals" that were to be "put to paper" by the Districts. I have a great deal of experience dealing with this type of effort, and I know that for some it is a bigger and more difficult task than for others.

A documented draft of goals, like this, are not a thing to be delayed (especially at this point) and should not be that difficult to produce. I mentioned before that this would be a difficulty for the Districts to do alone, and really should have the participation and/or leadership to include some other stakeholders.

I would like to participate in this process, regardless of the stage of the draft. I feel this has lingered far too long.

Sorry to get up on a "soap box" in an e-mail, but I do feel very strongly about this issue. I know this is (maybe wrongly) pressing you with a difficult question/situation...but is there someone, with the Districts, that I should discuss the matter?

Thanks,
Lonnie

On Fri, Jun 3, 2016 at 9:28 AM, Le, Bao <ChiBao.Le@hdrinc.com> wrote:

Hi Lonnie.

Action items have been assigned and are moving forward however I don't have the exact details/schedules. If there is a specific action item of interest to you, I'll try and track down more information on that one. Please let me know.

Thanks, Bao

From: Lonnie Moore [mailto:lmoorenorcal@gmail.com]
Sent: Wednesday, June 01, 2016 5:26 PM
To: Le, Bao
Subject: Introduction Goals Meeting and Action Items

Hi Bao,

Hope all is well with you!

Has anything moved forward, occurred, or changed from the decisions and "Action Items" generated by the "La Grange Reintroduction Goals Subcommittee Conference Call" of April 13, 2016?

I have received nothing except the "Draft Meeting Notes".

Thanks,

Lonnie

--

Lonnie Moore

Consultant

Office: 209-551-5958

Mobile: 209-247-3991

lmoorenorcal@gmail.com

--
Lonnie Moore
Consultant
Office: 209-551-5958
Mobile: 209-247-3991
lmoorenorcal@gmail.com

From: Le, Bao
Sent: Wednesday, June 08, 2016 2:40 PM
To: Vaughn, Gary D -FS; dfoote@fs.fed.us; Holdeman, Steven J -FS
Cc: Deason, Jesse; Warnock, Cory; Garello, Michael
Subject: Installation of a trail camera at RM 2.0 of the Clavey River

Importance: High

Follow Up Flag: Follow up
Flag Status: Flagged

Hi Dusty.

As you know, we've submitted our USFS permit application for new studies. We are now focused on amendments to the barriers work and the temperature work. Specific to the barriers amendment, there are two items of consideration. These are;

1. The trail camera install at the total barrier identified at approximately RM 2.0 on the Clavey River from 2015 field work.
2. Use of the drone at Lumsden.

As you know, the drone would not be used at Lumsden until the fall so it's really approval of a trail camera that is driving this schedule of submitting in the next week. Through previous discussions, I've heard that a trail camera install might not need a permit amendment since there has been precedent to use a camera (by UC Davis) coupled with this part of the Clavey not officially being designated as Wild and Scenic. Can you provide more insight/input here?

Please call or email if you have questions or would like to discuss.

Thanks, Bao

Bao Le
Senior Fisheries Biologist

HDR
1001 SW 5th Avenue, Suite 1800
Portland, OR 97204-1134
D 971.202.1722 **M** 503.309.9423
bao.le@hdrinc.com

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From: Risse, Danielle
Sent: Thursday, June 09, 2016 5:10 PM
To: 'Eicher, James'
Subject: RE: Cultural Inventory LaGrange

Ok, no worries Jim. I'll make sure they apply for the cultural resources use permit through the state office and then request a fieldwork authorization from your office prior to any fieldwork. HDR will be requesting a fieldwork authorization for the archaeological and architectural inventory of the La Grange project as well. We are currently finalizing the APE map, which we will submit to SHPO for concurrence. I don't expect that we will get to any fieldwork until the end of July or August. And the ethnographers probably won't want to go to the field for a while – they need to do research, contact the tribes, and conduct some interviews first.

Hope you can come to the kick-off meeting – we can discuss more then, if you would like.

Thanks for the heads up on the permit for the ethnographers! Danielle

Danielle Risse, M.A.
D 916-679-8796 **M** 916-679-8700

hdrinc.com/follow-us

From: Eicher, James [mailto:jeicher@blm.gov]
Sent: Thursday, June 09, 2016 4:48 PM
To: Risse, Danielle
Subject: Fwd: Cultural Inventory LaGrange

FYI from James. Please let me know ASAP what you are planning so we can get the authorization squared away.
Thanks Jim
---------- Forwarded message ----------
From: **Barnes, James** <jjbarnes@blm.gov>
Date: Thu, Jun 9, 2016 at 4:38 PM
Subject: Re: Cultural Inventory LaGrange
To: "Eicher, James" <jeicher@blm.gov>

If they're doing fieldwork related to identification of traditional cultural places and other cultural resources that may have religious or cultural significance to the tribes, ultimately for the purposes of Section 106 compliance, then they need to have a cultural resources use permit issued through the CASO and a fieldwork authorization through your office. Applied Earthworks/Moratto did have a permit and fieldwork authorization for the ethnographic work they did at Don Pedro.

James Barnes
Associate State Archaeologist

Bureau of Land Management
California State Office
2800 Cottage Way, W-1623
Sacramento, CA 95825
916-978-4676
Fax: 916-978-4684
jjbarnes@blm.gov

On Thu, Jun 9, 2016 at 4:28 PM, Eicher, James <jeicher@blm.gov> wrote:
FYI response from Danielle.
Jim
---------- Forwarded message ----------
From: **Risse, Danielle** <Danielle.Risse@hdrinc.com>
Date: Thu, Jun 9, 2016 at 4:23 PM
Subject: RE: Cultural Inventory LaGrange
To: "Eicher, James" <jeicher@blm.gov>

Hi Jim,

Are you referring to Northwest Cultural Resources Consultants? These folks are comprised of the ethnographers. The plan is that they will be doing site visits with the tribes to the La Grange project to try to identify any traditional cultural properties. It has been a while since implementing Don Pedro studies and there was so much back and forth on that project regarding permitting, so I don't recall – do the ethnographers need a BLM permit too to conduct their work?

Thanks for your help! Danielle

Danielle Risse, M.A.

D 916-679-8796 **M** 916-679-8700

hdrinc.com/follow-us

From: Eicher, James [mailto:jeicher@blm.gov]
Sent: Thursday, June 09, 2016 4:08 PM
To: Risse, Danielle
Subject: Cultural Inventory LaGrange

Hello Danielle I checked with James Barnes to see if this group has a permit to inventory on BLM lands and we don't have them listed with us. Can you let me know what the Districts plan is with BLM land.

Thanks Jim

From: Le, Bao
Sent: Thursday, June 09, 2016 9:55 AM
To: John Wooster - NOAA Federal
Cc: Deason, Jesse
Subject: RE: call

Ok. Thanks.

From: John Wooster - NOAA Federal [mailto:john.wooster@noaa.gov]
Sent: Thursday, June 09, 2016 9:50 AM
To: Le, Bao
Cc: Deason, Jesse
Subject: Re: call

Sounds good. I have a crazy day today, but will try and put out brief update email to the folks on the GIS/Hyperspec thread...

John

On Thu, Jun 9, 2016 at 9:05 AM, Le, Bao <ChiBao.Le@hdrinc.com> wrote:

Hi John.

I got your message but I've been travelling this week for other project meetings. I'll be home tomorrow and will try to give you a call in the morning.

Thanks, Bao

Bao Le

Senior Fisheries Biologist

HDR

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--
John Wooster
Hydrologist
NOAA Fisheries West Coast Region
U.S. Department of Commerce
john.wooster@noaa.gov

NOAA FISHERIES
West Coast Region

PHONE CALL MEMORANDUM

Topic	Districts' offer to assist in processing NMFS hyperspectral data
Date	June 10, 2016
From	Mr. Bao Le, HDR
To	Mr. John Wooster, National Marine Fisheries Service
Summary of Discussion	Mr. Le called Mr. Wooster to follow up on a previous conversation. Previously, Mr. Wooster had mentioned that Lee (the study lead) would likely require somebody to come work in his lab in Santa Barbara and that the work could take 2 to 3 months or longer given that over 100 miles of the Tuolumne and Merced rivers required hyperspectral processing to bathymetry. Mr. Le told Mr. Wooster that HDR's hyperspectral expert, Thomas Prescott, did not have that type of availability given other project commitments, personal conflicts, etc. to support this level of effort. Additionally, there was some concern about offering up assistance and then not being able to follow through, given the uncertainty of how long the data processing could take. Mr. Le said if there was some discrete piece of work that could be supported in a week or two that would be valuable in moving the habitat/carrying capacity study forward, this might be something that the Districts would consider. Mr. Wooster said he appreciated the feedback and understood the Districts' concern with supporting a task with an uncertain level of effort. Mr. Wooster said he did not know whether there was a smaller piece of work but that he would ask Lee. He also said he would follow up with Lee about the status of hiring a technician to do this work (Lee was currently advertising a position for a technician to assist on the study).

From: Staples, Rose
Sent: Monday, June 13, 2016 5:15 PM
Cc: Deason, Jesse; Le, Bao; Staples, Rose
Subject: RE: Final Notes April 13, 2016 Reintroduction Goals Subcommittee Conference Call Uploaded to Website

Please note date correction to the text of the message below—the subcommittee conference call was held on April 13—and is attached to that date on the website calendar.

Rose Staples, CAP-OM, MOS
D 207-239-3857

hdrinc.com/follow-us

From: Staples, Rose
Sent: Monday, June 13, 2016 8:06 PM
Cc: Deason, Jesse; Le, Bao; Staples, Rose (Rose.Staples@hdrinc.com)
Subject: FW: Final Notes April 13, 2016 Reintroduction Goals Subcommittee Conference Call Uploaded to Website

As noted below, the final notes from the April 13 Reintroduction Goals Subcommittee conference call has been uploaded to the La Grange licensing website, under both the DOCUMENTS and the CALENDAR tabs.

Rose Staples, CAP-OM, MOS
D 207-239-3857

hdrinc.com/follow-us

From: Staples, Rose
Sent: Monday, June 13, 2016 7:45 PM
Cc: Deason, Jesse; Le, Bao; Staples, Rose
Subject: Final Notes April 13, 2016 Reintroduction Goals Subcommittee Conference Call Uploaded to Website

Members of the Reintroduction Goals Subcommittee,

The FINAL notes from the April 13, 2016 Upper Tuolumne River Reintroduction Framework Reintroduction Goals Subcommittee conference call have been uploaded to the licensing website www.lagrange-licensing.com under the DOCUMENTS section and also as an attachment to the April 13 date on the website calendar.

Please note that on May 17, 2016 the Districts provided to the Reintroduction Goals Subcommittee DRAFT notes from the April 13 meeting and requested that the Subcommittee provide any comments on the meeting notes by June 1. No comments were received; therefore, these FINAL notes are the same as the draft notes originally provided on May 17.

Rose Staples, CAP-OM, MOS
Executive Assistant

HDR
970 Baxter Boulevard Suite 301
Portland ME 04103
D 207-239-3857
rose.staples@hdrinc.com

hdrinc.com/follow-us

From: Staples, Rose
Sent: Monday, June 13, 2016 5:28 PM
Cc: Deason, Jesse; Le, Bao; Staples, Rose
Subject: FW: Final Meeting Notes April 18, 2016 Technical Committee Conference Call Uploaded to Website

La Grange Licensing Participants,

The final notes from the April 18 Technical Committee conference call has been uploaded to the licensing website, under both the DOCUMENTS tab and the CALENDAR date of April 18th.

Rose Staples, CAP-OM, MOS
D 207-239-3857

hdrinc.com/follow-us

From: Staples, Rose
Sent: Monday, June 13, 2016 8:18 PM
Cc: Deason, Jesse; Le, Bao; Staples, Rose
Subject: Final Meeting Notes April 18, 2016 Technical Committee Conference Call Uploaded to Website

Members of the Tuolumne River Reintroduction Assessment Framework Technical Committee,

The FINAL notes from the April 18, 2016 Upper Tuolumne River Reintroduction Framework Technical Committee conference call have been uploaded to the licensing website www.lagrange-licensing.com under the DOCUMENTS section and also as an attachment to the April 18 date on the website calendar.

Please note that on May 17, 2016 the Districts provided to the Technical Committee DRAFT notes from the April 18 meeting and requested that the Technical Committee provide any comments on the meeting notes by June 1. No comments were received; therefore, these FINAL notes are the same as the draft notes originally provided on May 17.

Thank you.

Rose Staples, CAP-OM, MOS
Executive Assistant

HDR
970 Baxter Boulevard Suite 301
Portland ME 04103
D 207-239-3857
rose.staples@hdrinc.com

hdrinc.com/follow-us

From: Staples, Rose
Sent: Tuesday, June 14, 2016 8:14 AM
To: James Hastreiter
Subject: RE: La Grange Data Disks Have Been Sent

Excellent; thanks for letting me know!

Rose Staples, CAP-OM, MOS
D 207-239-3857

hdrinc.com/follow-us

From: James Hastreiter [mailto:James.Hastreiter@ferc.gov]
Sent: Tuesday, June 14, 2016 11:13 AM
To: Staples, Rose
Subject: RE: La Grange Data Disks Have Been Sent

Rose, Gary was holding the package for me for some reason instead of placing it in my inbox. So I now have it.

Thank you
Jim

From: Staples, Rose [mailto:Rose.Staples@hdrinc.com]
Sent: Monday, June 13, 2016 4:21 PM
To: James Hastreiter
Subject: RE: La Grange Data Disks Have Been Sent

Jim, the FEDEX envelope went to the following address—and was signed for on June 8th by "G Juden"! If you do not find it in the building, just let me know and I'll redo the data disks and try again! Thanks.

Delivery date:
Wed, 6/8/2016 9:58 am

JIM HASTREITER
FERC
805 SW BROADWAY SUITE 550
PORTLAND, OR 97205
US

Shipment Facts

Our records indicate that the following package has been delivered.

Tracking number:	672504804848
Status:	Delivered: 06/08/2016 09:58 AM Signed for By: G.JUDEN
Department number:	HASTREITER
Reference:	10030930 rs

Signed for by:	G.JUDEN
Delivery location:	PORTLAND, OR
Delivered to:	Receptionist/Front Desk
Service type:	FedEx Standard Overnight
Packaging type:	FedEx Envelope
Number of pieces:	1
Weight:	0.50 lb.
Special handling/Services:	Deliver Weekday

Rose Staples, CAP-OM, MOS
D 207-239-3857

hdrinc.com/follow-us

From: James Hastreiter [mailto:James.Hastreiter@ferc.gov]
Sent: Monday, June 13, 2016 6:24 PM
To: Staples, Rose
Subject: Re: La Grange Data Disks Have Been Sent

Not yet Rose. I'll let you know when they arrive.

Thanks
Jim

From: Staples, Rose <Rose.Staples@hdrinc.com>
Sent: Monday, June 13, 2016 3:21:46 PM
To: James Hastreiter
Subject: RE: La Grange Data Disks Have Been Sent

Just checking in that you received the data disks okay! Thank you!

Rose Staples, CAP-OM, MOS
D 207-239-3857

hdrinc.com/follow-us

From: James Hastreiter [mailto:James.Hastreiter@ferc.gov]
Sent: Tuesday, June 07, 2016 3:55 PM
To: Staples, Rose
Subject: Re: La Grange Data Disks Have Been Sent

Thank you Rose.

From: Staples, Rose <Rose.Staples@hdrinc.com>
Sent: Tuesday, June 7, 2016 12:53:39 PM
To: James Hastreiter
Subject: La Grange Data Disks Have Been Sent

You should be receiving by tomorrow a set of the La Grange data disks forwarded to John Wooster earlier in May.

Rose Staples, CAP-OM, MOS
Executive Assistant

HDR
970 Baxter Boulevard Suite 301
Portland ME 04103
D 207-239-3857
rose.staples@hdrinc.com

hdrinc.com/follow-us

From: Le, Bao
Sent: Thursday, June 16, 2016 4:45 PM
To: Vaughn, Gary D -FS
Cc: Warnock, Cory; Neal, Morgan; Foote, Debra -FS
Subject: Re: Migration Barriers Study - use of drone for Lumsden Falls survey

Hi Dusty.

Thanks for getting back to me. Modifications to the barrier study permit for the Clavey trail camera will be great.

With regard to the use of a drone, that sounds fine. We can provide any information the regional safety officer may need and would work with our contractor to accomplish this. This survey work would not occur until the fall, so we have a little time to run this up the chain.

One additional heads up: next week, we'll be submitting an amendment on our temperature monitoring work to include some additional pool stratification monitoring. This work will be accomplished by vehicle/foot so no additional raft trips necessary for this. Look for this submittal next week.

Thanks! Bao

Sent from my iPhone

On Jun 16, 2016, at 3:50 PM, Vaughn, Gary D -FS <gdvaughn@fs.fed.us> wrote:

> Hi Bao,
>
> Sorry for the delayed response. We will be modifying the permit to include the extended stay as well as the camera on Clavey – Debbie can make these modifications when she returns next week. We're still trying to navigate emerging direction and guidance with our Regional Office over the permitting and use of UAS/drones. There is a good chance right now that our Regional Aviation Officer will need to review and approve a "Project Aviation Safety Plan" and confirm that your aircraft and pilot are up to speed with the FAA rules and regulations. Once I have a point of contact, I will pass their information along to you.
>
> Thanks,
>
> <image001.png>

Dusty Vaughn
Public Service Program Leader
Forest Service
Stanislaus National Forest, Groveland Ranger District
p: 209-962-7825 x525
f: 209-962-7412
gdvaughn@fs.fed.us
24545 State Highway 120
Groveland, CA 95321
www.fs.fed.us
<image002.png> <image003.png> <image004.png>
Caring for the land and serving people

From: Le, Bao [mailto:ChiBao.Le@hdrinc.com]
Sent: Monday, June 13, 2016 1:32 PM
To: Vaughn, Gary D -FS <gdvaughn@fs.fed.us>
Cc: Warnock, Cory <Cory.Warnock@hdrinc.com>; Neal, Morgan <Morgan.Neal@hdrinc.com>
Subject: RE: Migration Barriers Study - use of drone for Lumsden Falls survey

Hi Dusty.

I just left you a voicemail regarding a few loose ends on amendments to existing permits for last year's studies (i.e., temperature monitoring and barriers work) that I'd like to discuss. When you're back in the office on the 15th, please let me know when you might be available for a quick call. I can be reached by cell phone this week. 503-309-9423.

Thanks, Bao

From: Vaughn, Gary D -FS [mailto:gdvaughn@fs.fed.us]
Sent: Friday, June 03, 2016 3:09 PM
To: Le, Bao
Cc: Devine, John; Warnock, Cory; Foote, Debra -FS; Holdeman, Steven J -FS
Subject: Re: Migration Barriers Study - use of drone for Lumsden Falls survey

Hi Bao,

I just wanted to let you know that I have reached out to some of our Regional Office folks regarding the permitting and use of drones. It would be a great use of technology that minimizes impacts to the values we are trying to protect in the canyon. Our Tuolumne Wild & Scenic River Management Plan prohibits the use of aircraft within the designated corridor, except for emergencies. Drones are considered aircraft by the agency. I'll let you know as soon as I hear back from some of our agency experts.

Thanks,
Dusty Vaughn
Public Service Program Leader

Groveland Ranger District, Stanislaus NF
24545 Highway 120
Groveland, CA 95321
(209) 962-7825 ext. 525
Fax: (209) 962-7412
email: gdvaughn@fs.fed.us

On May 31, 2016, at 7:13 PM, Le, Bao <ChiBao.Le@hdrinc.com> wrote:

> Hi Dusty.
>
> John had mentioned that recently he discussed the possibility of using a drone at Lumsden Falls to collect survey grade information to further inform the upstream migration barriers study being conducted in support of the Reintroduction Assessment Framework. It sounded like there was the potential to use this technology so I wanted to

circle back with you to discuss potential next steps and if/how we might proceed forward. Additional notes for consideration:

1. We have a brief scope of the proposed work and can provide that to you if interested.
2. We plan to conduct the work in the fall (after the rafting season is over) and think that it can be done in a day although we'd budget for two days to address unforeseen issues. Note that data collection would be considerably more efficient and result in much less time than a traditional survey.
3. We'd plan to submit this activity has an amendment to our existing USFS Permit for the Barriers Study unless otherwise instructed by your agency.

As you know, we've been working with Debbie to not only get the new 2016 study program permitted (application to be submitted later this week) but to identify potential refinements to our existing permits (via amendments).

Please let me know the best way to proceed regarding this item and if you have any other questions.

Thanks, Bao

Bao Le
Senior Fisheries Biologist

HDR
1001 SW 5th Avenue, Suite 1800
Portland, OR 97204-1134
D 971.202.1722 **M** 503.309.9423
bao.le@hdrinc.com

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From: Staples, Rose
Sent: Friday, June 17, 2016 11:32 AM
Cc: Deason, Jesse; Le, Bao; Staples, Rose
Subject: Correction to SAVE THE DATE - September 15, 2016 - La Grange Workshop No 6

Licensing Participants,

Please note that the LOCATION of the workshop/meeting on September 15th has been updated to read "TID"; thank you!

At Workshop No. 5 held on May 19, 2016, we set the date for our next meeting/workshop to be **Thursday, September 15, 2016** (from 10:00 a.m. to Noon) at the **TID** Offices in Turlock.

Additional details such as the agenda will be forthcoming closer to the meeting time; but we wanted to confirm the date on your calendar.

Thank you.

Rose Staples, CAP-OM, MOS
Executive Assistant

HDR
970 Baxter Boulevard Suite 301
Portland ME 04103
D 207-239-3857
rose.staples@hdrinc.com

hdrinc.com/follow-us

From: Le, Bao
Sent: Monday, June 20, 2016 11:41 AM
To: dfoote@fs.fed.us; Vaughn, Gary D -FS
Cc: Holdeman, Steven J -FS; jeicher@blm.gov; Deason, Jesse; Borovansky, Jenna; Warnock, Cory
Subject: Temperature Permit Amendment Application
Attachments: USFS Permit Amendment Application for Temperature Study_signed.pdf; Attachment A__TempAmendment_SF 299_6-17-2016.docx; Attachment B_OriginalPermit and Amendment_2015.pdf

Hi Debbie and Dusty.

Please find attached an amendment application to our existing temperature monitoring and modeling study permit in order to monitor/survey several deep pools in the Upper Tuolumne River over . The information will allow us to better integrate temperature dynamics in pools as part of our model development.

Please confirm receipt and let me know if you have any questions.

Thank you,
Bao

Bao Le
Senior Fisheries Biologist

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Authorization ID: GRO1122
Contact Name: TURLOCK IRRIGATION DISTRICT
Expiration Date: 12/31/2017
Use Code: 422

FS-2700-4 (V. 01/2014)
OMB 0596-0082

U.S. DEPARTMENT OF AGRICULTURE
FOREST SERVICE
SPECIAL USE PERMIT
Authority: ORGANIC ADMINISTRATION ACT June4, 1897

TURLOCK IRRIGATION DISTRICT of 333 EAST CANAL DRIVE TURLOCK CA 95380 (hereinafter "the holder") is authorized to use or occupy National Forest System lands in the Stanislaus National Forest, subject to the terms and conditions of this special use permit (the permit).

This permit covers less than 1 acre in the Stanislaus National Forest, ("the permit area"), as shown on the map(s) attached as Appendix A. This permit issued for the purpose of:

Installing, monitoring, and maintaining water temperature recorders at 10 locations. Each recorder will be placed in the active channel and secured by a removable steel cable or chain tethered to a stable root mass, boulder, or man-made structure such that the recorder is secured in the channel during high-flow periods. The recorder will be installed in the channel thalweg, and the housing and cable will be disguised as much as possible while ensuring the ability to retrieve the unit for future downloads.

TERMS AND CONDITIONS

I. GENERAL TERMS

A. AUTHORITY. This permit is issued pursuant to **ORGANIC ADMINISTRATION ACT June 4, 1897** and 36 CFR Part 251, Subpart B, as amended, and is subject to their provisions.

B. AUTHORIZED OFFICER. The authorized officer is the Forest or Grassland Supervisor or a subordinate officer with delegated authority.

C. TERM. This permit shall expire at midnight on 12/31/2016, 1 year and 8 months from the date of issuance.

D. RENEWAL. This permit is not renewable. Prior to expiration of this permit, the holder may apply for a new permit that would renew the use and occupancy authorized by this permit. Applications for a new permit must be submitted at least 6 months prior to expiration of this permit. Renewal of the use and occupancy authorized by this permit shall be at the sole discretion of the authorized officer. At a minimum, before renewing the use and occupancy authorized by this permit, the authorized officer shall require that (1) the use and occupancy to be authorized by the new permit

is consistent with the standards and guidelines in the applicable land management plan; (2) the type of use and occupancy to be authorized by the new permit is the same as the type of use and occupancy authorized by this permit; and (3) the holder is in compliance with all the terms of this permit. The authorized officer may prescribe new terms and conditions when a new permit is issued.

E. AMENDMENT. This permit may be amended in whole or in part by the Forest Service when, at the discretion of the authorized officer, such action is deemed necessary or desirable to incorporate new terms that may be required by law, regulation, directive, the applicable forest land and resource management plan, or projects and activities implementing a land management plan pursuant to 36 CFR Part 215.

F. COMPLIANCE WITH LAWS, REGULATIONS, AND OTHER LEGAL REQUIREMENTS. In exercising the rights and privileges granted by this permit, the holder shall comply with all present and future federal laws and regulations and all present and future state, county, and municipal laws, regulations, and other legal requirements that apply to the permit area, to the extent they do not conflict with federal law, regulation, or policy. The Forest Service assumes no responsibility for enforcing laws, regulations, and other legal requirements that fall under the jurisdiction of other governmental entities.

G. NON-EXCLUSIVE USE. The use or occupancy authorized by this permit is not exclusive. The Forest Service reserves the right of access to the permit area, including a continuing right of physical entry to the permit area for inspection, monitoring, or any other purpose consistent with any right or obligation of the United States under any law or regulation. The Forest Service reserves the right to allow others to use the permit area in any way that is not inconsistent with the holder's rights and privileges under this permit, after consultation with all parties involved. Except for any restrictions that the holder and the authorized officer agree are necessary to protect the installation and operation of authorized temporary improvements, the lands and waters covered by this permit shall remain open to the public for all lawful purposes.

H. ASSIGNABILITY. This permit is not assignable or transferable.

II. IMPROVEMENTS

A. LIMITATIONS ON USE. Nothing in this permit gives or implies permission to build or maintain any structure or facility or to conduct any activity, unless specifically authorized by this permit. Any use not specifically authorized by this permit must be proposed in accordance with 36 CFR 251.54. Approval of such a proposal through issuance of a new permit or permit amendment is at the sole discretion of the authorized officer.

B. PLANS. All plans for development, layout, construction, reconstruction, or alteration of improvements in the permit area, as well as revisions to those plans must be prepared by a professional engineer, architect, landscape architect, or other qualified professional based on federal employment standards acceptable to the authorized officer. These plans and plan revisions must have written approval from the authorized officer before they are implemented. The authorized officer may require the holder to furnish as-built plans, maps, or surveys upon completion of the work.

C. CONSTRUCTION. Any construction authorized by this permit shall commence by NA and shall be completed by NA.

III. OPERATIONS

A. PERIOD OF USE. Use or occupancy of the permit area shall be exercised at least 3 months each year.

B. CONDITION OF OPERATIONS. The holder shall maintain the authorized improvements and permit area to standards of repair, orderliness, neatness, sanitation, and safety acceptable to the authorized officer and consistent with other provisions of this permit. Standards are subject to periodic change by the authorized officer when deemed necessary to meet statutory, regulatory, or policy requirements or to protect national forest resources. The holder shall comply with inspection requirements deemed appropriate by the authorized officer.

C. INSPECTION BY THE FOREST SERVICE. The Forest Service shall monitor the holder's operations and reserves the right to inspect the permit area and transmission facilities at any time for compliance with the terms of this permit. The holder's obligations under this permit are not contingent upon any duty of the Forest Service to inspect the permit area or transmission facilities. A failure by the Forest Service or other governmental officials to inspect is not a justification for noncompliance with any of the terms and conditions of this permit.

IV. RIGHTS AND LIABILITIES

A. LEGAL EFFECT OF THE PERMIT. This permit, which is revocable and terminable, is not a contract or a lease, but rather a federal license. The benefits and requirements conferred by this authorization are reviewable solely under the procedures set forth in 36 CFR 251, Subpart C and 5 U.S.C. 704. This permit does not constitute a contract for purposes of the Contract Disputes Act, 41 U.S.C. 601. The permit is not real property, does not convey any interest in real property, and may not be used as collateral for a loan.

B. VALID OUTSTANDING RIGHTS. This permit is subject to all valid outstanding rights. Valid outstanding rights include those derived under mining and mineral leasing laws of the United States. The United States is not liable to the holder for the exercise of any such right.

C. ABSENCE OF THIRD-PARTY BENEFICIARY RIGHTS. The parties to this permit do not intend to confer any rights on any third party as a beneficiary under this permit.

D. SERVICES NOT PROVIDED. This permit does not provide for the furnishing of road or trail maintenance, water, fire protection, search and rescue, or any other such service by a government agency, utility, association, or individual.

E. RISK OF LOSS. The holder assumes all risk of loss associated with use or occupancy of the permit area, including but not limited to theft, vandalism, fire and any fire-fighting activities (including prescribed burns), avalanches, rising waters, winds, falling limbs or trees, and other forces of nature. If authorized temporary improvements in the permit area are destroyed or substantially

damaged, the authorized officer shall conduct an analysis to determine whether the improvements can be safely occupied in the future and whether rebuilding should be allowed. If rebuilding is not allowed, the permit shall terminate.

F. **DAMAGE TO UNITED STATES PROPERTY.** The holder has an affirmative duty to protect from damage the land, property, and other interests of the United States. Damage includes but is not limited to fire suppression costs, damage to government-owned improvements covered by this permit, and all costs and damages associated with or resulting from the release or threatened release of a hazardous material occurring during or as a result of activities of the holder or the holder's heirs, assigns, agents, employees, contractors, or lessees on, or related to, the lands, property, and other interests covered by this permit. For purposes of clause IV.F and section V, "hazardous material" shall mean (a) any hazardous substance under section 101(14) of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), 42 U.S.C. § 9601(14); (b) any pollutant or contaminant under section 101(33) of CERCLA, 42 U.S.C. § 9601(33); (c) any petroleum product or its derivative, including fuel oil, and waste oils; and (d) any hazardous substance, extremely hazardous substance, toxic substance, hazardous waste, ignitable, reactive or corrosive materials, pollutant, contaminant, element, compound, mixture, solution or substance that may pose a present or potential hazard to human health or the environment under any applicable environmental laws.

1. The holder shall avoid damaging or contaminating the environment, including but not limited to the soil, vegetation (such as trees, shrubs, and grass), surface water, and groundwater, during the holder's use or occupancy of the permit area. If the environment or any government property covered by this permit becomes damaged during the holder's use or occupancy of the permit area, the holder shall immediately repair the damage or replace the damaged items to the satisfaction of the authorized officer and at no expense to the United States.

2. The holder shall be liable for all injury, loss, or damage, including fire suppression, prevention and control of the spread of invasive species, or other costs in connection with rehabilitation or restoration of natural resources associated with the use or occupancy authorized by this permit. Compensation shall include but not be limited to the value of resources damaged or destroyed, the costs of restoration, cleanup, or other mitigation, fire suppression or other types of abatement costs, and all administrative, legal (including attorney's fees), and other costs. Such costs may be deducted from a performance bond required under clause IV.I.

3. The holder shall be liable for damage caused by use of the holder or the holder's heirs, assigns, agents, employees, contractors, or lessees to all roads and trails of the United States to the same extent as provided under clause IV.F.1, except that liability shall not include reasonable and ordinary wear and tear.

G. **HEALTH, SAFETY, AND ENVIRONMENTAL PROTECTION.** The holder shall promptly abate as completely as possible and in compliance with all applicable laws and regulations any activity or condition arising out of or relating to the authorized use or occupancy that causes or threatens to cause a hazard to public health or the safety of the holder's employees or agents or harm to the environment (including areas of vegetation or timber, fish or other wildlife populations, their habitats, or any other natural resources). The holder shall prevent impacts to the environment and cultural resources by implementing actions identified in the operating plan to prevent establishment

and spread of invasive species. The holder shall immediately notify the authorized officer of all serious accidents that occur in connection with such activities. The responsibility to protect the health and safety of all persons affected by the use or occupancy authorized by this permit is solely that of the holder. The Forest Service has no duty under the terms of this permit to inspect the permit area or operations and activities of the holder for hazardous conditions or compliance with health and safety standards.

H. INDEMNIFICATION OF THE UNITED STATES. The holder shall indemnify, defend, and hold harmless the United States for any costs, damages, claims, liabilities, and judgments arising from past, present, and future acts or omissions of the holder in connection with the use or occupancy authorized by this permit. This indemnification provision includes but is not limited to acts and omissions of the holder or the holder's heirs, assigns, agents, employees, contractors, or lessees in connection with the use or occupancy authorized by this permit which result in (1) violations of any laws and regulations which are now or which may in the future become applicable, and including but not limited to those environmental laws listed in clause V.A of this permit; (2) judgments, claims, demands, penalties, or fees assessed against the United States; (3) costs, expenses, and damages incurred by the United States; or (4) the release or threatened release of any solid waste, hazardous waste, hazardous materials, pollutant, contaminant, oil in any form, or petroleum product into the environment. The authorized officer may prescribe terms that allow the holder to replace, repair, restore, or otherwise undertake necessary curative actions to mitigate damages in addition to or as an alternative to monetary indemnification.

V. RESOURCE PROTECTION

A. COMPLIANCE WITH ENVIRONMENTAL LAWS. The holder shall in connection with the use or occupancy authorized by this permit comply with all applicable federal, state, and local environmental laws and regulations, including but not limited to those established pursuant to the Resource Conservation and Recovery Act, as amended, 42 U.S.C. 6901 et seq., the Federal Water Pollution Control Act, as amended, 33 U.S.C. 1251 et seq., the Oil Pollution Act, as amended, 33 U.S.C. 2701 et seq., the Clean Air Act, as amended, 42 U.S.C. 7401 et seq., CERCLA, as amended, 42 U.S.C. 9601 et seq., the Toxic Substances Control Act, as amended, 15 U.S.C. 2601 et seq., the Federal Insecticide, Fungicide, and Rodenticide Act, as amended, 7 U.S.C. 136 et seq., and the Safe Drinking Water Act, as amended, 42 U.S.C. 300f et seq.

B. VANDALISM. The holder shall take reasonable measures to prevent and discourage vandalism and disorderly conduct and when necessary shall contact the appropriate law enforcement officer.

C. PESTICIDE USE. Pesticides may not be used outside of buildings to control undesirable woody and herbaceous vegetation (including aquatic plants), insects, rodents, fish, and other pests and weeds without prior written approval from the authorized officer. A request for approval of planned uses of pesticides shall be submitted annually by the holder on the due date established by the authorized officer. The report shall cover a 12-month period of planned use beginning 3 months after the reporting date. Information essential for review shall be provided in the form specified. Exceptions to this schedule may be allowed, subject to emergency request and approval, only when unexpected outbreaks of pests or weeds require control measures that were not anticipated at the time an annual report was submitted. Only those materials registered by the U.S. Environmental

Protection Agency for the specific purpose planned shall be considered for use on National Forest System lands. Label instructions and all applicable laws and regulations shall be strictly followed in the application of pesticides and disposal of excess materials and containers.

D. ARCHAEOLOGICAL-PALEONTOLOGICAL DISCOVERIES. The holder shall immediately notify the authorized officer of all antiquities or other objects of historic or scientific interest, including but not limited to historic or prehistoric ruins, fossils, or artifacts discovered in connection with the use and occupancy authorized by this permit. The holder shall leave these discoveries intact and in place until directed otherwise by the authorized officer. Protective and mitigative measures specified by the authorized officer shall be the responsibility of the holder.

E. NATIVE AMERICAN GRAVES PROTECTION AND REPATRIATION. In accordance with 25 U.S.C. 3002(d) and 43 CFR 10.4, if the holder inadvertently discovers human remains, funerary objects, sacred objects, or objects of cultural patrimony on National Forest System lands, the holder shall immediately cease work in the area of the discovery and shall make a reasonable effort to protect and secure the items. The holder shall immediately notify the authorized officer by telephone of the discovery and shall follow up with written confirmation of the discovery. The activity that resulted in the inadvertent discovery may not resume until 30 days after the authorized officer certifies receipt of the written confirmation, if resumption of the activity is otherwise lawful, or at any time if a binding written agreement has been executed between the Forest Service and the affiliated Indian tribes that adopts a recovery plan for the human remains and objects.

F. PROTECTION OF HABITAT OF THREATENED, ENDANGERED, AND SENSITIVE SPECIES. The location of sites within the permit area needing special measures for protection of plants or animals listed as threatened or endangered under the Endangered Species Act (ESA) of 1973, 16 U.S.C. 1531 et seq., as amended, or identified as sensitive or otherwise requiring special protection by the Regional Forester under Forest Service Manual (FSM) 2670, pursuant to consultation conducted under section 7 of the ESA, may be shown on the ground or on a separate map. The map shall be attached to this permit as an appendix. The holder shall take any protective and mitigative measures specified by the authorized officer. If protective and mitigative measures prove inadequate, if other sites within the permit area containing threatened, endangered, or sensitive species or species otherwise requiring special protection are discovered, or if new species are listed as threatened or endangered under the ESA or identified as sensitive or otherwise requiring special protection by the Regional Forester under the FSM, the authorized officer may specify additional protective and mitigative measures. Discovery of these sites by the holder or the Forest Service shall be promptly reported to the other party.

G. CONSENT TO STORE HAZARDOUS MATERIALS. The holder shall not store any hazardous materials at the site without prior written approval from the authorized officer. This approval shall not be unreasonably withheld. If the authorized officer provides approval, this permit shall include, or in the case of approval provided after this permit is issued, shall be amended to include specific terms addressing the storage of hazardous materials, including the specific type of materials to be stored, the volume, the type of storage, and a spill plan. Such terms shall be proposed by the holder and are subject to approval by the authorized officer.

H. CLEANUP AND REMEDIATION.

1. The holder shall immediately notify all appropriate response authorities, including the National Response Center and the authorized officer or the authorized officer's designated representative, of any oil discharge or of the release of a hazardous material in the permit area in an amount greater than or equal to its reportable quantity, in accordance with 33 CFR Part 153, Subpart B, and 40 CFR Part 302. For the purposes of this requirement, "oil" is as defined by section 311(a)(1) of the Clean Water Act, 33 U.S.C. 1321(a)(1). The holder shall immediately notify the authorized officer or the authorized officer's designated representative of any release or threatened release of any hazardous material in or near the permit area which may be harmful to public health or welfare or which may adversely affect natural resources on federal lands.

2. Except with respect to any federally permitted release as that term is defined under Section 101(10) of CERCLA, 42 U.S.C. 9601(10), the holder shall clean up or otherwise remediate any release, threat of release, or discharge of hazardous materials that occurs either in the permit area or in connection with the holder's activities in the permit area, regardless of whether those activities are authorized under this permit. The holder shall perform cleanup or remediation immediately upon discovery of the release, threat of release, or discharge of hazardous materials. The holder shall perform the cleanup or remediation to the satisfaction of the authorized officer and at no expense to the United States. Upon revocation or termination of this permit, the holder shall deliver the site to the Forest Service free and clear of contamination.

I. CERTIFICATION UPON REVOCATION OR TERMINATION. If the holder uses or stores hazardous materials at the site, upon revocation or termination of this permit the holder shall provide the Forest Service with a report certified by a professional or professionals acceptable to the Forest Service that the permit area is uncontaminated by the presence of hazardous materials and that there has not been a release or discharge of hazardous materials upon the permit area, into surface water at or near the permit area, or into groundwater below the permit area during the term of the permit. This certification requirement may be waived by the authorized officer when the Forest Service determines that the risks posed by the hazardous material are minimal. If a release or discharge has occurred, the professional or professionals shall document and certify that the release or discharge has been fully remediated and that the permit area is in compliance with all federal, state, and local laws and regulations.

VI. LAND USE FEE AND ACCOUNTING ISSUES

A. LAND USE FEES. The use or occupancy authorized by this permit is exempt from a land use fee or the land use fee has been waived in full pursuant to 36 CFR 251.57 and Forest Service Handbook 2709.11, Chapter 30.

VII. REVOCATION, SUSPENSION, AND TERMINATION

A. REVOCATION AND SUSPENSION. The authorized officer may revoke or suspend this permit in whole or in part:

1. For noncompliance with federal, state, or local law.

2. For noncompliance with the terms of this permit.

3. For abandonment or other failure of the holder to exercise the privileges granted.

4. With the consent of the holder.

5. For specific and compelling reasons in the public interest.

Prior to revocation or suspension, other than immediate suspension under clause VII.B, the authorized officer shall give the holder written notice of the grounds for revocation or suspension. In the case of revocation or suspension based on clause VII.A.1, 2, or 3, the authorized officer shall give the holder a reasonable time, typically not to exceed 90 days, to cure any noncompliance.

B. IMMEDIATE SUSPENSION. The authorized officer may immediately suspend this permit in whole or in part when necessary to protect public health or safety or the environment. The suspension decision shall be in writing. The holder may request an on-site review with the authorized officer's supervisor of the adverse conditions prompting the suspension. The authorized officer's supervisor shall grant this request within 48 hours. Following the on-site review, the authorized officer's supervisor shall promptly affirm, modify, or cancel the suspension.

C. APPEALS AND REMEDIES. Written decisions by the authorized officer relating to administration of this permit are subject to administrative appeal pursuant to 36 CFR Part 214 as amended. Revocation or suspension of this permit shall not give rise to any claim for damages by the holder against the Forest Service.

D. TERMINATION. This permit shall terminate when by its terms a fixed or agreed upon condition, event, or time occurs without any action by the authorized officer. Examples include but are not limited to expiration of the permit by its terms on a specified date and termination upon change of control of the business entity. Termination of this permit shall not require notice, a decision document, or any environmental analysis or other documentation. Termination of this permit is not subject to administrative appeal and shall not give rise to any claim for damages by the holder against the Forest Service.

E. RIGHTS AND RESPONSIBILITIES UPON REVOCATION OR TERMINATION WITHOUT RENEWAL. Upon revocation or termination of this permit without renewal of the authorized use, the holder shall remove all structures and improvements, except those owned by the United States, within a reasonable period prescribed by the authorized officer and shall restore the site to the satisfaction of the authorized officer. If the holder fails to remove all structures and improvements within the prescribed period, they shall become the property of the United States and may be sold, destroyed, or otherwise disposed of without any liability to the United States. However, the holder shall remain liable for all costs associated with their removal, including costs of sale and impoundment, cleanup, and restoration of the site.

VIII. MISCELLANEOUS PROVISIONS

A. MEMBERS OF CONGRESS. No member of or delegate to Congress or resident commissioner shall benefit from this permit either directly or indirectly, except to the extent the authorized use provides a general benefit to a corporation.

B. CURRENT ADDRESSES. The holder and the Forest Service shall keep each other informed of current mailing addresses, including those necessary for billing and payment of land use fees.

C. SUPERIOR CLAUSES. If there is a conflict between any of the preceding printed clauses and any of the following clauses, the preceding printed clauses shall control.

THIS PERMIT IS ACCEPTED SUBJECT TO ALL ITS TERMS AND CONDITIONS.

BEFORE ANY PERMIT IS ISSUED TO AN ENTITY, DOCUMENTATION MUST BE PROVIDED TO THE AUTHORIZED OFFICER OF THE AUTHORITY OF THE SIGNATORY FOR THE ENTITY TO BIND IT TO THE TERMS AND CONDITIONS OF THE PERMIT.

ACCEPTED:

Steve Boyd — April 10, 2015

Steve Boyd, Licensing Coordinator — DATE

APPROVED:

Jim Junette — 04/22/15

Jim Junette, District Ranger — DATE

According to the Paperwork Reduction Act of 1995, an agency may not conduct or sponsor, and a person is not required to respond to a collection of information unless it displays a valid OMB control number. The valid OMB control number for this information collection is 0596-0082. The time required to complete this information collection is estimated to average one hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information.

The U.S. Department of Agriculture (USDA) prohibits discrimination in all its programs and activities on the basis of race, color, national origin, gender, religion, age, disability, political beliefs, sexual orientation, and marital or family status. (Not all prohibited bases apply to all programs.) Persons with disabilities who require alternative means for communication of program information (Braille, large print, audiotape, etc.) should contact USDA's TARGET Center at 202-720-2600 (voice and TDD).

To file a complaint of discrimination, write USDA, Director, Office of Civil Rights, 1400 Independence Avenue, SW, Washington, DC 20250-9410 or call (800) 975-3272 (voice) or (202) 720-6382 (TDD). USDA is an equal opportunity provider and employer

The Privacy Act of 1974 (5 U.S.C. 552a) and the Freedom of Information Act (5 U.S.C. 552) govern the confidentiality to be provided for information received by the Forest Service.

Appendix A

Attachment B for Forest Service SF-299
Filed by Turlock and Modesto Irrigation Districts
and HDR, Inc.
April 1, 2015

8. Maps of proposed water temperature logger locations (Figure 1 to Figure 7).

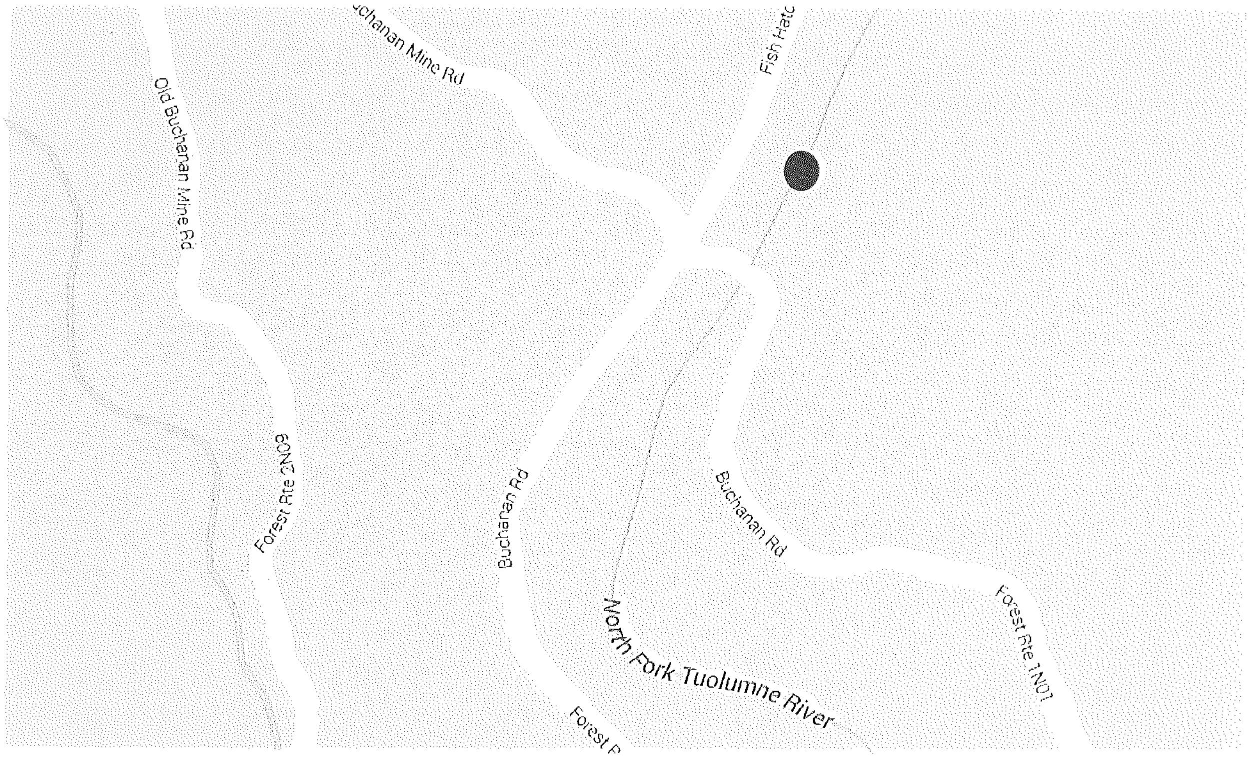

Figure 1. Approximate location of proposed temperature logger installation on North Fork Tuolumne River.

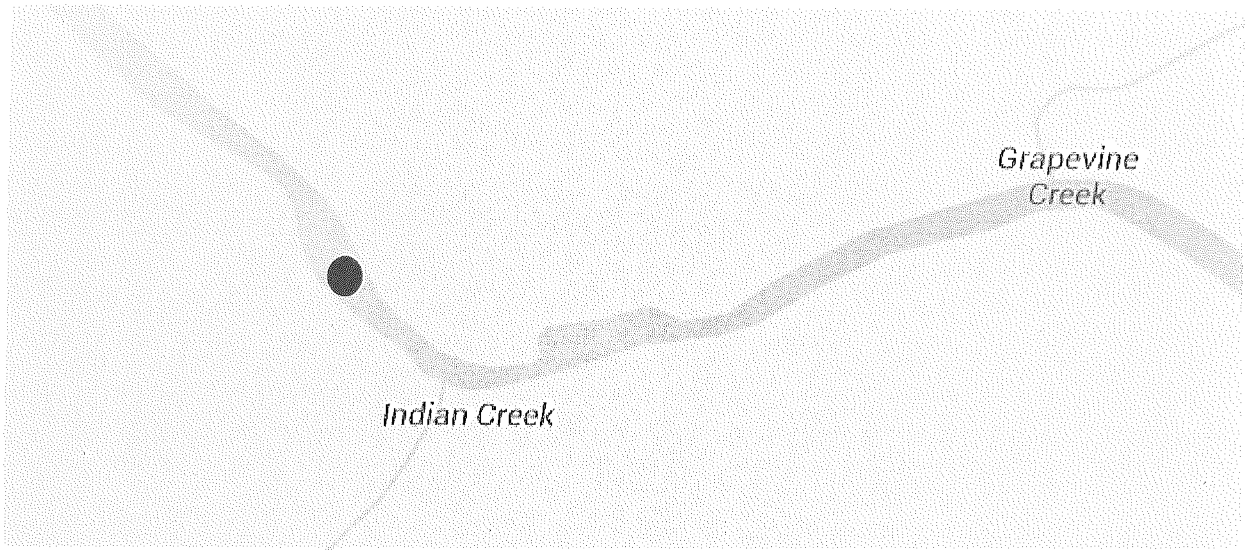

Figure 2. Approximate location of proposed temperature logger installation on the Tuolumne River near Indian Creek.

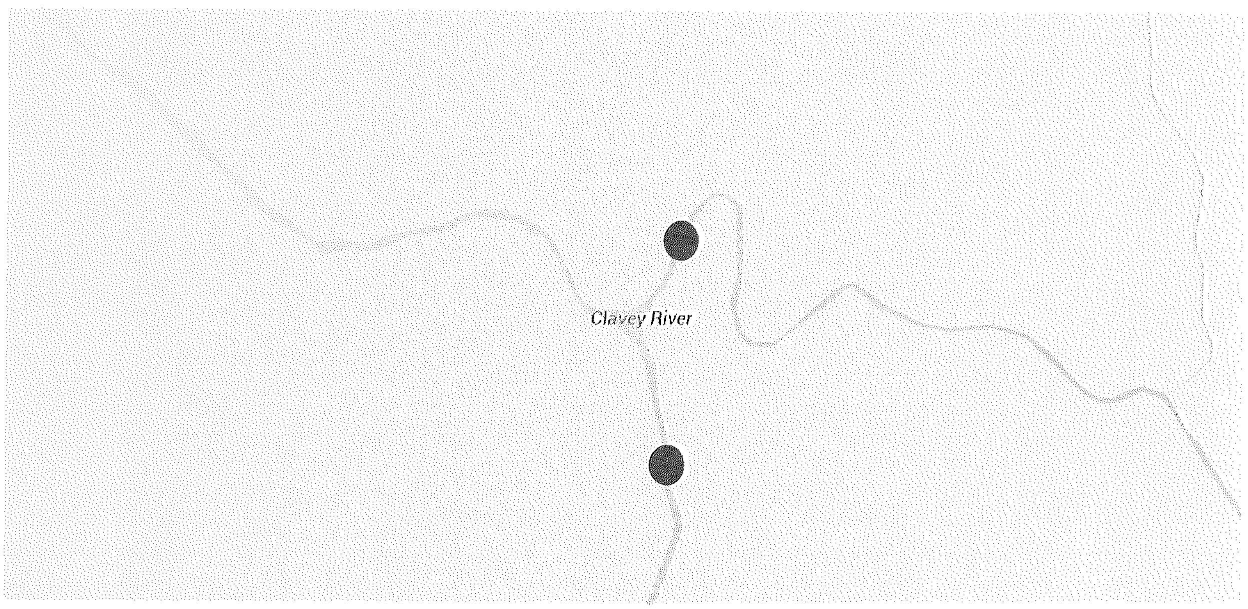

Figure 3. Approximate locations of proposed temperature logger installations on the Clavey and Tuolumne rivers.

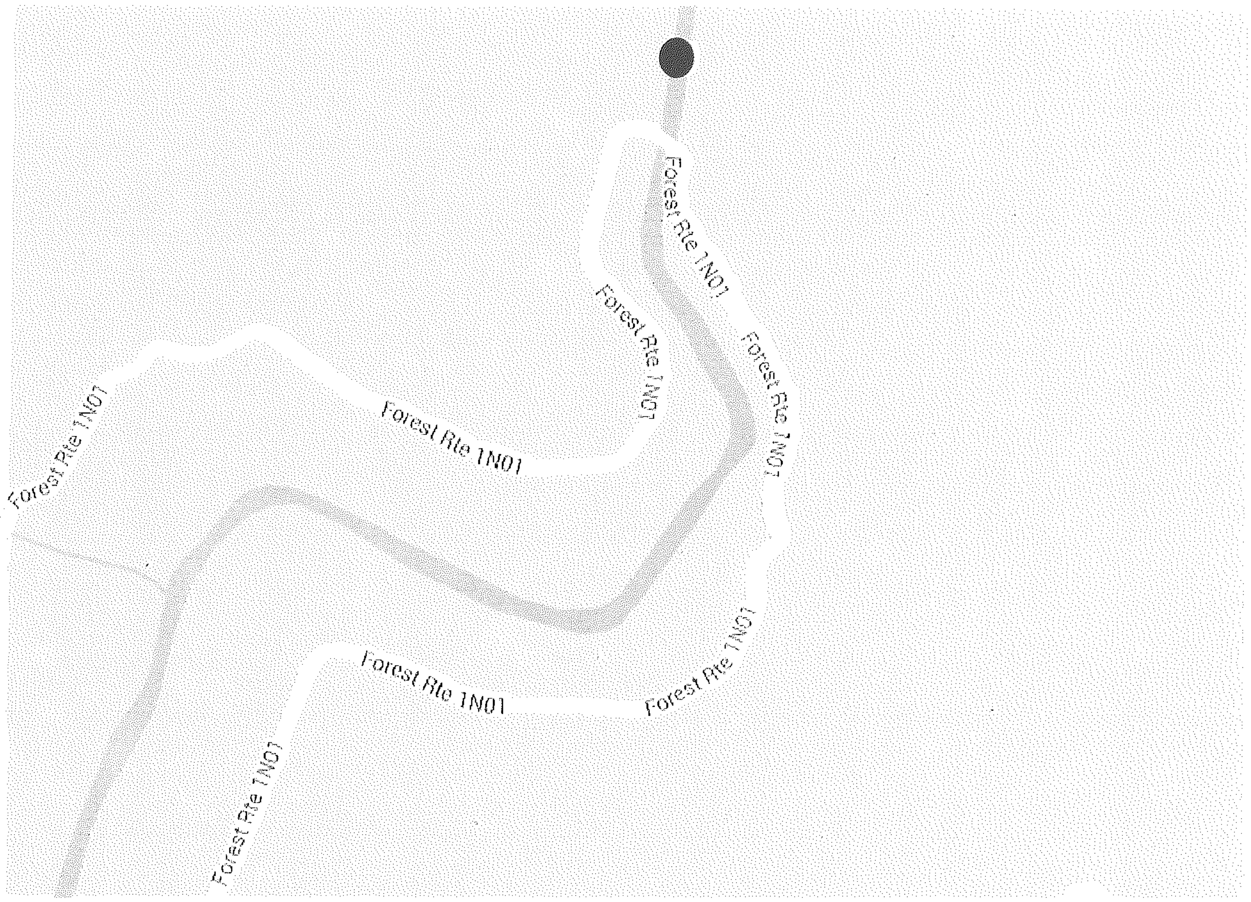

Figure 4. Approximate location of proposed temperature logger installation on the Clavey River near Forest Route 1N01.

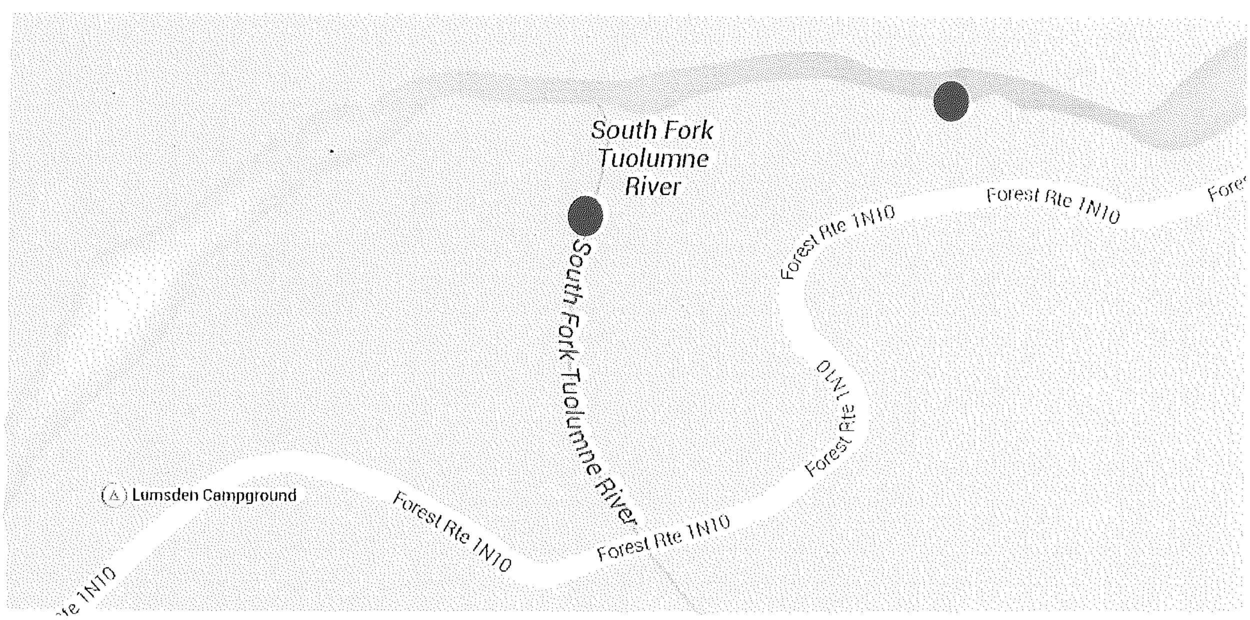

Figure 5. Approximate location of proposed temperature logger installations on the South Fork Tuolumne and Tuolumne rivers.

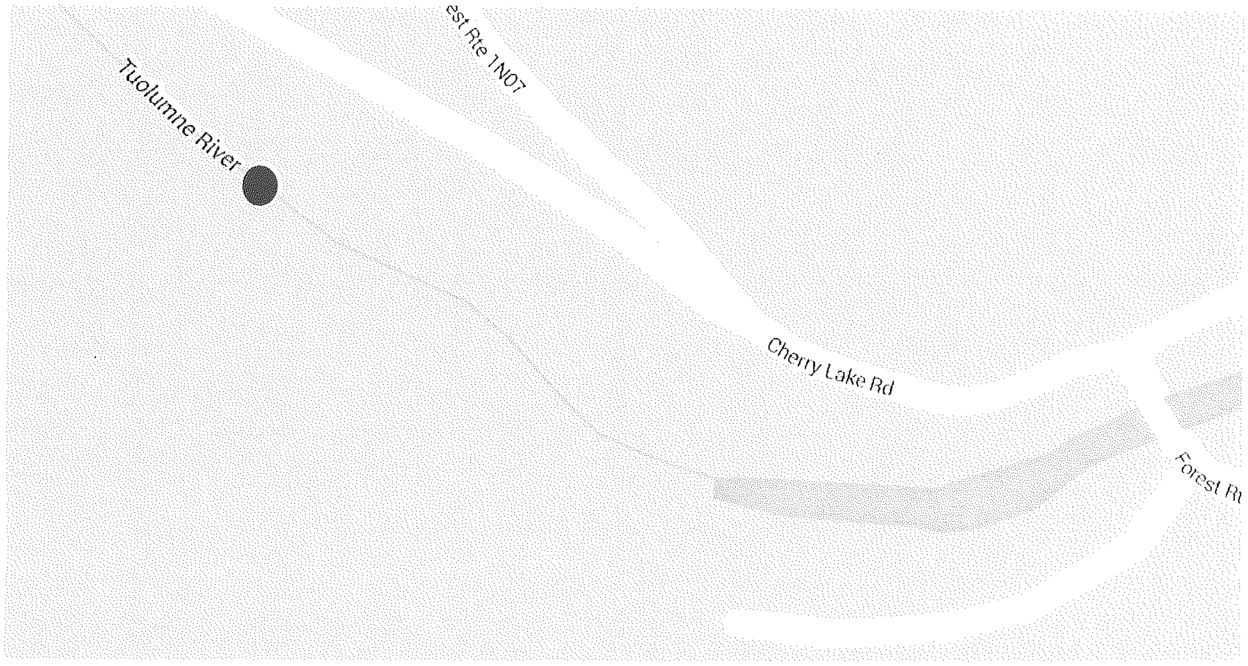

Figure 6. Approximate location of proposed temperature logger installation on the Tuolumne River below Early Intake Diversion.

Figure 7. Approximate location of proposed temperature logger installations on Cherry Creek above and below the Powerhouse.

Auth ID: GRO1122
Contact ID: 611267010602
Use Code: 422

FS-2700-23 (v. 10/09)
OMB No. 0596-0082

U.S. DEPARTMENT OF AGRICULTURE
FOREST SERVICE
AMENDMENT
FOR

SPECIAL-USE AUTHORIZATION

Amendment # 1

This amendment is attached to and made a part of the GRO1122 special use authorization for Research issued to TURLOCK IRRIGATION DISTRICT on 04/22/2015 which is hereby amended as follows:

Install, monitor, and maintain ten additional water temperature recorders seven locations will have Onset U20 Level loggers and three will have Onset Tidbit water temperature recorders see Attachment A (Project Description) for method of installation. The route of travel will be on Forest Roads 1N97, 1N07, 1N14, and 1N10 then by foot. Prior to any changes in installation, or access written approval must be received from the Forest Service.

This Amendment is accepted subject to the conditions set forth herein, and to conditions in Attachment A and Attachment B (Map) attached hereto and made a part of this Amendment.

Holder	Authorized Officer
Holder	Title
Date	Date

Authorization ID: GRO1122
Contact Name: TURLOCK IRRIGATION DISTRICT
Expiration Date: 12/31/2017
Use Code: 422

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E. AMENDMENT. This permit may be amended in whole or in part by the Forest Service when, at the discretion of the authorized officer, such action is deemed necessary or desirable to incorporate new terms that may be required by law, regulation, directive, the applicable forest land and resource management plan, or projects and activities implementing a land management plan pursuant to 36 CFR Part 215.

F. COMPLIANCE WITH LAWS, REGULATIONS, AND OTHER LEGAL REQUIREMENTS. In exercising the rights and privileges granted by this permit, the holder shall comply with all present and future federal laws and regulations and all present and future state, county, and municipal laws, regulations, and other legal requirements that apply to the permit area, to the extent they do not conflict with federal law, regulation, or policy. The Forest Service assumes no responsibility for enforcing laws, regulations, and other legal requirements that fall under the jurisdiction of other governmental entities.

G. NON-EXCLUSIVE USE. The use or occupancy authorized by this permit is not exclusive. The Forest Service reserves the right of access to the permit area, including a continuing right of physical entry to the permit area for inspection, monitoring, or any other purpose consistent with any right or obligation of the United States under any law or regulation. The Forest Service reserves the right to allow others to use the permit area in any way that is not inconsistent with the holder's rights and privileges under this permit, after consultation with all parties involved. Except for any restrictions that the holder and the authorized officer agree are necessary to protect the installation and operation of authorized temporary improvements, the lands and waters covered by this permit shall remain open to the public for all lawful purposes.

H. ASSIGNABILITY. This permit is not assignable or transferable.

II.IMPROVEMENTS

A. LIMITATIONS ON USE. Nothing in this permit gives or implies permission to build or maintain any structure or facility or to conduct any activity, unless specifically authorized by this permit. Any use not specifically authorized by this permit must be proposed in accordance with 36 CFR 251.54. Approval of such a proposal through issuance of a new permit or permit amendment is at the sole discretion of the authorized officer.

B. PLANS. All plans for development, layout, construction, reconstruction, or alteration of improvements in the permit area, as well as revisions to those plans must be prepared by a professional engineer, architect, landscape architect, or other qualified professional based on federal employment standards acceptable to the authorized officer. These plans and plan revisions must have written approval from the authorized officer before they are implemented. The authorized officer may require the holder to furnish as-built plans, maps, or surveys upon completion of the work.

C. **CONSTRUCTION**. Any construction authorized by this permit shall commence by NA and shall be completed by NA.

III. OPERATIONS

A. **PERIOD OF USE.** Use or occupancy of the permit area shall be exercised at least 3 months each year.

B. **CONDITION OF OPERATIONS.** The holder shall maintain the authorized improvements and permit area to standards of repair, orderliness, neatness, sanitation, and safety acceptable to the authorized officer and consistent with other provisions of this permit. Standards are subject to periodic change by the authorized officer when deemed necessary to meet statutory, regulatory, or policy requirements or to protect national forest resources. The holder shall comply with inspection requirements deemed appropriate by the authorized officer.

C. **INSPECTION BY THE FOREST SERVICE.** The Forest Service shall monitor the holder's operations and reserves the right to inspect the permit area and transmission facilities at any time for compliance with the terms of this permit. The holder's obligations under this permit are not contingent upon any duty of the Forest Service to inspect the permit area or transmission facilities. A failure by the Forest Service or other governmental officials to inspect is not a justification for noncompliance with any of the terms and conditions of this permit.

IV. RIGHTS AND LIABILITIES

A. **LEGAL EFFECT OF THE PERMIT.** This permit, which is revocable and terminable, is not a contract or a lease, but rather a federal license. The benefits and requirements conferred by this authorization are reviewable solely under the procedures set forth in 36 CFR 251, Subpart C and 5 U.S.C. 704. This permit does not constitute a contract for purposes of the Contract Disputes Act, 41 U.S.C. 601. The permit is not real property, does not convey any interest in real property, and may not be used as collateral for a loan.

B. **VALID OUTSTANDING RIGHTS.** This permit is subject to all valid outstanding rights. Valid outstanding rights include those derived under mining and mineral leasing laws of the United States. The United States is not liable to the holder for the exercise of any such right.

C. **ABSENCE OF THIRD-PARTY BENEFICIARY RIGHTS.** The parties to this permit do not intend to confer any rights on any third party as a beneficiary under this permit.

D. **SERVICES NOT PROVIDED.** This permit does not provide for the furnishing of road or trail maintenance, water, fire protection, search and rescue, or any other such service by a government agency, utility, association, or individual.

E. **RISK OF LOSS.** The holder assumes all risk of loss associated with use or occupancy of the permit area, including but not limited to theft, vandalism, fire and any fire-fighting activities (including prescribed burns), avalanches, rising waters, winds, falling limbs or trees, and other forces of nature. If authorized temporary improvements in the permit area are destroyed or substantially

damaged, the authorized officer shall conduct an analysis to determine whether the improvements can be safely occupied in the future and whether rebuilding should be allowed. If rebuilding is not allowed, the permit shall terminate.

F. **DAMAGE TO UNITED STATES PROPERTY.** The holder has an affirmative duty to protect from damage the land, property, and other interests of the United States. Damage includes but is not limited to fire suppression costs, damage to government-owned improvements covered by this permit, and all costs and damages associated with or resulting from the release or threatened release of a hazardous material occurring during or as a result of activities of the holder or the holder's heirs, assigns, agents, employees, contractors, or lessees on, or related to, the lands, property, and other interests covered by this permit. For purposes of clause IV.F and section V, "hazardous material" shall mean (a) any hazardous substance under section 101(14) of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), 42 U.S.C. § 9601(14); (b) any pollutant or contaminant under section 101(33) of CERCLA, 42 U.S.C. § 9601(33); (c) any petroleum product or its derivative, including fuel oil, and waste oils; and (d) any hazardous substance, extremely hazardous substance, toxic substance, hazardous waste, ignitable, reactive or corrosive materials, pollutant, contaminant, element, compound, mixture, solution or substance that may pose a present or potential hazard to human health or the environment under any applicable environmental laws.

1. The holder shall avoid damaging or contaminating the environment, including but not limited to the soil, vegetation (such as trees, shrubs, and grass), surface water, and groundwater, during the holder's use or occupancy of the permit area. If the environment or any government property covered by this permit becomes damaged during the holder's use or occupancy of the permit area, the holder shall immediately repair the damage or replace the damaged items to the satisfaction of the authorized officer and at no expense to the United States.

2. The holder shall be liable for all injury, loss, or damage, including fire suppression, prevention and control of the spread of invasive species, or other costs in connection with rehabilitation or restoration of natural resources associated with the use or occupancy authorized by this permit. Compensation shall include but not be limited to the value of resources damaged or destroyed, the costs of restoration, cleanup, or other mitigation, fire suppression or other types of abatement costs, and all administrative, legal (including attorney's fees), and other costs. Such costs may be deducted from a performance bond required under clause IV.I.

3. The holder shall be liable for damage caused by use of the holder or the holder's heirs, assigns, agents, employees, contractors, or lessees to all roads and trails of the United States to the same extent as provided under clause IV.F.1, except that liability shall not include reasonable and ordinary wear and tear.

G. **HEALTH, SAFETY, AND ENVIRONMENTAL PROTECTION.** The holder shall promptly abate as completely as possible and in compliance with all applicable laws and regulations any activity or condition arising out of or relating to the authorized use or occupancy that causes or threatens to cause a hazard to public health or the safety of the holder's employees or agents or harm to the environment (including areas of vegetation or timber, fish or other wildlife populations, their habitats, or any other natural resources). The holder shall prevent impacts to the environment and cultural resources by implementing actions identified in the operating plan to prevent establishment

and spread of invasive species. The holder shall immediately notify the authorized officer of all serious accidents that occur in connection with such activities. The responsibility to protect the health and safety of all persons affected by the use or occupancy authorized by this permit is solely that of the holder. The Forest Service has no duty under the terms of this permit to inspect the permit area or operations and activities of the holder for hazardous conditions or compliance with health and safety standards.

H. INDEMNIFICATION OF THE UNITED STATES. The holder shall indemnify, defend, and hold harmless the United States for any costs, damages, claims, liabilities, and judgments arising from past, present, and future acts or omissions of the holder in connection with the use or occupancy authorized by this permit. This indemnification provision includes but is not limited to acts and omissions of the holder or the holder's heirs, assigns, agents, employees, contractors, or lessees in connection with the use or occupancy authorized by this permit which result in (1) violations of any laws and regulations which are now or which may in the future become applicable, and including but not limited to those environmental laws listed in clause V.A of this permit; (2) judgments, claims, demands, penalties, or fees assessed against the United States; (3) costs, expenses, and damages incurred by the United States; or (4) the release or threatened release of any solid waste, hazardous waste, hazardous materials, pollutant, contaminant, oil in any form, or petroleum product into the environment. The authorized officer may prescribe terms that allow the holder to replace, repair, restore, or otherwise undertake necessary curative actions to mitigate damages in addition to or as an alternative to monetary indemnification.

V. RESOURCE PROTECTION

A. COMPLIANCE WITH ENVIRONMENTAL LAWS. The holder shall in connection with the use or occupancy authorized by this permit comply with all applicable federal, state, and local environmental laws and regulations, including but not limited to those established pursuant to the Resource Conservation and Recovery Act, as amended, 42 U.S.C. 6901 et seq., the Federal Water Pollution Control Act, as amended, 33 U.S.C. 1251 et seq., the Oil Pollution Act, as amended, 33 U.S.C. 2701 et seq., the Clean Air Act, as amended, 42 U.S.C. 7401 et seq., CERCLA, as amended, 42 U.S.C. 9601 et seq., the Toxic Substances Control Act, as amended, 15 U.S.C. 2601 et seq., the Federal Insecticide, Fungicide, and Rodenticide Act, as amended, 7 U.S.C. 136 et seq., and the Safe Drinking Water Act, as amended, 42 U.S.C. 300f et seq.

B. VANDALISM. The holder shall take reasonable measures to prevent and discourage vandalism and disorderly conduct and when necessary shall contact the appropriate law enforcement officer.

C. PESTICIDE USE. Pesticides may not be used outside of buildings to control undesirable woody and herbaceous vegetation (including aquatic plants), insects, rodents, fish, and other pests and weeds without prior written approval from the authorized officer. A request for approval of planned uses of pesticides shall be submitted annually by the holder on the due date established by the authorized officer. The report shall cover a 12-month period of planned use beginning 3 months after the reporting date. Information essential for review shall be provided in the form specified. Exceptions to this schedule may be allowed, subject to emergency request and approval, only when unexpected outbreaks of pests or weeds require control measures that were not anticipated at the time an annual report was submitted. Only those materials registered by the U.S. Environmental

Protection Agency for the specific purpose planned shall be considered for use on National Forest System lands. Label instructions and all applicable laws and regulations shall be strictly followed in the application of pesticides and disposal of excess materials and containers.

D. <u>ARCHAEOLOGICAL-PALEONTOLOGICAL DISCOVERIES</u>. The holder shall immediately notify the authorized officer of all antiquities or other objects of historic or scientific interest, including but not limited to historic or prehistoric ruins, fossils, or artifacts discovered in connection with the use and occupancy authorized by this permit. The holder shall leave these discoveries intact and in place until directed otherwise by the authorized officer. Protective and mitigative measures specified by the authorized officer shall be the responsibility of the holder.

E. <u>NATIVE AMERICAN GRAVES PROTECTION AND REPATRIATION</u>. In accordance with 25 U.S.C. 3002(d) and 43 CFR 10.4, if the holder inadvertently discovers human remains, funerary objects, sacred objects, or objects of cultural patrimony on National Forest System lands, the holder shall immediately cease work in the area of the discovery and shall make a reasonable effort to protect and secure the items. The holder shall immediately notify the authorized officer by telephone of the discovery and shall follow up with written confirmation of the discovery. The activity that resulted in the inadvertent discovery may not resume until 30 days after the authorized officer certifies receipt of the written confirmation, if resumption of the activity is otherwise lawful, or at any time if a binding written agreement has been executed between the Forest Service and the affiliated Indian tribes that adopts a recovery plan for the human remains and objects.

F. <u>PROTECTION OF HABITAT OF THREATENED, ENDANGERED, AND SENSITIVE SPECIES</u>. The location of sites within the permit area needing special measures for protection of plants or animals listed as threatened or endangered under the Endangered Species Act (ESA) of 1973, 16 U.S.C. 1531 et seq., as amended, or identified as sensitive or otherwise requiring special protection by the Regional Forester under Forest Service Manual (FSM) 2670, pursuant to consultation conducted under section 7 of the ESA, may be shown on the ground or on a separate map. The map shall be attached to this permit as an appendix. The holder shall take any protective and mitigative measures specified by the authorized officer. If protective and mitigative measures prove inadequate, if other sites within the permit area containing threatened, endangered, or sensitive species or species otherwise requiring special protection are discovered, or if new species are listed as threatened or endangered under the ESA or identified as sensitive or otherwise requiring special protection by the Regional Forester under the FSM, the authorized officer may specify additional protective and mitigative measures. Discovery of these sites by the holder or the Forest Service shall be promptly reported to the other party.

G. <u>CONSENT TO STORE HAZARDOUS MATERIALS</u>. The holder shall not store any hazardous materials at the site without prior written approval from the authorized officer. This approval shall not be unreasonably withheld. If the authorized officer provides approval, this permit shall include, or in the case of approval provided after this permit is issued, shall be amended to include specific terms addressing the storage of hazardous materials, including the specific type of materials to be stored, the volume, the type of storage, and a spill plan. Such terms shall be proposed by the holder and are subject to approval by the authorized officer.

H. CLEANUP AND REMEDIATION.

1. The holder shall immediately notify all appropriate response authorities, including the National Response Center and the authorized officer or the authorized officer's designated representative, of any oil discharge or of the release of a hazardous material in the permit area in an amount greater than or equal to its reportable quantity, in accordance with 33 CFR Part 153, Subpart B, and 40 CFR Part 302. For the purposes of this requirement, "oil" is as defined by section 311(a)(1) of the Clean Water Act, 33 U.S.C. 1321(a)(1). The holder shall immediately notify the authorized officer or the authorized officer's designated representative of any release or threatened release of any hazardous material in or near the permit area which may be harmful to public health or welfare or which may adversely affect natural resources on federal lands.

2. Except with respect to any federally permitted release as that term is defined under Section 101(10) of CERCLA, 42 U.S.C. 9601(10), the holder shall clean up or otherwise remediate any release, threat of release, or discharge of hazardous materials that occurs either in the permit area or in connection with the holder's activities in the permit area, regardless of whether those activities are authorized under this permit. The holder shall perform cleanup or remediation immediately upon discovery of the release, threat of release, or discharge of hazardous materials. The holder shall perform the cleanup or remediation to the satisfaction of the authorized officer and at no expense to the United States. Upon revocation or termination of this permit, the holder shall deliver the site to the Forest Service free and clear of contamination.

I. CERTIFICATION UPON REVOCATION OR TERMINATION. If the holder uses or stores hazardous materials at the site, upon revocation or termination of this permit the holder shall provide the Forest Service with a report certified by a professional or professionals acceptable to the Forest Service that the permit area is uncontaminated by the presence of hazardous materials and that there has not been a release or discharge of hazardous materials upon the permit area, into surface water at or near the permit area, or into groundwater below the permit area during the term of the permit. This certification requirement may be waived by the authorized officer when the Forest Service determines that the risks posed by the hazardous material are minimal. If a release or discharge has occurred, the professional or professionals shall document and certify that the release or discharge has been fully remediated and that the permit area is in compliance with all federal, state, and local laws and regulations.

VI. LAND USE FEE AND ACCOUNTING ISSUES

A. LAND USE FEES. The use or occupancy authorized by this permit is exempt from a land use fee or the land use fee has been waived in full pursuant to 36 CFR 251.57 and Forest Service Handbook 2709.11, Chapter 30.

VII. REVOCATION, SUSPENSION, AND TERMINATION

A. REVOCATION AND SUSPENSION. The authorized officer may revoke or suspend this permit in whole or in part:

1. For noncompliance with federal, state, or local law.

2. For noncompliance with the terms of this permit.

3. For abandonment or other failure of the holder to exercise the privileges granted.

4. With the consent of the holder.

5. For specific and compelling reasons in the public interest.

Prior to revocation or suspension, other than immediate suspension under clause VII.B, the authorized officer shall give the holder written notice of the grounds for revocation or suspension. In the case of revocation or suspension based on clause VII.A.1, 2, or 3, the authorized officer shall give the holder a reasonable time, typically not to exceed 90 days, to cure any noncompliance.

B. IMMEDIATE SUSPENSION. The authorized officer may immediately suspend this permit in whole or in part when necessary to protect public health or safety or the environment. The suspension decision shall be in writing. The holder may request an on-site review with the authorized officer's supervisor of the adverse conditions prompting the suspension. The authorized officer's supervisor shall grant this request within 48 hours. Following the on-site review, the authorized officer's supervisor shall promptly affirm, modify, or cancel the suspension.

C. APPEALS AND REMEDIES. Written decisions by the authorized officer relating to administration of this permit are subject to administrative appeal pursuant to 36 CFR Part 214 as amended. Revocation or suspension of this permit shall not give rise to any claim for damages by the holder against the Forest Service.

D. TERMINATION. This permit shall terminate when by its terms a fixed or agreed upon condition, event, or time occurs without any action by the authorized officer. Examples include but are not limited to expiration of the permit by its terms on a specified date and termination upon change of control of the business entity. Termination of this permit shall not require notice, a decision document, or any environmental analysis or other documentation. Termination of this permit is not subject to administrative appeal and shall not give rise to any claim for damages by the holder against the Forest Service.

E. RIGHTS AND RESPONSIBILITIES UPON REVOCATION OR TERMINATION WITHOUT RENEWAL. Upon revocation or termination of this permit without renewal of the authorized use, the holder shall remove all structures and improvements, except those owned by the United States, within a reasonable period prescribed by the authorized officer and shall restore the site to the satisfaction of the authorized officer. If the holder fails to remove all structures and improvements within the prescribed period, they shall become the property of the United States and may be sold, destroyed, or otherwise disposed of without any liability to the United States. However, the holder shall remain liable for all costs associated with their removal, including costs of sale and impoundment, cleanup, and restoration of the site.

VIII. MISCELLANEOUS PROVISIONS

A. MEMBERS OF CONGRESS. No member of or delegate to Congress or resident commissioner shall benefit from this permit either directly or indirectly, except to the extent the authorized use provides a general benefit to a corporation.

B. CURRENT ADDRESSES. The holder and the Forest Service shall keep each other informed of current mailing addresses, including those necessary for billing and payment of land use fees.

C. SUPERIOR CLAUSES. If there is a conflict between any of the preceding printed clauses and any of the following clauses, the preceding printed clauses shall control.

THIS PERMIT IS ACCEPTED SUBJECT TO ALL ITS TERMS AND CONDITIONS.

BEFORE ANY PERMIT IS ISSUED TO AN ENTITY, DOCUMENTATION MUST BE PROVIDED TO THE AUTHORIZED OFFICER OF THE AUTHORITY OF THE SIGNATORY FOR THE ENTITY TO BIND IT TO THE TERMS AND CONDITIONS OF THE PERMIT.

ACCEPTED:

Steve Boyd

April 10, 2015

Steve Boyd, Licensing Coordinator DATE

APPROVED:

Jim Junette

04/22/15

Jim Junette, District Ranger DATE

According to the Paperwork Reduction Act of 1995, an agency may not conduct or sponsor, and a person is not required to respond to a collection of information unless it displays a valid OMB control number. The valid OMB control number for this information collection is 0596-0082. The time required to complete this information collection is estimated to average one hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information.

The U.S. Department of Agriculture (USDA) prohibits discrimination in all its programs and activities on the basis of race, color, national origin, gender, religion, age, disability, political beliefs, sexual orientation, and marital or family status. (Not all prohibited bases apply to all programs.) Persons with disabilities who require alternative means for communication of program information (Braille, large print, audiotape, etc.) should contact USDA's TARGET Center at 202-720-2600 (voice and TDD).

To file a complaint of discrimination, write USDA, Director, Office of Civil Rights, 1400 Independence Avenue, SW, Washington, DC 20250-9410 or call (800) 975-3272 (voice) or (202) 720-6382 (TDD). USDA is an equal opportunity provider and employer

The Privacy Act of 1974 (5 U.S.C. 552a) and the Freedom of Information Act (5 U.S.C. 552) govern the confidentiality to be provided for information received by the Forest Service.

Appendix A

Attachment B for Forest Service SF-299
Filed by Turlock and Modesto Irrigation Districts
and HDR, Inc.
April 1, 2015

8. Maps of proposed water temperature logger locations (Figure 1 to Figure 7).

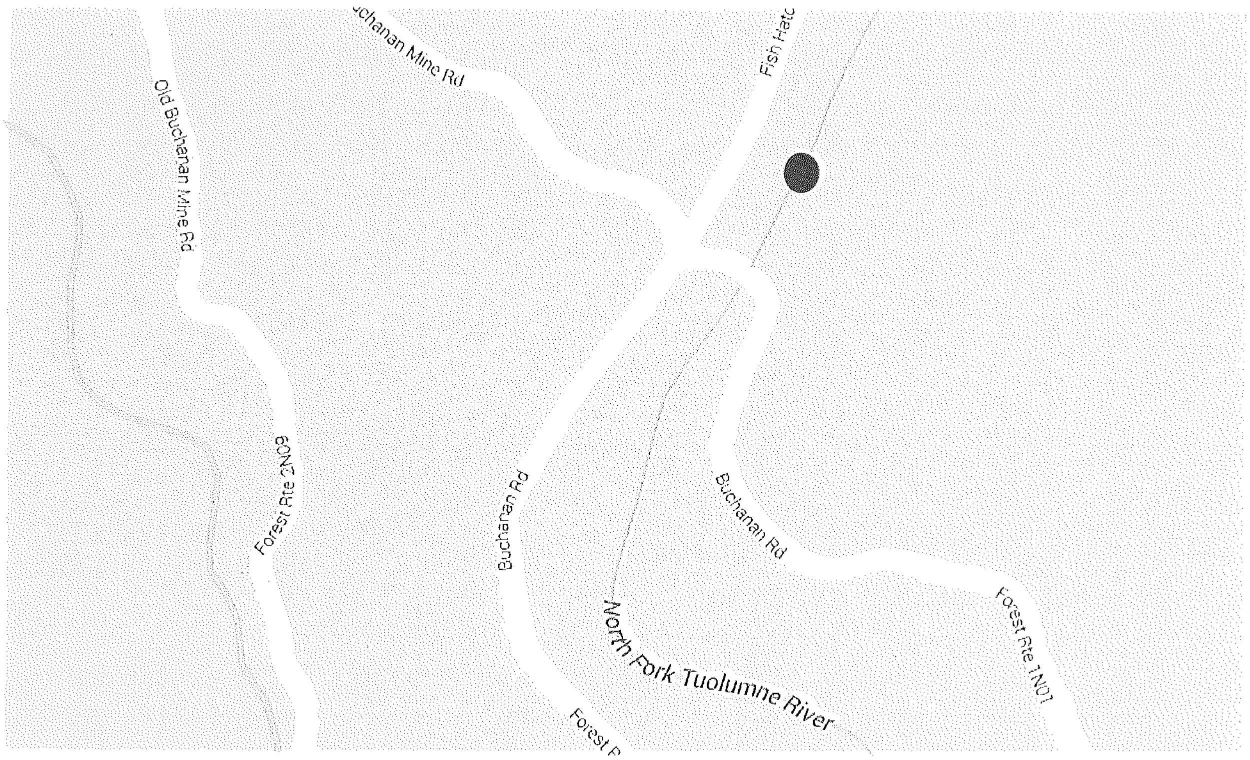

Figure 1. Approximate location of proposed temperature logger installation on North Fork Tuolumne River.

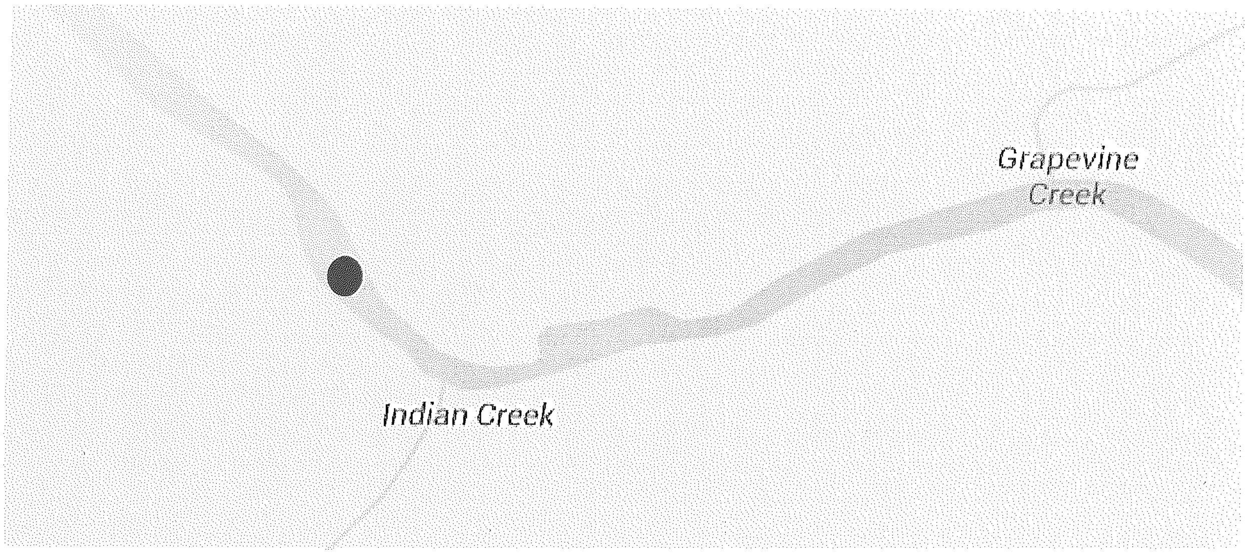

Figure 2. Approximate location of proposed temperature logger installation on the Tuolumne River near Indian Creek.

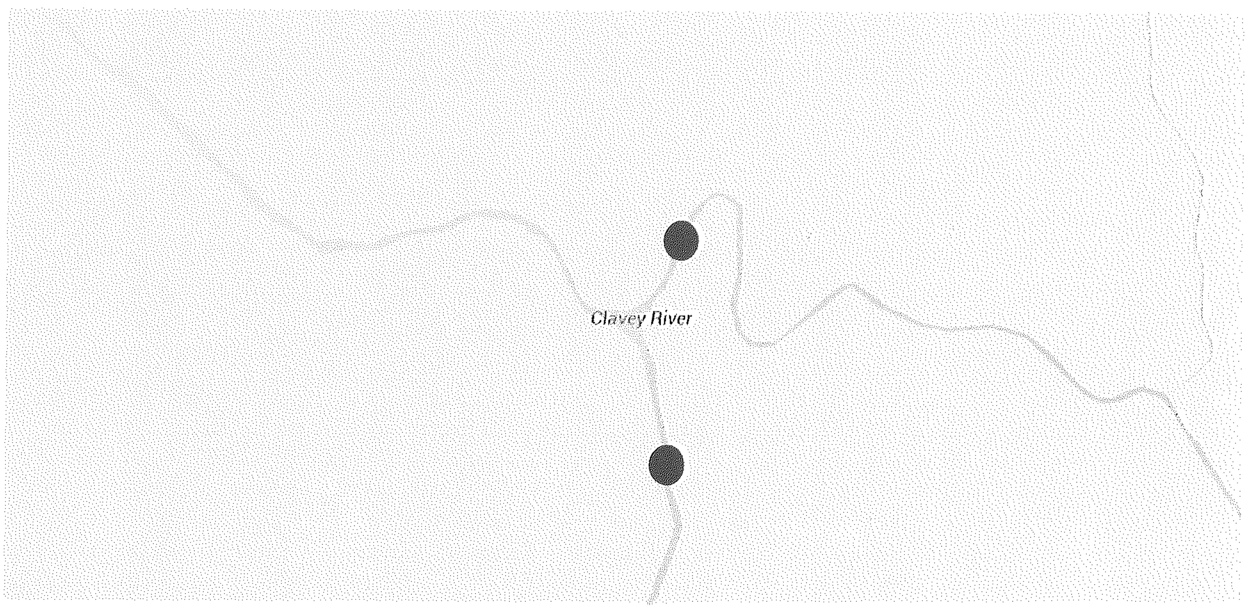

Figure 3. Approximate locations of proposed temperature logger installations on the Clavey and Tuolumne rivers.

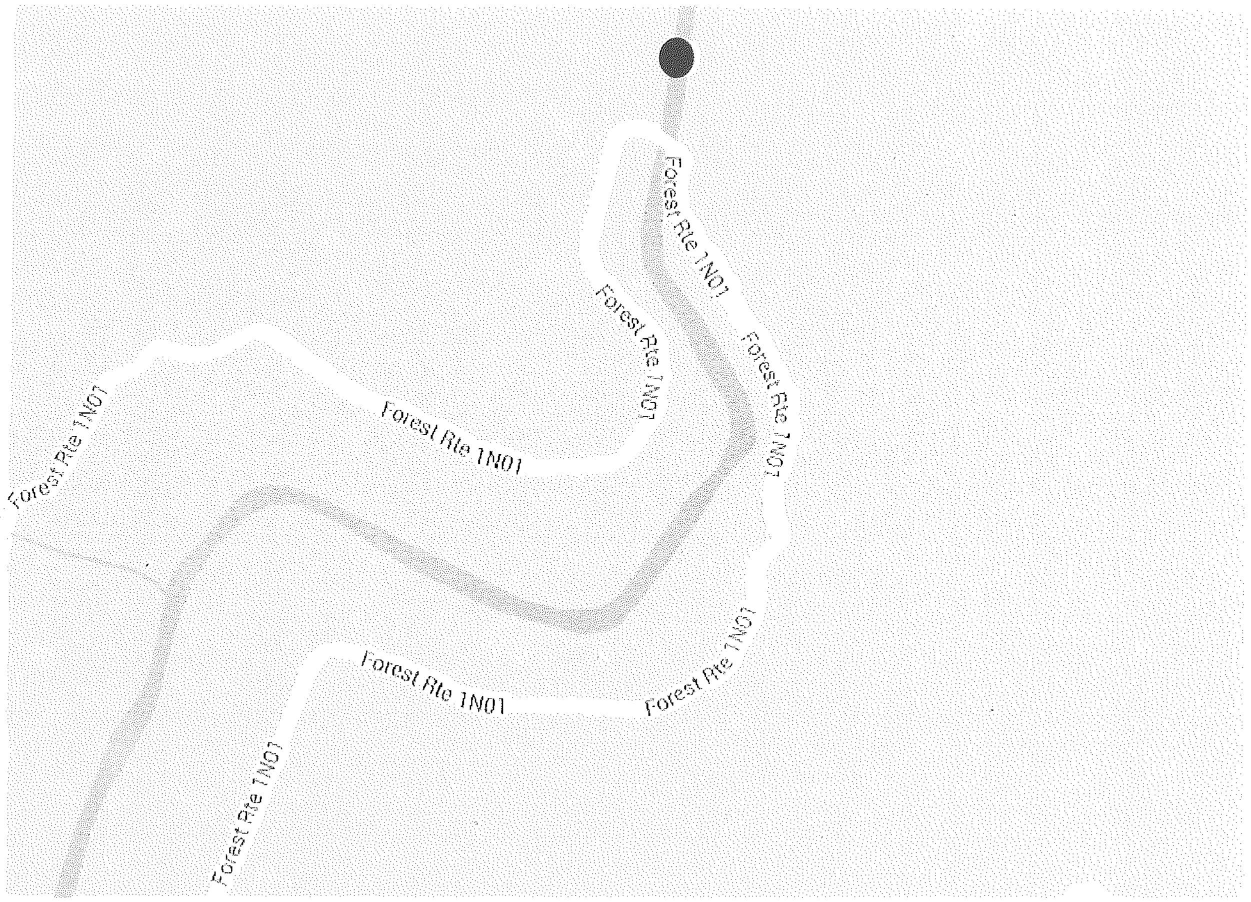

Figure 4. Approximate location of proposed temperature logger installation on the Clavey River near Forest Route 1N01.

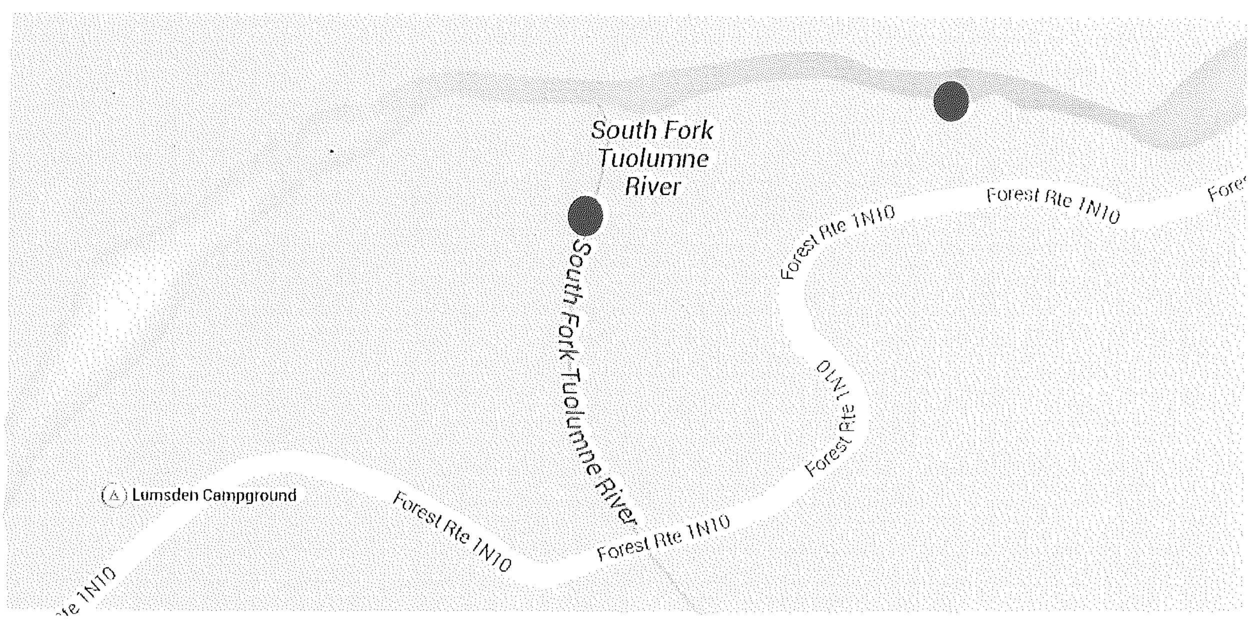

Figure 5. Approximate location of proposed temperature logger installations on the South Fork Tuolumne and Tuolumne rivers.

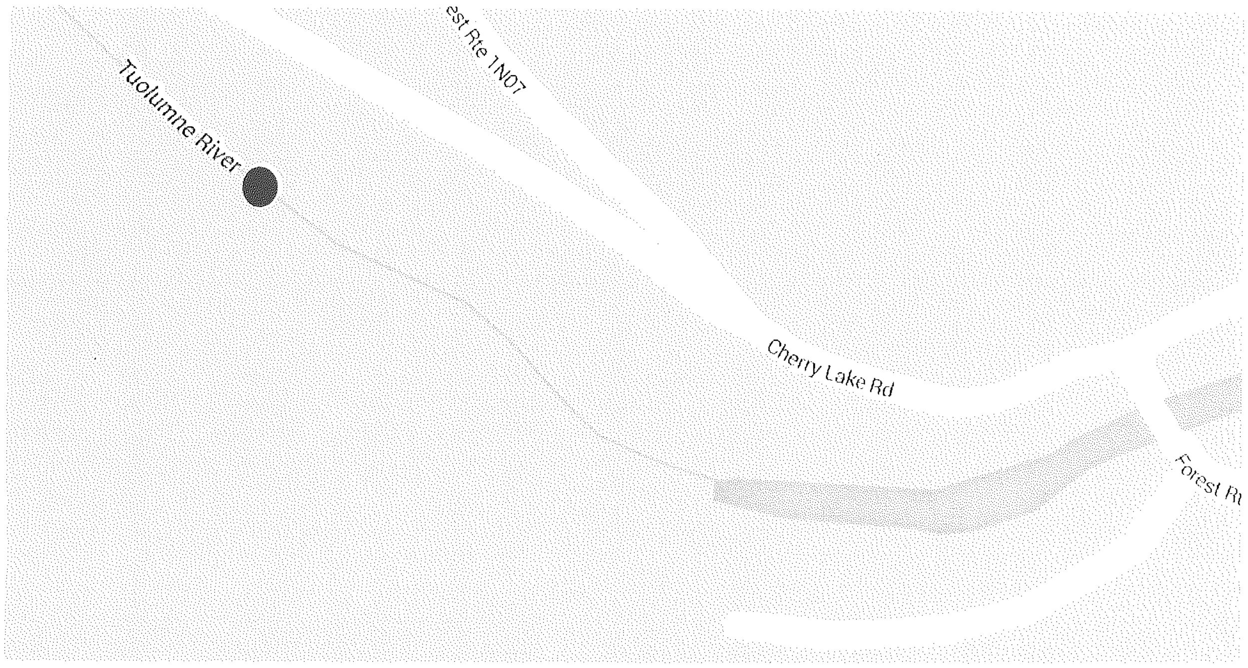

Figure 6. Approximate location of proposed temperature logger installation on the Tuolumne River below Early Intake Diversion.

Figure 7. Approximate location of proposed temperature logger installations on Cherry Creek above and below the Powerhouse.

Auth ID: GRO1122
Contact ID: 611267010602
Use Code: 422

FS-2700-23 (v. 10/09)
OMB No. 0596-0082

U.S. DEPARTMENT OF AGRICULTURE
FOREST SERVICE
AMENDMENT
FOR

SPECIAL-USE AUTHORIZATION

Amendment # 1

This amendment is attached to and made a part of the GRO1122 special use authorization for Research issued to TURLOCK IRRIGATION DISTRICT on 04/22/2015 which is hereby amended as follows:

Install, monitor, and maintain ten additional water temperature recorders seven locations will have Onset U20 Level loggers and three will have Onset Tidbit water temperature recorders see Attachment A (Project Description) for method of installation. The route of travel will be on Forest Roads 1N97, 1N07, 1N14, and 1N10 then by foot. Prior to any changes in installation, or access written approval must be received from the Forest Service.

This Amendment is accepted subject to the conditions set forth herein, and to conditions in Attachment A and Attachment B (Map) attached hereto and made a part of this Amendment.

Holder	Authorized Officer
Holder	Title
Date	Date

Attachment A for Forest Service SF-299 Amendment #2 to GRO1122

Filed by Turlock and Modesto Irrigation Districts
and HDR, Inc.
June 17, 2016

Names and Addresses of Applicants

Turlock Irrigation District
PO Box 949
Turlock, CA 95381-0949

Modesto Irrigation District
P.O. Box 4060
Modesto, CA 95352-4060

Project Description

The Turlock Irrigation District (TID) and Modesto Irrigation District (MID) (collectively, the Districts) own the La Grange Diversion Dam (LGDD) located on the Tuolumne River in Stanislaus County, California. Currently the Districts are working through the Federal Energy Regulatory Commission (FERC) licensing process with the end goal to file an application for a license. As part of the process the Districts, at the request of federal fish and wildlife agencies (NMFS, USFWS, and CDFW) have volunteered to complete a series of studies to evaluate ecological considerations related to the potential reintroduction of anadromous salmonids to the upper Tuolumne River.

This Amendment proposes to conduct more detailed surveying and water temperature monitoring in particular locations that were previously monitored in 2015 under GRO1122 in the upper Tuolumne River and Cherry Creek. Watercourse Engineering, Inc. has been retained by the Turlock Irrigation District and Modesto Irrigation District to complete the proposed monitoring to develop a water temperature model to inform potential anadromous salmonid reintroduction efforts.

Introduction

As part of the study goals and objectives for the Water Temperature Monitoring and Modeling Study, a field monitoring program was designed and implemented to assist in characterizing the thermal regime of the upper Tuolumne River from Early Intake to above Don Pedro Reservoir, including portions of the North and South Forks of the Tuolumne River, Cherry Creek, and the Clavey River. To develop a more complete understanding of the thermal regime in the upper Tuolumne River, an additional study was implemented in 2015 to provide a characterization of potential temperature stratification in the upper Tuolumne River. Two pools in the mainstem Tuolumne River and one pool in Cherry Creek were monitored for vertical variations in water temperature using water temperature data loggers installed near the surface and near the bottom at one location in each of the selected pools (**Figure 1**). In October 2015, data were retrieved from loggers at two of the study sites. Loggers at the third site were missing and no data were retrieved. Thermal stratification developed in each of the two pools from which data were retrieved.

This work is proposed to be expanded in 2016 for a more comprehensive survey of pool morphology, and velocity and thermal regime to more completely explore the potential for thermal stratification in the upper Tuolumne River and lower Cheery Creek. A second objective of this study is to provide sufficient information for possibly modeling the water temperature conditions in one or more of these pools to assess the dynamics around conditions in the pools and the potential for stratification under variable flow regimes. This study supports both the Upper Tuolumne River Reintroduction Assessment Framework (Framework) and water temperature modeling efforts.

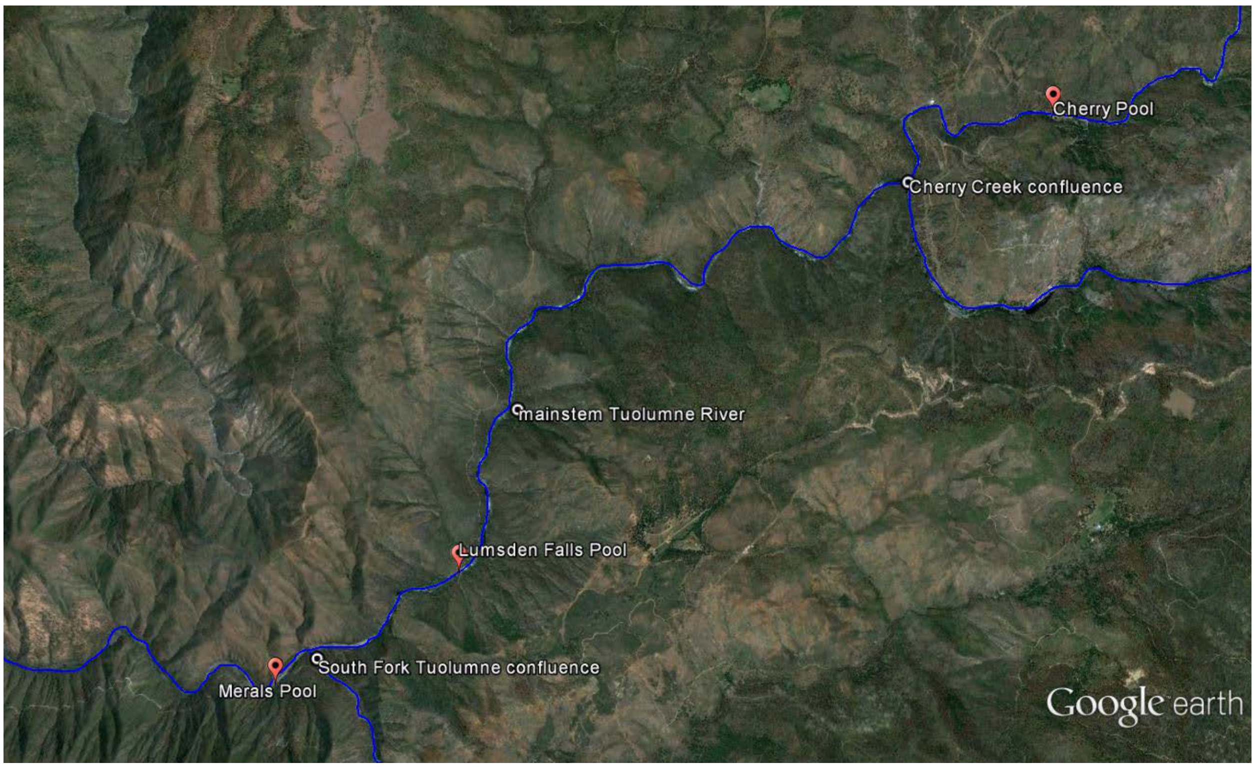

Figure 1. Locations of pools monitored for potential thermal stratification, upper Tuolumne River and Cherry Creek, 2015.

Previous Work

Data collected from Meral's Pool and from a pool at approximately RM2 on Cherry Creek in 2015 demonstrated that thermal stratification does occur in the upper Tuolumne River and Cherry Creek. Data were collected from August 12 through October 28, 2015. Presence of thermal stratification was determined by subtracting water temperature at the bottom of the pool from water temperature at the top of the pool. For the purposes of this report degree of stratification is defined as:

- Strong stratification: greater than or equal to a 2°C difference between surface and bottom waters in pools;
- Weak stratification: less than a 2°C difference between surface and bottom waters in pools;
- Persistent stratification: stratification (strong or weak) that persists for extended periods (e.g., weeks, months)
- Intermittent stratification (strong or weak) that persists for days (e.g., 24 to 96 hours)
- Brief stratification (strong or weak) that persists for less than one day (24 hours)

Persistent, strong thermal stratification was absent in the 2015 study period at all sites. In the Cherry Creek and Meral's pools, there were periods of brief, weak thermal stratification in August and October (**Figure 2**, **Figure 3**). Periods of brief, weak thermal stratification were typically less than 0.2°C (the resolution of the temperature loggers used in the study). In August and September there were periods of a few weeks where brief, weak stratification was between 0.3 and 0.4°C. However, the pools became isothermal (destratified) each evening.

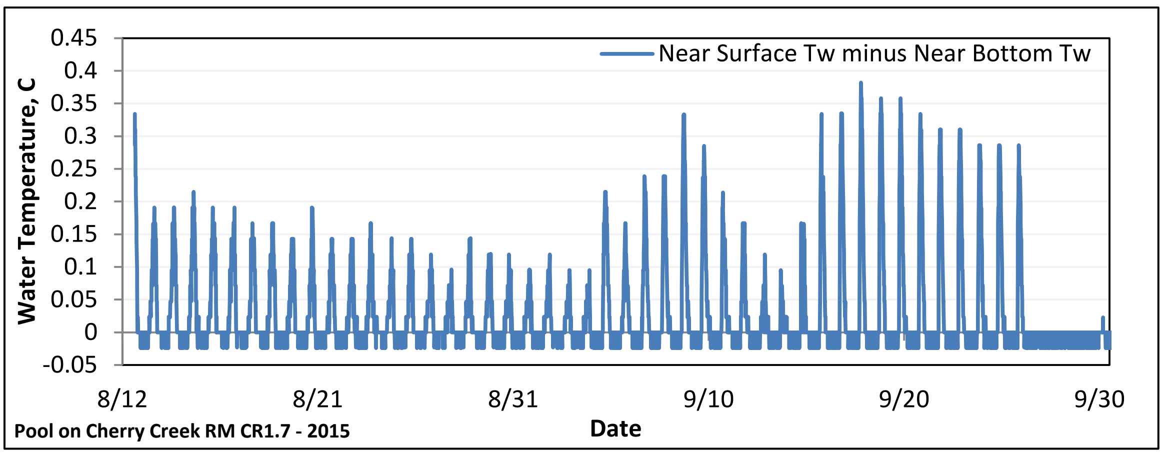

Figure 2. Difference between water temperature at the top and bottom of the pool at Cherry Creek RM2, August 12 to October 28, 2015.

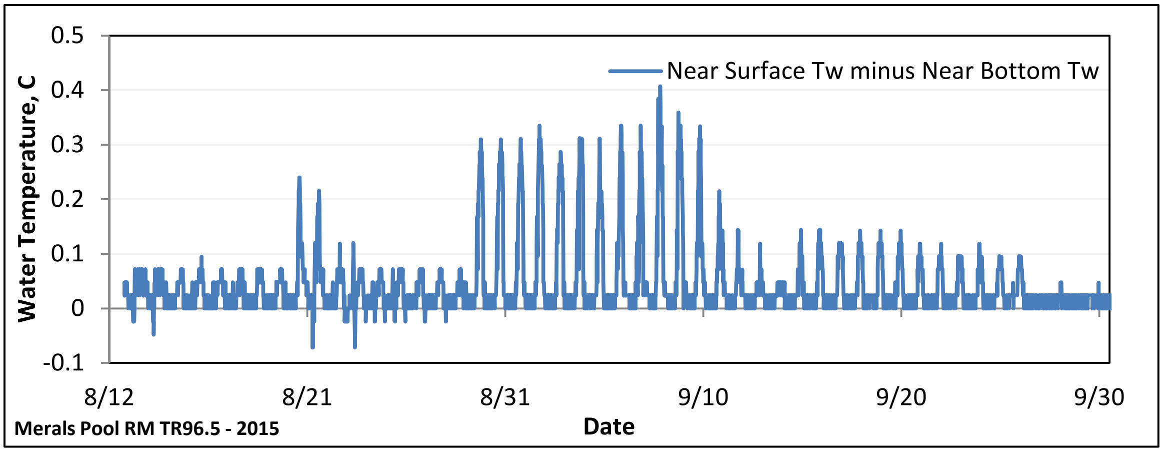

Figure 3. Difference between water temperature at the top and bottom of Meral's Pool, August 12 to October 28, 2015.

Study Area

The three pools monitored in 2015 (Figure 1), Lumsden and Meral's pools on the Tuolumne River and the pool on lower Cherry Creek are the sites where more detailed efforts are proposed for 2016. Review of previous data indicates that these pools experience thermal stratification later in the summer (mid-August into September), and therefore the sampling program in this amendment proposes to complete in-river monitoring between August 1 and September 30, 2016. Sampling would be conducted over two separate trips, with each trip occurring over approximately 5 days (4 nights).

Sampling Plan Overview and Methods

To characterize thermal conditions and potential for stratification in the deeper pools in the project area several physical attributes will be investigated. These include, but are not limited to:

- **Pool geometry/morphology**: characterizing overall pool morphology (length, mean width, mean depth, maximum depth, longitudinal profile, cross section variations, etc.) at low and high flows will provide pool volume, area, and complexity information. These data will be collected with a GPS and depth profiler to identify x-y-z information in the pools. Stage data will be collected as well to monitor the range of surface elevation fluctuations between low and high water.
- **Velocity**: Acoustic Doppler Current Profiler (ADCP) measurements at both low and high flows, possibly augmented with a handheld (staff) velocity meter, will quantify local velocities and allow calculation of flow rate and residence time (when coupled with morphology information).
- **Water temperature**: water temperature measurements at low and high flows will be completed at the upstream and downstream (inflow and outflow) as well as within the pool with both handheld and deployed temperature probes and/or loggers. Deployed temperature probes will be in place for multiple days to identify both vertical variations

in the water column from near-surface to near-bottom at up to three locations in each pool. These locations will be identified based on pool depth, velocity of water, distance from inflow, and other factors. Additionally, handheld temperature probes will be used to identify areas of potential thermal refugia, cold water sources (seeps, etc.), and characterization of deepest portions of the pool where cold water may persist (e.g., bottom 1.5m of pool). All remote sensing loggers will collect data at 15 minute intervals.

- **Meteorology**: local air temperatures will be collected at each pool, as well as the time of sunrise and sunset on the pool. Finally, light extinction coefficients will be quantified using photosynthetically available radiation (PAR) measurements at multiple depths. PAR measurements will assist in defining the depth at which solar radiation penetrates into the pools. All remote sensing loggers will collect data at 15 minute intervals.

Schedule and Logistics

Study Period – August 1 through September 30, 2016 (two trips of about 5 days and 4 nights each)

Study Locations – Tuolumne River mainstem: Lumsden and Meral's pools, and Cherry Creek: Cherry Creek Pool (**Table 1**).

Table 1. Locations of pools included in upper Tuolumne River pool stratification study, 2016.

Pool	River Mile	Coordinates
Cherry Creek Pool	Cherry Creek 1.7	37.89513 -119.95329
Lumsden Falls Pool	Tuolumne River 98 (approximate)	37.848273 -120.030139
Meral's Pool	Tuolumne River 96 (approximate)	37.836441 -120.054454

Site Access – All sites are accessible by motor vehicle and by foot. Small rafts would be used only to travel from shore to within the pool study sites.

Study Equipment – Rafts, hand-held or deployed equipment, and anchors.

Safety Planning

A safety plan will be completed by the Applicant's consultants to ensure the safety of the field staff and recreational rafters on the upper Tuolumne River during implementation of the field program. The plan will include standardized safety protocols that have been used by the Applicant's consultants in similar types of studies on rivers including the Tuolumne, Merced, Stanislaus and Yuba. The safety plan will include detailed information on daily "tailgate meetings", call in/call out and other communication procedures, water and boat safety, emergency protocols, and safety of other recreationists on the river. An approved safety plan will be on file prior to the start of the field program and relevant safety information will be in the possession of crews while conducting field work.

Additional Information for Permit Application Questions

15.

The cost of proposed studies is minimal compared to the overall cost of the ongoing Licensing effort. The Districts have allotted sufficient funds for the completion of all studies involved in the Licensing effort. The purpose of this study is to characterize and model pool stratification to inform thermal habitat quality for anadromous salmonid species. Results of the proposed studies will provide valuable and essential ecological information related to the potential feasibility of reintroducing anadromous salmonids into the upper Tuolumne River Watershed. Results of the studies will be made available to the public.

17.

The proposed study is not anticipated to affect air quality, aesthetics, surface and ground water quality and quantity, the control on any stream or body of water, or surface of the land. Equipment to be used for this study does not create noise above that of normal hand held electronic appliances (i.e., laser range finders, GPS units, total stations, etc.). Elevated noise levels would be restricted to noise levels associated with commercial rafting-related operations.

Water temperature loggers will be installed using weights or using a stake(s) driven into the bed. Use of weights or stakes would not be expected to result in any notable disturbance to the streambed, and all equipment would be removed from the water after completion of the study. Care will be taken to complete the temporary installations in areas that will not impact recreational or biological interests.

Elevated noise levels are not anticipated. Although a generator may be necessary to charge equipment during the study, a small generator that has a relatively low dB rating would be used in order to avoid potential noise disturbance to nearby recreationists and campers. The generator would be in good working condition and would be checked for any leaks before being used and on a daily basis.

In order to minimize the potential for spreading aquatic invasive species during the course of the proposed study, the California Department of Fish and Wildlife Aquatic Invasive Species Decontamination Protocol (https://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=43333) will be followed.

18.

The proposed study is not anticipated to have any probable effects on populations of fish or wildlife. The results of the study will provide valuable and critical information related to the suitability of the upper Tuolumne River for potential anadromous fish reintroduction efforts, and study results will be made available to the public.

From: Staples, Rose
Sent: Tuesday, June 21, 2016 9:06 AM
Cc: Deason, Jesse; Le, Bao; Staples, Rose
Subject: La Grange June 30 2016 Recreation Access & Safety Assessment Study Site Visit

Dear Licensing Participants,

As part of the La Grange Hydroelectric Project Recreation Access and Safety Assessment study, the Districts will conduct a site visit on **Thursday, June 30, 2016** from 8:00 am to approximately 12:00 pm. The purpose of the site visit is to gather site-specific information to be used along with existing aerial photography, topography data, and property ownership data to produce site assessments and descriptions of potential public access routes at the Project. Licensing participants are invited to attend this site visit.

Please note that the site visit will entail approximately 60 minutes of hiking steep, unimproved terrain. Participants may be exposed to heat and sun--and poisonous plants and venomous animals inhabit the area.

If you are interested in attending this site visit, please RSVP to me (Rose.Staples@hdrinc.com) no later than Friday, June 24. Further logistics will be provided to those who plan to attend. Thank you.

Rose Staples, CAP-OM, MOS
Executive Assistant

HDR
970 Baxter Boulevard Suite 301
Portland ME 04103
D 207-239-3857
rose.staples@hdrinc.com

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From: Staples, Rose
Sent: Tuesday, June 21, 2016 3:01 PM
Cc: Deason, Jesse; Le, Bao; Staples, Rose
Subject: La Grange Workshop No 5 DRAFT Meeting Notes Available for Comment

La Grange Licensing Participants,

DRAFT NOTES from Workshop No. 5, held on May 19, 2016, have been uploaded to the La Grange Project licensing website (www.lagrange-licensing.com) in the DOCUMENTS section and also as an attachment to the May 19 date of the licensing website calendar. Please provide any comments on the meeting notes to me at Rose.Staples@hdrinc.com by Thursday, July 21, 2016. The Districts will incorporate any comments received and then post a final version of the meeting notes to the licensing website.

If you have any difficulty locating and/or accessing the meeting notes, please let me know. Thank you.

Rose Staples, CAP-OM, MOS
Executive Assistant

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From: Le, Bao
Sent: Friday, June 24, 2016 5:26 PM
To: John Wooster - NOAA Federal
Cc: Deason, Jesse
Subject: RE: Questions and follow up

Hi John.

That'd be great if you can confirm any additional details on genetics study, conference/presentation, etc.

Please let me know what Amanda says or if she has any questions and how we can get her plugged in to this discussion with CDFW on test fish.

Have a good weekend,
Bao

From: John Wooster - NOAA Federal [mailto:john.wooster@noaa.gov]
Sent: Friday, June 24, 2016 11:53 AM
To: Le, Bao
Cc: Deason, Jesse
Subject: Re: Questions and follow up

I don't know which conference (they did mention it on phone, but I have completely forgotten), and can't confirm that they went ahead with their intentions of a few months ago - the intent wasn't a Tuolumne specific presentation, but have new Tuolumne info feed into their pile of CV genetic information.

Amanda should be the contact person. I'll try and track her down in the office on Monday and see what she recommends.

John

On Fri, Jun 24, 2016 at 11:01 AM, Le, Bao <ChiBao.Le@hdrinc.com> wrote:

Thanks, John. See below for additional comment.

From: John Wooster - NOAA Federal [mailto:john.wooster@noaa.gov]
Sent: Friday, June 24, 2016 9:47 AM
To: Le, Bao
Cc: Deason, Jesse
Subject: Re: Questions and follow up

Bao:

1. I am supposed to talk to Lee today about a few things, so will discuss further, but at the moment, no additional feedback. Sounds good.

2. There wasn't a plan to produce an interim product on the genetics. However, a few months back I heard that they were going to present some work at a conference (in July I think?) that would include some preliminary T results - so I can ask where that is at, and see about distributing whatever is presented at the conference. Also, I was aware of the Districts / their consultants asking the science center for a presentation on genetics - that isn't being run through me (or my office / FERC team), so I don't know where that stands, but that seems like one venue to get an update. They were out sampling again last week, so that team has somewhat transitioned into field work for the summer....Thanks for the update. Do you know which conference they'll be presenting at? That'd be great if you can see about the conference presentation and whether that can be shared. I'll also follow up with the Districts request to see if any progress was made on that front.

3. Yes. I actually think the time to get NMFS involved with getting the test fish is now, rather than wait until CDFW submits the request to NMFS for concurrence. We have a person on staff who works exclusively with the hatcheries / experimental fish, her name is Amanda Cranford. That'd be great. Is Amanda the person we'd want to have reach out to NMFS proactively? If so, should we communicate directly with her once we develop an approach? Please advise.

-John

On Thu, Jun 23, 2016 at 2:53 PM, Le, Bao <ChiBao.Le@hdrinc.com> wrote:

Hi John.

I wanted to follow up on a couple of items, old and new:

1. Any feedback on discrete pieces of more manageable work that can support Lee?

2. Curious as to the progress on the genetics study? Is there any interim product that is available to share? When do you expect a report to be ready for distribution?

3. As you know, we're working on a reservoir transit study plan that will be out to LPs soon for review. We've already given CDFW a head's up that we'll need to acquire test fish for the study next year (formal requests due by end of July for fish next year). Given that we've not had a lot of luck with getting fish for past studies and this is a NMFS requested and FERC approved study, we're hoping you might also be able to put in a good word of support when the time is right?

Thanks and hope all is well.

Bao

Bao Le

Senior Fisheries Biologist

HDR

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--

John Wooster
Hydrologist
NOAA Fisheries West Coast Region
U.S. Department of Commerce
john.wooster@noaa.gov

From: Foote, Debra -FS [mailto:dfoote@fs.fed.us]
Sent: Friday, June 24, 2016 10:31 AM
To: Le, Bao
Subject: RE: Overview of Turlock Irrigation District Permit Needs and other items

Bao,
We have not found any exclusions for generator use in the Tuolumne River Wild and Scenic River Plan. I spoke with fire prevention and the only thing needed is to have it placed in an area that has at least 10' diameter of clearance from all vegetation.

From: Le, Bao [mailto:ChiBao.Le@hdrinc.com]
Sent: Wednesday, June 22, 2016 4:33 PM
To: Foote, Debra -FS <dfoote@fs.fed.us>
Cc: Warnock, Cory <Cory.Warnock@hdrinc.com>; Borovansky, Jenna <Jenna.Borovansky@hdrinc.com>; Deason, Jesse <Jesse.Deason@hdrinc.com>; Neal, Morgan <Morgan.Neal@hdrinc.com>
Subject: Overview of Turlock Irrigation District Permit Needs and other items
Importance: High

Hi Debbie.

Thanks for your time today and glad we got to walk through various permitting items and get things straightened out. Here is a summary of permitting needs for the existing and new studies:

1. New Permit Application for 2016 New Studies: there are three studies (spawning gravel, habitat typing, and instream flow). We have submitted an application. This is also the permit that would require guidance on generator use. As discussed, this is the highest priority and you've set July 8 as a drop dead date for the permit and have noted that the June 27-28 reconnaissance trip is ok if the permit is not in place by then.

2. Barriers Existing Permit – we have a permit in place for the second year of this work. The permit number is GRO1128. We have not submitted an amendment application for the changes we'd need which are 1) to allow for a trail camera to be installed at approximately RM 2.0 on the Clavey River and 2) for an additional 3-day raft trip in summer of 2017 to retrieve that trail camera. This is also of high priority and per our discussion, you've set July 8 as a drop dead date for an amendment since we will be in the field for this work on July 11. We won't submit a formal amendment for this now that you have the information needed per our discussion.

3. Temperature Amendment Application – we have a permit in place for the second year of this work. The permit number is GRO1122. We submitted an amendment application to you to add pool stratification monitoring work in 2016. The amendment application has details of this work which will not include any raft trips. This amendment is a priority but can come after #1 and #2.

As discussed, you were going to follow up on the use of generators to confirm this is ok. As discussed, we've done a considerable amount of research on alternatives and have concluded that short periods of generator use are the only effective way to charge field equipment. We can abide by all policies/guidance for use, safety, noise, and operations that are necessary.

Let me know if you have any questions and thanks for your help!

Bao

Bao Le
Senior Fisheries Biologist

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From: Craig, Nancy
Sent: Friday, June 24, 2016 9:06 AM
To: aondrea_bartoo@fws.gov
Cc: Deason, Jesse; Staples, Rose
Subject: RE: La Grange June 30 2016 Recreation Access & Safety Assessment Study Site Visit

Hello Aondrea,
I am a Project Manager at HDR Engineering with responsibility for the La Grange Recreation Access and Safety Assessment Study.
I appreciate the challenges of travel outside normal business hours. We considered that but set the site assessment with an 8:00 AM start due to expected hot weather.
I would like to let you know there will be an opportunity for you to join us for the second half of the site assessment at approximately 10:00 AM at the gate into the La Grange Powerhouse. The gate will be locked; but when we arrive TID will open the gate and we will all drive our own vehicles into the parking area. The time is a little uncertain because we don't know exactly how the assessment will progress. Nonetheless, I think it could work to meet you at the gate. Please let me know if you would be interested in this option.
Thank you,

Nancy H. Craig
Project Manager, Hydropower Services

HDR
1825 N. Tegner St.
Wickenburg, AZ 85390
MOBILE 928.273.5772
nancy.craig@hdrinc.com

From: Bartoo, Aondrea [mailto:aondrea_bartoo@fws.gov]
Sent: Thursday, June 23, 2016 5:19 PM
To: Staples, Rose
Subject: Re: La Grange June 30 2016 Recreation Access & Safety Assessment Study Site Visit

Due to the logistics and early start time, I've decided I will not be able to make this site visit. I considered staying the night somewhere close, but being a single parent, I just can't make that happen. I'd appreciate it, if, in the future, the licensee would consider a later start time, perhaps 10am.

Thanks very much.

On Tue, Jun 21, 2016 at 9:05 AM, Staples, Rose <Rose.Staples@hdrinc.com> wrote:

Dear Licensing Participants,

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Please note that the site visit will entail approximately 60 minutes of hiking steep, unimproved terrain. Participants may be exposed to heat and sun--and poisonous plants and venomous animals inhabit the area.

If you are interested in attending this site visit, please RSVP to me (Rose.Staples@hdrinc.com) no later than Friday, June 24. Further logistics will be provided to those who plan to attend. Thank you.

Rose Staples, CAP-OM, MOS

Executive Assistant

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--

A. Leigh Bartoo
Fish and Wildlife Biologist
Bay-Delta Fish and Wildlife Office
U.S. Fish and Wildlife Service
650 Capitol Mall, 8-300
Sacramento, CA 95814
916-930-5621

From: Lonnie Moore [mailto:lmoorenorcal@gmail.com]
Sent: Friday, June 24, 2016 3:39 PM
To: Staples, Rose
Subject: La Grange Hydroelectric Project Recreation Access and Safety Assessment Study Visit

HI Rose,

Yes, I am planning to attend the " La Grange Hydroelectric Project Recreation Access and Safety Assessment Study Visit".
Please keep informed of the arrangements.

Also, can you please provide me the name (and e-mail/telephone #) for a person in charge/arranging the logistics of the Assessment Visit? I would like to ask someone a few short questions about the visit.

Thank you,
Lonnie

--
Lonnie Moore
Consultant
Office: 209-551-5958
Mobile: 209-247-3991
lmoorenorcal@gmail.com

From: Foote, Debra -FS [mailto:dfoote@fs.fed.us]
Sent: Friday, June 24, 2016 9:48 AM
To: Le, Bao
Subject: RE: Overview of Turlock Irrigation District Permit Needs and other items

Bao,
Thanks for helping to get all these details straight. I have located both of the previous permits. I currently have the new permit expiring 12/31/2018 does that allow ample time for the studies to be completed or do you need longer?

From: Le, Bao [mailto:ChiBao.Le@hdrinc.com]
Sent: Wednesday, June 22, 2016 4:33 PM
To: Foote, Debra -FS <dfoote@fs.fed.us>
Cc: Warnock, Cory <Cory.Warnock@hdrinc.com>; Borovansky, Jenna <Jenna.Borovansky@hdrinc.com>; Deason, Jesse <Jesse.Deason@hdrinc.com>; Neal, Morgan <Morgan.Neal@hdrinc.com>
Subject: Overview of Turlock Irrigation District Permit Needs and other items
Importance: High

Hi Debbie.

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Let me know if you have any questions and thanks for your help!

Bao

Bao Le
Senior Fisheries Biologist

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PHONE CALL MEMORANDUM

Topic	Attendance at June 20 Recreation Access and Safety Assessment site visit
Date	June 24, 2016
From	Ms. Nancy Craig (HDR)
To	Mr. Lonnie Moore (citizen)
Summary of Discussion	Ms. Craig called Mr. Moore to follow-up on an email that Mr. Moore had sent earlier in the day regarding his attendance at the upcoming June 30 La Grange Project Recreation Access and Safety Assessment site visit. Mr. Moore said he is nursing an ankle injury and is trying to decide whether to attend. Mr. Craig told Mr. Moore that one option may be to only attend the latter half of the site visit, which would entail meeting the study group at the La Grange Project gate. This would avoid much of the steep hiking required. Ms. Craig requested that Mr. Moore let HDR know once he made a decision whether or not to attend the site visit. Mr. Moore requested a copy of the Recreation Access and Safety Assessment study plan and the FERC Study Plan Determination. Ms. Craig told Mr. Moore that Ms. Rose Staples (HDR) will follow up with Mr. Moore directly with that information.

From: Le, Bao
Sent: Monday, June 27, 2016 2:38 PM
To: jeicher@blm.gov
Cc: Steve Boyd; Devine, John; Deason, Jesse; Joyce Medeiros
Subject: 2016 Upper Tuolumne River Field Studies - Request for BLM approval
Attachments: BLM Approval Request Package 6_27_16_w-revised address.pdf

Hi Jim.

On behalf of the Districts, attached is a letter (and supporting information) requesting authorization for La Grange Project licensing 2016 study activities to utilize BLM lands in the Upper Tuolumne River. Please note that these study activities will be using BLM land primarily for camping, staging, downloading of existing temperature loggers and passive data collection. We'll also put a hardcopy of the approval request package in the mail tomorrow.

The 2016 field season will begin the week of July 11 so if an updated letter of authorization could be provided in advance of this date, we'd very much appreciate it.

Please let Steve Boyd (Turlock Irrigation District) or I know if you have any questions.

Best regards,
Bao

Bao Le
Senior Fisheries Biologist

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June 27, 2016

Jim Eicher, Associate Field Manager
Bureau of Land Management
California State Office
2800 Cottage Way, W-1623
Sacramento, CA 95825

Re: Approval for the implementation of new and existing La Grange Hydroelectric Project Licensing Studies on Bureau of Land Management (BLM) land in the Upper Tuolumne River

Dear Mr. Eicher,

This summer, HDR, on behalf of the Turlock and Modesto Irrigation Districts (collectively, the "Districts"), will continue existing 2015 study activities (i.e., temperature monitoring and migration barriers assessment) in addition to implementing a suite of new studies to support the La Grange Hydroelectric Project licensing process and the Upper Tuolumne River Fish Passage and Reintroduction Assessment Framework (Framework). Following is a summary of the 2016 study program and the current status of or need for approval to access BLM land at the North Fork Tuolumne River to support these studies.

1. Fish Migration Barrier Assessment: the objective of this study is to assess potential fish migration barriers for anadromous salmonids in the Upper Tuolumne River. The study began in the summer of 2015 but at the time of field work, the North Fork Tuolumne River was dry and a decision was made to defer a barrier assessment of this watershed until 2016. Upcoming field work will consist of camping at the North Fork Tuolumne River confluence and hiking up the North Tuolumne River to collect data on potential fish migration barriers. All data collection will be passive and no equipment will be installed or left at the site. Currently, HDR has approval from BLM by letter of authorization dated July 31, 2015 (Attachment A) and plan to conduct this assessment the week of July 11, 2016.

2. Water Temperature Monitoring: the objective of this study is to collect water temperature data to support water temperature modeling of the Upper Tuolumne River. The study began in the spring of 2015 and temperature loggers continue to collect data at two locations on BLM land around the North Fork Tuolumne River. Field staff propose to visit this location twice in 2016 (July and October) to download and service monitoring equipment, address safety concerns with an existing installation (per our previous discussions), if any, and to remove equipment (during the fall event). No additional installations are required for this year's activities. HDR, by letter of authorization received October 7, 2015 completed last year's monitoring activities (Attachment B) but request renewal of this activity in order to complete this last year of temperature monitoring.

3. <u>2016 New Studies</u>: the Districts, in collaboration with licensing participants, identified three new field studies to be implemented in 2016 to support advancement of the Framework. Brief summaries of each study are described below and a detailed summary and original study plans are included in Attachment C and D, respectively.

    a. <u>Spawning Gravel Mapping Study</u>: the goal of this study is to assess the quantity and quality of spawning gravel for anadromous salmonids in the Upper Tuolumne River. Study objectives include mapping the distribution of suitable spawning substrate for spring-run Chinook and steelhead, assessing substrate quality and permeability, and assessing the amount of potentially suitable spawning. Field data collection will be comprised of four raft trips between late June and late August in 2016. No instrumentation will be left in-river and data collection will be passive. It is assumed that field crews may camp at the North Fork Tuolumne River confluence location.

    b. <u>Habitat Mapping and Macroinvertebrate Assessment</u>: the goal of this study is to develop information on habitat distribution, abundance and quality in the Upper Tuolumne River in order to inform the estimation of potential anadromous salmonid population size and development of fish passage engineering alternatives and to develop information on macroinvertebrate prey resource availability in order to inform an evaluation of the factors affecting production and viability of an existing or introduced salmonid population. Field data collection will be comprised of two float trips in July with a third potential trip in the fall (for seasonal macroinvertebrate sampling). No instrument will be left in-river however; temporary installation (up to a few hours) of drift nets or kick nets will occur to support macroinvertebrate sampling but will be manned by field staff during the entire deployment period. Aside from this activity, all other data collection will be passive. It is assumed that field crews may camp at the North Fork Tuolumne River confluence location.

    c. <u>Instream Flow Study</u>: the goal of this study is to assess instream flow-related habitat conditions for anadromous salmonids in the Upper Tuolumne River. Objectives of the study are to develop topographical and channel cover model input data, develop stage-discharge rating curves, and use modeling tools to develop weighted usable area relationships with flow. Field data collection will be comprised of three 7-day float trips in August at three to-be-determined sites. Surveying activities including installation of monuments and field deployment of temporary in-river water quality recorders during the week long sampling period are anticipated however, BLM lands associated with the North Fork Tuolumne River confluence are not to be included as part of any of the sites. As such, this study will require approval for camping and staging on BLM property only.

As noted above, activities on BLM lands in the Upper Tuolumne River will consist exclusively of camping and staging of field efforts in addition to passive forms of data collection. The exception will be the removal of existing temperature loggers (in the fall) and the possibility of brief periods of equipment deployment for macroinvertebrate sampling. The Districts respectfully request authorization to utilize BLM lands in the Upper Tuolumne River as described above for data collection efforts to support continuing implementation of the La Grange Hydroelectric Project licensing and associated Framework processes.

Please feel free to call me if you have any questions or concerns at (209) 883-8364.

Sincerely,

Steve Boyd
Turlock Irrigation District
Director of Water Resources and Regulatory Affairs

cc: Modesto Irrigation District

Enclosures: Attachment A – BLM letter of authorization to conduct fish barrier assessment on the Tuolumne and North Fork Tuolumne Rivers

Attachment B – BLM letter of authorization to the "Districts" to collect water temperature logger data on BLM land and waters within the Wild and Scenic Tuolumne and North Fork Tuolumne Rivers

Attachment C – Supplemental Information

Attachment D – Revised Draft Study Plans

United States Department of the Interior

BUREAU OF LAND MANAGEMENT
Mother Lode Field Office
5152 Hillsdale Circle
El Dorado Hills, CA 95762
www.blm.gov/ca/motherlode

7/31/2015

Mr. Steven Boyd
Turlock Irrigation District
333 East Canal Drive
Turlock, CA 95380

FERC No. 14581
CA018.14

Re: Letter of Authorization to Conduct Fish Barrier Assessment on the Tuolumne and North Fork American Rivers

Dear Mr. Boyd:

A request has been made by your authorized agent John Devine from HDR Inc., Senior Vice President Hydropower Services to seek authorization from BLM Mother Lode Field Office to conduct a fish barrier assessment along the North Fork Tuolumne River, and main stem of the Tuolumne River on BLM lands. Mr. Devine explained to Jim Eicher of my staff that the fish barrier assessment portion of the Fish Passage Assessment Study is for the La Grange Hydroelectric Project FERC No. 14581.

After reviewing the documents you sent, including the Revised Study Plan Fish Passage Assessment, the signed U.S. Department of Agriculture Forest Service Special Use Permit, and the signed Application For Transportation and Utility Systems and Facilities On Federal Lands, I will permit the Turlock Irrigation District and Modesto Irrigation District (collectively "Districts") to conduct a fish barriers assessment and camp on BLM lands located near the North Fork Tuolumne River. This Letter of Authorization allows the Districts and your agent HDR to conduct your fish barrier assessment for two different rafting trips ending on 12/31/2017.

Please inform Jim Eicher when you are going to utilize the BLM lands for the fish barrier assessments. Currently BLM is in Stage 1 Fire Restrictions, which does not allow for any fires on BLM lands in the Tuolumne River Canyon. BLM understands that HDR has hired Sierra Mac River Trips to escort your scientists down the river so they will need to abide by the USFS commercial rafting permit and stipulations.

If you have any questions concerning this Letter of Authorization please contact Jim Eicher Associate Field Manager at 916-941-3103.

Sincerely,

William S. Haigh
Field Manager

Attachment B

United States Department of the Interior

BUREAU OF LAND MANAGEMENT
Mother Lode Field Office
5152 Hillsdale Circle
El Dorado Hills, CA 95762
www.blm.gov/ca/motherlode

Mr. Steven Boyd
Turlock Irrigation District
333 East Canal Drive
Turlock, CA 95380

FERC No. 14581
CA018.14

Re: Letter of Authorization To the "Districts" To collect water temperature logger data on BLM land and waters within the Wild and Scenic Tuolumne and North Fork Tuolumne Rivers

Dear Mr. Boyd:

A request has been made by your authorized agent John Devine from HDR Inc., Senior Vice President Hydropower Services to seek authorization from BLM Mother Lode Field Office to collect water temperature data from water temperature loggers which were installed on BLM land and waters within the Wild and Scenic Tuolumne and North Fork Tuolumne Rivers this past year. BLM is currently reviewing the unauthorized installation of the temperature loggers placed by HDR on behalf of Turlock and Modesto Irrigation Districts. BLM will be responding to the unauthorized installation of these loggers shortly but in the meantime BLM will allow the Districts through HDR to enter BLM land to download the temperature data from the loggers that were installed.

This Letter of Authorization allows the Districts and your agent HDR to cross BLM land in order to download and collect water temperature data. At no time will the Districts or your agents HDR be allowed to enter BLM land that is within the Wild and Scenic River boundary by motorized vehicles of any kind, or by helicopters. Using Mohican Mine road and trail is allowed as long as the vehicles are outside of the Wild and Scenic boundary. Once inside the Wild and Scenic boundary access must be by non-motorized methods. This authorization is good for one time in order to retrieve the stored water temperature data. BLM will follow up with a trespass and permit for any further data collection purposes.

Please inform Jim Eicher when you are going to utilize the BLM lands to retrieve the water temperature data. If you have any questions concerning this Letter of Authorization please contact Jim Eicher Associate Field Manager at 916-941-3103.

Sincerely,

William S. Haigh
Field Manager

Attachment C

Filed by Turlock and Modesto Irrigation Districts
and HDR, Inc.

Names and Addresses of Applicants

Turlock Irrigation District
P.O. Box 949
Turlock, CA 95381-0949

Modesto Irrigation District
P.O. Box 4060
Modesto, CA 95352-4060

Project Description

The Turlock Irrigation District (TID) and Modesto Irrigation District (MID) (collectively, the Districts) own the La Grange Diversion Dam (LGDD) located on the Tuolumne River in Stanislaus County, California. Currently the Districts are working through the Federal Energy Regulatory Commission (FERC) licensing process with the end goal to file an application for a license. As part of the process the Districts, at the request of federal fish and wildlife agencies (NMFS, USFWS, and CDFW) have volunteered to complete a series of studies to evaluate ecological considerations related to the potential reintroduction of anadromous salmonids to the upper Tuolumne River.

Three primary studies are the subject of this permit: (1) Upper Tuolumne River Salmon and Steelhead Spawning Gravel Mapping; (2) Upper Tuolumne River Habitat Mapping and Macroinvertebrate Assessment; and (3) Upper Tuolumne River Instream Flow Study. These studies are described in more detail below.

Draft Rafting Schedule and Staffing for Proposed Studies

1. Spawning Gravel Study
    - i. Schedule – 4 trips during study season
        1. 2-day float tentatively planned for the week of June 27
        2. 7-day float tentatively planned for the week of July 18
        3. 7-day float tentatively planned for the week of August 1
        4. 5-day float tentatively planned for the week of August 22
    - ii. Total # of days on the river – 21
    - iii. Total # of rafts needed – 7 (1 for week of June 27 trip, and 2/trip for all other trips)
    - iv. Total # of staff/raft guides – 5-10 per trip

2. Habitat Mapping and Macroinvertebrate Assessment
   i. Schedule – 2 trips during study season
      1. 7-day float tentatively planned for the week of July 18
      2. 5-day float tentatively planned for the week of July 25
   ii. Total # of days on the river – 12
   iii. Total # of rafts needed – 4 (2/trip)
   iv. Total # of staff/raft guides – 5-10 per trip

3. Instream Flow Study
   i. Schedule – 3 trips during study season
      1. 7-day float tentatively planned for the week of August 15
      2. 7-day float tentatively planned for the week of August 29
      3. 7-day float tentatively planned for the week of August 29
   ii. Total # of days on the river – 21
   iii. Total # of rafts needed – 15 (5/trip)
   iv. Total # of staff/raft guides – 10-15 per trip

Spawning Gravel Mapping

Goals and Objectives

The goal of this study is to assess the quantity and quality of spawning gravel for anadromous salmonids in the upper Tuolumne River. Study objectives include the following:

- Map the distribution of potentially suitable spawning substrate available for Central Valley spring-run Chinook salmon and Central Valley steelhead in the upper Tuolumne River;

- Assess the quality of potentially suitable spawning substrates based on substrate size characteristics, angularity/roundness, sorting, embeddedness, and permeability measured in a statistically representative sample of gravel patches; and

- Quantify the amount of potentially suitable spawning gravel.

Methods

The study area includes the approximately 26.5-mile reach of the main stem Tuolumne River from Wards Ferry Bridge (RM 78.5) to Early Intake (RM 105) (**Figure 1**).

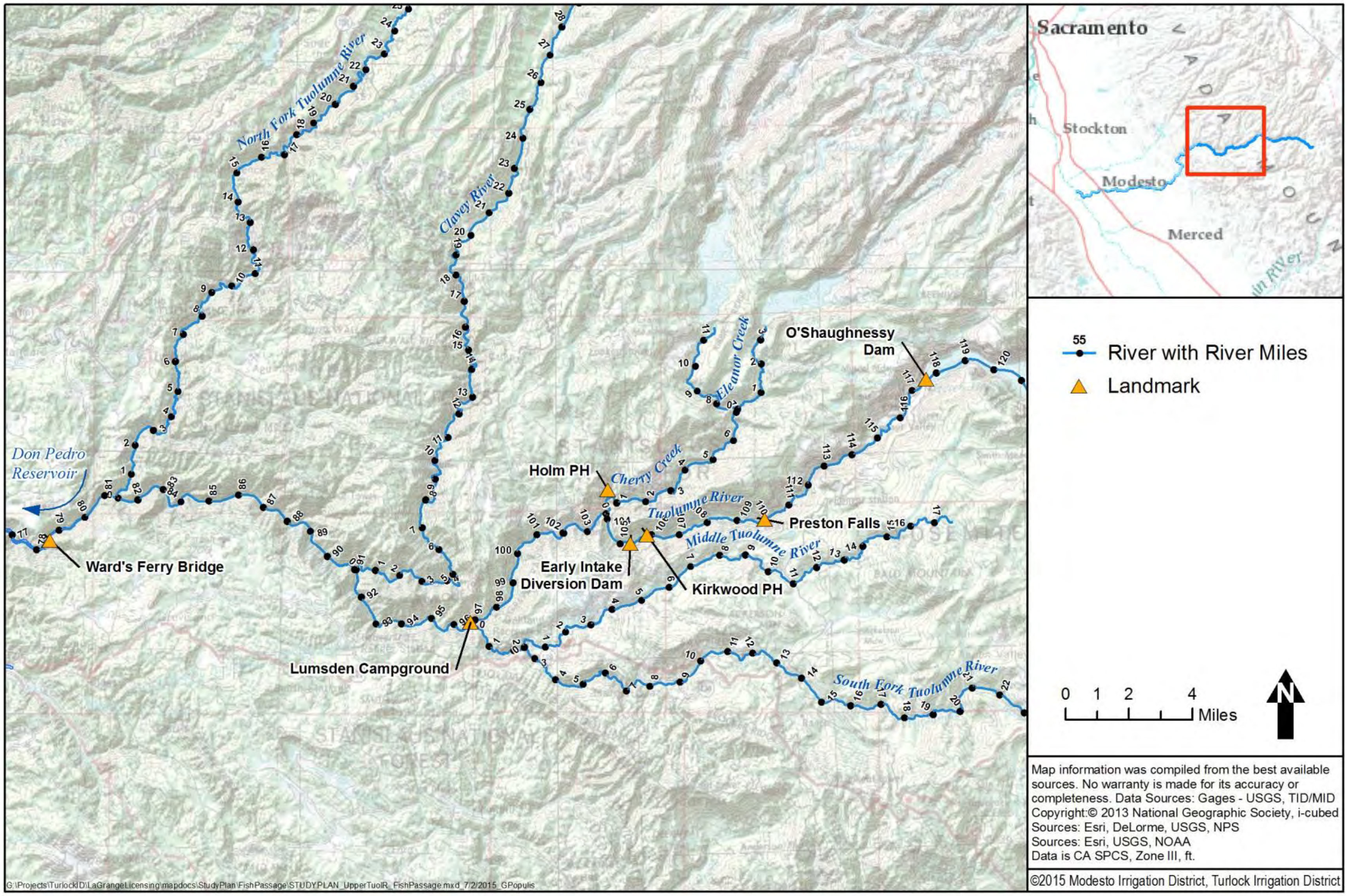

Figure 1. Overview map of the Upper Tuolumne River Watershed with notable rivers, tributaries and features.

The spawning gravel study will include desktop activities to delineate gravel patches in a Geographic Information System (GIS) to inform field staff as to the approximate distribution of gravel deposits and the most efficient process for locating and mapping those deposits prior to entering the field. Field mapping criteria and protocols will be refined following this initial desktop analysis, as needed and in consultation with appropriate agency technical staff.

Potentially suitable spawning substrate patches will then be delineated in the field on map tiles, using high resolution orthorectified aerial imagery (e.g., 08-13-2007 photography and mapbook) and preliminary gravel polygons from desktop mapping as the base. Field delineation of potentially suitable spawning substrate patches will be performed by a two-person crew using an inflatable raft to access the study reach. The crew will stop frequently to locate and investigate preliminary gravel polygons from desktop mapping and any other deposits that appear to meet the mapping criteria. Inflatable kayaks may also be used to navigate through unwadeable map areas. To the extent possible, mapping will be performed during low flow conditions to optimize visibility of potentially suitable spawning substrates.

Species-specific spawning substrate size criteria (e.g., D_{50} particle size and other grain characteristics) will be developed prior to the field effort based on relevant values reported in the scientific literature. Wolman (1954) pebble counts will be conducted in selected areas using methods developed by Bunte and Abt (2001) to calibrate visual estimates of grain size parameters. Mapping criteria will also include a minimum "mappable" patch size.

In addition to the mapping criteria described above, characteristics informing spawning habitat quality will be collected for each patch. These will include parameters such as additional substrate size characteristics (e.g., D_{16}, D_{84}), angularity/roundness, sorting, and embeddedness. A qualitative scoring (1–10) for overall suitability will also be determined for each patch.

Substrate permeability will be collected at select patches to characterize incubation conditions and estimate predicted survival-to-emergence. Since collecting substrate permeability is labor intensive, and can be highly variable between and among patches, a sampling plan for the study reach will be developed based on the results of spawning gravel mapping effort. The sampling plan will outline an approach for characterizing the permeability of spawning gravel map units throughout the study reach, and provide field sampling protocols. Sampling locations will be determined, in part, by accessibility and field crew safety, and may be constrained by boat and crew safety considerations as determined by the commercial boatman.

Potentially suitable spawning substrate patches delineated on field tiles will be digitized using GIS, and area estimates for each patch will be calculated. The quantity and quality of potentially suitable spawning substrate patches will be summarized in tabular format.

Staffing and Schedule

The proposed spawning gravel study includes four rafting trips representing a total of 21 days on the river:

- 2-day float tentatively planned for the week of June 27
- 7-day float tentatively planned for the week of July 18
- 7-day float tentatively planned for the week of August 1
- 5-day float tentatively planned for the week of August 22

Each proposed trip will include 5-10 field staff and commercial rafting guides.

Upper Tuolumne River Habitat Mapping and Macroinvertebrate Assessment

Habitat Mapping

Goals and Objectives

The goal of this study is to develop information on habitat distribution, abundance and quality in the upper Tuolumne River in order to inform the estimation of potential anadromous salmonid population size and development of fish passage engineering alternatives. Study objectives include the following:

- Document the number, size and distribution of mesohabitats available in the upper Tuolumne River;

- Collect detailed data on habitat attributes in representative reaches of the upper Tuolumne River; and

- Document potential pool holding habitat for over-summering adult Chinook salmon.

Methods

Habitat mapping will quantify the type, amount, and location of habitat types available to potentially reintroduced anadromous salmonids during their riverine life stages (adult holding/spawning, incubation and rearing). Habitat mapping will be conducted in the field and remotely using standardized methodologies. The frequency and area of each habitat type (e.g., pool, riffle, run) will be tabulated and where potential holding pools for adult Chinook occur, the size and depth of the pools will be measured to determine possible holding capacity. Additional mapping tasks will include assessments of channel gradient, width, habitat areas, etc. Habitat mapping will consist of mapping all mesohabitat units between Early Intake (RM 105) and the upstream limit of the Don Pedro Project (approximately RM 81), and collecting detailed habitat data in a sub-set of the mapped mesohabitat units.

Habitat units will be identified visually by a raft-based survey crew and mapped on pre-existing high resolution color aerial photographs. Boundaries of mesohabitat units will also be georeferenced in the field with a handheld GPS unit.

Mapped habitats will be digitized and added to the project GIS layer for mapping, as well as for quantitative and spatial analysis. Color maps will be created to depict the type and location of habitats throughout the study area and in relation to important features such as tributaries, potential passage barriers, access points, and water temperature monitoring locations. The frequency and area of each habitat type (e.g., pool, riffle, run) will also be tabulated.

Additional (remote) mapping tasks will include assessments of channel gradient, width, habitat areas, etc. following the CDFW Level III habitat typing methodology (CDFG 2010). Methods will be similar to habitat typing conducted in the lower Tuolumne River (TID/MID 2013). Sampling units selected for detailed habitat measurements will encompass approximately 10 to 20 percent of the study reach, as recommended in CDFG (2010). The habitat typing field effort will consist of a team of three biologists surveying the river by raft. The study area will be divided into seven sampling reaches, based on length of river rafted daily (two reaches from Early Intake to Lumsden and five reaches from Lumsden to Wards Ferry). Within each individual sampling reach, a one-mile section will be randomly selected for habitat typing. Prior to the field assessment, the team will use maps and existing aerial photographs to delineate the specific reaches to be surveyed. Refer to Appendix B for the additional detail on the Habitat Mapping study.

<u>Macroinvertebrate Assessment</u>

Goals and Objectives

The goal of this study is to develop information on macroinvertebrate prey resource availability in order to inform an evaluation of the factors affecting production and viability of an existing or introduced salmonid population. Study objectives include the following:

- Collect and analyze macroinvertebrate drift samples to determine whether the taxonomic composition and density of drift is consistent with other regional systems currently supporting healthy salmonid populations; and

- Collect and analyze benthic macroinvertebrate samples from the substrate to develop metrics for bioassessment and comparison with similar streams and data sets.

Methods

The study area for macroinvertebrate sampling within the upper main stem of the Tuolumne River is from RM 81 to Lumsden Bridge (RM 98). The location and number of sampling sites and sampling frequency will represent the seasonal variability of macroinvertebrate populations and related seasonal variability of food resources for stream-dwelling salmonids during the primary salmonid rearing and growth period (spring-fall), as well as the variability of physical habitat characteristics in each study reach.

Number of sites

Depending on opportunities encountered during stream habitat mapping, drift and benthic macroinvertebrate samples will be collected at five sites, equating to approximately one site per 3.5 river miles.

Locations

Drift sampling will occur in the vicinity of Lumsden and at four additional downstream locations corresponding to locations selected for overnight camping during each five-day (four-night) rafting trip. Drift samples will be collected in riffle or run habitats selected opportunistically in the vicinity of overnight camping locations along each study reach. Benthic macroinvertebrate sampling will occur at suitable riffles initially identified in the office using aerial photographs and verified in the field. One composite sample will be collected daily from a suitable riffle or combination of suitable fast-water habitat types during the five-day raft-based sampling.

Macroinvertebrate sampling will be conducted daily during the five-day raft-based sampling effort. Drift sampling in late summer (September) will characterize food resources available to rearing juvenile anadromous salmonids prior to overwintering. Spring sampling may also occur if scheduling allows in conjunction with other field efforts.

Drift sampling will begin each afternoon by 1700 hours and proceed until approximately 2000 hours. Benthic macroinvertebrate samples will be collected once per day during the raft-based sampling effort, typically during mid-day or as determined by the location of suitable sampling riffles and logistics of the habitat mapping study.

Sampling Protocols

Drift samples will be collected using stationary nets with rigid rectangular openings and tapered, nylon mesh bags with a collection jar fitted at the downstream end – similar to drift nets used by other researchers (Brittain and Eikeland 1988), including the 1987–1988 drift studies in the lower Tuolumne River (Stillwater Sciences 2010). All drift nets will be identical, with a mesh size small enough to capture small invertebrates such as immature chironomids that may be important salmonid prey, while also large enough to minimize clogging (e.g., 250–500 μ). There is no standard mesh size for drift nets, with mesh size instead chosen according to study objectives, and to represent a compromise between filtration efficiency and clogging (Svendsen et al. 2004).

At each sampling location two transects will be selected perpendicular to the river and two drift nets will be placed at each transect: one near shore and one in the thalweg or as close to the thalweg as water depth and velocity will safely allow. Each drift net will be anchored in the water column using steel (e.g., rebar stakes or fence posts) driven into the stream bed, with the bottom of the net at least 10 cm above the river bottom and the top of the net at least 4-5 cm above the water surface. This vertical net placement ensures capture of terrestrial-origin organisms originating from outside the stream (Leung et al. 2009), which may be an important diet component for anadromous salmonids (Tiffan et al. 2014, Leung et al. 2009, Rundio and Lindley 2008) while avoiding capture of organisms crawling on the substrate. During sampling, the drift nets will be attended by one or more field crew members to monitor for approaching rafts or other safety hazards. If needed, field personnel will verbally warn rafters of the potential hazard and assist rafts in avoiding the nets.

Drift nets will be deployed for three hours each day (1700-2000 hours). The width and depth of the submerged portion of each net will be measured upon installation to calculate the effective net area (i.e., the area being sampled). Water velocity will be measured at the midpoint of each net mouth immediately after net installation, at the midpoint of sampling (after 1.5 hours), and immediately before retrieving the net.

After removing each drift net from the water, the contents will be carefully washed to the end of the net and into the collection bottle using river water. The bottle will then be removed and all contents will be transferred to a sample container, labeled, and preserved with 95% ethanol for later processing.

Benthic sampling will be conducted using a modified version of the targeted riffle composite (TRC) method described in the California State Water Resources Control Board Surface Water Ambient Monitoring Program (SWAMP) Bioassessment Standard Operating Procedure (Ode 2007).

Due to site access constraints and non-wadeability in most habitat types, a modified version of the SWAMP protocol will be used to select riffles or other suitable fast-water habitat types for TRC sampling. Whereas the SWAMP protocol specifies that habitats (riffles or other fast-water habitats) for TRC sampling should be selected randomly from a pre-established reach 250 meters in length, riffles sampled for this study will instead be selected randomly from among all potentially wadeable riffles that are accessed during the habitat mapping study and were initially identified in the office by examining high-resolution color aerial photographs of the study reaches. Using the office-based method, a total of five riffles will be selected for sampling.

In the field, riffles initially selected for benthic sampling will be evaluated individually as they are encountered during the rafting trip to determine whether substrate, depth, and velocity are suitable for sampling, and if they can be sampled safely. A riffle will be deemed suitable if it has enough gravel or cobble substrate to allow collection of up to eight non-overlapping benthic samples in areas that can be safely accessed on foot by a two-person field crew (i.e., depth and velocity do not prohibit safe access and sampling). If a riffle initially chosen for TRC sampling is unsuitable, the crew will proceed to the next suitable riffle. Ideally, a total of five riffles or other fast-water habitats will be sampled in the study reach using the TRC method. At each riffle selected for TRC sampling, physical habitat and water chemistry data will be collected following the SWAMP protocol for the "basic" level of effort (Ode 2007). These data include GPS coordinates and photographs of the site, water temperature, pH, dissolved oxygen, specific conductance, channel width, riparian canopy cover, bank stability, and channel gradient

The TRC approach specifies collection of benthic samples at eight riffles within each 250 meter sampling reach (Ode 2007). However, preliminary examination of aerial photographs indicates that the riffles in the upper Tuolumne River are relatively infrequent and widely spaced, thus selection of a 250 meter sampling reach containing multiple riffles will likely be infeasible. A modified approach will therefore be used, which will entail collection of eight benthic samples per riffle. If additional suitable riffles or other suitable fast-water habitat types (e.g., run or pool tail) are located in close proximity to a riffle that has been selected for TRC sampling and can be safely accessed on foot, the required eight samples will be collected at locations distributed randomly among the suitable habitats. Sampling locations in each riffle or combination of fast-water habitat types at each site will be selected randomly using a digital stopwatch or random number chart, as described in Ode (2007). Samples will be collected using a standard D-frame kick net with 500-µ mesh. At each sampling location, a 0.09 m^2 (1 ft^2) area of bottom substrate will be sampled immediately upstream of the net following methods described in Ode (2007). All eight samples collected at each site (riffle or combination of fast-water habitats) will be combined into a single composite sample for the site, preserved in 95% ethanol, and labeled for laboratory processing.

Staffing and Schedule

The proposed habitat mapping and invertebrate assessment study includes two rafting trips representing a total of 10 days on the river:

- 7-day float tentatively planned for the week of July 18
- 5-day float tentatively planned for the week of July 25

Each proposed trip will include 5-10 field staff and commercial rafting guides.

Instream Flow Study

Goals and Objectives

The goal of this study is to assess instream flow-related habitat conditions for anadromous salmonids in the upper Tuolumne River. Objectives of the study are to develop topographical and channel cover model input data, develop stage-discharge rating curves, and use modeling tools to develop weighted usable area relationships with flow.

Methods

The study area may include the approximately 26.5-mile reach of the main stem Tuolumne River from Wards Ferry Bridge (RM 78.5) to Early Intake (RM 105) (Figure 1). Specific study sites will be defined based on results from the habitat-related studies being conducted during the summer of 2016. Three sites will be surveyed to develop information necessary to model weighted usable area for anadromous salmonids, as summarized below.

- Develop topographic surface, bed roughness, and channel cover model input data
- Create base computational mesh
- Develop upstream and downstream stage-discharge rating curves
- Compile WSE and depth/velocity validation data
- Create River2D input file for initial model runs. Model calibration and validation for two discharges (e.g. estimated to be approximately 200 cfs and 1200 cfs.)
- Model simulations
- Develop tabular and graphical WUA summary output from final model runs

Specific field data collection methodologies are described in Attachment D.

Staffing and Schedule

The proposed instream flow study includes three rafting trips representing a total of 21 days on the river:

- 7-day float tentatively planned for the week of August 15
- 7-day float tentatively planned for the week of August 29
- 7-day float tentatively planned for the week of August 29

Each proposed trip will include 10-15 field staff and commercial rafting guides.

Safety Planning for All Proposed Studies

A safety plan will be completed by the Applicant's consultants for the proposed studies to ensure the safety of the field staff and other recreational rafters on the upper Tuolumne River during implementation of the field program. The plan will include standardized safety protocols that have been used by the Applicant's consultants in similar types of studies on rivers including the Tuolumne, Merced, Stanislaus and Yuba. The safety plan will include detailed information on daily "tailgate meetings," call in/call out and other communication procedures, water and boat safety, emergency protocols, and safety of other recreationists on the river. An approved safety plan will be on file prior to the start of the field program and relevant safety information will be in the possession of crews while conducting field work. In addition, all field staff will follow standard safety guidelines required by the commercial rafting guides.

REVISED DRAFT STUDY PLAN

TURLOCK IRRIGATION DISTRICT
AND
MODESTO IRRIGATION DISTRICT

LA GRANGE HYDROELECTRIC PROJECT
FERC NO. 14581

Upper Tuolumne River Chinook Salmon and Steelhead Spawning Gravel Mapping Study

May 2016

1.0 BACKGROUND

As part of the La Grange Hydroelectric Project licensing proceeding, the Districts are undertaking the Fish Passage Facilities Alternatives Assessment (Fish Passage Assessment), the goal of which is to identify and develop concept-level alternatives for upstream and downstream passage of Chinook salmon and steelhead at the La Grange and Don Pedro dams. In September 2015, the Districts provided to licensing participants Technical Memorandum No. 1, which identified a number of information gaps critical to informing the biological and associated engineering basis of conceptual design for the Fish Passage Assessment. In November 2015, licensing participants adopted a plan to implement the Upper Tuolumne River Reintroduction Assessment Framework (Framework) intended to develop the information needed to undertake and complete the Fish Passage Assessment and to assess the overall feasibility of reintroducing anadromous salmonids into the upper Tuolumne River (TID/MID 2016). As part of implementing the Framework, a number of environmental studies are planned.

The Upper Tuolumne River Chinook Salmon and Steelhead Spawning Gravel Mapping Study is one of several studies to be implemented in 2016 in support of the Framework. Information collected during this study will be used to characterize the distribution, quantity, and quality of suitable Chinook salmon and steelhead spawning gravel in the upper Tuolumne River.

2.0 STUDY AREA

The study area for mapping Chinook salmon and steelhead spawning gravel in the upper Tuolumne River includes the approximately 24-mile reach from the upstream limit of the Don Pedro Project (approximately RM 81) to Early Intake (approximately RM 105).

3.0 STUDY GOALS

Successful Chinook salmon and steelhead spawning and fry production are dependent on the abundance and quality of suitable spawning gravel. Information on the amount, distribution, and quality of spawning gravel are critical components in estimating habitat carrying capacity and assessing limiting factors. Limited information is available to describe the distribution, quantity, and quality of spawning gravel in the upper Tuolumne River. The goal of this study is to characterize the distribution, quantity, and quality of suitable Chinook salmon and steelhead spawning gravel in the upper Tuolumne River.

The study objectives are:

- map the distribution of potentially suitable spawning gravel available for Chinook salmon and steelhead in the upper Tuolumne River;
- quantify the amount of suitable spawning gravel in the reach between RM 81 and RM 105; and
- assess the quality of potentially suitable spawning gravel based on gravel size characteristics, sorting, angularity, embeddedness, substrate depth, and permeability measured in a representative sample of gravel patches.

Study results will help inform the feasibility of introducing Chinook salmon and steelhead into the upper Tuolumne River.

4.0 STUDY METHODS

4.1 Spawning Gravel Mapping

Probable locations of gravel patches will initially be delineated in a Geographic Information System (GIS) using recent LIDAR, the best available aerial photography, and other existing information from prior mapping efforts and studies. This desktop mapping step will inform field staff as to the approximate distribution of gravel deposits and the most efficient logistical process for locating and mapping those deposits in the field. Field mapping criteria and protocols will be consistent with studies in the lower Tuolumne River (TID/MID 1992, 2013), and will be refined following this initial desktop analysis, as needed.

Potentially suitable spawning gravel patches will then be delineated in the field on map tiles from high resolution orthorectified aerial imagery (e.g., 8-13-2007 photography and mapbook). A laser range finder will be used to measure the approximate dimensions of each gravel patch, if necessary to support the delineation of patch areas on field tiles. Each patch will be assigned a unique ID. Field delineation of potentially suitable spawning gravel patches will be performed by a two-person crew using whitewater raft support to access the study reach. The crew will stop frequently to locate and investigate preliminary gravel polygons obtained from desktop mapping and any other deposits that appear to meet the mapping criteria. Inflatable kayaks may also be used to navigate unwadable areas requiring investigation. To the extent feasible, mapping will be performed during low or off-peak flow conditions to optimize visibility of potentially suitable spawning gravels. Supplemental access to limited portions of the study reach are available at vehicle road crossings and by foot, depending on terrain and river flow.

4.1.1 Gravel Particle Size Criteria

Species-specific particle size criteria that will be used to delineate potentially suitable spawning gravel for Chinook salmon and steelhead in the upper Tuolumne River study reach are summarized in Table 1.0. Patches with substantially different surface particle size characteristics will be separately delineated. Chinook salmon typically spawn in substrates with a D_{50} of 11–78 mm (0.42–3.0 in) (Platts et al. 1979, as cited in Kondolf and Wolman 1993, Chambers et al. 1954, 1955, as cited in Kondolf and Wolman 1993). Steelhead typically spawn in substrates with a D_{50} of 10–46 mm (0.4–1.8 in.) (Barnhart 1991, Kondolf and Wolman 1993). Wolman (1954) pebble counts will be conducted in selected areas to calibrate visual estimates of grain size parameters using methods developed by Bunte and Abt (2001). These preliminary particle size criteria, based on D_{50} reported in the literature, may be refined in coordination with the Technical Committee prior to the field effort.

4.1.2 Minimum Gravel Patch Size Criteria

Minimum patch size criteria for mapping potentially suitable spawning gravel will be determined prior to the field effort based on a combination of (1) the minimum area required for a spawning Chinook salmon or steelhead pair and (2) the scale and resolution of available imagery used as a base for field mapping tiles. The minimum spawning area generally identified for Chinook salmon is approximately 12 m^2 (Healy 1991, Bjorn and Reiser 1991, Ward and Kier 1999). Steelhead typically defend a redd only during the period of active spawning, and therefore the area required for a spawning steelhead pair is approximately equal to the disturbed area of the redd. . For mapping purposes, we will initially assume that a minimum patch size of approximately 6 m^2 is required for a steelhead pair to build and defend a redd (Bjornn and Reiser 1991; Orcutt et al. 1968). Preliminary minimum patch size criteria for mapping potentially suitable spawning gravel will be refined prior to field mapping based on review of available spawning patch information from the lower Tuolumne River and other relevant Central Valley river systems.

Table 1.0 Preliminary particle size and minimum patch size criteria for mapping potential spawning gravel for Chinook salmon and steelhead in the upper Tuolumne River.

Species	Gravel D_{50} mm (in.)	Minimum Patch Size Required for Spawning, m^2 (ft^2)	References
Chinook salmon	10–78 (0.4–3)	12 (130)	Platts et al. 1979, Chambers et al. 1954, 1955, all as cited in Kondolf and Wolman 1993; Healy 1991, Bjorn and Reiser 1991, Ward and Kier 1999
Steelhead	10–46 (0.4–2)	6 (65)	Barnhart 1991, Kondolf and Wolman 1993, Bjornn and Reiser 1991, Orcutt et al. 1968

Note: D_{50} – diameter of particle (in millimeters) at which 50 percent of the sample is smaller (*e.g.*, median).

4.2 Spawning Gravel Quality

In addition to the particle size and minimum patch size criteria described above, measurements and observations of the quality of gravel patches will be collected in the field to inform spawning habitat quality. These will include additional gravel particle size parameters (e.g., D_{16}, D_{84}); characterization of particle sorting, angularity, and embeddedness; an estimate of the average substrate depth (where feasible); and measurements of permeability.

4.2.1 Field Observations of Gravel Quality

Sorting describes the homogeneity of surficial particles within a patch. Spawning salmonids prefer substrates that are relatively well sorted. The degree of sorting will be visually estimated using the comparison chart in Compton (1985). Angular grains tend to pack more tightly than rounded particles and are more likely to slow intragravel flow. More loosely packed and rounded particles also increase a fish's ability to dislodge the substrate during redd construction. The degree of particle angularity within a patch will be visually estimated based on the comparison chart in Powers (1989). Substrate embeddedness describes the presence of fine sediment in the gravel interstices. Substrate embeddedness is measured by selecting a random sample of coarse surface particles within the patch and measuring the percent of the particle that is surrounded or buried by fine sediment (fines and sands <2 mm) (Burns and Edwards 1985). Embeddedness measurements will be conducted concurrent with pebble counts and/or during permeability sampling. The substrate depth required for redd construction and egg deposition likely depends on the size of the spawning female and on particle size characteristics, as well as flow depth and velocity. Chinook salmon egg pocket depths range from 8 to 51 cm (3 to 20 in), with an average of 22 cm (8.5 in) (Burner 1951). Steelhead egg pocket depths range from 15 to 28 cm (6 to 11 in), with an average of 21 cm (8.4 in) (Briggs 1953). Substrate depth will be estimated from exposure of bedrock and boulder framework and by probing with a Silvey rod.

4.2.2 Gravel Permeability

Gravel permeability will be collected to characterize incubation conditions and estimate predicted survival-to-emergence. The quality of spawning gravel will be assessed by measuring streambed permeability at select patches following the methods of Barnard and McBain (1994). Gravel inflow rate (ml/sec), which is an index of intragravel permeability (cm/hr), will be measured using a steel standpipe adapted from the Terhune Mark VI standpipe design (Terhume 1958; Barnard and McBain 1994). At select gravel patches, the standpipe will be driven into the gravel to an approximate depth of 30 cm (12 inches) using a protective end cap and sledge hammer. A battery powered peristaltic pump (e.g., IP Masterflex brand pump or equivalent) will be used to create a 2.5 cm head differential in the standpipe and the rate at which water is drawn from the pipe will be measured. While maintaining this constant pressure head, water will be drawn through the perforations in the standpipe buried in the gravel, and a stopwatch will be used to measure the time required to collect a volume of water.

Gravel permeability can be highly variable within and between patches in a reach. Therefore, a sampling plan will be developed based on the results of the spawning gravel mapping effort. The sampling plan will outline an approach and provide field protocols for characterizing the permeability of potential spawning patches throughout the study reach. The approach will generally rely on assigning patches to a morphologic unit (e.g., pool tail) and sampling from consistently similar positions within a morphologic unit. Sampling will occur in the morphological unit(s) that best exhibit the effects of fine sediment supply on spawning gravel quality and that have the highest potential value to spawning Chinook and steelhead. Permeability sampling results may be stratified by subreach, as appropriate. Desktop and field-based mapping of potentially suitable spawning gravel patches will inform an appropriate system for delineating morphological units, appropriate permeability sampling locations within those units, and appropriate delineation of any subreaches useful in extrapolating permeability sampling results.

4.2.3 Gravel Quality Ranking

When a gravel patch is identified as potentially suitable based on minimum area and particle size criteria, a qualitative ranking of overall suitability from 1 (poor) to 10 (good) will be assigned to the patch based on an overall assessment of the following physical characteristics (substrate particle size, sorting, angularity, embeddedness, gravel depth, permeability, and patch location and size). A separate ranking will be assigned for spawning gravel patches potentially suitable for Chinook salmon and steelhead. Although reliable rankings rely heavily on the professional judgment and personal experience of the survey participants, this ranking will allow comparison of patch quality. Rankings will be summarized as follows: 1–3= low suitability, 4–7= medium suitability, and 8–10= high suitability.

4.3 Data Processing and Analysis

Potentially suitable spawning gravel patches delineated on field tiles will be digitized using GIS, and area estimates for each patch will be calculated. The quantity and quality of potentially suitable spawning gravel patches will be summarized in tabular format.

Results to be reported include the following:

- shapefiles with polygons of potentially suitable spawning gravel patches and associated patch attributes;
- a database of attributes for each mapped gravel patch (i.e., measured and/or estimated particle size parameters, sorting, angularity, embeddedness, estimated mean depth [where feasible], associated channel morphological feature, and quality score);
- mean, minimum and maximum gravel inflow rates (ml/sec) as an index of intragravel permeability (cm/hr) for each sample site, presented by river mile location; and
- derived mean permeability (cm/hr) by river mile.

5.0 STUDY SCHEDULE

The anticipated schedule is to conduct the initial office-based analysis in May-June 2016, with subsequent field surveys in August/September 2016 for gravel mapping and gravel quality assessments. Mapping of potentially suitable spawning gravel will occur over two separate five-day field trips. Permeability sampling will occur over one three-day field trip to be conducted after the gravel mapping is completed. A draft report will be provided to the Technical Committee in November 2016 with a final report to be included in the February 2017 Updated Study Report.

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REVISED DRAFT STUDY PLAN

**TURLOCK IRRIGATION DISTRICT
AND
MODESTO IRRIGATION DISTRICT**

**LA GRANGE HYDROELECTRIC PROJECT
FERC NO. 14581**

Upper Tuolumne River Habitat Mapping and Macroinvertebrate Assessment

May 2016

1.0 BACKGROUND

As part of the La Grange Hydroelectric Project licensing proceeding, the Districts are undertaking the Fish Passage Facilities Alternatives Assessment (Fish Passage Assessment), the goal of which is to identify and develop concept-level alternatives for upstream and downstream passage of Chinook salmon and steelhead at the La Grange and Don Pedro dams. In September 2015, the Districts provided to licensing participants Technical Memorandum No. 1, which identified a number of information gaps critical to informing the biological and associated engineering basis of conceptual design for the Fish Passage Assessment. In November 2015, licensing participants adopted a plan to implement the Upper Tuolumne River Reintroduction Assessment Framework (Framework) intended to develop the information needed to undertake and complete the Fish Passage Assessment and to assess the overall feasibility of reintroducing anadromous salmonids into the upper Tuolumne River (TID/MID 2016). As part of implementing the Framework, a number of environmental studies are planned.

The Upper Tuolumne River Habitat Mapping and Macroinvertebrate Assessment is one of several studies to be implemented in 2016 in support of the Framework. Information collected during this study will be used to characterize habitat distribution, abundance, and quality in the upper Tuolumne River.

2.0 STUDY AREA

The study area will include the mainstem of the upper Tuolumne River from the upstream limit of the Don Pedro Project (approximately RM 81) to Early Intake (approximately RM 105).

3.0 STUDY GOALS

The primary goal of this study is to provide information on habitat distribution, abundance, and quality in the upper Tuolumne River. This information will inform evaluations in the Framework and is critical for assessing the feasibility of anadromous salmonid reintroduction, estimating potential population size and developing engineering alternatives for the upper Tuolumne River. Specific objectives include:

- documenting the number, size and distribution of mesohabitats available in the upper Tuolumne River;
- collecting detailed data on habitat attributes in representative reaches of the upper Tuolumne River;

- documenting potential pool holding habitat for over-summering adult Chinook salmon; and
- collecting drift and substrate samples of macroinvertebrates (salmonid prey organisms).

4.0 STUDY METHODS

For this assessment, habitat mapping will quantify the type, amount, and location of habitat types available to potentially reintroduced anadromous salmonids during their riverine life stages (adult holding/spawning, incubation and rearing). Habitat mapping will be conducted in the field and remotely using standardized methodologies. The frequency and area of each habitat type (e.g., pool, riffle, run) will be tabulated and where potential holding pools for adult Chinook occur, the size and depth of the pools will be measured to determine possible holding capacity. Additional mapping tasks will include assessments of channel gradient, width, habitat areas, etc.

Habitat mapping will consist of mapping all mesohabitat units between Early Intake (RM 105) and the upstream limit of the Don Pedro Project (approximately RM 81), and collecting detailed habitat data in a sub-set of the mapped mesohabitat units.

4.1 Task 1. Mesohabitat Mapping

Reconnaissance level mapping in the summer of 2015 consisted of mesohabitat classifications (Table 1.0) for portions of the reach between Lumsden (Merals Pool at RM 96) and approximately RM 81. In 2016, habitat mapping will be extended up to Early Intake (RM 105), and gaps in mapping between RM 96 and approximately RM 81 will be comprehensively assessed to obtain a more complete dataset. Habitat units will be identified visually by a boat-based survey crew and mapped on pre-existing high-resolution color aerial photographs. Boundaries of mesohabitat units will also be geo-referenced in the field with a handheld GPS unit.

Table 1.0 Mesohabitat mapping units and criteria for the mainstem Tuolumne River.

Mesohabitat types	Definitions/ Criteria
Deep Pool	>6 ft max depth
Shallow Pool	<6 ft max depth
Glide/ Pool tail	Typically in the downstream portion of a pool with negative bed slope where converging flow approaches the riffle crest. Wide, shallow, flat bottom with little to no surface agitation. Substrate type is typically smaller than riffle, but coarser than pool and often provides best salmonid spawning habitat.
Run	Long, smoothly flowing reaches, flat or concave bottom, and deeper than riffles with less surface agitation. Higher velocities than pools.
Boulder Garden/Pocket Water	Moderate to low gradient riffles, runs, and glides with numerous large boulders/obstructions that create scour pockets and eddies with near zero velocity. Often no clear thalweg present due to multiple flow paths.
Cascade/ Chute	>10% gradient, and with air entrainment (particularly in cascades), very large boulders and/or bedrock. Consisting of alternating small waterfalls and can have shallow pools in middle and margin of channel at low flows.
High Gradient Riffle	>4% gradient. Substrate is usually large boulder and bedrock (>24”)
Low Gradient Riffle	<4% gradient. Substrate is usually small boulder and large cobble(6-24”)
Side Channel	Contains < 20% of total flow. Connected at top and bottom to main channel at low flow.
Backwater	Low to zero velocities. Only connected to main channel from one end.

Mapped habitats will be digitized and added to the project GIS layer for mapping, as well as for quantitative and spatial analysis. Color maps will be created to depict the type and location of habitats throughout the study area and in relation to important features such as tributaries, potential passage barriers, access points, and water temperature monitoring locations. The frequency and area of each habitat type (e.g., pool, riffle, run) will also be tabulated.

4.2 Task 2. Habitat Inventory Mapping

Additional (remote) mapping tasks will include assessments of channel gradient, width, habitat areas, etc. following the CDFW Level III habitat typing methodology (CDFG 2010). Methods will be similar to habitat typing conducted in the lower Tuolumne River (TID/MID 2013). Sampling units selected for detailed habitat measurements will encompass approximately 10 to 20 percent of the study reach, as recommended in CDFG (2010). The habitat typing field effort will consist of a team of three biologists surveying the river by raft. The study area will be divided into seven sampling reaches, based on length of river rafted daily (two reaches from Early Intake to Lumsden and five reaches from Lumsden to Wards Ferry). Within each individual sampling reach, a one mile section will be randomly selected for habitat typing. Prior to the field assessment, the team will use maps and existing aerial photographs to delineate the specific reaches to be surveyed.

A suite of measurements consistent with the Level III CDFW criteria (Table 2.0) will be made within each mesohabitat type along each of the selected one-mile reaches. Data will be recorded on standardized datasheets to ensure all data are collected in a consistent manner. A photograph of each and GPS coordinates will be recorded at the bottom of each habitat unit. Unit length and width will be measured with a laser range finder. Depths will be measured using a stadia rod or handheld depth finder. Large woody debris (LWD) count will include a count of LWD pieces with a diameter greater than one foot and a length between six and twenty feet, as well as pieces greater than twenty feet in length, within the bankfull width. Percent total canopy will be measured using a spherical densiometer at the upstream end of each habitat unit in the center of the wetted channel, as well as general observations of riparian habitat. The remaining habitat parameters including substrate composition, substrate embeddedness, shelter complexity, and bank composition types will be visually estimated. Within each sampling reach, stream gradient will also be measured using a hand level over a distance of at least 20 bankfull channel widths. In addition, the size and depth of each pool will be collected throughout the study reach to help quantify the amount of potential Chinook salmon adult holding habitat.

Table 2.0 List of data collected as part of Level III CDFW habitat mapping.

Data	Description
Form Number	Sequential numbering
Date	Date of survey
Stream Name	As identified on USGS (U.S. Geological Survey) quadrangle
Legal	Township, Range, and Section
Surveyors	Names of surveyors
Latitude/Longitude	Degrees, Minutes, Seconds from a handheld GPS
Quadrant	7.5 USGS quadrangle where survey occurred
Reach	Reach name or river mile range
Habitat Unit Number	The habitat unit identification number
Time	Recorded for each new data sheet start time
Water Temperature	Recorded to nearest degree Celsius
Air Temperature	Recorded to nearest degree Celsius
Flow Measurement	Available from USGS monitoring stations
Mean Length	Measurement in feet of habitat unit
Mean Width	Measurement in feet of habitat unit wetted width
Mean Depth	Measurement in feet of habitat unit

Data	Description
Maximum Depth	Measurement in feet of habitat unit
Bankfull Width	Measurement in feet of channel width at bankfull discharge
Bankfull Depth	Averaged unit depth in feet at bankfull discharge
Depth Pool Tail Crest	Maximum thalweg depth at pool tail crest in feet
Pool Tail Embeddedness	Percentage in 25% interval ranges
Pool Tail Substrate	Dominant substrate: silt, sand, gravel, small cobble, large cobble, boulder, bedrock
Large Woody Debris Count	Count of LWD within wetted width and within bankfull width
Shelter Value	Assigned categorical value: 0 (none), 1 (low), 2 (medium), or 3 (high) according to complexity of the shelter.
Percent Unit Covered	Percent of the unit occupied
Substrate Composition	Composed of dominant and subdominant substrate: silt, sand, gravel, small cobble, large cobble, boulder, bedrock
Percent Exposed Substrate	Percent of substrate above water
Percent Total Canopy	Percent of canopy covering the stream
Percent Hardwood Trees	Percent of canopy composed of hardwood trees
Percent Coniferous Trees	Percent of canopy composed of coniferous trees

Results to be reported include the following:

- Ground-mapped habitat units
  - Total number of habitat units, by type
  - Total length of habitat units, by type
  - Number of habitat units (frequency)
  - Average width of habitat units, by type
  - Number and relative frequency of dominant instream cover types
  - Reach summary data (e.g., average bankfull width and depth, LWD density (within wetted and bankfull))
- Pool holding habitat
  - Total number of pools identified as potential holding habitat (and the criteria of determination)
  - Average and maximum pool depth
  - Percentage of pools with ≥ 5% cover
  - Map showing the suitable holding pools in each 1-mile sampled reach of the upper Tuolumne River
- Tributary mapping data and reconnaissance level mainstem Upper Tuolumne River habitat data collected in 2015

4.3 Task 3. Macroinvertebrate Assessment

If time and logistics allow as the final field schedule is developed, a macroinvertebrate assessment will be conducted following the methods outlined below.

4.3.1 Study Goals

Drifting and benthic macroinvertebrates typically comprise the primary food source for rearing salmonids in fresh water habitats (Allan 1978, Fausch 1984, Harvey and Railsback 2014). Information on macroinvertebrate prey resource availability is a component of an evaluation of the factors affecting production and viability of an existing or introduced salmonid population. The density and taxonomic composition of drifting macroinvertebrates can provide a relative measure of food availability for drift-feeding salmonids. To provide a relative measure of food availability for salmonids within the water column, a literature search of similar streams and macroinvertebrate studies in the region (Sierra foothill region) will be conducted. Substrate sampling for benthic macroinvertebrates will provide data that can be used in a standardized bioassessment approach to evaluate the potential for physical habitat impairment. The objectives of the macroinvertebrate assessment are to:

- collect and analyze macroinvertebrate drift samples to determine whether the taxonomic composition and density of drift is consistent with other regional systems currently supporting healthy salmonid populations; and
- collect and analyze benthic macroinvertebrate samples from the substrate to develop metrics for bioassessment and comparison with similar streams and data sets.

4.3.2 Study Methods

4.3.2.1 Sampling Site Selection

The study area for macroinvertebrate sampling within the upper mainstem of the Tuolumne River is from RM 81 to Early Intake (RM 105). The location and number of sampling sites and sampling frequency will represent the seasonal variability of macroinvertebrate populations and related seasonal variability of food resources for stream-dwelling salmonids during the primary salmonid rearing and growth period (spring-fall), as well as the variability of physical habitat characteristics in each study reach.

<u>Number of sites</u>
Depending on opportunities encountered during stream habitat mapping, drift and benthic macroinvertebrate samples will be collected at seven sites, equating to approximately one site per 3.5 river miles.

<u>Locations</u>
Drift sampling will occur at seven sites, based on length of river rafted daily (two sites from Early Intake to Lumsden and five sites from Lumsden to Wards Ferry) at sites selected near overnight camping locations during each rafting trip. Drift samples will be collected in riffle or run habitats and be selected based on suitable depth, velocity, substrate, and accessibility/safety considerations, with two sites per location and two replicates (net placements) per site.

Benthic macroinvertebrate sampling will occur at suitable riffles initially identified in the office using aerial photographs and verified in the field. One composite sample will be collected daily from a suitable riffle or combination of suitable fast-water habitat types during the seven-day raft-based sampling.

<u>Sample timing and frequency</u>
Macroinvertebrate sampling will be conducted daily during the raft-based habitat mapping effort. Drift sampling in early summer (June) will characterize food resources available to rearing juvenile anadromous salmonids. In many temperate streams, aquatic macroinvertebrate diversity and abundance peak during spring and summer and are reduced in late summer and fall. Peak feeding and growth by rearing salmonids occur when prey availability and water temperatures are relatively high, maximizing net energy gain (Rundio and Lindley 2008, Stillwater Sciences 2007, Wurtsbaugh and Davis 1977). Exact sampling dates for this study may be adjusted within the general seasonal period to coincide with other sampling efforts in order to maximize efficiency and accommodate river flow levels. However, macroinvertebrate sampling should not occur during periods of very high flows or when river discharge is changing rapidly due to safety and access concerns and the potential effects of flow fluctuations on invertebrate drift (Brittain and Eikland 1988).

Drift sampling will begin each afternoon by 1700 hours and proceed until approximately 2000 hours. This sample timing is intended to collect drifting macroinvertebrates during the daily period when feeding activity is often greatest for juvenile Chinook salmon and trout (Sagar and Glova 1988, Johnson 2008) and to avoid pre-dawn and post-dusk peaks in drifting macroinvertebrates that may not be available to drift-feeding salmonids at low light levels. The timing and duration of drift sampling can be adjusted if needed to accommodate rafting safety concerns or logistical constraints. All drift sampling should occur during the peak afternoon-evening feeding period and have the same start and end time.

The timing of the benthic macroinvertebrate sampling is not seasonally dependent, but will be coincident with the drift sampling effort to maximize efficiency and reduce the amount of field sampling time required for the study. Benthic macroinvertebrate samples will be collected once per day during the raft-based sampling effort, typically during mid-day or as determined by the location of suitable sampling riffles and logistics of the habitat mapping study.

4.3.2.2 Sampling Protocols

<u>Invertebrate drift sampling</u>
Drift samples will be collected using stationary nets with rigid rectangular openings and tapered, nylon mesh bags with a collection jar fitted at the downstream end – similar to drift nets used by other researchers (Brittain and Eikeland 1988), including the 1987–1988 drift studies in the lower Tuolumne River (Stillwater Sciences 2010). All drift nets will be identical, with a mesh size small enough to capture small invertebrates such as immature chironomids that may be important salmonid prey, while also large enough to minimize clogging (e.g., 250–500 μ). There is no standard mesh size for drift nets, with mesh size instead chosen according to study objectives, and to represent a compromise between filtration efficiency and clogging (Svendsen et al. 2004).

At each sampling location two transects will be selected perpendicular to the river and two drift nets will be placed at each transect: one near shore and one in the thalweg or as close to the thalweg as water depth and velocity will safely allow. Each drift net will be anchored in the water column using steel (e.g., rebar stakes or fence posts) driven into the stream bed, with the bottom of the net at least 10 cm above the river bottom and the top of the net at least 4–5 cm above the water surface. This vertical net placement ensures capture of terrestrial-origin organisms originating from outside the stream (Leung et al. 2009), which may be an important diet component for anadromous salmonids (Tiffan et al. 2014, Leung et al. 2009, Rundio and Lindley 2008) while avoiding capture of organisms crawling on the substrate. Because drift composition is not uniform across the channel (Waters 1969), placement of near-shore and mid-channel drift nets allows sampling of each portion of the channel to represent potential differences in taxonomic composition, origin (aquatic vs. terrestrial), density, or other factors. The safety of approaching rafts will be considered during the selection of transect locations, and each drift net will be clearly marked with a buoy. During sampling, the drift nets will be attended by one or more field crew members to monitor for approaching rafts or other safety hazards. If needed, field personnel will verbally warn rafters of the potential hazard and assist rafts in avoiding the nets.

Drift nets will be deployed for three hours each day (1700–2000 hours). The width and depth of the submerged portion of each net will be measured upon installation to calculate the effective net area (i.e., the area being sampled). Water velocity will be measured at the midpoint of each net mouth immediately after net installation, at the midpoint of sampling (after 1.5 hours), and immediately before retrieving the net. The three velocity values will be used to calculate the average water velocity at the mouth of each net during sampling, and the average velocity will be multiplied by the sampled area to determine the total volume of water passing through each net during the sampling event. Because net clogging during sampling can gradually reduce the velocity of water passing through the net, an average of several water velocities measured over the course of sampling provides a more accurate measure of volume than a single velocity measure.

After removing each drift net from the water, the contents will be carefully washed to the end of the net and into the collection bottle using river water. The bottle will then be removed and all contents will be transferred to a sample container, labeled, and preserved with 95% ethanol for later processing.

Benthic sampling

Benthic sampling will be conducted using a modified version of the targeted riffle composite (TRC) method described in the California State Water Resources Control Board Surface Water Ambient Monitoring Program (SWAMP) Bioassessment Standard Operating Procedure (Ode 2007). The TRC has been widely used in California by state and federal water resource agencies, is consistent with the methods of EPA's Environmental Monitoring and Assessment Program (EMAP) (Peck et al. 2006), and has been adopted as the standard riffle protocol for bioassessment in California (Ode 2007). A similar methodology, the former California Stream Bioassessment Protocol (CSBP) and later the California Monitoring and Assessment Program (CMAP), produced comparable results and was used for the Districts' benthic macroinvertebrate sampling program in the lower Tuolumne River from 2001–2005 and from 2007–2009 (Stillwater Sciences 2010). The SWAMP TRC method was recently used to collect benthic macroinvertebrate samples in the upper Merced River as part of the Merced River Alliance Biological Monitoring and Assessment project (Stillwater Sciences 2008).

Due to site access constraints and non-wadeability in most habitat types, a modified version of the SWAMP protocol will be used to select riffles or other suitable fast-water habitat types for TRC sampling. Whereas the SWAMP protocol specifies that habitats (riffles or other fast-water habitats) for TRC sampling should be selected randomly from a pre-established reach 250 meters in length, riffles sampled for this study will instead be selected randomly from among all potentially wadeable riffles that are accessed during the habitat mapping study and were initially identified in the office by examining high-resolution color aerial photographs of the study reaches. During field sampling, the field crew will carry a set of the aerial photographs with potential sampling riffles identified, to enable identification of alternative sampling riffles if needed. Using the office-based method, a total of seven riffles will be selected for sampling. Riffles selected for sampling will be spaced sufficiently to enable sampling of an average of one riffle per day during the raft-based field effort.

In the field, riffles initially selected for benthic sampling will be evaluated individually as they are encountered during the rafting trip to determine whether substrate, depth, and velocity are suitable for sampling, and if they can be sampled safely. A riffle will be deemed suitable if it has enough gravel or cobble substrate to allow collection of up to eight non-overlapping benthic samples in areas that can be safely accessed on foot by a two-person field crew (i.e., depth and velocity do not prohibit safe access and sampling). If a riffle initially chosen for TRC sampling is unsuitable, the crew will proceed to the next suitable riffle. Ideally, a total of five riffles or other fast-water habitats will be sampled in the study reach using the TRC method. At each riffle selected for TRC sampling, physical habitat and water chemistry data will be collected following the SWAMP protocol for the "basic" level of effort (Ode 2007). These data include GPS coordinates and photographs of the site, water temperature, pH, dissolved oxygen, specific conductance, channel width, riparian canopy cover, bank stability, and channel gradient.

The TRC approach specifies collection of benthic samples at eight riffles within each 250 meter sampling reach (Ode 2007). However, preliminary examination of aerial photographs indicates that the riffles in the upper Tuolumne River are relatively infrequent and widely spaced, thus selection of a 250 meter sampling reach containing multiple riffles will likely be infeasible. A modified approach will therefore be used, which will entail collection of eight benthic samples per riffle. If additional suitable riffles or other suitable fast-water habitat types (e.g., run or pool tail) are located in close proximity to a riffle that has been selected for TRC sampling and can be safely accessed on foot, the required eight samples will be collected at locations distributed randomly among the suitable habitats. Sampling locations in each riffle or combination of fast-water habitat types at each site will be selected randomly using a digital stopwatch or random number chart, as described in Ode (2007). Samples will be collected using a standard D-frame kick net with 500-μ mesh. At each sampling location, a 0.09 m^2 (1 ft^2) area of bottom substrate will be sampled immediately upstream of the net following methods described in Ode (2007). All eight samples collected at each site (riffle or combination of fast-water habitats) will be combined into a single composite sample for the site, preserved in 95% ethanol, and labeled for laboratory processing.

4.3.2.3 Analysis and Reporting

All macroinvertebrate samples will be processed in the laboratory following standardized methods and the data will be entered into a database. Processing will enumerate and identify organisms to the taxonomic level necessary to calculate commonly reported biological metrics (numerical attributes of biotic assemblages) for each sample site from the benthic samples (i.e., TRC samples) and identify the diversity and abundance of primary salmonid prey items in the drift. Benthic macroinvertebrate metrics may include those calculated for benthic macroinvertebrate samples collected in the lower Tuolumne River from 2000–2005 and 2007–2009 (Stillwater Sciences 2010). Laboratory analysis of drift samples will also include length measurement of individual organisms, to allow calculation of biomass at a later date, if desired, to provide a relative measure of energy content and available fish food resources. Results will be included in a technical report that evaluates the adequacy of the macroinvertebrate prey resources to support healthy populations of juvenile anadromous salmonids, as indicated by comparison of the taxonomic composition and relative abundance (drift density) of the upper Tuolumne River macroinvertebrate drift samples with drift samples from other salmonid streams.

5.0 STUDY SCHEDULE

The study will be completed during the summer and fall of 2016; a detailed field schedule will be developed in conjunction with other field studies.

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REVISED DRAFT STUDY PLAN

TURLOCK IRRIGATION DISTRICT
AND
MODESTO IRRIGATION DISTRICT

LA GRANGE HYDROELECTRIC PROJECT
FERC NO. 14581

Upper Tuolumne River Instream Flow Study

May 2016

1.0 BACKGROUND

As part of the La Grange Hydroelectric Project licensing proceeding, the Districts are undertaking the Fish Passage Facilities Alternatives Assessment (Fish Passage Assessment), the goal of which is to identify and develop concept-level alternatives for upstream and downstream passage of Chinook salmon and steelhead at the La Grange and Don Pedro dams. In September 2015, the Districts provided to licensing participants Technical Memorandum No. 1, which identified a number of information gaps critical to informing the biological and associated engineering basis of conceptual design for the Fish Passage Assessment. In November 2015, licensing participants adopted a plan to implement the Upper Tuolumne River Reintroduction Assessment Framework (Framework) intended to develop the information needed to undertake and complete the Fish Passage Assessment and to assess the overall feasibility of reintroducing anadromous salmonids into the upper Tuolumne River (TID/MID 2016). As part of implementing the Framework, a number of environmental studies are planned.

The Upper Tuolumne River Instream Flow Study is one of several studies to be implemented in 2016 in support of the Framework. Information collected during this study will be used to evaluate existing aquatic habitat and provide quantifiable metrics of aquatic habitat suitability in the upper Tuolumne River.

2.0 STUDY AREA

The study area for the Instream Flow Study is the main stem of the Tuolumne River extending from the upstream end of the Don Pedro Project (RM 81 +/-) to Early Intake (RM 105).

3.0 STUDY GOALS

The goals of this study are (1) to model existing aquatic habitat for spring-run and fall-run Chinook salmon (*Oncorhynchus tshawytscha*) and steelhead (O. *mykiss*); (2) to evaluate the existing aquatic habitat over a representative range of observed water years and operations of the City and County of San Francisco's Holm powerhouse; and (3) to provide quantifiable metrics of aquatic habitat suitability in the context of potential reintroduction of Chinook salmon and steelhead.

4.0 STUDY METHODS

The following instream flow study methods are consistent with normal and customary 2-dimensional (2D) instream flow methodologies, and will provide data that are comparable to data collected and used at other salmonid-bearing streams and rivers in California and elsewhere.

The study will be performed in five steps: (1) reach and site selection; (2) field data collection; (3) hydraulic modeling; (4) aquatic habitat modeling; and (5) report preparation. Each of these steps is described below.

Step 1 – Reach and Site Selection

The establishment of study reaches and the location of a study site within each reach will be based on five primary sources of information: (1) upper Tuolumne River geomorphology; (2) watershed hydrology; (3) habitat mapping study results; (4) spawning gravel mapping study results; and (5) existing aerial imagery. Based on current information, it is expected that two or three study sites will be selected throughout the study area.

Reach segmentation in the study area will be based on geomorphic characteristics (e.g., gradient, channel width, substrate composition) and hydrologic contributions (e.g., accretion, percent contribution to overall streamflow from tributaries, effects of hydropower peaking). Based on these characteristics and results from detailed mesohabitat mapping and gravel surveys, one or more study sites will be selected in each reach. Lastly, study site selection will focus on selecting both low gradient mesohabitats (pool, run and low gradient riffle) and likely short high gradient transition mesohabitats (e.g., high gradient riffle, cascade).

Study sites will be selected of a sufficient size and habitat composition to adequately characterize, and be indicative of, the range of habitat attributes (e.g., spawning, rearing and holding) documented through previous and concurrent field data gathering efforts conducted as part of the Framework. The final length of each site will be dependent on the geomorphic characteristics and lengths of mesohabitats contained within the selected study location. The number and types of mesohabitats selected will also depend on the length and variability of mapped units in the vicinity.

While study sites will initially be developed using field and aerial imagery data sources, final site selection may also be influenced by (1) proximity to camping locations, an important logistical consideration in this remote river canyon, and (2) safety considerations, which are influenced by gradient, channel configuration, hydraulic conditions, and availability of downstream recovery/safety zones.

Step 2 – Field Data Collection

Given the remoteness and limited access to the upper Tuolumne River, field data collection at each site will be completed in one continuous five to seven day period. It is anticipated that most of the out-of-water topography will be developed using airborne Light Detection and Ranging (LiDAR) data collected by NMFS in 2015 along the upper Tuolumne River. Before use, the LiDAR data will be evaluated by a remote sensing expert for quality and study utility.

Additional topographic data will be collected using a variety of methods depending on site conditions. Initially, LiDAR coverage will be evaluated and used to describe the majority of each study site not submerged at the time of the data collection. The remaining in-water and out-of-water topographic data collection will be completed utilizing a number of survey techniques. Given the steep nature of the canyon, standard Real Time Kinematic (RTK) Global Positioning System (GPS) survey will likely not be practical. Therefore, the primary survey instruments used will be Robotic Total Stations (RTS), surveyed into a RTK GPS network. The RTS units will be used for topographic surveys conducted on foot and for single beam bathymetric surveys conducted to collect unwadable in-channel topography. Depending on river conditions and safety considerations during each survey, a variety of manned and unmanned craft may be used for bathymetric data collection. Field staff will record all relevant survey information into predefined survey log sheets throughout each survey day.

After each data collection period, the RTK static GPS data files collected by the base station will be submitted to the National Oceanic and Atmospheric Administration's (NOAA) Online Positioning User Service (OPUS). OPUS returns a position corrected and mapped into the high accuracy National Spatial Reference System (NSRS). Using Trimble Business Center software, the OPUS-corrected position will then used to correct the network of RTS collected points from each survey instrument.

Habitat modeling for certain lifestages will require that substrate classification be consistent with habitat suitability criteria (HSC). Once final HSC are defined for this study, substrate classification tables and codes will be developed for use in the field. Similarly, and if applicable, cover types will correspond to cover codes defined in HSC selected for each species.

Prior to field work, detailed substrate information from the *Upper Tuolumne River Chinook Salmon and Steelhead Spawning Gravel Mapping Study* will be reviewed and, as appropriate, used for field reference. Additionally, if aerial photos are of suitable resolution, preliminary substrate polygons will be digitized throughout each model domain. In the field, crews will use an iPad loaded with aerial photos and GIS mapping software to either validate and refine the desktop delineation or develop substrate polygons and cover features throughout each study site.

Water surface elevations (WSE), discharges, and calibration depths and velocities will be collected throughout each study site at two calibration flows. The final measured flows will ultimately depend on the hydropower peaking operations and the duration of stable flows observed at each study site. Flow stability for data collection and modeling purposes is defined as a 'steady' discharge that results in minimal fluctuation in stage (e.g., no more than +/- 0.05 ft) for a long enough duration to measure discharge, WSEs, depths and velocities throughout the study site. It is anticipated that target flows will range from approximately 200 cfs to 1,200 cfs but will be dictated by upstream hydropeaking operations during each survey period. Based on these targets, hydraulic-habitat relationships modeled in each study site will extend from approximately 50 cfs to 2,000 cfs. The final range will be determined by the overall quality of site specific rating curves and model performance.

WSE's will be surveyed using a RTS in approximately 50 locations throughout the wetted channel for each calibration flow. In addition, spatially referenced depth and velocity validation data will be collected in at approximately 50 locations by an acoustic Doppler current profiler (ADCP) or manual velocity meter depending on location and hydraulic condition. Spot velocities depths and WSE measurements will span the entire longitudinal profile of model site.

Study site discharge measurements will be made using a combination of manual velocity meters and an ADCP mounted on an OceanSciences™ trimaran or similar vessel. ADCP measurements will follow standard USGS procedures (Mueller and Wagner 2009) for measuring discharge.

On-site rating curves will be developed using a combination of stage and discharge measurements and stage recording pressure transducers. At a minimum, three stage and discharge measurements will be made at each site. To supplement these data, stage recorders, which also record temperature, will be deployed at the top and bottom of the each study site to passively record stage over the data collection period. Stage recorders may also be deployed at various locations throughout the site to monitor the rate of stage change at specific mesohabitats. To relate WSE to discharge, the WSE will be measured directly above each installed logger at the time of deployment and again when the units are retrieved. A barometric pressure transducer will also be installed at the site to compensate for changes in atmospheric pressure. For validation purposes, WSEs will be measured during calibration flow surveys in the vicinity of each recorder. In addition to providing stage data for rating curve development, stage and temperature data from the recorders will be used to inform habitat and peaking analyses, discussed in Step 5 below.

Study site photographs will be collected to document site conditions during each survey. A representative collection of site photos, arranged by calibration survey flow will provided in a report attachment.

Step 3 – Hydraulic Modeling

Surface and Mesh Development

Hydraulic modeling for the study site will use River2D (Steffler and Blackburn 2002). The River2D model uses the finite element method to solve the basic equations of vertically averaged 2D flow incorporating mass and momentum conservation in the two horizontal dimensions (Steffler and Blackburn 2002).

The main input parameters for the River2D model include channel surface topography, bed roughness (in the form of an effective roughness height), and upstream and downstream hydraulic boundary conditions (i.e., water levels and discharge). Accurate topography is the primary variable that allows for the development of a well calibrated model.

Topographic surfaces will be constructed by combining the total station survey data, RTS and RTK GPS standard survey data, bathymetric data, and the LiDAR ground return data. In order to increase the definition in areas of topographic gradient and variability, breaklines will be defined within the topographic surface. Breaklines enforce the topographic surface to 'snap' to the entire length of the line and are used to define features with large vertical gradient changes, such as cascades, toe of slopes, and boulders.

Before entering the data into the River2D model, topographic data from the site will be reviewed for errors in ArcMap and ArcScene. Triangulated Irregular Networks (TINs) will be developed to visualize the data in two and three dimensions

Mesh development will follow procedures outlined in the R2D_Mesh User's Manual (Waddle and Steffler 2002). When building a computational mesh, it is important to optimize for computational performance without sacrificing mesh quality. Using the topographic surface nodes to define the mesh is not recommended as the computational requirements for such a model exceed the limits of the software and currently available computer hardware. Instead, a low density uniform mesh is developed and then refined using a variety of techniques.

As recommended by the R2D_Mesh User's Manual, a balance between mesh density and computational burden will be addressed in part by applying a procedure called 'wet refinement' which places nodes at the centroid of each mesh element. This process ensures the appropriate mesh density in wetted areas only, while limiting mesh density in dry areas.

Another method used to refine the mesh is to review mesh-generated elevation contours as compared to bed elevation contours at an interval of 0.82-foot with a goal of close contour approximation. Since the topographic points and mesh nodes are not in the same location, the contours will not be exactly the same. Therefore, to increase contour agreement, additional nodes may be added in topographically complex areas. To achieve the appropriate mesh density over all simulation flows, the mesh will be iteratively refined in the context of the full range of possible wetted areas.

A third method used to refine the mesh will be to identify large elevation differences between topographic data points and the interpolated elevation of each mesh triangle. Most often, large elevation differences exist in areas of high gradient (e.g., cascade) or significant localized topographic relief (e.g., cliff or vertical bank). Mesh triangles that exceed a 0.82-ft difference threshold are highlighted yellow in the mesh development software and further refined until the difference is no longer detected.

QI is a mesh quality index where a value of 1.0 represents a mesh comprised of perfect equilateral triangles. The goal minimum triangle quality index (QI) for each computational mesh is 0.15. Low QI values (i.e., <0.10) do not necessarily compromise model quality, but will increase computational run times. Tools in the mesh development software are used to improve geometry to achieve the minimum goal QI value.

One initial base mesh used for model calibration will be used for all simulation runs. However, it will be necessary to make small changes if model run time errors (i.e., eddy shedding velocity oscillation, extremely high velocity, or Froude number) occur.

Model Calibration

Model parameters such as bed roughness (Ks, in the form of an effective roughness height), substrate transmissivity (tr) and eddy viscosity can be adjusted during model calibration to reflect field conditions. A stage-wise approach with target criteria for model performance will be used to guide calibration. The specific stages and criteria are discussed below.

For the initial hydraulic model, hydraulic calibration tests will be conducted using the target calibration flows of 200 cfs and 1,200 cfs. Bed roughness (Ks) and transmissivity (tr) will be varied as necessary to match observed WSEs and wetted area. As part of normal calibration, Ks and tr values are incrementally adjusted through an integrative sensitivity analysis until modeled WSEs calibrate well to observed WSEs. In addition to the WSE comparisons, velocity and depth predictions will be compared to field measured data to evaluate changes made to Ks.

The term "Ks" is scientific notation for bed roughness factor (in meters) and the term refers to gradation of material in the river. Compared to traditional one-dimensional models, where many two-dimensional effects are abstracted into the resistance factor, the 2D resistance term accounts only for the direct bed shear (Steffler and Blackburn 2002). Ks is iteratively varied as necessary to match observed water surface elevations using the default transmissivity of tr = 0.1. In general, the initial Ks value entered is 1-3 times the grain size documented during field data collection. Multiple regional Ks values (i.e., heterogeneous substrate material and/or large elevation changes) may be selected for each study site based on model performance.

Groundwater transmissivity (tr) is a user-defined variable which corresponds to groundwater flow and the relationship to surface flow. The default value is 0.1 which ensures that groundwater discharge is negligible. Because subsurface flow through gravel or cobble may be present at the study site, it may be necessary to modify the default value of tr to aid in the wetting and drying function throughout the model domain.

The target criterion for mean error in WSE between simulated versus observed data is, to a large extent, based on the accuracy of the survey equipment used to measure WSE. It is also important to recognize the influence of highly heterogeneous or high gradient topography (e.g., cascades and high gradient riffles) habitats on differences between field data and model data. Given the expected range of site characteristics in the upper Tuolumne River an average of 0.10 ft difference between simulated and observed WSE will be targeted.

Similarly, no specific target calibration criteria exist for velocity or depth parameters as these variables are greatly influenced by the differences in topographic detail between the field conditions, initial bed file detail, and the final bed detail resulting from the interpolated mesh. Using professional judgment and standard industry practice, velocity and depth variables are reviewed for reasonableness and significant errors in depth (i.e., > 0.33 ft mean error) and velocity (i.e., > 0.5 fps mean error) are evaluated. For all sets of model calibration variables, the correlation coefficient (r) and the coefficient of determination (r2) (i.e., percent of variance in an indicator variable explained by a factor and the measure of the proportion of variance of model results, respectively) will be calculated. In general, coefficients greater than 0.7 are expected while coefficient of determination values for velocity magnitude are expected to be within a range of 0.4 and 0.8 (Pasternack 2011).

Flow field velocity vectors (i.e., the direction and magnitude) are used to evaluate velocity prediction reasonableness during the calibration process but are otherwise not incorporated into the statistical review process.

Model convergence for a given hydraulic simulation is achieved and accepted when the inflow (Qin) equals outflow (Qout) and the solution change is nominal. Solution change is the relative change in the solution variable over the last time step. Specific criteria thresholds do not exist for these parameters and are largely based on the magnitude of the simulation discharge and the professional judgment of the modeler. The target solution change goal will be 0.0001. This target value is consistent with recommendations made in the River2D User's Manual (Steffler and Blackburn 2002).

Step 4 – Aquatic Habitat Modeling

Habitat Suitability Criteria

HSC define the range of microhabitat variables that are suitable for a particular species and lifestage of interest. HSC provide the biological criteria input to the River2D model which combines the physical habitat data and the habitat suitability criteria into a site-wide habitat suitability index (i.e., Weighted Usable Area or WUA) over a range of simulation flows. Variables typically defined with HSC include depth, velocity, instream cover and bottom substrate. HSC values range from 0.0 to 1.0, indicating habitat conditions that are unsuitable to optimal, respectively. WUA is defined as the sum of stream surface area within a nodal area model domain or stream reach, weighted by multiplying area by habitat suitability variables, most often velocity, depth, and substrate or cover, which range from 0.0 to 1.0 each.

Spring-run Chinook salmon HSC information compiled for the McCloud River, a tributary of the Sacramento River, will be used for habitat modeling. The HSC were recently developed for use in a PHABSIM study assessing potential habitat availability related to the reintroduction of Chinook salmon upstream of Shasta Lake (PG&E 2011). The PHABSIM study was conducted for PG&E's McCloud Pit Hydroelectric Project (FERC No. 2106) (PG&E 2012). Using the best available HSC information and professional judgment, composite curves were developed for spawning, fry and juvenile lifestages. Holding HSC were not developed in the process. Holding habitat will be evaluated in the *Upper Tuolumne River Habitat Mapping and Macroinvertebrate Assessment.* Model results from this study may, however, inform the suitability of holding habitat. Spring-run periodicity information will rely upon information provided in Technical Memorandum No. 1 (TID/MID 2015).

Steelhead and fall-run Chinook salmon HSC information developed for the lower Tuolumne River instream flow study (Stillwater Sciences 2013) will be used to model habitat suitability in this study. Spawning and juvenile lifestages will be modeled. The Districts note that the lower Tuolumne River HSC may require some modification to appropriately be used in the upper Tuolumne River channel. Modifications to HSC will be made by a regional HSC expert familiar with the proposed curves and any changes will be thoroughly documented in the final report. Periodicity information for these species will rely upon information provided in Technical Memorandum No. 1 (TID/MID 2015).

Model Simulation

Approximately 18 discharges will be simulated for each study site resulting in an expected flow range of 50 cfs to 2,000 cfs. Habitat suitability and WUA for all fish species and lifestages will be calculated for each simulation flow. In order to calculate habitat suitability, four data inputs are required: a fish preference file (i.e., HSC), a channel index, depth, and velocity. A fish preference file is loaded into River2D as a text file. Depth and velocity values are provided from the model once a simulation has converged and is at a steady state. Channel index files are a River2D model file equivalent to a substrate and/or cover map of the entire study site. Substrate may only be applicable to the spawning lifestages and possibly fry/juvenile lifestages (as a cover component) but will depend on the HSC used.

For this study, the habitat suitability calculation will use the standard triple product function which multiplies depth, velocity, and channel index suitability together at each model node. Channel index interpolation will be defined using discrete node selection (i.e., nearest node rather than a continuous linear interpolation of the channel index values from surrounding nodes). Discrete node selection is typically applied to substrate classifications such that the original substrate code value is maintained. If cover codes are defined for the proposed HSC, continuous interpolation will be applied to cover indices where a gradient of cover may be best described by the interpolation function.

Hydropeaking Analysis – Habitat Persistence

It is of particular importance to evaluate and understand the potential effect of hydropeaking operations on the habitat utilized by various lifestages of aquatic organisms. For example, an area with suitable depth, velocity and substrate for spawning adults at one flow may become unsuitable as flows rise or recede over a large range of hydropeaking operations. At some point, if redds were developed at a high flow, they may become dewatered at lower flows. Similarly, it is important to understand the spatial and temporal distribution of habitat for fry and juvenile salmonids. Suitable rearing habitat at one flow may quickly become unsuitable and shift in location when flows rapidly increase or decrease. These analyses are often termed habitat effectiveness, or habitat persistence. These terms relate to the temporal and spatial change in habitat suitability and distribution under changing flow conditions.

Within each model domain, regions of special interest (e.g., spawning gravel patches) will be identified. The areas of interest (AOI) will be areas that could provide suitable spawning and rearing habitat under a range of flow conditions. Polygons representing the AOI regions will be digitized in ArcGIS in order to extract data from model nodes in the computational mesh.

Relying on information generated from each of the model simulation runs, model parameters such as suitability, WSE, velocity and depth will be extracted at each model node such that changes in each parameter, per unit discharge, can be calculated and evaluated. These analyses will be conducted using Geographic Information System (GIS) and spreadsheet tools.

Effects on aquatic habitat from daily changes in power plant operation will be modeled for time periods specified by species and lifestage periodicity and will be initially conducted at 15-minute to 1-hr time intervals using data collected at each site by stage recorders. Additional longer duration analyses will focus on weekly or monthly time steps and rely on hydrologic time series data from representative water years (e.g., dry, normal and wet). Results for the selected AOI regions in each model domain will be reported in both tabular and spatial form.

Step 5 – Reporting

A detailed technical memorandum will be provided that includes the following sections: (1) Study Goals and Objectives; (2) Methods; (3) Results; (4) Discussion; and (5) Description of Variances from the study plan, if any. A number of report attachments will include, but not be limited to, additional data such as representative site photographs and, habitat suitability maps. Models and interactive spreadsheets will be made available on CD.

5.0 STUDY SCHEDULE

Final study sites will be selected once data from habitat mapping and spawning gravel surveys are completed and data evaluated. Field data collection is anticipated to commence in the fall of 2016. Hydraulic and habitat modeling and associated analyses will be conducted in the fall of 2016 and winter of 2017. A progress report will be included in the February 2017 Updated Study Report.

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From: Staples, Rose
Sent: Monday, June 27, 2016 2:03 PM
Cc: Deason, Jesse; Craig, Nancy; Staples, Rose
Subject: June 30 Logistics for La Grange Recreation Access-Safety Assessment Study Site Visit

Confirmed: John Buckley, Chris Collett, Peter Drekmeier, Abimael Leon, and Theresa Simsiman
Maybe Second Half of Site Visit: Lonnie Moore, Aondrea Bartoo

Thank you for your interest in attending the June 30, 2016 site visit for the La Grange Hydroelectric Project Recreation Access and Safety Assessment study.

The purpose of the site visit is to gather site-specific information to be used along with existing aerial photography, topography data, and property ownership data to produce site assessments and descriptions of potential public access routes at the Project. The site visit is a requirement of the FERC-approved Recreation Access and Safety Assessment study plan, which can be found here on the La Grange Project licensing website (the study plan begins on page 90 of the PDF). The study plan was modified by the FERC Study Plan Determination, which can be found on the La Grange licensing website here (documents on this webpage are organized by the date each was uploaded to the website; FERC's Study Plan Determination was uploaded on April 24, 2015).

The site visit will begin by meeting at 8:00 am at the Blue Oaks Recreation Area (see directions below). Personnel at the entrance to Blue Oaks will direct you to our meeting location. The site visit will end at approximately 12:00 pm at the La Grange powerhouse.

The site visit will entail approximately 60 minutes of hiking steep, unimproved terrain. Participants may be exposed to heat and sun; and poisonous plants and venomous animals inhabit the area. Given these conditions, we recommend that attendees dress and pack accordingly. In particular, **attendees should wear or bring:**

1. Hiking boots and long pants
2. Adequate sun protection including long-sleeved shirt, a hat, sunglasses, and sunblock
3. Bug spray
4. Plenty of water

Please let us know if you have a change of plans and will not be attending the site visit.

Thank you.

Directions to Blue Oaks Recreation Area: From Modesto, head east on CA-132/Yosemite Boulevard. Turn left onto La Grange Road (J59). After approximately 4.7 miles, turn right onto Bonds Flat Road. Continue on Bonds Flat Road for approximately one mile. Blue Oaks Recreation Area will be on your left.

Rose Staples, CAP-OM, MOS
Executive Assistant

HDR
970 Baxter Boulevard Suite 301
Portland ME 04103
D 207-239-3857
rose.staples@hdrinc.com

hdrinc.com/follow-us

From: Gmail <lmoorenorcal@gmail.com>
Sent: Monday, June 27, 2016 8:45 AM
To: Staples, Rose
Cc: Craig, Nancy; Deason, Jesse
Subject: Re: La Grange Recreation Study Plan and FERC Study Plan Determinationg

Thank you Rose and Nancy!

Lonnie

On Jun 27, 2016, at 8:15 AM, Staples, Rose <Rose.Staples@hdrinc.com> wrote:

> I understand from Nancy Craig that you were looking for a copy of the La Grange *Recreation Access and Safety Assessment Study* as well as a copy of FERC's Study Plan Determination.
>
> You will find both documents in the DOCUMENTS listing on the La Grange licensing website www.lagrange-licensing.com. Please note the listing is in DATE SEQUENCE as of the date uploaded to the website—with the newest document at the top of the list.
>
> The Recreation Access and Safety Assessment study begins on page 90 of the Revised Study Plan (RSP), which was added to the Document listing on ***October 9, 2014***.
>
> FERC's Study Plan Determination was uploaded on ***April 24, 2015***.
>
> If you encounter any difficulty in locating and/or accessing these documents, please let me know. Thank you.
>
> Rose Staples, CAP-OM, MOS
> *Executive Assistant*
>
> HDR
> 970 Baxter Boulevard Suite 301
> Portland ME 04103
> D 207-239-3857
> rose.staples@hdrinc.com
>
> hdrinc.com/follow-us

From: Foote, Debra -FS [mailto:dfoote@fs.fed.us]
Sent: Monday, June 27, 2016 4:49 PM
To: Le, Bao
Cc: Vaughn, Gary D -FS
Subject: permit

Bao,
I have attached a copy of the permit for new Barriers permit. Please print, obtain approved signature on your side, and return so that I can obtain our authorized signature.
I will work on the amendments giving priority as per our conversation.

Debbie Foote
Resource Assistant

Forest Service
Groveland Ranger District

p: 209-962-7825 x533
f: 209-962-7412
dfoote@fs.fed.us

24545 Hwy. 120
Groveland, CA 95321
www.fs.fed.us

Caring for the land and serving people

Authorization ID: GRO1144
Contact Name: TURLOCK IRRIGATION DISTRICT
Expiration Date: 12/31/2018
Use Code: 422

FS-2700-4 (V. 01/2014)
OMB 0596-0082

U.S. DEPARTMENT OF AGRICULTURE
FOREST SERVICE
SPECIAL USE PERMIT
Authority: ORGANIC ADMINISTRATION ACT 1897

TURLOCK IRRIGATION DISTRICT of 333 EAST CANAL DRIVE TURLOCK CA 95380 (hereinafter "the holder") is authorized to use or occupy National Forest System lands in the STANISLAUS NATIONAL FOREST, subject to the terms and conditions of this special use permit (the permit).

This permit covers approximately 27 miles in the Sec. 35, T. 1 N., R. 18 E., MT. DIABLO MERIDIAN , ("the permit area"), as shown on the map attached as Appendix B. This permit issued for the purpose of:

Research on Tuolumne River for three primary studies: (1) Upper Tuolumne River Salmon and Steelhead Spawning Gravel Mapping; (2) Upper Tuolumne River Habitat Mapping and Macroinvertebrate Assessment; and (3) Upper Tuolumne River Instream Flow Study. These studies are described in more detail in Appendix A. Complete study plans will be attached to the final permit application.

Authorization is given for trips up to 14 days when needed. Avoid sites that are designated for commercial use:

Odd years	Even Years
Powerhouse	Indian
Clavey (upstream/right)	Clavey (left)
North Fork (downstream)	North Fork (upstream)
	Mohican Mine

Authorized use of low decibel generator for equipment charging needs is approved. Use of the generator will be during the hours of 8:00 am – 10:00 pm, a 10’ diameter clearance is required for fire prevention, fire tools and water must be available within 25’ of the generator. Store fuel in an approved flammable materials container(s) or MSR or similarly sealable fuel bottle(s) a safe distance away from generator and water.

Prior to initiating any trip occurring in waters of the Stanislaus National Forest, the following decontamination procedures **will be followed** to prevent the introduction and spread of aquatic invasive/nuisance species:

1. Remove all accumulations of organic (examples: plants, algae) and inorganic (mud) material from all equipment including nets, measuring and sampling devices, boots, waders, and other items that have come into prior contact with potentially contaminated water or sediments.
2. Prepare a solution of decontamination medium consisting of one of the following: 0.1% concentration of active ingredient of a quaternary ammonium compound (DDAC or didecyl dimethyl ammonium chloride) or 2% concentration of active ingredient of household bleach (sodium hypochlorite). The preferred quaternary ammonium compound is Quat 128.
3. Soak all potentially contaminated equipment for a minimum of 5 minutes.
4. Rinse with clean tap water.

If the equipment is going to be used at another site following Tuolumne River trips, we advise the permittee to decontaminate all equipment with an equivalent or more stringent process. The Tuolumne River is a known source of *Didymosphenia geminata*, commonly referred to as rock snot or didymo. Decontamination of equipment will prevent the spread of this nuisance algae to other waters.

If the equipment used during sampling has not been exposed to other waters between trips, decontamination of equipment is not required. However, we recommend the permittee allow the equipment to thoroughly dry before initiating another trip on the Tuolumne.

Decontamination of equipment is not necessary if moving from the Tuolumne River into the lower Clavey River (river mile 0 to river mile 2.5), or any of the other Tuolumne River tributaries.

Permittee needs to be aware that quaternary ammonium compounds are potentially damaging to aluminum products and bleach solutions are damaging to fabrics, rubber, plastics, and metal. These compounds are known to be or potentially corrosive.

TERMS AND CONDITIONS

I. GENERAL TERMS

A. AUTHORITY. This permit is issued pursuant to ORGANIC ADMINISTRATION ACT 1897 and 36 CFR Part 251, Subpart B, as amended, and is subject to their provisions.

B. AUTHORIZED OFFICER. The authorized officer is the Forest or Grassland Supervisor or a subordinate officer with delegated authority.

C. TERM. This permit shall expire at midnight on 12/31/2018, **1 year and 5 months** from the date of issuance.

D. RENEWAL. This permit is not renewable. Prior to expiration of this permit, the holder may apply for a new permit that would renew the use and occupancy authorized by this permit. Applications for a new permit must be submitted at least 6 months prior to expiration of this permit. Renewal of the use and occupancy authorized by this permit shall be at the sole discretion of the authorized officer. At a minimum, before renewing the use and occupancy authorized by this permit, the authorized officer shall require that (1) the use and occupancy to be authorized by the new permit is consistent with the standards and guidelines in the applicable land management plan; (2) the type of use and occupancy to be authorized by the new permit is the same as the type of use and occupancy authorized by this permit; and (3) the holder is in compliance with all the terms of this permit. The authorized officer may prescribe new terms and conditions when a new permit is issued.

E. AMENDMENT. This permit may be amended in whole or in part by the Forest Service when, at the discretion of the authorized officer, such action is deemed necessary or desirable to incorporate new terms that may be required by law, regulation, directive, the applicable forest land and resource management plan, or projects and activities implementing a land management plan pursuant to 36 CFR Part 215.

F. COMPLIANCE WITH LAWS, REGULATIONS, AND OTHER LEGAL REQUIREMENTS. In exercising the rights and privileges granted by this permit, the holder shall comply with all present and future federal laws and regulations and all present and future state, county, and municipal laws, regulations, and other legal requirements that apply to the permit area, to the extent they do not conflict with federal law, regulation, or policy. The Forest Service assumes no responsibility for enforcing laws, regulations, and other legal requirements that fall under the jurisdiction of other governmental entities.

G. NON-EXCLUSIVE USE. The use or occupancy authorized by this permit is not exclusive. The Forest Service reserves the right of access to the permit area, including a continuing right of physical entry to the permit area for inspection, monitoring, or any other purpose consistent with any right or obligation of the United States under any law or regulation. The Forest Service reserves the right to allow others to use the permit area in any way that is not inconsistent with the holder's rights and privileges under this permit, after consultation with all parties involved. Except for any restrictions that the holder and the authorized officer agree are necessary to protect the installation and operation of authorized temporary improvements, the lands and waters covered by this permit shall remain open to the public for all lawful purposes.

II.IMPROVEMENTS

A. LIMITATIONS ON USE. Nothing in this permit gives or implies permission to build or maintain any structure or facility or to conduct any activity, unless specifically authorized by this permit. Any use not specifically authorized by this permit must be proposed in accordance with 36 CFR 251.54. Approval of such a proposal through issuance of a new permit or permit amendment is at the sole discretion of the authorized officer.

B. PLANS. All plans for development, layout, construction, reconstruction, or alteration of improvements in the permit area, as well as revisions to those plans must be prepared by a professional engineer, architect, landscape architect, or other qualified professional based on federal employment standards acceptable to the authorized officer. These plans and plan revisions must have written approval from the authorized officer before they are implemented. The authorized officer may require the holder to furnish as-built plans, maps, or surveys upon completion of the work.

C. CONSTRUCTION. Any construction authorized by this permit shall commence by NA and shall be completed by NA.

III. OPERATIONS.

A. PERIOD OF USE. Use or occupancy of the permit area shall be exercised at least **14** days each year.

B. CONDITION OF OPERATIONS. The holder shall maintain the authorized improvements and permit area to standards of repair, orderliness, neatness, sanitation, and safety acceptable to the authorized officer and consistent with other provisions of this permit. Standards are subject to periodic change by the authorized officer when deemed necessary to meet statutory, regulatory, or policy requirements or to protect national forest resources. The holder shall comply with inspection requirements deemed appropriate by the authorized officer.

C. INSPECTION BY THE FOREST SERVICE. The Forest Service shall monitor the holder's operations and reserves the right to inspect the permit area and transmission facilities at any time for compliance with the terms of this permit. The holder's obligations under this permit are not contingent upon any duty of the Forest Service to inspect the permit area or transmission facilities. A failure by the Forest Service or other governmental officials to inspect is not a justification for noncompliance with any of the terms and conditions of this permit.

IV. RIGHTS AND LIABILITIES

A. LEGAL EFFECT OF THE PERMIT. This permit, which is revocable and terminable, is not a contract or a lease, but rather a federal license. The benefits and requirements conferred by this authorization are reviewable solely under the procedures set forth in 36 CFR 251, Subpart C and 5 U.S.C. 704. This permit does not constitute a contract for purposes of the Contract Disputes Act, 41 U.S.C. 601. The permit is not real property, does not convey any interest in real property, and may not be used as collateral for a loan.

B. VALID OUTSTANDING RIGHTS. This permit is subject to all valid outstanding rights. Valid outstanding rights include those derived under mining and mineral leasing laws of the United States. The United States is not liable to the holder for the exercise of any such right.

C. ABSENCE OF THIRD-PARTY BENEFICIARY RIGHTS. The parties to this permit do not intend to confer any rights on any third party as a beneficiary under this permit.

D. SERVICES NOT PROVIDED. This permit does not provide for the furnishing of road or trail maintenance, water, fire protection, search and rescue, or any other such service by a government agency, utility, association, or individual.

E. RISK OF LOSS. The holder assumes all risk of loss associated with use or occupancy of the permit area, including but not limited to theft, vandalism, fire and any fire-fighting activities (including prescribed burns), avalanches, rising waters, winds, falling limbs or trees, and other forces of nature. If authorized temporary improvements in the permit area are destroyed or substantially damaged, the authorized officer shall conduct an analysis to determine whether the improvements can be safely occupied in the future and whether rebuilding should be allowed. If rebuilding is not allowed, the permit shall terminate.

F. DAMAGE TO UNITED STATES PROPERTY. The holder has an affirmative duty to protect from damage the land, property, and other interests of the United States. Damage includes but is not limited to fire suppression costs, damage to government-owned improvements covered by this permit, and all costs and damages associated with or resulting from the release or threatened release of a hazardous material occurring during or as a result of activities of the holder or the holder's heirs, assigns, agents, employees, contractors, or lessees on, or related to, the lands, property, and other interests covered by this permit. For purposes of clause IV.F and section V, "hazardous material" shall mean (a) any hazardous substance under section 101(14) of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), 42 U.S.C. § 9601(14); (b) any pollutant or contaminant under section 101(33) of CERCLA, 42 U.S.C. § 9601(33); (c) any petroleum product or its derivative, including fuel oil, and waste oils; and (d) any hazardous substance, extremely hazardous substance, toxic substance, hazardous waste, ignitable, reactive or corrosive materials, pollutant, contaminant, element, compound, mixture, solution or substance that may pose a present or potential hazard to human health or the environment under any applicable environmental laws.

1. The holder shall avoid damaging or contaminating the environment, including but not limited to the soil, vegetation (such as trees, shrubs, and grass), surface water, and groundwater, during the holder's use or occupancy of the permit area. If the environment or any government property covered by this permit becomes damaged during the holder's use or occupancy of the permit area, the holder shall immediately repair the damage or replace the damaged items to the satisfaction of the authorized officer and at no expense to the United States.

2. The holder shall be liable for all injury, loss, or damage, including fire suppression, prevention and control of the spread of invasive species, or other costs in connection with rehabilitation or restoration of natural resources associated with the use or occupancy authorized by this permit. Compensation shall include but not be limited to the value of resources damaged or destroyed, the costs of restoration, cleanup, or other mitigation, fire suppression or other types of abatement costs, and all administrative, legal (including attorney's fees), and other costs. Such costs may be deducted from a performance bond required under clause IV.I.

3. The holder shall be liable for damage caused by use of the holder or the holder's heirs, assigns, agents, employees, contractors, or lessees to all roads and trails of the United States to the same extent as provided under clause IV.F.1, except that liability shall not include reasonable and ordinary wear and tear.

G. HEALTH, SAFETY, AND ENVIRONMENTAL PROTECTION. The holder shall promptly abate as completely as possible and in compliance with all applicable laws and regulations any activity or condition arising out of or relating to the authorized use or occupancy that causes or threatens to cause a hazard to public health or the safety of the holder's employees or agents or harm to the environment (including areas of vegetation or timber, fish or other wildlife populations, their habitats, or any other natural resources). The holder shall prevent impacts to the environment and cultural resources by implementing actions identified in the operating plan to prevent establishment and spread of invasive species. The holder shall immediately notify the authorized officer of all serious accidents that occur in connection with such activities. The responsibility to protect the health and safety of all persons affected by the use or occupancy authorized by this permit is solely that of the holder. The Forest Service has no duty under the terms of this permit to inspect the permit area or operations and activities of the holder for hazardous conditions or compliance with health and safety standards.

H. INDEMNIFICATION OF THE UNITED STATES. The holder shall indemnify, defend, and hold harmless the United States for any costs, damages, claims, liabilities, and judgments arising from past, present, and future acts or omissions of the holder in connection with the use or occupancy authorized by this permit. This indemnification provision includes but is not limited to acts and omissions of the holder or the holder's heirs, assigns, agents, employees, contractors, or lessees in connection with the use or occupancy authorized by this permit which result in (1) violations of any laws and regulations which are now or which may in the future become applicable, and including but not limited to those environmental laws listed in clause V.A of this permit; (2) judgments, claims, demands, penalties, or fees assessed against the United States; (3) costs, expenses, and damages incurred by the United States; or (4) the release or threatened release of any solid waste, hazardous waste, hazardous materials, pollutant, contaminant, oil in any form, or petroleum product into the environment. The authorized officer may prescribe terms that allow the holder to replace, repair, restore, or otherwise undertake necessary curative actions to mitigate damages in addition to or as an alternative to monetary indemnification.

V. RESOURCE PROTECTION

A. COMPLIANCE WITH ENVIRONMENTAL LAWS. The holder shall in connection with the use or occupancy authorized by this permit comply with all applicable federal, state, and local environmental laws and regulations, including but not limited to those established pursuant to the Resource Conservation and Recovery Act, as amended, 42 U.S.C. 6901 et seq., the Federal Water Pollution Control Act, as amended, 33 U.S.C. 1251 et seq., the Oil Pollution Act, as amended, 33 U.S.C. 2701 et seq., the Clean Air Act, as amended, 42 U.S.C. 7401 et seq., CERCLA, as amended, 42 U.S.C. 9601 et seq., the Toxic Substances Control Act, as amended, 15 U.S.C. 2601 et seq., the Federal Insecticide, Fungicide, and Rodenticide Act, as amended, 7 U.S.C. 136 et seq., and the Safe Drinking Water Act, as amended, 42 U.S.C. 300f et seq.

B. VANDALISM. The holder shall take reasonable measures to prevent and discourage vandalism and disorderly conduct and when necessary shall contact the appropriate law enforcement officer.

C. PESTICIDE USE. Pesticides may not be used outside of buildings to control undesirable woody and herbaceous vegetation (including aquatic plants), insects, rodents, fish, and other pests and weeds without prior written approval from the authorized officer. A request for approval of planned uses of pesticides shall be submitted annually by the holder on the due date established by the authorized officer. The report shall cover a 12-month period of planned use beginning 3 months after the reporting date. Information essential for review shall be provided in the form specified. Exceptions to this schedule may be allowed, subject to emergency request and approval, only when unexpected outbreaks of pests or weeds require control measures that were not anticipated at the time an annual report was submitted. Only those materials registered by the U.S. Environmental Protection Agency for the specific purpose planned shall be considered for use on National Forest System lands. Label instructions and all applicable laws and regulations shall be strictly followed in the application of pesticides and disposal of excess materials and containers.

D. <u>ARCHAEOLOGICAL-PALEONTOLOGICAL DISCOVERIES</u>. The holder shall immediately notify the authorized officer of all antiquities or other objects of historic or scientific interest, including but not limited to historic or prehistoric ruins, fossils, or artifacts discovered in connection with the use and occupancy authorized by this permit. The holder shall leave these discoveries intact and in place until directed otherwise by the authorized officer. Protective and mitigative measures specified by the authorized officer shall be the responsibility of the holder.

E. <u>NATIVE AMERICAN GRAVES PROTECTION AND REPATRIATION</u>. In accordance with 25 U.S.C. 3002(d) and 43 CFR 10.4, if the holder inadvertently discovers human remains, funerary objects, sacred objects, or objects of cultural patrimony on National Forest System lands, the holder shall immediately cease work in the area of the discovery and shall make a reasonable effort to protect and secure the items. The holder shall immediately notify the authorized officer by telephone of the discovery and shall follow up with written confirmation of the discovery. The activity that resulted in the inadvertent discovery may not resume until 30 days after the authorized officer certifies receipt of the written confirmation, if resumption of the activity is otherwise lawful, or at any time if a binding written agreement has been executed between the Forest Service and the affiliated Indian tribes that adopts a recovery plan for the human remains and objects.

F. <u>PROTECTION OF HABITAT OF THREATENED, ENDANGERED, AND SENSITIVE SPECIES</u>. The location of sites within the permit area needing special measures for protection of plants or animals listed as threatened or endangered under the Endangered Species Act (ESA) of 1973, 16 U.S.C. 1531 et seq., as amended, or identified as sensitive or otherwise requiring special protection by the Regional Forester under Forest Service Manual (FSM) 2670, pursuant to consultation conducted under section 7 of the ESA, may be shown on the ground or on a separate map. The map shall be attached to this permit as an appendix. The holder shall take any protective and mitigative measures specified by the authorized officer. If protective and mitigative measures prove inadequate, if other sites within the permit area containing threatened, endangered, or sensitive species or species otherwise requiring special protection are discovered, or if new species are listed as threatened or endangered under the ESA or identified as sensitive or otherwise requiring special protection by the Regional Forester under the FSM, the authorized officer may specify additional protective and mitigative measures. Discovery of these sites by the holder or the Forest Service shall be promptly reported to the other party.

G. <u>CONSENT TO STORE HAZARDOUS MATERIALS</u>. The holder shall not store any hazardous materials at the site without prior written approval from the authorized officer. This approval shall not be unreasonably withheld. If the authorized officer provides approval, this permit shall include, or in the case of approval provided after this permit is issued, shall be amended to include specific terms addressing the storage of hazardous materials, including the specific type of materials to be stored, the volume, the type of storage, and a spill plan. Such terms shall be proposed by the holder and are subject to approval by the authorized officer.

1. If the holder receives consent to store hazardous material, the holder shall identify to the Forest Service any hazardous material to be stored at the site. Such identification information shall be consistent with column (1) of the table of hazardous materials and special provisions enumerated at 49 CFR 172.101 whenever the hazardous material appears in that table. For hazard communication purposes, the holder shall maintain Material Safety Data Sheets for any stored hazardous chemicals, consistent with 29 CFR 1910.1200(c) and (g). In addition, all hazardous materials stored by the holder shall be used, labeled, stored, transported, and disposed of in accordance with all applicable federal, state, and local laws and regulations.

2. The holder shall not release any hazardous material as defined in clause IV.F. onto land or into rivers, streams, impoundments, or natural or man-made channels leading to them. All prudent and safe attempts must be made to contain any release of these materials. The authorized officer in charge may specify specific conditions that must be met, including conditions more stringent than federal, state, and local regulations, to prevent releases and protect natural resources.

H. <u>CLEANUP AND REMEDIATION</u>

1. The holder shall immediately notify all appropriate response authorities, including the National Response Center and the authorized officer or the authorized officer's designated representative, of any oil discharge or of the release of a hazardous material in the permit area in an amount greater than or equal to its reportable quantity, in accordance with 33 CFR Part 153, Subpart B, and 40 CFR Part 302. For the purposes of this requirement, "oil" is as defined by section 311(a) (1) of the Clean Water Act, 33 U.S.C. 1321(a)(1). The holder shall immediately notify the authorized officer or the authorized officer's designated representative of any release or threatened release of any hazardous material in or near the

permit area which may be harmful to public health or welfare or which may adversely affect natural resources on federal lands.

2. Except with respect to any federally permitted release as that term is defined under Section 101(10) of CERCLA, 42 U.S.C. 9601(10), the holder shall clean up or otherwise remediate any release, threat of release, or discharge of hazardous materials that occurs either in the permit area or in connection with the holder's activities in the permit area, regardless of whether those activities are authorized under this permit. The holder shall perform cleanup or remediation immediately upon discovery of the release, threat of release, or discharge of hazardous materials. The holder shall perform the cleanup or remediation to the satisfaction of the authorized officer and at no expense to the United States. Upon revocation or termination of this permit, the holder shall deliver the site to the Forest Service free and clear of contamination.

I. CERTIFICATION UPON REVOCATION OR TERMINATION. If the holder uses or stores hazardous materials at the site, upon revocation or termination of this permit the holder shall provide the Forest Service with a report certified by a professional or professionals acceptable to the Forest Service that the permit area is uncontaminated by the presence of hazardous materials and that there has not been a release or discharge of hazardous materials upon the permit area, into surface water at or near the permit area, or into groundwater below the permit area during the term of the permit. This certification requirement may be waived by the authorized officer when the Forest Service determines that the risks posed by the hazardous material are minimal. If a release or discharge has occurred, the professional or professionals shall document and certify that the release or discharge has been fully remediated and that the permit area is in compliance with all federal, state, and local laws and regulations.

VI. LAND USE FEE AND ACCOUNTING ISSUES

A. LAND USE FEES. The use or occupancy authorized by this permit is exempt from a land use fee or the land use fee has been waived in full pursuant to 36 CFR 251.57 and Forest Service Handbook 2709.11, Chapter 30.

VII. REVOCATION, SUSPENSION, AND TERMINATION

A. REVOCATION AND SUSPENSION. The authorized officer may revoke or suspend this permit in whole or in part:

1. For noncompliance with federal, state, or local law.

2. For noncompliance with the terms of this permit.

3. For abandonment or other failure of the holder to exercise the privileges granted.

4. With the consent of the holder.

5. For specific and compelling reasons in the public interest.

Prior to revocation or suspension, other than immediate suspension under clause VII.B, the authorized officer shall give the holder written notice of the grounds for revocation or suspension. In the case of revocation or suspension based on clause VII.A.1, 2, or 3, the authorized officer shall give the holder a reasonable time, typically not to exceed 90 days, to cure any noncompliance.

B. IMMEDIATE SUSPENSION. The authorized officer may immediately suspend this permit in whole or in part when necessary to protect public health or safety or the environment. The suspension decision shall be in writing. The holder may request an on-site review with the authorized officer's supervisor of the adverse conditions prompting the suspension. The authorized officer's supervisor shall grant this request within 48 hours. Following the on-site review, the authorized officer's supervisor shall promptly affirm, modify, or cancel the suspension.

C. APPEALS AND REMEDIES. Written decisions by the authorized officer relating to administration of this permit are subject to administrative appeal pursuant to 36 CFR Part 214 as amended. Revocation or suspension of this permit shall not give rise to any claim for damages by the holder against the Forest Service.

D. TERMINATION. This permit shall terminate when by its terms a fixed or agreed upon condition, event, or time occurs without any action by the authorized officer. Examples include but are not limited to expiration of the permit by its terms on a specified date and termination upon change of control of the business entity. Termination of this permit shall not require notice, a decision document, or any environmental analysis or other documentation. Termination of this permit is not subject to administrative appeal and shall not give rise to any claim for damages by the holder against the Forest Service.

E. RIGHTS AND RESPONSIBILITIES UPON REVOCATION OR TERMINATION WITHOUT RENEWAL. Upon revocation or termination of this permit without renewal of the authorized use, the holder shall remove all structures and improvements, except those owned by the United States, within a reasonable period prescribed by the authorized officer and shall restore the site to the satisfaction of the authorized officer. If the holder fails to remove all structures and improvements within the prescribed period, they shall become the property of the United States and may be sold, destroyed, or otherwise disposed of without any liability to the United States. However, the holder shall remain liable for all costs associated with their removal, including costs of sale and impoundment, cleanup, and restoration of the site.

VIII. MISCELLANEOUS PROVISIONS

A. MEMBERS OF CONGRESS. No member of or delegate to Congress or resident commissioner shall benefit from this permit either directly or indirectly, except to the extent the authorized use provides a general benefit to a corporation.

B. CURRENT ADDRESSES. The holder and the Forest Service shall keep each other informed of current mailing addresses, including those necessary for billing and payment of land use fees.

C. SUPERIOR CLAUSES. If there is a conflict between any of the preceding printed clauses and any of the following clauses, the preceding printed clauses shall control.

THIS PERMIT IS ACCEPTED SUBJECT TO ALL ITS TERMS AND CONDITIONS.

BEFORE ANY PERMIT IS ISSUED TO AN ENTITY, DOCUMENTATION MUST BE PROVIDED TO THE AUTHORIZED OFFICER OF THE AUTHORITY OF THE SIGNATORY FOR THE ENTITY TO BIND IT TO THE TERMS AND CONDITIONS OF THE PERMIT.

ACCEPTED:

HOLDER NAME, PRECEDED BY NAME AND TITLE OF PERSON SIGNING ON BEHALF OF HOLDER, IF HOLDER IS AN ENTITY	SIGNATURE	DATE

APPROVED:

Jim Junette, District Ranger	SIGNATURE	DATE

According to the Paperwork Reduction Act of 1995, an agency may not conduct or sponsor, and a person is not required to respond to a collection of information unless it displays a valid OMB control number. The valid OMB control number for this information collection is 0596-0082. The time required to complete this information collection is estimated to average one hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information.

The U.S. Department of Agriculture (USDA) prohibits discrimination in all its programs and activities on the basis of race, color, national origin, gender, religion, age, disability, political beliefs, sexual orientation, and marital or family status. (Not all prohibited bases apply to all programs.) Persons with disabilities who require alternative means for communication of program information (Braille, large print, audiotape, etc.) should contact USDA's TARGET Center at 202-720-2600 (voice and TDD).

To file a complaint of discrimination, write USDA, Director, Office of Civil Rights, 1400 Independence Avenue, SW, Washington, DC 20250-9410 or call (800) 975-3272 (voice) or (202) 720-6382 (TDD). USDA is an equal opportunity provider and employer

The Privacy Act of 1974 (5 U.S.C. 552a) and the Freedom of Information Act (5 U.S.C. 552) govern the confidentiality to be provided for information received by the Forest Service.

From: "Bartoo, Aondrea" <aondrea_bartoo@fws.gov>
Date: June 27, 2016 at 2:09:29 PM PDT
To: "Craig, Nancy" <Nancy.Craig@hdrinc.com>
Subject: Re: La Grange June 30 2016 Recreation Access & Safety Assessment Study Site Visit

Nancy, I've decided to not make the site visit this week, but I wanted to thank you very much for offering for me to join up with the group at 10am. I don't know if other site visits might happen in the coming year or so, but I will keep an eye out. I am curious, since I'm not familiar with La Grange, is there public access to the site? Or, perhaps I should ask, where does the public have access in the area?

On Fri, Jun 24, 2016 at 9:42 AM, Craig, Nancy <Nancy.Craig@hdrinc.com> wrote:

Wednesday, June 29 close of business.

Nancy H. Craig

T 928.273.5772

From: Bartoo, Aondrea [mailto:aondrea_bartoo@fws.gov]
Sent: Friday, June 24, 2016 12:34 PM
To: Craig, Nancy
Subject: Re: La Grange June 30 2016 Recreation Access & Safety Assessment Study Site Visit

I appreciate your offer. Let me see if I can make that work. When do you need to know by?

On Fri, Jun 24, 2016 at 9:05 AM, Craig, Nancy <Nancy.Craig@hdrinc.com> wrote:

Hello Aondrea,

I am a Project Manager at HDR Engineering with responsibility for the La Grange Recreation Access and Safety Assessment Study.

I appreciate the challenges of travel outside normal business hours. We considered that but set the site assessment with an 8:00 AM start due to expected hot weather.

I would like to let you know there will be an opportunity for you to join us for the second half of the site assessment at approximately 10:00 AM at the gate into the La Grange Powerhouse. The gate will be locked; but when we arrive TID will open the gate and we will all drive our own vehicles into the parking area. The time is a little uncertain because we don't know exactly how the assessment will progress. Nonetheless, I think it could work to meet you at the gate. Please let me know if you would be interested in this option.

Thank you,

Nancy H. Craig

Project Manager, Hydropower Services

HDR

1825 N. Tegner St.
Wickenburg, AZ 85390
MOBILE 928.273.5772
nancy.craig@hdrinc.com

From: Bartoo, Aondrea [mailto:aondrea_bartoo@fws.gov]
Sent: Thursday, June 23, 2016 5:19 PM
To: Staples, Rose
Subject: Re: La Grange June 30 2016 Recreation Access & Safety Assessment Study Site Visit

Due to the logistics and early start time, I've decided I will not be able to make this site visit. I considered staying the night somewhere close, but being a single parent, I just can't make that happen. I'd appreciate it, if, in the future, the licensee would consider a later start time, perhaps 10am.

Thanks very much.

On Tue, Jun 21, 2016 at 9:05 AM, Staples, Rose <Rose.Staples@hdrinc.com> wrote:

Dear Licensing Participants,

As part of the La Grange Hydroelectric Project Recreation Access and Safety Assessment study, the Districts will conduct a site visit on **Thursday, June 30, 2016** from 8:00 am to approximately 12:00 pm. The purpose of the site visit is to gather site-specific information to be used along with existing aerial photography, topography data, and property ownership data to produce site assessments and descriptions of potential public access routes at the Project. Licensing participants are invited to attend this site visit.

Please note that the site visit will entail approximately 60 minutes of hiking steep, unimproved terrain. Participants may be exposed to heat and sun--and poisonous plants and venomous animals inhabit the area.

If you are interested in attending this site visit, please RSVP to me (Rose.Staples@hdrinc.com) no later than Friday, June 24. Further logistics will be provided to those who plan to attend. Thank you.

Rose Staples, CAP-OM, MOS

Executive Assistant

HDR

970 Baxter Boulevard Suite 301
Portland ME 04103
D 207-239-3857
rose.staples@hdrinc.com

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A. Leigh Bartoo
Fish and Wildlife Biologist
Bay-Delta Fish and Wildlife Office
U.S. Fish and Wildlife Service
650 Capitol Mall, 8-300
Sacramento, CA 95814
916-930-5621

From: John Wooster - NOAA Federal <john.wooster@noaa.gov>
Sent: Tuesday, June 28, 2016 1:58 PM
To: Le, Bao
Cc: Deason, Jesse
Subject: Re: Questions and follow up

I have not spoken directly with Amanda, but have confirmed she is the proper contact person - at least as a starting point. I will be back in the office on Thursday and will try and track her down then.

I did have a conversation with our lead for above Shasta reintroduction, he sent me an email too, I will forward that, not a lot of concrete steps other than affirmation that it will be a challenging step - to get the test fish that is...

-John

On Tue, Jun 28, 2016 at 10:21 AM, Le, Bao <ChiBao.Le@hdrinc.com> wrote:

Hi John.

Just checking in with regard to items below…..

Also, as an fyi….the Districts will revise the Chinook minimum patch size on the spawning gravel study to 6 meter squared per NMFS' request. A formal communication will be coming out soon.

Thanks, Bao

From: John Wooster - NOAA Federal [mailto:john.wooster@noaa.gov]
Sent: Friday, June 24, 2016 11:53 AM
To: Le, Bao
Cc: Deason, Jesse
Subject: Re: Questions and follow up

I don't know which conference (they did mention it on phone, but I have completely forgotten), and can't confirm that they went ahead with their intentions of a few months ago - the intent wasn't a Tuolumne specific presentation, but have new Tuolumne info feed into their pile of CV genetic information.

Amanda should be the contact person. I'll try and track her down in the office on Monday and see what she recommends.

John

On Fri, Jun 24, 2016 at 11:01 AM, Le, Bao <ChiBao.Le@hdrinc.com> wrote:

Thanks, John. See below for additional comment.

From: John Wooster - NOAA Federal [mailto:john.wooster@noaa.gov]
Sent: Friday, June 24, 2016 9:47 AM
To: Le, Bao
Cc: Deason, Jesse
Subject: Re: Questions and follow up

Bao:

1. I am supposed to talk to Lee today about a few things, so will discuss further, but at the moment, no additional feedback. Sounds good.

2. There wasn't a plan to produce an interim product on the genetics. However, a few months back I heard that they were going to present some work at a conference (in July I think?) that would include some preliminary T results - so I can ask where that is at, and see about distributing whatever is presented at the conference. Also, I was aware of the Districts / their consultants asking the science center for a presentation on genetics - that isn't being run through me (or my office / FERC team), so I don't know where that stands, but that seems like one venue to get an update. They were out sampling again last week, so that team has somewhat transitioned into field work for the summer....Thanks for the update. Do you know which conference they'll be presenting at? That'd be great if you can see about the conference presentation and whether that can be shared. I'll also follow up with the Districts request to see if any progress was made on that front.

3. Yes. I actually think the time to get NMFS involved with getting the test fish is now, rather than wait until CDFW submits the request to NMFS for concurrence. We have a person on staff who works exclusively with the hatcheries / experimental fish, her name is Amanda Cranford. That'd be great. Is Amanda the person we'd want to have reach out to NMFS proactively? If so, should we communicate directly with her once we develop an approach? Please advise.

-John

On Thu, Jun 23, 2016 at 2:53 PM, Le, Bao <ChiBao.Le@hdrinc.com> wrote:

Hi John.

I wanted to follow up on a couple of items, old and new:

1. Any feedback on discrete pieces of more manageable work that can support Lee?

2. Curious as to the progress on the genetics study? Is there any interim product that is available to share? When do you expect a report to be ready for distribution?

3. As you know, we're working on a reservoir transit study plan that will be out to LPs soon for review. We've already given CDFW a head's up that we'll need to acquire test fish for the study next year (formal requests due by end of July for fish next year). Given that we've not had a lot of luck with getting fish for past studies and this is a NMFS requested and FERC approved study, we're hoping you might also be able to put in a good word of support when the time is right?

Thanks and hope all is well.

Bao

Bao Le

Senior Fisheries Biologist

HDR

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John Wooster
Hydrologist
NOAA Fisheries West Coast Region
U.S. Department of Commerce
john.wooster@noaa.gov

From: Foote, Debra -FS [mailto:dfoote@fs.fed.us]
Sent: Tuesday, June 28, 2016 3:25 PM
To: Le, Bao
Cc: Vaughn, Gary D -FS; Holdeman, Steven J -FS
Subject: executed permit

Bao,
I have attached a copy of the executed permit for your records.

Debbie Foote
Resource Assistant

Forest Service
Groveland Ranger District

p: 209-962-7825 x533
f: 209-962-7412
dfoote@fs.fed.us

24545 Hwy. 120
Groveland, CA 95321
www.fs.fed.us

Caring for the land and serving people

Authorization ID: GRO1144
Contact Name: TURLOCK IRRIGATION DISTRICT
Expiration Date: 12/31/2018
Use Code: 422

FS-2700-4 (V. 01/2014)
OMB 0596-0082

U.S. DEPARTMENT OF AGRICULTURE
FOREST SERVICE
SPECIAL USE PERMIT
Authority: ORGANIC ADMINISTRATION ACT 1897

TURLOCK IRRIGATION DISTRICT of 333 EAST CANAL DRIVE TURLOCK CA 95380 (hereinafter "the holder") is authorized to use or occupy National Forest System lands in the STANISLAUS NATIONAL FOREST, subject to the terms and conditions of this special use permit (the permit).

This permit covers approximately 27 miles in the Sec. 35, T. 1 N., R. 18 E., MT. DIABLO MERIDIAN , ("the permit area"), as shown on the map attached as Appendix B. This permit issued for the purpose of:

Research on Tuolumne River for three primary studies: (1) Upper Tuolumne River Salmon and Steelhead Spawning Gravel Mapping; (2) Upper Tuolumne River Habitat Mapping and Macroinvertebrate Assessment; and (3) Upper Tuolumne River Instream Flow Study. These studies are described in more detail in Appendix A. Complete study plans will be attached to the final permit application.

Authorization is given for trips up to 14 days when needed. Avoid sites that are designated for commercial use:

Odd years	Even Years
Powerhouse	Indian
Clavey (upstream/right)	Clavey (left)
North Fork (downstream)	North Fork (upstream)
	Mohican Mine

Authorized use of low decibel generator for equipment charging needs is approved. Use of the generator will be during the hours of 8:00 am – 10:00 pm, a 10' diameter clearance is required for fire prevention, fire tools and water must be available within 25' of the generator. Store fuel in an approved flammable materials container(s) or MSR or similarly sealable fuel bottle(s) a safe distance away from generator and water.

Prior to initiating any trip occurring in waters of the Stanislaus National Forest, the following decontamination procedures **will be followed** to prevent the introduction and spread of aquatic invasive/nuisance species:

1. Remove all accumulations of organic (examples: plants, algae) and inorganic (mud) material from all equipment including nets, measuring and sampling devices, boots, waders, and other items that have come into prior contact with potentially contaminated water or sediments.
2. Prepare a solution of decontamination medium consisting of one of the following: 0.1% concentration of active ingredient of a quaternary ammonium compound (DDAC or didecyl dimethyl ammonium chloride) or 2% concentration of active ingredient of household bleach (sodium hypochlorite). The preferred quaternary ammonium compound is Quat 128.
3. Soak all potentially contaminated equipment for a minimum of 5 minutes.
4. Rinse with clean tap water.

If the equipment is going to be used at another site following Tuolumne River trips, we advise the permittee to decontaminate all equipment with an equivalent or more stringent process. The Tuolumne River is a known source of *Didymosphenia geminata*, commonly referred to as rock snot or didymo. Decontamination of equipment will prevent the spread of this nuisance algae to other waters.

If the equipment used during sampling has not been exposed to other waters between trips, decontamination of equipment is not required. However, we recommend the permittee allow the equipment to thoroughly dry before initiating another trip on the Tuolumne.

Decontamination of equipment is not necessary if moving from the Tuolumne River into the lower Clavey River (river mile 0 to river mile 2.5), or any of the other Tuolumne River tributaries.

Permittee needs to be aware that quaternary ammonium compounds are potentially damaging to aluminum products and bleach solutions are damaging to fabrics, rubber, plastics, and metal. These compounds are known to be or potentially corrosive.

TERMS AND CONDITIONS

I. GENERAL TERMS

A. AUTHORITY. This permit is issued pursuant to ORGANIC ADMINISTRATION ACT 1897 and 36 CFR Part 251, Subpart B, as amended, and is subject to their provisions.

B. AUTHORIZED OFFICER. The authorized officer is the Forest or Grassland Supervisor or a subordinate officer with delegated authority.

C. TERM. This permit shall expire at midnight on 12/31/2018, **1 year and 5 months** from the date of issuance.

D. RENEWAL. This permit is not renewable. Prior to expiration of this permit, the holder may apply for a new permit that would renew the use and occupancy authorized by this permit. Applications for a new permit must be submitted at least 6 months prior to expiration of this permit. Renewal of the use and occupancy authorized by this permit shall be at the sole discretion of the authorized officer. At a minimum, before renewing the use and occupancy authorized by this permit, the authorized officer shall require that (1) the use and occupancy to be authorized by the new permit is consistent with the standards and guidelines in the applicable land management plan; (2) the type of use and occupancy to be authorized by the new permit is the same as the type of use and occupancy authorized by this permit; and (3) the holder is in compliance with all the terms of this permit. The authorized officer may prescribe new terms and conditions when a new permit is issued.

E. AMENDMENT. This permit may be amended in whole or in part by the Forest Service when, at the discretion of the authorized officer, such action is deemed necessary or desirable to incorporate new terms that may be required by law, regulation, directive, the applicable forest land and resource management plan, or projects and activities implementing a land management plan pursuant to 36 CFR Part 215.

F. COMPLIANCE WITH LAWS, REGULATIONS, AND OTHER LEGAL REQUIREMENTS. In exercising the rights and privileges granted by this permit, the holder shall comply with all present and future federal laws and regulations and all present and future state, county, and municipal laws, regulations, and other legal requirements that apply to the permit area, to the extent they do not conflict with federal law, regulation, or policy. The Forest Service assumes no responsibility for enforcing laws, regulations, and other legal requirements that fall under the jurisdiction of other governmental entities.

G. NON-EXCLUSIVE USE. The use or occupancy authorized by this permit is not exclusive. The Forest Service reserves the right of access to the permit area, including a continuing right of physical entry to the permit area for inspection, monitoring, or any other purpose consistent with any right or obligation of the United States under any law or regulation. The Forest Service reserves the right to allow others to use the permit area in any way that is not inconsistent with the holder's rights and privileges under this permit, after consultation with all parties involved. Except for any restrictions that the holder and the authorized officer agree are necessary to protect the installation and operation of authorized temporary improvements, the lands and waters covered by this permit shall remain open to the public for all lawful purposes.

II.IMPROVEMENTS

A. LIMITATIONS ON USE. Nothing in this permit gives or implies permission to build or maintain any structure or facility or to conduct any activity, unless specifically authorized by this permit. Any use not specifically authorized by this permit must be proposed in accordance with 36 CFR 251.54. Approval of such a proposal through issuance of a new permit or permit amendment is at the sole discretion of the authorized officer.

B. PLANS. All plans for development, layout, construction, reconstruction, or alteration of improvements in the permit area, as well as revisions to those plans must be prepared by a professional engineer, architect, landscape architect, or other qualified professional based on federal employment standards acceptable to the authorized officer. These plans and plan revisions must have written approval from the authorized officer before they are implemented. The authorized officer may require the holder to furnish as-built plans, maps, or surveys upon completion of the work.

C. CONSTRUCTION. Any construction authorized by this permit shall commence by NA and shall be completed by NA.

III. **OPERATIONS.**

A. **PERIOD OF USE.** Use or occupancy of the permit area shall be exercised at least **14** days each year.

B. **CONDITION OF OPERATIONS.** The holder shall maintain the authorized improvements and permit area to standards of repair, orderliness, neatness, sanitation, and safety acceptable to the authorized officer and consistent with other provisions of this permit. Standards are subject to periodic change by the authorized officer when deemed necessary to meet statutory, regulatory, or policy requirements or to protect national forest resources. The holder shall comply with inspection requirements deemed appropriate by the authorized officer.

C. **INSPECTION BY THE FOREST SERVICE.** The Forest Service shall monitor the holder's operations and reserves the right to inspect the permit area and transmission facilities at any time for compliance with the terms of this permit. The holder's obligations under this permit are not contingent upon any duty of the Forest Service to inspect the permit area or transmission facilities. A failure by the Forest Service or other governmental officials to inspect is not a justification for noncompliance with any of the terms and conditions of this permit.

IV. **RIGHTS AND LIABILITIES**

A. **LEGAL EFFECT OF THE PERMIT.** This permit, which is revocable and terminable, is not a contract or a lease, but rather a federal license. The benefits and requirements conferred by this authorization are reviewable solely under the procedures set forth in 36 CFR 251, Subpart C and 5 U.S.C. 704. This permit does not constitute a contract for purposes of the Contract Disputes Act, 41 U.S.C. 601. The permit is not real property, does not convey any interest in real property, and may not be used as collateral for a loan.

B. **VALID OUTSTANDING RIGHTS.** This permit is subject to all valid outstanding rights. Valid outstanding rights include those derived under mining and mineral leasing laws of the United States. The United States is not liable to the holder for the exercise of any such right.

C. **ABSENCE OF THIRD-PARTY BENEFICIARY RIGHTS.** The parties to this permit do not intend to confer any rights on any third party as a beneficiary under this permit.

D. **SERVICES NOT PROVIDED.** This permit does not provide for the furnishing of road or trail maintenance, water, fire protection, search and rescue, or any other such service by a government agency, utility, association, or individual.

E. **RISK OF LOSS.** The holder assumes all risk of loss associated with use or occupancy of the permit area, including but not limited to theft, vandalism, fire and any fire-fighting activities (including prescribed burns), avalanches, rising waters, winds, falling limbs or trees, and other forces of nature. If authorized temporary improvements in the permit area are destroyed or substantially damaged, the authorized officer shall conduct an analysis to determine whether the improvements can be safely occupied in the future and whether rebuilding should be allowed. If rebuilding is not allowed, the permit shall terminate.

F. **DAMAGE TO UNITED STATES PROPERTY.** The holder has an affirmative duty to protect from damage the land, property, and other interests of the United States. Damage includes but is not limited to fire suppression costs, damage to government-owned improvements covered by this permit, and all costs and damages associated with or resulting from the release or threatened release of a hazardous material occurring during or as a result of activities of the holder or the holder's heirs, assigns, agents, employees, contractors, or lessees on, or related to, the lands, property, and other interests covered by this permit. For purposes of clause IV.F and section V, "hazardous material" shall mean (a) any hazardous substance under section 101(14) of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), 42 U.S.C. § 9601(14); (b) any pollutant or contaminant under section 101(33) of CERCLA, 42 U.S.C. § 9601(33); (c) any petroleum product or its derivative, including fuel oil, and waste oils; and (d) any hazardous substance, extremely hazardous substance, toxic substance, hazardous waste, ignitable, reactive or corrosive materials, pollutant, contaminant, element, compound, mixture, solution or substance that may pose a present or potential hazard to human health or the environment under any applicable environmental laws.

1. The holder shall avoid damaging or contaminating the environment, including but not limited to the soil, vegetation (such as trees, shrubs, and grass), surface water, and groundwater, during the holder's use or occupancy of the permit area. If the environment or any government property covered by this permit becomes damaged during the holder's use or occupancy of the permit area, the holder shall immediately repair the damage or replace the damaged items to the satisfaction of the authorized officer and at no expense to the United States.

2. The holder shall be liable for all injury, loss, or damage, including fire suppression, prevention and control of the spread of invasive species, or other costs in connection with rehabilitation or restoration of natural resources associated with the use or occupancy authorized by this permit. Compensation shall include but not be limited to the value of resources damaged or destroyed, the costs of restoration, cleanup, or other mitigation, fire suppression or other types of abatement costs, and all administrative, legal (including attorney's fees), and other costs. Such costs may be deducted from a performance bond required under clause IV.I.

3. The holder shall be liable for damage caused by use of the holder or the holder's heirs, assigns, agents, employees, contractors, or lessees to all roads and trails of the United States to the same extent as provided under clause IV.F.1, except that liability shall not include reasonable and ordinary wear and tear.

G. HEALTH, SAFETY, AND ENVIRONMENTAL PROTECTION. The holder shall promptly abate as completely as possible and in compliance with all applicable laws and regulations any activity or condition arising out of or relating to the authorized use or occupancy that causes or threatens to cause a hazard to public health or the safety of the holder's employees or agents or harm to the environment (including areas of vegetation or timber, fish or other wildlife populations, their habitats, or any other natural resources). The holder shall prevent impacts to the environment and cultural resources by implementing actions identified in the operating plan to prevent establishment and spread of invasive species. The holder shall immediately notify the authorized officer of all serious accidents that occur in connection with such activities. The responsibility to protect the health and safety of all persons affected by the use or occupancy authorized by this permit is solely that of the holder. The Forest Service has no duty under the terms of this permit to inspect the permit area or operations and activities of the holder for hazardous conditions or compliance with health and safety standards.

H. INDEMNIFICATION OF THE UNITED STATES. The holder shall indemnify, defend, and hold harmless the United States for any costs, damages, claims, liabilities, and judgments arising from past, present, and future acts or omissions of the holder in connection with the use or occupancy authorized by this permit. This indemnification provision includes but is not limited to acts and omissions of the holder or the holder's heirs, assigns, agents, employees, contractors, or lessees in connection with the use or occupancy authorized by this permit which result in (1) violations of any laws and regulations which are now or which may in the future become applicable, and including but not limited to those environmental laws listed in clause V.A of this permit; (2) judgments, claims, demands, penalties, or fees assessed against the United States; (3) costs, expenses, and damages incurred by the United States; or (4) the release or threatened release of any solid waste, hazardous waste, hazardous materials, pollutant, contaminant, oil in any form, or petroleum product into the environment. The authorized officer may prescribe terms that allow the holder to replace, repair, restore, or otherwise undertake necessary curative actions to mitigate damages in addition to or as an alternative to monetary indemnification.

V. RESOURCE PROTECTION

A. COMPLIANCE WITH ENVIRONMENTAL LAWS. The holder shall in connection with the use or occupancy authorized by this permit comply with all applicable federal, state, and local environmental laws and regulations, including but not limited to those established pursuant to the Resource Conservation and Recovery Act, as amended, 42 U.S.C. 6901 et seq., the Federal Water Pollution Control Act, as amended, 33 U.S.C. 1251 et seq., the Oil Pollution Act, as amended, 33 U.S.C. 2701 et seq., the Clean Air Act, as amended, 42 U.S.C. 7401 et seq., CERCLA, as amended, 42 U.S.C. 9601 et seq., the Toxic Substances Control Act, as amended, 15 U.S.C. 2601 et seq., the Federal Insecticide, Fungicide, and Rodenticide Act, as amended, 7 U.S.C. 136 et seq., and the Safe Drinking Water Act, as amended, 42 U.S.C. 300f et seq.

B. VANDALISM. The holder shall take reasonable measures to prevent and discourage vandalism and disorderly conduct and when necessary shall contact the appropriate law enforcement officer.

C. PESTICIDE USE. Pesticides may not be used outside of buildings to control undesirable woody and herbaceous vegetation (including aquatic plants), insects, rodents, fish, and other pests and weeds without prior written approval from the authorized officer. A request for approval of planned uses of pesticides shall be submitted annually by the holder on the due date established by the authorized officer. The report shall cover a 12-month period of planned use beginning 3 months after the reporting date. Information essential for review shall be provided in the form specified. Exceptions to this schedule may be allowed, subject to emergency request and approval, only when unexpected outbreaks of pests or weeds require control measures that were not anticipated at the time an annual report was submitted. Only those materials registered by the U.S. Environmental Protection Agency for the specific purpose planned shall be considered for use on National Forest System lands. Label instructions and all applicable laws and regulations shall be strictly followed in the application of pesticides and disposal of excess materials and containers.

D. ARCHAEOLOGICAL-PALEONTOLOGICAL DISCOVERIES. The holder shall immediately notify the authorized officer of all antiquities or other objects of historic or scientific interest, including but not limited to historic or prehistoric ruins, fossils, or artifacts discovered in connection with the use and occupancy authorized by this permit. The holder shall leave these discoveries intact and in place until directed otherwise by the authorized officer. Protective and mitigative measures specified by the authorized officer shall be the responsibility of the holder.

E. NATIVE AMERICAN GRAVES PROTECTION AND REPATRIATION. In accordance with 25 U.S.C. 3002(d) and 43 CFR 10.4, if the holder inadvertently discovers human remains, funerary objects, sacred objects, or objects of cultural patrimony on National Forest System lands, the holder shall immediately cease work in the area of the discovery and shall make a reasonable effort to protect and secure the items. The holder shall immediately notify the authorized officer by telephone of the discovery and shall follow up with written confirmation of the discovery. The activity that resulted in the inadvertent discovery may not resume until 30 days after the authorized officer certifies receipt of the written confirmation, if resumption of the activity is otherwise lawful, or at any time if a binding written agreement has been executed between the Forest Service and the affiliated Indian tribes that adopts a recovery plan for the human remains and objects.

F. PROTECTION OF HABITAT OF THREATENED, ENDANGERED, AND SENSITIVE SPECIES. The location of sites within the permit area needing special measures for protection of plants or animals listed as threatened or endangered under the Endangered Species Act (ESA) of 1973, 16 U.S.C. 1531 et seq., as amended, or identified as sensitive or otherwise requiring special protection by the Regional Forester under Forest Service Manual (FSM) 2670, pursuant to consultation conducted under section 7 of the ESA, may be shown on the ground or on a separate map. The map shall be attached to this permit as an appendix. The holder shall take any protective and mitigative measures specified by the authorized officer. If protective and mitigative measures prove inadequate, if other sites within the permit area containing threatened, endangered, or sensitive species or species otherwise requiring special protection are discovered, or if new species are listed as threatened or endangered under the ESA or identified as sensitive or otherwise requiring special protection by the Regional Forester under the FSM, the authorized officer may specify additional protective and mitigative measures. Discovery of these sites by the holder or the Forest Service shall be promptly reported to the other party.

G. CONSENT TO STORE HAZARDOUS MATERIALS. The holder shall not store any hazardous materials at the site without prior written approval from the authorized officer. This approval shall not be unreasonably withheld. If the authorized officer provides approval, this permit shall include, or in the case of approval provided after this permit is issued, shall be amended to include specific terms addressing the storage of hazardous materials, including the specific type of materials to be stored, the volume, the type of storage, and a spill plan. Such terms shall be proposed by the holder and are subject to approval by the authorized officer.

1. If the holder receives consent to store hazardous material, the holder shall identify to the Forest Service any hazardous material to be stored at the site. Such identification information shall be consistent with column (1) of the table of hazardous materials and special provisions enumerated at 49 CFR 172.101 whenever the hazardous material appears in that table. For hazard communication purposes, the holder shall maintain Material Safety Data Sheets for any stored hazardous chemicals, consistent with 29 CFR 1910.1200(c) and (g). In addition, all hazardous materials stored by the holder shall be used, labeled, stored, transported, and disposed of in accordance with all applicable federal, state, and local laws and regulations.

2. The holder shall not release any hazardous material as defined in clause IV.F. onto land or into rivers, streams, impoundments, or natural or man-made channels leading to them. All prudent and safe attempts must be made to contain any release of these materials. The authorized officer in charge may specify specific conditions that must be met, including conditions more stringent than federal, state, and local regulations, to prevent releases and protect natural resources.

H. CLEANUP AND REMEDIATION

1. The holder shall immediately notify all appropriate response authorities, including the National Response Center and the authorized officer or the authorized officer's designated representative, of any oil discharge or of the release of a hazardous material in the permit area in an amount greater than or equal to its reportable quantity, in accordance with 33 CFR Part 153, Subpart B, and 40 CFR Part 302. For the purposes of this requirement, "oil" is as defined by section 311(a) (1) of the Clean Water Act, 33 U.S.C. 1321(a)(1). The holder shall immediately notify the authorized officer or the authorized officer's designated representative of any release or threatened release of any hazardous material in or near the

permit area which may be harmful to public health or welfare or which may adversely affect natural resources on federal lands.

2. Except with respect to any federally permitted release as that term is defined under Section 101(10) of CERCLA, 42 U.S.C. 9601(10), the holder shall clean up or otherwise remediate any release, threat of release, or discharge of hazardous materials that occurs either in the permit area or in connection with the holder's activities in the permit area, regardless of whether those activities are authorized under this permit. The holder shall perform cleanup or remediation immediately upon discovery of the release, threat of release, or discharge of hazardous materials. The holder shall perform the cleanup or remediation to the satisfaction of the authorized officer and at no expense to the United States. Upon revocation or termination of this permit, the holder shall deliver the site to the Forest Service free and clear of contamination.

I. CERTIFICATION UPON REVOCATION OR TERMINATION. If the holder uses or stores hazardous materials at the site, upon revocation or termination of this permit the holder shall provide the Forest Service with a report certified by a professional or professionals acceptable to the Forest Service that the permit area is uncontaminated by the presence of hazardous materials and that there has not been a release or discharge of hazardous materials upon the permit area, into surface water at or near the permit area, or into groundwater below the permit area during the term of the permit. This certification requirement may be waived by the authorized officer when the Forest Service determines that the risks posed by the hazardous material are minimal. If a release or discharge has occurred, the professional or professionals shall document and certify that the release or discharge has been fully remediated and that the permit area is in compliance with all federal, state, and local laws and regulations.

VI. LAND USE FEE AND ACCOUNTING ISSUES

A. LAND USE FEES. The use or occupancy authorized by this permit is exempt from a land use fee or the land use fee has been waived in full pursuant to 36 CFR 251.57 and Forest Service Handbook 2709.11, Chapter 30.

VII. REVOCATION, SUSPENSION, AND TERMINATION

A. REVOCATION AND SUSPENSION. The authorized officer may revoke or suspend this permit in whole or in part:

1. For noncompliance with federal, state, or local law.

2. For noncompliance with the terms of this permit.

3. For abandonment or other failure of the holder to exercise the privileges granted.

4. With the consent of the holder.

5. For specific and compelling reasons in the public interest.

Prior to revocation or suspension, other than immediate suspension under clause VII.B, the authorized officer shall give the holder written notice of the grounds for revocation or suspension. In the case of revocation or suspension based on clause VII.A.1, 2, or 3, the authorized officer shall give the holder a reasonable time, typically not to exceed 90 days, to cure any noncompliance.

B. IMMEDIATE SUSPENSION. The authorized officer may immediately suspend this permit in whole or in part when necessary to protect public health or safety or the environment. The suspension decision shall be in writing. The holder may request an on-site review with the authorized officer's supervisor of the adverse conditions prompting the suspension. The authorized officer's supervisor shall grant this request within 48 hours. Following the on-site review, the authorized officer's supervisor shall promptly affirm, modify, or cancel the suspension.

C. APPEALS AND REMEDIES. Written decisions by the authorized officer relating to administration of this permit are subject to administrative appeal pursuant to 36 CFR Part 214 as amended. Revocation or suspension of this permit shall not give rise to any claim for damages by the holder against the Forest Service.

D. TERMINATION. This permit shall terminate when by its terms a fixed or agreed upon condition, event, or time occurs without any action by the authorized officer. Examples include but are not limited to expiration of the permit by its terms on a specified date and termination upon change of control of the business entity. Termination of this permit shall not require notice, a decision document, or any environmental analysis or other documentation. Termination of this permit is not subject to administrative appeal and shall not give rise to any claim for damages by the holder against the Forest Service.

E. RIGHTS AND RESPONSIBILITIES UPON REVOCATION OR TERMINATION WITHOUT RENEWAL. Upon revocation or termination of this permit without renewal of the authorized use, the holder shall remove all structures and improvements, except those owned by the United States, within a reasonable period prescribed by the authorized officer and shall restore the site to the satisfaction of the authorized officer. If the holder fails to remove all structures and improvements within the prescribed period, they shall become the property of the United States and may be sold, destroyed, or otherwise disposed of without any liability to the United States. However, the holder shall remain liable for all costs associated with their removal, including costs of sale and impoundment, cleanup, and restoration of the site.

VIII. MISCELLANEOUS PROVISIONS

A. MEMBERS OF CONGRESS. No member of or delegate to Congress or resident commissioner shall benefit from this permit either directly or indirectly, except to the extent the authorized use provides a general benefit to a corporation.

B. CURRENT ADDRESSES. The holder and the Forest Service shall keep each other informed of current mailing addresses, including those necessary for billing and payment of land use fees.

C. SUPERIOR CLAUSES. If there is a conflict between any of the preceding printed clauses and any of the following clauses, the preceding printed clauses shall control.

THIS PERMIT IS ACCEPTED SUBJECT TO ALL ITS TERMS AND CONDITIONS.

BEFORE ANY PERMIT IS ISSUED TO AN ENTITY, DOCUMENTATION MUST BE PROVIDED TO THE AUTHORIZED OFFICER OF THE AUTHORITY OF THE SIGNATORY FOR THE ENTITY TO BIND IT TO THE TERMS AND CONDITIONS OF THE PERMIT.

ACCEPTED:

June 28, 2016

HOLDER NAME, PRECEDED BY NAME AND TITLE OF PERSON SIGNING ON BEHALF OF HOLDER, IF HOLDER IS AN ENTITY — SIGNATURE — DATE

STEVEN BOYD, DIRECTOR OF WATER RESOURCES
TURLOCK IRRIGATION DISTRICT

APPROVED:

6/28/16

Jim Junette, District Ranger — SIGNATURE — DATE

According to the Paperwork Reduction Act of 1995, an agency may not conduct or sponsor, and a person is not required to respond to a collection of information unless it displays a valid OMB control number. The valid OMB control number for this information collection is 0596-0082. The time required to complete this information collection is estimated to average one hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information.

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The Privacy Act of 1974 (5 U.S.C. 552a) and the Freedom of Information Act (5 U.S.C. 552) govern the confidentiality to be provided for information received by the Forest Service.

Attachment A for Forest Service SF-299
Filed by Turlock and Modesto Irrigation Districts
and HDR, Inc.
June 2, 2016

Names and Addresses of Applicants

Turlock Irrigation District
333 East Canal Drive
Turlock, CA 953

Modesto Irrigation District
P.O. Box 4060
Modesto, CA 95352-4060

Project Description

The Turlock Irrigation District (TID) and Modesto Irrigation District (MID) (collectively, the Districts) own the La Grange Diversion Dam (LGDD) located on the Tuolumne River in Stanislaus County, California. Currently the Districts are working through the Federal Energy Regulatory Commission (FERC) licensing process with the end goal to file an application for a license. As part of the process the Districts, at the request of federal fish and wildlife agencies (NMFS, USFWS, and CDFW) have volunteered to complete a series of studies to evaluate ecological considerations related to the potential reintroduction of anadromous salmonids to the upper Tuolumne River.

Three primary studies are the subject of this permit: (1) Upper Tuolumne River Salmon and Steelhead Spawning Gravel Mapping; (2) Upper Tuolumne River Habitat Mapping and Macroinvertebrate Assessment; and (3) Upper Tuolumne River Instream Flow Study. These studies are described in more detail below. Complete study plans are included in **Attachment B** to this permit application. References for citations included in this Attachment also are included in Attachment B.

Draft Rafting Schedule and Staffing for Proposed Studies

1. Spawning Gravel Study
    - i. Schedule – 4 trips during study season
        1. 2-day float tentatively planned for the week of June 27th
        2. 7-day float tentatively planned for the week of July 18th
        3. 7-day float tentatively planned for the week of August 1st
        4. 5-day float tentatively planned for the week of August 22nd
    - ii. Total # of days on the river – 21
    - iii. Total # of rafts needed – 7 (1 for week of June 27th trip, and 2/trip for all other trips)

iv. Total # of staff/raft guides – 5-10 per trip

2. Habitat Mapping and Macroinvertebrate Assessment
    i. Schedule – 2 trips during study season
        1. 7-day float tentatively planned for the week of July 18th
        2. 5-day float tentatively planned for the week of July 25^{th}
    ii. Total # of days on the river – 12
    iii. Total # of rafts needed – 4 (2/trip)
    iv. Total # of staff/raft guides – 5-10 per trip

3. Instream Flow Study
    i. Schedule – 3 trips during study season
        1. 7-day float tentatively planned for the week of August 15^{th}
        2. 7-day float tentatively planned for the week of August 29^{th}
        3. 7-day float tentatively planned for the week of August 29^{th}
    ii. Total # of days on the river – 21
    iii. Total # of rafts needed – 15 (5/trip)
    iv. Total # of staff/raft guides – 10-15 per trip

Spawning Gravel Mapping

Goals and Objectives

The goal of this study is to assess the quantity and quality of spawning gravel for anadromous salmonids in the upper Tuolumne River. Study objectives include the following:

- Map the distribution of potentially suitable spawning substrate available for Central Valley spring-run Chinook salmon and Central Valley steelhead in the upper Tuolumne River;
- Assess the quality of potentially suitable spawning substrates based on substrate size characteristics, angularity/roundness, sorting, embeddedness, and permeability measured in a statistically representative sample of gravel patches; and
- Quantify the amount of potentially suitable spawning gravel.

Methods

The study area includes the approximately 26.5-mile reach of the mainstem Tuolumne River from Wards Ferry Bridge (RM 78.5) to Early Intake (RM 105) (**Figure 1**).

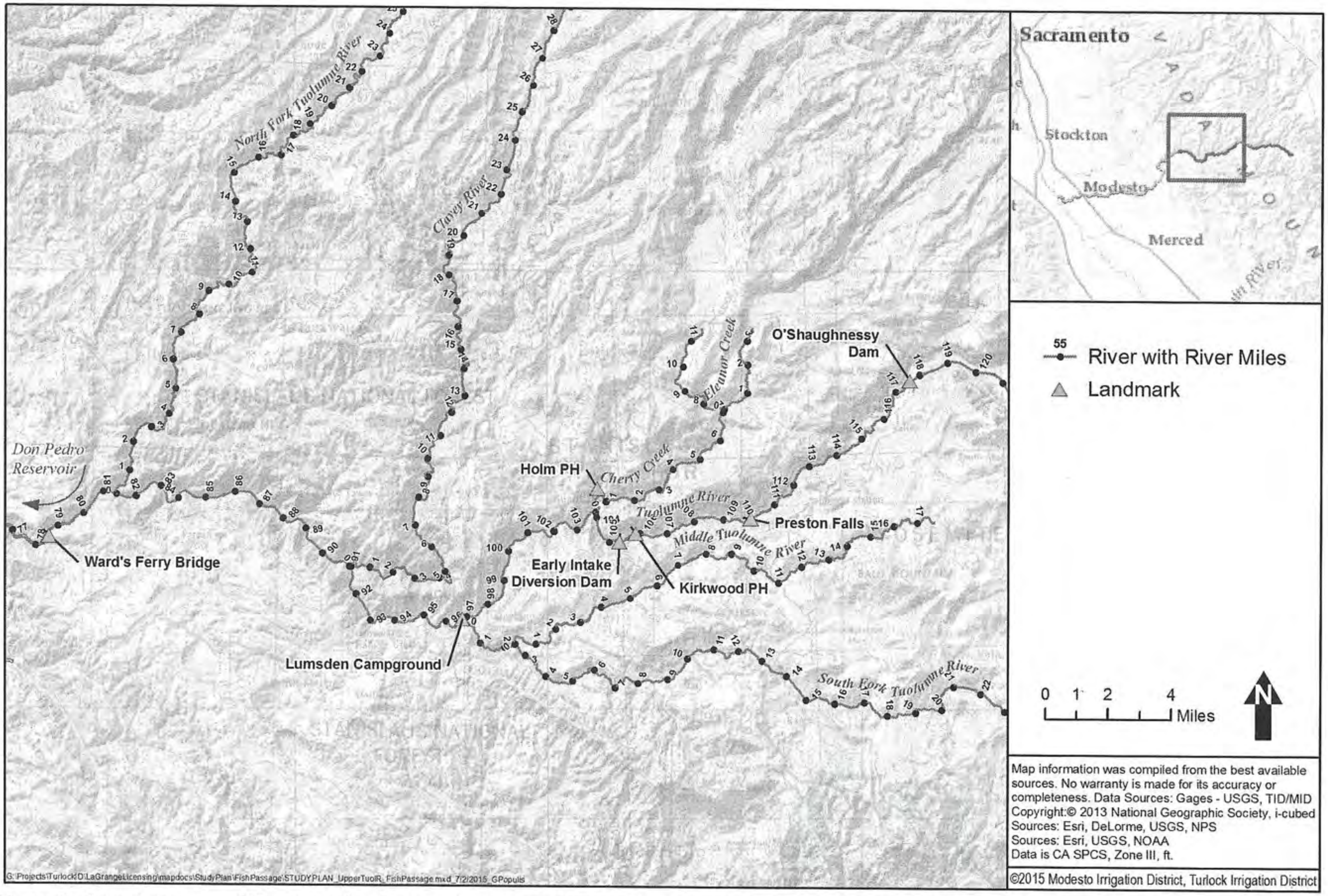

Figure 1. Overview map of the upper Tuolumne River Watershed with notable rivers, tributaries and features.

The spawning gravel study will include desktop activities to delineate gravel patches in a Geographic Information System (GIS) to inform field staff as to the approximate distribution of gravel deposits and the most efficient process for locating and mapping those deposits prior to entering the field. Field mapping criteria and protocols will be refined following this initial desktop analysis, as needed and in consultation with appropriate agency technical staff.

Potentially suitable spawning substrate patches will then be delineated in the field on map tiles, using high resolution orthorectified areal imagery (e.g., 8-13-2007 photography and mapbook) and preliminary gravel polygons from desktop mapping as the base. Field delineation of potentially suitable spawning substrate patches will be performed by a two-person crew using an inflatable raft to access the study reach. The crew will stop frequently to locate and investigate preliminary gravel polygons from desktop mapping and any other deposits that appear to meet the mapping criteria. Inflatable kayaks may also be used to navigate through unwadable map areas. To the extent possible, mapping will be performed during low flow conditions to optimize visibility of potentially suitable spawning substrates.

Species-specific spawning substrate size criteria (e.g., D_{50} particle size and other grain characteristics) will be developed prior to the field effort based on relevant values reported in the scientific literature. Wolman (1954) pebble counts will be conducted in selected areas using methods developed by Bunte and Abt (2001) to calibrate visual estimates of grain size parameters. Mapping criteria will also include a minimum "mappable" patch size.

In addition to the mapping criteria described above, characteristics informing spawning habitat quality will be collected for each patch. These will include parameters such as additional substrate size characteristics (e.g., D_{16}, D_{84}), angularity/roundness, sorting, and embeddedness. A qualitative scoring (1–10) for overall suitability will also be determined for each patch.

Substrate permeability will be collected at select patches to characterize incubation conditions and estimate predicted survival-to-emergence. Since collecting substrate permeability is labor intensive, and can be highly variable between and among patches, a sampling plan for the study reach will be developed based on the results of spawning gravel mapping effort. The sampling plan will outline an approach for characterizing the permeability of spawning gravel map units throughout the study reach, and provide field sampling protocols. Sampling locations will be determined, in part, by accessibility and field crew safety, and may be constrained by boat and crew safety considerations as determined by the commercial boatman.

Potentially suitable spawning substrate patches delineated on field tiles will be digitized using GIS, and area estimates for each patch will be calculated. The quantity and quality of potentially suitable spawning substrate patches will be summarized in tabular format.

Staffing and Schedule

The proposed spawning gravel study includes 4 rafting trips representing a total of 21 days on the river:

- 2-day float tentatively planned for the week of June 27th
- 7-day float tentatively planned for the week of July 18th

- 7-day float tentatively planned for the week of August 1st
- 5-day float tentatively planned for the week of August 22nd

Each proposed trip will include 5-10 field staff and commercial rafting guides.

Upper Tuolumne River Habitat Mapping and Macroinvertebrate Assessment

<u>Habitat Mapping</u>

Goals and Objectives

The goal of this study is to develop information on habitat distribution, abundance and quality in the upper Tuolumne River in order to inform the estimation of potential anadromous salmonid population size and development of fish passage engineering alternatives. Study objectives include the following:

- Document the number, size and distribution of mesohabitats available in the upper Tuolumne River;
- Collect detailed data on habitat attributes in representative reaches of the upper Tuolumne River;
- Document potential pool holding habitat for over-summering adult Chinook salmon; and

Methods

Habitat mapping will quantify the type, amount, and location of habitat types available to potentially reintroduced anadromous salmonids during their riverine life stages (adult holding/spawning, incubation and rearing). Habitat mapping will be conducted in the field and remotely using standardized methodologies. The frequency and area of each habitat type (e.g., pool, riffle, run) will be tabulated and where potential holding pools for adult Chinook occur, the size and depth of the pools will be measured to determine possible holding capacity. Additional mapping tasks will include assessments of channel gradient, width, habitat areas, etc. Habitat mapping will consist of mapping all mesohabitat units between Early Intake (RM 105) and the upstream limit of the Don Pedro Project (approximately RM 81), and collecting detailed habitat data in a sub-set of the mapped mesohabitat units.

Habitat units will be identified visually by a raft-based survey crew and mapped on pre-existing high resolution color aerial photographs. Boundaries of mesohabitat units will also be georeferenced in the field with a handheld GPS unit.

Mapped habitats will be digitized and added to the project GIS layer for mapping, as well as for quantitative and spatial analysis. Color maps will be created to depict the type and location of habitats throughout the study area and in relation to important features such as tributaries, potential passage barriers, access points, and water temperature monitoring locations. The frequency and area of each habitat type (e.g., pool, riffle, run) will also be tabulated.

Additional (remote) mapping tasks will include assessments of channel gradient, width, habitat areas, etc. following the CDFW Level III habitat typing methodology (CDFG 2010). Methods will be similar to habitat typing conducted in the lower Tuolumne River (TID/MID 2013). Sampling units selected for detailed habitat measurements will encompass approximately 10 to 20 percent of the study reach, as recommended in CDFG (2010). The habitat typing field effort will consist of a team of three biologists surveying the river by raft. The study area will be divided into seven sampling reaches, based on length of river rafted daily (two reaches from Early Intake to Lumsden and five reaches from Lumsden to Wards Ferry). Within each individual sampling reach, a one mile section will be randomly selected for habitat typing. Prior to the field assessment, the team will use maps and existing aerial photographs to delineate the specific reaches to be surveyed. Refer to Appendix B for the additional detail on the Habitat Mapping study.

Macroinvertebrate Assessment

Goals and Objectives

The goal of this study is to develop formation on macroinvertebrate prey resource availability in order to inform an evaluation of the factors affecting production and viability of an existing or introduced salmonid population. Study objectives include the following:

- Collect and analyze macroinvertebrate drift samples to determine whether the taxonomic composition and density of drift is consistent with other regional systems currently supporting healthy salmonid populations; and
- Collect and analyze benthic macroinvertebrate samples from the substrate to develop metrics for bioassessment and comparison with similar streams and data sets.

Methods

The study area for macroinvertebrate sampling within the upper mainstem of the Tuolumne River is from RM 81 to Lumsden Bridge (RM 98). The location and number of sampling sites and sampling frequency will represent the seasonal variability of macroinvertebrate populations and related seasonal variability of food resources for stream-dwelling salmonids during the primary salmonid rearing and growth period (spring-fall), as well as the variability of physical habitat characteristics in each study reach.

Number of sites

Depending on opportunities encountered during stream habitat mapping, drift and benthic macroinvertebrate samples will be collected at five sites, equating to approximately one site per 3.5 river miles.

Locations

Drift sampling will occur in the vicinity of Lumsden and at four additional downstream locations corresponding to locations selected for overnight camping during each five-day (four-night) rafting trip. Drift samples will be collected in riffle or run habitats selected opportunistically in the vicinity of overnight camping locations along each study reach. Benthic macroinvertebrate sampling will occur at suitable riffles initially identified in the office using aerial photographs and verified in the field. One composite sample will be collected daily from a suitable riffle or combination of suitable fast-water habitat types during the five-day raft-based sampling.

Macroinvertebrate sampling will be conducted daily during the five-day raft-based sampling effort. Drift sampling in late summer (September) will characterize food resources available to rearing juvenile anadromous salmonids prior to overwintering. Spring sampling may also occur if scheduling allows in conjunction with other field efforts.

Drift sampling will begin each afternoon by 1700 hours and proceed until approximately 2000 hours. Benthic macroinvertebrate samples will be collected once per day during the raftbased sampling effort, typically during mid-day or as determined by the location of suitable sampling riffles and logistics of the habitat mapping study.

Sampling Protocols

Drift samples will be collected using stationary nets with rigid rectangular openings and tapered, nylon mesh bags with a collection jar fitted at the downstream end – similar to drift nets used by other researchers (Brittain and Eikeland 1988), including the 1987–1988 drift studies in the lower Tuolumne River (Stillwater Sciences 2010). All drift nets will be identical, with a mesh size small enough to capture small invertebrates such as immature chironomids that may be important salmonid prey, while also large enough to minimize clogging (e.g., 250–500 μ). There is no standard mesh size for drift nets, with mesh size instead chosen according to study objectives, and to represent a compromise between filtration efficiency and clogging (Svendsen et al. 2004).

At each sampling location two transects will be selected perpendicular to the river and two drift nets will be placed at each transect: one near shore and one in the thalweg or as close to the thalweg as water depth and velocity will safely allow. Each drift net will be anchored in the water column using steel (e.g., rebar stakes or fence posts) driven into the stream bed, with the bottom of the net at least 10 cm above the river bottom and the top of the net at least 4–5 cm above the water surface. This vertical net placement ensures capture of terrestrial-origin organisms originating from outside the stream (Leung et al. 2009), which may be an important diet component for anadromous salmonids (Tiffan et al. 2014, Leung et al. 2009, Rundio and Lindley 2008) while avoiding capture of organisms crawling on the substrate. During sampling, the drift nets will be attended by one or more field crew members to monitor for approaching rafts or other safety hazards. If needed, field personnel will verbally warn rafters of the potential hazard and assist rafts in avoiding the nets.

Drift nets will be deployed for three hours each day (1700–2000 hours). The width and depth of the submerged portion of each net will be measured upon installation to calculate the effective net area (i.e., the area being sampled). Water velocity will be measured at the midpoint of each net mouth immediately after net installation, at the midpoint of sampling (after 1.5 hours), and immediately before retrieving the net.

After removing each drift net from the water, the contents will be carefully washed to the end of the net and into the collection bottle using river water. The bottle will then be removed and all contents will be transferred to a sample container, labeled, and preserved with 95% ethanol for later processing.

Benthic sampling will be conducted using a modified version of the targeted riffle composite (TRC) method described in the California State Water Resources Control Board Surface Water Ambient Monitoring Program (SWAMP) Bioassessment Standard Operating Procedure (Ode 2007).

Due to site access constraints and non-wadeability in most habitat types, a modified version of the SWAMP protocol will be used to select riffles or other suitable fast-water habitat types for TRC sampling. Whereas the SWAMP protocol specifies that habitats (riffles or other fast-water habitats) for TRC sampling should be selected randomly from a pre-established reach 250 meters in length, riffles sampled for this study will instead be selected randomly from among all potentially wadeable riffles that are accessed during the habitat mapping study and were initially identified in the office by examining high-resolution color aerial photographs of the study reaches. Using the office-based method, a total of five riffles will be selected for sampling.

In the field, riffles initially selected for benthic sampling will be evaluated individually as they are encountered during the rafting trip to determine whether substrate, depth, and velocity are suitable for sampling, and if they can be sampled safely. A riffle will be deemed suitable if it has enough gravel or cobble substrate to allow collection of up to eight non-overlapping benthic samples in areas that can be safely accessed on foot by a two-person field crew (i.e., depth and velocity do not prohibit safe access and sampling). If a riffle initially chosen for TRC sampling is unsuitable, the crew will proceed to the next suitable riffle. Ideally, a total of five riffles or other fast-water habitats will be sampled in the study reach using the TRC method. At each riffle selected for TRC sampling, physical habitat and water chemistry data will be collected following the SWAMP protocol for the "basic" level of effort (Ode 2007). These data include GPS coordinates and photographs of the site, water temperature, pH, dissolved oxygen, specific conductance, channel width, riparian canopy cover, bank stability, and channel gradient

The TRC approach specifies collection of benthic samples at eight riffles within each 250 meter sampling reach (Ode 2007). However, preliminary examination of aerial photographs indicates that the riffles in the upper Tuolumne River are relatively infrequent and widely spaced, thus selection of a 250 meter sampling reach containing multiple riffles will likely be infeasible. A modified approach will therefore be used, which will entail collection of eight benthic samples per riffle. If additional suitable riffles or other suitable fast-water habitat types (e.g., run or pool tail) are located in close proximity to a riffle that has been selected for TRC sampling and can be safely accessed on foot, the required eight samples will be collected at locations distributed randomly among the suitable habitats. Sampling locations in each riffle or combination of fast-water habitat types at each site will be selected randomly using a digital stopwatch or random number chart, as described in Ode (2007). Samples will be collected using a standard D-frame kick net with 500-μ mesh. At each sampling location, a 0.09 m^2 (1 ft^2) area of bottom substrate will be sampled immediately upstream of the net following methods described in Ode (2007). All eight samples collected at each site (riffle or combination of fast-water habitats) will be combined into a single composite sample for the site, preserved in 95% ethanol, and labeled for laboratory processing.

Staffing and Schedule

The proposed habitat mapping and invertebrate assessment study includes 2 rafting trips representing a total of 10 days on the river:

- 7-day float tentatively planned for the week of July 18th
- 5-day float tentatively planned for the week of July 25th

Each proposed trip will include 5-10 field staff and commercial rafting guides.

Instream Flow Study

Goals and Objectives

The goal of this study is to assess instream flow-related habitat conditions for anadromous salmonids in the upper Tuolumne River. Objectives of the study are to develop topographical and channel cover model input data, develop stage-discharge rating curves, and use modeling tools to develop weighted usable area relationships with flow.

Methods

The study area may include the approximately 26.5-mile reach of the mainstem Tuolumne River from Wards Ferry Bridge (RM 78.5) to Early Intake (RM 105) (Figure 1). Specific study sites will be defined based on results from the habitat-related studies being conducted during the summer of 2016. Three sites will be surveyed to develop information necessary to model weighted usable area for anadromous salmonids, as summarized below.

- Develop topographic surface, bed roughness, and channel cover model input data
- Create base computational mesh
- Develop upstream and downstream stage-discharge rating curves
- Compile WSE and depth/velocity validation data
- Create River2D input file for initial model runs. Model calibration and validation for two discharges (e.g. estimated to be approximately 200 cfs and 1200 cfs.)
- Model simulations
- Develop tabular and graphical WUA summary output from final model runs

Specific field data collection methodologies are described in Attachment B.

Staffing and Schedule

The proposed instream flow study includes 3 rafting trips representing a total of 21 days on the river:

- 7-day float tentatively planned for the week of August 15th
- 7-day float tentatively planned for the week of August 29th
- 7-day float tentatively planned for the week of August 29th

Each proposed trip will include 10-15 field staff and commercial rafting guides.

Safety Planning for All Proposed Studies

A safety plan will be completed by the Applicant's consultants for the proposed studies to ensure the safety of the field staff and other recreational rafters on the upper Tuolumne River during implementation of the field program. The plan will include standardized safety protocols that have been used by the Applicant's consultants in similar types of studies on rivers including the Tuolumne, Merced, Stanislaus and Yuba. The safety plan will include detailed information on daily "tailgate meetings", call in/call out and other communication procedures, water and boat safety, emergency protocols, and safety of other recreationists on the river. An approved safety plan will be on file prior to the start of the field program and relevant safety information will be in the possession of crews while conducting field work. In addition, all field staff will follow standard safety guidelines required by the commercial rafting guides.

Additional Information for Permit Application Questions

15.

The cost of proposed studies is minimal compared to the overall cost of the ongoing Licensing effort. The Districts have allotted sufficient funds for the completion of all studies involved in the Licensing effort. The purpose of these surveys is to characterize the extent and quality of the available habitat to anadromous salmonid species. Results of the proposed studies will provide valuable and essential ecological information related to the potential feasibility of reintroducing anadromous salmonids into the upper Tuolumne River Watershed. Results of the studies will be available to the public.

17.

The proposed studies are not anticipated to affect air quality, aesthetics, surface and ground water quality and quantity, the control on any stream or body of water, or surface of the land. Equipment to be used for this study does not create noise above that of normal hand held electronic appliances (i.e., laser range finders, GPS units, total stations, etc.). Elevated noise levels would be restricted to noise levels associated with commercial rafting-related operations.

Temporary instream equipment will be used for the spawning gravel and macroinvertebrate studies, but equipment will only be used at discrete sampling locations and will not be left in the water after completion of sampling activities. If needed, field personnel will verbally warn rafters of any potential hazards in the river and assist rafts in avoiding any instream equipment.

Installation of some pieces of equipment will be required in the mainstem upper Tuolumne River for the instream flow study, as described below.

Transducers will be temporarily installed in the upper Tuolumne River. A transducer housing will be attached to galvanized angle iron (2 inch x 2 inch, lengths not to exceed 36 inches) with hose clamps and bolted to bedrock or large boulders on the margins of the channel. Non-corrosive materials (galvanized or stainless) will be used to prevent any staining of the substrate. Removable plastic anchors requiring a small (5/16 of an inch or less) hole will be used to anchor the angle iron in order to minimize impacts of the installation. Transducers will be placed on the margin of the channel in discrete locations out of the normal view of downstream traffic to protect the aesthetic integrity of the site. All materials related to the installation will be removed upon completion of data collection.

At each of the three study sites, a minimum of three and maximum of six domed 2-inch monuments would be installed and would remain permanently. They will be installed in bedrock and require a ½ inch hole and epoxy to anchor them in place.

In order to minimize the potential for spreading aquatic invasive species during the course of all proposed studies, the California Department of Fish and Wildlife Aquatic Invasive Species Decontamination Protocol (https://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=43333) will be followed.

18.

The proposed studies are not anticipated to have any probable effects on populations of fish or wildlife. The macroinvertebrate sampling study will result in the disturbance and collection of a limited number of invertebrates at limited locations. However, standardized sampling protocols will be followed, and the study is not expected to have any notable effect on the macroinvertebrate community in the upper Tuolumne River. The results of the study will provide valuable and critical information related to the suitability of the upper Tuolumne River for potential anadromous fish reintroduction efforts, and study results will be made available to the public.

From: Staples, Rose
Sent: Wednesday, June 29, 2016 11:07 AM
To: Theresa Simsiman
Cc: Deason, Jesse; Craig, Nancy
Subject: RE: June 30 Logistics for La Grange Recreation Access-Safety Assessment Study Site Visit

Thank you for letting us know. Take care of that ankle; sprains are never easy.

Rose Staples, CAP-OM, MOS
D 207-239-3857

hdrinc.com/follow-us

From: Theresa Simsiman [mailto:theresa@americanwhitewater.org]
Sent: Wednesday, June 29, 2016 1:10 PM
To: Staples, Rose
Cc: Deason, Jesse; Craig, Nancy
Subject: Re: June 30 Logistics for La Grange Recreation Access-Safety Assessment Study Site Visit

Hi Rose,

A sprained ankle will prevent me from attending tomorrow's site visit.

I have reached out to Peter Drekmeier to keep me informed.

Thanks,

Theresa Simsiman
California Assistant Stewardship Director
American Whitewater
916-835-1460

On Jun 27, 2016, at 2:03 PM, Staples, Rose <Rose.Staples@hdrinc.com> wrote:

> Confirmed: John Buckley, Chris Collett, Peter Drekmeier, Abimael Leon, and Theresa Simsiman
> Maybe Second Half of Site Visit: Lonnie Moore, Aondrea Bartoo
>
> Thank you for your interest in attending the June 30, 2016 site visit for the La Grange Hydroelectric Project Recreation Access and Safety Assessment study.
>
> The purpose of the site visit is to gather site-specific information to be used along with existing aerial photography, topography data, and property ownership data to produce site assessments and descriptions of potential public access routes at the Project. The site visit is a requirement of the FERC-approved Recreation Access and Safety Assessment study plan, which can be found here on the La Grange Project licensing website (the study plan begins on page 90 of the PDF). The study plan was modified by the FERC Study Plan Determination, which can be found on the La Grange licensing website here (documents on this webpage are organized by the date each was uploaded to the website; FERC's Study Plan Determination was uploaded on April 24, 2015).

The site visit will begin by meeting at 8:00 am at the Blue Oaks Recreation Area (see directions below). Personnel at the entrance to Blue Oaks will direct you to our meeting location. The site visit will end at approximately 12:00 pm at the La Grange powerhouse.

The site visit will entail approximately 60 minutes of hiking steep, unimproved terrain. Participants may be exposed to heat and sun; and poisonous plants and venomous animals inhabit the area. Given these conditions, we recommend that attendees dress and pack accordingly. In particular, **attendees should wear or bring:**

1. Hiking boots and long pants
2. Adequate sun protection including long-sleeved shirt, a hat, sunglasses, and sunblock
3. Bug spray
4. Plenty of water

Please let us know if you have a change of plans and will not be attending the site visit.

Thank you.

Directions to Blue Oaks Recreation Area: From Modesto, head east on CA-132/Yosemite Boulevard. Turn left onto La Grange Road (J59). After approximately 4.7 miles, turn right onto Bonds Flat Road. Continue on Bonds Flat Road for approximately one mile. Blue Oaks Recreation Area will be on your left.

Rose Staples, CAP-OM, MOS
Executive Assistant

HDR
970 Baxter Boulevard Suite 301
Portland ME 04103
D 207-239-3857
rose.staples@hdrinc.com

hdrinc.com/follow-us

From: Foote, Debra -FS [mailto:dfoote@fs.fed.us]
Sent: Thursday, June 30, 2016 12:20 PM
To: Le, Bao
Cc: Vaughn, Gary D -FS
Subject: GRO1028 amendment

BAO,
Here is the amendment for the Barriers GRO1028 permit. Please obtain the signature and return to me for execution.

Debbie Foote
Resource Assistant

Forest Service
Groveland Ranger District

p: 209-962-7825 x533
f: 209-962-7412
dfoote@fs.fed.us

24545 Hwy. 120
Groveland, CA 95321
www.fs.fed.us

Caring for the land and serving people

Auth ID: GRO1128
Contact ID: 611267010602
Use Code: 422

FS-2700-23 (v. 10/09)
OMB No. 0596-0082

U.S. DEPARTMENT OF AGRICULTURE
FOREST SERVICE
AMENDMENT
FOR

SPECIAL-USE AUTHORIZATION

Amendment#: 1

This amendment is attached to and made a part of the Gro1128 Research special use authorization for barriers assessment issued to TURLOCK IRRIGATION DISTRICT on 07/29/2015 which is hereby amended as follows:

Install, monitor, and maintain a trail camera on the Clavey River approximately 2 miles up from the confluence of the Tuolumne River. Approval of an additional raft trip in 2017 to retrieve the equipment in 2017.

____________________ Holder	____________________ Jim Junette
____________________ Holder	____________________ District Ranger
____________________ Date	____________________ Date

From: Steve E. Boyd
Sent: Friday, July 01, 2016 7:44 AM
To: 'James Eicher (jeicher@blm.gov)'
Subject: July Field Studies

Jim

It was good to see you yesterday and I'm glad you were able to make it down for the tour. Aside from the climb, I hope you enjoyed it. I checked with everyone related to the proposed studies and confirmed that this year's field program will not be installing anything new into the river. There is the possibility of conducting some bug sampling which will require we use kick nets/drift nets but this is on the order of hours and nothing is left behind.

The one nuance I would add, as I mentioned at Don Pedro, is that for the temperature monitoring locations we will check all of the existing locations and repair any damage and replace broken missing loggers, but there will be nothing new or new locations. We will also rectify the rebar safety concern at the location you requested.

Please let me know if you need anything else.

Thanks

Steve

From: John Wooster - NOAA Federal <john.wooster@noaa.gov>
Sent: Friday, July 01, 2016 2:23 PM
To: Le, Bao
Cc: Deason, Jesse; Devine, John
Subject: Re: triploid fish

Follow Up Flag: Follow up
Flag Status: Flagged

I won't be back into the mix until the 6th. I'm going to try and get some NMFS folks from northwest to take a look, who have a lot more experience with these studies than I....

John

On Fri, Jul 1, 2016 at 12:53 PM, Le, Bao <ChiBao.Le@hdrinc.com> wrote:

Hi John.

On another note, are you interested in seeing a preview of the reservoir transit study plan? We are probably a week or so out from distributing a final draft plan to the entire LP group but note that when distributed, we'll probably have to ask for a more expedited review (14-21 days) because we need to have certainty in the plan prior to submitting a request for fish which I understand has an end of July deadline. Based upon the assumption that the key reviewers are NMFS and other agency folks, we could get it to you and other agency folks early next week so that you have more a little more time to review. Please let me know and we'll work to provide a preliminary draft on the 5th.

Have a good holiday.

Bao

From: John Wooster - NOAA Federal [mailto:john.wooster@noaa.gov]
Sent: Tuesday, June 28, 2016 2:04 PM
To: Le, Bao
Subject: Fwd: triploid fish

FYI....Note, Shasta is at the stage of actually testing some trap efficiencies of a couple of prototype collectors, so not just a reservoir transit study....

Hopefully I can talk to a few more people on Thursday...

-John

---------- Forwarded message ----------
From: **Jonathan Ambrose - NOAA Federal** <jonathan.ambrose@noaa.gov>
Date: Mon, Jun 27, 2016 at 4:41 PM
Subject: triploid fish
To: John Wooster - NOAA Federal <John.Wooster@noaa.gov>

Hi John. Just got off the phone with folks working on field studies for reintro and it helped spur some thoughts on some key issues.

We are looking at using approx. 100k fish to test trap efficiencies.

CDFW and USFWS are coordinating with each other. USFWS runs the Coleman Hatchery complex but are making sure the release protocols aligns with CDFW policies - such as all fish need to have adipose fin clips in order to be compliant with the Inland Trout Program.

CDFW wants all fish to IHN negative. This can be a problem, especially if there's a downstream hatchery without necessary water treatment facilities.

There's concern beyond 2017 that there might not be enough fish available for various experimental programs - due to predictions of poor hatchery returns in 2018.

Cost are unknown for Shasta at this exact moment but need to include clipping, triploiding, and possible tagging.

To make Shasta happen required a lot of coordination between USFWS (the hatchery manager), CDFW, Reclamation and NMFS. Alignment between the hatchery manager and CDFW will be critical for your effort. Best. Jon

--

John Wooster
Hydrologist
NOAA Fisheries West Coast Region
U.S. Department of Commerce
john.wooster@noaa.gov

From: Devine, John
Sent: Wednesday, July 06, 2016 8:59 AM
To: 'Barnes, Peter@Waterboards'; James.Hastreiter@FERC.gov; zachary_jackson@fws.gov; Hughes, Robert@Wildlife; Murphey, Gretchen@Wildlife; John Wooster; Larry Thompson; Heyne, Tim@Wildlife; Staples, Rose
Cc: Wetzel, Jeff@Waterboards
Subject: RE: New State Water Board Point of Contact - Don Pedro and La Grange Relicensings

Peter,

Thank you for the information. I want to wish you the best of luck in the new position. We look forward to working with Jeff.

John Devine, P.E., M.ASCE
Senior Vice President, Hydropower Services

HDR
970 Baxter Blvd, Suite 301
Portland, Maine 04103
D 207-775-4495 **M** 207-776-2206
john.devine@hdrinc.com

From: Barnes, Peter@Waterboards [mailto:Peter.Barnes@waterboards.ca.gov]
Sent: Tuesday, July 05, 2016 8:03 PM
To: Devine, John; James.Hastreiter@FERC.gov; zachary_jackson@fws.gov; Hughes, Robert@Wildlife; Murphey, Gretchen@Wildlife; John Wooster; Larry Thompson; Heyne, Tim@Wildlife; Staples, Rose
Cc: Wetzel, Jeff@Waterboards
Subject: New State Water Board Point of Contact - Don Pedro and La Grange Relicensings

All,

I have accepted a new position with the Cannabis Interim Instream Flow group within the Division of Water Rights. The transfer is effective July 11th. My current supervisor, Jeff Wetzel, will act as the State Water Board point of contact for both the Don Pedro and La Grange Relicensings. I cc'd him on this email and provided his contact information below. Since I will still be within the Division I will do my best to make sure the transfer is as smooth as possible. Please let me know if you have any questions. It was a pleasure working with you on these projects. Feel free to pass this information along to anyone that I may have missed.

Contact Information
Jeff Wetzel
916-323-9390
Jeff.Wetzel@waterboards.ca.gov

Sincerely,

Peter Barnes
Engineering Geologist
Water Quality Certification Program
Division of Water Rights
State Water Resources Control Board
Phone: (916) 445-9989
Email: Peter.Barnes@waterboards.ca.gov

From: Deason, Jesse
Sent: Thursday, July 07, 2016 3:10 PM
To: Deason, Jesse
Subject: FW: Upper Tuolumne scale samples

Begin forwarded message:

From: "Heyne, Tim@Wildlife" <Tim.Heyne@wildlife.ca.gov>
Subject: RE: Upper Tuolumne scale samples
Date: July 7, 2016 at 10:04:53 AM PDT
To: "guignard, jason@fishbio.com" <jasonguignard@fishbio.com>

Yeah it has been a while. I thought I saw you in a white Toyota Tundra in Oakdale this last weekend.

We are doing work with scales on the lower river and I had hoped that you were planning to image the scales for reading cause we would be able to check the growth patterns of those fish against the fish we have from the basin below the dams. If you are not going to image them we can work with scales directly so I was hoping to get a subsample of the scales for the fish. Is that going to work on your end? I will check to see if there are any known scales samples from the past as I know a couple of people that work in that have worked in that area. I would suggest you ask Stillwater folks cause they did work in that area in the recent past. Will be gone next two week but will get back regarding past samples by end of month. If you have questions over the next two weeks check in with Steve Tsao.

Talk with you later.

From: Jason Guignard [mailto:jasonguignard@fishbio.com]
Sent: Thursday, July 07, 2016 9:05 AM
To: Heyne, Tim@Wildlife
Subject: Upper Tuolumne scale samples

Hi Tim,

It has been a while since I have seen you, how are you doing these days?
We are getting ready to collect scale samples on the Tuolumne above Don Pedro. The SCP amendment (attached if you haven't seen it) asked for images of prepared scales along with fish data sent to you. It also asked to consider scale splitting with Region 4. I am assuming this is asking for a set of unprepared scales along with the images of scales that are mounted for aging. Is this correct?

Also, are you aware of any scale collection/age determination conducted previously on the reach between Early Intake and Wards Ferry?

Jason Guignard
Fisheries Biologist

FISHBIO
jasonguignard@fishbio.com
O: (209) 847-6300
C: (209) 840-9019

www.fishbio.com

PHONE CALL MEMORANDUM

Topic	Permit for upper Tuolumne River studies
Date	July 8, 2016
From	Mr. Steve Boyd, Turlock Irrigation District
To	Mr. Jim Eicher, Bureau of Land Management
Summary of Discussion	Mr. Boyd left a voicemail for Mr. Eicher requesting that Mr. Eicher provide an update on the status of BLM's review of the Districts' permit application.

From: Staples, Rose
Sent: Monday, July 11, 2016 3:04 PM
Cc: Deason, Jesse; Le, Bao; Staples, Rose
Subject: La Grange Reservoir Transit Draft Study Plan for Review and Comment
Attachments: LaGrangeProject_ReservoirTransitDraftStudyPlan_07112016.pdf

La Grange Licensing Participants,

As approved by FERC in its May 27, 2016 determination on requests for study modifications and new study, by this email the Districts are providing an anadromous fish reservoir transit draft study plan to licensing participants for review and comment. The goal of this study is to evaluate the biological feasibility of downstream (juvenile) movement of anadromous fish through Don Pedro Reservoir. The draft study plan is also available on the La Grange Project licensing website www.lagrange-licensing.com in the DOCUMENTS section.

The Districts respectfully request that all comments on the draft study plan be submitted to me at rose.staples@hdrinc.com by Wednesday, August 10, 2016.

Thank you.

Rose Staples, CAP-OM, MOS
Executive Assistant
HDR
Rose.Staples@hdrinc.com
(207) 239-3857

DRAFT STUDY PLAN

TURLOCK IRRIGATION DISTRICT
AND
MODESTO IRRIGATION DISTRICT

LA GRANGE HYDROELECTRIC PROJECT
FERC NO. 14581

Reservoir Transit Study

July 2016

1.0 Background

The Turlock Irrigation District (TID) and Modesto Irrigation District (MID) (collectively, the Districts) own the La Grange Diversion Dam (LGDD) located on the Tuolumne River in Stanislaus County, California. LGDD was constructed from 1891 to 1893 to replace Wheaton Dam, which was built by other parties in the early 1870s. The LGDD raises the level of the Tuolumne River to permit the diversion and delivery of water by gravity to irrigation systems owned by TID and MID. The Districts' irrigation systems currently provide water to over 200,000 acres of prime Central Valley farmland and drinking water to the City of Modesto and the community of La Grange. Built in 1924, the La Grange hydroelectric plant is located approximately 0.2 miles downstream of LGDD on the east (left) bank of the Tuolumne River and is owned and operated by TID. The powerhouse has a capacity of slightly less than five megawatts (MW). The La Grange Project operates in a run-of-river mode. The LGDD provides no flood control benefits, and there are no recreation facilities associated with the La Grange Project or the La Grange pool.

LGDD is 131 feet high and is located at river mile (RM) 52.2 at the exit of a narrow canyon, the walls of which contain the pool formed by the diversion dam. Under normal river flows, the pool formed by the diversion dam extends for approximately one mile upstream. When not in spill mode, the water level above the diversion dam is between elevation[1] 294 feet and 296 feet approximately 90 percent of the time. Within this 2-foot range, the pool storage is estimated to be less than 100 acre-feet of water.

The drainage area of the Tuolumne River upstream of LGDD is approximately 1,550 square miles. Tuolumne River flows upstream of LGDD are regulated by four upstream reservoirs: Hetch Hetchy, Lake Eleanor, Cherry Lake, and Don Pedro. The Don Pedro Hydroelectric Project (FERC No. 2299) is owned jointly by the Districts, and the other three dams are owned by the City and County of San Francisco (CCSF). Inflow to the La Grange pool is the sum of releases from the Don Pedro Project, located 2.6 miles upstream, and very minor contributions from two small intermittent streams downstream of Don Pedro Dam.

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[1] All elevations in this document are referenced to 1929 National Geodetic Vertical Datum (NGVD 29).

As part of the Integrated Licensing Process (ILP) for the La Grange Project, the Districts are completing a phased, two-year Fish Passage Facilities Alternatives Assessment (Assessment) to identify and develop potentially viable, concept-level alternatives for upstream and downstream passage of Chinook salmon and steelhead at the La Grange and Don Pedro dams.

Specific objectives of the Assessment are to:

- Obtain available information to establish existing baseline conditions relevant to impoundment operations and siting passage facilities,
- Obtain and evaluate available hydrologic data and biological information for the Tuolumne River to identify potential types and locations of facilities, run size, fish periodicity, and the anticipated range of flows that correspond to fish migration,
- Formulate and develop preliminary sizing and functional design for select, alternative potential upstream and downstream fish passage facilities, and
- Develop Class-V opinions of probable construction cost and annual operations and maintenance (O&M) costs for select fish passage concept(s).

The Assessment consists of two phases. Phase 1 (conducted in 2015) involved collaborative information gathering and evaluation of facility siting, sizing, general biological and engineering design parameters, and operational considerations. Phase 2 (conducted in 2016) will involve the development of preliminary functional layouts and site plans, estimation of preliminary capital and O&M costs, and identification of any additional significant information needs for select passage alternatives.

As detailed in FERC's May 27, 2016 determination on requests for study modifications and new study, a proposed modification of the Assessment's Phase 1 and Phase 2 implementation schedule was approved by extending Phase 1 an additional year to 2016 and completing Phase 2 in 2017 to allow for further coordination with licensing participants on gathering necessary information to ensure that the fish passage facility design basis and resulting cost estimates reflect reliable and defensible information. As part of this determination, FERC also noted the Districts' proposal to develop an anadromous fish reservoir transit study plan and provide it to licensing participants by July 2016, to advance the necessary planning and permitting to conduct such a study during Phase 2 in spring 2017, should the Phase 1 results indicate that such a study is necessary.

2.0 Study Area

The Reservoir Transit study area will include the mainstem of the upper Tuolumne River from Lumsden (RM 96) downstream to Don Pedro Dam (RM 54.8) including Don Pedro Reservoir.

3.0 Study Goals

The goal of the Reservoir Transit Study is to evaluate the biological feasibility of downstream (juvenile) movement of anadromous fish through Don Pedro Reservoir. Evaluating reservoir passage efficiency is one component of assessing overall fish passage performance, and results

of this study will be used to help inform feasibility of a potential downstream passage facility. There is no existing information regarding migration and migration success rates of juvenile salmonids through Don Pedro Reservoir, as there are no anadromous populations occurring upstream. The purpose of the Reservoir Transit Study is to evaluate juvenile salmonid reservoir passage efficiency through the Don Pedro Project Reservoir by determining estimates of reach specific migration success.

4.0 Study Methods

Permitting and Study Fish Availability

Scientific Collector Permit Amendments will be required for this study to be conducted and applications for the amendments will be submitted during summer 2016. The use of hatchery fish will also be required for this study, and a request will be submitted to California Department of Fish and Wildlife (CDFW) in July 2016 for hatchery origin Chinook salmon to be allocated for this study during spring 2017. This request will be for spring-run Chinook salmon in a size range representing large young-of-the-year smolts and/or yearlings (95-120 mm). While spring-run Chinook salmon are preferred, it is recognized that these fish may not be available for a variety of reasons. Alternatively, fall-run Chinook salmon of a similar size could be used for this study as a surrogate to spring-run Chinook salmon (SJRRP 2011).

Releases of hatchery origin steelhead juveniles were also considered in development of the study design, but are not proposed due to the potential uncertainties that would be introduced related to the fact that the steelhead fish obtained would not actually be smolting, but simply of smolt-size. Therefore, these fish may not have the urge to sustain downstream migration behavior. While fish that moved upstream following release would be excluded from analyses of migration success, there is no guarantee that a juvenile steelhead that initially moves downstream for some distance does not stop migrating to take up temporary or permanent residence in the river or reservoir (Del Real et al. 2011, Plumb et al. 2006). A key assumption of the study design is that study fish will continue to try to migrate downstream through the river and reservoir. Due to potential sample losses due to upstream movement and/or temporary or permanent residency in the river or reservoir, compounded with the possibility of low migration success through many of the study reaches, including steelhead in the study was deemed infeasible.

Acoustic Telemetry

VEMCO acoustic technology (tags and receivers) likely represents the best technology given the study objectives and study site. Autonomous acoustic receivers (model VR2W – 180 kHz) are self-powered for 8 months and record and decode data automatically. Each receiver is capable of storing up to 1.6 million records. Under optimal acoustic conditions (e.g., no boat traffic and calm water), 180 kHz tags can be detected up to 250 m away (about 820 ft). However, it should be noted that in areas (near marinas or boat ramps) or periods (on weekends) with high boat traffic, detection range could be considerably less. Therefore, detection range testing will be performed to evaluate the appropriate spacing and configuration of receivers within arrays.

Tagging Methods

A total of 960 hatchery reared juvenile Chinook salmon will be surgically implanted with VEMCO acoustic transmitters. Chinook salmon, with average size ranging from 95-120 mm, will be implanted with V4-180 kHz tags (0.24 g). All tagging will be performed by experienced personnel following standard implantation procedures (Adams et al. 1998, Martinelli et al. 1998). The tag to body weight ratio will not exceed 5%.

Eight groups of 60 tagged juvenile Chinook salmon will be released at each of two release sites during the study period. Release sites have been identified at Lumsden (RM 96) and Wards Ferry (RM 78.5), as these are the only accessible sites near or upstream of the reservoir. While there is a preference to select a release location that ensures that fish travel through riverine habitat prior to entering the reservoir (e.g., Lumsden), there is also a desire to minimize loss of tagged fish prior to entering the reservoir by making releases near the head of the reservoir (e.g., Wards Ferry).

Following release of study fish, a combination of fixed and mobile receivers will be used to document movement of juvenile Chinook salmon through the Don Pedro Project Reservoir. Fixed receivers will be deployed near proposed locations of potential downstream fish collection facilities (Table 4-1; TID/MID 2016) to document travel time and reach specific migration success. Mobile tracking may be used to document locations of tagged fish between acoustic receiver locations.

Table 4-1. Proposed locations of acoustic receivers.

Site No.	Location	River Mile	Max Depth (ft)[1]	Max Width (ft)[1]
Release	Lumsden	96	--	--
Release	Wards Ferry	78.5	--	--
1	Abv. Wards Ferry	79	30	250
2	Below Wards Ferry	78	80	400
3	Abv. Moccasin Point	73.3	180	650
4	Jacksonville Rd. Bridge	72.5	200	1200
5	Railroad Canyon	70	280	1000
6	East Bay	60	330	1300
7	Abv. DP Dam	55	530	2000

[1] Maximum depth and width assume that Don Pedro Reservoir is at full pool (830'), based on bathymetry data from Don Pedro relicensing.

Array Design

The entire Don Pedro Reservoir acoustic array will consist of single- and double-gated arrays as shown in Figure 4-1. This particular arrangement of acoustic receivers will provide valuable information on the movement, migration success, and movement direction of tagged fish as well as the detection efficiency of specific locations and the entire array. Proposed array locations provide finer scale resolution near the head of reservoir to provide more information on movement patterns and migration success within this area.

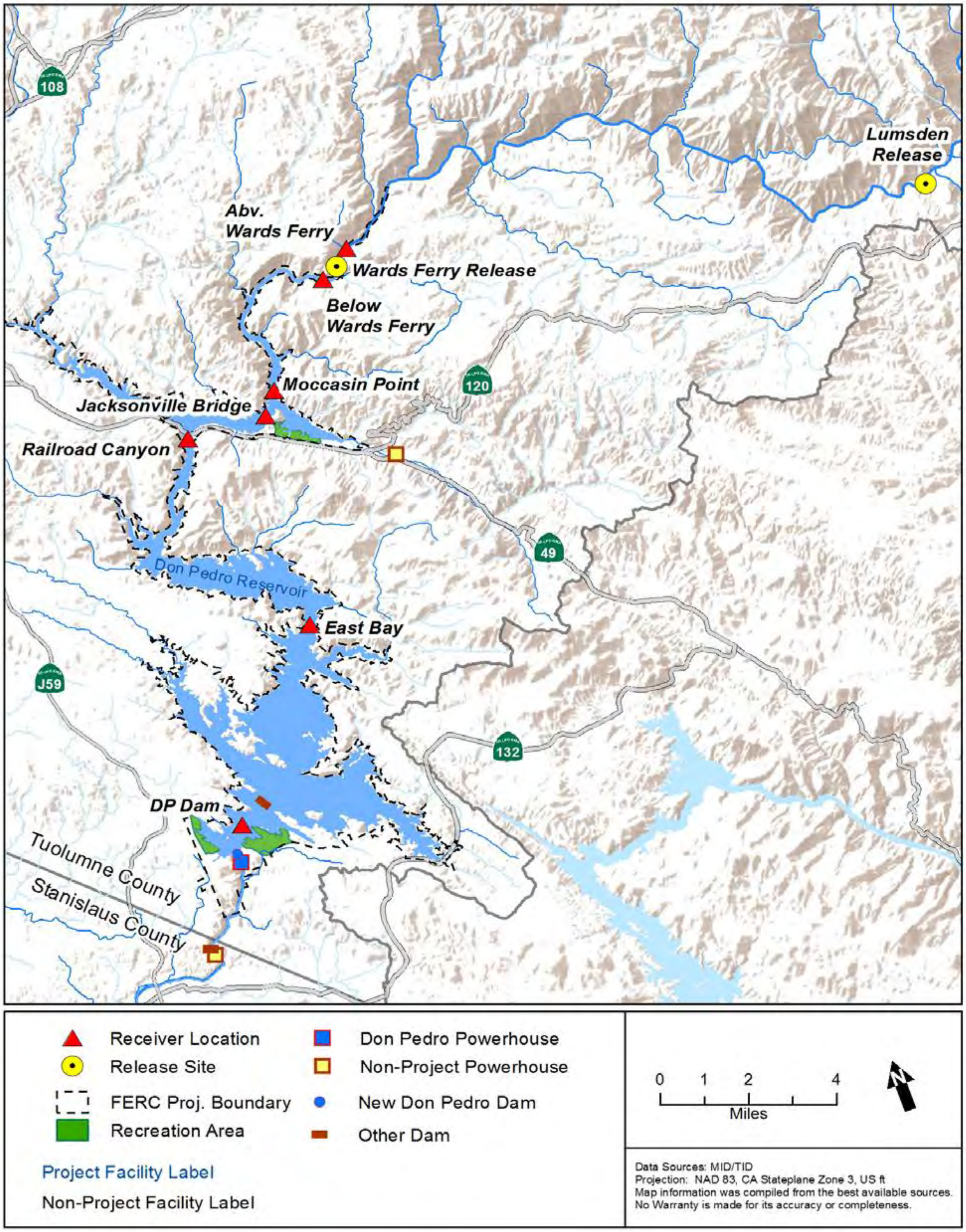

Figure 4-1. Proposed release and acoustic array locations in the upper Tuolumne River and Don Pedro Reservoir.

Based on the approximate dimensions of each monitoring site (shown in Table 4-1), the number of receivers per site will vary from 1 to 8 (Table 4-2). This proposed number at each site is based on the assumption of a detection range of about 330 ft, and allows for some overlap between detection fields of each receiver. Therefore, based on results from detection range testing, the actual number of receivers may differ (e.g., if detection range is reliably > 330 ft, potentially one less receiver could be used per array). An additional consideration for the number of receivers is the water level in Don Pedro Reservoir at the time of the study. If water level in the reservoir is significantly reduced from the assumed full pool (used to estimate dimensions), the number of receivers could be reduced further.

Table 4-2. Proposed number of acoustic receivers and number of arrays at each site (based on assumption of 330 ft detection range).

Site No.	Location	River Mile	No. of Arrays	No. of Receivers
Release	Lumsden	96	-	-
Release	Wards Ferry	78.5	-	-
1	Abv. Wards Ferry	79	1	1
2	Below Wards Ferry	78	2	1
3	Moccasin Point	73.3	2	2
4	Jacksonville Rd. Bridge	72.5	1	3
5	Railroad Canyon	70	2	4
6	East Bay	60	1	6
7	DP Dam	55	2	8

Range Testing

Estimating the range of detection through range testing will be an important first step in determining the spacing and configuration of receivers within acoustic arrays (Kessel et al. 2013). As noted above, detection range can vary by site, and through time within a site. A variety of factors can cause changes in detection range including, weather, boats, conductivity, temperature, depth, or temperature gradients, among others (Kessel et al. 2013). To conduct range testing, up to 8 receivers will be deployed at 100 ft increments away from a test tag(s). A test tag emits an acoustic pulse or signal every 30 seconds. Therefore, if a receiver 100 ft away was detecting at 100%, the number of detections in an hour for that tag should equal 120 (i.e., 2 pulses per minute * 60 = 120). Receivers close to the test tag should typically detect the tag with high detection rates, and then at increasing distance away from the tag, detection rates will decrease. The range test will be conducted for one week prior to the study and ideally represent typical ambient conditions at each site.

After the range test is completed, the number of detections on an hourly or daily basis will be plotted against distance away from the tag. Typically, the rate at which tag detection decreases with increasing distance follows a logistic function (Figure 4-2; from Figure 2 of Kessel et al. 2013). Using Figure 4-3 as an example, in order to achieve 50% detection probability, the receivers should be deployed approximately 1000 m apart (since the detection range represents the radius of a ~500 m circle around the receiver). A similar method will be used to determine the appropriate spacing for the receivers in each array in this study.

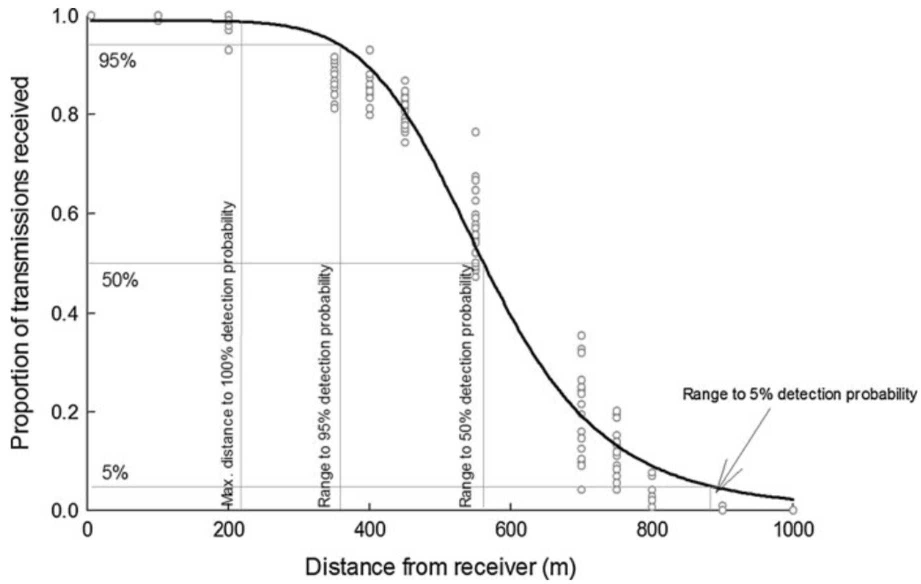

Figure 4-2. Conceptual diagram of collected data from range tests and method to determine appropriate spacing of receivers. From Figure 2 of Kessel et al. 2013.

Deployment Methods / Equipment

For deployments in the reservoir, acoustic receivers will be affixed to a mooring and buoy system, subject to approval by Don Pedro Recreation Agency and consistent with existing rules and regulations. Moorings will be constructed of concrete and weigh approximately 100 lbs each. The cabling will be secured to the underside of the buoy to minimize tampering. Acoustic receivers will be secured to 3/8" stainless steel cable with stainless steel hose clamps and will be deployed approximately 10 ft from the water surface to prevent tampering or loss from the public. Receivers deployed near the surface will be oriented to face downwards to maximize the detection range in the upper portion of the water column. In the deeper portions of the lake (Railroad Canyon, East Bay, and at Don Pedro Dam), two acoustic receivers will be deployed on the same mooring system. These will face upwards and will be deployed so that they are approximately 10 ft from the substrate.

Data Analysis

The proposed study design will determine, for any given study reach, the proportion of fish that migrated successfully to pass into the next downstream reach. The mechanisms via which any fish failed to arrive at the next reach will not be identified by this study but may include the following: some fish may have died, taken up residence, moved up into a tributary, turned around, or had a failed tag. Detection data will be analyzed using a Cormack-Jolly-Seber (CJS) framework and the commonly accepted CJS formulation (see Lebreton et al. 1992). A similar method was used by Skalski (1998), and the specific method was later described as a 'Single Release-Recapture Model' (Giorgi et al. 2010). These models simultaneously allow the estimation of detection probability at each receiver array, and the probability of successful passage between each array. Multiple detection arrays are required in order to tease-apart the effects of passage-success and detection-probability. Since no arrays exist downstream of the

last one, the detection efficiency of the last array cannot be determined, and because of that, the effects of successful passage and successful detection cannot be teased-apart in the last reach.

The Single Release-Recapture Model does not allow for handling effects to be controlled. Thus any latent handling related effects that manifest in a given study reach will contribute to the failure of some fish to reach the next detection point, and hence will be attributed as a loss to the reach itself. While a Paired Release-Recapture Model would avoid this issue (see Giorgi et al. 2010), these models require more tagged fish for releases to be made at the top of each study reach and *a priori* knowledge of reach-specific transit times which are not available. In this study, we propose to release fish at Lumsden, i.e., far enough upstream of the reservoir as to maximize the probability that any handling related effects are fully manifest by the time the tagged fish enter the first reach of interest at Wards Ferry. Since there is no available information to predict how many of these fish will survive to Wards Ferry or migrate successfully through each of the reservoir reaches, releases will also be made at Wards Ferry with the intent of bolstering the sample size of fish reaching the downstream reaches (i.e., the fish released at Wards Ferry will not have fully expressed any potential handling-related mortality to be useful for estimation of passage success through their first study reach, but if subsequent detection probabilities and passage success rates are comparable to those of the Lumsden fish, both release groups may be pooled for increased sample size in the lowest reaches).

Detection arrays will be deployed at Wards Ferry, Moccasin Point, Jacksonville Road Bridge, Railroad Canyon, East Bay, and two arrays in the forebay of Don Pedro Dam (Figure 4-3). The double array in the Don Pedro Forebay will allow estimation of passage-success through the last study reach without dealing with non-estimable parameters. At various other key locations in the Reservoir, we propose that double arrays be deployed. There is no *a priori* knowledge of reach-specific passage success, which could be low enough in some reaches as to make it difficult for the model to separate the effects of passage-success and detection-probability. Thus, while not strictly required for the analysis, especially if passage success is good, double arrays will add value by helping to resolve the models under certain scenarios.

All modeling will be carried out in the R computing environment (R Development Core Team 2015) using the RMark package (Laake 2013) to construct and fit models in Program MARK (White and Burnham 1999). In Figure 4-3, model parameters are mapped onto a conceptualized image of the river and reservoir, where the waterways have been simplified for the sake of the illustration as a linear system. The parameters that will be estimated are listed and defined in Table 4-3.

Table 4-3. List of model parameters, and their definitions.

Parameter	Definition
$\Phi_{L\text{-}W1}$	Probability of successfully passing between Lumsden and the first array at Wards Ferry
p_{W1}	Probability of detection at the first array at Wards Ferry
p_{W2}	Probability of detection at the second array at Wards Ferry
$\Phi_{W2\text{-}M1}$	Probability of successfully passing between the second array at Wards Ferry and the first array at Moccasin Point
p_{M1}	Probability of detection at the first array at Moccasin Point
p_{M2}	Probability of detection at the second array at Moccasin Point
$\Phi_{M2\text{-}J}$	Probability of successfully passing between the second array at Moccasin Point and Jacksonville Rd. Bridge
p_{J}	Probability of detection at Jacksonville Rd. Bridge
$\Phi_{J\text{-}R1}$	Probability of successfully passing between Jacksonville Rd. Bridge and the first array at Railroad Canyon
p_{R1}	Probability of detection at the first array at Railroad Canyon
p_{R2}	Probability of detection at the second array at Railroad Canyon
$\Phi_{R2\text{-}E}$	Probability of successfully passing between the second array at Railroad Canyon and East Bay
p_{E}	Probability of detection at East Bay
$\Phi_{E\text{-}D1}$	Probability of successfully passing between East Bay and the first array in the Don Pedro forebay
p_{D1}	Probability of detection at the first array in the Don Pedro forebay
$\lambda_{D1\text{-}D2}$	Probability of *both* successfully passing between the two arrays in the Don Pedro Forebay ($\Phi_{D1\text{-}D2}$) *and* being detected at the second array (p_{D2}). The two effects cannot be disentangled, thus are represented by a single parameter, $\lambda_{D1\text{-}D2}$

Note that passage success will be assumed to be 100% between paired arrays (where two sets of arrays are deployed together) at Wards Ferry, Moccasin Point and Railroad Canyon.

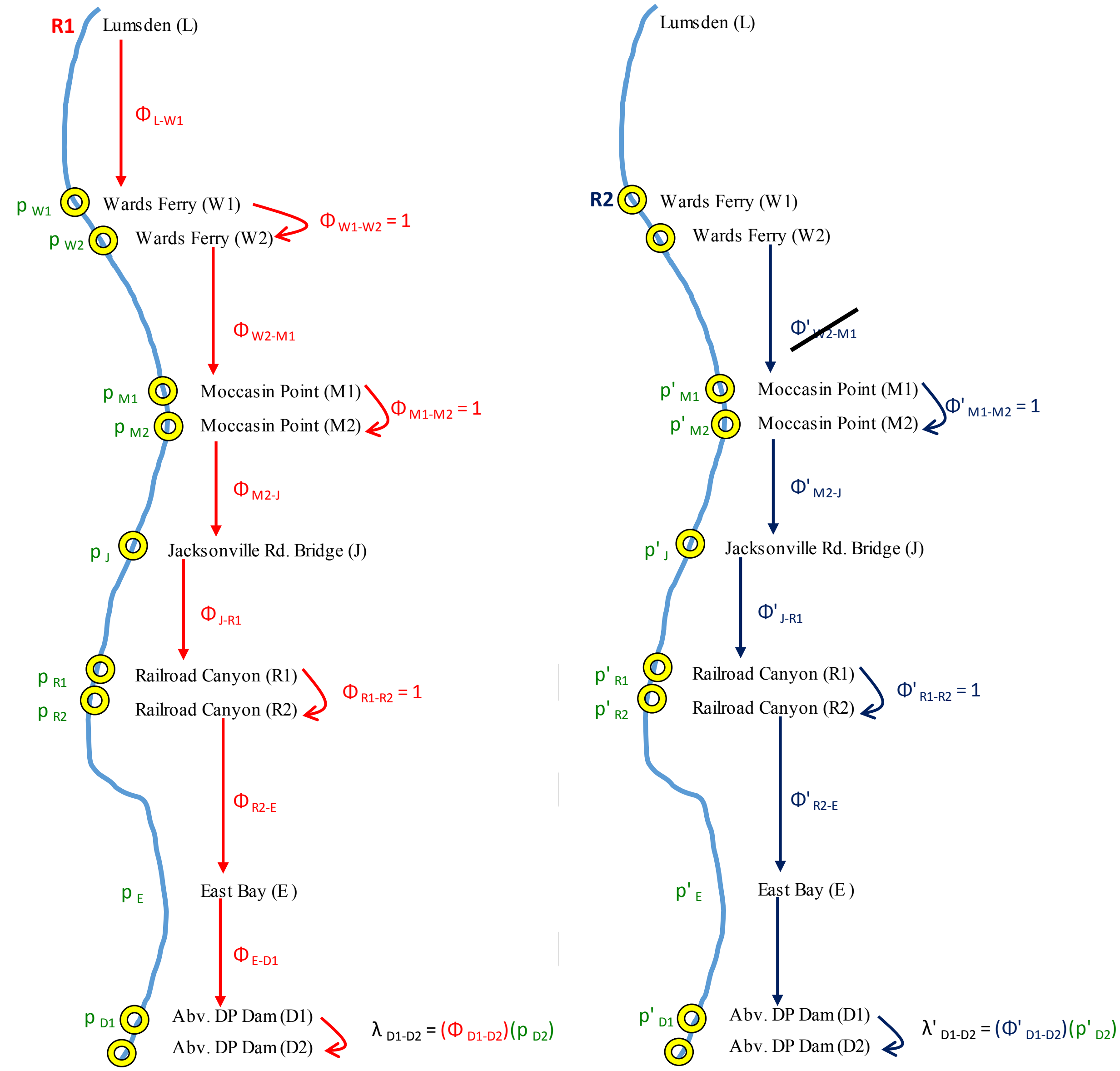

Figure 4-3. Model parameters mapped onto a simplified (conceptual) image of the river and reservoir, shown for the sake of the illustration as a linear system. Yellow circles show detection arrays. Parameters associated with the Lumsden releases (R1) will be estimated separately from their equivalents (marked with an apostrophe) for the Wards Ferry releases (R2), unless data pooling is required or unless model results suggest separation is not parsimonious. Definitions of parameter symbols are shown in Table 4-3.

5.0 Study Schedule

- Study Planning and Permitting ....May 2016 – December 2016
- Draft Study Plan to Licensing Participants ....July 2016
- Provide Interim Study Updates……………………………………….....February – May 2017
- Field Data Collection ....April – June 2017
- Data Entry Processing, and QA/QC .... February –July 2017
- Data Analysis…………………………………………………………......April – August 2017
- Report Preparation .... June - August 2017
- Draft Report for 30-day Review ....August 2017
- Final Report Issuance ....October 2017

6.0 References

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White, G.C. and K.P. Burnham. 1999. Program MARK: Survival estimation from populations of marked animals. Bird Study, 46 Supplement: 120-138.

From: Staples, Rose
Sent: Monday, July 11, 2016 2:58 PM
Cc: Deason, Jesse; Le, Bao; Staples, Rose
Subject: La Grange Revised UTR Chinook Salmon-Steelhead Spawning Gravel Mapping Study

La Grange Licensing Participants,

On May 10, 2016, the Districts circulated to licensing participants the final draft study plan for the *Upper Tuolumne River Chinook Salmon and Steelhead Spawning Gravel Mapping Study* (Spawning Gravel Study), one of several studies to be implemented in 2016 in support of the Upper Tuolumne River Reintroduction Assessment Framework.

At Workshop No. 5, held on May 19, 2016, NMFS provided feedback on the Spawning Gravel Study Plan. Noting that the study plan currently assumes a minimum patch size of 12 square meters for Chinook salmon, NMFS requested that the study plan be revised to assume instead a 6-square-meter minimum patch size for Chinook salmon. Per NMFS's request, the study plan has been revised to assume a 6-square-meter patch size for Chinook salmon. A copy of the revised study plan is now available on the La Grange Project licensing website www.lagrange-licensing.com in the DOCUMENTS section.

Rose Staples, CAP-OM, MOS
Executive Assistant
HDR
Rose.Staples@hdrinc.com
(207) 239-3857

From: Deason, Jesse
Sent: Tuesday, July 12, 2016 7:54 AM
To: Deason, Jesse
Subject: Request for hatchery fish- Don Pedro Reservoir Transit Study
Attachments: FishRequestTuolumne_071116.doc; ATT00001.htm

From: "Jason Guignard" <jasonguignard@fishbio.com>
To: "Mark.Clifford@wildlife.ca.gov" <Mark.Clifford@wildlife.ca.gov>
Cc: "Le, Bao" <ChiBao.Le@hdrinc.com>
Subject: Request for hatchery fish- Don Pedro Reservoir Transit Study

Hi Mark,

Attached below is the anadromous hatchery fish request for the Upper Tuolumne River which we had discussed a few weeks ago.
I appreciate your willingness to distribute this to necessary regional staff ahead of the August 1 request deadline.

Please let me know if any questions come up during review of this request.

Thank You,
Jason

Jason Guignard
Fisheries Biologist

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July 11, 2016

Dr. Mark Clifford
Hatchery Coordinator
California Dept. of Fish and Game
#3 North Old Stage Road
Mount Shasta, CA 96067

Dear Dr. Clifford:

FISHBIO is submitting a formal request for 1,500 spring-run juvenile Chinook salmon from Feather River Hatchery to be used on the upper Tuolumne River for licensing studies being conducted for the La Grange Hydroelectric Project (FERC No. 14581). The goal of this particular study is to evaluate the biological feasibility of downstream (juvenile) movement of anadromous fish through Don Pedro Reservoir. Evaluating reservoir passage efficiency is one component of assessing overall fish passage performance, and results of this study will be used to help inform feasibility of a potential downstream passage facility. There is no existing information regarding migration and migration success rates of juvenile salmonids through Don Pedro Reservoir, as there are no anadromous populations occurring upstream. The purpose of the Reservoir Transit Study is to evaluate juvenile salmonid reservoir passage efficiency through the Don Pedro Project Reservoir by determining estimates of reach specific migration success. The attached draft study plan is currently under review by relicensing participants.

The proposed study plan requires releases of acoustic tagged juvenile Chinook salmon tagged in the upper Tuolumne River during spring 2017 to estimate migration success through reaches of the reservoir. The proposed release locations for these fish are at Lumsden (RM 96) and Wards Ferry (RM 78.5). Target size for tagging is approximately 105-125 mm, which is expected to correspond to individuals weighing at least 12 g to maintain a tag weight to body weight ratio of less than 5%. This is approximately 38 fish/lb and study fish would need to be available starting April 1, 2017. As the study plan is currently in draft form pending review by licensing participants, the total number of fish released may be adjusted. We are currently requesting 1,500 spring-run juvenile Chinook salmon from Feather River Hatchery to provide some flexibility to adjust the sample size if needed. Should spring-run juvenile Chinook salmon not be available from Feather River Hatchery, we are open to considering other sources of juvenile Chinook salmon that would be of the target size during the study period.

We appreciate your willingness to consider this request prior to the August 1 deadline. Due to time constraints associated with obtaining acoustic tags for this study we request that a decision regarding allocation of these fish be made prior to January 1, 2017. Field data collection is scheduled to occur during April-June 2017, with a final study report issued to FERC in October 2017.

My Scientific Collecting Permit number is SC-9966. If you have any questions, or if any additional information is needed to process this request please contact me using the information below.

Sincerely,

Jason Guignard
Fisheries Biologist

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C: 209.840.9019
www.fishbio.com

DRAFT STUDY PLAN

TURLOCK IRRIGATION DISTRICT
AND
MODESTO IRRIGATION DISTRICT

LA GRANGE HYDROELECTRIC PROJECT
FERC NO. 14581

Reservoir Transit Study

July 2016

1.0 Background

The Turlock Irrigation District (TID) and Modesto Irrigation District (MID) (collectively, the Districts) own the La Grange Diversion Dam (LGDD) located on the Tuolumne River in Stanislaus County, California. LGDD was constructed from 1891 to 1893 to replace Wheaton Dam, which was built by other parties in the early 1870s. The LGDD raises the level of the Tuolumne River to permit the diversion and delivery of water by gravity to irrigation systems owned by TID and MID. The Districts' irrigation systems currently provide water to over 200,000 acres of prime Central Valley farmland and drinking water to the City of Modesto and the community of La Grange. Built in 1924, the La Grange hydroelectric plant is located approximately 0.2 miles downstream of LGDD on the east (left) bank of the Tuolumne River and is owned and operated by TID. The powerhouse has a capacity of slightly less than five megawatts (MW). The La Grange Project operates in a run-of-river mode. The LGDD provides no flood control benefits, and there are no recreation facilities associated with the La Grange Project or the La Grange pool.

LGDD is 131 feet high and is located at river mile (RM) 52.2 at the exit of a narrow canyon, the walls of which contain the pool formed by the diversion dam. Under normal river flows, the pool formed by the diversion dam extends for approximately one mile upstream. When not in spill mode, the water level above the diversion dam is between elevation[1] 294 feet and 296 feet approximately 90 percent of the time. Within this 2-foot range, the pool storage is estimated to be less than 100 acre-feet of water.

The drainage area of the Tuolumne River upstream of LGDD is approximately 1,550 square miles. Tuolumne River flows upstream of LGDD are regulated by four upstream reservoirs: Hetch Hetchy, Lake Eleanor, Cherry Lake, and Don Pedro. The Don Pedro Hydroelectric Project (FERC No. 2299) is owned jointly by the Districts, and the other three dams are owned by the City and County of San Francisco (CCSF). Inflow to the La Grange pool is the sum of releases from the Don Pedro Project, located 2.6 miles upstream, and very minor contributions from two small intermittent streams downstream of Don Pedro Dam.

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[1] All elevations in this document are referenced to 1929 National Geodetic Vertical Datum (NGVD 29).

As part of the Integrated Licensing Process (ILP) for the La Grange Project, the Districts are completing a phased, two-year Fish Passage Facilities Alternatives Assessment (Assessment) to identify and develop potentially viable, concept-level alternatives for upstream and downstream passage of Chinook salmon and steelhead at the La Grange and Don Pedro dams.

Specific objectives of the Assessment are to:

- Obtain available information to establish existing baseline conditions relevant to impoundment operations and siting passage facilities,
- Obtain and evaluate available hydrologic data and biological information for the Tuolumne River to identify potential types and locations of facilities, run size, fish periodicity, and the anticipated range of flows that correspond to fish migration,
- Formulate and develop preliminary sizing and functional design for select, alternative potential upstream and downstream fish passage facilities, and
- Develop Class-V opinions of probable construction cost and annual operations and maintenance (O&M) costs for select fish passage concept(s).

The Assessment consists of two phases. Phase 1 (conducted in 2015) involved collaborative information gathering and evaluation of facility siting, sizing, general biological and engineering design parameters, and operational considerations. Phase 2 (conducted in 2016) will involve the development of preliminary functional layouts and site plans, estimation of preliminary capital and O&M costs, and identification of any additional significant information needs for select passage alternatives.

As detailed in FERC's May 27, 2016 determination on requests for study modifications and new study, a proposed modification of the Assessment's Phase 1 and Phase 2 implementation schedule was approved by extending Phase 1 an additional year to 2016 and completing Phase 2 in 2017 to allow for further coordination with licensing participants on gathering necessary information to ensure that the fish passage facility design basis and resulting cost estimates reflect reliable and defensible information. As part of this determination, FERC also noted the Districts' proposal to develop an anadromous fish reservoir transit study plan and provide it to licensing participants by July 2016, to advance the necessary planning and permitting to conduct such a study during Phase 2 in spring 2017, should the Phase 1 results indicate that such a study is necessary.

2.0 Study Area

The Reservoir Transit study area will include the mainstem of the upper Tuolumne River from Lumsden (RM 96) downstream to Don Pedro Dam (RM 54.8) including Don Pedro Reservoir.

3.0 Study Goals

The goal of the Reservoir Transit Study is to evaluate the biological feasibility of downstream (juvenile) movement of anadromous fish through Don Pedro Reservoir. Evaluating reservoir passage efficiency is one component of assessing overall fish passage performance, and results

of this study will be used to help inform feasibility of a potential downstream passage facility. There is no existing information regarding migration and migration success rates of juvenile salmonids through Don Pedro Reservoir, as there are no anadromous populations occurring upstream. The purpose of the Reservoir Transit Study is to evaluate juvenile salmonid reservoir passage efficiency through the Don Pedro Project Reservoir by determining estimates of reach specific migration success.

4.0 Study Methods

Permitting and Study Fish Availability

Scientific Collector Permit Amendments will be required for this study to be conducted and applications for the amendments will be submitted during summer 2016. The use of hatchery fish will also be required for this study, and a request will be submitted to California Department of Fish and Wildlife (CDFW) in July 2016 for hatchery origin Chinook salmon to be allocated for this study during spring 2017. This request will be for spring-run Chinook salmon in a size range representing large young-of-the-year smolts and/or yearlings (95-120 mm). While spring-run Chinook salmon are preferred, it is recognized that these fish may not be available for a variety of reasons. Alternatively, fall-run Chinook salmon of a similar size could be used for this study as a surrogate to spring-run Chinook salmon (SJRRP 2011).

Releases of hatchery origin steelhead juveniles were also considered in development of the study design, but are not proposed due to the potential uncertainties that would be introduced related to the fact that the steelhead fish obtained would not actually be smolting, but simply of smolt-size. Therefore, these fish may not have the urge to sustain downstream migration behavior. While fish that moved upstream following release would be excluded from analyses of migration success, there is no guarantee that a juvenile steelhead that initially moves downstream for some distance does not stop migrating to take up temporary or permanent residence in the river or reservoir (Del Real et al. 2011, Plumb et al. 2006). A key assumption of the study design is that study fish will continue to try to migrate downstream through the river and reservoir. Due to potential sample losses due to upstream movement and/or temporary or permanent residency in the river or reservoir, compounded with the possibility of low migration success through many of the study reaches, including steelhead in the study was deemed infeasible.

Acoustic Telemetry

VEMCO acoustic technology (tags and receivers) likely represents the best technology given the study objectives and study site. Autonomous acoustic receivers (model VR2W – 180 kHz) are self-powered for 8 months and record and decode data automatically. Each receiver is capable of storing up to 1.6 million records. Under optimal acoustic conditions (e.g., no boat traffic and calm water), 180 kHz tags can be detected up to 250 m away (about 820 ft). However, it should be noted that in areas (near marinas or boat ramps) or periods (on weekends) with high boat traffic, detection range could be considerably less. Therefore, detection range testing will be performed to evaluate the appropriate spacing and configuration of receivers within arrays.

Tagging Methods

A total of 960 hatchery reared juvenile Chinook salmon will be surgically implanted with VEMCO acoustic transmitters. Chinook salmon, with average size ranging from 95-120 mm, will be implanted with V4-180 kHz tags (0.24 g). All tagging will be performed by experienced personnel following standard implantation procedures (Adams et al. 1998, Martinelli et al. 1998). The tag to body weight ratio will not exceed 5%.

Eight groups of 60 tagged juvenile Chinook salmon will be released at each of two release sites during the study period. Release sites have been identified at Lumsden (RM 96) and Wards Ferry (RM 78.5), as these are the only accessible sites near or upstream of the reservoir. While there is a preference to select a release location that ensures that fish travel through riverine habitat prior to entering the reservoir (e.g., Lumsden), there is also a desire to minimize loss of tagged fish prior to entering the reservoir by making releases near the head of the reservoir (e.g., Wards Ferry).

Following release of study fish, a combination of fixed and mobile receivers will be used to document movement of juvenile Chinook salmon through the Don Pedro Project Reservoir. Fixed receivers will be deployed near proposed locations of potential downstream fish collection facilities (Table 4-1; TID/MID 2016) to document travel time and reach specific migration success. Mobile tracking may be used to document locations of tagged fish between acoustic receiver locations.

Table 4-1. Proposed locations of acoustic receivers.

Site No.	Location	River Mile	Max Depth (ft)[1]	Max Width (ft)[1]
Release	Lumsden	96	--	--
Release	Wards Ferry	78.5	--	--
1	Abv. Wards Ferry	79	30	250
2	Below Wards Ferry	78	80	400
3	Abv. Moccasin Point	73.3	180	650
4	Jacksonville Rd. Bridge	72.5	200	1200
5	Railroad Canyon	70	280	1000
6	East Bay	60	330	1300
7	Abv. DP Dam	55	530	2000

[1] Maximum depth and width assume that Don Pedro Reservoir is at full pool (830'), based on bathymetry data from Don Pedro relicensing.

Array Design

The entire Don Pedro Reservoir acoustic array will consist of single- and double-gated arrays as shown in Figure 4-1. This particular arrangement of acoustic receivers will provide valuable information on the movement, migration success, and movement direction of tagged fish as well as the detection efficiency of specific locations and the entire array. Proposed array locations provide finer scale resolution near the head of reservoir to provide more information on movement patterns and migration success within this area.

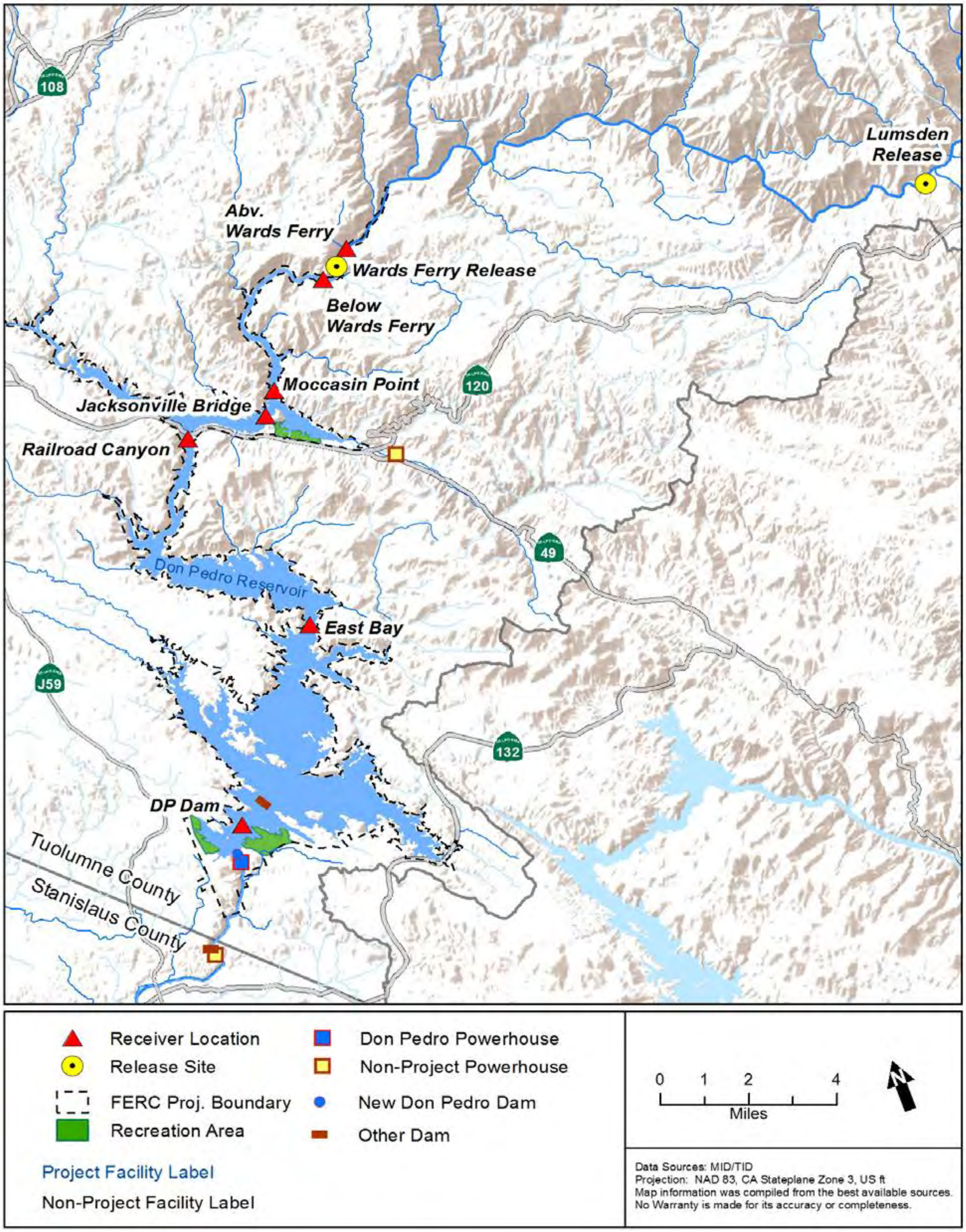

Figure 4-1. Proposed release and acoustic array locations in the upper Tuolumne River and Don Pedro Reservoir.

Based on the approximate dimensions of each monitoring site (shown in Table 4-1), the number of receivers per site will vary from 1 to 8 (Table 4-2). This proposed number at each site is based on the assumption of a detection range of about 330 ft, and allows for some overlap between detection fields of each receiver. Therefore, based on results from detection range testing, the actual number of receivers may differ (e.g., if detection range is reliably > 330 ft, potentially one less receiver could be used per array). An additional consideration for the number of receivers is the water level in Don Pedro Reservoir at the time of the study. If water level in the reservoir is significantly reduced from the assumed full pool (used to estimate dimensions), the number of receivers could be reduced further.

Table 4-2. Proposed number of acoustic receivers and number of arrays at each site (based on assumption of 330 ft detection range).

Site No.	Location	River Mile	No. of Arrays	No. of Receivers
Release	Lumsden	96	-	-
Release	Wards Ferry	78.5	-	-
1	Abv. Wards Ferry	79	1	1
2	Below Wards Ferry	78	2	1
3	Moccasin Point	73.3	2	2
4	Jacksonville Rd. Bridge	72.5	1	3
5	Railroad Canyon	70	2	4
6	East Bay	60	1	6
7	DP Dam	55	2	8

Range Testing

Estimating the range of detection through range testing will be an important first step in determining the spacing and configuration of receivers within acoustic arrays (Kessel et al. 2013). As noted above, detection range can vary by site, and through time within a site. A variety of factors can cause changes in detection range including, weather, boats, conductivity, temperature, depth, or temperature gradients, among others (Kessel et al. 2013). To conduct range testing, up to 8 receivers will be deployed at 100 ft increments away from a test tag(s). A test tag emits an acoustic pulse or signal every 30 seconds. Therefore, if a receiver 100 ft away was detecting at 100%, the number of detections in an hour for that tag should equal 120 (i.e., 2 pulses per minute * 60 = 120). Receivers close to the test tag should typically detect the tag with high detection rates, and then at increasing distance away from the tag, detection rates will decrease. The range test will be conducted for one week prior to the study and ideally represent typical ambient conditions at each site.

After the range test is completed, the number of detections on an hourly or daily basis will be plotted against distance away from the tag. Typically, the rate at which tag detection decreases with increasing distance follows a logistic function (Figure 4-2; from Figure 2 of Kessel et al. 2013). Using Figure 4-3 as an example, in order to achieve 50% detection probability, the receivers should be deployed approximately 1000 m apart (since the detection range represents the radius of a ~500 m circle around the receiver). A similar method will be used to determine the appropriate spacing for the receivers in each array in this study.

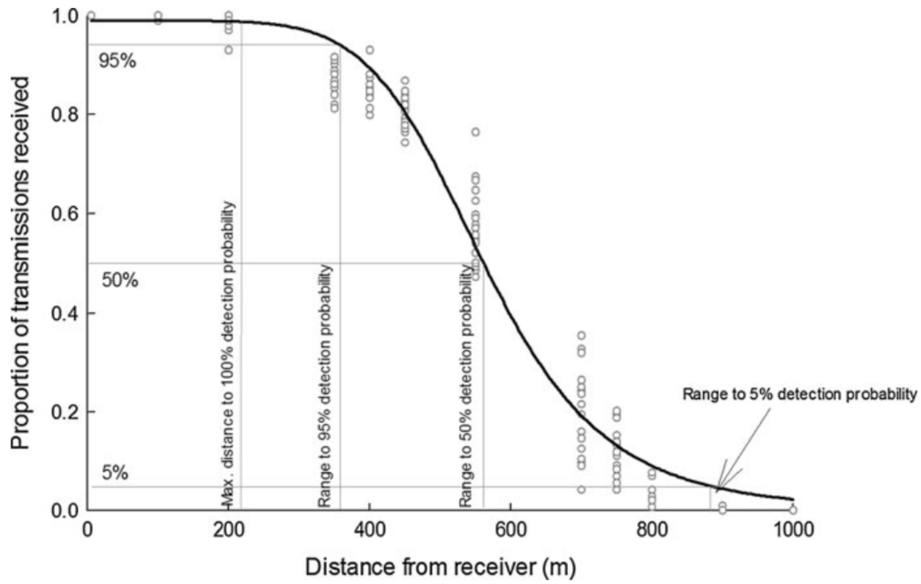

Figure 4-2. Conceptual diagram of collected data from range tests and method to determine appropriate spacing of receivers. From Figure 2 of Kessel et al. 2013.

Deployment Methods / Equipment

For deployments in the reservoir, acoustic receivers will be affixed to a mooring and buoy system, subject to approval by Don Pedro Recreation Agency and consistent with existing rules and regulations. Moorings will be constructed of concrete and weigh approximately 100 lbs each. The cabling will be secured to the underside of the buoy to minimize tampering. Acoustic receivers will be secured to 3/8" stainless steel cable with stainless steel hose clamps and will be deployed approximately 10 ft from the water surface to prevent tampering or loss from the public. Receivers deployed near the surface will be oriented to face downwards to maximize the detection range in the upper portion of the water column. In the deeper portions of the lake (Railroad Canyon, East Bay, and at Don Pedro Dam), two acoustic receivers will be deployed on the same mooring system. These will face upwards and will be deployed so that they are approximately 10 ft from the substrate.

Data Analysis

The proposed study design will determine, for any given study reach, the proportion of fish that migrated successfully to pass into the next downstream reach. The mechanisms via which any fish failed to arrive at the next reach will not be identified by this study but may include the following: some fish may have died, taken up residence, moved up into a tributary, turned around, or had a failed tag. Detection data will be analyzed using a Cormack-Jolly-Seber (CJS) framework and the commonly accepted CJS formulation (see Lebreton et al. 1992). A similar method was used by Skalski (1998), and the specific method was later described as a 'Single Release-Recapture Model' (Giorgi et al. 2010). These models simultaneously allow the estimation of detection probability at each receiver array, and the probability of successful passage between each array. Multiple detection arrays are required in order to tease-apart the effects of passage-success and detection-probability. Since no arrays exist downstream of the

last one, the detection efficiency of the last array cannot be determined, and because of that, the effects of successful passage and successful detection cannot be teased-apart in the last reach.

The Single Release-Recapture Model does not allow for handling effects to be controlled. Thus any latent handling related effects that manifest in a given study reach will contribute to the failure of some fish to reach the next detection point, and hence will be attributed as a loss to the reach itself. While a Paired Release-Recapture Model would avoid this issue (see Giorgi et al. 2010), these models require more tagged fish for releases to be made at the top of each study reach and *a priori* knowledge of reach-specific transit times which are not available. In this study, we propose to release fish at Lumsden, i.e., far enough upstream of the reservoir as to maximize the probability that any handling related effects are fully manifest by the time the tagged fish enter the first reach of interest at Wards Ferry. Since there is no available information to predict how many of these fish will survive to Wards Ferry or migrate successfully through each of the reservoir reaches, releases will also be made at Wards Ferry with the intent of bolstering the sample size of fish reaching the downstream reaches (i.e., the fish released at Wards Ferry will not have fully expressed any potential handling-related mortality to be useful for estimation of passage success through their first study reach, but if subsequent detection probabilities and passage success rates are comparable to those of the Lumsden fish, both release groups may be pooled for increased sample size in the lowest reaches).

Detection arrays will be deployed at Wards Ferry, Moccasin Point, Jacksonville Road Bridge, Railroad Canyon, East Bay, and two arrays in the forebay of Don Pedro Dam (Figure 4-3). The double array in the Don Pedro Forebay will allow estimation of passage-success through the last study reach without dealing with non-estimable parameters. At various other key locations in the Reservoir, we propose that double arrays be deployed. There is no *a priori* knowledge of reach-specific passage success, which could be low enough in some reaches as to make it difficult for the model to separate the effects of passage-success and detection-probability. Thus, while not strictly required for the analysis, especially if passage success is good, double arrays will add value by helping to resolve the models under certain scenarios.

All modeling will be carried out in the R computing environment (R Development Core Team 2015) using the RMark package (Laake 2013) to construct and fit models in Program MARK (White and Burnham 1999). In Figure 4-3, model parameters are mapped onto a conceptualized image of the river and reservoir, where the waterways have been simplified for the sake of the illustration as a linear system. The parameters that will be estimated are listed and defined in Table 4-3.

Table 4-3. List of model parameters, and their definitions.

Parameter	Definition
$\Phi_{L\text{-}W1}$	Probability of successfully passing between Lumsden and the first array at Wards Ferry
p_{W1}	Probability of detection at the first array at Wards Ferry
p_{W2}	Probability of detection at the second array at Wards Ferry
$\Phi_{W2\text{-}M1}$	Probability of successfully passing between the second array at Wards Ferry and the first array at Moccasin Point
p_{M1}	Probability of detection at the first array at Moccasin Point
p_{M2}	Probability of detection at the second array at Moccasin Point
$\Phi_{M2\text{-}J}$	Probability of successfully passing between the second array at Moccasin Point and Jacksonville Rd. Bridge
p_{J}	Probability of detection at Jacksonville Rd. Bridge
$\Phi_{J\text{-}R1}$	Probability of successfully passing between Jacksonville Rd. Bridge and the first array at Railroad Canyon
p_{R1}	Probability of detection at the first array at Railroad Canyon
p_{R2}	Probability of detection at the second array at Railroad Canyon
$\Phi_{R2\text{-}E}$	Probability of successfully passing between the second array at Railroad Canyon and East Bay
p_{E}	Probability of detection at East Bay
$\Phi_{E\text{-}D1}$	Probability of successfully passing between East Bay and the first array in the Don Pedro forebay
p_{D1}	Probability of detection at the first array in the Don Pedro forebay
$\lambda_{D1\text{-}D2}$	Probability of *both* successfully passing between the two arrays in the Don Pedro Forebay ($\Phi_{D1\text{-}D2}$) *and* being detected at the second array (p_{D2}). The two effects cannot be disentangled, thus are represented by a single parameter, $\lambda_{D1\text{-}D2}$

Note that passage success will be assumed to be 100% between paired arrays (where two sets of arrays are deployed together) at Wards Ferry, Moccasin Point and Railroad Canyon.

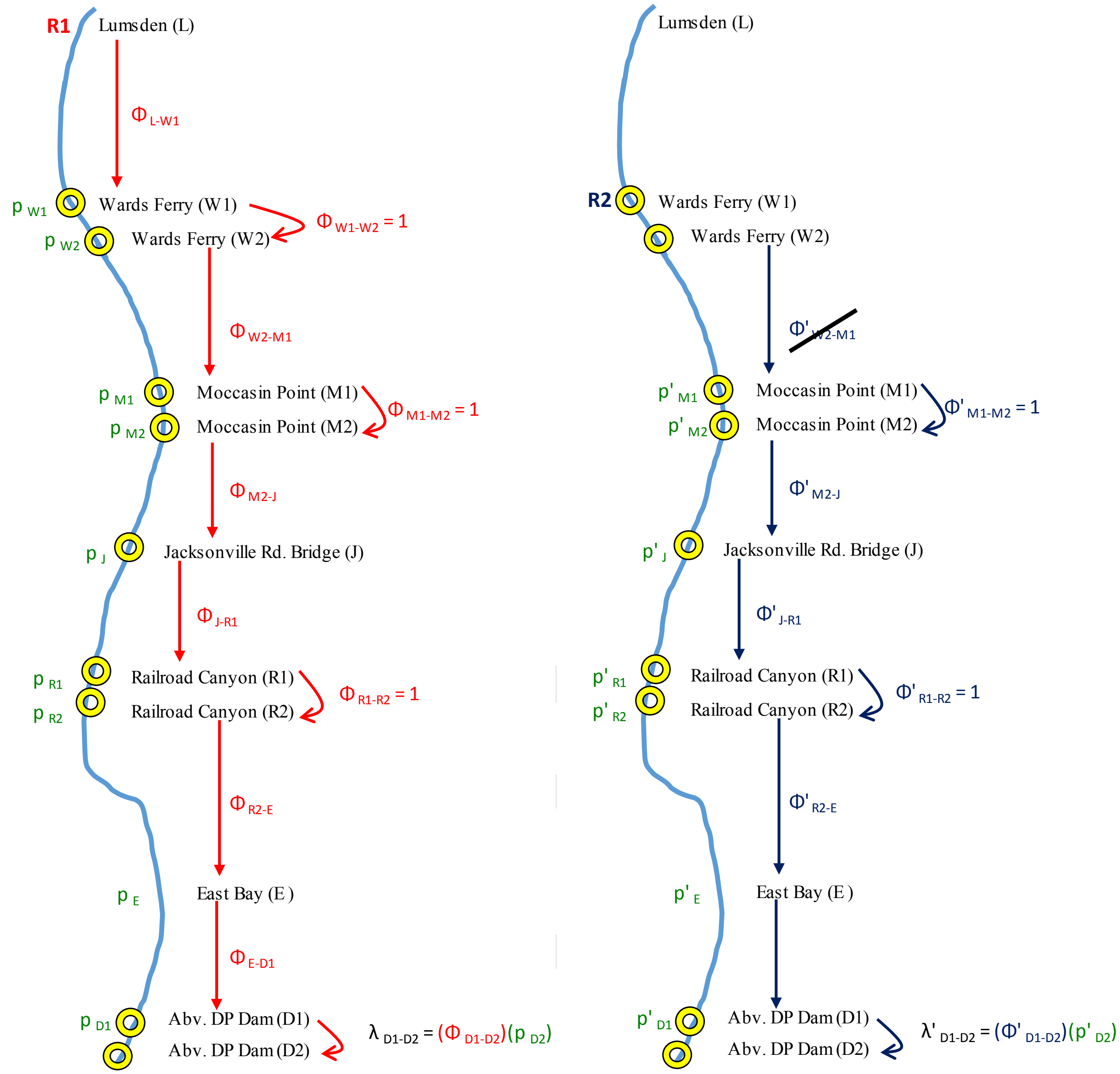

Figure 4-3. Model parameters mapped onto a simplified (conceptual) image of the river and reservoir, shown for the sake of the illustration as a linear system. Yellow circles show detection arrays. Parameters associated with the Lumsden releases (R1) will be estimated separately from their equivalents (marked with an apostrophe) for the Wards Ferry releases (R2), unless data pooling is required or unless model results suggest separation is not parsimonious. Definitions of parameter symbols are shown in Table 4-3.

5.0 Study Schedule

- Study Planning and Permitting ....May 2016 – December 2016
- Draft Study Plan to Licensing Participants ....July 2016
- Provide Interim Study Updates…………………………………….....February – May 2017
- Field Data Collection ....April – June 2017
- Data Entry Processing, and QA/QC .... February –July 2017
- Data Analysis………………………………………………………......April – August 2017
- Report Preparation .... June - August 2017
- Draft Report for 30-day Review ....August 2017
- Final Report Issuance ....October 2017

6.0 References

Adams, N.S., Rondorf, D.W., Evans, S.D., and J.E. Kelly, 1998. Effects of surgically and gastrically implanted radio tags on growth and feeding behavior of juvenile Chinook salmon: Transactions of the American Fisheries Society, v.127, p. 128-136.

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From: Le, Bao
Sent: Friday, July 22, 2016 12:08 PM
To: Vaughn, Gary D -FS; Foote, Debra -FS
Cc: Garello, Michael; Deason, Jesse; Junette, Jim -FS; Holdeman, Steven J -FS
Subject: RE: La Grange Studies Permitting - drones and temperature permitting

Thanks, Gary and Debbie.

All of the requirements below are fine. Once the amendment is issued, we will provide to field leads/staff. With regard to removal of metal, anchors, etc., I believe this is our intent and will ensure that field staff is made aware of it.

With regard to drone use, thank you for keeping this moving along and please let us know if we can assist in any way.

Bao

From: Vaughn, Gary D -FS [mailto:gdvaughn@fs.fed.us]
Sent: Friday, July 22, 2016 11:28 AM
To: Le, Bao; Foote, Debra -FS
Cc: Garello, Michael; Deason, Jesse; Junette, Jim -FS; Holdeman, Steven J -FS
Subject: RE: La Grange Studies Permitting - drones and temperature permitting

Hi Bao,

Debbie is working on incorporating your amendments to the Temperature Monitoring Permit with the following notes:

1. Temperature Monitoring Permit (GRO1122)
    a. "Monitoring temperatures at several pools to better understand temperature stratification in these pools. The work would not require rafting and would last about a week at the end of August. Field staff will be camping and all monitoring equipment is temporary and would be removed after data collection is complete."
        i. Please incorporate the following regulations with are in effect for the Tuolumne Wild & Scenic River for camping in the canyon:
            1. Litter of any kind may not be discarded in rivers, along the shore, or in adjacent canyons. Burn or carry out all burnables. Carry out all unburnable material including cans, bottles, left-over food, egg shells, melon rinds, and cigarette butts. Liquid garbage must be strained through a fine mesh screen capable of holding small food particles, and the particles then placed in garbage containers or bags to be carried out of the canyon. Sump holes are to be dug away from camp and above the high-water line.
            2. All trips must carry portable toilet systems ("wag bags"). All portable toilet waste must be carried out and deposited in an authorized sewage disposal facility.
            3. Build campfires only on sand bars and at least 10 feet away from vegetation or combustible material. Use charcoal or driftwood from along the riverbank below high-water line. Wood and charcoal fires are allowed in fire pans only. No fires in rock rings on the ground. Keep a pail of water near the fire and be sure fire is completely extinguished before leaving the site. All ash and charcoal must be carried out of the canyon. Do not cut or burn live trees or standing dead trees.
                a. Fire restrictions are currently in effect (see attachments). The fire restriction prohibits wood campfires, briquette barbecues, and smoking outside developed campgrounds in designated High Hazard Areas of the Forest. You crew will need to rely on portable gas stoves for heating anything.

4. Wash dishes away from river. Do not bathe or wash in the river or any tributary streams.
5. Do not remove, damage, or destroy any archeological, historical, or ecological resources.

b. "An additional detail that has recently come up is an interest in keeping temperature/stage monitoring equipment at the Clavey River confluence through the summer of 2017 (currently this permit expires at the end of 2016). The reason for this is because our barrier permit amendment which allowed us to install a trail camera at the identified total barrier (RM 2.0) would benefit greatly from this data at the confluence (i.e., being able to tie stage/flows to pictures taken at the barrier). Is it possible that the amendment could extend the permit for this location to September 2017?"

i. Yes, the permit can be extended/reissued for another year.

ii. We want to further describe actions needed to be completed at the end of your monitoring efforts:

1. Remove all trace of activities as soon as possible once data collection is over: remove the metal and conceal to the maximum extent possible the holes for the anchor bolts. Drill the metal out as completely as possible and fill the holes with an epoxy resin that closely matches the color of the rock.

I recommend taking the same removal actions for the North Fork on BLM, but you will need to coordinate with BLM first (see attached photos of what is currently in the water where users are wading and swiming).

2. Amendment to Barrier Study – to use of a drone to conduct topographic surveying of Lumsden Falls: I sent another follow-up e-mail to our Regional Fire and Aviation Manager who must review all requests for UAVs on USFS land at this time. I'll let you know of any responses and direction we receive as soon as possible. Sorry for the delay – we have additional similar requests from other groups waiting on a response as well.

Let me know if you have any questions.

Thanks,

Dusty Vaughn
Public Service Program Leader
Forest Service
Stanislaus National Forest, Groveland Ranger District
p: 209-962-7825 x525
f: 209-962-7412
gdvaughn@fs.fed.us
24545 State Highway 120
Groveland, CA 95321
www.fs.fed.us

Caring for the land and serving people

From: Le, Bao [mailto:ChiBao.Le@hdrinc.com]
Sent: Friday, July 22, 2016 9:34 AM
To: Vaughn, Gary D -FS <gdvaughn@fs.fed.us>; Foote, Debra -FS <dfoote@fs.fed.us>
Cc: Garello, Michael <Mike.Garello@hdrinc.com>; Deason, Jesse <Jesse.Deason@hdrinc.com>
Subject: La Grange Studies Permitting - drones and temperature permitting

Hi Debbie and Dusty.

Our 2016 field season has begun and we've been successful in collecting data thus far. We appreciate your support for the implementation of these studies. I wanted to follow up on two items that I'm currently tracking as it relates to permitting:

1. Amendment for Temperature Monitoring Permit (GRO1122) – this is a permit for the monitoring of temperature/stage at 10 locations in the Tuolumne River. We've submitted an application for amendment of this permit for the following:
    a. Monitoring temperatures at several pools to better understand temperature stratification in these pools. The work would not require rafting and would last about a week at the end of August. Field staff will be camping and all monitoring equipment is temporary and would be removed after data collection is complete.
    b. An additional detail that has recently come up is an interest in keeping temperature/stage monitoring equipment at the Clavey River confluence through the summer of 2017 (currently this permit expires at the end of 2016). The reason for this is because our barrier permit amendment which allowed us to install a trail camera at the identified total barrier (RM 2.0) would benefit greatly from this data at the confluence (i.e., being able to tie stage/flows to pictures taken at the barrier). Is it possible that the amendment could extend the permit for this location to September 2017?

2. Amendment to Barrier Study – to use of a drone to conduct topographic surveying of Lumsden Falls – we understand that this is a unique request in the W&S area and that it is currently in discussion at higher levels of the agency. As discussed, half of a day of drone use may be much more efficient than a survey crew working at the falls for a week. If there are any questions or any way we can help facilitate this process, please let us know as we can provide information from our identified contractor as needed. This work is planned for the fall.

Please let me know if you have questions.

Thanks!
Bao

Bao Le
Senior Fisheries Biologist

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USDA United States Department of Agriculture | Forest Service | Stanislaus National Forest | 19777 Greenley Road
Sonora, CA 95370
(209) 532-3671
FAX: (209) 533-1890
TTY/TDD: (209) 533-0765
http://www.fs.usda.gov/stanislaus

File Code: 1950 **Date:** June 30 , 2016
Route To:

Subject: Temporary Fire Restrictions in the High Fire Hazard Area

To: Project File

From: Jeanne M. Higgins, Forest Supervisor

The High Fire Hazard Area of the Stanislaus National Forest is located in Calaveras, Mariposa and Tuolumne Counties, California. The Forest's Fire Management Reference System (Appendix A, Wildland Fire Management Program Implementation) and Forest Service Manual (FSM) 5110.4 provide authority and guidance on implementing actions that reduce the risk of certain ignition sources during periods of high fire risk.

Criteria for activating prohibitions in the High Fire Hazard Area through a forest order is based on National Fire Danger Rating System indices and fuel moisture conditions. Indices that can trigger restrictions are: Burning Index is 60 or greater for three consecutive days with a predicted stable or upward trend; dead fuel moistures for thousand-hour time lag fuels are less than 14%; and Energy Release Component greater than 70.

The Forest currently meets the criteria for activating the High Fire Hazard fire restrictions using the Mt. Elizabeth weather station as a representative site. Combination of the data above threshold levels for multiple days along with upward trending data indicate a need for restricting potential fire causing activities of persons in the High Fire Hazard Area.

These restrictions are believed to be the most immediate and effective method to reduce the potential for loss of life and property, and to protect the physical, biological, and cultural resources of the forest from fire. In response to the situation described, the Forest Service will issue a temporary Forest Order prohibiting the following activities in the High Fire Hazard Area:

1. Building, maintaining, attending or using a fire, campfire, or stove fire, except in the Developed Recreation Sites listed in Exhibit C. 36 CFR 261.52(a).

2. Smoking, except within an enclosed vehicle or building, within a Developed Recreation Site listed in Exhibit C, or while stopped in an area at least three feet in diameter that is barren or cleared of all flammable material. 36 CFR 261.52(d).

3. Welding, or operating an acetylene or other torch with an open flame. 36 CFR 261.52(i).

These actions are determined to be admistrative in nature. Minimal ground disturbance will occur, and no other additional impact on any natural resources will occur with the implementation of this proposed action. The public notification of these restrictions occurred via a press announcement published by the local newspapers and postings in public places of the

National Forest's facilties.The Forest Service will install signs along roads entering the High Fire Hazard Area to alert the public to these fire restrictions.

I have concluded that this decision may be categorically excluded from documentation in an Environmental Impact Statement (EIS) or Environmental Assessment (EA) under the National Environmental Policy Act. This action falls within the category identified in 36 CFR 220.6(d)(1) – prohibitions to provide short-term resource protection or to protect public health and safety – and does not require documentation in a decision memo, decision notice, or record of decision. I have determined that there are no extraordinary circumstances associated with this temporary closure. Implementation of the decision may begin immediately.

For further information regarding this decision, contact: Robert Laeng, Fire Management Officer, Stanislaus National Forest, 19777 Greenley Road, Sonora, CA. (209) 532-3671.

cc: Heidi Rieck, Robert Laeng

Forest Order No. 16-2016-03
Temporary Fire Restrictions
High Fire Hazard Area
Stanislaus National Forest

Pursuant to 16 USC 551 and 36 CFR 261.50(a) and (b), and to provide for public safety and protect natural resources, the following acts are prohibited within the High Fire Hazard Area of the Stanislaus National Forest, as shown on Exhibit A and described in Exhibit B. This Order is effective from July 1, 2016 through the end of the official 2016 fire season.

1. Building, maintaining, attending or using a fire, campfire, or stove fire, except in the Developed Recreation Sites listed in Exhibit C. 36 CFR 261.52(a).

2. Smoking, except within an enclosed vehicle or building, within a Developed Recreation Site listed in Exhibit C, or while stopped in an area at least three feet in diameter that is barren or cleared of all flammable material. 36 CFR 261.52(d).

3. Welding, or operating an acetylene or other torch with an open flame. 36 CFR 261.52(i).

Pursuant to 36 CFR 261.50(e), the following persons are exempt from this Order:

1. Persons with a permit from the Forest Service specifically authorizing the otherwise prohibited act or omission.

2. Persons with a valid California Campfire Permit are not exempt from the prohibitions listed above. However, persons with a valid California Campfire Permit may use a portable stove or lantern using gas, jellied petroleum, or pressurized liquid fuel on National Forest System lands within the High Hazard Area.

3. Any Federal, State, or local officer, or member of an organized rescue or fire fighting force in the performance of an official duty.

4. Persons with a Special Use Permit from the Forest Service for a recreation residence on National Forest System lands within the High Hazard Area are not exempt from the prohibitions listed above. However, persons with a Special Use Permit from the Forest Service for a recreation residence on National Forest System lands within the High Hazard Area may use a campfire or stove fire at their recreation residence.

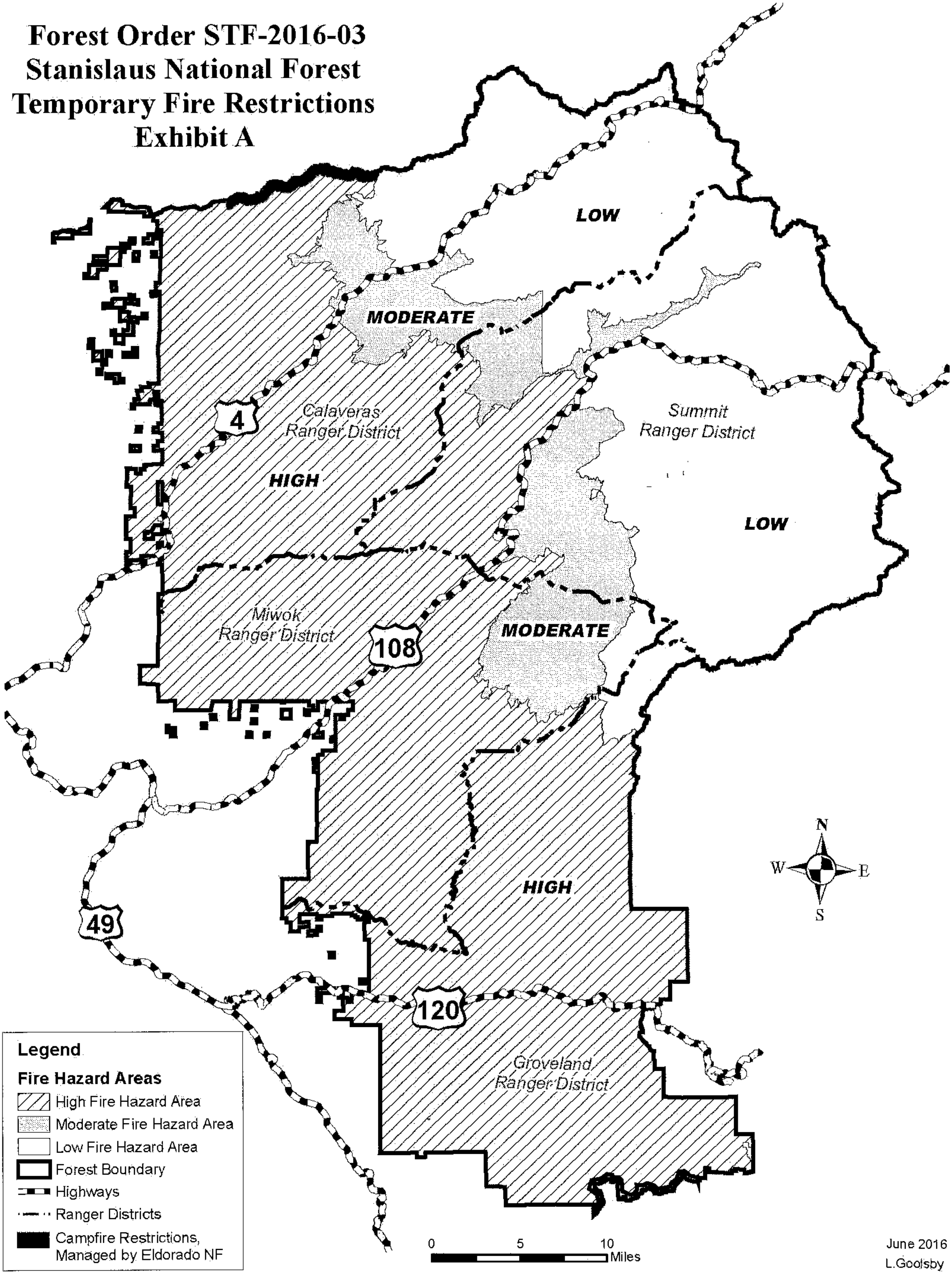
These prohibitions are in addition to the general prohibitions in 36 CFR Part 261, Subpart A.

A violation of these prohibitions is punishable by a fine of not more than $5,000.00 for an individual or $10,000.00 for an organization, or imprisonment for not more than six months, or both.
16 USC 551 and 18 USC 3559, 3571 and 3581.

Done at Sonora California, this 30th day of June, 2016.

JEANNE M. HIGGINS
Forest Supervisor
Stanislaus National Forest

Forest Order STF-2016-03
Stanislaus National Forest
Temporary Fire Restrictions
Exhibit A



Forest Order No. 2016-03
Temporary Fire Restrictions
High Fire Hazard Area
Stanislaus National Forest
Exhibit B

The Stanislaus National Forest High Fire Hazard Area boundary begins at a point on the west boundary of the Mokelumne Wilderness 0.5 miles south of the east end of Salt Spring Reservoir, then continues due south across the SW ¼ of Section 6 and the NW ¼ of Section 7, T7N R17E, to its intersection with Forest Road No. 7N16, then continues 2 miles west along Forest Road No. 7N16 to its intersection with Forest Road No. 7N09, then it continues 11 miles west along Forest Road No. 7N09 to its intersection with Forest Road No. 7N23, then continues 6 miles south along Forest Road No. 7N23 to its intersection with Highway 4, then continues due southeast to Forest Road No. 6N17, then continues 3 miles south along Forest Road No. 6N17 to its intersection with Forest Road No. 5N14, then continues 19 miles east along Forest Road No. 5N14 to its intersection with Forest Road No. 6N05, then continues 2 miles north along Forest Road No. 6N05 to Basin Creek, then continues 1 mile east along Basin Creek to the confluence with the Middle Fork Stanislaus River, then continues 4 miles northeast along the Middle Fork Stanislaus River to Donnell Lake, then continues 1.5 miles east along the south shore of Donnell Lake to Niagara Creek, then continues 1.5 miles south and east along Niagara Creek to its intersection with Highway 108, then continues 15 miles south along Highway 108 to Forest Road No. 4N26 (Crabtree Road), then continues 7 miles east along Forest Road No. 4N26 (Crabtree Road) to its intersection with Forest Road No. 4N33, then continues 8 miles southwest along Forest Road No. 4N33 to its intersection with Forest Road No. 3N01, then continues 15 miles east and then south along Forest Road No. 3N01 to its intersection with Reynolds Creek, then continues 0.6 mile due east to the Emigrant Wilderness boundary, then continues 6 miles south and east along the Emigrant Wilderness boundary to the Stanislaus National Forest boundary, then continues along the boundary of the Yosemite National Park and the Stanislaus National Forest to the boundary of the Sierra National Forest and the Stanislaus National Forest, then continues west, north and east along the boundary of the Stanislaus National Forest to the SE1/4 of Section 12, T7N R15E, then continues due south 0.5 mile, then continues east and northeast paralleling the Stanislaus National Forest northern boundary and the southern edge of Salt Springs Reservoir at a distance of 0.5 mile back to the starting point, as shown on the attached map.

Forest Order No. 2016-03
Temporary Fire Restrictions
High Fire Hazard Area
Stanislaus National Forest
Exhibit C

Developed Recreation Sites

MIWOK RANGER DISTRICT

1. Fraser Flat Campground
2. Hull Creek Campground
3. River Ranch Campground
4. Riverside Picnic Area
5. Sand Bar Flat Campground

CALAVERAS RANGER DISTRICT

1. Boards Crossing Campground
2. Waka Luu Hep Yoo Campground
3. Sourgrass Day Use Area

SUMMIT RANGER DISTRICT

1. Cascade Campground
2. Beardsley Lake Day-Use Area
3. North Beardsley Campground

GROVELAND RANGER DISTRICT

1. Lower Carlon Day-Use Area
2. Diamond O Campground
3. Lost Claim Campground
4. Lumsden Campground
5. Lumsden Bridge Campground
6. Rainbow Pool Day Use Area
7. Sweetwater Campground
8. The Pines Campground
9. Peach Growers Tract

U.S. Forest Service
Stanislaus National Forest
19777 Greenley Road
Sonora, CA 95370
Voice: 209-532-3671
Web: http://www.fs.usda.gov/stanislaus/

News Release

Media Contact: Rebecca Garcia
209-532-3671 Ext. 244
rebeccagarcia@fs.fed.us

U.S. Forest Service enacts temporary fire restrictions in High Hazard Areas

Sonora, Calif. June 30, 2016**…**Due to high fire danger, temporary fire restrictions are in effect in High Hazard Areas on the Stanislaus National Forest (STF) July 1 through the end of the official 2016 fire season.

Forest Order 16-2016-3 prohibits campfires, briquette barbecues and smoking outside developed campgrounds, as well as welding and blasting activities in designated High Hazard Areas of the forest – **fireworks are not allowed on the forest at any time.**

In some specific cases, individuals may be exempt from these fire restrictions. For further information, please review the forest order and high hazard area map. This Forest Order serves as an extra measure to help reduce the potential for large and damaging wildfires.

Stanislaus National Forest leadership and fire personnel thank the public for doing their part to help prevent destructive wildfires. Please know the restrictions in High Hazard Areas will be actively patrolled by STF, Law Enforcement Officers and Fire Prevention Specialists. Persons found in violation of these fire restrictions may be cited and fined.

Criteria for activating prohibitions in the High Fire Hazard Area through a forest order is based on National Fire Danger Rating System indices and fuel moisture conditions. The Forest currently meets the criteria for activating the High Fire Hazard fire restrictions using the Mt. Elizabeth weather station as a representative site. These restrictions are believed to be the most immediate and effective method to reduce the potential for loss of life and property, and to protect the physical, biological, and cultural resources of the forest from fire.

For further Forest information, call: the Stanislaus NF Supervisor's Office at: 209-532-3671; Calaveras Ranger District (RD) at 209-795-1381; Groveland RD 209-962-7825; Mi-Wok RD at 209-586-3234 or Summit RD at 209-965-3434.

###

"Like" us on Facebook: The Forest Service-Stanislaus National Forest

From: Le, Bao
Sent: Monday, July 25, 2016 10:36 AM
To: Vaughn, Gary D -FS; Foote, Debra -FS
Cc: Garello, Michael; Deason, Jesse; Junette, Jim -FS; Holdeman, Steven J -FS
Subject: RE: La Grange Studies Permitting - drones and temperature permitting

Hi Dusty.

Just to follow up on the email below, I spoke with field staff that downloaded the temperature/stage recorders a couple of weeks ago and they repaired/replaced angle iron where needed. When possible, they reset new angle iron flush with the tops of rocks so that they are less of a safety issue.

Please let me know if you have any questions.

Thanks, Bao

From: Le, Bao
Sent: Friday, July 22, 2016 12:08 PM
To: 'Vaughn, Gary D -FS'; Foote, Debra -FS
Cc: Garello, Michael; Deason, Jesse; Junette, Jim -FS; Holdeman, Steven J -FS
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Bao

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Let me know if you have any questions.

Thanks,

Dusty Vaughn
Public Service Program Leader
Forest Service
Stanislaus National Forest, Groveland Ranger District
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f: 209-962-7412
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Caring for the land and serving people

From: Le, Bao [mailto:ChiBao.Le@hdrinc.com]
Sent: Friday, July 22, 2016 9:34 AM
To: Vaughn, Gary D -FS <gdvaughn@fs.fed.us>; Foote, Debra -FS <dfoote@fs.fed.us>
Cc: Garello, Michael <Mike.Garello@hdrinc.com>; Deason, Jesse <Jesse.Deason@hdrinc.com>
Subject: La Grange Studies Permitting - drones and temperature permitting

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Please let me know if you have questions.

Thanks!
Bao

Bao Le
Senior Fisheries Biologist

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bao.le@hdrinc.com

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From: Staples, Rose
Sent: Tuesday, July 26, 2016 12:31 PM
Cc: Deason, Jesse; Le, Bao; Staples, Rose
Subject: La Grange Upper Tuolumne River FINAL Study Plans Available on Licensing Website

La Grange Licensing Participants,

Final study plans for the following studies are now available on the La Grange Project licensing website (www.lagrange-licensing.com under the DOCUMENTS tab):

1. Upper Tuolumne River Habitat Mapping and Macroinvertebrate Assessment
2. Upper Tuolumne River Chinook Salmon and Steelhead Spawning Gravel Mapping Study
3. Upper Tuolumne River Instream Flow Study
4. Regulatory Context for Reintroduction
5. Hatchery and Stocking Practices Review
6. Socioeconomic Scoping Study

The study plans are available HERE.

Rose Staples, CAP-OM, MOS
Executive Assistant

HDR
970 Baxter Boulevard Suite 301
Portland ME 04103
D 207-239-3857
rose.staples@hdrinc.com

hdrinc.com/follow-us

From: Staples, Rose
Sent: Tuesday, July 26, 2016 12:55 PM
Cc: Deason, Jesse; Le, Bao; Staples, Rose
Subject: La Grange May 19 2016 Workshop No 5 FINAL NOTES Available on Licensing Website

La Grange Licensing Participants,

The FINAL notes from the May 19, 2016 Fish Passage Facilities Alternatives Assessment and Upper Tuolumne River Fish Reintroduction Assessment Framework Workshop No. 5 have been uploaded to the licensing website www.lagrange-licensing.com under the DOCUMENTS section and also as an attachment to the May 19 date on the website calendar.

On June 21, 2016 the Districts provided Workshop No. 5 draft meeting notes to licensing participants and requested that any comments on the meeting notes be provided by July 21. No comments were received; therefore, these FINAL notes are the same as the draft notes originally provided on June 21.

Rose Staples, CAP-OM, MOS
Executive Assistant

HDR
970 Baxter Boulevard Suite 301
Portland ME 04103
D 207-239-3857
rose.staples@hdrinc.com

hdrinc.com/follow-us

From: Le, Bao
Sent: Tuesday, July 26, 2016 5:08 PM
To: John Wooster - NOAA Federal
Cc: Deason, Jesse
Subject: RE: FW: Request for hatchery fish- Don Pedro Reservoir Transit Study

Thanks, John.

This is really good information. Let me circle back with the Districts and see what it is they would like to do. My feeling is that using spring run would be preferred but acknowledge that the challenges of acquiring them needs to be carefully considered. I'll get back to you as soon as I can.

Bao

From: John Wooster - NOAA Federal [mailto:john.wooster@noaa.gov]
Sent: Tuesday, July 26, 2016 12:38 PM
To: Le, Bao
Cc: Deason, Jesse
Subject: Re: FW: Request for hatchery fish- Don Pedro Reservoir Transit Study

Hi Bao:

I had multiple discussions with folks in the office yesterday, and the general opinion of folks was that choosing fall-run is probably the better path forward, particularly if the spring-run option is feathery river hatchery fish - the spring-run returns have been so low there are questions whether the hatchery will meet broodstock goals let alone produce surplus fish (and there are other demands already in place on any surplus fish). However, there was some optimism that the San Joaquin Restoration Program might have or be able to produce extra spring-run - I have no idea how realistic that is and have some email inquires out, to try and find out.

Yes, if spring-run are involved this will trigger a federal permit because of the listing, there won't be anyway around that. From my experience, and from feedback from Amanda, going the 4(d) authorization is the better path, it is a joint state/federal process where both review concurrently - Amanda is the lead for NMFS on Central Valley permit applications. I updated Amanda yesterday, she has the draft study plan, and is more or less ready to be involved as needed.

Let me see if I can get some clarification on the SJRRP and then maybe we can chat in the next few days.

-John

On Fri, Jul 22, 2016 at 12:16 PM, Le, Bao <ChiBao.Le@hdrinc.com> wrote:

Hi John.

Just checking in on the below. Hope you had a nice vacation.

Welcome back.

Bao

From: John Wooster - NOAA Federal [mailto:john.wooster@noaa.gov]
Sent: Monday, July 18, 2016 9:33 AM
To: Le, Bao
Subject: Re: FW: Request for hatchery fish- Don Pedro Reservoir Transit Study

Bao:

I am on vacation this week through Thursday, but will see what I can get done. I have briefed Amanda on this study and she is going to help us in whatever capacity possible, but let me wade through all the traffic first....

John

On Mon, Jul 18, 2016 at 9:19 AM, Le, Bao <ChiBao.Le@hdrinc.com> wrote:

Hi John.

Please see below regarding the CDFW request for fish to support the Reservoir Transit Study. CDFW has noted that using spring Chinook, which are only available from the Feather River Hatchery, would require a Federal permit. Further input notes that a 4(d) authorization would be preferable given it would meet both state and Federal needs. Questions/thoughts for you here:

1. Given NMFS has requested and FERC has granted this study, can NMFS assist in facilitating, expediting or even bypassing this requirement?

2. If a process is needed, a key component seems to be the timing of an approval/permit since securing spring Chinook juveniles for study will need to be planned for in advance of next year. I imagine CDFW will want to know this is authorized by this fall when adults are available at the facility? Perhaps FISHBIO (cc'd here) can provide some input here? But it would seem that this would require that any process be complete or near complete in the next few months to give CDFW the assurance they need?

3. It would still be valuable to have Amanda formally communicate NMFS' support for this study to CDFW. Perhaps after we've identified a path forward, we could identify key points in that communication.

Let me know if you have time to discuss this week. I'm taking some PTO this week (Tuesday-Thursday) but will be working here and there and could jump on the phone as needed.

Thanks, Bao

From: Alber, Leslie@Wildlife [mailto:Leslie.Alber@wildlife.ca.gov]
Sent: Friday, July 15, 2016 10:27 AM
To: Clifford, Mark@Wildlife; guignard, jason@fishbio.com
Cc: Le, Bao; Purdy, Colin@Wildlife
Subject: RE: Request for hatchery fish- Don Pedro Reservoir Transit Study

Hi Jason,

You will need to get a CESA MOU and either a 10(a)(1)(A) or 4(d) authorization. Because the work in the 4(d) program is thoroughly reviewed by both NOAA and the Department, you will receive a CESA MOU through the process if you are in the program. ESA section 10(a)(1)(A)s are not reviewed by the Department so if you get one you will also need to contact Colin Purdy (Colin.Purdy@wildlife.ca.gov, 916-358-2943) for a CESA MOU. Please feel free to contact me if you have any questions.

Thanks,

Leslie

From: Clifford, Mark@Wildlife
Sent: Friday, July 15, 2016 9:07 AM
To: guignard, jason@fishbio.com
Cc: Bao Le
Subject: RE: Request for hatchery fish- Don Pedro Reservoir Transit Study

Hi Jason,

I was about to forward your request for a pre-Aug 1 review but first gave it a quick read myself….Feather River Hatchery spring run Chinook salmon are CESA and ESA listed, so you would need to get a CESA MOU and appropriate Federal Permit …. Maybe ESA section 10(a)(1)(A) or 4(d), I don't know since I am not a fed permitting expert.

PS: Scientific Collecting Permits do not apply to listed species, so I don't think your SCP applies to this project.

Anyway…..without these authorizations, these fish cannot be made available and you will have to consider an appropriate surrogate.

Mark Clifford, Ph.D.

Statewide Hatchery Coordinator

Senior Environmental Scientist (Specialist)

California Dept Fish and Wildlife

#3 North Old Stage Road

Mt. Shasta, CA 96067

Office: 530-918-9450

SaveOurWater.com · Drought.CA.gov

From: Jason Guignard [mailto:jasonguignard@fishbio.com]
Sent: Monday, July 11, 2016 2:37 PM
To: Clifford, Mark@Wildlife
Cc: Bao Le
Subject: Request for hatchery fish- Don Pedro Reservoir Transit Study

Hi Mark,

Attached below is the anadromous hatchery fish request for the Upper Tuolumne River which we had discussed a few weeks ago.

I appreciate your willingness to distribute this to necessary regional staff ahead of the August 1 request deadline.

Please let me know if any questions come up during review of this request.

Thank You,

Jason

Jason Guignard

Fisheries Biologist

FISHBIO

jasonguignard@fishbio.com

O: (209) 847-6300

C: (209) 840-9019

www.fishbio.com

--

John Wooster
Hydrologist
NOAA Fisheries West Coast Region
U.S. Department of Commerce
john.wooster@noaa.gov

NOAA FISHERIES
West Coast Region

From: "Clifford, Mark@Wildlife" <Mark.Clifford@wildlife.ca.gov>
Subject: RE: Request for hatchery fish- Don Pedro Reservoir Transit Study
Date: July 27, 2016 at 9:32:25 AM PDT
To: "guignard, jason@fishbio.com" <jasonguignard@fishbio.com>

Received. I looked it over quickly and fall run Chinook from Merced or Mokelumne might prove to be a good surrogate and option if the federal permitting for spring run does not happen in time, or if spring run are not available. We will respond as soon as we have consensus after the August 1 deadline.

Best regards,

Mark Clifford, Ph.D.
Statewide Hatchery Coordinator
Senior Environmental Scientist (Specialist)
California Dept Fish and Wildlife
#3 North Old Stage Road
Mt. Shasta, CA 96067
Office: 530-918-9450

From: Jason Guignard [mailto:jasonguignard@fishbio.com]
Sent: Wednesday, July 27, 2016 8:18 AM
To: Clifford, Mark@Wildlife
Cc: Bao Le; Andrea Fuller
Subject: Re: Request for hatchery fish- Don Pedro Reservoir Transit Study

Hi Mark,

Here is a revised hatchery allocation request for Don Pedro Reservoir Transit Study.
We are working on federal permitting for spring-run, but as a contingent would like to request 1,500 fall-run should permits not be issued in time.

I will be working in the field for the remainder of this week with no email access, so any further questions prior to the Aug. 1 deadline should go to Andrea Fuller (included on this message).

Thank You,

Jason Guignard
Fisheries Biologist

FISHBIO
jasonguignard@fishbio.com
O: (209) 847-6300
C: (209) 840-9019
www.fishbio.com

FISHBIO

1617 S. Yosemite Avenue • Oakdale, CA 95361 • Phone: (209) 847-6300 • Fax: (209) 847-1925

July 27, 2016

Dr. Mark Clifford
Hatchery Coordinator
California Dept. of Fish and Game
#3 North Old Stage Road
Mount Shasta, CA 96067

Dear Dr. Clifford:

FISHBIO is submitting a formal request for 1,500 Chinook salmon to be used on the upper Tuolumne River for licensing studies being conducted for the La Grange Hydroelectric Project (FERC No. 14581). The goal of this particular study is to evaluate the biological feasibility of downstream (juvenile) movement of anadromous fish through Don Pedro Reservoir. Evaluating reservoir passage efficiency is one component of assessing overall fish passage performance, and results of this study will be used to help inform feasibility of a potential downstream passage facility. There is no existing information regarding migration and migration success rates of juvenile salmonids through Don Pedro Reservoir, as there are no anadromous populations occurring upstream. The purpose of the Reservoir Transit Study is to evaluate juvenile salmonid reservoir passage efficiency through the Don Pedro Project Reservoir by determining estimates of reach specific migration success. The attached draft study plan is currently under review by relicensing participants.

The proposed study plan requires releases of acoustic tagged juvenile Chinook salmon tagged in the upper Tuolumne River during spring 2017 to estimate migration success through reaches of the reservoir. The proposed release locations for these fish are at Lumsden (RM 96) and Wards Ferry (RM 78.5). Target size for tagging is approximately 105-125 mm, which is expected to correspond to individuals weighing at least 12 g to maintain a tag weight to body weight ratio of less than 5%. This is approximately 38 fish/lb and study fish would need to be available starting April 1, 2017. As the study plan is currently in draft form pending review by licensing participants, the total number of fish released may be adjusted.

We are currently requesting 1,500 spring-run juvenile Chinook salmon from Feather River Hatchery to provide some flexibility to adjust the sample size if needed. Recognizing that spring-run are CESA and ESA listed, we are currently exploring options for obtaining a CESA MOU and ESA section 10(a)(1)(a) or 4(d) permit. Should these permits not be issued in time, we request contingent allocation of fall-run Chinook salmon that would be of the target size during the study period. Contingent allocation of fall-run from Merced River Hatchery or Mokelumne River Hatchery is preferred, but we would also consider other hatcheries based on expected production in spring 2017.

We appreciate your willingness to consider this request prior to the August 1 deadline. Due to time constraints associated with obtaining acoustic tags for this study we request that a decision regarding allocation of these fish be made prior to January 1, 2017. Field data collection is scheduled to occur during April-June 2017, with a final study report issued to FERC in October 2017.

My Scientific Collecting Permit number is SC-9966. If you have any questions, or if any additional information is needed to process this request please contact me using the information below.

Sincerely,

Jason Guignard
Fisheries Biologist

FISHBIO
jasonguignard@fishbio.com
O: 209.847.6300
C: 209.840.9019
www.fishbio.com

From: Le, Bao
Sent: Thursday, July 28, 2016 10:14 PM
To: Foote, Debra -FS
Cc: Deason, Jesse
Subject: RE: GRO1122 amendment

Thanks, Debbie.

This is great. I'll get it signed and sent back to you.

One question: we also would like to extend our temp monitoring permit through next summer (2017) so that we can leave the stage/temp recorder at the Clavey River confluence to collect data as the trail camera takes photos at the total barrier at RM 2.0. Per my discussions with Dusty, he said this would be fine. I assumed it would be a part of this amendment (since this is a temp amendment) but maybe I should be expecting it in a forthcoming amendment? Please advise.

Bao

From: Foote, Debra -FS [mailto:dfoote@fs.fed.us]
Sent: Thursday, July 28, 2016 12:15 PM
To: Le, Bao
Subject: GRO1122 amendment

Bao,
Please see attached for the amendment for the GRO1122 permit. Please have the permit signed and return to me for the final authorized signature.

Debbie Foote
Resource Assistant

Forest Service
Groveland Ranger District

p: 209-962-7825 x533
f: 209-962-7412
dfoote@fs.fed.us

24545 Hwy. 120
Groveland, CA 95321
www.fs.fed.us

Caring for the land and serving people

Auth ID: GRO1122
Contact ID: 611267010602
Use Code: 422

FS-2700-23 (v. 10/09)
OMB No. 0596-0082

U.S. DEPARTMENT OF AGRICULTURE
FOREST SERVICE
AMENDMENT
FOR SPECIAL-USE AUTHORIZATION

Amendment#: 2

This amendment is attached to and made a part of the special use authorization identified above for research issued to TURLOCK IRRIGATION DISTRICT on 04/22/2015 which is hereby amended as follows:

Additional temporary installation, maintenance, and monitoring of handheld and deployed temperature probes and/or loggers at the following locations of the Tuolumne River mainstem, Lumsden and Meral's Pools, and Cherry Creek Pool. Water temperature loggers will be installed using weights or stakes that do not result in any notable disturbance to the streambed. All equipment will be removed upon completion of the study period August 1 through September 30, 2016.

The following regulations are in effect for the Tuolumne Wild & Scenic River for camping in the canyon:

1. Litter of any kind may not be discarded in rivers, along the shore, or in adjacent canyons. Burn or carry out all burnable trash. Carry out all unburnable material including cans, bottles, left-over food, egg shells, melon rinds, and cigarette butts. Liquid garbage must be strained through a fine mesh screen capable of holding small food particles, and the particles then placed in garbage containers or bags to be carried out of the canyon. Sump holes are to be dug away from camp and above the high-water line.

2. All trips must carry portable toilet systems ("wag bags"). All portable toilet waste must be carried out and deposited in an authorized sewage disposal facility.

3. Build campfires only on sand bars and at least 10 feet away from vegetation or combustible material. Use charcoal or driftwood from along the riverbank below high-water line. Wood and charcoal fires are allowed in fire pans only. No fires in rock rings on the ground. Keep a pail of water near the fire and be sure fire is completely extinguished before leaving the site. All ash and charcoal must be carried out of the canyon. Do not cut or burn live trees or standing dead trees.

When fire restrictions are in effect the fire restrictions prohibits wood campfires, briquette barbecues, and smoking outside developed campgrounds in designated High Hazard Areas of the Forest.

4. Wash dishes away from river. Do not bathe or wash in the river or any tributary streams.

5. Do not remove, damage, or destroy any archeological, historical, or ecological resources.

Additional actions required to be completed at the end of the permitted monitoring.

1. Remove all trace of activities as soon as possible once data collection is over: remove the metal and conceal to the maximum extent possible the holes for the anchor bolts. Drill the metal out as completely as possible and fill the holes with an epoxy resin that closely matches the color of the rock.

This Amendment is accepted subject to the conditions set forth here in Attachment A, and is attached hereto and made a part of this Amendment.

Holder	Authorized Office
Holder	Title
Date	Date

According to the Paperwork Reduction Act of 1995, an agency may not conduct or sponsor, and a person is not required to respond to a collection of information unless it displays a valid OMB control number. The valid OMB control number for this information collection is 0596-0082. The time required to complete this information collection is estimated to average one (1) hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information.

The U.S. Department of Agriculture (USDA) prohibits discrimination in all its programs and activities on the basis of race, color, national origin, age, disability, and where applicable, sex, marital status, familial status, parental status, religion, sexual orientation, genetic information, political beliefs, reprisal, or because all or part of an individual's income is derived from any public assistance. (Not all prohibited bases apply to all programs.) Persons with disabilities who require alternative means for communication of program information (Braille, large print, audiotape, etc.) should contact USDA's TARGET Center at 202-720-2600 (voice and TDD).

To file a complaint of discrimination, write USDA, Director, Office of Civil Rights, 1400 Independence Avenue, SW, Washington, DC 20250-9410 or call toll free (866) 632-9992 (voice). TDD users can contact USDA through local relay or the Federal relay at (800) 877-8339 (TDD) or (866) 377-8642 (relay voice). USDA is an equal opportunity provider and employer.

The Privacy Act of 1974 (5 U.S.C. 552a) and the Freedom of Information Act (5 U.S.C. 552) govern the confidentiality to be provided for information received by the Forest Service.

From: John Wooster - NOAA Federal <john.wooster@noaa.gov>
Date: July 28, 2016 at 2:20:11 PM PDT
To: "Le, Bao" <ChiBao.Le@hdrinc.com>
Subject: Re: La Grange Reservoir Transit Draft Study Plan for Review and Comment

Hi Bao:

I'm having NMFS folks in the Northwest take a look at the reservoir transit study plan, and they have had a couple of information requests, ones that I have mostly been able to fill, except for ones wondering about downstream velocities through the reservoir. Do you have any data that could speak to this at all? Maybe from the reservoir temperature model? I realize the velocities will be highly variable based on reservoir inflow, but I think anything you might have could be helpful to generally characterize conditions - and if possible looking more at springtime inflow levels....

Thanks

John

On Mon, Jul 11, 2016 at 4:57 PM, Le, Bao <ChiBao.Le@hdrinc.com> wrote:
Hi John.

FISHBIO put in a request with CDFW for fish. Wondering if we could work with Amanda to help support this?

Thanks, Bao

Sent from my iPhone

Begin forwarded message:

From: "Staples, Rose" <Rose.Staples@hdrinc.com>
Cc: "Deason, Jesse" <Jesse.Deason@hdrinc.com>, "Le, Bao" <ChiBao.Le@hdrinc.com>, "Staples, Rose" <Rose.Staples@hdrinc.com>
Subject: La Grange Reservoir Transit Draft Study Plan for Review and Comment

La Grange Licensing Participants,

As approved by FERC in its May 27, 2016 determination on requests for study modifications and new study, by this email the Districts are providing an anadromous fish reservoir transit draft study plan to licensing participants for review and comment. The goal of this study is to evaluate the biological feasibility of downstream (juvenile) movement of anadromous fish through Don Pedro Reservoir. The draft study plan is also available on the La Grange Project licensing website www.lagrange-licensing.com<http://www.lagrange-licensing.com> in the DOCUMENTS section.

The Districts respectfully request that all comments on the draft study plan be submitted to me at rose.staples@hdrinc.com<mailto:rose.staples@hdrinc.com> by Wednesday, August 10, 2016.

Thank you.

Rose Staples, CAP-OM, MOS
Executive Assistant
HDR
Rose.Staples@hdrinc.com<mailto:Rose.Staples@hdrinc.com>
(207) 239-3857

--
John Wooster
Hydrologist
NOAA Fisheries West Coast Region
U.S. Department of Commerce
john.wooster@noaa.gov

From: Staples, Rose
Sent: Tuesday, August 02, 2016 2:04 PM
Cc: Deason, Jesse; Staples, Rose; Le, Bao
Subject: Addendum to proposed Don Pedro Reservoir Transit Study Plan
Attachments: 20160802_LG_Don Pedro Reservoir Transit Study Addendum.pdf

La Grange Licensing Participants,

Please find attached an addendum to the proposed *Don Pedro Reservoir Transit Study Plan* for the La Grange Hydroelectric Project licensing process. Please provide comments by COB on August 10, 2016 (consistent with the existing comment deadline for the study plan) to Rose.Staples@hdrinc.com. A copy of this addendum has also been uploaded to the La Grange licensing website at www.lagrange-licensing.com.

Thank you.

Rose Staples, CAP-OM, MOS
Executive Assistant

HDR
970 Baxter Boulevard Suite 301
Portland ME 04103
D 207-239-3857
rose.staples@hdrinc.com

hdrinc.com/follow-us

Amendment to Draft Reservoir Transit Study Plan
August 1, 2016

As part of the La Grange Hydroelectric Project (FERC No. 14581) Integrated Licensing Process, Turlock Irrigation District (TID) and Modesto Irrigation District (MID) (collectively, the Districts) submitted to Licensing Participants (LPs) a draft Reservoir Transit Study Plan (TID/MID 2016) for review on July 11, 2016. The goal of this particular study is to evaluate the downstream migration of juvenile anadromous fish through Don Pedro Reservoir. Evaluating reservoir passage efficiency is one component of assessing overall fish passage performance. There is no existing information regarding migration rates, routes and success of juvenile salmonids through Don Pedro Reservoir. The purpose of the Reservoir Transit Study is to evaluate juvenile salmonid reservoir passage efficiency through the Don Pedro Project Reservoir by estimating reach specific migration success.

The proposed study plan requires the release of acoustic tagged juvenile Chinook salmon in the spring of 2017 to estimate migration success through reaches of the reservoir. FISHBIO, consultant to the Districts, has submitted a formal request to the California Department of Fish and Wildlife (CDFW) to use spring-run juvenile Chinook salmon as test fish to support study implementation. Recognizing that spring-run are CESA and ESA listed, we are currently in the process of preparing the necessary CESA and ESA-related permits for the test fish. Should these permits not be issued in time, the use of fall-run Chinook salmon is proposed as an alternative to ensure the study can be completed by fall 2017. The Districts seek LP's comments on this proposed alternative by August 10, 2016. Please submit your comments to Rose Staples (rose.staples@hdrinc.com).

Turlock Irrigation District and Modesto Irrigation District (TID/MID). 2016. Reservoir Transit Study Plan. Prepared by HDR, Inc. Appendix to La Grange Hydroelectric Project Initial Study Report. July 2016.

From: Le, Bao
Sent: Monday, August 08, 2016 11:00 AM
To: John Wooster - NOAA Federal; Amanda Cranford - NOAA Federal
Cc: Deason, Jesse; Jason Guignard
Subject: RE: FW: Request for hatchery fish- Don Pedro Reservoir Transit Study

Thanks, John, for making the connection.

Hi Amanda.

As John noted, we will be pursuing permitting for spring run juveniles; however, after discussions with FishBio, who will be leading up the process on the Districts/HDR's behalf, we'll be pursuing a Section 10 permit. I've cc'd Jason here as I imagine he'll be getting in contact with you soon to discuss.

Thanks, Bao

From: John Wooster - NOAA Federal [mailto:john.wooster@noaa.gov]
Sent: Monday, August 08, 2016 10:38 AM
To: Amanda Cranford - NOAA Federal
Cc: Deason, Jesse; Le, Bao
Subject: Re: FW: Request for hatchery fish- Don Pedro Reservoir Transit Study

Hi Amanda:

Please see the email train below. At this time the Districts on the Tuolumne River (and HDR as their consultants) are interested in applying for the necessary permits to obtain spring-run juveniles / smolts for their reservoir transit study. I believe they are going to want to pursue a 4(d) authorization. Can you send them the link for where to apply for that, and any other information you might have?

Bao, I worked with HDR on getting 4(d) authorization for a FERC study on the Yuba - acoustic tracking of spring and fall run near Narrows 2 powerhouse, I believe Joel Passovoy lead that permit application. You might want to check in with him.

I am on leave for another 1.5 weeks, so my email will be sporadic, but I will try and check in as I can.

Thanks,

John

On Tue, Aug 2, 2016 at 1:52 PM, Le, Bao <ChiBao.Le@hdrinc.com> wrote:

Thanks for the information, John. That's unfortunate but understandable.

I understand and acknowledge the challenges and uncertainty of pursuing only Feather River hatchery fish as you describe below but currently, our study plan identifies spring Chinook as the preferred option. To remain consistent with that proposal, we are planning to pursue permitting to acquire them understanding that if returns back to the Feather River hatchery are low, our chances might be small. But in order to ensure that we could get fish (if summer/fall returns are sufficient), we'll need to get a jump on the permitting process. If you could let Amanda know or connect me with her regarding our interest in starting this process that would be much appreciated.

Bao

From: John Wooster - NOAA Federal [mailto:john.wooster@noaa.gov]
Sent: Friday, July 29, 2016 11:50 AM
To: Le, Bao
Cc: Deason, Jesse
Subject: Re: FW: Request for hatchery fish- Don Pedro Reservoir Transit Study

Bao:

Regrading the SJRRP hatchery producing spring-run fish for Don Pedro studies - the answer is no. It doesn't have the capacity to produce extra fish, but probably more relevant, it is not permitted to release fish out of the SJRRP area, to do so would require additional NEPA / section 7 consultation, etc.. - I think more or less redoing the initial hatchery permitting process that took longer than the time frame we are looking at. This is different than the hatchery management plan for Feather River, they are permitted to do such things.....So from what I can tell, the options for obtaining spring-run for this study, are basically Feather River Hatchery - and that is it....How realistic is that? I have a feeling that no one could really tell you until they see what the production /return numbers are from this summer / early fall, but I haven't run into much optimism about the chances. So a whole other layer of permitting to get in line for listed spring run, with a lot longer odds of getting the fish.....

John

On Tue, Jul 26, 2016 at 5:07 PM, Le, Bao <ChiBao.Le@hdrinc.com> wrote:

Thanks, John.

This is really good information. Let me circle back with the Districts and see what it is they would like to do. My feeling is that using spring run would be preferred but acknowledge that the challenges of acquiring them needs to be carefully considered. I'll get back to you as soon as I can.

Bao

From: John Wooster - NOAA Federal [mailto:john.wooster@noaa.gov]
Sent: Tuesday, July 26, 2016 12:38 PM
To: Le, Bao
Cc: Deason, Jesse
Subject: Re: FW: Request for hatchery fish- Don Pedro Reservoir Transit Study

Hi Bao:

I had multiple discussions with folks in the office yesterday, and the general opinion of folks was that choosing fall-run is probably the better path forward, particularly if the spring-run option is feathery river hatchery fish - the spring-run returns have been so low there are questions whether the hatchery will meet broodstock goals let alone produce surplus fish (and there are other demands already in place on any surplus fish). However, there was some optimism that the San Joaquin Restoration Program might have or be able to produce extra spring-run - I have no idea how realistic that is and have some email inquires out, to try and find out.

Yes, if spring-run are involved this will trigger a federal permit because of the listing, there won't be anyway around that. From my experience, and from feedback from Amanda, going the 4(d) authorization is the better path, it is a joint state/federal process where both review concurrently - Amanda is the lead for NMFS on Central Valley permit applications. I updated Amanda yesterday, she has the draft study plan, and is more or less ready to be involved as needed.

Let me see if I can get some clarification on the SJRRP and then maybe we can chat in the next few days.

-John

On Fri, Jul 22, 2016 at 12:16 PM, Le, Bao <ChiBao.Le@hdrinc.com> wrote:

Hi John.

Just checking in on the below. Hope you had a nice vacation.

Welcome back.

Bao

From: John Wooster - NOAA Federal [mailto:john.wooster@noaa.gov]
Sent: Monday, July 18, 2016 9:33 AM
To: Le, Bao
Subject: Re: FW: Request for hatchery fish- Don Pedro Reservoir Transit Study

Bao:

I am on vacation this week through Thursday, but will see what I can get done. I have briefed Amanda on this study and she is going to help us in whatever capacity possible, but let me wade through all the traffic first....

John

On Mon, Jul 18, 2016 at 9:19 AM, Le, Bao <ChiBao.Le@hdrinc.com> wrote:

Hi John.

Please see below regarding the CDFW request for fish to support the Reservoir Transit Study. CDFW has noted that using spring Chinook, which are only available from the Feather River Hatchery, would require a Federal permit. Further input notes that a 4(d) authorization would be preferable given it would meet both state and Federal needs. Questions/thoughts for you here:

1. Given NMFS has requested and FERC has granted this study, can NMFS assist in facilitating, expediting or even bypassing this requirement?

2. If a process is needed, a key component seems to be the timing of an approval/permit since securing spring Chinook juveniles for study will need to be planned for in advance of next year. I imagine CDFW will want to know this is authorized by this fall when adults are available at the facility? Perhaps FISHBIO (cc'd here) can provide some input here? But it would seem that this would require that any process be complete or near complete in the next few months to give CDFW the assurance they need?

3. It would still be valuable to have Amanda formally communicate NMFS' support for this study to CDFW. Perhaps after we've identified a path forward, we could identify key points in that communication.

Let me know if you have time to discuss this week. I'm taking some PTO this week (Tuesday-Thursday) but will be working here and there and could jump on the phone as needed.

Thanks, Bao

From: Alber, Leslie@Wildlife [mailto:Leslie.Alber@wildlife.ca.gov]
Sent: Friday, July 15, 2016 10:27 AM
To: Clifford, Mark@Wildlife; guignard, jason@fishbio.com
Cc: Le, Bao; Purdy, Colin@Wildlife
Subject: RE: Request for hatchery fish- Don Pedro Reservoir Transit Study

Hi Jason,

You will need to get a CESA MOU and either a 10(a)(1)(A) or 4(d) authorization. Because the work in the 4(d) program is thoroughly reviewed by both NOAA and the Department, you will receive a CESA MOU through the process if you are in the program. ESA section 10(a)(1)(A)s are not reviewed by the Department so if you get one you will also need to contact Colin Purdy (Colin.Purdy@wildlife.ca.gov, 916-358-2943) for a CESA MOU. Please feel free to contact me if you have any questions.

Thanks,

Leslie

From: Clifford, Mark@Wildlife
Sent: Friday, July 15, 2016 9:07 AM
To: guignard, jason@fishbio.com
Cc: Bao Le
Subject: RE: Request for hatchery fish- Don Pedro Reservoir Transit Study

Hi Jason,

I was about to forward your request for a pre-Aug 1 review but first gave it a quick read myself….Feather River Hatchery spring run Chinook salmon are CESA and ESA listed, so you would need to get a CESA MOU and appropriate Federal Permit …. Maybe ESA section 10(a)(1)(A) or 4(d), I don't know since I am not a fed permitting expert.

PS: Scientific Collecting Permits do not apply to listed species, so I don't think your SCP applies to this project.

Anyway…..without these authorizations, these fish cannot be made available and you will have to consider an appropriate surrogate.

Mark Clifford, Ph.D.

Statewide Hatchery Coordinator

Senior Environmental Scientist (Specialist)

California Dept Fish and Wildlife

#3 North Old Stage Road

Mt. Shasta, CA 96067

Office: 530-918-9450

CALIFORNIA DEPARTMENT OF FISH and WILDLIFE

Save Our Water

SaveOurWater.com · Drought.CA.gov

From: Jason Guignard [mailto:jasonguignard@fishbio.com]
Sent: Monday, July 11, 2016 2:37 PM
To: Clifford, Mark@Wildlife
Cc: Bao Le
Subject: Request for hatchery fish- Don Pedro Reservoir Transit Study

Hi Mark,

Attached below is the anadromous hatchery fish request for the Upper Tuolumne River which we had discussed a few weeks ago.

I appreciate your willingness to distribute this to necessary regional staff ahead of the August 1 request deadline.

Please let me know if any questions come up during review of this request.

Thank You,

Jason

Jason Guignard

Fisheries Biologist

FISHBIO

jasonguignard@fishbio.com

O: (209) 847-6300

C: (209) 840-9019

www.fishbio.com

--

John Wooster
Hydrologist
NOAA Fisheries West Coast Region
U.S. Department of Commerce
john.wooster@noaa.gov

NOAA FISHERIES
West Coast Region

From:	Bill Hevlin - NOAA Federal <bill.hevlin@noaa.gov>
Sent:	Monday, August 08, 2016 11:23 AM
To:	Le, Bao
Cc:	John Wooster - NOAA Federal; Deason, Jesse; Devine, John; Bill Hevlin - NOAA Federal; Jean Castillo - NOAA Federal
Subject:	Re: La Grange Reservoir Transit Draft Study Plan for Review and Comment

Bao,
Thanks for your response, very good points.

I am also thinking about what is in spring chinook genetic makeup that has helped them survive through the ages. They migrate downstream under higher spring flows and cooler water conditions, get to salt water as quick as possible and try to avoid predators.

However, in this case, a large deep reservoir has been placed in their path, which is not their normal environment. To increase the potential of their migration survival, I am thinking that it would be wise to start releases of tagged fish in the tributary in early March, acting on the possibility that the freshet may be early and cooler conditions will increase downstream survival, however, do continue release groups through April and May, to compare release group behavior and survival as water heats and stratifies. Also, I think you will need to plan fish releases over at least 3 springs, just to cover a range of environmental conditions due to climate variation.

I understand that you have no intention of manipulating the tributary input flow or project outflows, the flow and temperature variation will be due to the climate conditions, such as snow pack & freshet timing, and upstream project releases. What I was inquiring about was whether the 3-D CFD temperature model could track a particle of water released in the tributary through the reservoir under 3 different conditions, including in the normal winter when there is little or no stratification or thermocline, in the spring with moderate stratification and in the summer with a strong thermocline. I want to see if your model predicts what becomes of the cooler, more dense, water inputs, and the downstream flow net at depths or streamlines through the reservoir, not just cross-sectional velocities.

And a couple of other things to think about. We need to have a sufficient acoustic array through the reservoir, at various depths, middle and along the sides, so that we can understand fish behavior and what they may be cuing on during passage, as well as passage progress and survival. Secondly, with the high population of predator fish in the reservoir, there needs to be a way to determine the difference in behavior between a predator with a tag it consumed and a salmon smolt.

Thanks, I look forward to your responses.

Bill Hevlin
NOAA Fisheries

On Tue, Aug 2, 2016 at 1:44 PM, Le, Bao <ChiBao.Le@hdrinc.com> wrote:

Thanks for your response, Bill.

I am also a fish biologist so I'll do my best to answer your question from this perspective. The most straightforward answer is that the study has proposed to conduct the field component during the period of time when spring Chinook would typically be migrating (April/May) and have presumably evolved to outmigrate during this time since flows are likely highest (although this may not always be the case with CCSF managed operations above). That said, our study does not have the ability to manipulate environmental conditions and generally at that time, CCSF facilities are at the mercy of snowpack, air temperatures, and un-managed run-off anyways. Since we can't manipulate conditions, we're going on typical outmigration periods which generally would provide the best conditions for transit.

Let me know if you have any questions.

Bao

From: Bill Hevlin - NOAA Federal [mailto:bill.hevlin@noaa.gov]
Sent: Tuesday, August 02, 2016 11:38 AM
To: Le, Bao
Cc: John Wooster - NOAA Federal; Deason, Jesse; Bill Hevlin - NOAA Federal
Subject: Re: La Grange Reservoir Transit Draft Study Plan for Review and Comment

Hi Bao,

While I am a fish biologist, rather than a hydrologist or engineer, I think I understand that a 3D reservoir temperature model will provide downstream velocities or flows, at different depths. The depth that I find most promising for smolt survival and passage is near the bottom in a density current of cool water. How does the downstream current fluctuate with depth? Can the 3D temperature model show this? And how does the profile vary with different inflows, outflows, and day in the later winter, early spring? I would like to use the model to help us recommend when and under what conditions might be the best time to release these tagged fish, increasing the likelihood that they might show up downstream.

thanks

Bill Hevlin

NOAA Fisheries

On Tue, Aug 2, 2016 at 9:04 AM, Le, Bao <ChiBao.Le@hdrinc.com> wrote:

Hi John (and Bill).

After asking around, I found that we do have some capability to describe general velocity distribution of the Don Pedro Reservoir using the 3D reservoir temperature model (John, you had identified this model in an earlier email). However, the model is being used for other purposes currently and is approximately a week out from being available. At that time, it could take a few days to run any request. However, if you could provide us with some more detail about what is desired, I could explore more if anything could be done. Let me know.

Thanks, Bao

From: John Wooster - NOAA Federal [mailto:john.wooster@noaa.gov]
Sent: Friday, July 29, 2016 10:19 AM
To: Le, Bao
Subject: Re: La Grange Reservoir Transit Draft Study Plan for Review and Comment

Hi Bao:

Thanks for looking into this, I am going to be out of email contact next week. If you find anything can you also cc Bill Hevlin with NMFS (email below), so that the information gets to him as available?

bill.hevlin@noaa.gov

Thanks,

John

On Thu, Jul 28, 2016 at 5:31 PM, Le, Bao <ChiBao.Le@hdrinc.com> wrote:

Hi John.

I don't know the answer to this but I'll check with John and Jenna and see if anything is available.

Bao

Sent from my iPhone

On Jul 28, 2016, at 2:20 PM, John Wooster - NOAA Federal <john.wooster@noaa.gov> wrote:

Hi Bao:

I'm having NMFS folks in the Northwest take a look at the reservoir transit study plan, and they have had a couple of information requests, ones that I have mostly been able to fill, except for ones wondering about downstream velocities through the reservoir. Do you have any data that could speak to this at all? Maybe from the reservoir temperature model? I realize the velocities will be highly variable based on reservoir inflow, but I think anything you might have could be helpful to generally characterize conditions - and if possible looking more at springtime inflow levels....

Thanks

John

On Mon, Jul 11, 2016 at 4:57 PM, Le, Bao <ChiBao.Le@hdrinc.com> wrote:

Hi John.

FISHBIO put in a request with CDFW for fish. Wondering if we could work with Amanda to help support this?

Thanks, Bao

Sent from my iPhone

Begin forwarded message:

From: "Staples, Rose" <Rose.Staples@hdrinc.com>
Cc: "Deason, Jesse" <Jesse.Deason@hdrinc.com>, "Le, Bao" <ChiBao.Le@hdrinc.com>, "Staples, Rose" <Rose.Staples@hdrinc.com>
Subject: La Grange Reservoir Transit Draft Study Plan for Review and Comment

La Grange Licensing Participants,

As approved by FERC in its May 27, 2016 determination on requests for study modifications and new study, by this email the Districts are providing an anadromous fish reservoir transit draft study plan to licensing participants for review and comment. The goal of this study is to evaluate the biological feasibility of downstream (juvenile) movement of anadromous fish through Don Pedro Reservoir. The draft study plan is also available on the La Grange Project licensing website www.lagrange-licensing.com<http://www.lagrange-licensing.com> in the DOCUMENTS section.

The Districts respectfully request that all comments on the draft study plan be submitted to me at rose.staples@hdrinc.com<mailto:rose.staples@hdrinc.com> by Wednesday, August 10, 2016.

Thank you.

Rose Staples, CAP-OM, MOS
Executive Assistant
HDR
Rose.Staples@hdrinc.com<mailto:Rose.Staples@hdrinc.com>
(207) 239-3857

--

John Wooster
Hydrologist
NOAA Fisheries West Coast Region
U.S. Department of Commerce
john.wooster@noaa.gov

From: Deason, Jesse
Sent: Monday, August 08, 2016 12:57 PM
To: Deason, Jesse
Subject: Update to the Don Pedro / La Grange Participants Group Listing

Greetings,

I retired from Federal service effective July 31, 2016. Therefore, your email will not be answered. If you need assistance on matters related to FERC licensing, please contact Steve Edmondson by phone (707) 575-6052, or email steve.edmondson@noaa.gov.

--

Larry Thompson
Fishery Biologist
NOAA Fisheries West Coast Region
U.S. Department of Commerce
Office Phone: 916-930-3613
Postal Address: NOAA Fisheries, 650 Capitol Mall, Rm 5100, Sacramento, CA 95814
larry.thompson@noaa.gov

From: Le, Bao
Sent: Wednesday, August 10, 2016 3:01 PM
To: Vaughn, Gary D -FS
Cc: dfoote@fs.fed.us; Garello, Michael; Deason, Jesse
Subject: Drone Survey Follow Up - alternative options and drop dead date

Hi Dusty.

I just wanted to check-in with you regarding any progress from region on the ability to use a drone to survey Lumsden Falls. Do you have a sense of when you might get feedback? On our end, we need to start planning for both use of a drone and a contingency (using a traditional field crew to collect data at Lumsden Falls) and we assume that this will also require us to amend our existing fish migration barriers study permit. Working backwards from early October (which is when we'd like to conduct the field work), I'm guessing we'll need to better understand our options no later than the end of the month. Any input you may have would be appreciated.

Thanks, Bao

Bao Le
Senior Fisheries Biologist

HDR
1001 SW 5th Avenue, Suite 1800
Portland, OR 97204-1134
D 971.202.1722 **M** 503.309.9423
bao.le@hdrinc.com

hdrinc.com/follow-us

From: Le, Bao
Sent: Wednesday, August 10, 2016 2:49 PM
To: dfoote@fs.fed.us
Cc: Warnock, Cory; Deason, Jesse
Subject: 2016 Upper Tuolumne River Field Studies

Hi Debbie.

I just wanted to give you a quick update of our study program. We've had successful July field events/floats for the fish barrier assessment, temperature monitoring, habitat typing and spawning gravel studies. Coming up in August the Instream Flow Study will begin (first week is next week starting August 15th), the spawning gravel study will do a follow up field event to examine substrate permeability (starting August 22nd), and the pool stratification monitoring (start on August 29th).

Please let me know if you have any questions or would like more details.

Thanks, Bao

Bao Le
Senior Fisheries Biologist

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bao.le@hdrinc.com

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From: Le, Bao
Sent: Wednesday, August 10, 2016 2:51 PM
To: dfoote@fs.fed.us
Cc: Vaughn, Gary D -FS; Deason, Jesse
Subject: RE: GRO 1128 Permit Signed
Attachments: HDR TID Gro1128 amendment.pdf

Hi Debbie.

I just wanted to check in on this permit. We've not yet received an executed copy. As noted in previous email, we still have some time as the pool monitoring work will not begin until August 29th.

Thanks, Bao

From: Le, Bao
Sent: Friday, July 01, 2016 8:37 AM
To: dfoote@fs.fed.us
Cc: Vaughn, Gary D -FS; Deason, Jesse
Subject: GRO 1128 Permit Signed

Good morning, Debbie.

Attached is the permit amendment signed by Steve Boyd. We'll await an executed copy.

Thanks,
Bao

Bao Le
Senior Fisheries Biologist

HDR
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Portland, OR 97204-1134
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Auth ID: GRO1128
Contact ID: 611267010602
Use Code: 422

FS-2700-23 (v. 10/09)
OMB No. 0596-0082

U.S. DEPARTMENT OF AGRICULTURE
FOREST SERVICE
AMENDMENT
FOR

SPECIAL-USE AUTHORIZATION

Amendment#: 1

This amendment is attached to and made a part of the Gro1128 Research special use authorization for barriers assessment issued to TURLOCK IRRIGATION DISTRICT on 07/29/2015 which is hereby amended as follows:

Install, monitor, and maintain a trail camera on the Clavey River approximately 2 miles up from the confluence of the Tuolumne River. Approval of an additional raft trip in 2017 to retrieve the equipment in 2017.

[signature] Holder STEVE BOYD TURLOCK IRRIGATION DISTRICT	Jim Junette
Holder	District Ranger
JULY 1, 2016 Date	Date

According to the Paperwork Reduction Act of 1995, an agency may not conduct or sponsor, and a person is not required to respond to a collection of information unless it displays a valid OMB control number. The valid OMB control number for this information collection is 0596-0082. The time required to complete this information collection is estimated to average one (1) hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information.

The U.S. Department of Agriculture (USDA) prohibits discrimination in all its programs and activities on the basis of race, color, national origin, age, disability, and where applicable, sex, marital status, familial status, parental status, religion, sexual orientation, genetic information, political beliefs, reprisal, or because all or part of an individual's income is derived from any public assistance. (Not all prohibited bases apply to all programs.) Persons with disabilities who require alternative means for communication of program information (Braille, large print, audiotape, etc.) should contact USDA's TARGET Center at 202-720-2600 (voice and TDD).

To file a complaint of discrimination, write USDA, Director, Office of Civil Rights, 1400 Independence Avenue, SW, Washington, DC 20250-9410 or call toll free (866) 632-9992 (voice). TDD users can contact USDA through local relay or the Federal relay at (800) 877-8339 (TDD) or (866) 377-8642 (relay voice). USDA is an equal opportunity provider and employer.

The Privacy Act of 1974 (5 U.S.C. 552a) and the Freedom of Information Act (5 U.S.C. 552) govern the confidentiality to be provided for information received by the Forest Service.

From: Le, Bao
Sent: Wednesday, August 10, 2016 2:59 PM
To: Foote, Debra -FS
Cc: Deason, Jesse; Vaughn, Gary D -FS
Subject: RE: GRO1122 amendment
Attachments: HDR GRO1122 Amendment 2.docx

Hi Debbie.

Here is the signed amendment for the pool monitoring work (please ignore the previous email with attached amendment as that's the wrong one – a lot of permits to keep track of!). I've cc'd Dusty and we'll await a copy with the final authorized signature on your end.

Thanks, Bao

From: Le, Bao
Sent: Monday, August 01, 2016 9:09 AM
To: 'Foote, Debra -FS'
Cc: Deason, Jesse
Subject: RE: GRO1122 amendment

Good morning, Debbie.

Attached is the permit amendment with the Districts signature. We'll await receipt a copy with final authorized signature.

Thanks,
Bao

From: Foote, Debra -FS [mailto:dfoote@fs.fed.us]
Sent: Thursday, July 28, 2016 12:15 PM
To: Le, Bao
Subject: GRO1122 amendment

Bao,
Please see attached for the amendment for the GRO1122 permit. Please have the permit signed and return to me for the final authorized signature.

Debbie Foote
Resource Assistant

Forest Service
Groveland Ranger District

p: 209-962-7825 x533
f: 209-962-7412
dfoote@fs.fed.us

24545 Hwy. 120
Groveland, CA 95321
www.fs.fed.us

Caring for the land and serving people

Auth ID: GRO1122
Contact ID: 611267010602
Use Code: 422

FS-2700-23 (v. 10/09)
OMB No. 0596-0082

U.S. DEPARTMENT OF AGRICULTURE

FOREST SERVICE

AMENDMENT

FOR SPECIAL-USE AUTHORIZATION

Amendment#: 2

This amendment is attached to and made a part of the special use authorization identified above for research issued to TURLOCK IRRIGATION DISTRICT on 04/22/2015 which is hereby amended as follows:

Additional temporary installation, maintenance, and monitoring of handheld and deployed temperature probes and/or loggers at the following locations of the Tuolumne River mainstem, Lumsden and Meral's Pools, and Cherry Creek Pool. Water temperature loggers will be installed using weights or stakes that do not result in any notable disturbance to the streambed. All equipment will be removed upon completion of the study period August 1 through September 30, 2016.

The following regulations are in effect for the Tuolumne Wild & Scenic River for camping in the canyon:

1. Litter of any kind may not be discarded in rivers, along the shore, or in adjacent canyons. Burn or carry out all burnable trash. Carry out all unburnable material including cans, bottles, left-over food, egg shells, melon rinds, and cigarette butts. Liquid garbage must be strained through a fine mesh screen capable of holding small food particles, and the particles then placed in garbage containers or bags to be carried out of the canyon. Sump holes are to be dug away from camp and above the high-water line.

2. All trips must carry portable toilet systems ("wag bags"). All portable toilet waste must be carried out and deposited in an authorized sewage disposal facility.

3. Build campfires only on sand bars and at least 10 feet away from vegetation or combustible material. Use charcoal or driftwood from along the riverbank below high-water line. Wood and charcoal fires are allowed in fire pans only. No fires in rock rings on the ground. Keep a pail of water near the fire and be sure fire is completely extinguished before leaving the site. All ash and charcoal must be carried out of the canyon. Do not cut or burn live trees or standing dead trees.

   When fire restrictions are in effect the fire restrictions prohibits wood campfires, briquette barbecues, and smoking outside developed campgrounds in designated High Hazard Areas of the Forest.

4. Wash dishes away from river. Do not bathe or wash in the river or any tributary streams.

5. Do not remove, damage, or destroy any archeological, historical, or ecological resources.

Additional actions required to be completed at the end of the permitted monitoring.

1. Remove all trace of activities as soon as possible once data collection is over: remove the metal and conceal to the maximum extent possible the holes for the anchor bolts. Drill the metal out as completely as possible and fill the holes with an epoxy resin that closely matches the color of the rock.

This Amendment is accepted subject to the conditions set forth here in Attachment A, and is attached hereto and made a part of this Amendment.

	Turlock Irrigation District
Holder	Authorized Office
	Water Resources and Regulatory Affairs Director
Holder	Title
July 29, 2016	July 29, 2016
Date	Date

According to the Paperwork Reduction Act of 1995, an agency may not conduct or sponsor, and a person is not required to respond to a collection of information unless it displays a valid OMB control number. The valid OMB control number for this information collection is 0596-0082. The time required to complete this information collection is estimated to average one (1) hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information.

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To file a complaint of discrimination, write USDA, Director, Office of Civil Rights, 1400 Independence Avenue, SW, Washington, DC 20250-9410 or call toll free (866) 632-9992 (voice). TDD users can contact USDA through local relay or the Federal relay at (800) 877-8339 (TDD) or (866) 377-8642 (relay voice). USDA is an equal opportunity provider and employer.

The Privacy Act of 1974 (5 U.S.C. 552a) and the Freedom of Information Act (5 U.S.C. 552) govern the confidentiality to be provided for information received by the Forest Service.

Begin forwarded message:

From: apps.feedback@noaa.gov
Subject: Submitted Permit Application File #20656: Reservoir Transit Study
Date: August 11, 2016 at 1:21:14 PM PDT
To: andreafuller@fishbio.com
Cc: nmfs.swr.apps@noaa.gov

Congratulations! You have successfully submitted your application via APPS. You may no longer make changes to your application at this time.

The appropriate Federal and/or state agency has been notified of your application. Your application will be assigned a permit analyst, who will review your application and contact you.

If you have questions before you are assigned a permit analyst, please use the "Contact Us" section in APPS (https://apps.nmfs.noaa.gov). PLEASE NOTE: Jason Guignard is listed as a contact for this application, but does not currently have an active account in APPS. He/She will need to create an account before being able to access APPS or receiving any notifications about this application.

Permit Application File #20656: Reservoir Transit Study.
Permit/authorization type(s): ESA Section 10(a)(1)(A) permit (Pacific fish/invertebrate research)

General location(s): California (including offshore waters)

Here is a link to the submitted file:
https://apps.nmfs.noaa.gov/preview/applicationpreview.cfm?ProjectID=20656&Login=1&View=01000000000

Applicant Information

Affiliation:	FISHBIO
Address:	1617 S. Yosemite Ave.
City,State,Zip:	Oakdale, CA 95361

Project Information

File Number:	20656
Application Status:	Submitted
Project Title:	Reservoir Transit Study
Project Status:	New
Previous Federal or State Permit:	
Permit Requested:	• ESA Section 10(a)(1)(A) permit (Pacific fish/invertebrate research)
Where will activities occur?	California (including offshore waters)
State department of fish and game/wildlife:	N/A
Research Timeframe:	Start: 04/01/2017 End: 06/30/2017

Sampling Season/Project Duration: Field work will occur between April and June 2017. Data entry, analysis and reporting will be completed by October 2017.

Abstract: The purpose of the Reservoir Transit Study is to evaluate juvenile salmonid reservoir passage efficiency through the Don Pedro Project Reservoir by determining estimates of reach specific migration success. Results from the study will be used to help inform feasibility of a potential downstream passage facility. Passage efficiency will be evaluated using 960 acoustically tagged hatchery reared fish from Feather River Hatchery in the spring of 2017. The fish will be surgically implanted with VEMCO acoustic transmitters and eight groups of 60 tagged juvenile Chinook salmon will be released at each of two release sites during the study period. Release sites have been identified at Lumsden (RM 96) and Wards Ferry (RM 78.5), as these are the only accessible sites near or upstream of the reservoir. Following release of study fish, a combination of fixed and mobile receivers will be used to document movement of juvenile Chinook salmon through the Don Pedro Reservoir. Fixed receivers will be deployed near proposed locations of potential downstream fish collection facilities to document travel time and reach specific migration success. Mobile tracking may be used to document locations of tagged fish between acoustic receiver locations.

Project Description

Purpose: As part of the Integrated Licensing Process (ILP) for the La Grange Project, the Districts are completing a phased, two-year Fish Passage Facilities Alternatives Assessment (Assessment) to identify and develop potentially viable, concept-level alternatives for upstream and downstream passage of Chinook salmon and steelhead at the La Grange and Don Pedro dams.

Specific objectives of the Assessment are to:

*Obtain available information to establish existing baseline conditions relevant to impoundment operations and siting passage facilities,

*Obtain and evaluate available hydrologic data and biological information for the Tuolumne River to identify potential types and locations of facilities, run size, fish periodicity, and the anticipated range of flows that correspond to fish migration,

*Formulate and develop preliminary sizing and functional design for select, alternative potential upstream and downstream fish passage facilities, and

*Develop Class-V opinions of probable construction cost and annual operations and maintenance (O&M) costs for select fish passage concept(s).

The Assessment consists of two phases. Phase 1 (conducted in 2015) involved collaborative information gathering and evaluation of facility siting, sizing, general biological and engineering design parameters, and operational considerations. Phase 2 (conducted in 2016) will involve the development of preliminary functional layouts and site plans, estimation of preliminary capital and O&M costs, and identification of any additional significant information needs for select passage alternatives.

As detailed in FERC's May 27, 2016 determination on requests for study modifications and new study, a proposed modification of the Assessment's Phase 1 and Phase 2 implementation schedule was approved by extending Phase 1 an additional year to 2016 and completing Phase 2 in 2017 to allow for further coordination with licensing participants on gathering necessary information to ensure that the fish passage facility design basis and resulting cost estimates reflect reliable and defensible information. As part of this determination, FERC also noted the Districts' proposal to develop an anadromous fish reservoir transit study plan and provide it to licensing participants by July 2016, to advance the necessary planning and permitting to conduct such a study during Phase 2 in spring 2017, should the Phase 1 results indicate that such a study is necessary.

Description: The Reservoir Transit study area will include the mainstem of the upper Tuolumne River from Lumsden (RM 96) downstream to Don Pedro Dam (RM 54.8) including Don Pedro Reservoir.

The goal of the Reservoir Transit Study is to evaluate the biological feasibility of downstream (juvenile) movement of anadromous fish through Don Pedro Reservoir. Evaluating reservoir passage efficiency is one component of assessing overall fish passage performance, and results of this study will be used to help inform feasibility of a potential downstream passage facility. There is no existing information regarding migration and migration success rates of juvenile salmonids through Don Pedro Reservoir, as there are no anadromous populations occurring upstream. The purpose of the Reservoir Transit Study is to evaluate juvenile salmonid reservoir passage efficiency through the Don Pedro Project Reservoir by determining estimates of reach specific migration success.

A request for spring-run Chinook salmon in a size range representing large young-of-the-year smolts and/or yearlings (95-120 mm) was requested from the California Department of Fish and Wildlife in July 2016. While spring-run Chinook salmon are preferred, it is recognized that these fish may not be available for a variety of reasons. Alternatively, fall-run Chinook salmon of a similar size could be used for this study as a surrogate to spring-run Chinook salmon.

A total of 960 hatchery reared juvenile Chinook salmon will be surgically implanted with VEMCO acoustic transmitters. An additional 160 fish will be implanted with dummy tags and held to evaluate transmitter effects. Chinook salmon, with average size ranging from 95-120 mm, will be implanted with V4-180 kHz tags (0.24 g). Eight groups of 60 tagged juvenile Chinook salmon will be released at each of two release sites during the study period. Release sites have been identified at Lumsden (RM 96) and Wards Ferry (RM 78.5), as these are the only accessible sites near or upstream of the reservoir.

Following release of study fish, a combination of fixed and mobile receivers will be used to document movement of juvenile Chinook salmon through the Don Pedro Project Reservoir. Fixed receivers will be deployed near proposed locations of potential downstream fish collection facilities to document travel time and reach specific migration success. Mobile tracking may be used to document locations of tagged fish between acoustic receiver locations.

The proposed study design will determine, for any given study reach, the proportion of fish that migrated successfully to pass into the next downstream reach. Detection data will be analyzed using a Cormack-Jolly-Seber (CJS) framework and the commonly accepted CJS formulation.

Supplemental Information

Status of Species: Spring-run Chinook salmon were historically in the Tuolumne River watershed but were extirpated when they were no longer able to reach their spawning grounds after the construction of La Grange Diversion Dam and the impoundment of Don Pedro Reservoir. There is no existing information regarding migration and migration success rates of juvenile salmonids through Don Pedro Reservoir, as there are no anadromous populations occurring upstream. The purpose of the Reservoir Transit Study is to evaluate juvenile salmonid reservoir passage efficiency through the Don Pedro Project Reservoir by determining estimates of reach specific migration success.

Methods: Note: Please refer to attached study plan for tables and figures referenced in the methods below.

The use of hatchery fish will be required for this study, and a request was submitted to California Department of Fish and Wildlife (CDFW) in July 2016 for hatchery origin Chinook salmon to be allocated for this study during spring 2017. This request was for spring-run Chinook salmon in a size range representing large young-of-the-year smolts and/or yearlings (95-120 mm). While spring-run Chinook salmon are preferred, it is recognized that these fish may not be available for a variety of reasons. Alternatively, fall-run Chinook salmon of a similar size could be used for this study as a surrogate to spring-run Chinook salmon (SJRRP 2011).

Releases of hatchery origin steelhead juveniles were also considered in development of the study design, but are not proposed due to the potential uncertainties that would be introduced related to the fact that the steelhead fish obtained would not actually be smolting, but simply of smolt-size. Therefore, these fish may not have the urge to sustain downstream migration behavior. While fish that moved upstream following release would be excluded from analyses of migration success, there is no guarantee that a juvenile steelhead that initially moves downstream for some distance does not stop migrating to take up temporary or permanent residence in the river or reservoir (Del Real et al. 2011, Plumb et al. 2006). A key assumption of the study design is that study fish will continue to try to migrate downstream through the river and reservoir. Due to potential sample losses due to upstream movement and/or temporary or permanent residency in the river or reservoir, compounded with the possibility of low migration success through many of the study reaches, including steelhead in the study was deemed infeasible.

Acoustic Telemetry

VEMCO acoustic technology (tags and receivers) likely represents the best technology given the study objectives and study site. Autonomous acoustic receivers (model VR2W – 180 kHz) are self-powered for 8 months and record and decode data automatically. Each receiver is capable of storing up to 1.6 million records. Under optimal acoustic conditions (e.g., no boat traffic and calm water), 180 kHz tags can be detected up to 250 m away (about 820 ft). However, it should be noted that in areas (near marinas or boat ramps) or periods (on weekends) with high boat traffic, detection range could be considerably less. Therefore, detection range testing will be performed to evaluate the appropriate spacing and configuration of receivers within arrays.

Tagging Methods

1,500 Chinook salmon were requested from the Feather River hatchery. Only fish ranging between 95 mm and 120 mm will used for the tagging study; and all fish outside the size criteria will be released back into the raceways at the hatchery. 960 fish will be surgically implanted with V4-180 kHz tags (0.24 g) at the Feather River Hatchery. 160 fish will be surgically implanted with dummy tags. All tagging will be performed by experienced personnel following standard implantation procedures (Liedtke et al 2012). The tag to body weight ratio will not exceed 5%.

Prior to surgery, all fish were anesthetized in a separate 53 L container using a solution of 70 mg/L tricane methane sulfonate in water buffered with an equal concentration of sodium bicarbonate. A ventral incision approximately 20 mm long will be made anterior to the apex of the pelvic girdle. The tag will be inserted into the peritoneal cavity and the incision will be closed with three interrupted sutures. Typical surgery times are less than four minutes. Fish will then placed into raceways at hatchery to recover from anesthesia. Function of the tag will be confirmed using a tag detector prior to tag insertion and again during the recovery period. All fish will be transported from the hatchery to the reservoir by either FISHBIO staff or CDFW staff. Fish will be transported in a 400 gallon hauling tank equipped with oxygen and agitators. Ice blocks will be added if needed to keep water temperatures down during transport. Fish will be acclimated before transfer to the river, and held in-river for 24 hrs prior to release.

Eight groups of 60 tagged juvenile Chinook salmon will be released at each of two release sites during the study period. 10 fish with dummy tags per release/location (total of 160) will be held to evaluate tagging effects. Release sites have been identified at Lumsden (RM 96) and Wards Ferry (RM 78.5), as these are the only accessible sites near or upstream of the reservoir. While there is a preference to select a release location that ensures that fish travel through riverine habitat prior to entering the reservoir (e.g., Lumsden), there is also a desire to minimize loss of tagged fish prior to entering the reservoir by making releases near the head of the reservoir (e.g., Wards Ferry).

Following release of study fish, a combination of fixed and mobile receivers will be used to document movement of juvenile Chinook salmon through the Don Pedro Project Reservoir. Fixed receivers will be deployed near proposed locations of potential downstream fish collection facilities (Table 4-1; TID/MID 2016) to document travel time and reach specific migration success. Mobile tracking may be used to document locations of tagged fish between acoustic receiver locations.

Array Design

The entire Don Pedro Reservoir acoustic array will consist of single- and double-gated arrays as shown in Figure 4-1. This particular arrangement of acoustic receivers will provide valuable information on the movement, migration success, and movement direction of tagged fish as well as the detection efficiency of specific locations and the entire array. Proposed array locations provide finer scale resolution near the head of reservoir to provide more information on movement patterns and migration success within this area.

Based on the approximate dimensions of each monitoring site (shown in Table 4-1), the number of receivers per site will vary from 1 to 8 (Table 4-2). This proposed number at each site is based on the assumption of a detection range of about 330 ft, and allows for some overlap between detection fields of each receiver. Therefore, based on results from detection range testing, the actual number of receivers may differ (e.g., if detection range is reliably > 330 ft, potentially one less receiver could be used per array). An additional consideration for the number of receivers is the water level in Don Pedro Reservoir at the time of the study. If water level in the reservoir is significantly reduced from the assumed full pool (used to estimate dimensions), the number of receivers could be reduced further.

Range Testing

Estimating the range of detection through range testing will be an important first step in determining the spacing and configuration of receivers within acoustic arrays (Kessel et al. 2013). As noted above, detection range can vary by site, and through time within a site. A variety of factors can cause changes in detection range including, weather, boats, conductivity, temperature, depth, or temperature gradients, among others (Kessel et al. 2013). To conduct range testing, up to 8 receivers will be deployed at 100 ft increments away from a test tag(s). A test tag emits an acoustic pulse or signal every 30 seconds. Therefore, if a receiver 100 ft away was detecting at 100%, the number of detections in an hour for that tag should equal 120 (i.e., 2 pulses per minute * 60 = 120). Receivers close to the test tag should typically detect the tag with high detection rates, and then at increasing distance away from the tag, detection rates will decrease. The range test will be conducted for one week prior to the study and ideally represent typical ambient conditions at each site.

After the range test is completed, the number of detections on an hourly or daily basis will be plotted against distance away from the tag. Typically, the rate at which tag detection decreases with increasing distance follows a logistic function (Figure 4-2; from Figure 2 of Kessel et al. 2013). Using Figure 4-3 as an example, in order to achieve 50% detection probability, the receivers should be deployed approximately 1000 m apart (since the detection range represents the radius of a ~500 m circle around the receiver). A similar method will be used to determine the appropriate spacing for the receivers in each array in this study.

Deployment Methods / Equipment

For deployments in the reservoir, acoustic receivers will be affixed to a mooring and buoy system, subject to approval by Don Pedro Recreation Agency and consistent with existing rules and regulations. Moorings will be constructed of concrete and weigh approximately 100 lbs each. The cabling will be secured to the underside of the buoy to minimize tampering. Acoustic receivers will be secured to 3/8" stainless steel cable with stainless steel hose clamps and will be deployed approximately 10 ft from the water surface to prevent tampering or loss from the public. Receivers deployed near the surface will be oriented to face downwards to maximize the detection range in the upper portion of the water column. In the deeper portions of the lake (Railroad Canyon, East Bay, and at Don Pedro Dam), two acoustic receivers will be deployed on the same mooring system. These will face upwards and will be deployed so that they are approximately 10 ft from the substrate.

Data Analysis

The proposed study design will determine, for any given study reach, the proportion of fish that migrated successfully to pass into the next downstream reach. The mechanisms via which any fish failed to arrive at the next reach will not be identified by this study but may include the following: some fish may have died, taken up residence, moved up into a tributary, turned around, or had a failed tag. Detection data will be analyzed using a Cormack-Jolly-Seber (CJS) framework and the commonly accepted CJS formulation (see Lebreton et al. 1992). A similar method was used by Skalski (1998), and the specific method was later described as a 'Single Release-Recapture Model' (Giorgi et al. 2010). These models simultaneously allow the estimation of detection probability at each receiver array, and the probability of successful passage between each array. Multiple detection arrays are required in order to tease-apart the effects of passage-success and detection-probability. Since no arrays exist downstream of the last one, the detection efficiency of the last array cannot be determined, and because of that, the effects of successful passage and successful detection cannot be teased-apart in the last reach.

The Single Release-Recapture Model does not allow for handling effects to be controlled. Thus any latent handling related effects that manifest in a given study reach will contribute to the failure of some fish to reach the next detection point, and hence will be attributed as a loss to the reach itself. While a Paired Release-Recapture Model would avoid this issue (see Giorgi et al. 2010), these models require more tagged fish for releases to be made at the top of each study reach and a priori knowledge of reach-specific transit times which are not available. In this study, we propose to release fish at Lumsden, i.e., far enough upstream of the reservoir as to maximize the probability that any handling related effects are fully manifest by the time the tagged fish enter the first reach of interest at Wards Ferry. Since there is no available information to predict how many of these fish will survive to Wards Ferry or migrate successfully through each of the reservoir reaches, releases will also be made at Wards Ferry with the intent of bolstering the sample size of fish reaching the downstream reaches (i.e., the fish released at Wards Ferry will not have fully expressed any potential handling-related mortality to be useful for estimation of passage success through their first study reach, but if subsequent detection probabilities and passage success rates are comparable to those of the Lumsden fish, both release groups may be pooled for increased sample size in the lowest reaches).
Detection arrays will be deployed at Wards Ferry, Moccasin Point, Jacksonville Road Bridge, Railroad Canyon, East Bay, and two arrays in the forebay of Don Pedro Dam (Figure 4-3). The double array in the Don Pedro Forebay will allow estimation of passage-success through the last study reach without dealing with non-estimable parameters. At various other key locations in the Reservoir, we propose that double arrays be deployed. There is no a priori knowledge of reach-specific passage success, which could be low enough in some reaches as to make it difficult for the model to separate the effects of passage-success and detection-probability. Thus, while not strictly required for the analysis, especially if passage success is good, double arrays will add value by helping to resolve the models under certain scenarios.

	All modeling will be carried out in the R computing environment (R Development Core Team 2015) using the RMark package (Laake 2013) to construct and fit models in Program MARK (White and Burnham 1999). In Figure 4-3, model parameters are mapped onto a conceptualized image of the river and reservoir, where the waterways have been simplified for the sake of the illustration as a linear system. The parameters that will be estimated are listed and defined in Table 4-3.
Lethal Take:	Not Applicable
Anticipated Effects on Animals:	Negative effects of the Reservoir Transit Study may include complications during or after implantation surgery, such as stress, infections at suture site, problems recovering from anesthesia, and death. Tagged fish will either be lost in reservoir or preyed upon. Fish are unable to pass Don Pedro Dam and continue their migration in the lower Tuolumne River. Fish implanted with dummy transmitters will be euthanized at the end of the study.
Measures to Minimize Effects:	All tagging will be performed by experienced personnel following standard implantation procedures (Liedtke et al. 2012). The tag to body weight ratio will not exceed 5%. Once fish are released there will be no additional handling since the fish will be passively monitored using fixed and mobile receivers.
Resources Needed to Accomplish Objectives:	hatchery reared Chinook salmon (average size ranging from 95-120 mm); VEMCO V4-180 kHz tags; autonomous acoustic receivers (model VR2W – 180 kHz); surgical supplies; boat; mooring and buoy system; and experienced personnel.
Disposition of Tissues:	not applicable
Public Availability of Product/Publications:	A final report will be issued to FERC in October 2017 and can be found at elibrary.ferc.gov

Federal Information

No Federal comments or authorizations.

Location/Take Information

Location

Research Area: Pacific Ocean State: CA Sub Basin (4th Field HUC): Upper Tuolumne Stream Name: Upper Tuolumne River/Don Pedro Reservoir Begin Mile: 54.8 End Mile: 96.0
Location Description: Mainstem of the upper Tuolumne River from Lumsden (RM 96) downstream to Don Pedro Dam (RM 54.8) including Don Pedro Reservoir.

Take Information

Line	Ver	Species	Listing Unit/Stock	Production /Origin	Life Stage	Sex	Expected Take	Indirect Mort	Take Action	Observe /Collect Method	Procedure	Run	Transport Record	Begin Date	End Date
1		Salmon, Chinook	Central Valley spring-run (NMFS Threatened)	Listed Hatchery Adipose Clip	Juvenile	Unknown	960	19	Capture/Mark, Tag, Sample Tissue/Release Live Animal	N/A	Tag, Acoustic or Sonic (Internal)	Spring	N/A	4/1/2017	6/30/2017
2		Salmon, Chinook	Central Valley spring-run (NMFS Threatened)	Listed Hatchery Adipose Clip	Juvenile	Unknown	160	160	Intentional (Directed) Mortality	N/A	Anesthetize; Tag, Radio (Internal)	Spring	N/A	4/1/2017	6/30/2017
3		Salmon, Chinook	Central Valley spring-run (NMFS Threatened)	Listed Hatchery Adipose Clip	Juvenile	Unknown	380	0	Capture/Handle/Release Fish	N/A	Anesthetize	Spring	N/A	4/1/2017	6/30/2017

NEPA Checklist

1) If your activities will involve equipment (e.g., scientific instruments) or techniques that are new, untested,or otherwise have unknown or uncertain impacts on the biological or physical environment , please discuss the degree to which they are likely to be adopted by others for similar activities or applied more broadly.

No, acoustic tracking is not a new or controversial technique. This method of tracking has been widely used in fisheries and wildlife for many years.
2) If your activities involve collecting, handling, or transporting potentially infectious agents or pathogens (e.g., biological specimens such as live animals or blood), or using or transporting hazardous substances (e.g., toxic chemicals), provide a description of the protocols you will use to ensure public health and human safety are not adversely affected, such as by spread of zoonotic diseases or contamination of food or water supplies.

No, the only substance that will be used in the project is 70 mg/L tricane methanesulfonate buffered with an equal concentration of sodium bicarbonate for anesthetizing the fish prior to surgery to implant acoustic tag. Latex gloves will be worn during surgery. Surgery will be performed at the Feather River hatchery and tagged fish will be transported to Don Pedro for release.
3) Describe the physical characteristics of your project location, including whether you will be working in or near unique geographic areas such as state or National Marine Sanctuaries, Marine Protected Areas, Parks or Wilderness Areas, Wildlife Refuges, Wild and Scenic Rivers, designated Critical Habitat for endangered or threatened species, Essential Fish Habitat, etc. Discuss how your activities could impact the physical environment, such as by direct alteration of substrate during use of bottom trawls, setting nets, anchoring vessels or buoys, erecting blinds or other structures, or ingress and egress of researchers, and measures you will take to minimize these impacts.

The project area is designated critical habitat for Central Valley Steelhead and spring-run Chinook; however, the project activities will not impact the physical environment.
4) Briefly describe important scientific, cultural, or historic resources (e.g., archeological resources, animals used for subsistence, sites listed in or eligible for listing in the National Register of Historic Places) in your project area and discuss measures you will take to ensure your work does not cause loss or destruction of such resources. If your activity will target marine mammals in Alaska or Washington, discuss measures you will take to ensure your project does not adversely affect the availability (e.g., distribution, abundance) or suitability (e.g., food safety) of these

animals for subsistence uses.

The project will not affect sites listed in or eligible for listing in the National Register of Historic Places. There will be no major construction associated with the project.
5) Discuss whether your project involves activities known or suspected of introducing or spreading invasive species, intentionally or not, (e.g., transporting animals or tissues, discharging ballast water, use of equipment at multiple sites). Describe measures you would take to prevent the possible introduction or spread of non-indigenous or invasive species, including plants, animals, microbes, or other biological agents.

No. To the extent practical, sampling equipment and gear is site or watershed specific. Any gear or equipment used at more than one location is frozen, dried, or otherwise disinfected according to agency recommended guidelines after each use. The boat will be inspected thoroughly for invasive species prior to launching.

Project Contacts

Responsible Party: Andrea Fuller
Primary Contact: Jason Guignard
Principal Investigator: Jason Guignard

Other Personnel:

Name	Role(s)
Andrea Fuller	Co-Investigator
Rob Fuller	Co-Investigator
Jason Guignard	Co-Investigator
Mike Kersten	Co-Investigator
Colleen A Moore	Co-Investigator
Matt Peterson	Co-Investigator

Attachments

Certification of Identity - P20656T1108111600.PDF (Added Aug 11, 2016)
Contact - Andrea Fuller C12040T5Andrea Fuller.doc (Added Oct 29, 2008)
Contact - Colleen A Moore C19057T5ColleenMooreCV.docx (Added Oct 8, 2015)
Contact - Jason Guignard C12121T5Jason Guignard.doc (Added Oct 29, 2008)
Contact - Matt Peterson C17125T5MattPeterson7-15.docx (Added Oct 8, 2015)

Contact - Matt Peterson C17125T5MattPetersonResume.pdf (Added Mar 11, 2016)
Contact - Mike Kersten C13943T5Mike Kersten Qualifications.doc (Added Aug 19, 2010)
Contact - Rob Fuller C12039T5ROB FULLER_resume.doc (Added Nov 17, 2008)
Project Description - P20656T1ofr20121267.pdf (Added Aug 10, 2016)
Project Description - P20656T1ReservoirTransitStudyPlan_070716.docx (Added Aug 4, 2016)

Status

Application Status:	Submitted
Date Submitted:	August 11, 2016
Last Date Archived:	August 11, 2016

• ESA Section 10(a)(1)(A) permit (Pacific fish/invertebrate research)

Current Status: N/A Status Date: August 3, 2016

Expire Date:

Reports

This section is currently empty.

From: Le, Bao
Sent: Friday, August 12, 2016 9:34 AM
To: Holdeman, Steven J -FS; Vaughn, Gary D -FS
Cc: Garello, Michael; Deason, Jesse
Subject: RE: Anadromous Fish Migration Barriers Study - access to FS road - potentially gated

Thanks, Steve.

I may be imagining it but when we were up at Lumsden Bridge this spring, we noted that the gate was closed/locked. I've cc'd Mike Garello, Barrier Study Lead, who was with me so that he can confirm this observation. If it's usually open or will be so this fall, that's great, as we'd like to drive up that road to get as close to our access points to the river as possible but Dusty, please advise.

Bao

From: Holdeman, Steven J -FS [mailto:sholdeman@fs.fed.us]
Sent: Thursday, August 11, 2016 2:21 PM
To: Le, Bao; Vaughn, Gary D -FS
Subject: RE: Anadromous Fish Migration Barriers Study - access to FS road - potentially gated

Hey Bao,

I'm going to have to refer you to Dusty on that one as to why the road is closed. I have been on that road, 1N10, something like 10 years ago, but we accessed it from the north side of the river. I remember it being pretty rough and steep at one point. I can't remember why we went that way, maybe the bridge isn't safe?

Steven J. Holdeman
Forest Aquatic Biologist

Forest Service
Stanislaus National Forest, Supervisor's Office

p: 209-288-6317
sholdeman@fs.fed.us

19777 Greenley Road
Sonora, CA 95370
www.fs.fed.us

Caring for the land and serving people

From: Le, Bao [mailto:ChiBao.Le@hdrinc.com]
Sent: Thursday, August 11, 2016 12:42 PM
To: Holdeman, Steven J -FS <sholdeman@fs.fed.us>
Cc: Foote, Debra -FS <dfoote@fs.fed.us>; Garello, Michael <Mike.Garello@hdrinc.com>; Deason, Jesse <Jesse.Deason@hdrinc.com>
Subject: Anadromous Fish Migration Barriers Study - access to FS road - potentially gated

Hi Steve.

I hope you're having a great summer. As part of our Fish Migration Barriers Study, we're hoping to evaluate several natural features within the first couple of miles upstream of Lumsden Falls. Mike (study lead cc'd here) and I determined that rafting the Cherry Creek reach would not be the most effective way to evaluate these features and as such, we're planning a foot survey into this area (acknowledging that this approach will be pretty arduous). In our scoping of the area, we noticed a FS road on the north side of Lumsden Bridge that runs above but parallel to the river in the area where the features of interest are located. On our last trip, we noticed this gate was closed and were hoping there might be a way to gain access to this road (if it's not open regularly) so that we can get as close to the features as possible by car using the road before we begin hiking. Is this possible? Our next potential field visit is the week of September 12th and a follow up trip sometime in early/mid-October. Please advise.

Thanks, Bao

Bao Le
Senior Fisheries Biologist

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bao.le@hdrinc.com

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From: Le, Bao
Sent: Monday, August 15, 2016 8:27 AM
To: John Wooster - NOAA Federal
Cc: Staples, Rose; Devine, John; Deason, Jesse
Subject: RE: FW: Request for hatchery fish- Don Pedro Reservoir Transit Study

Ok. Thanks for the head's up, John.

From: John Wooster - NOAA Federal [mailto:john.wooster@noaa.gov]
Sent: Friday, August 12, 2016 12:14 PM
To: Le, Bao
Cc: Staples, Rose
Subject: Re: FW: Request for hatchery fish- Don Pedro Reservoir Transit Study

Hi Bao:

Because of vacations, both mine and others at NMFS, NMFS's comments on the reservoir transit study are going to be delayed. I should be able to have our comments to you early next week.

Sorry for the delay.

John

On Mon, Aug 8, 2016 at 10:59 AM, Le, Bao <ChiBao.Le@hdrinc.com> wrote:

Thanks, John, for making the connection.

Hi Amanda.

As John noted, we will be pursuing permitting for spring run juveniles; however, after discussions with FishBio, who will be leading up the process on the Districts/HDR's behalf, we'll be pursuing a Section 10 permit. I've cc'd Jason here as I imagine he'll be getting in contact with you soon to discuss.

Thanks, Bao

From: John Wooster - NOAA Federal [mailto:john.wooster@noaa.gov]
Sent: Monday, August 08, 2016 10:38 AM
To: Amanda Cranford - NOAA Federal
Cc: Deason, Jesse; Le, Bao
Subject: Re: FW: Request for hatchery fish- Don Pedro Reservoir Transit Study

Hi Amanda:

Please see the email train below. At this time the Districts on the Tuolumne River (and HDR as their consultants) are interested in applying for the necessary permits to obtain spring-run juveniles / smolts for their reservoir transit study. I believe they are going to want to pursue a 4(d) authorization. Can you send them the link for where to apply for that, and any other information you might have?

Bao, I worked with HDR on getting 4(d) authorization for a FERC study on the Yuba - acoustic tracking of spring and fall run near Narrows 2 powerhouse, I believe Joel Passovoy lead that permit application. You might want to check in with him.

I am on leave for another 1.5 weeks, so my email will be sporadic, but I will try and check in as I can.

Thanks,

John

On Tue, Aug 2, 2016 at 1:52 PM, Le, Bao <ChiBao.Le@hdrinc.com> wrote:

Thanks for the information, John. That's unfortunate but understandable.

I understand and acknowledge the challenges and uncertainty of pursuing only Feather River hatchery fish as you describe below but currently, our study plan identifies spring Chinook as the preferred option. To remain consistent with that proposal, we are planning to pursue permitting to acquire them understanding that if returns back to the Feather River hatchery are low, our chances might be small. But in order to ensure that we could get fish (if summer/fall returns are sufficient), we'll need to get a jump on the permitting process. If you could let Amanda know or connect me with her regarding our interest in starting this process that would be much appreciated.

Bao

From: John Wooster - NOAA Federal [mailto:john.wooster@noaa.gov]
Sent: Friday, July 29, 2016 11:50 AM
To: Le, Bao
Cc: Deason, Jesse
Subject: Re: FW: Request for hatchery fish- Don Pedro Reservoir Transit Study

Bao:

Regrading the SJRRP hatchery producing spring-run fish for Don Pedro studies - the answer is no. It doesn't have the capacity to produce extra fish, but probably more relevant, it is not permitted to release fish out of the SJRRP area, to do so would require additional NEPA / section 7 consultation, etc.. - I think more or less redoing the initial hatchery permitting process that took longer than the time frame we are looking at. This is different than the hatchery management plan for Feather River, they are permitted to do such things.....So from what I can tell, the options for obtaining spring-run for this study, are basically Feather River Hatchery - and that is it....How realistic is that? I have a feeling that no one could really tell you until they see what the production /return numbers are from this summer / early fall, but I haven't run into much optimism about the chances. So a whole other layer of permitting to get in line for listed spring run, with a lot longer odds of getting the fish.....

John

On Tue, Jul 26, 2016 at 5:07 PM, Le, Bao <ChiBao.Le@hdrinc.com> wrote:

Thanks, John.

This is really good information. Let me circle back with the Districts and see what it is they would like to do. My feeling is that using spring run would be preferred but acknowledge that the challenges of acquiring them needs to be carefully considered. I'll get back to you as soon as I can.

Bao

From: John Wooster - NOAA Federal [mailto:john.wooster@noaa.gov]
Sent: Tuesday, July 26, 2016 12:38 PM
To: Le, Bao
Cc: Deason, Jesse
Subject: Re: FW: Request for hatchery fish- Don Pedro Reservoir Transit Study

Hi Bao:

I had multiple discussions with folks in the office yesterday, and the general opinion of folks was that choosing fall-run is probably the better path forward, particularly if the spring-run option is feathery river hatchery fish - the spring-run returns have been so low there are questions whether the hatchery will meet broodstock goals let alone produce surplus fish (and there are other demands already in place on any surplus fish). However, there was some optimism that the San Joaquin Restoration Program might have or be able to produce extra spring-run - I have no idea how realistic that is and have some email inquires out, to try and find out.

Yes, if spring-run are involved this will trigger a federal permit because of the listing, there won't be anyway around that. From my experience, and from feedback from Amanda, going the 4(d) authorization is the better path, it is a joint state/federal process where both review concurrently - Amanda is the lead for NMFS on Central Valley permit applications. I updated Amanda yesterday, she has the draft study plan, and is more or less ready to be involved as needed.

Let me see if I can get some clarification on the SJRRP and then maybe we can chat in the next few days.

-John

On Fri, Jul 22, 2016 at 12:16 PM, Le, Bao <ChiBao.Le@hdrinc.com> wrote:

Hi John.

Just checking in on the below. Hope you had a nice vacation.

Welcome back.

Bao

From: John Wooster - NOAA Federal [mailto:john.wooster@noaa.gov]
Sent: Monday, July 18, 2016 9:33 AM
To: Le, Bao
Subject: Re: FW: Request for hatchery fish- Don Pedro Reservoir Transit Study

Bao:

I am on vacation this week through Thursday, but will see what I can get done. I have briefed Amanda on this study and she is going to help us in whatever capacity possible, but let me wade through all the traffic first....

John

On Mon, Jul 18, 2016 at 9:19 AM, Le, Bao <ChiBao.Le@hdrinc.com> wrote:

Hi John.

Please see below regarding the CDFW request for fish to support the Reservoir Transit Study. CDFW has noted that using spring Chinook, which are only available from the Feather River Hatchery, would require a Federal permit. Further input notes that a 4(d) authorization would be preferable given it would meet both state and Federal needs. Questions/thoughts for you here:

1.   Given NMFS has requested and FERC has granted this study, can NMFS assist in facilitating, expediting or even bypassing this requirement?

2.   If a process is needed, a key component seems to be the timing of an approval/permit since securing spring Chinook juveniles for study will need to be planned for in advance of next year. I imagine CDFW will want to know this is authorized by this fall when adults are available at the facility? Perhaps FISHBIO (cc'd here) can provide some input here? But it would seem that this would require that any process be complete or near complete in the next few months to give CDFW the assurance they need?

3.   It would still be valuable to have Amanda formally communicate NMFS' support for this study to CDFW. Perhaps after we've identified a path forward, we could identify key points in that communication.

Let me know if you have time to discuss this week. I'm taking some PTO this week (Tuesday-Thursday) but will be working here and there and could jump on the phone as needed.

Thanks, Bao

From: Alber, Leslie@Wildlife [mailto:Leslie.Alber@wildlife.ca.gov]
Sent: Friday, July 15, 2016 10:27 AM
To: Clifford, Mark@Wildlife; guignard, jason@fishbio.com
Cc: Le, Bao; Purdy, Colin@Wildlife
Subject: RE: Request for hatchery fish- Don Pedro Reservoir Transit Study

Hi Jason,

You will need to get a CESA MOU and either a 10(a)(1)(A) or 4(d) authorization. Because the work in the 4(d) program is thoroughly reviewed by both NOAA and the Department, you will receive a CESA MOU through the process if you are in the program. ESA section 10(a)(1)(A)s are not reviewed by the Department so if you get one you will also need to contact Colin Purdy (Colin.Purdy@wildlife.ca.gov, 916-358-2943) for a CESA MOU. Please feel free to contact me if you have any questions.

Thanks,

Leslie

From: Clifford, Mark@Wildlife
Sent: Friday, July 15, 2016 9:07 AM
To: guignard, jason@fishbio.com
Cc: Bao Le
Subject: RE: Request for hatchery fish- Don Pedro Reservoir Transit Study

Hi Jason,

I was about to forward your request for a pre-Aug 1 review but first gave it a quick read myself….Feather River Hatchery spring run Chinook salmon are CESA and ESA listed, so you would need to get a CESA MOU and appropriate Federal Permit …. Maybe ESA section 10(a)(1)(A) or 4(d), I don't know since I am not a fed permitting expert.

PS: Scientific Collecting Permits do not apply to listed species, so I don't think your SCP applies to this project.

Anyway…..without these authorizations, these fish cannot be made available and you will have to consider an appropriate surrogate.

Mark Clifford, Ph.D.

Statewide Hatchery Coordinator

Senior Environmental Scientist (Specialist)

California Dept Fish and Wildlife

#3 North Old Stage Road

Mt. Shasta, CA 96067

Office: 530-918-9450

CALIFORNIA DEPARTMENT OF FISH and WILDLIFE

Save Our Water

SaveOurWater.com · Drought.CA.gov

From: Jason Guignard [mailto:jasonguignard@fishbio.com]
Sent: Monday, July 11, 2016 2:37 PM
To: Clifford, Mark@Wildlife
Cc: Bao Le
Subject: Request for hatchery fish- Don Pedro Reservoir Transit Study

Hi Mark,

Attached below is the anadromous hatchery fish request for the Upper Tuolumne River which we had discussed a few weeks ago.

I appreciate your willingness to distribute this to necessary regional staff ahead of the August 1 request deadline.

Please let me know if any questions come up during review of this request.

Thank You,

Jason

Jason Guignard

Fisheries Biologist

FISHBIO

jasonguignard@fishbio.com

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--

John Wooster
Hydrologist
NOAA Fisheries West Coast Region
U.S. Department of Commerce
john.wooster@noaa.gov

NOAA FISHERIES West Coast Region

From: Staples, Rose
Sent: Tuesday, August 16, 2016 10:28 AM
Cc: Le, Bao; Deason, Jesse; Staples, Rose
Subject: LG Sept 15 UTR Reintro Assess Framework Workshop No 6 Cancelled

La Grange Licensing Participants,

Please be advised that the La Grange Project Upper Tuolumne River Reintroduction Assessment Framework **Workshop No. 6**, scheduled for **Thursday, September 15, 2016**, has been cancelled. The Districts will reschedule this meeting for later this fall to better allow for the opportunity to present on this summer's upper Tuolumne River field studies and to allow time to make progress on several technical subcommittees.

Note that for those interested in participating, the September 15 date is now being considered for the first conference call of the Temperature Criteria Subcommittee (email forthcoming).

Rose Staples, CAP-OM, MOS
Executive Assistant

HDR
970 Baxter Boulevard Suite 301
Portland ME 04103
D 207-239-3857
rose.staples@hdrinc.com

hdrinc.com/follow-us

From: John Buckley [mailto:johnb@cserc.org]
Sent: Wednesday, August 17, 2016 4:38 PM
To: Staples, Rose; greg.dias@mid.org; seboyd@tid.org; Craig, Nancy; Deason, Jesse
Cc: Peter Drekmeier; James Eicher; abimael.leon@wildlife.ca.gov; Meg Layhee; Patrick Koepele; Theresa Simsiman; epeterson@co.tuolumne.ca.us; Daniel Richardson
Subject: Re: Suggested additions and comments related to the meeting notes for La Grange recreation site visits

From John Buckley
CSERC

Please look over the attached comments to consider their benefit for recreation and as additional input from the field session.

Photos attached are also requested to be part of legal record. Photo #1 shows participants along La Grange Pool. Photo #2 shows the attractive nature of the pool area. Photo #3 shows the rockwork of the canal/ditch on the canyon wall across from the Pool.

John Buckley
CSERC

Photo #1 Participants at the site most likely to be favored for recreational visits to La Grange Pool.

Photo #2 La Grange Pool with island in the river.

Photo #3 (note rock work - historic canal wall on far canyon slope above river)

Central Sierra Environmental Resource Center

Box 396, Twain Harte, CA 95383 • (209) 586-7440 • fax (209) 586-4986

Visit our website at: www.cserc.org or contact us at: johnb@cserc.org

August 16, 2016

Feedback to Nancy Craig and Licensees concerning the debrief meeting at the La Grange recreation fieldtrip session.

1) PARKING TRAILHEAD SITE DOWNSTREAM FROM LA GRANGE POWERHOUSE
As we drove from the La Grange Project powerhouse location, we passed a fairly open, flat area (between the road and the river) that appeared suitable for a public parking area for recreational access to the river (10 parking spaces or less). If the goal is to keep recreational members of the public from driving in further along the road closer to the powerhouse or to prevent any disturbance of the residence, then moving the security gate back slightly closer to the residence could allow public access to the potential parking location.

If such a trailhead parking site was smoothed out, graveled or paved, and bordered with barriers between the parking and the slope down to the river, a relatively minor trail down to the river could provide adequate access for fishing, kayaks/canoes, or wildlife viewing.

Options for enhancement might consider whether either a portable restroom or small permanent restroom would be justified at the site, and whether or not the extension of a water line from the residence area to provide a drinking fountain or water at a restroom would or would not be justified.

2) LA GRANGE POOL LOCATION AS A HIKING OR FISHING ACCESS DESTINATION
At the first recreational site visit some distance below Lake Don Pedro, various participants on the hike down to the La Grange Pool location acknowledged the scenic beauty of the blue oak woodland, the attractive nature of the pool area itself, and the extremely interesting cultural ditch rock wall that had historic significance that could be seen on the south side of the river. Informal discussions at the Pool location included recreational satisfaction from observing ospreys flying back and forth at the site, the obvious value of that Pool location as a good fishing destination worth walking to, and the broad area along the north shore of the river that was available for either picnic tables, benches, or other low cost amenities for recreational visitors.

As at the La Grange Pool location, a recreational assessment might consider whether a minimal outhouse restroom might be located 100" or more back from the riverbank at that flat adjacent to La Grange Pool to provide sanitary benefit. The possibility of a discrete educational and public safety awareness signboard at the flat next to La Grange Pool was also recommended. Any recreational trail to the site or trash clean up/maintenance at the La Grange Pool site was recommended to be very minimal to avoid burdening Licensees while still providing desirable recreational access.

John Buckley

John Buckley, executive director

From: Staples, Rose
Sent: Wednesday, August 17, 2016 11:40 AM
Cc: Deason, Jesse; Craig, Nancy; Staples, Rose
Subject: LG Recreation Site Visit Debrief Mtg Notes for 30-Day Review - Comment
Attachments: LaGrange_RecreationStudySiteVisitDebrief_MeetingNotes.pdf

La Grange Project Licensing Participants,

As part of the La Grange Hydroelectric Project ***Recreation Access and Safety Assessment*** study, on June 30, 2016, the Districts conducted a site visit with licensing participants. Per the FERC-approved study plan, after the site visit a debrief meeting was held with licensing participants. Notes have been prepared summarizing discussions at this debrief meeting.

By this email, the Districts are distributing these draft debrief meeting notes to licensing participants for 30-day review and comment. Please provide any comments on these notes to me at rose.staples@hdrinc.com by Friday, September 16. Final debrief meeting notes will be included in the Recreation Access and Safety Assessment Study Report.

Rose Staples, CAP-OM, MOS
Executive Assistant

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La Grange Hydroelectric Project Licensing (FERC No. 14581)
Recreation Access and Safety Assessment

Site Visit Debrief Meeting Notes

On June 30, 2016, the Districts held a site visit as required by the FERC-approved Recreation Access and Safety Assessment study plan. The purpose of the site visit was to gather site-specific information to be used along with existing aerial photography, topographic data, and property ownership data to produce site assessments and descriptions of potential public access routes at the La Grange Hydroelectric Project (La Grange Project or Project). The site visit began at approximately 8:00 am and concluded at approximately 11:15 am. Individuals who attended the site visit are listed in Table 1.0. The site visit entailed visiting two locations (Figure 1.0, at back): (1) a site along La Grange pool ("La Grange Pool Location") and (2) the La Grange powerhouse.

Table 1.0 Site visit attendees.

No.	Name	Organization
1	Steve Boyd	Turlock Irrigation District
2	Anna Brathwaite	Modesto Irrigation District
3	John Buckley	Central Sierra Environmental Resource Center
4	Chris Collett	Don Pedro Recreation Agency
5	Nancy Craig	HDR, consultant to the Districts
6	Jesse Deason	HDR, consultant to the Districts
7	Greg Dias	Modesto Irrigation District
8	Peter Drekmeier	Tuolumne River Trust
9	Jim Eicher	Bureau of Land Management
10	Art Godwin	Turlock Irrigation District
11	Danielle Hanson	HDR, consultant to the Districts
12	Abimael Leon	California Department of Fish and Wildlife
13	Jim McCoy	Don Pedro Recreation Agency
14	Bill Paris	Modesto Irrigation District

The purpose of these meeting notes is to summarize discussions at the debrief meeting held at the conclusion of the site visit, during which time Ms. Nancy Craig solicited comments from attendees.

Mr. John Buckley said that when there are desirable locations that can provide safe recreation at low cost, he asked that the Districts please think about doing so. In particular, he noted some potential river access sites a short distance downstream of the USGS gaging station and the existing residence located below the La Grange Project powerhouse (see Downstream Location on Figure 1.0). Mr. Buckley said allowing public access to this location would not be particularly burdensome, and could allow for safe access that maintains both security at the Project and residential privacy. He said providing access to this location would likely require relocating the security gate, which is currently located at the turnoff from La Grange Dam Road and prevents public access, to a location farther along the road and closer to the Project facilities.

Mr. Buckley said he also sees value in providing trail access to the La Grange Pool Location, and perhaps installing a small educational sign at the head of the trail. He recognized that there may be constraints to this option as well, given that providing access to this site would also require relocating a security gate.

Mr. Jim Eicher said the route we walked to the La Grange Pool Location was very steep, but that there is a lot of open space which could provide an opportunity to build a contoured trail, or perhaps switchbacks. This trail could provide fishing access and vantage points.

Mr. Eicher said the old ditch on the east side of the river, observable from the La Grange Pool Location, is an interesting cultural and historic feature and has potential to serve as a level hiking trail. He said more information is needed on where the ditch begins and ends, as well as the current condition of the ditch. He said if developing the ditch as a trail is not feasible, the ditch still provides an opportunity for cultural interpretation and education.

Mr. Eicher agreed with Mr. Buckley that the Downstream Location has recreation potential, and that it would be appropriate to provide only a limited number of parking spaces. Mr. Eicher agreed that recreationists should be kept away from Project facilities and the existing residence.

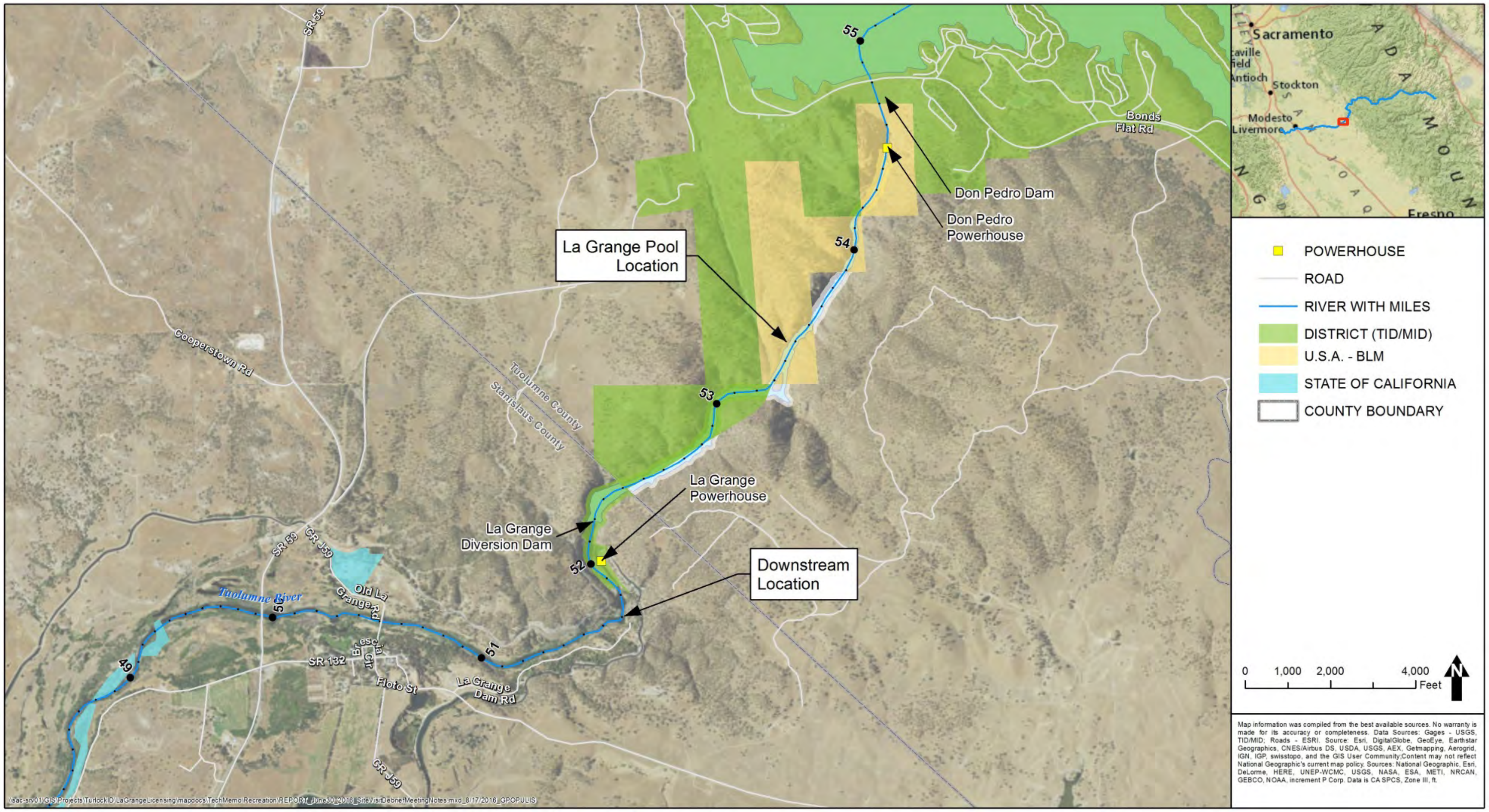

Figure 1.0. **Locations visited during site visit.**

From: Staples, Rose
Sent: Wednesday, August 17, 2016 9:39 AM
Cc: Le, Bao; Deason, Jesse; Staples, Rose
Subject: LG UTR Reintro Assessment Framework-Temp Criteria Subcommittee-Doodle for 1st Conf Call

La Grange Licensing Participants,

Subject: La Grange Upper Tuolumne River Reintroduction Assessment Framework – Temperature Criteria Subcommittee – Doodle for First Conference Call.

As part of the La Grange Project Reintroduction Assessment Framework, the Districts have an action item to convene a subcommittee in order to facilitate the collaborative development of anadromous salmonid temperature criteria to support the evaluation of reintroduction feasibility.

If you are interested in participating in the Temperature Criteria Subcommittee, please go to the Doodle Link below and provide us with your availability regarding the current potential dates for the first subcommittee conference call: September 15 or 16. An agenda and materials are currently being developed and will be distributed in advance of this call.

Thank you.

http://doodle.com/poll/nbaf3s87bv22bnm4

Rose Staples, CAP-OM, MOS
Executive Assistant

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From: John Wooster - NOAA Federal <john.wooster@noaa.gov>
Sent: Monday, August 22, 2016 10:48 AM
To: Jason Guignard
Cc: Le, Bao; Deason, Jesse
Subject: Re: Application #20656

Permitting is obviously not my area of expertise, but from what I have been able to glean from the two processes is that 4(d) authorization is a faster process than Section 10 unless you have just missed the once a year 4(d) application window (which you have not at this point). I understand that with a 4(d) authorization you often don't get your permit in hand until late winter/early spring, I believe because they issue all the 4(d) authorizations for the entire region at one time (so ever 4(d) application must complete a full cycle of review, and they are not all simple requests). However, I believe that it is possible to determine with a fairly high degree of certainty whether you will ultimately receive the permit much earlier than this. The 4(d) applications go out to review to technical staff (sometimes to people like myself) in November / early December, and this is also the time when the state/federal permit folks will notify you if they have any questions and/or foresee any problems.

In your case, where you want to use hatchery fish, ultimately do not expect any (or a very low %) of your experimental population to reach anadromous waters, and would not expect to take/harass any anadromous fish in the lower Tuolumne (at least I can't think of any means at the moment) - this would appear to be a fairly straightforward 4(d) application. Your much larger unknown is whether any hatchery stock can be made available, and whether you can get in line for the hatchery stock prior to actually holding the official authorization - and I don't know the answer to the later, but will inquire....

-John

On Fri, Aug 19, 2016 at 3:42 PM, Jason Guignard <jasonguignard@fishbio.com> wrote:
Hi John,
The issue with the 4(d) process is that the application period closes in October, but new projects are not permitted until sometime in March or April.
With Section 10s being reviewed on an individual basis, thought there was potential for it to be approved earlier.

Jason Guignard
FISHBIO

Sent from my iPhone

On Aug 19, 2016, at 2:47 PM, John Wooster - NOAA Federal <john.wooster@noaa.gov> wrote:

> I'll inquire on Monday, I've never been directly involved with a section 10 permit. I do believe that in order to get one, the permit application needs to be federally noticed (which takes awhile), and there has to be a mandatory public comment period once noticed - and then the folks issuing the permit complete the review with any public comment in hand. While there may be some help that Amanda and I can provide, my gut reaction to a December 1 timeline (just over 3 months away) is not likely.

The extra layers of a Section 10 permit process (and associated time frame), was a primary reason for recommending the 4(d) authorization route. While there is only a once a year window to apply for that, it usually closes around end of September.....

I'll follow up more on Monday....

John

On Fri, Aug 19, 2016 at 9:34 AM, Le, Bao <ChiBao.Le@hdrinc.com> wrote:

Hi John.

Below is an email from Shivonne who is reviewing/processing the Section 10 application. She notes that 6-9 months is typical but in order for this to line up for a 2017 study, we think we'll need NMFS approval by December 1. Is this something you and/or Amanda can assist with?

Thanks, Bao

From: Jason Guignard [mailto:jasonguignard@fishbio.com]
Sent: Thursday, August 18, 2016 1:55 PM
To: Le, Bao
Subject: Fwd: Application #20656

Bao,

Here is the reply from Shivonne regarding the Section 10 timeline.

Any thoughts on the best way to proceed? Should I give her a call, or should we forward on to John W. to see if he is able to move it along?

Begin forwarded message:

From: Shivonne Nesbit - NOAA Federal <shivonne.nesbit@noaa.gov>

Subject: Re: Application #20656

Date: August 18, 2016 at 1:24:04 PM PDT

To: Jason Guignard <jasonguignard@fishbio.com>

Hi Jason,

Section 10(a)(1)(A) permit applications typically take 6-9 months to process. I plan to review your permit application in the next few weeks so I will be in touch with questions.

Shivonne Nesbit

Fish Biologist/ESA Permit Specialist

Protected Resources Division

NOAA Fisheries West Coast Region

1201 NE Lloyd Blvd Suite 1100, Portland, OR 97232

503.231.6741

shivonne.nesbit@noaa.gov

www.westcoast.fisheries.noaa.gov

On Wed, Aug 17, 2016 at 7:27 AM, Jason Guignard <jasonguignard@fishbio.com> wrote:

Thank You Shivonne,

Do you have a general idea on the timeline for processing this application?

Jason Guignard

Fisheries Biologist

FISHBIO

jasonguignard@fishbio.com

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On Aug 16, 2016, at 3:54 PM, Shivonne Nesbit - NOAA Federal <shivonne.nesbit@noaa.gov> wrote:

Hi Chrissy,

Thanks for the email. Yes, we received your Section 10(a)(1)(A) permit application and I changed Jason's address the address included above.

I am currently reviewing applications so I will in touch if I have any questions.

Shivonne Nesbit

Fish Biologist/ESA Permit Specialist

Protected Resources Division

NOAA Fisheries West Coast Region

1201 NE Lloyd Blvd Suite 1100, Portland, OR 97232

503.231.6741

shivonne.nesbit@noaa.gov

www.westcoast.fisheries.noaa.gov

On Fri, Aug 12, 2016 at 3:38 PM, Chrissy Sonke <chrissysonke@fishbio.com> wrote:

Hi,

Our company recently submitted a Section 10 research application. After it was submitted, we realized the physical address for the contact was incorrect in the database. Could you please update Jason Guignard's contact information with the following address?

1617 S. Yosemite Ave.

Oakdale, CA

Thank you! I wasn't sure if it was possible for me to make the changes in the APP system.

Chrissy Sonke

Fisheries Biologist

FISHBIO

chrissysonke@fishbio.com

(209) 614-0813

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--
John Wooster
Hydrologist
NOAA Fisheries West Coast Region
U.S. Department of Commerce
john.wooster@noaa.gov

From: Le, Bao
Sent: Wednesday, August 24, 2016 8:23 AM
To: Vaughn, Gary D -FS
Cc: dfoote@fs.fed.us; Garello, Michael; Deason, Jesse; Holdeman, Steven J -FS
Subject: RE: Drone Survey Follow Up - alternative options and drop dead date

Good morning, Dusty.

Just checking in on the below regarding drone use approval and/or alternatives. Any word?

Thanks, Bao

From: Le, Bao
Sent: Wednesday, August 10, 2016 3:01 PM
To: Vaughn, Gary D -FS
Cc: dfoote@fs.fed.us; Garello, Michael; Deason, Jesse
Subject: Drone Survey Follow Up - alternative options and drop dead date

Hi Dusty.

I just wanted to check-in with you regarding any progress from region on the ability to use a drone to survey Lumsden Falls. Do you have a sense of when you might get feedback? On our end, we need to start planning for both use of a drone and a contingency (using a traditional field crew to collect data at Lumsden Falls) and we assume that this will also require us to amend our existing fish migration barriers study permit. Working backwards from early October (which is when we'd like to conduct the field work), I'm guessing we'll need to better understand our options no later than the end of the month. Any input you may have would be appreciated.

Thanks, Bao

Bao Le
Senior Fisheries Biologist

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From: John Wooster - NOAA Federal [mailto:john.wooster@noaa.gov]
Sent: Wednesday, August 24, 2016 3:10 PM
To: Le, Bao
Subject: Re: FW: Request for hatchery fish- Don Pedro Reservoir Transit Study

The unpublished information was just referring to all the O.mykiss that we sampled during the genetics study, and specifically on the Clavey River for that comment. The reference should have read (2015) since that is when the fish were caught. Hopefully sooner than later there will be a detailed report on all of those fish.

John

On Wed, Aug 24, 2016 at 11:36 AM, Le, Bao <ChiBao.Le@hdrinc.com> wrote:

Thanks, John.

We'll take a look at these along with other comments received.

On another note, I've been meaning to request some unpublished data (2014) that was referenced in your comments on the ISR regarding O. mykiss observations in the upper reach. Can you provide that information for our records since any basic population/distribution information would be useful.

Bao

From: John Wooster - NOAA Federal [mailto:john.wooster@noaa.gov]
Sent: Tuesday, August 23, 2016 4:18 PM
To: Le, Bao
Cc: Staples, Rose; Deason, Jesse
Subject: Re: FW: Request for hatchery fish- Don Pedro Reservoir Transit Study

Hi Bao:

Attached are NMFS comments on the Draft Reservoir Transit Study Plan.

I apologize for the delay and appreciate your patience.

I know your time window is short to turn around the draft study plan and file with FERC. Please give me a call/email if you want to discuss further, I don't have many conflicts this week.....

Thanks,

John

On Fri, Aug 19, 2016 at 8:14 AM, Le, Bao <ChiBao.Le@hdrinc.com> wrote:

Hi John.

As a follow up, please provide NMFS' comments to us by Tuesday of next week so that we can review/address all comments together and get the study plan filed with FERC per the determination.

Let me know if you have any questions.

Thanks, Bao

From: Le, Bao
Sent: Thursday, August 18, 2016 8:39 AM
To: 'John Wooster - NOAA Federal'
Cc: Staples, Rose; Deason, Jesse
Subject: RE: FW: Request for hatchery fish- Don Pedro Reservoir Transit Study

Hi John.

Just checking in on the status of comments? Note we have comments from our email string with Bill Hevlin (you were cc'd on this discussion) but nothing in reference to your email below. Should we still expect more comments and when?

Thanks, Bao

From: John Wooster - NOAA Federal [mailto:john.wooster@noaa.gov]
Sent: Friday, August 12, 2016 12:14 PM
To: Le, Bao
Cc: Staples, Rose
Subject: Re: FW: Request for hatchery fish- Don Pedro Reservoir Transit Study

Hi Bao:

Because of vacations, both mine and others at NMFS, NMFS's comments on the reservoir transit study are going to be delayed. I should be able to have our comments to you early next week.

Sorry for the delay.

John

On Mon, Aug 8, 2016 at 10:59 AM, Le, Bao <ChiBao.Le@hdrinc.com> wrote:

Thanks, John, for making the connection.

Hi Amanda.

As John noted, we will be pursuing permitting for spring run juveniles; however, after discussions with FishBio, who will be leading up the process on the Districts/HDR's behalf, we'll be pursuing a Section 10 permit. I've cc'd Jason here as I imagine he'll be getting in contact with you soon to discuss.

Thanks, Bao

From: John Wooster - NOAA Federal [mailto:john.wooster@noaa.gov]
Sent: Monday, August 08, 2016 10:38 AM
To: Amanda Cranford - NOAA Federal

Cc: Deason, Jesse; Le, Bao
Subject: Re: FW: Request for hatchery fish- Don Pedro Reservoir Transit Study

Hi Amanda:

Please see the email train below. At this time the Districts on the Tuolumne River (and HDR as their consultants) are interested in applying for the necessary permits to obtain spring-run juveniles / smolts for their reservoir transit study. I believe they are going to want to pursue a 4(d) authorization. Can you send them the link for where to apply for that, and any other information you might have?

Bao, I worked with HDR on getting 4(d) authorization for a FERC study on the Yuba - acoustic tracking of spring and fall run near Narrows 2 powerhouse, I believe Joel Passovoy lead that permit application. You might want to check in with him.

I am on leave for another 1.5 weeks, so my email will be sporadic, but I will try and check in as I can.

Thanks,

John

On Tue, Aug 2, 2016 at 1:52 PM, Le, Bao <ChiBao.Le@hdrinc.com> wrote:

Thanks for the information, John. That's unfortunate but understandable.

I understand and acknowledge the challenges and uncertainty of pursuing only Feather River hatchery fish as you describe below but currently, our study plan identifies spring Chinook as the preferred option. To remain consistent with that proposal, we are planning to pursue permitting to acquire them understanding that if returns back to the Feather River hatchery are low, our chances might be small. But in order to ensure that we could get fish (if summer/fall returns are sufficient), we'll need to get a jump on the permitting process. If you could let Amanda know or connect me with her regarding our interest in starting this process that would be much appreciated.

Bao

From: John Wooster - NOAA Federal [mailto:john.wooster@noaa.gov]
Sent: Friday, July 29, 2016 11:50 AM
To: Le, Bao
Cc: Deason, Jesse
Subject: Re: FW: Request for hatchery fish- Don Pedro Reservoir Transit Study

Bao:

Regrading the SJRRP hatchery producing spring-run fish for Don Pedro studies - the answer is no. It doesn't have the capacity to produce extra fish, but probably more relevant, it is not permitted to release fish out of the SJRRP area, to do so would require additional NEPA / section 7 consultation, etc.. - I think more or less redoing the initial hatchery permitting process that took longer than the time frame we are looking at. This is different than the hatchery management plan for Feather River, they are permitted to do such things.....So from what I can tell, the options for obtaining spring-run for this study, are basically Feather River Hatchery - and that is it....How realistic is that? I have a feeling that no one could really tell you until they see what the production /return numbers are from this summer / early fall, but I haven't run into much optimism about the chances. So a whole other layer of permitting to get in line for listed spring run, with a lot longer odds of getting the fish.....

John

On Tue, Jul 26, 2016 at 5:07 PM, Le, Bao <ChiBao.Le@hdrinc.com> wrote:

Thanks, John.

This is really good information. Let me circle back with the Districts and see what it is they would like to do. My feeling is that using spring run would be preferred but acknowledge that the challenges of acquiring them needs to be carefully considered. I'll get back to you as soon as I can.

Bao

From: John Wooster - NOAA Federal [mailto:john.wooster@noaa.gov]
Sent: Tuesday, July 26, 2016 12:38 PM
To: Le, Bao
Cc: Deason, Jesse
Subject: Re: FW: Request for hatchery fish- Don Pedro Reservoir Transit Study

Hi Bao:

I had multiple discussions with folks in the office yesterday, and the general opinion of folks was that choosing fall-run is probably the better path forward, particularly if the spring-run option is feathery river hatchery fish - the spring-run returns have been so low there are questions whether the hatchery will meet broodstock goals let alone produce surplus fish (and there are other demands already in place on any surplus fish). However, there was some optimism that the San Joaquin Restoration Program might have or be able to produce extra spring-run - I have no idea how realistic that is and have some email inquires out, to try and find out.

Yes, if spring-run are involved this will trigger a federal permit because of the listing, there won't be anyway around that. From my experience, and from feedback from Amanda, going the 4(d) authorization is the better path, it is a joint state/federal process where both review concurrently - Amanda is the lead for NMFS on Central Valley permit applications. I updated Amanda yesterday, she has the draft study plan, and is more or less ready to be involved as needed.

Let me see if I can get some clarification on the SJRRP and then maybe we can chat in the next few days.

-John

On Fri, Jul 22, 2016 at 12:16 PM, Le, Bao <ChiBao.Le@hdrinc.com> wrote:

Hi John.

Just checking in on the below. Hope you had a nice vacation.

Welcome back.

Bao

From: John Wooster - NOAA Federal [mailto:john.wooster@noaa.gov]
Sent: Monday, July 18, 2016 9:33 AM

To: Le, Bao
Subject: Re: FW: Request for hatchery fish- Don Pedro Reservoir Transit Study

Bao:

I am on vacation this week through Thursday, but will see what I can get done. I have briefed Amanda on this study and she is going to help us in whatever capacity possible, but let me wade through all the traffic first....

John

On Mon, Jul 18, 2016 at 9:19 AM, Le, Bao <ChiBao.Le@hdrinc.com> wrote:

Hi John.

Please see below regarding the CDFW request for fish to support the Reservoir Transit Study. CDFW has noted that using spring Chinook, which are only available from the Feather River Hatchery, would require a Federal permit. Further input notes that a 4(d) authorization would be preferable given it would meet both state and Federal needs. Questions/thoughts for you here:

1. Given NMFS has requested and FERC has granted this study, can NMFS assist in facilitating, expediting or even bypassing this requirement?

2. If a process is needed, a key component seems to be the timing of an approval/permit since securing spring Chinook juveniles for study will need to be planned for in advance of next year. I imagine CDFW will want to know this is authorized by this fall when adults are available at the facility? Perhaps FISHBIO (cc'd here) can provide some input here? But it would seem that this would require that any process be complete or near complete in the next few months to give CDFW the assurance they need?

3. It would still be valuable to have Amanda formally communicate NMFS' support for this study to CDFW. Perhaps after we've identified a path forward, we could identify key points in that communication.

Let me know if you have time to discuss this week. I'm taking some PTO this week (Tuesday-Thursday) but will be working here and there and could jump on the phone as needed.

Thanks, Bao

From: Alber, Leslie@Wildlife [mailto:Leslie.Alber@wildlife.ca.gov]
Sent: Friday, July 15, 2016 10:27 AM
To: Clifford, Mark@Wildlife; guignard, jason@fishbio.com
Cc: Le, Bao; Purdy, Colin@Wildlife
Subject: RE: Request for hatchery fish- Don Pedro Reservoir Transit Study

Hi Jason,

You will need to get a CESA MOU and either a 10(a)(1)(A) or 4(d) authorization. Because the work in the 4(d) program is thoroughly reviewed by both NOAA and the Department, you will receive a CESA MOU through the process if you are in the program. ESA section 10(a)(1)(A)s are not reviewed by the Department so if you get one you will also need to contact Colin Purdy (Colin.Purdy@wildlife.ca.gov, 916-358-2943) for a CESA MOU. Please feel free to contact me if you have any questions.

Thanks,

Leslie

From: Clifford, Mark@Wildlife
Sent: Friday, July 15, 2016 9:07 AM
To: guignard, jason@fishbio.com
Cc: Bao Le
Subject: RE: Request for hatchery fish- Don Pedro Reservoir Transit Study

Hi Jason,

I was about to forward your request for a pre-Aug 1 review but first gave it a quick read myself….Feather River Hatchery spring run Chinook salmon are CESA and ESA listed, so you would need to get a CESA MOU and appropriate Federal Permit …. Maybe ESA section 10(a)(1)(A) or 4(d), I don't know since I am not a fed permitting expert.

PS: Scientific Collecting Permits do not apply to listed species, so I don't think your SCP applies to this project.

Anyway…..without these authorizations, these fish cannot be made available and you will have to consider an appropriate surrogate.

Mark Clifford, Ph.D.

Statewide Hatchery Coordinator

Senior Environmental Scientist (Specialist)

California Dept Fish and Wildlife

#3 North Old Stage Road

Mt. Shasta, CA 96067

Office: 530-918-9450

CALIFORNIA DEPARTMENT OF FISH and WILDLIFE

Save Our Water

SaveOurWater.com · Drought.CA.gov

From: Jason Guignard [mailto:jasonguignard@fishbio.com]
Sent: Monday, July 11, 2016 2:37 PM
To: Clifford, Mark@Wildlife
Cc: Bao Le
Subject: Request for hatchery fish- Don Pedro Reservoir Transit Study

Hi Mark,

Attached below is the anadromous hatchery fish request for the Upper Tuolumne River which we had discussed a few weeks ago.

I appreciate your willingness to distribute this to necessary regional staff ahead of the August 1 request deadline.

Please let me know if any questions come up during review of this request.

Thank You,

Jason

Jason Guignard

Fisheries Biologist

FISHBIO

jasonguignard@fishbio.com

O: (209) 847-6300

C: (209) 840-9019

www.fishbio.com

--

John Wooster
Hydrologist
NOAA Fisheries West Coast Region
U.S. Department of Commerce
john.wooster@noaa.gov

NOAA FISHERIES West Coast Region

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
WEST COAST REGION
650 Capitol Mall Way, Suite 5-100
Sacramento, California 95814

August 22, 2016

Bao Le, HDR, Inc.
Rose Staples, HDR, Inc.
Turlock Irrigation District (TID)
Modesto Irrigation District (MID)

Re: Comments of NOAA's National Marine Fisheries Service on the Draft Reservoir Transit Study Plan for the La Grange Hydroelectric Project; and Proposed New Information Gathering or Study for the La Grange Hydroelectric Project, P-14581-000.

Dear TID and MID:

NOAA's National Marine Fisheries Service (NMFS) provides the following comments for the Draft Reservoir Transit Study Plan (Study Plan) distributed on July 11, 2016 and the amendment to Study Plan distributed on August 2, 2016:

1. The Study Plan states that eight groups of 60 fish will be released at two sites. However, other than describing that the releases will occur between April and June 2017, there is no detail provided as to the frequency or timing of the releases. For examples, are the fish releases intended to occur at regular weekly or bi-weekly intervals? Will there be an effort to time releases with potential elevated flows due to storms, snowmelt, and/or releases from upstream hydroelectric facilities? NMFS requests that the Districts work with relicensing participants to develop a release schedule for the study fish, including potential adaptively managing the fish releases based on snowpack for the 2016-17 winter as well as spring storm activity.

2. NMFS recommends that the Districts consider releasing fish in early March, when temperatures are cooler, and the potential for spring storms higher. While the precise timing of downstream migration for anadromous fish potentially reintroduced upstream of Don Pedro Reservoir is unknown, spring-run populations in other basins exhibit downstream migratory behavior as early as March and occasionally as early as February. If fish releases are made in early March, then it is likely that at least one, if not two additional groups of study fish are needed. NMFS recommends that additional fish release groups be added to the study plan and permitting process.

3. NMFS recommends installing additional arrays of acoustic receivers in order to maximize the information obtained from implementing the transit study. NMFS recommends installing additional arrays at the following locations: A) One location in the riverine reach of the Tuolumne River between the Lumsden release point and the Above Wards Ferry acoustic array. This gap between release point and first detection array is at least 17 miles, but likely closer to 19 miles. NMFS recommends installing an array near the Grapevine Creek confluence with the Tuolumne River, which is approximately halfway between Lumsden and Wards Ferry, and there is an adequate foot/horse trail down to the Tuolumne River from the south rim. B) NMFS recommends installing an acoustic array in the Woods Creek arm of Don Pedro Reservoir, which is just upstream of the Highway 120 Bridge and Railroad Canyon acoustic array installation site. An array in the Woods Creek reservoir arm, one of the most prominent tributary arms of Don Pedro Reservoir, will provide information as to the location and fate of fish detected near Moccasin Point but not found at Railroad Canyon. C) NMFS also recommends installing an additional array between Railroad Canyon and East Bay, which is proposed to be a 10 mile gap between detection sites. NMFS recommends installing an additional array approximately halfway between these sites, such that the maximum distance between detection sites in Don Pedro Reservoir is about 5 miles.

4. As detailed in the Study Plan Amendment, NMFS supports the use of hatchery fall-run juvenile Chinook in the event that hatchery spring-run Chinook are not available for use. Preliminary information available to NMFS suggests that hatchery spring-run juveniles will be in very low supply in 2017. NMFS recommends that the Districts begin the necessary procedures and permits to obtain fall-run hatchery at this point in time for study implementation.

Sincerely,

John Wooster
FERC Branch
NMFS, West Coast Region

From: "Clifford, Mark@Wildlife" <Mark.Clifford@wildlife.ca.gov>
Subject: RE: Request for hatchery fish- Don Pedro Reservoir Transit Study
Date: August 25, 2016 at 11:16:15 AM PDT
To: "guignard, jason@fishbio.com" <jasonguignard@fishbio.com>

Hi Jason,

Understood on the fall run CHIN as contingency. I think getting a response back by December is a realistic expectation. We're currently reading through the proposals but have not yet had a consensus meeting. I'm scheduling those ASAP.

I'll keep you posted.

Best,

Mark Clifford, Ph.D.
Statewide Hatchery Coordinator
Senior Environmental Scientist (Specialist)
Office: 530-918-9450
Cell: 916-764-2526

CALIFORNIA DEPARTMENT OF FISH and WILDLIFE

Save Our Water

SaveOurWater.com · Drought.CA.gov

From: Jason Guignard [mailto:jasonguignard@fishbio.com]
Sent: Thursday, August 25, 2016 11:10 AM
To: Clifford, Mark@Wildlife
Cc: Bao Le
Subject: Re: Request for hatchery fish- Don Pedro Reservoir Transit Study

Hi Mark,

I just wanted to follow-up with your regarding our hatchery fish request for the Don Pedro Reservoir Transit Study.

We have submitted a Section 10 application with NMFS for use of spring-run fish. While use of spring-run is our preferred option, we recognize that the probability of timely Section 10 approval and availability of hatchery fish is likely low for the proposed 2017 study period.
I wanted to make sure it is clear that our request defaults to fall-run Chinook if it is decided by CDFW that allocation of spring-run is not possible.
Do you have an expected timeframe of when a decision on this allocation request will be made? Given the necessary lead-time for purchase of acoustic tags for this project we will need to make a decision to move forward in early January, so it would be good if we could get an indication from CDFW in December regarding the availability of hatchery fish.

Thanks for your time on this issue, and feel free to call me if you have any questions.

Jason Guignard
Fisheries Biologist

FISHBIO
jasonguignard@fishbio.com
O: (209) 847-6300
C: (209) 840-9019
www.fishbio.com

On Jul 27, 2016, at 9:32 AM, Clifford, Mark@Wildlife <Mark.Clifford@wildlife.ca.gov> wrote:

Received. I looked it over quickly and fall run Chinook from Merced or Mokelumne might prove to be a good surrogate and option if the federal permitting for spring run does not happen in time, or if spring run are not available. We will respond as soon as we have consensus after the August 1 deadline.

Best regards,

Mark Clifford, Ph.D.
Statewide Hatchery Coordinator
Senior Environmental Scientist (Specialist)
California Dept Fish and Wildlife
#3 North Old Stage Road
Mt. Shasta, CA 96067
Office: 530-918-9450
<image001.png>

<image002.jpg>
SaveOurWater.com · Drought.CA.gov

From: Jason Guignard [mailto:jasonguignard@fishbio.com]
Sent: Wednesday, July 27, 2016 8:18 AM
To: Clifford, Mark@Wildlife
Cc: Bao Le; Andrea Fuller
Subject: Re: Request for hatchery fish- Don Pedro Reservoir Transit Study

Hi Mark,

Here is a revised hatchery allocation request for Don Pedro Reservoir Transit Study.

We are working on federal permitting for spring-run, but as a contingent would like to request 1,500 fall-run should permits not be issued in time.

I will be working in the field for the remainder of this week with no email access, so any further questions prior to the Aug. 1 deadline should go to Andrea Fuller (included on this message).

Thank You,

Jason Guignard
Fisheries Biologist

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jasonguignard@fishbio.com
O: (209) 847-6300
C: (209) 840-9019
www.fishbio.com

From: Staples, Rose
Sent: Thursday, August 25, 2016 3:14 PM
To: Steve Edmondson; Jean Castillo - NOAA Federal; John Wooster; Devine, John
Subject: RE: LG Sept 15 UTR Reintro Assess Framework Workshop No 6 Cancelled

Thank you; I have added Jean to my Email Group for La Grange Fish Passage Participants.

Rose Staples, CAP-OM, MOS
D 207-239-3857

hdrinc.com/follow-us

From: Steve Edmondson [mailto:steve.edmondson@noaa.gov]
Sent: Thursday, August 25, 2016 2:50 PM
To: Staples, Rose; Jean Castillo - NOAA Federal; John Wooster; Devine, John
Subject: Re: LG Sept 15 UTR Reintro Assess Framework Workshop No 6 Cancelled

Rose:

Please include Jean Castillo in meetings and notices regarding fish passage. Thanks.-----Steve.

On 8/16/2016 10:27 AM, Staples, Rose wrote:

La Grange Licensing Participants,

Please be advised that the La Grange Project Upper Tuolumne River Reintroduction Assessment Framework **Workshop No. 6**, scheduled for **Thursday, September 15, 2016**, has been cancelled. The Districts will reschedule this meeting for later this fall to better allow for the opportunity to present on this summer's upper Tuolumne River field studies and to allow time to make progress on several technical subcommittees.

Note that for those interested in participating, the September 15 date is now being considered for the first conference call of the Temperature Criteria Subcommittee (email forthcoming).

Rose Staples, CAP-OM, MOS
Executive Assistant

HDR
970 Baxter Boulevard Suite 301
Portland ME 04103
D 207-239-3857
rose.staples@hdrinc.com

hdrinc.com/follow-us

From: "Clifford, Mark@Wildlife" <Mark.Clifford@wildlife.ca.gov>
Subject: RE: Request for hatchery fish- Don Pedro Reservoir Transit Study
Date: August 25, 2016 at 11:16:15 AM PDT
To: "guignard, jason@fishbio.com" <jasonguignard@fishbio.com>

Hi Jason,

Understood on the fall run CHIN as contingency. I think getting a response back by December is a realistic expectation. We're currently reading through the proposals but have not yet had a consensus meeting. I'm scheduling those ASAP.

I'll keep you posted.

Best,

Mark Clifford, Ph.D.
Statewide Hatchery Coordinator
Senior Environmental Scientist (Specialist)
Office: 530-918-9450
Cell: 916-764-2526

CALIFORNIA DEPARTMENT OF FISH and WILDLIFE

From: Jason Guignard [mailto:jasonguignard@fishbio.com]
Sent: Thursday, August 25, 2016 11:10 AM
To: Clifford, Mark@Wildlife
Cc: Bao Le
Subject: Re: Request for hatchery fish- Don Pedro Reservoir Transit Study

Hi Mark,

I just wanted to follow-up with your regarding our hatchery fish request for the Don Pedro Reservoir Transit Study.

We have submitted a Section 10 application with NMFS for use of spring-run fish. While use of spring-run is our preferred option, we recognize that the probability of timely Section 10 approval and availability of hatchery fish is likely low for the proposed 2017 study period.
I wanted to make sure it is clear that our request defaults to fall-run Chinook if it is decided by CDFW that allocation of spring-run is not possible.
Do you have an expected timeframe of when a decision on this allocation request will be made? Given the necessary lead-time for purchase of acoustic tags for this project we will need to make a decision to move forward in early January, so it would be good if we could get an indication from CDFW in December regarding the availability of hatchery fish.

Thanks for your time on this issue, and feel free to call me if you have any questions.

Jason Guignard
Fisheries Biologist

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On Jul 27, 2016, at 9:32 AM, Clifford, Mark@Wildlife <Mark.Clifford@wildlife.ca.gov> wrote:

Received. I looked it over quickly and fall run Chinook from Merced or Mokelumne might prove to be a good surrogate and option if the federal permitting for spring run does not happen in time, or if spring run are not available. We will respond as soon as we have consensus after the August 1 deadline.

Best regards,

Mark Clifford, Ph.D.
Statewide Hatchery Coordinator
Senior Environmental Scientist (Specialist)
California Dept Fish and Wildlife
#3 North Old Stage Road
Mt. Shasta, CA 96067
Office: 530-918-9450
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SaveOurWater.com · Drought.CA.gov

From: Jason Guignard [mailto:jasonguignard@fishbio.com]
Sent: Wednesday, July 27, 2016 8:18 AM
To: Clifford, Mark@Wildlife
Cc: Bao Le; Andrea Fuller
Subject: Re: Request for hatchery fish- Don Pedro Reservoir Transit Study

Hi Mark,

Here is a revised hatchery allocation request for Don Pedro Reservoir Transit Study.

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I will be working in the field for the remainder of this week with no email access, so any further questions prior to the Aug. 1 deadline should go to Andrea Fuller (included on this message).

Thank You,

Jason Guignard
Fisheries Biologist

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jasonguignard@fishbio.com
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C: (209) 840-9019
www.fishbio.com

From: Staples, Rose
Sent: Friday, August 26, 2016 12:41 PM
Cc: Deason, Jesse; Le, Bao; Staples, Rose
Subject: La Grange Temperature Criteria Subcommittee Meeting September 15

La Grange Licensing Participants,

The first conference call for the Temperature Criteria Subcommittee will take place on Thursday, September 15, from 1:00 pm to 3:00 pm.

An agenda and meeting materials are currently being developed and will be distributed in advance of this call, along with the call-in information.

Thank you.

Rose Staples, CAP-OM, MOS
Executive Assistant

HDR
970 Baxter Boulevard Suite 301
Portland ME 04103
D 207-239-3857
rose.staples@hdrinc.com

hdrinc.com/follow-us

From: Le, Bao
Sent: Friday, August 26, 2016 11:19 AM
To: John Wooster - NOAA Federal
Cc: Jason Guignard; Deason, Jesse; Amanda Cranford - NOAA Federal
Subject: RE: FW: Application #20656

Thanks, John.

I'll give Amanda a call shortly (finishing up a task here). As a note, we've already requested fall run Chinook as our back up alternative to the spring Chinook request and have made CDFW aware of this. So in the event spring run fish aren't feasible to obtain, the state is aware that we'd still need test fish of the same number (and as similar in size as possible) in the form of fall run fish.

Bao

From: John Wooster - NOAA Federal [mailto:john.wooster@noaa.gov]
Sent: Friday, August 26, 2016 11:14 AM
To: Le, Bao
Cc: Jason Guignard; Deason, Jesse; Amanda Cranford - NOAA Federal
Subject: Re: FW: Application #20656

Hi Bao:

I was able to cross paths with Amanda in the office yesterday and we discussed the reservoir transit study. Rather than try and summarize our conversation, I think it would be best if you give Amanda a call, as after hearing some updates from Amanda, I believe obtaining juvenile spring-run is going to have more complications than already identified. And the window to try and get fall-run is rapidly closing. While I don't think I need to be on the call per se, I am happy to participate if you think that my history with the Project / study would be of use.

Amanda's office line is: (916) 930-3706 ; cc'ed on this email...

Thanks,

John

On Fri, Aug 19, 2016 at 9:34 AM, Le, Bao <ChiBao.Le@hdrinc.com> wrote:

Hi John.

Below is an email from Shivonne who is reviewing/processing the Section 10 application. She notes that 6-9 months is typical but in order for this to line up for a 2017 study, we think we'll need NMFS approval by December 1. Is this something you and/or Amanda can assist with?

Thanks, Bao

From: Jason Guignard [mailto:jasonguignard@fishbio.com]
Sent: Thursday, August 18, 2016 1:55 PM
To: Le, Bao
Subject: Fwd: Application #20656

Bao,

Here is the reply from Shivonne regarding the Section 10 timeline.

Any thoughts on the best way to proceed? Should I give her a call, or should we forward on to John W. to see if he is able to move it along?

Begin forwarded message:

From: Shivonne Nesbit - NOAA Federal <shivonne.nesbit@noaa.gov>

Subject: Re: Application #20656

Date: August 18, 2016 at 1:24:04 PM PDT

To: Jason Guignard <jasonguignard@fishbio.com>

Hi Jason,

Section 10(a)(1)(A) permit applications typically take 6-9 months to process. I plan to review your permit application in the next few weeks so I will be in touch with questions.

Shivonne Nesbit

Fish Biologist/ESA Permit Specialist

Protected Resources Division

NOAA Fisheries West Coast Region

1201 NE Lloyd Blvd Suite 1100, Portland, OR 97232

503.231.6741

shivonne.nesbit@noaa.gov

NOAA FISHERIES
West Coast Region

www.westcoast.fisheries.noaa.gov

On Wed, Aug 17, 2016 at 7:27 AM, Jason Guignard <jasonguignard@fishbio.com> wrote:

Thank You Shivonne,

Do you have a general idea on the timeline for processing this application?

Jason Guignard

Fisheries Biologist

FISHBIO

jasonguignard@fishbio.com

O: (209) 847-6300

C: (209) 840-9019

www.fishbio.com

On Aug 16, 2016, at 3:54 PM, Shivonne Nesbit - NOAA Federal <shivonne.nesbit@noaa.gov> wrote:

Hi Chrissy,

Thanks for the email. Yes, we received your Section 10(a)(1)(A) permit application and I changed Jason's address the address included above.

I am currently reviewing applications so I will in touch if I have any questions.

Shivonne Nesbit

Fish Biologist/ESA Permit Specialist

Protected Resources Division

NOAA Fisheries West Coast Region

1201 NE Lloyd Blvd Suite 1100, Portland, OR 97232

503.231.6741

shivonne.nesbit@noaa.gov

NOAA FISHERIES West Coast Region

www.westcoast.fisheries.noaa.gov

On Fri, Aug 12, 2016 at 3:38 PM, Chrissy Sonke <chrissysonke@fishbio.com> wrote:

Hi,

Our company recently submitted a Section 10 research application. After it was submitted, we realized the physical address for the contact was incorrect in the database. Could you please update Jason Guignard's contact information with the following address?

1617 S. Yosemite Ave.

Oakdale, CA

Thank you! I wasn't sure if it was possible for me to make the changes in the APP system.

Chrissy Sonke

Fisheries Biologist

FISHBIO

chrissysonke@fishbio.com

(209) 614-0813

www.fishbio.com

--

John Wooster
Hydrologist
NOAA Fisheries West Coast Region
U.S. Department of Commerce
john.wooster@noaa.gov

NOAA FISHERIES West Coast Region

PHONE CALL MEMORANDUM

Topic	Availability of spring-run Chinook for use in Reservoir Transit Study
Date	August 26, 2016
From	Mr. Bao Le, HDR, consultant to the Districts
To	Ms. Amanda Cranford, National Marine Fisheries Service
Summary of Discussion	Mr. Le called Ms. Cranford to discuss the potential for use of spring-run Chinook in the Reservoir Transit Study. Ms. Cranford noted that last week there was an interagency Central Valley hatchery coordination meeting and the Districts' request for spring-run Chinook test fish came up during a discussion about interbasin transfers. Ms. Cranford noted that the current purpose of the Feather River Hatchery did not include producing fish for the Districts' type of request (i.e., this type of purpose is not included in the Hatchery Genetic Management Plan), but she also acknowledged that the hatchery has supplied fish to the San Joaquin River Restoration Program and this was covered under a separate Section 10 permit. Ms. Cranford said given this and the expected low returns to the facility, she did not think that NMFS could grant spring-run Chinook to support this study and recommended the use of fall-run Chinook instead. Mr. Le said the Districts had anticipated these challenges and had already identified fall-run Chinook an alternative test fish. Mr. Le noted that to ensure the study was as scientifically rigorous as possible, and to ensure that the record reflected the Districts' due diligence in the planning phase, the Districts had submitted a Section 10 application and are committed to going through the process. Mr. Le asked if this conversation reflected NMFS' formal determination on the application and said the Districts would appreciate a formal final determination notice from NMFS. Ms. Cranford said this wouldn't be a problem and that the Districts should expect to receive a formal communication by the middle of next week.

From:	Le, Bao
Sent:	Monday, August 29, 2016 9:44 AM
To:	Vaughn, Gary D -FS
Cc:	Foote, Debra -FS; Garello, Michael; Deason, Jesse; Holdeman, Steven J -FS
Subject:	RE: Drone Survey Follow Up - alternative options and drop dead date

Thanks, Dusty.

We're starting to work through a back-up alternative (traditional survey approach with field crew) just in case this doesn't come in or doesn't come in on time. As noted before, we'd hope to collect data in early/mid-October so appreciate you letting us know as soon as you hear.

Bao

From: Vaughn, Gary D -FS [mailto:gdvaughn@fs.fed.us]
Sent: Saturday, August 27, 2016 12:21 PM
To: Le, Bao
Cc: Foote, Debra -FS; Garello, Michael; Deason, Jesse; Holdeman, Steven J -FS
Subject: RE: Drone Survey Follow Up - alternative options and drop dead date

Hi Bao – still no word from our Regional Aviation Officer. I bumped up my request to the USFS UAS Program Manager. I'll let you know as soon as I hear something back.

Thanks,

Dusty Vaughn
Public Service Program Leader
Forest Service
Stanislaus National Forest, Groveland Ranger District
p: 209-962-7825 x525
f: 209-962-7412
gdvaughn@fs.fed.us
24545 State Highway 120
Groveland, CA 95321
www.fs.fed.us

Caring for the land and serving people

From: Le, Bao [mailto:ChiBao.Le@hdrinc.com]
Sent: Wednesday, August 24, 2016 8:23 AM
To: Vaughn, Gary D -FS <gdvaughn@fs.fed.us>
Cc: Foote, Debra -FS <dfoote@fs.fed.us>; Garello, Michael <Mike.Garello@hdrinc.com>; Deason, Jesse <Jesse.Deason@hdrinc.com>; Holdeman, Steven J -FS <sholdeman@fs.fed.us>
Subject: RE: Drone Survey Follow Up - alternative options and drop dead date

Good morning, Dusty.

Just checking in on the below regarding drone use approval and/or alternatives. Any word?

Thanks, Bao

From: Le, Bao
Sent: Wednesday, August 10, 2016 3:01 PM
To: Vaughn, Gary D -FS
Cc: dfoote@fs.fed.us; Garello, Michael; Deason, Jesse
Subject: Drone Survey Follow Up - alternative options and drop dead date

Hi Dusty.

I just wanted to check-in with you regarding any progress from region on the ability to use a drone to survey Lumsden Falls. Do you have a sense of when you might get feedback? On our end, we need to start planning for both use of a drone and a contingency (using a traditional field crew to collect data at Lumsden Falls) and we assume that this will also require us to amend our existing fish migration barriers study permit. Working backwards from early October (which is when we'd like to conduct the field work), I'm guessing we'll need to better understand our options no later than the end of the month. Any input you may have would be appreciated.

Thanks, Bao

Bao Le
Senior Fisheries Biologist

HDR
1001 SW 5th Avenue, Suite 1800
Portland, OR 97204-1134
D 971.202.1722 **M** 503.309.9423
bao.le@hdrinc.com

hdrinc.com/follow-us

From: Le, Bao
Sent: Monday, August 29, 2016 9:41 AM
To: Vaughn, Gary D -FS; Holdeman, Steven J -FS
Cc: Garello, Michael; Deason, Jesse; Foote, Debra -FS
Subject: RE: Anadromous Fish Migration Barriers Study - access to FS road - potentially gated

Thanks for the information, Dusty.

We plan to drive Lumsden Road to get closer to a couple of barrier locations above Lumsden Falls in September and October so it sounds like the road should be open. If this is the case, we should be ok without a key.

Bao

From: Vaughn, Gary D -FS [mailto:gdvaughn@fs.fed.us]
Sent: Saturday, August 27, 2016 12:08 PM
To: Le, Bao; Holdeman, Steven J -FS
Cc: Garello, Michael; Deason, Jesse; Foote, Debra -FS
Subject: RE: Anadromous Fish Migration Barriers Study - access to FS road - potentially gated

Hi Bao,

Lumsden Road (1N10) is closed between Lumsden Bridge and the northern terminus at 1N01 from December 16 to April 14 each year, but we can issue you a key to the lock if you need access to this road during the seasonal closure. The section between Ferretti Road and Lumsden Bridge is open year-round.

Dusty Vaughn
Public Service Program Leader
Forest Service
Stanislaus National Forest, Groveland Ranger District
p: 209-962-7825 x525
f: 209-962-7412
gdvaughn@fs.fed.us
24545 State Highway 120
Groveland, CA 95321
www.fs.fed.us

Caring for the land and serving people

From: Le, Bao [mailto:ChiBao.Le@hdrinc.com]
Sent: Friday, August 12, 2016 9:34 AM
To: Holdeman, Steven J -FS <sholdeman@fs.fed.us>; Vaughn, Gary D -FS <gdvaughn@fs.fed.us>
Cc: Garello, Michael <Mike.Garello@hdrinc.com>; Deason, Jesse <Jesse.Deason@hdrinc.com>
Subject: RE: Anadromous Fish Migration Barriers Study - access to FS road - potentially gated

Thanks, Steve.

I may be imagining it but when we were up at Lumsden Bridge this spring, we noted that the gate was closed/locked. I've cc'd Mike Garello, Barrier Study Lead, who was with me so that he can confirm this observation. If it's usually open or will be so this fall, that's great, as we'd like to drive up that road to get as close to our access points to the river as possible but Dusty, please advise.

Bao

From: Holdeman, Steven J -FS [mailto:sholdeman@fs.fed.us]
Sent: Thursday, August 11, 2016 2:21 PM
To: Le, Bao; Vaughn, Gary D -FS
Subject: RE: Anadromous Fish Migration Barriers Study - access to FS road - potentially gated

Hey Bao,

I'm going to have to refer you to Dusty on that one as to why the road is closed. I have been on that road, 1N10, something like 10 years ago, but we accessed it from the north side of the river. I remember it being pretty rough and steep at one point. I can't remember why we went that way, maybe the bridge isn't safe?

Steven J. Holdeman
Forest Aquatic Biologist

Forest Service
Stanislaus National Forest, Supervisor's Office

p: 209-288-6317
sholdeman@fs.fed.us

19777 Greenley Road
Sonora, CA 95370
www.fs.fed.us

Caring for the land and serving people

From: Le, Bao [mailto:ChiBao.Le@hdrinc.com]
Sent: Thursday, August 11, 2016 12:42 PM
To: Holdeman, Steven J -FS <sholdeman@fs.fed.us>
Cc: Foote, Debra -FS <dfoote@fs.fed.us>; Garello, Michael <Mike.Garello@hdrinc.com>; Deason, Jesse <Jesse.Deason@hdrinc.com>
Subject: Anadromous Fish Migration Barriers Study - access to FS road - potentially gated

Hi Steve.

I hope you're having a great summer. As part of our Fish Migration Barriers Study, we're hoping to evaluate several natural features within the first couple of miles upstream of Lumsden Falls. Mike (study lead cc'd here) and I determined that rafting the Cherry Creek reach would not be the most effective way to evaluate these features and as such, we're planning a foot survey into this area (acknowledging that this approach will be pretty arduous). In our scoping of the area, we noticed a FS road on the north side of Lumsden Bridge that runs above but parallel to the river in the area where the features of interest are located. On our last trip, we noticed this gate was closed and were hoping there might be a way to gain access to this road (if it's not open regularly) so that we can get as close to the features as possible by car using the road before we begin hiking. Is this possible? Our next potential field visit is the week of September 12th and a follow up trip sometime in early/mid-October. Please advise.

Thanks, Bao

Bao Le
Senior Fisheries Biologist

HDR
1001 SW 5th Avenue, Suite 1800
Portland, OR 97204-1134
D 971.202.1722 **M** 503.309.9423
bao.le@hdrinc.com

hdrinc.com/follow-us

From: Staples, Rose
Sent: Wednesday, August 31, 2016 1:40 PM
To: 'Kyle Olcott'
Subject: RE: LG Recreation Site Visit Debrief Mtg Notes for 30-Day Review - Comment

I have added you to the La Grange licensing participants Email group; thank you.

Rose Staples, CAP-OM, MOS
D 207-239-3857

hdrinc.com/follow-us

From: Kyle Olcott [mailto:Kyle.Olcott@ferc.gov]
Sent: Tuesday, August 30, 2016 8:27 AM
To: Staples, Rose
Subject: FW: LG Recreation Site Visit Debrief Mtg Notes for 30-Day Review - Comment

Hi Rose,

I'm the FERC rec planner working on LaGrange. Can you add me to the project mailing list?

Thanks,
Kyle

Kyle Olcott, M.S.
Outdoor Recreation Planner
Federal Energy Regulatory Commission
Division of Hydropower Licensing
888 First Street NE
Washington, DC 20426
Office: 62-16
Office Phone: 202 502 8963

From: James Hastreiter
Sent: Wednesday, August 17, 2016 3:32 PM
To: Kyle Olcott
Subject: FW: LG Recreation Site Visit Debrief Mtg Notes for 30-Day Review - Comment

Hi Kyle,

Here's the meeting notes on the La Grange Project Recreation Access and Safety Assessment site visit I mentioned to you and Tim a while back. You might want to email Rose Staples to get your name on their distribution list.

Thanks
Jim

From: Staples, Rose [mailto:Rose.Staples@hdrinc.com]
Sent: Wednesday, August 17, 2016 11:40 AM
Cc: Deason, Jesse; Craig, Nancy; Staples, Rose
Subject: LG Recreation Site Visit Debrief Mtg Notes for 30-Day Review - Comment

La Grange Project Licensing Participants,

As part of the La Grange Hydroelectric Project ***Recreation Access and Safety Assessment*** study, on June 30, 2016, the Districts conducted a site visit with licensing participants. Per the FERC-approved study plan, after the site visit a debrief meeting was held with licensing participants. Notes have been prepared summarizing discussions at this debrief meeting.

By this email, the Districts are distributing these draft debrief meeting notes to licensing participants for 30-day review and comment. Please provide any comments on these notes to me at rose.staples@hdrinc.com by Friday, September 16. Final debrief meeting notes will be included in the Recreation Access and Safety Assessment Study Report.

Rose Staples, CAP-OM, MOS
Executive Assistant

HDR
970 Baxter Boulevard Suite 301
Portland ME 04103
D 207-239-3857
rose.staples@hdrinc.com

hdrinc.com/follow-us

From: John Wooster - NOAA Federal <john.wooster@noaa.gov>
Sent: Wednesday, August 31, 2016 2:30 PM
To: Le, Bao
Cc: Deason, Jesse
Subject: Re: FW: Request for hatchery fish- Don Pedro Reservoir Transit Study

The genetics report I am not thinking this fall. We've collected a whole additional batch of samples this summer (mostly in the upper Merced, but those will help constrain the story for both basins), and am assuming it will be about the New Year before those are all analyzed in the lab and put through the algorithms, then a few more months to pull the report together.

I don't have an update on the habitat / carrying capacity report, I haven't had contact since before my leave, but is on my to do list.

-John

On Wed, Aug 31, 2016 at 2:17 PM, Le, Bao <ChiBao.Le@hdrinc.com> wrote:

Hi John.

Any ideas as to when this report will be available? Are you thinking this fall?

Also, any updates on timing of availability of the Habitat/Carrying Capacity Report?

Thanks, Bao

From: John Wooster - NOAA Federal [mailto:john.wooster@noaa.gov]
Sent: Wednesday, August 24, 2016 3:10 PM
To: Le, Bao
Subject: Re: FW: Request for hatchery fish- Don Pedro Reservoir Transit Study

The unpublished information was just referring to all the O.mykiss that we sampled during the genetics study, and specifically on the Clavey River for that comment. The reference should have read (2015) since that is when the fish were caught. Hopefully sooner than later there will be a detailed report on all of those fish.

John

On Wed, Aug 24, 2016 at 11:36 AM, Le, Bao <ChiBao.Le@hdrinc.com> wrote:

Thanks, John.

We'll take a look at these along with other comments received.

On another note, I've been meaning to request some unpublished data (2014) that was referenced in your comments on the ISR regarding O. mykiss observations in the upper reach. Can you provide that information for our records since any basic population/distribution information would be useful.

Bao

From: John Wooster - NOAA Federal [mailto:john.wooster@noaa.gov]
Sent: Tuesday, August 23, 2016 4:18 PM
To: Le, Bao
Cc: Staples, Rose; Deason, Jesse
Subject: Re: FW: Request for hatchery fish- Don Pedro Reservoir Transit Study

Hi Bao:

Attached are NMFS comments on the Draft Reservoir Transit Study Plan.

I apologize for the delay and appreciate your patience.

I know your time window is short to turn around the draft study plan and file with FERC. Please give me a call/email if you want to discuss further, I don't have many conflicts this week.....

Thanks,

John

On Fri, Aug 19, 2016 at 8:14 AM, Le, Bao <ChiBao.Le@hdrinc.com> wrote:

Hi John.

As a follow up, please provide NMFS' comments to us by Tuesday of next week so that we can review/address all comments together and get the study plan filed with FERC per the determination.

Let me know if you have any questions.

Thanks, Bao

From: Le, Bao
Sent: Thursday, August 18, 2016 8:39 AM
To: 'John Wooster - NOAA Federal'
Cc: Staples, Rose; Deason, Jesse
Subject: RE: FW: Request for hatchery fish- Don Pedro Reservoir Transit Study

Hi John.

Just checking in on the status of comments? Note we have comments from our email string with Bill Hevlin (you were cc'd on this discussion) but nothing in reference to your email below. Should we still expect more comments and when?

Thanks, Bao

From: John Wooster - NOAA Federal [mailto:john.wooster@noaa.gov]
Sent: Friday, August 12, 2016 12:14 PM
To: Le, Bao
Cc: Staples, Rose
Subject: Re: FW: Request for hatchery fish- Don Pedro Reservoir Transit Study

Hi Bao:

Because of vacations, both mine and others at NMFS, NMFS's comments on the reservoir transit study are going to be delayed. I should be able to have our comments to you early next week.

Sorry for the delay.

John

On Mon, Aug 8, 2016 at 10:59 AM, Le, Bao <ChiBao.Le@hdrinc.com> wrote:

Thanks, John, for making the connection.

Hi Amanda.

As John noted, we will be pursuing permitting for spring run juveniles; however, after discussions with FishBio, who will be leading up the process on the Districts/HDR's behalf, we'll be pursuing a Section 10 permit. I've cc'd Jason here as I imagine he'll be getting in contact with you soon to discuss.

Thanks, Bao

From: John Wooster - NOAA Federal [mailto:john.wooster@noaa.gov]
Sent: Monday, August 08, 2016 10:38 AM
To: Amanda Cranford - NOAA Federal
Cc: Deason, Jesse; Le, Bao
Subject: Re: FW: Request for hatchery fish- Don Pedro Reservoir Transit Study

Hi Amanda:

Please see the email train below. At this time the Districts on the Tuolumne River (and HDR as their consultants) are interested in applying for the necessary permits to obtain spring-run juveniles / smolts for their reservoir transit study. I believe they are going to want to pursue a 4(d) authorization. Can you send them the link for where to apply for that, and any other information you might have?

Bao, I worked with HDR on getting 4(d) authorization for a FERC study on the Yuba - acoustic tracking of spring and fall run near Narrows 2 powerhouse, I believe Joel Passovoy lead that permit application. You might want to check in with him.

I am on leave for another 1.5 weeks, so my email will be sporadic, but I will try and check in as I can.

Thanks,

John

On Tue, Aug 2, 2016 at 1:52 PM, Le, Bao <ChiBao.Le@hdrinc.com> wrote:

Thanks for the information, John. That's unfortunate but understandable.

I understand and acknowledge the challenges and uncertainty of pursuing only Feather River hatchery fish as you describe below but currently, our study plan identifies spring Chinook as the preferred option. To remain consistent with that proposal, we are planning to pursue permitting to acquire them understanding that if returns back to the Feather River hatchery are low, our chances might be small. But in order to ensure that we could get fish (if summer/fall returns are sufficient), we'll need to get a jump on the permitting process. If you could let Amanda know or connect me with her regarding our interest in starting this process that would be much appreciated.

Bao

From: John Wooster - NOAA Federal [mailto:john.wooster@noaa.gov]
Sent: Friday, July 29, 2016 11:50 AM
To: Le, Bao
Cc: Deason, Jesse
Subject: Re: FW: Request for hatchery fish- Don Pedro Reservoir Transit Study

Bao:

Regrading the SJRRP hatchery producing spring-run fish for Don Pedro studies - the answer is no. It doesn't have the capacity to produce extra fish, but probably more relevant, it is not permitted to release fish out of the SJRRP area, to do so would require additional NEPA / section 7 consultation, etc.. - I think more or less redoing the initial hatchery permitting process that took longer than the time frame we are looking at. This is different than the hatchery management plan for Feather River, they are permitted to do such things.....So from what I can tell, the options for obtaining spring-run for this study, are basically Feather River Hatchery - and that is it....How realistic is that? I have a feeling that no one could really tell you until they see what the production /return numbers are from this summer / early fall, but I haven't run into much optimism about the chances. So a whole other layer of permitting to get in line for listed spring run, with a lot longer odds of getting the fish.....

John

On Tue, Jul 26, 2016 at 5:07 PM, Le, Bao <ChiBao.Le@hdrinc.com> wrote:

Thanks, John.

This is really good information. Let me circle back with the Districts and see what it is they would like to do. My feeling is that using spring run would be preferred but acknowledge that the challenges of acquiring them needs to be carefully considered. I'll get back to you as soon as I can.

Bao

From: John Wooster - NOAA Federal [mailto:john.wooster@noaa.gov]
Sent: Tuesday, July 26, 2016 12:38 PM
To: Le, Bao
Cc: Deason, Jesse
Subject: Re: FW: Request for hatchery fish- Don Pedro Reservoir Transit Study

Hi Bao:

I had multiple discussions with folks in the office yesterday, and the general opinion of folks was that choosing fall-run is probably the better path forward, particularly if the spring-run option is feathery river hatchery fish - the spring-run returns have been so low there are questions whether the hatchery will meet broodstock goals let alone produce surplus fish (and there are other demands already in place on any surplus fish). However, there was some optimism that the San Joaquin Restoration Program might have or be able to produce extra spring-run - I have no idea how realistic that is and have some email inquires out, to try and find out.

Yes, if spring-run are involved this will trigger a federal permit because of the listing, there won't be anyway around that. From my experience, and from feedback from Amanda, going the 4(d) authorization is the better path, it is a joint state/federal process where both review concurrently - Amanda is the lead for NMFS on Central Valley permit applications. I updated Amanda yesterday, she has the draft study plan, and is more or less ready to be involved as needed.

Let me see if I can get some clarification on the SJRRP and then maybe we can chat in the next few days.

-John

On Fri, Jul 22, 2016 at 12:16 PM, Le, Bao <ChiBao.Le@hdrinc.com> wrote:

Hi John.

Just checking in on the below. Hope you had a nice vacation.

Welcome back.

Bao

From: John Wooster - NOAA Federal [mailto:john.wooster@noaa.gov]
Sent: Monday, July 18, 2016 9:33 AM
To: Le, Bao
Subject: Re: FW: Request for hatchery fish- Don Pedro Reservoir Transit Study

Bao:

I am on vacation this week through Thursday, but will see what I can get done. I have briefed Amanda on this study and she is going to help us in whatever capacity possible, but let me wade through all the traffic first....

John

On Mon, Jul 18, 2016 at 9:19 AM, Le, Bao <ChiBao.Le@hdrinc.com> wrote:

Hi John.

Please see below regarding the CDFW request for fish to support the Reservoir Transit Study. CDFW has noted that using spring Chinook, which are only available from the Feather River Hatchery, would require a Federal permit. Further input notes that a 4(d) authorization would be preferable given it would meet both state and Federal needs. Questions/thoughts for you here:

1. Given NMFS has requested and FERC has granted this study, can NMFS assist in facilitating, expediting or even bypassing this requirement?

2. If a process is needed, a key component seems to be the timing of an approval/permit since securing spring Chinook juveniles for study will need to be planned for in advance of next year. I imagine CDFW will want to know this is authorized by this fall when adults are available at the facility? Perhaps FISHBIO (cc'd here) can provide some input here? But it would seem that this would require that any process be complete or near complete in the next few months to give CDFW the assurance they need?

3. It would still be valuable to have Amanda formally communicate NMFS' support for this study to CDFW. Perhaps after we've identified a path forward, we could identify key points in that communication.

Let me know if you have time to discuss this week. I'm taking some PTO this week (Tuesday-Thursday) but will be working here and there and could jump on the phone as needed.

Thanks, Bao

From: Alber, Leslie@Wildlife [mailto:Leslie.Alber@wildlife.ca.gov]
Sent: Friday, July 15, 2016 10:27 AM
To: Clifford, Mark@Wildlife; guignard, jason@fishbio.com
Cc: Le, Bao; Purdy, Colin@Wildlife
Subject: RE: Request for hatchery fish- Don Pedro Reservoir Transit Study

Hi Jason,

You will need to get a CESA MOU and either a 10(a)(1)(A) or 4(d) authorization. Because the work in the 4(d) program is thoroughly reviewed by both NOAA and the Department, you will receive a CESA MOU through the process if you are in the program. ESA section 10(a)(1)(A)s are not reviewed by the Department so if you get one you will also need to contact Colin Purdy (Colin.Purdy@wildlife.ca.gov, 916-358-2943) for a CESA MOU. Please feel free to contact me if you have any questions.

Thanks,

Leslie

From: Clifford, Mark@Wildlife
Sent: Friday, July 15, 2016 9:07 AM
To: guignard, jason@fishbio.com
Cc: Bao Le
Subject: RE: Request for hatchery fish- Don Pedro Reservoir Transit Study

Hi Jason,

I was about to forward your request for a pre-Aug 1 review but first gave it a quick read myself….Feather River Hatchery spring run Chinook salmon are CESA and ESA listed, so you would need to get a CESA MOU and appropriate Federal Permit …. Maybe ESA section 10(a)(1)(A) or 4(d), I don't know since I am not a fed permitting expert.

PS: Scientific Collecting Permits do not apply to listed species, so I don't think your SCP applies to this project.

Anyway…..without these authorizations, these fish cannot be made available and you will have to consider an appropriate surrogate.

Mark Clifford, Ph.D.

Statewide Hatchery Coordinator

Senior Environmental Scientist (Specialist)

California Dept Fish and Wildlife

#3 North Old Stage Road

Mt. Shasta, CA 96067

Office: 530-918-9450

CALIFORNIA DEPARTMENT OF FISH and WILDLIFE

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From: Jason Guignard [mailto:jasonguignard@fishbio.com]
Sent: Monday, July 11, 2016 2:37 PM
To: Clifford, Mark@Wildlife
Cc: Bao Le
Subject: Request for hatchery fish- Don Pedro Reservoir Transit Study

Hi Mark,

Attached below is the anadromous hatchery fish request for the Upper Tuolumne River which we had discussed a few weeks ago.

I appreciate your willingness to distribute this to necessary regional staff ahead of the August 1 request deadline.

Please let me know if any questions come up during review of this request.

Thank You,

Jason

Jason Guignard

Fisheries Biologist

FISHBIO

jasonguignard@fishbio.com

O:(209)847-6300

C: (209)840-9019

www.fishbio.com

--

John Wooster
Hydrologist
NOAA Fisheries West Coast Region
U.S. Department of Commerce
john.wooster@noaa.gov

From: Staples, Rose
Sent: Friday, September 2, 2016 3:55 PM
To: 'Peter Drekmeier'
Subject: RE: Uploading to FERC eLibrary

First of all, he needs to E-Register his email address via the FERC.gov website (www.FERC.gov; go to Documents & Filing tab). It should be an easy process to do so.

eRegister - Individuals must register with the Commission to obtain access to all the FERC Online applications.

This then allows him to e-file a document via FERC's E-filing procedure, which would then put the document into FERC's E-Library.

eFiling - Electronically submit qualified documents to FERC in lieu of paper filings

Alternately, in lieu of electronic filing, he can express a paper copy of the document to FERC, noting on a cover page the reason for the filing and noting the FERC Project Number (P-2299 for Don Pedro; La Grange P-14581).

In the COMMUNICATIONS section of the www.donpedro-relicensing.com website, there is also more detailed information on how to file with FERC and points the reader to guidelines available on FERC's website for both electronic and paper filings.

Rose Staples, CAP-OM, MOS
D 207-239-3857

hdrinc.com/follow-us

From: Peter Drekmeier [mailto:peter@tuolumne.org]
Sent: Friday, September 2, 2016 2:55 PM
To: Staples, Rose
Subject: Uploading to FERC eLibrary

Hi Rose,

Lonnie Moore, a Modesto resident who has been participating in the FERC fish passage workshops, has put together a document titled "Fish Passage Project: Species Determination Paper for Anadromous Salmonids." He would like to upload it to the FERC eLibrary.

Could you please explain the best way for him to do this?

Thanks.

-Peter

Peter Drekmeier
Policy Director
peter@tuolumne.org
(415) 882-7252

From: Staples, Rose
Sent: Tuesday, September 06, 2016 3:46 PM
Cc: Deason, Jesse; Le, Bao; Staples, Rose
Subject: La Grange Temp Criteria Subcommittee Conference Call Agenda - Meeting Materials

La Grange Licensing Participants,

At the May 19, 2016 Upper Tuolumne River Reintroduction Assessment Framework Workshop No. 5, the Districts took on several action items toward supporting collaborative development of temperature criteria for assessing reintroduction.

To begin discussions, the ***first conference call for the Temperature Criteria Subcommittee*** will take place on ***Thursday, September 15, from 1:00 pm to 3:00 pm***. A meeting agenda and meeting materials are now available on the La Grange licensing website www.lagrange-licensing.com (see ANNOUNCEMENTS and/or CALENDAR date attachments).

The conference call-in information is as follows:

Phone: 866-583-7984
Code: 8140607

Rose Staples, CAP-OM, MOS
Executive Assistant

HDR
970 Baxter Boulevard Suite 301
Portland ME 04103
D 207-239-3857
rose.staples@hdrinc.com

hdrinc.com/follow-us

From: Le, Bao
Sent: Wednesday, September 07, 2016 12:03 PM
To: Amanda Cranford - NOAA Federal; jasonguignard@fishbio.com
Cc: Deason, Jesse; John Wooster - NOAA Federal; Shivonne Nesbit - NOAA Federal
Subject: RE: Application # 20656 - Reservoir Transit Study

Thanks, Amanda.

We'll continue forward with our efforts to acquire CV fall-run Chinook to support the study.

Bao

From: Amanda Cranford - NOAA Federal [mailto:amanda.cranford@noaa.gov]
Sent: Wednesday, September 07, 2016 11:56 AM
To: Le, Bao; jasonguignard@fishbio.com
Cc: Deason, Jesse; John Wooster - NOAA Federal; Shivonne Nesbit - NOAA Federal
Subject: Application # 20656 - Reservoir Transit Study

Good morning Bao,

This email relates to the pending Section 10(a)(1)(A) Permit application (# 20656), submitted by FISHBIO on August 11, 2016. The purpose of the proposed study is to evaluate the biological feasibility of downstream (juvenile) movement of anadromous fish through Don Pedro Reservoir on the Tuolumne River. In order to conduct this effort, FISHBIO is requesting to obtain Central Valley spring-run Chinook salmon (listed as threatened under the Endangered Species Act) from Feather River Hatchery.

The purpose of this email is to inform you that NMFS has determined that ESA-listed spring-run Chinook salmon from the Feather River Hatchery are the not the appropriate stock to use for this study. This conclusion is based on the following:

1) In order to issue a Section 10(a)(1)(A) Permit for scientific research purposes, a permit application must meet the Section 10(a)(1)(A) Issuance Criteria. One of the questions to consider is, "Whether alternative non-endangered species or population stocks can and should be used."

This question is particularly relevant because there is a high level of uncertainty regarding the survival and fate of these fish. Further, given the purpose of this study (as described in the online permit application), an alternative stock could be used while still answering the questions at hand. Fall-run Chinook salmon and spring-run Chinook salmon exhibit similar sizes and run-timing during juvenile emigration and are often misidentified when using length-at-date criteria due to these similarities.

Non-listed Central Valley fall-run Chinook salmon would be an ideal and appropriate surrogate for spring-run Chinook salmon and should be considered for this study. The following are some of the benefits associated with using hatchery-origin fall-run Chinook salmon in lieu of ESA-listed spring-run Chinook salmon from the Feather River Hatchery:

1) There is no Federal permitting necessary for the experimental use of non-listed hatchery stocks. Given the proposed timeline of the study, use of fall-run Chinook salmon ensures that initiation of the study is not held up while waiting for the issuance of a permit, which can take anywhere from 6-9 months for completion.

2) There are currently five hatcheries in the Central Valley that produce fall-run Chinook salmon, and only one that produces spring-run Chinook salmon. The likelihood of obtaining fall-run Chinook salmon for experimental purposes is far greater than the likelihood of obtaining spring-run from the Feather River Hatchery. This is partially due to the ongoing impacts of drought in California, coupled with lower survival and poor adult returns this year.

3) The spring-run Chinook salmon program at Feather River Hatchery is carried out for conservation and enhancement purposes. This includes contribution to reintroduction efforts, *i.e.* the San Joaquin River Restoration Program. Research, Monitoring, and Evaluation are also a component of this program. However, this is only for the evaluation of the spring-run Chinook salmon hatchery program and does not include general research not related to the Feather River Hatchery.

We are pleased to hear that efforts are currently underway to secure the necessary number of non-listed hatchery-origin Central Valley fall-run Chinook salmon for use in this study, given the potential issues associated with the use of ESA-listed stocks. NMFS is supportive of the proposed study and encourages your continued coordination with the California Department of Fish and Wildlife in order to obtain the juvenile fall-run Chinook salmon needed to carry out this effort. We look forward to seeing the results of the reservoir transit study when they are available.

If you have any questions or concerns regarding this email, please feel free to contact me to discuss further.

Thank you,

Amanda

--

Amanda Cranford
Natural Resource Management Specialist
NOAA Fisheries West Coast Region
U.S. Department of Commerce
California Central Valley Area Office
650 Capitol Mall, Suite 5-100
Sacramento, CA 95814
Office: (916) 930-3706

NOAA FISHERIES
West Coast Region
www.westcoast.fisheries.noaa.gov

From: Jason Guignard [mailto:jasonguignard@fishbio.com]
Sent: Thursday, September 08, 2016 8:06 AM
To: Mark.Clifford@wildlife.ca.gov
Cc: Le, Bao; Devine, John; Andrea Fuller
Subject: Fwd: Application # 20656 - Don Pedro Reservoir Transit Study

Hi Mark,

Below is an email that we received from NMFS yesterday. They will not be approving our Section 10 application for use of spring-run Chinook, and recommend that we move forward with use of fall-run Chinook as a surrogate. I wanted to send this on to you so that CDFW does not further consider allocation of spring-run, but continues to move forward with considering our request for allocation of fall-run Chinook.

Thank You,

Jason Guignard
Fisheries Biologist

FISHBIO
jasonguignard@fishbio.com
O: (209) 847-6300
C: (209) 840-9019
www.fishbio.com

Begin forwarded message:

From: Amanda Cranford - NOAA Federal <amanda.cranford@noaa.gov>
Subject: Application # 20656 - Reservoir Transit Study
Date: September 7, 2016 at 11:56:04 AM PDT
To: chibao.le@hdrinc.com, jasonguignard@fishbio.com
Cc: jesse.deason@hdrinc.com, John Wooster - NOAA Federal <john.wooster@noaa.gov>, Shivonne Nesbit - NOAA Federal <shivonne.nesbit@noaa.gov>

Good morning Bao,

This email relates to the pending Section 10(a)(1)(A) Permit application (# 20656), submitted by FISHBIO on August 11, 2016. The purpose of the proposed study is to evaluate the biological feasibility of downstream (juvenile) movement of anadromous fish through Don Pedro Reservoir on the Tuolumne River. In order to conduct this effort, FISHBIO is requesting to obtain Central Valley spring-run Chinook salmon (listed as threatened under the Endangered Species Act) from Feather River Hatchery.

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This question is particularly relevant because there is a high level of uncertainty regarding the survival and fate of these fish. Further, given the purpose of this study (as described in the online permit application), an alternative stock could be used while still answering the questions at hand. Fall-run Chinook salmon and spring-run Chinook salmon exhibit similar sizes and run-timing during juvenile emigration and are often misidentified when using length-at-date criteria due to these similarities.

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1) There is no Federal permitting necessary for the experimental use of non-listed hatchery stocks. Given the proposed timeline of the study, use of fall-run Chinook salmon ensures that initiation of the study is not held up while waiting for the issuance of a permit, which can take anywhere from 6-9 months for completion.

2) There are currently five hatcheries in the Central Valley that produce fall-run Chinook salmon, and only one that produces spring-run Chinook salmon. The likelihood of obtaining fall-run Chinook salmon for experimental purposes is far greater than the likelihood of obtaining spring-run from the Feather River Hatchery. This is partially due to the ongoing impacts of drought in California, coupled with lower survival and poor adult returns this year.

3) The spring-run Chinook salmon program at Feather River Hatchery is carried out for conservation and enhancement purposes. This includes contribution to reintroduction efforts, *i.e.* the San Joaquin River Restoration Program. Research, Monitoring, and Evaluation are also a component of this program. However, this is only for the evaluation of the spring-run Chinook salmon hatchery program and does not include general research not related to the Feather River Hatchery.

We are pleased to hear that efforts are currently underway to secure the necessary number of non-listed hatchery-origin Central Valley fall-run Chinook salmon for use in this study, given the potential issues associated with the use of ESA-listed stocks. NMFS is supportive of the proposed study and encourages your continued coordination with the California Department of Fish and Wildlife in order to obtain the juvenile fall-run Chinook salmon needed to carry out this effort. We look forward to seeing the results of the reservoir transit study when they are available.

If you have any questions or concerns regarding this email, please feel free to contact me to discuss further.

Thank you,

Amanda

--

Amanda Cranford
Natural Resource Management Specialist
NOAA Fisheries West Coast Region
U.S. Department of Commerce
California Central Valley Area Office
650 Capitol Mall, Suite 5-100
Sacramento, CA 95814
Office: (916) 930-3706

NOAA FISHERIES West Coast Region
www.westcoast.fisheries.noaa.gov

From: "Clifford, Mark@Wildlife" <Mark.Clifford@wildlife.ca.gov>
Subject: Re: Application # 20656 - Don Pedro Reservoir Transit Study
Date: September 9, 2016 at 11:37:23 AM PDT
To: "guignard, jason@fishbio.com" <jasonguignard@fishbio.com>

Received. Thanks Jason.

Mark Clifford, Ph.D.
Statewide Hatchery Coordinator
California Department of Fish and Wildlife

On Sep 8, 2016, at 8:06 AM, Jason Guignard <jasonguignard@fishbio.com> wrote:

> Hi Mark,
>
> Below is an email that we received from NMFS yesterday. They will not be approving our Section 10 application for use of spring-run Chinook, and recommend that we move forward with use of fall-run Chinook as a surrogate. I wanted to send this on to you so that CDFW does not further consider allocation of spring-run, but continues to move forward with considering our request for allocation of fall-run Chinook.
>
> Thank You,
>
> Jason Guignard
> Fisheries Biologist
>
> ***FISHBIO***
> jasonguignard@fishbio.com
> O: (209) 847-6300
> C: (209) 840-9019
> www.fishbio.com
>
> Begin forwarded message:
>
> **From:** Amanda Cranford - NOAA Federal <amanda.cranford@noaa.gov>
> **Subject: Application # 20656 - Reservoir Transit Study**
> **Date:** September 7, 2016 at 11:56:04 AM PDT
> **To:** chibao.le@hdrinc.com, jasonguignard@fishbio.com

Cc: jesse.deason@hdrinc.com, John Wooster - NOAA Federal <john.wooster@noaa.gov>, Shivonne Nesbit - NOAA Federal <shivonne.nesbit@noaa.gov>

Good morning Bao,

This email relates to the pending Section 10(a)(1)(A) Permit application (# 20656), submitted by FISHBIO on August 11, 2016. The purpose of the proposed study is to evaluate the biological feasibility of downstream (juvenile) movement of anadromous fish through Don Pedro Reservoir on the Tuolumne River. In order to conduct this effort, FISHBIO is requesting to obtain Central Valley spring-run Chinook salmon (listed as threatened under the Endangered Species Act) from Feather River Hatchery.

The purpose of this email is to inform you that NMFS has determined that ESA-listed spring-run Chinook salmon from the Feather River Hatchery are the not the appropriate stock to use for this study. This conclusion is based on the following:

1) In order to issue a Section 10(a)(1)(A) Permit for scientific research purposes, a permit application must meet the Section 10(a)(1)(A) Issuance Criteria. One of the questions to consider is, "Whether alternative non-endangered species or population stocks can and should be used."

This question is particularly relevant because there is a high level of uncertainty regarding the survival and fate of these fish. Further, given the purpose of this study (as described in the online permit application), an alternative stock could be used while still answering the questions at hand. Fall-run Chinook salmon and spring-run Chinook salmon exhibit similar sizes and run-timing during juvenile emigration and are often misidentified when using length-at-date criteria due to these similarities.

Non-listed Central Valley fall-run Chinook salmon would be an ideal and appropriate surrogate for spring-run Chinook salmon and should be considered for this study. The following are some of the benefits associated with using hatchery-origin fall-run Chinook salmon in lieu of ESA-listed spring-run Chinook salmon from the Feather River Hatchery:

1) There is no Federal permitting necessary for the experimental use of non-listed hatchery stocks. Given the proposed timeline of the study, use of fall-run Chinook salmon ensures that initiation of the study is not held up while waiting for the issuance of a permit, which can take anywhere from 6-9 months for completion.

2) There are currently five hatcheries in the Central Valley that produce fall-run Chinook salmon, and only one that produces spring-run Chinook salmon. The likelihood of obtaining fall-run Chinook salmon for experimental purposes is far greater than the likelihood of obtaining spring-run from the Feather River Hatchery. This is partially due to the ongoing impacts of drought in California, coupled with lower survival and poor adult returns this year.

3) The spring-run Chinook salmon program at Feather River Hatchery is carried out for conservation and enhancement purposes. This includes contribution to reintroduction efforts, *i.e.* the San Joaquin River Restoration Program. Research, Monitoring, and Evaluation are also a component of this program. However, this is only for the evaluation of the spring-run Chinook salmon hatchery program and does not include general research not related to the Feather River Hatchery.

We are pleased to hear that efforts are currently underway to secure the necessary number of non-listed hatchery-origin Central Valley fall-run Chinook salmon for use in this study, given the potential issues associated with the use of ESA-listed stocks. NMFS is supportive of the proposed study and encourages your continued coordination with the California Department of Fish and Wildlife in order to obtain the juvenile fall-run Chinook salmon needed to carry out this effort. We look forward to seeing the results of the reservoir transit study when they are available.

If you have any questions or concerns regarding this email, please feel free to contact me to discuss further.

Thank you,

Amanda

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Amanda Cranford
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U.S. Department of Commerce
California Central Valley Area Office
650 Capitol Mall, Suite 5-100
Sacramento, CA 95814
Office: (916) 930-3706

NOAA FISHERIES West Coast Region
www.westcoast.fisheries.noaa.gov

From: Le, Bao
Sent: Monday, September 12, 2016 4:50 PM
To: Vaughn, Gary D -FS
Cc: Foote, Debra -FS; Garello, Michael; Deason, Jesse; Holdeman, Steven J -FS
Subject: RE: Drone Survey Follow Up - alternative options and drop dead date

Hi Dusty and Debbie.

We're fast approaching mid-October which is our planned timeframe to survey Lumsden Falls. From a planning perspective on our end, it seems prudent to scope an alternative to the use of a drone to ensure that we complete the Lumsden Falls data collection before winter. As such, Mike Garello has been working on scoping a more traditional ground-based approach to gathering the needed information. The effort may take longer and put "boots on the ground" but the data is extremely important to complete our Migration Barriers Assessment. Since we need to apply for an amendment to the existing permit amendment anyways, we'll be putting this information together in a permit amendment application. What we'd like to know is what the drop dead date would be to file an permit amendment application to ensure that we have approval to conduct the field work; whatever method it might be. Please advise.

Thanks, Bao

From: Vaughn, Gary D -FS [mailto:gdvaughn@fs.fed.us]
Sent: Saturday, August 27, 2016 12:21 PM
To: Le, Bao
Cc: Foote, Debra -FS; Garello, Michael; Deason, Jesse; Holdeman, Steven J -FS
Subject: RE: Drone Survey Follow Up - alternative options and drop dead date

Hi Bao – still no word from our Regional Aviation Officer. I bumped up my request to the USFS UAS Program Manager. I'll let you know as soon as I hear something back.

Thanks,

Dusty Vaughn
Public Service Program Leader
Forest Service
Stanislaus National Forest, Groveland Ranger District
p: 209-962-7825 x525
f: 209-962-7412
gdvaughn@fs.fed.us
24545 State Highway 120
Groveland, CA 95321
www.fs.fed.us

Caring for the land and serving people

From: Le, Bao [mailto:ChiBao.Le@hdrinc.com]
Sent: Wednesday, August 24, 2016 8:23 AM
To: Vaughn, Gary D -FS <gdvaughn@fs.fed.us>
Cc: Foote, Debra -FS <dfoote@fs.fed.us>; Garello, Michael <Mike.Garello@hdrinc.com>; Deason, Jesse <Jesse.Deason@hdrinc.com>; Holdeman, Steven J -FS <sholdeman@fs.fed.us>
Subject: RE: Drone Survey Follow Up - alternative options and drop dead date

Good morning, Dusty.

Just checking in on the below regarding drone use approval and/or alternatives. Any word?

Thanks, Bao

From: Le, Bao
Sent: Wednesday, August 10, 2016 3:01 PM
To: Vaughn, Gary D -FS
Cc: dfoote@fs.fed.us; Garello, Michael; Deason, Jesse
Subject: Drone Survey Follow Up - alternative options and drop dead date

Hi Dusty.

I just wanted to check-in with you regarding any progress from region on the ability to use a drone to survey Lumsden Falls. Do you have a sense of when you might get feedback? On our end, we need to start planning for both use of a drone and a contingency (using a traditional field crew to collect data at Lumsden Falls) and we assume that this will also require us to amend our existing fish migration barriers study permit. Working backwards from early October (which is when we'd like to conduct the field work), I'm guessing we'll need to better understand our options no later than the end of the month. Any input you may have would be appreciated.

Thanks, Bao

Bao Le
Senior Fisheries Biologist

HDR
1001 SW 5th Avenue, Suite 1800
Portland, OR 97204-1134
D 971.202.1722 **M** 503.309.9423
bao.le@hdrinc.com

hdrinc.com/follow-us

From: John Wooster - NOAA Federal <john.wooster@noaa.gov>
Sent: Tuesday, September 13, 2016 4:11 PM
To: Staples, Rose
Cc: Deason, Jesse; Le, Bao; Steve Edmondson - NOAA Federal
Subject: Re: La Grange Temp Criteria Subcommittee Conference Call Agenda - Meeting Materials

Bao:

Regrettably I will not make this call as I am in the field all week, and the most likely NMFS substitute for me (Tom Holley) is also in the field with me. Thus it is uncertain whether NMFS will be on the call on Thursday.

-John

On Tue, Sep 6, 2016 at 3:45 PM, Staples, Rose <Rose.Staples@hdrinc.com> wrote:

La Grange Licensing Participants,

At the May 19, 2016 Upper Tuolumne River Reintroduction Assessment Framework Workshop No. 5, the Districts took on several action items toward supporting collaborative development of temperature criteria for assessing reintroduction.

To begin discussions, the ***first conference call for the Temperature Criteria Subcommittee*** will take place on ***Thursday, September 15, from 1:00 pm to 3:00 pm***. A meeting agenda and meeting materials are now available on the La Grange licensing website www.lagrange-licensing.com (see ANNOUNCEMENTS and/or CALENDAR date attachments).

The conference call-in information is as follows:

Phone: 866-583-7984

Code: 8140607

Rose Staples, CAP-OM, MOS

Executive Assistant

HDR

970 Baxter Boulevard Suite 301
Portland ME 04103

D 207-239-3857
rose.staples@hdrinc.com

hdrinc.com/follow-us

--
John Wooster
Hydrologist
NOAA Fisheries West Coast Region
U.S. Department of Commerce
john.wooster@noaa.gov

From: Le, Bao
Sent: Thursday, September 15, 2016 9:52 AM
To: John Wooster - NOAA Federal; Staples, Rose
Cc: Deason, Jesse; Steve Edmondson - NOAA Federal; Devine, John
Subject: RE: La Grange Temp Criteria Subcommittee Conference Call Agenda - Meeting Materials

Thanks for the update, John.

We'll miss you.

Bao

From: John Wooster - NOAA Federal [mailto:john.wooster@noaa.gov]
Sent: Tuesday, September 13, 2016 4:11 PM
To: Staples, Rose
Cc: Deason, Jesse; Le, Bao; Steve Edmondson - NOAA Federal
Subject: Re: La Grange Temp Criteria Subcommittee Conference Call Agenda - Meeting Materials

Bao:

Regrettably I will not make this call as I am in the field all week, and the most likely NMFS substitute for me (Tom Holley) is also in the field with me. Thus it is uncertain whether NMFS will be on the call on Thursday.

-John

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Code: 8140607

Rose Staples, CAP-OM, MOS

Executive Assistant

HDR

970 Baxter Boulevard Suite 301
Portland ME 04103
D 207-239-3857
rose.staples@hdrinc.com

hdrinc.com/follow-us

--
John Wooster
Hydrologist
NOAA Fisheries West Coast Region
U.S. Department of Commerce
john.wooster@noaa.gov

NOAA FISHERIES
West Coast Region

From: Staples, Rose
Sent: Friday, September 16, 2016 1:39 PM
Cc: Deason, Jesse; Staples, Rose; Le, Bao
Subject: La Grange - Reservoir Transit Study Plan filed with FERC Today

The Districts filed with FERC today for the La Grange Project P-14581 the *Reservoir Transit Study Plan, Plan Amendment, and Response to Comments.* A copy of this document can be found on the licensing website (www.lagrange-licensing.com) under the DOCUMENTS tab—or on FERC's E-Library at www.FERC.gov.

Rose Staples, CAP-OM, MOS
Executive Assistant

HDR
970 Baxter Boulevard Suite 301
Portland ME 04103
D 207-239-3857
rose.staples@hdrinc.com

hdrinc.com/follow-us

From: Le, Bao
Sent: Monday, September 19, 2016 2:36 PM
To: Jean Castillo - NOAA Federal; Staples, Rose
Cc: Deason, Jesse; Devine, John
Subject: RE: La Grange Temp Criteria Subcommittee Conference Call Agenda - Meeting Materials
Attachments: TMNo 1_LaGrange_Fish Passage Alternatives Assessment_20150904.pdf

Hi Jean.

Attached is technical memorandum No. 1 to the Fish Passage Facilities Assessment. As some background, this was the initial fish passage engineering scoping document developed for the study and identified a number of information gaps that would help support the development of potential fish passage concepts. It was distributed in October of last year for review/comment and feedback but none were received. Information needs are in section 3.4 of the document so any input on these items would be greatly appreciated (target species, migration timing, population sizes, etc.). I've cc'd John Devine in case he has anything to add.

Please let me know if you have any questions.

Thanks, Bao

From: Jean Castillo - NOAA Federal [mailto:jean.castillo@noaa.gov]
Sent: Monday, September 19, 2016 1:49 PM
To: Staples, Rose
Cc: Deason, Jesse; Le, Bao
Subject: Re: La Grange Temp Criteria Subcommittee Conference Call Agenda - Meeting Materials

HI Bao,

Were you able to find the fish passage report you spoke of during last weeks meeting? I believe you said you were still waiting for some feedback from NMFS on it?

Thanks,
Jean

Jean M. Castillo, MSCE, P.E.
Hydraulic/Fish Passage Engineer

NOAA Fisheries West Coast Region
U.S. Department of Commerce
650 Capitol Mall, Suite 5-100
Sacramento, California 95814-4700
Office: 916-930-3613
jean.castillo@noaa.gov

On Tue, Sep 6, 2016 at 3:45 PM, Staples, Rose <Rose.Staples@hdrinc.com> wrote:

La Grange Licensing Participants,

At the May 19, 2016 Upper Tuolumne River Reintroduction Assessment Framework Workshop No. 5, the Districts took on several action items toward supporting collaborative development of temperature criteria for assessing reintroduction.

To begin discussions, the ***first conference call for the Temperature Criteria Subcommittee*** will take place on ***Thursday, September 15, from 1:00 pm to 3:00 pm***. A meeting agenda and meeting materials are now available on the La Grange licensing website www.lagrange-licensing.com (see ANNOUNCEMENTS and/or CALENDAR date attachments).

The conference call-in information is as follows:

Phone: 866-583-7984

Code: 8140607

Rose Staples, CAP-OM, MOS

Executive Assistant

HDR

970 Baxter Boulevard Suite 301
Portland ME 04103
D 207-239-3857
rose.staples@hdrinc.com

hdrinc.com/follow-us

FISH PASSAGE FACILITIES ALTERNATIVES ASSESSMENT
TECHNICAL MEMORANDUM NO. 1
EXISTING SITE CONSIDERATIONS AND DESIGN CRITERIA

LA GRANGE HYDROELECTRIC PROJECT
FERC NO. 14581

TID WATER & POWER
Serving Central California since 1887

MID Modesto Irrigation District
The Power to Grow

Prepared for:
Turlock Irrigation District – Turlock, California
Modesto Irrigation District – Modesto, California

Prepared by:
HDR, Inc.

September 2015

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List of Acronyms and Abbreviations

ACOE.........................U.S. Army Corps of Engineers
CCSF..........................City and County of San Francisco
CDFG.........................California Department of Fish and Game
CDFW........................California Department of Fish and Wildlife
cfs..............................cubic feet per second
Districts......................Modesto Irrigation District and Turlock Irrigation District
EDF............................energy dissipation factor
ESA............................Endangered Species Act
ESU............................evolutionary significant unit
FERC..........................Federal Energy Regulatory Commission
ft................................feet
ft/s.............................feet/second
ILP.............................Integrated Licensing Process
LGDD........................La Grange Diversion Dam
LP..............................licensing participant
M&I...........................municipal and industrial
MID...........................Modesto Irrigation District
mm............................millimeters
MW...........................megawatt
NGVD 29...................1929 National Geodetic Vertical Datum
NMFS.........................National Marine Fisheries Service
O&M..........................operations and maintenance
RM............................river mile
SFPUC.......................San Francisco Public Utilities Commission
TID............................Turlock Irrigation District
TM.............................Technical Memorandum
TRTAC......................Tuolumne River Technical Advisory Committee
USGS.........................Unite State Geological Survey

1.0 INTRODUCTION

This Technical Memorandum (TM) No. 1 is the first of three interim work products developed for the Fish Passage Alternatives Facilities Assessment for the La Grange Hydroelectric Project (La Grange Project or Project; Federal Energy Regulatory Commission [FERC] No. 14581). This TM No. 1 provides information and analysis necessary to characterize site-specific considerations and anticipated fish passage criteria which may influence the formulation, evaluation, and conceptual design of fish passage facilities alternatives which may be determined viable for the Project. Upon receipt of feedback from licensing participants (LP), future versions of the TM will be prepared and released for review. The release of multiple interim work products is intended to facilitate a collaborative process where feedback and consensus can be obtained prior to initiating next steps in the study.

1.1 Background

The Turlock Irrigation District (TID) and Modesto Irrigation District (MID) (collectively, the Districts) own the La Grange Diversion Dam (LGDD) located on the Tuolumne River in Stanislaus County, California (Figure 1.1-1). LGDD was constructed from 1891 to 1893 to replace Wheaton Dam, which was built by other parties in the early 1870s. The LGDD raised the level of the Tuolumne River to permit the diversion and delivery of water by gravity to irrigation systems owned by TID and MID. The Districts' irrigation systems currently provide water to over 200,000 acres of prime Central Valley farmland and drinking water to the City of Modesto. Built in 1924, the La Grange hydroelectric plant is located approximately 0.2 miles downstream of LGDD on the east (left) bank of the Tuolumne River and is owned and operated by TID. The powerhouse has a capacity of slightly less than five megawatts (MW). The La Grange Project operates in a run-of-river mode. The LGDD provides no flood control benefits, and there are no recreation facilities associated with the La Grange Project or the La Grange pool.

LGDD is 131 feet high and is located at river mile (RM) 52.2 at the exit of a narrow canyon, the walls of which contain the pool formed by the diversion dam. Under normal river flows, the pool formed by the diversion dam extends for approximately one mile upstream. When not in spill mode, the water level above the diversion dam is between elevation[1] 294 feet and 296 feet approximately 90 percent of the time. Within this 2-foot range, the pool storage is estimated to be less than 100 acre-feet of water.

The drainage area of the Tuolumne River upstream of LGDD is approximately 1,550 square miles. Tuolumne River flows upstream of LGDD are regulated by four upstream reservoirs: Hetch Hetchy, Lake Eleanor, Cherry Lake, and Don Pedro. The Don Pedro Hydroelectric Project (FERC No. 2299) is owned jointly by the Districts, and the other three dams are owned by the City and County of San Francisco (CCSF). Inflow to the La Grange pool is the sum of releases from the Don Pedro Project, located 2.6 miles upstream, and very minor contributions from two small intermittent streams downstream of Don Pedro Dam.

[1] All elevations in this document are referenced to 1929 National Geodetic Vertical Datum (NGVD 29).

Figure 1.1-1. Site and vicinity of La Grange Diversion Dam.

1.2 Fish Passage Facilities Alternatives Assessment

As part of the Integrated Licensing Process (ILP) for the La Grange Project, the Districts are completing a phased, two-year Fish Passage Facilities Alternatives Assessment to identify and develop potentially viable, concept-level alternatives for upstream and downstream passage of Chinook salmon and steelhead at the La Grange and Don Pedro dams. The study area for the Fish Passage Facilities Alternatives Assessment is the Tuolumne River immediately downstream of the LGDD (at the confluence of the main river channel and the powerhouse tailrace channel) upstream to the upper Tuolumne River at the upper most extent of the Don Pedro Reservoir. For the purposes of the Fish Passage Facilities Alternatives Assessment, all facilities are assumed to occur within the designated study area in control of the Project owners TID and MID. The overall study area for the assessment is presented in Figure 1.2-1.

Specific objectives of the Fish Passage Facilities Alternatives Assessment are to:

- Obtain available information to establish existing baseline conditions relevant to impoundment operations and siting passage facilities,
- Obtain and evaluate available hydrologic data and biological information for the Tuolumne River to identify potential types and locations of facilities, run size, fish periodicity, and the anticipated range of flows that correspond to fish migration,
- Formulate and develop preliminary sizing and functional design for select, alternative potential upstream and downstream fish passage facilities, and
- Develop Class-V opinions of probable construction cost and annual operations and maintenance (O&M) costs for select fish passage concept(s).

The Fish Passage Facilities Alternatives Assessment will occur in two phases. Phase 1 (conducted in 2015) will involve collaborative information gathering and evaluation of facility siting, sizing, general biological and engineering design parameters, and operational considerations. Phase 2 (conducted in 2016) will involve the development of preliminary functional layouts and site plans, estimation of preliminary capital and O&M costs, and identification of any additional significant information needs for select passage alternatives.

To facilitate a collaborative process, the Districts will produce two TMs during Phase 1, each summarizing key results to date. Both TMs will be provided to LPs for review and comment, with the goal of soliciting feedback on the overall approach and findings and reaching a consensus prior to initiating next steps in the study.

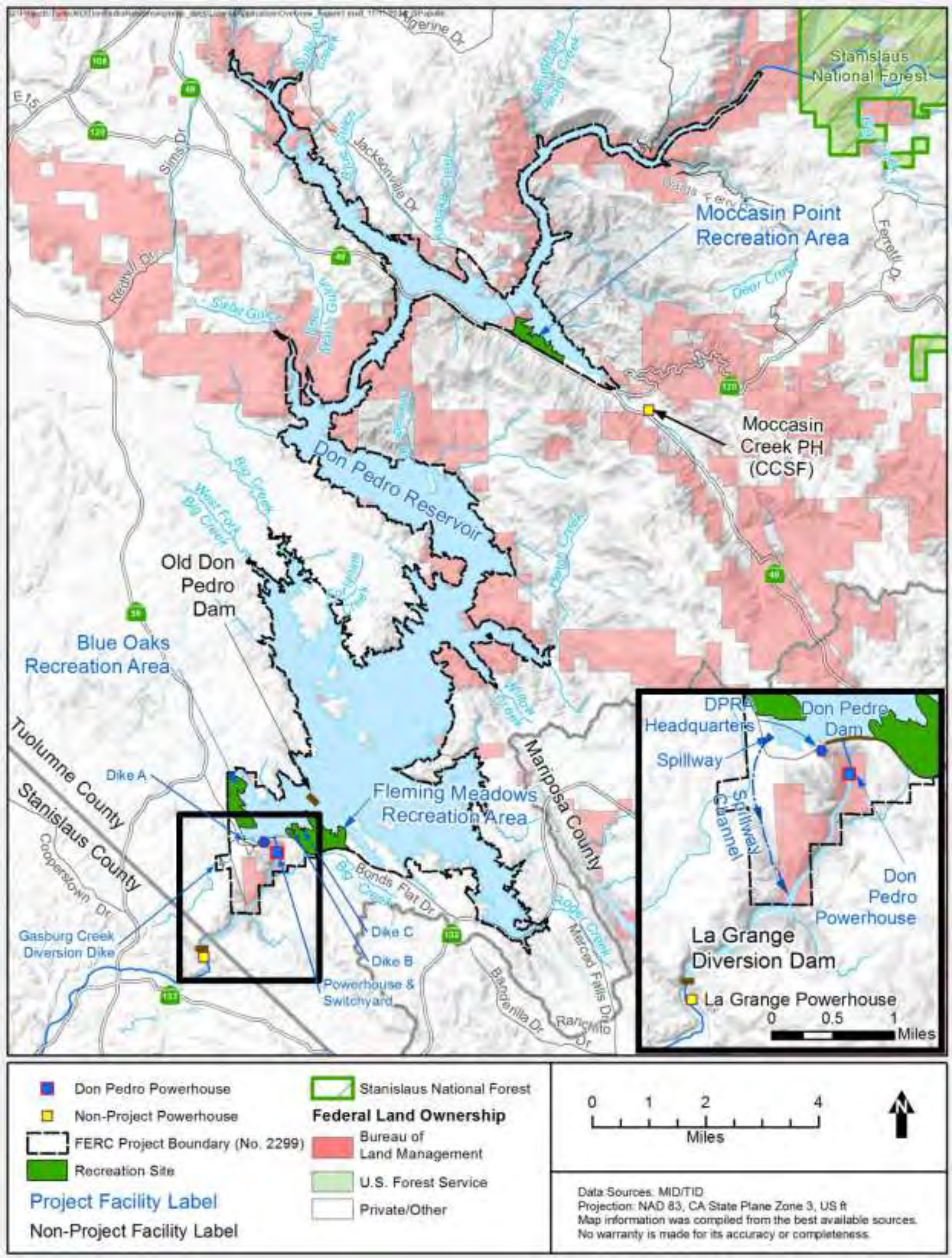

Figure 1.2-1 Overall study area for the Fish Passage Facilities Alternatives Assessment.

1.3 Goal of Technical Memorandum No. 1

The goal of this TM No. 1 is to provide the information, analysis, and design criteria necessary to characterize site-specific fish passage considerations and objectives. Where needed information is not available, data gaps have been identified. It is the Districts' hope that LPs review this document and come to the La Grange Fish Passage Facilities Alternatives Assessment Workshop No. 2 (scheduled for Thursday, September 17) prepared to discuss its contents. Information relative to future expected fish species occurrence, population sizes, run timing, and facility performance will require input from others. Input received from LPs during review and discussion of the TM No. 1 contents will be incorporated into future work being performed to complete this assessment.

2.0 FISH PASSAGE FACILITIES CONSIDERATIONS

The following sections include existing, site-specific information that characterizes the biological and physical setting of the proposed study area which influences the applicability and selection of fish passage facilities alternatives.

2.1 Anadromous Fisheries Resources

The intent of the Fish Passage Facilities Alternatives Assessment was formulated based upon information provided by LPs in their study requests and considers passage of three anadromous fish species: fall-run Chinook, spring-run Chinook, and steelhead. Historically, both fall- and spring-run Chinook salmon occurred in the Tuolumne River basin. Currently, only a fall-run Chinook salmon population is present, while spring-run have been extirpated from the Tuolumne and San Joaquin River watershed for decades. A population of *O. mykiss* occur within the Tuolumne River but there is no evidence that a self-sustaining population of anadromous steelhead currently exists within the Tuolumne River watershed. The habitat suitability and future occurrence and numbers of these species is therefore unknown as all three candidate species would require reintroduction into the Tuolumne River above Don Pedro Reservoir. The viability of reintroduction is unknown at this time and therefore the inclusion of these three target species into the Fish Passage Facilities Alternatives Assessment process may be revised as input from LPs is obtained. A more detailed description of each species and their occurrence in the Tuolumne River is provided in the following sections.

2.1.1 Fall-run Chinook

Adult fall-run Chinook salmon migration in the Tuolumne River extends upstream to the vicinity of the LGDD and occurs from September through December, with peak migration activity occurring in October and November (TID/MID 2013c). Spawning occurs in late October to early January, soon after fish enter the river. Spawning occurs in the gravel-bedded reach (upstream of RM 24) where suitable spawning substrates exist. Egg incubation and fry emergence occur from October through early February. Juvenile fall-run Chinook have a relatively short freshwater rearing period before smolt emigrate to the ocean during the spring months.

Since completion of Don Pedro Dam in 1971, spawner estimates have ranged from 40,300 in 1985 to 77 in 1991 (TID/MID 2010, Report 2009-2). From 1971 to 2013, the date of the peak weekly live spawner count has ranged from October 31 (1996) to November 27 (1972), with a median date of November 12 (TID/MID 2010, Report 2009-2). Since fall 2009, escapement monitoring has been conducted at a counting weir established at RM 24.5, near the downstream end of the gravel-bedded reach (TID/MID 2010, Report 2009-8). Since 1971, California Department of Fish and Wildlife (CDFW; formerly known as the California Department of Fish and Game [CDFG]) has conducted annual salmon spawning surveys. In addition to CDFW's work, the Districts have studied fall-run Chinook salmon on the lower Tuolumne River through annual seine surveys conducted since 1986, annual snorkel surveys since 1982, fish weir counts since 2009, and more recently as part of the Don Pedro Project relicensing process.

2.1.2 Spring-Run Chinook

Currently, spring-run Chinook salmon do not occur within Tuolumne River. Central Valley spring-run Chinook salmon, were listed by the National Marine Fisheries Service (NMFS) as threatened under the Endangered Species Act (ESA) on September 16, 1999 (64 FR 50394). NMFS (1999) concluded that the Central Valley spring-run Chinook salmon evolutionary significant unit (ESU) was in danger of extinction and native spring-run Chinook salmon were extirpated from the San Joaquin River Basin. NMFS has acknowledged that information is limited regarding the historical adult escapement for Chinook salmon in the Tuolumne River and review of available literature did not reveal readily available estimates of historical escapement estimates (NMFS 2014). Spring-run Chinook escapement estimates have been described more broadly to the San Joaquin River but tributary-specific escapement estimates are not available. Moyle (2002) suggested that spring-run Chinook salmon in the upper San Joaquin River probably exceeded 200,000 fish at times, and further stated that "*it is likely that an equal number of fish were once produced by the combined spring runs in Merced, Tuolumne, and Stanislaus Rivers. However, early historical population levels were never measured*." Reintroduction of an experimental population of spring-run Chinook salmon to the San Joaquin River downstream of Friant Dam is currently being developed.

2.1.3 Oncorhynchus mykiss

Oncorhynchus mykiss exhibits two life history forms: a resident form commonly known as rainbow trout, and an anadromous form commonly known as steelhead. Central Valley steelhead begin to enter fresh water in August and peak spawning occurs from December through April. After spawning, adults may survive and return to the ocean. Steelhead progeny rear for one to three years in fresh water before they emigrate to the ocean where most of their growth occurs. Spawning by resident rainbow trout in the Central Valley coincides with steelhead and interbreeding is possible. Although low numbers of anadromous *O. mykiss* have been documented in the Tuolumne River, there is no empirical scientific evidence of a self-sustaining "run" or population of steelhead currently in the Tuolumne River. Existing fish monitoring data indicate that smaller *O. mykiss* exhibiting a resident life history are common in the Tuolumne River below LGDD.

2.2 Potential Targeted Species and Life Stages for Fish Passage Under Consideration

Selection of targeted fish species and life stages for fish passage design drives the overall selection of potential fish passage alternatives. This TM No. 1 focuses on the development of fish passage alternatives which facilitates the upstream migration of adult spring-run Chinook salmon and adult steelhead as well as the downstream migration of juvenile life history stages for these species. At this time, fall-run Chinook salmon are considered a target species for fish passage however historical distribution of fall-Chinook was generally believed to be confined to lower elevations (i.e., below the reach of the Tuolumne River identified for possible reintroduction). As such, agreement among LPs regarding assumed target species and exclusion of fall-run Chinook will be required. Recognized, general characteristics for the adult life stage of each fish species are presented in Table 2.2-1. These characteristics vary based upon population genetics, return age, and other watershed specific factors not discussed here.

Table 2.2-1. General characteristics of select species (Bell 1991; TRTAC 2000).

Target Fish Species	General Characteristics
Chinook Salmon (fall and spring run)	• Typical weight range 10 to 30 lbs • Spend 2 to 5 years in the ocean (most fall-run return to the Tuolumne at 3 years) • Reach maturity at 3 to 6 years • Adults exhibit burst swimming speeds of 11 to 21.5 ft/s, prolonged speeds of 4 to 11 ft/s, and sustained speeds of 0 to 4 ft/s
Steelhead (winter run)	• Typical weight range 5 to 20 lbs • Spend 1 to 4 years in the ocean • Reach maturity at 3 to 6 years • Adults exhibit burst swimming speeds of 14.5 to 26.5 ft/s, prolonged speeds of 5 to 14.5 ft/s, and sustained speeds of 0 to 5 ft/s

Monitoring of juvenile fall-run Chinook currently occurs within the lower Tuolumne River at the Waterford (RM 30) and Grayson (RM 5) rotary screw trap locations. Much of the data collected relative to numbers, fork lengths, and weights are published in FISHBIO's monthly San Joaquin Basin Update. Published data suggests that the juvenile Chinook fork lengths range from 34 to 120 millimeters (mm) with the majority of fish falling into sub-smolt categories (68 mm or less) (FISHBIO 2008 through 2010) during the outmigration period (i.e., January through June). This range of values may provide some insight on required capture velocities and need for pumped fish collection systems and the lifestage/size that may be considered feasible for collection and/or passage; but it is recognized that over 150 studies have been conducted on the Tuolumne River since 1992 and ultimately complete data sets should be reviewed as part of further design concept development.

Data supporting the determination of age-class, size, maturation, and migration timing of spring-run Chinook and steelhead life-stages occurring within the Tuolumne River watershed does not currently exist. In addition, emigrating juvenile spring-run Chinook salmon and steelhead, if introduced into the upper watershed, would be expected to vary in size and seasonal run timing from fall-run Chinook that are currently monitored downstream of LGDD. For the purposes of this TM No. 1, several regional sources of information originating from the San Joaquin and Sacramento rivers were reviewed to generate potential estimates of migration timing. Potential migration timing for target species under consideration in the Tuolumne River is presented in Table 2.2-2. Results of fish monitoring in the Sacramento River tributaries, such as Mill and Butte creeks and the Feather River, show variation in the seasonal timing of juvenile migration among watersheds and in response to variation in environmental conditions such as spring freshets. Information on seasonal run timing presented in this TM No. 1 has been generalized to classify typical species tendencies with regard to upstream and downstream migration but does not reflect the detailed estimates of fish periodicity that are required to move forward with an accurate assessment of fish passage facilities needs. Future phases of the Fish Passage Facilities Alternatives Assessment will require input from the LPs and agreement on the period of migration for both adult and juvenile fish life stages. Data presented in Table 2.2-2 suggest that migration of adult target species may occur from October through June with the possibility of spring-run Chinook arrival in March. Downstream migration of juveniles may occur from

October through the end of June. The months of July through September are anticipated to exhibit relatively little activity with regard to adult upstream migration of targeted species, while the months of July through December are anticipated to exhibit relatively little activity with regard to juvenile downstream migration.

Table 2.2-2. Anticipated life history timing of potential targeted species.

1 TID/MID 2013c
2 NMFS 2014 Central Valley salmonid recovery plan

In addition to migration timing, the relative ages-class, fish size, population abundance, and migration timing of target fish species has a significant influence on the applicability and selection of potentially viable fish passage facilities alternatives. Currently, information regarding these factors are only available through other regional data sources where populations of these species currently exist. Input from the LPs is required to finalize the design basis regarding these potential future populations and their various characteristics for use in the future phases of the Fish Passage Facilities Alternatives Assessment.

2.3 Physical Characteristics of Don Pedro and La Grange Dams

Don Pedro Dam stands at a total height of approximately 580 feet tall with a normal maximum pool elevation of 830 feet. LGDD, located 2.6 miles downstream of Don Pedro Dam, is 131 feet tall with an approximate minimum tailwater elevation of 175 feet at the TID powerhouse. The total vertical differential between the tailwater at LGDD and the full pool elevation of Don Pedro Reservoir is therefore about 650 feet. Additional characteristics for each structure are provided in Table 2.3-1.

Table 2.3-1. Summary of general physical characteristics of Don Pedro and La Grange dams.

Item	Don Pedro Dam	La Grange Diversion Dam
Date Completed	1971	1893, Modified in 1923 and 1930
River Mile	54.8 mi	52.2 mi
Gross Storage	2,030,000 acre-feet	200 acre-feet
Drainage Area	1,533 mi^2	1,548 mi^2
Dam Height	580 ft	131 ft
Top of Dam Elevation	855 ft	N/A
Maximum/Full Pool Elevation	830 ft	N/A
Gated Spillway Crest Elevation	800 ft	N/A
Ungated Spillway Crest Elevation	830 ft	296.5 ft
Minimum Power Pool Elevation	600 ft	-
Minimum Tailwater Elevation	300 ft[1]	175 ft

1 Approximated from available data sources

2.4 Site Accessibility

Accessibility to the LGDD and to the head of Don Pedro Reservoir is an important factor in siting fish passage facilities and fish release locations. Fish passage operations may occur on a daily basis throughout each migration season. The ability to access each location, travel time between facilities, and road conditions has a direct effect on construction cost as well as on long term operation costs. Trap and haul facilities require daily transport of fish and therefore the safety of drivers, route reliability, and transport duration should also be factors in site selection.

2.4.1 Access to La Grange Diversion Dam

LGDD is accessible from the north via La Grange Road (J-59) and from the south via Yosemite Boulevard (CA-132) and La Grange Road (J-59). A short 1.4 mile section of La Grange Dam Road leads from the intersection of Yosemite Boulevard (CA-132) to the LGDD outlet and diversion facilities. The presence of publicly owned paved roads and only a short section of a TID/MID maintained road make LGDD accessible nearly 365 days a year. Severe weather and flood events have been known to limit access for short periods of time, but those events are rare and episodic.

2.4.2 Access to Don Pedro Dam

Don Pedro Dam is accessible from the east and west via Bonds Flat Road. Bonds Flat Road intersects J-59 approximately 5 miles and CA-132 approximately 12 miles north of La Grange. All roads are publicly owned and well maintained for travel by larger vehicles.

2.4.3 Access to Upper Extent of Don Pedro Reservoir

The head (i.e., upstream end) of Don Pedro Reservoir can be accessed at three primary locations: Wards Ferry Bridge, Jacksonville Road Bridge, and at the CA-120/49 Bridge.

- Wards Ferry Bridge is accessed from the east and west via Wards Ferry Road. From the west, the access route requires travel to CA 120/108, then through the City of Jamestown, then through several smaller County roads, and eventually to Wards Ferry Road. One alternative would be to travel to CA 120/108, then to CA 120/49, then to Jacksonville Road, then to Twist Road, and then to Wards Ferry Road. From the east, the access route requires travel to CA 120/49, then to the City of Big Oak Flat up New Priest Grade, and then to Wards Ferry Road. Each potential route requires travel on smaller low-volume County maintained roads which exhibit one-lane widths and switch-backs in some locations. The eastern route through Big Oak Flat requires travel to higher elevations where snow and ice can impede travel on a seasonal basis.

- Jacksonville Road Bridge is accessed directly from LGDD by traveling north to CA 120/49, then east to Jacksonville Road. A narrower part of the reservoir can then be accessed by traveling further north on a gravel road named River Road. With the exception of River Road, all roads are publicly owned and well maintained for travel by larger vehicles. The short 1.3 mile portion of River Road is privately owned and maintained with gravel surfacing. Existing parcels owned by BLM in the general area are also accessed via River Road. Despite the occasional rock fall, land slide, or ice, this route is likely travelable 365 days a year.
- The CA-120/49 Bridge can be accessed from LGDD by traveling north to CA 120/49 and then east to the bridge. All roads are publicly owned and well maintained for travel by larger vehicles. Despite the occasional rock fall, land slide, or ice, this route is likely travelable 365 days a year.

2.5 Project Operations

The following sections provide information on related to pertinent operational considerations of the Don Pedro and La Grange project facilities.

2.5.1 La Grange Pool Operations

LGDD is a 131-foot tall run-of-river structure that is used to split flows between irrigation, municipal, and environmental water uses managed by TID, MID, and others. Under normal river flows, the pool formed by LGDD extends for approximately one mile upstream. When not spilling, the water level above the diversion dam is typically between elevation 294 feet and 296 feet which occurs approximately 90 percent of the time. Within this 2-foot range, the pool storage is estimated to be less than 100 acre-feet of water. Inflow to the La Grange pool is the sum of releases from the Don Pedro Project, located 2.6 miles upstream, and very minor contributions from two small intermittent streams downstream of Don Pedro Dam. Water spilling over the LGDD structure continues down the lower Tuolumne River.

2.5.2 Don Pedro Reservoir Operations

The Don Pedro Project is managed consistent with providing for reliable water supply for irrigation and municipal and industrial (M&I) purposes, providing flood flow management, hydropower generation, recreation, and protection of downstream aquatic resources.

Annual operations create substantial fluctuations in the Don Pedro Reservoir pool elevations. The reservoir is generally at its greatest storage volume in June, July, and August. Then each year, Don Pedro Reservoir is lowered to at least elevation 801.9 feet in October to provide required flood control benefits. During the typical course of each water year, Don Pedro Reservoir is lowered further as water releases are made to accommodate water deliveries and environmental flow objectives.

Historical and potential future pool elevations are described with two available data sets: Historical observations and “Base Case” predicted estimations. The Historical dataset includes mean daily pool elevations observed at Don Pedro Reservoir for the period of record beginning in October 1, 1974 and ending in April 30, 2013 (n=40). The Base Case data set represents predicted values of mean daily pool elevations calculated with the Tuolumne River Daily Operations Model (TID/MID 2013a). The Base Case dataset includes mean daily pool elevations for the period of record beginning in October 1, 1970 and ending in September 30, 2012 (n=43). The Base Case results depict the anticipated operation of the Don Pedro Project in accordance with the current FERC license, U.S. Army Corps of Engineers (ACOE) flood management guidelines, and the TID and MID irrigation and M&I water management practices using historic watershed inputs. Given that operational changes have been made to the Don Pedro Project over the Historical record, the Base Case scenario provides estimated values of pool elevation for current operations over a longer period of record. The Base Case data therefore takes into consideration more climactic variability and provides a better estimate of future pool conditions when considering the potential for implementation of future fish passage facilities. Figure 2.5-1 illustrates pool elevation trends and variation for Historical and Base Case data sets for their respective periods of record.

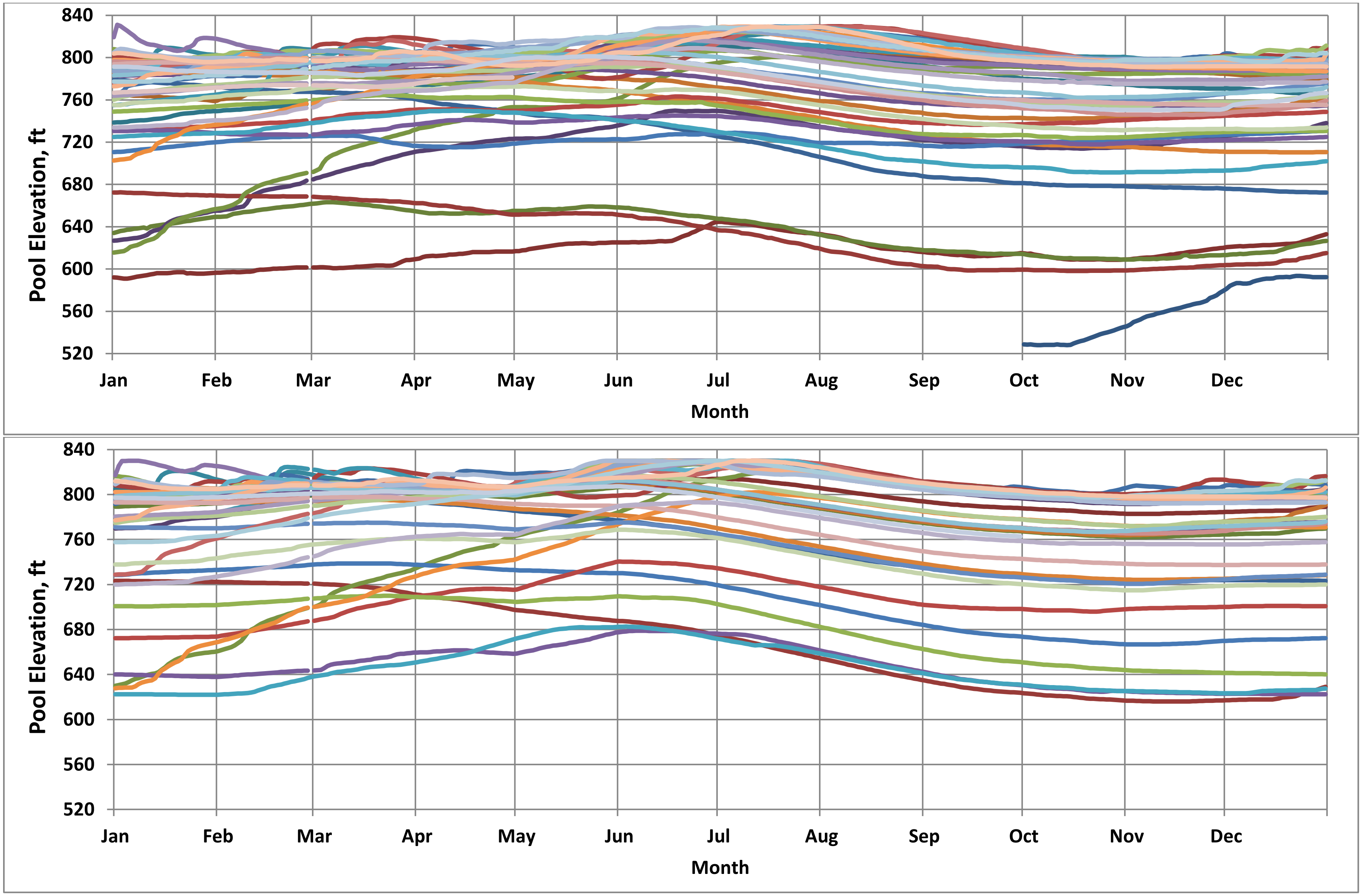

Figure 2.5-1 Mean daily pool elevation for the Historical (top) and Base Case (bottom) Don Pedro Dam operational scenarios.

Table 2.5-1 provides the percent exceedance of mean daily pool elevation over an annual basis for Historical observations. The data shows that the median pool elevation on an annual basis is approximately 788.2 feet. Observed elevations which accounts for 80 percent of Historical conditions from a probability of 10 to 90 percent of time exceeded would range from 726.0 to 812.4 feet. From 5 to 95 percent exceedance, which accounts for 90 percent of Historical conditions – the range of elevations would be from 702.7 to 820.3 feet. From 1 to 99 percent, which accounts for 98 percent of Historical conditions – the range of elevations would be from 613.7 to 828.2 feet. Using these exceedance values, Historical mean daily pool fluctuations of 86.4 feet were exceeded 20 percent of the time, 117.6 feet were exceeded 10 percent of the time, and 214.5 feet were exceeded 2 percent of the time.

Table 2.5-1. Percent exceedance of mean daily pool elevations of Don Pedro Reservoir for Historical observations (Oct 1, 1974 to Apr 30, 2013).

Percent of Time Exceeded	Pool Elevation, ft
99.9%	598.5
99.0%	613.7
95.0%	702.7
90.0%	726.0
80.0%	749.7
50.0%	788.2
20.0%	802.7
10.0%	812.4
5.0%	820.3
1.0%	828.2
0.1%	829.5

Data for the anticipated migration periods of fall-run Chinook, spring-run Chinook, and steelhead were further evaluated to identify the potential requirements of target fish species given Historical observations. Table 2.5-2 provides the Historical percent exceedance of mean daily pool elevation for anticipated outmigration periods while Table 2.5-3 provides results of the same analysis on anticipated upstream migration periods. The annual exceedance elevation data is also provided in each table for comparative purposes.

Table 2.5-2. Percent exceedance of mean daily pool elevations of Don Pedro Reservoir for outmigrating juvenile salmonids using Historical observations (Oct 1, 1974 to Apr 30, 2013).

Percent of Time Exceeded	Historical Reservoir Elevations (ft)			
	Annual	Outmigration Fall-Run Chinook 01Apr – 30Jun	Outmigration Spring-Run Chinook 01Jan – 31May	Outmigration Steelhead 01Jan – 30Jun
99.9%	598.5	639.3	620.6	621.9
99.0%	613.7	651.6	652.7	652.1
95.0%	702.7	727.3	717.6	720.3
90.0%	726.0	744.2	734.4	735.5
50.0%	788.2	794.9	788.0	790.1
10.0%	812.4	815.6	804.8	809.2
5.0%	820.3	820.5	809.1	816.1
1.0%	828.2	827.0	817.6	825.1
0.1%	829.5	828.6	821.0	828.5

Table 2.5-3. Percent exceedance of mean daily pool elevations of Don Pedro Reservoir for arriving adult salmonids using Historical observations (Oct 1, 1974 to Apr 30, 2013).

Percent of Time Exceeded	Historical Reservoir Elevations (ft)			
	Annual	Arriving Adult Fall-Run Chinook 01Oct – 31Dec	Arriving Adult Spring-Run Chinook 01Mar – 30Jun	Arriving Adult Steelhead 01Oct – 31Mar
99.9%	598.5	598.3	640.0	598.3
99.0%	613.7	599.4	652.2	604.6
95.0%	702.7	680.3	725.6	691.8
90.0%	726.0	717.3	742.9	722.8
50.0%	788.2	779.4	794.0	784.5
10.0%	812.4	798.6	813.8	800.3
5.0%	820.3	800.8	818.4	803.6
1.0%	828.2	805.7	826.3	812.3
0.1%	829.5	808.9	828.5	819.4

Table 2.5-4 provides the percent exceedance of mean daily pool elevation for the Base Case operational scenario over an annual basis. The data shows that the median pool elevation on an annual basis is approximately 797.4 feet which is 9.2 feet higher than Historical observations. Observed elevations which accounts for 80 percent of Historical conditions from a probability of 10 to 90 percent of time exceeded would range from 698.5 to 818.5 feet. From 5 to 95 percent - which accounts for 90 percent of historical conditions - the range of elevations would be from 654.8 to 825.3 feet. From 1 to 99 percent - which accounts for 98 percent of Historical conditions - the range of elevations would be from 622.9 to 830.0 feet. Given these observations, Base Case mean daily pool fluctuations of 120.0 feet may be exceeded 20 percent of the time, 170.5 feet may be exceeded 10 percent of the time, and 207.1 feet were exceeded 2 percent of the time.

Table 2.5-4. Percent exceedance of mean daily pool elevations of Don Pedro Reservoir for the Base Case operational scenario (Oct 1, 1970 to Sept 30, 2012).

Percent of Time Exceeded	Pool Elevation, ft
99.9%	616.3
99.0%	622.9
95.0%	654.8
90.0%	698.5
80.0%	739.4
50.0%	797.4
20.0%	809.2
10.0%	818.5
5.0%	825.3
1.0%	830.0
0.1%	830.0

Data occurring within the anticipated migration periods of fall-run Chinook, spring-run Chinook, and steelhead were further evaluated to identify the potential requirements of target fish species for the Base Case operational scenario. Table 2.5-5 provides the percent exceedance of mean daily pool elevation for anticipated outmigration periods while Table 2.5-6 provides results of the same analysis on anticipated upstream migration periods, each for the Base Case operational scenario.

Table 2.5-5. Percent exceedance of mean daily pool elevations of Don Pedro Reservoir for outmigrating juvenile salmonids using the Base Case operational scenario (Oct 1, 1970 to Sept 30, 2012).

Percent of Time Exceeded	Base Case Reservoir Elevations (ft)			
	Annual	Outmigration Fall-Run Chinook 01Apr – 30Jun	Outmigration Spring-Run Chinook 01Jan – 31May	Outmigration Steelhead 01Jan – 30Jun
99.9%	616.3	652.3	622.0	622.0
99%	622.9	660.5	632.0	636.0
95%	654.8	682.4	667.2	673.8
90%	698.5	715.5	705.9	707.2
50%	797.4	804.4	801.0	802.1
10%	818.5	826.3	812.5	819.7
5%	825.3	829.6	818.1	826.6
1%	830.0	830.0	824.3	830.0
0.1%	830.0	830.0	830.0	830.0

Table 2.5-6. Percent exceedance of mean daily pool elevations of Don Pedro Reservoir for arriving adult salmonids using the Base Case operational scenario (Oct 1, 1970 to Sept 30, 2012).

Percent of Time Exceeded	Base Case Reservoir Elevations (ft)			
	Annual	Arriving Adult Fall-Run Chinook 01Oct – 31Dec	Arriving Adult Spring-Run Chinook 01Mar – 30Jun	Arriving Adult Steelhead 01Oct – 31Mar
99.9%	616.3	616.1	640.3	616.1
99%	622.9	617.5	652.6	621.5
95%	654.8	625.1	682.5	639.1
90%	698.5	667.3	710.5	678.9
50%	797.4	792.9	804.1	794.7
10%	818.5	801.4	823.3	807.1
5%	825.3	803.1	828.6	810.6
1%	830.0	810.1	830.0	821.0
0.1%	830.0	815.6	830.0	829.3

2.6 Hydrologic Conditions Relative to Fish Passage

The objective for fish passage design is to provide suitable hydraulic conditions over a range of reasonable streamflows under which the targeted fish species and life stages are expected to migrate, either upstream or downstream. Understanding the recurrence and magnitude of such stream flows is an important component in establishing the anticipated range of flows which directly influences the sizing and complexity of fish passage facilities. Available hydrologic data were obtained and preliminary analyses were performed in order to define the anticipated range of flows that coincide with fish migration for each target species. A summary of the available data and results of the analysis are provided in the following paragraphs.

Two different hydrologic conditions need to be addressed to accommodate upstream and downstream fish passage goals. Adult upstream fish passage design will be influenced by the flows occurring downstream of the La Grange Project. These flows are regulated by Don Pedro Reservoir operations. Downstream collection of out-migrating juvenile fish that originate above

Don Pedro Reservoir will be influenced by the combination of seasonal flows from unregulated portions of the upper watershed and flows from the portion of the watershed regulated by the CCSF Hetch Hetchy Project. Depending on the water year type, the natural hydrograph may dominate during juvenile outmigration in wetter years; however, regulated flows may dominate in dry water years. In winter, summer and fall months, the hydrograph upstream of the study area will be dominated by operational flows regulated by CCSF facilities. The timing, complexity, and downstream migration triggers of juvenile life stages of the target species are unknown and may vary from what is currently observed in the lower Tuolumne River below LGDD or in other Central Valley rivers where target species are present.

2.6.1 River Flow Data

Flow data collected by the United States Geological Survey (USGS) is available on the Tuolumne River approximately 0.5 miles downstream of the LGDD (USGS Gage 11289650). At LGDD, diversions are also made into the adjacent Modesto and Turlock main canals. USGS Gage 11289650 is active and has current data available, while USGS Gage 11289651 has daily flow data available through September 30, 2012.

Flows upstream of the Don Pedro Reservoir at Wards Ferry Bridge are collected by USGS Gage 11285500 which began collecting mean daily flow data on December 5, 2013 and is currently active. In combination, the available flow data obtained from gaging stations does not adequately characterize the potential frequency, magnitude, and duration of flow needed to evaluate potential fish passage alternatives.

For the purposes of this assessment the flow simulations resulting from the Tuolumne River Daily Operations Model were used to assess the potential frequency, magnitude, and duration of flow into Don Pedro Reservoir, reservoir stage, and flow measured at La Grange Bridge downstream of the LGDD. The resulting simulated data provides a continuous set of mean daily values for all required locations sufficient to assess factors that may influence development of fish passage facilities concepts. The Historical data set reflects the combination of both the regulated and unregulated portions of the upper watershed while the calculated Base Case data set is referred to as the Base Case project operational scenario. The Base Case operational scenario depicts the operation of the Don Pedro Project in accordance with its current FERC license, ACOE flood management guidelines, and the Districts' irrigation and M&I water management practices. Detailed summaries of simulation development and the resulting data are presented in Appendix B-2 of the Don Pedro Hydroelectric Project Final License Application (TID/MID 2013b).

2.6.2 Inflow to Don Pedro Reservoir

Inflow into Don Pedro Reservoir is characterized in the following section using a combination of historical data sources and the future casted predictions from the Base Case operational model results. The percent exceedance of flows into Don Pedro Reservoir based upon the Historical data set is summarized in Table 2.6-1. The calculated values show that the median inflow (50 percent exceeded) to Don Pedro is 1,240 cubic feet per second (cfs) on an annual basis and ranges from 2,319 to 3,213 cfs during the anticipated migration periods of target fish species.

The percent exceedance of flows into Don Pedro Reservoir using the Base Case operational scenario is summarized in Table 2.6-2. The median inflow for this scenario to Don Pedro is anticipated to be 860 cfs on an annual basis and ranges from 2,701 to 4,024 cfs during the anticipated migration periods of target fish species.

Table 2.6-1. Historical exceedance Tuolumne River flows into Don Pedro Reservoir for outmigrating juveniles using a period of record of Oct 1, 1970 to Sept 30, 2012

Percent of Time Exceeded	Historical Tuolumne River Flows into Don Pedro Reservoir (cfs)			
	Annual	Outmigration Fall-Run Chinook 01Apr – 30Jun	Outmigration Spring-Run Chinook 01Jan – 31May	Outmigration Steelhead 01Jan – 30Jun
99%	84	184	120	122
95%	194	467	372	366
90%	308	873	654	628
50%	1,240	3,213	2,319	2,415
10%	5,141	7,934	5,927	6,727
5%	7,018	10,044	7,670	8,507
1%	12,037	14,021	12,767	13,332

Table 2.6-2. Base Case exceedance Tuolumne River flows into Don Pedro Reservoir for outmigrating juveniles using a period of record of Oct 1, 1970 to Sept 30, 2012.

Percent of Time Exceeded	Base Case Tuolumne River Flows into Don Pedro Reservoir (cfs)			
	Annual	Outmigration Fall-Run Chinook 01Apr – 30Jun	Outmigration Spring-Run Chinook 01Jan – 31May	Outmigration Steelhead 01Jan – 30Jun
99%	101	367	154	162
95%	164	577	309	356
90%	235	859	559	555
50%	860	4,024	2,701	2,781
10%	5,828	8,208	6,854	7,337
5%	7,547	9,489	8,114	8,634
1%	11,449	14,277	11,210	13,568

2.6.3 River Flow below LGDD

River discharge immediately downstream of the La Grange Project is characterized in the following section using a combination of historical data sources and the future casted predicted predictions from the Base Case operational model results. The percent exceedance of flows based upon Historical data set is summarized in Table 2.6-3. The calculated values show that the median discharge (50 percent exceeded) downstream of the La Grange Project is 257 cfs on an annual basis and ranges from 306 to 337 cfs during the anticipated migration periods of target fish species. The percent exceedance of flows below the La Grange Project based upon the Base Case operational scenario is summarized in Table 2.6-4. The median inflow for this scenario is 250 cfs on an annual basis and ranges from 300 to 767 cfs during the anticipated migration periods of target fish species.

Table 2.6-3. Historical exceedance Tuolumne River flows below LGDD for arriving adults using a period of record of Oct 1, 1970 – Dec 31, 2013.

Percent of Time Exceeded	Historical Tuolumne River Flows below LGDD (cfs)			
	Annual	Arriving Adult Fall-Run Chinook 01Oct – 31Dec	Arriving Adult Spring-Run Chinook 01Mar – 30Jun	Arriving Adult Steelhead 01Oct – 31Mar
99%	6	2	8	8
95%	11	61	11	92
90%	18	119	17	120
50%	257	306	321	337
10%	3,290	1,460	5,110	3,790
5%	5,000	2,750	7,130	4,930
1%	8,340	4,902	8,830	7,717

[1] The minimum flow release below LGDD was 3 cfs prior to the 1996 settlement agreement. After 1996, operations of the Don Pedro Project were modified to provide no less than 50 cfs even in critical years as shown in Table 2.7-4.

Table 2.6-4. Base Case exceedance Tuolumne River flows below LGDD for arriving adults using a period of record of Oct 1, 1970 to Sept 30, 2012.

Percent of Time Exceeded	Base Case Tuolumne River Flows below LGDD (cfs)			
	Annual	Arriving Adult Fall-Run Chinook 01Oct – 31Dec	Arriving Adult Spring-Run Chinook 01Mar – 30Jun	Arriving Adult Steelhead 01Oct – 31Mar
99%	50	126	50	126
95%	50	126	50	150
90%	50	126	75	150
50%	250	300	767	300
10%	3,884	300	5,955	3,572
5%	5,979	1,800	7,499	5,675
1%	8,747	5,310	8,845	8,784

2.6.4 Minimum Releases to Support Existing Fisheries Resources on the Tuolumne River

In accordance with an agreement with the U.S. Department of the Interior, the San Francisco Public Utilities Commission (SFPUC) releases a minimum stream flow from Hetch Hetchy Reservoir. Once made, releases cannot be diverted below O'Shaughnessy Dam (i.e., at Early Intake); they flow down the Tuolumne River, are supplemented by releases at Kirkwood and Homm powerhouse and tributary flows, and enter Don Pedro Reservoir. A detailed summary of minimum releases required for normal, dry, and critical years is provided in Table 5.3.1-2 of the CCSF Program Environmental Impact Report (CCSF 2008). For normal years, minimum flow releases downstream of Early Intake range from a minimum of 50 cfs in December and January to 125 cfs in June through August. For dry years, minimum flow releases are a minimum of 40 cfs in December and January to 110 cfs in June through August. For critical years, minimum flow releases are a minimum of 35 cfs in December and January to 75 cfs in June through August.

Under its FERC license, the Don Pedro Project is required to provide minimum stream flows in the lower Tuolumne River. As of October 1 of each year, flows are adjusted to meet minimum flow and pulse flow requirements to benefit upstream migrating adult Chinook salmon. Minimum flows are adjusted on October 16 to benefit spawning, egg incubation, emergence, fry and juvenile development, and smolt outmigration. Another adjustment is made on June 1 and continues through September 30. The schedule of flow releases to the lower Tuolumne River by water year type are contained in FERC's 1996 order (TID/MID 2013b). Minimum flow requirements ranging from "Median Dry" years to "Median Above Normal" years occur approximately 50.8 percent of the observed annual water years. Typical minimum flows during these periods range from 150 to 300 cfs from October 1 to October 16, 150 to 300 cfs from October 16 to May 31, and 75 to 250 cfs from June 1 to September 30. In critical years, instream flow requirements are as low as 50 cfs.

3.0 DESIGN CRITERIA AND GUIDELINES FOR FISH PASSAGE DESIGN

There are numerous guidelines and design criteria established by the CDFW and NMFS which provide a framework for fish passage design. Other literature sources are available which provide design guidance and biological criteria for the collection, handling, and transport of fish. Although not explicitly referenced, applicable criteria are used in this TM No. 1 throughout the passage alternatives formulation process. Some are specifically outlined in the alterative descriptions. Such reference documentation includes the following:

- California Salmonid Stream Habitat Restoration Manual Part XII - Fish Passage Design and Implementation. CDFG 2009.
- Fish Screening Criteria. CDFG 2000.
- Fish Screening Criteria for Anadromous Salmonids. NMFS Southwest Region, 1997.
- Anadromous Salmonid Passage Facility Design. NMFS Northwest Region, 2011.
- Fisheries Handbook of Engineering Requirements and Biological Criteria. U.S. Army Corps of Engineers (Milo Bell), 1991.

3.1 Selection of Range of Reservoir Pool Elevations Coincident with Target Fish Species Migration

Reservoir pool fluctuation is a significant factor in determining the type, size, and complexity of upstream and downstream fish passage facilities. Upstream fish passage technologies may require safe release or exit of fish to the reservoir pool. Downstream fish passage technologies occurring in the reservoir either float or possess multiple inlets to maintain a hydraulic connection with the reservoir surface. Each type of fish technology must accommodate some form of continuous hydraulic connection throughout the anticipated range of pool elevations. As the pool fluctuations become larger, so does the facility. In many cases, certain fish passage technologies can be dismissed due to pool fluctuation alone.

The overall fish passage performance of downstream passage facilities is measured and regulated based upon reservoir passage efficiency, collection efficiency, passage efficiency to a downstream release point, and percent mortality. Typical expectations for facilities of this type are in the range of 85 to 95 percent overall with a minimum compliance of 75 percent. The overall fish passage performance expectations of upstream passage facilities are similar in nature but based upon different evaluation factors such as migration delay, collection efficiency at the facility entrance, fall back, rate at which fish are passed, and stress and mortality considerations.

As introduced in the data presented Section 2.5 of this document Don Pedro Reservoir experiences a high level of seasonal fluctuation. In reference to the Historical data set, results indicate that 98 percent of potential reservoir conditions may be accommodated with a downstream passage facility designed for an overall range of reservoir pool elevations from 651.6 feet to 827.0 feet which is a total of 175.4 feet. Ninety-eight percent of potential conditions may be accommodated with an upstream fish passage facility designed for an overall range of reservoir pool elevations from 599.4 feet to 826.3 feet which is a total of 226.9 feet. Predicted Base Case conditions indicate that 98 percent of anticipated reservoir conditions would be accommodated with a downstream fish passage facility designed for an overall range of reservoir pool elevations from 632.0 feet to 830.0 feet which is a total of 198.0 feet. Ninety-eight percent of potential conditions may be accommodated with an upstream fish passage facility designed for an overall range of reservoir elevations from 617.5 feet to 830.0 feet which is a total of 212.5 feet. This information suggests that downstream facilities may be required to accommodate reservoir pool fluctuations on the order of 200 feet while upstream fish passage facilities may be required to accommodate on the order of 230 feet.

The expectations for facility performance are currently unknown at this point in the process and the above information is presented as a generalization based upon the operational requirements of other known facilities. These requirements are typically set through consultation with fisheries agencies and are necessary to proceed further into the related assessment of engineering and economic feasibility. Further input from the LPs is required to determine performance criteria and expectations for this study. After the performance criteria and operation expectations are identified, several key factors can be selected by the assessment team such as the target range of reservoir elevations that would require accommodation of downstream fish passage.

3.2 Selection of River Flow Design Guidelines Coincident with Target Fish Species Migration

Fish passage design flow criteria also influences a number of factors associated with fish passage facilities size and complexity. Guidelines presented by NMFS are based on exceedance calculations of daily mean flows but can be modified to suit site-specific requirements. The exceedance flows statistically represent the flow equaled or exceeded during certain percentages of the time when migrating fish may be present or collected at a facility. The established guidelines are used to set instream flow depths, flow velocities, debris and bedload conditions, fish attraction requirements, tailwater fluctuations, and numerous other factors which a facility may experience during anticipated operational periods.

NMFS (2011) states that the high fish passage design flow shall be the mean daily average streamflow that is exceeded 5 percent of the time during periods when migrating fish may be present. NMFS (2011) also states that low fish passage design flow shall equal the mean daily average streamflow that is exceeded 95 percent of the time during periods when migrating fish may be present. These criteria are generally applied to facilities which are designed to collect adult anadromous salmon and steelhead migrating upstream. Currently, there are no full scale downstream in-river collection facilities for outmigrating juvenile fish and post-spawn adult fish. As such, there are no associated guidelines with such a facility. The anticipated operational range will largely be a function of the stipulated performance requirements if such a facility is to be permitted and constructed. Therefore, for the purposes of this TM No. 1 the same 5 to 95 percent guidelines are assumed for downstream collection facilities as well.

Design flow criteria for downstream in-river collection facilities would rely on records and corresponding percent exceedance values for river flows entering at the head of Don Pedro Reservoir. These values are presented in Section 2.6.2. Design flow criteria for upstream collection facilities would rely on the records and corresponding percent exceedance values for river flows passing downstream of the La Grange Project. These values are presented previously in Section 2.6.3. The anticipated low (exceeded 95 percent of the time) and high (exceeded 5 percent of the time) fish passage design flows for upstream and downstream collection facilities are summarized in Table 3.2-1.

Table 3.2-1. Fish passage facility flows calculated for the anticipated period of migration for target fish species.

Facility Type (hydrologic scenario)	Low Design Flow (cfs) NMFS (95% Exceedance)	High Design Flow (cfs) NMFS (5% Exceedance)
Upstream (Historical)	11	7,130
Upstream (Base Case)	50	7,499
Downstream (Historical)	366	10,044
Downstream (Base Case)	309	9,489

Concept level designs for upstream fish passage facilities will be formulated to facilitate conditions which promote passage throughout the range of anticipated migration flows: the lowest of the low fish passage design flows through the highest of the high fish passage design flows which represents the range of targeted fish species and life stages. The resulting low fish passage design flow is 11 cfs and the high fish passage design flow is approximately 7,130 cfs using Historical observations. The resulting range of flows is 50 to 7,499 cfs using Base Case operational scenario data. In summary, any proposed upstream passage facility will need to meet fish passage design criteria throughout this range of flows. Once flows exceed the high fish passage design flow or are below the low fish passage design flow, compliance with fish passage criteria is not assured and is typically not expected by regulatory agencies.

It should be noted that although the statistical calculations identify a low fish passage design flow of 11 cfs, this low flow value will likely be regulated by the minimum flow release schedule (refer to Table 2.5-2 in TID/MID 2013a). The flow release schedule suggests that minimum river flows will likely be on the order of 150 to 300 cfs for most of the primary migration period between October 1 and May 31 and may only reach a low flow of 50 cfs during the worst of drought years. Therefore, the selected range of flows to be used for concept upstream fish passage facility development is 50 to 7,499 cfs.

Concept level designs for downstream fish passage facilities that are to be constructed in-river will also be formulated to facilitate conditions which promote passage throughout a similar range of anticipated migration flows. The resulting low fish passage design flow for downstream facilities is 366 cfs and the high fish passage design flow is approximately 10,044 cfs using Historical observations. The resulting range of flows is 309 to 9,489 cfs using Base Case operational scenario data.

Contrary to the upstream fish passage facilities which correspond with flows occurring downstream of the La Grange Project, the downstream fish passage facility will rely on flows being conveyed into Don Pedro Reservoir. Low flow values will similarly be regulated by the minimum flow release schedule adhered to by CCSF. Therefore, the selected range of flows to be used for concept downstream fish passage facility development is 50 to 9,489 cfs.

3.3 Other Criteria and Guidelines Influencing Potential Fish Passage Facilities Configuration and Size

Many other design criteria and guidelines are applicable to upstream and downstream fish passage facilities beyond the pool elevation and instream design flows. For brevity, applicable criteria which have significant influence on fish passage facilities size, configuration, and complexity are summarized by category in the following sections.

3.3.1 Fish Screen Criteria

Any water diversions that could capture fish and introduce them into areas or flow paths that they cannot escape must include fish screens. The exception is both low- and high-head hydropower facilities where other means are implemented to reduce harm to outmigrating fish such as Eicher screens and/or fish friendly turbine technologies. Specific criteria relative to adequate screen area, maintenance features, and facility hydraulics must be met to assure compliance with regulatory requirements. Fish screens are designed using the Screening Criteria Guidelines provided by CDFW (2000) and the NMFS Northwest Region's Anadromous Salmonid Passage Facility Design (NMFS 2011). The intent of the fish screening criteria is to provide design guidelines and criteria that protect juvenile fish from entrainment or impingement and to guide juveniles to a collection and/or bypass system.

The following is a summary of the fish screen criteria for the design of a screening system:

- Structure Orientation – In a river, the screen must be oriented parallel to river flow. Upstream and downstream transitions must minimize eddies. In a reservoir, the screening and bypass system must be designed to withdraw water from the appropriate elevation for best fish attraction and providing appropriate water temperature control downstream. The design must accommodate the entire range of forebay fluctuations (NMFS 2011).
- Screen Size – The minimum screen area required is determined by dividing the maximum screened flow by the allowable approach velocity (NMFS 2011).
- Approach Velocity – Uniform approach velocity must be provided across the face of the screen. Approach velocity for the listed target species must be less than 0.33 feet/second (ft/s) for actively cleaned systems and measures to adjust flow patterns across the face of the screen to assure uniformity is maintained must be provided (CDFW 2000). Approach velocities of 0.4 or 0.2 ft/s are allowed for diversions less than 40 cfs (CDFW 2000). For passively cleaned screens, approach velocity must not exceed 0.2 ft/s (NMFS 2011 and CDFW 2000).
- Sweeping Velocity –The sweeping velocity should be greater than the approach velocity. Sweeping velocity must be maintained or gradually increase for the entire length of screen (NMFS 2011; CDFW 2000).
- Travel Time – Fish can only be exposed to a screen face for a maximum of 60 seconds, assuming fish are moving at rate equal to the sweeping velocity (NMFS 2011; CDFW 2000).
- Screen Openings – For salmonid fry, screen opening size must not exceed 1.75 mm, with a minimum open area of 27 percent. If the screen is made from wire mesh or perforated plate,

the screen opening size must not exceed 3/32 inches, with a minimum open area of 27 percent (NMFS 2011; CDFW 2000).

- Screen Materials – The screens must be constructed of rigid, corrosion-resistant material with no sharp edges or projections (e.g., stainless steel, plastic) (NMFS 2011).
- Screen Cleaning – Automatically cleaned screens are referred to as active screens. Cleaning systems should provide complete debris removal at least every 5 minutes and operated as required to prevent debris accumulation. The cleaning system should be automatically triggered if the head differential across the screen exceeds 0.1 feet or as agreed to by NMFS (NMFS 2011).
- Redundancy – Although not required by fisheries regulatory agencies, it is common design practice to oversize screen area for maximum diversion by a factor of 1.2 to 1.3.

3.3.2 Fish Bypass Criteria

Bypass systems are designed to facilitate both juvenile and adult fish downstream passage back to the river system, typically around a diversion or fish screen system, in a manner that minimizes risk of injury and delay. Fish bypass systems typically contain three major components; the bypass entrance, conduit, and exit.

3.3.2.1 Bypass Entrance Criteria

- Flow Control – Independent flow control should be provided at each bypass entrance (NMFS 2011).
- Travel Time – Fish are to enter a bypass within 60 seconds of exposure to any length of screen (NMFS 2011).
- Velocity – Bypass entrance velocity must be greater than 110 percent of the maximum screen-sweeping velocity. Velocity should not decrease between the screen terminus and bypass entrance and should accelerate gradually (NMFS 2011).
- Acceleration – The flow should not decelerate and should not exceed an acceleration rate of 0.2 ft/s per foot of travel (NMFS 2011).
- Lighting – Ambient lighting is required at the entrance to the bypass flow control (NMFS 2011).
- Dimensions – Bypass entrance should be a minimum of 18 inches wide, and its height must extend from floor of the screen to water surface (NMFS 2011). For weirs used in bypass systems that have diversions greater than 25 cfs, a minimum weir depth of 1 foot should be maintained throughout the smolt out-migration period (NMFS 2011).
- Juvenile Capture Velocity – A minimum velocity of 8 ft/s is a common design threshold used in situations that require the capture of juvenile salmonids. Experience with current projects will be considered if a bypass system becomes part of the facility design.

3.3.2.2 Bypass Conduit Criteria

- Materials and fittings – Smooth pipes, joints, and other interior surfaces are required to minimize turbulence and the potential for fish injury. Closure valves should not be used within the bypass pipe (NMFS 2011).
- Flow Transitions – Pumping if fish are within the bypass system is not allowed. If site conditions permit, bypass flows should be open channel (NMFS 2011). Where site conditions don't permit open channel bypass flows, a bypass pipe may be used. NMFS criteria state that pressures within bypass pipes must be equal to or above atmospheric pressure. NMFS criteria also state that transitions from pressurized to non-pressurized (or vice-versa) should be avoided within the pipe. Free-fall of fish within a pipe or enclosed conduit within the bypass system is not allowed (NFMS 2011).
- Bypass Flow – Bypass flow should be approximately 5 percent of the total screened flow (NMFS 2011). Based on professional judgment, this proportion may be considered a minimum. Higher bypass flow proportions will be considered if a bypass is included in the design.
- Velocity – NMFS criteria state the bypass pipe should be designed to have velocities between 6 and 12 ft/s; however, higher velocities can be approved with special attention to pipe and joint smoothness (NMFS 2011).
- Geometry – NMFS requires the open channel or pipe diameter to be sized based on bypass flow and slope in order to meet other bypass conduit criteria.
- Bends – The ratio of bypass centerline to pipe diameter must be 5 or greater, and larger ratios may be required for super-critical velocities (NMFS 2011).
- Depth – NMFS criteria requires a minimum depth of at least 40 percent of the bypass pipe diameter, unless otherwise approved (NMFS 2011).
- Hydraulic Jump – Hydraulic jumps should not occur within the pipe (NMFS 2011).

3.3.2.3 Bypass Exit Criteria

- Velocity – The outfall impact velocity, the velocity of the bypass flow entering the river, should not exceed 25 ft/s (NFMS 2011).
- Location – The outfall should be located in an area with strong downstream currents, at least 4 ft/s, free of eddies, reverse flow, or likely predator habitat. The outfall should also be located in an area with sufficient depth to avoid fish injuries (NMFS 2011).
- Adult Attraction – The bypass outfall must be designed to avoid the attraction of upstream migrants. Upstream migrants might leap at the outfall; therefore, provisions for minimizing risk to injury or stranding on the bank must be included in the outfall design (NMFS 2011). It should be noted that this criteria is only applicable where upstream and downstream passage facilities are separate.

3.3.2.4 Velocity Barrier Criteria

Velocity barriers create a combination of shallow depth and high velocity conditions that restrict a fish's ability to swim and leap into oncoming flow. Barriers are commonly used to help guide upstream migrating fish to the entrance of a fish passage facility. A velocity barrier typically consists of a full-spanning concrete apron that distributes streamflow evenly across the width of the channel, and a vertical weir that is higher than the leaping ability of the target fish species. Velocity barrier design guidelines for anadromous salmonids have been developed by NMFS (NMFS 2011) and include the following:

- The minimum weir height relative to the maximum apron elevation is 3.5 feet.
- The minimum apron length (extending downstream from base of weir) is 16 feet.
- The minimum apron downstream slope is 16:1 (horizontal:vertical).
- The maximum head over the weir crest is two feet.
- The elevation of the downstream end of the apron shall be greater than the tailrace water surface elevation corresponding to the high design flow.
- Other combinations of weir height and weir crest head may be approved by NMFS Hydro Program staff on a site-specific basis.
- The flow over the weir must be fully and continuously vented along its entire length, to allow a fully aerated nappe to develop between the weir crest and the apron.

3.3.3 Fishway Criteria

Upstream fish passage designs at dams use widely recognized fishway design guidelines and references and are traditionally designed for the adult fish life stage. There are three major components to a fishway: the fishway entrance, fish ladder, and fishway exit. The fishway entrance's primary objective is to maximize fish attraction. The fish ladder's primary objective is to provide hydraulic conditions that promote fish passage up and around a passage barrier. The fishway exit's primary function is to maintain hydraulic conditions suitable for fish passage for the range of forebay or reservoir water surface elevations. The design criteria specific to each component is presented below.

3.3.3.1 Fishway Entrance

- Entrance Location – The entrance located should be based on site-specific operations and stream flow characteristics. Entrances must be placed in locations where fish can easily locate the attraction flow. Multiple entrances may be required if the site has multiple locations where fish hold (NMFS 2011).
- Entrance Geometry – The entrance should have a minimum width of 4 feet and depth of 6 feet (NMFS 2011).
- Entrance Head Differential– The head differential at the entrance should be maintained between 1.0 and 1.5 feet (NMFS 2011).

- Attraction Flow – Minimum 5 to 10 percent of high fish passage design flow (NMFS 2011). Fishway attraction flow must be adequate to compete with spillway or powerhouse flows for attraction of fish. Auxiliary water systems may be used to increase the fishway entrance attraction flow.

3.3.3.2 Fish Ladder Design

- Head Differential – The hydraulic drop between each pool within the fish ladder must be a maximum of 1 foot (NMFS 2011).
- Minimum Pool Dimensions – Minimum of 8 feet long, 6 feet wide, and 5 feet deep (NMFS 2011).
- Energy Dissipation Factor (EDF) – Each pool volume should be sized to have a maximum energy dissipation factor of 4 ft-lb/sec/ft3. Only the volume of the pool having active flow and contributing to energy dissipation should be included in the energy dissipation calculation (NMFS 2011).
- Minimum Depth Over Weirs – Overflow weirs in fishways should have 1 foot of flow depth over weirs (NMFS 2011).
- Turning pools – Turning pools are required at each location where the fishway bends more than 90°. Turning pools should be at least double the length of the designed standard pool measured along the centerline (NMFS 2011).
- Orifice Dimensions – NMFS criteria state orifices should be a minimum of 15 inches high and 12 inches wide (NMFS 2011).
- Freeboard – Freeboard must be a minimum of 3 feet within the fish ladder at the high design flow (NMFS 2011).
- Lighting – The use of ambient lighting throughout the entire fishway is preferred. Abrupt lighting changes within the fishway are not allowed (NMFS 2011).

3.3.3.3 Fishway Exit

- Head Differential – The fishway exit head differential should range from 0.25 to 1.0 feet (NMFS 2011). In order to accommodate forebay fluctuations this may require the use of adjustable weirs, multiple exits at different elevations, or other engineered solutions that accommodate forebay fluctuations.
- Length – A minimum channel length of two standard ladder pools should be incorporated upstream of the exit control (NMFS 2011).
- Location – The exit should be located along the shoreline at a location with similar depths to those within the fishway and with velocities less than 4.0 ft/s. Exits should be located well upstream of spillways, sluiceways, and powerhouses to minimize the risk of being swept downstream.
- Debris Rack – Coarse trash racks should be installed at the fishway exit and must be oriented at a deflection angle greater than 45° relative to the river flow (NMFS 2011).

3.3.4 Debris Rack Criteria

Debris racks are commonly used to exclude large debris from entering fish passage facilities. Debris rack openings should be a minimum of 8 inches clear, or 12 inches clear if adult Chinook are present. NMFS criteria state that approach velocity should be less than 1.5 ft/s. Debris racks should be sloped at 1:5 or flatter to assists with manual cleaning. In systems with coarse floating debris, debris booms or other provisions must be incorporated into the debris rack design (NMFS 2011).

3.3.5 Fish Trapping and Holding Criteria

If the design requires trapping, holding, and handling of fish then the following criteria applies:

- Holding Pool Volume – Fish holding pools must be sized to provide a minimum volume of 0.25 cubic feet per pound of fish. For holding durations greater than 72 hours, holding pool volumes should be increased by a factor of three. The maximum daily fish return, or number of fish expected to be trapped before fish are removed, is used to determine the required trap capacity (NMFS 2011).
- Temperature – Water temperatures must be less than 50° F. If temperatures exceed this threshold, the poundage of fish held should be reduced 5 percent for each degree above 50° F (NMFS 2011). It should be noted however that this criteria would require a variance to sufficiently accommodate water temperatures typically experienced by such fish species in the Tuolumne River. As an example, Mokelumne River juveniles collected for transport are held in water temperatures of approximately 70° F (18 C).
- Dissolved Oxygen – Must be maintained between 6 and 7 parts per million (NMFS 2011).
- Water Supply – A minimum of 0.67 gallons per minute per adult fish must be supplied to the holding pool (NMFS 2011).
- Handling – Fish must be handled with extreme care, use of nets should be minimized or eliminated. Fish should be anesthetized before being handled and only be handled by individuals trained to safely handle fish (NMFS 2011).
- Frequency of Removal – Fish must not remain in traps for more than a day. Traps may have to be cleared more often to prevent crowding or adverse water quality (NMFS 2011).
- Adult Jumping Provisions – Fish may be injured by jumping, and provisions must be included in the holding pool design to minimize adult jumping. Provisions can include: freeboard of 5 feet or more; covering of the holding pool to create a darkened environment; use of netting over the pool; or sprinklers above the holding pool (NMFS 2011).
- Segregation of fish – Specific criteria for segregating different species and life stages of fish are established on a site-specific basis. This could include picket panels, screens, and other materials to limit certain sizes of fish holding in pools.

3.3.6 Juvenile Salmonid Upstream Passage Criteria

Juvenile upstream passage will not be considered as part of this Fish Passage Facilities Alternatives Assessment.

3.4 Other Factors That Require Further Consideration

There are a number of remaining factors that require careful consideration when siting, selecting and formulating fish passage alternatives for both adult and juvenile life stages of target fish species. The following list summarizes additional considerations that should be evaluated prior to subsequent phases of alternative development.

- Confirmation of Target Species – The target species must still be agreed upon. None of the three potential target anadromous species currently occur above Don Pedro Reservoir. The viability, funding, or planning of such reintroduction is unknown at this time and therefore the inclusion of these three target species into the Fish Passage Facilities Alternatives Assessment is speculative. Further discussion and concurrence with the LPs is necessary to finalize target species.
- Migration Timing for Various Life Stages – The migration timing of target fish species has a significant influence on the applicability and selection of potentially viable fish passage facilities alternatives. Information on the seasonal timing of adult and juvenile passage would be required for all three of the potential target fish species for use in the engineering feasibility study. Currently, assumptions regarding these factors are only available through other regional data sources where populations of these species currently exist. Input from the LPs is required to finalize assumptions regarding these potential future populations and their various characteristics.
- Population Size and Peak Run Values – The number of fish to be passed has a significant impact on the size and configuration of facility components. At the time this TM No. 1 was prepared, there is no known or assumed population numbers or objectives set forth for the upper Tuolumne River relative to the target species assumed to be reintroduced. Information on the availability of suitable habitat and potential carrying capacity for all relevant life stages of target species (e.g., adult spawning, juvenile rearing, etc.) in the reintroduction reach will be necessary to inform potential population goals and specific facility design characteristics.
- Suitability of Reservoir Passage – Reservoirs foster slow and deep hydraulic conditions which provide habitat for predators of outmigrating juvenile fish. The potential for predation on target species and its effect on escapement objectives should be evaluated prior to final determination of facility siting and technology selection. The applicability of reservoir passage will be evaluated if fish passage alternatives requiring reservoir passage are selected for further development.
- Suitability of Reservoir Water Quality– In addition to predation, reservoir water quality (temperature and dissolved oxygen levels, etc.) can have a detrimental impact on both adult and juvenile life stages. Water quality, the potential residence time for fish in the reservoir, and any potential detrimental effects of such adverse conditions will be evaluated if alternatives requiring reservoir passage are selected for further development.

- Water Supply – All upstream fish passage facilities require operational flow and fish attraction flow to successfully guide fish to a facility entrance and to support fish handling systems. The source of the supplied water will need to be of a unique temperature and water quality that attracts fish to a facility entrance and sufficiently maintains their health when in a holding facility prior to transport. The source and type of water required will be evaluated further as the alternative evaluation and design development moves forward.
- Power Supply – Virtually all fish passage technology options of the magnitude required for this project will require some level of electrical power supply to operate measurement, automated control, monitoring, lighting, pumping, and other miscellaneous systems. The accessibility to power supply for each potential location should be evaluated prior to final determination of facility siting and technology selection.
- Reservoir Recreation – Don Pedro Reservoir fosters a high level of sport fishing, boat touring, and aquatic activities. Fish passage facilities present within the reservoir may interfere with such public activities and in some cases may become a safety hazard. Careful consideration of both safety and interference with existing recreational opportunities should be considered if the design process moves forward.

4.0 NEXT STEPS IN THE DEVELOPMENT OF THE FISH PASSAGE FACILITIES ALTERNATIVES ASSESSMENT

This is the first of two TMs being prepared as part of the Fish Passage Facilities Alternatives Assessment. The purpose of the interim TMs being developed is to move forward with LP participation, identify information needs, establish the linkage of certain biological and ecological criteria to the engineering design process, obtain input and feedback in a collaborative process, and to establish when information will be available to support the feasibility assessment of alternative fish passage facilities.

Providing fish passage facilities for the reintroduction of anadromous salmonids to the upper Tuolumne River watershed would be a significant and costly undertaking. The feasibility study of fish passage facilities is one component of the investigation of the potential reintroduction of anadromous species, an investigation which must consider a host of issues ranging from engineering and regulatory guidance (e.g., ESA considerations, experimental designation, etc.) to biological objectives and ecological feasibility (e.g., upstream habitat suitability, estimated carrying capacity and adult and juvenile abundance estimates, seasonal and interannual environmental conditions, etc.). Economic feasibility and potential impacts to other resources (e.g., recreation, existing fisheries, etc.) must also be determined. As such, implementing a collaborative process to collect needed information at the appropriate level of detail is critical to supporting the study process and ensuring the information produced is accurate and can be used to inform future decision making.

The assessment of potential fish passage and reintroduction to the upper watershed requires information on a number of factors that currently have high uncertainty and require agreements among the LPs. Examples of such factors include but are not limited to seasonal timing of adult and juvenile migration, target species to consider in the assessment and their source, escapement goals, and expected adult and juvenile abundance. Although all of these factors require careful consideration, certain ones are needed to directly support the development of facility alternatives for both upstream and downstream passage. Examples include:

- target species identification and source,
- life stages proposed for collection at each type of facility,
- migration timing of these species specific to the Tuolumne River,
- environmental conditions associated with adult and juvenile collection, handling, transport, and release, and
- population goals and expected peak return numbers (linked to habitat availability, suitability, and carrying capacity).

The review of materials in advance of the September 17 workshop is encouraged. Please come prepared to provide input and pertinent discussion to information needs to further the study program.

5.0 REFERENCES

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From: Vaughn, Gary D -FS <gdvaughn@fs.fed.us>
Sent: Tuesday, September 20, 2016 4:06 PM
To: Le, Bao
Cc: Foote, Debra -FS; Garello, Michael; Deason, Jesse; Holdeman, Steven J -FS
Subject: RE: Drone Survey Follow Up - alternative options and drop dead date

Bao – Debbie just returned back from annual leave. We believe that we could review and have your amendment approved if you have the amendment in by October 3rd. I am still hoping that we hear back from our Regional and National program leaders on authorizing the drones, but it seems highly unlikely that they will respond to us before mid-October.

Thanks,

Dusty Vaughn
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From: Le, Bao [mailto:ChiBao.Le@hdrinc.com]
Sent: Monday, September 12, 2016 4:50 PM
To: Vaughn, Gary D -FS <gdvaughn@fs.fed.us>
Cc: Foote, Debra -FS <dfoote@fs.fed.us>; Garello, Michael <Mike.Garello@hdrinc.com>; Deason, Jesse <Jesse.Deason@hdrinc.com>; Holdeman, Steven J -FS <sholdeman@fs.fed.us>
Subject: RE: Drone Survey Follow Up - alternative options and drop dead date

Hi Dusty and Debbie.

We're fast approaching mid-October which is our planned timeframe to survey Lumsden Falls. From a planning perspective on our end, it seems prudent to scope an alternative to the use of a drone to ensure that we complete the Lumsden Falls data collection before winter. As such, Mike Garello has been working on scoping a more traditional ground-based approach to gathering the needed information. The effort may take longer and put "boots on the ground" but the data is extremely important to complete our Migration Barriers Assessment. Since we need to apply for an amendment to the existing permit amendment anyways, we'll be putting this information together in a permit amendment application. What we'd like to know is what the drop dead date would be to file an permit amendment application to ensure that we have approval to conduct the field work; whatever method it might be. Please advise.

Thanks, Bao

From: Vaughn, Gary D -FS [mailto:gdvaughn@fs.fed.us]
Sent: Saturday, August 27, 2016 12:21 PM
To: Le, Bao
Cc: Foote, Debra -FS; Garello, Michael; Deason, Jesse; Holdeman, Steven J -FS
Subject: RE: Drone Survey Follow Up - alternative options and drop dead date

Hi Bao – still no word from our Regional Aviation Officer. I bumped up my request to the USFS UAS Program Manager. I'll let you know as soon as I hear something back.

Thanks,

Dusty Vaughn
Public Service Program Leader
Forest Service
Stanislaus National Forest, Groveland Ranger District
p: 209-962-7825 x525
f: 209-962-7412
gdvaughn@fs.fed.us
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Groveland, CA 95321
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From: Le, Bao [mailto:ChiBao.Le@hdrinc.com]
Sent: Wednesday, August 24, 2016 8:23 AM
To: Vaughn, Gary D -FS <gdvaughn@fs.fed.us>
Cc: Foote, Debra -FS <dfoote@fs.fed.us>; Garello, Michael <Mike.Garello@hdrinc.com>; Deason, Jesse <Jesse.Deason@hdrinc.com>; Holdeman, Steven J -FS <sholdeman@fs.fed.us>
Subject: RE: Drone Survey Follow Up - alternative options and drop dead date

Good morning, Dusty.

Just checking in on the below regarding drone use approval and/or alternatives. Any word?

Thanks, Bao

From: Le, Bao
Sent: Wednesday, August 10, 2016 3:01 PM
To: Vaughn, Gary D -FS
Cc: dfoote@fs.fed.us; Garello, Michael; Deason, Jesse
Subject: Drone Survey Follow Up - alternative options and drop dead date

Hi Dusty.

I just wanted to check-in with you regarding any progress from region on the ability to use a drone to survey Lumsden Falls. Do you have a sense of when you might get feedback? On our end, we need to start planning for both use of a drone and a contingency (using a traditional field crew to collect data at Lumsden Falls) and we assume that this will also require us to amend our existing fish migration barriers study permit. Working backwards from early October (which is when we'd like to conduct the field work), I'm guessing we'll need to better understand our options no later than the end of the month. Any input you may have would be appreciated.

Thanks, Bao

Bao Le
Senior Fisheries Biologist

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From: Devine, John
Sent: Tuesday, September 20, 2016 8:26 AM
To: James Hastreiter
Cc: Le, Bao; Deason, Jesse
Subject: RE: agency and stakeholder comments on La Grange Reservoir Transit Study Plan

Will do.

John Devine, P.E.
D 207-775-4495 **M** 207-776-2206

hdrinc.com/follow-us

From: James Hastreiter [mailto:James.Hastreiter@ferc.gov]
Sent: Tuesday, September 20, 2016 10:50 AM
To: Devine, John
Subject: agency and stakeholder comments on La Grange Reservoir Transit Study Plan

Hi John,

In my quick look at your filing, I see your summary table of the agency comments on the plan and your responses, but I didn't find the actual comment letters or emails from them. Would you please file the comment letters or emails from the stakeholders and agencies with the Secretary, so they become part of the record for the licensing/relicensing process.

Thanks,
Jim

From: Le, Bao
Sent: Tuesday, September 20, 2016 11:29 AM
To: dfoote@fs.fed.us
Cc: Garello, Michael; Deason, Jesse
Subject: Barrier Permit Amendment

Hi Debbie.

We've gotten no feedback from Dusty on the use of a drone to survey Lumsden Falls for our Barrier Study so we're starting to work on an alternative approach that would use a traditional, "boots on the ground" survey crew (likely 2-3 people). Can you tell us how quickly you would be able to turn around a permit amendment application for the existing Barrier Permit that we have in place with the USFS? That will help us determine drop dead date to send you this and when to schedule our field work before accessibility and weather are an issue.

Thanks and hope all is well.

Bao

Bao Le
Senior Fisheries Biologist

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From: Devine, John
Sent: Tuesday, September 20, 2016 10:03 AM
To: Murphey, Gretchen@Wildlife
Cc: 'Steve E. Boyd'; Anna Brathwaite; Greg Dias (Greg.Dias@mid.org); Godwin, Art; [redacted] Staples, Rose; Deason, Jesse; Borovansky, Jenna
Subject: Swim Tunnel Study

Hi Gretchen,

On last Thursday's conference call of the Temperature Subcommittee for La Grange licensing, you had requested a copy of the Districts' Swim Tunnel study. I indicated it had been recently filed with FERC and should be available on the FERC website, but I also confirmed I had not seen it noticed on the FERC website. In looking into this further, I was mistaken. The Districts have yet to file the report. On September 6 of this year, the Districts received comments on the May 2015 draft Swim Tunnel study from CDFW. The Districts want to respond to and address these comments in the final report filed with FERC, so we are holding off on filing the final report until we reply to, and include, the CDFW comments.

I am sorry for any confusion this may have caused.

John Devine, P.E., M.ASCE
Senior Vice President, Hydropower Services

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970 Baxter Blvd, Suite 301
Portland, Maine 04103
D 207-775-4495 **M** 207-776-2206
john.devine@hdrinc.com

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From: Le, Bao
Sent: Wednesday, September 21, 2016 5:00 PM
To: jeicher@blm.gov
Cc: Vertucci, Charles; Warnock, Cory; Deason, Jesse; Devine, John
Subject: NF Tuolumne River removal of temperature/stage recorders - October 4th

Hi Jim.

I wanted to let you know that HDR, on behalf of the Districts' Temperature Monitoring/Modeling Study, will be removing monitoring equipment from the North Fork Tuolumne River confluence location on October 4th. All flagging, angle iron, etc. will also be removed and the site will follow guidelines as identified in our permit to ensure this site doesn't pose any future safety hazards.

Thank you again for your support in conducting this and all of our other studies. It is much appreciated.

Let me know if you have any questions.

Thanks, Bao

Bao Le
Senior Fisheries Biologist

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From: Staples, Rose
Sent: Wednesday, September 21, 2016 3:08 PM
Cc: Deason, Jesse; Staples, Rose; Le, Bao
Subject: La Grange Temp Criteria Subcommittee - Doodle Poll for Date of Next Conf Call

La Grange Temperature Criteria Subcommittee Members,

Thank you for your participation in last week's Temperature Criteria conference call to support the Upper Tuolumne River Reintroduction Assessment Framework. A Doodle link is below identifying possible dates for our next two-hour conference call in October. Please visit the link and provide us with your availability by COB on September 26th.

http://doodle.com/poll/w9qswaaxpahgaxtc

Notes from the meeting will be forthcoming.

Rose Staples, CAP-OM, MOS
Executive Assistant

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Portland ME 04103
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From:	Le, Bao
Sent:	Wednesday, September 21, 2016 8:37 AM
To:	Vaughn, Gary D -FS
Cc:	Foote, Debra -FS; Garello, Michael; Deason, Jesse; Holdeman, Steven J -FS
Subject:	RE: Drone Survey Follow Up - alternative options and drop dead date

Thanks, Dusty.

We'll plan on submitting a Barrier Permit Amendment Application by October 3rd using a more traditional survey method. If we do get guidance to use a drone, we can shift gears quickly since the description and scope of that information is readily available to us.

Bao

From: Vaughn, Gary D -FS [mailto:gdvaughn@fs.fed.us]
Sent: Tuesday, September 20, 2016 4:06 PM
To: Le, Bao
Cc: Foote, Debra -FS; Garello, Michael; Deason, Jesse; Holdeman, Steven J -FS
Subject: RE: Drone Survey Follow Up - alternative options and drop dead date

Bao – Debbie just returned back from annual leave. We believe that we could review and have your amendment approved if you have the amendment in by October 3rd. I am still hoping that we hear back from our Regional and National program leaders on authorizing the drones, but it seems highly unlikely that they will respond to us before mid-October.

Thanks,

Dusty Vaughn
Public Service Program Leader
Forest Service
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f: 209-962-7412
gdvaughn@fs.fed.us
24545 State Highway 120
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From: Le, Bao [mailto:ChiBao.Le@hdrinc.com]
Sent: Monday, September 12, 2016 4:50 PM
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Cc: Foote, Debra -FS <dfoote@fs.fed.us>; Garello, Michael <Mike.Garello@hdrinc.com>; Deason, Jesse <Jesse.Deason@hdrinc.com>; Holdeman, Steven J -FS <sholdeman@fs.fed.us>
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Hi Bao – still no word from our Regional Aviation Officer. I bumped up my request to the USFS UAS Program Manager. I'll let you know as soon as I hear something back.

Thanks,

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Subject: RE: Drone Survey Follow Up - alternative options and drop dead date

Good morning, Dusty.

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Thanks, Bao

Bao Le
Senior Fisheries Biologist

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bao.le@hdrinc.com

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From: Vaughn, Gary D -FS <gdvaughn@fs.fed.us>
Sent: Wednesday, September 21, 2016 5:08 PM
To: Le, Bao; Foote, Debra -FS; Holdeman, Steven J -FS
Cc: Vertucci, Charles; Warnock, Cory; Deason, Jesse; Devine, John
Subject: RE: Upper TR removal of temperature/stage recorders - October 4th

Thanks for keeping us updated Bao!

Dusty Vaughn
Public Service Program Leader
Forest Service
Stanislaus National Forest, Groveland Ranger District
p: 209-962-7825 x525
f: 209-962-7412
gdvaughn@fs.fed.us
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From: Le, Bao [mailto:ChiBao.Le@hdrinc.com]
Sent: Wednesday, September 21, 2016 4:57 PM
To: Foote, Debra -FS <dfoote@fs.fed.us>; Vaughn, Gary D -FS <gdvaughn@fs.fed.us>; Holdeman, Steven J -FS <sholdeman@fs.fed.us>
Cc: Vertucci, Charles <Charles.Vertucci@hdrinc.com>; Warnock, Cory <Cory.Warnock@hdrinc.com>; Deason, Jesse <Jesse.Deason@hdrinc.com>; Devine, John <John.Devine@hdrinc.com>
Subject: Upper TR removal of temperature/stage recorders - October 4th

Hi Debbie, Dusty, and Steve.

I just wanted to reach out and let you know that HDR, on behalf of the Districts' Temperature Monitoring/Modeling Study, will be removing monitoring equipment from the mainstem Tuolumne River locations on October 4th. All flagging, angle iron, etc. will also be removed and the site will follow guidelines as identified in our permit to ensure these sites don't pose any future safety hazards.

The one exception for equipment removal will be at the Clavey River confluence location where we've received permission to keep stage recording equipment instream to support the trail camera at the total fish barrier at approximately RM 2.0. The equipment at this location will be removed in the summer of 2017 (when the trail cameras are removed).

Thank you again for your support in conducting this and all of our other studies. It's been extremely helpful and is much appreciated.

Let me know if you have any questions.

Thanks, Bao

Bao Le
Senior Fisheries Biologist

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Portland, OR 97204-1134
D 971.202.1722 **M** 503.309.9423
bao.le@hdrinc.com

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From: Staples, Rose
Sent: Thursday, September 22, 2016 2:42 PM
Cc: Deason, Jesse; Le, Bao; Staples, Rose
Subject: Filing with FERC of Comment Letters Received on LG Transit Study Plan

La Grange Licensing Participants,

In conjunction with the Reservoir Transit Study Plan, the Plan Amendment, and the Districts' Response to Comments which was filed with FERC on September 16, 2016, today HDR has filed on behalf of the Districts the comment letters which had been received on the Transit Study Plan during the Review/Comment period. A copy of this filing can be found on the La Grange licensing website at www.lagrange-licensing.com – and it should also be available tomorrow on FERC's website at www.ferc.gov.

Rose Staples, CAP-OM, MOS
Executive Assistant

HDR
970 Baxter Boulevard Suite 301
Portland ME 04103
D 207-239-3857
rose.staples@hdrinc.com

hdrinc.com/follow-us

From: Pitts, Adrian
Sent: Monday, September 26, 2016 4:19 PM
To: JURRUTIA@wildlife.ca.gov
Cc: Borovansky, Jenna; Le, Bao; Neal, Morgan
Subject: Hatchery Stocking Information for the Tuolumne River Watershed

Hello Judy,
My name is Adrian Pitts, and I'm conducting a hatchery practices review and trying to develop information regarding fish stocking (planting) in the Tuolumne River watershed, with specific emphasis on the Don Pedro Reservoir and its tributaries. I received your name as someone that may be able to help provide information that would help the Districts and FERC with this effort.

Is there any chance that you have access to the following information (and would be willing to provide it)?

- Detailed stocking information for Don Pedro Reservoir from 2013 through 2016.
- Detailed stocking information for Tuolumne Watershed from 2010 through 2016
- Any information regarding disease outbreaks in the watershed that were specifically attributed to planted fish (or suspected to be associated with planted fish)
- Information regarding disease outbreaks in hatcheries that stock fish in the Tuolumne watershed

If you don't have the information, do you know any individuals or organizations that we might contact to obtain the information?

Thank you in advance for your time.

Adrian E. Pitts
Fisheries and Aquatics Section Manager

HDR
2379 Gateway Oaks Drive, Suite 200
Sacramento, CA 95833
D 916.679.8841 **M** 916.5013199
adrian.pitts@hdrinc.com

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From: Pitts, Adrian
Sent: Monday, September 26, 2016 4:57 PM
To: Greg.Kollenborn@wildlife.ca.gov
Cc: Neal, Morgan; Borovansky, Jenna; Le, Bao
Subject: Hatchery Stocking Information for the Tuolumne River Watershed

Hello Greg,
My name is Adrian Pitts, and I'm conducting a hatchery practices review and trying to develop information regarding fish stocking (planting) in the Tuolumne River watershed, with specific emphasis on the Don Pedro Reservoir and its tributaries. I received your name as someone that may be able to help provide information that would help the Districts and FERC with this effort.

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Fisheries and Aquatics Section Manager

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Sacramento, CA 95833
D 916.679.8841 **M** 916.5013199
adrian.pitts@hdrinc.com

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From: Pitts, Adrian
Sent: Monday, September 26, 2016 4:19 PM
To: GKOLLENBORN@wildlife.ca.gov
Cc: Neal, Morgan; Borovansky, Jenna; Le, Bao
Subject: Hatchery Stocking Information for the Tuolumne River Watershed

Hello Greg,
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From: Pitts, Adrian
Sent: Monday, September 26, 2016 4:57 PM
To: Brian.Beal@wildlife.ca.gov
Cc: Neal, Morgan; Borovansky, Jenna; Le, Bao
Subject: Hatchery Stocking Information for the Tuolumne River Watershed

Hello Brian,
My name is Adrian Pitts, and I'm conducting a hatchery practices review and trying to develop information regarding fish stocking (planting) in the Tuolumne River watershed, with specific emphasis on the Don Pedro Reservoir and its tributaries. I received your name as someone that may be able to help provide information that would help the Districts and FERC with this effort.

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Fisheries and Aquatics Section Manager

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adrian.pitts@hdrinc.com

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From: Pitts, Adrian
Sent: Monday, September 26, 2016 4:19 PM
To: BBeal@wildlife.ca.gov
Cc: Neal, Morgan; Le, Bao; Borovansky, Jenna
Subject: Hatchery Stocking Information for the Tuolumne River Watershed

Hello Brian,
My name is Adrian Pitts, and I'm conducting a hatchery practices review and trying to develop information regarding fish stocking (planting) in the Tuolumne River watershed, with specific emphasis on the Don Pedro Reservoir and its tributaries. I received your name as someone that may be able to help provide information that would help the Districts and FERC with this effort.

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Fisheries and Aquatics Section Manager

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Sacramento, CA 95833
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adrian.pitts@hdrinc.com

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From: Pitts, Adrian
Sent: Monday, September 26, 2016 4:19 PM
To: Kyle.Murphy@wildlife.ca.gov
Cc: Neal, Morgan; Borovansky, Jenna; Le, Bao
Subject: Hatchery Stocking Information for the Tuolumne River Watershed

Hello Kyle,
My name is Adrian Pitts, and I'm conducting a hatchery practices review and trying to develop information regarding fish stocking (planting) in the Tuolumne River watershed, with specific emphasis on the Don Pedro Reservoir and its tributaries. I received your name as someone that may be able to help provide information that would help the Districts and FERC with this effort.

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Adrian E. Pitts
Fisheries and Aquatics Section Manager

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adrian.pitts@hdrinc.com

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From: Pitts, Adrian
Sent: Monday, September 26, 2016 4:19 PM
To: jvance@wildlife.ca.gov
Cc: Neal, Morgan; Borovansky, Jenna; Le, Bao
Subject: Hatchery Stocking Information for the Tuolumne River Watershed

Hello Julie,
My name is Adrian Pitts, and I'm conducting a hatchery practices review and trying to develop information regarding fish stocking (planting) in the Tuolumne River watershed, with specific emphasis on the Don Pedro Reservoir and its tributaries. I received your name as someone that may be able to help provide information that would help the Districts and FERC with this effort.

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adrian.pitts@hdrinc.com

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From: Pitts, Adrian
Sent: Monday, September 26, 2016 4:19 PM
To: moccasincreek@wildlife.ca.gov
Cc: Neal, Morgan; Le, Bao; Borovansky, Jenna
Subject: Hatchery Stocking Information for the Tuolumne River Watershed

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adrian.pitts@hdrinc.com

hdrinc.com/follow-us

From: Staples, Rose
Sent: Monday, September 26, 2016 1:59 PM
Cc: Deason, Jesse; Le, Bao; Staples, Rose
Subject: La Grange Reintroduction Goals Statement DRAFT for Discussion

La Grange Licensing Reintroduction Goals Subcommittee members,

Please find below a draft goals statement developed by the Districts to support continuing discussions of the Reintroduction Goals Subcommittee.

> *Identify and evaluate, in collaboration with stakeholders, reasonable efforts which may enhance and assist in the recovery of ESA listed salmonids in the Central Valley.*

Note that the above draft goal statement is intended solely for the purpose of jump-starting discussions within the subcommittee and shall not be attributed to the Districts or interpreted as the Districts' preferred goals for anadromous fish introduction to the Tuolumne River. Also note that while the Districts feel that it is the fishery management agencies' responsibility to develop draft fish reintroduction goals to facilitate these discussions, the Districts took this as an action item from the April 13, 2016 Reintroduction Goals Subcommittee conference call since no other parties volunteered to do so.

By COB on October 3, 2016, please visit the link below to identify your availability for a conference call to discuss the draft goals statement and next steps.

http://doodle.com/poll/y8fdp57rik8m9m63

Thank you.

Rose Staples, CAP-OM, MOS
Executive Assistant

HDR
970 Baxter Boulevard Suite 301
Portland ME 04103
D 207-239-3857
rose.staples@hdrinc.com

hdrinc.com/follow-us

From: Le, Bao
Sent: Tuesday, September 27, 2016 10:32 AM
To: Steven Raber
Cc: Tucker Selko; Deason, Jesse
Subject: RE: Questions related to NMFS LiDAR

Hi Steve.

Thanks for the input. I work for a consultant to the Turlock and Modesto Irrigation Districts. As part of the FERC licensing process for the La Grange Project, we're implementing a Reintroduction Assessment Framework for the Upper Tuolumne River. This is a collaborative process that both NOAA and the Districts are a part of not to mention other state, federal, and local stakeholders. Although we are not working for NOAA, we are both collecting information to support the Framework and have been coordinating the sharing of information. We received permission from NOAA's representative in this process (John Wooster) to reach out to your firm.

Let me know if you have any other questions.

Thanks again for your assistance, Bao

From: Steven Raber [mailto:sraber@quantumspatial.com]
Sent: Friday, September 16, 2016 12:25 PM
To: Le, Bao
Cc: Tucker Selko
Subject: RE: Questions related to NMFS LiDAR

Hi Bao,

Here is some info regarding your questions. One question I have is, what is your relationship to our NOAA NMFS client? Are you working for them, regarding the analysis you are conducting? … just so you know, we only collected NIR (topo) LiDAR and hyperspectral imagery for the project. Any bathymetric determination/analysis was conducted by our NOAA NMFS client (or that was their original intent).

1. The technical report that accompanies the data is general (weekly) with regards to flight times of the Tuolumne and Merced rivers. Is it possible to get the exact flight dates/times for the different reaches of the Tuolumne River?

The project tracking KML is attached. The LiDAR flights occurred between 9/7/14 and 9/12/14. The hyperspectral flights were between 9/21/14 and 9/24/14. We pretty much flew the hyperspectral between 10:30 and 2:30 local time. Full flight trajectories with accurate date/time were delivered to our NOAA NMFS client, with the data.

2. Were ground measurements collected concurrent with or close to the time of the aerial data collection? If so, do you know at what frequency?

We collected only RTK for LiDAR calibration. Are you referring to spectrometer or bathy ground measurements?

3. Was a flat field correction adequate for this study? Why was the empirical line method not used?

The problem was that this data was collected without plans for calibration, and we would have needed to have tarps in the flight line in order to do ELC. We did manage to get tarps out there for another round of acquisition. The data was later recalibrated using the ATCOR atmospheric model, so there is a version that is fully calibrated reflectance. You may be looking at the old report, but there is better reflectance data that was delivered after that report. You should talk with the NOAA NMFS client.

4. Did riffles or river turbulence present challenges or special adjustments in order to penetrate the water surface and obtain bathymetry data?

This is a question for our NOAA NMFS client, since this refers to analysis they conducted.

5. What is the expected accuracy of bathymetric data? Would accuracy vary with hydraulic condition of the river (pool, glide, riffle, cascade)?

This is a question for our NOAA NMFS client, since this refers to analysis they conducted.

6. Was there glint in the data and if so how was this dealt with?

Assuming this question is related to the hyperspectral data (??) - we did not perform any glint corrections on the hyperspectral data.

7. Was it possible to clearly distinguish sediment sizes in riffles?

Again, this is a question for our NOAA NMFS client, since this refers to information that they would have gathered from their analysis.

Hopefully this is helpful …
Steve

Steve Raber
Quantum Spatial, Inc.
Senior Program Manager
2955 Professional Place, Suite 300 | Colorado Springs, CO 80904
www.quantumspatial.com
C: (719) 646-9141 | **W:** (719) 375-1452

From: Le, Bao [mailto:ChiBao.Le@hdrinc.com]
Sent: Thursday, September 15, 2016 12:51 PM
To: Tucker Selko
Cc: Steven Raber
Subject: RE: Questions related to NMFS LiDAR

Thanks, Tucker.

Hi Steve.

Attached are the questions we've posed to Tucker regarding the NMFS LiDAR/hyperspectral flight. Please let me know if you can help with some answers to the questions.

Thanks, Bao

From: Tucker Selko [mailto:tselko@quantumspatial.com]
Sent: Thursday, September 15, 2016 9:07 AM
To: Le, Bao
Cc: Steven Raber
Subject: Re: Questions related to NMFS LiDAR

Hi, Bao

I apologize for the delay. I am going to direct you to Steve Raber, cc'd, who will be better able to direct your questions regarding hyperspectral work on the Tuolumne.

Best regards,

On Fri, Sep 9, 2016 at 9:22 AM, Le, Bao <ChiBao.Le@hdrinc.com> wrote:

Hi Tucker.

I hope you've had a good summer. I'm sure it's been busy. I wanted to follow up again regarding some questions we had about flights done for NMFS on the Tuolumne River. Are you still able to provide us with some answers to our questions? I've attached them again for your reference.

Thanks, Bao

Bao Le

Senior Fisheries Biologist

HDR

1001 SW 5th Avenue, Suite 1800
Portland, OR 97204-1134
D 971.202.1722 **M** 503.309.9423
bao.le@hdrinc.com

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--
Tucker Selko MS PMP
Project Manager
Quantum Spatial Corvallis
517 SW 2nd Street, Suite 400, Corvallis, OR 97333
P: (541) 752-1204

From: "Clifford, Mark@Wildlife" <Mark.Clifford@wildlife.ca.gov>
Subject: RE: Request for hatchery fish- Don Pedro Reservoir Transit Study
Date: September 29, 2016 at 11:32:24 AM PDT
To: "guignard, jason@fishbio.com" <jasonguignard@fishbio.com>
Cc: "Marston, Dean@Wildlife" <Dean.Marston@wildlife.ca.gov>, "Shaffer, Kevin@Wildlife" <Kevin.Shaffer@wildlife.ca.gov>, "Heyne, Tim@Wildlife" <Tim.Heyne@wildlife.ca.gov>, "Kollenborn, Greg@Wildlife" <Greg.Kollenborn@wildlife.ca.gov>, "Nelson, Jonathan@Wildlife" <Jonathan.Nelson@wildlife.ca.gov>, "Kratville, Daniel@Wildlife" <Daniel.Kratville@wildlife.ca.gov>, "Cox, William@Wildlife" <William.Cox@wildlife.ca.gov>

Hi Jason,

As we discussed this morning, your fish request was approved but fish in the study must be triploid Chinook. Don Pedro has a triploid Chinook allotment and it is our intention to triploid Chinook for this and other inland fisheries, if Iron Gate Hatchery receives enough adult returns to meet mitigation requirements. As of now the run looks insufficient and we may not proceed with Chinook triploidy or supplying that inland fishery this year. The Hatchery Manager will give us an update the week of October 10th and I will relay information to you.

Iron Gate (Klamath River) Hatchery is our only site and source for the triploid Chinook program due to complete absence of Infectious Hematopoietic Necrosis Virus (IHN) going back several decades. Also, the mitigator (owner) is supportive of these activities while other mitigators- not so much. We are considering other locations for triploiding excess Chinook eggs, but nothing could be implemented this year.

Response letter attached.

Best regards,

Mark Clifford, Ph.D.
Statewide Hatchery Coordinator
Senior Environmental Scientist (Specialist)
Office: 530-918-9450
Cell: 916-764-2526

Document Number 16/17-02 .

Response to CDFW Hatchery Anadromous Fish Request

Page 1

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Name of Requester	Jason Guignard
Name of Agency/Institution	FISHBIO
Name/Description of Proposed Activity	Don Pedro Transit Study
Scientific Colleting Permit Number (must be obtained before fish are provided)	SC-9966
Species/type fish or fish products requested	Fall-Run Chinook
Number requested	1,500
Size of fish requested	105-125 mm FL, 12 grams
Hatchery Source	Mokolumne or Merced Fish Hatcheries
River or location of activity	River Name: Tuolumne Other: Don Pedro Reservoir

CDFW Determination	Approved	Approved with Modification (See comments)	Denied

Basis of Denial

- ☐ Lacks Scientific Validity
- ☐ Lacks applicability to fisheries management
- ☐ No data or report sent to CDFW on results of previous investigations using CDFW anadromous fish
- ☐ Need more information on proposed activity (see comments)
- Limited CDFW resources
  - ☐ Activity too labor intensive for hatchery staff
  - ☐ Insufficient room/areas at hatchery
  - ☐ Excessive financial obligation from CDFW
- ☐ Other (see comments)

Disposition of Fish at completion of endeavor	Euthanasia	Release to waters where experiment took place	Transfer to Laboratory

Comments: Study approved only with use of triploid (sterile) and disease-free certified Chinook salmon. These will be made available from the Iron Gate Hatchery (IGH) if sufficient numbers of Chinook return to IGH such that mitigation goals are met and the Department proceeds with triploid efforts there. As of today the run looks insufficient. An update will be provided the around the second week of October, 2016.
Call me if you have questions: 530-918-9450 or 916-764-2526.

Response to CDFW Hatchery Anadromous Fish Request

20__/__

Important Caveats:

Fish are not approved for release into any waters of the State other than specified in approved proposal (if applicable).

Fish approved for proposed activity are intended to be available, though circumstances may limit or prevent the availability of fish (e.g., drought, flood, poor escapement, disease epizootic, equipment failure etc.).

Size of fish requested and approved is intended to be made available for the proposed activity but circumstances may dictate that other size fish are offered. This will be at the discretion of Hatchery Manager.

Logistics such as tagging, marking, grading, feeding (for example) may be the responsibility of the requester. This will be determined by Hatchery Manager and Regional Staff.

Fish transport equipment must be free of any risk of spreading aquatic invasive species or fish pathogens and must be adequate to ensure fish survival throughout transport. Evaluating these parameters and approving/denying use of vehicles and equipment on hatchery grounds will be at the discretion of the Hatchery Manager.

Failure to supply data or publication of these or prior year's research efforts may preclude approval of fish for future research endeavors. Please provide research results and conclusions to CDFW Statewide Hatchery Coordinator for agreed upon appropriate distribution to Regional and Fisheries Branch staff.

____

Statewide Hatchery Coordinator
Departmant of Fish and Wildlife

From: Staples, Rose
Sent: Friday, September 30, 2016 8:06 AM
Cc: Deason, Jesse; Le, Bao; Staples, Rose
Subject: Next La Grange Temp Criteria Subcommittee Conf Call scheduled for OCT 14

La Grange Temperature Criteria Subcommittee participants,

SAVE THE DATE: Friday, October 14, 2016

The next conference call of the La Grange Temperature Criteria Subcommittee is being scheduled for Friday, October 14 from 1:00 to 3:00 p.m.

Rose Staples, CAP-OM, MOS
Executive Assistant

HDR
970 Baxter Boulevard Suite 301
Portland ME 04103
D 207-239-3857
rose.staples@hdrinc.com

hdrinc.com/follow-us

From: Staples, Rose
Sent: Monday, October 03, 2016 2:55 PM
Cc: Deason, Jesse; Le, Bao; Staples, Rose
Subject: FW: La Grange Sept 15 Temperature Criteria Subcommittee Draft Notes Available for Review

The following message was sent to the members of the Water Temperature Criteria Subcommittee today advising them that the draft notes from the September 15 Subcommittee call was available for review on the www.lagrange-licensing.com website. Thank you.

Rose Staples, CAP-OM, MOS
D 207-239-3857

hdrinc.com/follow-us

From: Staples, Rose
Sent: Monday, October 3, 2016 5:48 PM
Cc: Deason, Jesse; Le, Bao; Staples, Rose
Subject: La Grange Sept 15 Temperature Criteria Subcommittee Draft Notes Available for Review

Temperature Criteria Subcommittee,

DRAFT NOTES from the September 15, 2016 Water Temperature Criteria Subcommittee call have been uploaded to the licensing website www.lagrange-licensing.com in the DOCUMENTS section and also as an attachment to the September 15, 2016 date on the website calendar.

Please provide any comments on the meeting notes by Wednesday, November 2, 2016, to rose.staples@hdrinc.com. The Districts will incorporate any comments received and then post a final version of the meeting notes to the licensing website.

In addition, this email will also be forwarded to the La Grange Project licensing email list stating that the draft meeting notes are available online.

If you have any difficulties locating and/or accessing the document, please let me know. Thank you.

Rose Staples, CAP-OM, MOS
Executive Assistant

HDR
970 Baxter Boulevard Suite 301
Portland ME 04103
D 207-239-3857
rose.staples@hdrinc.com

hdrinc.com/follow-us

From: Vaughn, Gary D -FS <gdvaughn@fs.fed.us>
Sent: Monday, October 03, 2016 1:30 PM
To: Vertucci, Charles; Le, Bao; Foote, Debra -FS; Holdeman, Steven J -FS
Cc: Warnock, Cory; Deason, Jesse; Devine, John
Subject: RE: Upper TR removal of temperature/stage recorders - October 4th

Thanks!

Dusty Vaughn
Public Service Program Leader
Forest Service
Stanislaus National Forest, Groveland Ranger District
p: 209-962-7825 x525
f: 209-962-7412
gdvaughn@fs.fed.us
24545 State Highway 120
Groveland, CA 95321
www.fs.fed.us

Caring for the land and serving people

From: Vertucci, Charles [mailto:Charles.Vertucci@hdrinc.com]
Sent: Monday, October 03, 2016 9:36 AM
To: Vaughn, Gary D -FS <gdvaughn@fs.fed.us>; Le, Bao <ChiBao.Le@hdrinc.com>; Foote, Debra -FS <dfoote@fs.fed.us>; Holdeman, Steven J -FS <sholdeman@fs.fed.us>
Cc: Warnock, Cory <Cory.Warnock@hdrinc.com>; Deason, Jesse <Jesse.Deason@hdrinc.com>; Devine, John <John.Devine@hdrinc.com>
Subject: RE: Upper TR removal of temperature/stage recorders - October 4th

Dusty, Debbie and Steve,

We plan to remove the temperature logger equipment accessible by USFS roads and hiking on October 11-13. Similar to our plans this week, all flagging, angle iron, etc. will be removed and the site will follow guidelines as identified in our permit to ensure these sites don't pose any future safety hazards.

Thanks,
Chuck

Charles Vertucci
Senior Aquatic and Water Resources Scientist

HDR
2379 Gateway Oaks Dr. Suite 200
Sacramento, CA 95833
D 916.679.8768 **C** 916.425.8342
charles.vertucci@hdrinc.com

hdrinc.com/follow-us

From: Vaughn, Gary D -FS [mailto:gdvaughn@fs.fed.us]
Sent: Wednesday, September 21, 2016 5:08 PM
To: Le, Bao; Foote, Debra -FS; Holdeman, Steven J -FS
Cc: Vertucci, Charles; Warnock, Cory; Deason, Jesse; Devine, John
Subject: RE: Upper TR removal of temperature/stage recorders - October 4th

Thanks for keeping us updated Bao!

Dusty Vaughn
Public Service Program Leader
Forest Service
Stanislaus National Forest, Groveland Ranger District
p: 209-962-7825 x525
f: 209-962-7412
gdvaughn@fs.fed.us
24545 State Highway 120
Groveland, CA 95321
www.fs.fed.us

Caring for the land and serving people

From: Le, Bao [mailto:ChiBao.Le@hdrinc.com]
Sent: Wednesday, September 21, 2016 4:57 PM
To: Foote, Debra -FS <dfoote@fs.fed.us>; Vaughn, Gary D -FS <gdvaughn@fs.fed.us>; Holdeman, Steven J -FS <sholdeman@fs.fed.us>
Cc: Vertucci, Charles <Charles.Vertucci@hdrinc.com>; Warnock, Cory <Cory.Warnock@hdrinc.com>; Deason, Jesse <Jesse.Deason@hdrinc.com>; Devine, John <John.Devine@hdrinc.com>
Subject: Upper TR removal of temperature/stage recorders - October 4th

Hi Debbie, Dusty, and Steve.

I just wanted to reach out and let you know that HDR, on behalf of the Districts' Temperature Monitoring/Modeling Study, will be removing monitoring equipment from the mainstem Tuolumne River locations on October 4th. All flagging, angle iron, etc. will also be removed and the site will follow guidelines as identified in our permit to ensure these sites don't pose any future safety hazards.

The one exception for equipment removal will be at the Clavey River confluence location where we've received permission to keep stage recording equipment instream to support the trail camera at the total fish barrier at approximately RM 2.0. The equipment at this location will be removed in the summer of 2017 (when the trail cameras are removed).

Thank you again for your support in conducting this and all of our other studies. It's been extremely helpful and is much appreciated.

Let me know if you have any questions.

Thanks, Bao

Bao Le
Senior Fisheries Biologist

HDR
1001 SW 5th Avenue, Suite 1800
Portland, OR 97204-1134
D 971.202.1722 **M** 503.309.9423
bao.le@hdrinc.com

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From: Staples, Rose
Sent: Tuesday, October 04, 2016 2:41 PM
Cc: Deason, Jesse; Le, Bao; Staples, Rose
Subject: FW: LG Reintro Goals Subcommittee Conference Call Scheduled For Oct 20

La Grange Licensing Participants,

The following message was sent to the members of the Reintroduction Goals Subcommittee today regarding the next subcommittee conference call scheduled for October 20, 2016.

Rose Staples, CAP-OM, MOS
D 207-239-3857

hdrinc.com/follow-us

From: Staples, Rose
Sent: Tuesday, October 4, 2016 5:34 PM
Cc: Deason, Jesse; 'Le, Bao'; Staples, Rose (Rose.Staples@hdrinc.com)
Subject: LG Reintro Goals Subcommittee Conference Call Scheduled For Oct 20

To members of the La Grange Reintroduction Goals Subcommittee:

Thank you all for responding to the Doodle Poll regarding availability.

The next Reintroduction Goals Subcommittee conference call will be on Thursday, October 20, 2016 from 1:00 to 3:00 p.m.

The Agenda and any meeting materials will be forthcoming closer to the date. Call-in information is as follows:

Call-In Number: 866-583-7984
Conference Code: 814-0607

Rose Staples, CAP-OM, MOS
Executive Assistant

HDR
970 Baxter Boulevard Suite 301
Portland ME 04103
D 207-239-3857
rose.staples@hdrinc.com

hdrinc.com/follow-us

From: Le, Bao
Sent: Tuesday, October 04, 2016 2:27 PM
To: dfoote@fs.fed.us
Cc: Vaughn, Gary D -FS; Holdeman, Steven J -FS; Deason, Jesse; Devine, John; Garello, Michael
Subject: GRO 1128 Migration Barrier Study Permit - Amendment Application
Attachments: SF-299_TID_BarrierSurveyingAmendment_10-03-2016.pdf; Attachment A__BarrierSurveyingAmendment_SF 299_9-28-2016_10-03-16.pdf

Hi Debbie et al.,

Please find attached a permit amendment application to the GRO 1128 permit we have in place for the Fish Migration Barriers Study. As discussed, we have shifted the scope of work to a more traditional ground survey of Lumsden Falls given our inability to get approval for use of a drone. Our hope is to conduct this field work in mid-late October (exact dates TBD). Thank you again for your support and please let me know if you have any questions.

Best regards,
Bao

Bao Le
Senior Fisheries Biologist

HDR
1001 SW 5th Avenue, Suite 1800
Portland, OR 97204-1134
D 971.202.1722 **M** 503.309.9423
bao.le@hdrinc.com

hdrinc.com/follow-us

STANDARD FORM 299 (6/99)
Prescribed by DOI/USDA/DOT
P.L. 96-487 and Federal
Register Notice 5-22-95

APPLICATION FOR TRANSPORTATION AND UTILITY SYSTEMS AND FACILITIES ON FEDERAL LANDS

FORM APPROVED
OMB NO. 0596-0082

FOR AGENCY USE ONLY
Application Number

Date Filed

NOTE: Before completing and filing the application, the applicant should completely review this package and schedule a preapplication meeting with representatives of the agency responsible for processing the application. Each agency may have specific and unique requirements to be met in preparing and processing the application. Many times, with the help of the agency representative, the application can be completed at the preapplication meeting.

1. Name and address of applicant (*include zip code*)
Turlock Irrigation District
Modesto Irrigation District
(Attachment A)

2. Name, title, and address of authorized agent if different from item 1 *(include zip code)*
HDR
2379 Gateway Oaks Dr #200
Sacramento,CA 95835

3. Telephone (area code)
Applicant 209-883-8364
Authorized Agent 971-202-1722

4. As applicant are you? *(check one)*
a. ☐ Individual
b. ☐ Corporation*
c. ☐ Partnership/Association*
d. ☐ State Government/State Agency
e. ☒ Local Government
f. ☐ Federal Agency

** If checked, complete supplemental page*

5. Specify what application is for: *(check one)*
a. ☐ New authorization
b. ☐ Renewing existing authorization No.
c. ☒ Amend existing authorization No.
d. ☐ Assign existing authorization No.
e. ☐ Existing use for which no authorization has been received *
f. ☐ Other*

** If checked, provide details under item 7*

6. If an individual, or partnership are you a citizen(s) of the United States? ☐ Yes ☐ No

7. Project description (describe in detail): (a) Type of system or facility, *(e.g., canal, pipeline, road);* (b) related structures and facilities; (c) physical specifications *(Length, width, grading, etc.)*; (d) term of years needed: (e) time of year of use or operation; (f) Volume or amount of product to be transported; (g) duration and timing of construction; and (h) temporary work areas needed for construction *(Attach additional sheets, if additional space is needed.)*

As part of the La Grange Hydroelectric licensing, Turlock and Modesto irrigation districts and their consultant, HDR Inc. propose additional fish passage barrier surveying on the Tuolumne River within the Stanislaus National Forest. See Attachment A for additional information.

8. Attach a map covering area and show location of project proposal
9. State or Local government approval: ☒ Attached ☐ Applied for ☒ Not Required
10. Nonreturnable application fee: ☐ Attached ☐ Not required
11. Does project cross international boundary or affect international waterways? ☐ Yes ☒ No *(if "yes," indicate on map)*
12. Give statement of your technical and financial capability to construct, operate, maintain, and terminate system for which authorization is being requested.

The Districts have hired qualified biologists to help them execute each study they have proposed to complete. HDR, Inc. will complete the proposed fish barrier surveying using ground-based traditional surveying methods and laser scanning. Consultant biologists have completed similar surveying studies in various other rivers in the Central Valley. Study leads have extensive expertise in conducting studies to survey rivers using the proposed methods.

13a. Describe other reasonable alternative routes and modes considered.

No other reasonable alternative routes exist that allow for the completion of the study objectives. Travel through the Stanislaus National Forest (SNF) is necessary to reach the target locations.

b. Why were these alternatives not selected?

Previous monitoring has been conducted in the proposed work area in 2015. Previous work identified the need to conduct more detailed fish passage barrier monitoring and surveying.

c. Give explanation as to why it is necessary to cross Federal Lands.

The study sites are located within the SNF. Travel onto the SNF will be on established roadways and trails and within the river.

14. List authorizations and pending applications filed for similar projects which may provide information to the authorizing agency. *(Specify number, date, code, or name)*

Authorization ID: GRO1128 (approved on 07/29/2015) (see Attachment B)

15. Provide statement of need for project, including the economic feasibility and items such as: (a) cost of proposal (construction, operation, and

maintenance); (b) estimated cost of next best alternative; and (c) expected public benefits.

This work is part of the FERC licensing of the La Grange Hydroelectric Project. Information collected will be used to evaluate fish passage associated with the potential for Chinook salmon and steelhead reintroduction to the upper Tuolumne River basin. Cost of the monitoring is minimal compared to overall cost of licensing effort. Refer to Attachment A for additional information.

16. Describe probable effects on the population in the area, including the social and economic aspects, and the rural lifestyles.

The proposed study would not have any reasonable foreseeable impacts on the local population. Overnight camping will occur at locations along the upper Tuolumne River that are not located adjcent to established camping areas to the extent feasible.

17. Describe likely environmental effects that the proposed project will have on: (a) air quality; (b) visual impact; (c) surface and ground water quality and quantity; (d) the control or structural change on any stream or other body of water; (e) existing noise levels; and (f) the surface of the land, including vegetation, permafrost, soil, and soil stability.

This proposed surveying will not result in substantial effects on the local environment. Equipment may be charged with a generator as needed, but is not expected to result in substantial noise levels. See Attachment A for more detail.

18. Describe the probable effects that the proposed project will have on (a) populations of fish, plantlife, wildlife, and marine life, including threatened and endangered species; and (b) marine mammals, including hunting, capturing, collecting, or killing these animals.

There are no expected effects to local flora and fauna associated with the proposed surveying. See Attachment A for more detail.

19. State whether any hazardous material, as defined in this paragraph, will be used, produced, transported or stored on or within the right-of-way or any of the right-of-way facilities, or used in the construction, operation, maintenance or termination of the right-of-way or any of its facilities. "Hazardous material" means any substance, pollutant or contaminant that is listed as hazardous under the Comprehensive Environmental Response, Compensation, and Liability Act of 1980, as amended, 42 U.S.C. 9601 et seq., and its regulations. The definition of hazardous substances under CERCLA includes any "hazardous waste" as defined in the Resource Conservation and Recovery Act of 1976 (RCRA), as amended, 42 U.S.C. 6901 et seq., and its regulations. The term hazardous materials also includes any nuclear or byproduct material as defined by the Atomic Energy Act of 1954, as amended, 42 U.S.C. 2011 et seq. The term does not include petroleum, including crude oil or any fraction thereof that is not otherwise specifically listed or designated as a hazardous substance under CERCIA Section 101(14), 42 U.S.C. 9601(14), nor does the term include natural gas.

No hazardous materials will be produced, transported or stored during the course of the proposed studies.

20. Name all the Department(s)/Agency(ies) where this application is being filed.

Stanislaus National Forest, USFS.

I HEREBY CERTIFY, That I am of legal age and authorized to do business in the State and that I have personally examined the information contained in the application and believe that the information submitted is correct to the best of my knowledge.

Signature of Applicant	Date
Steve Boyd	*October 3, 2016*

Title 18, U.S.C. Section 1001, makes it a crime for any person knowingly and willfully to make to any department or agency of the United States any false, fictitious, or fraudulent statements or representations as to any matter within its jurisdiction.

GENERAL INFORMATION
ALASKA NATIONAL INTEREST LANDS

This application will be used when applying for a right-of-way, permit, license, lease, or certificate for the use of Federal lands which lie within conservation system units and National Recreation or Conservation Areas as defined in the Alaska National Interest lands Conservation Act. Conservation system units include the National Park System, National Wildlife Refuge System, National Wild and Scenic Rivers System, National Trails System, National Wilderness Preservation System, and National Forest Monuments.

Transportation and utility systems and facility uses for which the application may be used are:

1. Canals, ditches, flumes, laterals, pipes, pipelines, tunnels, and other systems for the transportation of water.

2. Pipelines and other systems for the transportation of liquids other than water, including oil, natural gas, synthetic liquid and gaseous fuels, and any refined product produced therefrom.

3. Pipelines, slurry and emulsion systems, and conveyor belts for transportation of solid materials.

4. Systems for the transmission and distribution of electric energy.

5. Systems for transmission or reception of radio, television, telephone, telegraph, and other electronic signals, and other means of communications.

6. Improved right-of-way for snow machines, air cushion vehicles, and all-terrain vehicles.

7. Roads, highways, railroads, tunnels, tramways, airports, landing strips, docks, and other systems of general transportation.

This application must be filed simultaneously with each Federal department or agency requiring authorization to establish and operate your proposal.

In Alaska, the following agencies will help the applicant file an application and identify the other agencies the applicant should contact and possibly file with:

Department of Agriculture
Regional Forester, Forest Service (USFS)
Federal Office Building,
P.O. Box 21628
Juneau, Alaska 99802-1628
Telephone: (907) 586-7847 *(or a local Forest Service Office)*

Department of the Interior
Bureau of Indian Affairs (BIA)
Juneau Area Office
Federal Building Annex
9109 Mendenhall Mall Road, Suite 5
Juneau, Alaska 99802
Telephone: (907) 586-7177

Department of the Interior
Bureau of Land Management
222 West 7th Avenue
P.O. Box 13
Anchorage, Alaska 99513-7599
Telephone: (907) 271-5477 (or a local BLM Office)

U.S. Fish & Wildlife Service (FWS)
Office of the Regional Director
1011 East Tudor Road
Anchorage, Alaska 99503
Telephone: (907) 786-3440

National Park Service (NPA)
Alaska Regional Office,
2225 Gambell St., Rm. 107
Anchorage, Alaska 99502-2892
Telephone: (907) 786-3440

Note - Filings with any Interior agency may be filed with any office noted above or with the Office of the Secretary of the Interior, Regional Environmental Office,r P.O. Box 120, 1675 C Street, Anchorage, Alaska 9513.

Department of Transportation
Federal Aviation Administration
Alaska Region AAL-4, 222 West 7th Ave., Box 14
Anchorage, Alaska 99513-7587
Telephone: (907) 271-5285

NOTE - The Department of Transportation has established the above central filing point for agencies within that Department. Affected agencies are: Federal Aviation Administration (FAA), Coast Guard (USCG), Federal Highway Administration (FHWA), Federal Railroad Administration (FRA).

OTHER THAN ALASKA NATIONAL INTEREST LANDS

Use of this form is not limited to National Interest Conservation Lands of Alaska.

Individual department/agencies may authorize the use of this form by applicants for transportation and utility systems and facilities on other Federal lands outside those areas described above.

For proposals located outside of Alaska, applications will be filed at the local agency office or at a location specified by the responsible Federal agency.

SPECIFIC INSTRUCTIONS
(Items not listed are self-explanatory)

7 Attach preliminary site and facility construction plans. The responsible agency will provide instructions whenever specific plans are required.

8 Generally, the map must show the section(s), township(s), and range(s) within which the project is to be located. Show the proposed location of the project on the map as accurately as possible. Some agencies require detailed survey maps. The responsible agency will provide additional instructions.

9, 10, and 12 The responsible agency will provide additional instructions.

13 Providing information on alternate routes and modes in as much detail as possible, discussing why certain routes or modes were rejected and why it is necessary to cross Federal lands will assist the agency(ies) in processing your application and reaching a final decision. Include only reasonable alternate routes and modes as related to current technology and economics.

14 The responsible agency will provide instructions.

15 Generally, a simple statement of the purpose of the proposal will be sufficient. However, major proposals located in critical or sensitive areas may require a full analysis with additional specific information. The responsible agency will provide additional instructions.

16 through 19 Providing this information is as much detail as possible will assist the Federal agency(ies) in processing the application and reaching a decision. When completing these items, you should use a sound judgment in furnishing relevant information. Fore example, if the project is not near a stream or other body of water, do not address this subject. The responsible agency will provide additional instructions.

Application must be signed by the applicant or applicant's authorized representative.

EFFECT OF NOT PROVIDING INFORMATION: Disclosure of the information is voluntary. If all the information is not provided, the application may be rejected.

DATA COLLECTION STATEMENT

The Federal agencies collect this information from applicants requesting right-of-way, permit, license, lease, or certification for the use of Federal lands. The Federal agencies use this information to evaluate the applicant's proposal. The public is obligated to submit this form if they wish to obtain permission to use Federal lands.

SUPPLEMENTAL		
NOTE: The responsible agency(ies) will provide instructions	CHECK APPROPRIATE BLOCK	
I - PRIVATE CORPORATIONS	ATTACHED	FILED*
a. Articles of Incorporation	☐	☐
b. Corporation Bylaws	☐	☐
c. A certification from the State showing the corporation is in good standing and is entitled to operate within the State	☐	☐
c. Copy of resolution authorizing filing	☐	☐
e. The name and address of each shareholder owning 3 percent or more of the shares, together with the number and percentage of any class of voting shares of the entity which such shareholder is authorized to vote and the name and address of each affiliate of the entity together with, in the case of an affiliate controlled by the entity, the number of shares and the percentage of any class of voting stock of that affiliate owned, directly or indirectly, by that entity, and in the case of an affiliate which controls that entity, the number of shares and the percentage of any class of voting stock of that entity owned, directly or indirectly, by the affiliate.	☐	☐
f. If application is for an oil or gas pipeline, describe any related right-of-way or temporary use permit applications, and identify previous applications.	☐	☐
g. If application is for an oil and gas pipeline, identify all Federal lands by agency impacted by proposal.	☐	☐
II - PUBLIC CORPORATIONS		
a. Copy of law forming corporation	☐	☐
b. Proof of organization	☐	☐
c. Copy of Bylaws	☐	☐
d. Copy of resolution authorizing filing	☐	☐
e. If application is for an oil or gas pipeline, provide information required by item "I-f" and "I-g" above.	☐	☐
III - PARTNERSHIP OR OTHER UNINCORPORATED ENTITY		
a. Articles of association, if any	☐	☐
b. If one partner is authorized to sign, resolution authorizing action is	☐	☐
c. Name and address of each participant, partner, association, or other	☐	☐
d. If application is for an oil or gas pipeline, provide information required by item "I-f" and "I-g" above.	☐	☐

* If the required information is already filed with the agency processing this application and is current, check block entitled "Filed." Provide the file identification information *(e.g., number, date, code, name)*. If not on file or current, attach the requested information.

NOTICE

Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number. The valid OMB control number for this information collection is 0596-0082.

This information is needed by the Forest Service to evaluate the requests to use National Forest System lands and manage those lands to protect natural resources, administer the use, and ensure public health and safety. This information is required to obtain or retain a benefit. The authority for that requirement is provided by the Organic Act of 1897 and the Federal Land Policy and Management Act of 1976, which authorize the secretary of Agriculture to promulgate rules and regulations for authorizing and managing National Forest System lands. These statutes, along with the Term Permit Act, National Forest Ski Area Permit Act, Granger-Thye Act, Mineral Leasing Act, Alaska Term Permit Act , Act of September 3, 1954, Wilderness Act, National Forest Roads and Trails Act, Act of November 16, 1973, Archeological Resources Protection Act, and Alaska National Interest Lands Conservation Act, authorize the Secretary of Agriculture to issue authorizations or the use and occupancy of National Forest System lands. The Secretary of Agriculture's regulations at 36 CFR Part 251, Subpart B, establish procedures for issuing those authorizations.

The Privacy Act of 1974 (5 U.S.C. 552a) and the Freedom of Information Act (5 U.S.C. 552) govern the confidentiality to be provided for information received by the Forest Service.

Public reporting burden for this collection of information is estimated to average 8 hours per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information.

Attachment A for Forest Service SF-299 Amendment to GRO1128

Filed by Turlock and Modesto Irrigation Districts and HDR, Inc.

October 3, 2016

Names and Addresses of Applicants

Turlock Irrigation District
PO Box 949
Turlock, CA 95381-0949

Modesto Irrigation District
PO Box 4060
Modesto, CA 95352-4060

Project Description

The Turlock Irrigation District (TID) and Modesto Irrigation District (MID) (collectively, the Districts) own the La Grange Diversion Dam (LGDD) located on the Tuolumne River in Stanislaus County, California. Currently the Districts are working through the Federal Energy Regulatory Commission (FERC) licensing process with the end goal of filing an application for a license. As part of the process the Districts, at the request of state and federal fish and wildlife agencies (NMFS, USFWS, and CDFW) have volunteered to complete a series of studies to evaluate ecological considerations related to the potential reintroduction of anadromous salmonids (i.e., Chinook salmon and steelhead) to the upper Tuolumne River.

This Amendment proposes to conduct more detailed fish passage barrier surveying in a particular location that was previously accessed in 2015 under GRO1128. HDR, Inc. has been retained by the Districts to conduct ground-based traditional surveying and terrestrial laser scanning in the vicinity of and upstream of Lumsden Falls to evaluate fish passage conditions, for the purposes of informing potential anadromous salmonid reintroduction efforts.

Introduction

Preliminary fish passage barrier monitoring conducted in the upper Tuolumne River during 2015 (under GRO1128) identified the need to collect more detailed information in the vicinity of and upstream of Lumsden Falls, due to potential constraints to anadromous fish passage observed in 2015. This study supports the Upper Tuolumne River Reintroduction Assessment Framework (Framework).

Study Area

The study area for the proposed surveying effort includes a limited portion of the study area associated with the initial work conducted under GRO1128. Specifically, the area to be surveyed includes the upper Tuolumne River in the vicinity of and upstream of Lumsden Falls.

Sampling Plan Overview and Methods

The proposed effort is expected to produce topographic mapping of the upper Tuolumne River in the vicinity of Lumsden Falls. Field data will be obtained using a combination of terrestrial laser scanning and traditional survey methods, as described in more detail below.

<u>Task 1: Survey Control</u>

Establish site control based upon the USDA benchmark located on the bridge near Lumsden Falls. A local horizontal coordinate system will be assumed.

<u>Task 2: Terrestrial Laser Scanning</u>

Perform terrestrial laser scanning of the area in question. Subsurface features will not be captured within the scan data.

<u>Task 3: Traditional Ground Surveying</u>

Although the laser scanning technology is efficient and accurate for terrestrial features above the water surface, this technology cannot be used to obtain ground surface elevations below the water surface. Therefore, additional ground elevations occurring below the water surface in safe and accessible areas near the falls will also be collected. This, more traditional type of surveying will utilize a robotic total station to obtain data on surface features occurring below the waters surface.

<u>Task 4: Mapping</u>

Perform point registration of scan data and combine with survey data to prepare an AutoCAD surface. Contours are expected to be provided at 1’ intervals.

Schedule and Logistics

<u>Study Period</u> – The surveying effort, including mobilization to the site, equipment deployment, and data collection, is expected to be completed within 5 days. The surveying effort needs to be conducted under relatively low-flow conditions, and therefore is anticipated to be conducted during mid to late October of 2016.

<u>Study Location</u> – Upper Tuolumne River mainstem in the vicinity of Lumsden Falls.

<u>Site Access</u> – The site is accessible by motor vehicle and by foot on USFS roads and hiking routes.

Additional Information for Permit Application Questions

15.

The cost of proposed studies is minimal compared to the overall cost of the ongoing Licensing effort. The Districts have allotted sufficient funds for the completion of all studies involved in the Licensing effort. The purpose of this study is to develop topographic mapping near Lumsden Falls to inform potential access by anadromous salmonid species. Results of the proposed study will provide valuable and essential information related to the potential feasibility of reintroducing anadromous salmonids into the upper Tuolumne River Watershed. Results of the study (i.e., topographic mapping) will be made available to the public.

17.

The proposed study is not anticipated to substantially affect air quality, aesthetics, surface and ground water quality and quantity, the control on any stream or body of water, or surface of the land. Equipment to be used for this study does not create noise above that of typical electronic hand-held or surveying devices, with the exception of the potential use of a generator. However, generator use will be restricted to charging equipment that is essential for conducting the proposed study, and will be operated in accordance with USFS regulations (e.g., will be placed in an area that has at least 10' diameter of clearance from all vegetation). All equipment will be removed after completion of the study.

In order to minimize the potential for spreading aquatic invasive species during the course of the proposed study, the California Department of Fish and Wildlife Aquatic Invasive Species Decontamination Protocol (https://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=43333) will be followed.

18.

The proposed study is not anticipated to have any probable effects on populations of fish or wildlife. The results of the study will provide valuable and critical information related to the suitability of the upper Tuolumne River for potential anadromous fish reintroduction efforts, and study results will be made available to the public.

From: Pitts, Adrian
Sent: Thursday, October 06, 2016 9:12 AM
To: 'Vance, Julie@Wildlife'
Subject: RE: Hatchery Stocking Information for the Tuolumne River Watershed

Hi Julie,
Thank you for sending my request to the PRA folks. By chance, do you know how long it will/could take to get the information? Just looking to manage expectations on our end.

Thanks you again
Adrian

Adrian Pitts
D 916.679.8841 **M** 916.501.3199

hdrinc.com/follow-us

From: Vance, Julie@Wildlife [mailto:Julie.Vance@wildlife.ca.gov]
Sent: Friday, September 30, 2016 4:09 PM
To: Pitts, Adrian
Cc: Neal, Morgan; Borovansky, Jenna; Le, Bao
Subject: RE: Hatchery Stocking Information for the Tuolumne River Watershed

I'll see what we have and will get back to you.

Julie

Julie Vance
Regional Manager, Central Region
California Department of Fish and Wildlife
1234 E. Shaw
Fresno, CA 93710
(559) 243-4005 x 154
julie.vance@wildlife.ca.gov

From: Pitts, Adrian [mailto:Adrian.Pitts@hdrinc.com]
Sent: Monday, September 26, 2016 5:02 PM
To: Vance, Julie@Wildlife
Cc: Morgan.Neal@hdrinc.com; Borovansky, Jenna; Le, Bao
Subject: Hatchery Stocking Information for the Tuolumne River Watershed

Hello Julie,
My name is Adrian Pitts, and I'm conducting a hatchery practices review and trying to develop information regarding fish stocking (planting) in the Tuolumne River watershed, with specific emphasis on the Don Pedro Reservoir and its tributaries. I received your name as someone that may be able to help provide information that would help the Districts and FERC with this effort.

Is there any chance that you have access to the following information (and would be willing to provide it)?

- Detailed stocking information for Don Pedro Reservoir from 2013 through 2016.
- Detailed stocking information for Tuolumne Watershed from 2010 through 2016
- Any information regarding disease outbreaks in the watershed that were specifically attributed to planted fish (or suspected to be associated with planted fish)
- Information regarding disease outbreaks in hatcheries that stock fish in the Tuolumne watershed

If you don't have the information, do you know any individuals or organizations that we might contact to obtain the information?

Thank you in advance for your time.

Adrian E. Pitts
Fisheries and Aquatics Section Manager

HDR
2379 Gateway Oaks Drive, Suite 200
Sacramento, CA 95833
D 916.679.8841 **M** 916.5013199
adrian.pitts@hdrinc.com

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From: Steven Raber [mailto:sraber@quantumspatial.com]
Sent: Monday, October 10, 2016 1:41 PM
To: Le, Bao
Cc: Tucker Selko; Prescott, Thomas; Deason, Jesse; Scott Venables
Subject: RE: Questions related to NMFS LiDAR

Hi Bao,

As I indicated in #1 below, the trajectory files should have been included with the original delivery to NOAA. Is there some reason why you did not receive that info from NOAA? If you need the trajectory info, we will have to pull this out of archives, which will take a little time. I can't say for sure when we'd be able to get this to you.

Steve

Steve Raber
Quantum Spatial, Inc.
Senior Program Manager
2955 Professional Place, Suite 300 | Colorado Springs, CO 80904
www.quantumspatial.com
C: (719) 646-9141 | **W:** (719) 375-1452

From: Le, Bao [mailto:ChiBao.Le@hdrinc.com]
Sent: Monday, October 10, 2016 11:01 AM
To: Steven Raber
Cc: Tucker Selko; Prescott, Thomas; Deason, Jesse
Subject: RE: Questions related to NMFS LiDAR

Hi Steve.

One follow up request regarding #1 below. Are you able to provide us with the trajectory files for the Tuolumne River? That would allow us to identify exact times certain reaches were flown and tie this river flow. I have cc'd Tom Prescott who is our imagery lead on the project as he can facilitate any data sharing of large files if necessary.

Thank you.

Bao

From: Steven Raber [mailto:sraber@quantumspatial.com]
Sent: Friday, September 16, 2016 12:25 PM
To: Le, Bao
Cc: Tucker Selko
Subject: RE: Questions related to NMFS LiDAR

Hi Bao,

Here is some info regarding your questions. One question I have is, what is your relationship to our NOAA NMFS client? Are you working for them, regarding the analysis you are conducting? … just so you know, we only collected NIR (topo) LiDAR and hyperspectral imagery for the project. Any bathymetric determination/analysis was conducted by our NOAA NMFS client (or that was their original intent).

1. The technical report that accompanies the data is general (weekly) with regards to flight times of the Tuolumne and Merced rivers. Is it possible to get the exact flight dates/times for the different reaches of the Tuolumne River?

The project tracking KML is attached. The LiDAR flights occurred between 9/7/14 and 9/12/14. The hyperspectral flights were between 9/21/14 and 9/24/14. We pretty much flew the hyperspectral between 10:30 and 2:30 local time. Full flight trajectories with accurate date/time were delivered to our NOAA NMFS client, with the data.

2. Were ground measurements collected concurrent with or close to the time of the aerial data collection? If so, do you know at what frequency?

We collected only RTK for LiDAR calibration. Are you referring to spectrometer or bathy ground measurements?

3. Was a flat field correction adequate for this study? Why was the empirical line method not used?

The problem was that this data was collected without plans for calibration, and we would have needed to have tarps in the flight line in order to do ELC. We did manage to get tarps out there for another round of acquisition. The data was later recalibrated using the ATCOR atmospheric model, so there is a version that is fully calibrated reflectance. You may be looking at the old report, but there is better reflectance data that was delivered after that report. You should talk with the NOAA NMFS client.

4. Did riffles or river turbulence present challenges or special adjustments in order to penetrate the water surface and obtain bathymetry data?

This is a question for our NOAA NMFS client, since this refers to analysis they conducted.

5. What is the expected accuracy of bathymetric data? Would accuracy vary with hydraulic condition of the river (pool, glide, riffle, cascade)?

This is a question for our NOAA NMFS client, since this refers to analysis they conducted.

6. Was there glint in the data and if so how was this dealt with?

Assuming this question is related to the hyperspectral data (??) - we did not perform any glint corrections on the hyperspectral data.

7. Was it possible to clearly distinguish sediment sizes in riffles?

Again, this is a question for our NOAA NMFS client, since this refers to information that they would have gathered from their analysis.

Hopefully this is helpful …
Steve

quantum SPATIAL
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Quantum Spatial, Inc.
Senior Program Manager
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From: Le, Bao [mailto:ChiBao.Le@hdrinc.com]
Sent: Thursday, September 15, 2016 12:51 PM
To: Tucker Selko
Cc: Steven Raber
Subject: RE: Questions related to NMFS LiDAR

Thanks, Tucker.

Hi Steve.

Attached are the questions we've posed to Tucker regarding the NMFS LiDAR/hyperspectral flight. Please let me know if you can help with some answers to the questions.

Thanks, Bao

From: Tucker Selko [mailto:tselko@quantumspatial.com]
Sent: Thursday, September 15, 2016 9:07 AM
To: Le, Bao
Cc: Steven Raber
Subject: Re: Questions related to NMFS LiDAR

Hi, Bao

I apologize for the delay. I am going to direct you to Steve Raber, cc'd, who will be better able to direct your questions regarding hyperspectral work on the Tuolumne.

Best regards,

On Fri, Sep 9, 2016 at 9:22 AM, Le, Bao <ChiBao.Le@hdrinc.com> wrote:

Hi Tucker.

I hope you've had a good summer. I'm sure it's been busy. I wanted to follow up again regarding some questions we had about flights done for NMFS on the Tuolumne River. Are you still able to provide us with some answers to our questions? I've attached them again for your reference.

Thanks, Bao

Bao Le

Senior Fisheries Biologist

HDR

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--
Tucker Selko MS PMP
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Quantum Spatial Corvallis
517 SW 2nd Street, Suite 400, Corvallis, OR 97333
P: (541) 752-1204

From: Staples, Rose
Sent: Thursday, October 13, 2016 12:36 PM
Subject: FW: La Grange Temp Criteria Subcommittee Oct 14 Call AGENDA and Advance Materials
Attachments: Upper TR Lifestage Temp Lit Review WT Sub 20161014.pdf; Glossary-Acronym list_WT Sub 20161014.pdf; LG UTR Reintro Framework WT Sub_Agenda 20161014Final.pdf

Follow Up Flag: Follow up
Flag Status: Flagged

La Grange Licensing Participants,

The following message was sent to the members of the Temperature Criteria Subcommittee today regarding the agenda and advance materials for tomorrow's conference call.

Rose Staples, CAP-OM, MOS
D 207-239-3857

hdrinc.com/follow-us

From: Staples, Rose
Sent: Thursday, October 13, 2016 3:31 PM
Cc: Deason, Jesse <jesse.deason@hdrinc.com>; 'Le, Bao' <Bao.Le@hdrinc.com>; Staples, Rose (Rose.Staples@hdrinc.com) <Rose.Staples@hdrinc.com>
Subject: La Grange Temp Criteria Subcommittee Oct 14 Call AGENDA and Advance Materials

Temperature Criteria Subcommittee members,

In preparation for tomorrow's conference call, a meeting agenda and meeting materials are attached--and they are also available on the La Grange licensing website www.lagrange-licensing.com (see ANNOUNCEMENTS and/or CALENDAR date attachments). If you have any difficulties locating and/or accessing this material, please let me know at rose.staples@hdrinc.com.

Thank you.

Rose Staples, CAP-OM, MOS
Executive Assistant

HDR
970 Baxter Boulevard Suite 301
Portland ME 04103
D 207-239-3857
rose.staples@hdrinc.com

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UPPER TUOLUMNE RIVER REINTRODUCTION ASSESSMENT FRAMEWORK
WATER TEMPERATURE CRITERIA SUBCOMMITTEE

LIFESTAGE-SPECIFIC WATER TEMPERATURE BIOLOGICAL EFFECTS AND INDEX TEMPERATURE VALUES

Literature Review Summary

INTRODUCTION

The La Grange Hydroelectric Project (La Grange Project), owned and operated by the Turlock Irrigation District and Modesto Irrigation District (TID/MID), is currently undergoing the Federal Energy Regulatory Commission (FERC) Integrated Licensing Process. As part of this process, the Districts are implementing a FERC-approved Fish Passage Facilities Alternatives Assessment which consists of developing general design criteria and design considerations applicable to upstream and downstream fish passage facilities at the La Grange Project. Design criteria and considerations include such items as site-specific physical and operational parameters; applicable regulatory requirements; National Marine Fisheries Service (NMFS),U.S. Fish and Wildlife Service (USFWS), and California Department of Fish and Wildlife (CDFW) biological and engineering design criteria; site-specific biological/habitat information relevant to the sizing and configuration of facilities; and any other information gaps that may affect siting, sizing, general design parameters, capital cost, and operating requirements of potential fish passage facilities.

To make certain that detailed, site-specific information is available to support and adequately inform decisions regarding fish reintroduction and fish passage, TID, MID, and licensing participants came to a consensus on the need for and utility of an Upper Tuolumne River Reintroduction Assessment Framework (Framework). The Framework is intended to provide a comprehensive, collaborative, and transparent approach for evaluating the full range of potential issues associated with the future reintroduction of anadromous fish to the upper Tuolumne River. In addition to considering aspects of the technical feasibility of building and operating fish passage facilities, the Framework considers the interrelated issues of ecological feasibility, biological constraints, economics, regulatory implications, and other considerations of reintroduction. Elements of the Framework are interconnected, with fish passage construction and operational requirements needing to properly reflect biological constraints, ecological considerations, and economic cost:benefit assessments.

Water temperature considerations are a primary component of assessing any potential anadromous salmonid reintroduction effort. In support of the Framework, the Districts and licensing participants established a Water Temperature Criteria Subcommittee to begin investigating water temperature considerations pertinent to anadromous salmonid reintroduction opportunities in the accessible reaches of the Tuolumne River upstream of Don Pedro Reservoir (upper Tuolumne River). On September 15, 2016, the Districts hosted the first conference call for the Water Temperature Criteria Subcommittee (draft meeting notes from this call were distributed on October 3 for a 30-day comment period). On the conference call, attendees discussed the need for a comprehensive literature review of regional and site-specific information to inform the selection of water temperature index values to be used in an evaluation of the water temperature-related reintroduction potential in the reaches of the upper Tuolumne River. Meeting attendees agreed that the literature review performed for the Yuba Salmon Forum (Appendix A; Bratovich et al. 2012) to support the anadromous salmonid reintroduction assessment in this watershed coupled with site-specific temperature studies or data for the Tuolumne River, if available, would be a good basis for this effort. The following represents and updated literature review summary and is provided to the Water Temperature Criteria Subcommittee to support selection of water temperature index values for the Framework.

STEELHEAD LIFESTAGE-SPECIFIC WATER TEMPERATURE INDEX VALUES

Adult Immigration and Holding

Water temperatures can control the timing of adult spawning migrations and can affect the viability of eggs in holding females. Yuba County Water Agency (YCWA) *et al.* (2007) suggests that few studies have been published examining the effects of water temperature on either steelhead immigration or steelhead holding, and none of the available studies were recent (Bruin and Waldsdorf 1975; McCullough *et al.* 2001). The available studies suggest that adverse effects occur to immigrating and holding steelhead at water temperatures exceeding the mid 50°F range, and that immigration will be delayed if water temperatures approach approximately 70°F. Water temperature index values of 52°F, 56°F, 61°F, 65°F and 70°F were chosen because they provide a gradation of potential water temperature effects, and the available literature provided the strongest support for these values.

Because of the paucity of literature pertaining to steelhead adult immigration and holding, an evenly spaced range of water temperature index values could not be achieved. We also used some pertinent information related to other salmonids (e.g., Chinook salmon). 52°F was selected as a water temperature index value because it has been referred to as a "recommended" (Reclamation 2003), "preferred" (McEwan and Jackson 1996; NMFS 2000; NMFS 2002), and "optimum" (Reclamation 1997a) water temperature for steelhead adult immigration. Increasing levels of thermal stress to this life stage may reportedly occur above the 52°F water temperature index value. 56°F was selected as a water temperature index value because 56°F represents a water temperature above which adverse effects to migratory and holding steelhead begin to arise (Bruin and Waldsdorf 1975; Leitritz and Lewis 1980; McCullough *et al.* 2001; Smith *et al.* 1983). 50-59°F is referred to as the "preferred" range of water temperatures for California summer steelhead holding (Moyle *et al.* 1995). Whereas, water temperatures greater than 61°F may result in "chronic high stress" of holding Central Valley winter- run steelhead (USFWS 1995a). 65°F was selected as a water temperature index value because steelhead (and fall-run Chinook salmon) encounter potentially stressful temperatures between 64.4-73.4°F (Richter and Kolmes 2005). Additionally, over 93% of steelhead detections occurred in the 65.3-71.6°F range, although this may be above the temperature for optimal immigration (Salinger and Anderson 2006) and/or may modify migration timing due to holding in coldwater refugia (High *et al.* 2006). 70°F was selected as the highest water temperature index value because the literature suggests that water temperatures near and above 70.0°F may result in a thermal barrier to adult steelhead migrating upstream (McCullough *et al.* 2001) and are water temperatures referred to as "stressful" to upstream migrating steelhead in the Columbia River (Lantz 1971 as cited in Beschta et al 1987). Further, Coutant (1972) found that the upper incipient lethal temperature (UILT) for adult steelhead was 69.8°F and temperatures between 73-75°F are described as "lethal" to holding adult steelhead in Moyle (2002).

As part of the Framework, TID and MID, in collaboration with stakeholders developed a table of established water temperature criteria from select salmon and steelhead programs in the Central Valley (Temperature Criteria Matrix; presented at the September 15, 2016 Water Temperature

Subcommittee conference call). The table was developed to support the Framework's Water Temperature Criteria Subcommittee whose purpose is to establish a technical basis to evaluate water temperature regimes for target anadromous salmonid reintroduction into the Tuolumne River upstream of Don Pedro Reservoir. For steelhead adult immigration, the Temperature Criteria Matrix identified 64°F in for the San Joaquin (CALFED 2009) and 64°F (Upper Optimum Value) and 68°F (Upper Tolerable Value) for the Yuba Reintroduction Assessment (Bratovich *et al.* 2012). For steelhead adult holding, the Temperature Criteria Matrix identified 61°F (Upper Optimum Value) and 65°F (Upper Tolerable Value) for the Yuba Reintroduction Assessment (Bratovich et al. 2012).

EPA Region 10 Guidance for Pacific Northwest State and Tribal Temperature Water Quality Standards (EPA 2003b) identifies 64°F (7DADM) for "salmon and trout" migration.

Spawning and Embryo Incubation

Relatively few studies have been published directly addressing the effects of water temperature on steelhead spawning and embryo incubation (Redding and Schreck 1979; Rombough 1988). Because anadromous steelhead and non-anadromous rainbow trout are genetically and physiologically similar, studies on non-anadromous rainbow trout also were considered in the development of water temperature index values for steelhead spawning and embryo incubation (Moyle 2002; McEwan 2001). From the available literature, water temperatures in the low 50°F range appear to support high embryo survival, with substantial mortality to steelhead eggs reportedly occurring at water temperatures in the high 50°F range and above. Water temperatures in the 45-50°F range have been referred to as the "optimum" for spawning steelhead (FERC 1993).

Water temperature index values of 46°F, 52°F, 54°F, 57°F, and 60°F were selected for two reasons. First, the available literature provided the strongest support for water temperature index values at or near 46°F, 52°F, 54°F, 57°F, and 60°F. Second, the index values reflect a gradation of potential water temperature effects ranging between optimal to lethal conditions for steelhead spawning and embryo incubation. Some literature suggests water temperatures ≤ 50°F are when steelhead spawn (Orcutt *et al.* 1968) and/or are optimal for steelhead spawning and embryo survival (FERC 1993; Myrick and Cech 2001; Timoshina 1972) and temperatures between 39-52°F are "preferred" by spawning steelhead (IEP Steelhead Project Work Team (no date); McEwan and Jackson 1996), a larger body of literature suggests optimal conditions occur at water temperatures ≤ 52°F (Humpesch 1985; NMFS 2000; NMFS 2001a; NMFS 2002; Reclamation 1997b; SWRCB 2003; USFWS 1995b). Further, water temperatures between 48-52°F were referred to as "optimal" (FERC 1993; McEwan and Jackson 1996; NMFS 2000) and "preferred" (Bell 1986) for steelhead embryo incubation. Therefore, 52°F was selected as the lowest water temperature index value. Increasing levels of thermal stress to the steelhead spawning and embryo incubation life stage may reportedly occur above the 52°F water temperature index value.

54°F was selected as the next index value, because although most of the studies conducted at or near 54.0°F report high survival and normal development (Kamler and Kato 1983; Redding and Schreck 1979; Rombough 1988), some evidence suggests that symptoms of thermal stress arise at or near 54.0°F (Humpesch 1985; Timoshina 1972). Thus, water temperatures near 54°F may represent an inflection point between properly functioning water temperature conditions, and conditions that cause negative effects to steelhead spawning and embryo incubation. Further, water temperatures greater than 55°F were referred to as "stressful" for incubating steelhead embryos (FERC 1993). 57°F was selected as an index value because embryonic mortality increases sharply and development becomes retarded at incubation temperatures greater than or equal to 57.0°F. Velsen (1987) provided a compilation of data on rainbow trout and steelhead embryo mortality to 50% hatch under incubation temperatures ranging from 33.8°F to 60.8°F that demonstrated a two-fold increase in mortality for embryos incubated at 57.2°F, compared to embryos incubated at 53.6°F. In a laboratory study using gametes from Big Qualicum River, Vancouver Island, steelhead mortality increased to 15% at a constant temperature of 59.0°F, compared to less than 4% mortality at constant temperatures of 42.8°F, 48.2°F, and 53.6°F (Rombough 1988). Also, alevins hatching at 59.0°F were considerably smaller and appeared less well developed than those incubated at the lower temperature treatments. From fertilization to 50% hatch, Big Qualicum River steelhead had 93% mortality at 60.8°F, 7.7% mortality at 57.2°F, and 1% mortality at 47.3°F and 39.2°F (Velsen 1987). Myrick and Cech (2001) similarly described water temperatures >59°F as "lethal" to incubating steelhead embryos, although FERC (1993) suggested that water temperatures exceeding 68°F were "stressful" to spawning steelhead and "lethal" when greater than 72°F.

As part of the Don Pedro Hydroelectric Project FERC relicensing process, the TID and MID conducted an *O. mykiss* Population Study (TID/MID 2014) for the Lower Tuolumne River below La Grange Diversion Dam. The goal of the study is to provide a quantitative population model to investigate the relative influences of various factors on the lifestage specific production of *O. mykiss in* the Tuolumne River including water temperature effects on population response for specific in-river lifestages. The study noted that although no literature information could be identified regarding upper temperature limits for spawning initiation, maximum temperature limits for spawning are assumed to be on the order of 15°C (59°F) inferred from egg mortality thresholds for resident *O. mykiss* (Velsen 1987) as well as steelhead (Rombough 1988). Similarly, for egg incubation, the model allowed for a broad range of flow and water temperature conditions using the completed model, an initial acute mortality threshold of 15°C (59°F) was included based upon a literature review by Myrick and Cech (2001).

For steelhead spawning and embryo incubation in the Yuba River, the Framework Temperature Criteria Matrix identified 54°F and 57°F for Upper Optimum and Upper Tolerable values, respectively (Bratovich *et al.* 2012).

EPA Region 10 Guidance for Pacific Northwest State and Tribal Temperature Water Quality Standards (EPA 2003b) identifies 55°F (7DADM) for "salmon and trout" spawning and egg incubation.

Juvenile Rearing & Downstream Movement

Water temperature index values were developed to evaluate the combined steelhead rearing (fry and juvenile) and juvenile downstream movement lifestages. Some steelhead may rear in freshwater for up to three years before emigrating as yearling+ smolts, whereas other individuals move downstream shortly after emergence as post- emergent fry, or rear in the river for several months and move downstream as juveniles without exhibiting the ontogenetic characteristics of smolts . Presumably, these individuals continue to rear and grow in downstream areas (e.g., lower Feather River, Sacramento River, and Upper Delta) and undergo the smoltification process prior to entry into saline environments. Thus, fry and juvenile rearing occur concurrently with post-emergent fry and juvenile downstream movement and are assessed in this Technical Memorandum using the fry and juvenile rearing water temperature index values.

The growth, survival, and successful smoltification of juvenile steelhead are controlled largely by water temperature. The duration of freshwater residence for juvenile steelhead is long relative to that of Chinook salmon, making the juvenile life stage of steelhead more susceptible to the influences of water temperature, particularly during the over-summer rearing period. Central Valley juvenile steelhead have high growth rates at water temperatures in the mid 60°F range, but reportedly require lower water temperatures to successfully undergo the transformation to the smolt stage.

Water temperature index values of 63°F, 65°F, 68°F, 72°F, and 75°F were selected to represent a gradation of potential water temperature effects ranging between optimal to lethal conditions for steelhead juvenile rearing. The lowest water temperature index value of 63°F was established because Myrick and Cech (2001) describe 63°F as the "preferred" water temperature for wild juvenile steelhead, whereas "preferred" water temperatures for juvenile hatchery steelhead reportedly range between 64-66°F. 65°F was also identified as a water temperature index value because NMFS (2000; 2002a) reported 65°F as the upper limit preferred for growth and development of Sacramento and American River juvenile steelhead. Also, 65°F was found to be within the optimum water temperature range for juvenile growth (i.e., 59-66°F) (Myrick and Cech 2001), and supported high growth of Nimbus strain juvenile steelhead (Cech and Myrick 1999).

Increasing levels of thermal stress to this life stage may reportedly occur above the 65°F water temperature index value. For example, Kaya *et al.* (1977) reported that the upper avoidance water temperature for juvenile rainbow trout was measured at 68°F to 71.6°F. Cherry *et al.* (1977) observed an upper preference water temperature near 68.0°F for juvenile rainbow trout, duplicating the upper preferred limit for juvenile steelhead observed in Cech and Myrick (1999) and FERC (1993). Empirical adult *O. mykiss* population data from the North Yuba, Middle Yuba, South Yuba, Middle Fork American, and Rubicon rivers were collected in 2007-2009 were plotted against temperature (Figure 4 of Bratovich et al. 2012). The temperature used was the 8th largest average daily temperature during the summer (i.e., up to seven days had higher daily average temperatures). The data show a population density break at about 68.0°F. Although smaller population densities occurred at higher temperatures, the largest population densities occurred at temperatures near 68.0°F or less. In addition growth for a 200 mm juvenile *O. mykiss* versus temperature for three food levels (percent of maximum consumption = 30%, 50%, and 70%) was evaluated. The average empirically derived percent of maximum consumption in an adjacent watershed (Middle Fork American Fork River) was 50% (Hanson *et al.* 1997). Positive growth only occurs up to approximately 68°F. Because of the literature describing 68.0°F as both an upper preferred and an avoidance limit for juvenile *O. mykiss*, and because of the empirical fish population data and bioenergetics growth data, 68°F was established as a upper tolerable water temperature index value.

A water temperature index value of 72°F was established because symptoms of thermal stress in juvenile steelhead have been reported to arise at water temperatures approaching 72°F. For example, physiological stress to juvenile steelhead in Northern California streams was demonstrated by increased gill flare rates, decreased foraging activity, and increased agonistic activity as stream temperatures rose above 71.6°F (Nielsen *et al.* 1994). Also, 72°F was selected as a water temperature index value because 71.6°F has been reported as an upper avoidance water temperature (Kaya *et al.* 1977) and an upper thermal tolerance water temperature (Ebersole *et al.* 2001) for juvenile rainbow trout. The highest water temperature index value of 75°F was established because NMFS and EPA report that direct mortality to rearing juvenile steelhead results when stream temperatures reach 75.0°F (EPA 2002; NMFS 2001b). Water temperatures >77°F have been referred to as "lethal" to juvenile steelhead (FERC 1993; Myrick and Cech 2001). The UILT for juvenile rainbow trout, based on numerous studies, is between 75-79°F (Sullivan *et al.* 2000; McCullough 2001).

A swim tunnel study conducted on the Lower Tuolumne River (TID/MID 2016) generated high quality field data on the physiological performance of Tuolumne River *O. mykiss* acutely exposed to a temperature range of 13 to 25°C. The data indicated that wild juvenile *O. mykiss* represents an exception to the expected based on the 7DADM criterion for juvenile rearing set out by EPA (2003b) for Pacific Northwest *O. mykiss*. The study recommended that a conservative upper aerobic performance limit of 71.6°F, instead of 64.4°F (EPA), be considered in re-determining a 7DADM for this population.

The Lower Tuolumne River *O. mykiss* Population Study (TID/MID 2014) identified the upper incipient lethal temperature (UILT) for *O. mykiss* juveniles has been estimated at 22.8–25.9ºC (73–79°F) (Threader and Houston 1983). In the model, an initial mortality threshold of 25°C (77°F) daily average temperature was selected for *O. mykiss* juveniles. Note also that both fry rearing and resident adult rearing lifestages of *O. mykiss* also had UILT values of 77°F to support the model.

For steelhead juvenile rearing, the Temperature Criteria Matrix identified 65°F for the Lower American River (Water Forum 2007); 61°F for the San Joaquin (CALFED 2009); and 65°F (Upper Optimum Value) and 68°F (Upper Tolerable Value) for the Yuba (Bratovich *et al.* 2012).

EPA Region 10 Guidance for Pacific Northwest State and Tribal Temperature Water Quality Standards (EPA 2003b) identifies 64°F (7DADM) for "salmon and steelhead" juvenile rearing.

<u>Yearling + Smolt Emigration</u>

Laboratory data suggest that smoltification, and therefore successful emigration of steelhead smolts, is directly controlled by water temperature (Adams *et al.* 1975). Water temperature index values of 52°F and 55°F were selected to evaluate the steelhead smolt emigration life stage, because most literature on water temperature effects on steelhead smolting suggest that water temperatures less than 52°F (Adams *et al.*1975; Myrick and Cech 2001; Rich 1987a) or less than 55°F (EPA 2003a; McCullough *et al.* 2001; Wedemeyer *et al.* 1980; Zaugg and Wagner 1973) are required for successful smoltification to occur. (Adams *et al.* 1973) tested the effect of water temperature (43.7°F, 50.0°F, 59.0°F or 68.0°F) on the increase of gill microsomal Na^+-, K^+-stimulated ATPase activity associated with parr-smolt transformation in steelhead and found a two-fold increase in Na^+-, K^+-ATPase at 43.7 and 50.0°C, but no increase at 59.0°F or 68.0°F . In a subsequent study, the highest water temperature where a parr-smolt transformation occurred was at 52.3°F (Adams *et al.* 1975). The results of Adams *et al.* (1975) were reviewed in Myrick and Cech (2001) and Rich (1987b), which both recommended that water temperatures below 52.3°F are required to successfully complete the parr-smolt transformation. Further, Myrick and Cech (2001) suggest that water temperatures between 43-50°F are the "physiologically optimal" temperatures required during the parr-smolt transformation and necessary to maximize saltwater survival. The 52°F water temperature index value established for the steelhead smolt emigration life stage is the index value generally reported in the literature as the upper limit of the water temperature range that provides successful smolt transformation thermal conditions. Increasing levels of thermal stress to this life stage may reportedly occur above the 52°F water temperature index value.

Zaugg and Wagner (1973) examined the influence of water temperature on gill ATPase activity related to parr-smolt transformation and migration in steelhead. They found ATPase activity was decreased and migration reduced when juveniles were exposed to water temperatures of 55.4°F or greater. In a technical document prepared by the EPA to provide temperature water quality standards for the protection of Northwest native salmon and trout, water temperatures less than or equal to 54.5°F were recommended for emigrating juvenile steelhead (EPA 2003b). Water temperatures are considered "unsuitable" for steelhead smolts at >59°F (Myrick and Cech 2001) and "lethal" at 77°F (FERC 1993).

The Lower Tuolumne River *O. mykiss* Population Study (TID/MID 2014) identified an initial UILT mortality threshold of 77°F daily average temperature for *O. mykiss* smolts on the basis of literature reviews by Myrick and Cech (2001).

For steelhead smolt emigration, the Temperature Criteria Matrix identified 57°F for the San Joaquin (CALFED 2009) and 52°F (Upper Optimum Value) and 55°F (Upper Tolerable Value) for the Yuba (Bratovich *et al.* 2012).

EPA Region 10 Guidance for Pacific Northwest State and Tribal Temperature Water Quality Standards (EPA 2003b) identifies 57°F (7DADM) for steelhead smolt.

CHINOOK SALMON LIFESTAGE-SPECIFIC WATER TEMPERATURE INDEX VALUES

It has been suggested that separate water temperatures standards should be developed for each run-type of Chinook salmon. For example, McCullough (1999) states that spring-run Chinook salmon immigrate in spring and spawn in 3rd to 5th order streams and, therefore, face different migration and adult holding temperature regimes than do summer- or fall-run Chinook salmon, which spawn in streams of 5th order or greater . However, to meet the objectives of the current literature review, run-types are not separated because: (1) there is a paucity of literature specific to each life stage of each run-type; (2) there is an insufficient amount of data available in the literature suggesting that Chinook salmon run-types respond to water temperatures differently; (3) the water temperature index (WTI) values derived from all the literature pertaining to Chinook salmon for a particular life stage will be sufficiently protective of that life stage for each run-type; and (4) all run- types overlap in timing of adult immigration and holding and in some cases are not easily distinguished (Healey 1991).

Adult Immigration and Holding

The adult immigration and adult holding life stages are evaluated together, because it is difficult to determine the thermal regime that Chinook salmon have been exposed to in the river prior to spawning and in order to be sufficiently protective of pre-spawning fish, water temperatures that provide high adult survival and high egg viability must be available throughout the entire pre-spawning freshwater period. Although studies examining the effects of thermal stress on immigrating Chinook salmon are generally lacking, it has been demonstrated that thermal stress during the upstream spawning migration of sockeye salmon negatively affected the secretion of hormones controlling sexual maturation causing numerous reproductive impairment problems (McCullough *et al.* 2001).

The water temperature index values reflect a gradation of potential water temperature effects that range between those reported as "optimal" to those reported as "lethal" for adult Chinook salmon during upstream spawning migrations and holding. The water temperature index values established for the Chinook salmon adult immigration and holding lifestage are 61°F, 65°F, and 68°F. Although 56°F is referenced in the literature frequently as the upper "optimal" water temperature limit for upstream migration and holding, the references are not foundational studies and often are inappropriate citations. For example, Boles *et al.* (1988), Marine (1992), and NMFS (1997b) all cite Hinze (1959) in support of recommendations for a water temperature of 56°F for adult Chinook salmon immigration. However, Hinze (1959) is a study examining the effects of water temperature on incubating Chinook salmon eggs in the American River Basin. Further, water temperatures between 38-56°F are considered to represent the "observed range" for upstream migrating spring-run Chinook salmon (Bell 1986).

The lowest water temperature index value established was 61°F, because in the NMFS biological opinion for the proposed operation of the Central Valley Project (CVP) and State Water Project (SWP), 59°F to 60°F is reported as…"*The upper limit of the optimal temperature range for adults holding while eggs are maturing*" (NMFS 2000). Also, NMFS (1997b) states…"*Generally, the maximum temperature of adults holding, while eggs are maturing, is about 59°F to 60°F*" …and… "*Acceptable range for adults migrating upstream range from 57°F to 67°F*." Oregon Department of Environmental Quality (ODEQ; 1995) reports that "…*many of the diseases that commonly affect Chinook become highly infectious and virulent above 60°F*." Study summaries in EPA (2003a) indicate disease risk is high at 62.6°F. Additionally, Ward and Kier (1999) designated temperatures <60.8°F as an "optimum" water temperature threshold for holding Battle Creek spring-run Chinook salmon. EPA (2003a) chose a holding value of 61°F (7DADM) based on laboratory data various assumptions regarding diel temperature fluctuations. 61°F is also a holding temperature index value for steelhead (see above). The 61°F water temperature index value established for the Chinook salmon adult immigration and holding life stage is the index value generally reported in the literature as the upper limit of the optimal range, and is within the reported acceptable range. Increasing levels of thermal stress to this life stage may reportedly occur above the 61°F water temperature index value.

An index value of 65°F was established because Berman (1990) suggests effects of thermal stress to pre-spawning adults are evident at water temperatures near 65°F. Berman (1990) conducted a laboratory study to determine if pre-spawning water temperatures experienced by adult Chinook salmon influenced reproductive success, and found evidence suggesting latent embryonic abnormalities associated with water temperature exposure to pre-spawning adults that ranged from 63.5°F to 66.2°F. Ward *et al.* (2003; 2004) identified an extended period of average daily temperatures above 67°F during July as measured at the Quartz Bowl that preceded the onset of significant pre-spawn mortalities. During 2002, temperatures exceeded 67°F a total of 16 days with a maximum of 20.8°C on July 12. During 2003, temperatures exceed 67°F a total of 11 days with a maximum of 20.9°C on July 23. However during other years when there were minimal pre-spawn mortalities, maximum daily average water temperature at Quartz Bowl never exceeded 67°F more than an few days (Ward *et al.* 2004; Ward *et al.* 2006; McReynolds *et al*. 2007; McReynolds and Garman 2008). During each of the years when Chinook salmon temperature mortality was not observed at Butte Creek (2001, 2004-2007), on average, daily temperature did not exceed 65.8°F for more than 7 days (Figure 6 of Bratovich et al. 2012). Tracy McReynolds (Pers. Comm. October 2011) indicated that an upper tolerable holding temperature of 65°F was reasonable based on her experience.

An index value of 68°F was established because the Butte Creek data and the literature suggests that thermal stress at water temperatures greater than 68°F is pronounced, and severe adverse effects to immigrating and holding pre-spawning adults, including mortality, can be expected (Berman 1990; Marine 1997; NMFS 1997b; Ward *et al.* 2004).

Water temperatures between 70-77°F are reported as the range of maximum temperatures for holding pool conditions used by spring-run Chinook salmon in the Sacramento-San Joaquin system (Moyle *et al*. 1995). Migration blockage occurs for Chinook salmon at temperatures from 70-71+°F (McCollough 1999; McCullough *et al*. 2001; EPA 2003b). Strange (2010) found that the mean average body temperature during the first week of Chinook salmon migration on the Klamath River was 71.4°F. The UILT for Chinook salmon jacks is 69.8-71.6°F (McCullough 1999). The upper limit for spring-run Chinook salmon holding in Deer Creek is reportedly 80.6°F, at which point temperatures exceeding this value become "lethal" (Cramer and Hammack 1952, as cited in Moyle *et al.* 1995). As a result of the potential effects to immigrating and holding adult Chinook salmon that reportedly occur at water temperatures greater than or equal to 68°F, index values higher than 68°F were not established.

For Chinook adult immigration, the Framework Temperature Criteria Matrix identified 64°F (Upper Optimum Value) and 68°F (Upper Tolerable Value) for the Yuba River (Bratovich et al. 2012). For Chinook adult holding, the Framework Temperature Criteria Matrix identified 61°F

(Upper Optimum Value) and 65°F (Upper Tolerable Value) for the Yuba River (Bratovich *et al.* 2012).

EPA Region 10 Guidance for Pacific Northwest State and Tribal Temperature Water Quality Standards (EPA 2003b) identifies 64°F (7DADM) for "salmon and trout" adult migration.

Spawning and Embryo Incubation

The adult spawning and embryo (i.e., eggs and alevins) incubation life stage includes redd construction, egg deposition, and embryo incubation. Potential effects to the adult spawning and embryo incubation life stages are evaluated together using one set of water temperature index values because it is difficult to separate the effects of water temperature between lifestages that are closely linked temporally, especially considering that studies describing how water temperature affects embryonic survival and development have included a pre-spawning or spawning adult component in the reporting of water temperature experiments conducted on fertilized eggs (Marine 1992; McCullough 1999; Seymour 1956).

The water temperature index values selected for the Chinook salmon spawning and embryo incubation life stages are 56°F, 58°F, 60°F, and 62°F. Anomalously, FERC (1993) refers to 50°F as the "optimum" water temperature for spawning and incubating Chinook salmon. Additionally, for the adult spawning lifestage, FERC (1993) reports "stressful" and "lethal" water temperatures occurring at >60°F and >70°F, respectively, whereas for incubating Chinook salmon embryos, water temperatures are considered to be "stressful" at <56°F or "lethal" at >60°F. Much literature suggests that water temperatures must be less than or equal to 56°F for maximum survival of Chinook salmon embryos (i.e., eggs and alevins) during spawning and incubation. NMFS (1993b) reported that optimum water temperatures for egg development are between 43°F and 56°F. Similarly, Myrick and Cech (2001) reported the highest egg survival rates occur between water temperatures of 39-54°F. Reclamation (unpublished work) reports that water temperatures less than 56°F results in a natural rate of mortality for fertilized Chinook salmon eggs. Bell (1986) recommends water temperatures ranging between 42-57°F for spawning Chinook salmon, and water temperatures between 41-58°F for incubating embryos. USFWS (1995a) reported a water temperature range of 41.0°F to 56.0°F for maximum survival of eggs and yolk-sac larvae in the Central Valley of California. The preferred water temperature range for Chinook salmon egg incubation in the Sacramento River was suggested as 42.0°F to 56.0°F (NMFS 1997a). Alevin mortality is reportedly significantly higher when Chinook salmon embryos are incubated at water temperatures above 56°F (USFWS 1999). NMFS (2002a) reported 56.0°F as the upper limit of suitable water temperatures for spring-run Chinook salmon spawning in the Sacramento River. The 56°F water temperature index value established for the Chinook salmon spawning and embryo incubation life stage is the index value generally reported in the literature as the upper limit of the optimal range for egg development and the upper limit of the range reported to provide maximum survival of eggs and yolk-sac larvae in the Central Valley of California. Increasing levels of thermal stress to this life stage may reportedly occur above the 56°F water temperature index value.

High survival of Chinook salmon embryos also has been suggested to occur at incubation temperatures at or near 58.0°F. For example, (Reclamation Unpublished Work) reported that the natural rate of mortality for alevins occurs at 58°F or less. Combs (1957) concluded constant incubation temperatures between 42.5°F and 57.5°F resulted in normal development of Chinook salmon eggs, and NMFS (2002a) suggests 53.0°F to 58.0°F is the preferred water temperature range for Chinook salmon eggs and fry. Johnson (1953) found consistently higher Chinook salmon egg losses resulted at water temperatures above 60.0°F than at lower temperatures. In order to protect late incubating Chinook salmon embryos and newly emerged fry NMFS (1993a) has determined a water temperature criterion of less than or equal to 60.0°F be maintained in the Sacramento River from Keswick Dam to Bend Bridge from October 1 to October 31. Seymour (1956) provides evidence that 100% mortality occurs to late incubating Chinook salmon embryos when held at a constant water temperature greater than or equal to 60.0°F. For Chinook salmon eggs incubated at constant temperatures, mortality increases rapidly at temperatures greater than about 59-60°F (see data plots in Myrick and Cech 2001). Olsen and Foster (1957), however, found high survival of Chinook salmon eggs and fry (89.6%) when incubation temperatures started at 60.9°F and declined naturally for the Columbia River (about 7°F/month). Geist *et al.* (2006) found high (93.8%) Chinook salmon incubation survival through emergence for naturally declining temperatures (0.36°F/day) starting as high as 61.7°F; however, a significant reduction in survival occurred above this temperature.

The literature largely agrees that 100% mortality will result to Chinook salmon embryos incubated at water temperatures greater than or equal to 62.0°F (Hinze 1959; Myrick and Cech 2003; Seymour 1956; USFWS 1999). Approximately 80% or greater mortality of eggs incubated at constant temperatures of 63°F or greater (see data plots in Myrick and Cech 2001). Olsen and Foster (1957) found high mortality of Chinook salmon eggs and fry (79%) when incubation temperatures started at 65.2°F and declined naturally for the Columbia River (about 7°F / month). Geist *et al.* (2006) found low Chinook salmon incubation survival (1.7%) for naturally declining temperatures (0.36°F/day) when temperatures started at 62.6°F

As part of the Don Pedro Hydroelectric Project FERC relicensing process, the TID and MID developed a Chinook Salmon Population Model Study (TID/MID 2013) for the Lower Tuolumne River below La Grange Diversion Dam. The goal of the study is to provide a quantitative population model to investigate the relative influences of various factors on the lifestage specific production of Chinook salmon in the Tuolumne River including water temperature effects on population response for specific in-river lifestages. The Chinook Salmon Population Model (TID/MID 2013) established an initial estimate of 60.4°F as the upper limit for initiation of spawning (Groves and Chandler 1999); also interpreted as the temperature at which spawning habitat will be considered usable by spawners. To address the egg and alevin lifestages, the model established an initial acute egg/alevin mortality threshold of 58°F (TID/MID 2013).

For Chinook spawning and incubation, the Framework Temperature Criteria Matrix identified 60°F or less (as early in October as possible) and 56°F or less (as early in November as possible) for Lower American River fall-run Chinook (Water Forum 2007); 64°F (spawning) and 55°F (incubation) for San Joaquin fall-run Chinook (CALFED 2009); 56°F for Shasta River winter and spring-run Chinook (SWRCB 2016); and 54°F (Upper Optimum Value) and 57°F (Upper Tolerable Value) in the Yuba (Bratovich et al. 2012).

EPA Region 10 Guidance for Pacific Northwest State and Tribal Temperature Water Quality

Standards (EPA 2003b) identifies 55°F (7DADM) for "salmon and trout" spawning, egg incubation, and fry emergence.

Juvenile Rearing and Downstream Movement

Water temperature index values were identified for the combined spring-run Chinook salmon rearing (fry and juvenile) and juvenile downstream movement lifestages, for the reasons previously described regarding steelhead. Fry and juvenile rearing occur concurrently with post-emergent fry and juvenile downstream movement, and are assessed in this Technical Memorandum using the fry and juvenile rearing water temperature index values.

The water temperature index values of 60°F, 65°F, 68°F, 70°F and 75°F were identified for the spring-run Chinook salmon juvenile rearing and downstream movement lifestage . The lowest index value of 60°F was chosen because regulatory documents as well as several source studies, including ones recently conducted on Central Valley Chinook salmon fry and juveniles report 60°F as an optimal water temperature for growth (Banks *et al.* 1971; Brett *et al.* 1982; Marine 1997; NMFS 1997b; NMFS 2000; NMFS 2001a; NMFS 2002; Rich 1987b). Water temperatures below 60°F also have been reported as providing conditions optimal for fry and fingerling growth, but were not selected as index values, because the studies were conducted on fish from outside of the Central Valley (Brett 1952; Seymour 1956). Studies conducted using local fish may be particularly important because *Oncorhynchus* species show considerable variation in morphology, behavior, and physiology along latitudinal gradients (Myrick 1998; Taylor 1990b; Taylor 1990a). More specifically, it has been suggested that salmonid populations in the Central Valley prefer higher water temperatures than those from more northern latitudes (Myrick and Cech 2000).

The 60°F water temperature index value established for the Chinook salmon juvenile rearing and downstream movement life stage is the index value generally reported in the literature as the upper limit of the optimal range for fry and juvenile growth and the upper limit of the preferred range for growth and development of spring-run Chinook salmon fry and fingerlings. FERC (1993) referred to 58°F as an "optimum" water temperature for juvenile Chinook salmon in the American River. NMFS (2002a) identified 60°F as the "preferred" water temperature for juvenile spring-run Chinook salmon in the Central Valley. Increasing levels of thermal stress to this life stage may reportedly occur above the 60°F water temperature index value.

The index value of 65°F was selected because it represents an intermediate value between 64.0°F and 66.2°F, at which both adverse and beneficial effects to juvenile salmonids have been reported to occur. For example, at temperatures approaching and beyond 65°F, sub-lethal effects associated with increased incidence of disease reportedly become severe for juvenile Chinook salmon (EPA 2003a; Johnson and Brice 1953; Ordal and Pacha 1963; Rich 1987a). Conversely, numerous studies report that temperatures between 64.0°F and 66.2°F provide conditions ranging from suitable to optimal for juvenile Chinook salmon growth (Brett *et al.* 1982; Cech and Myrick 1999; Clarke and Shelbourn 1985; EPA 2003a; Myrick and Cech 2001; NMFS 2002; USFWS 1995b). Maximum growth of juvenile fall-run Chinook salmon has been reported to occur in the American River at water temperatures between 56-59°F (Rich 1987b) and in Nimbus Hatchery spring-run Chinook salmon at 66°F (Cech and Myrick 1999).

Growth for a 100 mm juvenile Chinook salmon versus temperature for three food levels (percent of maximum consumption = 30%, 50%, and 70%) was evaluated. The average percent of maximum consumption in an adjacent watershed (Middle Fork American Fork River) for O. mykiss was 50% (Hanson et al. 1997). Positive growth only occurs up to approximately 64°F for food levels expected in the wild (e.g., 50% maximum consumption).

A water temperature index value of 68°F was selected because, at water temperatures above 68°F, sub-lethal effects become severe such as reductions in appetite and growth of juveniles (Marine 1997; Rich 1987a; Zedonis and Newcomb 1997). Chronic stress associated with water temperature can be expected when conditions reach the index value of 70°F. For example, growth becomes drastically reduced at temperatures close to 70.0°F and has been reported to be completely prohibited at 70.5°F (Brett *et al.* 1982; Marine 1997). 75°F was chosen as the highest water temperature index value because high levels of direct mortality to juvenile Chinook salmon reportedly result at this water temperature (Cech and Myrick 1999; Hanson 1991; Myrick and Cech 2001; Rich 1987b). Other studies have suggested higher upper lethal water temperature levels (Brett 1952; Orsi 1971), but 75°F was chosen because it was derived from experiments using Central Valley Chinook salmon and it is a more rigorous index value representing a more protective upper lethal water temperature level. Furthermore, the lethal level determined in Rich (1987b) was derived using slow rates of water temperature change and, thus, is ecologically relevant. The juvenile Chinook Salmon UILT based on numerous studies is 75-77°F (Sullivan *et al.* 2000; McCullough *et al.* 2001; Myrick and Cech 2001).

Based upon information reviewed for Chinook salmon juvenile mortality (Brett 1952; Orsi 1971), the Chinook Salmon Population Model (TID/MID 2013) established an initial UILT mortality threshold of 77°F for Chinook salmon juveniles as a daily average water temperature. Note that the model also selected this same value for fry mortality.

For Chinook juvenile rearing, the Framework Temperature Criteria Matrix identified 61°F for the San Joaquin (CALFED 2009) and 61°F (Upper Optimum Value) and 65°F (Upper Tolerable Value) for both fall and spring-run Chinook in the Yuba River (Bratovich *et al.* 2012).

EPA Region 10 Guidance for Pacific Northwest State and Tribal Temperature Water Quality Standards (EPA 2003b) identifies 61°F (early year) and 64°F (late year) for salmon juvenile rearing based upon a 7DADM.

Yearling + Smolt Emigration

Juvenile Chinook salmon that exhibit extended rearing in the lower Yuba River are assumed to undergo the smoltification process and volitionally emigrate from the river as yearling+ individuals . Water temperature index values of 63°F, 68°F and 72°F were selected for the spring-run Chinook yearling+ emigration lifestage.

A water temperature index value of 63°F was selected because water temperatures at or below this value allow for successful transformation to the smolt stage, and water temperatures above this value may result in impaired smoltification indices, inhibition of smolt development, and decreased survival and successful smoltification of juvenile spring-run Chinook salmon . Laboratory experiments suggest that water temperatures at or below 62.6°F provide conditions that allow for successful transformation to the smolt stage (Clarke and Shelbourn 1985; Marine 1997; Zedonis and Newcomb 1997). 62.6°F was rounded and used to support an index value of 63°F. Indirect evidence from tagging studies suggests that the survival of fall-run Chinook salmon smolts decreases with increasing water temperatures between 59°F and 75°F in the Sacramento-San Joaquin Delta (Kjelson and Brandes 1989). A water temperature index value of 68°F was selected because water temperatures above 68°F prohibit successful smoltification (Marine 1997; Rich 1987a; Zedonis and Newcomb 1997). Support for an index value of 72°F is provided from a study conducted by (Baker *et al.* 1995) in which a statistical model is presented that treats survival of Chinook salmon smolts fitted with coded wire tags in the Sacramento River as a logistic function of water temperature. Using data obtained from mark-recapture surveys, the statistical model suggests a 95% confidence interval for the upper incipient lethal water temperature for Chinook salmon smolts as 71.5°F to 75.4°F.

Based upon information reviewed for Chinook salmon juvenile mortality (Brett 1952), the Chinook Salmon Population Model (TID/MID 2013) established an initial mortality threshold of 77°F for Chinook salmon smolts as a daily average water temperature.

For Chinook smolt migration, the Framework Temperature Criteria Matrix identified 57°F for the San Joaquin (CALFED 2009) and 63°F (Upper Optimum Value) and 68°F (Upper Tolerable Value) for both fall and spring-run Chinook in the Yuba River (Bratovich et al. 2012).

EPA Region 10 Guidance for Pacific Northwest State and Tribal Temperature Water Quality Standards (EPA 2003b) identifies 59°F (7DADM) for salmon smolt.

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Upper Tuolumne River Reintroduction Assessment Framework
Water Temperature Criteria Subcommittee
Water Temperature Evaluation
Glossary of Terms

Acute temperature criteria – water temperature identified as being in the **acute temperature zone** for a particular species/lifestage.

Acute temperature exposure – water temperature exposure that is less than 7 days and results in 50% mortality.

Acute temperature zone – zone where acute water temperature exposure occurs with potential for rapid mortality; **zone of resistance**.

Average daily temperature (ADT) – average of temperatures in a 24-hour period.

Chronic temperature criteria – water temperature identified as being in the **chronic temperature zone** for a particular species/lifestage.

Chronic temperature exposure – water temperature exposure that is long-term or $\geq$ 7 days and results in 50% mortality.

Chronic temperature zone – zone where chronic water temperature exposure occurs with no or reduced growth and reproduction and increased mortality; **zone of tolerance**.

Critical thermal maximum – very short duration (minutes) mortality after acute temperature exposure.

Diel temperature – temperature over 24-hour period.

Diurnal temperature – temperature fluctuations between high and low or day and night of the same day.

Lifestage periodicity – season/dates corresponding to a specific lifestage (e.g. spring-run Chinook salmon spawning); identified through study of a particular watershed.

Maximum weekly average temperature (MWAT) – the highest value calculated for all possible 7-day periods over a given time period (e.g. season or lifestage) and generally used to summarize instream water temperature variation occurring on daily or seasonal basis for evaluation of chronic water temperature impacts; found by calculating mathematical mean of multiple, equally spaced, daily water temperatures over a 7-day consecutive period.

Optimum temperature range – zone of temperatures where fish growth, reproduction, and behavior is not appreciably affected by temperature.

Seven (7)-day moving average temperature (7DMA) – "smoothed" average of temperatures over a period of time using moving seven day subsets.

Seven(7)-day moving average daily maximum temperature (7DMADM) – “smoothed” water temperature metric describing the maximum 7-day average of the daily maxima; calculated by adding the daily maximum temperatures recorded at a site on seven consecutive days and dividing by seven, uses moving seven day subsets.

Seven (7)-day average daily maximum temperature (7DADM) – water temperature metric describing the maximum 7-day average of the daily maxima; calculated by adding the daily maximum temperatures recorded at a site on seven consecutive days and dividing by seven.

Upper incipient lethal temperature (UILT) – boundary between lower end of **acute temperature exposure** range and upper end of **chronic temperature exposure** range; where 50% mortality occurs after 7 days (If a shorter duration is used, temperatures will be correspondingly higher).

Upper optimal WTI (UOWTI) – temperatures where physiological processes (growth, disease resistance, normal development of embryos) are not stressed by temperature; **optimal temperature range** identified for specific lifestage.

Upper tolerance WTI (UTWTI) – temperature identified as the boundary between sustained (chronic) tolerance and no tolerance; boundary between **zone of tolerance** and **zone of resistance** identified for a specific lifestage.

Use designation – category applied to a waterbody that determines which **water quality standards (WQS)** will be enforced.

Volitional migration – upstream or downstream migration occurring when anadromous fish are physiologically ready.

Water quality standards (WQS) – specified concentrations/values of various water quality parameters not to be exceeded as established by the U.S. Environmental Protection Agency (EPA) and/or state for beneficial uses such as aquatic life and drinking water.

Water temperature index (WTI) – description of water temperatures that are optimal and/or tolerated by an aquatic species; developed empirically through laboratory and field studies.

Water temperature exceedance curves – used to identify probabilities/duration of time that lifestage-specific **WTI** values would be exceeded over a given time.

Water temperature metrics – provide index of temperature over a period of time (e.g. **MWAT**, **7DADM**).

Water year type – describes amount of precipitation received during water year (e.g. critically dry to wet).

Zone of resistance – water temperature zone between the **UILT** (7 days) and **critical thermal maximum**.

Zone of tolerance – water temperature zone that fish can tolerate that is below the **UILT** and above the **optimal temperature** range, but at higher end temperatures may not thrive and may have modified behavior.

La Grange Hydroelectric Project
Reintroduction Assessment Framework
Water Temperature Criteria Subcommittee Conference Call

Friday, October 14, 2016, 1:00 pm to 3:00 pm
Conference Line: 1-866-583-7984; Passcode: 8140607

Meeting Objectives:

1. Review and discuss water temperature literature review summary, glossary of terms/acronym list (Districts' action item).
2. Discuss potential water temperature index (WTI) values that may be relevant to the Upper Tuolumne River Reintroduction Assessment Framework.
3. Discuss next steps and schedule for WTI selection.

TIME	TOPIC
1:00 pm – 1:15 pm	Introduction of Participants (All) Review Agenda and Meeting Objectives (Districts)
1:15 pm – 2:45 pm	Water Temperature Literature Review Summary, Glossary of Terms/Acronym List (All) a. Summary of documents (Districts) b. Subcommittee discussion and relevance to selection of WTI values (All)
2:45 pm – 3:00 pm	Next Steps (All) a. Schedule next call and agenda topics b. Action items from this call

From: Staples, Rose
Sent: Monday, October 17, 2016 8:01 AM
Cc: Deason, Jesse; Le, Bao; Staples, Rose
Subject: FW: Water Temperature Considerations Document Discussed on Call Today

La Grange Licensing Participants,

The following message was sent to the members of the Water Temperature Criteria Subcommittee on Friday, along with the copy of a document discussed during Friday's Conference Call. A copy of the document is available as an attachment to the October 14th date on the website CALENDAR.

Rose Staples, CAP-OM, MOS
D 207-239-3857

hdrinc.com/follow-us

From: Staples, Rose
Sent: Friday, October 14, 2016 5:18 PM
Subject: Water Temperature Considerations Document Discussed on Call Today

Water Temperature Criteria Subcommittee members,

Thank you for your participation on today's conference call. As requested, attached is the Water Temperature Considerations document discussed on today's call. It is also available on the www.lagrange-licensing.com website as an attachment to the CALENDAR date.

Rose Staples, CAP-OM, MOS
Executive Assistant

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Water Temperature Considerations for Yuba River Basin Anadromous Salmonid Reintroduction Evaluations

Prepared for:

Yuba Salmon Forum Technical Working Group

Prepared by:

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Heather Bowen (HDR Engineering, Inc.)

October 2012

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1 INTRODUCTION

The Yuba Salmon Forum (YSF) is a multi-stakeholder group addressing the opportunities for reintroducing anadromous salmonids (i.e., spring-run Chinook salmon and steelhead) in the Upper Yuba River Basin upstream of Englebright Dam.

The YSF stakeholder group is comprised of representatives from National Marine Fisheries Service (NMFS), U.S. Forest Service (USFS), California Department of Fish and Game (CDFG), the Yuba County Water Agency (YCWA), Placer County Water Agency (PCWA) and a group of the non-governmental organizations (NGOs) including Trout Unlimited, American Rivers, The Bay Institute, Sierra Club, California Sport Fishing Protection Alliance, and South Yuba River Citizens League. The YSF is comprised of a Plenary Group and a Technical Working Group (TWG). The purpose of the TWG is to address technical issues associated with anadromous salmonid reintroduction. One of the technical issues addressed by the TWG includes water temperature considerations for the reintroduction of anadromous salmonids into the Upper Yuba River Basin.

2 TECHNICAL MEMORANDUM PURPOSE AND OBJECTIVES

The overall purpose of this Technical Memorandum is to establish the technical basis to evaluate water temperature regimes for spring-run Chinook salmon and steelhead reintroduction in the various rivers and reaches of the Upper Yuba River Basin (North Yuba River upstream of New Bullards Bar Reservoir, North Yuba River downstream of New Bullards Bar Dam to the high water mark of Englebright Reservoir, Middle Yuba River, and South Yuba River) **(Figure 1)**.

Specific objectives are to: (1) conduct a comprehensive literature review of lifestage-specific water temperature relationships; (2) identify a suite of water temperature index (WTI) values representing a summarization of the literature review; (3) select water temperature criteria for each species-specific lifestage for reintroduction evaluation; and (4) identify the water temperature evaluation methodological approach (water temperature metrics and metric application to water temperature monitoring and/or modeling data).

NMFS commented (NOAA Memorandum dated January 18, 2012) on the November 2011 version of this technical memorandum, stating that it should demonstrate the need for new criteria in consideration of criteria previously developed by Stillwater Sciences (2006). In summary, this technical memorandum differs from Stillwater Sciences (2006) in some lifestage periodicities (e.g., spring-run Chinook salmon spawning (Sep – mid Nov vs. Sep – Oct), and embryo incubation (Sep – Feb vs. late Sep – Jan). Notably,

Stillwater Sciences (2006) assumed that juvenile spring-run Chinook salmon in the Upper Yuba River Basin *"…would not typically over-summer due to excessively high summer water temperatures*." By contrast, this technical memorandum assumes that juvenile rearing in the Upper Yuba River Basin could occur year-round. In addition, this technical memorandum identifies spring-run Chinook salmon smolt emigration potentially occurring from November through mid-May, whereas Stillwater Sciences (2006) did not identify spring-run Chinook salmon smolt emigration as a lifestage to be addressed. Similarly, Stillwater Sciences (2006) did not identify smolt emigration as a steelhead lifestage to be addressed. In addition to lifestage periodicities, this technical memorandum identifies upper optimum and upper tolerance water temperature index values to be used in the evaluation of water temperature suitability for reintroduction of spring-run Chinook salmon and steelhead into the Upper Yuba River Basin, whereas Stillwater Sciences (2006) identified optimal, suboptimal, and chronic-to-acute stress water temperature index values. These categories are not directly comparable, and the actual values also differ between the two reports.

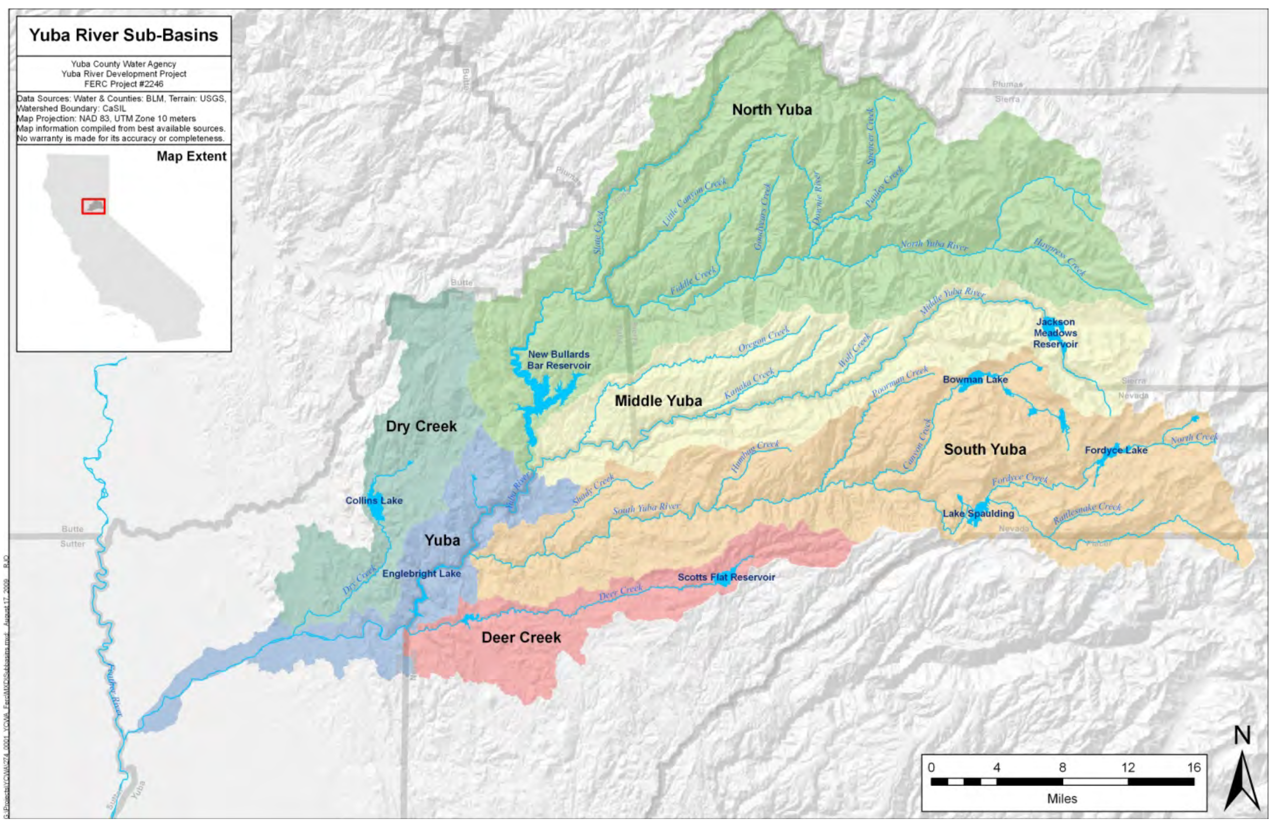

Figure 1. Sub-basins of the Yuba River Basin (source: Yuba County Water Agency 2010).

3 LIFESTAGE PERIODICITIES OF ANADROMOUS SALMONIDS

Lifestage-specific water temperature considerations for spring-run Chinook salmon and steelhead were addressed by the TWG in the evaluation of anadromous reintroduction in the Upper Yuba River Basin. A review of previously conducted studies, as well as recent and currently ongoing data collection activities by the Yuba Accord Monitoring and Evaluation Program (M&E Program) in the lower Yuba River was conducted to identify species- and lifestage-specific temporal periodicities for water temperature considerations. The TWG agreed on the spring-run Chinook salmon and steelhead lifestage periodicities presented in **Table 1** for reintroduction consideration in the Upper Yuba River Basin during a meeting held May 20, 2011. However, it was noted that these periodicities reflect existing conditions in the lower Yuba River, and that lifestage periodicities may change in response to local adaptation over time. It was further noted that although some lifestages may occur concurrently, the periodicities presented in Table 1 reflect specific consideration for water temperature evaluation for reintroduction. For example, spring-run Chinook salmon holding continues to occur during September, even though spawning activity begins during that month.

Table 1. Lifestage-Specific Periodicities for Spring-run Chinook Salmon and Steelhead in the Lower Yuba River.

Lifestage	Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Sep		Oct		Nov		Dec	
Spring-Run Chinook Salmon																								
Adult Immig. & Holding							■	■	■	■	■	■	■	■	■	■								
Spawning																	■	■	■	■	■			
Embryo Incubation	■	■	■	■													■	■	■	■	■	■	■	■
Juv. Rearing & Outmig.	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Yearling+ Smolt Emig.	■	■	■	■	■	■	■	■	■												■	■	■	■
Steelhead																								
Adult Immig. & Holding	■	■	■	■	■	■									■	■	■	■	■	■	■	■	■	■
Spawning	■	■	■	■	■	■	■	■																
Embryo Incubation	■	■	■	■	■	■	■	■	■	■														
Juv. Rearing & Outmig.	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Yearling+ Smolt Emig.	■	■	■	■	■	■	■												■	■	■	■	■	■

4 LITERATURE REVIEW OF WATER TEMPERATURE RELATIONSHIPS FOR STEELHEAD AND CHINOOK SALMON

A comprehensive review and compilation of available literature was conducted to identify the range of acceptable water temperatures for reintroduction evaluation of Chinook salmon and steelhead, by lifestage, in the Upper Yuba River Basin. The thermal requirements of Chinook salmon and steelhead have been extensively studied in California and elsewhere. The literature review informed the selection of a range of WTI values to be used in the TWG's evaluation of the water temperature-related

reintroduction potential in the Upper Yuba River Basin. The information presented herein is largely based on information provided in Appendix E2 to the Public Draft EIR/EIS for the Yuba Accord (YCWA *et al.* 2007), Appendix B (Stillwater Sciences 2006) to the Upper Yuba River Studies Program (UYRSP) Technical Report (DWR 2007), and the Yuba Accord River Management Team Water Temperature Objectives Technical Memorandum (RMT 2010).

WTI values were identified from laboratory experiments and field studies that examined how water temperature affects Central Valley Chinook salmon and steelhead. WTI values were also identified from regulatory documents such as biological opinions from NMFS. Results of the literature review are presented in **Appendix A**. Specific temperature index values were then selected by the TWG to evaluate temperature-related reintroduction potential in the Upper Yuba River Basin.

Studies on fish from outside the Central Valley were used to establish WTI values when local studies were unavailable. To avoid unwarranted specificity, only whole integers were selected as WTI values. In some cases, whole integer WTI values were partially derived from literature results that varied from the index value by several tenths of a degree. For example, Combs and Burrows (1957) reported that constant incubation temperatures up to 57.5°F resulted in normal development of Chinook salmon eggs, and their report was referenced as support for a rounded[1] WTI value of 58°F.

The WTI values presented herein represent a gradation of potential biological effects from optimal to lethal water temperatures for each lifestage. Literature on salmonid water temperature requirements generally reports water temperature thresholds using various descriptive terms including "optimal", "preferred", "suitable", "suboptimal", "tolerable", "stressful – chronic and acute", "sublethal", "incipient lethal", and "lethal". Water temperature effects on salmonids are often discussed in terms of "lethal" and "sublethal" effects, and depend on the both the magnitude and the duration of exposure (Sullivan *et al.* 2000), as well as acclimation water temperature. Exposure to adverse water temperatures can result in adverse effects on the biological functions, feeding activity, lifestage timing, growth, reproduction, competitive interactions, susceptibility to disease, growth and development and ultimately probability of survival (McCullough 1999).

[1] Rounding for the purposes of selecting index values is appropriate because the daily variation of experimental treatment temperatures is often high. For example, temperature treatments in Marine (1997) consisted of control (55.4°F to 60.8°F), intermediate (62.6°F to 68.0°F) and extreme (69.8°F to 75.2°F) treatments that varied daily by several degrees.

There are inherent limitations associated with the development and application of WTI values. Some of the limitations are summarized by McEwan (2001). Namely, that WTI values serve as general guidelines, originally developed by researchers on specific streams or under laboratory conditions. Also, research under controlled laboratory conditions does not take into account ecological considerations associated with water temperature regimes, such as predation risk, inter- and intra-specific competition, long-term survival and local adaptation.

5 LIFESTAGE-SPECIFIC WATER TEMPERATURE INDEX VALUES

Lifestage-specific WTI summary tables derived from the literature review are provided for steelhead and Chinook salmon: (1) adult immigration and holding; (2) spawning and embryo incubation; (3) juvenile rearing and downstream movement; and (4) yearling + smolt emigration in **Tables 2 - 9** (see below). A written discussion of the literature used to create the summary tables is provided in Appendix A. A short discussion of acute versus chronic temperature tolerance also is provided.

5.1 Steelhead and Chinook Salmon Acute Versus Chronic Temperature Tolerance (Juveniles and Adults)

Lifestage-specific WTI values (Sections 5.2 and 5.3 below) were based on long-term (≥ 7 days) chronic temperature exposure rather than acute temperature exposure (< 7 days). The boundary between the upper end of the chronic exposure range and the lower end of the acute exposure range is typically measured as the upper incipient lethal temperature (UILT) where 50% mortality occurs after 7 days (Elliott 1981)[2].

The UILT for both juvenile steelhead and Chinook salmon is very similar and is between 75-79°F (24-26°C) depending on the study (McCullough 1999; Sullivan et al. 2000; McCullough et al. 2001). The UILT for adult steelhead and Chinook salmon is 70-72°F (21-22°C) (Coutant 1970; Becker 1973; McCullough et al. 2001), which is much lower than that for juveniles and is approximately the same temperature that has been identified as an upstream migration barrier for Chinook salmon (McCullough 1999).

Acute temperature response (< 7 days) is strongly dependent on duration of exposure. **Figure 2** shows some example acute exposure relationships for juvenile salmonids. The hourly (60 minute) acute temperature is 5.4 – 9.0°F (3-5°C) higher than the 7-day (10,000 minute) chronic temperature. Because the acute temperature for juvenile salmonids, approximately 82.4°F (28.4°C) is relatively high, it rarely becomes a factor affecting

[2] Note that some authors have measured the UILT using shorter duration exposure than 7 days (e.g., 1,000 mins or 24 hrs). UILT values based on a shorter duration exposure than 7 days will be higher than the UILT values based on a 7 day exposure.

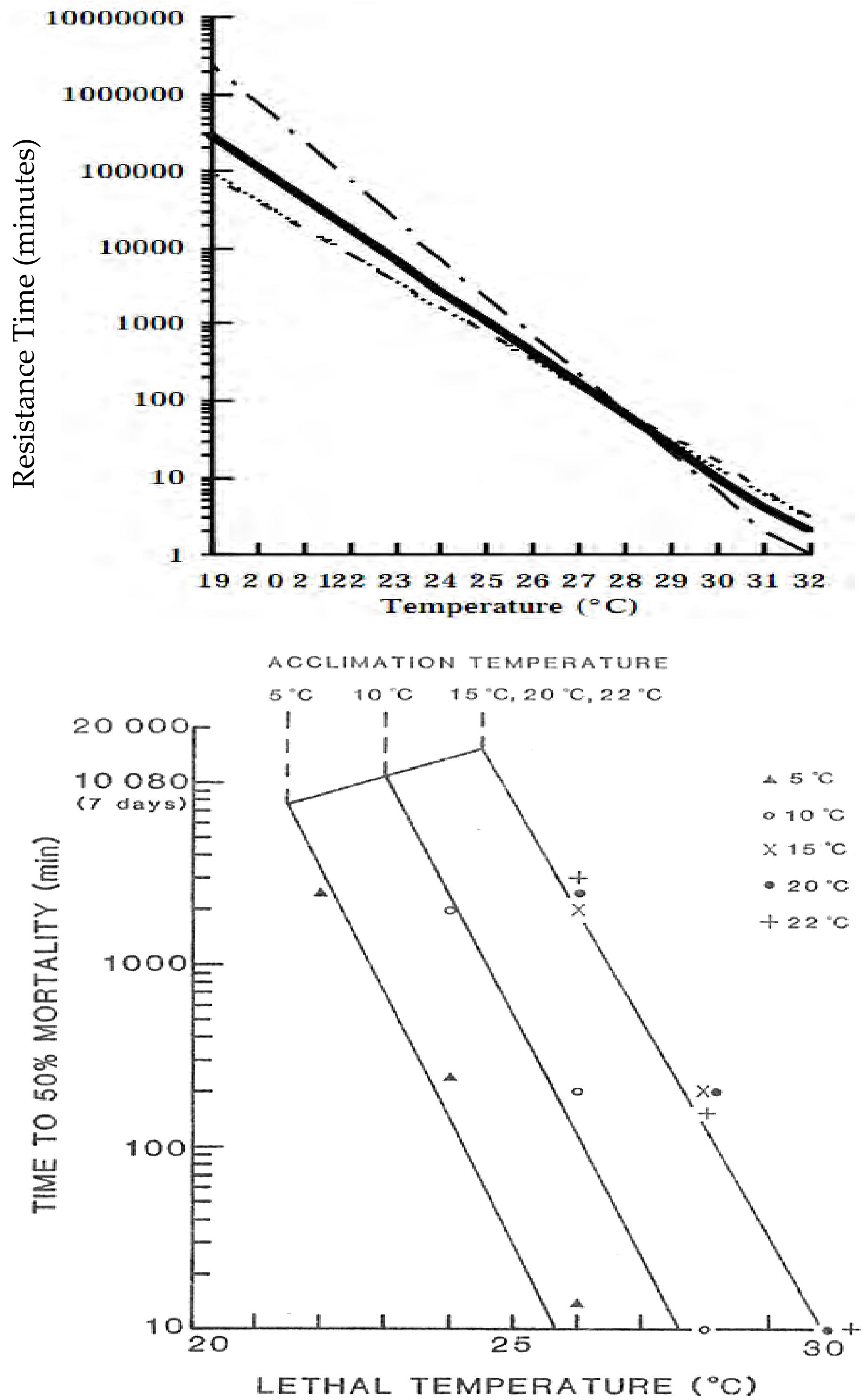

Figure 2. Relationship Between the Time (Minutes) to Mortality and the Lethal Temperature for Rainbow Trout (Top) (Bidgood 1969) and Brown Trout (Bottom) (Elliott 1981). Note the Effect of Acclimation Temperature in the Bottom Figure.

survival in natural streams (Sullivan et al. 2000). However, the acute temperature for adult salmonids is lower – it could become a survival factor particularly for adult spring-run Chinook salmon holding through the summer.

The temperature range between the UILT (7 days) and very short duration mortality (minutes) (e.g., critical thermal maximum) is called the zone of resistance. Below the UILT is a zone of tolerance where fish can tolerate the temperature for an extended period of time (> 7 days). At the higher temperatures in the tolerance zone fish may not feed, grow, or reproduce and they may have modified behavior (e.g., holding in temperature refugia locations). An important point to note is that the effects of water temperature are associated with duration of exposure and, depending upon the actual water temperature value, short duration exposure to relatively high temperatures may not result in sustained adverse effects if temperatures quickly decrease to non-impactive levels.

At lower temperatures in the tolerance zone, denoted “tolerable” in this report, growth and/or reproduction occur, but are reduced from optimal due to temperature effects. The zone of temperature where fish processes (growth, reproduction, behavior) are not affected appreciably by temperature is denoted as the “optimum” temperature range in this report (**Figure 3**).

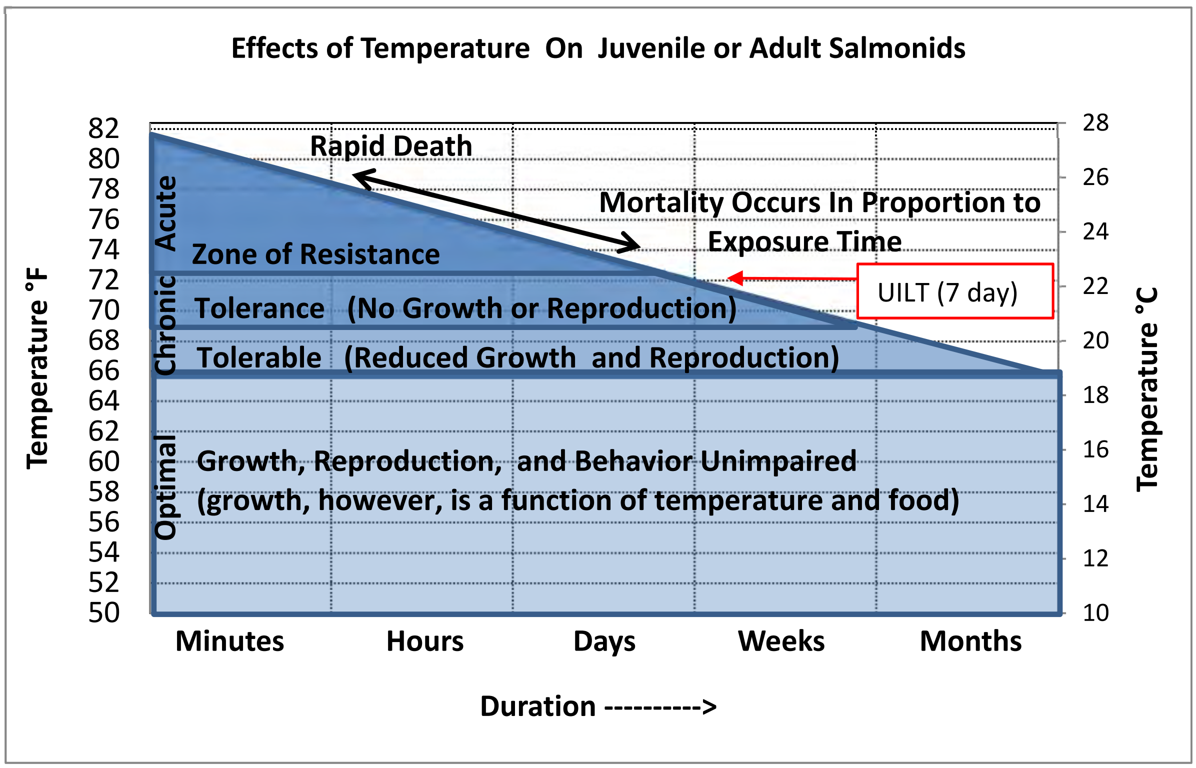

Figure 3. Illustration of Acute, Chronic, and Optimum Temperature Zones.

5.2 Steelhead Lifestage-specific Water Temperature Index Values

5.2.1 Adult Immigration and Holding

Table 2. Steelhead Adult Immigration and Holding Water Temperature Index Values and the Literature Supporting Each Value.

Index Value	Supporting Literature
52°F	Preferred range for adult steelhead immigration of 46.0°F to 52.0°F (NMFS 2000; NMFS 2001a; SWRCB 2003). Optimum range for adult steelhead immigration of 46.0°F to 52.1°F (Reclamation 1997a). Recommended adult steelhead immigration temperature range of 46.0°F to 52.0°F (Reclamation 2003).
56°F	To produce rainbow trout eggs of good quality, brood fish must be held at water temperatures not exceeding 56.0°F (Leitritz and Lewis 1980). Rainbow trout brood fish must be held at water temperatures not exceeding 56°F for a period of 2 to 6 months before spawning to produce eggs of good quality (Bruin and Waldsdorf 1975). Holding migratory fish at constant water temperatures above 55.4°F to 60.1°F may impede spawning success (McCullough *et al.* 2001).
61°F	Water temperatures greater than 61°F may result in "chronic high stress" of holding Central Valley winter-run steelhead (USFWS 1995a). Preferred range of water temperature for holding Caliifornia summer steelhead occurs between 50-59°F (Moyle 1995).
64°F	Steelhead (and fall-run Chinook salmon) encounter potentially stressful temperatures between 64.4-73.4°F (Richter and Kolmes 2005). Over 93% of steelhead detections occurred in the 65.3-71.6°F, although this may be above the temperature for optimal immigration (Salinger and Anderson 2006).
70°F	Migration barriers have frequently been reported for pacific salmonids when water temperatures reach 69.8°F to 71.6°F (McCullough *et al.* 2001). Snake River adult steelhead immigration was blocked when water temperatures reached 69.8 (McCullough *et al.* 2001). A water temperature of 68°F was found to drop egg fertility in vivo to 5 percent after 4.5 days (McCullough *et al.* 2001). The UILT for adult steelhead was determined to be 69.8°F (Coutant 1972).

5.2.2 Spawning and Embryo Incubation

Table 3. Steelhead Spawning and Embryo Incubation Water Temperature Index Values and the Literature Supporting Each Value.

Index Value	Supporting Literature
46°F	Orcutt et al. (1968) reported that steelhead spawning in late spring in the Clearwater and Salmon Rivers, Idaho, occurred at temperatures between 35.6 and 46.4°F.
52°F	Rainbow trout from Mattighofen (Austria) had highest egg survival at 52.0°F compared to 45.0°F, 59.4°F, and 66.0°F (Humpesch 1985). Water temperatures from 48.0°F to 52.0°F are suitable for steelhead incubation and emergence in the American River and Clear Creek (NMFS 2000; NMFS 2001a; NMFS 2002a). Optimum water temperature range of 46.0°F to 52.0°F for steelhead spawning in the Central Valley (USFWS 1995b). Optimum water temperature range of 46.0°F to 52.1°F for steelhead spawning and 48.0°F to 52.1°F for steelhead egg incubation (Reclamation 1997a). Upper limit of preferred water temperature of 52.0°F for steelhead spawning and egg incubation (SWRCB 2003).
54°F	Big Qualicum River steelhead eggs had 96.6 percent survival to hatch at 53.6°F (Rombough 1988). Highest survival from fertilization to hatch for *Salmo gairdneri* incubated at 53.6°F (Kamler and Kato 1983). Emergent fry were larger when North Santiam River (Oregon) winter steelhead eggs were incubated at 53.6°F than at 60.8°F (Redding and Schreck 1979). The upper optimal water temperature regime based on constant or acclimation water temperatures necessary to achieve full protection of steelhead is 51.8°F to 53.6°F (EPA 2001). From fertilization to hatch, rainbow trout eggs and larvae had 47.3 percent mortality (Timoshina 1972). Survival of rainbow trout eggs declined at water temperatures between 52.0 and 59.4°F (Humpesch 1985). The optimal constant incubation water temperature for steelhead occurs below 53.6°F (McCullough *et al.* 2001).

Index Value	Supporting Literature
57°F	From fertilization to 50 percent hatch, Big Qualicum River steelhead had 93 percent mortality at 60.8°F, 7.7 percent mortality at 57.2°F, and 1 percent mortality at 47.3°F and 39.2°F (Velsen 1987). A sharp decrease in survival was observed for rainbow trout embryos incubated above 57.2°F (Kamler and Kato 1983).
60°F	Water temperatures >59°F are described as "lethal" to incubating steelhead embryos (Myrick and Cech 2001), From fertilization to 50 percent hatch, Big Qualicum River steelhead had 93 percent mortality at 60.8°F, 7.7 percent mortality at 57.2°F, and 1 percent mortality at 47.3°F and 39.2°F (Velsen 1987). From fertilization to 50 percent hatch, rainbow trout eggs from Ontario Provincial Normendale Hatchery had 56 percent survival when incubated at 59.0°F (Kwain 1975).

5.2.3 Juvenile Rearing and Downstream Movement

Table 4. Steelhead Juvenile Rearing and Downstream Movement Water Temperature Index Values and the Literature Supporting Each Value.

Index Value	Supporting Literature
63°F	Preferred water temperature for wild juvenile steelhead is reportedly 63°F, whereas preferred water temperatures for juvenile hatchery steelhead reportedly range between 64-66°F. Myrick and Cech (2001)
65°F	Upper limit of 65°F preferred for growth and development of Sacramento River and American River juvenile steelhead (NMFS 2002a). Nimbus juvenile steelhead growth showed an increasing trend with water temperature to 66.2°F, irrespective of ration level or rearing temperature (Cech and Myrick 1999). The final preferred water temperature for rainbow fingerlings was between 66.2 and 68°F (Cherry *et al.* 1977). Nimbus juvenile steelhead preferred water temperatures between 62.6°F and 68.0°F (Cech and Myrick 1999). Rainbow trout fingerlings preferred or selected water temperatures in the 62.6°F to 68.0°F range (McCauley and Pond 1971).
68°F	Nimbus juvenile steelhead preferred water temperatures between 62.6°F and 68.0°F (Cech and Myrick 1999). The final preferred water temperature for rainbow trout fingerlings was between 66.2°F and 68°F (Cherry *et al.* 1977). Rainbow trout fingerlings preferred or selected water temperatures in the 62.6°F to 68.0°F range (McCauley and Pond 1971). The upper avoidance water temperature for juvenile rainbow trout was measured at 68°F to 71.6°F (Kaya et al. 1977). FERC (1993) referred to 68°F as "stressful" to juvenile steelhead. Empirical fish population and water temperature data in the North Yuba, Middle Yuba, South Yuba, Middle Fork American, and Rubicon Rivers (**Figure 4**) indicate a sharp reduction in O. *mykiss* population densities when temperatures exceed 68°F for greater than one week. Bioenergetics modeling of growth based on consumption (P value = 0.5) in the Middle Fork American River watershed (adjacent watershed) indicates that growth likely does not occur above 68°F (**Figure 5**).
72°F	Increased physiological stress, increased agonistic activity, and a decrease in forage activity in juvenile steelhead occur after ambient stream temperatures exceed 71.6°F (Nielsen *et al.* 1994). The upper avoidance water temperature for juvenile rainbow trout was measured at 68°F to 71.6°F (Kaya *et al.* 1977). Estimates of upper thermal tolerance or avoidance limits for juvenile rainbow trout (at maximum ration) ranged from 71.6°F to 79.9°F (Ebersole *et al.* 2001).
75°F	The maximum weekly average water temperature for survival of juvenile and adult rainbow trout is 75.2°F (EPA 2002). Rearing steelhead juveniles have an upper lethal limit of 75.0°F (NMFS 2001a). Estimates of upper thermal tolerance or avoidance limits for juvenile rainbow trout (at maximum ration) ranged from 71.6 to 79.9°F (Ebersole *et al.* 2001). The UILT for juvenile rainbow trout, based on numerous studies, is between 75-79°F (Sullivan et al. 2000; McCullough 2001).

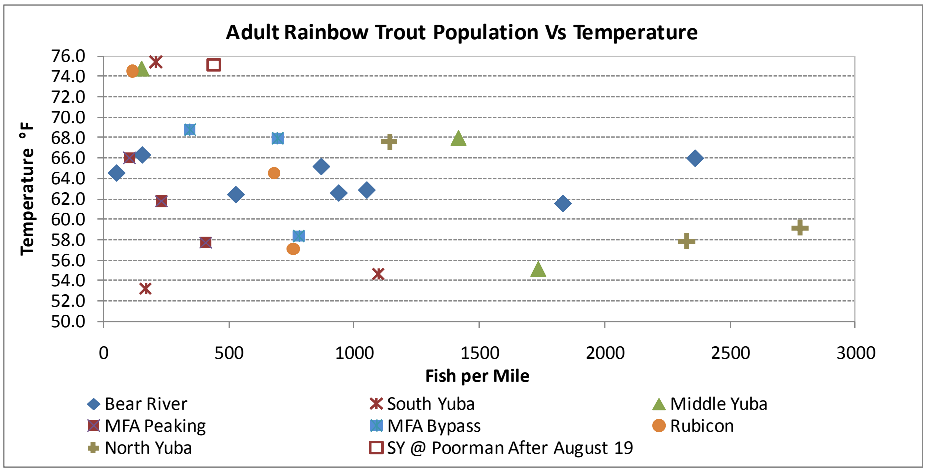

Figure 4. Empirical Adult Fish Population Data in the Middle Fork American and Yuba River Rivers Compared to the Maximum Temperature Exceeded Less Than 7 Days.

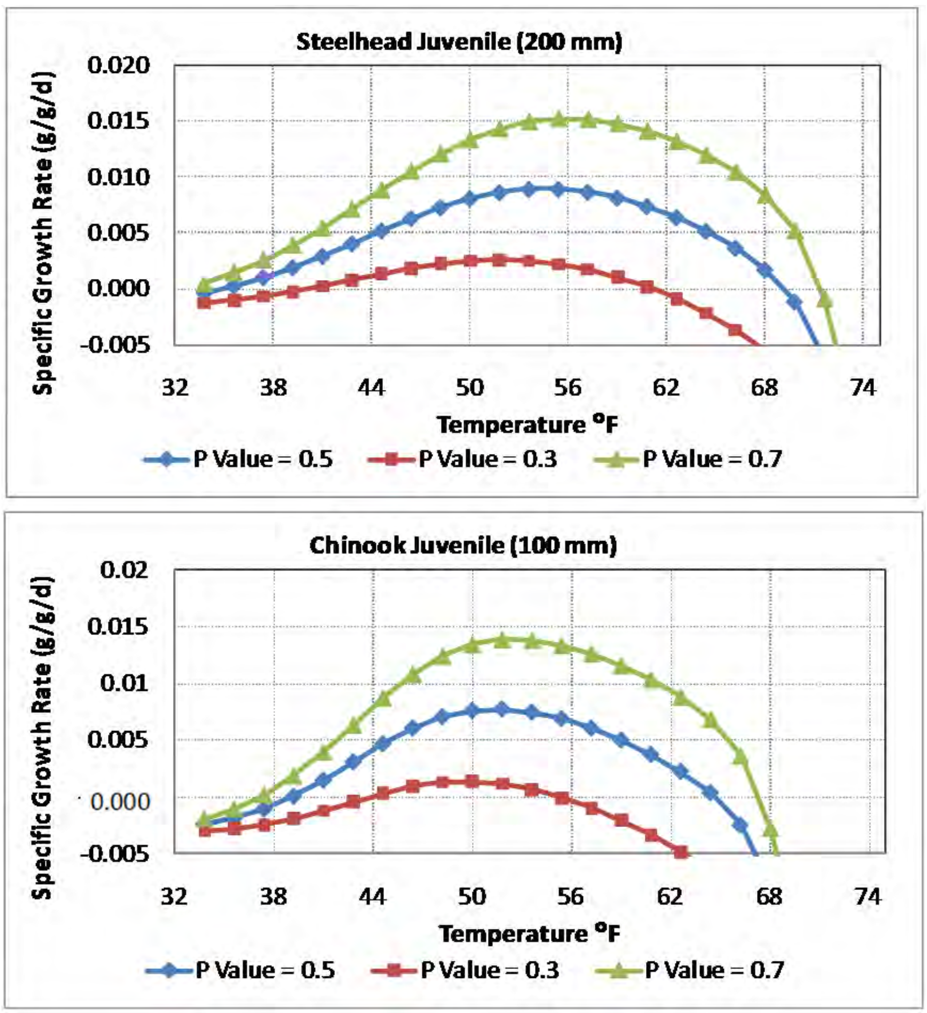

Figure 5. Bioenergetics Growth Rate Modeling For Steelhead and Chinook Salmon Juveniles Over a Range of Temperatures.

5.2.4 Yearling + Smolt Emigration

Table 5. Steelhead Smolt Emigration Water Temperature Index Values and the Literature Supporting Each Value.

Index Value	Supporting Literature
52°F	Steelhead successfully smolt at water temperatures in the 43.7°F to 52.3°F range (Myrick and Cech 2001). Steelhead undergo the smolt transformation when reared in water temperatures below 52.3°F, but not at higher water temperatures (Adams *et al.* 1975). Optimum water temperature range for successful smoltification in young steelhead is 44.0°F to 52.3°F (Rich 1987a).
55°F	ATPase activity was decreased and migration reduced for steelhead at water temperatures greater than or equal to 55.4°F (Zaugg and Wagner 1973). Water temperatures should be below 55.4°F at least 60 days prior to release of hatchery steelhead to prevent premature smolting and desmoltification (Wedemeyer *et al.* 1980). In winter steelhead, a temperature of 54.1°F is nearly the upper limit for smolting (McCullough *et al.* 2001; Zaugg and Wagner 1973). Water temperatures less than or equal to 54.5°F are suitable for emigrating juvenile steelhead (EPA 2003b). Water temperatures greater than 55°F prevent increases in ATPase activity in steelhead juveniles (Hoar 1988). Water temperatures greater than 56°F do not permit smoltification in summer steelhead (Zaugg *et al.* 1972)
59°F	Yearling steelhead held at 43.7°F and transferred to 59°F had a substantial reduction in gill ATPase activity, indicating that physiological changes associated with smoltification were reversed (Wedemeyer *et al.* 1980).

5.3 Chinook Salmon Lifestage-Specific Water Temperature Index Values

5.3.1 Adult Immigration and Holding

Table 6. Chinook Salmon Adult Immigration and Holding Water Temperature Index Values and the Literature Supporting Each Value.

Index Value	Supporting Literature
60°F	Maximum water temperature for adults holding, while eggs are maturing, is approximately 59°F to 60°F (NMFS 1997b). Acceptable water temperatures for adults migrating upstream range from 57°F to 67°F (NMFS 1997b). Upper limit of the optimal water temperature range for adults holding while eggs are maturing is 59°F to 60°F (NMFS 2000). Many of the diseases that commonly affect Chinook salmon become highly infectious and virulent above 60°F (ODEQ 1995). Mature females subjected to prolonged exposure to water temperatures above 60°F have poor survival rates and produce less viable eggs than females exposed to lower water temperatures (USFWS 1995b). Ward and Kier (1999) designated temperatures <60.8°F as an "optimum" water temperature threshold for holding Battle Creek spring-run Chinook salmon.
65°F	Acceptable range for adults migrating upstream is from 57°F to 67°F (NMFS 1997b). Disease risk becomes high at water temperatures above 64.4°F (EPA 2003b). Latent embryonic mortalities and abnormalities associated with water temperature exposure to pre-spawning adults occur at 63.5°F to 66.2°F (Berman 1990). During each of the years when Chinook salmon temperature mortality was not observed at Butte Creek (2001, 2004-2007), on average, daily temperature did not exceed 65.8°F for more than 7 days (**Figure 6**).
68°F	Acceptable range for adults migrating upstream range from 57°F to 67°F (NMFS 1997b). For chronic exposures, an incipient upper lethal water temperature limit for pre-spawning adult salmon probably falls within the range of 62.6°F to 68.0°F (Marine 1992). Spring-run Chinook salmon embryos from adults held at 63.5°F to 66.2°F had greater numbers of pre-hatch mortalities and developmental abnormalities than embryos from adults held at 57.2°F to 59.9°F (Berman 1990). Water temperatures of 68°F resulted in nearly 100 percent mortality of Chinook salmon during columnaris outbreaks (Ordal and Pacha 1963). In Butte Creek a period of average daily temperatures above 67°F (11-16 days) preceded the onset of significant pre-spawn mortalities. In

	years when 67°F was exceeded only a few days, pre-spawn mortality was minimal (Ward et al. 2004). Adult Chinook salmon migration rates through the lower Columbia River were slowed significantly when water temperatures exceeded 68°F (Goniea et al. 2006).
70°F	Migration blockage occurs for Chinook salmon at temperatures from 70-71+°F (McCollough 1999; McCullough *et al.* 2001; EPA 2003b). Strange (2010) found that the mean average body temperature during the first week of Chinook salmon migration on the Klamath River was 71.4°F. The UILT for Chinook salmon jacks is 69.8-71.6°F (McCullough 1999).

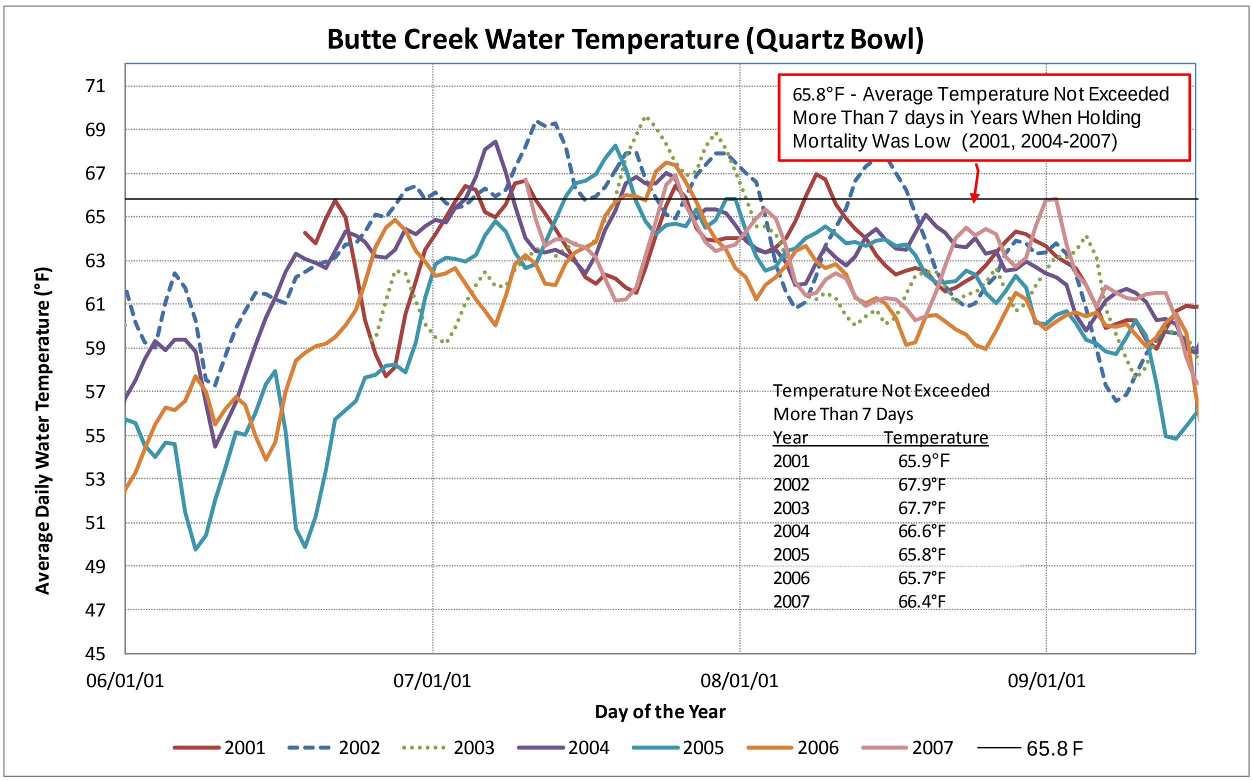

Figure 6. Water Temperature in Butte Creek at Quartz Bowl (2001-2007).

5.3.2 Spawning and Embryo Incubation

Table 7. Chinook Salmon Spawning and Embryo Incubation Water Temperature Index Values and the Literature Supporting Each Value.

Index Value	Supporting Literature
56°F	Less than 56°F results in a natural rate of mortality for fertilized Chinook salmon eggs (Reclamation Unpublished Work). Optimum water temperatures for egg development are between 43°F and 56°F (NMFS 1993b). Upper value of the water temperature range (i.e., 41.0°F to 56.0°F) suggested for maximum survival of eggs and yolk-sac larvae in the Central Valley of California (USFWS 1995b). Upper value of the range (i.e., 42.0°F to 56.0°F) given for the preferred water temperature for Chinook salmon egg incubation in the Sacramento River (NMFS 1997a). Incubation temperatures above 56°F result in significantly higher alevin mortality (USFWS 1999). 56.0°F is the upper limit of suitable water temperatures for spring-run Chinook salmon spawning in the Sacramento River (NMFS 2002a). Water temperatures averaged 56.5°F during the week of fall-run Chinook salmon spawning initiation on the Snake River (Groves and Chandler 1999).
58°F	Upper value of the range given for preferred water temperatures (i.e., 53.0°F to 58.0°F) for eggs and fry (NMFS 2002a). Constant egg incubation temperatures between 42.5°F and 57.5°F resulted in normal development (Combs and Burrows 1957). The natural rate of mortality for alevins occurs at 58°F or less (Reclamation Unpublished Work).
60°F	100 percent mortality can occur to late incubating Chinook salmon embryos (yolk-sac stage) if temperatures are 60°F or greater (Seymour 1956). An October 1 to October 31 water temperature criterion of less than or equal to 60°F in the Sacramento River from Keswick Dam to Bend Bridge has been determined for protection of late incubating larvae and newly emerged fry (NMFS 1993b). Mean weekly water temperature at first observed Chinook salmon spawning in the Columbia River was 59.5°F (Dauble and Watson 1997). Consistently higher egg losses resulted at water temperatures above 60.0°F than at lower temperatures (Johnson and Brice 1953). For Chinook Salmon eggs incubated at constant temperatures, mortality increases rapidly at temperatures greater than about 59-60°F (see data plots in Myrick and Cech 2001). Olsen and Foster (1957) found high survival of Chinook salmon eggs and fry (89.6%) when incubation temperatures started at 60.9°F and declined naturally for the Columbia River (about 7°F / month). Geist et al. (2006) found high (93.8%) Chinook salmon incubation survival through emergence for naturally declining temperatures (0.36°F/day) starting as high as 61.7°F; however, a significant reduction in survival occurred above this temperature.
62°F	100 percent mortality of fertilized Chinook salmon eggs after 12 days at 62°F (Reclamation Unpublished Work). Incubation temperatures of 62ºF to 64°F appear to be the physiological limit for embryo development resulting in 80 to 100 percent mortality prior to emergence (USFWS 1999). 100 percent loss of eggs incubated at water temperatures above 62°F (Hinze 1959). 100 percent mortality occurs during yolk-sac stage when embryos are incubated at 62.5°F (Seymour 1956). Approximately 80% or greater mortality of eggs incubated at constant temperatures of 63°F or greater (see data plots in Myrick and Cech 2001). Olsen and Foster (1957) found high mortality of Chinook salmon eggs and fry (79%) when incubation temperatures started at 65.2°F and declined naturally for the Columbia River (about 7°F / month). Geist et al. (2006) found low Chinook salmon incubation survival (1.7%) for naturally declining temperatures (0.36°F/day) when temperatures started at 62.6°F.

5.3.3 Juvenile Rearing and Downstream Movement

Table 8. Chinook Salmon Juvenile Rearing and Downstream Movement Water Temperature Index Values and the Literature Supporting Each Value.

Index Value	Supporting Literature
60°F	Optimum water temperature for Chinook salmon fry growth is between 55.0°F and 60°F (Seymour 1956). Water temperature range that produced optimum growth in juvenile Chinook salmon was between 54.0°F and 60.0°F (Rich 1987b). Water temperature criterion of less than or equal to 60.0°F for the protection of Sacramento River winter-run Chinook salmon from Keswick Dam to Bend Bridge (NMFS 1993b). Upper optimal water temperature limit of 61°F for Sacramento River fall-run Chinook salmon juvenile rearing (Marine 1997; Marine and Cech 2004). Upper water temperature limit of 60.0°F preferred for growth and development of spring-run Chinook salmon fry and fingerlings (NMFS 2000; NMFS 2002a). To protect salmon fry and juvenile Chinook salmon in the upper Sacramento River, daily average water temperatures should not exceed 60°F after September 30 (NMFS 1997b). A water temperature of 60°F appeared closest to the optimum for growth of fingerlings (Banks *et al.* 1971). Optimum growth of Nechako River Chinook salmon juveniles would occur at 59°F at a feeding level that is 60 percent of that required to satiate them (Brett *et al.* 1982). In a laboratory study, juvenile fall-run Chinook salmon from the Sacramento River reared in water temperatures between 70°F and 75°F experienced significantly decreased growth rates, and increased predation vulnerability compared with juveniles reared between 55°F and 61°F (Marine 1997; Marine and Cech 2004).
65°F	Water temperatures between 45°F to 65°F are preferred for growth and development of fry and juvenile spring-run Chinook salmon in the Feather River (NMFS 2002a). Recommended summer maximum water temperature of 64.4°F for migration and non-core rearing (EPA 2003b). Water temperatures greater than 64.0°F are considered not "properly functioning" by NMFS in Amendment 14 to the Pacific Coast Salmon Plan (NMFS 1995). Fatal infection rates caused by *C. columnaris* are high at temperatures greater than or equal to 64.0°F (EPA 2001). Disease mortalities diminish at water temperatures below 65.0°F (Ordal and Pacha 1963). Fingerling Chinook salmon reared in water greater than 65.0°F contracted *C. columnaris* and exhibited high mortality (Johnson and Brice 1953). Water temperatures greater than 64.9°F identified as being stressful in the Columbia River Ecosystem (Independent Scientific Group 1996). Juvenile Chinook salmon have an optimum temperature for growth that appears to occur at about 66.2°F (Brett *et al.* 1982). Juvenile Chinook salmon reached a growth maximum at 66.2°F (Cech and Myrick 1999). Optimal range for Chinook salmon survival and growth from 53.0°F to 64.0°F (USFWS 1995b). Survival of Central Valley juvenile Chinook salmon declines at temperatures greater than 64.4°F (Myrick and Cech 2001). Increased incidence of disease, reduced appetite, and reduced growth rates at 66.2±1.4 °F (Rich 1987b). Bioenergetics modeling of growth based on consumption of rainbow trout (P value = 0.5) in the Middle Fork American River watershed (adjacent watershed) indicates that growth likely does not occur above about 65°F (Figure 5)
68°F	Sacramento River juvenile Chinook salmon reared at water temperatures greater than or equal to 68.0°F suffer reductions in appetite and growth (Marine 1997; Marine and Cech 2004). Significant reductions in growth rates may occur when chronic elevated temperatures exceed 68°F (Marine 1997; Marine and Cech 2004). Juvenile spring-run Chinook salmon were not found in areas having mean weekly water temperatures between 67.1°F and 71.6°F (Burck *et al.* 1980; Zedonis and Newcomb 1997). Results from a study on wild spring-run Chinook salmon in the John Day River system indicate that juvenile fish were not found in areas having mean weekly water temperatures between 67.1°F and 72.9°F (McCullough 1999; Zedonis and Newcomb 1997).
70°F	No growth at all would occur for Nechako River juvenile Chinook salmon at 70.5°F (Brett *et al.* 1982; Zedonis and Newcomb 1997). Juvenile spring-run Chinook salmon were not found in areas having mean weekly water temperatures between 67.1°F and 71.6°F (Burck *et al.* 1980; Zedonis and Newcomb 1997). Results from a study on wild spring-run Chinook salmon in the John Day River system indicate that juvenile fish were not found in areas having mean weekly water temperatures between 67.1°F and 72.9°F (McCullough 1999; Zedonis and Newcomb 1997). Increased incidence of disease, hyperactivity, reduced appetite, and reduced growth rates at 69.8 ±1.8 °F (Rich 1987b). In a laboratory study, juvenile fall-run Chinook salmon from the Sacramento River reared in water temperatures between 70°F and 75°F experienced significantly decreased growth rates and increased predation vulnerability compared with juveniles reared between 55°F and 61°F (Marine 1997; Marine and Cech 2004).

75°F	For juvenile Chinook salmon in the lower American River fed maximum rations under laboratory conditions, 75.2°F was determined to be 100 percent lethal due to hyperactivity and disease (Rich 1987b; Zedonis and Newcomb 1997). Lethal temperature threshold for fall-run juvenile Chinook salmon between 74.3 and 76.1°F (McCullough 1999). In a laboratory study, juvenile fall-run Chinook salmon from the Sacramento River reared in water temperatures between 70°F and 75°F experienced significantly decreased growth rates, and increased predation vulnerability compared with juveniles reared between 55°F and 61°F (Marine 1997; Marine and Cech 2004). The juvenile Chinook Salmon UILT based on numerous studies is 75-77°F (Sullivan et al. 2000; McCullough et al. 2001; Myrick and Cech 2001)

5.3.4 Yearling + Smolt Emigration

Table 9. Chinook Salmon Yearling + Smolt Emigration Water Temperature Index Values and the Literature Supporting Each Value.

Index Value	Supporting Literature
63°F	Acceleration and inhibition of Sacramento River Chinook salmon smolt development reportedly may occur at water temperatures above 63°F (Marine 1997; Marine and Cech 2004). Laboratory evidence suggest that survival and smoltification become compromised at water temperatures above 62.6°F (Zedonis and Newcomb 1997). Juvenile Chinook salmon growth was highest at 62.6°F (Clarke and Shelbourn 1985).
68°F	Significant inhibition of gill sodium ATPase activity and associated reductions of hyposmoregulatory capacity, and significant reductions in growth rates, may occur when chronic elevated temperatures exceed 68°F (Marine 1997; Marine and Cech 2004). Water temperatures supporting smoltification of fall-run Chinook salmon range between 50°F to 68°F, the colder temperatures represent more optimal conditions (50°F to 62.6°F), and the warmer conditions (62.6°F to 68°F) represent marginal conditions (Zedonis and Newcomb 1997).
72°F	In a laboratory study, juvenile fall-run Chinook salmon from the Sacramento River reared in water temperatures between 70°F and 75°F experienced significantly decreased growth rates, impaired smoltification indices, and increased predation vulnerability compared with juveniles reared between 55°F and 61°F (Marine 1997; Marine and Cech 2004). Indirect evidence from tagging studies suggests that the survival of fall-run Chinook salmon smolts decreases with increasing water temperatures between 59°F and 75°F in the Sacramento-San Joaquin Delta (Kjelson and Brandes 1989).

5.4 Upstream Migration Behavioral Effects Due to River Temperature Gradients

If volitional upstream passage was provided past Englebright Reservoir (e.g., ladder, dam removal), the potential exists for upstream migrating adult salmonids to have to volitionally pass through significant water temperature differentials from the Lower Yuba River into the South or Middle Yuba rivers (Upper Yuba River) due to cold water releases from New Bullards Bar Reservoir into the Yuba River (via Colgate Powerhouse). **Figure 7** shows an example of water temperature in the Yuba River below Colgate Powerhouse and the South and Middle Fork Yuba rivers near their confluence with the Yuba River. It is possible to modify the temperature differentials by selective withdrawal of water from New Bullards Bar Reservoir (Colgate Powerhouse temperature) or by modifying flows in the South or Middle Yuba rivers; nevertheless, the temperature differentials could be large. For example, during the May-June migration period for spring-run Chinook salmon or the late summer/fall

migration period for steelhead, Middle and South Yuba river temperatures are much warmer than the downstream Yuba River temperatures (e.g., > 7°F or > 4°C).

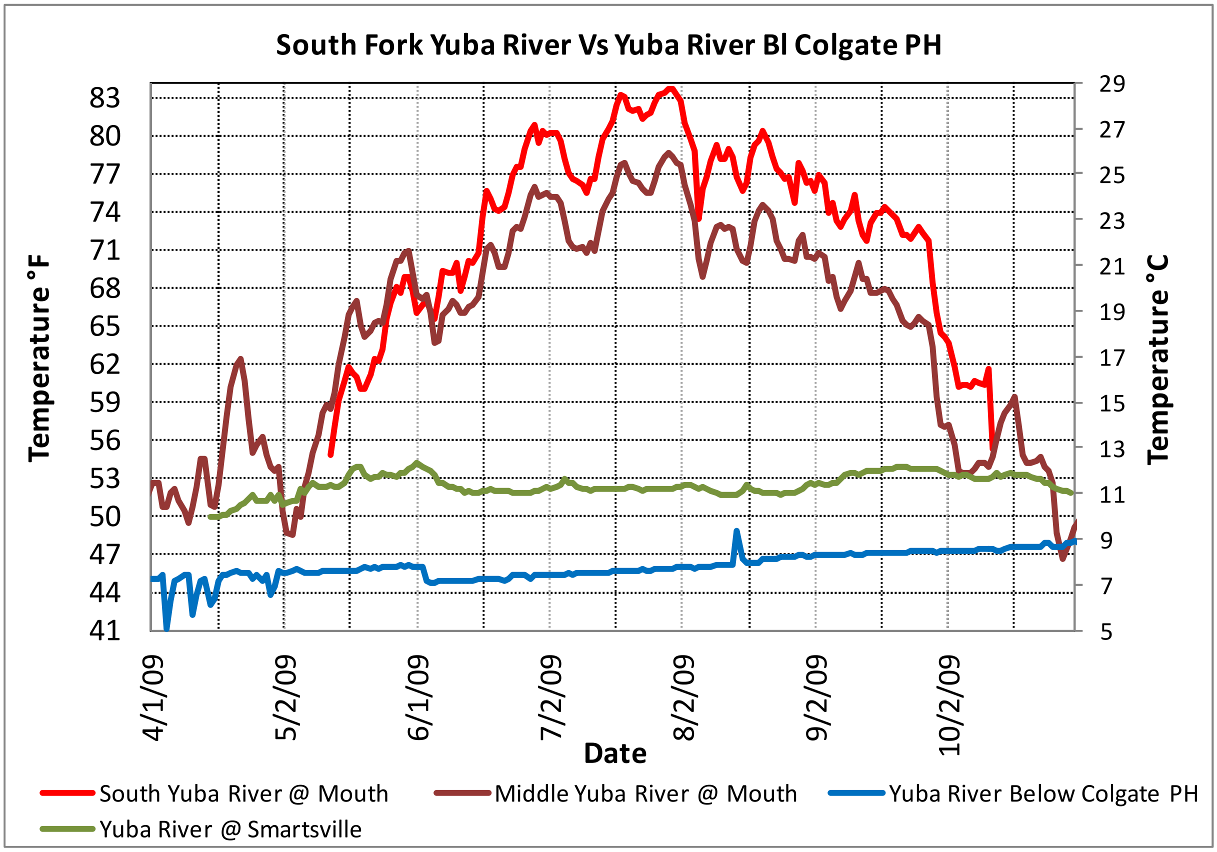

Figure 7. Water Temperature Differentials Between the South and Middle Yuba Rivers, and the Yuba River Below Colgate and at Smartsville.

To date, we have only identified limited information in the literature regarding the effect of temperature differentials on volitional upstream migration of Chinook salmon or steelhead. Typically, as fish migrate upstream in rivers the water temperature becomes cooler. Migrating fish may move from cooler ocean/estuary temperatures (Strange 2010) into warmer river temperatures, but as fish move upstream in rivers, the temperature typically gets cooler. In the case of migration from the Yuba River to the South and Middle Yuba rivers, fish could be faced with moving in a reverse temperature gradient from cooler downstream water, into warmer upstream water.

In the Columbia River both migrating Chinook salmon and steelhead use coolwater tributaries as thermal refugia during warm summer conditions. Staging in coolwater tributaries significantly slows and affects the migratory behavior of the fish (High et al.

2006; Goniea et al. 2006). Also temperature differentials at Columbia River ladders (e.g., colder water at the entrance to the ladder versus warmer water in the ladder), even relatively small temperature differentials, can slow migration rates through the ladders. Caudill et al. (2005) found that few fish passed the ladders when temperature differentials were > 7°F (> 4°C) and that passage times increased with increased temperature differential (e.g., > 2°F).

In the Snake River/Clearwater River system a somewhat analogous temperature situation exists compared to that which may occur in the Yuba River system. During the summer (July-August) cold water is released from Dworshak Reservoir on the North Fork Clearwater River into the Clearwater River. As a result, the Clearwater River becomes colder than the Snake River where they meet near Lewiston, Idaho. Spring-run Chinook salmon are generally not affected because by July, most spring-run Chinook salmon moving up the Clearwater River are already past the mouth of the North Fork Clearwater River, and are up close to or in their higher elevation natal streams getting ready to spawn. It does appear, however, that some later returning spring-run Chinook salmon do hold longer than they would have normally, near or in the North Fork Clearwater River, because of the colder water coming out of Dworshak Reservoir. As a result, there is spawning activity that occurs in the lower North Fork Clearwater River (it is possible that some of these fish may be hatchery fish shunted off from entering Dworshak Hatchery).

The cooling effect of Dworshak Reservoir releases to the Clearwater River does modify the behavior of returning steelhead and fall-run Chinook salmon at the confluence with the Snake River. The cooler water in the Clearwater River draws fish destined for the Snake River into the Clearwater River and they hold in the mouth of the Clearwater River until the Snake River cools down (Personal Communication, Bill Arnsberg, Nez Perce Tribal Biologist).

Our recommendation is that additional literature and data should be obtained and summarized regarding the effect of water temperature differentials on volitional migration (if such information exists). In addition, based on the limited information available, a temperature differential of 7°F (4°C) should precautionarily be viewed as a potential thermal barrier to adult upstream migration. It is possible that even lower temperature differentials (< 7°F) could result in migrating fish holding downstream and not migrating, or significantly delaying migration.

6 TEMPORAL TEMPERATURE PATTERNS RELATED TO WATER TEMPERATURE INDEX VALUES AND METRICS

Typical water temperature patterns in the Yuba River system exhibit a week or two of high temperatures and a much broader range of temperatures that are lower. For example, **Figure 8** shows historical water temperature in the section of the Middle Yuba River near Wolf Creek in 2008. This site is used below to briefly discuss temporal temperature patterns and their relationship to critical WTI values and some typical water temperature metrics used in the literature to summarize water temperature.

Historical daily average water temperatures at the Middle Yuba River site were near the temperature that has been observed to cause mortality to Chinook Salmon in Butte Creek (e.g., 67°F or greater) (Ward et al. 2004). Most of the summer, daily average water temperatures at the Middle Yuba River site were at or below 67°F, but there were a couple of weeks that the average daily water temperature exceeded 67°F (similar to conditions that caused mortality in Butte Creek). Maximum daily water temperatures at the site during much of the summer were near the 7-day UILT[3] for Chinook salmon adults of 69.8-71.6°F (McCullough 1999). However, the duration of time within a day that the water temperature was near the 7-day UILT was short and is not available from the plot nor from typical maximum temperature metrics (see below).

Some typical temperature metrics are shown on Figure 8. The 7-day moving average temperature (7DMA) also exceeded 67°F for the same two time periods that the average daily temperature exceeded 67°F. The maximum weekly average temperature (MWAT) (average of the daily mean temperature of the 7 warmest days) occurred in mid-July and was 67.9°F. The maximum daily temperatures, 7-day moving average daily maximum (7DMADM), were about 4°F greater than the mean daily temperature during the warmest months, and the 7-day average daily maximum temperature (7DADM) occurred at the same time as the MWAT (67.9 °F versus 71.7°F).

Historically in Butte Creek, when average daily water temperature was 67°F for more than about a week (11 and 16 days in 2002 and 2003, respectively) significant adult Chinook salmon mortality occurred. However, if water temperature exceeded 67°F for a relatively short number of days (e.g., < 7 days), significant mortality did not occur (Ward et al. 2004).

An analogous approach for analyzing the Yuba River water temperatures could be used. This could be done by using WTI values, where exceeding the WTI temperature criteria for less than 7 days would not be expected to affect each lifestage, but exceeding the WTI for more than 7 days would be detrimental.

[3] Note, however, the UILT is 7 continuous days exposure and is not comparable to a daily maximum temperature.

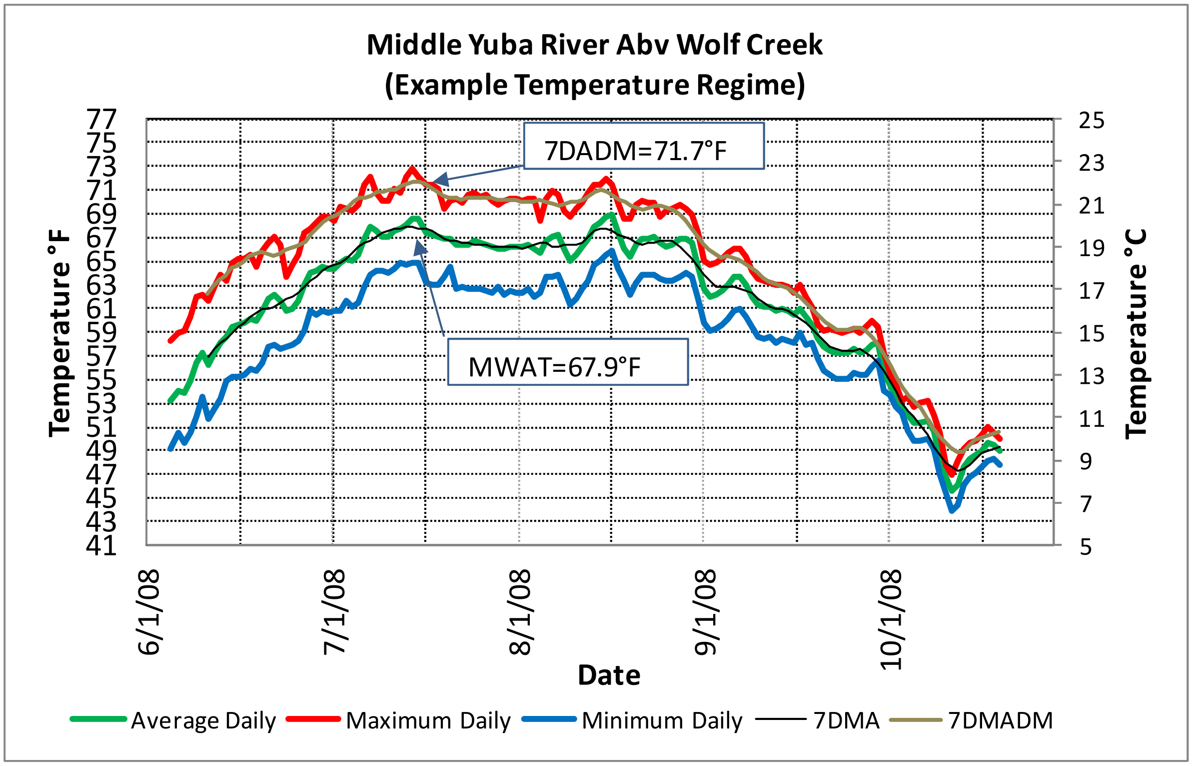

Figure 8. Middle Fork Yuba River Water Temperature Including 7 Day Moving Averages of the Average Daily Temperature and the Maximum Daily Temperature. Also Included Are the Maximum Weekly Average Temperature (MWAT) and the 7 Day Average Daily Maximum Temperature (7DADM).

Quantifying the number of average daily water temperature values that exceed a WTI threshold would be a direct approach to quantifying habitat suitability. The MWAT and/or the moving average (7DMA) identify a maximum average weekly water temperature value, but do not indicate the duration of time that this occurred. Similarly, if acute temperature was a concern, the individual water temperature measurements (e.g., hourly) could be used to identify the number of hours (duration) that a maximum WTI value was exceeded (e.g., tally the number of days and hours). Conversely, the 7DADM and/or the moving average (7DMADM) identify a maximum average weekly maximum temperature value, but do not indicate the duration of time that it occurred.

7 SPECIES- AND LIFESTAGE-SPECIFIC WATER TEMPERATURE RANGE ACCEPTABLE FOR REINTRODUCTION EVALUATION

The goal of the temperature analysis is twofold: (1) to identify the high temperature WTI value(s) that clearly demarcate the spatial/temperature boundary between where steelhead and Chinook salmon lifestages can and cannot exist (even though temperature is a stressor) (upper tolerable WTI); and (2) to determine within the "can

exist" boundary, if there is a core area where they can thrive without temperature as a stressor (upper optimal WTI). The upper tolerable temperature represents the upper boundary of the range of acceptable water temperatures for reintroduction evaluation. It represents a water temperature at which fish can survive indefinitely, without experiencing substantial detrimental effects to physiological and biological functions such that survival occurs, but growth and reproduction success are reduced below optimal. The upper optimal temperature represents the upper boundary of the optimum range and represents a temperature below which growth, reproduction, and/or behavior are not affected by temperature. Below, we discuss: (1) existing regulatory water temperature standards or guidelines that could be used as index values; and (2) specific water temperature index values that have been derived based on the literature review in this report.

7.1 Existing Water Temperature Standards/Guidelines

Several different water temperature standards are used currently by states for salmonids (e.g., California, Oregon, and Washington water temperature standards). California's Basin Plan is largely based on not altering the temperature of intrastate waters unless alterations can be shown to not have an effect on beneficial uses for cold freshwater habitat, migration, and/or spawning (**Table 10**). The beneficial uses of the Yuba River are listed in **Table 11**. Specific temperature criteria for species/lifestages are not identified in the Basin Plan nor are there specific temperature objectives for the Yuba River system. However, for the Sacramento River, seasonal temperature criteria have been developed (Table 10). These temperature objectives, while not directly applicable to the Yuba River, give an indication of temperature objectives that have been set for anadromous fish in the basin.

Table 10. Basin Plan Temperature Standards Including Specific Standards for the Sacramento River.

Temperature

The natural receiving water temperature of intrastate waters shall not be altered unless it can be demonstrated to the satisfaction of the Regional Water Board that such alteration in temperature does not adversely affect beneficial uses.

Temperature objectives for COLD interstate waters, WARM interstate waters, and Enclosed Bays and Estuaries are as specified in the *Water Quality Control Plan for Control of Temperature in the Coastal and Interstate Waters and Enclosed Bays of California* including any revisions. There are also temperature objectives for the Delta in the State Water Board's May 1991 *Water Quality Control Plan for Salinity*.

At no time or place shall the temperature of COLD or WARM intrastate waters be increased more than 5°F above natural receiving water temperature. Temperature changes due to controllable factors shall be limited for the water bodies specified as described in Table III-4. To the extent of any conflict with the above, the more stringent objective applies.

In determining compliance with the water quality objectives for temperature, appropriate averaging periods may be applied provided that beneficial uses will be fully protected.

TABLE III-4
SPECIFIC TEMPERATURE OBJECTIVES

DATES	APPLICABLE WATER BODY
From 1 December to 15 March, the maximum temperature shall be 55°F. From 16 March to 15 April, the maximum temperature shall be 60°F. From 16 April to 15 May, the maximum temperature shall be 65°F. From 16 May to 15 October, the maximum temperature shall be 70°F. From 16 October to 15 November, the maximum temperature shall be 65°F. From 16 November to 30 November, the maximum temperature shall be 60°F.	Sacramento River from its source to Box Canyon Reservoir (9); Sacramento River from Box Canyon Dam to Shasta Lake (11)
The temperature in the epilimnion shall be less than or equal to 75°F or mean daily ambient air temperature, whichever is greater.	Lake Siskiyou (10)
The temperature shall not be elevated above 56°F in the reach from Keswick Dam to Hamilton City nor above 68°F in the reach from Hamilton City to the I Street Bridge during periods when temperature increases will be detrimental to the fishery.	Sacramento River from Shasta Dam to I Street Bridge (13, 30)

Table 11. Basin Plan Beneficial Uses for the Yuba River.

TABLE II-1

SURFACE WATER BODIES AND BENEFICIAL USES

	SURFACE WATER BODIES (1)			AGRI-CULTURE		INDUSTRY			RECREATION			FRESHWATER HABITAT (2)		MIGRATION		SPAWNING			
			MUN	AGR		PROC	IND	POW	REC-1		REC-2	WARM	COLD	MIGR		SPWN		WILD	NAV
		HYDRO UNIT NUMBER	MUNICIPAL AND DOMESTIC SUPPLY	IRRIGATION	STOCK WATERING	PROCESS	SERVICE SUPPLY	POWER	CONTACT	CANOEING (1) AND RAFTING	OTHER NONCONTACT	WARM	COLD	WARM (3)	COLD (4)	WARM (3)	COLD (4)	WILDLIFE HABITAT	NAVIGATION
	YUBA RIVER																		
41	SOURCES TO ENGLEBRIGHT RESERVOIR	517.	E	E	E			E	E	E	E		E				E	E	
42	ENGLEBRIGHT DAM TO FEATHER RIVER	515.3		E	E			E	E	E	E	E	E	E	E	E	E	E	

LEGEND
E = EXISTING BENEFICIAL USES
P = POTENTIAL BENEFICIAL USES
L = EXISTING LIMITED BENEFICIAL USE

The EPA Region 10 Guidance for Pacific Northwest State and Tribal Temperature Water Quality Standards (EPA 2003b) provides water temperature recommendations regarding coldwater salmonid uses and numeric criteria to protect those uses for the following:

Salmonid Uses	Criteria
Salmon/trout core juvenile rearing	61°F (16°C) 7DADM
Salmon/trout migration plus non-core juvenile rearing	64°F (18°C) 7DADM
Salmon/trout migration	68°F (20°C) 7DADM
Salmon/trout spawning, egg incubation, and fry emergence	55°F (13°C) 7DADM
Steelhead smoltification	57°F (14°C) 7DADM

These temperature criteria are developed for summer water temperatures, except for the spawning and smolting lifestages which occur earlier in the year. The criteria are intended to represent the upper end of the optimal temperature range for each lifestage. It is important to note that the criteria are based on 7DADM (daily maximum temperatures), while the data used to generate the criteria were primarily based on daily average or continuous temperature field/laboratory data sets (**Table 12**). Several general assumptions were applied by EPA (2003b) to the data to make a connection between 7DADM temperature and the field/laboratory data (Section 8.1).

Table 12. EPA (2003b) Laboratory and Field Data Summary for Generating Water Temperature Criteria.

Life Stage	Temperature Consideration	Temperature & Unit	Reference
Spawning and Egg Incubation	*Temp. Range at which Spawning is Most Frequently Observed in the Field	4 - 14°C (daily avg)	Issue Paper 1; pp 17-18 Issue Paper 5; p 81
	* Egg Incubation Studies - Results in Good Survival -Optimal Range	 4 - 12°C (constant) 6 - 10°C (constant)	 Issue Paper 5; p 16
	*Reduced Viability of Gametes in Holding Adults	> 13°C (constant)	Issue Paper 5; pp 16 and 75
Juvenile Rearing	*Lethal Temp. (1 Week Exposure)	23 - 26°C (constant)	Issue Paper 5; pp 12, 14 (Table 4), 17, and 83-84
	*Optimal Growth - unlimited food - limited food	 13 - 20°C (constant) 10 - 16°C (constant)	 Issue Paper 5; pp 3-6 (Table 1), and 38-56
	*Rearing Preference Temp. in Lab and Field Studies	10 - 17°C (constant) < 18°C (7DADM)	Issue Paper 1; p 4 (Table 2). Welsh et al. 2001.
	*Impairment to Smoltification	12 - 15°C (constant)	Issue Paper 5; pp 7 and 57-65 Issue Paper 5; pp 7 and 57-65
	*Impairment to Steelhead Smoltification	> 12°C (constant)	
	*Disease Risk (lab studies) -High - Elevated - Minimized	 > 18 - 20°C (constant) 14 - 17°C (constant) 12 - 13°C (constant)	Issue Paper 4, pp 12 - 23
Adult Migration	*Lethal Temp. (1 Week Exposure)	21- 22°C (constant)	Issue Paper 5; pp 17, 83 - 87
	*Migration Blockage and Migration Delay	21 - 22°C (average)	Issue Paper 5; pp 9, 10, 72-74. Issue Paper 1; pp 15 - 16
	*Disease Risk (lab studies) - High - Elevated - Minimized	 > 18 - 20°C (constant) 14 - 17°C (constant) 12- 13°C (constant)	 Issue Paper 4; pp 12 - 23
	*Adult Swimming Performance - Reduced - Optimal	 > 20°C (constant) 15 - 19°C (constant)	 Issue Paper 5; pp 8, 9, 13, 65 - 71
	* Overall Reduction in Migration Fitness due to Cumulative Stresses	> 17-18°C (prolonged exposures)	Issue Paper 5; p 74

In addition to the numeric temperature criteria, there are a number of other factors (e.g., site specific issues, background temperatures) that EPA (2003b) considered in recommending coldwater salmonid uses and water quality standards (WQS) to protect those uses. These factors and the EPA's recommended approach for establishing WQS are described in EPA (2003b).

EPA (2003b) recognized that salmonids will use waters that are warmer than their optimal thermal range and further recognizes that some portions of rivers and streams naturally (i.e., absent human impacts) were warmer than the salmonid optimal range. They also recognized that some streams have unique diurnal temperature patterns, which may necessitate modified WQS. To account for these issues, the EPA identified three alternate salmonid temperature standard approaches. These include identifying the natural background temperature of the water body, creating site-specific temperature criteria, and/or identifying that a criterion is "unattainable" and altering the use designation to a use designation that has a criterion that is obtainable.

The EPA's water temperature recommendations are intended to assist States and Tribes to adopt temperature WQS that the EPA can approve consistent with its obligations under the Clean Water Act and the Endangered Species Act. States and Tribes that adopt temperature WQS consistent with these recommendations can expect an expedited review by EPA and the Services, subject to new data and information that might be available to during that review (EPA 2003b). In some cases, the criteria seem to be conservative and may exclude habitat that is currently used and/or demonstrably usable by salmonid lifestages. Section 8.1 has a brief discussion of issues related to the EPA (2003b) numerical criteria based on 7DADM temperatures and the needs of the Yuba Salmon Forum.

7.2 Site Specific Water Temperature Index Values

In addition to the EPA (2003b) numeric temperature criteria (Section 7.1) it also seems appropriate to develop Yuba Salmon Forum water temperature index values that are specific to the purposes of the Yuba Salmon Forum and the Yuba River. Below, for each species/lifestage, we provide: (1) an upper tolerance WTI (UTWTI) that identifies the sustained (chronic) tolerance/no tolerance boundary; and (2) the upper optimal WTI (UOWTI) where physiological processes (growth, disease resistance, normal development of embryos) are not stressed by temperature.

The lifestage-specific WTI values are not intended to represent significance thresholds, but instead provide criteria to evaluate reintroduction of anadromous salmonids. Moreover, as suggested by DWR (2007), the use of temperature "boundaries" has inherent drawbacks associated with the often indistinguishable effects at the upper and

lower ends of an identified range and attributing undue specificity to values slightly exceeding an identified range. Nonetheless, WTI values, as defined, are used for evaluation of water temperature considerations regarding the reintroduction of steelhead (**Table 13**) and spring-run Chinook salmon (**Table 14**) in the Upper Yuba River Basin.

7.2.1 Steelhead

Table 13. Lifestage-Specific Upper Optimal Water Temperature Index (UOWTI) Values and Upper Tolerance Water Temperature Index (UTWTI) Values Identified as Defining the Range of Acceptable Water Temperatures for Evaluation of the Reintroduction of Steelhead in the Upper Yuba River Basin.

Lifestage	Upper Optimum WTI[1]	Upper Tolerance WTI[1]	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec
Adult Migration	64°F	68°F	■■	■■	■■	□□	□□	□□	□□	■■	■■	■■	■■	■■
Adult Holding	61°F	65°F	■■	■■	■■	□□	□□	□□	□□	■■	■■	■■	■■	■■
Spawning	54°F	57°F	■■	■■	■■	■■	□□	□□	□□	□□	□□	□□	□□	□□
Embryo Incubation	54°F	57°F	■■	■■	■■	■■	■■	□□	□□	□□	□□	□□	□□	□□
Juv. Rearing & Downstream Mvmt.	65°F	68°F	■■	■■	■■	■■	■■	■■	■■	■■	■■	■■	■■	■■
Smolt Emigration	52°F	55°F	■■	■■	■■	■□	□□	□□	□□	□□	□□	■■	■■	■■

[1] The WTI values are to be applied to the water temperature metrics recommended in Section 8, below.

7.2.2 Spring-run Chinook Salmon

Table 14. Lifestage-Specific Upper Optimal Water Temperature Index (UOWTI) Values and Upper Tolerance Water Temperature Index (UTWTI) Values Identified as Defining the Upper Acceptable Water Temperatures for Evaluation of the Reintroduction of Spring-Run Chinook Salmon in the Upper Yuba River Basin.

Lifestage	Upper Optimum WTI[1]	Upper Tolerance WTI[1]	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec
Adult Migration	64°F	68°F	□□	□□	□□	■■	■■	■■	■■	■■	□□	□□	□□	□□
Adult Holding	61°F	65°F	□□	□□	□□	■■	■■	■■	■■	■■	□□	□□	□□	□□
Spawning	56°F	58°F	□□	□□	□□	□□	□□	□□	□□	□□	■■	■■	■□	□□
Embryo Incubation	56°F	58°F	■■	■■	□□	□□	□□	□□	□□	□□	■■	■■	■■	■■
Juv. Rearing & Downstream Mvmt.	61°F	65°F	■■	■■	■■	■■	■■	■■	■■	■■	■■	■■	■■	■■
Smolt Emigration	63°F	68°F	■■	■■	■■	■■	■□	□□	□□	□□	□□	■■	■■	■■

[1] The WTI values are to be applied to the water temperature metrics recommended in Section 8, below.

8 WATER TEMPERATURE METRICS

Water temperature metrics (e.g., MWAT, 7DADM) are typically designed to provide a reproducible index of temperature over a period of time that can be used in combination with temperature standards (numeric criteria values) to determine if a water temperature body is impaired. Water temperature metrics are by definition an index of the complete temperature time series. As such, they do not completely represent the temperature time series nor are they always the most accurate way to

represent the biological response of various lifestages. Water temperature metrics for potential application to the Yuba Salmon Forum specific criteria (UOWTI and UTWTI) are described below.

8.1 7DADM

The EPA (2003a) recommends the 7DADM (maximum 7-day average of the daily maxima) as a water temperature metric for all of the numeric criteria that is applied to a specific species and lifestage. The 7DADM is similar to the maximum weekly average temperature metric that was previously used by the EPA for its national temperature criteria recommendations (EPA 1977). However, in 2003, the EPA initiated use of the 7DADM metric "because it describes the maximum temperatures in a stream, but is not overly influenced by the maximum temperature of a single day."

A 7DADM value is calculated by adding the daily maximum temperatures recorded at a site on seven consecutive days and dividing by seven. Thus, it reflects an average of daily maximum temperatures that fish are exposed to over a week-long period. EPA (2003b) states that because this metric "is oriented to daily maximum temperatures, it can be used to protect against acute effects, such as lethality and migration blockage conditions." This statement illustrates two shortcomings of the EPA (2003a) use of the 7DADM metric. The 7DADM: (1) includes no duration information, which is critical to understanding acute (zone of resistance) temperature analysis – rather, it is an index of maximum temperature that occurs for a short time each day and, most importantly; (2) the numeric criteria that are identified by EPA (2003b) are not acute criteria nor derived from acute criteria data, but are chronic temperature criteria.

The EPA (2003b) numeric criteria were derived from chronic field or laboratory studies (e.g., > 7 day continuous or average daily temperatures), including the migratory blockage data (see Section 5.1; Table 12). A couple of simple examples illustrate this concept. The EPA (2003b) juvenile core rearing criteria is 61°F 7DADM and is the same temperature value as the upper optimal growth temperature under limited food (Table 12, 16°C), but the optimal growth temperature was derived from constant temperature laboratory studies. This temperature is much lower than the temperature where acute temperature affects occur. The UILT (7 day) from literature studies is 72 - 79°F (e.g., Table 12) and for shorter duration exposure is even much higher 80 - 88°F (e.g., see Table TT2 in Myrick and Cech 2001). Another example is the migration criteria. The migration blockage source data is based on observations in natural rivers, and is based on daily average or weekly field temperatures (70 – 72°F) (Table 12; McCullough 1999).

A daily maximum temperature equivalent of this temperature (70°F) is approximately 75°F [4], but the EPA (2003b) 7DADM numeric criterion for migration was set at 68°F.

EPA (2003b) states that the 7DADM metric can also can be used to protect against sub-lethal or chronic effects (e.g., temperature effects on growth, disease, smoltification, and competition), but the resultant cumulative thermal exposure fish experience over the course of a week or more needs to be considered when selecting a 7DADM value to protect against these effects. The EPA's general conclusion from studies on fluctuating water temperature regimes (which is what fish generally experience in rivers) is that fluctuating temperatures increase juvenile growth rates when mean temperatures are colder than the optimal growth temperature derived from constant temperature studies, but will reduce growth when the mean temperature exceeds the optimal growth temperature (see Issues Paper 5, pages 51-56). When the mean temperature is above the optimal growth temperature, the "mid-point" temperature between the mean and the maximum is the "equivalent" constant temperature. This "equivalent" constant temperature then can be directly compared to laboratory studies done at constant temperatures. For example, a river with a 7DADM value of 64°F and a 58°F weekly mean temperature (i.e., diurnal variation of ± 5.4°F) will be roughly equivalent to a constant laboratory study temperature of 61.7°F (mid-point between 58°F and 65°F). Thus, both maximum and mean temperatures are important when determining a 7DADM value that is protective against sub-lethal/chronic temperature effects.

To account for using the 7DADM metric based on constant temperature laboratory data, EPA (2003a) assumed an average diel temperature difference between the mean and daily maximum temperature of 5.4°F, although the EPA appears to have decreased the temperature in the laboratory data down by 2.7°F (equivalently added 2.7°F to the criteria). It is completely unclear, however, if or how EPA then also accounted for the fact that 7DADM temperature is on average also 5.4°F greater than the average daily temperature (i.e., was this accounted for or not).

It also is unclear if the "midpoint of the maximum and average temperature" correction was applied for all lifestages. If so, this would be inappropriate based on the data available. The "midpoint" correction literature is only applicable to juvenile growth. There is no evidence presented that it is applicable to other lifestages. Also, the juvenile growth "midpoint" temperature correction is somewhat mis-represented in EPA (2003b). The main study relied on by EPA (2003b) is Hokanson et al. (1977), and that study states that the difference in growth between constant and diel fluctuating temperatures was 39% (1.5°C in a ±3.8C fluctuating range) of the difference between the

[4] Maximum daily temperatures are typically 5.4°F higher than average daily temperature (EPA 2003b).

average and maximum temperature (not 50% or the midpoint) and, perhaps more importantly, most of the studies reviewed by EPA indicate that growth in constant temperature was essentially equivalent to growth in fluctuating temperatures. Elliott (1975), for example, found that a growth model developed from constant temperature experimental data predicted brown trout growth in daily fluctuating temperature environments accurately when the mean daily value of the fluctuating temperature was used as input to the growth model.

For the evaluation of potential water temperature-related impacts associated with the reintroduction of anadromous salmonids into the Upper Yuba River Basin, 7DADM values could be calculated for species-specific lifestage periods on an annual basis over the simulation or empirical data period, and the occurrences when that 7DADM values exceed the EPA (2003b) numeric values could be compared among rivers/reaches in the Upper Yuba River Basin.

8.2 ADT

The average daily temperature (ADT) should be considered for application to the Yuba Salmon Forum specific criteria (WTI values) because nearly all of the data in the literature review were either based on ADT or on continuous temperature (also see Table 12). For juvenile growth, the data from Hokanson et al. (1977) can be directly applied to the constant temperature data to provide a correction, if deemed appropriate. The average daily temperature also can be used to determine the number of days (duration) that a WTI is exceeded, and duration of exceedance can be compared among specific geographic areas.

8.3 MWAT

The Maximum Weekly Average Temperature (MWAT) is a metric used by the California RWQCB that is commonly applied to water temperature numeric objectives. Generally, the MWAT serves as a summary measurement of instream water temperature variation that may occur on a daily or seasonal basis, and is used to evaluate chronic (sub-lethal) water temperature impacts (SWRCB website).

The MWAT is found by calculating the mathematical mean of multiple, equally spaced, daily water temperatures over a 7-day consecutive period. The MWAT is defined as the highest value calculated for all possible 7-day periods over a given time period, which usually extends over the summer or is commensurate to the duration of a salmonid lifestage. In order to determine whether the maximum weekly temperature standard is attained, the mathematical mean of multiple, equally spaced, daily temperatures over a seven-day consecutive period is compared to the criterion.

For the evaluation of acceptable water temperature-related reintroduction potential associated with spring-run Chinook salmon and steelhead in the Upper Yuba River Basin, MWAT values should be calculated for species-specific lifestage periods, on an annual basis over the monitoring or simulation period, and the probability that MWAT values exceed specified water temperature index values will be compared among rivers/reaches in the Upper Yuba River Basin.

The use of a single temperature measurement such as MWAT is convenient from a monitoring and regulatory standpoint, but oversimplifies the complex interactions between water temperature regimes and fish health which are affected by the duration of peak and daily average temperatures. Therefore, for the evaluation of acceptable water temperature-related reintroduction potential associated with spring-run Chinook salmon and steelhead in the Upper Yuba River Basin, it is recommended that both the MWAT, and ADT lifestage-specific exceedance durations, be compared with the UOWTI and UTWTI values.

8.4 7DMAVG

The 7-day moving average of maximum daily temperature (7DMAVG) serves as the basis for instream water temperature standards, including those of the Oregon Department of Environmental Quality (ODEQ). The reason for using the 7DMAVG is to decrease the effect of a single peak temperature on data interpretation. Aquatic organisms are affected more by exposure to high temperature over an extended period than to a single exceedance of the criteria. The ODEQ recognizes that not only summer maximum temperatures are of importance to aquatic biota. The intent is to protect the temperature regime through the year. Built into the ODEQ 7DMAVG standard is the assumption that if stream and riparian conditions are managed such that they meet the summer maximum criteria, those same conditions will protect the temperature regime of the stream through the year.

The 7DMAVG standard is based not on directly lethal temperatures (usually above 70°F), but on sub-lethal effects, which are numerous. Sub-lethal effects can lead to death indirectly, or they may reduce the ability of the fish to successfully reproduce and for their offspring to survive and grow. These sub-lethal effects include an increase in the incidence of disease, an inability to spawn, a reduced survival rate of eggs, a reduced growth and survival rate of juveniles, increased competition for limited habitat and food, reduced ability to compete with other species that are better adapted to higher temperatures (many of these are introduced species) and other adverse effects. Sub-lethal effects of temperature on salmonids occur gradually as stream temperatures increase.

In California, the 7DMAVG has been applied in effectiveness monitoring protocols (e.g. 2006 Green Diamond Resource Company Aquatic Habitat Conservation Plan/Candidate Conservation Agreement and Assurances) and other monitoring efforts (e.g., Upper Yuba River Studies Program 2006 Upper Yuba River Water Temperature Criteria for Chinook salmon and Steelhead). However, for the evaluation of water temperature-related reintroduction potential associated with spring-run Chinook salmon and steelhead in the Upper Yuba River Basin, 7DMAVG is not recommended as a metric.

9 WATER TEMPERATURE EVALUATION CONSIDERATIONS

For the evaluation of water temperatures acceptable for reintroduction of salmonids in the Upper Yuba River Basin, it is anticipated that water temperature modeling and/or monitoring will be applied for a comparison among rivers and reaches in the Upper Yuba River Basin. In addition to the application of the criteria and metrics as described in the preceding sections, it may be appropriate to consider other specific evaluation methodologies.

9.1 Water Year Type

Model output and/or monitoring data could be summarized by water year type. Comparisons of the water temperature-related potential among rivers and reaches in the Upper Yuba River Basin could include water year types. This would help identify reaches/lengths of river that would be suitable in all conditions (e.g., critically dry to wet years) as well as the lengths of river that would be suitable under more favorable conditions (e.g., wet water year types only).

9.2 Water Temperature Exceedance Curves

Model output and/or monitoring data also could be summarized by the calculation of water temperature exceedance curves, by month, occurring over the period of evaluation for each of the rivers and reaches. Exceedance curves are particularly useful for examining the probability of occurrence/duration of water temperatures. The evaluation approach could specifically evaluate the probabilities/duration of time that each of the identified lifestage-specific water temperature index values would be exceeded over the period of evaluation. Comparisons of the water temperature-related potential among rivers and reaches in the Upper Yuba River Basin could be made by presentation of monthly cumulative water temperature exceedance distribution probabilities (using average daily water temperatures) relative to specified water temperature index values corresponding to the appropriate months for each lifestage of spring-run Chinook salmon and steelhead.

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APPENDIX A

LIFESTAGE-SPECIFIC WATER TEMPERATURE BIOLOGICAL EFFECTS AND INDEX TEMPERATURE VALUES

STEELHEAD LIFESTAGE-SPECIFIC WATER TEMPERATURE INDEX VALUES

Adult Immigration and Holding

Water temperatures can control the timing of adult spawning migrations and can affect the viability of eggs in holding females. YCWA et al. (2007) suggests that few studies have been published examining the effects of water temperature on either steelhead immigration or steelhead holding, and none of the available studies were recent (Bruin and Waldsdorf 1975; McCullough *et al.* 2001). The available studies suggest that adverse effects occur to immigrating and holding steelhead at water temperatures exceeding the mid 50°F range, and that immigration will be delayed if water temperatures approach approximately 70°F (**Table 2**). Water temperature index values of 52°F, 56°F, 61°F, 65°F and 70°F were chosen because they provide a gradation of potential water temperature effects, and the available literature provided the strongest support for these values.

Because of the paucity of literature pertaining to steelhead adult immigration and holding, an evenly spaced range of water temperature index values could not be achieved. We also used some pertinent information related to other salmonids (e.g., Chinook salmon). 52°F was selected as a water temperature index value because it has been referred to as a "recommended" (Reclamation 2003), "preferred" (McEwan and Jackson 1996; NMFS 2000; NMFS 2002a), and "optimum" (Reclamation 1997a) water temperature for steelhead adult immigration. Increasing levels of thermal stress to this life stage may reportedly occur above the 52°F water temperature index value. 56°F was selected as a water temperature index value because 56°F represents a water temperature above which adverse effects to migratory and holding steelhead begin to arise (Bruin and Waldsdorf 1975; Leitritz and Lewis 1980; McCullough *et al.* 2001; Smith *et al.* 1983). 50-59°F is referred to as the "preferred" range of water temperatures for California summer steelhead holding (Moyle 1995). Whereas, water temperatures greater than 61°F may result in "chronic high stress" of holding Central Valley winter-run steelhead (USFWS 1995). 65°F was selected as a water temperature index value because steelhead (and fall-run Chinook salmon) encounter potentially stressful temperatures between 64.4-73.4°F (Richter and Kolmes 2005). Additionally, over 93% of steelhead detections occurred in the 65.3-71.6°F range, although this may be above the temperature for optimal immigration (Salinger and Anderson 2006) and/or may modify migration timing due to holding in coldwater refugia (High et al. 2006). 70°F was selected as the highest water temperature index value because the literature suggests that water temperatures near and above 70.0°F may result in a thermal barrier to adult steelhead migrating upstream (McCullough *et al.* 2001) and are water temperatures referred to as "stressful" to upstream migrating steelhead in the Columbia River (Lantz

1971 as cited in Beschta et al 1987). Further, Coutant (1972) found that the UILT for adult steelhead was 69.8°F and temperatures between 73-75°F are described as "lethal" to holding adult steelhead in Moyle (2002).

Spawning and Embryo Incubation

Relatively few studies have been published directly addressing the effects of water temperature on steelhead spawning and embryo incubation (Redding and Schreck 1979; Rombough 1988). Because anadromous steelhead and non-anadromous rainbow trout are genetically and physiologically similar, studies on non-anadromous rainbow trout also were considered in the development of water temperature index values for steelhead spawning and embryo incubation (Moyle 2002; McEwan 2001). From the available literature, water temperatures in the low 50°F range appear to support high embryo survival, with substantial mortality to steelhead eggs reportedly occurring at water temperatures in the high 50°F range and above (**Table 3**). Water temperatures in the 45-50°F range have been referred to as the "optimum" for spawning steelhead (FERC 1993).

Water temperature index values of 46°F , 52°F, 54°F, 57°F, and 60°F were selected for two reasons. First, the available literature provided the strongest support for water temperature index values at or near 46°F, 52°F, 54°F, 57°F, and 60°F. Second, the index values reflect a gradation of potential water temperature effects ranging between optimal to lethal conditions for steelhead spawning and embryo incubation. Some literature suggests water temperatures ≤ 50°F are when steelhead spawn (Orcutt et al. 1968) and/or are optimal for steelhead spawning and embryo survival (FERC 1993; Myrick and Cech 2001; Timoshina 1972) and temperatures between 39-52°F are "preferred" by spawning steelhead (IEP Steelhead Project Work Team (no date); McEwan and Jackson 1996), a larger body of literature suggests optimal conditions occur at water temperatures ≤ 52°F (Humpesch 1985; NMFS 2000; NMFS 2001a; NMFS 2002a; Reclamation 1997b; SWRCB 2003; USFWS 1995a). Further, water temperatures between 48-52°F were referred to as "optimal" (FERC 1993; McEwan and Jackson 1996; NMFS 2000) and "preferred" (Bell 1986) for steelhead embryo incubation. Therefore, 52°F was selected as the lowest water temperature index value. Increasing levels of thermal stress to the steelhead spawning and embryo incubation life stage may reportedly occur above the 52°F water temperature index value.

54°F was selected as the next index value, because although most of the studies conducted at or near 54.0°F report high survival and normal development (Kamler and Kato 1983; Redding and Schreck 1979; Rombough 1988), some evidence suggests that symptoms of thermal stress arise at or near 54.0°F (Humpesch 1985; Timoshina 1972). Thus, water temperatures near 54°F may represent an inflection point between properly

functioning water temperature conditions, and conditions that cause negative effects to steelhead spawning and embryo incubation. Further, water temperatures greater than 55°F were referred to as "stressful" for incubating steelhead embryos (FERC 1993). 57°F was selected as an index value because embryonic mortality increases sharply and development becomes retarded at incubation temperatures greater than or equal to 57.0°F. Velsen (1987) provided a compilation of data on rainbow trout and steelhead embryo mortality to 50% hatch under incubation temperatures ranging from 33.8°F to 60.8°F that demonstrated a two-fold increase in mortality for embryos incubated at 57.2°F, compared to embryos incubated at 53.6°F. In a laboratory study using gametes from Big Qualicum River, Vancouver Island, steelhead mortality increased to 15% at a constant temperature of 59.0°F, compared to less than 4% mortality at constant temperatures of 42.8°F, 48.2°F, and 53.6°F (Rombough 1988). Also, alevins hatching at 59.0°F were considerably smaller and appeared less well developed than those incubated at the lower temperature treatments. From fertilization to 50% hatch, Big Qualicum River steelhead had 93% mortality at 60.8°F, 7.7% mortality at 57.2°F, and 1% mortality at 47.3°F and 39.2°F (Velsen 1987). Myrick and Cech (2001) similarly described water temperatures >59°F as "lethal" to incubating steelhead embryos, although FERC (1993) suggested that water temperatures exceeding 68°F were "stressful" to spawning steelhead and "lethal" when greater than 72°F.

Juvenile Rearing & Downstream Movement

Water temperature index values were developed to evaluate the combined steelhead rearing (fry and juvenile) and juvenile downstream movement lifestages. Some steelhead may rear in freshwater for up to three years before emigrating as yearling+ smolts, whereas other individuals move downstream shortly after emergence as post-emergent fry, or rear in the river for several months and move downstream as juveniles without exhibiting the ontogenetic characteristics of smolts. Presumably, these individuals continue to rear and grow in downstream areas (e.g., lower Feather River, Sacramento River, and Upper Delta) and undergo the smoltification process prior to entry into saline environments. Thus, fry and juvenile rearing occur concurrently with post-emergent fry and juvenile downstream movement and are assessed in this Technical Memorandum using the fry and juvenile rearing water temperature index values.

The growth, survival, and successful smoltification of juvenile steelhead are controlled largely by water temperature. The duration of freshwater residence for juvenile steelhead is long relative to that of Chinook salmon, making the juvenile life stage of steelhead more susceptible to the influences of water temperature, particularly during the over-summer rearing period. Central Valley juvenile steelhead have high growth

rates at water temperatures in the mid 60°F range, but reportedly require lower water temperatures to successfully undergo the transformation to the smolt stage.

Water temperature index values of 63°F, 65°F, 68°F, 72°F, and 75°F were selected to represent a gradation of potential water temperature effects ranging between optimal to lethal conditions for steelhead juvenile rearing (Table 4). The lowest water temperature index value of 63°F was established because Myrick and Cech (2001) describe 63°F as the "preferred" water temperature for wild juvenile steelhead, whereas "preferred" water temperatures for juvenile hatchery steelhead reportedly range between 64-66°F. 65°F was also identified as a water temperature index value because NMFS (2000; 2002a) reported 65°F as the upper limit preferred for growth and development of Sacramento and American River juvenile steelhead. Also, 65°F was found to be within the optimum water temperature range for juvenile growth (i.e., 59-66°F) (Myrick and Cech 2001), and supported high growth of Nimbus strain juvenile steelhead (Cech and Myrick 1999).

Increasing levels of thermal stress to this life stage may reportedly occur above the 65°F water temperature index value. For example, Kaya *et al.* (1977) reported that the upper avoidance water temperature for juvenile rainbow trout was measured at 68°F to 71.6°F. Cherry *et al.* (1977) observed an upper preference water temperature near 68.0°F for juvenile rainbow trout, duplicating the upper preferred limit for juvenile steelhead observed in Cech and Myrick (1999) and FERC (1993). Empirical adult *O. mykiss* population data from the North Yuba, Middle Yuba, South Yuba, Middle Fork American, and Rubicon rivers collected in 2007-2009 are plotted against temperature in Figure 4. The temperature used was the 8th largest average daily temperature during the summer (i.e., up to seven days had higher daily average temperatures). The data show a population density break at about 68.0°F. Although smaller population densities occurred at higher temperatures, the largest population densities occurred at temperatures near 68.0°F or less. In addition Figure 5 shows growth for a 200 mm juvenile O. mykiss versus temperature for three food levels (percent of maximum consumption = 30%, 50%, and 70%). The average empirically derived percent of maximum consumption in an adjacent watershed (Middle Fork American Fork River) was 50% (Hanson et al. 1997). Positive growth only occurs up to approximately 68°F. Because of the literature describing 68.0°F as both an upper preferred and an avoidance limit for juvenile *Oncorhynchus mykiss*, and because of the empirical fish population data and bioenergetics growth data, 68°F was established as a upper tolerable water temperature index value.

A water temperature index value of 72°F was established because symptoms of thermal stress in juvenile steelhead have been reported to arise at water temperatures approaching 72°F. For example, physiological stress to juvenile steelhead in Northern

California streams was demonstrated by increased gill flare rates, decreased foraging activity, and increased agonistic activity as stream temperatures rose above 71.6°F (Nielsen *et al.* 1994). Also, 72°F was selected as a water temperature index value because 71.6°F has been reported as an upper avoidance water temperature (Kaya *et al.* 1977) and an upper thermal tolerance water temperature (Ebersole *et al.* 2001) for juvenile rainbow trout. The highest water temperature index value of 75°F was established because NMFS and EPA report that direct mortality to rearing juvenile steelhead results when stream temperatures reach 75.0°F (EPA 2002; NMFS 2001b). Water temperatures >77°F have been referred to as "lethal" to juvenile steelhead (FERC 1993; Myrick and Cech 2001). The UILT for juvenile rainbow trout, based on numerous studies, is between 75-79°F (Sullivan et al. 2000; McCullough 2001).

Yearling + Smolt Emigration

Laboratory data suggest that smoltification, and therefore successful emigration of steelhead smolts, is directly controlled by water temperature (Adams *et al.* 1975) (**Table 5**). Water temperature index values of 52°F and 55°F were selected to evaluate the steelhead smolt emigration life stage, because most literature on water temperature effects on steelhead smolting suggest that water temperatures less than 52°F (Adams *et al.* 1975; Myrick and Cech 2001; Rich 1987a) or less than 55°F (EPA 2003a; McCullough *et al.* 2001; Wedemeyer *et al.* 1980; Zaugg and Wagner 1973) are required for successful smoltification to occur. (Adams *et al.* 1973) tested the effect of water temperature (43.7°F, 50.0°F, 59.0°F or 68.0°F) on the increase of gill microsomal Na^+-, K^+-stimulated ATPase activity associated with parr-smolt transformation in steelhead and found a two-fold increase in Na^+-, K^+-ATPase at 43.7 and 50.0°C, but no increase at 59.0°F or 68.0°F. In a subsequent study, the highest water temperature where a parr-smolt transformation occurred was at 52.3°F (Adams *et al.* 1975). The results of Adams *et al.* (1975) were reviewed in Myrick and Cech (2001) and Rich (1987b), which both recommended that water temperatures below 52.3°F are required to successfully complete the parr-smolt transformation. Further, Myrick and Cech (2001) suggest that water temperatures between 43-50°F are the "physiologically optimal" temperatures required during the parr-smolt transformation and necessary to maximize saltwater survival. The 52°F water temperature index value established for the steelhead smolt emigration life stage is the index value generally reported in the literature as the upper limit of the water temperature range that provides successful smolt transformation thermal conditions. Increasing levels of thermal stress to this life stage may reportedly occur above the 52°F water temperature index value.

Zaugg and Wagner (1973) examined the influence of water temperature on gill ATPase activity related to parr-smolt transformation and migration in steelhead. They found ATPase activity was decreased and migration reduced when juveniles were exposed to

water temperatures of 55.4°F or greater. In a technical document prepared by the EPA to provide temperature water quality standards for the protection of Northwest native salmon and trout, water temperatures less than or equal to 54.5°F were recommended for emigrating juvenile steelhead (EPA 2003b). Water temperatures are considered "unsuitable" for steelhead smolts at >59°F (Myrick and Cech 2001) and "lethal" at 77°F (FERC 1993).

CHINOOK SALMON LIFESTAGE-SPECIFIC WATER TEMPERATURE INDEX VALUES

It has been suggested that separate water temperatures standards should be developed for each run-type of Chinook salmon. For example, McCullough (1999) states that spring-run Chinook salmon immigrate in spring and spawn in 3rd to 5th order streams and, therefore, face different migration and adult holding temperature regimes than do summer- or fall-run Chinook salmon, which spawn in streams of 5th order or greater. However, to meet the objectives of the current literature review, run-types are not separated because: (1) there is a paucity of literature specific to each life stage of each run-type; (2) there is an insufficient amount of data available in the literature suggesting that Chinook salmon run-types respond to water temperatures differently; (3) the WTI values derived from all the literature pertaining to Chinook salmon for a particular life stage will be sufficiently protective of that life stage for each run-type; and (4) all run-types overlap in timing of adult immigration and holding and in some cases are not easily distinguished (Healey 1991). Nonetheless, water temperature relationships for each lifestage of spring-run Chinook salmon available in the literature are emphasized in the consideration and identification of WTI values for evaluation of reintroduction of spring-run Chinook salmon in the Upper Yuba River Basin.

Adult Immigration and Holding

The adult immigration and adult holding life stages are evaluated together, because it is difficult to determine the thermal regime that Chinook salmon have been exposed to in the river prior to spawning and in order to be sufficiently protective of pre-spawning fish, water temperatures that provide high adult survival and high egg viability must be available throughout the entire pre-spawning freshwater period. Although studies examining the effects of thermal stress on immigrating Chinook salmon are generally lacking, it has been demonstrated that thermal stress during the upstream spawning migration of sockeye salmon negatively affected the secretion of hormones controlling sexual maturation causing numerous reproductive impairment problems (McCullough *et al.* 2001).

The water temperature index values reflect a gradation of potential water temperature effects that range between those reported as "optimal" to those reported as "lethal" for adult Chinook salmon during upstream spawning migrations and holding. The water temperature index values established for the Chinook salmon adult immigration and holding lifestage are 61°F, 65°F, and 68°F (**Table 6)**. Although 56°F is referenced in the literature frequently as the upper "optimal" water temperature limit for upstream migration and holding, the references are not foundational studies and often are inappropriate citations. For example, Boles *et al.* (1988), Marine (1992), and NMFS (1997b) all cite Hinze (1959) in support of recommendations for a water temperature of 56°F for adult Chinook salmon immigration. However, Hinze (1959) is a study examining the effects of water temperature on incubating Chinook salmon eggs in the American River Basin. Further, water temperatures between 38-56°F are considered to represent the "observed range" for upstream migrating spring-run Chinook salmon (Bell 1986).

The lowest water temperature index value established was 61°F, because in the NMFS biological opinion for the proposed operation of the Central Valley Project (CVP) and State Water Project (SWP), 59°F to 60°F is reported as…"*The upper limit of the optimal temperature range for adults holding while eggs are maturing*" (NMFS 2000). Also, NMFS (1997b) states…"*Generally, the maximum temperature of adults holding, while eggs are maturing, is about 59°F to 60°F*" …and… "*Acceptable range for adults migrating upstream range from 57°F to 67°F*." ODEQ (1995) reports that "…*many of the diseases that commonly affect Chinook become highly infectious and virulent above 60°F*." Study summaries in EPA (2003) indicate disease risk is high at 62.6°F. Additionally, Ward and Kier (1999) designated temperatures <60.8°F as an "optimum" water temperature threshold for holding Battle Creek spring-run Chinook salmon. EPA (2003) chose a holding value of 61°F (7DADM) based on laboratory data various assumptions regarding diel temperature fluctuations. 61°F is also a holding temperature index value for steelhead (see above). The 61°F water temperature index value established for the Chinook salmon adult immigration and holding life stage is the index value generally reported in the literature as the upper limit of the optimal range, and is within the reported acceptable range. Increasing levels of thermal stress to this life stage may reportedly occur above the 61°F water temperature index value.

An index value of 65°F was established because Berman (1990) suggests effects of thermal stress to pre-spawning adults are evident at water temperatures near 65°F. Berman (1990) conducted a laboratory study to determine if pre-spawning water temperatures experienced by adult Chinook salmon influenced reproductive success, and found evidence suggesting latent embryonic abnormalities associated with water temperature exposure to pre-spawning adults that ranged from 63.5°F to 66.2°F. Ward

et al. (2003; 2004) identified an extended period of average daily temperatures above 67°F during July as measured at the Quartz Bowl that preceded the onset of significant pre-spawn mortalities. During 2002, temperatures exceeded 67°F a total of 16 days with a maximum of 20.8°C on July 12. During 2003, temperatures exceed 67°F a total of 11 days with a maximum of 20.9°C on July 23. However during other years when there were minimal pre-spawn mortalities, maximum daily average water temperature at Quartz Bowl never exceeded 67°F more than an few days (Ward et al. 2004; Ward et al. 2006; Ward et al. 2007; McReynolds and Garman 2008; McReynolds and Garman 2010). During each of the years when Chinook salmon temperature mortality was not observed at Butte Creek (2001, 2004-2007), on average, daily temperature did not exceed 65.8°F for more than 7 days (Figure 6). Tracy McReynolds (Pers. Comm. October 2011) indicated that an upper tolerable holding temperature of 65°F was reasonable based on her experience.

An index value of 68°F was established because the Butte Creek data and the literature suggests that thermal stress at water temperatures greater than 68°F is pronounced, and severe adverse effects to immigrating and holding pre-spawning adults, including mortality, can be expected (Berman 1990; Marine 1997; NMFS 1997b; Ward et al. 2004).

Water temperatures between 70-77°F are reported as the range of maximum temperatures for holding pool conditions used by spring-run Chinook salmon in the Sacramento-San Joaquin system (Moyle et al. 1995). Migration blockage occurs for Chinook salmon at temperatures from 70-71+°F (McCollough 1999; McCullough et al. 2001; EPA 2003b). Strange (2010) found that the mean average body temperature during the first week of Chinook salmon migration on the Klamath River was 71.4°F. The UILT for Chinook salmon jacks is 69.8-71.6°F (McCullough 1999). The upper limit for spring-run Chinook salmon holding in Deer Creek is reportedly 80.6°F, at which point temperatures exceeding this value become "lethal" (Cramer and Hammack (1952), as cited in Moyle et al. (1995). As a result of the potential effects to immigrating and holding adult Chinook salmon that reportedly occur at water temperatures greater than or equal to 68°F, index values higher than 68°F were not established.

Spawning and Embryo Incubation

The adult spawning and embryo (i.e., eggs and alevins) incubation life stage includes redd construction, egg deposition, and embryo incubation. Potential effects to the adult spawning and embryo incubation life stages are evaluated together using one set of water temperature index values because it is difficult to separate the effects of water temperature between lifestages that are closely linked temporally, especially considering that studies describing how water temperature affects embryonic survival

and development have included a pre-spawning or spawning adult component in the reporting of water temperature experiments conducted on fertilized eggs (Marine 1992; McCullough 1999; Seymour 1956).

The water temperature index values selected for the Chinook salmon spawning and embryo incubation life stages are 56°F, 58°F, 60°F, and 62°F (**Table 7**). Anomalously, FERC (1993) refers to 50°F as the "optimum" water temperature for spawning and incubating Chinook salmon. Additionally, for the adult spawning lifestage, FERC (1993) reports "stressful" and "lethal" water temperatures occuring at >60°F and >70°F, respectively, whereas for incubating Chinook salmon embryos, water temperatures are considered to be "stressful" at <56°F or "lethal" at >60°F. Much literature suggests that water temperatures must be less than or equal to 56°F for maximum survival of Chinook salmon embryos (i.e., eggs and alevins) during spawning and incubation. NMFS (1993b) reported that optimum water temperatures for egg development are between 43°F and 56°F. Similarly, Myrick and Cech (2001) reported the highest egg survival rates occur between water temperatures of 39-54°F. Reclamation (unpublished work) reports that water temperatures less than 56°F results in a natural rate of mortality for fertilized Chinook salmon eggs. Bell (1986) recommends water temperatures ranging between 42-57°F for spawning Chinook salmon, and water temperatures between 41-58°F for incubating embryos. USFWS (1995a) reported a water temperature range of 41.0°F to 56.0°F for maximum survival of eggs and yolk-sac larvae in the Central Valley of California. The preferred water temperature range for Chinook salmon egg incubation in the Sacramento River was suggested as 42.0°F to 56.0°F (NMFS 1997a). Alevin mortality is reportedly significantly higher when Chinook salmon embryos are incubated at water temperatures above 56°F (USFWS 1999). NMFS (2002a) reported 56.0°F as the upper limit of suitable water temperatures for spring-run Chinook salmon spawning in the Sacramento River. The 56°F water temperature index value established for the Chinook salmon spawning and embryo incubation life stage is the index value generally reported in the literature as the upper limit of the optimal range for egg development and the upper limit of the range reported to provide maximum survival of eggs and yolk-sac larvae in the Central Valley of California. Increasing levels of thermal stress to this life stage may reportedly occur above the 56°F water temperature index value.

High survival of Chinook salmon embryos also has been suggested to occur at incubation temperatures at or near 58.0°F. For example, (Reclamation Unpublished Work) reported that the natural rate of mortality for alevins occurs at 58°F or less. Combs (1957) concluded constant incubation temperatures between 42.5°F and 57.5°F resulted in normal development of Chinook salmon eggs, and NMFS (2002a) suggests 53.0°F to 58.0°F is the preferred water temperature range for Chinook salmon eggs and fry.

Johnson (1953) found consistently higher Chinook salmon egg losses resulted at water temperatures above 60.0°F than at lower temperatures. In order to protect late incubating Chinook salmon embryos and newly emerged fry NMFS (1993a) has determined a water temperature criterion of less than or equal to 60.0°F be maintained in the Sacramento River from Keswick Dam to Bend Bridge from October 1 to October 31. Seymour (1956) provides evidence that 100% mortality occurs to late incubating Chinook salmon embryos when held at a constant water temperature greater than or equal to 60.0°F. For Chinook salmon eggs incubated at constant temperatures, mortality increases rapidly at temperatures greater than about 59-60°F (see data plots in Myrick and Cech 2001). Olsen and Foster (1957), however, found high survival of Chinook salmon eggs and fry (89.6%) when incubation temperatures started at 60.9°F and declined naturally for the Columbia River (about 7°F / month). Geist et al. (2006) found high (93.8%) Chinook salmon incubation survival through emergence for naturally declining temperatures (0.36°F/day) starting as high as 61.7°F; however, a significant reduction in survival occurred above this temperature.

The literature largely agrees that 100% mortality will result to Chinook salmon embryos incubated at water temperatures greater than or equal to 62.0°F (Hinze 1959; Myrick and Cech 2003; Seymour 1956; USFWS 1999). Approximately 80% or greater mortality of eggs incubated at constant temperatures of 63°F or greater (see data plots in Myrick and Cech 2001). Olsen and Foster (1957) found high mortality of Chinook salmon eggs and fry (79%) when incubation temperatures started at 65.2°F and declined naturally for the Columbia River (about 7°F / month). Geist et al. (2006) found low Chinook salmon incubation survival (1.7%) for naturally declining temperatures (0.36°F/day) when temperatures started at 62.6°F

Juvenile Rearing & Downstream Movement

Water temperature index values were identified for the combined spring-run Chinook salmon rearing (fry and juvenile) and juvenile downstream movement lifestages, for the reasons previously described regarding steelhead. Fry and juvenile rearing occur concurrently with post-emergent fry and juvenile downstream movement, and are assessed in this Technical Memorandum using the fry and juvenile rearing water temperature index values.

The water temperature index values of 60°F, 65°F, 68°F, 70°F and 75°F were identified for the spring-run Chinook salmon juvenile rearing and downstream movement lifestage. The lowest index value of 60°F was chosen because regulatory documents as well as several source studies, including ones recently conducted on Central Valley Chinook salmon fry and juveniles report 60°F as an optimal water temperature for growth (Banks *et al.* 1971; Brett *et al.* 1982; Marine 1997; NMFS 1997b; NMFS 2000;

NMFS 2001a; NMFS 2002a; Rich 1987b) (**Table 8**). Water temperatures below 60°F also have been reported as providing conditions optimal for fry and fingerling growth, but were not selected as index values, because the studies were conducted on fish from outside of the Central Valley (Brett 1952; Seymour 1956). Studies conducted using local fish may be particularly important because *Oncorhynchus* species show considerable variation in morphology, behavior, and physiology along latitudinal gradients (Myrick 1998; Taylor 1990b; Taylor 1990a). More specifically, it has been suggested that salmonid populations in the Central Valley prefer higher water temperatures than those from more northern latitudes (Myrick and Cech 2000).

The 60°F water temperature index value established for the Chinook salmon juvenile rearing and downstream movement life stage is the index value generally reported in the literature as the upper limit of the optimal range for fry and juvenile growth and the upper limit of the preferred range for growth and development of spring-run Chinook salmon fry and fingerlings. FERC (1993) referred to 58°F as an "optimum" water temperature for juvenile Chinook salmon in the American River. NMFS (2002a) identified 60°F as the "preferred" water temperature for juvenile spring-run Chinook salmon in the Central Valley. Increasing levels of thermal stress to this life stage may reportedly occur above the 60°F water temperature index value.

The index value of 65°F was selected because it represents an intermediate value between 64.0°F and 66.2°F, at which both adverse and beneficial effects to juvenile salmonids have been reported to occur. For example, at temperatures approaching and beyond 65°F, sub-lethal effects associated with increased incidence of disease reportedly become severe for juvenile Chinook salmon (EPA 2003a; Johnson and Brice 1953; Ordal and Pacha 1963; Rich 1987a). Conversely, numerous studies report that temperatures between 64.0°F and 66.2°F provide conditions ranging from suitable to optimal for juvenile Chinook salmon growth (Brett *et al.* 1982; Cech and Myrick 1999; Clarke and Shelbourn 1985; EPA 2003a; Myrick and Cech 2001; NMFS 2002a; USFWS 1995a). Maximum growth of juvenile fall-run Chinook salmon has been reported to occur in the American River at water temperatures between 56-59°F (Rich 1987) and in Nimbus Hatchery spring-run Chinook salmon at 66°F (Cech and Myrick 1999). Figure 5 shows growth for a 100 mm juvenile Chinook salmon versus temperature for three food levels (percent of maximum consumption = 30%, 50%, and 70%). The average percent of maximum consumption in an adjacent watershed (Middle Fork American Fork River) for O. *mykiss* was 50% (Hanson et al. 1997). Positive growth only occurs up to approximately 64°F for food levels expected in the wild (e.g., 50% maximum consumption).

A water temperature index value of 68°F was selected because, at water temperatures above 68°F, sub-lethal effects become severe such as reductions in appetite and growth

of juveniles (Marine 1997; Rich 1987a; Zedonis and Newcomb 1997). Chronic stress associated with water temperature can be expected when conditions reach the index value of 70°F. For example, growth becomes drastically reduced at temperatures close to 70.0°F and has been reported to be completely prohibited at 70.5°F (Brett *et al.* 1982; Marine 1997). 75°F was chosen as the highest water temperature index value because high levels of direct mortality to juvenile Chinook salmon reportedly result at this water temperature (Cech and Myrick 1999; Hanson 1991; Myrick and Cech 2001; Rich 1987b). Other studies have suggested higher upper lethal water temperature levels (Brett 1952; Orsi 1971), but 75°F was chosen because it was derived from experiments using Central Valley Chinook salmon and it is a more rigorous index value representing a more protective upper lethal water temperature level. Furthermore, the lethal level determined in Rich (1987b) was derived using slow rates of water temperature change and, thus, is ecologically relevant. The juvenile Chinook Salmon UILT based on numerous studies is 75-77°F (Sullivan et al. 2000; McCullough et al. 2001; Myrick and Cech 2001)

Yearling + Smolt Emigration

Juvenile Chinook salmon that exhibit extended rearing in the lower Yuba River are assumed to undergo the smoltification process and volitionally emigrate from the river as yearling+ individuals. Water temperature index values of 63°F, 68°F and 72°F were selected for the spring-run Chinook yearling+ emigration lifestage (**Table 9)**.

A water temperature index value of 63°F was selected because water temperatures at or below this value allow for successful transformation to the smolt stage, and water temperatures above this value may result in impaired smoltification indices, inhibition of smolt development, and decreased survival and successful smoltification of juvenile spring-run Chinook salmon. Laboratory experiments suggest that water temperatures at or below 62.6°F provide conditions that allow for successful transformation to the smolt stage (Clarke and Shelbourn 1985; Marine 1997; Zedonis and Newcomb 1997). 62.6°F was rounded and used to support an index value of 63°F. Indirect evidence from tagging studies suggests that the survival of fall-run Chinook salmon smolts decreases with increasing water temperatures between 59°F and 75°F in the Sacramento-San Joaquin Delta (Kjelson and Brandes 1989). A water temperature index value of 68°F was selected because water temperatures above 68°F prohibit successful smoltification (Marine 1997; Rich 1987a; Zedonis and Newcomb 1997). Support for an index value of 72°F is provided from a study conducted by (Baker *et al.* 1995) in which a statistical model is presented that treats survival of Chinook salmon smolts fitted with coded wire tags in the Sacramento River as a logistic function of water temperature. Using data obtained from mark-recapture surveys, the statistical model suggests a 95% confidence

interval for the upper incipient lethal water temperature for Chinook salmon smolts as 71.5°F to 75.4°F.

From: Staples, Rose
Sent: Tuesday, October 18, 2016 3:35 PM
Cc: Deason, Jesse; Le, Bao; Staples, Rose
Subject: FW: AGENDA for LG Reintro Goals Subcommittee Conf Call Oct 20 2016

La Grange Licensing Participants,

The following message was forwarded to the members of the La Grange Reintroduction Goals Subcommittee earlier today regarding the AGENDA for Thursday afternoon's conference call.

Rose Staples, CAP-OM, MOS
D 207-239-3857

hdrinc.com/follow-us

From: Staples, Rose
Sent: Tuesday, October 18, 2016 2:43 PM
Cc: Deason, Jesse <jesse.deason@hdrinc.com>; 'Le, Bao' <Bao.Le@hdrinc.com>; Staples, Rose (Rose.Staples@hdrinc.com) <Rose.Staples@hdrinc.com>
Subject: AGENDA for LG Reintro Goals Subcommittee Conf Call Oct 20 2016

Reintroduction Goals Subcommittee,

Please find below the agenda for this Thursday's conference call (October 20th from 1:00-3:00 pm) to discuss the draft reintroduction goals statement developed by the Districts. The agenda can also be found at on the licensing website (www.lagrange-licensing.com) as an attachment to the date on the website CALENDAR.

La Grange Hydroelectric Project
Reintroduction Assessment Framework
Reintroduction Goals Subcommittee Conference Call

Thursday, October 20, 2016, 1:00 pm to 3:00 pm
Conference Line: 1-866-583-7984; Passcode: 8140607

Meeting Objectives:

1. Review and confirm the purpose of the Reintroduction Goals Subcommittee.
2. Review and discuss preliminary draft reintroduction goals statement.
3. Identify next steps on Reintroduction Goals Subcommittee.

TIME	TOPIC
1:00 pm – 1:15 pm	Introduction of Participants (All) Review Agenda and Meeting Objectives (Districts)

1:15 pm – 1:45 pm	Reintroduction Assessment Framework – Development of Program Goals. Why Is It Important? What Purpose Does it Serve? Potential sources to further inform goal development (All) a. Planning Pacific Salmon and Steelhead Reintroductions Aimed at Long-Term Viability and Recovery, Andersen et al. b. NMFS Recovery Plan c. Others?
1:45 pm – 2:45 pm	Tuolumne River Reintroduction Goals – preliminary draft narrative statement (All) – "*Identify and evaluate, in collaboration with stakeholders, reasonable efforts which may enhance and assist in the recovery of ESA listed salmonids in the Central Valley*." a. Brief background on draft narrative statement b. Discuss feedback/refinement from subcommittee members c. Need for quantitative metrics?
2:45 pm – 3:00 pm	Next Steps toward (All) a. Schedule next call and agenda topics Action items from this call

Thank you.

Rose Staples, CAP-OM, MOS
Executive Assistant

HDR
970 Baxter Boulevard Suite 301
Portland ME 04103
D 207-239-3857
rose.staples@hdrinc.com

hdrinc.com/follow-us

From:	Staples, Rose
Sent:	Tuesday, October 18, 2016 11:43 AM
Cc:	Deason, Jesse; Le, Bao; Staples, Rose
Subject:	AGENDA for LG Reintro Goals Subcommittee Conf Call Oct 20 2016

Reintroduction Goals Subcommittee,

Please find below the agenda for this Thursday's conference call (October 20th from 1:00-3:00 pm) to discuss the draft reintroduction goals statement developed by the Districts. The agenda can also be found at on the licensing website (www.lagrange-licensing.com) as an attachment to the date on the website CALENDAR.

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Thank you.

Rose Staples, CAP-OM, MOS
Executive Assistant

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970 Baxter Boulevard Suite 301
Portland ME 04103
D 207-239-3857
rose.staples@hdrinc.com

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From: Vaughn, Gary D -FS <gdvaughn@fs.fed.us>
Sent: Tuesday, October 18, 2016 1:05 PM
To: Le, Bao; Foote, Debra -FS
Cc: Garello, Michael; Deason, Jesse
Subject: RE: Lumsden Falls field survey

Thanks. Sorry for the delay for the studies, but we're excited to have the rain!

Dusty Vaughn
Public Service Program Leader
Forest Service
Stanislaus National Forest, Groveland Ranger District
p: 209-962-7825 x525
f: 209-962-7412
gdvaughn@fs.fed.us
24545 State Highway 120
Groveland, CA 95321
www.fs.fed.us

Caring for the land and serving people

From: Le, Bao [mailto:ChiBao.Le@hdrinc.com]
Sent: Tuesday, October 18, 2016 1:04 PM
To: Vaughn, Gary D -FS <gdvaughn@fs.fed.us>; Foote, Debra -FS <dfoote@fs.fed.us>
Cc: Garello, Michael <Mike.Garello@hdrinc.com>; Deason, Jesse <Jesse.Deason@hdrinc.com>
Subject: RE: Lumsden Falls field survey

Thanks, Dusty.

I just got word from study lead and field crew that flows over the next few days won't support the needed ground-based surveys (no drone/UAS) so we're going to delay these to a later date but are still hoping to accomplish them prior to the end of the year. We'll keep you updated.

Bao

From: Vaughn, Gary D -FS [mailto:gdvaughn@fs.fed.us]
Sent: Tuesday, October 18, 2016 11:35 AM
To: Le, Bao; Foote, Debra -FS
Cc: Garello, Michael; Deason, Jesse
Subject: RE: Lumsden Falls field survey

Bao – you are cleared to complete the Lumsden Falls survey this weekend. Unfortunately, we are still not in a position to approve the use of the UAS/drone.

Thanks,

Dusty Vaughn
Public Service Program Leader
Forest Service
Stanislaus National Forest, Groveland Ranger District

p: 209-962-7825 x525
f: 209-962-7412
gdvaughn@fs.fed.us
24545 State Highway 120
Groveland, CA 95321
www.fs.fed.us

Caring for the land and serving people

From: Le, Bao [mailto:ChiBao.Le@hdrinc.com]
Sent: Tuesday, October 18, 2016 11:27 AM
To: Foote, Debra -FS <dfoote@fs.fed.us>
Cc: Vaughn, Gary D -FS <gdvaughn@fs.fed.us>; Garello, Michael <Mike.Garello@hdrinc.com>; Deason, Jesse <Jesse.Deason@hdrinc.com>
Subject: Lumsden Falls field survey

Hi Debbie.

Sorry to bother but I just wanted to check in on the status of an amendment to the Barriers Study permit. Flows have shot up due to rains, etc. and we're currently working with CCSF to try and better understand what the next few days will look like but we've not ruled out field work at the falls this week. Please let me know how things are going. Happy to hop on the phone or support in any way to ensure we can get the needed approval.

Thanks!
Bao

Bao Le
Senior Fisheries Biologist

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Portland, OR 97204-1134
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bao.le@hdrinc.com

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From: "Clifford, Mark@Wildlife" <Mark.Clifford@wildlife.ca.gov>
Subject: Re: Request for hatchery fish- Don Pedro Reservoir Transit Study
Date: October 20, 2016 at 3:32:20 PM PDT
To: "guignard, jason@fishbio.com" <jasonguignard@fishbio.com>

Hi Jason

I'm afraid we will not be triploiding any chinook this year due to extremely low returns in the Klamath. We will have none for our inland program or for research as a result. If you'd like to discuss, let's talk next week.

Sorry Jason. Best,

Mark Clifford, Ph.D.
Statewide Hatchery Coordinator
California Department of Fish and Wildlife

On Oct 20, 2016, at 4:24 PM, Jason Guignard <jasonguignard@fishbio.com> wrote:

> Hi Mark,
>
> I wanted to check-in with you regarding current fish numbers at Iron Gate, and potential for us to receive our requested study fish.
> We have been seeing good numbers of Chinook in the San Joaquin Basin the last few weeks, so hopefully the same is true up North.
>
> Thanks,
>
> Jason Guignard
> Fisheries Biologist
>
> ***FISHBIO***
> jasonguignard@fishbio.com
> O: (209) 847-6300
> C: (209) 840-9019
> www.fishbio.com
>
>> On Sep 29, 2016, at 11:32 AM, Clifford, Mark@Wildlife <Mark.Clifford@wildlife.ca.gov> wrote:
>>
>> Hi Jason,

As we discussed this morning, your fish request was approved but fish in the study must be triploid Chinook. Don Pedro has a triploid Chinook allotment and it is our intention to triploid Chinook for this and other inland fisheries, if Iron Gate Hatchery receives enough adult returns to meet mitigation requirements. As of now the run looks insufficient and we may not proceed with Chinook triploidy or supplying that inland fishery this year. The Hatchery Manager will give us an update the week of October 10th and I will relay information to you.

Iron Gate (Klamath River) Hatchery is our only site and source for the triploid Chinook program due to complete absence of Infectious Hematopoietic Necrosis Virus (IHN) going back several decades. Also, the mitigator (owner) is supportive of these activities while other mitigators- not so much. We are considering other locations for triploiding excess Chinook eggs, but nothing could be implemented this year.

Response letter attached.

Best regards,

Mark Clifford, Ph.D.
Statewide Hatchery Coordinator
Senior Environmental Scientist (Specialist)
Office: 530-918-9450
Cell: 916-764-2526
<image001.png>

<image002.jpg>
SaveOurWater.com · Drought.CA.gov

From: Jason Guignard [mailto:jasonguignard@fishbio.com]
Sent: Wednesday, July 27, 2016 8:18 AM
To: Clifford, Mark@Wildlife
Cc: Bao Le; Andrea Fuller
Subject: Re: Request for hatchery fish- Don Pedro Reservoir Transit Study

Hi Mark,

Here is a revised hatchery allocation request for Don Pedro Reservoir Transit Study.
We are working on federal permitting for spring-run, but as a contingent would like to request 1,500 fall-run should permits not be issued in time.

I will be working in the field for the remainder of this week with no email access, so any further questions prior to the Aug. 1 deadline should go to Andrea Fuller (included on this message).

Thank You,

Jason Guignard
Fisheries Biologist

FISHBIO
jasonguignard@fishbio.com

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C: (209) 840-9019
www.fishbio.com

<Jason Guignard FishBio Don Pedro Transit 3N IGH CHIN .pdf>

From: Le, Bao
Sent: Thursday, October 20, 2016 2:19 PM
To: John Wooster - NOAA Federal
Cc: Deason, Jesse
Subject: Bratovich et al 2012
Attachments: Bratovich et al_2012_Water Temp Considerations for Yuba.pdf

Here you go, John.

Thanks for participating today.

Bao

Bao Le
Senior Fisheries Biologist

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Water Temperature Considerations for Yuba River Basin Anadromous Salmonid Reintroduction Evaluations

Prepared for:

Yuba Salmon Forum Technical Working Group

Prepared by:

Paul Bratovich (HDR Engineering, Inc.)
Craig Addley (Cardno ENTRIX)
Dianne Simodynes (HDR Engineering, Inc.)
Heather Bowen (HDR Engineering, Inc.)

October 2012

Table of Contents

List of Appendices

1 INTRODUCTION

The Yuba Salmon Forum (YSF) is a multi-stakeholder group addressing the opportunities for reintroducing anadromous salmonids (i.e., spring-run Chinook salmon and steelhead) in the Upper Yuba River Basin upstream of Englebright Dam.

The YSF stakeholder group is comprised of representatives from National Marine Fisheries Service (NMFS), U.S. Forest Service (USFS), California Department of Fish and Game (CDFG), the Yuba County Water Agency (YCWA), Placer County Water Agency (PCWA) and a group of the non-governmental organizations (NGOs) including Trout Unlimited, American Rivers, The Bay Institute, Sierra Club, California Sport Fishing Protection Alliance, and South Yuba River Citizens League. The YSF is comprised of a Plenary Group and a Technical Working Group (TWG). The purpose of the TWG is to address technical issues associated with anadromous salmonid reintroduction. One of the technical issues addressed by the TWG includes water temperature considerations for the reintroduction of anadromous salmonids into the Upper Yuba River Basin.

2 TECHNICAL MEMORANDUM PURPOSE AND OBJECTIVES

The overall purpose of this Technical Memorandum is to establish the technical basis to evaluate water temperature regimes for spring-run Chinook salmon and steelhead reintroduction in the various rivers and reaches of the Upper Yuba River Basin (North Yuba River upstream of New Bullards Bar Reservoir, North Yuba River downstream of New Bullards Bar Dam to the high water mark of Englebright Reservoir, Middle Yuba River, and South Yuba River) **(Figure 1)**.

Specific objectives are to: (1) conduct a comprehensive literature review of lifestage-specific water temperature relationships; (2) identify a suite of water temperature index (WTI) values representing a summarization of the literature review; (3) select water temperature criteria for each species-specific lifestage for reintroduction evaluation; and (4) identify the water temperature evaluation methodological approach (water temperature metrics and metric application to water temperature monitoring and/or modeling data).

NMFS commented (NOAA Memorandum dated January 18, 2012) on the November 2011 version of this technical memorandum, stating that it should demonstrate the need for new criteria in consideration of criteria previously developed by Stillwater Sciences (2006). In summary, this technical memorandum differs from Stillwater Sciences (2006) in some lifestage periodicities (e.g., spring-run Chinook salmon spawning (Sep – mid Nov vs. Sep – Oct), and embryo incubation (Sep – Feb vs. late Sep – Jan). Notably,

Stillwater Sciences (2006) assumed that juvenile spring-run Chinook salmon in the Upper Yuba River Basin "*…would not typically over-summer due to excessively high summer water temperatures*." By contrast, this technical memorandum assumes that juvenile rearing in the Upper Yuba River Basin could occur year-round. In addition, this technical memorandum identifies spring-run Chinook salmon smolt emigration potentially occurring from November through mid-May, whereas Stillwater Sciences (2006) did not identify spring-run Chinook salmon smolt emigration as a lifestage to be addressed. Similarly, Stillwater Sciences (2006) did not identify smolt emigration as a steelhead lifestage to be addressed. In addition to lifestage periodicities, this technical memorandum identifies upper optimum and upper tolerance water temperature index values to be used in the evaluation of water temperature suitability for reintroduction of spring-run Chinook salmon and steelhead into the Upper Yuba River Basin, whereas Stillwater Sciences (2006) identified optimal, suboptimal, and chronic-to-acute stress water temperature index values. These categories are not directly comparable, and the actual values also differ between the two reports.

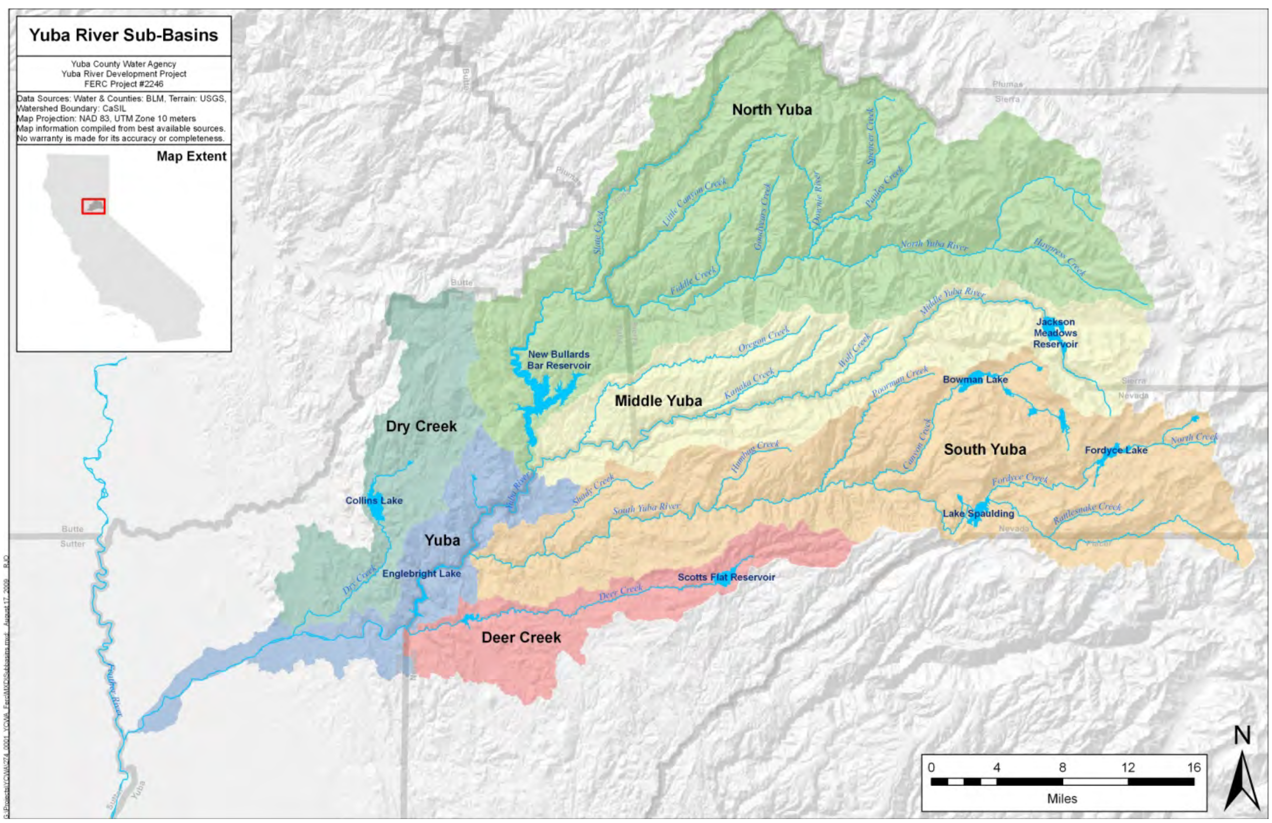


Figure 1. Sub-basins of the Yuba River Basin (source: Yuba County Water Agency 2010).

3 LIFESTAGE PERIODICITIES OF ANADROMOUS SALMONIDS

Lifestage-specific water temperature considerations for spring-run Chinook salmon and steelhead were addressed by the TWG in the evaluation of anadromous reintroduction in the Upper Yuba River Basin. A review of previously conducted studies, as well as recent and currently ongoing data collection activities by the Yuba Accord Monitoring and Evaluation Program (M&E Program) in the lower Yuba River was conducted to identify species- and lifestage-specific temporal periodicities for water temperature considerations. The TWG agreed on the spring-run Chinook salmon and steelhead lifestage periodicities presented in **Table 1** for reintroduction consideration in the Upper Yuba River Basin during a meeting held May 20, 2011. However, it was noted that these periodicities reflect existing conditions in the lower Yuba River, and that lifestage periodicities may change in response to local adaptation over time. It was further noted that although some lifestages may occur concurrently, the periodicities presented in Table 1 reflect specific consideration for water temperature evaluation for reintroduction. For example, spring-run Chinook salmon holding continues to occur during September, even though spawning activity begins during that month.

Table 1. Lifestage-Specific Periodicities for Spring-run Chinook Salmon and Steelhead in the Lower Yuba River.

Lifestage	Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Sep		Oct		Nov		Dec	
Spring-Run Chinook Salmon																								
Adult Immig. & Holding							■	■	■	■	■	■	■	■	■	■								
Spawning																	■	■	■	■	■			
Embryo Incubation	■	■	■	■													■	■	■	■	■	■	■	■
Juv. Rearing & Outmig.	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Yearling+ Smolt Emig.	■	■	■	■	■	■	■	■	■												■	■	■	■
Steelhead																								
Adult Immig. & Holding	■	■	■	■	■	■									■	■	■	■	■	■	■	■	■	■
Spawning	■	■	■	■	■	■	■	■																
Embryo Incubation	■	■	■	■	■	■	■	■	■	■														
Juv. Rearing & Outmig.	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Yearling+ Smolt Emig.	■	■	■	■	■	■	■												■	■	■	■	■	■

4 LITERATURE REVIEW OF WATER TEMPERATURE RELATIONSHIPS FOR STEELHEAD AND CHINOOK SALMON

A comprehensive review and compilation of available literature was conducted to identify the range of acceptable water temperatures for reintroduction evaluation of Chinook salmon and steelhead, by lifestage, in the Upper Yuba River Basin. The thermal requirements of Chinook salmon and steelhead have been extensively studied in California and elsewhere. The literature review informed the selection of a range of WTI values to be used in the TWG's evaluation of the water temperature-related

reintroduction potential in the Upper Yuba River Basin. The information presented herein is largely based on information provided in Appendix E2 to the Public Draft EIR/EIS for the Yuba Accord (YCWA *et al.* 2007), Appendix B (Stillwater Sciences 2006) to the Upper Yuba River Studies Program (UYRSP) Technical Report (DWR 2007), and the Yuba Accord River Management Team Water Temperature Objectives Technical Memorandum (RMT 2010).

WTI values were identified from laboratory experiments and field studies that examined how water temperature affects Central Valley Chinook salmon and steelhead. WTI values were also identified from regulatory documents such as biological opinions from NMFS. Results of the literature review are presented in **Appendix A**. Specific temperature index values were then selected by the TWG to evaluate temperature-related reintroduction potential in the Upper Yuba River Basin.

Studies on fish from outside the Central Valley were used to establish WTI values when local studies were unavailable. To avoid unwarranted specificity, only whole integers were selected as WTI values. In some cases, whole integer WTI values were partially derived from literature results that varied from the index value by several tenths of a degree. For example, Combs and Burrows (1957) reported that constant incubation temperatures up to 57.5°F resulted in normal development of Chinook salmon eggs, and their report was referenced as support for a rounded[1] WTI value of 58°F.

The WTI values presented herein represent a gradation of potential biological effects from optimal to lethal water temperatures for each lifestage. Literature on salmonid water temperature requirements generally reports water temperature thresholds using various descriptive terms including "optimal", "preferred", "suitable", "suboptimal", "tolerable", "stressful – chronic and acute", "sublethal", "incipient lethal", and "lethal". Water temperature effects on salmonids are often discussed in terms of "lethal" and "sublethal" effects, and depend on the both the magnitude and the duration of exposure (Sullivan *et al.* 2000), as well as acclimation water temperature. Exposure to adverse water temperatures can result in adverse effects on the biological functions, feeding activity, lifestage timing, growth, reproduction, competitive interactions, susceptibility to disease, growth and development and ultimately probability of survival (McCullough 1999).

[1] Rounding for the purposes of selecting index values is appropriate because the daily variation of experimental treatment temperatures is often high. For example, temperature treatments in Marine (1997) consisted of control (55.4°F to 60.8°F), intermediate (62.6°F to 68.0°F) and extreme (69.8°F to 75.2°F) treatments that varied daily by several degrees.

There are inherent limitations associated with the development and application of WTI values. Some of the limitations are summarized by McEwan (2001). Namely, that WTI values serve as general guidelines, originally developed by researchers on specific streams or under laboratory conditions. Also, research under controlled laboratory conditions does not take into account ecological considerations associated with water temperature regimes, such as predation risk, inter- and intra-specific competition, long-term survival and local adaptation.

5 LIFESTAGE-SPECIFIC WATER TEMPERATURE INDEX VALUES

Lifestage-specific WTI summary tables derived from the literature review are provided for steelhead and Chinook salmon: (1) adult immigration and holding; (2) spawning and embryo incubation; (3) juvenile rearing and downstream movement; and (4) yearling + smolt emigration in **Tables 2 - 9** (see below). A written discussion of the literature used to create the summary tables is provided in Appendix A. A short discussion of acute versus chronic temperature tolerance also is provided.

5.1 Steelhead and Chinook Salmon Acute Versus Chronic Temperature Tolerance (Juveniles and Adults)

Lifestage-specific WTI values (Sections 5.2 and 5.3 below) were based on long-term (≥ 7 days) chronic temperature exposure rather than acute temperature exposure (< 7 days). The boundary between the upper end of the chronic exposure range and the lower end of the acute exposure range is typically measured as the upper incipient lethal temperature (UILT) where 50% mortality occurs after 7 days (Elliott 1981)[2].

The UILT for both juvenile steelhead and Chinook salmon is very similar and is between 75-79°F (24-26°C) depending on the study (McCullough 1999; Sullivan et al. 2000; McCullough et al. 2001). The UILT for adult steelhead and Chinook salmon is 70-72°F (21-22°C) (Coutant 1970; Becker 1973; McCullough et al. 2001), which is much lower than that for juveniles and is approximately the same temperature that has been identified as an upstream migration barrier for Chinook salmon (McCullough 1999).

Acute temperature response (< 7 days) is strongly dependent on duration of exposure. **Figure 2** shows some example acute exposure relationships for juvenile salmonids. The hourly (60 minute) acute temperature is 5.4 – 9.0°F (3-5°C) higher than the 7-day (10,000 minute) chronic temperature. Because the acute temperature for juvenile salmonids, approximately 82.4°F (28.4°C) is relatively high, it rarely becomes a factor affecting

[2] Note that some authors have measured the UILT using shorter duration exposure than 7 days (e.g., 1,000 mins or 24 hrs). UILT values based on a shorter duration exposure than 7 days will be higher than the UILT values based on a 7 day exposure.

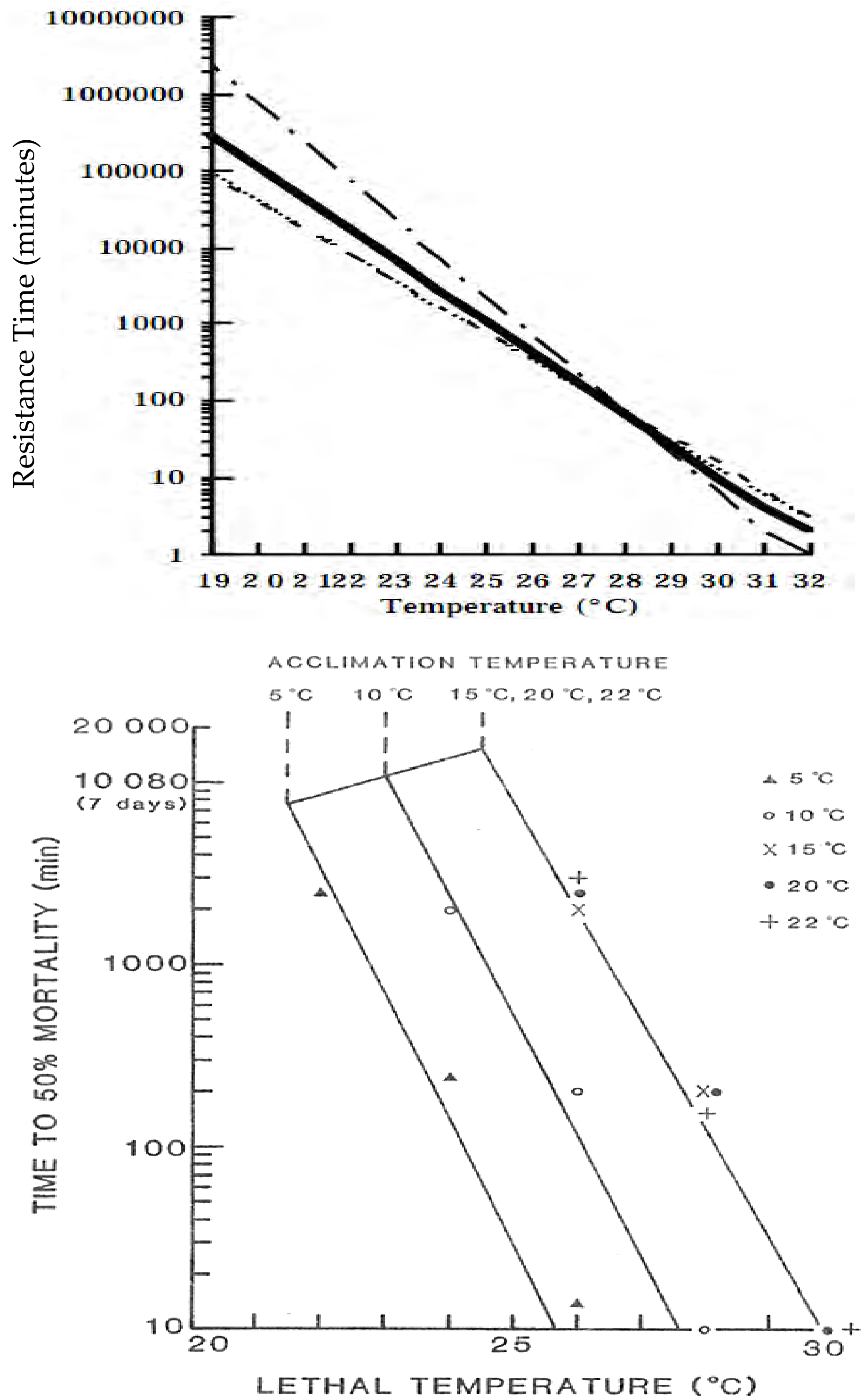


Figure 2. Relationship Between the Time (Minutes) to Mortality and the Lethal Temperature for Rainbow Trout (Top) (Bidgood 1969) and Brown Trout (Bottom) (Elliott 1981). Note the Effect of Acclimation Temperature in the Bottom Figure.

survival in natural streams (Sullivan et al. 2000). However, the acute temperature for adult salmonids is lower – it could become a survival factor particularly for adult spring-run Chinook salmon holding through the summer.

The temperature range between the UILT (7 days) and very short duration mortality (minutes) (e.g., critical thermal maximum) is called the zone of resistance. Below the UILT is a zone of tolerance where fish can tolerate the temperature for an extended period of time (> 7 days). At the higher temperatures in the tolerance zone fish may not feed, grow, or reproduce and they may have modified behavior (e.g., holding in temperature refugia locations). An important point to note is that the effects of water temperature are associated with duration of exposure and, depending upon the actual water temperature value, short duration exposure to relatively high temperatures may not result in sustained adverse effects if temperatures quickly decrease to non-impactive levels.

At lower temperatures in the tolerance zone, denoted "tolerable" in this report, growth and/or reproduction occur, but are reduced from optimal due to temperature effects. The zone of temperature where fish processes (growth, reproduction, behavior) are not affected appreciably by temperature is denoted as the "optimum" temperature range in this report (**Figure 3**).

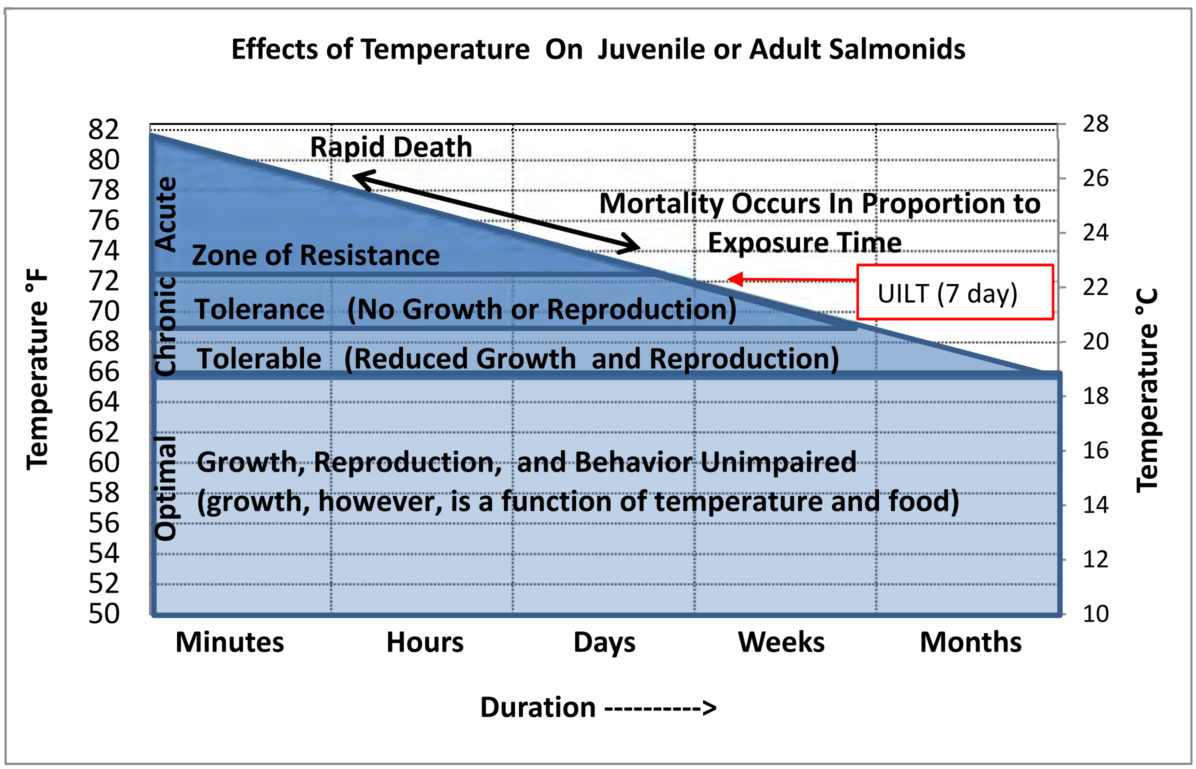


Figure 3. Illustration of Acute, Chronic, and Optimum Temperature Zones.

5.2 Steelhead Lifestage-specific Water Temperature Index Values

5.2.1 Adult Immigration and Holding

Table 2. Steelhead Adult Immigration and Holding Water Temperature Index Values and the Literature Supporting Each Value.

Index Value	Supporting Literature
52°F	Preferred range for adult steelhead immigration of 46.0°F to 52.0°F (NMFS 2000; NMFS 2001a; SWRCB 2003). Optimum range for adult steelhead immigration of 46.0°F to 52.1°F (Reclamation 1997a). Recommended adult steelhead immigration temperature range of 46.0°F to 52.0°F (Reclamation 2003).
56°F	To produce rainbow trout eggs of good quality, brood fish must be held at water temperatures not exceeding 56.0°F (Leitritz and Lewis 1980). Rainbow trout brood fish must be held at water temperatures not exceeding 56°F for a period of 2 to 6 months before spawning to produce eggs of good quality (Bruin and Waldsdorf 1975). Holding migratory fish at constant water temperatures above 55.4°F to 60.1°F may impede spawning success (McCullough *et al.* 2001).
61°F	Water temperatures greater than 61°F may result in "chronic high stress" of holding Central Valley winter-run steelhead (USFWS 1995a). Preferred range of water temperature for holding Caliifornia summer steelhead occurs between 50-59°F (Moyle 1995).
64°F	Steelhead (and fall-run Chinook salmon) encounter potentially stressful temperatures between 64.4-73.4°F (Richter and Kolmes 2005). Over 93% of steelhead detections occurred in the 65.3-71.6°F, although this may be above the temperature for optimal immigration (Salinger and Anderson 2006).
70°F	Migration barriers have frequently been reported for pacific salmonids when water temperatures reach 69.8°F to 71.6°F (McCullough *et al.* 2001). Snake River adult steelhead immigration was blocked when water temperatures reached 69.8 (McCullough *et al.* 2001). A water temperature of 68°F was found to drop egg fertility in vivo to 5 percent after 4.5 days (McCullough *et al.* 2001). The UILT for adult steelhead was determined to be 69.8°F (Coutant 1972).

5.2.2 Spawning and Embryo Incubation

Table 3. Steelhead Spawning and Embryo Incubation Water Temperature Index Values and the Literature Supporting Each Value.

Index Value	Supporting Literature
46°F	Orcutt et al. (1968) reported that steelhead spawning in late spring in the Clearwater and Salmon Rivers, Idaho, occurred at temperatures between 35.6 and 46.4°F.
52°F	Rainbow trout from Mattighofen (Austria) had highest egg survival at 52.0°F compared to 45.0°F, 59.4°F, and 66.0°F (Humpesch 1985). Water temperatures from 48.0°F to 52.0°F are suitable for steelhead incubation and emergence in the American River and Clear Creek (NMFS 2000; NMFS 2001a; NMFS 2002a). Optimum water temperature range of 46.0°F to 52.0°F for steelhead spawning in the Central Valley (USFWS 1995b). Optimum water temperature range of 46.0°F to 52.1°F for steelhead spawning and 48.0°F to 52.1°F for steelhead egg incubation (Reclamation 1997a). Upper limit of preferred water temperature of 52.0°F for steelhead spawning and egg incubation (SWRCB 2003).
54°F	Big Qualicum River steelhead eggs had 96.6 percent survival to hatch at 53.6°F (Rombough 1988). Highest survival from fertilization to hatch for *Salmo gairdneri* incubated at 53.6°F (Kamler and Kato 1983). Emergent fry were larger when North Santiam River (Oregon) winter steelhead eggs were incubated at 53.6°F than at 60.8°F (Redding and Schreck 1979). The upper optimal water temperature regime based on constant or acclimation water temperatures necessary to achieve full protection of steelhead is 51.8°F to 53.6°F (EPA 2001). From fertilization to hatch, rainbow trout eggs and larvae had 47.3 percent mortality (Timoshina 1972). Survival of rainbow trout eggs declined at water temperatures between 52.0 and 59.4°F (Humpesch 1985). The optimal constant incubation water temperature for steelhead occurs below 53.6°F (McCullough *et al.* 2001).

Index Value	Supporting Literature
57°F	From fertilization to 50 percent hatch, Big Qualicum River steelhead had 93 percent mortality at 60.8°F, 7.7 percent mortality at 57.2°F, and 1 percent mortality at 47.3°F and 39.2°F (Velsen 1987). A sharp decrease in survival was observed for rainbow trout embryos incubated above 57.2°F (Kamler and Kato 1983).
60°F	Water temperatures >59°F are described as "lethal" to incubating steelhead embryos (Myrick and Cech 2001), From fertilization to 50 percent hatch, Big Qualicum River steelhead had 93 percent mortality at 60.8°F, 7.7 percent mortality at 57.2°F, and 1 percent mortality at 47.3°F and 39.2°F (Velsen 1987). From fertilization to 50 percent hatch, rainbow trout eggs from Ontario Provincial Normendale Hatchery had 56 percent survival when incubated at 59.0°F (Kwain 1975).

5.2.3 Juvenile Rearing and Downstream Movement

Table 4. Steelhead Juvenile Rearing and Downstream Movement Water Temperature Index Values and the Literature Supporting Each Value.

Index Value	Supporting Literature
63°F	Preferred water temperature for wild juvenile steelhead is reportedly 63°F, whereas preferred water temperatures for juvenile hatchery steelhead reportedly range between 64-66°F. Myrick and Cech (2001)
65°F	Upper limit of 65°F preferred for growth and development of Sacramento River and American River juvenile steelhead (NMFS 2002a). Nimbus juvenile steelhead growth showed an increasing trend with water temperature to 66.2°F, irrespective of ration level or rearing temperature (Cech and Myrick 1999). The final preferred water temperature for rainbow fingerlings was between 66.2 and 68°F (Cherry *et al.* 1977). Nimbus juvenile steelhead preferred water temperatures between 62.6°F and 68.0°F (Cech and Myrick 1999). Rainbow trout fingerlings preferred or selected water temperatures in the 62.6°F to 68.0°F range (McCauley and Pond 1971).
68°F	Nimbus juvenile steelhead preferred water temperatures between 62.6°F and 68.0°F (Cech and Myrick 1999). The final preferred water temperature for rainbow trout fingerlings was between 66.2°F and 68°F (Cherry *et al.* 1977). Rainbow trout fingerlings preferred or selected water temperatures in the 62.6°F to 68.0°F range (McCauley and Pond 1971). The upper avoidance water temperature for juvenile rainbow trout was measured at 68°F to 71.6°F (Kaya et al. 1977). FERC (1993) referred to 68°F as "stressful" to juvenile steelhead. Empirical fish population and water temperature data in the North Yuba, Middle Yuba, South Yuba, Middle Fork American, and Rubicon Rivers (**Figure 4**) indicate a sharp reduction in O. *mykiss* population densities when temperatures exceed 68°F for greater than one week. Bioenergetics modeling of growth based on consumption (P value = 0.5) in the Middle Fork American River watershed (adjacent watershed) indicates that growth likely does not occur above 68°F (**Figure 5**).
72°F	Increased physiological stress, increased agonistic activity, and a decrease in forage activity in juvenile steelhead occur after ambient stream temperatures exceed 71.6°F (Nielsen *et al.* 1994). The upper avoidance water temperature for juvenile rainbow trout was measured at 68°F to 71.6°F (Kaya *et al.* 1977). Estimates of upper thermal tolerance or avoidance limits for juvenile rainbow trout (at maximum ration) ranged from 71.6°F to 79.9°F (Ebersole *et al.* 2001).
75°F	The maximum weekly average water temperature for survival of juvenile and adult rainbow trout is 75.2°F (EPA 2002). Rearing steelhead juveniles have an upper lethal limit of 75.0°F (NMFS 2001a). Estimates of upper thermal tolerance or avoidance limits for juvenile rainbow trout (at maximum ration) ranged from 71.6 to 79.9°F (Ebersole *et al.* 2001). The UILT for juvenile rainbow trout, based on numerous studies, is between 75-79°F (Sullivan et al. 2000; McCullough 2001).

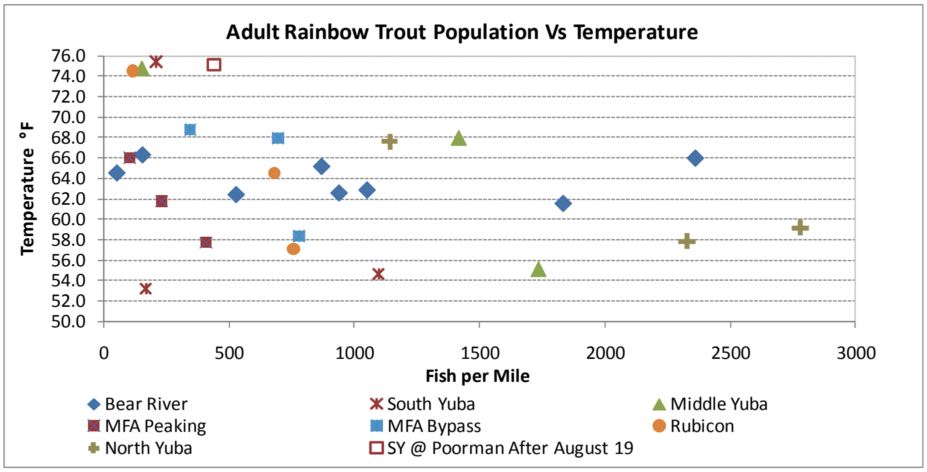
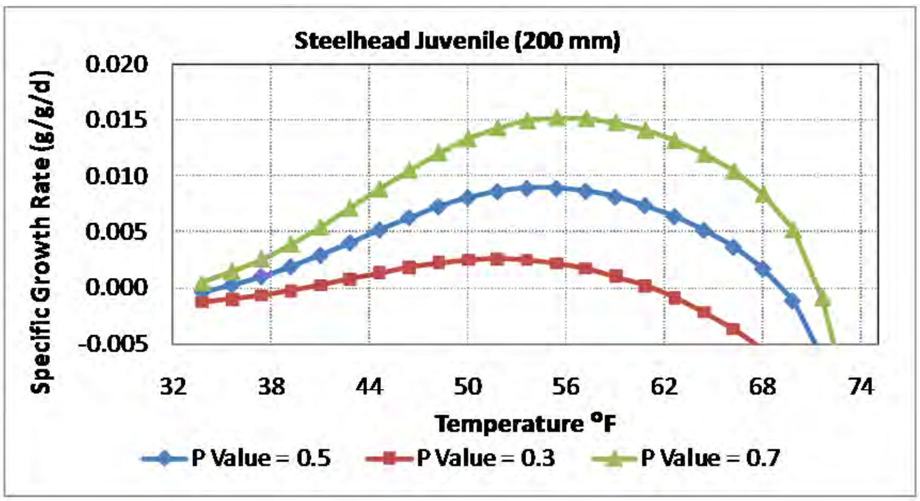


Figure 4. Empirical Adult Fish Population Data in the Middle Fork American and Yuba River Rivers Compared to the Maximum Temperature Exceeded Less Than 7 Days.



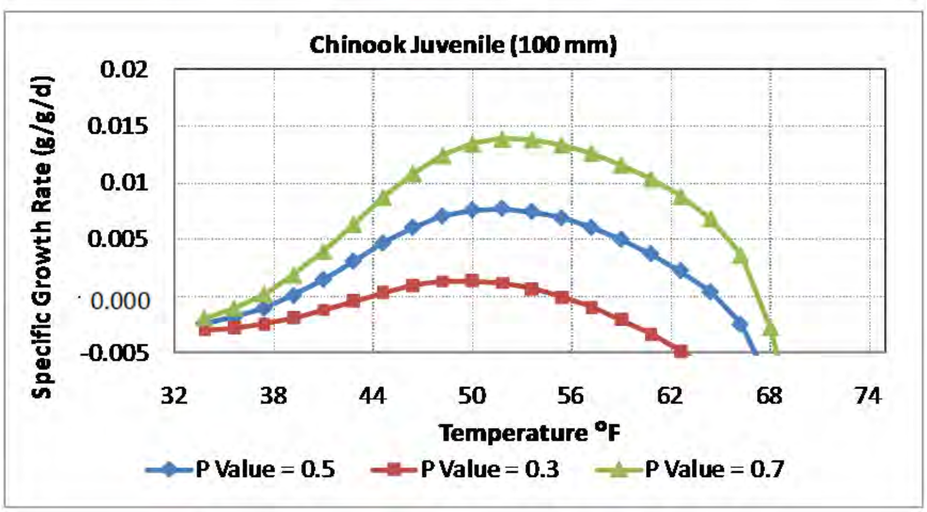


Figure 5. Bioenergetics Growth Rate Modeling For Steelhead and Chinook Salmon Juveniles Over a Range of Temperatures.

5.2.4 Yearling + Smolt Emigration

Table 5. Steelhead Smolt Emigration Water Temperature Index Values and the Literature Supporting Each Value.

Index Value	Supporting Literature
52°F	Steelhead successfully smolt at water temperatures in the 43.7°F to 52.3°F range (Myrick and Cech 2001). Steelhead undergo the smolt transformation when reared in water temperatures below 52.3°F, but not at higher water temperatures (Adams *et al.* 1975). Optimum water temperature range for successful smoltification in young steelhead is 44.0°F to 52.3°F (Rich 1987a).
55°F	ATPase activity was decreased and migration reduced for steelhead at water temperatures greater than or equal to 55.4°F (Zaugg and Wagner 1973). Water temperatures should be below 55.4°F at least 60 days prior to release of hatchery steelhead to prevent premature smolting and desmoltification (Wedemeyer *et al.* 1980). In winter steelhead, a temperature of 54.1°F is nearly the upper limit for smolting (McCullough *et al.* 2001; Zaugg and Wagner 1973). Water temperatures less than or equal to 54.5°F are suitable for emigrating juvenile steelhead (EPA 2003b). Water temperatures greater than 55°F prevent increases in ATPase activity in steelhead juveniles (Hoar 1988). Water temperatures greater than 56°F do not permit smoltification in summer steelhead (Zaugg *et al.* 1972)
59°F	Yearling steelhead held at 43.7°F and transferred to 59°F had a substantial reduction in gill ATPase activity, indicating that physiological changes associated with smoltification were reversed (Wedemeyer *et al.* 1980).

5.3 Chinook Salmon Lifestage-Specific Water Temperature Index Values

5.3.1 Adult Immigration and Holding

Table 6. Chinook Salmon Adult Immigration and Holding Water Temperature Index Values and the Literature Supporting Each Value.

Index Value	Supporting Literature
60°F	Maximum water temperature for adults holding, while eggs are maturing, is approximately 59°F to 60°F (NMFS 1997b). Acceptable water temperatures for adults migrating upstream range from 57°F to 67°F (NMFS 1997b). Upper limit of the optimal water temperature range for adults holding while eggs are maturing is 59°F to 60°F (NMFS 2000). Many of the diseases that commonly affect Chinook salmon become highly infectious and virulent above 60°F (ODEQ 1995). Mature females subjected to prolonged exposure to water temperatures above 60°F have poor survival rates and produce less viable eggs than females exposed to lower water temperatures (USFWS 1995b). Ward and Kier (1999) designated temperatures <60.8°F as an "optimum" water temperature threshold for holding Battle Creek spring-run Chinook salmon.
65°F	Acceptable range for adults migrating upstream is from 57°F to 67°F (NMFS 1997b). Disease risk becomes high at water temperatures above 64.4°F (EPA 2003b). Latent embryonic mortalities and abnormalities associated with water temperature exposure to pre-spawning adults occur at 63.5°F to 66.2°F (Berman 1990). During each of the years when Chinook salmon temperature mortality was not observed at Butte Creek (2001, 2004-2007), on average, daily temperature did not exceed 65.8°F for more than 7 days (**Figure 6**).
68°F	Acceptable range for adults migrating upstream range from 57°F to 67°F (NMFS 1997b). For chronic exposures, an incipient upper lethal water temperature limit for pre-spawning adult salmon probably falls within the range of 62.6°F to 68.0°F (Marine 1992). Spring-run Chinook salmon embryos from adults held at 63.5°F to 66.2°F had greater numbers of pre-hatch mortalities and developmental abnormalities than embryos from adults held at 57.2°F to 59.9°F (Berman 1990). Water temperatures of 68°F resulted in nearly 100 percent mortality of Chinook salmon during columnaris outbreaks (Ordal and Pacha 1963). In Butte Creek a period of average daily temperatures above 67°F (11-16 days) preceded the onset of significant pre-spawn mortalities. In

	years when 67°F was exceeded only a few days, pre-spawn mortality was minimal (Ward et al. 2004). Adult Chinook salmon migration rates through the lower Columbia River were slowed significantly when water temperatures exceeded 68°F (Goniea et al. 2006).
70°F	Migration blockage occurs for Chinook salmon at temperatures from 70-71+°F (McCollough 1999; McCullough *et al.* 2001; EPA 2003b). Strange (2010) found that the mean average body temperature during the first week of Chinook salmon migration on the Klamath River was 71.4°F. The UILT for Chinook salmon jacks is 69.8-71.6°F (McCullough 1999).

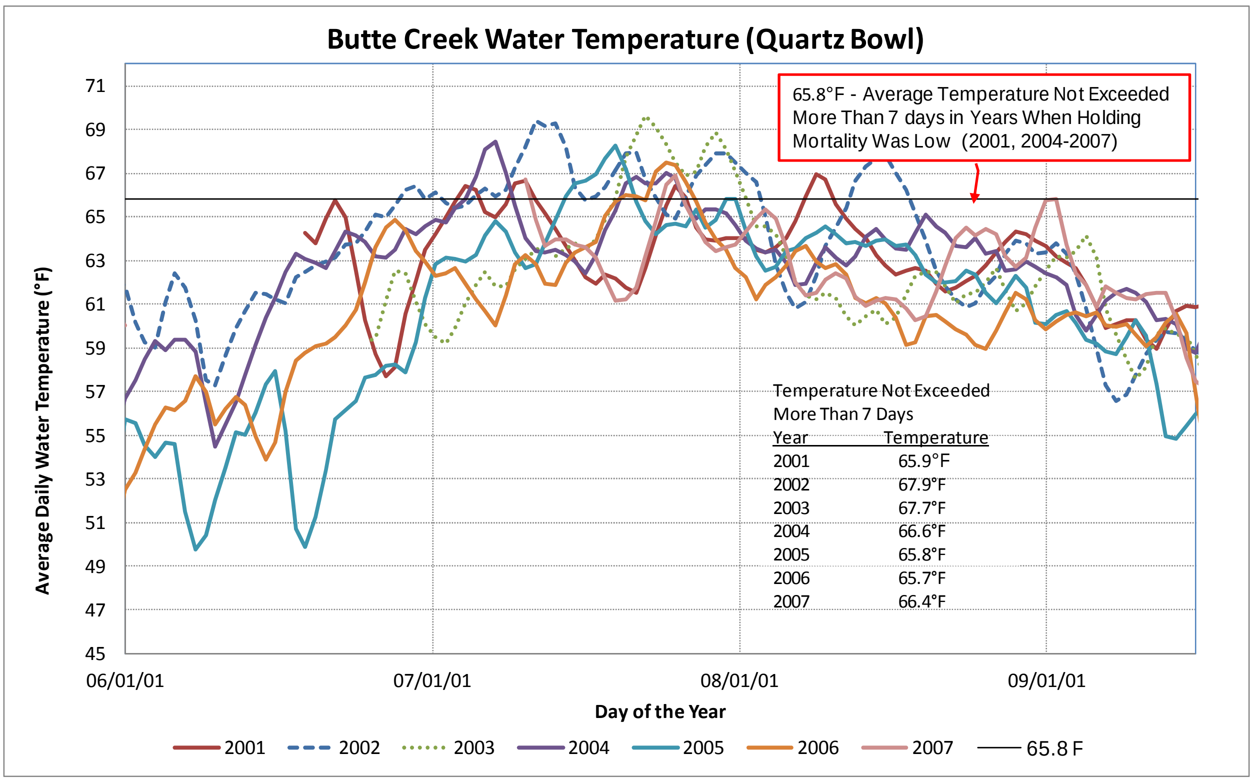


Figure 6. Water Temperature in Butte Creek at Quartz Bowl (2001-2007).

5.3.2 Spawning and Embryo Incubation

Table 7. Chinook Salmon Spawning and Embryo Incubation Water Temperature Index Values and the Literature Supporting Each Value.

Index Value	Supporting Literature
56°F	Less than 56°F results in a natural rate of mortality for fertilized Chinook salmon eggs (Reclamation Unpublished Work). Optimum water temperatures for egg development are between 43°F and 56°F (NMFS 1993b). Upper value of the water temperature range (i.e., 41.0°F to 56.0°F) suggested for maximum survival of eggs and yolk-sac larvae in the Central Valley of California (USFWS 1995b). Upper value of the range (i.e., 42.0°F to 56.0°F) given for the preferred water temperature for Chinook salmon egg incubation in the Sacramento River (NMFS 1997a). Incubation temperatures above 56°F result in significantly higher alevin mortality (USFWS 1999). 56.0°F is the upper limit of suitable water temperatures for spring-run Chinook salmon spawning in the Sacramento River (NMFS 2002a). Water temperatures averaged 56.5°F during the week of fall-run Chinook salmon spawning initiation on the Snake River (Groves and Chandler 1999).
58°F	Upper value of the range given for preferred water temperatures (i.e., 53.0°F to 58.0°F) for eggs and fry (NMFS 2002a). Constant egg incubation temperatures between 42.5°F and 57.5°F resulted in normal development (Combs and Burrows 1957). The natural rate of mortality for alevins occurs at 58°F or less (Reclamation Unpublished Work).
60°F	100 percent mortality can occur to late incubating Chinook salmon embryos (yolk-sac stage) if temperatures are 60°F or greater (Seymour 1956). An October 1 to October 31 water temperature criterion of less than or equal to 60°F in the Sacramento River from Keswick Dam to Bend Bridge has been determined for protection of late incubating larvae and newly emerged fry (NMFS 1993b). Mean weekly water temperature at first observed Chinook salmon spawning in the Columbia River was 59.5°F (Dauble and Watson 1997). Consistently higher egg losses resulted at water temperatures above 60.0°F than at lower temperatures (Johnson and Brice 1953). For Chinook Salmon eggs incubated at constant temperatures, mortality increases rapidly at temperatures greater than about 59-60°F (see data plots in Myrick and Cech 2001). Olsen and Foster (1957) found high survival of Chinook salmon eggs and fry (89.6%) when incubation temperatures started at 60.9°F and declined naturally for the Columbia River (about 7°F / month). Geist et al. (2006) found high (93.8%) Chinook salmon incubation survival through emergence for naturally declining temperatures (0.36°F/day) starting as high as 61.7°F; however, a significant reduction in survival occurred above this temperature.
62°F	100 percent mortality of fertilized Chinook salmon eggs after 12 days at 62°F (Reclamation Unpublished Work). Incubation temperatures of 62ºF to 64°F appear to be the physiological limit for embryo development resulting in 80 to 100 percent mortality prior to emergence (USFWS 1999). 100 percent loss of eggs incubated at water temperatures above 62°F (Hinze 1959). 100 percent mortality occurs during yolk-sac stage when embryos are incubated at 62.5°F (Seymour 1956). Approximately 80% or greater mortality of eggs incubated at constant temperatures of 63°F or greater (see data plots in Myrick and Cech 2001). Olsen and Foster (1957) found high mortality of Chinook salmon eggs and fry (79%) when incubation temperatures started at 65.2°F and declined naturally for the Columbia River (about 7°F / month). Geist et al. (2006) found low Chinook salmon incubation survival (1.7%) for naturally declining temperatures (0.36°F/day) when temperatures started at 62.6°F.

5.3.3 Juvenile Rearing and Downstream Movement

Table 8. Chinook Salmon Juvenile Rearing and Downstream Movement Water Temperature Index Values and the Literature Supporting Each Value.

Index Value	Supporting Literature
60°F	Optimum water temperature for Chinook salmon fry growth is between 55.0°F and 60°F (Seymour 1956). Water temperature range that produced optimum growth in juvenile Chinook salmon was between 54.0°F and 60.0°F (Rich 1987b). Water temperature criterion of less than or equal to 60.0°F for the protection of Sacramento River winter-run Chinook salmon from Keswick Dam to Bend Bridge (NMFS 1993b). Upper optimal water temperature limit of 61°F for Sacramento River fall-run Chinook salmon juvenile rearing (Marine 1997; Marine and Cech 2004). Upper water temperature limit of 60.0°F preferred for growth and development of spring-run Chinook salmon fry and fingerlings (NMFS 2000; NMFS 2002a). To protect salmon fry and juvenile Chinook salmon in the upper Sacramento River, daily average water temperatures should not exceed 60°F after September 30 (NMFS 1997b). A water temperature of 60°F appeared closest to the optimum for growth of fingerlings (Banks *et al.* 1971). Optimum growth of Nechako River Chinook salmon juveniles would occur at 59°F at a feeding level that is 60 percent of that required to satiate them (Brett *et al.* 1982). In a laboratory study, juvenile fall-run Chinook salmon from the Sacramento River reared in water temperatures between 70°F and 75°F experienced significantly decreased growth rates, and increased predation vulnerability compared with juveniles reared between 55°F and 61°F (Marine 1997; Marine and Cech 2004).
65°F	Water temperatures between 45°F to 65°F are preferred for growth and development of fry and juvenile spring-run Chinook salmon in the Feather River (NMFS 2002a). Recommended summer maximum water temperature of 64.4°F for migration and non-core rearing (EPA 2003b). Water temperatures greater than 64.0°F are considered not "properly functioning" by NMFS in Amendment 14 to the Pacific Coast Salmon Plan (NMFS 1995). Fatal infection rates caused by *C. columnaris* are high at temperatures greater than or equal to 64.0°F (EPA 2001). Disease mortalities diminish at water temperatures below 65.0°F (Ordal and Pacha 1963). Fingerling Chinook salmon reared in water greater than 65.0°F contracted *C. columnaris* and exhibited high mortality (Johnson and Brice 1953). Water temperatures greater than 64.9°F identified as being stressful in the Columbia River Ecosystem (Independent Scientific Group 1996). Juvenile Chinook salmon have an optimum temperature for growth that appears to occur at about 66.2°F (Brett *et al.* 1982). Juvenile Chinook salmon reached a growth maximum at 66.2°F (Cech and Myrick 1999). Optimal range for Chinook salmon survival and growth from 53.0°F to 64.0°F (USFWS 1995b). Survival of Central Valley juvenile Chinook salmon declines at temperatures greater than 64.4°F (Myrick and Cech 2001). Increased incidence of disease, reduced appetite, and reduced growth rates at 66.2±1.4 °F (Rich 1987b). Bioenergetics modeling of growth based on consumption of rainbow trout (P value = 0.5) in the Middle Fork American River watershed (adjacent watershed) indicates that growth likely does not occur above about 65°F (Figure 5)
68°F	Sacramento River juvenile Chinook salmon reared at water temperatures greater than or equal to 68.0°F suffer reductions in appetite and growth (Marine 1997; Marine and Cech 2004). Significant reductions in growth rates may occur when chronic elevated temperatures exceed 68°F (Marine 1997; Marine and Cech 2004). Juvenile spring-run Chinook salmon were not found in areas having mean weekly water temperatures between 67.1°F and 71.6°F (Burck *et al.* 1980; Zedonis and Newcomb 1997). Results from a study on wild spring-run Chinook salmon in the John Day River system indicate that juvenile fish were not found in areas having mean weekly water temperatures between 67.1°F and 72.9°F (McCullough 1999; Zedonis and Newcomb 1997).
70°F	No growth at all would occur for Nechako River juvenile Chinook salmon at 70.5°F (Brett *et al.* 1982; Zedonis and Newcomb 1997). Juvenile spring-run Chinook salmon were not found in areas having mean weekly water temperatures between 67.1°F and 71.6°F (Burck *et al.* 1980; Zedonis and Newcomb 1997). Results from a study on wild spring-run Chinook salmon in the John Day River system indicate that juvenile fish were not found in areas having mean weekly water temperatures between 67.1°F and 72.9°F (McCullough 1999; Zedonis and Newcomb 1997). Increased incidence of disease, hyperactivity, reduced appetite, and reduced growth rates at 69.8 ±1.8 °F (Rich 1987b). In a laboratory study, juvenile fall-run Chinook salmon from the Sacramento River reared in water temperatures between 70°F and 75°F experienced significantly decreased growth rates and increased predation vulnerability compared with juveniles reared between 55°F and 61°F (Marine 1997; Marine and Cech 2004).

75°F	For juvenile Chinook salmon in the lower American River fed maximum rations under laboratory conditions, 75.2°F was determined to be 100 percent lethal due to hyperactivity and disease (Rich 1987b; Zedonis and Newcomb 1997). Lethal temperature threshold for fall-run juvenile Chinook salmon between 74.3 and 76.1°F (McCullough 1999). In a laboratory study, juvenile fall-run Chinook salmon from the Sacramento River reared in water temperatures between 70°F and 75°F experienced significantly decreased growth rates, and increased predation vulnerability compared with juveniles reared between 55°F and 61°F (Marine 1997; Marine and Cech 2004). The juvenile Chinook Salmon UILT based on numerous studies is 75-77°F (Sullivan et al. 2000; McCullough et al. 2001; Myrick and Cech 2001)

5.3.4 Yearling + Smolt Emigration

Table 9. Chinook Salmon Yearling + Smolt Emigration Water Temperature Index Values and the Literature Supporting Each Value.

Index Value	Supporting Literature
63°F	Acceleration and inhibition of Sacramento River Chinook salmon smolt development reportedly may occur at water temperatures above 63°F (Marine 1997; Marine and Cech 2004). Laboratory evidence suggest that survival and smoltification become compromised at water temperatures above 62.6°F (Zedonis and Newcomb 1997). Juvenile Chinook salmon growth was highest at 62.6°F (Clarke and Shelbourn 1985).
68°F	Significant inhibition of gill sodium ATPase activity and associated reductions of hyposmoregulatory capacity, and significant reductions in growth rates, may occur when chronic elevated temperatures exceed 68°F (Marine 1997; Marine and Cech 2004). Water temperatures supporting smoltification of fall-run Chinook salmon range between 50°F to 68°F, the colder temperatures represent more optimal conditions (50°F to 62.6°F), and the warmer conditions (62.6°F to 68°F) represent marginal conditions (Zedonis and Newcomb 1997).
72°F	In a laboratory study, juvenile fall-run Chinook salmon from the Sacramento River reared in water temperatures between 70°F and 75°F experienced significantly decreased growth rates, impaired smoltification indices, and increased predation vulnerability compared with juveniles reared between 55°F and 61°F (Marine 1997; Marine and Cech 2004). Indirect evidence from tagging studies suggests that the survival of fall-run Chinook salmon smolts decreases with increasing water temperatures between 59°F and 75°F in the Sacramento-San Joaquin Delta (Kjelson and Brandes 1989).

5.4 Upstream Migration Behavioral Effects Due to River Temperature Gradients

If volitional upstream passage was provided past Englebright Reservoir (e.g., ladder, dam removal), the potential exists for upstream migrating adult salmonids to have to volitionally pass through significant water temperature differentials from the Lower Yuba River into the South or Middle Yuba rivers (Upper Yuba River) due to cold water releases from New Bullards Bar Reservoir into the Yuba River (via Colgate Powerhouse). **Figure 7** shows an example of water temperature in the Yuba River below Colgate Powerhouse and the South and Middle Fork Yuba rivers near their confluence with the Yuba River. It is possible to modify the temperature differentials by selective withdrawal of water from New Bullards Bar Reservoir (Colgate Powerhouse temperature) or by modifying flows in the South or Middle Yuba rivers; nevertheless, the temperature differentials could be large. For example, during the May-June migration period for spring-run Chinook salmon or the late summer/fall

migration period for steelhead, Middle and South Yuba river temperatures are much warmer than the downstream Yuba River temperatures (e.g., > 7°F or > 4°C).

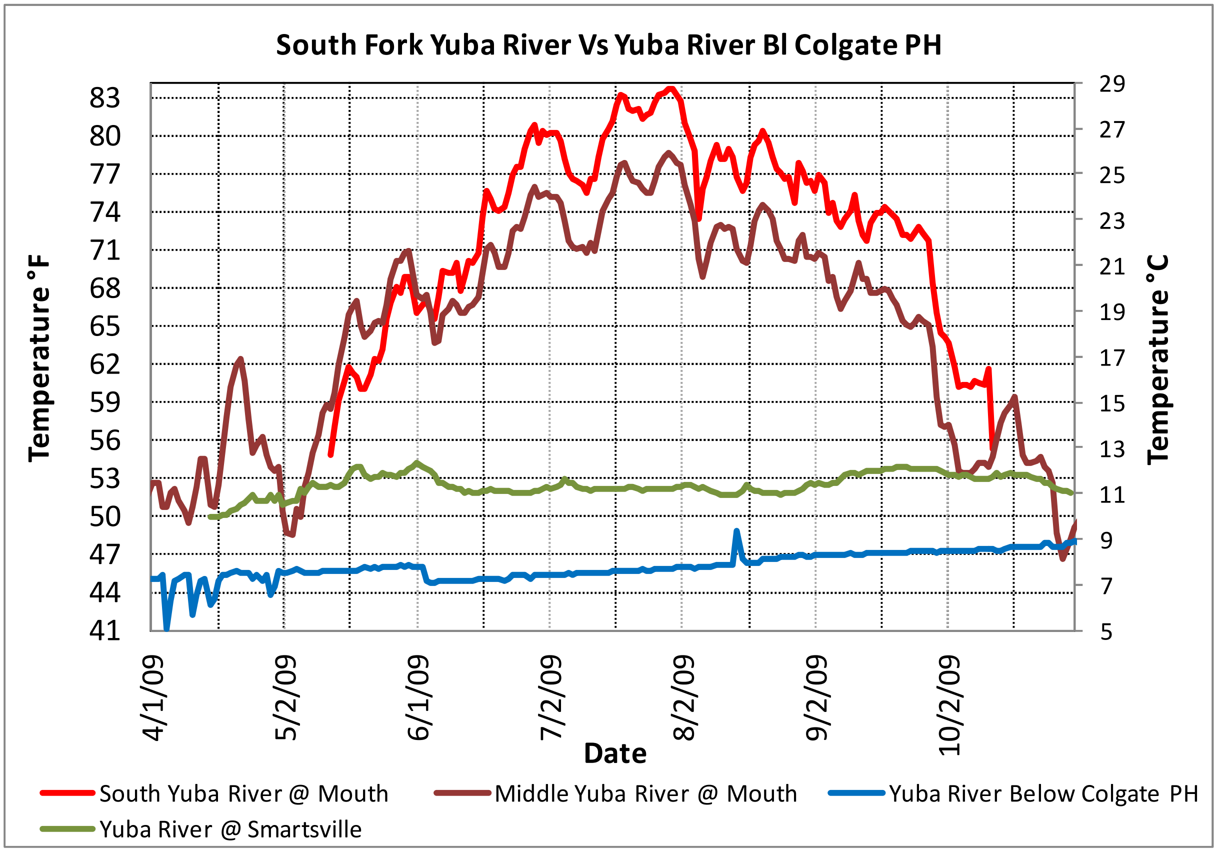


Figure 7. Water Temperature Differentials Between the South and Middle Yuba Rivers, and the Yuba River Below Colgate and at Smartsville.

To date, we have only identified limited information in the literature regarding the effect of temperature differentials on volitional upstream migration of Chinook salmon or steelhead. Typically, as fish migrate upstream in rivers the water temperature becomes cooler. Migrating fish may move from cooler ocean/estuary temperatures (Strange 2010) into warmer river temperatures, but as fish move upstream in rivers, the temperature typically gets cooler. In the case of migration from the Yuba River to the South and Middle Yuba rivers, fish could be faced with moving in a reverse temperature gradient from cooler downstream water, into warmer upstream water.

In the Columbia River both migrating Chinook salmon and steelhead use coolwater tributaries as thermal refugia during warm summer conditions. Staging in coolwater tributaries significantly slows and affects the migratory behavior of the fish (High et al.

2006; Goniea et al. 2006). Also temperature differentials at Columbia River ladders (e.g., colder water at the entrance to the ladder versus warmer water in the ladder), even relatively small temperature differentials, can slow migration rates through the ladders. Caudill et al. (2005) found that few fish passed the ladders when temperature differentials were > 7°F (> 4°C) and that passage times increased with increased temperature differential (e.g., > 2°F).

In the Snake River/Clearwater River system a somewhat analogous temperature situation exists compared to that which may occur in the Yuba River system. During the summer (July-August) cold water is released from Dworshak Reservoir on the North Fork Clearwater River into the Clearwater River. As a result, the Clearwater River becomes colder than the Snake River where they meet near Lewiston, Idaho. Spring-run Chinook salmon are generally not affected because by July, most spring-run Chinook salmon moving up the Clearwater River are already past the mouth of the North Fork Clearwater River, and are up close to or in their higher elevation natal streams getting ready to spawn. It does appear, however, that some later returning spring-run Chinook salmon do hold longer than they would have normally, near or in the North Fork Clearwater River, because of the colder water coming out of Dworshak Reservoir. As a result, there is spawning activity that occurs in the lower North Fork Clearwater River (it is possible that some of these fish may be hatchery fish shunted off from entering Dworshak Hatchery).

The cooling effect of Dworshak Reservoir releases to the Clearwater River does modify the behavior of returning steelhead and fall-run Chinook salmon at the confluence with the Snake River. The cooler water in the Clearwater River draws fish destined for the Snake River into the Clearwater River and they hold in the mouth of the Clearwater River until the Snake River cools down (Personal Communication, Bill Arnsberg, Nez Perce Tribal Biologist).

Our recommendation is that additional literature and data should be obtained and summarized regarding the effect of water temperature differentials on volitional migration (if such information exists). In addition, based on the limited information available, a temperature differential of 7°F (4°C) should precautionarily be viewed as a potential thermal barrier to adult upstream migration. It is possible that even lower temperature differentials (< 7°F) could result in migrating fish holding downstream and not migrating, or significantly delaying migration.

6 TEMPORAL TEMPERATURE PATTERNS RELATED TO WATER TEMPERATURE INDEX VALUES AND METRICS

Typical water temperature patterns in the Yuba River system exhibit a week or two of high temperatures and a much broader range of temperatures that are lower. For example, **Figure 8** shows historical water temperature in the section of the Middle Yuba River near Wolf Creek in 2008. This site is used below to briefly discuss temporal temperature patterns and their relationship to critical WTI values and some typical water temperature metrics used in the literature to summarize water temperature.

Historical daily average water temperatures at the Middle Yuba River site were near the temperature that has been observed to cause mortality to Chinook Salmon in Butte Creek (e.g., 67°F or greater) (Ward et al. 2004). Most of the summer, daily average water temperatures at the Middle Yuba River site were at or below 67°F, but there were a couple of weeks that the average daily water temperature exceeded 67°F (similar to conditions that caused mortality in Butte Creek). Maximum daily water temperatures at the site during much of the summer were near the 7-day UILT[3] for Chinook salmon adults of 69.8-71.6°F (McCullough 1999). However, the duration of time within a day that the water temperature was near the 7-day UILT was short and is not available from the plot nor from typical maximum temperature metrics (see below).

Some typical temperature metrics are shown on Figure 8. The 7-day moving average temperature (7DMA) also exceeded 67°F for the same two time periods that the average daily temperature exceeded 67°F. The maximum weekly average temperature (MWAT) (average of the daily mean temperature of the 7 warmest days) occurred in mid-July and was 67.9°F. The maximum daily temperatures, 7-day moving average daily maximum (7DMADM), were about 4°F greater than the mean daily temperature during the warmest months, and the 7-day average daily maximum temperature (7DADM) occurred at the same time as the MWAT (67.9 °F versus 71.7°F).

Historically in Butte Creek, when average daily water temperature was 67°F for more than about a week (11 and 16 days in 2002 and 2003, respectively) significant adult Chinook salmon mortality occurred. However, if water temperature exceeded 67°F for a relatively short number of days (e.g., < 7 days), significant mortality did not occur (Ward et al. 2004).

An analogous approach for analyzing the Yuba River water temperatures could be used. This could be done by using WTI values, where exceeding the WTI temperature criteria for less than 7 days would not be expected to affect each lifestage, but exceeding the WTI for more than 7 days would be detrimental.

[3] Note, however, the UILT is 7 continuous days exposure and is not comparable to a daily maximum temperature.

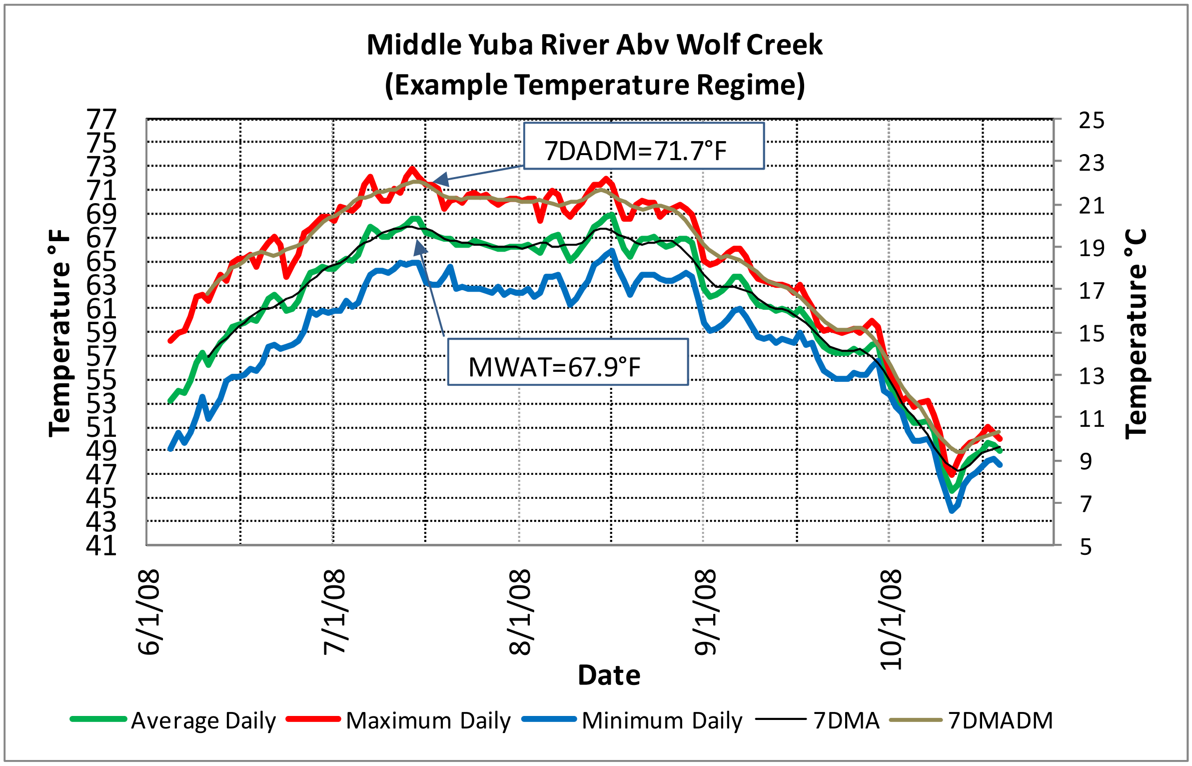


Figure 8. Middle Fork Yuba River Water Temperature Including 7 Day Moving Averages of the Average Daily Temperature and the Maximum Daily Temperature. Also Included Are the Maximum Weekly Average Temperature (MWAT) and the 7 Day Average Daily Maximum Temperature (7DADM).

Quantifying the number of average daily water temperature values that exceed a WTI threshold would be a direct approach to quantifying habitat suitability. The MWAT and/or the moving average (7DMA) identify a maximum average weekly water temperature value, but do not indicate the duration of time that this occurred. Similarly, if acute temperature was a concern, the individual water temperature measurements (e.g., hourly) could be used to identify the number of hours (duration) that a maximum WTI value was exceeded (e.g., tally the number of days and hours). Conversely, the 7DADM and/or the moving average (7DMADM) identify a maximum average weekly maximum temperature value, but do not indicate the duration of time that it occurred.

7 SPECIES- AND LIFESTAGE-SPECIFIC WATER TEMPERATURE RANGE ACCEPTABLE FOR REINTRODUCTION EVALUATION

The goal of the temperature analysis is twofold: (1) to identify the high temperature WTI value(s) that clearly demarcate the spatial/temperature boundary between where steelhead and Chinook salmon lifestages can and cannot exist (even though temperature is a stressor) (upper tolerable WTI); and (2) to determine within the "can

exist" boundary, if there is a core area where they can thrive without temperature as a stressor (upper optimal WTI). The upper tolerable temperature represents the upper boundary of the range of acceptable water temperatures for reintroduction evaluation. It represents a water temperature at which fish can survive indefinitely, without experiencing substantial detrimental effects to physiological and biological functions such that survival occurs, but growth and reproduction success are reduced below optimal. The upper optimal temperature represents the upper boundary of the optimum range and represents a temperature below which growth, reproduction, and/or behavior are not affected by temperature. Below, we discuss: (1) existing regulatory water temperature standards or guidelines that could be used as index values; and (2) specific water temperature index values that have been derived based on the literature review in this report.

7.1 Existing Water Temperature Standards/Guidelines

Several different water temperature standards are used currently by states for salmonids (e.g., California, Oregon, and Washington water temperature standards). California's Basin Plan is largely based on not altering the temperature of intrastate waters unless alterations can be shown to not have an effect on beneficial uses for cold freshwater habitat, migration, and/or spawning (**Table 10**). The beneficial uses of the Yuba River are listed in **Table 11**. Specific temperature criteria for species/lifestages are not identified in the Basin Plan nor are there specific temperature objectives for the Yuba River system. However, for the Sacramento River, seasonal temperature criteria have been developed (Table 10). These temperature objectives, while not directly applicable to the Yuba River, give an indication of temperature objectives that have been set for anadromous fish in the basin.

Table 10. Basin Plan Temperature Standards Including Specific Standards for the Sacramento River.

Temperature

The natural receiving water temperature of intrastate waters shall not be altered unless it can be demonstrated to the satisfaction of the Regional Water Board that such alteration in temperature does not adversely affect beneficial uses.

Temperature objectives for COLD interstate waters, WARM interstate waters, and Enclosed Bays and Estuaries are as specified in the *Water Quality Control Plan for Control of Temperature in the Coastal and Interstate Waters and Enclosed Bays of California* including any revisions. There are also temperature objectives for the Delta in the State Water Board's May 1991 *Water Quality Control Plan for Salinity*.

At no time or place shall the temperature of COLD or WARM intrastate waters be increased more than 5°F above natural receiving water temperature. Temperature changes due to controllable factors shall be limited for the water bodies specified as described in Table III-4. To the extent of any conflict with the above, the more stringent objective applies.

In determining compliance with the water quality objectives for temperature, appropriate averaging periods may be applied provided that beneficial uses will be fully protected.

TABLE III-4
SPECIFIC TEMPERATURE OBJECTIVES

DATES	APPLICABLE WATER BODY
From 1 December to 15 March, the maximum temperature shall be 55°F. From 16 March to 15 April, the maximum temperature shall be 60°F. From 16 April to 15 May, the maximum temperature shall be 65°F. From 16 May to 15 October, the maximum temperature shall be 70°F. From 16 October to 15 November, the maximum temperature shall be 65°F. From 16 November to 30 November, the maximum temperature shall be 60°F.	Sacramento River from its source to Box Canyon Reservoir (9); Sacramento River from Box Canyon Dam to Shasta Lake (11)
The temperature in the epilimnion shall be less than or equal to 75°F or mean daily ambient air temperature, whichever is greater.	Lake Siskiyou (10)
The temperature shall not be elevated above 56°F in the reach from Keswick Dam to Hamilton City nor above 68°F in the reach from Hamilton City to the I Street Bridge during periods when temperature increases will be detrimental to the fishery.	Sacramento River from Shasta Dam to I Street Bridge (13, 30)

Table 11. Basin Plan Beneficial Uses for the Yuba River.

TABLE II-1

SURFACE WATER BODIES AND BENEFICIAL USES

	SURFACE WATER BODIES (1)	HYDRO UNIT NUMBER	MUN	AGRI-CULTURE AGR		INDUSTRY PROC	IND	POW	RECREATION REC-1		REC-2	FRESHWATER HABITAT (2) WARM	COLD	MIGRATION MIGR		SPAWNING SPWN		WILD	NAV
			MUNICIPAL AND DOMESTIC SUPPLY	IRRIGATION	STOCK WATERING	PROCESS	SERVICE SUPPLY	POWER	CONTACT	CANOEING (1) AND RAFTING	OTHER NONCONTACT	WARM	COLD	WARM (3)	COLD (4)	WARM (3)	COLD (4)	WILDLIFE HABITAT	NAVIGATION
	YUBA RIVER																		
41	SOURCES TO ENGLEBRIGHT RESERVOIR	517.	E	E	E			E	E	E	E		E				E	E	
42	ENGLEBRIGHT DAM TO FEATHER RIVER	515.3		E	E			E	E	E	E	E	E	E	E	E	E	E	

LEGEND
E = EXISTING BENEFICIAL USES
P = POTENTIAL BENEFICIAL USES
L = EXISTING LIMITED BENEFICIAL USE

The EPA Region 10 Guidance for Pacific Northwest State and Tribal Temperature Water Quality Standards (EPA 2003b) provides water temperature recommendations regarding coldwater salmonid uses and numeric criteria to protect those uses for the following:

Salmonid Uses	Criteria
Salmon/trout core juvenile rearing	61°F (16°C) 7DADM
Salmon/trout migration plus non-core juvenile rearing	64°F (18°C) 7DADM
Salmon/trout migration	68°F (20°C) 7DADM
Salmon/trout spawning, egg incubation, and fry emergence	55°F (13°C) 7DADM
Steelhead smoltification	57°F (14°C) 7DADM

These temperature criteria are developed for summer water temperatures, except for the spawning and smolting lifestages which occur earlier in the year. The criteria are intended to represent the upper end of the optimal temperature range for each lifestage. It is important to note that the criteria are based on 7DADM (daily maximum temperatures), while the data used to generate the criteria were primarily based on daily average or continuous temperature field/laboratory data sets (**Table 12**). Several general assumptions were applied by EPA (2003b) to the data to make a connection between 7DADM temperature and the field/laboratory data (Section 8.1).

Table 12. EPA (2003b) Laboratory and Field Data Summary for Generating Water Temperature Criteria.

Life Stage	Temperature Consideration	Temperature & Unit	Reference
Spawning and Egg Incubation	*Temp. Range at which Spawning is Most Frequently Observed in the Field	4 - 14°C (daily avg)	Issue Paper 1; pp 17-18 Issue Paper 5; p 81
	* Egg Incubation Studies - Results in Good Survival -Optimal Range	4 - 12°C (constant) 6 - 10°C (constant)	Issue Paper 5; p 16
	*Reduced Viability of Gametes in Holding Adults	> 13°C (constant)	Issue Paper 5; pp 16 and 75
Juvenile Rearing	*Lethal Temp. (1 Week Exposure)	23 - 26°C (constant)	Issue Paper 5; pp 12, 14 (Table 4), 17, and 83-84
	*Optimal Growth - unlimited food - limited food	13 - 20°C (constant) 10 - 16°C (constant)	Issue Paper 5; pp 3-6 (Table 1), and 38-56
	*Rearing Preference Temp. in Lab and Field Studies	10 - 17°C (constant) < 18°C (7DADM)	Issue Paper 1; p 4 (Table 2). Welsh et al. 2001.
	*Impairment to Smoltification	12 - 15°C (constant)	Issue Paper 5; pp 7 and 57-65
	*Impairment to Steelhead Smoltification	> 12°C (constant)	Issue Paper 5; pp 7 and 57-65
	*Disease Risk (lab studies) -High - Elevated - Minimized	> 18 - 20°C (constant) 14 - 17°C (constant) 12 - 13°C (constant)	Issue Paper 4, pp 12 - 23
Adult Migration	*Lethal Temp. (1 Week Exposure)	21- 22°C (constant)	Issue Paper 5; pp 17, 83 - 87
	*Migration Blockage and Migration Delay	21 - 22°C (average)	Issue Paper 5; pp 9, 10, 72-74. Issue Paper 1; pp 15 - 16
	*Disease Risk (lab studies) - High - Elevated - Minimized	> 18 - 20°C (constant) 14 - 17°C (constant) 12- 13°C (constant)	Issue Paper 4; pp 12 - 23
	*Adult Swimming Performance - Reduced - Optimal	> 20°C (constant) 15 - 19°C (constant)	Issue Paper 5; pp 8, 9, 13, 65 - 71
	* Overall Reduction in Migration Fitness due to Cumulative Stresses	> 17-18°C (prolonged exposures)	Issue Paper 5; p 74

In addition to the numeric temperature criteria, there are a number of other factors (e.g., site specific issues, background temperatures) that EPA (2003b) considered in recommending coldwater salmonid uses and water quality standards (WQS) to protect those uses. These factors and the EPA's recommended approach for establishing WQS are described in EPA (2003b).

EPA (2003b) recognized that salmonids will use waters that are warmer than their optimal thermal range and further recognizes that some portions of rivers and streams naturally (i.e., absent human impacts) were warmer than the salmonid optimal range. They also recognized that some streams have unique diurnal temperature patterns, which may necessitate modified WQS. To account for these issues, the EPA identified three alternate salmonid temperature standard approaches. These include identifying the natural background temperature of the water body, creating site-specific temperature criteria, and/or identifying that a criterion is "unattainable" and altering the use designation to a use designation that has a criterion that is obtainable.

The EPA's water temperature recommendations are intended to assist States and Tribes to adopt temperature WQS that the EPA can approve consistent with its obligations under the Clean Water Act and the Endangered Species Act. States and Tribes that adopt temperature WQS consistent with these recommendations can expect an expedited review by EPA and the Services, subject to new data and information that might be available to during that review (EPA 2003b). In some cases, the criteria seem to be conservative and may exclude habitat that is currently used and/or demonstrably usable by salmonid lifestages. Section 8.1 has a brief discussion of issues related to the EPA (2003b) numerical criteria based on 7DADM temperatures and the needs of the Yuba Salmon Forum.

7.2 Site Specific Water Temperature Index Values

In addition to the EPA (2003b) numeric temperature criteria (Section 7.1) it also seems appropriate to develop Yuba Salmon Forum water temperature index values that are specific to the purposes of the Yuba Salmon Forum and the Yuba River. Below, for each species/lifestage, we provide: (1) an upper tolerance WTI (UTWTI) that identifies the sustained (chronic) tolerance/no tolerance boundary; and (2) the upper optimal WTI (UOWTI) where physiological processes (growth, disease resistance, normal development of embryos) are not stressed by temperature.

The lifestage-specific WTI values are not intended to represent significance thresholds, but instead provide criteria to evaluate reintroduction of anadromous salmonids. Moreover, as suggested by DWR (2007), the use of temperature "boundaries" has inherent drawbacks associated with the often indistinguishable effects at the upper and

lower ends of an identified range and attributing undue specificity to values slightly exceeding an identified range. Nonetheless, WTI values, as defined, are used for evaluation of water temperature considerations regarding the reintroduction of steelhead (**Table 13**) and spring-run Chinook salmon (**Table 14**) in the Upper Yuba River Basin.

7.2.1 Steelhead

Table 13. Lifestage-Specific Upper Optimal Water Temperature Index (UOWTI) Values and Upper Tolerance Water Temperature Index (UTWTI) Values Identified as Defining the Range of Acceptable Water Temperatures for Evaluation of the Reintroduction of Steelhead in the Upper Yuba River Basin.

Lifestage	Upper Optimum WTI[1]	Upper Tolerance WTI[1]	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec
Adult Migration	64°F	68°F	■■	■■	■■	□□	□□	□□	□□	■■	■■	■■	■■	■■
Adult Holding	61°F	65°F	■■	■■	■■	□□	□□	□□	□□	■■	■■	■■	■■	■■
Spawning	54°F	57°F	■■	■■	■■	■■	□□	□□	□□	□□	□□	□□	□□	□□
Embryo Incubation	54°F	57°F	■■	■■	■■	■■	■■	□□	□□	□□	□□	□□	□□	□□
Juv. Rearing & Downstream Mvmt.	65°F	68°F	■■	■■	■■	■■	■■	■■	■■	■■	■■	■■	■■	■■
Smolt Emigration	52°F	55°F	■■	■■	■■	■□	□□	□□	□□	□□	□□	■■	■■	■■

[1] The WTI values are to be applied to the water temperature metrics recommended in Section 8, below.

7.2.2 Spring-run Chinook Salmon

Table 14. Lifestage-Specific Upper Optimal Water Temperature Index (UOWTI) Values and Upper Tolerance Water Temperature Index (UTWTI) Values Identified as Defining the Upper Acceptable Water Temperatures for Evaluation of the Reintroduction of Spring-Run Chinook Salmon in the Upper Yuba River Basin.

Lifestage	Upper Optimum WTI[1]	Upper Tolerance WTI[1]	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec
Adult Migration	64°F	68°F	□□	□□	□□	■■	■■	■■	■■	■■	□□	□□	□□	□□
Adult Holding	61°F	65°F	□□	□□	□□	■■	■■	■■	■■	■■	□□	□□	□□	□□
Spawning	56°F	58°F	□□	□□	□□	□□	□□	□□	□□	□□	■■	■■	■□	□□
Embryo Incubation	56°F	58°F	■■	■■	□□	□□	□□	□□	□□	□□	■■	■■	■■	■■
Juv. Rearing & Downstream Mvmt.	61°F	65°F	■■	■■	■■	■■	■■	■■	■■	■■	■■	■■	■■	■■
Smolt Emigration	63°F	68°F	■■	■■	■■	■■	■□	□□	□□	□□	□□	■■	■■	■■

[1] The WTI values are to be applied to the water temperature metrics recommended in Section 8, below.

8 WATER TEMPERATURE METRICS

Water temperature metrics (e.g., MWAT, 7DADM) are typically designed to provide a reproducible index of temperature over a period of time that can be used in combination with temperature standards (numeric criteria values) to determine if a water temperature body is impaired. Water temperature metrics are by definition an index of the complete temperature time series. As such, they do not completely represent the temperature time series nor are they always the most accurate way to

represent the biological response of various lifestages. Water temperature metrics for potential application to the Yuba Salmon Forum specific criteria (UOWTI and UTWTI) are described below.

8.1 7DADM

The EPA (2003a) recommends the 7DADM (maximum 7-day average of the daily maxima) as a water temperature metric for all of the numeric criteria that is applied to a specific species and lifestage. The 7DADM is similar to the maximum weekly average temperature metric that was previously used by the EPA for its national temperature criteria recommendations (EPA 1977). However, in 2003, the EPA initiated use of the 7DADM metric "because it describes the maximum temperatures in a stream, but is not overly influenced by the maximum temperature of a single day."

A 7DADM value is calculated by adding the daily maximum temperatures recorded at a site on seven consecutive days and dividing by seven. Thus, it reflects an average of daily maximum temperatures that fish are exposed to over a week-long period. EPA (2003b) states that because this metric "is oriented to daily maximum temperatures, it can be used to protect against acute effects, such as lethality and migration blockage conditions." This statement illustrates two shortcomings of the EPA (2003a) use of the 7DADM metric. The 7DADM: (1) includes no duration information, which is critical to understanding acute (zone of resistance) temperature analysis – rather, it is an index of maximum temperature that occurs for a short time each day and, most importantly; (2) the numeric criteria that are identified by EPA (2003b) are not acute criteria nor derived from acute criteria data, but are chronic temperature criteria.

The EPA (2003b) numeric criteria were derived from chronic field or laboratory studies (e.g., > 7 day continuous or average daily temperatures), including the migratory blockage data (see Section 5.1; Table 12). A couple of simple examples illustrate this concept. The EPA (2003b) juvenile core rearing criteria is 61°F 7DADM and is the same temperature value as the upper optimal growth temperature under limited food (Table 12, 16°C), but the optimal growth temperature was derived from constant temperature laboratory studies. This temperature is much lower than the temperature where acute temperature affects occur. The UILT (7 day) from literature studies is 72 - 79°F (e.g., Table 12) and for shorter duration exposure is even much higher 80 - 88°F (e.g., see Table TT2 in Myrick and Cech 2001). Another example is the migration criteria. The migration blockage source data is based on observations in natural rivers, and is based on daily average or weekly field temperatures (70 – 72°F) (Table 12; McCullough 1999).

A daily maximum temperature equivalent of this temperature (70°F) is approximately 75°F [4], but the EPA (2003b) 7DADM numeric criterion for migration was set at 68°F.

EPA (2003b) states that the 7DADM metric can also can be used to protect against sub-lethal or chronic effects (e.g., temperature effects on growth, disease, smoltification, and competition), but the resultant cumulative thermal exposure fish experience over the course of a week or more needs to be considered when selecting a 7DADM value to protect against these effects. The EPA's general conclusion from studies on fluctuating water temperature regimes (which is what fish generally experience in rivers) is that fluctuating temperatures increase juvenile growth rates when mean temperatures are colder than the optimal growth temperature derived from constant temperature studies, but will reduce growth when the mean temperature exceeds the optimal growth temperature (see Issues Paper 5, pages 51-56). When the mean temperature is above the optimal growth temperature, the "mid-point" temperature between the mean and the maximum is the "equivalent" constant temperature. This "equivalent" constant temperature then can be directly compared to laboratory studies done at constant temperatures. For example, a river with a 7DADM value of 64°F and a 58°F weekly mean temperature (i.e., diurnal variation of ± 5.4°F) will be roughly equivalent to a constant laboratory study temperature of 61.7°F (mid-point between 58°F and 65°F). Thus, both maximum and mean temperatures are important when determining a 7DADM value that is protective against sub-lethal/chronic temperature effects.

To account for using the 7DADM metric based on constant temperature laboratory data, EPA (2003a) assumed an average diel temperature difference between the mean and daily maximum temperature of 5.4°F, although the EPA appears to have decreased the temperature in the laboratory data down by 2.7°F (equivalently added 2.7°F to the criteria). It is completely unclear, however, if or how EPA then also accounted for the fact that 7DADM temperature is on average also 5.4°F greater than the average daily temperature (i.e., was this accounted for or not).

It also is unclear if the "midpoint of the maximum and average temperature" correction was applied for all lifestages. If so, this would be inappropriate based on the data available. The "midpoint" correction literature is only applicable to juvenile growth. There is no evidence presented that it is applicable to other lifestages. Also, the juvenile growth "midpoint" temperature correction is somewhat mis-represented in EPA (2003b). The main study relied on by EPA (2003b) is Hokanson et al. (1977), and that study states that the difference in growth between constant and diel fluctuating temperatures was 39% (1.5°C in a ±3.8C fluctuating range) of the difference between the

[4] Maximum daily temperatures are typically 5.4°F higher than average daily temperature (EPA 2003b).

average and maximum temperature (not 50% or the midpoint) and, perhaps more importantly, most of the studies reviewed by EPA indicate that growth in constant temperature was essentially equivalent to growth in fluctuating temperatures. Elliott (1975), for example, found that a growth model developed from constant temperature experimental data predicted brown trout growth in daily fluctuating temperature environments accurately when the mean daily value of the fluctuating temperature was used as input to the growth model.

For the evaluation of potential water temperature-related impacts associated with the reintroduction of anadromous salmonids into the Upper Yuba River Basin, 7DADM values could be calculated for species-specific lifestage periods on an annual basis over the simulation or empirical data period, and the occurrences when that 7DADM values exceed the EPA (2003b) numeric values could be compared among rivers/reaches in the Upper Yuba River Basin.

8.2 ADT

The average daily temperature (ADT) should be considered for application to the Yuba Salmon Forum specific criteria (WTI values) because nearly all of the data in the literature review were either based on ADT or on continuous temperature (also see Table 12). For juvenile growth, the data from Hokanson et al. (1977) can be directly applied to the constant temperature data to provide a correction, if deemed appropriate. The average daily temperature also can be used to determine the number of days (duration) that a WTI is exceeded, and duration of exceedance can be compared among specific geographic areas.

8.3 MWAT

The Maximum Weekly Average Temperature (MWAT) is a metric used by the California RWQCB that is commonly applied to water temperature numeric objectives. Generally, the MWAT serves as a summary measurement of instream water temperature variation that may occur on a daily or seasonal basis, and is used to evaluate chronic (sub-lethal) water temperature impacts (SWRCB website).

The MWAT is found by calculating the mathematical mean of multiple, equally spaced, daily water temperatures over a 7-day consecutive period. The MWAT is defined as the highest value calculated for all possible 7-day periods over a given time period, which usually extends over the summer or is commensurate to the duration of a salmonid lifestage. In order to determine whether the maximum weekly temperature standard is attained, the mathematical mean of multiple, equally spaced, daily temperatures over a seven-day consecutive period is compared to the criterion.

For the evaluation of acceptable water temperature-related reintroduction potential associated with spring-run Chinook salmon and steelhead in the Upper Yuba River Basin, MWAT values should be calculated for species-specific lifestage periods, on an annual basis over the monitoring or simulation period, and the probability that MWAT values exceed specified water temperature index values will be compared among rivers/reaches in the Upper Yuba River Basin.

The use of a single temperature measurement such as MWAT is convenient from a monitoring and regulatory standpoint, but oversimplifies the complex interactions between water temperature regimes and fish health which are affected by the duration of peak and daily average temperatures. Therefore, for the evaluation of acceptable water temperature-related reintroduction potential associated with spring-run Chinook salmon and steelhead in the Upper Yuba River Basin, it is recommended that both the MWAT, and ADT lifestage-specific exceedance durations, be compared with the UOWTI and UTWTI values.

8.4 7DMAVG

The 7-day moving average of maximum daily temperature (7DMAVG) serves as the basis for instream water temperature standards, including those of the Oregon Department of Environmental Quality (ODEQ). The reason for using the 7DMAVG is to decrease the effect of a single peak temperature on data interpretation. Aquatic organisms are affected more by exposure to high temperature over an extended period than to a single exceedance of the criteria. The ODEQ recognizes that not only summer maximum temperatures are of importance to aquatic biota. The intent is to protect the temperature regime through the year. Built into the ODEQ 7DMAVG standard is the assumption that if stream and riparian conditions are managed such that they meet the summer maximum criteria, those same conditions will protect the temperature regime of the stream through the year.

The 7DMAVG standard is based not on directly lethal temperatures (usually above 70°F), but on sub-lethal effects, which are numerous. Sub-lethal effects can lead to death indirectly, or they may reduce the ability of the fish to successfully reproduce and for their offspring to survive and grow. These sub-lethal effects include an increase in the incidence of disease, an inability to spawn, a reduced survival rate of eggs, a reduced growth and survival rate of juveniles, increased competition for limited habitat and food, reduced ability to compete with other species that are better adapted to higher temperatures (many of these are introduced species) and other adverse effects. Sub-lethal effects of temperature on salmonids occur gradually as stream temperatures increase.

In California, the 7DMAVG has been applied in effectiveness monitoring protocols (e.g. 2006 Green Diamond Resource Company Aquatic Habitat Conservation Plan/Candidate Conservation Agreement and Assurances) and other monitoring efforts (e.g., Upper Yuba River Studies Program 2006 Upper Yuba River Water Temperature Criteria for Chinook salmon and Steelhead). However, for the evaluation of water temperature-related reintroduction potential associated with spring-run Chinook salmon and steelhead in the Upper Yuba River Basin, 7DMAVG is not recommended as a metric.

9 WATER TEMPERATURE EVALUATION CONSIDERATIONS

For the evaluation of water temperatures acceptable for reintroduction of salmonids in the Upper Yuba River Basin, it is anticipated that water temperature modeling and/or monitoring will be applied for a comparison among rivers and reaches in the Upper Yuba River Basin. In addition to the application of the criteria and metrics as described in the preceding sections, it may be appropriate to consider other specific evaluation methodologies.

9.1 Water Year Type

Model output and/or monitoring data could be summarized by water year type. Comparisons of the water temperature-related potential among rivers and reaches in the Upper Yuba River Basin could include water year types. This would help identify reaches/lengths of river that would be suitable in all conditions (e.g., critically dry to wet years) as well as the lengths of river that would be suitable under more favorable conditions (e.g., wet water year types only).

9.2 Water Temperature Exceedance Curves

Model output and/or monitoring data also could be summarized by the calculation of water temperature exceedance curves, by month, occurring over the period of evaluation for each of the rivers and reaches. Exceedance curves are particularly useful for examining the probability of occurrence/duration of water temperatures. The evaluation approach could specifically evaluate the probabilities/duration of time that each of the identified lifestage-specific water temperature index values would be exceeded over the period of evaluation. Comparisons of the water temperature-related potential among rivers and reaches in the Upper Yuba River Basin could be made by presentation of monthly cumulative water temperature exceedance distribution probabilities (using average daily water temperatures) relative to specified water temperature index values corresponding to the appropriate months for each lifestage of spring-run Chinook salmon and steelhead.

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APPENDIX A

LIFESTAGE-SPECIFIC WATER TEMPERATURE BIOLOGICAL EFFECTS AND INDEX TEMPERATURE VALUES

STEELHEAD LIFESTAGE-SPECIFIC WATER TEMPERATURE INDEX VALUES

Adult Immigration and Holding

Water temperatures can control the timing of adult spawning migrations and can affect the viability of eggs in holding females. YCWA et al. (2007) suggests that few studies have been published examining the effects of water temperature on either steelhead immigration or steelhead holding, and none of the available studies were recent (Bruin and Waldsdorf 1975; McCullough *et al.* 2001). The available studies suggest that adverse effects occur to immigrating and holding steelhead at water temperatures exceeding the mid 50°F range, and that immigration will be delayed if water temperatures approach approximately 70°F (**Table 2**). Water temperature index values of 52°F, 56°F, 61°F, 65°F and 70°F were chosen because they provide a gradation of potential water temperature effects, and the available literature provided the strongest support for these values.

Because of the paucity of literature pertaining to steelhead adult immigration and holding, an evenly spaced range of water temperature index values could not be achieved. We also used some pertinent information related to other salmonids (e.g., Chinook salmon). 52°F was selected as a water temperature index value because it has been referred to as a "recommended" (Reclamation 2003), "preferred" (McEwan and Jackson 1996; NMFS 2000; NMFS 2002a), and "optimum" (Reclamation 1997a) water temperature for steelhead adult immigration. Increasing levels of thermal stress to this life stage may reportedly occur above the 52°F water temperature index value. 56°F was selected as a water temperature index value because 56°F represents a water temperature above which adverse effects to migratory and holding steelhead begin to arise (Bruin and Waldsdorf 1975; Leitritz and Lewis 1980; McCullough *et al.* 2001; Smith *et al.* 1983). 50-59°F is referred to as the "preferred" range of water temperatures for California summer steelhead holding (Moyle 1995). Whereas, water temperatures greater than 61°F may result in "chronic high stress" of holding Central Valley winter-run steelhead (USFWS 1995). 65°F was selected as a water temperature index value because steelhead (and fall-run Chinook salmon) encounter potentially stressful temperatures between 64.4-73.4°F (Richter and Kolmes 2005). Additionally, over 93% of steelhead detections occurred in the 65.3-71.6°F range, although this may be above the temperature for optimal immigration (Salinger and Anderson 2006) and/or may modify migration timing due to holding in coldwater refugia (High et al. 2006). 70°F was selected as the highest water temperature index value because the literature suggests that water temperatures near and above 70.0°F may result in a thermal barrier to adult steelhead migrating upstream (McCullough *et al.* 2001) and are water temperatures referred to as "stressful" to upstream migrating steelhead in the Columbia River (Lantz

1971 as cited in Beschta et al 1987). Further, Coutant (1972) found that the UILT for adult steelhead was 69.8°F and temperatures between 73-75°F are described as "lethal" to holding adult steelhead in Moyle (2002).

Spawning and Embryo Incubation

Relatively few studies have been published directly addressing the effects of water temperature on steelhead spawning and embryo incubation (Redding and Schreck 1979; Rombough 1988). Because anadromous steelhead and non-anadromous rainbow trout are genetically and physiologically similar, studies on non-anadromous rainbow trout also were considered in the development of water temperature index values for steelhead spawning and embryo incubation (Moyle 2002; McEwan 2001). From the available literature, water temperatures in the low 50°F range appear to support high embryo survival, with substantial mortality to steelhead eggs reportedly occurring at water temperatures in the high 50°F range and above (**Table 3**). Water temperatures in the 45-50°F range have been referred to as the "optimum" for spawning steelhead (FERC 1993).

Water temperature index values of 46°F , 52°F, 54°F, 57°F, and 60°F were selected for two reasons. First, the available literature provided the strongest support for water temperature index values at or near 46°F, 52°F, 54°F, 57°F, and 60°F. Second, the index values reflect a gradation of potential water temperature effects ranging between optimal to lethal conditions for steelhead spawning and embryo incubation. Some literature suggests water temperatures ≤ 50°F are when steelhead spawn (Orcutt et al. 1968) and/or are optimal for steelhead spawning and embryo survival (FERC 1993; Myrick and Cech 2001; Timoshina 1972) and temperatures between 39-52°F are "preferred" by spawning steelhead (IEP Steelhead Project Work Team (no date); McEwan and Jackson 1996), a larger body of literature suggests optimal conditions occur at water temperatures ≤ 52°F (Humpesch 1985; NMFS 2000; NMFS 2001a; NMFS 2002a; Reclamation 1997b; SWRCB 2003; USFWS 1995a). Further, water temperatures between 48-52°F were referred to as "optimal" (FERC 1993; McEwan and Jackson 1996; NMFS 2000) and "preferred" (Bell 1986) for steelhead embryo incubation. Therefore, 52°F was selected as the lowest water temperature index value. Increasing levels of thermal stress to the steelhead spawning and embryo incubation life stage may reportedly occur above the 52°F water temperature index value.

54°F was selected as the next index value, because although most of the studies conducted at or near 54.0°F report high survival and normal development (Kamler and Kato 1983; Redding and Schreck 1979; Rombough 1988), some evidence suggests that symptoms of thermal stress arise at or near 54.0°F (Humpesch 1985; Timoshina 1972). Thus, water temperatures near 54°F may represent an inflection point between properly

functioning water temperature conditions, and conditions that cause negative effects to steelhead spawning and embryo incubation. Further, water temperatures greater than 55°F were referred to as "stressful" for incubating steelhead embryos (FERC 1993). 57°F was selected as an index value because embryonic mortality increases sharply and development becomes retarded at incubation temperatures greater than or equal to 57.0°F. Velsen (1987) provided a compilation of data on rainbow trout and steelhead embryo mortality to 50% hatch under incubation temperatures ranging from 33.8°F to 60.8°F that demonstrated a two-fold increase in mortality for embryos incubated at 57.2°F, compared to embryos incubated at 53.6°F. In a laboratory study using gametes from Big Qualicum River, Vancouver Island, steelhead mortality increased to 15% at a constant temperature of 59.0°F, compared to less than 4% mortality at constant temperatures of 42.8°F, 48.2°F, and 53.6°F (Rombough 1988). Also, alevins hatching at 59.0°F were considerably smaller and appeared less well developed than those incubated at the lower temperature treatments. From fertilization to 50% hatch, Big Qualicum River steelhead had 93% mortality at 60.8°F, 7.7% mortality at 57.2°F, and 1% mortality at 47.3°F and 39.2°F (Velsen 1987). Myrick and Cech (2001) similarly described water temperatures >59°F as "lethal" to incubating steelhead embryos, although FERC (1993) suggested that water temperatures exceeding 68°F were "stressful" to spawning steelhead and "lethal" when greater than 72°F.

Juvenile Rearing & Downstream Movement

Water temperature index values were developed to evaluate the combined steelhead rearing (fry and juvenile) and juvenile downstream movement lifestages. Some steelhead may rear in freshwater for up to three years before emigrating as yearling+ smolts, whereas other individuals move downstream shortly after emergence as post-emergent fry, or rear in the river for several months and move downstream as juveniles without exhibiting the ontogenetic characteristics of smolts. Presumably, these individuals continue to rear and grow in downstream areas (e.g., lower Feather River, Sacramento River, and Upper Delta) and undergo the smoltification process prior to entry into saline environments. Thus, fry and juvenile rearing occur concurrently with post-emergent fry and juvenile downstream movement and are assessed in this Technical Memorandum using the fry and juvenile rearing water temperature index values.

The growth, survival, and successful smoltification of juvenile steelhead are controlled largely by water temperature. The duration of freshwater residence for juvenile steelhead is long relative to that of Chinook salmon, making the juvenile life stage of steelhead more susceptible to the influences of water temperature, particularly during the over-summer rearing period. Central Valley juvenile steelhead have high growth

rates at water temperatures in the mid 60°F range, but reportedly require lower water temperatures to successfully undergo the transformation to the smolt stage.

Water temperature index values of 63°F, 65°F, 68°F, 72°F, and 75°F were selected to represent a gradation of potential water temperature effects ranging between optimal to lethal conditions for steelhead juvenile rearing (Table 4). The lowest water temperature index value of 63°F was established because Myrick and Cech (2001) describe 63°F as the "preferred" water temperature for wild juvenile steelhead, whereas "preferred" water temperatures for juvenile hatchery steelhead reportedly range between 64-66°F. 65°F was also identified as a water temperature index value because NMFS (2000; 2002a) reported 65°F as the upper limit preferred for growth and development of Sacramento and American River juvenile steelhead. Also, 65°F was found to be within the optimum water temperature range for juvenile growth (i.e., 59-66°F) (Myrick and Cech 2001), and supported high growth of Nimbus strain juvenile steelhead (Cech and Myrick 1999).

Increasing levels of thermal stress to this life stage may reportedly occur above the 65°F water temperature index value. For example, Kaya *et al.* (1977) reported that the upper avoidance water temperature for juvenile rainbow trout was measured at 68°F to 71.6°F. Cherry *et al.* (1977) observed an upper preference water temperature near 68.0°F for juvenile rainbow trout, duplicating the upper preferred limit for juvenile steelhead observed in Cech and Myrick (1999) and FERC (1993). Empirical adult *O. mykiss* population data from the North Yuba, Middle Yuba, South Yuba, Middle Fork American, and Rubicon rivers collected in 2007-2009 are plotted against temperature in Figure 4. The temperature used was the 8th largest average daily temperature during the summer (i.e., up to seven days had higher daily average temperatures). The data show a population density break at about 68.0°F. Although smaller population densities occurred at higher temperatures, the largest population densities occurred at temperatures near 68.0°F or less. In addition Figure 5 shows growth for a 200 mm juvenile O. mykiss versus temperature for three food levels (percent of maximum consumption = 30%, 50%, and 70%). The average empirically derived percent of maximum consumption in an adjacent watershed (Middle Fork American Fork River) was 50% (Hanson et al. 1997). Positive growth only occurs up to approximately 68°F. Because of the literature describing 68.0°F as both an upper preferred and an avoidance limit for juvenile *Oncorhynchus mykiss*, and because of the empirical fish population data and bioenergetics growth data, 68°F was established as a upper tolerable water temperature index value.

A water temperature index value of 72°F was established because symptoms of thermal stress in juvenile steelhead have been reported to arise at water temperatures approaching 72°F. For example, physiological stress to juvenile steelhead in Northern

California streams was demonstrated by increased gill flare rates, decreased foraging activity, and increased agonistic activity as stream temperatures rose above 71.6°F (Nielsen *et al.* 1994). Also, 72°F was selected as a water temperature index value because 71.6°F has been reported as an upper avoidance water temperature (Kaya *et al.* 1977) and an upper thermal tolerance water temperature (Ebersole *et al.* 2001) for juvenile rainbow trout. The highest water temperature index value of 75°F was established because NMFS and EPA report that direct mortality to rearing juvenile steelhead results when stream temperatures reach 75.0°F (EPA 2002; NMFS 2001b). Water temperatures >77°F have been referred to as "lethal" to juvenile steelhead (FERC 1993; Myrick and Cech 2001). The UILT for juvenile rainbow trout, based on numerous studies, is between 75-79°F (Sullivan et al. 2000; McCullough 2001).

Yearling + Smolt Emigration

Laboratory data suggest that smoltification, and therefore successful emigration of steelhead smolts, is directly controlled by water temperature (Adams *et al.* 1975) (**Table 5**). Water temperature index values of 52°F and 55°F were selected to evaluate the steelhead smolt emigration life stage, because most literature on water temperature effects on steelhead smolting suggest that water temperatures less than 52°F (Adams *et al.* 1975; Myrick and Cech 2001; Rich 1987a) or less than 55°F (EPA 2003a; McCullough *et al.* 2001; Wedemeyer *et al.* 1980; Zaugg and Wagner 1973) are required for successful smoltification to occur. (Adams *et al.* 1973) tested the effect of water temperature (43.7°F, 50.0°F, 59.0°F or 68.0°F) on the increase of gill microsomal Na^+-, K^+-stimulated ATPase activity associated with parr-smolt transformation in steelhead and found a two-fold increase in Na^+-, K^+-ATPase at 43.7 and 50.0°C, but no increase at 59.0°F or 68.0°F. In a subsequent study, the highest water temperature where a parr-smolt transformation occurred was at 52.3°F (Adams *et al.* 1975). The results of Adams *et al.* (1975) were reviewed in Myrick and Cech (2001) and Rich (1987b), which both recommended that water temperatures below 52.3°F are required to successfully complete the parr-smolt transformation. Further, Myrick and Cech (2001) suggest that water temperatures between 43-50°F are the "physiologically optimal" temperatures required during the parr-smolt transformation and necessary to maximize saltwater survival. The 52°F water temperature index value established for the steelhead smolt emigration life stage is the index value generally reported in the literature as the upper limit of the water temperature range that provides successful smolt transformation thermal conditions. Increasing levels of thermal stress to this life stage may reportedly occur above the 52°F water temperature index value.

Zaugg and Wagner (1973) examined the influence of water temperature on gill ATPase activity related to parr-smolt transformation and migration in steelhead. They found ATPase activity was decreased and migration reduced when juveniles were exposed to

water temperatures of 55.4°F or greater. In a technical document prepared by the EPA to provide temperature water quality standards for the protection of Northwest native salmon and trout, water temperatures less than or equal to 54.5°F were recommended for emigrating juvenile steelhead (EPA 2003b). Water temperatures are considered "unsuitable" for steelhead smolts at >59°F (Myrick and Cech 2001) and "lethal" at 77°F (FERC 1993).

CHINOOK SALMON LIFESTAGE-SPECIFIC WATER TEMPERATURE INDEX VALUES

It has been suggested that separate water temperatures standards should be developed for each run-type of Chinook salmon. For example, McCullough (1999) states that spring-run Chinook salmon immigrate in spring and spawn in 3rd to 5th order streams and, therefore, face different migration and adult holding temperature regimes than do summer- or fall-run Chinook salmon, which spawn in streams of 5th order or greater. However, to meet the objectives of the current literature review, run-types are not separated because: (1) there is a paucity of literature specific to each life stage of each run-type; (2) there is an insufficient amount of data available in the literature suggesting that Chinook salmon run-types respond to water temperatures differently; (3) the WTI values derived from all the literature pertaining to Chinook salmon for a particular life stage will be sufficiently protective of that life stage for each run-type; and (4) all run-types overlap in timing of adult immigration and holding and in some cases are not easily distinguished (Healey 1991). Nonetheless, water temperature relationships for each lifestage of spring-run Chinook salmon available in the literature are emphasized in the consideration and identification of WTI values for evaluation of reintroduction of spring-run Chinook salmon in the Upper Yuba River Basin.

Adult Immigration and Holding

The adult immigration and adult holding life stages are evaluated together, because it is difficult to determine the thermal regime that Chinook salmon have been exposed to in the river prior to spawning and in order to be sufficiently protective of pre-spawning fish, water temperatures that provide high adult survival and high egg viability must be available throughout the entire pre-spawning freshwater period. Although studies examining the effects of thermal stress on immigrating Chinook salmon are generally lacking, it has been demonstrated that thermal stress during the upstream spawning migration of sockeye salmon negatively affected the secretion of hormones controlling sexual maturation causing numerous reproductive impairment problems (McCullough *et al.* 2001).

The water temperature index values reflect a gradation of potential water temperature effects that range between those reported as "optimal" to those reported as "lethal" for adult Chinook salmon during upstream spawning migrations and holding. The water temperature index values established for the Chinook salmon adult immigration and holding lifestage are 61°F, 65°F, and 68°F (**Table 6)**. Although 56°F is referenced in the literature frequently as the upper "optimal" water temperature limit for upstream migration and holding, the references are not foundational studies and often are inappropriate citations. For example, Boles *et al.* (1988), Marine (1992), and NMFS (1997b) all cite Hinze (1959) in support of recommendations for a water temperature of 56°F for adult Chinook salmon immigration. However, Hinze (1959) is a study examining the effects of water temperature on incubating Chinook salmon eggs in the American River Basin. Further, water temperatures between 38-56°F are considered to represent the "observed range" for upstream migrating spring-run Chinook salmon (Bell 1986).

The lowest water temperature index value established was 61°F, because in the NMFS biological opinion for the proposed operation of the Central Valley Project (CVP) and State Water Project (SWP), 59°F to 60°F is reported as…"*The upper limit of the optimal temperature range for adults holding while eggs are maturing*" (NMFS 2000). Also, NMFS (1997b) states…"*Generally, the maximum temperature of adults holding, while eggs are maturing, is about 59°F to 60°F*" …and… "*Acceptable range for adults migrating upstream range from 57°F to 67°F*." ODEQ (1995) reports that "…*many of the diseases that commonly affect Chinook become highly infectious and virulent above 60°F*." Study summaries in EPA (2003) indicate disease risk is high at 62.6°F. Additionally, Ward and Kier (1999) designated temperatures <60.8°F as an "optimum" water temperature threshold for holding Battle Creek spring-run Chinook salmon. EPA (2003) chose a holding value of 61°F (7DADM) based on laboratory data various assumptions regarding diel temperature fluctuations. 61°F is also a holding temperature index value for steelhead (see above). The 61°F water temperature index value established for the Chinook salmon adult immigration and holding life stage is the index value generally reported in the literature as the upper limit of the optimal range, and is within the reported acceptable range. Increasing levels of thermal stress to this life stage may reportedly occur above the 61°F water temperature index value.

An index value of 65°F was established because Berman (1990) suggests effects of thermal stress to pre-spawning adults are evident at water temperatures near 65°F. Berman (1990) conducted a laboratory study to determine if pre-spawning water temperatures experienced by adult Chinook salmon influenced reproductive success, and found evidence suggesting latent embryonic abnormalities associated with water temperature exposure to pre-spawning adults that ranged from 63.5°F to 66.2°F. Ward

et al. (2003; 2004) identified an extended period of average daily temperatures above 67°F during July as measured at the Quartz Bowl that preceded the onset of significant pre-spawn mortalities. During 2002, temperatures exceeded 67°F a total of 16 days with a maximum of 20.8°C on July 12. During 2003, temperatures exceed 67°F a total of 11 days with a maximum of 20.9°C on July 23. However during other years when there were minimal pre-spawn mortalities, maximum daily average water temperature at Quartz Bowl never exceeded 67°F more than an few days (Ward et al. 2004; Ward et al. 2006; Ward et al. 2007; McReynolds and Garman 2008; McReynolds and Garman 2010). During each of the years when Chinook salmon temperature mortality was not observed at Butte Creek (2001, 2004-2007), on average, daily temperature did not exceed 65.8°F for more than 7 days (Figure 6). Tracy McReynolds (Pers. Comm. October 2011) indicated that an upper tolerable holding temperature of 65°F was reasonable based on her experience.

An index value of 68°F was established because the Butte Creek data and the literature suggests that thermal stress at water temperatures greater than 68°F is pronounced, and severe adverse effects to immigrating and holding pre-spawning adults, including mortality, can be expected (Berman 1990; Marine 1997; NMFS 1997b; Ward et al. 2004).

Water temperatures between 70-77°F are reported as the range of maximum temperatures for holding pool conditions used by spring-run Chinook salmon in the Sacramento-San Joaquin system (Moyle et al. 1995). Migration blockage occurs for Chinook salmon at temperatures from 70-71+°F (McCollough 1999; McCullough et al. 2001; EPA 2003b). Strange (2010) found that the mean average body temperature during the first week of Chinook salmon migration on the Klamath River was 71.4°F. The UILT for Chinook salmon jacks is 69.8-71.6°F (McCullough 1999). The upper limit for spring-run Chinook salmon holding in Deer Creek is reportedly 80.6°F, at which point temperatures exceeding this value become “lethal” (Cramer and Hammack (1952), as cited in Moyle et al. (1995). As a result of the potential effects to immigrating and holding adult Chinook salmon that reportedly occur at water temperatures greater than or equal to 68°F, index values higher than 68°F were not established.

Spawning and Embryo Incubation

The adult spawning and embryo (i.e., eggs and alevins) incubation life stage includes redd construction, egg deposition, and embryo incubation. Potential effects to the adult spawning and embryo incubation life stages are evaluated together using one set of water temperature index values because it is difficult to separate the effects of water temperature between lifestages that are closely linked temporally, especially considering that studies describing how water temperature affects embryonic survival

and development have included a pre-spawning or spawning adult component in the reporting of water temperature experiments conducted on fertilized eggs (Marine 1992; McCullough 1999; Seymour 1956).

The water temperature index values selected for the Chinook salmon spawning and embryo incubation life stages are 56°F, 58°F, 60°F, and 62°F (**Table 7**). Anomalously, FERC (1993) refers to 50°F as the "optimum" water temperature for spawning and incubating Chinook salmon. Additionally, for the adult spawning lifestage, FERC (1993) reports "stressful" and "lethal" water temperatures occuring at >60°F and >70°F, respectively, whereas for incubating Chinook salmon embryos, water temperatures are considered to be "stressful" at <56°F or "lethal" at >60°F. Much literature suggests that water temperatures must be less than or equal to 56°F for maximum survival of Chinook salmon embryos (i.e., eggs and alevins) during spawning and incubation. NMFS (1993b) reported that optimum water temperatures for egg development are between 43°F and 56°F. Similarly, Myrick and Cech (2001) reported the highest egg survival rates occur between water temperatures of 39-54°F. Reclamation (unpublished work) reports that water temperatures less than 56°F results in a natural rate of mortality for fertilized Chinook salmon eggs. Bell (1986) recommends water temperatures ranging between 42-57°F for spawning Chinook salmon, and water temperatures between 41-58°F for incubating embryos. USFWS (1995a) reported a water temperature range of 41.0°F to 56.0°F for maximum survival of eggs and yolk-sac larvae in the Central Valley of California. The preferred water temperature range for Chinook salmon egg incubation in the Sacramento River was suggested as 42.0°F to 56.0°F (NMFS 1997a). Alevin mortality is reportedly significantly higher when Chinook salmon embryos are incubated at water temperatures above 56°F (USFWS 1999). NMFS (2002a) reported 56.0°F as the upper limit of suitable water temperatures for spring-run Chinook salmon spawning in the Sacramento River. The 56°F water temperature index value established for the Chinook salmon spawning and embryo incubation life stage is the index value generally reported in the literature as the upper limit of the optimal range for egg development and the upper limit of the range reported to provide maximum survival of eggs and yolk-sac larvae in the Central Valley of California. Increasing levels of thermal stress to this life stage may reportedly occur above the 56°F water temperature index value.

High survival of Chinook salmon embryos also has been suggested to occur at incubation temperatures at or near 58.0°F. For example, (Reclamation Unpublished Work) reported that the natural rate of mortality for alevins occurs at 58°F or less. Combs (1957) concluded constant incubation temperatures between 42.5°F and 57.5°F resulted in normal development of Chinook salmon eggs, and NMFS (2002a) suggests 53.0°F to 58.0°F is the preferred water temperature range for Chinook salmon eggs and fry.

Johnson (1953) found consistently higher Chinook salmon egg losses resulted at water temperatures above 60.0°F than at lower temperatures. In order to protect late incubating Chinook salmon embryos and newly emerged fry NMFS (1993a) has determined a water temperature criterion of less than or equal to 60.0°F be maintained in the Sacramento River from Keswick Dam to Bend Bridge from October 1 to October 31. Seymour (1956) provides evidence that 100% mortality occurs to late incubating Chinook salmon embryos when held at a constant water temperature greater than or equal to 60.0°F. For Chinook salmon eggs incubated at constant temperatures, mortality increases rapidly at temperatures greater than about 59-60°F (see data plots in Myrick and Cech 2001). Olsen and Foster (1957), however, found high survival of Chinook salmon eggs and fry (89.6%) when incubation temperatures started at 60.9°F and declined naturally for the Columbia River (about 7°F / month). Geist et al. (2006) found high (93.8%) Chinook salmon incubation survival through emergence for naturally declining temperatures (0.36°F/day) starting as high as 61.7°F; however, a significant reduction in survival occurred above this temperature.

The literature largely agrees that 100% mortality will result to Chinook salmon embryos incubated at water temperatures greater than or equal to 62.0°F (Hinze 1959; Myrick and Cech 2003; Seymour 1956; USFWS 1999). Approximately 80% or greater mortality of eggs incubated at constant temperatures of 63°F or greater (see data plots in Myrick and Cech 2001). Olsen and Foster (1957) found high mortality of Chinook salmon eggs and fry (79%) when incubation temperatures started at 65.2°F and declined naturally for the Columbia River (about 7°F / month). Geist et al. (2006) found low Chinook salmon incubation survival (1.7%) for naturally declining temperatures (0.36°F/day) when temperatures started at 62.6°F

Juvenile Rearing & Downstream Movement

Water temperature index values were identified for the combined spring-run Chinook salmon rearing (fry and juvenile) and juvenile downstream movement lifestages, for the reasons previously described regarding steelhead. Fry and juvenile rearing occur concurrently with post-emergent fry and juvenile downstream movement, and are assessed in this Technical Memorandum using the fry and juvenile rearing water temperature index values.

The water temperature index values of 60°F, 65°F, 68°F, 70°F and 75°F were identified for the spring-run Chinook salmon juvenile rearing and downstream movement lifestage. The lowest index value of 60°F was chosen because regulatory documents as well as several source studies, including ones recently conducted on Central Valley Chinook salmon fry and juveniles report 60°F as an optimal water temperature for growth (Banks *et al.* 1971; Brett *et al.* 1982; Marine 1997; NMFS 1997b; NMFS 2000;

NMFS 2001a; NMFS 2002a; Rich 1987b) (**Table 8**). Water temperatures below 60°F also have been reported as providing conditions optimal for fry and fingerling growth, but were not selected as index values, because the studies were conducted on fish from outside of the Central Valley (Brett 1952; Seymour 1956). Studies conducted using local fish may be particularly important because *Oncorhynchus* species show considerable variation in morphology, behavior, and physiology along latitudinal gradients (Myrick 1998; Taylor 1990b; Taylor 1990a). More specifically, it has been suggested that salmonid populations in the Central Valley prefer higher water temperatures than those from more northern latitudes (Myrick and Cech 2000).

The 60°F water temperature index value established for the Chinook salmon juvenile rearing and downstream movement life stage is the index value generally reported in the literature as the upper limit of the optimal range for fry and juvenile growth and the upper limit of the preferred range for growth and development of spring-run Chinook salmon fry and fingerlings. FERC (1993) referred to 58°F as an "optimum" water temperature for juvenile Chinook salmon in the American River. NMFS (2002a) identified 60°F as the "preferred" water temperature for juvenile spring-run Chinook salmon in the Central Valley. Increasing levels of thermal stress to this life stage may reportedly occur above the 60°F water temperature index value.

The index value of 65°F was selected because it represents an intermediate value between 64.0°F and 66.2°F, at which both adverse and beneficial effects to juvenile salmonids have been reported to occur. For example, at temperatures approaching and beyond 65°F, sub-lethal effects associated with increased incidence of disease reportedly become severe for juvenile Chinook salmon (EPA 2003a; Johnson and Brice 1953; Ordal and Pacha 1963; Rich 1987a). Conversely, numerous studies report that temperatures between 64.0°F and 66.2°F provide conditions ranging from suitable to optimal for juvenile Chinook salmon growth (Brett *et al.* 1982; Cech and Myrick 1999; Clarke and Shelbourn 1985; EPA 2003a; Myrick and Cech 2001; NMFS 2002a; USFWS 1995a). Maximum growth of juvenile fall-run Chinook salmon has been reported to occur in the American River at water temperatures between 56-59°F (Rich 1987) and in Nimbus Hatchery spring-run Chinook salmon at 66°F (Cech and Myrick 1999). Figure 5 shows growth for a 100 mm juvenile Chinook salmon versus temperature for three food levels (percent of maximum consumption = 30%, 50%, and 70%). The average percent of maximum consumption in an adjacent watershed (Middle Fork American Fork River) for O. *mykiss* was 50% (Hanson et al. 1997). Positive growth only occurs up to approximately 64°F for food levels expected in the wild (e.g., 50% maximum consumption).

A water temperature index value of 68°F was selected because, at water temperatures above 68°F, sub-lethal effects become severe such as reductions in appetite and growth

of juveniles (Marine 1997; Rich 1987a; Zedonis and Newcomb 1997). Chronic stress associated with water temperature can be expected when conditions reach the index value of 70°F. For example, growth becomes drastically reduced at temperatures close to 70.0°F and has been reported to be completely prohibited at 70.5°F (Brett *et al.* 1982; Marine 1997). 75°F was chosen as the highest water temperature index value because high levels of direct mortality to juvenile Chinook salmon reportedly result at this water temperature (Cech and Myrick 1999; Hanson 1991; Myrick and Cech 2001; Rich 1987b). Other studies have suggested higher upper lethal water temperature levels (Brett 1952; Orsi 1971), but 75°F was chosen because it was derived from experiments using Central Valley Chinook salmon and it is a more rigorous index value representing a more protective upper lethal water temperature level. Furthermore, the lethal level determined in Rich (1987b) was derived using slow rates of water temperature change and, thus, is ecologically relevant. The juvenile Chinook Salmon UILT based on numerous studies is 75-77°F (Sullivan et al. 2000; McCullough et al. 2001; Myrick and Cech 2001)

Yearling + Smolt Emigration

Juvenile Chinook salmon that exhibit extended rearing in the lower Yuba River are assumed to undergo the smoltification process and volitionally emigrate from the river as yearling+ individuals. Water temperature index values of 63°F, 68°F and 72°F were selected for the spring-run Chinook yearling+ emigration lifestage (**Table 9)**.

A water temperature index value of 63°F was selected because water temperatures at or below this value allow for successful transformation to the smolt stage, and water temperatures above this value may result in impaired smoltification indices, inhibition of smolt development, and decreased survival and successful smoltification of juvenile spring-run Chinook salmon. Laboratory experiments suggest that water temperatures at or below 62.6°F provide conditions that allow for successful transformation to the smolt stage (Clarke and Shelbourn 1985; Marine 1997; Zedonis and Newcomb 1997). 62.6°F was rounded and used to support an index value of 63°F. Indirect evidence from tagging studies suggests that the survival of fall-run Chinook salmon smolts decreases with increasing water temperatures between 59°F and 75°F in the Sacramento-San Joaquin Delta (Kjelson and Brandes 1989). A water temperature index value of 68°F was selected because water temperatures above 68°F prohibit successful smoltification (Marine 1997; Rich 1987a; Zedonis and Newcomb 1997). Support for an index value of 72°F is provided from a study conducted by (Baker *et al.* 1995) in which a statistical model is presented that treats survival of Chinook salmon smolts fitted with coded wire tags in the Sacramento River as a logistic function of water temperature. Using data obtained from mark-recapture surveys, the statistical model suggests a 95% confidence

interval for the upper incipient lethal water temperature for Chinook salmon smolts as 71.5°F to 75.4°F.

PHONE CALL MEMORANDUM

Topic	Protocol if Chinook are in sluicegate channel
Date	October 20, 2016
From	Gretchen Murphey, California Department of Fish and Wildlife
To	Jason Guignard, FISHBIO, consultant to the Districts
Summary of Discussion	Ms. Murphey and Mr. Guignard discussed the protocol to follow if Chinook are observed in the sluicegate channel after a release. Ms. Murphey said CDFW are not concerned with Chinook being in the sluicegate channel as long as there is adequate flow to prevent stranding. Ms. Murphey said to continue monitoring the sluiceway for Chinook, and that relocation should only be considered if dewatering becomes a concern.

Deason, Jesse

From: Staples, Rose
Sent: Friday, October 21, 2016 3:34 PM
Cc: Deason, Jesse; Le, Bao; Staples, Rose
Subject: FW: Availability for Next La Grange Temp Criteria Subcommittee Meeting

The following message was sent to the La Grange Temperature Criteria Subcommittee today regarding their availability for the next subcommittee meeting.

Rose Staples, CAP-OM, MOS
D 207-239-3857

hdrinc.com/follow-us

From: Staples, Rose
Sent: Friday, October 21, 2016 6:10 PM
Cc: Deason, Jesse <jesse.deason@hdrinc.com>; 'Le, Bao' <Bao.Le@hdrinc.com>; Staples, Rose (Rose.Staples@hdrinc.com) <Rose.Staples@hdrinc.com>
Subject: Availability for Next La Grange Temp Criteria Subcommittee Meeting

Temperature Criteria Subcommittee Members,

Please visit the Doodle link below and provide your availability to participate in the next Reintroduction Assessment Framework - Temperature Criteria Subcommittee meeting. We plan to review the updated temperature literature review and begin discussing water temperature index values/metrics for assessing thermal suitability applicable to species identified for reintroduction or expansion.

The four-hour timeframes used in the Doodle poll are to allow for a meeting plus travel time—though we have yet to confirm interest in the next meeting being in-person or as a conference call.

http://doodle.com/poll/ie77qnxn8reabyii

Thank you.

Rose Staples, CAP-OM, MOS
Executive Assistant

HDR
970 Baxter Boulevard Suite 301
Portland ME 04103
D 207-239-3857
rose.staples@hdrinc.com

hdrinc.com/follow-us

From: Lonnie Moore <lmoorenorcal@gmail.com>
Date: October 21, 2016 at 1:48:35 PM PDT
To: "Le, Bao" <ChiBao.Le@hdrinc.com>
Subject: Re: "Bradovich" document? Copy?

Thanks Bao!

Lonnie

Deason, Jesse

From:	Le, Bao
Sent:	Thursday, October 20, 2016 2:19 PM
To:	Lonnie Moore
Cc:	Deason, Jesse
Subject:	RE: "Bradovich" document? Copy?
Attachments:	Bratovich et al_2012_Water Temp Considerations for Yuba.pdf

Here you go, Lonnie.

From: Lonnie Moore [mailto:lmoorenorcal@gmail.com]
Sent: Thursday, October 20, 2016 2:13 PM
To: Le, Bao
Subject: "Bradovich" document? Copy?

Hi Bao,

On the Goals conference call today, you mentioned the "Bradovich" document? Would you please also send me a copy of that document?

Thanks,
Lonnie

--
Lonnie Moore
Consultant
Office: 209-551-5958
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Water Temperature Considerations for Yuba River Basin Anadromous Salmonid Reintroduction Evaluations

Prepared for:

Yuba Salmon Forum Technical Working Group

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1 INTRODUCTION

The Yuba Salmon Forum (YSF) is a multi-stakeholder group addressing the opportunities for reintroducing anadromous salmonids (i.e., spring-run Chinook salmon and steelhead) in the Upper Yuba River Basin upstream of Englebright Dam.

The YSF stakeholder group is comprised of representatives from National Marine Fisheries Service (NMFS), U.S. Forest Service (USFS), California Department of Fish and Game (CDFG), the Yuba County Water Agency (YCWA), Placer County Water Agency (PCWA) and a group of the non-governmental organizations (NGOs) including Trout Unlimited, American Rivers, The Bay Institute, Sierra Club, California Sport Fishing Protection Alliance, and South Yuba River Citizens League. The YSF is comprised of a Plenary Group and a Technical Working Group (TWG). The purpose of the TWG is to address technical issues associated with anadromous salmonid reintroduction. One of the technical issues addressed by the TWG includes water temperature considerations for the reintroduction of anadromous salmonids into the Upper Yuba River Basin.

2 TECHNICAL MEMORANDUM PURPOSE AND OBJECTIVES

The overall purpose of this Technical Memorandum is to establish the technical basis to evaluate water temperature regimes for spring-run Chinook salmon and steelhead reintroduction in the various rivers and reaches of the Upper Yuba River Basin (North Yuba River upstream of New Bullards Bar Reservoir, North Yuba River downstream of New Bullards Bar Dam to the high water mark of Englebright Reservoir, Middle Yuba River, and South Yuba River) **(Figure 1)**.

Specific objectives are to: (1) conduct a comprehensive literature review of lifestage-specific water temperature relationships; (2) identify a suite of water temperature index (WTI) values representing a summarization of the literature review; (3) select water temperature criteria for each species-specific lifestage for reintroduction evaluation; and (4) identify the water temperature evaluation methodological approach (water temperature metrics and metric application to water temperature monitoring and/or modeling data).

NMFS commented (NOAA Memorandum dated January 18, 2012) on the November 2011 version of this technical memorandum, stating that it should demonstrate the need for new criteria in consideration of criteria previously developed by Stillwater Sciences (2006). In summary, this technical memorandum differs from Stillwater Sciences (2006) in some lifestage periodicities (e.g., spring-run Chinook salmon spawning (Sep – mid Nov vs. Sep – Oct), and embryo incubation (Sep – Feb vs. late Sep – Jan). Notably,

Stillwater Sciences (2006) assumed that juvenile spring-run Chinook salmon in the Upper Yuba River Basin *"…would not typically over-summer due to excessively high summer water temperatures*." By contrast, this technical memorandum assumes that juvenile rearing in the Upper Yuba River Basin could occur year-round. In addition, this technical memorandum identifies spring-run Chinook salmon smolt emigration potentially occurring from November through mid-May, whereas Stillwater Sciences (2006) did not identify spring-run Chinook salmon smolt emigration as a lifestage to be addressed. Similarly, Stillwater Sciences (2006) did not identify smolt emigration as a steelhead lifestage to be addressed. In addition to lifestage periodicities, this technical memorandum identifies upper optimum and upper tolerance water temperature index values to be used in the evaluation of water temperature suitability for reintroduction of spring-run Chinook salmon and steelhead into the Upper Yuba River Basin, whereas Stillwater Sciences (2006) identified optimal, suboptimal, and chronic-to-acute stress water temperature index values. These categories are not directly comparable, and the actual values also differ between the two reports.

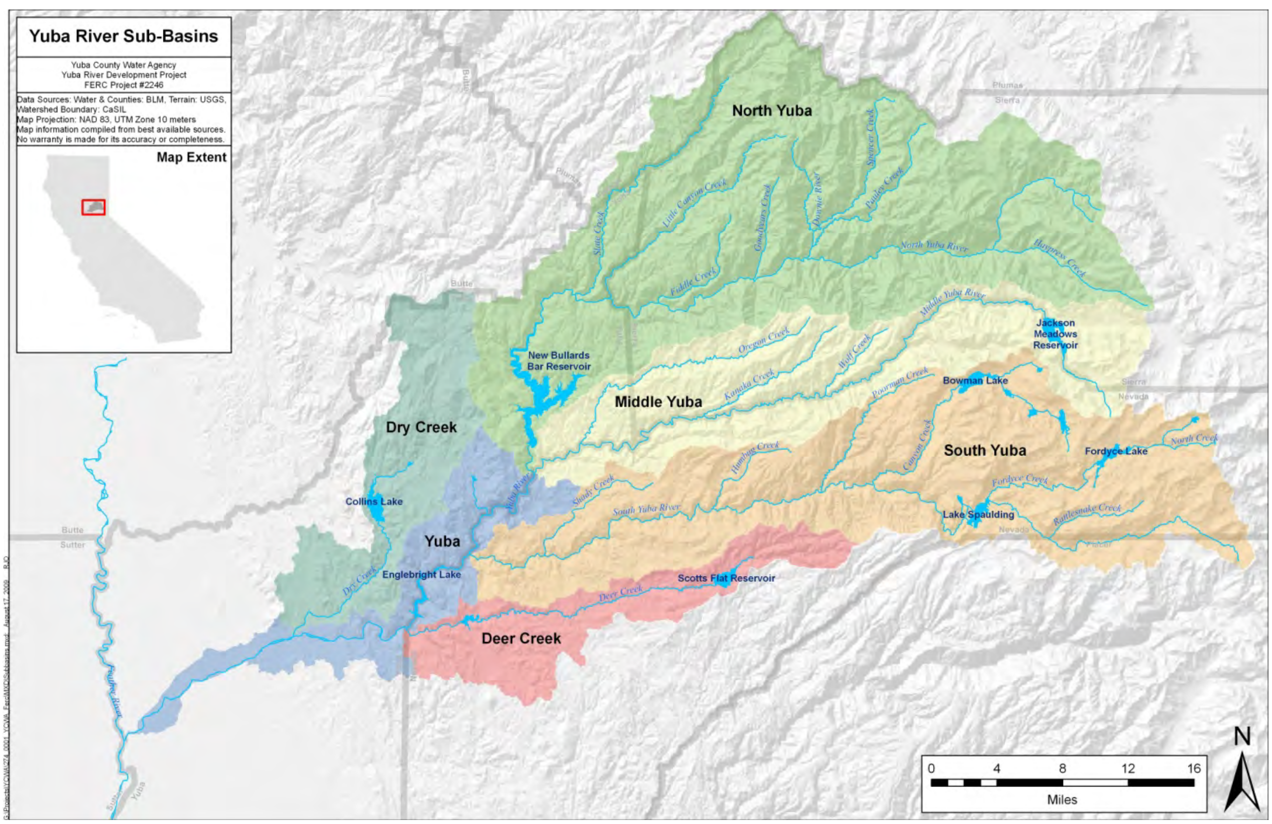

Figure 1. Sub-basins of the Yuba River Basin (source: Yuba County Water Agency 2010).

3 LIFESTAGE PERIODICITIES OF ANADROMOUS SALMONIDS

Lifestage-specific water temperature considerations for spring-run Chinook salmon and steelhead were addressed by the TWG in the evaluation of anadromous reintroduction in the Upper Yuba River Basin. A review of previously conducted studies, as well as recent and currently ongoing data collection activities by the Yuba Accord Monitoring and Evaluation Program (M&E Program) in the lower Yuba River was conducted to identify species- and lifestage-specific temporal periodicities for water temperature considerations. The TWG agreed on the spring-run Chinook salmon and steelhead lifestage periodicities presented in **Table 1** for reintroduction consideration in the Upper Yuba River Basin during a meeting held May 20, 2011. However, it was noted that these periodicities reflect existing conditions in the lower Yuba River, and that lifestage periodicities may change in response to local adaptation over time. It was further noted that although some lifestages may occur concurrently, the periodicities presented in Table 1 reflect specific consideration for water temperature evaluation for reintroduction. For example, spring-run Chinook salmon holding continues to occur during September, even though spawning activity begins during that month.

Table 1. Lifestage-Specific Periodicities for Spring-run Chinook Salmon and Steelhead in the Lower Yuba River.

Lifestage	Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Sep		Oct		Nov		Dec	
Spring-Run Chinook Salmon																								
Adult Immig. & Holding							■	■	■	■	■	■	■	■	■	■								
Spawning																	■	■	■	■	■			
Embryo Incubation	■	■	■	■													■	■	■	■	■	■	■	■
Juv. Rearing & Outmig.	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Yearling+ Smolt Emig.	■	■	■	■	■	■	■	■	■												■	■	■	■
Steelhead																								
Adult Immig. & Holding	■	■	■	■	■	■									■	■	■	■	■	■	■	■	■	■
Spawning	■	■	■	■	■	■	■	■																
Embryo Incubation	■	■	■	■	■	■	■	■	■	■														
Juv. Rearing & Outmig.	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Yearling+ Smolt Emig.	■	■	■	■	■	■	■												■	■	■	■	■	■

4 LITERATURE REVIEW OF WATER TEMPERATURE RELATIONSHIPS FOR STEELHEAD AND CHINOOK SALMON

A comprehensive review and compilation of available literature was conducted to identify the range of acceptable water temperatures for reintroduction evaluation of Chinook salmon and steelhead, by lifestage, in the Upper Yuba River Basin. The thermal requirements of Chinook salmon and steelhead have been extensively studied in California and elsewhere. The literature review informed the selection of a range of WTI values to be used in the TWG's evaluation of the water temperature-related

reintroduction potential in the Upper Yuba River Basin. The information presented herein is largely based on information provided in Appendix E2 to the Public Draft EIR/EIS for the Yuba Accord (YCWA *et al.* 2007), Appendix B (Stillwater Sciences 2006) to the Upper Yuba River Studies Program (UYRSP) Technical Report (DWR 2007), and the Yuba Accord River Management Team Water Temperature Objectives Technical Memorandum (RMT 2010).

WTI values were identified from laboratory experiments and field studies that examined how water temperature affects Central Valley Chinook salmon and steelhead. WTI values were also identified from regulatory documents such as biological opinions from NMFS. Results of the literature review are presented in **Appendix A**. Specific temperature index values were then selected by the TWG to evaluate temperature-related reintroduction potential in the Upper Yuba River Basin.

Studies on fish from outside the Central Valley were used to establish WTI values when local studies were unavailable. To avoid unwarranted specificity, only whole integers were selected as WTI values. In some cases, whole integer WTI values were partially derived from literature results that varied from the index value by several tenths of a degree. For example, Combs and Burrows (1957) reported that constant incubation temperatures up to 57.5°F resulted in normal development of Chinook salmon eggs, and their report was referenced as support for a rounded[1] WTI value of 58°F.

The WTI values presented herein represent a gradation of potential biological effects from optimal to lethal water temperatures for each lifestage. Literature on salmonid water temperature requirements generally reports water temperature thresholds using various descriptive terms including "optimal", "preferred", "suitable", "suboptimal", "tolerable", "stressful – chronic and acute", "sublethal", "incipient lethal", and "lethal". Water temperature effects on salmonids are often discussed in terms of "lethal" and "sublethal" effects, and depend on the both the magnitude and the duration of exposure (Sullivan *et al.* 2000), as well as acclimation water temperature. Exposure to adverse water temperatures can result in adverse effects on the biological functions, feeding activity, lifestage timing, growth, reproduction, competitive interactions, susceptibility to disease, growth and development and ultimately probability of survival (McCullough 1999).

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[1] Rounding for the purposes of selecting index values is appropriate because the daily variation of experimental treatment temperatures is often high. For example, temperature treatments in Marine (1997) consisted of control (55.4°F to 60.8°F), intermediate (62.6°F to 68.0°F) and extreme (69.8°F to 75.2°F) treatments that varied daily by several degrees.

There are inherent limitations associated with the development and application of WTI values. Some of the limitations are summarized by McEwan (2001). Namely, that WTI values serve as general guidelines, originally developed by researchers on specific streams or under laboratory conditions. Also, research under controlled laboratory conditions does not take into account ecological considerations associated with water temperature regimes, such as predation risk, inter- and intra-specific competition, long-term survival and local adaptation.

5 LIFESTAGE-SPECIFIC WATER TEMPERATURE INDEX VALUES

Lifestage-specific WTI summary tables derived from the literature review are provided for steelhead and Chinook salmon: (1) adult immigration and holding; (2) spawning and embryo incubation; (3) juvenile rearing and downstream movement; and (4) yearling + smolt emigration in **Tables 2 - 9** (see below). A written discussion of the literature used to create the summary tables is provided in Appendix A. A short discussion of acute versus chronic temperature tolerance also is provided.

5.1 Steelhead and Chinook Salmon Acute Versus Chronic Temperature Tolerance (Juveniles and Adults)

Lifestage-specific WTI values (Sections 5.2 and 5.3 below) were based on long-term (≥ 7 days) chronic temperature exposure rather than acute temperature exposure (< 7 days). The boundary between the upper end of the chronic exposure range and the lower end of the acute exposure range is typically measured as the upper incipient lethal temperature (UILT) where 50% mortality occurs after 7 days (Elliott 1981)[2].

The UILT for both juvenile steelhead and Chinook salmon is very similar and is between 75-79°F (24-26°C) depending on the study (McCullough 1999; Sullivan et al. 2000; McCullough et al. 2001). The UILT for adult steelhead and Chinook salmon is 70-72°F (21-22°C) (Coutant 1970; Becker 1973; McCullough et al. 2001), which is much lower than that for juveniles and is approximately the same temperature that has been identified as an upstream migration barrier for Chinook salmon (McCullough 1999).

Acute temperature response (< 7 days) is strongly dependent on duration of exposure. **Figure 2** shows some example acute exposure relationships for juvenile salmonids. The hourly (60 minute) acute temperature is 5.4 – 9.0°F (3-5°C) higher than the 7-day (10,000 minute) chronic temperature. Because the acute temperature for juvenile salmonids, approximately 82.4°F (28.4°C) is relatively high, it rarely becomes a factor affecting

[2] Note that some authors have measured the UILT using shorter duration exposure than 7 days (e.g., 1,000 mins or 24 hrs). UILT values based on a shorter duration exposure than 7 days will be higher than the UILT values based on a 7 day exposure.

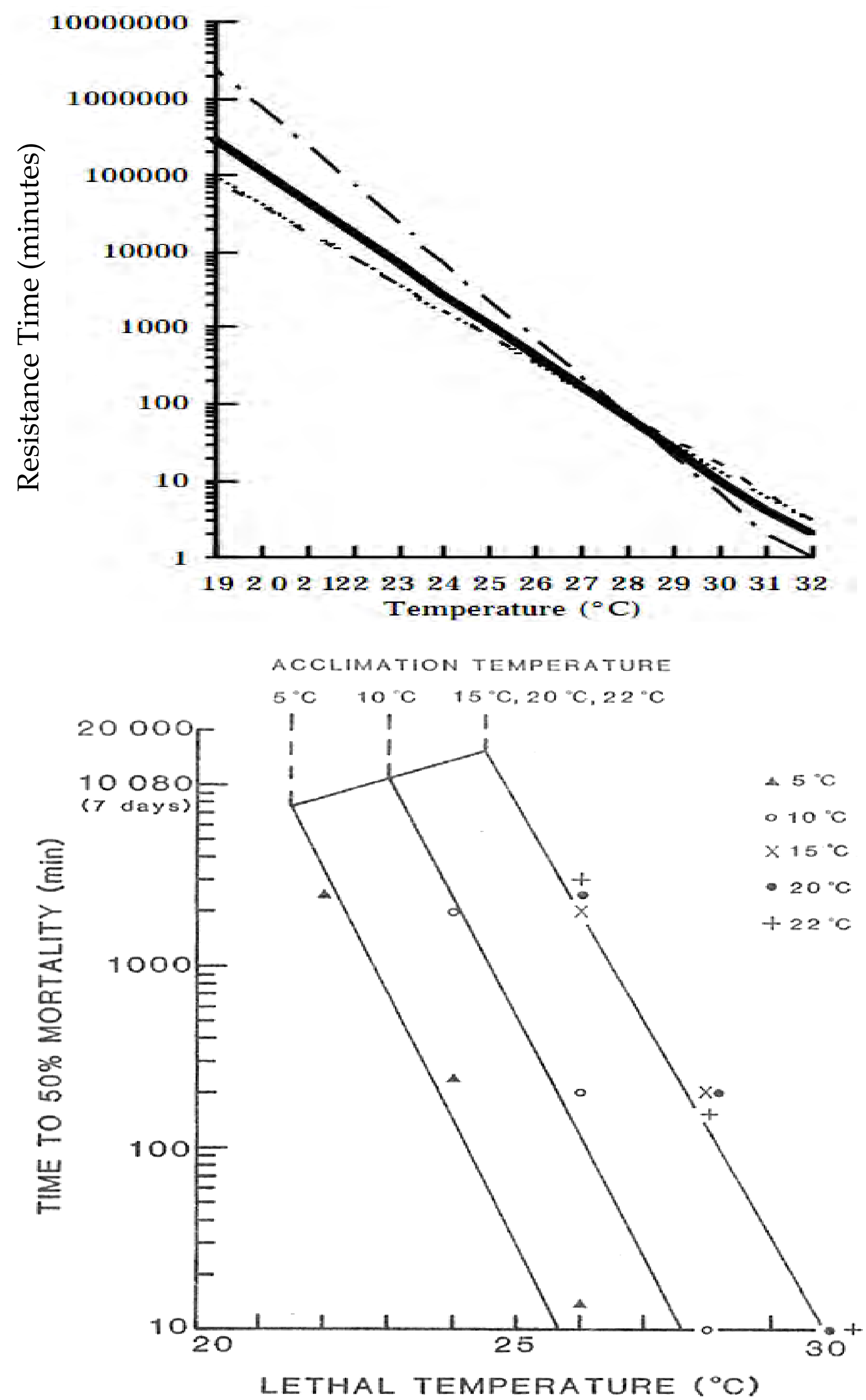


Figure 2. Relationship Between the Time (Minutes) to Mortality and the Lethal Temperature for Rainbow Trout (Top) (Bidgood 1969) and Brown Trout (Bottom) (Elliott 1981). Note the Effect of Acclimation Temperature in the Bottom Figure.

survival in natural streams (Sullivan et al. 2000). However, the acute temperature for adult salmonids is lower – it could become a survival factor particularly for adult spring-run Chinook salmon holding through the summer.

The temperature range between the UILT (7 days) and very short duration mortality (minutes) (e.g., critical thermal maximum) is called the zone of resistance. Below the UILT is a zone of tolerance where fish can tolerate the temperature for an extended period of time (> 7 days). At the higher temperatures in the tolerance zone fish may not feed, grow, or reproduce and they may have modified behavior (e.g., holding in temperature refugia locations). An important point to note is that the effects of water temperature are associated with duration of exposure and, depending upon the actual water temperature value, short duration exposure to relatively high temperatures may not result in sustained adverse effects if temperatures quickly decrease to non-impactive levels.

At lower temperatures in the tolerance zone, denoted "tolerable" in this report, growth and/or reproduction occur, but are reduced from optimal due to temperature effects. The zone of temperature where fish processes (growth, reproduction, behavior) are not affected appreciably by temperature is denoted as the "optimum" temperature range in this report (**Figure 3**).

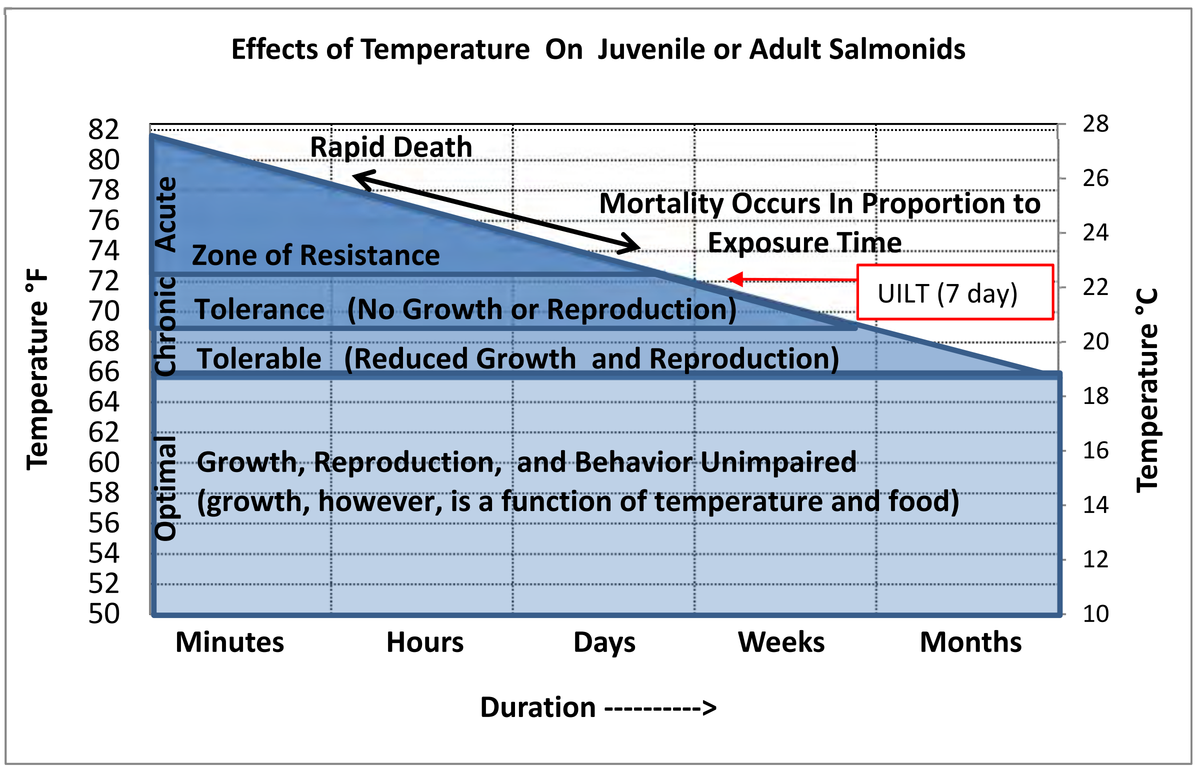


Figure 3. Illustration of Acute, Chronic, and Optimum Temperature Zones.

5.2 Steelhead Lifestage-specific Water Temperature Index Values

5.2.1 Adult Immigration and Holding

Table 2. Steelhead Adult Immigration and Holding Water Temperature Index Values and the Literature Supporting Each Value.

Index Value	Supporting Literature
52°F	Preferred range for adult steelhead immigration of 46.0°F to 52.0°F (NMFS 2000; NMFS 2001a; SWRCB 2003). Optimum range for adult steelhead immigration of 46.0°F to 52.1°F (Reclamation 1997a). Recommended adult steelhead immigration temperature range of 46.0°F to 52.0°F (Reclamation 2003).
56°F	To produce rainbow trout eggs of good quality, brood fish must be held at water temperatures not exceeding 56.0°F (Leitritz and Lewis 1980). Rainbow trout brood fish must be held at water temperatures not exceeding 56°F for a period of 2 to 6 months before spawning to produce eggs of good quality (Bruin and Waldsdorf 1975). Holding migratory fish at constant water temperatures above 55.4°F to 60.1°F may impede spawning success (McCullough *et al.* 2001).
61°F	Water temperatures greater than 61°F may result in "chronic high stress" of holding Central Valley winter-run steelhead (USFWS 1995a). Preferred range of water temperature for holding Caliifornia summer steelhead occurs between 50-59°F (Moyle 1995).
64°F	Steelhead (and fall-run Chinook salmon) encounter potentially stressful temperatures between 64.4-73.4°F (Richter and Kolmes 2005). Over 93% of steelhead detections occurred in the 65.3-71.6°F, although this may be above the temperature for optimal immigration (Salinger and Anderson 2006).
70°F	Migration barriers have frequently been reported for pacific salmonids when water temperatures reach 69.8°F to 71.6°F (McCullough *et al.* 2001). Snake River adult steelhead immigration was blocked when water temperatures reached 69.8 (McCullough *et al.* 2001). A water temperature of 68°F was found to drop egg fertility in vivo to 5 percent after 4.5 days (McCullough *et al.* 2001). The UILT for adult steelhead was determined to be 69.8°F (Coutant 1972).

5.2.2 Spawning and Embryo Incubation

Table 3. Steelhead Spawning and Embryo Incubation Water Temperature Index Values and the Literature Supporting Each Value.

Index Value	Supporting Literature
46°F	Orcutt et al. (1968) reported that steelhead spawning in late spring in the Clearwater and Salmon Rivers, Idaho, occurred at temperatures between 35.6 and 46.4°F.
52°F	Rainbow trout from Mattighofen (Austria) had highest egg survival at 52.0°F compared to 45.0°F, 59.4°F, and 66.0°F (Humpesch 1985). Water temperatures from 48.0°F to 52.0°F are suitable for steelhead incubation and emergence in the American River and Clear Creek (NMFS 2000; NMFS 2001a; NMFS 2002a). Optimum water temperature range of 46.0°F to 52.0°F for steelhead spawning in the Central Valley (USFWS 1995b). Optimum water temperature range of 46.0°F to 52.1°F for steelhead spawning and 48.0°F to 52.1°F for steelhead egg incubation (Reclamation 1997a). Upper limit of preferred water temperature of 52.0°F for steelhead spawning and egg incubation (SWRCB 2003).
54°F	Big Qualicum River steelhead eggs had 96.6 percent survival to hatch at 53.6°F (Rombough 1988). Highest survival from fertilization to hatch for *Salmo gairdneri* incubated at 53.6°F (Kamler and Kato 1983). Emergent fry were larger when North Santiam River (Oregon) winter steelhead eggs were incubated at 53.6°F than at 60.8°F (Redding and Schreck 1979). The upper optimal water temperature regime based on constant or acclimation water temperatures necessary to achieve full protection of steelhead is 51.8°F to 53.6°F (EPA 2001). From fertilization to hatch, rainbow trout eggs and larvae had 47.3 percent mortality (Timoshina 1972). Survival of rainbow trout eggs declined at water temperatures between 52.0 and 59.4°F (Humpesch 1985). The optimal constant incubation water temperature for steelhead occurs below 53.6°F (McCullough *et al.* 2001).

Index Value	Supporting Literature
57°F	From fertilization to 50 percent hatch, Big Qualicum River steelhead had 93 percent mortality at 60.8°F, 7.7 percent mortality at 57.2°F, and 1 percent mortality at 47.3°F and 39.2°F (Velsen 1987). A sharp decrease in survival was observed for rainbow trout embryos incubated above 57.2°F (Kamler and Kato 1983).
60°F	Water temperatures >59°F are described as "lethal" to incubating steelhead embryos (Myrick and Cech 2001), From fertilization to 50 percent hatch, Big Qualicum River steelhead had 93 percent mortality at 60.8°F, 7.7 percent mortality at 57.2°F, and 1 percent mortality at 47.3°F and 39.2°F (Velsen 1987). From fertilization to 50 percent hatch, rainbow trout eggs from Ontario Provincial Normendale Hatchery had 56 percent survival when incubated at 59.0°F (Kwain 1975).

5.2.3 Juvenile Rearing and Downstream Movement

Table 4. Steelhead Juvenile Rearing and Downstream Movement Water Temperature Index Values and the Literature Supporting Each Value.

Index Value	Supporting Literature
63°F	Preferred water temperature for wild juvenile steelhead is reportedly 63°F, whereas preferred water temperatures for juvenile hatchery steelhead reportedly range between 64-66°F. Myrick and Cech (2001)
65°F	Upper limit of 65°F preferred for growth and development of Sacramento River and American River juvenile steelhead (NMFS 2002a). Nimbus juvenile steelhead growth showed an increasing trend with water temperature to 66.2°F, irrespective of ration level or rearing temperature (Cech and Myrick 1999). The final preferred water temperature for rainbow fingerlings was between 66.2 and 68°F (Cherry *et al.* 1977). Nimbus juvenile steelhead preferred water temperatures between 62.6°F and 68.0°F (Cech and Myrick 1999). Rainbow trout fingerlings preferred or selected water temperatures in the 62.6°F to 68.0°F range (McCauley and Pond 1971).
68°F	Nimbus juvenile steelhead preferred water temperatures between 62.6°F and 68.0°F (Cech and Myrick 1999). The final preferred water temperature for rainbow trout fingerlings was between 66.2°F and 68°F (Cherry *et al.* 1977). Rainbow trout fingerlings preferred or selected water temperatures in the 62.6°F to 68.0°F range (McCauley and Pond 1971). The upper avoidance water temperature for juvenile rainbow trout was measured at 68°F to 71.6°F (Kaya et al. 1977). FERC (1993) referred to 68°F as "stressful" to juvenile steelhead. Empirical fish population and water temperature data in the North Yuba, Middle Yuba, South Yuba, Middle Fork American, and Rubicon Rivers (**Figure 4**) indicate a sharp reduction in O. *mykiss* population densities when temperatures exceed 68°F for greater than one week. Bioenergetics modeling of growth based on consumption (P value = 0.5) in the Middle Fork American River watershed (adjacent watershed) indicates that growth likely does not occur above 68°F (**Figure 5**).
72°F	Increased physiological stress, increased agonistic activity, and a decrease in forage activity in juvenile steelhead occur after ambient stream temperatures exceed 71.6°F (Nielsen *et al.* 1994). The upper avoidance water temperature for juvenile rainbow trout was measured at 68°F to 71.6°F (Kaya *et al.* 1977). Estimates of upper thermal tolerance or avoidance limits for juvenile rainbow trout (at maximum ration) ranged from 71.6°F to 79.9°F (Ebersole *et al.* 2001).
75°F	The maximum weekly average water temperature for survival of juvenile and adult rainbow trout is 75.2°F (EPA 2002). Rearing steelhead juveniles have an upper lethal limit of 75.0°F (NMFS 2001a). Estimates of upper thermal tolerance or avoidance limits for juvenile rainbow trout (at maximum ration) ranged from 71.6 to 79.9°F (Ebersole *et al.* 2001). The UILT for juvenile rainbow trout, based on numerous studies, is between 75-79°F (Sullivan et al. 2000; McCullough 2001).

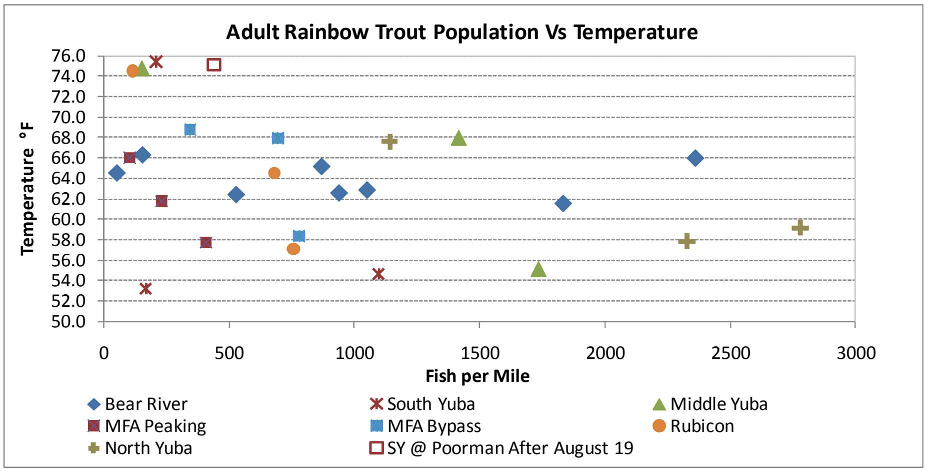
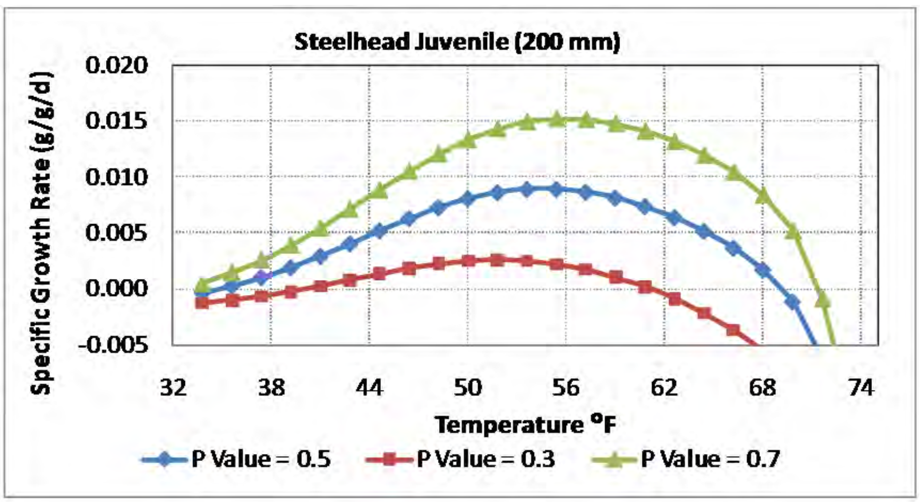


Figure 4. Empirical Adult Fish Population Data in the Middle Fork American and Yuba River Rivers Compared to the Maximum Temperature Exceeded Less Than 7 Days.



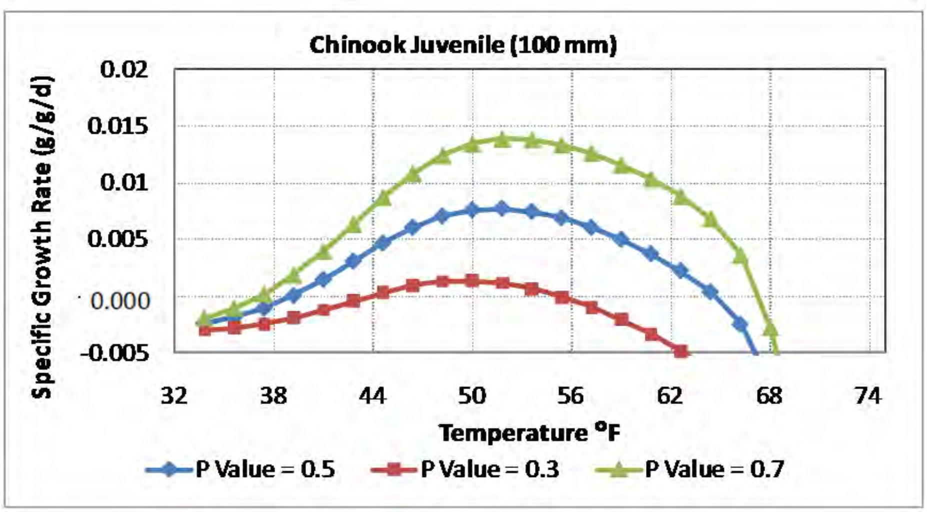


Figure 5. Bioenergetics Growth Rate Modeling For Steelhead and Chinook Salmon Juveniles Over a Range of Temperatures.

5.2.4 Yearling + Smolt Emigration

Table 5. Steelhead Smolt Emigration Water Temperature Index Values and the Literature Supporting Each Value.

Index Value	Supporting Literature
52°F	Steelhead successfully smolt at water temperatures in the 43.7°F to 52.3°F range (Myrick and Cech 2001). Steelhead undergo the smolt transformation when reared in water temperatures below 52.3°F, but not at higher water temperatures (Adams *et al.* 1975). Optimum water temperature range for successful smoltification in young steelhead is 44.0°F to 52.3°F (Rich 1987a).
55°F	ATPase activity was decreased and migration reduced for steelhead at water temperatures greater than or equal to 55.4°F (Zaugg and Wagner 1973). Water temperatures should be below 55.4°F at least 60 days prior to release of hatchery steelhead to prevent premature smolting and desmoltification (Wedemeyer *et al.* 1980). In winter steelhead, a temperature of 54.1°F is nearly the upper limit for smolting (McCullough *et al.* 2001; Zaugg and Wagner 1973). Water temperatures less than or equal to 54.5°F are suitable for emigrating juvenile steelhead (EPA 2003b). Water temperatures greater than 55°F prevent increases in ATPase activity in steelhead juveniles (Hoar 1988). Water temperatures greater than 56°F do not permit smoltification in summer steelhead (Zaugg *et al.* 1972)
59°F	Yearling steelhead held at 43.7°F and transferred to 59°F had a substantial reduction in gill ATPase activity, indicating that physiological changes associated with smoltification were reversed (Wedemeyer *et al.* 1980).

5.3 Chinook Salmon Lifestage-Specific Water Temperature Index Values

5.3.1 Adult Immigration and Holding

Table 6. Chinook Salmon Adult Immigration and Holding Water Temperature Index Values and the Literature Supporting Each Value.

Index Value	Supporting Literature
60°F	Maximum water temperature for adults holding, while eggs are maturing, is approximately 59°F to 60°F (NMFS 1997b). Acceptable water temperatures for adults migrating upstream range from 57°F to 67°F (NMFS 1997b). Upper limit of the optimal water temperature range for adults holding while eggs are maturing is 59°F to 60°F (NMFS 2000). Many of the diseases that commonly affect Chinook salmon become highly infectious and virulent above 60°F (ODEQ 1995). Mature females subjected to prolonged exposure to water temperatures above 60°F have poor survival rates and produce less viable eggs than females exposed to lower water temperatures (USFWS 1995b). Ward and Kier (1999) designated temperatures <60.8°F as an "optimum" water temperature threshold for holding Battle Creek spring-run Chinook salmon.
65°F	Acceptable range for adults migrating upstream is from 57°F to 67°F (NMFS 1997b). Disease risk becomes high at water temperatures above 64.4°F (EPA 2003b). Latent embryonic mortalities and abnormalities associated with water temperature exposure to pre-spawning adults occur at 63.5°F to 66.2°F (Berman 1990). During each of the years when Chinook salmon temperature mortality was not observed at Butte Creek (2001, 2004-2007), on average, daily temperature did not exceed 65.8°F for more than 7 days (**Figure 6**).
68°F	Acceptable range for adults migrating upstream range from 57°F to 67°F (NMFS 1997b). For chronic exposures, an incipient upper lethal water temperature limit for pre-spawning adult salmon probably falls within the range of 62.6°F to 68.0°F (Marine 1992). Spring-run Chinook salmon embryos from adults held at 63.5°F to 66.2°F had greater numbers of pre-hatch mortalities and developmental abnormalities than embryos from adults held at 57.2°F to 59.9°F (Berman 1990). Water temperatures of 68°F resulted in nearly 100 percent mortality of Chinook salmon during columnaris outbreaks (Ordal and Pacha 1963). In Butte Creek a period of average daily temperatures above 67°F (11-16 days) preceded the onset of significant pre-spawn mortalities. In

	years when 67°F was exceeded only a few days, pre-spawn mortality was minimal (Ward et al. 2004). Adult Chinook salmon migration rates through the lower Columbia River were slowed significantly when water temperatures exceeded 68°F (Goniea et al. 2006).
70°F	Migration blockage occurs for Chinook salmon at temperatures from 70-71+°F (McCollough 1999; McCullough *et al.* 2001; EPA 2003b). Strange (2010) found that the mean average body temperature during the first week of Chinook salmon migration on the Klamath River was 71.4°F. The UILT for Chinook salmon jacks is 69.8-71.6°F (McCullough 1999).

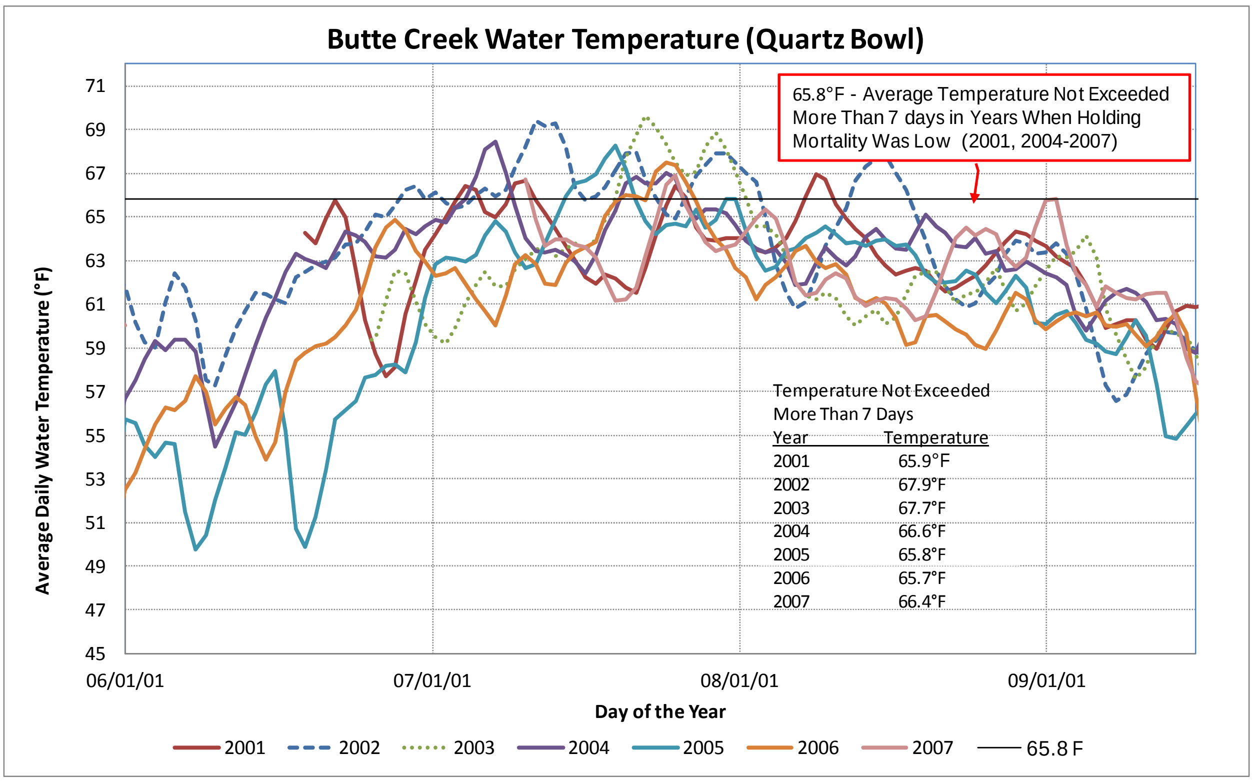


Figure 6. Water Temperature in Butte Creek at Quartz Bowl (2001-2007).

5.3.2 Spawning and Embryo Incubation

Table 7. Chinook Salmon Spawning and Embryo Incubation Water Temperature Index Values and the Literature Supporting Each Value.

Index Value	Supporting Literature
56°F	Less than 56°F results in a natural rate of mortality for fertilized Chinook salmon eggs (Reclamation Unpublished Work). Optimum water temperatures for egg development are between 43°F and 56°F (NMFS 1993b). Upper value of the water temperature range (i.e., 41.0°F to 56.0°F) suggested for maximum survival of eggs and yolk-sac larvae in the Central Valley of California (USFWS 1995b). Upper value of the range (i.e., 42.0°F to 56.0°F) given for the preferred water temperature for Chinook salmon egg incubation in the Sacramento River (NMFS 1997a). Incubation temperatures above 56°F result in significantly higher alevin mortality (USFWS 1999). 56.0°F is the upper limit of suitable water temperatures for spring-run Chinook salmon spawning in the Sacramento River (NMFS 2002a). Water temperatures averaged 56.5°F during the week of fall-run Chinook salmon spawning initiation on the Snake River (Groves and Chandler 1999).
58°F	Upper value of the range given for preferred water temperatures (i.e., 53.0°F to 58.0°F) for eggs and fry (NMFS 2002a). Constant egg incubation temperatures between 42.5°F and 57.5°F resulted in normal development (Combs and Burrows 1957). The natural rate of mortality for alevins occurs at 58°F or less (Reclamation Unpublished Work).
60°F	100 percent mortality can occur to late incubating Chinook salmon embryos (yolk-sac stage) if temperatures are 60°F or greater (Seymour 1956). An October 1 to October 31 water temperature criterion of less than or equal to 60°F in the Sacramento River from Keswick Dam to Bend Bridge has been determined for protection of late incubating larvae and newly emerged fry (NMFS 1993b). Mean weekly water temperature at first observed Chinook salmon spawning in the Columbia River was 59.5°F (Dauble and Watson 1997). Consistently higher egg losses resulted at water temperatures above 60.0°F than at lower temperatures (Johnson and Brice 1953). For Chinook Salmon eggs incubated at constant temperatures, mortality increases rapidly at temperatures greater than about 59-60°F (see data plots in Myrick and Cech 2001). Olsen and Foster (1957) found high survival of Chinook salmon eggs and fry (89.6%) when incubation temperatures started at 60.9°F and declined naturally for the Columbia River (about 7°F / month). Geist et al. (2006) found high (93.8%) Chinook salmon incubation survival through emergence for naturally declining temperatures (0.36°F/day) starting as high as 61.7°F; however, a significant reduction in survival occurred above this temperature.
62°F	100 percent mortality of fertilized Chinook salmon eggs after 12 days at 62°F (Reclamation Unpublished Work). Incubation temperatures of 62ºF to 64°F appear to be the physiological limit for embryo development resulting in 80 to 100 percent mortality prior to emergence (USFWS 1999). 100 percent loss of eggs incubated at water temperatures above 62°F (Hinze 1959). 100 percent mortality occurs during yolk-sac stage when embryos are incubated at 62.5°F (Seymour 1956). Approximately 80% or greater mortality of eggs incubated at constant temperatures of 63°F or greater (see data plots in Myrick and Cech 2001). Olsen and Foster (1957) found high mortality of Chinook salmon eggs and fry (79%) when incubation temperatures started at 65.2°F and declined naturally for the Columbia River (about 7°F / month). Geist et al. (2006) found low Chinook salmon incubation survival (1.7%) for naturally declining temperatures (0.36°F/day) when temperatures started at 62.6°F.

5.3.3 Juvenile Rearing and Downstream Movement

Table 8. Chinook Salmon Juvenile Rearing and Downstream Movement Water Temperature Index Values and the Literature Supporting Each Value.

Index Value	Supporting Literature
60°F	Optimum water temperature for Chinook salmon fry growth is between 55.0°F and 60°F (Seymour 1956). Water temperature range that produced optimum growth in juvenile Chinook salmon was between 54.0°F and 60.0°F (Rich 1987b). Water temperature criterion of less than or equal to 60.0°F for the protection of Sacramento River winter-run Chinook salmon from Keswick Dam to Bend Bridge (NMFS 1993b). Upper optimal water temperature limit of 61°F for Sacramento River fall-run Chinook salmon juvenile rearing (Marine 1997; Marine and Cech 2004). Upper water temperature limit of 60.0°F preferred for growth and development of spring-run Chinook salmon fry and fingerlings (NMFS 2000; NMFS 2002a). To protect salmon fry and juvenile Chinook salmon in the upper Sacramento River, daily average water temperatures should not exceed 60°F after September 30 (NMFS 1997b). A water temperature of 60°F appeared closest to the optimum for growth of fingerlings (Banks *et al.* 1971). Optimum growth of Nechako River Chinook salmon juveniles would occur at 59°F at a feeding level that is 60 percent of that required to satiate them (Brett *et al.* 1982). In a laboratory study, juvenile fall-run Chinook salmon from the Sacramento River reared in water temperatures between 70°F and 75°F experienced significantly decreased growth rates, and increased predation vulnerability compared with juveniles reared between 55°F and 61°F (Marine 1997; Marine and Cech 2004).
65°F	Water temperatures between 45°F to 65°F are preferred for growth and development of fry and juvenile spring-run Chinook salmon in the Feather River (NMFS 2002a). Recommended summer maximum water temperature of 64.4°F for migration and non-core rearing (EPA 2003b). Water temperatures greater than 64.0°F are considered not "properly functioning" by NMFS in Amendment 14 to the Pacific Coast Salmon Plan (NMFS 1995). Fatal infection rates caused by *C. columnaris* are high at temperatures greater than or equal to 64.0°F (EPA 2001). Disease mortalities diminish at water temperatures below 65.0°F (Ordal and Pacha 1963). Fingerling Chinook salmon reared in water greater than 65.0°F contracted *C. columnaris* and exhibited high mortality (Johnson and Brice 1953). Water temperatures greater than 64.9°F identified as being stressful in the Columbia River Ecosystem (Independent Scientific Group 1996). Juvenile Chinook salmon have an optimum temperature for growth that appears to occur at about 66.2°F (Brett *et al.* 1982). Juvenile Chinook salmon reached a growth maximum at 66.2°F (Cech and Myrick 1999). Optimal range for Chinook salmon survival and growth from 53.0°F to 64.0°F (USFWS 1995b). Survival of Central Valley juvenile Chinook salmon declines at temperatures greater than 64.4°F (Myrick and Cech 2001). Increased incidence of disease, reduced appetite, and reduced growth rates at 66.2±1.4 °F (Rich 1987b). Bioenergetics modeling of growth based on consumption of rainbow trout (P value = 0.5) in the Middle Fork American River watershed (adjacent watershed) indicates that growth likely does not occur above about 65°F (Figure 5)
68°F	Sacramento River juvenile Chinook salmon reared at water temperatures greater than or equal to 68.0°F suffer reductions in appetite and growth (Marine 1997; Marine and Cech 2004). Significant reductions in growth rates may occur when chronic elevated temperatures exceed 68°F (Marine 1997; Marine and Cech 2004). Juvenile spring-run Chinook salmon were not found in areas having mean weekly water temperatures between 67.1°F and 71.6°F (Burck *et al.* 1980; Zedonis and Newcomb 1997). Results from a study on wild spring-run Chinook salmon in the John Day River system indicate that juvenile fish were not found in areas having mean weekly water temperatures between 67.1°F and 72.9°F (McCullough 1999; Zedonis and Newcomb 1997).
70°F	No growth at all would occur for Nechako River juvenile Chinook salmon at 70.5°F (Brett *et al.* 1982; Zedonis and Newcomb 1997). Juvenile spring-run Chinook salmon were not found in areas having mean weekly water temperatures between 67.1°F and 71.6°F (Burck *et al.* 1980; Zedonis and Newcomb 1997). Results from a study on wild spring-run Chinook salmon in the John Day River system indicate that juvenile fish were not found in areas having mean weekly water temperatures between 67.1°F and 72.9°F (McCullough 1999; Zedonis and Newcomb 1997). Increased incidence of disease, hyperactivity, reduced appetite, and reduced growth rates at 69.8 ±1.8 °F (Rich 1987b). In a laboratory study, juvenile fall-run Chinook salmon from the Sacramento River reared in water temperatures between 70°F and 75°F experienced significantly decreased growth rates and increased predation vulnerability compared with juveniles reared between 55°F and 61°F (Marine 1997; Marine and Cech 2004).

75°F	For juvenile Chinook salmon in the lower American River fed maximum rations under laboratory conditions, 75.2°F was determined to be 100 percent lethal due to hyperactivity and disease (Rich 1987b; Zedonis and Newcomb 1997). Lethal temperature threshold for fall-run juvenile Chinook salmon between 74.3 and 76.1°F (McCullough 1999). In a laboratory study, juvenile fall-run Chinook salmon from the Sacramento River reared in water temperatures between 70°F and 75°F experienced significantly decreased growth rates, and increased predation vulnerability compared with juveniles reared between 55°F and 61°F (Marine 1997; Marine and Cech 2004). The juvenile Chinook Salmon UILT based on numerous studies is 75-77°F (Sullivan et al. 2000; McCullough et al. 2001; Myrick and Cech 2001)

5.3.4 Yearling + Smolt Emigration

Table 9. Chinook Salmon Yearling + Smolt Emigration Water Temperature Index Values and the Literature Supporting Each Value.

Index Value	Supporting Literature
63°F	Acceleration and inhibition of Sacramento River Chinook salmon smolt development reportedly may occur at water temperatures above 63°F (Marine 1997; Marine and Cech 2004). Laboratory evidence suggest that survival and smoltification become compromised at water temperatures above 62.6°F (Zedonis and Newcomb 1997). Juvenile Chinook salmon growth was highest at 62.6°F (Clarke and Shelbourn 1985).
68°F	Significant inhibition of gill sodium ATPase activity and associated reductions of hyposmoregulatory capacity, and significant reductions in growth rates, may occur when chronic elevated temperatures exceed 68°F (Marine 1997; Marine and Cech 2004). Water temperatures supporting smoltification of fall-run Chinook salmon range between 50°F to 68°F, the colder temperatures represent more optimal conditions (50°F to 62.6°F), and the warmer conditions (62.6°F to 68°F) represent marginal conditions (Zedonis and Newcomb 1997).
72°F	In a laboratory study, juvenile fall-run Chinook salmon from the Sacramento River reared in water temperatures between 70°F and 75°F experienced significantly decreased growth rates, impaired smoltification indices, and increased predation vulnerability compared with juveniles reared between 55°F and 61°F (Marine 1997; Marine and Cech 2004). Indirect evidence from tagging studies suggests that the survival of fall-run Chinook salmon smolts decreases with increasing water temperatures between 59°F and 75°F in the Sacramento-San Joaquin Delta (Kjelson and Brandes 1989).

5.4 Upstream Migration Behavioral Effects Due to River Temperature Gradients

If volitional upstream passage was provided past Englebright Reservoir (e.g., ladder, dam removal), the potential exists for upstream migrating adult salmonids to have to volitionally pass through significant water temperature differentials from the Lower Yuba River into the South or Middle Yuba rivers (Upper Yuba River) due to cold water releases from New Bullards Bar Reservoir into the Yuba River (via Colgate Powerhouse). **Figure 7** shows an example of water temperature in the Yuba River below Colgate Powerhouse and the South and Middle Fork Yuba rivers near their confluence with the Yuba River. It is possible to modify the temperature differentials by selective withdrawal of water from New Bullards Bar Reservoir (Colgate Powerhouse temperature) or by modifying flows in the South or Middle Yuba rivers; nevertheless, the temperature differentials could be large. For example, during the May-June migration period for spring-run Chinook salmon or the late summer/fall

migration period for steelhead, Middle and South Yuba river temperatures are much warmer than the downstream Yuba River temperatures (e.g., > 7°F or > 4°C).

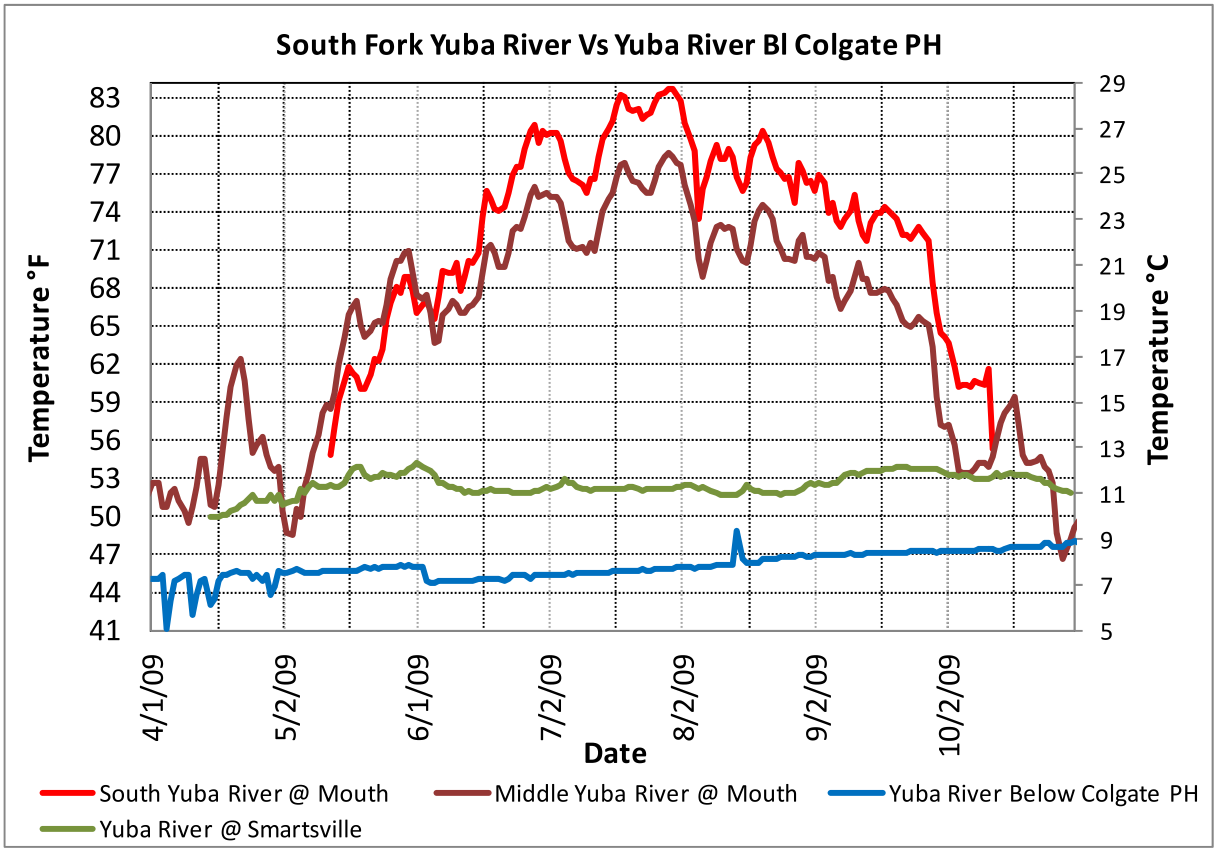


Figure 7. Water Temperature Differentials Between the South and Middle Yuba Rivers, and the Yuba River Below Colgate and at Smartsville.

To date, we have only identified limited information in the literature regarding the effect of temperature differentials on volitional upstream migration of Chinook salmon or steelhead. Typically, as fish migrate upstream in rivers the water temperature becomes cooler. Migrating fish may move from cooler ocean/estuary temperatures (Strange 2010) into warmer river temperatures, but as fish move upstream in rivers, the temperature typically gets cooler. In the case of migration from the Yuba River to the South and Middle Yuba rivers, fish could be faced with moving in a reverse temperature gradient from cooler downstream water, into warmer upstream water.

In the Columbia River both migrating Chinook salmon and steelhead use coolwater tributaries as thermal refugia during warm summer conditions. Staging in coolwater tributaries significantly slows and affects the migratory behavior of the fish (High et al.

2006; Goniea et al. 2006). Also temperature differentials at Columbia River ladders (e.g., colder water at the entrance to the ladder versus warmer water in the ladder), even relatively small temperature differentials, can slow migration rates through the ladders. Caudill et al. (2005) found that few fish passed the ladders when temperature differentials were > 7°F (> 4°C) and that passage times increased with increased temperature differential (e.g., > 2°F).

In the Snake River/Clearwater River system a somewhat analogous temperature situation exists compared to that which may occur in the Yuba River system. During the summer (July-August) cold water is released from Dworshak Reservoir on the North Fork Clearwater River into the Clearwater River. As a result, the Clearwater River becomes colder than the Snake River where they meet near Lewiston, Idaho. Spring-run Chinook salmon are generally not affected because by July, most spring-run Chinook salmon moving up the Clearwater River are already past the mouth of the North Fork Clearwater River, and are up close to or in their higher elevation natal streams getting ready to spawn. It does appear, however, that some later returning spring-run Chinook salmon do hold longer than they would have normally, near or in the North Fork Clearwater River, because of the colder water coming out of Dworshak Reservoir. As a result, there is spawning activity that occurs in the lower North Fork Clearwater River (it is possible that some of these fish may be hatchery fish shunted off from entering Dworshak Hatchery).

The cooling effect of Dworshak Reservoir releases to the Clearwater River does modify the behavior of returning steelhead and fall-run Chinook salmon at the confluence with the Snake River. The cooler water in the Clearwater River draws fish destined for the Snake River into the Clearwater River and they hold in the mouth of the Clearwater River until the Snake River cools down (Personal Communication, Bill Arnsberg, Nez Perce Tribal Biologist).

Our recommendation is that additional literature and data should be obtained and summarized regarding the effect of water temperature differentials on volitional migration (if such information exists). In addition, based on the limited information available, a temperature differential of 7°F (4°C) should precautionarily be viewed as a potential thermal barrier to adult upstream migration. It is possible that even lower temperature differentials (< 7°F) could result in migrating fish holding downstream and not migrating, or significantly delaying migration.

6 TEMPORAL TEMPERATURE PATTERNS RELATED TO WATER TEMPERATURE INDEX VALUES AND METRICS

Typical water temperature patterns in the Yuba River system exhibit a week or two of high temperatures and a much broader range of temperatures that are lower. For example, **Figure 8** shows historical water temperature in the section of the Middle Yuba River near Wolf Creek in 2008. This site is used below to briefly discuss temporal temperature patterns and their relationship to critical WTI values and some typical water temperature metrics used in the literature to summarize water temperature.

Historical daily average water temperatures at the Middle Yuba River site were near the temperature that has been observed to cause mortality to Chinook Salmon in Butte Creek (e.g., 67°F or greater) (Ward et al. 2004). Most of the summer, daily average water temperatures at the Middle Yuba River site were at or below 67°F, but there were a couple of weeks that the average daily water temperature exceeded 67°F (similar to conditions that caused mortality in Butte Creek). Maximum daily water temperatures at the site during much of the summer were near the 7-day UILT[3] for Chinook salmon adults of 69.8-71.6°F (McCullough 1999). However, the duration of time within a day that the water temperature was near the 7-day UILT was short and is not available from the plot nor from typical maximum temperature metrics (see below).

Some typical temperature metrics are shown on Figure 8. The 7-day moving average temperature (7DMA) also exceeded 67°F for the same two time periods that the average daily temperature exceeded 67°F. The maximum weekly average temperature (MWAT) (average of the daily mean temperature of the 7 warmest days) occurred in mid-July and was 67.9°F. The maximum daily temperatures, 7-day moving average daily maximum (7DMADM), were about 4°F greater than the mean daily temperature during the warmest months, and the 7-day average daily maximum temperature (7DADM) occurred at the same time as the MWAT (67.9 °F versus 71.7°F).

Historically in Butte Creek, when average daily water temperature was 67°F for more than about a week (11 and 16 days in 2002 and 2003, respectively) significant adult Chinook salmon mortality occurred. However, if water temperature exceeded 67°F for a relatively short number of days (e.g., < 7 days), significant mortality did not occur (Ward et al. 2004).

An analogous approach for analyzing the Yuba River water temperatures could be used. This could be done by using WTI values, where exceeding the WTI temperature criteria for less than 7 days would not be expected to affect each lifestage, but exceeding the WTI for more than 7 days would be detrimental.

[3] Note, however, the UILT is 7 continuous days exposure and is not comparable to a daily maximum temperature.

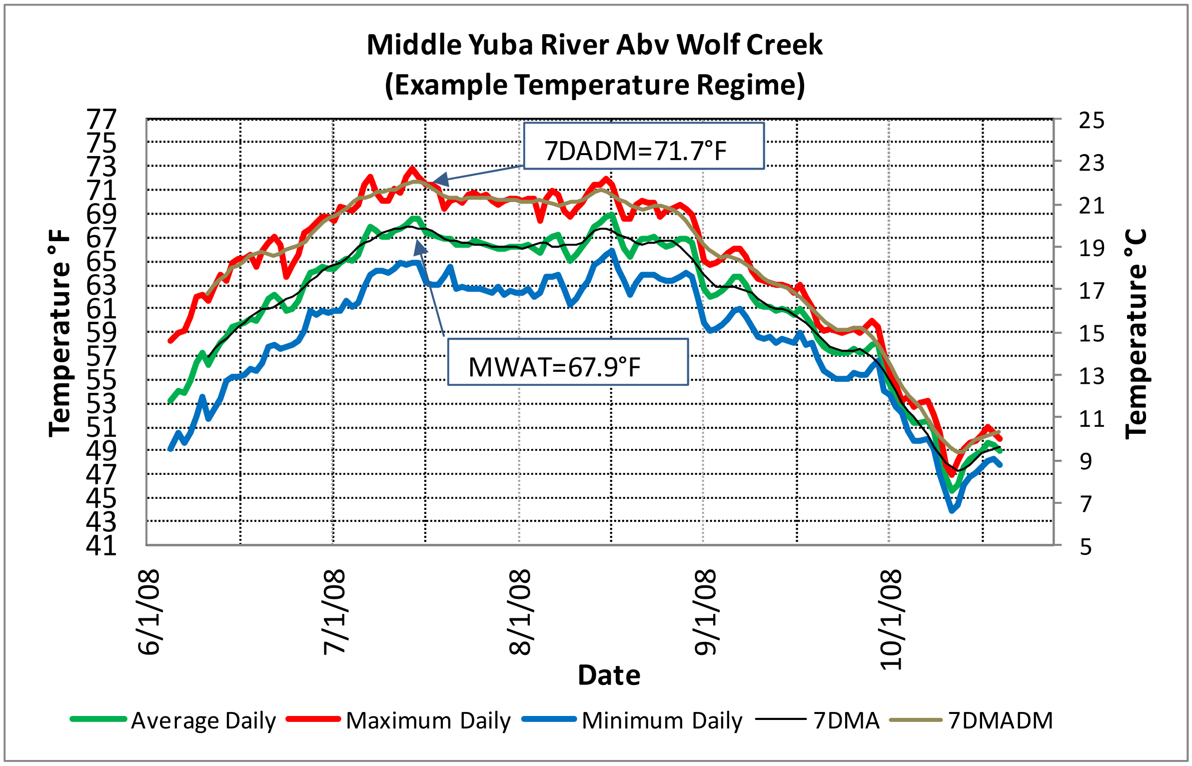


Figure 8. Middle Fork Yuba River Water Temperature Including 7 Day Moving Averages of the Average Daily Temperature and the Maximum Daily Temperature. Also Included Are the Maximum Weekly Average Temperature (MWAT) and the 7 Day Average Daily Maximum Temperature (7DADM).

Quantifying the number of average daily water temperature values that exceed a WTI threshold would be a direct approach to quantifying habitat suitability. The MWAT and/or the moving average (7DMA) identify a maximum average weekly water temperature value, but do not indicate the duration of time that this occurred. Similarly, if acute temperature was a concern, the individual water temperature measurements (e.g., hourly) could be used to identify the number of hours (duration) that a maximum WTI value was exceeded (e.g., tally the number of days and hours). Conversely, the 7DADM and/or the moving average (7DMADM) identify a maximum average weekly maximum temperature value, but do not indicate the duration of time that it occurred.

7 SPECIES- AND LIFESTAGE-SPECIFIC WATER TEMPERATURE RANGE ACCEPTABLE FOR REINTRODUCTION EVALUATION

The goal of the temperature analysis is twofold: (1) to identify the high temperature WTI value(s) that clearly demarcate the spatial/temperature boundary between where steelhead and Chinook salmon lifestages can and cannot exist (even though temperature is a stressor) (upper tolerable WTI); and (2) to determine within the "can

exist" boundary, if there is a core area where they can thrive without temperature as a stressor (upper optimal WTI). The upper tolerable temperature represents the upper boundary of the range of acceptable water temperatures for reintroduction evaluation. It represents a water temperature at which fish can survive indefinitely, without experiencing substantial detrimental effects to physiological and biological functions such that survival occurs, but growth and reproduction success are reduced below optimal. The upper optimal temperature represents the upper boundary of the optimum range and represents a temperature below which growth, reproduction, and/or behavior are not affected by temperature. Below, we discuss: (1) existing regulatory water temperature standards or guidelines that could be used as index values; and (2) specific water temperature index values that have been derived based on the literature review in this report.

7.1 Existing Water Temperature Standards/Guidelines

Several different water temperature standards are used currently by states for salmonids (e.g., California, Oregon, and Washington water temperature standards). California's Basin Plan is largely based on not altering the temperature of intrastate waters unless alterations can be shown to not have an effect on beneficial uses for cold freshwater habitat, migration, and/or spawning (**Table 10**). The beneficial uses of the Yuba River are listed in **Table 11**. Specific temperature criteria for species/lifestages are not identified in the Basin Plan nor are there specific temperature objectives for the Yuba River system. However, for the Sacramento River, seasonal temperature criteria have been developed (Table 10). These temperature objectives, while not directly applicable to the Yuba River, give an indication of temperature objectives that have been set for anadromous fish in the basin.

Table 10. Basin Plan Temperature Standards Including Specific Standards for the Sacramento River.

Temperature

The natural receiving water temperature of intrastate waters shall not be altered unless it can be demonstrated to the satisfaction of the Regional Water Board that such alteration in temperature does not adversely affect beneficial uses.

Temperature objectives for COLD interstate waters, WARM interstate waters, and Enclosed Bays and Estuaries are as specified in the *Water Quality Control Plan for Control of Temperature in the Coastal and Interstate Waters and Enclosed Bays of California* including any revisions. There are also temperature objectives for the Delta in the State Water Board's May 1991 *Water Quality Control Plan for Salinity*.

At no time or place shall the temperature of COLD or WARM intrastate waters be increased more than 5°F above natural receiving water temperature. Temperature changes due to controllable factors shall be limited for the water bodies specified as described in Table III-4. To the extent of any conflict with the above, the more stringent objective applies.

In determining compliance with the water quality objectives for temperature, appropriate averaging periods may be applied provided that beneficial uses will be fully protected.

TABLE III-4
SPECIFIC TEMPERATURE OBJECTIVES

DATES	APPLICABLE WATER BODY
From 1 December to 15 March, the maximum temperature shall be 55°F. From 16 March to 15 April, the maximum temperature shall be 60°F. From 16 April to 15 May, the maximum temperature shall be 65°F. From 16 May to 15 October, the maximum temperature shall be 70°F. From 16 October to 15 November, the maximum temperature shall be 65°F. From 16 November to 30 November, the maximum temperature shall be 60°F.	Sacramento River from its source to Box Canyon Reservoir (9); Sacramento River from Box Canyon Dam to Shasta Lake (11)
The temperature in the epilimnion shall be less than or equal to 75°F or mean daily ambient air temperature, whichever is greater.	Lake Siskiyou (10)
The temperature shall not be elevated above 56°F in the reach from Keswick Dam to Hamilton City nor above 68°F in the reach from Hamilton City to the I Street Bridge during periods when temperature increases will be detrimental to the fishery.	Sacramento River from Shasta Dam to I Street Bridge (13, 30)

Table 11. Basin Plan Beneficial Uses for the Yuba River.

TABLE II-1

SURFACE WATER BODIES AND BENEFICIAL USES

	SURFACE WATER BODIES (1)	HYDRO UNIT NUMBER	MUN: MUNICIPAL AND DOMESTIC SUPPLY	AGRI-CULTURE AGR: IRRIGATION	AGRI-CULTURE AGR: STOCK WATERING	INDUSTRY PROC: PROCESS	INDUSTRY IND: SERVICE SUPPLY	INDUSTRY POW: POWER	RECREATION REC-1: CONTACT	RECREATION REC-1: CANOEING AND RAFTING (1)	RECREATION REC-2: OTHER NONCONTACT	FRESHWATER HABITAT (2) WARM: WARM	FRESHWATER HABITAT (2) COLD: COLD	MIGRATION MIGR: WARM (3)	MIGRATION MIGR: COLD (4)	SPAWNING SPWN: WARM (3)	SPAWNING SPWN: COLD (4)	WILD: WILDLIFE HABITAT	NAV: NAVIGATION
	YUBA RIVER																		
41	SOURCES TO ENGLEBRIGHT RESERVOIR	517.	E	E	E			E	E	E	E		E				E	E	
42	ENGLEBRIGHT DAM TO FEATHER RIVER	515.3		E	E			E	E	E	E	E	E	E	E	E	E	E	

LEGEND
E = EXISTING BENEFICIAL USES
P = POTENTIAL BENEFICIAL USES
L = EXISTING LIMITED BENEFICIAL USE

The EPA Region 10 Guidance for Pacific Northwest State and Tribal Temperature Water Quality Standards (EPA 2003b) provides water temperature recommendations regarding coldwater salmonid uses and numeric criteria to protect those uses for the following:

Salmonid Uses	Criteria
Salmon/trout core juvenile rearing	61°F (16°C) 7DADM
Salmon/trout migration plus non-core juvenile rearing	64°F (18°C) 7DADM
Salmon/trout migration	68°F (20°C) 7DADM
Salmon/trout spawning, egg incubation, and fry emergence	55°F (13°C) 7DADM
Steelhead smoltification	57°F (14°C) 7DADM

These temperature criteria are developed for summer water temperatures, except for the spawning and smolting lifestages which occur earlier in the year. The criteria are intended to represent the upper end of the optimal temperature range for each lifestage. It is important to note that the criteria are based on 7DADM (daily maximum temperatures), while the data used to generate the criteria were primarily based on daily average or continuous temperature field/laboratory data sets (**Table 12**). Several general assumptions were applied by EPA (2003b) to the data to make a connection between 7DADM temperature and the field/laboratory data (Section 8.1).

Table 12. EPA (2003b) Laboratory and Field Data Summary for Generating Water Temperature Criteria.

Life Stage	Temperature Consideration	Temperature & Unit	Reference
Spawning and Egg Incubation	*Temp. Range at which Spawning is Most Frequently Observed in the Field	4 - 14°C (daily avg)	Issue Paper 1; pp 17-18 Issue Paper 5; p 81
	* Egg Incubation Studies - Results in Good Survival -Optimal Range	 4 - 12°C (constant) 6 - 10°C (constant)	 Issue Paper 5; p 16
	*Reduced Viability of Gametes in Holding Adults	> 13°C (constant)	Issue Paper 5; pp 16 and 75
Juvenile Rearing	*Lethal Temp. (1 Week Exposure)	23 - 26°C (constant)	Issue Paper 5; pp 12, 14 (Table 4), 17, and 83-84
	*Optimal Growth - unlimited food - limited food	 13 - 20°C (constant) 10 - 16°C (constant)	 Issue Paper 5; pp 3-6 (Table 1), and 38-56
	*Rearing Preference Temp. in Lab and Field Studies	10 - 17°C (constant) < 18°C (7DADM)	Issue Paper 1; p 4 (Table 2). Welsh et al. 2001.
	*Impairment to Smoltification	12 - 15°C (constant)	Issue Paper 5; pp 7 and 57-65
	*Impairment to Steelhead Smoltification	> 12°C (constant)	Issue Paper 5; pp 7 and 57-65
	*Disease Risk (lab studies) -High - Elevated - Minimized	 > 18 - 20°C (constant) 14 - 17°C (constant) 12 - 13°C (constant)	Issue Paper 4, pp 12 - 23
Adult Migration	*Lethal Temp. (1 Week Exposure)	21- 22°C (constant)	Issue Paper 5; pp 17, 83 - 87
	*Migration Blockage and Migration Delay	21 - 22°C (average)	Issue Paper 5; pp 9, 10, 72-74. Issue Paper 1; pp 15 - 16
	*Disease Risk (lab studies) - High - Elevated - Minimized	 > 18 - 20°C (constant) 14 - 17°C (constant) 12- 13°C (constant)	 Issue Paper 4; pp 12 - 23
	*Adult Swimming Performance - Reduced - Optimal	 > 20°C (constant) 15 - 19°C (constant)	 Issue Paper 5; pp 8, 9, 13, 65 - 71
	* Overall Reduction in Migration Fitness due to Cumulative Stresses	> 17-18°C (prolonged exposures)	Issue Paper 5; p 74

In addition to the numeric temperature criteria, there are a number of other factors (e.g., site specific issues, background temperatures) that EPA (2003b) considered in recommending coldwater salmonid uses and water quality standards (WQS) to protect those uses. These factors and the EPA's recommended approach for establishing WQS are described in EPA (2003b).

EPA (2003b) recognized that salmonids will use waters that are warmer than their optimal thermal range and further recognizes that some portions of rivers and streams naturally (i.e., absent human impacts) were warmer than the salmonid optimal range. They also recognized that some streams have unique diurnal temperature patterns, which may necessitate modified WQS. To account for these issues, the EPA identified three alternate salmonid temperature standard approaches. These include identifying the natural background temperature of the water body, creating site-specific temperature criteria, and/or identifying that a criterion is "unattainable" and altering the use designation to a use designation that has a criterion that is obtainable.

The EPA's water temperature recommendations are intended to assist States and Tribes to adopt temperature WQS that the EPA can approve consistent with its obligations under the Clean Water Act and the Endangered Species Act. States and Tribes that adopt temperature WQS consistent with these recommendations can expect an expedited review by EPA and the Services, subject to new data and information that might be available to during that review (EPA 2003b). In some cases, the criteria seem to be conservative and may exclude habitat that is currently used and/or demonstrably usable by salmonid lifestages. Section 8.1 has a brief discussion of issues related to the EPA (2003b) numerical criteria based on 7DADM temperatures and the needs of the Yuba Salmon Forum.

7.2 Site Specific Water Temperature Index Values

In addition to the EPA (2003b) numeric temperature criteria (Section 7.1) it also seems appropriate to develop Yuba Salmon Forum water temperature index values that are specific to the purposes of the Yuba Salmon Forum and the Yuba River. Below, for each species/lifestage, we provide: (1) an upper tolerance WTI (UTWTI) that identifies the sustained (chronic) tolerance/no tolerance boundary; and (2) the upper optimal WTI (UOWTI) where physiological processes (growth, disease resistance, normal development of embryos) are not stressed by temperature.

The lifestage-specific WTI values are not intended to represent significance thresholds, but instead provide criteria to evaluate reintroduction of anadromous salmonids. Moreover, as suggested by DWR (2007), the use of temperature "boundaries" has inherent drawbacks associated with the often indistinguishable effects at the upper and

lower ends of an identified range and attributing undue specificity to values slightly exceeding an identified range. Nonetheless, WTI values, as defined, are used for evaluation of water temperature considerations regarding the reintroduction of steelhead (**Table 13**) and spring-run Chinook salmon (**Table 14**) in the Upper Yuba River Basin.

7.2.1 Steelhead

Table 13. Lifestage-Specific Upper Optimal Water Temperature Index (UOWTI) Values and Upper Tolerance Water Temperature Index (UTWTI) Values Identified as Defining the Range of Acceptable Water Temperatures for Evaluation of the Reintroduction of Steelhead in the Upper Yuba River Basin.

Lifestage	Upper Optimum WTI[1]	Upper Tolerance WTI[1]	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec
Adult Migration	64°F	68°F	■■	■■	■■	□□	□□	□□	□□	■■	■■	■■	■■	■■
Adult Holding	61°F	65°F	■■	■■	■■	□□	□□	□□	□□	■■	■■	■■	■■	■■
Spawning	54°F	57°F	■■	■■	■■	■■	□□	□□	□□	□□	□□	□□	□□	□□
Embryo Incubation	54°F	57°F	■■	■■	■■	■■	■■	□□	□□	□□	□□	□□	□□	□□
Juv. Rearing & Downstream Mvmt.	65°F	68°F	■■	■■	■■	■■	■■	■■	■■	■■	■■	■■	■■	■■
Smolt Emigration	52°F	55°F	■■	■■	■■	■□	□□	□□	□□	□□	□□	■■	■■	■■

[1] The WTI values are to be applied to the water temperature metrics recommended in Section 8, below.

7.2.2 Spring-run Chinook Salmon

Table 14. Lifestage-Specific Upper Optimal Water Temperature Index (UOWTI) Values and Upper Tolerance Water Temperature Index (UTWTI) Values Identified as Defining the Upper Acceptable Water Temperatures for Evaluation of the Reintroduction of Spring-Run Chinook Salmon in the Upper Yuba River Basin.

Lifestage	Upper Optimum WTI[1]	Upper Tolerance WTI[1]	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec
Adult Migration	64°F	68°F	□□	□□	□□	■■	■■	■■	■■	■■	□□	□□	□□	□□
Adult Holding	61°F	65°F	□□	□□	□□	■■	■■	■■	■■	■■	□□	□□	□□	□□
Spawning	56°F	58°F	□□	□□	□□	□□	□□	□□	□□	□□	■■	■■	■□	□□
Embryo Incubation	56°F	58°F	■■	■■	□□	□□	□□	□□	□□	□□	■■	■■	■■	■■
Juv. Rearing & Downstream Mvmt.	61°F	65°F	■■	■■	■■	■■	■■	■■	■■	■■	■■	■■	■■	■■
Smolt Emigration	63°F	68°F	■■	■■	■■	■■	■□	□□	□□	□□	□□	■■	■■	■■

[1] The WTI values are to be applied to the water temperature metrics recommended in Section 8, below.

8 WATER TEMPERATURE METRICS

Water temperature metrics (e.g., MWAT, 7DADM) are typically designed to provide a reproducible index of temperature over a period of time that can be used in combination with temperature standards (numeric criteria values) to determine if a water temperature body is impaired. Water temperature metrics are by definition an index of the complete temperature time series. As such, they do not completely represent the temperature time series nor are they always the most accurate way to

represent the biological response of various lifestages. Water temperature metrics for potential application to the Yuba Salmon Forum specific criteria (UOWTI and UTWTI) are described below.

8.1 7DADM

The EPA (2003a) recommends the 7DADM (maximum 7-day average of the daily maxima) as a water temperature metric for all of the numeric criteria that is applied to a specific species and lifestage. The 7DADM is similar to the maximum weekly average temperature metric that was previously used by the EPA for its national temperature criteria recommendations (EPA 1977). However, in 2003, the EPA initiated use of the 7DADM metric "because it describes the maximum temperatures in a stream, but is not overly influenced by the maximum temperature of a single day."

A 7DADM value is calculated by adding the daily maximum temperatures recorded at a site on seven consecutive days and dividing by seven. Thus, it reflects an average of daily maximum temperatures that fish are exposed to over a week-long period. EPA (2003b) states that because this metric "is oriented to daily maximum temperatures, it can be used to protect against acute effects, such as lethality and migration blockage conditions." This statement illustrates two shortcomings of the EPA (2003a) use of the 7DADM metric. The 7DADM: (1) includes no duration information, which is critical to understanding acute (zone of resistance) temperature analysis – rather, it is an index of maximum temperature that occurs for a short time each day and, most importantly; (2) the numeric criteria that are identified by EPA (2003b) are not acute criteria nor derived from acute criteria data, but are chronic temperature criteria.

The EPA (2003b) numeric criteria were derived from chronic field or laboratory studies (e.g., > 7 day continuous or average daily temperatures), including the migratory blockage data (see Section 5.1; Table 12). A couple of simple examples illustrate this concept. The EPA (2003b) juvenile core rearing criteria is 61°F 7DADM and is the same temperature value as the upper optimal growth temperature under limited food (Table 12, 16°C), but the optimal growth temperature was derived from constant temperature laboratory studies. This temperature is much lower than the temperature where acute temperature affects occur. The UILT (7 day) from literature studies is 72 - 79°F (e.g., Table 12) and for shorter duration exposure is even much higher 80 - 88°F (e.g., see Table TT2 in Myrick and Cech 2001). Another example is the migration criteria. The migration blockage source data is based on observations in natural rivers, and is based on daily average or weekly field temperatures (70 – 72°F) (Table 12; McCullough 1999).

A daily maximum temperature equivalent of this temperature (70°F) is approximately 75°F [4], but the EPA (2003b) 7DADM numeric criterion for migration was set at 68°F.

EPA (2003b) states that the 7DADM metric can also can be used to protect against sub-lethal or chronic effects (e.g., temperature effects on growth, disease, smoltification, and competition), but the resultant cumulative thermal exposure fish experience over the course of a week or more needs to be considered when selecting a 7DADM value to protect against these effects. The EPA's general conclusion from studies on fluctuating water temperature regimes (which is what fish generally experience in rivers) is that fluctuating temperatures increase juvenile growth rates when mean temperatures are colder than the optimal growth temperature derived from constant temperature studies, but will reduce growth when the mean temperature exceeds the optimal growth temperature (see Issues Paper 5, pages 51-56). When the mean temperature is above the optimal growth temperature, the "mid-point" temperature between the mean and the maximum is the "equivalent" constant temperature. This "equivalent" constant temperature then can be directly compared to laboratory studies done at constant temperatures. For example, a river with a 7DADM value of 64°F and a 58°F weekly mean temperature (i.e., diurnal variation of ± 5.4°F) will be roughly equivalent to a constant laboratory study temperature of 61.7°F (mid-point between 58°F and 65°F). Thus, both maximum and mean temperatures are important when determining a 7DADM value that is protective against sub-lethal/chronic temperature effects.

To account for using the 7DADM metric based on constant temperature laboratory data, EPA (2003a) assumed an average diel temperature difference between the mean and daily maximum temperature of 5.4°F, although the EPA appears to have decreased the temperature in the laboratory data down by 2.7°F (equivalently added 2.7°F to the criteria). It is completely unclear, however, if or how EPA then also accounted for the fact that 7DADM temperature is on average also 5.4°F greater than the average daily temperature (i.e., was this accounted for or not).

It also is unclear if the "midpoint of the maximum and average temperature" correction was applied for all lifestages. If so, this would be inappropriate based on the data available. The "midpoint" correction literature is only applicable to juvenile growth. There is no evidence presented that it is applicable to other lifestages. Also, the juvenile growth "midpoint" temperature correction is somewhat mis-represented in EPA (2003b). The main study relied on by EPA (2003b) is Hokanson et al. (1977), and that study states that the difference in growth between constant and diel fluctuating temperatures was 39% (1.5°C in a ±3.8C fluctuating range) of the difference between the

[4] Maximum daily temperatures are typically 5.4°F higher than average daily temperature (EPA 2003b).

average and maximum temperature (not 50% or the midpoint) and, perhaps more importantly, most of the studies reviewed by EPA indicate that growth in constant temperature was essentially equivalent to growth in fluctuating temperatures. Elliott (1975), for example, found that a growth model developed from constant temperature experimental data predicted brown trout growth in daily fluctuating temperature environments accurately when the mean daily value of the fluctuating temperature was used as input to the growth model.

For the evaluation of potential water temperature-related impacts associated with the reintroduction of anadromous salmonids into the Upper Yuba River Basin, 7DADM values could be calculated for species-specific lifestage periods on an annual basis over the simulation or empirical data period, and the occurrences when that 7DADM values exceed the EPA (2003b) numeric values could be compared among rivers/reaches in the Upper Yuba River Basin.

8.2 ADT

The average daily temperature (ADT) should be considered for application to the Yuba Salmon Forum specific criteria (WTI values) because nearly all of the data in the literature review were either based on ADT or on continuous temperature (also see Table 12). For juvenile growth, the data from Hokanson et al. (1977) can be directly applied to the constant temperature data to provide a correction, if deemed appropriate. The average daily temperature also can be used to determine the number of days (duration) that a WTI is exceeded, and duration of exceedance can be compared among specific geographic areas.

8.3 MWAT

The Maximum Weekly Average Temperature (MWAT) is a metric used by the California RWQCB that is commonly applied to water temperature numeric objectives. Generally, the MWAT serves as a summary measurement of instream water temperature variation that may occur on a daily or seasonal basis, and is used to evaluate chronic (sub-lethal) water temperature impacts (SWRCB website).

The MWAT is found by calculating the mathematical mean of multiple, equally spaced, daily water temperatures over a 7-day consecutive period. The MWAT is defined as the highest value calculated for all possible 7-day periods over a given time period, which usually extends over the summer or is commensurate to the duration of a salmonid lifestage. In order to determine whether the maximum weekly temperature standard is attained, the mathematical mean of multiple, equally spaced, daily temperatures over a seven-day consecutive period is compared to the criterion.

For the evaluation of acceptable water temperature-related reintroduction potential associated with spring-run Chinook salmon and steelhead in the Upper Yuba River Basin, MWAT values should be calculated for species-specific lifestage periods, on an annual basis over the monitoring or simulation period, and the probability that MWAT values exceed specified water temperature index values will be compared among rivers/reaches in the Upper Yuba River Basin.

The use of a single temperature measurement such as MWAT is convenient from a monitoring and regulatory standpoint, but oversimplifies the complex interactions between water temperature regimes and fish health which are affected by the duration of peak and daily average temperatures. Therefore, for the evaluation of acceptable water temperature-related reintroduction potential associated with spring-run Chinook salmon and steelhead in the Upper Yuba River Basin, it is recommended that both the MWAT, and ADT lifestage-specific exceedance durations, be compared with the UOWTI and UTWTI values.

8.4 7DMAVG

The 7-day moving average of maximum daily temperature (7DMAVG) serves as the basis for instream water temperature standards, including those of the Oregon Department of Environmental Quality (ODEQ). The reason for using the 7DMAVG is to decrease the effect of a single peak temperature on data interpretation. Aquatic organisms are affected more by exposure to high temperature over an extended period than to a single exceedance of the criteria. The ODEQ recognizes that not only summer maximum temperatures are of importance to aquatic biota. The intent is to protect the temperature regime through the year. Built into the ODEQ 7DMAVG standard is the assumption that if stream and riparian conditions are managed such that they meet the summer maximum criteria, those same conditions will protect the temperature regime of the stream through the year.

The 7DMAVG standard is based not on directly lethal temperatures (usually above 70°F), but on sub-lethal effects, which are numerous. Sub-lethal effects can lead to death indirectly, or they may reduce the ability of the fish to successfully reproduce and for their offspring to survive and grow. These sub-lethal effects include an increase in the incidence of disease, an inability to spawn, a reduced survival rate of eggs, a reduced growth and survival rate of juveniles, increased competition for limited habitat and food, reduced ability to compete with other species that are better adapted to higher temperatures (many of these are introduced species) and other adverse effects. Sub-lethal effects of temperature on salmonids occur gradually as stream temperatures increase.

In California, the 7DMAVG has been applied in effectiveness monitoring protocols (e.g. 2006 Green Diamond Resource Company Aquatic Habitat Conservation Plan/Candidate Conservation Agreement and Assurances) and other monitoring efforts (e.g., Upper Yuba River Studies Program 2006 Upper Yuba River Water Temperature Criteria for Chinook salmon and Steelhead). However, for the evaluation of water temperature-related reintroduction potential associated with spring-run Chinook salmon and steelhead in the Upper Yuba River Basin, 7DMAVG is not recommended as a metric.

9 WATER TEMPERATURE EVALUATION CONSIDERATIONS

For the evaluation of water temperatures acceptable for reintroduction of salmonids in the Upper Yuba River Basin, it is anticipated that water temperature modeling and/or monitoring will be applied for a comparison among rivers and reaches in the Upper Yuba River Basin. In addition to the application of the criteria and metrics as described in the preceding sections, it may be appropriate to consider other specific evaluation methodologies.

9.1 Water Year Type

Model output and/or monitoring data could be summarized by water year type. Comparisons of the water temperature-related potential among rivers and reaches in the Upper Yuba River Basin could include water year types. This would help identify reaches/lengths of river that would be suitable in all conditions (e.g., critically dry to wet years) as well as the lengths of river that would be suitable under more favorable conditions (e.g., wet water year types only).

9.2 Water Temperature Exceedance Curves

Model output and/or monitoring data also could be summarized by the calculation of water temperature exceedance curves, by month, occurring over the period of evaluation for each of the rivers and reaches. Exceedance curves are particularly useful for examining the probability of occurrence/duration of water temperatures. The evaluation approach could specifically evaluate the probabilities/duration of time that each of the identified lifestage-specific water temperature index values would be exceeded over the period of evaluation. Comparisons of the water temperature-related potential among rivers and reaches in the Upper Yuba River Basin could be made by presentation of monthly cumulative water temperature exceedance distribution probabilities (using average daily water temperatures) relative to specified water temperature index values corresponding to the appropriate months for each lifestage of spring-run Chinook salmon and steelhead.

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APPENDIX A

LIFESTAGE-SPECIFIC WATER TEMPERATURE BIOLOGICAL EFFECTS AND INDEX TEMPERATURE VALUES

STEELHEAD LIFESTAGE-SPECIFIC WATER TEMPERATURE INDEX VALUES

Adult Immigration and Holding

Water temperatures can control the timing of adult spawning migrations and can affect the viability of eggs in holding females. YCWA et al. (2007) suggests that few studies have been published examining the effects of water temperature on either steelhead immigration or steelhead holding, and none of the available studies were recent (Bruin and Waldsdorf 1975; McCullough *et al.* 2001). The available studies suggest that adverse effects occur to immigrating and holding steelhead at water temperatures exceeding the mid 50°F range, and that immigration will be delayed if water temperatures approach approximately 70°F (**Table 2**). Water temperature index values of 52°F, 56°F, 61°F, 65°F and 70°F were chosen because they provide a gradation of potential water temperature effects, and the available literature provided the strongest support for these values.

Because of the paucity of literature pertaining to steelhead adult immigration and holding, an evenly spaced range of water temperature index values could not be achieved. We also used some pertinent information related to other salmonids (e.g., Chinook salmon). 52°F was selected as a water temperature index value because it has been referred to as a "recommended" (Reclamation 2003), "preferred" (McEwan and Jackson 1996; NMFS 2000; NMFS 2002a), and "optimum" (Reclamation 1997a) water temperature for steelhead adult immigration. Increasing levels of thermal stress to this life stage may reportedly occur above the 52°F water temperature index value. 56°F was selected as a water temperature index value because 56°F represents a water temperature above which adverse effects to migratory and holding steelhead begin to arise (Bruin and Waldsdorf 1975; Leitritz and Lewis 1980; McCullough *et al.* 2001; Smith *et al.* 1983). 50-59°F is referred to as the "preferred" range of water temperatures for California summer steelhead holding (Moyle 1995). Whereas, water temperatures greater than 61°F may result in "chronic high stress" of holding Central Valley winter-run steelhead (USFWS 1995). 65°F was selected as a water temperature index value because steelhead (and fall-run Chinook salmon) encounter potentially stressful temperatures between 64.4-73.4°F (Richter and Kolmes 2005). Additionally, over 93% of steelhead detections occurred in the 65.3-71.6°F range, although this may be above the temperature for optimal immigration (Salinger and Anderson 2006) and/or may modify migration timing due to holding in coldwater refugia (High et al. 2006). 70°F was selected as the highest water temperature index value because the literature suggests that water temperatures near and above 70.0°F may result in a thermal barrier to adult steelhead migrating upstream (McCullough *et al.* 2001) and are water temperatures referred to as "stressful" to upstream migrating steelhead in the Columbia River (Lantz

1971 as cited in Beschta et al 1987). Further, Coutant (1972) found that the UILT for adult steelhead was 69.8°F and temperatures between 73-75°F are described as "lethal" to holding adult steelhead in Moyle (2002).

Spawning and Embryo Incubation

Relatively few studies have been published directly addressing the effects of water temperature on steelhead spawning and embryo incubation (Redding and Schreck 1979; Rombough 1988). Because anadromous steelhead and non-anadromous rainbow trout are genetically and physiologically similar, studies on non-anadromous rainbow trout also were considered in the development of water temperature index values for steelhead spawning and embryo incubation (Moyle 2002; McEwan 2001). From the available literature, water temperatures in the low 50°F range appear to support high embryo survival, with substantial mortality to steelhead eggs reportedly occurring at water temperatures in the high 50°F range and above (**Table 3**). Water temperatures in the 45-50°F range have been referred to as the "optimum" for spawning steelhead (FERC 1993).

Water temperature index values of 46°F , 52°F, 54°F, 57°F, and 60°F were selected for two reasons. First, the available literature provided the strongest support for water temperature index values at or near 46°F, 52°F, 54°F, 57°F, and 60°F. Second, the index values reflect a gradation of potential water temperature effects ranging between optimal to lethal conditions for steelhead spawning and embryo incubation. Some literature suggests water temperatures ≤ 50°F are when steelhead spawn (Orcutt et al. 1968) and/or are optimal for steelhead spawning and embryo survival (FERC 1993; Myrick and Cech 2001; Timoshina 1972) and temperatures between 39-52°F are "preferred" by spawning steelhead (IEP Steelhead Project Work Team (no date); McEwan and Jackson 1996), a larger body of literature suggests optimal conditions occur at water temperatures ≤ 52°F (Humpesch 1985; NMFS 2000; NMFS 2001a; NMFS 2002a; Reclamation 1997b; SWRCB 2003; USFWS 1995a). Further, water temperatures between 48-52°F were referred to as "optimal" (FERC 1993; McEwan and Jackson 1996; NMFS 2000) and "preferred" (Bell 1986) for steelhead embryo incubation. Therefore, 52°F was selected as the lowest water temperature index value. Increasing levels of thermal stress to the steelhead spawning and embryo incubation life stage may reportedly occur above the 52°F water temperature index value.

54°F was selected as the next index value, because although most of the studies conducted at or near 54.0°F report high survival and normal development (Kamler and Kato 1983; Redding and Schreck 1979; Rombough 1988), some evidence suggests that symptoms of thermal stress arise at or near 54.0°F (Humpesch 1985; Timoshina 1972). Thus, water temperatures near 54°F may represent an inflection point between properly

functioning water temperature conditions, and conditions that cause negative effects to steelhead spawning and embryo incubation. Further, water temperatures greater than 55°F were referred to as "stressful" for incubating steelhead embryos (FERC 1993). 57°F was selected as an index value because embryonic mortality increases sharply and development becomes retarded at incubation temperatures greater than or equal to 57.0°F. Velsen (1987) provided a compilation of data on rainbow trout and steelhead embryo mortality to 50% hatch under incubation temperatures ranging from 33.8°F to 60.8°F that demonstrated a two-fold increase in mortality for embryos incubated at 57.2°F, compared to embryos incubated at 53.6°F. In a laboratory study using gametes from Big Qualicum River, Vancouver Island, steelhead mortality increased to 15% at a constant temperature of 59.0°F, compared to less than 4% mortality at constant temperatures of 42.8°F, 48.2°F, and 53.6°F (Rombough 1988). Also, alevins hatching at 59.0°F were considerably smaller and appeared less well developed than those incubated at the lower temperature treatments. From fertilization to 50% hatch, Big Qualicum River steelhead had 93% mortality at 60.8°F, 7.7% mortality at 57.2°F, and 1% mortality at 47.3°F and 39.2°F (Velsen 1987). Myrick and Cech (2001) similarly described water temperatures >59°F as "lethal" to incubating steelhead embryos, although FERC (1993) suggested that water temperatures exceeding 68°F were "stressful" to spawning steelhead and "lethal" when greater than 72°F.

Juvenile Rearing & Downstream Movement

Water temperature index values were developed to evaluate the combined steelhead rearing (fry and juvenile) and juvenile downstream movement lifestages. Some steelhead may rear in freshwater for up to three years before emigrating as yearling+ smolts, whereas other individuals move downstream shortly after emergence as post-emergent fry, or rear in the river for several months and move downstream as juveniles without exhibiting the ontogenetic characteristics of smolts. Presumably, these individuals continue to rear and grow in downstream areas (e.g., lower Feather River, Sacramento River, and Upper Delta) and undergo the smoltification process prior to entry into saline environments. Thus, fry and juvenile rearing occur concurrently with post-emergent fry and juvenile downstream movement and are assessed in this Technical Memorandum using the fry and juvenile rearing water temperature index values.

The growth, survival, and successful smoltification of juvenile steelhead are controlled largely by water temperature. The duration of freshwater residence for juvenile steelhead is long relative to that of Chinook salmon, making the juvenile life stage of steelhead more susceptible to the influences of water temperature, particularly during the over-summer rearing period. Central Valley juvenile steelhead have high growth

rates at water temperatures in the mid 60°F range, but reportedly require lower water temperatures to successfully undergo the transformation to the smolt stage.

Water temperature index values of 63°F, 65°F, 68°F, 72°F, and 75°F were selected to represent a gradation of potential water temperature effects ranging between optimal to lethal conditions for steelhead juvenile rearing (Table 4). The lowest water temperature index value of 63°F was established because Myrick and Cech (2001) describe 63°F as the "preferred" water temperature for wild juvenile steelhead, whereas "preferred" water temperatures for juvenile hatchery steelhead reportedly range between 64-66°F. 65°F was also identified as a water temperature index value because NMFS (2000; 2002a) reported 65°F as the upper limit preferred for growth and development of Sacramento and American River juvenile steelhead. Also, 65°F was found to be within the optimum water temperature range for juvenile growth (i.e., 59-66°F) (Myrick and Cech 2001), and supported high growth of Nimbus strain juvenile steelhead (Cech and Myrick 1999).

Increasing levels of thermal stress to this life stage may reportedly occur above the 65°F water temperature index value. For example, Kaya *et al.* (1977) reported that the upper avoidance water temperature for juvenile rainbow trout was measured at 68°F to 71.6°F. Cherry *et al.* (1977) observed an upper preference water temperature near 68.0°F for juvenile rainbow trout, duplicating the upper preferred limit for juvenile steelhead observed in Cech and Myrick (1999) and FERC (1993). Empirical adult *O. mykiss* population data from the North Yuba, Middle Yuba, South Yuba, Middle Fork American, and Rubicon rivers collected in 2007-2009 are plotted against temperature in Figure 4. The temperature used was the 8th largest average daily temperature during the summer (i.e., up to seven days had higher daily average temperatures). The data show a population density break at about 68.0°F. Although smaller population densities occurred at higher temperatures, the largest population densities occurred at temperatures near 68.0°F or less. In addition Figure 5 shows growth for a 200 mm juvenile O. mykiss versus temperature for three food levels (percent of maximum consumption = 30%, 50%, and 70%). The average empirically derived percent of maximum consumption in an adjacent watershed (Middle Fork American Fork River) was 50% (Hanson et al. 1997). Positive growth only occurs up to approximately 68°F. Because of the literature describing 68.0°F as both an upper preferred and an avoidance limit for juvenile *Oncorhynchus mykiss*, and because of the empirical fish population data and bioenergetics growth data, 68°F was established as a upper tolerable water temperature index value.

A water temperature index value of 72°F was established because symptoms of thermal stress in juvenile steelhead have been reported to arise at water temperatures approaching 72°F. For example, physiological stress to juvenile steelhead in Northern

California streams was demonstrated by increased gill flare rates, decreased foraging activity, and increased agonistic activity as stream temperatures rose above 71.6°F (Nielsen *et al.* 1994). Also, 72°F was selected as a water temperature index value because 71.6°F has been reported as an upper avoidance water temperature (Kaya *et al.* 1977) and an upper thermal tolerance water temperature (Ebersole *et al.* 2001) for juvenile rainbow trout. The highest water temperature index value of 75°F was established because NMFS and EPA report that direct mortality to rearing juvenile steelhead results when stream temperatures reach 75.0°F (EPA 2002; NMFS 2001b). Water temperatures >77°F have been referred to as "lethal" to juvenile steelhead (FERC 1993; Myrick and Cech 2001). The UILT for juvenile rainbow trout, based on numerous studies, is between 75-79°F (Sullivan et al. 2000; McCullough 2001).

Yearling + Smolt Emigration

Laboratory data suggest that smoltification, and therefore successful emigration of steelhead smolts, is directly controlled by water temperature (Adams *et al.* 1975) (**Table 5**). Water temperature index values of 52°F and 55°F were selected to evaluate the steelhead smolt emigration life stage, because most literature on water temperature effects on steelhead smolting suggest that water temperatures less than 52°F (Adams *et al.* 1975; Myrick and Cech 2001; Rich 1987a) or less than 55°F (EPA 2003a; McCullough *et al.* 2001; Wedemeyer *et al.* 1980; Zaugg and Wagner 1973) are required for successful smoltification to occur. (Adams *et al.* 1973) tested the effect of water temperature (43.7°F, 50.0°F, 59.0°F or 68.0°F) on the increase of gill microsomal Na^+-, K^+-stimulated ATPase activity associated with parr-smolt transformation in steelhead and found a two-fold increase in Na^+-, K^+-ATPase at 43.7 and 50.0°C, but no increase at 59.0°F or 68.0°F. In a subsequent study, the highest water temperature where a parr-smolt transformation occurred was at 52.3°F (Adams *et al.* 1975). The results of Adams *et al.* (1975) were reviewed in Myrick and Cech (2001) and Rich (1987b), which both recommended that water temperatures below 52.3°F are required to successfully complete the parr-smolt transformation. Further, Myrick and Cech (2001) suggest that water temperatures between 43-50°F are the "physiologically optimal" temperatures required during the parr-smolt transformation and necessary to maximize saltwater survival. The 52°F water temperature index value established for the steelhead smolt emigration life stage is the index value generally reported in the literature as the upper limit of the water temperature range that provides successful smolt transformation thermal conditions. Increasing levels of thermal stress to this life stage may reportedly occur above the 52°F water temperature index value.

Zaugg and Wagner (1973) examined the influence of water temperature on gill ATPase activity related to parr-smolt transformation and migration in steelhead. They found ATPase activity was decreased and migration reduced when juveniles were exposed to

water temperatures of 55.4°F or greater. In a technical document prepared by the EPA to provide temperature water quality standards for the protection of Northwest native salmon and trout, water temperatures less than or equal to 54.5°F were recommended for emigrating juvenile steelhead (EPA 2003b). Water temperatures are considered "unsuitable" for steelhead smolts at >59°F (Myrick and Cech 2001) and "lethal" at 77°F (FERC 1993).

CHINOOK SALMON LIFESTAGE-SPECIFIC WATER TEMPERATURE INDEX VALUES

It has been suggested that separate water temperatures standards should be developed for each run-type of Chinook salmon. For example, McCullough (1999) states that spring-run Chinook salmon immigrate in spring and spawn in 3rd to 5th order streams and, therefore, face different migration and adult holding temperature regimes than do summer- or fall-run Chinook salmon, which spawn in streams of 5th order or greater. However, to meet the objectives of the current literature review, run-types are not separated because: (1) there is a paucity of literature specific to each life stage of each run-type; (2) there is an insufficient amount of data available in the literature suggesting that Chinook salmon run-types respond to water temperatures differently; (3) the WTI values derived from all the literature pertaining to Chinook salmon for a particular life stage will be sufficiently protective of that life stage for each run-type; and (4) all run-types overlap in timing of adult immigration and holding and in some cases are not easily distinguished (Healey 1991). Nonetheless, water temperature relationships for each lifestage of spring-run Chinook salmon available in the literature are emphasized in the consideration and identification of WTI values for evaluation of reintroduction of spring-run Chinook salmon in the Upper Yuba River Basin.

Adult Immigration and Holding

The adult immigration and adult holding life stages are evaluated together, because it is difficult to determine the thermal regime that Chinook salmon have been exposed to in the river prior to spawning and in order to be sufficiently protective of pre-spawning fish, water temperatures that provide high adult survival and high egg viability must be available throughout the entire pre-spawning freshwater period. Although studies examining the effects of thermal stress on immigrating Chinook salmon are generally lacking, it has been demonstrated that thermal stress during the upstream spawning migration of sockeye salmon negatively affected the secretion of hormones controlling sexual maturation causing numerous reproductive impairment problems (McCullough *et al.* 2001).

The water temperature index values reflect a gradation of potential water temperature effects that range between those reported as "optimal" to those reported as "lethal" for adult Chinook salmon during upstream spawning migrations and holding. The water temperature index values established for the Chinook salmon adult immigration and holding lifestage are 61°F, 65°F, and 68°F (**Table 6)**. Although 56°F is referenced in the literature frequently as the upper "optimal" water temperature limit for upstream migration and holding, the references are not foundational studies and often are inappropriate citations. For example, Boles *et al.* (1988), Marine (1992), and NMFS (1997b) all cite Hinze (1959) in support of recommendations for a water temperature of 56°F for adult Chinook salmon immigration. However, Hinze (1959) is a study examining the effects of water temperature on incubating Chinook salmon eggs in the American River Basin. Further, water temperatures between 38-56°F are considered to represent the "observed range" for upstream migrating spring-run Chinook salmon (Bell 1986).

The lowest water temperature index value established was 61°F, because in the NMFS biological opinion for the proposed operation of the Central Valley Project (CVP) and State Water Project (SWP), 59°F to 60°F is reported as…"*The upper limit of the optimal temperature range for adults holding while eggs are maturing*" (NMFS 2000). Also, NMFS (1997b) states…"*Generally, the maximum temperature of adults holding, while eggs are maturing, is about 59°F to 60°F*" …and… "*Acceptable range for adults migrating upstream range from 57°F to 67°F*." ODEQ (1995) reports that "…*many of the diseases that commonly affect Chinook become highly infectious and virulent above 60°F*." Study summaries in EPA (2003) indicate disease risk is high at 62.6°F. Additionally, Ward and Kier (1999) designated temperatures <60.8°F as an "optimum" water temperature threshold for holding Battle Creek spring-run Chinook salmon. EPA (2003) chose a holding value of 61°F (7DADM) based on laboratory data various assumptions regarding diel temperature fluctuations. 61°F is also a holding temperature index value for steelhead (see above). The 61°F water temperature index value established for the Chinook salmon adult immigration and holding life stage is the index value generally reported in the literature as the upper limit of the optimal range, and is within the reported acceptable range. Increasing levels of thermal stress to this life stage may reportedly occur above the 61°F water temperature index value.

An index value of 65°F was established because Berman (1990) suggests effects of thermal stress to pre-spawning adults are evident at water temperatures near 65°F. Berman (1990) conducted a laboratory study to determine if pre-spawning water temperatures experienced by adult Chinook salmon influenced reproductive success, and found evidence suggesting latent embryonic abnormalities associated with water temperature exposure to pre-spawning adults that ranged from 63.5°F to 66.2°F. Ward

et al. (2003; 2004) identified an extended period of average daily temperatures above 67°F during July as measured at the Quartz Bowl that preceded the onset of significant pre-spawn mortalities. During 2002, temperatures exceeded 67°F a total of 16 days with a maximum of 20.8°C on July 12. During 2003, temperatures exceed 67°F a total of 11 days with a maximum of 20.9°C on July 23. However during other years when there were minimal pre-spawn mortalities, maximum daily average water temperature at Quartz Bowl never exceeded 67°F more than an few days (Ward et al. 2004; Ward et al. 2006; Ward et al. 2007; McReynolds and Garman 2008; McReynolds and Garman 2010). During each of the years when Chinook salmon temperature mortality was not observed at Butte Creek (2001, 2004-2007), on average, daily temperature did not exceed 65.8°F for more than 7 days (Figure 6). Tracy McReynolds (Pers. Comm. October 2011) indicated that an upper tolerable holding temperature of 65°F was reasonable based on her experience.

An index value of 68°F was established because the Butte Creek data and the literature suggests that thermal stress at water temperatures greater than 68°F is pronounced, and severe adverse effects to immigrating and holding pre-spawning adults, including mortality, can be expected (Berman 1990; Marine 1997; NMFS 1997b; Ward et al. 2004).

Water temperatures between 70-77°F are reported as the range of maximum temperatures for holding pool conditions used by spring-run Chinook salmon in the Sacramento-San Joaquin system (Moyle et al. 1995). Migration blockage occurs for Chinook salmon at temperatures from 70-71+°F (McCollough 1999; McCullough et al. 2001; EPA 2003b). Strange (2010) found that the mean average body temperature during the first week of Chinook salmon migration on the Klamath River was 71.4°F. The UILT for Chinook salmon jacks is 69.8-71.6°F (McCullough 1999). The upper limit for spring-run Chinook salmon holding in Deer Creek is reportedly 80.6°F, at which point temperatures exceeding this value become "lethal" (Cramer and Hammack (1952), as cited in Moyle et al. (1995). As a result of the potential effects to immigrating and holding adult Chinook salmon that reportedly occur at water temperatures greater than or equal to 68°F, index values higher than 68°F were not established.

Spawning and Embryo Incubation

The adult spawning and embryo (i.e., eggs and alevins) incubation life stage includes redd construction, egg deposition, and embryo incubation. Potential effects to the adult spawning and embryo incubation life stages are evaluated together using one set of water temperature index values because it is difficult to separate the effects of water temperature between lifestages that are closely linked temporally, especially considering that studies describing how water temperature affects embryonic survival

and development have included a pre-spawning or spawning adult component in the reporting of water temperature experiments conducted on fertilized eggs (Marine 1992; McCullough 1999; Seymour 1956).

The water temperature index values selected for the Chinook salmon spawning and embryo incubation life stages are 56°F, 58°F, 60°F, and 62°F (**Table 7**). Anomalously, FERC (1993) refers to 50°F as the "optimum" water temperature for spawning and incubating Chinook salmon. Additionally, for the adult spawning lifestage, FERC (1993) reports "stressful" and "lethal" water temperatures occuring at >60°F and >70°F, respectively, whereas for incubating Chinook salmon embryos, water temperatures are considered to be "stressful" at <56°F or "lethal" at >60°F. Much literature suggests that water temperatures must be less than or equal to 56°F for maximum survival of Chinook salmon embryos (i.e., eggs and alevins) during spawning and incubation. NMFS (1993b) reported that optimum water temperatures for egg development are between 43°F and 56°F. Similarly, Myrick and Cech (2001) reported the highest egg survival rates occur between water temperatures of 39-54°F. Reclamation (unpublished work) reports that water temperatures less than 56°F results in a natural rate of mortality for fertilized Chinook salmon eggs. Bell (1986) recommends water temperatures ranging between 42-57°F for spawning Chinook salmon, and water temperatures between 41-58°F for incubating embryos. USFWS (1995a) reported a water temperature range of 41.0°F to 56.0°F for maximum survival of eggs and yolk-sac larvae in the Central Valley of California. The preferred water temperature range for Chinook salmon egg incubation in the Sacramento River was suggested as 42.0°F to 56.0°F (NMFS 1997a). Alevin mortality is reportedly significantly higher when Chinook salmon embryos are incubated at water temperatures above 56°F (USFWS 1999). NMFS (2002a) reported 56.0°F as the upper limit of suitable water temperatures for spring-run Chinook salmon spawning in the Sacramento River. The 56°F water temperature index value established for the Chinook salmon spawning and embryo incubation life stage is the index value generally reported in the literature as the upper limit of the optimal range for egg development and the upper limit of the range reported to provide maximum survival of eggs and yolk-sac larvae in the Central Valley of California. Increasing levels of thermal stress to this life stage may reportedly occur above the 56°F water temperature index value.

High survival of Chinook salmon embryos also has been suggested to occur at incubation temperatures at or near 58.0°F. For example, (Reclamation Unpublished Work) reported that the natural rate of mortality for alevins occurs at 58°F or less. Combs (1957) concluded constant incubation temperatures between 42.5°F and 57.5°F resulted in normal development of Chinook salmon eggs, and NMFS (2002a) suggests 53.0°F to 58.0°F is the preferred water temperature range for Chinook salmon eggs and fry.

Johnson (1953) found consistently higher Chinook salmon egg losses resulted at water temperatures above 60.0°F than at lower temperatures. In order to protect late incubating Chinook salmon embryos and newly emerged fry NMFS (1993a) has determined a water temperature criterion of less than or equal to 60.0°F be maintained in the Sacramento River from Keswick Dam to Bend Bridge from October 1 to October 31. Seymour (1956) provides evidence that 100% mortality occurs to late incubating Chinook salmon embryos when held at a constant water temperature greater than or equal to 60.0°F. For Chinook salmon eggs incubated at constant temperatures, mortality increases rapidly at temperatures greater than about 59-60°F (see data plots in Myrick and Cech 2001). Olsen and Foster (1957), however, found high survival of Chinook salmon eggs and fry (89.6%) when incubation temperatures started at 60.9°F and declined naturally for the Columbia River (about 7°F / month). Geist et al. (2006) found high (93.8%) Chinook salmon incubation survival through emergence for naturally declining temperatures (0.36°F/day) starting as high as 61.7°F; however, a significant reduction in survival occurred above this temperature.

The literature largely agrees that 100% mortality will result to Chinook salmon embryos incubated at water temperatures greater than or equal to 62.0°F (Hinze 1959; Myrick and Cech 2003; Seymour 1956; USFWS 1999). Approximately 80% or greater mortality of eggs incubated at constant temperatures of 63°F or greater (see data plots in Myrick and Cech 2001). Olsen and Foster (1957) found high mortality of Chinook salmon eggs and fry (79%) when incubation temperatures started at 65.2°F and declined naturally for the Columbia River (about 7°F / month). Geist et al. (2006) found low Chinook salmon incubation survival (1.7%) for naturally declining temperatures (0.36°F/day) when temperatures started at 62.6°F

Juvenile Rearing & Downstream Movement

Water temperature index values were identified for the combined spring-run Chinook salmon rearing (fry and juvenile) and juvenile downstream movement lifestages, for the reasons previously described regarding steelhead. Fry and juvenile rearing occur concurrently with post-emergent fry and juvenile downstream movement, and are assessed in this Technical Memorandum using the fry and juvenile rearing water temperature index values.

The water temperature index values of 60°F, 65°F, 68°F, 70°F and 75°F were identified for the spring-run Chinook salmon juvenile rearing and downstream movement lifestage. The lowest index value of 60°F was chosen because regulatory documents as well as several source studies, including ones recently conducted on Central Valley Chinook salmon fry and juveniles report 60°F as an optimal water temperature for growth (Banks *et al.* 1971; Brett *et al.* 1982; Marine 1997; NMFS 1997b; NMFS 2000;

NMFS 2001a; NMFS 2002a; Rich 1987b) (**Table 8**). Water temperatures below 60°F also have been reported as providing conditions optimal for fry and fingerling growth, but were not selected as index values, because the studies were conducted on fish from outside of the Central Valley (Brett 1952; Seymour 1956). Studies conducted using local fish may be particularly important because *Oncorhynchus* species show considerable variation in morphology, behavior, and physiology along latitudinal gradients (Myrick 1998; Taylor 1990b; Taylor 1990a). More specifically, it has been suggested that salmonid populations in the Central Valley prefer higher water temperatures than those from more northern latitudes (Myrick and Cech 2000).

The 60°F water temperature index value established for the Chinook salmon juvenile rearing and downstream movement life stage is the index value generally reported in the literature as the upper limit of the optimal range for fry and juvenile growth and the upper limit of the preferred range for growth and development of spring-run Chinook salmon fry and fingerlings. FERC (1993) referred to 58°F as an "optimum" water temperature for juvenile Chinook salmon in the American River. NMFS (2002a) identified 60°F as the "preferred" water temperature for juvenile spring-run Chinook salmon in the Central Valley. Increasing levels of thermal stress to this life stage may reportedly occur above the 60°F water temperature index value.

The index value of 65°F was selected because it represents an intermediate value between 64.0°F and 66.2°F, at which both adverse and beneficial effects to juvenile salmonids have been reported to occur. For example, at temperatures approaching and beyond 65°F, sub-lethal effects associated with increased incidence of disease reportedly become severe for juvenile Chinook salmon (EPA 2003a; Johnson and Brice 1953; Ordal and Pacha 1963; Rich 1987a). Conversely, numerous studies report that temperatures between 64.0°F and 66.2°F provide conditions ranging from suitable to optimal for juvenile Chinook salmon growth (Brett *et al.* 1982; Cech and Myrick 1999; Clarke and Shelbourn 1985; EPA 2003a; Myrick and Cech 2001; NMFS 2002a; USFWS 1995a). Maximum growth of juvenile fall-run Chinook salmon has been reported to occur in the American River at water temperatures between 56-59°F (Rich 1987) and in Nimbus Hatchery spring-run Chinook salmon at 66°F (Cech and Myrick 1999). Figure 5 shows growth for a 100 mm juvenile Chinook salmon versus temperature for three food levels (percent of maximum consumption = 30%, 50%, and 70%). The average percent of maximum consumption in an adjacent watershed (Middle Fork American Fork River) for O. *mykiss* was 50% (Hanson et al. 1997). Positive growth only occurs up to approximately 64°F for food levels expected in the wild (e.g., 50% maximum consumption).

A water temperature index value of 68°F was selected because, at water temperatures above 68°F, sub-lethal effects become severe such as reductions in appetite and growth

of juveniles (Marine 1997; Rich 1987a; Zedonis and Newcomb 1997). Chronic stress associated with water temperature can be expected when conditions reach the index value of 70°F. For example, growth becomes drastically reduced at temperatures close to 70.0°F and has been reported to be completely prohibited at 70.5°F (Brett *et al.* 1982; Marine 1997). 75°F was chosen as the highest water temperature index value because high levels of direct mortality to juvenile Chinook salmon reportedly result at this water temperature (Cech and Myrick 1999; Hanson 1991; Myrick and Cech 2001; Rich 1987b). Other studies have suggested higher upper lethal water temperature levels (Brett 1952; Orsi 1971), but 75°F was chosen because it was derived from experiments using Central Valley Chinook salmon and it is a more rigorous index value representing a more protective upper lethal water temperature level. Furthermore, the lethal level determined in Rich (1987b) was derived using slow rates of water temperature change and, thus, is ecologically relevant. The juvenile Chinook Salmon UILT based on numerous studies is 75-77°F (Sullivan et al. 2000; McCullough et al. 2001; Myrick and Cech 2001)

Yearling + Smolt Emigration

Juvenile Chinook salmon that exhibit extended rearing in the lower Yuba River are assumed to undergo the smoltification process and volitionally emigrate from the river as yearling+ individuals. Water temperature index values of 63°F, 68°F and 72°F were selected for the spring-run Chinook yearling+ emigration lifestage (**Table 9)**.

A water temperature index value of 63°F was selected because water temperatures at or below this value allow for successful transformation to the smolt stage, and water temperatures above this value may result in impaired smoltification indices, inhibition of smolt development, and decreased survival and successful smoltification of juvenile spring-run Chinook salmon. Laboratory experiments suggest that water temperatures at or below 62.6°F provide conditions that allow for successful transformation to the smolt stage (Clarke and Shelbourn 1985; Marine 1997; Zedonis and Newcomb 1997). 62.6°F was rounded and used to support an index value of 63°F. Indirect evidence from tagging studies suggests that the survival of fall-run Chinook salmon smolts decreases with increasing water temperatures between 59°F and 75°F in the Sacramento-San Joaquin Delta (Kjelson and Brandes 1989). A water temperature index value of 68°F was selected because water temperatures above 68°F prohibit successful smoltification (Marine 1997; Rich 1987a; Zedonis and Newcomb 1997). Support for an index value of 72°F is provided from a study conducted by (Baker *et al.* 1995) in which a statistical model is presented that treats survival of Chinook salmon smolts fitted with coded wire tags in the Sacramento River as a logistic function of water temperature. Using data obtained from mark-recapture surveys, the statistical model suggests a 95% confidence

interval for the upper incipient lethal water temperature for Chinook salmon smolts as 71.5°F to 75.4°F.

From: Le, Bao
Sent: Thursday, October 27, 2016 9:21 AM
To: John Wooster - NOAA Federal
Cc: Deason, Jesse
Subject: RE: Bratovich et al 2012

Thanks, John.

From: John Wooster - NOAA Federal [mailto:john.wooster@noaa.gov]
Sent: Wednesday, October 26, 2016 5:17 PM
To: Le, Bao
Cc: Deason, Jesse
Subject: Re: Bratovich et al 2012

Bao:

Thanks for the article. Sorry, slipped my mind that I had one coming back to you. Attached is Lindley et al 2007.

-John

On Thu, Oct 20, 2016 at 2:19 PM, Le, Bao <ChiBao.Le@hdrinc.com> wrote:

Here you go, John.

Thanks for participating today.

Bao

Bao Le

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Title:

Framework for Assessing Viability of Threatened and Endangered Chinook Salmon and Steelhead in the Sacramento–San Joaquin Basin

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Abstract:
Protected evolutionarily significant units (ESUs) of salmonids require objective and measurable criteria for guiding their recovery. In this report, we develop a method for assessing population viability and two ways to integrate these population-level assessments into an assessment of ESU viability. Population viability is assessed with quantitative extinction models or criteria relating to population size, population growth rate, the occurrence of catastrophic declines, and the degree of hatchery influence. ESU viability is assessed by examining the number and distribution of viable populations across the landscape and their proximity to sources of catastrophic disturbance.

Central Valley spring-run and winter-run Chinook salmon ESUs are not currently viable, according to the criteria-based assessment. In both ESUs, extant populations may be at low risk of extinction, but these populations represent a small portion of the historical ESUs, and are vulnerable to catastrophic disturbance. The winter-run Chinook salmon ESU, in the extreme case, is represented by a single population that spawns outside of its historical spawning range. We are unable to assess the status of the Central Valley steelhead ESU with our framework because almost all of its roughly 80 populations are classified as data deficient. The few exceptions are those populations with a closely associated hatchery, and the naturally-spawning fish in these streams are at high risk of extinction. Population monitoring in this ESU is urgently needed.

Global and regional climate change poses an additional risk to the survival of salmonids in the Central Valley. A literature review suggests that by 2100, mean summer temperatures in the Central Valley region may increase by 2-8°C, precipitation will likely shift to more rain and less snow, with significant declines in total precipitation possible, and hydrographs will likely change, especially the the southern Sierra Nevada mountains. Warming at the lower end of the predicted range may allow spring-run Chinook salmon to persist in some streams, while making some currently utilized habitat inhospitable. At the upper end of the range of predicted warming, very little spring-run Chinook salmon habitat is expected to remain suitable.

In spite of the precarious position of Central Valley salmonid ESUs, there are prospects for greatly improving their viability. Recovering Central Valley ESUs may require re-establishing populations where historical populations have been extirpated (e.g., upstream of major dams). Such major efforts should be focused on those watersheds that offer the best possibility of providing suitable habitat in a warmer future.

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Framework for Assessing Viability of Threatened and Endangered Chinook Salmon and Steelhead in the Sacramento-San Joaquin Basin

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ABSTRACT

Protected evolutionarily significant units (ESUs) of salmonids require objective and measurable criteria for guiding their recovery. In this report, we develop a method for assessing population viability and two ways to integrate these population-level assessments into an assessment of ESU viability. Population viability is assessed with quantitative extinction models or criteria relating to population size, population growth rate, the occurrence of catastrophic declines, and the degree of hatchery influence. ESU viability is assessed by examining the number and distribution of viable populations across the landscape and their proximity to sources of catastrophic disturbance.

Central Valley spring-run and winter-run Chinook salmon ESUs are not currently viable, according to the criteria-based assessment. In both ESUs, extant populations may be at low risk of extinction, but these populations represent a small portion of the historical ESUs, and are vulnerable to catastrophic disturbance. The winter-run Chinook salmon ESU, in the extreme case, is represented by a single population that spawns outside of its historical spawning range. We are unable to assess the status of the Central Valley steelhead ESU with our framework because almost all of its roughly 80 populations are classified as data deficient. The few exceptions are those populations with a closely associated hatchery, and the naturally-spawning fish in these streams are at high risk of extinction. Population monitoring in this ESU is urgently needed.

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In spite of the precarious position of Central Valley salmonid ESUs, there are prospects for greatly improving their viability. Recovering Central Valley ESUs may require re-establishing populations where historical populations have been extirpated (e.g., upstream of major dams). Such major efforts should be focused on those watersheds that offer the best possibility of providing suitable habitat in a warmer future.

KEYWORDS

Central Valley, Chinook salmon, steelhead, *Oncorhynchus tshawytscha, Oncorhynchus mykiss,* population viability, conservation, recovery planning, catastrophes, climate change, endangered species, biocomplexity

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INTRODUCTION

Numerous evolutionarily significant units (ESUs) of Pacific salmon and steelhead are listed as threatened or endangered species under the US Endangered Species Act (ESA) of 1973. The ESA, as amended in 1988, requires that recovery plans have quantitative, objective criteria that define when a species can be removed from the list, but does not offer detailed guidance on how to define recovery criteria. Logically, some of the recovery criteria should be biological indicators of low extinction risk. Recovery plans prepared since the 1988 amendment typically have about six recovery criteria, but only about half of these are quantitative or clearly related to biological information (Gerber and Hatch 2002). Gerber and Hatch (2002) found a positive relationship between the number of well-defined biological recovery criteria and the trend in abundance for the species. This empirical finding supports our intuition that well-defined recovery goals are important for recovering species.

Recovery planning seeks to ensure the viability of protected species. Viability of populations and ESUs depends on the demographic properties of the population or ESU, such as population size, growth rate, the variation in growth rate, and carrying capacity (e.g., Tuljapurkar and Orzack 1980). In the short term, the demographic properties of a population depend largely on the quality and quantity of habitat. In the longer term, genetic diversity, and the diversity of habitats that support genetic diversity, become increasingly important (McElhany et al. 2000; Kendall and Fox 2002; Williams and Reeves 2003). Consequently, McElhany et al. (2000) suggested that the viability of Pacific salmon populations should be assessed in terms of abundance, productivity, spatial structure, and genetic and life-history diversity. ESUs can be assessed in these same terms. While providing a useful conceptual framework for thinking about viability of Pacific salmon, McElhany et al. (2000) did not provide quantitative criteria that would allow one to assess whether particular populations or ESUs are viable.

Developing objective, quantitative, and biologically meaningful recovery criteria for Pacific salmonid ESUs is difficult. Ideally, these criteria would be population- and ESU-specific, taking into account the constraints in some factors that influence viability. For example, quantity of suitable habitat will usually set some limit on the size of a population, and populations with less habitat will need to have higher intrinsic growth rates (or less variable growth) than populations with more habitat, if they are to have similar viability. Unfortunately, population-specific information is frequently unavailable. One way out of this problem is to forego population-specific goals and develop biologically relevant criteria that are generic to *Oncorhynchus* species. Conservation biologists have developed a number of such criteria for the related task of identifying and prioritizing species in need of conservation (Mace and Lande 1991; IUCN 1994; Gärdenfors et al. 2001), and these taxonomically general criteria have been modified for application to Pacific salmonids (Allendorf et al. 1997).

If extinction risks of populations were independent, assessing the extinction risk of the ESU would be straightforward—the extinction risk of the ESU would be the product of the extinction risks of all its populations. We expect the extinction risks of populations to be correlated, however, because normal environmental influences affecting the population dynamics of salmonids are spatially correlated. Perhaps even more importantly, the effects of catastrophes (defined as rare environmental perturbations with very strong negative effects on afflicted populations) can be quite widespread. Finally, in cases like the Central Valley, all populations must use certain small areas (e.g., San Pablo Bay) where a single event such as a toxic spill could affect all populations even though they are widely dispersed for most of their life cycle. In some cases, it may be possible to explicitly examine the vulnerability of ESUs to catastrophic risks. We are unlikely to be able to identify all possible sources of risk, however, so we should also think of managing risk by maximizing diversity within ESUs.

In this report, we develop an approach for assessing the viability of Pacific salmonid populations and ESUs, and apply it to listed ESUs in California's Central Valley domain. In the "Assessment Framework" section below, we extend the criteria-based approach of Allendorf et al. (1997) to account for the effects of hatchery fish on the extinction risk of naturally-spawning populations, and explicitly define a "low" extinction risk category. This low-risk definition can serve as a default goal for recovering populations for which too little data exist for more detailed goals to be developed. ESU viability is addressed in two ways. In the first, risk-spreading is assessed by examining how viable populations are spread among geographically-defined regions within the ESU. In the second, we attempt to account explicitly for the spatial structure of the ESU and the spatial structure of various catastrophic risks, including volcanos, wildfires, and droughts. In the "Application to Central Valley Salmonids" section, we apply the analyses to Central Valley spring-run Chinook salmon (*Oncorhynchus tshawytscha)*, Sacramento River winter-run Chinook salmon (*O. tshawytscha)*, and Central Valley steelhead (*Oncorhynchus mykiss)*. As these methods implicitly assume that the future will be like the recent past, we review the likely effects of climate variation and climate change in "Climate Variability and Change." The "Summary and Recommendations" section summarizes our findings and makes some recommendations for recovery planners.

ASSESSMENT FRAMEWORK

Population Viability

Risk Categories

The goal of our population-level viability assessment is to classify populations into one of six categories, including "extinct," "extinct in the wild," "high," "moderate," and "low" extinction risk, or "data deficient," following the general approach of the IUCN (1994) as modified for Pacific salmonids by Allendorf et al. (1997). The goal of recovery activities should be to achieve at least a low risk of extinction for focal populations. We assume that a 5% risk of extinction in 100 years is an acceptably low extinction risk for populations (Thompson, 1991). Many salmonid populations are capable of achieving much lower risk levels and can provide additional benefits to ecosystems (Schindler et al. 2003) and people (e.g., by providing fishing opportunities) at these higher levels of abundance and productivity.

For Chinook salmon, we infer that populations are extinct if all of their historically utilized spawning habitat is blocked by impassable dams. *O. mykiss* pop-

Table 1. Criteria for assessing the level of risk of extinction for populations of Pacific salmonids. Overall risk is determined by the highest risk score for any category. (Modified from Allendorf et al. 1977)

	Risk of Extinction		
Criterion	High	Moderate	Low
Extinction risk from PVA	$> 20\%$ within 20 years	$> 5\%$ within 100 years	$< 5\%$ within 100 years
	– or any ONE of –	– or any ONE of –	– or ALL of –
Population size[a]	$N_e \leq 50$	$50 < N_e \leq 500$	$N_e > 500$
	–or–	–or–	–or–
	$N \leq 250$	$250 < N \leq 2500$	$N > 2500$
Population decline	Precipitous decline[b]	Chronic decline or depression[c]	No decline apparent or probable
Catastrophe, rate and effect[d]	Order of magnitude decline within one generation	Smaller but significant decline[e]	not apparent
Hatchery influence[f]	High	Moderate	Low

[a] Census size N can be used if direct estimates of effective size N_e are not available, assuming $N_e/N = 0.2$.
[b] Decline within last two generations to annual run size ≤ 500 spawners, or run size > 500 but declining at $\geq 10\%$ per year. Historically small but stable population not included.
[c] Run size has declined to ≤ 500, but now stable.
[d] Catastrophes occuring within the last 10 years.
[e] Decline $< 90\%$ but biologically significant.
[f] See Figure 1 for assessing hatchery impacts.

ulations may persist above migration barriers even if spawning habitat is inaccessible to anadromous fish, so migration barriers can not be taken as evidence of extinction for *O. mykiss*. In some cases, dams create suitable habitat in downstream reaches (typically through regulated discharges of cold water), and may support a population. We assess the status of such populations with the criteria described below, but note that the identity of tailwater populations may differ from populations historically found above the barrier.

Populations entirely dependent on artificial production (i.e., found only in a captive broodstock program or hatchery) would be considered extinct in the wild.

Risk categories from "high" to "low" are defined by various quantitative criteria, and correspond to specific risks of extinction within specific time horizons (Table 1). We extend Allendorf et al.'s (1997) criteria categories and risk levels in two ways (Table 1). First, we define criteria for the "low" risk category, which are implicit in Allendorf et al. (1997) Table 1. To simplify analysis, we collapse Allendorf et al. (1997) "very high" and "high" risk categories into a single "high" risk category. We add a set of criteria to deal with fish produced by hatcheries that spawn in the wild. Allendorf et al. (1997) deal with hatchery fish in their assessment of conservation value, but for our purposes of defining recovery criteria, the influence of hatchery fish must be included in the viability criteria.

Populations are classified as "data deficient" when there are not enough data to classify them otherwise. It is possible to classify a population as "high" risk with incomplete data (e.g., if it is known that $N_e < 50$, but trend data and hatchery straying are lacking), but a low risk classification must be met with all criteria.

Risk Criteria

Following Allendorf et al. (1997), the first set of criteria deal with direct estimates of extinction risk from population viability models. If such analyses exist and are deemed reasonable, such assessments may be sufficient for assessing risk; indeed, Allendorf et al. (1997) intended that their other criteria be used when such analyses were not available. The simplest useful population viability assessments are based on the random-walk-with-drift model (Dennis et al. 1991), and can be extended to account for observation error (Lindley 2003); we use this model where possible in this paper. We note that trying to predict absolute extinction risk is subject to many pitfalls and is viewed with skepticism by many conservation biologists and ecologists (Beissinger and Westphal (1998) provides a review of the various issues). We therefore recommend that population viability analysis (PVA) results be compared to the results of applying the simpler criteria, described below.

The effective population size criteria in the second row of Table 1 relate to loss of genetic diversity. The effective population size, N_e, is smaller than the population census size N due to variation in reproductive success among individuals. For Chinook salmon, N_e/N ranges from 0.06 to 0.29 (Waples et al. 2004). N_e can be estimated from detailed demographic or genetic data (e.g., see Ardren and Kapuscinski 2003). Very small populations, for example with $N_e < 50$, suffer severe inbreeding depression (Franklin 1980; Soulé 1980), and normally outbred populations with such low Ne have a high risk of extinction from this inbreeding.

Somewhat larger, but still small, populations can be expected to lose variation in quantitative traits through genetic drift faster than it can be replaced by mutation. Franklin (1980) and Soulé (1980) used population genetics models to show that such drift is significant when $N_e < 500$. The assumptions behind the $N_e > 500$ rule are problematical in two ways. On one hand, the original models used to derive the 500 rule (Franklin 1980; Soulé 1980) assumed that all mutations were mildly deleterious, but later research showed that only 10% of mutations are mildly deleterious (Lande 1995). This means that mutation effectively introduces new genetic variation at only 10% of the rate previously assumed, so N_e should therefore be > 5000 to attenuate the loss of genetic diversity due to drift. On the other hand, the models of Franklin and Sóule also assume that populations are closed to immigration. Very low levels of immigration, on the order of one individual per generation, can prevent the loss of alleles through drift (Wright 1931). We note that salmonid populations within ESUs are expected to have immigration at such low rates. Given the countervailing effects of the violations of the assumptions underlying the $N_e > 500$ rule, we apply the Allendorf et al. (1997) criteria as they stand, but note that with future research, it may be possible to define population size targets that conserve genetic variation and account for migration and genetic structuring within ESUs (e.g., Whitlock and Barton 1997).

The population decline criteria are intended to capture demographic risks. The rationale behind the population decline criteria are fairly straightforward– severe and prolonged declines to small run sizes are strong evidence that a population is at risk of extinction. The criteria have two components– a downward trend in abundance and a critical run size (< 500 spawners). Note that spawning run size is distinct from N_e. Although it is not clear how Allendorf et al. (1997) chose 500 as the threshold spawning run size, we adopt this threshold to maximize consistency with their criteria. We also note that typical salmonid populations near a carrying capacity of 500 spawners require only modest intrinsic growth rates to have low probability of extinction, given typical levels of variation in population growth (D. Boughton, NOAA Fisheries, Santa Cruz, CA; in preparation).

The catastrophe criteria trace back to Mace and Lande (1991), and the underlying theory is further developed by Lande (1993). The overall goal of the catastrophe criteria is to capture a sudden shift from a low risk state to a higher one. Catastrophes are defined as instantaneous declines in population size due to events that occur randomly in time, in contrast to regular environmental variation, which occurs constantly and can have both positive and negative effects on the population. Catastrophes have a qualitatively different effect on the distribution of mean time to extinction than does environmental variation. Because of this, it is sensible to treat catastrophes separately from population declines. We view catastrophes as singular events with an identifiable cause and only negative immediate consequences, as opposed to normal environmental variation which can produce very good as well as very bad conditions. Some examples of catastrophes include disease outbreaks, toxic spills, or vol-

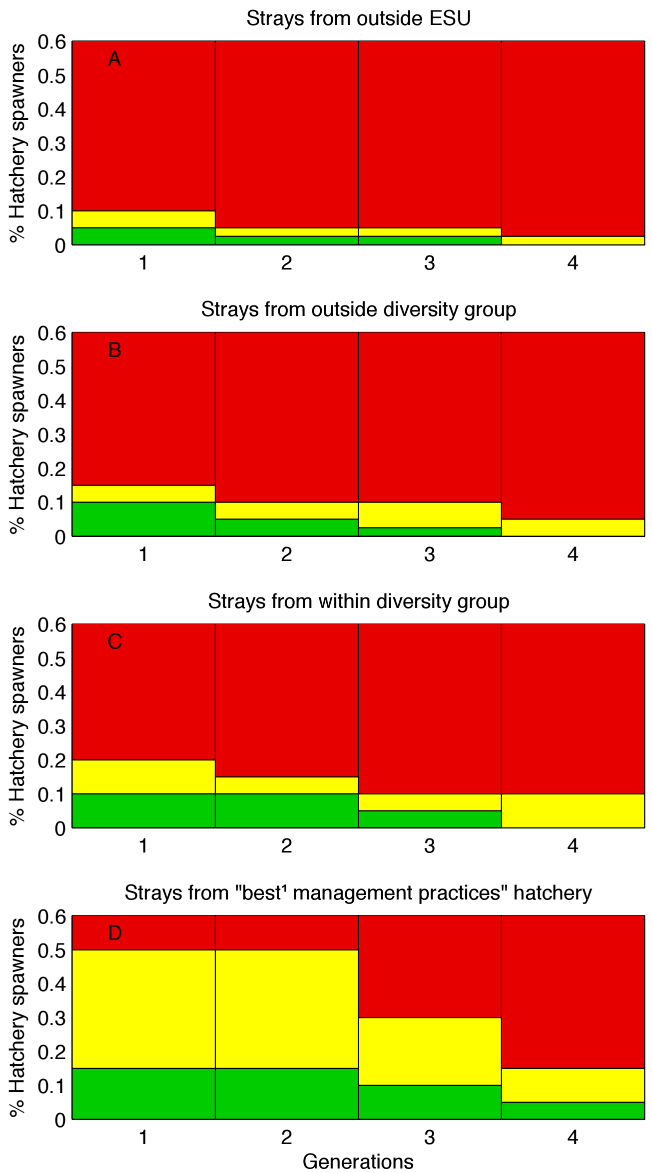

Figure 1. Extinction risk levels corresponding to different amount, duration and source of hatchery strays. Green bars indicate the range of low risk, yellow bars moderate risk, and red areas indicate high risk. Which chart to use depends on the relationship between the source and recipient populations. A: hatchery strays are from a different ESU than the wild population. B: Hatchery strays are from the same ESU but from a different diversity group within the ESU. C: Hatchery strays are from the same ESU and diversity group, but the hatchery does not employ "best management practices." D: Hatchery strays are from the same ESU and diversity group, and the hatchery employs "best management practices." Redrawn from Interior Columbia Basin Technical Recovery Team (2005).

canic eruptions. A high risk situation is created by a 90% decline in population size over one generation. A moderate risk event is one that is smaller but biologically significant, such as a year-class failure.

We view the spawning of hatchery fish in the wild as a potentially serious threat to the viability of natural populations. Population genetics theory predicts that fish hatcheries can negatively impact wild populations when hatchery fish spawn in the wild (e.g., Emlen 1991; Lynch and O'Hely 2001; Ford 2002; Goodman 2005). These predictions are supported by mounting empirical evidence (e.g., Reisenbichler and McIntyre 1977; Chilcote et al. 1986; Reisenbichler and Rubin 1999; McLean et al. 2003; Kostow 2004). In assessing the genetic impact of immigration on a population, one must consider the source of the immigrants, how long the impact goes on, the number of immigrants relative to the size of the recipient population, and how divergent the immigrants are from the recipient population. We adopt the approach of the Interior Columbia Basin Technical Recovery Team (TRT) (2005) to define how different scenarios relate to extinction risk for natural populations, summarized in Figure 1. We made one significant change to the Interior Columbia Basin Technical Recovery Team (2005) hatchery introgression criteria, allowing up to 5% of naturally spawning fish to be of hatchery origin while maintaining a low risk, if the hatchery fish are from a hatchery using "best management practices" (see Flagg et al. 2004; Olson et al. 2004; Mobrand et al. 2005, for a description of these practices) using broodstock derived from the wild population. This is consistent with the ICBTRT scheme, which can result in a low-risk classification even with moderate amounts of straying from best-practices hatcheries, so long as other risk measures are acceptable. We note that the risk levels depicted in Figure 1 are based on expert opinion, and that the empirical basis for relating hatchery impacts to extinction risk is currently limited (Bilby et al. 2003).

Allendorf et al. (1997) did not specify how to calculate estimates for the various viability criteria. Table 2 provides estimators that we have used in this paper. The average run size is computed as the mean of up to the three most recent generations, if that much data are available. Mean population size is estimated as the

Table 2. Estimation methods and data requirements for population metrics. St denotes the number of spawners in year t; g is mean generation time, which we take as three years for California salmon.

Metric	Estimator	Data	Criterion
$\hat{S}_t$	$\sum_{i=t-g+1}^{t} S_i/g$	$\geq$ 3 years spawning run estimates	Population decline
N_e	$N \times 0.2$ or other	varies	Population size
N	$\hat{S}_t \times g$	$\geq$ 3 years spawning run estimates	Population size
Population growth rate (% per year)	slope of $\log(S_t)$ v. time $\times 100$	10 years S_t	Population decline
c	$100 \times (1 - \min(N_{t+g}/N_t))$	time series of N	Catastrophe
h	average fraction of natural spawners of hatchery origin	mean of 1-4 generations	Hatchery influence

product of the mean run size and the average generation time. Population growth (or decline) rate is estimated from the slope of the natural logarithm of spawners versus time for the most recent 10 years of spawner count data. The fraction of naturally spawning fish of hatchery origin is the mean fraction over one to four generations.

ESU Viability

ESU viability depends on the number of populations within the ESU, their individual status, their spatial arrangement with respect to each other and sources of catastrophic disturbance, and diversity of the populations and their habitats. In the most general terms, ESU viability increases with the number of populations, the viability of these populations, the diversity of the populations, and the diversity of habitats that they occupy. Under natural conditions, most salmonid ESUs have persisted for at least many centuries, and perhaps much longer, given the observed level of genetic differentiation within and among them. How much can an ESU be altered before it is considered at risk of extinction?

While we will not assess ESU viability in absolute terms, we assume that recovery planners will want ESUs to be likely to persist in the face of environmental variation of the sort we know has occurred over the last 500-1000 years. Such variation has included natural catastrophes such as prolonged drought, volcanic eruptions, large wildfires, and anthropogenic impacts such as the 1991 Cantara metam sodium spill. Such catastrophes could occur at any time in the foreseeable future. Therefore, for ESUs to be considered viable, they should at a minimum be able to persist if challenged by any one of these types of catastrophes.

Viability by Representation

We assess ESU viability with two different approaches. The goal of both approaches is to spread risk and maximize future potential for adaptation. The Puget Sound, Willamette/Lower Columbia and Interior Columbia TRTs have used variations on the idea of dividing ESUs into subunits (Myers et al. 2003; Ruckelshaus et al. 2002; Interior Columbia Basin Technical Recovery Team 2003), and requiring representation of all subunits and redundancy within the subunits (which we call the "representation and redundancy" rule). The ESU subunits are intended to capture important components of habitat, life history or genetic diversity that contribute to the viability of salmonid ESUs (Hilborn et al. 2003; Bottom et al. 2005). If extinction risks are not strongly correlated between populations, two populations, each with low risk of extinction, would be extremely unlikely to go extinct simultaneously (McElhany et al. 2003). Should one go extinct, the other could serve as a source of colonists to re-establish the extirpated population. Therefore, at

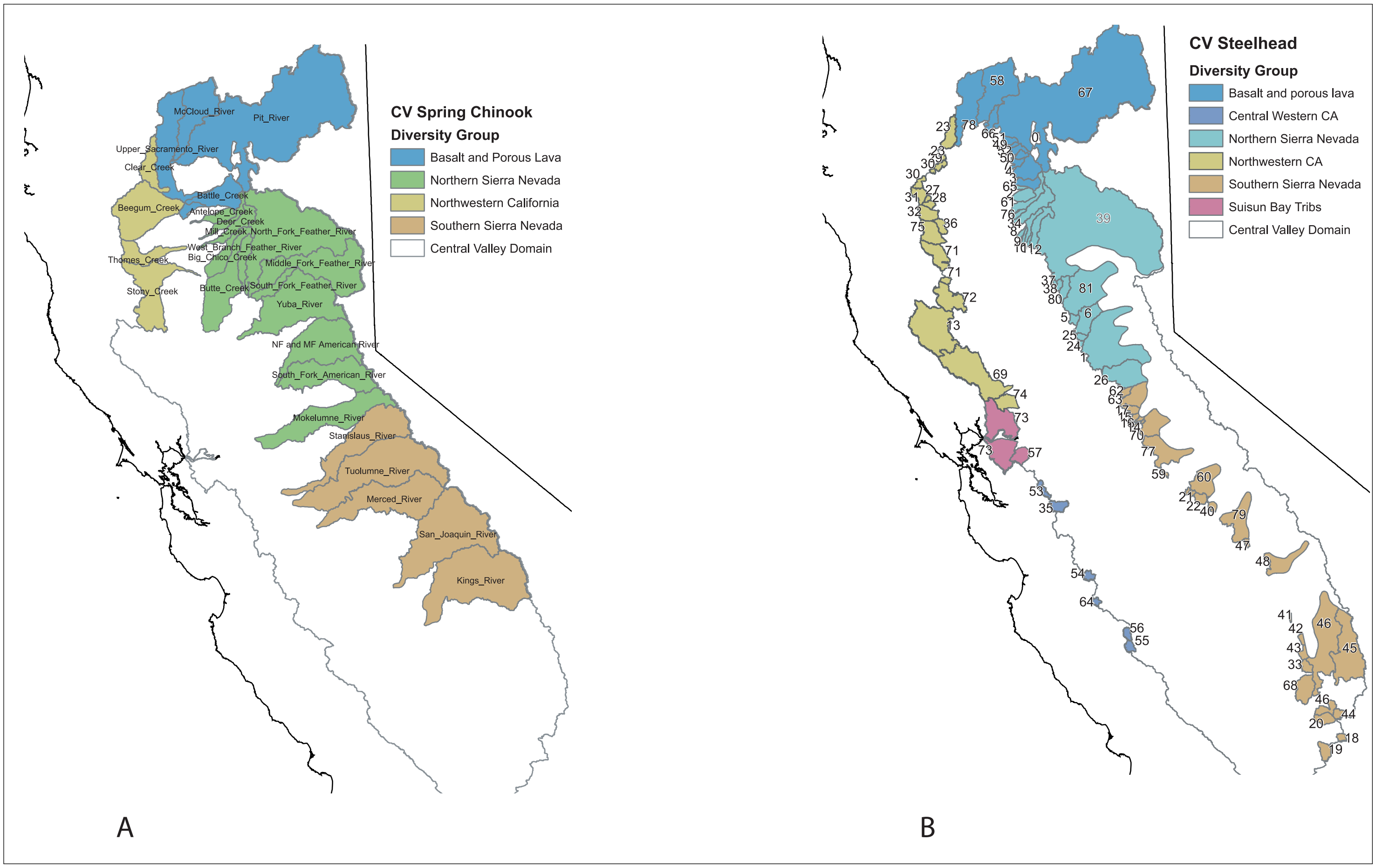

Figure 2. Salmonid ecoregions within the Central Valley. Map A: Central Valley spring-run Chinook salmon. Map B: Central Valley steelhead. Sacramento River Winter-run Chinook salmon not shown because this ESU has only one region (Basalt and porous lava). The numbers identifying steelhead populations correspond to Table 1 in Lindley et al. (2006).

least two viable populations within each ESU subunit are required to ensure viability of the subunit, and hence the ESU. In the cases of large subunits, more than two viable populations may be required to maintain connectivity among populations.

As discussed in Lindley et al. (2004), drainages in the Central Valley basin are characterized by a wide variety of climatological, hydrological, and geological conditions. To a first approximation, floristic ecoregions, such as the Jepson ecoregions defined by Hickman (1993), provide an integrative view of these differences. We use the Jepson ecoregions as a starting point for salmonid ecoregions, but modify them to account for the effect of springs, which are very influential on salmonids, but less influential to upland plants (Figure 2). Instead of the Cascade Ranges region, we define a "basalt and porous lava" region that comprises the streams that historically supported winter-run Chinook salmon. All of these streams receive large inflows of cold water from springs through the summer, upon which winter-run Chinook salmon depended. This region excludes streams south of Battle Creek, but would include the part of the Upper Sacramento drainage used by winter-run, and part of the Modoc Plateau region. The southern part of the Cascades region (i.e., the drainages of Mill, Deer, and Butte creeks) is added to the Sierra Nevada region, but the Sierra Nevada region is divided into northern and southern parts (split somewhat arbitrarily south of the Mokelumne River). This split reflects the greater importance of snowmelt runoff in the southern part, and distinguishes tributaries to the Sacramento and

San Joaquin rivers. The Central Valley steelhead ESU has two additional salmonid ecoregions: the Suisun Bay region which consists of tributaries to or near Suisun Bay, where summer temperatures are moderated by the marine influence of nearby San Francisco Bay and the Pacific Ocean, and the Central Western California ecoregion, which contains west-side San Joaquin Valley tributaries.

Viability by Assessment of Specific Threats

An alternative to the representation and redundancy rule is to assess the relationship between ESU structure and specific sources of catastrophic risk. For example, one can assess whether a spill of toxic material at a certain point could extirpate all populations of an ESU. The advantage of this approach is that it is explicit: benefits or shortcomings of a particular ESU structure can be seen. The disadvantage is that we are unlikely to foresee all possible catastrophes, and more generally, this approach does not fully consider the value that biocomplexity has for ESUs. With this caution in mind, we assess the present structure of ESUs in relation to volcanic eruptions, wildfire, and drought[1].

Volcanos may seem like an unlikely threat, but the Mt. St. Helens eruptions of 1980 extirpated salmon in the Toutle River (Jones and Salo, 1986). The Cascades Range, of which Mt. St. Helens is a member, forms the northeastern boundary of the Sacramento River basin and is volcanically active. To assess the risk from volcanic eruptions, we obtained data on impact for lava flow, volcanic blast, pyroclastic flows, and debris-lahar flows from Hoblitt et al. (1987). For each volcano and impact type, we computed the percentage of habitat that would be impacted for each population.

While probably less devastating than a major volcanic eruption, fires can cause large injections of fine particles into streams, and fires have been implicated in the extinction of trout populations (e.g., Rinne 1996; Brown et al. 2001). In addition, fire-fighting chemicals are toxic to juvenile salmon (Buhl and Hamilton 1998). Assessing whether two populations might be vulnerable to a single large fire is in part a question of how frequently fires of such size arise. Moritz (1997) provides a way of estimating the relationship between fire size and return frequency from fire size data. We acquired data on fire sizes within the Central Valley domain from the California Department of Forestry, and created a time series of the largest fire in each year for the period 1908–2003. We then found the maximum diameter of the polygon describing each fire. The probability of the largest fire in a year having a maximum diameter less than than some specific size x, $P(X_{max} \leq x)$, was estimated empirically following Moritz (1997).

Prolonged droughts have been implicated in the extinction of riverine fish species in the southwestern US (Douglas et al. 2003; Matthews and Marsh-Matthews, 2003), and a short drought had severe impacts on Sacramento River winter-run Chinook salmon broods in 1976 and 1977 (National Marine Fisheries Service, 1997). We estimated the correlation scale for drought by computing the correlation among the Palmer drought severity index scores among the grid points within CA presented by Cook et al. (2004) using a spline correlogram, which estimates a non-parametric covariance function (Bjornstad et al. 1999). Of particular interest is whether this characteristic scale is larger or smaller than the scale of ESUs—if it is larger, then drought risk can not be mitigated by maintaining widely-separated populations (although it would reduce the risk of simultaneous drought).

APPLICATION TO CENTRAL VALLEY SALMONIDS

Central Valley Spring-run Chinook Salmon

Perhaps 15 of the 18 or 19 historical populations of Central Valley spring-run Chinook salmon are extinct, with their entire historical spawning habitats behind various impassable dams (Figure 3 and Table 3). Butte Creek and Deer Creek spring-run Chinook salmon are at low risk of extinction, satisfying both the PVA (Figure 4) and other viability criteria (Table 3). Mill Creek is at moderate extinction risk according to the PVA, but appear to satisfy the other viability criteria for low-risk status. Lindley et al. (2004) were uncertain whether Mill and Deer creek populations were each independent or two parts of a single larger population. If viewed as a single population, Mill and Deer Creek spring-run Chinook salmon are at low extinction risk. Early-returning Chinook salmon persist within the

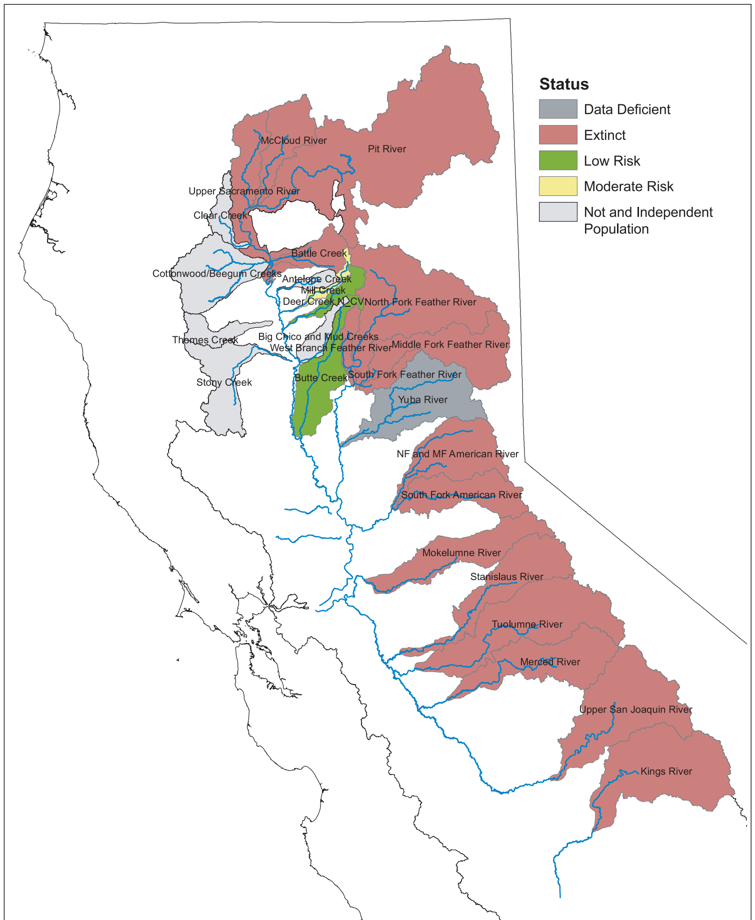

Figure 3. Status of historical Central Valley spring-run Chinook salmon populations.

Feather River Hatchery population and spawn in the Feather River below Oroville Dam and the Yuba River below Englebright Dam. The current status of these fish is impossible to assess due to insufficient data.

With demonstrably viable populations in only one of at least three diversity groups that historically con-

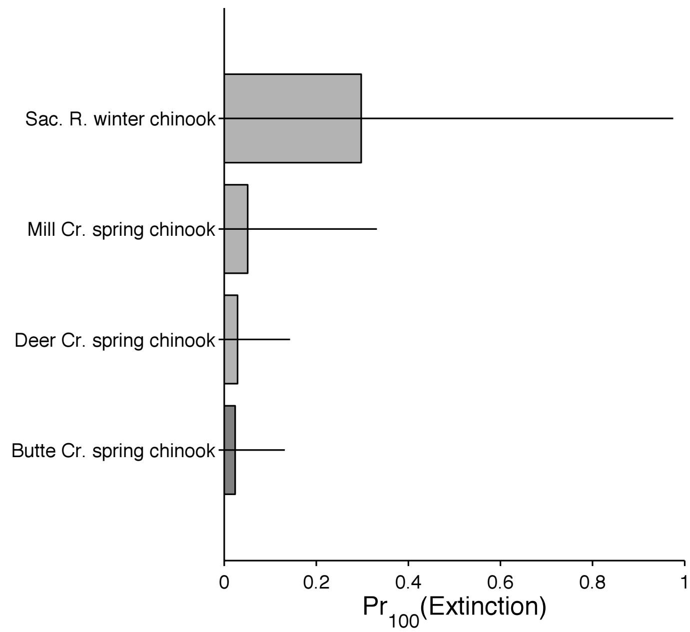

Figure 4. Probability of population extinction as estimated by the random-walk-with-drift model. Bars indicate the expected probability of extinction; lines indicate the 90% central interval for the estimate of the mean.

Table 3. Viability of populations. Steelhead populations that are not listed are data deficient. Chinook populations that are not listed are presumed extinct, due to impassable dams blocking access to spawning habitat. WRC = winter-run Chinook salmon; SRC = spring-run Chinook salmon. Catastrophes not included in this table because none were observed in the last decade. See Table 2 for definition of metrics. Spawning escapement data was obtained from California Department of Fish and Game's 2005 GrandTab database, available from the Native Anadromous Fish & Watershed Branch, 830 S Street, Sacramento, CA 95814. Steelhead data for American River from McCracken et al. (2005).

ESU	Population Name	PVA result	N	std	Pop. growth (% per year)	std	$\hat{S}$	std	h	Risk Category
Sac. R. WRC	mainstem	Moderate	26,870	2280	27.7	6.3	8140	691	Low	Low
C. V. SRC	Butte Cr	Low	22,630	7400	11.4	12.6	6860	2240	Very Low	Low
C. V. SRC	Mill Cr	Moderate	3360	1300	17.9	5.95	1020	394	Very Low	Low
C. V. SRC	Deer Cr	Low	6320	1920	7.63	7.58	1920	1010	Very Low	Low
C. V. SRC	Yuba									Data Deficient
C. V. SRC	Feather									Data Deficient
C. V. Steelhead	Feather								High	High
C. V. Steelhead	Battle Cr								High	High
C. V. Steelhead	American						< 500		High	High
C. V. Steelhead	Mokelumne								High	High

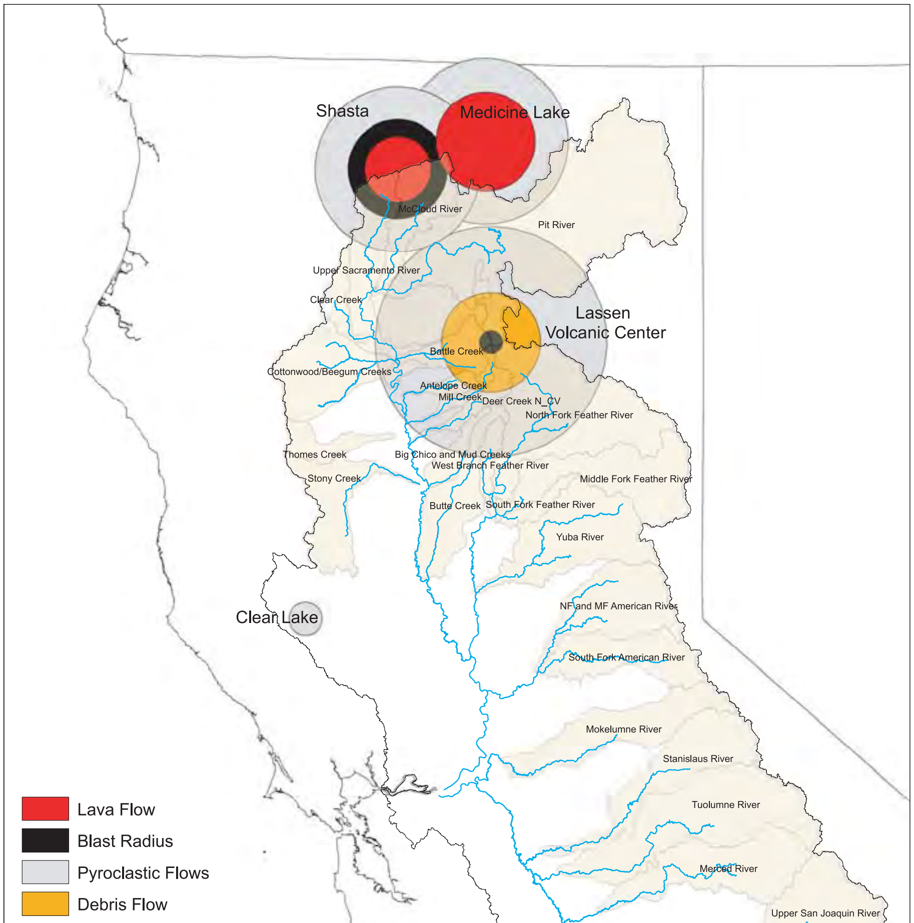

Figure 5. Volcanic hazards affecting the Central Valley recovery domain. Circles indicate the possible spatial extent of various kinds of volcanic effects that could devastate salmonid stream habitat, including lava flow, blast, pyroclastic flow, and debris. Data from Hobblitt et al. (1987)

tained them, Central Valley spring-run Chinook salmon fail the representation and redundancy rule for ESU viability. Historically, the Central Valley spring-run Chinook salmon ESU spanned four ecoregions: the region used by winter-run Chinook salmon plus the northern and southern Sierra Nevada and the northwestern California region. There are two or three viable populations in the northern Sierra Nevada (Mill, Deer and Butte creeks), although these populations were once probably relatively small compared to populations such as the Feather River. A few ephemeral or dependent populations are found in the Northwestern California region (e.g., Beegum and perhaps Clear creeks). Spring-run Chinook salmon have been entirely extirpated from both the basalt and porous lava region and the southern Sierra Nevada region.

The current distribution of viable populations makes the Central Valley spring-run Chinook salmon ESU vulnerable to catastrophic disturbance. All three extant independent populations are in basins whose headwaters lie within the debris and pyroclastic flow radii of Mt. Lassen (Figure 5), an active volcano that the USGS views as highly dangerous[2] (Hoblitt et al. 1987). The historical ESU was of such a large scale that neither Mt. Lassen, Mt. Shasta, or Medicine Lake could have extirpated even an entire diversity group, let alone the entire ESU. The current ESU structure is, not surprisingly, vulnerable to drought, which has a correlation scale of approximately 640 km (Figure 6), on order of the length of the historical ESU. Even wildfires, which are of much smaller scale than droughts or large volcanic eruptions, pose a significant threat to the ESU in its current configuration. A fire with a maximum diameter of 30 km, big enough to burn the headwaters of Mill, Deer and Butte creeks simultaneously, has roughly a 10% chance of occurring somewhere in the Central Valley each year (Figure 7).

We note that the historical Central Valley spring-run Chinook salmon ESU was widespread enough to be invulnerable to all of these catastrophes, except perhaps prolonged drought. The correlation scale of drought is roughly 640 km, and the Central Valley spring-run Chinook salmon ESU is about 500 km from the Pit River to the Kings River. It is possible that Central Valley spring-run Chinook salmon were less vulnerable to drought than might be expected because they once occupied diverse types of watersheds, including those with very high influence from springs. In fact, annual mean stream flow in Southern Cascade streams is less well correlated with annual mean precipitation than in other regions (see Appendix A in Lindley et al. (2006)).

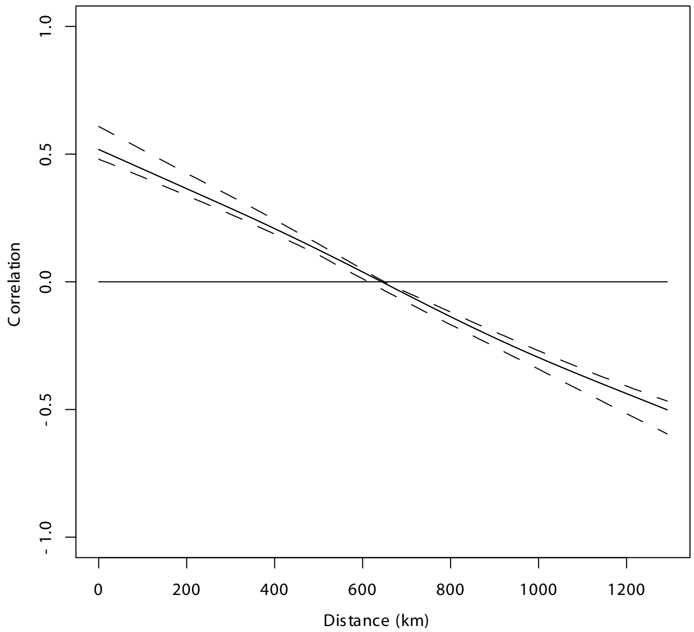

Figure 6. Spline correlogram fit to the gridded Palmer drought severity index data for California of Cook et al. (2004). Solid line indicates the estimated correlation function; dashed lines are the 95% confidence interval. Note that the correlation of drought indices declines with distance between locations, with no correlation evident at a distance 640 km.

Sacramento River Winter-run Chinook Salmon

All four historical populations of Sacramento River winter-run Chinook salmon are extinct in their historical spawning range (Table 3). The upper Sacramento, McCloud and Pit River populations had spawning and rearing habitat far upstream of impassable Keswick and Shasta dams, although these populations were apparently in poor condition even before the construction of Shasta dam in the 1940s (Moffett 1949). Winter-run Chinook salmon no longer inhabit Battle Creek as a self-sustaining population, probably because hydropower operations make conditions for eggs and fry unsuitable (National Marine Fisheries Service 1997). Also, until recently access to much of the basin was blocked by the Coleman National Fish Hatchery barrier weir.

The population of Sacramento River winter-run Chinook salmon that now spawns below Keswick dam is at moderate extinction risk according to the PVA (Figure 4), and at low risk according to the other criteria. Since roughly the mid-1990s, this population has been growing, although its previous precipitous decline to a few hundred spawners per year would have qualified it as high risk at that time, and prior to that, the 1976-77 drought would have qualified as a high-risk catastrophe. At present, the population easily satisfies the low-risk criteria for population size, population decline, and catastrophe, but hatchery influence is a looming concern. Since 2001, hatchery-origin winter-run Chinook salmon from Livingston Stone National Fish Hatchery (LSNFH, perhaps one of the best examples of a "best-management practices" Chinook salmon hatchery) have made up more than 5% of the natural spawning run, and in 2005 it exceeded >18% (K. Niemela, USFWS, Red Bluff CA, unpublished data). If the contribution of LSNFH to natural spawning exceeds 15% in 2006-07, the winter-run Chinook salmon population would be reclassified as moderate risk, and even the lower observed rates will become problematic if they continue for the next decade.

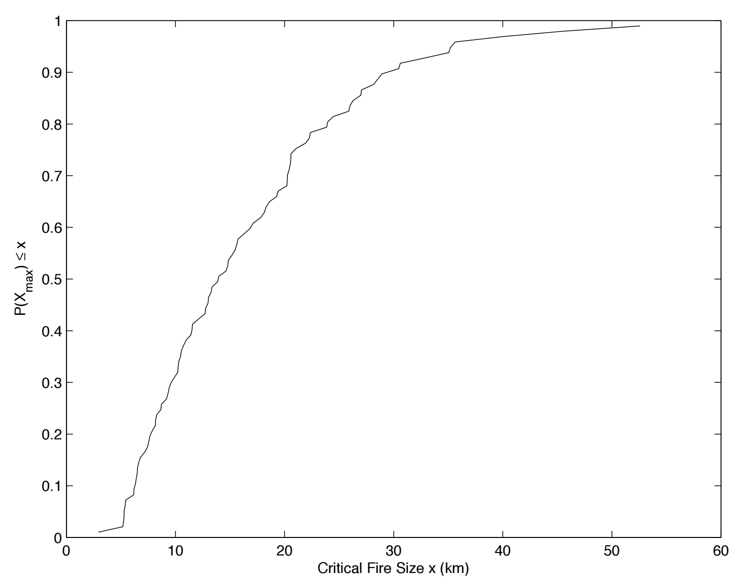

Figure 7. The probability that the largest fire in a year (Xmax) will be smaller than the critical size x. Based on observed fire sizes for the Central Valley recovery domain during the 1908–2003 period.

The Sacramento River winter-run Chinook salmon ESU does not currently satisfy the representation and redundancy rule because it has only one population, and that population spawns outside of the ecoregion where it evolved. For the Sacramento River winter-run Chinook salmon ESU to satisfy the representation and redundancy rule, at least two populations would need to be re-established in the basalt-and-porous-lava region. This may require passage past Shasta and Keswick dams.

Obviously, an ESU represented by a single population at moderate risk of extinction is at high risk of extinction over the long run. A single catastrophe could extirpate the entire Sacramento River winter-run Chinook salmon ESU, if its effects persisted for four or more years. The entire stretch of the Sacramento River used by winter-run Chinook salmon is within the zone of influence of Mt. Lassen. Some other possible catastrophes include a prolonged drought that depletes the cold water storage of Lake Shasta or some related failure to manage cold water storage, a spill of toxic materials with effects that persist for four years, or a disease outbreak.

Central Valley Steelhead

There are almost no data with which to assess the status of any of the 81 Central Valley steelhead populations described by Lindley et al. (2006). With few exceptions, therefore, Central Valley steelhead populations are classified as data deficient. The exceptions are restricted to streams with long-running hatchery programs: Battle Creek and the Feather, American and Mokelumne rivers. In all cases, hatchery-origin fish likely comprise the majority of the natural spawning run, placing the natural populations at high risk of extinction. In the American River, the natural spawning run appears to be comprised mostly of hatchery-origin spawners (McCracken et al. 2005). The broodstock used by Feather River Hatchery is derived from native fish from the Feather River, but hatchery-origin fish probably play a large role in maintaining the Feather River population (Kindopp et al. 2003). The Coleman National Fish Hatchery steelhead program uses many “best management practices,” but hatchery fish make up substantially more than 15% of the natural spawners in Battle Creek (Campton et al. 2004).

There is no evidence to suggest that the Central Valley steelhead ESU is at low risk of extinction, or that there are viable populations of steelhead anywhere in the ESU. Conversely, there is evidence to suggest that the Central Valley steelhead ESU is at moderate or high risk of extinction (McEwan 2001; Good et al. 2005). Clearly, most of the historical habitat once available to steelhead has been lost (Yoshiyama et al. 1996; McEwan 2001; Lindley et al. 2006). Furthermore, the observation that anadromous *O. mykiss* are becoming rare in areas where they were probably once abundant (California Department of Fish and Game, unpublished data; McEwan (2001)) indicates that an important component of life history diversity is being suppressed or lost. It should be noted, however, that habitat fragmentation, degradation, and loss are likely having a strong negative impact on many resident as well as anadromous *O. mykiss* populations (Hopelain 2003).

Discussion

Population Viability

In this section, we applied viability criteria, and PVA where possible, to assess the status of Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, and Central Valley steelhead populations identified by Lindley et al. (2004) and Lindley et al. (2006). For Central Valley steelhead, we were only able to assess the status of populations with a strong hatchery influence, even though the criteria-based approach that we employed has low data requirements compared to some PVA approaches. For extant, independent Chinook salmon populations, we were able to apply a PVA model as well as the simpler criteria (because relatively long time series of spawning run size are available for these populations). In two cases, the PVA gave the same result (Butte Creek and Deer Creek both classified as low risk), and in the other two cases, risk assignments differed by one category (winter-run Chinook salmon and Mill Creek spring-run Chinook salmon classified by the PVA as moderate risk, while the criteria indicate low risk). That populations can satisfy the criteria for low risk while just failing a PVA suggests that the criteria for low risk really are criteria for minimal viability. Recovery planners may want to aim somewhat higher for at least some populations as a precautionary measure.

There have been three population-level risk assessments for winter-run Chinook salmon, by Botsford and Brittnacher (1998), Lindley and Mohr (2003), and Good et al. (2005). The analysis of Botsford and Brittnacher (1998) was conducted at a time when it was much less clear that winter-run Chinook salmon were on an upward trend, and not surprisingly, Botsford and Brittnacher (1998) found that winter-run Chinook salmon were certain to go extinct if the trends seen up to the time of their analysis were to continue. Lindley and Mohr (2003) used a model that allowed for a change in population growth rate following initiation of conservation measures in 1989 and density-dependent reproduction. Allowing for the possibility that winter-run Chinook salmon population growth rate increased after 1989 led to a much more optimistic prediction for extinction risk of 24% in 100 years. The analysis in Good et al. (2005), like Lindley and Mohr (2003), allowed for a change in population growth in 1989, but included more recent data and ignored density dependence. Good et al. (2005) found that if the 1989-present growth rate holds into the future, the winter-run Chinook salmon population has essentially no risk of extinction. The varying conclusions of these studies illustrates the sensitivity of PVA results to both data and model assumptions, especially those about future conditions and the effect of density on population growth rate.

ESU Viability

Our assessment of the viability of Central Valley Chinook salmon ESUs is broadly consistent with other recent assessments. Good et al. (2005), based on the combined opinion of an expert panel, considered the Sacramento River winter-run Chinook salmon ESU to be in danger of extinction, and the Central Valley spring-run Chinook salmon ESU to be likely to become endangered in the foreseeable future. These findings were essentially unchanged from the earlier review of Myers et al. (1998). United States Fish and Wildlife Service (1994) suggested that Central Valley spring-run Chinook salmon could be considered "restored" when Mill and Deer creeks both have >500 spawners, and the average total number of spawners in Sacramento tributaries exceeds 8,000, with a minimum of 5,000 spawners, over a 15 year period that includes at least three critically dry years. Central Valley spring-run Chinook salmon have achieved these abundance levels since about 1998, but are not yet "restored" as defined by United States Fish and Wildlife Service (1994). The restoration goals of United States Fish and Wildlife Service (1994) are based on estimates of what could be attained in Sacramento River tributaries that are still accessible to spring-run Chinook salmon, and do not address issues of viability.

National Marine Fisheries Service (1997) proposed that for Sacramento River winter-run Chinook salmon to be recovered, there would need to be on average 10,000 females spawning naturally in the mainstem Sacramento River, and recommended creation of a second winter-run Chinook salmon population in Battle Creek. Should Sacramento River winter-run Chinook salmon achieve these draft goals, their status would be much improved, but they would still be excluded from much of the apparently unique areas in the upper Sacramento, McCloud, and Pit River tributaries that gave rise to their unique life-history strategy.

Good et al. (2005) found Central Valley steelhead to be in danger of extinction in the foreseeable future, in agreement with an earlier assessment (Busby et al. 1996). We were unable to assess the status of the Central Valley steelhead ESU with the more quantitative approach developed in this paper, because of data limitations. This should not be viewed as a contradictory finding—what little information is available for Central Valley steelhead is not positive (Busby et al. 1996; McEwan, 2001; Good et al. 2005).

Even if there were adequate data on the distribution and abundance of steelhead in the Central Valley, our approaches for assessing population and ESU viability might be problematical because the effect of resident *O. mykiss* on the viability of populations and ESUs is unknown. From one perspective, resident fish may reduce the extinction risk of the ESU through the production of anadromous individuals that can bolster or rescue weak steelhead populations. Such life history diversity also confers risk spreading, in that members of the ESU are spread among habitats that are subject to independent sources of disturbance. For instance, fish in the ocean are unaffected by flooding, while fish in rivers are immune to poor feeding conditions in the ocean. At the margins of a species' range, where conditions may be more frequently unfavorable, such life history diversity could be an adaptation to the unpredictable environment (Jonsson and Jonsson 1993.)

On the other hand, the apparent dominance of the resident form is a recent and unnatural phenomenon. It is likely that the apparent shift towards the resident life history strategy is partly a response to hypolimnetic releases from reservoirs, which alter trophic, temperature and flow conditions for some distance below the dam (McEwan, 2001). *O. mykiss* may take up residency in these altered areas due to their phenotypic plasticity, or the fitness of *O. mykiss* using these areas may exceed the fitness of anadromous fish, which would drive an evolutionary (i.e., genetic) change if life history strategy is heritable. Another component of the shift is likely the decline of steelhead due to loss of suitable steelhead habitat. Even if the shift in life history strategy is a plastic response, the fitness of steelhead may decline due to relaxed selection pressure. At longer time scales, this is likely to be a problem, because storage reservoirs have finite lifetimes, and when they are filled with sediments, the rivers downstream will be much less suitable for year-round residency.

Both the United States Fish and Wildlife Service (1994) goals for Central Valley spring-run Chinook salmon and the National Marine Fisheries Service (1997) goals for Sacramento River winter-run Chinook salmon are primarily focused on abundance and productivity, a traditional fisheries and natural resource perspective. In light of the mounting failures of that traditional perspective, ecologists are increasingly recognizing the importance of diversity in sustaining ecological processes (e.g., Daily 1999; Pauly et al. 2002; Elmqvist et al. 2003; Fischer et al. 2006). Recent thinking on salmonids (e.g., McElhany et al. 2000; Hilborn et al. 2003; Bottom et al. 2005) highlights the importance of habitat, life history, and genetic diversity as the foundation for productivity (and hence abundance). Our approach to assessing and specifying ESU viability broaden the focus from abundance and trends to include the numbers, diversity, and spatial distribution of populations across the landscape. Restoring and sustaining diverse populations of salmonids will require restoring and sustaining the habitats and ecological processes upon which they depend.

Summary

In this paper, we have developed a framework for evaluating the viability of salmonid populations and ESUs, based on simple criteria and rules that have modest data requirements. When applied to Chinook salmon ESUs, the framework makes clear that the risk facing these ESUs is not so much the low viability of extant populations, but rather that much of the diversity historically present in these ESUs has been lost. While the criteria and rules that comprise our framework are based in no small part on expert judgment and are subject to considerable uncertainty, our conclusions are not particularly sensitive to the exact values of the criteria.

The utility of our framework can be judged in several ways. It provides quantitative criteria that allow that status of salmonid ESUs to be assessed in an objective way, and it points out areas where things need to improve for ESUs to be removed from the endangered species list. The framework is, however, rather simplistic, and significant improvements, especially at the ESU level, could be made as our understanding of salmonid population biology improves. Perhaps the most significant shortcoming of our framework is the implicit assumption that future will be like the past. In the next section, we evaluate this critical assumption.

CLIMATE VARIABILITY AND CHANGE

Introduction

Viability assessments, including ours, typically attempt to answer the question of whether the population will persist into the future if it continues to experience conditions like it has in the recent past. Future conditions, however, are not likely to be like the recent past. In this section, we briefly review descriptions of natural climate variability, and regional-scale predictions of how climate might change over the next century in response to rising atmospheric greenhouse gas concentrations. Natural climate variation will make it difficult to properly assess whether ESUs are recovering in response to management actions. Anthropogenic climate change may preclude some otherwise attractive recovery strategies, depending on future greenhouse gas emissions and the response of regional climate.

Natural Climate Variability

Fisheries scientists have shown that ocean climate varies strongly at decadal scales (e.g., Beamish 1993; Beamish and Bouillon 1993; Graham, 1994; Miller et al. 1994; Hare and Francis 1995; Mantua et al. 1997; Mueter et al. 2002). In particular, the identification of the Pacific Decadal Oscillation (Mantua et al. 1997) seems to have led to the belief that decadal-scale variation may be cyclical, and thus predictable. As pointed out by Rudnick and Davis (2003) and Hsieh et al. (2005), apparent regime shifts need not be cyclical or predictable, but rather may be the expression of a stochastic process with red noise. If this interpretation is correct, then we should expect future ocean climate conditions to be different than those we have observed in the past few decades.

Terrestrial climate, like ocean climate, appears more variable the longer that it is observed. For example, Ingram et al. (1996) showed that freshwater inputs to San Francisco Bay varied with a period of 200 years, and several extreme and prolonged wet and dry periods occurred over the last 2,000 years. A 7,000-year river-flow reconstruction by Goman and Wells (2000) for the same area shows even longer-lasting periods of extreme conditions. Analysis of tree-ring data show that prolonged and intense droughts were more common during the period 750-1100 before present than in more recent centuries (Cook et al. 2004).

Natural climate variability poses several potential challenges for recovery planners. First, the population viability criteria that we have proposed may not offer sufficient protection in the case of a prolonged period of unfavorable climatic conditions. Second, a prolonged period of unusually favorable climatic conditions could cause populations to grow enough that they satisfy our biological viability criteria even though serious problems with habitat quality remain. In other words, the ESU may temporarily appear to be recovered, but its status would decline as soon as conditions become more typical. Conversely, the effects of substantial improvements to habitat quality could be masked by poor climatic conditions, possibly eroding society's enthusiasm for doing the hard work of salmon recovery. The key to overcoming these challenges is to consider climate variation in future assessments, hopefully with the benefit of improved understanding of the links between specific populations and regional climate conditions. Research is needed in this area.

Presumably, Central Valley salmonid ESUs are capable of surviving the kinds of climate extremes observed over the past few thousand years if they have functional habitats, because these lineages are on order of a thousand years old or older[3]. There is rising concern, however, that the future climate will be unlike that seen since perhaps the Pliocene, due to global warming in response to anthropogenic greenhouse gas emissions.

Climate Warming

The consensus of climate scientists is that the Earth's climate is warming, and that the warming is caused in part by the accumulation of greenhouse gases in the atmosphere (McCarthy et al. 2001; Oreskes, 2004). While there is a scientific consensus about global climate change, the effects of global warming at regional scales are generally less certain. Here, we briefly review available regional-scale forecasts relevant to the Central Valley domain, and then speculate on possible impacts on Central Valley salmonids.

Climate forecasts for the Central Valley

Making regional-scale climate forecasts involves choosing an "emissions pathway" and running one of a number of global climate models with an embedded regional-scale model that can capture features, such as mountain ranges, that can significantly modify the global pattern. As in any modeling exercise, there are a number of sources of uncertainty, but particularly important ones in this case are the assumption about future emissions and the choice of climate model. The uncertainties are addressed by examining a number of emissions pathways and by using several models.

The recent paper by Hayhoe et al. (2004) examines multiple emissions pathways using two global models to make regional forecasts for California. Their results are alarming. The more sensitive Hadley Center Climate Model (HadCM3) predicts that under the high emissions scenario (where CO_2 rises to 970 ppm by 2100, also known as the "business as usual" scenario), average summer temperature would rise 8.3°C and snowpack would be reduced by 89%. The HadCM3 also predicts that the climate will get drier, with possibly a 43% reduction of inflows to southern Sierra reservoirs. At the other extreme, the low-sensitivity Parallel Climate Model (PCM) predicts that average summer temperature would rise slightly more than 2°C if emissions were curtailed such that CO_2 rises to 550 ppm by 2100. The PCM predicts that total precipitation could rise slightly, but snowpack would still be reduced by 28% in this scenario.

Dettinger (2005) analyzed six different climate models under three emissions scenarios to produce distributions of future temperature and precipitation. This analysis showed that uncertainty due to the models was about equal to that due to emission scenario. There was general agreement among the models that temperatures will rise significantly (between 2 and 7 °C by 2100), while total precipitation is expected to decline slightly. Temperature and precipitation predictions were negatively correlated (i.e., warming is associated with drying).

Dettinger et al. (2004) and VanRheenen et al. (2004) used the PCM to investigate in detail how climate change may influence the hydrology of Central Valley rivers. These analyses find that average precipitation will decline over time, while the variation in precipitation is expected to increase substantially. Extreme discharge events are predicted to become more common, as are critically dry water years. Peak monthly mean flows will generally occur earlier in the season due to a decline in the proportion of precipitation falling as snow, and earlier melting of the (reduced) snowpack. By the end of the century, it may be difficult to achieve current operations targets for fish conservation even with substantial decreases in other demands for water. Knowles and Cayan (2002) show that in summer, saline water will intrude farther into the Bay and Delta than it does now. Within some limits, water storage reservoirs might be operated to mitigate changes to the hydrograph caused by climate change, although water project operations are likely to become even more contentious as temperature rises, snowmelt falls, and population rises.

Possible Effects on Salmon and Steelhead

Regional-scale climate models for California are in broad agreement that temperatures in the future will warm significantly, total precipitation may decline, and snowfall will decline significantly. What are the likely consequences for salmon and steelhead in the Central Valley? Melack et al. (1997) states that predicting the response of salmon to climate warming "requires examination of the responses of all life history stages to the cumulative effects of likely environmental changes in the lakes, rivers and oceans inhabited by the fish." Such an endeavor is beyond the scope of this paper, and the question of climate change effects on Pacific salmonids has received surprisingly little attention to date. In this subsection, we briefly review the literature and conduct a simple assessment of the effects of warmer summer temperature on the availability of freshwater habitat.

Focusing on freshwater life history phases, Neitzel (1991) reviewed the likely responses of salmonids in the Columbia River basin to climate warming, which he anticipated would affect salmonids through alterations to the timing of discharge and changes in sedimentation rate, temperature, and flow. Effects are predicted to depend on the river and on the species or run. As in the case of many salmonid populations in the Columbia River basin, spring-run Chinook salmon are likely to be negatively impacted by the shift in peak discharge (needed for smolt migration), and juvenile steelhead are likely to be negatively impacted by reduced summer flows. All Central Valley salmonids are likely to be negatively affected by warmer temperatures, especially those that are in freshwater during the summer.

Recent summer mortality of adult spring-run Chinook salmon in Butte Creek offers a case in point. Mean July water temperature in the middle of the spawning reach of Butte Creek is often around 18-20°C in July. In 2002 and 2003, mean water temperature in Butte Creek exceeded 21°C for 10 or more days in July, and 20-30% of adults in 2002 and 65% of adults in 2003 died (reviewed by Williams 2006), primarily from columnaris.

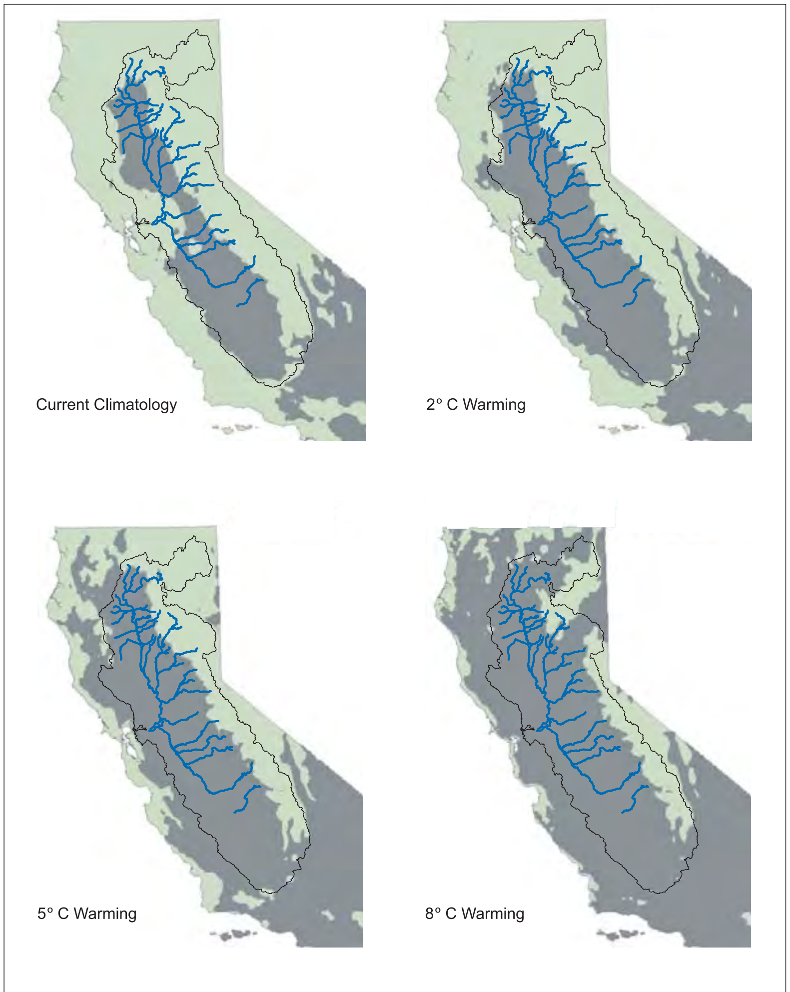

Figure 8. Effects of climate warming on availability of over-summer habitat. Mean August air temperatures exceeding 25°C are shown in gray; blue lines indicate the historical distribution of spring-run Chinook salmon.

Less obvious effects, such as reduced viability of gametes, may also have occurred. These data suggest that existing conditions in Butte Creek are close to the thermal tolerance limit for Chinook salmon.

Myrick and Cech (2004) state that juvenile Chinook salmon are unlikely to be capable of rearing for extended periods in temperatures exceeding 24°C, and juvenile steelhead may be able to withstand slightly higher temperatures. Maximum in-stream temperatures of many streams frequently exceed 24°C at lower elevations, which may determine the lower distributional limit of salmonids (Yoshiyama et al. 1996; Lindley et al. 2006).

Distributions at higher elevations were once largely restricted by natural barriers to movement, but are now limited by dams in many streams (Lindley et al. 2006). If these artificial migration barriers are not removed, climate warming is expected to reduce the amount of habitat available to Central Valley salmonids that reside in freshwater during summer months, as the lower distributional limit rises, and the upper limit remains constrained by physical barriers.

A rough view of the consequences for Central Valley spring-run Chinook salmon and Central Valley steelhead can be obtained by adding the regional warming forecasts of Dettinger (2005) to PRISM temperature fields, and overlaying this with the distributional data presented in Lindley et al. (2004). Figure 8 shows how the area with high summer temperatures (mean August air temperature > 25°C) may expand under three warming scenarios. Under current conditions, streams that had major independent populations of spring-run Chinook salmon all have significant amounts of habitat above the 25°C isotherm, although dependent populations generally had little or no habitat above the 25°C isotherm (Figure 8, upper left). By 2100, mean summer air temperatures are expected to rise by at least 2°C. Under this scenario, the amount of habitat above the 25°C isotherm is reduced, but in general, most streams that historically contained habitat above this isotherm would not lose all such habitat. The exceptions are the Tuolumne, Merced, and upper San Joaquin rivers, and Butte Creek, where the 25°C isotherm might just rise to the upper limit of the historical distribution of spring-run Chinook salmon (Figure 8, upper right). Under the expected warming of around 5°C, substantial habitat would be lost, with significant amounts of habitat remaining primarily in the Feather and Yuba rivers, and remnants of habitat in the upper Sacramento, McCloud, and Pit rivers, Battle and Mill creeks, and the Stanislaus River (Figure 8, lower left). Under the less likely but still possible scenario of an 8°C warming, spring-run Chinook salmon habitat would be found only in the upper-most reaches of the north fork Feather River, Battle Creek, and Mill Creek. This simple analysis suggests that Central

Valley salmonids are vulnerable to warming, but more research is needed to evaluate the details of how warming would influence individual populations and subbasins.

The hydrologic effects of climate change are harder to evaluate. Increased frequency of scouring floods might be expected to reduce the productivity of populations, as egg scour becomes a more common occurrence. The timing of various life history events is presumably an adaption to past climate conditions (temperature and discharge timing), and populations may not be well-adapted to future hydrographs. One concern is that warmer summers will delay spawning, and earlier and more frequent floods will impact eggs and alevins before they emerge from the gravel, a phenomenon thought to limit the productivity of some Chinook salmon stocks (Beer and Anderson 2001), and one that might be impossible for salmonids to adapt to, given fundamental constraints on development.

The flip side of frequent flooding is the possibility of more frequent and severe droughts. Long-term climate records show that warm periods have been associated with droughts in California (Davis 1999; Cook et al. 2004), and the regional climate change models reviewed above hint at the possibility of increasing frequency of droughts. In the Central Valley, low flows during juvenile rearing and outmigration are associated with poor survival (Kjelson and Brandes 1989; Baker and Morhardt 2001; Newman and Rice 2002) and poor returns in subsequent years (Speed 1993).

Climate change may also impact Central Valley salmonids through community effects. For example, warming may increase the activity and metabolic demand of predators, reducing the survival of juvenile salmonids (Vigg and Burley, 1991). Peterson and Kitchell (2001) showed that on the Columbia River, pikeminnow predation on juvenile salmon during the warmest year was 96% higher than during the coldest.

To summarize, climate change may pose new threats to Central Valley salmonids by reducing the quantity and quality of freshwater habitat. Under the worst-case scenario, spring-run Chinook salmon may be driven extinct by warming in this century, while the best-case scenario may allow them to persist in some streams. Uncertainties abound at all levels, however. First, the composition of Earth's atmosphere is partly under human control, and we cannot predict how it might be managed in the future. Even if the emissions pathway was known, different climate models offer significantly different climate forecasts (although we note that the differences are quantitative, and the models are in qualitative agreement). Finally, we have only the crudest understanding of how salmonid habitats will change and how salmonid populations will respond to those changes, given a certain climate scenario. This is another area where research is needed.

SUMMARY AND RECOMMENDATIONS

For Central Valley steelhead, there are insufficient data to assess the risk of any but a few populations, and therefore, we cannot assess the viability of this ESU using the quantitative approach described in this paper. However, qualitative information does suggest that the Central Valley steelhead ESU is at a moderate or high risk of extinction. Most of the historical habitat once available to steelhead is largely inaccessible and the observation that the anadromous forms of *O. mykiss* are becoming less abundant or rare in areas where they were probably once abundant indicates that an important component of life history diversity is being suppressed or lost. Even in populations that exhibit life-history polymorphism, steelhead are important to viability and long-term persistence and are critical to the conservation of the population (Travis et al. 2004; Bilby et al. 2005).

For the Chinook salmon ESUs, we found that extant populations are now at low or moderate risk of extinction, but the extensive extirpation of historical populations has placed these ESUs in jeopardy of extinction. The proximate problem afflicting these ESUs and the Central Valley steelhead ESU is that their historical spawning and rearing areas are largely inaccessible, due to the direct or indirect effects of dams.

Recovering even a few populations may therefore be a challenging and slow process, although we stress that there appear to be some opportunities that, if successful, would greatly increase the viability of all three ESUs. Some possibilities that are being considered include restoring flows and habitat in the San Joaquin River below Friant Dam and in Battle Creek, and restoring access to the Yuba River above Englebright Dam. All of these actions, in our view, have the potential to significantly improve the status of affected ESUs, but achieving recovery may require access to additional historically-utilized spawning areas that are currently blocked by dams.

As we pursue the more ambitious and long-term habitat restoration solutions, there are some easier but very important things that should be done as soon as possible. These include the following, in no particular order:

1. Secure all extant populations. All three ESUs are far short of being viable, and extant populations, even if not presently viable, may be needed for recovery. An important lesson to draw from Hilborn et al. (2003) is that tomorrow's most important populations might come from populations that are relatively unimpressive today. We recommend that every extant population be viewed as necessary for the recovery of the ESU. Wherever possible, the status of extant populations should be improved.

2. Begin collecting distribution and abundance data for *O. mykiss* in habitats accessible to anadromous fish. This is fundamental to designing effective recovery actions and eventual delisting. Of equal importance is assessing the relationship of resident and anadromous forms of *O. mykiss*. Any quantitative assessment of population or ESU viability could be inadequate unless we know the role resident fish play in population maintenance and persistence. It has been well-documented that Chinook salmon has been the major focus of anadromous fish monitoring, assessment, and research in the Central Valley (McEwan 2001) and there needs to be a more equitable partitioning of research funds and effort.

3. Minimize straying from hatcheries to natural spawning areas. Even low levels of straying from hatchery populations to wild ones works against the goal of maximizing diversity within ESUs and populations. Current mark and recovery regimes do not generally allow reliable estimation of contributions of hatchery fish to natural spawning, so we recommend that all hatchery fish be marked in some way. A number of actions could reduce straying from hatcheries to natural areas, including replacing off-site releases with volitional releases from the hatchery, allowing all fish that attempt to return to the hatchery to do so, and reducing the amount of fish released (see CDFG and NMFS 2001, for a review of hatchery issues).

4. Begin conducting critical research on fish passage, reintroductions, and climate change[4]. To recover Central Valley salmon and steelhead ESUs, some populations will need to be established in areas now blocked by dams or insufficient flows. Assuming that most of these dams will remain in place for the foreseeable future, it will be necessary to move fish around the dams. We are unaware of such projects involving dams of the scale typical in the Central Valley. Assuming that a feasible solution to that problem is found, it is necessary to reintroduce fish to the newly available habitat. Should this be allowed to occur naturally, or should a more active approach be taken? If so, which fish should be used as the donors? Finally, in a warmer future, some basins might cease to be suitable for salmon or steelhead. It would be a costly mistake to invest heavily in restoring habitat that will become too warm to support salmonids.

5. Accept the notion that listed salmonid ESUs are likely to be conservation-reliant (Scott et al. 2005). It seems highly unlikely that enough habitat can be restored in the foreseeable future such that Central Valley salmonid ESUs could be expected to persist without continued conservation management. Rather, it may be possible to restore enough habitat such that ESUs can persist with appropriate management, which should focus on maintaining ecological processes at the landscape level. NOAA regulators should begin considering how to implement conservation agreements among agencies and stakeholders that will be acceptable to all parties and ensure the persistence of populations and ESUs.

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ENDNOTES

[1]We also examined the potential of toxic spills, earthquakes, and landslides to extirpate ESUs, but concluded that these risk sources were generally not a threat to ESUs with more than one population.

[2]We note that any particular debris flow would cover only a portion of the circle depicted in Figure 5, and that a single flow might not necessarily devastate all three spring-run Chinook salmon streams.

[3]Using data in Lindley et al. (2004) and relationships in Waples et al. (2004), the Fst observed between Sacramento River winter-run Chinook salmon and fall-run Chinook salmon (based on neutral markers) could have arisen in around 780 years if these ESUs were completely isolated from one another.

[4]The CVTRT is preparing a comprehensive list of research recommendations.

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From: Staples, Rose
Sent: Friday, October 28, 2016 2:48 PM
Cc: Deason, Jesse; Le, Bao; Staples, Rose
Subject: FW: La Grange Doodle Poll Availability Survey for Next Reintroduction Goals Subcommittee Call

La Grange Relicensing Participants,

The following message was sent to the Reintroduction Goals subcommittee members today regarding their availability for the next conference call.

Rose Staples, CAP-OM, MOS
D 207-239-3857

hdrinc.com/follow-us

From: Staples, Rose
Sent: Friday, October 28, 2016 5:40 PM
Cc: Deason, Jesse <jesse.deason@hdrinc.com>; 'Le, Bao' <Bao.Le@hdrinc.com>; Staples, Rose (Rose.Staples@hdrinc.com) <Rose.Staples@hdrinc.com>
Subject: La Grange Doodle Poll Availability Survey for Next Reintroduction Goals Subcommittee Call

La Grange Reintroduction Goals Subcommittee Members,

Please visit the Doodle link below and provide your availability to participate in the next Reintroduction Goals Subcommittee conference call. This call will be dedicated to continuing discussions on the development of the draft goals statement (shared on the October 20th conference call). Input on availability is requested by COB on November 4th, 2016.

http://doodle.com/poll/ft36qq2zx9taad9z

Thank you.

Rose Staples, CAP-OM, MOS
Executive Assistant

HDR
970 Baxter Boulevard Suite 301
Portland ME 04103
D 207-239-3857
rose.staples@hdrinc.com

hdrinc.com/follow-us

From: Staples, Rose
Sent: Monday, October 31, 2016 4:52 PM
Cc: Deason, Jesse; Le, Bao; Staples, Rose
Subject: FW: LG Reintroduction Goals Subcommittee Oct 20 Draft Meeting Notes Available for Review

La Grange Licensing Participants,

The following message was forwarded to the members of the Reintroduction Goals Subcommittee today regarding the availability of the draft meeting notes from the October 20, 2016 conference call.

Rose Staples, CAP-OM, MOS
D 207-239-3857

hdrinc.com/follow-us

From: Staples, Rose
Sent: Monday, October 31, 2016 7:37 PM
Cc: Deason, Jesse <jesse.deason@hdrinc.com>; 'Le, Bao' <Bao.Le@hdrinc.com>; Staples, Rose (Rose.Staples@hdrinc.com) <Rose.Staples@hdrinc.com>
Subject: LG Reintroduction Goals Subcommittee Oct 20 Draft Meeting Notes Available for Review

Reintroduction Goals Subcommittee,

DRAFT NOTES from the October 20, 2016 Reintroduction Goals Subcommittee call have been uploaded to the licensing website www.lagrange-licensing.com in the DOCUMENTS section and also as an attachment to the October 20, 2016 date on the website calendar.

Please provide any comments on the meeting notes by Wednesday, November 30, 2016, to rose.staples@hdrinc.com. The Districts will incorporate any comments received and then post a final version of the meeting notes to the licensing website.

In addition, this email will also be forwarded to the La Grange Project licensing email list stating that the draft meeting notes are available online.

If you have any difficulties locating and/or accessing the document, please let me know.

As a reminder, please provide any feedback on the draft goals statement, as well as additional documents that may be helpful for drafting the goals statement, to rose.staples@hdrinc.com by November 3, 2016.

Thank you.

Rose Staples, CAP-OM, MOS
Executive Assistant

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Portland ME 04103
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rose.staples@hdrinc.com

hdrinc.com/follow-us

From: Staples, Rose
Sent: Monday, October 31, 2016 4:47 PM
Cc: Deason, Jesse; Le, Bao; Staples, Rose
Subject: FW: Change in Due Date for Comments on the Temp Criteria Subcommittee Oct 14 Conf Call Draft Notes

La Grange Licensing Participants,

The following message regarding the availability of the Oct 14, 2016 Temp Criteria Subcommittee conference call draft notes was forwarded to the subcommittee members today.

Rose Staples, CAP-OM, MOS
D 207-239-3857

hdrinc.com/follow-us

From: Staples, Rose
Sent: Monday, October 31, 2016 7:41 PM
Cc: Deason, Jesse <jesse.deason@hdrinc.com>; 'Le, Bao' <Bao.Le@hdrinc.com>; Staples, Rose (Rose.Staples@hdrinc.com) <Rose.Staples@hdrinc.com>
Subject: Change in Due Date for Comments on the Temp Criteria Subcommittee Oct 14 Conf Call Draft Notes

Please note correction in the date to provide comments on the draft meeting notes—it is Wednesday, November 30th. Thank you.

Temperature Criteria Subcommittee,

DRAFT NOTES from the October 14, 2016 Water Temperature Criteria Subcommittee call have been uploaded to the licensing website www.lagrange-licensing.com in the DOCUMENTS section and also as an attachment to the October 14, 2016 date on the website calendar.

Please provide any comments on the meeting notes by ~~Monday, November 28, 2016~~ Wednesday, November 30, 2016 to rose.staples@hdrinc.com. The Districts will incorporate any comments received and then post a final version of the meeting notes to the licensing website.

In addition, this email will be forwarded to the La Grange Project licensing email list stating that the draft meeting notes are available online.

If you have any difficulties locating and/or accessing the document, please let me know.

As a reminder, please provide any comments on the updated literature review and glossary of terms to rose.staples@hdrinc.com by November 1, 2016.

Thank you.

Rose Staples, CAP-OM, MOS
Executive Assistant

HDR
970 Baxter Boulevard Suite 301
Portland ME 04103

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rose.staples@hdrinc.com

hdrinc.com/follow-us

From: Murphey, Gretchen@Wildlife [mailto:Gretchen.Murphey@wildlife.ca.gov]
Sent: Tuesday, November 01, 2016 11:03 AM
To: Le, Bao
Subject: Re: Temperature Subcommittee Mtg - November 18th

Bao,
I can make it work.

Gretchen Murphey
Environmental Scientist
Cell (209) 617-1903
Office (209) 853-2533 ex 3#
Sent from my iPhone

On Nov 1, 2016, at 10:43 AM, Le, Bao <ChiBao.Le@hdrinc.com> wrote:

> Thanks, Gretchen.
>
> I apologize for encroaching on your Friday off but it seems like the best possible day. I want to clarify that it would be Friday morning (10-noon) and it might be a meeting in Modesto or Turlock but if you couldn't attend in person, we'd have a conference line too (although in person would be preferred of course). Please let me know if his would work.
>
> Thanks again for your flexibility,
> Bao
>
> **From:** Murphey, Gretchen@Wildlife [mailto:Gretchen.Murphey@wildlife.ca.gov]
> **Sent:** Tuesday, November 01, 2016 10:03 AM
> **To:** Le, Bao
> **Subject:** Re: Temperature Subcommittee Mtg - November 18th
>
> Bao,
> I can do the afternoon of 18th if that is the only possible day. I generally have Fridays off which is why I said no on the 18th.
>
> Gretchen Murphey
> Environmental Scientist
> Cell (209) 617-1903
> Office (209) 853-2533 ex 3#
> Sent from my iPhone
>
> On Nov 1, 2016, at 9:53 AM, Le, Bao <ChiBao.Le@hdrinc.com> wrote:
>
> > Hi Gretchen.

We're struggling a bit to identify a date that meets everyone's needs for the next Temperature Subcommittee Meeting. Currently, we've landed on November 18th however you're unable to participate that day. The other date that is possible is the 22nd but NMFS can't participate on that day. So I'm hoping that you might be able to identify/coordinate with CDFW staff to participate in your absence. I recall that Andrew Gordus participated on an earlier call? Can you or should I reach out to him to see if he could participate on behalf of the Department? That way, we can avoid re-Doodling this meeting (which I must say gets a bit chaotic). Please advise and let me know if I can help.

Thanks, Bao

Bao Le
Senior Fisheries Biologist

HDR
1001 SW 5th Avenue, Suite 1800
Portland, OR 97204-1134
Note new direct line:**D** 503.423.3828 **M** 503.309.9423
bao.le@hdrinc.com

hdrinc.com/follow-us

From: Staples, Rose
Sent: Tuesday, November 01, 2016 12:14 PM
Cc: Deason, Jesse; Le, Bao; Staples, Rose
Subject: FW: Next La Grange Temp Criteria Subcommittee Meeting Scheduled

La Grange Licensing Participants,

The following message was sent today to members of the La Grange Temperature Criteria Subcommittee regarding the date for the next conference call/meeting, which has been scheduled for the morning of November 18, 2016.

Rose Staples, CAP-OM, MOS
D 207-239-3857

hdrinc.com/follow-us

From: Staples, Rose
Sent: Tuesday, November 1, 2016 2:29 PM
Cc: Deason, Jesse <jesse.deason@hdrinc.com>; 'Le, Bao' <Bao.Le@hdrinc.com>; Staples, Rose (Rose.Staples@hdrinc.com) <Rose.Staples@hdrinc.com>
Subject: Next La Grange Temp Criteria Subcommittee Meeting Scheduled

Temperature Criteria Subcommittee members,

Please hold the morning (8am-noon) of Friday, November 18th for the next Upper Tuolumne River Reintroduction Assessment – Temperature Subcommittee Meeting/Call. At this time, we're still determining whether an in-person meeting (in Modesto or Turlock) or a conference call would be most productive to continue discussing the development of water temperature index value for the upper Tuolumne River. There will be more information to come; but at this time, please save this date/time on your calendars.

Thank you.

Rose Staples, CAP-OM, MOS
Executive Assistant

HDR
970 Baxter Boulevard Suite 301
Portland ME 04103
D 207-239-3857
rose.staples@hdrinc.com

hdrinc.com/follow-us

From: Staples, Rose
Sent: Tuesday, November 01, 2016 11:29 AM
Cc: Deason, Jesse; Le, Bao; Staples, Rose
Subject: Next La Grange Temp Criteria Subcommittee Meeting Scheduled

Temperature Criteria Subcommittee members,

Please hold the morning (8am-noon) of Friday, November 18th for the next Upper Tuolumne River Reintroduction Assessment – Temperature Subcommittee Meeting/Call. At this time, we're still determining whether an in-person meeting (in Modesto or Turlock) or a conference call would be most productive to continue discussing the development of water temperature index value for the upper Tuolumne River. There will be more information to come; but at this time, please save this date/time on your calendars.

Thank you.

Rose Staples, CAP-OM, MOS
Executive Assistant

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rose.staples@hdrinc.com

hdrinc.com/follow-us

From: Murphey, Gretchen@Wildlife [mailto:Gretchen.Murphey@wildlife.ca.gov]
Sent: Thursday, November 3, 2016 5:28 PM
To: Staples, Rose <Rose.Staples@hdrinc.com>
Cc: Heyne, Tim@Wildlife <Tim.Heyne@wildlife.ca.gov>; Marston, Dean@Wildlife <Dean.Marston@wildlife.ca.gov>; Gordus, Andy@Wildlife <Andy.Gordus@wildlife.ca.gov>
Subject: Comments on La Grange Licencing Lifestage specific water temperture biological effects and index temperature values literature review summary

Rose,

The California Department of Fish and Wildlife appreciates the efforts of those involved in putting together the literature review summery for the Water Temperature Subcommittee and has the following comments:

Glossary of Terms

It would be helpful to include definitions for both **acute** and **chronic** especially in terms to timeframes and implications.

Literature Review

- The literature review contains temperatures in both English and Metric units which is confusing. In the interest of clarity and consistency with established scientific literature we request that all temperatures be available Celsius.

- Water Temperature Indices- The literature review is unclear as to the purpose of water temperature index values. It is stated that they provide a gradation of potential effects but there is no indication as to what the index values will be used for.

- The inclusion of water temperature criteria for other Rivers and the EPA is helpful for comparison but, clarification as to how the Upper Optimum Value and Upper Tolerable Value are applied in the Yuba River would be helpful.

- The inclusion of data obtained from the Lower Tuolumne River swim tunnel study is inappropriate. Results obtained during the study are based on an acute response to temperature which does little to inform a fish's response to a chronic condition. CDFW has provided extensive comments on this study to HRD Inc. in a letter dated August 31, 2016.

Thank you,

Gretchen Murphey

Environmental Scientist, Tuolumne River
California Department of Fish and Wlidlife
La Grange Field Office
Office: (209) 853-2533 ex 3#
Cell: (209) 617-1903

From: Staples, Rose
Sent: Thursday, November 3, 2016 1:49 PM
To: 'BHackamack[redacted]
Subject: RE: Need help with Tuolumne WY UF

I'm back! Would recommend you contact Dan Steiner at [redacted] and request the data from him, like the data that was provided, I believe, with the USR. If I can assist you with anything further, please do get back in contact. Thank you.

Rose Staples, CAP-OM, MOS
D 207-239-3857

hdrinc.com/follow-us

From: Bob Hackamack [redacted]
Sent: Monday, October 31, 2016 6:15 PM
To: Staples, Rose <Rose.Staples@hdrinc.com>
Subject: Need help with Tuolumne WY UF

Rose: thanks for keeping me advised of all the work HDR is doing for La Grange and Don Pedro relicensing. I made an error in my water database for one water year of Unimpaired Flow for the Tuolumne watershed. Could you refer me to a person that could fill in my data for UF for WY 2010 through 2014 (and 2015 if available). I tried your Don Pedro web site, but I only has text for WAR-2. Many thanks and hello to John. Bob Hackamack

From: Le, Bao
Sent: Thursday, November 03, 2016 3:27 PM
To: 'Jean Castillo - NOAA Federal'
Subject: RE: La Grange

Hi Jean.

Sorry for the delay in getting back to you. I've been in and out of the office the last couple of days and just got to this email.

Your understanding of La Grange Diversion Dam is correct; it's behind a gate. I'd be happy to circle back with the Districts to see if they can arrange for someone to be available to meet you at the gate and to take you down to/around the Project. A couple of questions may help them plan for a visit…..when do you plan on arriving and how much time do you have at the site? Will it just be the two of you? Do you want to just see the dam or do you have other Project features you're interested in?

Let me know and I'll reach out on your behalf.

Thanks, Bao

From: Jean Castillo - NOAA Federal [mailto:jean.castillo@noaa.gov]
Sent: Wednesday, November 02, 2016 3:19 PM
To: Le, Bao
Subject: La Grange

Hi Bao,

I was wondering if there was any way I could get on site at the La Grange Dam on Tuesday of next week? My boss, Keith Kirkendall, is coming down from Portland and we are going to head out and see some sites. Since I am working on this project I thought it a good time to get familiar with the area and the dams.

It is my understanding the La Grange site access is behind a gate and we would need someone to open it and possibly take us up to the dam. Is this something you can set up for us?

It is also my understanding that there is a public access road that goes over the Don Pedro so we can get there on our own.

Anything you can do to assist us in this request would be greatly appreciated.

Sincere regards,
Jean

Jean M. Castillo, MSCE, P.E.
Hydraulic/Fish Passage Engineer

NOAA Fisheries West Coast Region
U.S. Department of Commerce
650 Capitol Mall, Suite 5-100
Sacramento, California 95814-4700
Office: 916-930-3613
jean.castillo@noaa.gov

From: Le, Bao
Sent: Friday, November 04, 2016 1:28 PM
To: 'Jean Castillo - NOAA Federal'
Cc: Steve Boyd; Anna Brathwaite (Anna.Brathwaite@mid.org)
Subject: RE: site visit

Hi Jean.

I just got off the phone with the Districts and they appreciate your interest in seeing the Projects. Being relatively new to this licensing process, it seems like a great opportunity to have access to information other licensing participants have already received through other FERC related activities (e.g., site visits, etc.). To that end, Steve Boyd (TID) is planning to give you call to discuss further.

Thanks, Bao

From: Jean Castillo - NOAA Federal [mailto:jean.castillo@noaa.gov]
Sent: Friday, November 04, 2016 12:41 PM
To: Le, Bao
Subject: site visit

Hi Bao,

Any luck contacting someone from the district? Is there someone I can call??

Thanks,
Jean

Jean M. Castillo, MSCE, P.E.
Hydraulic/Fish Passage Engineer

NOAA Fisheries West Coast Region
U.S. Department of Commerce
650 Capitol Mall, Suite 5-100
Sacramento, California 95814-4700
Office: 916-930-3613
jean.castillo@noaa.gov

From: John Wooster - NOAA Federal <john.wooster@noaa.gov>
Sent: Monday, November 07, 2016 4:16 PM
To: Le, Bao
Cc: Deason, Jesse; Staples, Rose; Steve Edmondson; Jean Castillo - NOAA Federal
Subject: Re: Change in Due Date for Comments on the Temp Criteria Subcommittee Oct 14 Conf Call Draft Notes
Attachments: BoughtonEtAl2015.pdf

Bao:

I think an important component for the temperature sub-group is to understand how the NMFS Science Center will treat the topic of thermal suitability in modeling habitat capacity in their study of the Upper Tuolumne watershed. Their approach for O.mykiss is currently likely to follow the approach used in this 2015 Boughton et al. paper that I am attaching to this email – with emphasis on the *Thermal Indicators of habitat suitability* section on pdf page 263. The Science Center has another technical memo in draft form that provides greater detail for this approach and the rationale / data behind it– once that memo is finalized I can pass it along too. The spring-run Chinook approach for the Tuolumne is still under development, although likely to follow a similar mechanistic/bio-energetic approach but maybe some adjustment to the temperature thresholds.

In short, they will not be taking a relatively simplistic approach of selecting one temperature metric and deciding if a reach is "suitable" or "not". For O.mykiss, if a given day has a maximum temp >29C or average daily temp >25C then it is not suitable. Temperatures in the 21 to 25C range are considered stressful. What impacts those stressful temperatures have and whether the O.mykiss can utilize the habitat depends on several factors, including but not limited to: thermal refugia (e.g., stratified deep pools), food availability, growth potential, level of stress (e.g., function of the degrees above 20C and for how many hours), etc…

I also inquired about other useful references towards temperature and steelhead and the lab recommended these papers (in addition to the one I am attaching):

Rodnick, K. J., A. K. Gamperl, K. R. Lizars, M. T. Bennett, R. N. Rausch, and E. R. Keeley. 2004. Thermal tolerance and metabolic physiology among Redband Trout populations in southeastern Oregon. Journal of Fish Biology 64:310–335.

Sloat, M. R., and A. M. K. Osterback. 2013. Maximum stream temperature and the occurrence, abundance, and behavior of steelhead trout (Oncorhynchus mykiss) in a southern California stream. Canadian Journal of Fisheries and Aquatic Sciences 70:64–73.

Spina, A. P. 2007. Thermal ecology of juvenile steelhead in a warm-water environment. Environmental Biology of Fishes 80:23–34.

Zoellick, B. W. 1999. Stream temperatures and the elevational distribution of Redband Trout in southwestern Idaho. Great Basin Naturalist 59:136–143.

Regards,

John

On Mon, Oct 31, 2016 at 4:40 PM, Staples, Rose <Rose.Staples@hdrinc.com> wrote:

Please note correction in the date to provide comments on the draft meeting notes—it is Wednesday, November 30th. Thank you.

Temperature Criteria Subcommittee,

DRAFT NOTES from the October 14, 2016 Water Temperature Criteria Subcommittee call have been uploaded to the licensing website www.lagrange-licensing.com in the DOCUMENTS section and also as an attachment to the October 14, 2016 date on the website calendar.

Please provide any comments on the meeting notes by Monday, November 28, 2016 Wednesday, November 30, 2016 to rose.staples@hdrinc.com. The Districts will incorporate any comments received and then post a final version of the meeting notes to the licensing website.

In addition, this email will be forwarded to the La Grange Project licensing email list stating that the draft meeting notes are available online.

If you have any difficulties locating and/or accessing the document, please let me know.

As a reminder, please provide any comments on the updated literature review and glossary of terms to rose.staples@hdrinc.com by November 1, 2016.

Thank you.

Rose Staples, CAP-OM, MOS

Executive Assistant

HDR

970 Baxter Boulevard Suite 301
Portland ME 04103
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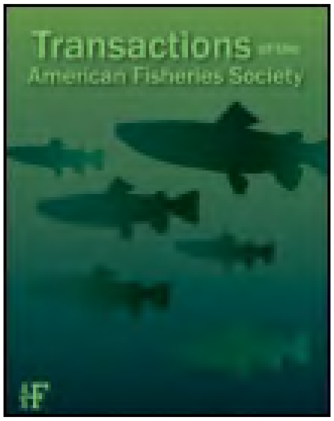
--
John Wooster
Hydrologist
NOAA Fisheries West Coast Region
U.S. Department of Commerce
john.wooster@noaa.gov



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Thermal Potential for Steelhead Life History Expression in a Southern California Alluvial River

David A. Boughton[a], Lee R. Harrison[ad], Andrew S. Pike[b], Juan L. Arriaza[c] & Marc Mangel[c]

[a] National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southwest Fisheries Science Center, Fisheries Ecology Division, 110 Shaffer Road, Santa Cruz, California 95060, USA

[b] Institute of Marine Sciences, University of California-Santa Cruz, 1156 High Street, Santa Cruz, California 95064, USA

[c] Center for Stock Assessment Research, Department of Applied Mathematics and Statistics, University of California-Santa Cruz, 1156 High Street. 95064, Santa Cruz, California, USA; and Earth Research Institute, University of California, Santa Barbara, California 93106, USA

[d] Present address: Earth Research Institute, University of California, Santa Barbara, California 93106, USA

Published online: 23 Feb 2015.

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DOI: 10.1080/00028487.2014.986338

ARTICLE

Thermal Potential for Steelhead Life History Expression in a Southern California Alluvial River

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National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southwest Fisheries Science Center, Fisheries Ecology Division, 110 Shaffer Road, Santa Cruz, California 95060, USA

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Abstract
Steelhead *Oncorhynchus mykiss* (anadromous Rainbow Trout) near the southern limit of the species' range commonly use shallow alluvial rivers for migration, spawning, and rearing. These rivers have been widely modified for water management, and an enduring question is whether their rehabilitation would create summer nursery habitat for steelhead. We used process-based models to evaluate the thermal potential for steelhead nursery habitat in the Santa Ynez River, California, a regulated alluvial river that currently supports few steelhead. We assessed (1) how well a calibrated model of river heat fluxes predicted summer temperature patterns for a warm year and an average year; (2) whether those patterns created thermal potential for the rapid growth that is characteristic of steelhead nursery habitat; and (3) whether manipulation of flows from an upstream dam significantly altered thermal potential. In the heat flux model, the root mean square error for 15-min temperatures was 1.51°C, about three times greater than that of the larger, deeper Sacramento River in northern California. Generally, the Santa Ynez River was thermally suitable but stressful for juvenile steelhead. Flow augmentation reduced the number of thermally stressful days only near the dam, but it reduced the intensity of thermal stress throughout the river. Daytime movement of steelhead into natural, thermally stratified pools would reduce stress intensity by similar levels. In this region, *O. mykiss* commonly pursue an anadromous (steelhead) life history by entering nursery habitat early in their first or second summer and rapidly growing to attain a threshold size for anadromy by fall. In the average year, the river was thermally suitable for the first-summer pathway under high food availability and for the second-summer pathway under medium food availability. The warm year also supported the second-summer pathway under high food availability. Currently, the Santa Ynez River's capacity to support these pathways does not appear to be limited by summer temperature, thus indicating a need to identify other limiting factors.

Steelhead *Oncorhynchus mykiss* (anadromous Rainbow Trout) in southern California near the southern limit of the species' native range historically migrated up wide, shallow alluvial rivers that drained arid mountain ranges (Figure 1). An enduring question is whether the summertime thermal patterns of these rivers constitute a fundamental control on

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FIGURE 1. Coastal California alluvial rivers currently or formerly used by steelhead (anadromous *Oncorhynchus mykiss*) near the southern limit of the species' native range (Boughton et al. 2005). Steelhead historically used alluvial rivers as migration corridors to upland creek habitat and possibly as spawning and rearing habitat. The alluvial rivers that are highlighted here are channels with gradients less than 1% and upstream watershed areas greater than 500 km^2 within the shrub-dominated coastal mountain ranges south of Monterey Bay.

productivity and life history diversity of *O. mykiss* in this region. Southern California steelhead are currently scarce and considered highly endangered, in part due to widespread human impacts but also to challenging climatic conditions that may limit the rivers' suitability (Boughton et al. 2009). Better insight into thermal factors that limit steelhead has implications for recovery potential in the region and, more broadly, for the responses of other steelhead populations to the impacts of climate change on rivers (e.g., Mantua et al. 2010; Benjamin et al. 2013).

Steelhead are stressed by or excluded from water that is warmer than specific tolerance limits (Jobling 1981; Eaton et al. 1995; Werner et al. 2005; Kammerer and Heppell 2013a), which indirectly links their geographic distribution to summer climate via river temperature (Mohseni et al. 2003). Water temperature also sets an upper limit on the potential growth of juveniles (Wurtsbaugh and Davis 1977; Kammerer and Heppell 2013b, 2013a), with implications for the fitness and expression of anadromous and nonanadromous (resident) life histories (Mangel and Satterthwaite 2008; McMillan et al. 2012; Sogard et al. 2012; Benjamin et al. 2013). Numerous other ecological factors and human impacts also influence distribution, abundance, and life history expression in *O. mykiss* (Busby et al. 1996) but only within the bounds of a river's thermal potential for the species. Thus, if a given river habitat lacks the basic thermal potential to support the anadromous life history, then there is little scope for steelhead recovery, irrespective of other factors. We used this premise to assess the recovery potential of steelhead in an alluvial main-stem river in southern California.

Southern California *O. mykiss* populations historically expressed both anadromous (steelhead) and resident (Rainbow Trout) life histories. Anadromous life histories appear to depend on habitats that produce large smolts, which survive well in the ocean and are disproportionately represented in adult spawning migrations (Bond 2006). Such areas qualify as nursery habitat—defined as rearing habitats for which the contribution per unit area to the production of recruits to the adult population is greater than the contributions from other habitats where juveniles occur (Beck et al. 2001). Thus, steelhead nursery habitats constitute the subset of juvenile rearing habitats that generate high numbers of adult steelhead per unit area, and these nursery habitats are important for maintaining population size and persistence (Beck et al. 2001). Hayes et al. (2008) identified three pathways by which juvenile *O. mykiss* use nursery habitat in coastal California to achieve sizes that are suitable for anadromous life histories; each of the pathways involves the use of summer habitats that are capable of sustaining rapid growth (Figure 2). In the "first-summer" pathway, age-0 steelhead enter nursery habitat in early summer and grow rapidly. By fall, they reach a size that enables them to exhibit more typical growth during winter yet still successfully smolt the following spring at age 1. In the "second-summer" pathway and the much rarer "third-summer" pathway, age-0

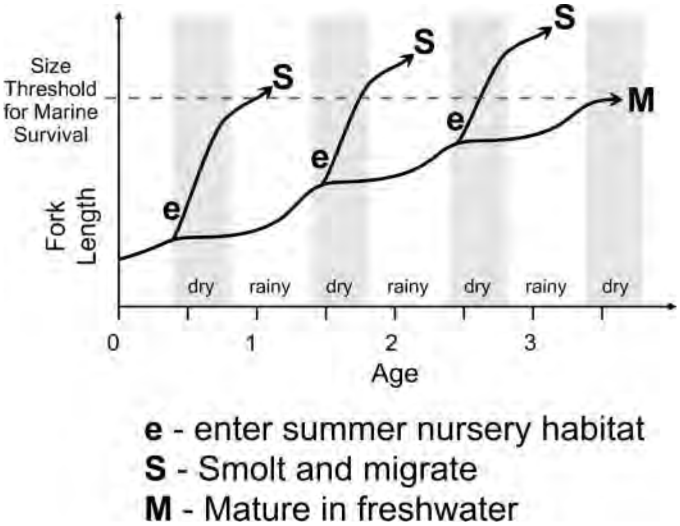

FIGURE 2. Conceptual model for *Oncorhynchus mykiss* life history pathways in stream systems of the California coast (adapted from Hayes et al. 2008; see also Bond 2006; Satterthwaite et al. 2009, 2012; and Beakes et al. 2010). Because marine survival is low for *O. mykiss* smaller than a certain size threshold (∼150 mm FL), habitats only produce the anadromous life history form (steelhead) if the fish sustain rapid growth during the summer before smolting. Such habitats disproportionately contribute recruits to anadromous runs and thus fit the definition of steelhead nursery habitat (sensu Beck et al. 2001).

steelhead remain in upland creeks for 1 or 2 years, where they grow slowly until entering nursery habitat in their second or third summer and then smolting the following spring at age 2 or age 3. Some fish also follow a resident pathway, maturing in freshwater as Rainbow Trout (Hayes et al. 2012).

Growth potential is probably a central feature distinguishing steelhead nursery habitat from Rainbow Trout nursery habitat. This is because body size correlates strongly with fitness components, such as habitat-specific survival (Ward et al. 1989; Bond 2006; Evans et al. 2014; Thompson and Beauchamp 2014) and female fecundity (Shapovalov and Taft 1954), and such fitness components evolutionarily favor anadromy in some environments and freshwater residency in others (Satterthwaite et al. 2009, 2010). Thus, although life histories are partly under genetic control (Thrower and Joyce 2004; McPhee et al. 2007; Heath et al. 2008; Pearse et al. 2014), natural selection should favor a conditional life history strategy that uses body size as an internal cue for whether and when to switch from freshwater habitat to marine habitat (Mangel and Satterthwaite 2008; Satterthwaite et al. 2009; McMillan et al. 2012; Sloat et al. 2014). At the same time, the growth and body size necessary to cue the switch are expected to (1) differ for males and females (Sloat et al. 2014); (2) vary regionally as a function of local survival in both the marine and freshwater environments; and (3) depend on the maximum attainable body size (asymptotic body size) in the two environments (Satterthwaite et al. 2010). For simplicity, we focus here on female life histories under the assumption that limits on anadromous production are more closely tied to female fecundity than to male fecundity. For some salmonid species in some environments, very rapid growth and large attainable body sizes for females in freshwater appear to favor resident life histories (i.e., maturation in freshwater; Sloat et al. 2014). For *O. mykiss* in coastal California, the combination of survival schedules and very rapid growth that favors such a strategy has not yet been observed (Hayes et al. 2008). Instead, rapid growth appears to evolutionarily favor an anadromous life history, whereas moderate growth apparently favors a resident life history (Satterthwaite et al. 2009). Feeding experiments suggest that the physiological "decision" to forsake a nonanadromous path and switch to marine habitats is made in the fall—after the summer growth period and before outmigration the next spring (Beakes et al. 2010). Thus, to a first approximation, a habitat's potential to generate the anadromous life history in coastal California simplifies to the potential to support survival and rapid growth of juvenile female *O. mykiss* during summer. In the context of thermal potential addressed here, survival will fail if temperatures become lethally warm, and rapid growth will fail if water temperatures are either too warm or too cool for the growth rate required to trigger smoltification and the switch to marine habitats.

The best-studied steelhead nursery habitats in the region are coastal estuaries (Bond 2006), which form dry-season lagoons that produce abundant large smolts. Coastal climate and inputs of marine wrack and invertebrates provide the appropriate combination of temperature and feeding opportunity for rapid growth, but the total productivity of estuaries is limited by their small spatial extent. Upland creek habitat is more widespread and supports abundant juvenile *O. mykiss* (e.g., Boughton et al. 2009). However, the channels must be well shaded to stay cool enough for the species (Boughton et al. 2012), whereas dense shade appears to limit instream primary productivity, creating a food-limited environment and low growth potential in summer (Hayes et al. 2008; Rundio and Lindley 2008; Sogard et al. 2009). Coastal estuaries are usually steelhead nurseries and upland creeks are usually not, but the nursery role of a third common habitat, alluvial rivers, remains an open question.

Lowland alluvial rivers, defined here as streams with low gradients (<1%) and large upstream watersheds (>500 km^2), are numerous and widespread at the species' southern range limit in California (Figure 1); therefore, these systems could potentially produce large steelhead runs if they are capable of functioning as nursery habitat. In summer, alluvial rivers are wide, shallow, and sparsely shaded, making them vulnerable to heating but also typically allowing them to support substantial algal growth, which suggests a physical basis for a productive food web and the high feeding opportunities necessary for rapid growth of juvenile fish. Summer air temperatures in this region routinely exceed 30°C, but river temperatures are reduced to varying extents by cool onshore winds and fog from the ocean and by hydrological exchange with large aquifers. These physical influences on temperature are spatially heterogeneous (e.g., Alagona et al. 2012; Booth et al. 2013), and the degree to which they keep rivers in the thermal zone required for rapid growth—or even survival—of juvenile *O. mykiss* is unclear. Unfortunately, the potential role of lowland alluvial rivers as summer nursery habitat is ambiguous due to an incomplete historical record and the extensive negative impacts from water development, adjacent land uses, and nonnative species (Marchetti et al. 2004; Klose et al. 2012; Cooper et al. 2013).

We used process-based models of river temperature and fish response to evaluate whether a representative alluvial river in southern California has the thermal potential to support anadromous life history expression by the local population of *O. mykiss*. The Santa Ynez River serves as a useful case study because it has a historical record of occasional (and perhaps frequent) large steelhead runs (Alagona et al. 2012) and because the existing river and its human impacts are representative of many other rivers in the region (Kondolf et al. 2013). We focused our analysis on three questions: (1) Do summer temperature patterns in the main stem of the river create thermal potential for steelhead survival and a first-summer or second-summer life history strategy?; (2) How much does the manipulation of water releases from an upstream dam alter the thermal potential of the river?; and (3) How much do cold patches of water in thermally stratified pools increase the thermal potential of the river by reducing thermal stress on steelhead?

STUDY AREA

The Santa Ynez River flows west about 110 km from tributaries in the Transverse Ranges of California to the Pacific Ocean just north of Point Conception. The reach we modeled was the lower 65-km section below Bradbury Dam (Figure 3). Historical data suggest that steelhead runs once numbered in the tens of thousands in some years but were nearly nonexistent in other years (Alagona et al. 2012). Currently, anadromous *O. mykiss* are consistently rare despite the predominance of anadromous genotypes in the local population (Pearse et al. 2014, cf. Salsipuedes and Hilton creeks) and more than a decade of rehabilitation efforts (Robinson et al. 2009). Bradbury Dam impounds a large reservoir near the middle of the basin and blocks steelhead migration 70 km upstream of the

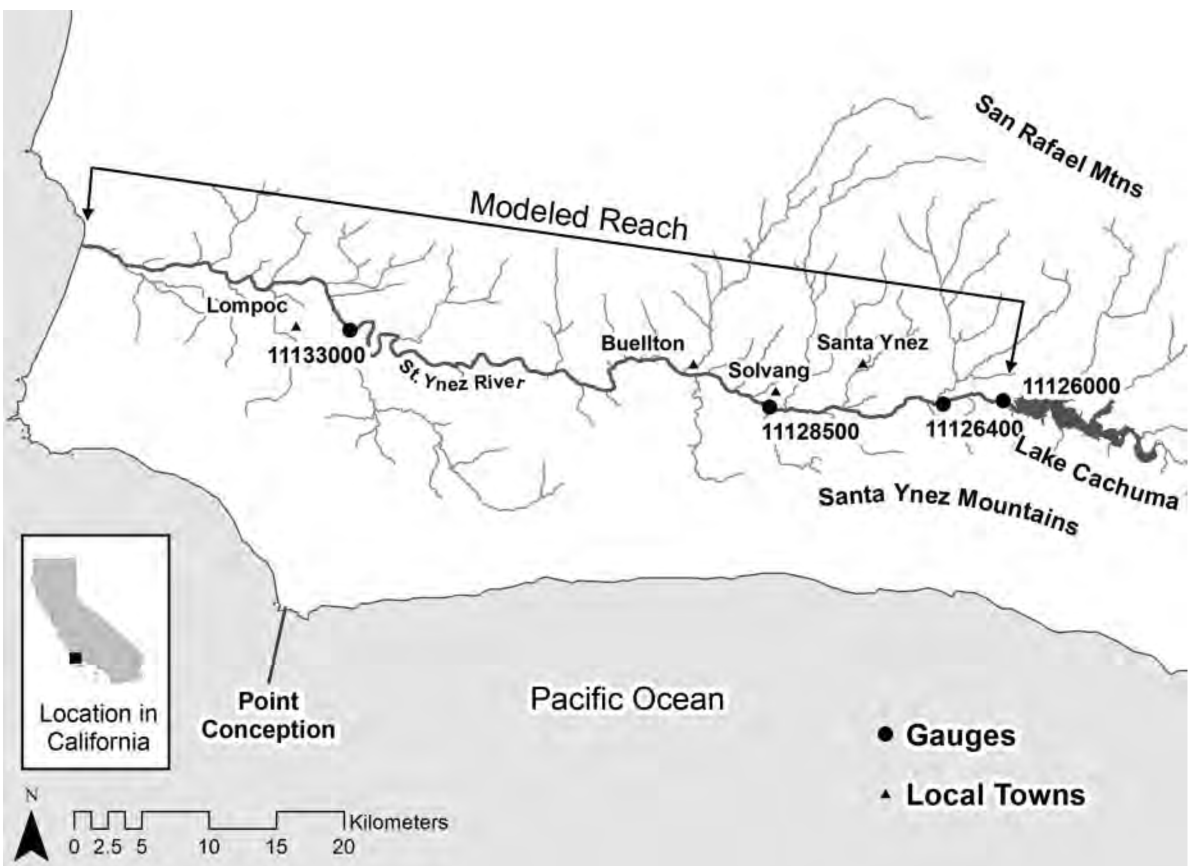

FIGURE 3. Map of the study area in the Santa Ynez River, showing landmarks and locations of stream gauges that recorded flow and temperature. U.S. Geological Survey (USGS) gauge 1112600 defined the upstream boundary conditions for the River Assessment for Forecasting Temperature model; USGS gauges 11126400, 11128500, and 11133000 were used to calibrate the parameters.

estuary; about two-thirds of the basin's spawning and rearing habitat are located upstream of the dam and are therefore inaccessible (Alagona et al. 2012). Genetically similar but nonanadromous *O. mykiss* occupy the stream network upstream of the dam (Clemento et al. 2009; Pearse et al. 2014). Summertime flows below the dam are managed for multiple objectives, including steelhead rearing and continuous replenishment of aquifers tapped by agriculture. Summer flows typically range between 0.3 and 1.0 m^3/s but may be temporarily ramped up as high as 4 m^3/s to replenish the downstream aquifers.

Between Bradbury Dam and the town of Solvang (Figure 3), the Santa Ynez River has a gravel bed with alternating pool–riffle sequences and a sparsely vegetated floodplain. The channel migrates laterally during infrequent flood events, thereby scouring pools, shaping gravel bars, and recruiting coarse woody debris via bank migration. Together, these processes produce physical habitat complexity that is characteristic of the habitats typically used by steelhead. This complexity includes a diversity of water depths and velocities; visual cover provided by instream wood, undercut banks, and overhanging vegetation; and gravel beds suitable for spawning. During years between floods, dense shrubby vegetation colonizes the active channel margins, and the riverbed develops thick algal mats. Further downstream from Solvang, the Santa Ynez River shifts to a sand-bedded channel with fewer pool–riffle sequences and more closely resembles a braided river. Important human impacts include managed flow regimes, high nitrogen loading from agricultural activities, and a profusion of exotic fish species. Juvenile and adult Largemouth Bass *Micropterus salmoides* are especially abundant, occurring in the tens of thousands throughout the lower river during summer (Robinson et al. 2009).

In summer, juvenile steelhead are common in a few small tributaries of the lower Santa Ynez River; in the river itself, however, they are rare and confined to small coldwater patches associated with thermally stratified pools or groundwater seeps (Robinson et al. 2009). Thermal stratification occurs at low flows, when water velocities are slow enough to allow poorly mixed layers of water at different temperatures to develop in well-shaded pools, or in areas where groundwater seeps up from the bed. Geomorphically, the river seems suitable for steelhead rearing, yet rearing is rare; therefore, the key questions (and the motivation for this study) are whether the lack of steelhead rearing can be attributed to thermal constraints and whether such constraints are more closely linked to dam releases or to prevailing weather.

METHODS

River temperature.—We estimated fine-grained temperature dynamics in the Santa Ynez River by using the River Assessment for Forecasting Temperature (RAFT) model (Pike et al. 2013). The RAFT model was previously developed for the Sacramento River, a large, cool California river with managed summer flows that typically range from 180 to 520 m^3/s—or about 200–1,500 times greater than typical summer flows in the Santa Ynez River. The much shallower Santa Ynez River provides a more challenging system to model because heat fluxes with the riverbed and atmosphere are potentially large relative to the thermal capacity of the river. Pike et al. (2013) described the RAFT model in detail; below, we summarize aspects that are relevant to the challenge of simulating thermal processes in the Santa Ynez River.

The RAFT model assimilates data on meteorology, flow, and river temperature to simulate hydrological and thermal processes at a temporal resolution of 15 min and a spatial resolution of 1 km. A one-dimensional hydrodynamic model simulates the advection and diffusion of heat longitudinally in the river, coupled to physical models of all upward and downward heat fluxes with the atmosphere and streambed, respectively. For the Sacramento River, RAFT accurately predicted (root mean square error [RMSE] $< 0.5°C$) the magnitude and timing of diel temperature fluctuations over entire summers, including thermal artifacts, such as the phase–antiphase pattern of downstream temperature below a dam releasing water of constant temperature (Pike et al. 2013). The model requires channel bathymetry as input, which in this study comprised topographic cross-sections spaced at ~50-m intervals, derived from aerial LiDAR and ground surveys of the Santa Ynez River. Other required input included gridded hourly meteorological data and a time series of measured hourly temperature and flow at the upstream boundary of the modeled reach (U.S. Geological Survey [USGS] gauge 1112600, about 5 km downstream of Bradbury Dam; see Figure 3).

The model runs in either a hindcast or forecast mode. Hindcasts simply assimilate temperature observations to spatiotemporally infer a past temperature field that is encompassed by the time span of the data. Forecasts predict future temperature time series based on constructed flow and temperature scenarios at the upstream boundary. We used hindcasts to calibrate RAFT and reconstruct temperature fields from the recent past, and we used forecasts to predict the effects of hypothetical water release scenarios.

Calibration of the model benefits from the assimilation of flow records that include both large and small flows, so we focused on two recent summers (2006 and 2010) with flows spanning a relatively broad range (0.3 to 5.0 m^3/s). Based on daily temperatures at the Lompoc gauge (USGS gauge 11133000), 2006 had the hottest summer of the last decade, with a mean summer water temperature of 21.41°C (range of summer means for the last decade = 19.46–21.41°C; calculated for June 1–October 1 of each year from 2003 to 2012). In contrast, 2010 had a nearly average summer, with a mean water temperature of 20.48°C (mean of summer means for the last decade = 20.56°C).

For each summer, the RAFT model was calibrated by adjusting several tunable parameters to achieve a best fit with 15-min water temperatures at three gauges downstream of

Bradbury Dam (USGS gauges 11126400, 11128500, and 11133000; Figure 3). Tunable parameters included the depth of the streambed (affecting the rate of bed heat conduction), the temperature of the deep groundwater reservoir (assumed to be constant over time), and coefficients for the rate of evaporative cooling relative to wind speed.

After calibration, we simulated alternative flow scenarios by using the same data used for hindcasts, altering only the flow. Seven scenarios of constant flow (0.14, 0.28, 0.71, 1.4, 2.8, 4.3, and 5.7 m^3/s [5, 10, 25, 50, 100, 150, and 200 ft^3/s]) were simulated for the dry season (May 1–October 1).

Thermal indicators of habitat suitability.—To evaluate how river temperature was likely to affect southern California steelhead, we developed a set of biological indicators. A review of the literature suggested that steelhead in various regions can persist in streams if short-term maximum temperatures remain below 30°C or perhaps 29°C (Zoellick 1999; Rodnick et al. 2004; Huff et al. 2005; Werner et al. 2005; Sloat and Osterback 2013), which is similar to laboratory estimates of the critical thermal maximum, a measure of short-term physiological tolerance for high temperature (Myrick and Cech 2004; Rodnick et al. 2004; Hasnain et al. 2013). However, at temperatures above 22–24°C, feeding and agonistic behaviors decline in frequency (Sloat and Osterback 2013), and the fish show signs of stress (Werner et al. 2005). Laboratory estimates of incipient lethal temperature (50% mortality after long exposure) vary across studies but average around 25°C. Steelhead start to concentrate in thermal refugia, if available, when temperatures exceed 21°C, and they almost completely retreat to refugia when temperatures are around 24°C (Nielsen et al. 1994; Ebersole et al. 2001; Baird and Krueger 2003; Sutton et al. 2007). Many southern California streams that support steelhead do not provide such refugia, and steelhead actively feed in the temperature range of 21–24°C, which is presumably stressful (Spina 2007; Sloat and Osterback 2013).

Based on this review, we define thermal indicators as follows. A day is "thermally suitable" if maximum daily temperature stays below 29°C *and* mean daily temperature stays below 25°C. However, a day is "thermally stressful" if temperature rises above 21°C at any time, with the daily stress intensity quantified as degree-hours above 21°C (i.e., for each day, $\Sigma[T_t - 21]\Delta t$).

Thermal growth potential.—We defined thermal growth potential as the maximum attainable growth of an individual fish, a function of the river's thermal regime and food availability. Thermal growth potential was estimated using the bioenergetics model for *O. mykiss* described by Railsback and Rose (1999), as modified by Satterthwaite et al. (2010) and Arriaza (2013). Individual growth arises from the difference between energy intake and energy expenditure (Rand et al. 1993; Railsback and Rose 1999; Satterthwaite et al. 2010), which are modeled as weight- and temperature-dependent functions for food consumption and respiration, respectively (see Arriaza [2013] for details). The functional form of the growth response to temperature is hump-shaped after Thornton and Lessem (1978) for coldwater species; the functional form was parameterized for California steelhead as in Railsback and Rose (1999). Expressions for maximum food intake and respiration costs in the basic model were modified by functions simulating the energy cost of activity and the difficulty of finding food in a wild habitat, in accordance with recommendations made by Andersen and Riis-Vestergaard (2004) and Bajer et al. (2004). Higher activity increases food consumption, but total energetic cost also increases. For simplicity, we assumed that fish choose a unique activity level that optimizes growth given all other parameters (Arriaza 2013). In the resulting model, the growth rate depends on fish size and food availability but generally peaks in the range of 15–17°C and becomes negative at temperatures above 22–24°C.

We applied the bioenergetics model to temperature output from RAFT scenarios in combination with assumptions about food availability. For *O. mykiss* in the Santa Ynez River (either in its current state or under hypothetical flow scenarios), the level of difficulty in finding food is unknown although presumably low, as judged from the great abundance of juvenile Largemouth Bass and other exotic fish in the river. For simplicity, we assumed that the difficulty of finding food over the summer was constant, and uncertainty was represented by simulating low, medium, and high food availability as drawn from parameter estimates for the same model when applied to two alluvial rivers in California's Central Valley over various years and seasons (Satterthwaite et al. 2010).

Nursery potential.—Growth potential was used to evaluate whether thermal patterns in the Santa Ynez River were sufficient to support either a first-summer or second-summer pathway to anadromy. Growth of age-0 and age-1 *O. mykiss* from June 1 to October 1 was simulated at daily time steps by using mean daily temperature from the RAFT scenarios. Weights of juveniles on June 1 were assumed to be 1.9 g for age-0 fish and 13.6 g for age-1 fish (D. Rundio, National Oceanic and Atmospheric Administration, Southwest Fisheries Science Center, personal communication).

Thermal growth potential was judged to be sufficient for steelhead nursery habitat if fish had grown past a smolting criterion, defined as the minimum FL on October 1 associated with successful anadromy. In the spring, FLs greater than 150 mm are associated with successful anadromy (i.e., a high smolting rate and high marine survival; Ward et al. 1989; Bond 2006; Evans et al. 2014; Thompson and Beauchamp 2014). We examined two versions of the October 1 criterion to account for uncertainty. The "high" smolting criterion was an October 1 FL exceeding 150 mm, which makes the very conservative assumption that growth is negligible in the intervening winter. The "typical" smolting criterion was an October 1 FL greater than 100 mm; this criterion is more apt because it assumes that growth in the intervening winter is typical of upland creeks in the region, which would produce fish larger than the 150-mm threshold by the following spring (Satterthwaite et al. 2009).

Stratified pools.—To assess the extent to which thermally stratified pools might reduce thermal stress, we deployed vertical arrays of temperature loggers in five sections of the Santa Ynez River during summer 2011. Sites were chosen on the basis of accessibility and wide geographic distribution. Stratified pools have been observed in California rivers with large gravel bars, flow separation, extensive intergravel flow, groundwater seeps, and pools that are forced by large woody debris or boulders (Nielsen et al. 1994). Based largely on these findings, we selected pools within each section that possessed at least three geomorphic and hydrologic criteria indicating a high potential for stratification. We identified 16 such pools. In each pool, we positioned a fence post vertically at the deepest point (either by driving it into the substrate or placing it in a manufactured concrete base) and attached three Hobo pendant loggers (Onset Corporation) housed by gray plastic sunshields. One logger was placed 10 cm below the water's surface, another logger was placed against the streambed, and the third logger was deployed midway between the first two. The period of record was July 1–October 1, except for three loggers that were not deployed until the second week of July.

The pools were snorkel surveyed for the presence of steelhead in late summer (August 16–18). Standard methods (e.g., Boughton et al. 2009) were used for the survey, including visual assignment of fish to three general size-classes (<100, 100–200, or >200 mm FL). Such methods generally achieve per-fish observation probabilities around 0.70–0.85.

Complete data sets were recovered from 14 pools. In many cases, declining flows exposed the upper (surface) temperature logger; in the remaining cases, the records of the middle and surface loggers were nearly identical, so records from the middle logger were taken to represent the main flow. Pools were defined as stratified if they showed an absolute difference greater than 1°C between middle and bottom loggers for at least 5% of the period of record. Mean daily stress intensity was calculated for the middle and bottom logger positions in each pool.

RESULTS

Performance of the RAFT Model

Each RAFT hindcast produced 14,689 temperature predictions for the 153 d from midnight on May 1 to midnight on October 1. The RMSE of 15-min temperatures was 1.51°C in both years, with the RMSE of daily means being slightly smaller and the RMSE of daily maximums being slightly larger (Table 1). The RMSE broken down by USGS gauge and flow showed a negative relationship with flow but not consistently; the lower flows generally involved prediction error ranging from 1°C to 2°C. Thermal stress had an RMSE of 14.8 degree-hours in 2006 and 11.0 degree-hours in 2010, which were comparable in magnitude to the predicted daily stress itself (see below).

TABLE 1. Performance metrics for the River Assessment for Forecasting Temperature hindcasts estimated from three downstream temperature gauges in the Santa Ynez River, California (RMSE = root mean square error).

	RMSE		Bias	
Metric	2006	2010	2006	2010
15-min temperature (°C)	1.51	1.51	−0.04	0.30
Daily mean temperature (°C)	1.03	0.80	−0.04	0.30
Daily maximum temperature (°C)	1.70	2.00	−0.24	1.60

Mean biases in 15-min and daily temperatures were small (≤0.3°C; Table 1). The bias in maximum daily temperature was about five times larger than the bias in mean daily temperature for each year (Table 1). Bias as a function of flow tended to be hump-shaped, with a relatively small or negative bias at low and high flows and a positive bias at intermediate flows.

Thermal Suitability and Thermal Stress

The seven flow scenarios altered the mean daily river temperature relative to the temperature records of the recent past (Figure 4A, C). The lowest flow (0.14 m^3/s) raised temperature by as much as 1.25°C but only in the vicinity of Bradbury Dam; effects were less than 0.5°C further than 10 km from the dam and were negligible beyond 20 km from the dam. The highest flow (5.7 m^3/s) lowered temperature by as much as −2.6°C in 2006 and −1.6°C in 2010, with effects persisting further downstream (40–50 km); however, less extreme scenarios (1.4 m^3/s or less) always had negligible effects further than 20 km below the dam.

In contrast, the seven flow scenarios had larger and more extensive effects on mean maximum daily temperature (Figure 4B, D). The largest effects were close to the dam and ranged from +2.5°C to −4.6°C for the lowest and highest flow scenarios, respectively. However, effects ranging between about +0.8°C and −1.7°C persisted as far as 60 km from the dam, much further than the effects for mean daily temperature.

Based on the recent temperature data and based on the scenarios, no part of the river became thermally unsuitable for steelhead, with one small exception. In 2006, at the lowest flow (0.14 m^3/s), 3 km of the lower river became unsuitable for 1 d in late summer.

In general, nearly all summer days were thermally stressful throughout the entire river except for the area immediately below Bradbury Dam (Figure 5A, C). Higher water releases could expand this less-stressful zone downstream, but the highest release could only create a truly low-stress zone a few kilometers long just below the dam. However, dam releases had large effects on the intensity of stressful days, and these effects persisted much further downstream, especially for the three largest releases (Figure 5B, D).

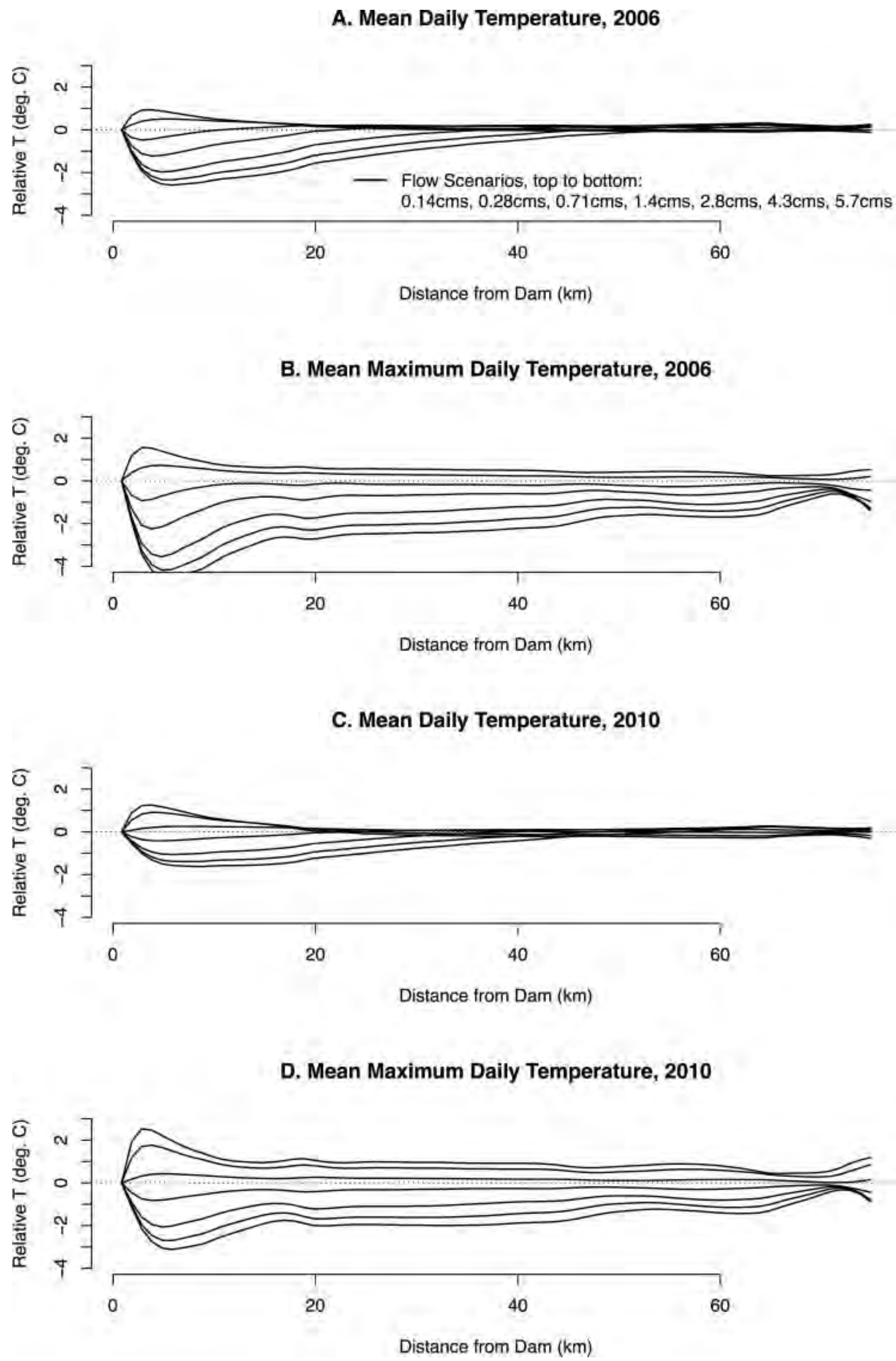

FIGURE 4. Effects of flow levels (simulated dam releases; cms = cubic meters per second) on temperatures (T) downstream of Bradbury Dam on the Santa Ynez River relative to the calibration scenario (hindcast temperature from actual flow releases occurring in 2006 and 2010). The mean of mean daily temperature and mean maximum daily temperature for the summer release season (May 1–October 1) are shown.

Nursery Potential

For clarity, nursery potential results from the various scenarios are reported in terms of relative final mass, calculated as the final mass of fish on October 1 divided by the corresponding final mass projected under the actual summer flows of 2006 and 2010.

Age-0 fish.—In 2010, the average year, medium to high food availability produced fish with masses greater than the

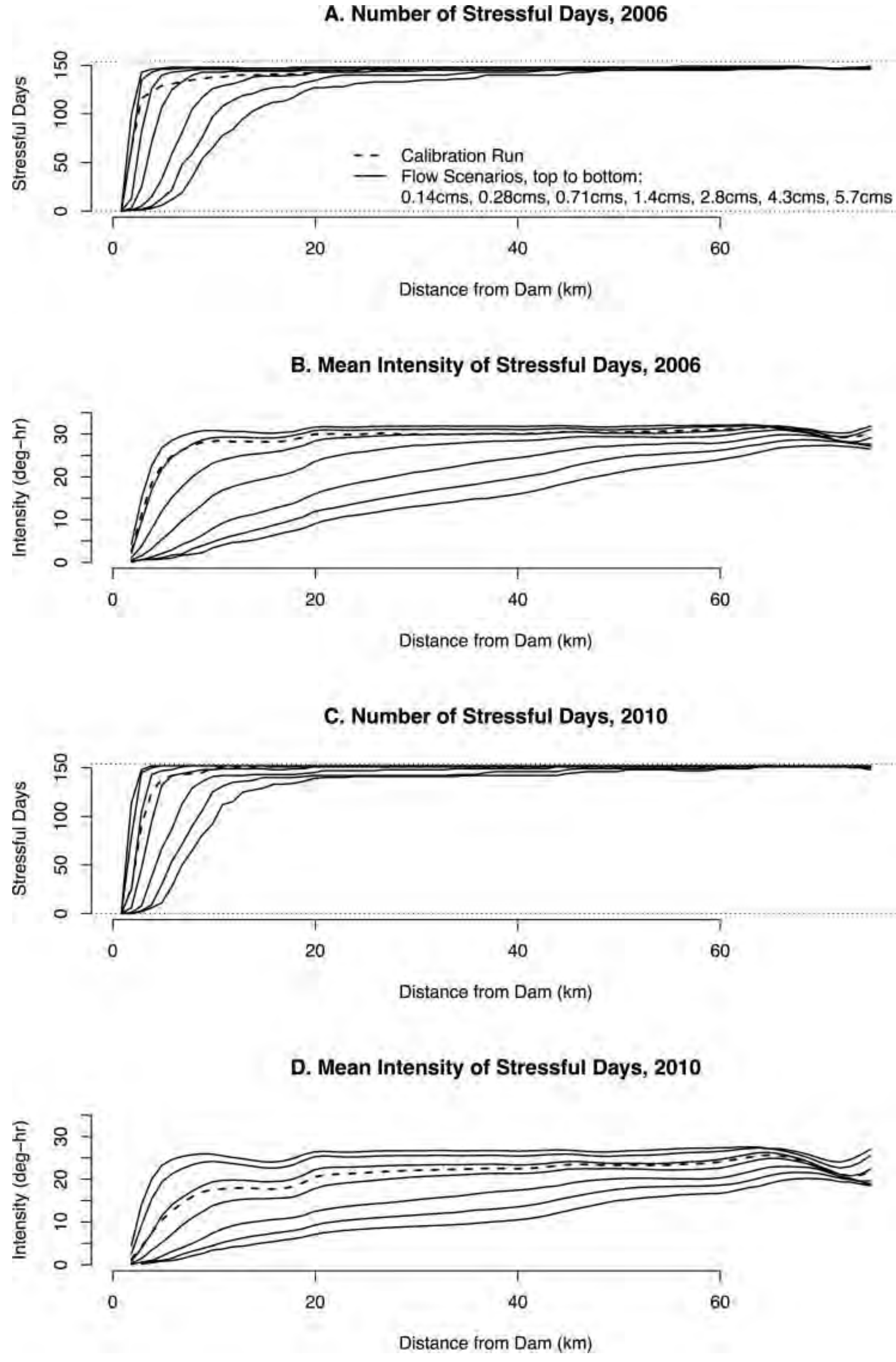

FIGURE 5. Number of days that were thermally stressful for steelhead and the mean stress intensity (degree-hours) under various simulated flow levels (cms = cubic meters per second) in the Santa Ynez River during the summer season (May 1–October 1).

typical smolting criterion throughout the entire river and regardless of flow scenario (Figure 6A, B). For other combinations (high food availability plus high smolting criterion; or low food availability plus typical smolting criterion), fish only reached smolting size near the dam (Figure 6A, C). The size of the potential nursery zone near the dam ranged from 3 to 20 km depending on the flow scenario examined (Figure 6A, C). If the high smolting criterion was used in combination with medium or low food availability, the first-summer pathway was not supported in any area of the river.

The year 2006, a hot year, had results similar to those for 2010 except that at intermediate food availability under the typical smolting criterion, the first-summer strategy was not supported throughout the entire river (Figure 6D). Instead, a nursery zone was present below the dam, and the size of the zone varied greatly (5–42 km) depending on the flow scenario. Very high flows (>4 m^3/s) were necessary to expand the nursery zone to a length greater than 20 km.

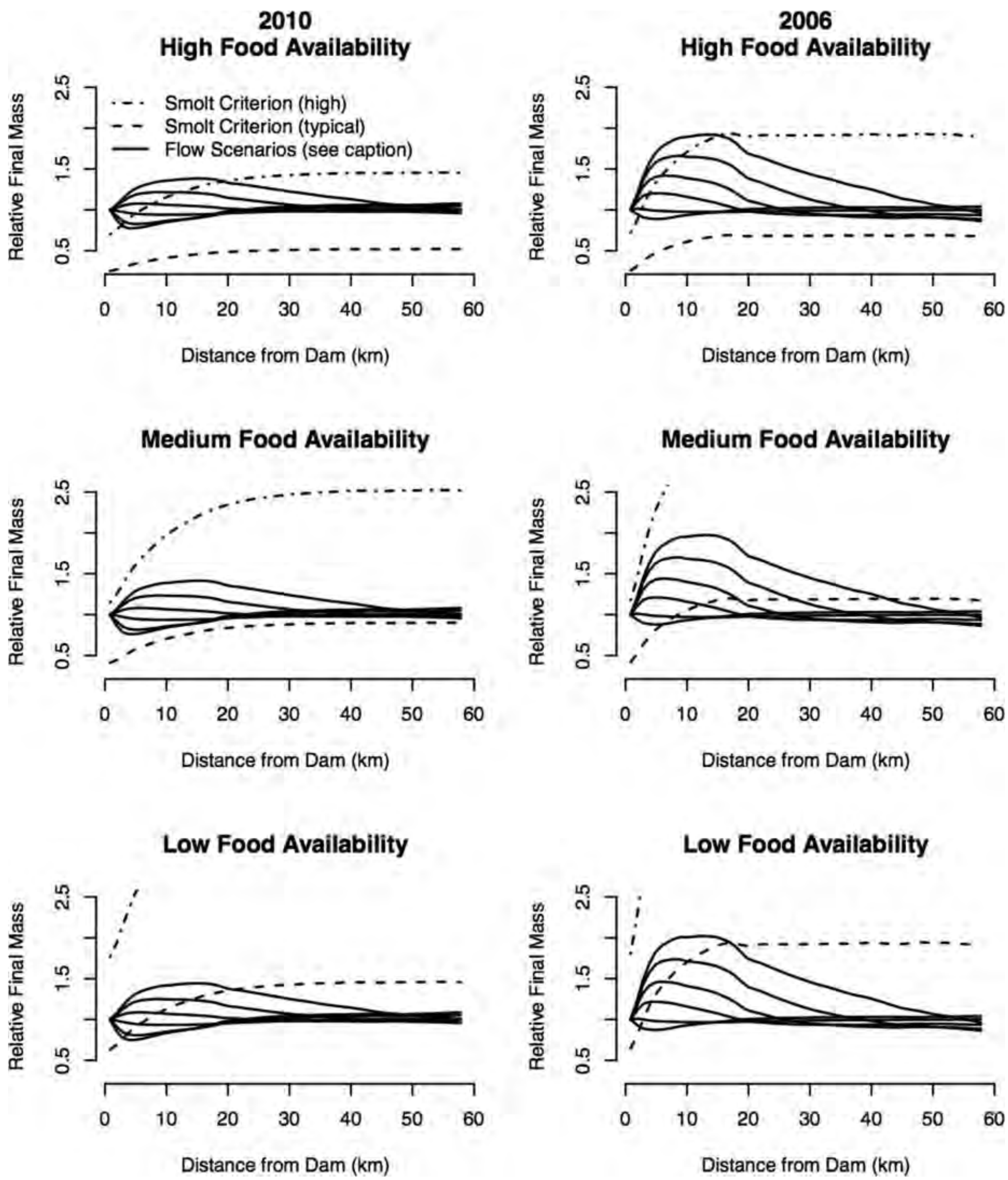

FIGURE 6. Relative final mass for age-0 steelhead on October 1 as modeled for various flow scenarios (solid lines), years (columns), and levels of food availability (rows) at locations downstream of Bradbury Dam on the Santa Ynez River. The "typical" smolt criterion describes the final mass on October 1 that is assumed necessary to trigger smolting and out-migration during the following spring, given typical winter growth conditions. The "high" smolt criterion conservatively assumes zero winter growth. Flow scenarios (lines from top to bottom) are 5.7, 4.3, 2.8, 1.4, 0.71, and 0.28 m^3/s.

Age-1 fish.—In 2010, the entire river could support the second-summer pathway under a typical smolting criterion, regardless of food availability (Figure 7A, C, E). Under the high smolting criterion, the area supporting the second-summer pathway was still the entire river if food availability was high (Figure 7A), but the area shrank to a flow-dependent zone near the dam if food availability was intermediate (Figure 7C). The year 2006 gave similar overall results except

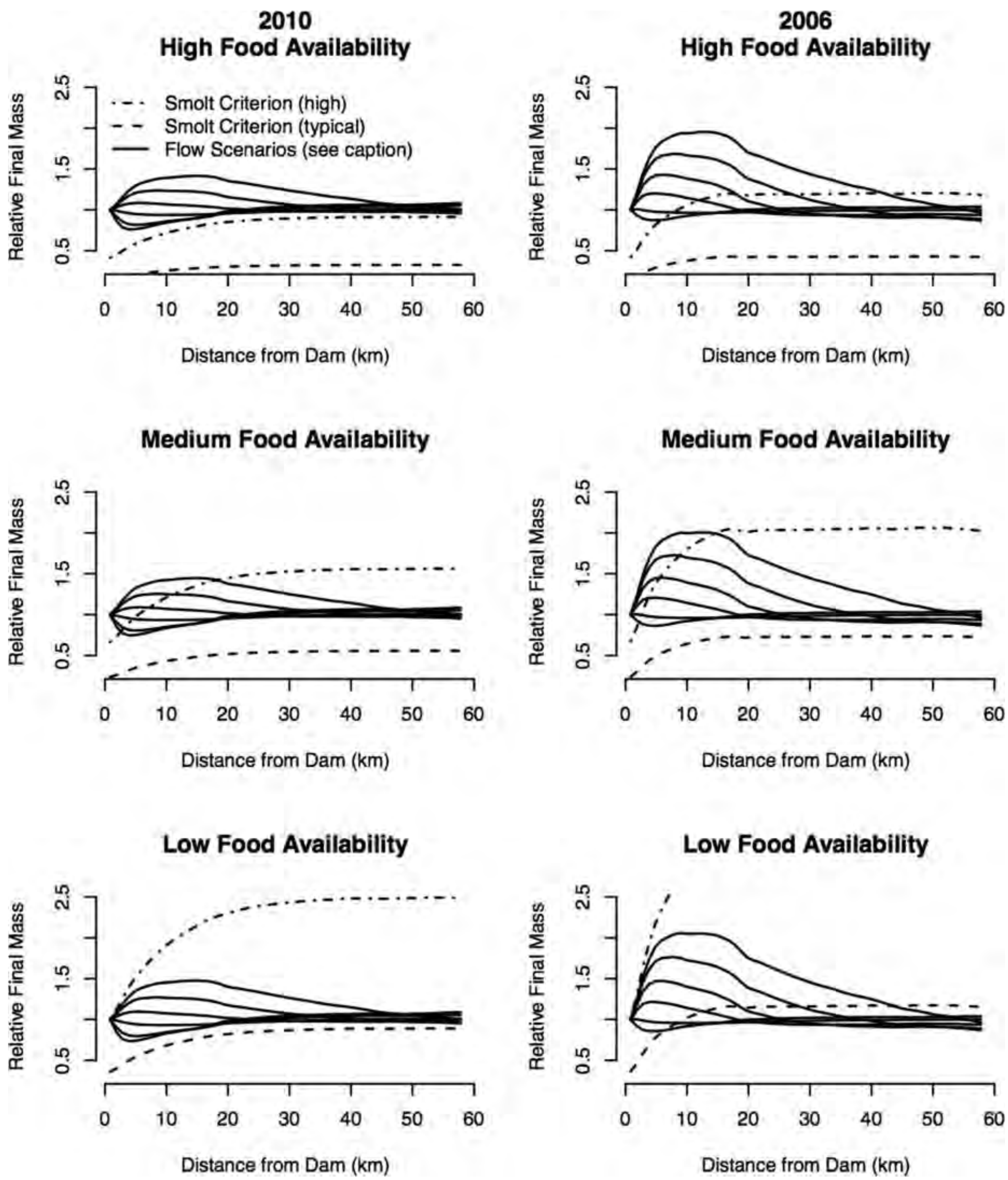

FIGURE 7. Relative final mass for age-1 steelhead on October 1 as modeled for various flow scenarios (solid lines), years (columns), and food availability (rows) at locations downstream of Bradbury Dam on the Santa Ynez River. The "typical" smolt criterion describes the final mass on October 1 that is assumed necessary to trigger smolting and out-migration during the following spring, given typical winter growth conditions. The "high" smolt criterion conservatively assumes zero winter growth. Flow scenarios (lines from top to bottom) are 5.7, 4.3, 2.8, 1.4, 0.71, and 0.28 m^3/s.

that reaches supporting a second-summer pathway shrank from the entire river to the zone below the dam for two scenarios: (1) high food availability plus the high smolting criterion (Figure 7B); and (2) low food availability plus the typical smolting criterion (Figure 7F). The size of the nursery zone generally ranged from 5 to 18 km depending on flow; however, for very high flows (>4 m^3/s), the zone could extend as far as 43 km downstream.

In no case did a flow scenario convert the entire river into potential nursery habitat—either the combination of year (meteorological conditions) and food availability produced riverwide nursery habitat or the flow scenarios created a nursery zone near the dam that disappeared downstream as the river reached thermal "quasi-equilibrium" with meteorological conditions. Only for flows greater than 4 m^3/s was the nursery zone ever longer than approximately 20 km.

Stratified Pools

Of the 14 pools that were successfully monitored, eight (~60%) were thermally stratified. Neither the bottom nor the main flow of any pool became thermally unsuitable for steelhead during the study, but water temperatures were often stressful. Mean daily stress intensity was consistently lower at the bottoms of stratified pools (Figure 8).

Only five of the pools were thermally stratified on the day of their fish survey; of these pools, three harbored juvenile *O. mykiss*, whereas only one of the nine unstratified pools harbored *O. mykiss* (one-tailed z-test: $P = 0.027$).

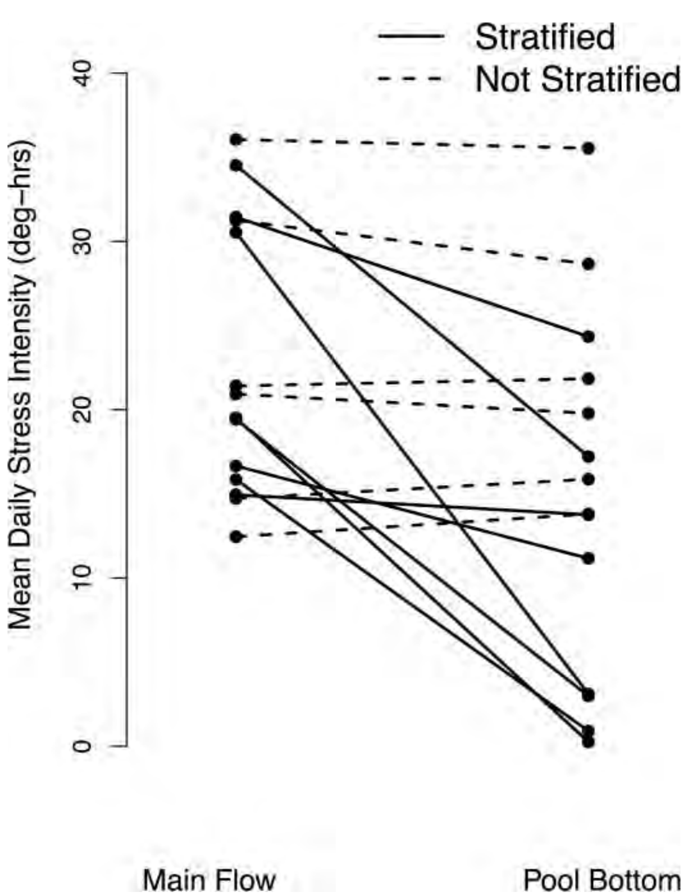

FIGURE 8. Mean daily intensity of thermal stress (degree-hours) for steelhead, as measured in the main flow and at the bottom of thermally stratified and unstratified pools in the Santa Ynez River during summer 2011.

DISCUSSION

Thermal Potential for Steelhead Life Histories

The simulations suggested that even during relatively hot summers, a coastal alluvial river in southern California was thermally suitable for juvenile steelhead. Nevertheless, nearly every summer day in both 2006 (the hot year) and 2010 (the average year) was thermally stressful throughout the Santa Ynez River, with stress intensity about 20% higher during 2006 than during 2010. Increasing the flow did not reduce the number of thermally stressful days except in an area just downstream of Bradbury Dam, but it did reduce the stress intensity throughout the entire river (Figure 5). Our data suggest that fish movement into stratified pools when temperatures exceed 21°C would tend to reduce stress intensity by an amount comparable to that achieved by increasing the flow (10–20 degree-hours/d; Figure 8). Presumably, this retreat to stratified pools would lower the rearing capacity for the river as a whole. However, juvenile steelhead appear to be able to use thermal refugia as a base from which to exploit the wider river during cool times of day (Brewitt and Danner 2014), so overall rearing capacity would be considerably larger than the pools themselves. Increasing the water releases from the dam might have additional benefits beyond stress reduction, such as increasing the river's capacity for first-summer life histories relative to second-summer life histories, thus supporting a greater life history diversity overall.

Predictions for potential steelhead nursery habitat can be summarized as follows. If the Santa Ynez River system supports typical winter growth, the second-summer pathway will be thermally available throughout the entire lower river but will be sensitive to climate if summer feeding opportunity is low. The first-summer pathway will also be thermally available but will become sensitive to climate when feeding opportunity is intermediate. In such situations, the pathways to anadromy can become thermally restricted to a tailwater zone below Bradbury Dam. On the other hand, if the river system produces neglible winter growth, then nursery habitat usually will be restricted to the tailwater or will be completely absent, depending on food availability.

In the simulations, flow scenarios did not determine whether the entire Santa Ynez River was nursery versus non-nursery habitat. Flow only altered the spatial extent of the tailwater zone when the river was otherwise physically unsuited to producing rapid growth of *O. mykiss*. Downstream of this zone, the river temperature became more equilibrated to local microclimate and riverbed conditions. Thus, temperature presumably became shaped much more by natural processes than by upstream dam releases and therefore was more similar to what would generally be considered an unimpaired thermal regime for this climate. In general, temperatures tended to stay above the range for maximum growth (15–17°C) but below the threshold for thermal exclusion (mean daily temperature <25°C, maximum temperature <29°C). Whether the river is thermally suitable for steelhead production (as opposed to producing *O. mykiss* that grow slowly and mature in freshwater) appears to depend more on annual weather than on flow, at least for the 2 years studied. This result accords with historical information for the late-19th and early 20th centuries, which suggests that annual runs of adult steelhead in the Santa Ynez River numbered in the thousands during some years and in the single digits during other years (Alagona et al. 2012).

Recent annual runs of steelhead in the Santa Ynez River have consistently stayed below approximately 10 fish since intensive monitoring began in the 1990s (Robinson et al. 2009). Our results suggest that water temperatures are not so high that they eliminate the potential for considerable smolt production; this indicates the existence of some other factor that keeps current steelhead production depressed relative to the production observed a century ago. Recent snorkel surveys conducted in the summer usually have found juvenile *O. mykiss* to be few and concentrated in stratified pools (Robinson et al. 2009), suggesting that very few fish currently pursue a first-summer or second-summer strategy in the lower main stem. The capacity for the second-summer pathway could also be limited by a lack of suitable upland creek habitat that can support successful spawning by anadromous *O. mykiss* and successful rearing of their progeny up to the second summer. Currently, most such habitat occurs upstream of the dam, where it is inaccessible to anadromous steelhead although commonly used by Rainbow Trout.

Exotic fish species almost certainly impact steelhead rearing in the Santa Ynez River. In particular, Largemouth Bass are quite abundant in the lower river (Robinson et al. 2009), occupy a thermal niche that broadly overlaps with the thermal niche of steelhead (Currie et al. 1998, 2004), and may both compete with and prey on juvenile steelhead (Hodgson et al. 1991; Christensen and Moore 2008, 2010; Braun and Walser 2011). Prior to the introduction of exotic fishes, southern California steelhead would have been the only medium-to-large bodied fish (>150 mm TL) feeding on invertebrates and other fishes in the Santa Ynez River and in nearby streams, where steelhead remain the only such fish and are observed to behave normally in water temperatures up to around 24°C (Spina 2007; Sloat and Osterback 2013). One explanation for the rarity of steelhead in the Santa Ynez River may be the competitive or predatory dominance of introduced fish (e.g., Largemouth Bass) that are adapted to the high end of the steelhead's thermal niche.

Shallow-River Heat Dynamics

Changing climate is generally expected to decrease summer flows relative to winter flows in western U.S. rivers that are occupied by Pacific salmonids; mechanisms include less water storage in deep soil, increased water demand by vegetation, greater surface evaporation, and especially the loss of snowpack (Mantua et al. 2010; Null et al. 2010). Although decreased summer flow affects heat fluxes by a variety of mechanisms, for simplicity these are often omitted from assessments (Mantua et al. 2010; Wenger et al. 2011; Benjamin et al. 2013). Instead, water temperature is assumed to track air temperature; this assumption relies on equilibrium assumptions that are only valid at relatively large flows and at a resolution of weekly (or coarser) average temperature (Bogan et al. 2003). Finer-grained temperature patterns, such as daily maximum temperature or degree-hours above some temperature threshold, are often biologically important but are poorly predicted by equilibrium assumptions. For example, Caissie et al. (2001) used statistical techniques to predict maximum daily creek temperature from air temperature and found that the empirical coefficient linking stream temperature and air temperature varied seasonally and was not independent of flow within seasons.

In general, subdaily temperature patterns should be sensitive to flow because for a given channel geometry and microclimate, flow establishes the scaling between heat fluxes and the thermal mass, or responsiveness, of the stream. Heat fluxes tend to scale to areas (surface area, streambed area, and cross-sectional area), whereas thermal mass, which describes the temperature response to a given flux, scales to water volume. In contrast to deep rivers, such as those fed by snowmelt, a wide, shallow river like the Santa Ynez River will have a cross-sectional area and volume that are quite small relative to horizontal surface areas; thus, longitudinal flux and thermal mass will be small relative to vertical energy fluxes. Longitudinal heat flux is reduced even further by slow water velocities in shallow rivers due to a greater effect of bed roughness. This situation would tend to decouple a shallow river from upstream conditions and raise the river's responsiveness to vertical heat exchange with the immediate riverbed and atmosphere. Since thermal mass acts as a sort of "smoother" on the temperature response, a RAFT hindcast for a shallow river such as the Santa Ynez River should involve greater error than a hindcast for a deeper river with a relatively high thermal mass; indeed, this is what we observed (RMSE = 1.5°C for the Santa Ynez River, whereas RMSE = 0.5°C for the Sacramento River; Pike et al. 2013).

Our results suggest that when the thermal mass of the water itself becomes small relative to vertical heat flux, the thermal mass of the riverbed becomes an important smoother of subdaily fluctuations. In the RAFT model, heat exchange between water and bed passively follows thermal gradients and thus reduces the temperature response to the diurnal fluctuations in atmospheric heat fluxes. When we conducted RAFT simulations with the streambed flux turned off (results not reported here), we found that this mechanism was essential to accurately hindcasting the temperatures of the lower Santa Ynez River. In our results, each doubling (or halving) of flow changed the maximum daily temperature by less than 1°C in most of the river (Figure 4), suggesting that a large amount of water must be released to add enough thermal mass to significantly augment what the riverbed already provides. In general, heat exchanges between rivers and their beds are often highly heterogeneous due to various mechanisms (Constantz 1998; Arscott et al. 2001; Arrigoni et al. 2008; Burkholder et al. 2008; Westhoff et al. 2010; Boughton et al. 2012). Anticipation of such heterogeneity may be important in identifying rivers with greater thermal resilience to the loss of summer flow, which is expected to result from climate change.

In our case study, changes in flow altered summer thermal habitat in the Santa Ynez River by two mechanisms: (1) the release of water that was out of thermal equilibrium with the local climate directly downstream of the dam; and (2) modulation of the mean depth—and thus thermal mass—of the entire river. Mechanism 1 produced a zone near the dam that functioned as a heat sink, with thermal properties that attenuated rapidly downstream, whereas mechanism 2 produced a heat buffer throughout the river. Steelhead indices that were sensitive to fine-grained fluctuations in temperature (e.g., stress intensity) responded to flow scenarios throughout the entire river (Figure 5). In contrast, the indices that integrated temperature effects over multiple days (e.g., potential growth) only responded strongly to flow scenarios within 20 km of Bradbury Dam (Figures 6, 7) or to extremely high-flow scenarios (>2.8 m^3/s [>100 ft^3/s]) that would probably not be characteristic of the river if the dam was absent. By decreasing upstream temperature, increasing mean depth, and raising water velocities, large enough summer releases from the dam might expand steelhead life history diversity in the Santa Ynez River, especially by enabling more steelhead to pursue a first-summer pathway, although it remains unclear whether this first-summer expression would be characteristic of the river in the absence of dams.

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From: Staples, Rose
Sent: Tuesday, November 08, 2016 3:21 PM
Cc: Deason, Jesse; Le, Bao; Staples, Rose
Subject: La Grange Fall 2016 Licensing Newsletter Uploaded to Website

La Grange Licensing Participants,

The newest issue of the La Grange Licensing Newsletter has been uploaded to the La Grange licensing website (www.lagrange-licensing.com) in the DOCUMENTS section.

Rose Staples, CAP-OM, MOS
Executive Assistant

HDR
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Portland ME 04103
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rose.staples@hdrinc.com

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From: Staples, Rose
Sent: Tuesday, November 08, 2016 3:12 PM
Cc: Deason, Jesse; Le, Bao; Staples, Rose
Subject: FW: Temp Criteria Subcommittee - Final Notes for Sept 15 conference call

La Grange Licensing Participants,

The following message regarding the release of the final meeting notes for the Temperature Criteria Subcommittee September 15, 2016 conference call was sent to the subcommittee members today.

Rose Staples, CAP-OM, MOS
D 207-239-3857

hdrinc.com/follow-us

From: Staples, Rose
Sent: Tuesday, November 8, 2016 6:05 PM
Cc: Deason, Jesse <jesse.deason@hdrinc.com>; 'Le, Bao' <Bao.Le@hdrinc.com>; Staples, Rose (Rose.Staples@hdrinc.com) <Rose.Staples@hdrinc.com>
Subject: Temp Criteria Subcommittee - Final Notes for Sept 15 conference call

Temperature Criteria Subcommittee members,

The FINAL notes from the September 15, 2016 Water Temperature Criteria Subcommittee conference call have been uploaded to the licensing website www.lagrange-licensing.com under the DOCUMENTS section and also as an attachment to the September 15, 2016 date on the website calendar.

On October 3, 2016 the Districts provided the draft meeting notes to licensing participants and requested that any comments on the meeting notes be provided by November 2. One comment was received regarding the misspelling of an individual's last name. The notes were revised to correct this misspelling. No other comments were received.

Thank you.

Rose Staples, CAP-OM, MOS
Executive Assistant

HDR
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MEMORANDUM SUMMARIZING SITE VISIT

Topic	Site visit to the La Grange Project and the Don Pedro Project
Date	November 8, 2016
Attendees	1. Steve Boyd (Turlock Irrigation District) 2. Anna Brathwaite (Modesto Irrigation District) 3. Jean Castillo (National Marine Fisheries Service) 4. Keith Kirkendall (National Marine Fisheries Service)
Summary of Discussion	Meeting attendees visited Don Pedro Recreation headquarters, the La Grange Project, Don Pedro Dam, Blue Oaks Recreation Area, Fleming Meadows Recreation Area, Moccasin Point Recreation Area, Jacksonville Bridge, and Wards Ferry. Meeting attendees discussed the history of the Turlock Irrigation District, Modesto Irrigation District, and the City and County of San Francisco, Don Pedro and La Grange operations, past work on the Tuolumne River, the Don Pedro Hydroelectric Project relicensing proceeding, the La Grange Hydroelectric Project licensing proceeding, studies completed for the Don Pedro relicensing proceeding, and the physical challenges of building fish passage facilities at La Grange and Don Pedro.

From: Jason Guignard [mailto:jasonguignard@fishbio.com]
Sent: Wednesday, November 09, 2016 3:53 PM
To: Steve Tsao
Cc: Murphey, Gretchen@Wildlife; Chris Becker; Le, Bao
Subject: Re: La Grange Weir Stacking Survey

We only kept the heads, but have photos of fish prior to processing. One of the fish was ad-clipped. Would you like us to keep full fish in the future?

> On Nov 9, 2016, at 3:40 PM, Tsao, Steve@Wildlife <Steve.Tsao@wildlife.ca.gov> wrote:
>
> Jason,
>
> Did you retain the whole fish or just the heads? If just the heads I would assume they were ad/clipped.
>
> **From:** Jason Guignard [mailto:jasonguignard@fishbio.com]
> **Sent:** Wednesday, November 09, 2016 3:33 PM
> **To:** Tsao, Steve@Wildlife; Murphey, Gretchen@Wildlife
> **Cc:** Chris Becker; Bao Le
> **Subject:** Re: La Grange Weir Stacking Survey
>
> Steve,
>
> Not sure if you noticed, but we also saw 2 carcasses above the tailrace weir on Monday. We were able to recover both carcasses today, and they were both unspawned females. We removed the heads from both fish, and they are in the freezer along with samples from the other weir locations that we are saving for you.
>
> There were ~35 fish above the weir again this morning, but all fish moved downstream of the weir when the crew entered water to remove the carcasses. Will keep you updated on fish counts above the weir at the end of this week.
>
> Jason Guignard
> Fisheries Biologist
>
> ***FISHBIO***
> jasonguignard@fishbio.com
> O: (209) 847-6300
> C: (209) 840-9019
> www.fishbio.com

On Nov 8, 2016, at 3:45 PM, Tsao, Steve@Wildlife
<Steve.Tsao@wildlife.ca.gov> wrote:

Jason,

It sounds like that you are aware of the issue and on top of it. Let's keep talking to each other about this in the next two weeks. As the situation escalated, like more than 30 fish are observed upstream of the weir three days in a row, then we will talk about making the weir more passable for fish.

Steve

From: Jason Guignard [mailto:jasonguignard@fishbio.com]
Sent: Tuesday, November 08, 2016 3:26 PM
To: Tsao, Steve@Wildlife
Cc: Chris Becker; Murphey, Gretchen@Wildlife
Subject: Re: La Grange Weir Stacking Survey

Hi Steve,

We have been seeing a large number of salmon upstream of the tailrace weir. This is something we did not see last year, but likely do to the higher escapement numbers this season.
However I do not feel that the weir is causing this stacking. A quick review of video files from the past few days showed that fish are actively moving upstream and downstream through the passing chute. With this being the peak of the run these fish may just be schooling up, and will hopefully move back downstream to spawn

Do you have any recommendations on how we could address this apparent "stacking" issue. Would you like us to remove a portion of the weir, or should we just continue to monitor and re-assess later this week or next week?

Jason Guignard
Fisheries Biologist

FISHBIO
jasonguignard@fishbio.com
O: (209) 847-6300
C: (209) 840-9019
www.fishbio.com

> On Nov 8, 2016, at 2:45 PM, Tsao, Steve@Wildlife
> <Steve.Tsao@wildlife.ca.gov> wrote:
>
> Chris,
>
> With large number of salmon moving into Tuolumne River now, and seeing increasing number of salmon hanging/observing upstream of the La Grange weir (>30). Do you have any method or respond plan to deal with seeing more than 30 fish on either side of the weir structure?
>
> Steve

From: Chris Becker [mailto:chrisbecker@fishbio.com]
Sent: Tuesday, November 08, 2016 1:33 PM
To: Tsao, Steve@Wildlife; Murphey, Gretchen@Wildlife
Cc: guignard, jason@fishbio.com
Subject: La Grange Weir Stacking Survey

Hey Steve and Gretchen,
Here is the update for the stacking survey at the La Grange weir.
Thanks,
Chris

Chris Becker
Fisheries Biologist

FISHBIO
chrisbecker@fishbio.com
(209) 847-6300
www.fishbio.com

From: Staples, Rose
Sent: Friday, November 11, 2016 10:35 AM
Cc: Deason, Jesse; Le, Bao; Staples, Rose
Subject: FW: La Grange Temp Criteria and Reintro Goals Subcommittees Next Meeting - Proposing Dec 1 2016

La Grange participants,

The following message was sent today to the members of the Temperature Criteria Subcommittee and the Reintroduction Goals Subcommittee regarding the cancellation of the Temp Criteria November 18 meeting—and the proposed new combined in-person meeting on December 1.

Rose Staples, CAP-OM, MOS
D 207-239-3857

hdrinc.com/follow-us

From: Staples, Rose
Sent: Friday, November 11, 2016 1:11 PM
Cc: Deason, Jesse <jesse.deason@hdrinc.com>; 'Le, Bao' <Bao.Le@hdrinc.com>; Staples, Rose (Rose.Staples@hdrinc.com) <Rose.Staples@hdrinc.com>
Subject: La Grange Temp Criteria and Reintro Goals Subcommittees Next Meeting - Proposing Dec 1 2016

La Grange Temperature Criteria Subcommittee and Reintroduction Goals Subcommittee members,

Due to schedule conflicts, the November 18, 2016 Temperature Criteria Subcommittee meeting has been cancelled.

The Reintroduction Goals Subcommittee Doodle Poll has closed and the afternoon of December 1, 2016 is a date with high availability.

Given the overlap in participants and to be more efficient, the Districts would like to propose using the afternoon (likely 1:00 pm – 4:00 pm) of December 1 to have a ***combined, in-person*** meeting with both the Temperature Criteria and Reintroduction Goals subcommittees.

Please let me (rose.staples@hdrinc.com) know by November 18 if there are any concerns with this.

Thank you.

Rose Staples, CAP-OM, MOS
Executive Assistant

HDR
970 Baxter Boulevard Suite 301
Portland ME 04103
D 207-239-3857
rose.staples@hdrinc.com

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From: Le, Bao
Sent: Monday, November 14, 2016 11:18 AM
To: John Wooster - NOAA Federal; Staples, Rose
Cc: Deason, Jesse
Subject: RE: La Grange Temp Criteria and Reintro Goals Subcommittees Next Meeting - Proposing Dec 1 2016

Hi John.

Currently, the plan is to have it in Modesto.

Thanks, Bao

From: John Wooster - NOAA Federal [mailto:john.wooster@noaa.gov]
Sent: Monday, November 14, 2016 10:59 AM
To: Staples, Rose
Cc: Deason, Jesse; Le, Bao
Subject: Re: La Grange Temp Criteria and Reintro Goals Subcommittees Next Meeting - Proposing Dec 1 2016

Do you know where the meeting will be?

-JW

On Fri, Nov 11, 2016 at 10:11 AM, Staples, Rose <Rose.Staples@hdrinc.com> wrote:

La Grange Temperature Criteria Subcommittee and Reintroduction Goals Subcommittee members,

Due to schedule conflicts, the November 18, 2016 Temperature Criteria Subcommittee meeting has been cancelled.

The Reintroduction Goals Subcommittee Doodle Poll has closed and the afternoon of December 1, 2016 is a date with high availability.

Given the overlap in participants and to be more efficient, the Districts would like to propose using the afternoon (likely 1:00 pm – 4:00 pm) of December 1 to have a ***combined, in-person*** meeting with both the Temperature Criteria and Reintroduction Goals subcommittees.

Please let me (rose.staples@hdrinc.com) know by November 18 if there are any concerns with this.

Thank you.

Rose Staples, CAP-OM, MOS

Executive Assistant

HDR

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--
John Wooster
Hydrologist
NOAA Fisheries West Coast Region
U.S. Department of Commerce
john.wooster@noaa.gov

NOAA FISHERIES
West Coast Region

From: Jean Castillo - NOAA Federal [mailto:jean.castillo@noaa.gov]
Sent: Monday, November 14, 2016 9:19 AM
To: Steve Boyd
Cc: Le, Bao; Anna Brathwaite (Anna.Brathwaite@mid.org); Keith Kirkendall - NOAA Federal
Subject: Thank You

Good Morning Steve,

I wanted to take a moment and thank you for the great project tour last week. It was very generous of you to take time out of your busy schedule to acclimate Keith and I to the area and the project. The narrative you provided touched on the topics I was interested in covering so I could better understand the intricacies of the water delivery system.

The trip to the "painted bridge" was quite valuable and enlightened me on some of the considerations that will be required as we move forward with the project.

I am glad to be able to put a face to the voice I hear during the phone conferences.

Take care and thank you again,

Jean

Jean M. Castillo, MSCE, P.E.
Hydraulic/Fish Passage Engineer

NOAA Fisheries West Coast Region
U.S. Department of Commerce
650 Capitol Mall, Suite 5-100
Sacramento, California 95814-4700
Office: 916-930-3613
jean.castillo@noaa.gov

From: Staples, Rose
Sent: Tuesday, November 15, 2016 7:30 AM
To: John Wooster - NOAA Federal
Cc: Deason, Jesse; Le, Bao
Subject: RE: La Grange Temp Criteria and Reintro Goals Subcommittees Next Meeting - Proposing Dec 1 2016

Thanks for asking; it is likely that if the meeting is held in-person, it would be in Modesto.

Rose Staples, CAP-OM, MOS
D 207-239-3857

hdrinc.com/follow-us

From: John Wooster - NOAA Federal [mailto:john.wooster@noaa.gov]
Sent: Monday, November 14, 2016 1:59 PM
To: Staples, Rose <Rose.Staples@hdrinc.com>
Cc: Deason, Jesse <Jesse.Deason@hdrinc.com>; Le, Bao <ChiBao.Le@hdrinc.com>
Subject: Re: La Grange Temp Criteria and Reintro Goals Subcommittees Next Meeting - Proposing Dec 1 2016

Do you know where the meeting will be?

-JW

On Fri, Nov 11, 2016 at 10:11 AM, Staples, Rose <Rose.Staples@hdrinc.com> wrote:

La Grange Temperature Criteria Subcommittee and Reintroduction Goals Subcommittee members,

Due to schedule conflicts, the November 18, 2016 Temperature Criteria Subcommittee meeting has been cancelled.

The Reintroduction Goals Subcommittee Doodle Poll has closed and the afternoon of December 1, 2016 is a date with high availability.

Given the overlap in participants and to be more efficient, the Districts would like to propose using the afternoon (likely 1:00 pm – 4:00 pm) of December 1 to have a ***combined, in-person*** meeting with both the Temperature Criteria and Reintroduction Goals subcommittees.

Please let me (rose.staples@hdrinc.com) know by November 18 if there are any concerns with this.

Thank you.

Rose Staples, CAP-OM, MOS

Executive Assistant

HDR

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--
John Wooster
Hydrologist
NOAA Fisheries West Coast Region
U.S. Department of Commerce
john.wooster@noaa.gov

From: Staples, Rose
Sent: Thursday, November 17, 2016 5:02 PM
Cc: Deason, Jesse; Le, Bao; Staples, Rose
Subject: Districts File with FERC Today Current Status La Grange Reservoir Transit Study

La Grange Licensing Participants,

The Districts filed a letter with FERC today regarding the status of the Reservoir Transit Study. A copy of this filing is available in the DOCUMENTS section of the La Grange licensing website at www.lagrange-licensing.com and should be available in FERC's E-Library (www.FERC.gov) later tomorrow.

Rose Staples, CAP-OM, MOS
Executive Assistant

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From: Le, Bao
Sent: Saturday, November 19, 2016 10:39 AM
To: John Wooster - NOAA Federal
Cc: Deason, Jesse; Borovansky, Jenna
Subject: La Grange Updated Study Report - NMFS Studies

Hi John.

Similar to the Initial Study Report, the Updated Study Report (USR) will report upon the NMFS studies (habitat and genetics) since they are items that would inform the licensing process as cited in the Revised Study Plan. I've not touched base with you on the progress of these studies but given USR reporting is fast approaching I wanted to touch base on these studies. Are there progress or interim reports that can be shared as part of the USR? Or are you able to provide status updates on these studies (i.e., a few paragraphs describing objective, methods, field work, any preliminary analysis, and completion schedule)? Any of this would be really useful information to include in the USR.

Thanks,
Bao

Bao Le
Senior Fisheries Biologist

HDR
1001 SW 5th Avenue, Suite 1800
Portland, OR 97204-1134
Note new direct line:**D** 503.423.3828 **M** 503.309.9423
bao.le@hdrinc.com

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From: Staples, Rose
Sent: Monday, November 21, 2016 3:02 PM
Cc: Deason, Jesse; Le, Bao; Staples, Rose
Subject: FW: Count for December 1 2016 La Grange Afternoon Joint Subcommittees Meeting in Modesto

La Grange Licensing Participants,

The message below regarding participation in the Reintroduction Goals and Temperature Criteria Subcommittees joint meeting Friday afternoon, December 1, 2016 in Modesto was sent to all subcommittee members today.

Rose Staples, CAP-OM, MOS
D 207-239-3857

hdrinc.com/follow-us

From: Staples, Rose
Sent: Monday, November 21, 2016 5:58 PM
Cc: Deason, Jesse <jesse.deason@hdrinc.com>; 'Le, Bao' <Bao.Le@hdrinc.com>; Staples, Rose (Rose.Staples@hdrinc.com) <Rose.Staples@hdrinc.com>
Subject: Count for December 1 2016 La Grange Afternoon Joint Subcommittees Meeting in Modesto

Reintroduction Goals and Temperature Criteria subcommittees members,

For space planning purposes, could you please confirm with me at rose.staples@hdrinc.com by Wednesday, November 23, 2016, if you will attend the in-person meeting of the joint subcommittees on Thursday, December 1, 2016 (1:00 – 4:00 pm) in Modesto. Thank you.

Rose Staples, CAP-OM, MOS
Executive Assistant

HDR
970 Baxter Boulevard Suite 301
Portland ME 04103
D 207-239-3857
rose.staples@hdrinc.com

hdrinc.com/follow-us

From: Jean Castillo - NOAA Federal <jean.castillo@noaa.gov>
Sent: Monday, November 21, 2016 3:23 PM
To: Staples, Rose
Cc: Deason, Jesse; Le, Bao
Subject: Re: Count for December 1 2016 La Grange Afternoon Joint Subcommittees Meeting in Modesto

Hi Rose,

Yes, I will be attending the meeting in person. When you have a minute can you please send me the address.

Regards,
Jean

Jean M. Castillo, MSCE, P.E.
Hydraulic/Fish Passage Engineer

NOAA Fisheries West Coast Region
U.S. Department of Commerce
650 Capitol Mall, Suite 5-100
Sacramento, California 95814-4700
Office: 916-930-3613
jean.castillo@noaa.gov

On Mon, Nov 21, 2016 at 2:57 PM, Staples, Rose <Rose.Staples@hdrinc.com> wrote:

Reintroduction Goals and Temperature Criteria subcommittees members,

For space planning purposes, could you please confirm with me at rose.staples@hdrinc.com by Wednesday, November 23, 2016, if you will attend the in-person meeting of the joint subcommittees on Thursday, December 1, 2016 (1:00 – 4:00 pm) in Modesto. Thank you.

Rose Staples, CAP-OM, MOS

Executive Assistant

HDR

970 Baxter Boulevard Suite 301
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D 207-239-3857
rose.staples@hdrinc.com

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From: Jackson, Zachary <zachary_jackson@fws.gov>
Sent: Friday, November 25, 2016 10:39 AM
To: Staples, Rose
Cc: Deason, Jesse; Le, Bao
Subject: Re: FW: Count for December 1 2016 La Grange Afternoon Joint Subcommittees Meeting in Modesto

Rose,

I would attend in person if there is adequate space.

Thanks,

Zac Jackson
Anadromous Fish Restoration Program
Lodi Fish and Wildlife Office
850 S Guild Ave., Suite 105
Lodi, CA 95240
Tel (209) 334-2968 x 408, Cell (209) 403-1457, Fax (209) 334-2171

On Mon, Nov 21, 2016 at 3:02 PM, Staples, Rose <Rose.Staples@hdrinc.com> wrote:

La Grange Licensing Participants,

The message below regarding participation in the Reintroduction Goals and Temperature Criteria Subcommittees joint meeting Friday afternoon, December 1, 2016 in Modesto was sent to all subcommittee members today.

Rose Staples, CAP-OM, MOS

D 207-239-3857

hdrinc.com/follow-us

From: Staples, Rose
Sent: Monday, November 21, 2016 5:58 PM
Cc: Deason, Jesse <jesse.deason@hdrinc.com>; 'Le, Bao' <Bao.Le@hdrinc.com>; Staples, Rose (Rose.Staples@hdrinc.com) <Rose.Staples@hdrinc.com>
Subject: Count for December 1 2016 La Grange Afternoon Joint Subcommittees Meeting in Modesto

Reintroduction Goals and Temperature Criteria subcommittees members,

For space planning purposes, could you please confirm with me at rose.staples@hdrinc.com by Wednesday, November 23, 2016, if you will attend the in-person meeting of the joint subcommittees on Thursday, December 1, 2016 (1:00 – 4:00 pm) in Modesto. Thank you.

Rose Staples, CAP-OM, MOS

Executive Assistant

HDR

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rose.staples@hdrinc.com

hdrinc.com/follow-us

From: Staples, Rose
Sent: Monday, November 28, 2016 3:32 PM
Cc: Deason, Jesse; Le, Bao; Staples, Rose
Subject: FW: La Grange Subcommittees Joint In-Person Meeting will be held at MID Offices on December 1, 2016

FYI that the following message was sent today to the members of the La Grange Water Temperature and Reintroduction Goals subcommittees confirming Thursday afternoon's joint in-person meeting at the MID offices in Modesto.

Rose Staples, CAP-OM, MOS
D 207-239-3857

hdrinc.com/follow-us

From: Staples, Rose
Sent: Monday, November 28, 2016 6:24 PM
Cc: Deason, Jesse <jesse.deason@hdrinc.com>; 'Le, Bao' <Bao.Le@hdrinc.com>; Staples, Rose (Rose.Staples@hdrinc.com) <Rose.Staples@hdrinc.com>
Subject: La Grange Subcommittees Joint In-Person Meeting will be held at MID Offices on December 1, 2016

The joint **in-person** meeting of the La Grange Water Temperature and Reintroduction Goals Subcommittees will be held at the MID offices in Modesto (1231 11th Street) on Thursday, December 1, 2016 from 1:00 to 4:00 p.m. Materials for use at the meeting will be made available on Tuesday, November 29, 2016.

Rose Staples, CAP-OM, MOS
Executive Assistant

HDR
970 Baxter Boulevard Suite 301
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D 207-239-3857
rose.staples@hdrinc.com

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From: Le, Bao
Sent: Monday, November 28, 2016 1:23 PM
To: John Wooster - NOAA Federal
Cc: Deason, Jesse
Subject: RE: Change in Due Date for Comments on the Temp Criteria Subcommittee Oct 14 Conf Call Draft Notes

Thanks, John.

It's probably easiest just to forward along your email with the attachment. It'd be great if you could be ready to discuss/explain on Thursday.

Bao

From: John Wooster - NOAA Federal [mailto:john.wooster@noaa.gov]
Sent: Monday, November 28, 2016 1:15 PM
To: Le, Bao
Cc: Deason, Jesse
Subject: Re: Change in Due Date for Comments on the Temp Criteria Subcommittee Oct 14 Conf Call Draft Notes

Either way works for me, if you want to just do the paper, I can attempt to explain on Thursday as well.

-JW

On Mon, Nov 28, 2016 at 1:03 PM, Le, Bao <ChiBao.Le@hdrinc.com> wrote:

Hi John.

In advanced of this Thursday's meeting, we wanted to send out the information that you have provided below. Do you have a preference as to whether we just forward along this email (with attachment) or whether we just send the attachment to subcommittee members? Please advise as soon as possible.

Thanks, Bao

From: John Wooster - NOAA Federal [mailto:john.wooster@noaa.gov]
Sent: Monday, November 07, 2016 4:16 PM
To: Le, Bao
Cc: Deason, Jesse; Staples, Rose; Steve Edmondson; Jean Castillo - NOAA Federal
Subject: Re: Change in Due Date for Comments on the Temp Criteria Subcommittee Oct 14 Conf Call Draft Notes

Bao:

I think an important component for the temperature sub-group is to understand how the NMFS Science Center will treat the topic of thermal suitability in modeling habitat capacity in their study of the Upper Tuolumne watershed. Their approach for O.mykiss is currently likely to follow the approach used in this 2015 Boughton et al. paper that I am attaching to this email – with emphasis on the *Thermal Indicators of habitat suitability* section on pdf page 263. The Science Center has another technical memo in draft form that provides greater detail for this approach and the rationale / data behind it– once that memo is finalized I can pass it along too. The spring-run Chinook approach for the Tuolumne is still under development, although likely to follow a similar mechanistic/bio-energetic approach but maybe some adjustment to the temperature thresholds.

In short, they will not be taking a relatively simplistic approach of selecting one temperature metric and deciding if a reach is "suitable" or "not". For O.mykiss, if a given day has a maximum temp >29C or average daily temp >25C then it is not suitable. Temperatures in the 21 to 25C range are considered stressful. What impacts those stressful temperatures have and whether the O.mykiss can utilize the habitat depends on several factors, including but not limited to: thermal refugia (e.g., stratified deep pools), food availability, growth potential, level of stress (e.g., function of the degrees above 20C and for how many hours), etc…

I also inquired about other useful references towards temperature and steelhead and the lab recommended these papers (in addition to the one I am attaching):

Rodnick, K. J., A. K. Gamperl, K. R. Lizars, M. T. Bennett, R. N. Rausch, and E. R. Keeley. 2004. Thermal tolerance and metabolic physiology among Redband Trout populations in southeastern Oregon. Journal of Fish Biology 64:310–335.

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Zoellick, B. W. 1999. Stream temperatures and the elevational distribution of Redband Trout in southwestern Idaho. Great Basin Naturalist 59:136–143.

Regards,

John

On Mon, Oct 31, 2016 at 4:40 PM, Staples, Rose <Rose.Staples@hdrinc.com> wrote:

Please note correction in the date to provide comments on the draft meeting notes—it is Wednesday, November 30th. Thank you.

Temperature Criteria Subcommittee,

DRAFT NOTES from the October 14, 2016 Water Temperature Criteria Subcommittee call have been uploaded to the licensing website www.lagrange-licensing.com in the DOCUMENTS section and also as an attachment to the October 14, 2016 date on the website calendar.

Please provide any comments on the meeting notes by Monday, November 28, 2016 Wednesday, November 30, 2016 to rose.staples@hdrinc.com. The Districts will incorporate any comments received and then post a final version of the meeting notes to the licensing website.

In addition, this email will be forwarded to the La Grange Project licensing email list stating that the draft meeting notes are available online.

If you have any difficulties locating and/or accessing the document, please let me know.

As a reminder, please provide any comments on the updated literature review and glossary of terms to rose.staples@hdrinc.com by November 1, 2016.

Thank you.

Rose Staples, CAP-OM, MOS

Executive Assistant

HDR

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--

John Wooster
Hydrologist
NOAA Fisheries West Coast Region
U.S. Department of Commerce
john.wooster@noaa.gov

NOAA FISHERIES
West Coast Region

From: Deason, Jesse
Sent: Monday, November 28, 2016 1:30 PM
To: 'John Wooster - NOAA Federal'
Cc: Le, Bao; Borovansky, Jenna
Subject: RE: La Grange Updated Study Report - NMFS Studies

Thanks John, will do.

Jesse Deason
D 206.826.4744 M 781.249.2452

hdrinc.com/follow-us

From: John Wooster - NOAA Federal [mailto:john.wooster@noaa.gov]
Sent: Monday, November 28, 2016 1:29 PM
To: Deason, Jesse
Cc: Le, Bao; Borovansky, Jenna
Subject: Re: La Grange Updated Study Report - NMFS Studies

Sounds good, a reminder about a week out wouldn't be the worst idea...

-JW

On Mon, Nov 28, 2016 at 1:26 PM, Deason, Jesse <Jesse.Deason@hdrinc.com> wrote:

Hi John,

Given that USR is due to FERC by February 1, if we could get your input by the mid-January (say by Friday, January 13), it would be much appreciated.

Jesse Deason

D 206.826.4744 M 781.249.2452

hdrinc.com/follow-us

From: Le, Bao
Sent: Monday, November 28, 2016 1:24 PM
To: John Wooster - NOAA Federal
Cc: Deason, Jesse; Borovansky, Jenna
Subject: RE: La Grange Updated Study Report - NMFS Studies

Excellent. Thanks, John.

For due date, I will defer to Jesse Deason since she is managing overall production schedule.

Bao

From: John Wooster - NOAA Federal [mailto:john.wooster@noaa.gov]
Sent: Monday, November 28, 2016 1:16 PM
To: Le, Bao
Cc: Deason, Jesse; Borovansky, Jenna
Subject: Re: La Grange Updated Study Report - NMFS Studies

I can provide update paragraphs, when is the due date?

-JW

On Sat, Nov 19, 2016 at 10:39 AM, Le, Bao <ChiBao.Le@hdrinc.com> wrote:

Hi John.

Similar to the Initial Study Report, the Updated Study Report (USR) will report upon the NMFS studies (habitat and genetics) since they are items that would inform the licensing process as cited in the Revised Study Plan. I've not touched base with you on the progress of these studies but given USR reporting is fast approaching I wanted to touch base on these studies. Are there progress or interim reports that can be shared as part of the USR? Or are you able to provide status updates on these studies (i.e., a few paragraphs describing objective, methods, field work, any preliminary analysis, and completion schedule)? Any of this would be really useful information to include in the USR.

Thanks,

Bao

Bao Le

Senior Fisheries Biologist

HDR

1001 SW 5th Avenue, Suite 1800
Portland, OR 97204-1134

Note new direct line:**D** 503.423.3828 **M** 503.309.9423
bao.le@hdrinc.com

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--

John Wooster
Hydrologist
NOAA Fisheries West Coast Region
U.S. Department of Commerce
john.wooster@noaa.gov

From: Staples, Rose
Sent: Tuesday, November 29, 2016 3:19 PM
Cc: Deason, Jesse; Le, Bao; Staples, Rose
Subject: FW: Materials for La Grange December 1, 2016 Water Temp - Reintroduction Goals Joint Subcommittees Meeting

The following message was sent today to the members of the La Grange Water Temperature and Reintroduction Goals subcommittees regarding availability online (www.lagrange-licensing.com) of the meeting AGENDA and other advance materials.

Rose Staples, CAP-OM, MOS
D 207-239-3857

hdrinc.com/follow-us

From: Staples, Rose
Sent: Tuesday, November 29, 2016 6:09 PM
Cc: Deason, Jesse <jesse.deason@hdrinc.com>; 'Le, Bao' <Bao.Le@hdrinc.com>; Staples, Rose (Rose.Staples@hdrinc.com) <Rose.Staples@hdrinc.com>
Subject: Materials for La Grange December 1, 2016 Water Temp - Reintroduction Goals Joint Subcommittees Meeting

Materials for the December 1, 2016 Water Temperature and Reintroduction Goals Joint Subcommittee Meeting are now available on the La Grange Licensing Website (www.lagrange-licensing.com) both in the DOCUMENTS section and as attachments to the meeting notice on the CALENDAR. Note that the meeting will be held at the Modesto Irrigation District office. Materials include the following:

1. Agenda – meeting is from 1-4pm. Address of meeting location and call-in information are noted.
2. Literature Review Summary Document – updated version per comments received.
3. Glossary of Terms Document – updated version per comments received.
4. Literature Review Summary Comment/Response Table – summary of comments received and Districts' actions/responses.
5. Upper Tuolumne River Temperature/Timing Working Document – draft working document to facilitate next steps in the Water Temperature Subcommittee process. This document will be projected at the meeting and serve as the basis for collaborative discussion on developing water temperature index values.

Please let me know if there are any questions.

Rose Staples, CAP-OM, MOS
Executive Assistant

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rose.staples@hdrinc.com

hdrinc.com/follow-us

From: Staples, Rose
Sent: Tuesday, November 29, 2016 4:24 PM
Cc: Deason, Jesse; Le, Bao; Staples, Rose
Subject: FW: NMFS Input for Discussion at Water Temperature Subcommittee December 1 2016 Joint Meeting
Attachments: LaGrange_TempSubcomm_NMFSfeedback.pdf

The following message was forwarded to the members of the Water Temperature and Reintroduction Goals Subcommittees today.

Rose Staples, CAP-OM, MOS
D 207-239-3857

hdrinc.com/follow-us

From: Staples, Rose
Sent: Tuesday, November 29, 2016 7:22 PM
Cc: Deason, Jesse <jesse.deason@hdrinc.com>; 'Le, Bao' <Bao.Le@hdrinc.com>; Staples, Rose (Rose.Staples@hdrinc.com) <Rose.Staples@hdrinc.com>
Subject: NMFS Input for Discussion at Water Temperature Subcommittee December 1 2016 Joint Meeting

Please find attached input received from NMFS related to the Water Temperature Subcommittee. This input will be discussed during the December 1, 2016 Water Temperature Subcommittee meeting.

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Executive Assistant

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rose.staples@hdrinc.com

hdrinc.com/follow-us

From: John Wooster - NOAA Federal <john.wooster@noaa.gov>
Sent: Monday, November 07, 2016 4:16 PM
To: Le, Bao
Cc: Deason, Jesse; Staples, Rose; Steve Edmondson; Jean Castillo - NOAA Federal
Subject: Re: Change in Due Date for Comments on the Temp Criteria Subcommittee Oct 14 Conf Call Draft Notes
Attachments: BoughtonEtAl2015.pdf

Bao:

I think an important component for the temperature sub-group is to understand how the NMFS Science Center will treat the topic of thermal suitability in modeling habitat capacity in their study of the Upper Tuolumne watershed. Their approach for O.mykiss is currently likely to follow the approach used in this 2015 Boughton et al. paper that I am attaching to this email – with emphasis on the *Thermal Indicators of habitat suitability* section on pdf page 263. The Science Center has another technical memo in draft form that provides greater detail for this approach and the rationale / data behind it– once that memo is finalized I can pass it along too. The spring-run Chinook approach for the Tuolumne is still under development, although likely to follow a similar mechanistic/bio-energetic approach but maybe some adjustment to the temperature thresholds.

In short, they will not be taking a relatively simplistic approach of selecting one temperature metric and deciding if a reach is "suitable" or "not". For O.mykiss, if a given day has a maximum temp >29C or average daily temp >25C then it is not suitable. Temperatures in the 21 to 25C range are considered stressful. What impacts those stressful temperatures have and whether the O.mykiss can utilize the habitat depends on several factors, including but not limited to: thermal refugia (e.g., stratified deep pools), food availability, growth potential, level of stress (e.g., function of the degrees above 20C and for how many hours), etc…

I also inquired about other useful references towards temperature and steelhead and the lab recommended these papers (in addition to the one I am attaching):

Rodnick, K. J., A. K. Gamperl, K. R. Lizars, M. T. Bennett, R. N. Rausch, and E. R. Keeley. 2004. Thermal tolerance and metabolic physiology among Redband Trout populations in southeastern Oregon. Journal of Fish Biology 64:310–335.

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Thank you.

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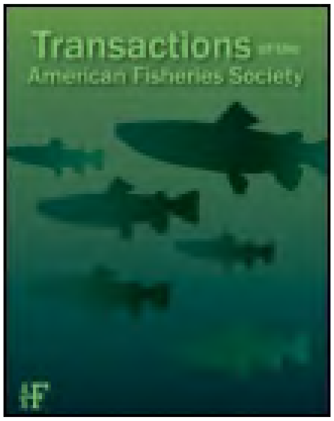

Transactions of the American Fisheries Society
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Thermal Potential for Steelhead Life History Expression in a Southern California Alluvial River

David A. Boughton[a], Lee R. Harrison[ad], Andrew S. Pike[b], Juan L. Arriaza[c] & Marc Mangel[c]

[a] National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southwest Fisheries Science Center, Fisheries Ecology Division, 110 Shaffer Road, Santa Cruz, California 95060, USA

[b] Institute of Marine Sciences, University of California-Santa Cruz, 1156 High Street, Santa Cruz, California 95064, USA

[c] Center for Stock Assessment Research, Department of Applied Mathematics and Statistics, University of California-Santa Cruz, 1156 High Street. 95064, Santa Cruz, California, USA; and Earth Research Institute, University of California, Santa Barbara, California 93106, USA

[d] Present address: Earth Research Institute, University of California, Santa Barbara, California 93106, USA

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DOI: 10.1080/00028487.2014.986338

ARTICLE

Thermal Potential for Steelhead Life History Expression in a Southern California Alluvial River

David A. Boughton* and Lee R. Harrison[1]
National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southwest Fisheries Science Center, Fisheries Ecology Division, 110 Shaffer Road, Santa Cruz, California 95060, USA

Andrew S. Pike
Institute of Marine Sciences, University of California–Santa Cruz, 1156 High Street, Santa Cruz, California 95064, USA

Juan L. Arriaza and Marc Mangel
Center for Stock Assessment Research, Department of Applied Mathematics and Statistics, University of California–Santa Cruz, 1156 High Street, Santa Cruz, California 95064, USA

Abstract
Steelhead *Oncorhynchus mykiss* (anadromous Rainbow Trout) near the southern limit of the species' range commonly use shallow alluvial rivers for migration, spawning, and rearing. These rivers have been widely modified for water management, and an enduring question is whether their rehabilitation would create summer nursery habitat for steelhead. We used process-based models to evaluate the thermal potential for steelhead nursery habitat in the Santa Ynez River, California, a regulated alluvial river that currently supports few steelhead. We assessed (1) how well a calibrated model of river heat fluxes predicted summer temperature patterns for a warm year and an average year; (2) whether those patterns created thermal potential for the rapid growth that is characteristic of steelhead nursery habitat; and (3) whether manipulation of flows from an upstream dam significantly altered thermal potential. In the heat flux model, the root mean square error for 15-min temperatures was 1.51°C, about three times greater than that of the larger, deeper Sacramento River in northern California. Generally, the Santa Ynez River was thermally suitable but stressful for juvenile steelhead. Flow augmentation reduced the number of thermally stressful days only near the dam, but it reduced the intensity of thermal stress throughout the river. Daytime movement of steelhead into natural, thermally stratified pools would reduce stress intensity by similar levels. In this region, *O. mykiss* commonly pursue an anadromous (steelhead) life history by entering nursery habitat early in their first or second summer and rapidly growing to attain a threshold size for anadromy by fall. In the average year, the river was thermally suitable for the first-summer pathway under high food availability and for the second-summer pathway under medium food availability. The warm year also supported the second-summer pathway under high food availability. Currently, the Santa Ynez River's capacity to support these pathways does not appear to be limited by summer temperature, thus indicating a need to identify other limiting factors.

Steelhead *Oncorhynchus mykiss* (anadromous Rainbow Trout) in southern California near the southern limit of the species' native range historically migrated up wide, shallow alluvial rivers that drained arid mountain ranges (Figure 1). An enduring question is whether the summertime thermal patterns of these rivers constitute a fundamental control on

*Corresponding author: david.boughton@noaa.gov
[1]Present address: National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southwest Fisheries Science Center, Fisheries Ecology Division, 110 Shaffer Road, Santa Cruz, California 95060, USA; and Earth Research Institute, University of California, Santa Barbara, California 93106, USA.
Received July 21, 2014; accepted November 5, 2014

FIGURE 1. Coastal California alluvial rivers currently or formerly used by steelhead (anadromous *Oncorhynchus mykiss*) near the southern limit of the species' native range (Boughton et al. 2005). Steelhead historically used alluvial rivers as migration corridors to upland creek habitat and possibly as spawning and rearing habitat. The alluvial rivers that are highlighted here are channels with gradients less than 1% and upstream watershed areas greater than 500 km^2 within the shrub-dominated coastal mountain ranges south of Monterey Bay.

productivity and life history diversity of *O. mykiss* in this region. Southern California steelhead are currently scarce and considered highly endangered, in part due to widespread human impacts but also to challenging climatic conditions that may limit the rivers' suitability (Boughton et al. 2009). Better insight into thermal factors that limit steelhead has implications for recovery potential in the region and, more broadly, for the responses of other steelhead populations to the impacts of climate change on rivers (e.g., Mantua et al. 2010; Benjamin et al. 2013).

Steelhead are stressed by or excluded from water that is warmer than specific tolerance limits (Jobling 1981; Eaton et al. 1995; Werner et al. 2005; Kammerer and Heppell 2013a), which indirectly links their geographic distribution to summer climate via river temperature (Mohseni et al. 2003). Water temperature also sets an upper limit on the potential growth of juveniles (Wurtsbaugh and Davis 1977; Kammerer and Heppell 2013b, 2013a), with implications for the fitness and expression of anadromous and nonanadromous (resident) life histories (Mangel and Satterthwaite 2008; McMillan et al. 2012; Sogard et al. 2012; Benjamin et al. 2013). Numerous other ecological factors and human impacts also influence distribution, abundance, and life history expression in *O. mykiss* (Busby et al. 1996) but only within the bounds of a river's thermal potential for the species. Thus, if a given river habitat lacks the basic thermal potential to support the anadromous life history, then there is little scope for steelhead recovery, irrespective of other factors. We used this premise to assess the recovery potential of steelhead in an alluvial main-stem river in southern California.

Southern California *O. mykiss* populations historically expressed both anadromous (steelhead) and resident (Rainbow Trout) life histories. Anadromous life histories appear to depend on habitats that produce large smolts, which survive well in the ocean and are disproportionately represented in adult spawning migrations (Bond 2006). Such areas qualify as nursery habitat—defined as rearing habitats for which the contribution per unit area to the production of recruits to the adult population is greater than the contributions from other habitats where juveniles occur (Beck et al. 2001). Thus, steelhead nursery habitats constitute the subset of juvenile rearing habitats that generate high numbers of adult steelhead per unit area, and these nursery habitats are important for maintaining population size and persistence (Beck et al. 2001). Hayes et al. (2008) identified three pathways by which juvenile *O. mykiss* use nursery habitat in coastal California to achieve sizes that are suitable for anadromous life histories; each of the pathways involves the use of summer habitats that are capable of sustaining rapid growth (Figure 2). In the "first-summer" pathway, age-0 steelhead enter nursery habitat in early summer and grow rapidly. By fall, they reach a size that enables them to exhibit more typical growth during winter yet still successfully smolt the following spring at age 1. In the "second-summer" pathway and the much rarer "third-summer" pathway, age-0

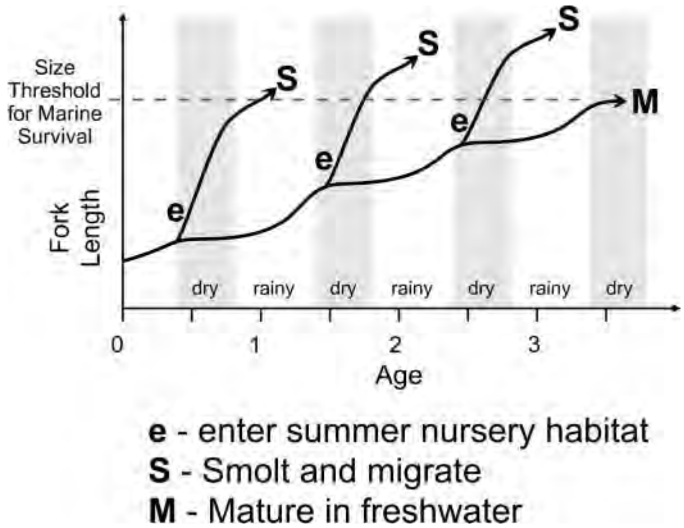

FIGURE 2. Conceptual model for *Oncorhynchus mykiss* life history pathways in stream systems of the California coast (adapted from Hayes et al. 2008; see also Bond 2006; Satterthwaite et al. 2009, 2012; and Beakes et al. 2010). Because marine survival is low for *O. mykiss* smaller than a certain size threshold (~150 mm FL), habitats only produce the anadromous life history form (steelhead) if the fish sustain rapid growth during the summer before smolting. Such habitats disproportionately contribute recruits to anadromous runs and thus fit the definition of steelhead nursery habitat (sensu Beck et al. 2001).

steelhead remain in upland creeks for 1 or 2 years, where they grow slowly until entering nursery habitat in their second or third summer and then smolting the following spring at age 2 or age 3. Some fish also follow a resident pathway, maturing in freshwater as Rainbow Trout (Hayes et al. 2012).

Growth potential is probably a central feature distinguishing steelhead nursery habitat from Rainbow Trout nursery habitat. This is because body size correlates strongly with fitness components, such as habitat-specific survival (Ward et al. 1989; Bond 2006; Evans et al. 2014; Thompson and Beauchamp 2014) and female fecundity (Shapovalov and Taft 1954), and such fitness components evolutionarily favor anadromy in some environments and freshwater residency in others (Satterthwaite et al. 2009, 2010). Thus, although life histories are partly under genetic control (Thrower and Joyce 2004; McPhee et al. 2007; Heath et al. 2008; Pearse et al. 2014), natural selection should favor a conditional life history strategy that uses body size as an internal cue for whether and when to switch from freshwater habitat to marine habitat (Mangel and Satterthwaite 2008; Satterthwaite et al. 2009; McMillan et al. 2012; Sloat et al. 2014). At the same time, the growth and body size necessary to cue the switch are expected to (1) differ for males and females (Sloat et al. 2014); (2) vary regionally as a function of local survival in both the marine and freshwater environments; and (3) depend on the maximum attainable body size (asymptotic body size) in the two environments (Satterthwaite et al. 2010). For simplicity, we focus here on female life histories under the assumption that limits on anadromous production are more closely tied to female fecundity than to male fecundity. For some salmonid species in some environments, very rapid growth and large attainable body sizes for females in freshwater appear to favor resident life histories (i.e., maturation in freshwater; Sloat et al. 2014). For *O. mykiss* in coastal California, the combination of survival schedules and very rapid growth that favors such a strategy has not yet been observed (Hayes et al. 2008). Instead, rapid growth appears to evolutionarily favor an anadromous life history, whereas moderate growth apparently favors a resident life history (Satterthwaite et al. 2009). Feeding experiments suggest that the physiological "decision" to forsake a nonanadromous path and switch to marine habitats is made in the fall—after the summer growth period and before outmigration the next spring (Beakes et al. 2010). Thus, to a first approximation, a habitat's potential to generate the anadromous life history in coastal California simplifies to the potential to support survival and rapid growth of juvenile female *O. mykiss* during summer. In the context of thermal potential addressed here, survival will fail if temperatures become lethally warm, and rapid growth will fail if water temperatures are either too warm or too cool for the growth rate required to trigger smoltification and the switch to marine habitats.

The best-studied steelhead nursery habitats in the region are coastal estuaries (Bond 2006), which form dry-season lagoons that produce abundant large smolts. Coastal climate and inputs of marine wrack and invertebrates provide the appropriate combination of temperature and feeding opportunity for rapid growth, but the total productivity of estuaries is limited by their small spatial extent. Upland creek habitat is more widespread and supports abundant juvenile *O. mykiss* (e.g., Boughton et al. 2009). However, the channels must be well shaded to stay cool enough for the species (Boughton et al. 2012), whereas dense shade appears to limit instream primary productivity, creating a food-limited environment and low growth potential in summer (Hayes et al. 2008; Rundio and Lindley 2008; Sogard et al. 2009). Coastal estuaries are usually steelhead nurseries and upland creeks are usually not, but the nursery role of a third common habitat, alluvial rivers, remains an open question.

Lowland alluvial rivers, defined here as streams with low gradients ($<1\%$) and large upstream watersheds (>500 km^2), are numerous and widespread at the species' southern range limit in California (Figure 1); therefore, these systems could potentially produce large steelhead runs if they are capable of functioning as nursery habitat. In summer, alluvial rivers are wide, shallow, and sparsely shaded, making them vulnerable to heating but also typically allowing them to support substantial algal growth, which suggests a physical basis for a productive food web and the high feeding opportunities necessary for rapid growth of juvenile fish. Summer air temperatures in this region routinely exceed 30°C, but river temperatures are reduced to varying extents by cool onshore winds and fog from the ocean and by hydrological exchange with large aquifers. These physical influences on temperature are spatially heterogeneous (e.g., Alagona et al. 2012; Booth et al. 2013), and the degree to which they keep rivers in the thermal zone required for rapid growth—or even survival—of juvenile *O. mykiss* is unclear. Unfortunately, the potential role of lowland alluvial rivers as summer nursery habitat is ambiguous due to an incomplete historical record and the extensive negative impacts from water development, adjacent land uses, and nonnative species (Marchetti et al. 2004; Klose et al. 2012; Cooper et al. 2013).

We used process-based models of river temperature and fish response to evaluate whether a representative alluvial river in southern California has the thermal potential to support anadromous life history expression by the local population of *O. mykiss*. The Santa Ynez River serves as a useful case study because it has a historical record of occasional (and perhaps frequent) large steelhead runs (Alagona et al. 2012) and because the existing river and its human impacts are representative of many other rivers in the region (Kondolf et al. 2013). We focused our analysis on three questions: (1) Do summer temperature patterns in the main stem of the river create thermal potential for steelhead survival and a first-summer or second-summer life history strategy?; (2) How much does the manipulation of water releases from an upstream dam alter the thermal potential of the river?; and (3) How much do cold patches of water in thermally stratified pools increase the thermal potential of the river by reducing thermal stress on steelhead?

STUDY AREA

The Santa Ynez River flows west about 110 km from tributaries in the Transverse Ranges of California to the Pacific Ocean just north of Point Conception. The reach we modeled was the lower 65-km section below Bradbury Dam (Figure 3). Historical data suggest that steelhead runs once numbered in the tens of thousands in some years but were nearly nonexistent in other years (Alagona et al. 2012). Currently, anadromous *O. mykiss* are consistently rare despite the predominance of anadromous genotypes in the local population (Pearse et al. 2014, cf. Salsipuedes and Hilton creeks) and more than a decade of rehabilitation efforts (Robinson et al. 2009). Bradbury Dam impounds a large reservoir near the middle of the basin and blocks steelhead migration 70 km upstream of the

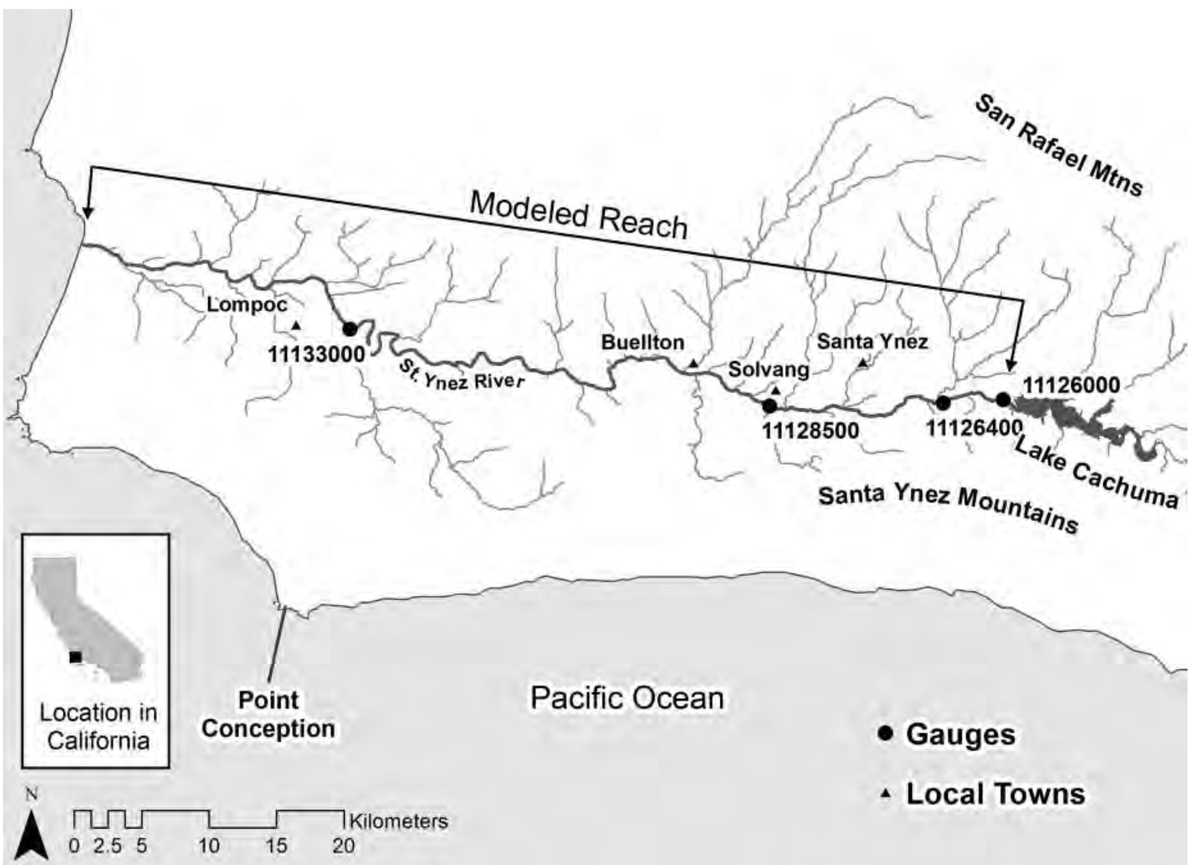

FIGURE 3. Map of the study area in the Santa Ynez River, showing landmarks and locations of stream gauges that recorded flow and temperature. U.S. Geological Survey (USGS) gauge 1112600 defined the upstream boundary conditions for the River Assessment for Forecasting Temperature model; USGS gauges 11126400, 11128500, and 11133000 were used to calibrate the parameters.

estuary; about two-thirds of the basin's spawning and rearing habitat are located upstream of the dam and are therefore inaccessible (Alagona et al. 2012). Genetically similar but nonanadromous *O. mykiss* occupy the stream network upstream of the dam (Clemento et al. 2009; Pearse et al. 2014). Summertime flows below the dam are managed for multiple objectives, including steelhead rearing and continuous replenishment of aquifers tapped by agriculture. Summer flows typically range between 0.3 and 1.0 m^3/s but may be temporarily ramped up as high as 4 m^3/s to replenish the downstream aquifers.

Between Bradbury Dam and the town of Solvang (Figure 3), the Santa Ynez River has a gravel bed with alternating pool–riffle sequences and a sparsely vegetated floodplain. The channel migrates laterally during infrequent flood events, thereby scouring pools, shaping gravel bars, and recruiting coarse woody debris via bank migration. Together, these processes produce physical habitat complexity that is characteristic of the habitats typically used by steelhead. This complexity includes a diversity of water depths and velocities; visual cover provided by instream wood, undercut banks, and overhanging vegetation; and gravel beds suitable for spawning. During years between floods, dense shrubby vegetation colonizes the active channel margins, and the riverbed develops thick algal mats. Further downstream from Solvang, the Santa Ynez River shifts to a sand-bedded channel with fewer pool–riffle sequences and more closely resembles a braided river. Important human impacts include managed flow regimes, high nitrogen loading from agricultural activities, and a profusion of exotic fish species. Juvenile and adult Largemouth Bass *Micropterus salmoides* are especially abundant, occurring in the tens of thousands throughout the lower river during summer (Robinson et al. 2009).

In summer, juvenile steelhead are common in a few small tributaries of the lower Santa Ynez River; in the river itself, however, they are rare and confined to small coldwater patches associated with thermally stratified pools or groundwater seeps (Robinson et al. 2009). Thermal stratification occurs at low flows, when water velocities are slow enough to allow poorly mixed layers of water at different temperatures to develop in well-shaded pools, or in areas where groundwater seeps up from the bed. Geomorphically, the river seems suitable for steelhead rearing, yet rearing is rare; therefore, the key questions (and the motivation for this study) are whether the lack of steelhead rearing can be attributed to thermal constraints and whether such constraints are more closely linked to dam releases or to prevailing weather.

METHODS

River temperature.—We estimated fine-grained temperature dynamics in the Santa Ynez River by using the River Assessment for Forecasting Temperature (RAFT) model (Pike et al. 2013). The RAFT model was previously developed for the Sacramento River, a large, cool California river with managed summer flows that typically range from 180 to 520 m^3/s—or about 200–1,500 times greater than typical summer flows in the Santa Ynez River. The much shallower Santa Ynez River provides a more challenging system to model because heat fluxes with the riverbed and atmosphere are potentially large relative to the thermal capacity of the river. Pike et al. (2013) described the RAFT model in detail; below, we summarize aspects that are relevant to the challenge of simulating thermal processes in the Santa Ynez River.

The RAFT model assimilates data on meteorology, flow, and river temperature to simulate hydrological and thermal processes at a temporal resolution of 15 min and a spatial resolution of 1 km. A one-dimensional hydrodynamic model simulates the advection and diffusion of heat longitudinally in the river, coupled to physical models of all upward and downward heat fluxes with the atmosphere and streambed, respectively. For the Sacramento River, RAFT accurately predicted (root mean square error [RMSE] $< 0.5°C$) the magnitude and timing of diel temperature fluctuations over entire summers, including thermal artifacts, such as the phase–antiphase pattern of downstream temperature below a dam releasing water of constant temperature (Pike et al. 2013). The model requires channel bathymetry as input, which in this study comprised topographic cross-sections spaced at ~50-m intervals, derived from aerial LiDAR and ground surveys of the Santa Ynez River. Other required input included gridded hourly meteorological data and a time series of measured hourly temperature and flow at the upstream boundary of the modeled reach (U.S. Geological Survey [USGS] gauge 1112600, about 5 km downstream of Bradbury Dam; see Figure 3).

The model runs in either a hindcast or forecast mode. Hindcasts simply assimilate temperature observations to spatiotemporally infer a past temperature field that is encompassed by the time span of the data. Forecasts predict future temperature time series based on constructed flow and temperature scenarios at the upstream boundary. We used hindcasts to calibrate RAFT and reconstruct temperature fields from the recent past, and we used forecasts to predict the effects of hypothetical water release scenarios.

Calibration of the model benefits from the assimilation of flow records that include both large and small flows, so we focused on two recent summers (2006 and 2010) with flows spanning a relatively broad range (0.3 to 5.0 m^3/s). Based on daily temperatures at the Lompoc gauge (USGS gauge 11133000), 2006 had the hottest summer of the last decade, with a mean summer water temperature of 21.41°C (range of summer means for the last decade = 19.46–21.41°C; calculated for June 1–October 1 of each year from 2003 to 2012). In contrast, 2010 had a nearly average summer, with a mean water temperature of 20.48°C (mean of summer means for the last decade = 20.56°C).

For each summer, the RAFT model was calibrated by adjusting several tunable parameters to achieve a best fit with 15-min water temperatures at three gauges downstream of

Bradbury Dam (USGS gauges 11126400, 11128500, and 11133000; Figure 3). Tunable parameters included the depth of the streambed (affecting the rate of bed heat conduction), the temperature of the deep groundwater reservoir (assumed to be constant over time), and coefficients for the rate of evaporative cooling relative to wind speed.

After calibration, we simulated alternative flow scenarios by using the same data used for hindcasts, altering only the flow. Seven scenarios of constant flow (0.14, 0.28, 0.71, 1.4, 2.8, 4.3, and 5.7 m^3/s [5, 10, 25, 50, 100, 150, and 200 ft^3/s]) were simulated for the dry season (May 1–October 1).

Thermal indicators of habitat suitability.—To evaluate how river temperature was likely to affect southern California steelhead, we developed a set of biological indicators. A review of the literature suggested that steelhead in various regions can persist in streams if short-term maximum temperatures remain below 30°C or perhaps 29°C (Zoellick 1999; Rodnick et al. 2004; Huff et al. 2005; Werner et al. 2005; Sloat and Osterback 2013), which is similar to laboratory estimates of the critical thermal maximum, a measure of short-term physiological tolerance for high temperature (Myrick and Cech 2004; Rodnick et al. 2004; Hasnain et al. 2013). However, at temperatures above 22–24°C, feeding and agonistic behaviors decline in frequency (Sloat and Osterback 2013), and the fish show signs of stress (Werner et al. 2005). Laboratory estimates of incipient lethal temperature (50% mortality after long exposure) vary across studies but average around 25°C. Steelhead start to concentrate in thermal refugia, if available, when temperatures exceed 21°C, and they almost completely retreat to refugia when temperatures are around 24°C (Nielsen et al. 1994; Ebersole et al. 2001; Baird and Krueger 2003; Sutton et al. 2007). Many southern California streams that support steelhead do not provide such refugia, and steelhead actively feed in the temperature range of 21–24°C, which is presumably stressful (Spina 2007; Sloat and Osterback 2013).

Based on this review, we define thermal indicators as follows. A day is "thermally suitable" if maximum daily temperature stays below 29°C *and* mean daily temperature stays below 25°C. However, a day is "thermally stressful" if temperature rises above 21°C at any time, with the daily stress intensity quantified as degree-hours above 21°C (i.e., for each day, $\Sigma[T_t - 21]\Delta t$).

Thermal growth potential.—We defined thermal growth potential as the maximum attainable growth of an individual fish, a function of the river's thermal regime and food availability. Thermal growth potential was estimated using the bioenergetics model for *O. mykiss* described by Railsback and Rose (1999), as modified by Satterthwaite et al. (2010) and Arriaza (2013). Individual growth arises from the difference between energy intake and energy expenditure (Rand et al. 1993; Railsback and Rose 1999; Satterthwaite et al. 2010), which are modeled as weight- and temperature-dependent functions for food consumption and respiration, respectively (see Arriaza [2013] for details). The functional form of the growth response to temperature is hump-shaped after Thornton and Lessem (1978) for coldwater species; the functional form was parameterized for California steelhead as in Railsback and Rose (1999). Expressions for maximum food intake and respiration costs in the basic model were modified by functions simulating the energy cost of activity and the difficulty of finding food in a wild habitat, in accordance with recommendations made by Andersen and Riis-Vestergaard (2004) and Bajer et al. (2004). Higher activity increases food consumption, but total energetic cost also increases. For simplicity, we assumed that fish choose a unique activity level that optimizes growth given all other parameters (Arriaza 2013). In the resulting model, the growth rate depends on fish size and food availability but generally peaks in the range of 15–17°C and becomes negative at temperatures above 22–24°C.

We applied the bioenergetics model to temperature output from RAFT scenarios in combination with assumptions about food availability. For *O. mykiss* in the Santa Ynez River (either in its current state or under hypothetical flow scenarios), the level of difficulty in finding food is unknown although presumably low, as judged from the great abundance of juvenile Largemouth Bass and other exotic fish in the river. For simplicity, we assumed that the difficulty of finding food over the summer was constant, and uncertainty was represented by simulating low, medium, and high food availability as drawn from parameter estimates for the same model when applied to two alluvial rivers in California's Central Valley over various years and seasons (Satterthwaite et al. 2010).

Nursery potential.—Growth potential was used to evaluate whether thermal patterns in the Santa Ynez River were sufficient to support either a first-summer or second-summer pathway to anadromy. Growth of age-0 and age-1 *O. mykiss* from June 1 to October 1 was simulated at daily time steps by using mean daily temperature from the RAFT scenarios. Weights of juveniles on June 1 were assumed to be 1.9 g for age-0 fish and 13.6 g for age-1 fish (D. Rundio, National Oceanic and Atmospheric Administration, Southwest Fisheries Science Center, personal communication).

Thermal growth potential was judged to be sufficient for steelhead nursery habitat if fish had grown past a smolting criterion, defined as the minimum FL on October 1 associated with successful anadromy. In the spring, FLs greater than 150 mm are associated with successful anadromy (i.e., a high smolting rate and high marine survival; Ward et al. 1989; Bond 2006; Evans et al. 2014; Thompson and Beauchamp 2014). We examined two versions of the October 1 criterion to account for uncertainty. The "high" smolting criterion was an October 1 FL exceeding 150 mm, which makes the very conservative assumption that growth is negligible in the intervening winter. The "typical" smolting criterion was an October 1 FL greater than 100 mm; this criterion is more apt because it assumes that growth in the intervening winter is typical of upland creeks in the region, which would produce fish larger than the 150-mm threshold by the following spring (Satterthwaite et al. 2009).

Stratified pools.—To assess the extent to which thermally stratified pools might reduce thermal stress, we deployed vertical arrays of temperature loggers in five sections of the Santa Ynez River during summer 2011. Sites were chosen on the basis of accessibility and wide geographic distribution. Stratified pools have been observed in California rivers with large gravel bars, flow separation, extensive intergravel flow, groundwater seeps, and pools that are forced by large woody debris or boulders (Nielsen et al. 1994). Based largely on these findings, we selected pools within each section that possessed at least three geomorphic and hydrologic criteria indicating a high potential for stratification. We identified 16 such pools. In each pool, we positioned a fence post vertically at the deepest point (either by driving it into the substrate or placing it in a manufactured concrete base) and attached three Hobo pendant loggers (Onset Corporation) housed by gray plastic sunshields. One logger was placed 10 cm below the water's surface, another logger was placed against the streambed, and the third logger was deployed midway between the first two. The period of record was July 1–October 1, except for three loggers that were not deployed until the second week of July.

The pools were snorkel surveyed for the presence of steelhead in late summer (August 16–18). Standard methods (e.g., Boughton et al. 2009) were used for the survey, including visual assignment of fish to three general size-classes ($<$100, 100–200, or $>$200 mm FL). Such methods generally achieve per-fish observation probabilities around 0.70–0.85.

Complete data sets were recovered from 14 pools. In many cases, declining flows exposed the upper (surface) temperature logger; in the remaining cases, the records of the middle and surface loggers were nearly identical, so records from the middle logger were taken to represent the main flow. Pools were defined as stratified if they showed an absolute difference greater than 1°C between middle and bottom loggers for at least 5% of the period of record. Mean daily stress intensity was calculated for the middle and bottom logger positions in each pool.

RESULTS

Performance of the RAFT Model

Each RAFT hindcast produced 14,689 temperature predictions for the 153 d from midnight on May 1 to midnight on October 1. The RMSE of 15-min temperatures was 1.51°C in both years, with the RMSE of daily means being slightly smaller and the RMSE of daily maximums being slightly larger (Table 1). The RMSE broken down by USGS gauge and flow showed a negative relationship with flow but not consistently; the lower flows generally involved prediction error ranging from 1°C to 2°C. Thermal stress had an RMSE of 14.8 degree-hours in 2006 and 11.0 degree-hours in 2010, which were comparable in magnitude to the predicted daily stress itself (see below).

TABLE 1. Performance metrics for the River Assessment for Forecasting Temperature hindcasts estimated from three downstream temperature gauges in the Santa Ynez River, California (RMSE = root mean square error).

	RMSE		Bias	
Metric	2006	2010	2006	2010
15-min temperature (°C)	1.51	1.51	−0.04	0.30
Daily mean temperature (°C)	1.03	0.80	−0.04	0.30
Daily maximum temperature (°C)	1.70	2.00	−0.24	1.60

Mean biases in 15-min and daily temperatures were small ($\leq$0.3°C; Table 1). The bias in maximum daily temperature was about five times larger than the bias in mean daily temperature for each year (Table 1). Bias as a function of flow tended to be hump-shaped, with a relatively small or negative bias at low and high flows and a positive bias at intermediate flows.

Thermal Suitability and Thermal Stress

The seven flow scenarios altered the mean daily river temperature relative to the temperature records of the recent past (Figure 4A, C). The lowest flow (0.14 m^3/s) raised temperature by as much as 1.25°C but only in the vicinity of Bradbury Dam; effects were less than 0.5°C further than 10 km from the dam and were negligible beyond 20 km from the dam. The highest flow (5.7 m^3/s) lowered temperature by as much as −2.6°C in 2006 and −1.6°C in 2010, with effects persisting further downstream (40–50 km); however, less extreme scenarios (1.4 m^3/s or less) always had negligible effects further than 20 km below the dam.

In contrast, the seven flow scenarios had larger and more extensive effects on mean maximum daily temperature (Figure 4B, D). The largest effects were close to the dam and ranged from +2.5°C to −4.6°C for the lowest and highest flow scenarios, respectively. However, effects ranging between about +0.8°C and −1.7°C persisted as far as 60 km from the dam, much further than the effects for mean daily temperature.

Based on the recent temperature data and based on the scenarios, no part of the river became thermally unsuitable for steelhead, with one small exception. In 2006, at the lowest flow (0.14 m^3/s), 3 km of the lower river became unsuitable for 1 d in late summer.

In general, nearly all summer days were thermally stressful throughout the entire river except for the area immediately below Bradbury Dam (Figure 5A, C). Higher water releases could expand this less-stressful zone downstream, but the highest release could only create a truly low-stress zone a few kilometers long just below the dam. However, dam releases had large effects on the intensity of stressful days, and these effects persisted much further downstream, especially for the three largest releases (Figure 5B, D).

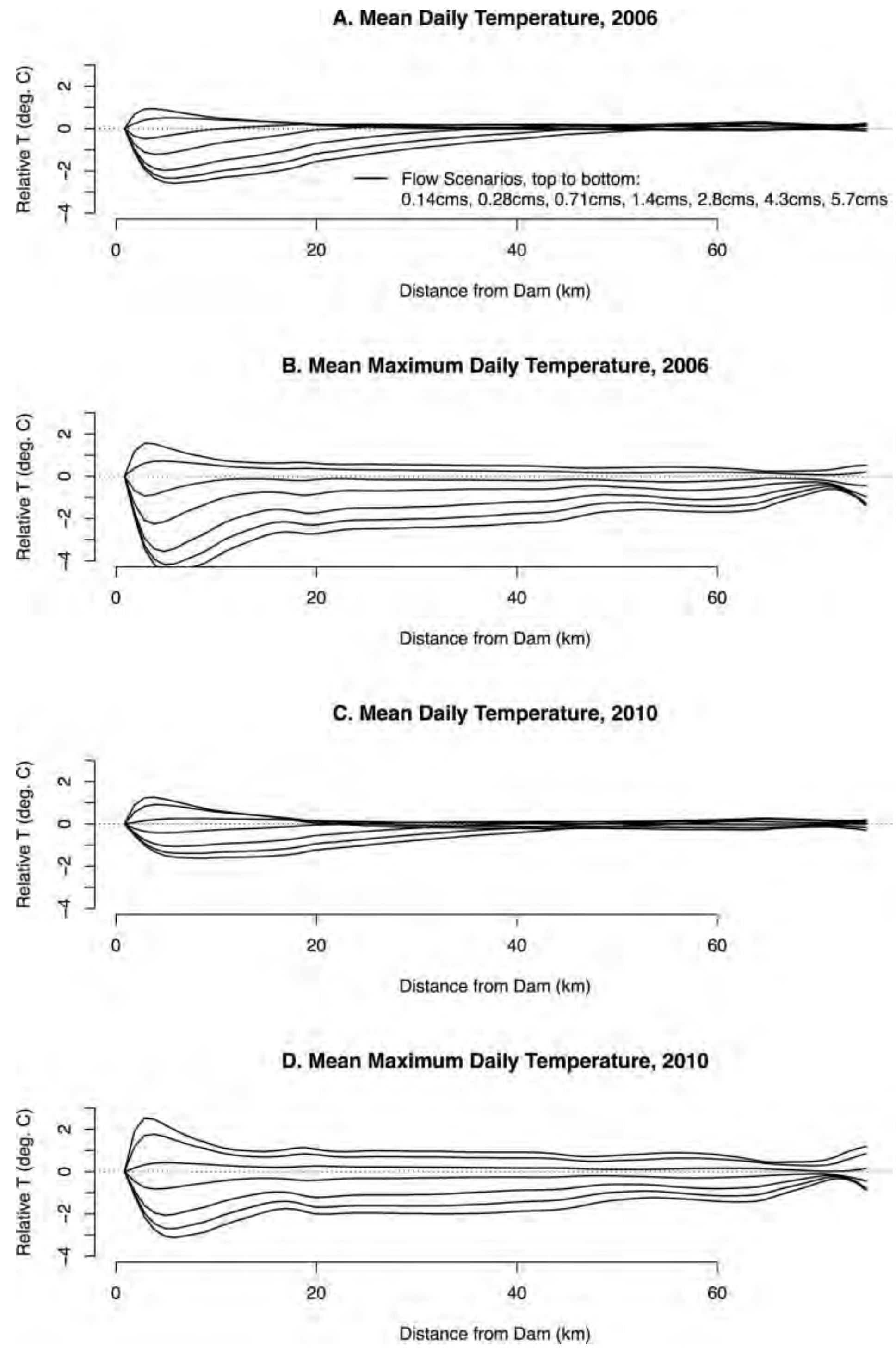

FIGURE 4. Effects of flow levels (simulated dam releases; cms = cubic meters per second) on temperatures (*T*) downstream of Bradbury Dam on the Santa Ynez River relative to the calibration scenario (hindcast temperature from actual flow releases occurring in 2006 and 2010). The mean of mean daily temperature and mean maximum daily temperature for the summer release season (May 1–October 1) are shown.

Nursery Potential

For clarity, nursery potential results from the various scenarios are reported in terms of relative final mass, calculated as the final mass of fish on October 1 divided by the corresponding final mass projected under the actual summer flows of 2006 and 2010.

Age-0 fish.—In 2010, the average year, medium to high food availability produced fish with masses greater than the

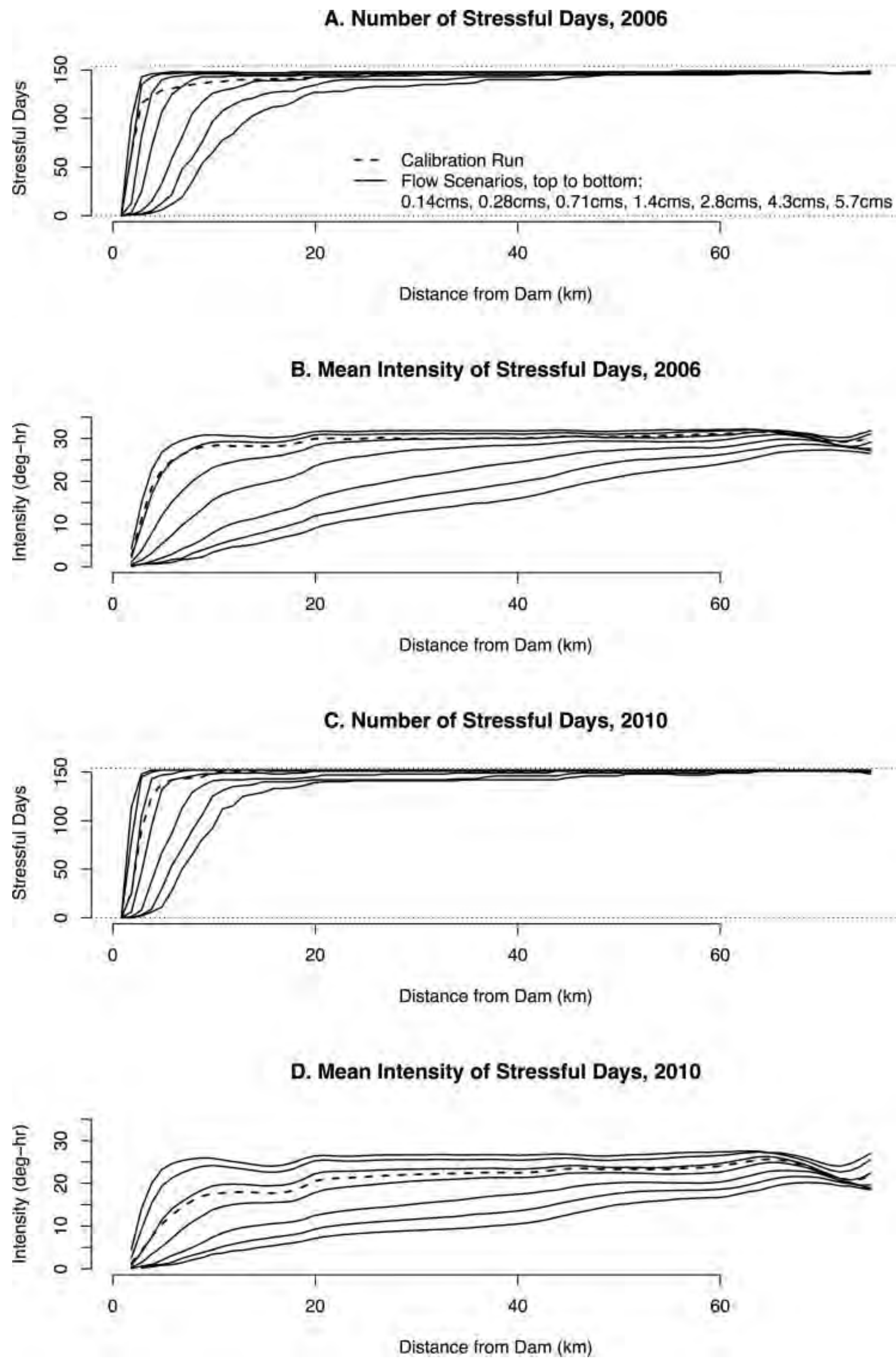

FIGURE 5. Number of days that were thermally stressful for steelhead and the mean stress intensity (degree-hours) under various simulated flow levels (cms = cubic meters per second) in the Santa Ynez River during the summer season (May 1–October 1).

typical smolting criterion throughout the entire river and regardless of flow scenario (Figure 6A, B). For other combinations (high food availability plus high smolting criterion; or low food availability plus typical smolting criterion), fish only reached smolting size near the dam (Figure 6A, C). The size of the potential nursery zone near the dam ranged from 3 to 20 km depending on the flow scenario examined (Figure 6A, C). If the high smolting criterion was used in combination with medium or low food availability, the first-summer pathway was not supported in any area of the river.

The year 2006, a hot year, had results similar to those for 2010 except that at intermediate food availability under the typical smolting criterion, the first-summer strategy was not supported throughout the entire river (Figure 6D). Instead, a nursery zone was present below the dam, and the size of the zone varied greatly (5–42 km) depending on the flow scenario. Very high flows (>4 m^3/s) were necessary to expand the nursery zone to a length greater than 20 km.

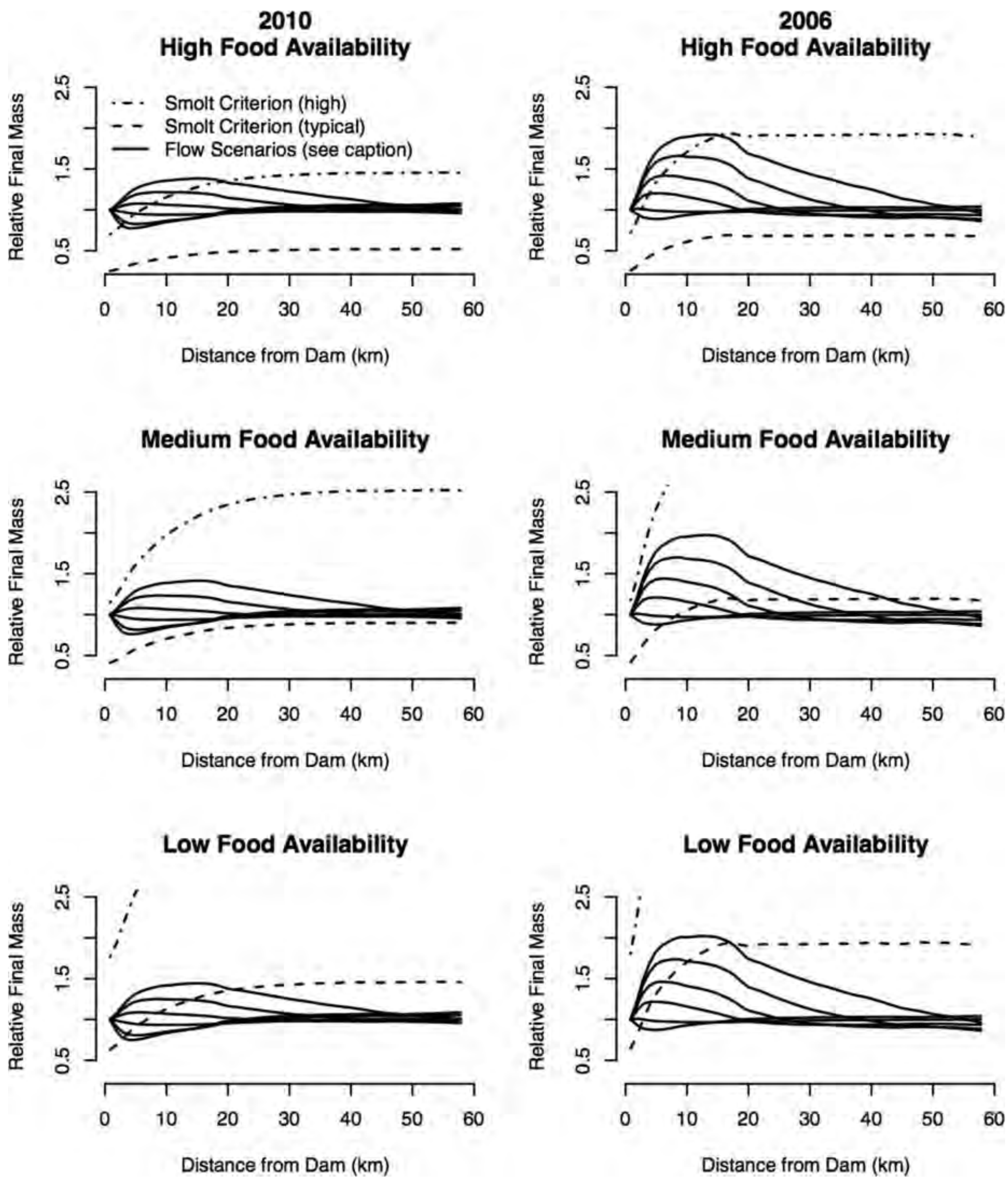

FIGURE 6. Relative final mass for age-0 steelhead on October 1 as modeled for various flow scenarios (solid lines), years (columns), and levels of food availability (rows) at locations downstream of Bradbury Dam on the Santa Ynez River. The "typical" smolt criterion describes the final mass on October 1 that is assumed necessary to trigger smolting and out-migration during the following spring, given typical winter growth conditions. The "high" smolt criterion conservatively assumes zero winter growth. Flow scenarios (lines from top to bottom) are 5.7, 4.3, 2.8, 1.4, 0.71, and 0.28 m^3/s.

Age-1 fish.—In 2010, the entire river could support the second-summer pathway under a typical smolting criterion, regardless of food availability (Figure 7A, C, E). Under the high smolting criterion, the area supporting the second-summer pathway was still the entire river if food availability was high (Figure 7A), but the area shrank to a flow-dependent zone near the dam if food availability was intermediate (Figure 7C). The year 2006 gave similar overall results except

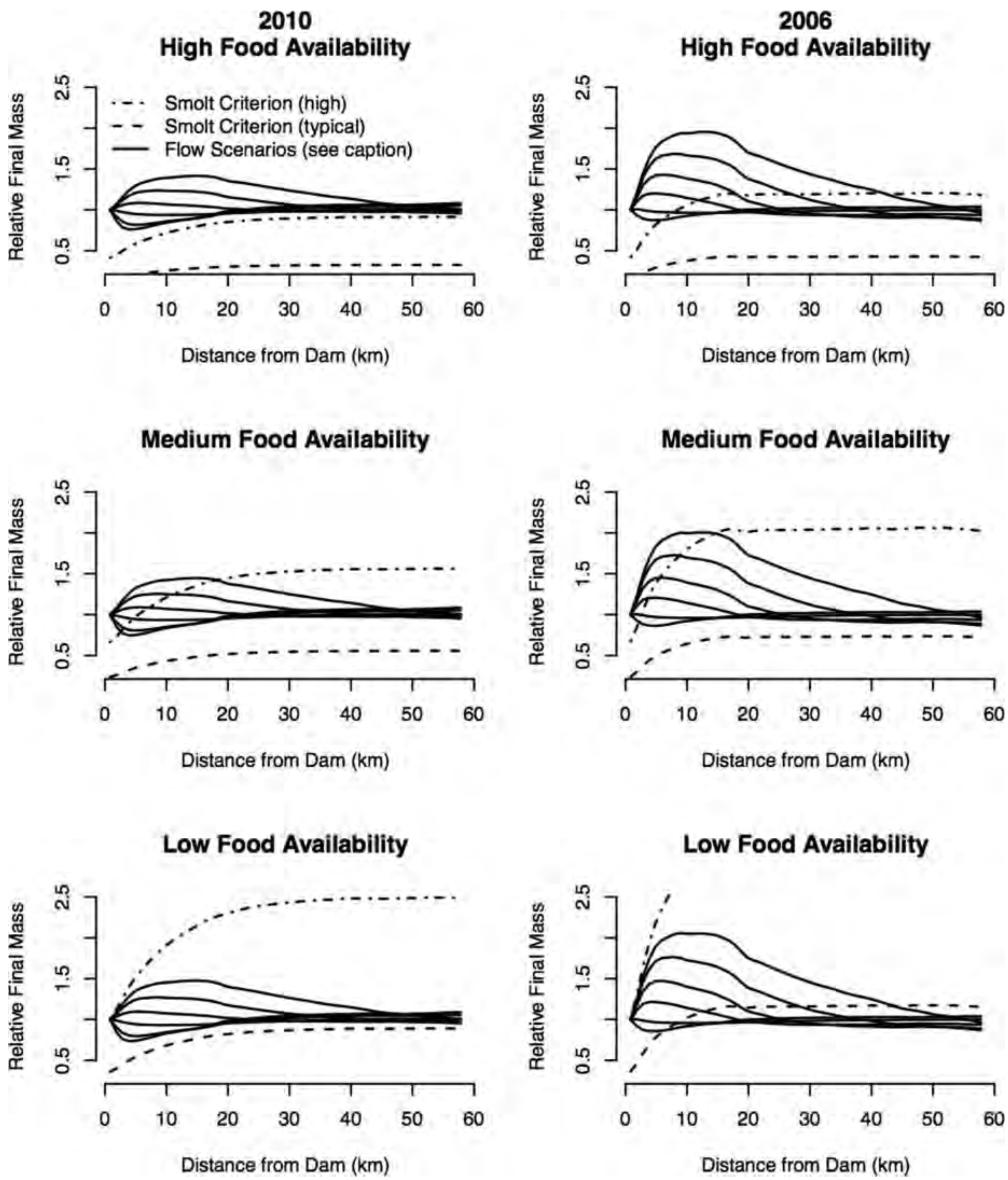

FIGURE 7. Relative final mass for age-1 steelhead on October 1 as modeled for various flow scenarios (solid lines), years (columns), and food availability (rows) at locations downstream of Bradbury Dam on the Santa Ynez River. The "typical" smolt criterion describes the final mass on October 1 that is assumed necessary to trigger smolting and out-migration during the following spring, given typical winter growth conditions. The "high" smolt criterion conservatively assumes zero winter growth. Flow scenarios (lines from top to bottom) are 5.7, 4.3, 2.8, 1.4, 0.71, and 0.28 m^3/s.

that reaches supporting a second-summer pathway shrank from the entire river to the zone below the dam for two scenarios: (1) high food availability plus the high smolting criterion (Figure 7B); and (2) low food availability plus the typical smolting criterion (Figure 7F). The size of the nursery zone generally ranged from 5 to 18 km depending on flow; however, for very high flows (>4 m^3/s), the zone could extend as far as 43 km downstream.

In no case did a flow scenario convert the entire river into potential nursery habitat—either the combination of year (meteorological conditions) and food availability produced riverwide nursery habitat or the flow scenarios created a nursery zone near the dam that disappeared downstream as the river reached thermal "quasi-equilibrium" with meteorological conditions. Only for flows greater than 4 m^3/s was the nursery zone ever longer than approximately 20 km.

Stratified Pools

Of the 14 pools that were successfully monitored, eight (~60%) were thermally stratified. Neither the bottom nor the main flow of any pool became thermally unsuitable for steelhead during the study, but water temperatures were often stressful. Mean daily stress intensity was consistently lower at the bottoms of stratified pools (Figure 8).

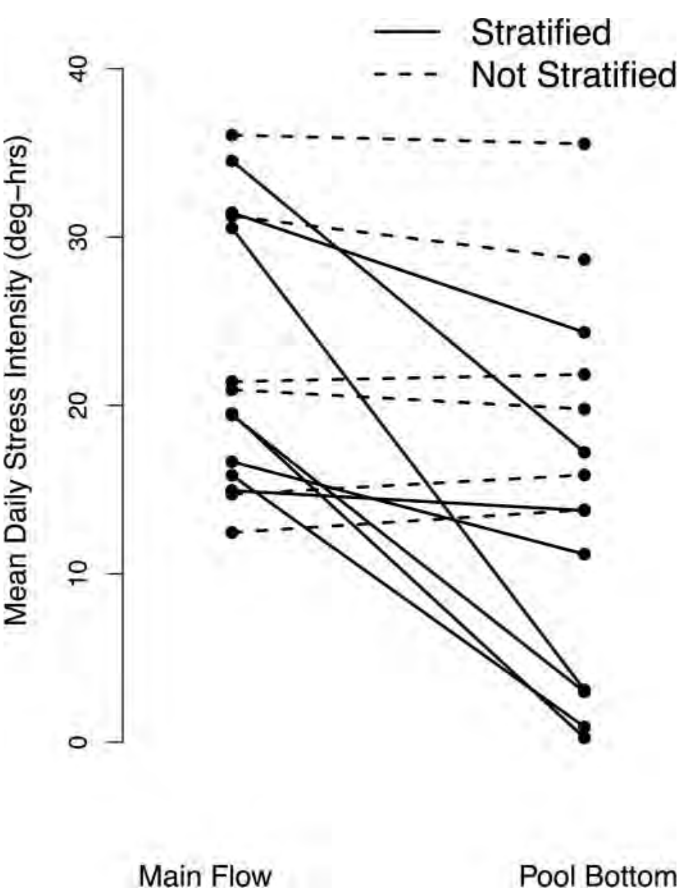

FIGURE 8. Mean daily intensity of thermal stress (degree-hours) for steelhead, as measured in the main flow and at the bottom of thermally stratified and unstratified pools in the Santa Ynez River during summer 2011.

Only five of the pools were thermally stratified on the day of their fish survey; of these pools, three harbored juvenile *O. mykiss*, whereas only one of the nine unstratified pools harbored *O. mykiss* (one-tailed *z*-test: $P = 0.027$).

DISCUSSION

Thermal Potential for Steelhead Life Histories

The simulations suggested that even during relatively hot summers, a coastal alluvial river in southern California was thermally suitable for juvenile steelhead. Nevertheless, nearly every summer day in both 2006 (the hot year) and 2010 (the average year) was thermally stressful throughout the Santa Ynez River, with stress intensity about 20% higher during 2006 than during 2010. Increasing the flow did not reduce the number of thermally stressful days except in an area just downstream of Bradbury Dam, but it did reduce the stress intensity throughout the entire river (Figure 5). Our data suggest that fish movement into stratified pools when temperatures exceed 21°C would tend to reduce stress intensity by an amount comparable to that achieved by increasing the flow (10–20 degree-hours/d; Figure 8). Presumably, this retreat to stratified pools would lower the rearing capacity for the river as a whole. However, juvenile steelhead appear to be able to use thermal refugia as a base from which to exploit the wider river during cool times of day (Brewitt and Danner 2014), so overall rearing capacity would be considerably larger than the pools themselves. Increasing the water releases from the dam might have additional benefits beyond stress reduction, such as increasing the river's capacity for first-summer life histories relative to second-summer life histories, thus supporting a greater life history diversity overall.

Predictions for potential steelhead nursery habitat can be summarized as follows. If the Santa Ynez River system supports typical winter growth, the second-summer pathway will be thermally available throughout the entire lower river but will be sensitive to climate if summer feeding opportunity is low. The first-summer pathway will also be thermally available but will become sensitive to climate when feeding opportunity is intermediate. In such situations, the pathways to anadromy can become thermally restricted to a tailwater zone below Bradbury Dam. On the other hand, if the river system produces neglible winter growth, then nursery habitat usually will be restricted to the tailwater or will be completely absent, depending on food availability.

In the simulations, flow scenarios did not determine whether the entire Santa Ynez River was nursery versus nonnursery habitat. Flow only altered the spatial extent of the tailwater zone when the river was otherwise physically unsuited to producing rapid growth of *O. mykiss*. Downstream of this zone, the river temperature became more equilibrated to local microclimate and riverbed conditions. Thus, temperature presumably became shaped much more by natural processes than by upstream dam releases and therefore was more similar to what would generally be considered an unimpaired thermal regime for this climate. In general, temperatures tended to stay above the range for maximum growth (15–17°C) but below the threshold for thermal exclusion (mean daily temperature <25°C, maximum temperature <29°C). Whether the river is thermally suitable for steelhead production (as opposed to producing *O. mykiss* that grow slowly and mature in freshwater) appears to depend more on annual weather than on flow, at least for the 2 years studied. This result accords with historical information for the late-19th and early 20th centuries, which suggests that annual runs of adult steelhead in the Santa Ynez River numbered in the thousands during some years and in the single digits during other years (Alagona et al. 2012).

Recent annual runs of steelhead in the Santa Ynez River have consistently stayed below approximately 10 fish since intensive monitoring began in the 1990s (Robinson et al. 2009). Our results suggest that water temperatures are not so high that they eliminate the potential for considerable smolt production; this indicates the existence of some other factor that keeps current steelhead production depressed relative to the production observed a century ago. Recent snorkel surveys conducted in the summer usually have found juvenile *O. mykiss* to be few and concentrated in stratified pools (Robinson et al. 2009), suggesting that very few fish currently pursue a first-summer or second-summer strategy in the lower main stem. The capacity for the second-summer pathway could also be limited by a lack of suitable upland creek habitat that can support successful spawning by anadromous *O. mykiss* and successful rearing of their progeny up to the second summer. Currently, most such habitat occurs upstream of the dam, where it is inaccessible to anadromous steelhead although commonly used by Rainbow Trout.

Exotic fish species almost certainly impact steelhead rearing in the Santa Ynez River. In particular, Largemouth Bass are quite abundant in the lower river (Robinson et al. 2009), occupy a thermal niche that broadly overlaps with the thermal niche of steelhead (Currie et al. 1998, 2004), and may both compete with and prey on juvenile steelhead (Hodgson et al. 1991; Christensen and Moore 2008, 2010; Braun and Walser 2011). Prior to the introduction of exotic fishes, southern California steelhead would have been the only medium-to-large bodied fish (>150 mm TL) feeding on invertebrates and other fishes in the Santa Ynez River and in nearby streams, where steelhead remain the only such fish and are observed to behave normally in water temperatures up to around 24°C (Spina 2007; Sloat and Osterback 2013). One explanation for the rarity of steelhead in the Santa Ynez River may be the competitive or predatory dominance of introduced fish (e.g., Largemouth Bass) that are adapted to the high end of the steelhead's thermal niche.

Shallow-River Heat Dynamics

Changing climate is generally expected to decrease summer flows relative to winter flows in western U.S. rivers that are occupied by Pacific salmonids; mechanisms include less water storage in deep soil, increased water demand by vegetation, greater surface evaporation, and especially the loss of snowpack (Mantua et al. 2010; Null et al. 2010). Although decreased summer flow affects heat fluxes by a variety of mechanisms, for simplicity these are often omitted from assessments (Mantua et al. 2010; Wenger et al. 2011; Benjamin et al. 2013). Instead, water temperature is assumed to track air temperature; this assumption relies on equilibrium assumptions that are only valid at relatively large flows and at a resolution of weekly (or coarser) average temperature (Bogan et al. 2003). Finer-grained temperature patterns, such as daily maximum temperature or degree-hours above some temperature threshold, are often biologically important but are poorly predicted by equilibrium assumptions. For example, Caissie et al. (2001) used statistical techniques to predict maximum daily creek temperature from air temperature and found that the empirical coefficient linking stream temperature and air temperature varied seasonally and was not independent of flow within seasons.

In general, subdaily temperature patterns should be sensitive to flow because for a given channel geometry and microclimate, flow establishes the scaling between heat fluxes and the thermal mass, or responsiveness, of the stream. Heat fluxes tend to scale to areas (surface area, streambed area, and cross-sectional area), whereas thermal mass, which describes the temperature response to a given flux, scales to water volume. In contrast to deep rivers, such as those fed by snowmelt, a wide, shallow river like the Santa Ynez River will have a cross-sectional area and volume that are quite small relative to horizontal surface areas; thus, longitudinal flux and thermal mass will be small relative to vertical energy fluxes. Longitudinal heat flux is reduced even further by slow water velocities in shallow rivers due to a greater effect of bed roughness. This situation would tend to decouple a shallow river from upstream conditions and raise the river's responsiveness to vertical heat exchange with the immediate riverbed and atmosphere. Since thermal mass acts as a sort of "smoother" on the temperature response, a RAFT hindcast for a shallow river such as the Santa Ynez River should involve greater error than a hindcast for a deeper river with a relatively high thermal mass; indeed, this is what we observed (RMSE = 1.5°C for the Santa Ynez River, whereas RMSE = 0.5°C for the Sacramento River; Pike et al. 2013).

Our results suggest that when the thermal mass of the water itself becomes small relative to vertical heat flux, the thermal mass of the riverbed becomes an important smoother of subdaily fluctuations. In the RAFT model, heat exchange between water and bed passively follows thermal gradients and thus reduces the temperature response to the diurnal fluctuations in atmospheric heat fluxes. When we conducted RAFT simulations with the streambed flux turned off (results not reported here), we found that this mechanism was essential to accurately hindcasting the temperatures of the lower Santa Ynez River. In our results, each doubling (or halving) of flow changed the maximum daily temperature by less than 1°C in most of the river (Figure 4), suggesting that a large amount of water must be released to add enough thermal mass to significantly augment what the riverbed already provides. In general, heat exchanges between rivers and their beds are often highly heterogeneous due to various mechanisms (Constantz 1998; Arscott et al. 2001; Arrigoni et al. 2008; Burkholder et al. 2008; Westhoff et al. 2010; Boughton et al. 2012). Anticipation of such heterogeneity may be important in identifying rivers with greater thermal resilience to the loss of summer flow, which is expected to result from climate change.

In our case study, changes in flow altered summer thermal habitat in the Santa Ynez River by two mechanisms: (1) the release of water that was out of thermal equilibrium with the local climate directly downstream of the dam; and (2) modulation of the mean depth—and thus thermal mass—of the entire river. Mechanism 1 produced a zone near the dam that functioned as a heat sink, with thermal properties that attenuated rapidly downstream, whereas mechanism 2 produced a heat buffer throughout the river. Steelhead indices that were sensitive to fine-grained fluctuations in temperature (e.g., stress intensity) responded to flow scenarios throughout the entire river (Figure 5). In contrast, the indices that integrated temperature effects over multiple days (e.g., potential growth) only responded strongly to flow scenarios within 20 km of Bradbury Dam (Figures 6, 7) or to extremely high-flow scenarios (>2.8 m^3/s [>100 ft^3/s]) that would probably not be characteristic of the river if the dam was absent. By decreasing upstream temperature, increasing mean depth, and raising water velocities, large enough summer releases from the dam might expand steelhead life history diversity in the Santa Ynez River, especially by enabling more steelhead to pursue a first-summer pathway, although it remains unclear whether this first-summer expression would be characteristic of the river in the absence of dams.

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From:	Staples, Rose
Sent:	Thursday, December 01, 2016 12:33 PM
Cc:	Deason, Jesse; Le, Bao; Staples, Rose
Subject:	FW: Presentation To Be Shown at Dec 1 La Grange Joint Subcommittees Meeting
Attachments:	20161201_Tuolumne Thermal Suitability Considerations for Reintroduction.pdf

La Grange licensing participants,

The following message (and attached presentation) was forwarded to the members of the La Grange subcommittees prior to today's joint meeting.

Rose Staples, CAP-OM, MOS
D 207-239-3857

hdrinc.com/follow-us

From: Staples, Rose
Sent: Thursday, December 1, 2016 3:30 PM
Cc: Deason, Jesse <jesse.deason@hdrinc.com>; 'Le, Bao' <Bao.Le@hdrinc.com>; Staples, Rose (Rose.Staples@hdrinc.com) <Rose.Staples@hdrinc.com>
Subject: Presentation To Be Shown at Dec 1 La Grange Joint Subcommittees Meeting

Please find attached a presentation that will be shown at today's Water Temperature Subcommittee meeting. A copy of this presentation will also be available on the La Grange Licensing website at www.lagrange-licensing.com both in the DOCUMENTS section and as an attachment to the Calendar date.

Rose Staples, CAP-OM, MOS
Executive Assistant

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Thermal Suitability Considerations for Anadromous Salmonid Reintroduction

LA GRANGE HYDROELECTRIC PROJECT

FERC NO. 14581

December 1, 2016

Evaluating Thermal Habitat Suitability

- A fundamental component in determining the feasibility of a reintroduction program for anadromous salmonids.
- An initial step in evaluating physical habitat suitability and availability.
  - If habitat is not thermally suitable then it will not be suitable from other habitat perspectives.
- Purpose – To establish the technical basis to evaluate water temperature regimes for anadromous salmonid reintroduction into the Tuolumne River upstream of Don Pedro Reservoir.

Process Overview

- **Literature Review**
  - Conduct a comprehensive literature review of species/lifestage-specific water temperature relationships.
- **Water Temperature Indices**
  - Identify a suite of water temperature index (WTI) values representing a summarization of the literature review. A WTI value is an integer in a sequence characterizing thermally-related physiologic and behavioral responses.
- **Water Temperature Metrics**
  - Identify water temperature metrics and metric application to water temperature monitoring and/or modeling data. Water temperature metrics provide a reproducible measure of temperature over a period of time that can be used in combination with WTIs to determine thermal suitability.
- **Water Temperature Evaluation Guidelines**
  - Select water temperature guidelines (WTIs and metrics) for each species/lifestage-specific period for reintroduction evaluation.
- **Evaluation Methodology**
  - Identify water temperature evaluation methodological approach.

Literature Review

Water Temperature Effects

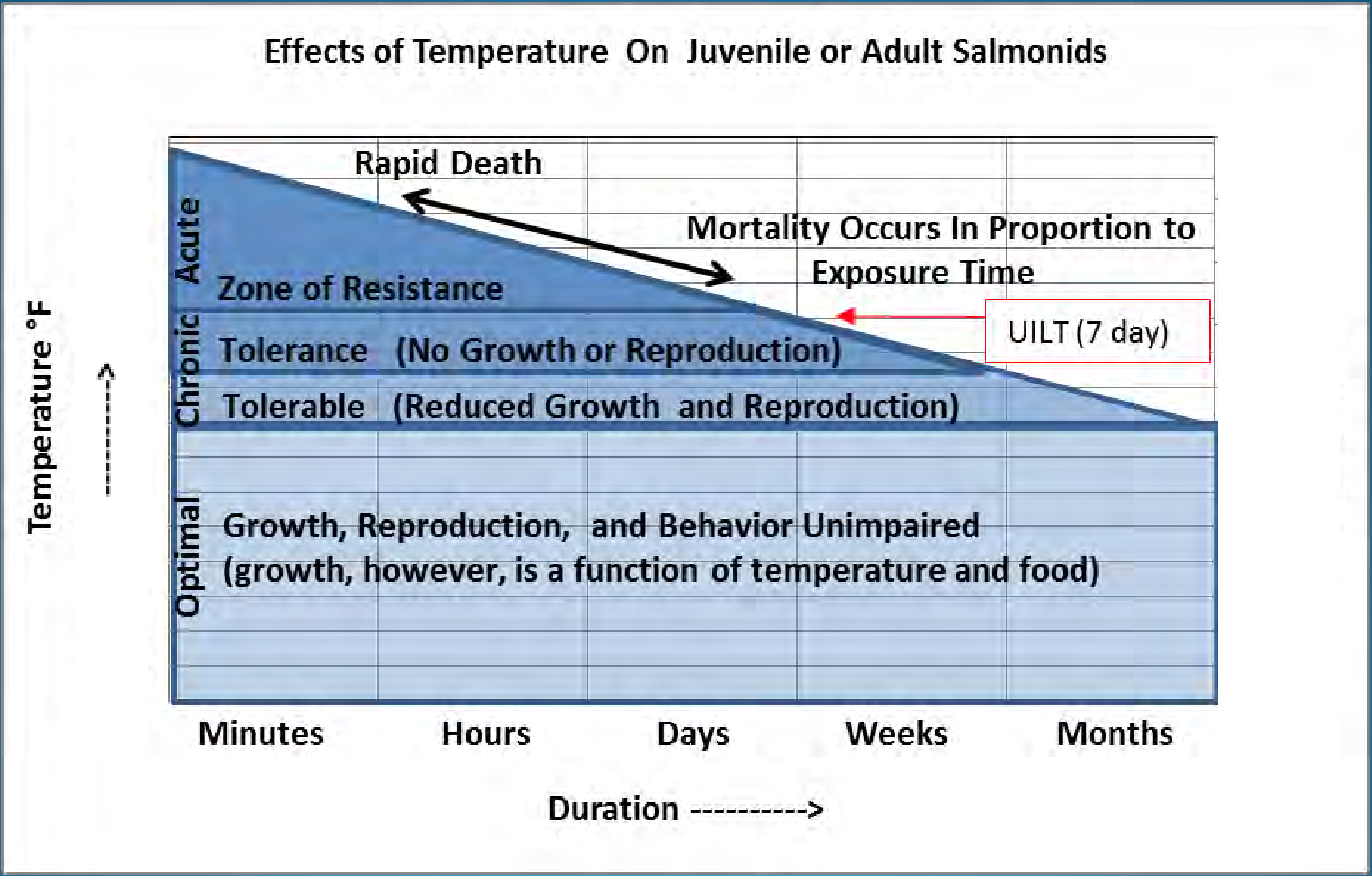

Illustration of Acute, Chronic, and Optimal Temperature Zones (adapted from Sullivan et al. 2000).

Water Temperature

LETHAL – temperatures at which direct mortality occurs.

X

Critical Thermal Maximum – Very short duration (minutes) mortality after acute temperature exposure.

Acute – Temperatures at which short-term exposure (<7days) results in rapid mortality. Mortality occurs in proportion to magnitude and duration of exposure.

Upper Incipient Lethal (UILT) – Boundary between lower end of acute temperature exposure range and upper end of chronic temperature exposure range. Temperature at which 50% mortality occurs after 7 days.

Sublethal – Temperatures that can result in indirect mortality, or that may reduce the survival and fitness of offspring. Associated with reduced disease resistance, reproductive success, juvenile growth and survival. Interference with physiological processes (e.g., metabolism, smoltification). Reduced competitive ability and altered behaviors (e.g., migration).

Suboptimal – Does not cause direct mortality, but may result in a higher probability of diminished success of a particular life stage due to sublethal effects (e.g., reduced fitness, viability, competitive ability or growth, and increased susceptibility to disease) .

Chronic – Long-term (> 7 days) exposure associated with reduced growth and reproduction. With increasing magnitude and duration of exposure, increasing potential for no growth and reproduction, and increased mortality.

Upper Tolerable (UT) – Upper boundary of the range of water temperatures at which fish can survive indefinitely, without experiencing substantial detrimental effects to physiological and biological functions such that survival occurs, but growth and reproduction success are reduced below optimal.

Upper Optimal (UO) – Upper boundary of the optimal temperature range where physiological processes (growth, reproduction, disease resistance) and behavior are not stressed by temperature.

OPTIMAL – temperatures at which physiological processes (growth, reproduction, disease resistance) and behavior are not stressed.

Water Temperature Metrics

- Designed to provide a reproducible index of water temperature over a period of time that can be used in combination with index values to determine habitat suitability for reintroduction.

- Metrics for potential application to the WTI values
  - ADT - Average Daily Temperature
  - 7DADM - Maximum of the Running 7-Day Average of the Daily Maxima for a specified time period
  - MWAT - Maximum of the Running Weekly (7-Day) Average Daily Temperature for a specified time period

Water Temperature Metrics

Average Daily Temperature

- Average daily temperature (ADT) could be considered for application because a majority of data in the literature review are based on ADT or continuous (constant) temperature.

- ADT can be used to determine the number of days (duration) that a water temperature index is exceeded, and duration of exceedance can be compared among specific geographic areas.

Water Temperature Metrics

Maximum 7-Day Average of the Daily Maxima

- The EPA (2003) recommends the maximum 7-day average of the daily maxima (7DADM)… "*because it describes the maximum temperatures in a stream, but is not overly influenced by the maximum temperature of a single day*".

- 7DADM is calculated by summing the daily maximum temperatures at a site for 7 consecutive days and dividing by 7.

Water Temperature Metrics

Maximum Weekly Average Temperature

- Maximum Weekly Average (Daily) Temperature (MWAT) is a summary measurement of instream water temperature variation that may occur on a daily or seasonal basis, and is used to evaluate chronic (sub-lethal) water temperature impacts.

- MWAT is found by calculating the mathematical mean of multiple, equally spaced, daily water temperatures over a 7-day consecutive period. The MWAT is defined as the highest value calculated for all possible consecutive 7-day periods over a given time period.

Lifestage & Water Temperature Indices

Steelhead

Lifestage	WTI Identified in Literature Review	WTIs for Reintroduction Consideration
Adult Upstream Migration	52°F, 56°F, 61°F, 64°F, 65°F, 68°F, 70°F	?
Adult Spawning	46°F, 52°F, 54°F, 55°F, 57°F, 59°F, 60°F	?
Egg Incubation and Fry Emergence	46°F, 52°F, 54°F, 55°F, 57°F, 59°F, 60°F	?
Fry Rearing	61°F, 63°F, 64°F, 65°F, 68°F, 72°F, 75°F, 77°F	?
Juvenile Rearing and Downstream Movement	61°F, 63°F, 64°F, 65°F, 68°F, 72°F, 75°F, 77°F	?
Smolt Outmigration	52°F, 55°F, 57°F, 59°F, 77°F	?

Lifestage & Water Temperature Indices
Spring-run Chinook Salmon

Lifestage	WTIs Identified in Literature Review	WTIs for Reintroduction Consideration
Adult Upstream Migration	60°F, 61°F, 64°F, 65°F, 68°F, 70°F	?
Adult Holding	60°F, 61°F, 64°F, 65°F, 68°F, 70°F	?
Adult Spawning	55°F, 56°F, 58°F, 60°F, 62°F	?
Egg Incubation and Fry Emergence	55°F, 56°F, 58°F, 60°F, 62°F	?
Fry Rearing	60°F, 61°F, 64°F, 65°F, 68°F, 70°F, 75°F, 77°F	?
Juvenile Rearing & Downstream Movement	60°F, 61°F, 64°F, 65°F, 68°F, 70°F, 75°F, 77°F	?
Smolt Outmigration	57°F, 59°F, 63°F, 68°F 72°F, 77°F	?

Lifestage & Water Temperature Indices

Fall-run Chinook Salmon

Lifestage	WTI Identified in Literature Review	WTIs for Reintroduction Consideration
Adult Upstream Migration	60°F, 61°F, 64°F, 65°F, 68°F, 70°F	?
Adult Spawning	55°F, 56°F, 58°F, 60°F, 62°F	?
Egg Incubation and Fry Emergence	55°F, 56°F, 58°F, 60°F, 62°F	?
In-River Rearing (Age 0+)	60°F, 61°F, 64°F, 65°F, 68°F, 70°F, 75°F, 77°F	?
Smolt Outmigration	57°F, 59°F, 63°F, 68°F 72°F, 77°F	?

Process Overview

- **Literature Review**
  - **Conduct a comprehensive literature review of species/lifestage-specific water temperature relationships.**
- **Water Temperature Indices**
  - **Identify a suite of WTI values representing a summarization of the literature review.**
- **Water Temperature Metrics**
  - **Identify potential water temperature metrics for application to water temperature monitoring and/or modeling data.**
- **Water Temperature Evaluation Guidelines**
  - **Select water temperature guidelines (WTIs and metrics) for each species/lifestage-specific period for reintroduction evaluation.**
- **Determine Species/Run-Specific Lifestage Periodicities**
  - **Establish the time period associated with each lifestage.**
- **Evaluation Methodology**
  - **Compare temperature guidelines to monitored and/or modeled data.**
  - **Quantify the length of river with suitable species/run lifestage-specific water temperatures.**

Thermal Suitability Considerations for Anadromous Salmonid Reintroduction

LA GRANGE HYDROELECTRIC PROJECT

FERC NO. 14581

December 1, 2016

From: Staples, Rose
Sent: Friday, December 09, 2016 8:42 AM
Cc: Deason, Jesse; Le, Bao; Staples, Rose
Subject: FW: La Grange Water Temperature/Reintroduction Goals Joint Subcommittee Next Meeting – Doodle Poll

La Grange Licensing Participants,

The following message was sent today to the members of the La Grange Water Temperature Subcommittee and the Reintroduction Goals Subcommittee regarding their availability for the next joint meeting.

Rose Staples, CAP-OM, MOS
D 207-239-3857

hdrinc.com/follow-us

From: Staples, Rose
Sent: Friday, December 9, 2016 11:34 AM
Cc: Deason, Jesse <jesse.deason@hdrinc.com>; 'Le, Bao' <Bao.Le@hdrinc.com>; Staples, Rose (Rose.Staples@hdrinc.com) <Rose.Staples@hdrinc.com>
Subject: La Grange Water Temperature/Reintroduction Goals Joint Subcommittee Next Meeting – Doodle Poll

Please visit the link below and provide your availability for the next La Grange Water Temperature/Reintroduction Goals Joint Subcommittee meeting. Please respond by Friday, December 23rd, COB.

Thank you.

http://doodle.com/poll/ct38yxpnmtu25rmr

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From: Staples, Rose
Sent: Wednesday, December 14, 2016 3:24 PM
Cc: Deason, Jesse; Le, Bao; Staples, Rose; Johnson, Laura
Subject: FW: Final Meeting Notes La Grange Licensing Reintroduction Goals Oct 20 Subcommittee Conf Call Now Available

The following message was sent today to the members of the La Grange Licensing Reintroduction Goals Subcommittee regarding the availability of the final meeting notes for the October 20, 2016 subcommittee conference call.

Rose Staples, CAP-OM, MOS
D 207-239-3857

hdrinc.com/follow-us

From: Staples, Rose
Sent: Wednesday, December 14, 2016 6:18 PM
Cc: Deason, Jesse <jesse.deason@hdrinc.com>; 'Le, Bao' <Bao.Le@hdrinc.com>; Staples, Rose (Rose.Staples@hdrinc.com) <Rose.Staples@hdrinc.com>
Subject: Final Meeting Notes La Grange Licensing Reintroduction Goals Oct 20 Subcommittee Conf Call Now Available

La Grange Licensing Reintroduction Goals Subcommittee members,

On October 31, 2016 the Districts provided to the technical subcommittee *draft* notes from the October 20, 2016 meeting and requested that the technical subcommittee provide any comments on the meeting notes by November 30, 2016. No comments were received; therefore, the final notes are the same as the draft notes originally provided on October 31.

A copy of these final notes has been uploaded to the licensing website www.lagrange-licensing.com in the DOCUMENTS section and also as an attachment to the October 20, 2016 date on the website calendar.

Thank you.

Rose Staples, CAP-OM, MOS
Executive Assistant

HDR
970 Baxter Boulevard Suite 301
Portland ME 04103
D 207-239-3857
rose.staples@hdrinc.com

hdrinc.com/follow-us

From: Staples, Rose
Sent: Wednesday, December 14, 2016 3:15 PM
Cc: Deason, Jesse; Le, Bao; Staples, Rose; Johnson, Laura
Subject: FW: Final Meeting Notes for Oct 14 2016 La Grange Licensing Water Temp Subcommittee Conf Call Now Available

The following message regarding the availability of the final meeting notes for the October 14, 2016 Water Temperature Subcommittee conference call was forwarded to the subcommittee members today.

Rose Staples, CAP-OM, MOS
D 207-239-3857

hdrinc.com/follow-us

From: Staples, Rose
Sent: Wednesday, December 14, 2016 6:08 PM
Cc: Deason, Jesse <jesse.deason@hdrinc.com>; Le, Bao <ChiBao.Le@hdrinc.com>; Staples, Rose (Rose.Staples@hdrinc.com) <Rose.Staples@hdrinc.com>
Subject: Final Meeting Notes for Oct 14 2016 La Grange Licensing Water Temp Subcommittee Conf Call Now Available

La Grange Licensing Water Temperature Subcommittee members,

On October 31, 2016 the Districts provided to the technical subcommittee *draft* notes from the October 14, 2016 meeting and requested that the technical subcommittee provide any comments on the meeting notes by November 30, 2016. No comments were received; therefore, the final notes are the same as the draft notes originally provided on October 31.

A copy of these final notes has been uploaded to the licensing website www.lagrange-licensing.com in the DOCUMENTS section and also as an attachment to the October 14, 2016 date on the website calendar.

Thank you.

Rose Staples, CAP-OM, MOS
Executive Assistant

HDR
970 Baxter Boulevard Suite 301
Portland ME 04103
D 207-239-3857
rose.staples@hdrinc.com

hdrinc.com/follow-us

From: Staples, Rose
Sent: Friday, December 16, 2016 5:35 PM
Cc: Deason, Jesse; Le, Bao; Staples, Rose; Johnson, Laura
Subject: FW: Action item - La Grange Water Temperature Subcommittee Review of Working Document
Attachments: LG_TempSubcom_TimingTempWorkingDoc_Nov2016.pdf

The following message was sent today to the members of the La Grange Licensing Water Temperature Subcommittee.

Rose Staples, CAP-OM, MOS
D 207-239-3857

hdrinc.com/follow-us

From: Staples, Rose
Sent: Friday, December 16, 2016 8:30 PM
Cc: Deason, Jesse <jesse.deason@hdrinc.com>; 'Le, Bao' <Bao.Le@hdrinc.com>; Staples, Rose (Rose.Staples@hdrinc.com) <Rose.Staples@hdrinc.com>
Subject: Action item - La Grange Water Temperature Subcommittee Review of Working Document

Water Temperature Subcommittee members,

Per an action item captured at the December 1, 2016 joint subcommittees meeting, please review the attached Water Temperature/Timing Working Document and provide any input you may have to me at Rose.Staples@hdrinc.com by Friday, January 13, 2017. Thank you.

Rose Staples, CAP-OM, MOS
Executive Assistant

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rose.staples@hdrinc.com

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	UOWTI	UTWTI	Incip Lethal WTI	Other WTI Values?	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Fall-run Chinook Salmon																
Adult Upstream Migration																
Adult Spawning																
Egg Incubation and Fry Emergence																
In-River Rearing (Age 0+)																
Smolt Outmigration																
Spring-run Chinook Salmon																
Adult Upstream Migration																
Adult Holding																
Adult Spawning																
Egg Incubation and Fry Emergence																
Fry Rearing																
Juvenile Rearing and Downstream Movement																
Smolt Outmigration																
Steelhead																
Adult Upstream Migration																
Adult Spawning																
Egg Incubation and Fry Emergence																
Fry Rearing																
Juvenile Rearing and Downstream Movement																
Smolt Outmigration																

UOWTI = Upper Optimum Water Temperature Index
UTWTI = Upper Tolerance Water Temperature Index

From:	Jean Castillo - NOAA Federal <jean.castillo@noaa.gov>
Sent:	Friday, December 16, 2016 9:48 PM
To:	Staples, Rose
Cc:	Deason, Jesse; Le, Bao
Subject:	Re: attendees

Oh thank you very much. I am still trying to put names to voices and and such.

Sincere regards,
Jean

Jean M. Castillo, MSCE, P.E.
Hydraulic/Fish Passage Engineer

NOAA Fisheries West Coast Region
U.S. Department of Commerce
650 Capitol Mall, Suite 5-100
Sacramento, California 95814-4700
Office: 916-930-3613
jean.castillo@noaa.gov

On Fri, Dec 16, 2016 at 5:48 PM, Staples, Rose <Rose.Staples@hdrinc.com> wrote:

Here is the initial list of participants, taken from the preliminary DRAFT of the notes from that meeting. I have highlighted those who were noted as attending via phone.

Meeting Attendees		
No.	**Name**	**Organization**
1	Steve Boyd	Turlock Irrigation District
2	Paul Bratovich	HDR, consultant to the Districts
3	Jean Castillo	National Marine Fisheries Service
4	Calvin Curtin	Turlock Irrigation District
5	Jesse Deason	HDR, consultant to the Districts
6	John Devine*	HDR, consultant to the Districts
7	Greg Dias	Modesto Irrigation District
8	Nann Fangue*	U.C. Davis
9	Dana Ferreira	Office of U.S. Congressman Jeff Denham
10	Mark Gard*	U.S. Fish and Wildlife Service
11	Art Godwin	Turlock Irrigation District
12	Andy Gordus	California Department of Fish and Wildlife
13	Chuck Hanson	Hanson Environmental, consultant to the Districts
14	Zac Jackson	U.S. Fish and Wildlife Service

15	Bill Ketcher	Private citizen
16	Patrick Koepele*	Tuolumne River Trust
17	Bao Le	HDR, consultant to the Districts
18	Ellen Levin*	City and County of San Francisco
19	Lonnie Moore	Private citizen
20	Marco Moreno	Latino Community Roundtable
21	Gretchen Murphy	California Department of Fish and Wildlife
22	Bill Paris	Modesto Irrigation District
23	Amanda Ransom	HDR, consultant to the Districts
24	Bill Sears*	City and County of San Francisco
25	Samantha Wookey	Modesto Irrigation District
26	John Wooster*	National Marine Fisheries Service
27	Ron Yoshiyama	City and County of San Francisco

- Attended by phone

Rose Staples, CAP-OM, MOS

D 207-239-3857

hdrinc.com/follow-us

From: Jean Castillo - NOAA Federal [mailto:jean.castillo@noaa.gov]
Sent: Tuesday, December 13, 2016 4:55 PM
To: Staples, Rose <Rose.Staples@hdrinc.com>
Subject: attendees

Hi Rose,

Can you please send me a list of those who attended the meeting on December 1st? If possible could you identify who was on the phone as compared to who was there in person?

Thanks,

Jean

Jean M. Castillo, MSCE, P.E.
Hydraulic/Fish Passage Engineer

NOAA Fisheries West Coast Region
U.S. Department of Commerce
650 Capitol Mall, Suite 5-100
Sacramento, California 95814-4700
Office: 916-930-3613

jean.castillo@noaa.gov

From: John Wooster - NOAA Federal <john.wooster@noaa.gov>
Sent: Monday, December 19, 2016 10:09 AM
To: Le, Bao
Cc: Deason, Jesse
Subject: Re: La Grange Water Temperature/Reintroduction Goals Joint Subcommittee Next Meeting – Doodle Poll

We could ask David (Bouhgton) if he would be available to call in to answer any questions during one of the next temperature sub group calls, and thus be requesting some informal technical assistance. If you want him to travel and/or give a presentation, that request will need to go through Rachel.

As to the studies conducted last summer, if the Science Center came up with a few pointed data requests that they felt would be very beneficial to their habitat evaluation, could data be shared prior to all the reports being produced?

Thanks

John

On Mon, Dec 19, 2016 at 9:44 AM, Le, Bao <ChiBao.Le@hdrinc.com> wrote:

> Thanks for the input, John.
>
> We can reach out to Rachel but to clarify, in addition to the Habitat and Genetics Study, there is also an interest in better understanding how the method described by Boughton (temperature stress index) is being applied so per our discussion, that seemed to be best detailed in the Russian River work?
>
> Congratulations on your new position. I hope this was a move you were hoping for. We'll continue working with you until we've been notified of a new biologist contact (and will keep engaging Jean also). It's been great working with you.
>
> With regard to the upper river studies, study schedules have been interrupted due to the attention that the SED is demanding. After the January 17 due date of the SED response, the Districts will be reevaluating the schedule of the voluntary studies.
>
> Bao
>
> **From:** John Wooster - NOAA Federal [mailto:john.wooster@noaa.gov]
> **Sent:** Thursday, December 15, 2016 11:27 AM
> **To:** Le, Bao

Cc: Deason, Jesse
Subject: Re: La Grange Water Temperature/Reintroduction Goals Joint Subcommittee Next Meeting – Doodle Poll

In regards to #4, I don't have the ability to make meetings with the Science Center happen on my own - there is a Science Center liaison (Rachel Johnson) that facilitates / arranges meetings with the public and the Science Center. This is an intentional buffer between NMFS staff and the Science Center as we had problems with NMFS staff constantly asking for meetings, and in this case the contracts I wrote for them had zero budget for meetings and travel, so we have to go through this process. I believe there was already one attempt to arrange a meeting on the Genetic Study with Rachel - not sure why that didn't come to fruition, as the last time we spoke I thought there was going to be an attempt at early summer (which admittedly was somewhat problematic from the out set as it was in the middle of high field sampling season). But I think the best path forward is to reengage Rachel on requests for both Habitat and Genetics Study.

Yes, I have moved positions within NMFS, from the FERC Branch to the Environmental Services / Engineering branch as a fish passage engineer (I actually used to be part of this branch before FERC branch was split off during the West Coast merger in 2014). I am maintaining some involvement in the Tuolumne and Merced Projects. Specifically, I am maintaining management of the Science Center contracts / reports related to upper Tuolumne and Merced studies. I am maintaining the temperature loggers deployed in the field. I will be transitioning out of day to day FERC duties and move more into reviewer / advisor on FERC stuff, and Jean will stay on as the primary engineer on the Tuolumne. I expect a new biologist to be assigned to the FERC Project to help Jean - but to my knowledge that hasn't happened yet. For the time being it is fine to keep questions coming my way, as most of it is probably related to the Science Center contracts anyway.

Speaking of which the Science Center asked me to check in on the availability of study results/data from all the field work you guys did last summer? I think there would be interest in pretty much everything you collected, as it is all related to habitat one way or another.

Thanks,

-John

On Wed, Dec 14, 2016 at 6:14 PM, Le, Bao <ChiBao.Le@hdrinc.com> wrote:

Hi John.

The notes we have are still draft and in review but this is what I have. If they change at all, I'll let you know but I'm pretty sure we captured them accurately.

1. The Districts will try to match up the temperature numbers presented in Boughton (2015) with the water temperature definitions/responses provided on slide 5 of Mr. Bratovich's presentation. The Districts will provide their findings to the Temperature Subcommittee and NMFS for feedback. John Wooster to see if NMFS Science Center can review and provide input.

2. Mr. Wooster will provide schedule of availability for the Russian River memo.

3. Mr. Wooster will provide schedule of availability for the Tuolumne and Merced Habitat and Carrying Capacity and Genetics studies.

4. Districts to evaluate preference for a meeting with the NMFS Science Center for a presentation on temperature methodology.

With respect to #4, the Districts understand they might only have one engagement with NMFS Science Center folks but think it's important to have this meeting sooner rather than later. So they've asked that I reach out to you to see if you can facilitate having a meeting in mid to late February 2017.

Lastly, at the meeting, Jean mentioned that you accepted a new position and said I should touch base with you. Are you able to provide any details?

Thanks, Bao

From: John Wooster - NOAA Federal [mailto:john.wooster@noaa.gov]
Sent: Wednesday, December 14, 2016 3:30 PM
To: Le, Bao
Cc: Deason, Jesse
Subject: Re: La Grange Water Temperature/Reintroduction Goals Joint Subcommittee Next Meeting – Doodle Poll

Bao:

Can you send me any action items I had from the last temp / reintroduction group call? Sorry, I was driving for most of that call.

The only one I have at the moment is check in on date of release of Russian River Estuary Report on modeling / temp of O.mykiss.

Thanks,

John

On Fri, Dec 9, 2016 at 8:33 AM, Staples, Rose <Rose.Staples@hdrinc.com> wrote:

Please visit the link below and provide your availability for the next La Grange Water Temperature/Reintroduction Goals Joint Subcommittee meeting. Please respond by Friday, December 23rd, COB.

Thank you.

http://doodle.com/poll/ct38yxpnmtu25rmr

Rose Staples, CAP-OM, MOS

Executive Assistant

HDR

970 Baxter Boulevard Suite 301
Portland ME 04103
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rose.staples@hdrinc.com

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--

John Wooster
Hydrologist
NOAA Fisheries West Coast Region
U.S. Department of Commerce
john.wooster@noaa.gov

From: Staples, Rose
Sent: Wednesday, December 21, 2016 2:22 PM
Cc: Deason, Jesse; Le, Bao; Staples, Rose; Johnson, Laura
Subject: FW: LA Grange Reintroduction Goals Subcommittee Review of Updated Draft Narrative Statement

La Grange Licensing participants,

The following message was sent today to the members of the La Grange Reintroduction Goals Subcommittee.

Rose Staples, CAP-OM, MOS
D 207-239-3857

hdrinc.com/follow-us

From: Staples, Rose
Sent: Wednesday, December 21, 2016 5:16 PM
Cc: Deason, Jesse <jesse.deason@hdrinc.com>; 'Le, Bao' <Bao.Le@hdrinc.com>; Staples, Rose (Rose.Staples@hdrinc.com) <Rose.Staples@hdrinc.com>
Subject: LA Grange Reintroduction Goals Subcommittee Review of Updated Draft Narrative Statement

Reintroduction Goal Subcommittee members,

Per discussions at the December 1, 2016 joint subcommittee meeting, the draft narrative reintroduction goal statement was modified. An action item was captured to send to the subcommittee for review an updated draft narrative goal statement reflective of this discussion. The **updated draft narrative goal statement** is as follows:

"Contribute to the recovery of ESA listed salmonids in the Central Valley by establishing viable populations in the Tuolumne River at fair and reasonable cost.

Specific objectives consistent with the goal statement include the following:"

Please review and provide input on the updated statement to me (Rose.Staples@hdrinc.com) by January 13, 2017.

Thank you.

Rose Staples, CAP-OM, MOS
Executive Assistant

HDR
970 Baxter Boulevard Suite 301
Portland ME 04103
D 207-239-3857
rose.staples@hdrinc.com

hdrinc.com/follow-us

From: John Buckley <johnb@cserc.org>
Sent: Thursday, December 22, 2016 10:20 AM
To: Staples, Rose
Cc: Deason, Jesse; Le, Bao; Johnson, Laura
Subject: Re: LA Grange Reintroduction Goals Subcommittee Review of Updated Draft Narrative Statement

Rose and others:

As a participant in the past in settlement discussions and the development of FERC licensing conditions, I believe that wording definitely matters to the success of a process.

The updated draft narrative goal statement contains two words that are nebulous, non-measurable, and subjective. The word "reasonable" may at least have some broad consensus in that if measures result in costs that are staggering compared to the expected beneficial outcome, most FERC participants may generally agree that such measures are not "reasonable."

But the inclusion of the word "fair" in any goal statement is not appropriate. It is unlikely there will ever be strong, broad agreement from all the participating interests as to how to define "fair" when it comes to the cost of reaching goals or implementing measures.

This e-mail communication is simply intended to be helpful, and I can "live with" and accept whatever generalized draft narrative goal statement that the subcommittee selects. But as the FERC process unfolds, any choice to include highly subjective wording that can mean completely different things to different parties will not be helpful to the process.

John Buckley
CSERC

On Dec 21, 2016, at 2:22 PM, Staples, Rose <Rose.Staples@hdrinc.com> wrote:

> La Grange Licensing participants,
>
> The following message was sent today to the members of the La Grange Reintroduction Goals Subcommittee.
>
> Rose Staples, CAP-OM, MOS
> D 207-239-3857
>
> hdrinc.com/follow-us
>
> ---
>
> **From:** Staples, Rose
> **Sent:** Wednesday, December 21, 2016 5:16 PM
> **Cc:** Deason, Jesse <jesse.deason@hdrinc.com>; 'Le, Bao' <Bao.Le@hdrinc.com>; Staples, Rose

(Rose.Staples@hdrinc.com) <Rose.Staples@hdrinc.com>
Subject: LA Grange Reintroduction Goals Subcommittee Review of Updated Draft Narrative Statement

Reintroduction Goal Subcommittee members,

Per discussions at the December 1, 2016 joint subcommittee meeting, the draft narrative reintroduction goal statement was modified. An action item was captured to send to the subcommittee for review an updated draft narrative goal statement reflective of this discussion. The **updated draft narrative goal statement** is as follows:

"Contribute to the recovery of ESA listed salmonids in the Central Valley by establishing viable populations in the Tuolumne River at fair and reasonable cost.

Specific objectives consistent with the goal statement include the following:"

Please review and provide input on the updated statement to me (Rose.Staples@hdrinc.com) by January 13, 2017.

Thank you.

Rose Staples, CAP-OM, MOS
Executive Assistant

HDR
970 Baxter Boulevard Suite 301
Portland ME 04103
D 207-239-3857
rose.staples@hdrinc.com

hdrinc.com/follow-us

From: John Wooster - NOAA Federal <john.wooster@noaa.gov>
Sent: Wednesday, January 04, 2017 11:13 AM
To: Deason, Jesse
Cc: Le, Bao
Subject: Re: La Grange Updated Study Report - NMFS Studies

Thanks for the reminder, I just sent an email to the study leads asking for a check-in call, provided they are all around, January 13 shouldn't be a problem.

-JW

On Wed, Jan 4, 2017 at 10:43 AM, Deason, Jesse <Jesse.Deason@hdrinc.com> wrote:

It would be great to receive the status updates by Friday, January 13.

Jesse Deason

D 206.826.4744 M 781.249.2452

hdrinc.com/follow-us

From: Le, Bao
Sent: Wednesday, January 04, 2017 10:40 AM
To: Deason, Jesse <Jesse.Deason@hdrinc.com>; John Wooster - NOAA Federal (John.Wooster@noaa.gov) <John.Wooster@noaa.gov>
Subject: RE: La Grange Updated Study Report - NMFS Studies

Thanks, Jesse. When do you need John's feedback?

John, Happy New Year. Just a note that I have not forgotten about your last request via email. I've routed it to John and the Districts and haven't gotten any feedback yet (likely due to the holidays). I'll circle back when I hear something.

Thanks, Bao

From: Deason, Jesse
Sent: Wednesday, January 04, 2017 10:13 AM
To: John Wooster - NOAA Federal (John.Wooster@noaa.gov)
Cc: Le, Bao
Subject: RE: La Grange Updated Study Report - NMFS Studies

Hi John,

This a friendly reminder to please send us an update on the NMFS studies (habitat and genetics) for us to include in the USR.

Thanks,

Jesse

Jesse Deason

D 206.826.4744 **M** 781.249.2452

hdrinc.com/follow-us

From: John Wooster - NOAA Federal [mailto:john.wooster@noaa.gov]
Sent: Monday, November 28, 2016 1:29 PM
To: Deason, Jesse <Jesse.Deason@hdrinc.com>
Cc: Le, Bao <ChiBao.Le@hdrinc.com>; Borovansky, Jenna <Jenna.Borovansky@hdrinc.com>
Subject: Re: La Grange Updated Study Report - NMFS Studies

Sounds good, a reminder about a week out wouldn't be the worst idea...

-JW

On Mon, Nov 28, 2016 at 1:26 PM, Deason, Jesse <Jesse.Deason@hdrinc.com> wrote:

Hi John,

Given that USR is due to FERC by February 1, if we could get your input by the mid-January (say by Friday, January 13), it would be much appreciated.

Jesse Deason

D 206.826.4744 M 781.249.2452

hdrinc.com/follow-us

From: Le, Bao
Sent: Monday, November 28, 2016 1:24 PM
To: John Wooster - NOAA Federal
Cc: Deason, Jesse; Borovansky, Jenna
Subject: RE: La Grange Updated Study Report - NMFS Studies

Excellent. Thanks, John.

For due date, I will defer to Jesse Deason since she is managing overall production schedule.

Bao

From: John Wooster - NOAA Federal [mailto:john.wooster@noaa.gov]
Sent: Monday, November 28, 2016 1:16 PM
To: Le, Bao
Cc: Deason, Jesse; Borovansky, Jenna
Subject: Re: La Grange Updated Study Report - NMFS Studies

I can provide update paragraphs, when is the due date?

-JW

On Sat, Nov 19, 2016 at 10:39 AM, Le, Bao <ChiBao.Le@hdrinc.com> wrote:

Hi John.

Similar to the Initial Study Report, the Updated Study Report (USR) will report upon the NMFS studies (habitat and genetics) since they are items that would inform the licensing process as cited in the Revised Study Plan. I've not touched base with you on the progress of these studies but given USR reporting is fast approaching I wanted to touch base on these studies. Are there progress or interim reports that can be shared as part of the USR? Or are you able to provide status updates on these studies (i.e., a few paragraphs describing objective, methods, field work, any preliminary analysis, and completion schedule)? Any of this would be really useful information to include in the USR.

Thanks,

Bao

Bao Le

Senior Fisheries Biologist

HDR

1001 SW 5th Avenue, Suite 1800
Portland, OR 97204-1134
Note new direct line:**D** 503.423.3828 **M** 503.309.9423
bao.le@hdrinc.com

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--

John Wooster
Hydrologist
NOAA Fisheries West Coast Region
U.S. Department of Commerce
john.wooster@noaa.gov

From: Staples, Rose
Sent: Thursday, January 12, 2017 2:13 PM
Cc: Deason, Jesse; Le, Bao; Johnson, Laura
Subject: Districts E-Filing with FERC Today Regarding Reservoir Transit Study

La Grange licensing participants,

The Districts have e-filed with FERC today an update on the Reservoir Transit Study. A copy of this filing is available in the DOCUMENTS section of the www.lagrange-licensing.com website—and is also available for viewing on FERC E-Library at www.FERC.gov.

Rose Staples, CAP-OM, MOS
Executive Assistant

HDR
970 Baxter Boulevard Suite 301
Portland ME 04103
D 207-239-3857
rose.staples@hdrinc.com

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From: Staples, Rose
Sent: Thursday, January 12, 2017 2:19 PM
Cc: Deason, Jesse; Le, Bao; Johnson, Laura
Subject: La Grange USR Meeting Scheduled for February 16, 2017

La Grange Licensing Participants,

The La Grange Project Updated Study Report (USR) Meeting will be held on Thursday, February 16, 2017 at MID's offices in Modesto. The Districts will release more details (e.g., meeting time and agenda) closer to the meeting date.

Rose Staples, CAP-OM, MOS
Executive Assistant

HDR
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Portland ME 04103
D 207-239-3857
rose.staples@hdrinc.com

hdrinc.com/follow-us

From: Staples, Rose
Sent: Thursday, January 12, 2017 5:01 PM
Cc: Deason, Jesse; Le, Bao; Staples, Rose; Johnson, Laura
Subject: FW: La Grange Reintroduction Goals Subcommittee Dec 1 2016 Meeting Draft Notes Available for Review

La Grange Licensing Participants,

The following message was sent today to the members of the La Grange Reintroduction Goals Subcommittee regarding the availability for review of the draft notes for the December 1, 2016 joint subcommittees meeting.

Rose Staples, CAP-OM, MOS
D 207-239-3857

hdrinc.com/follow-us

From: Staples, Rose
Sent: Thursday, January 12, 2017 7:55 PM
Cc: Deason, Jesse <jesse.deason@hdrinc.com>; 'Le, Bao' <Bao.Le@hdrinc.com>; Staples, Rose (Rose.Staples@hdrinc.com) <Rose.Staples@hdrinc.com>; Johnson, Laura <Laura.Johnson@hdrinc.com>
Subject: La Grange Reintroduction Goals Subcommittee Dec 1 2016 Meeting Draft Notes Available for Review

Reintroduction Goals Subcommittee,

DRAFT NOTES from the December 1, 2016 Reintroduction Goals Subcommittee meeting have been uploaded to the licensing website www.lagrange-licensing.com in the DOCUMENTS section and also as an attachment to the December 1, 2016 date on the website calendar.

Please provide any comments on the meeting notes by Monday, February 13, 2017, to rose.staples@hdrinc.com. The Districts will incorporate any comments received and then post a final version of the meeting notes to the licensing website.

As a reminder, please provide any feedback on the updated draft narrative goal statement to rose.staples@hdrinc.com by January 13, 2017.

Rose Staples, CAP-OM, MOS
Executive Assistant

HDR
970 Baxter Boulevard Suite 301
Portland ME 04103
D 207-239-3857
rose.staples@hdrinc.com

hdrinc.com/follow-us

From: Staples, Rose
Sent: Thursday, January 12, 2017 4:50 PM
Cc: Deason, Jesse; Le, Bao; Johnson, Laura; Staples, Rose
Subject: FW: La Grange Water Temp Subcommittee Dec 1 2016 Meeting Draft Notes Available for Review

La Grange Licensing Participants,

The following message were sent to members of the Water Temperature Subcommittee today regarding the availability for review of the DRAFT NOTES for the December 1, 2016 joint subcommittees meeting.

Rose Staples, CAP-OM, MOS
D 207-239-3857

hdrinc.com/follow-us

From: Staples, Rose
Sent: Thursday, January 12, 2017 7:43 PM
Cc: Deason, Jesse <jesse.deason@hdrinc.com>; 'Le, Bao' <Bao.Le@hdrinc.com>; Johnson, Laura <Laura.Johnson@hdrinc.com>; Staples, Rose (Rose.Staples@hdrinc.com) <Rose.Staples@hdrinc.com>
Subject: La Grange Water Temp Subcommittee Dec 1 2016 Meeting Draft Notes Available for Review

Water Temperature Subcommittee,

DRAFT NOTES from the December 1, 2016 Water Temperature Subcommittee meeting have been uploaded to the licensing website www.lagrange-licensing.com in the DOCUMENTS section and also as an attachment to the December 1, 2016 date on the website calendar.

Please provide any comments on the meeting notes by Monday, February 13, 2017, to rose.staples@hdrinc.com. The Districts will incorporate any comments received and then post a final version of the meeting notes to the licensing website.

As a reminder, please provide any comments on the Water Temp/Timing Working Document to rose.staples@hdrinc.com by January 13, 2017.

Rose Staples, CAP-OM, MOS
Executive Assistant

HDR
970 Baxter Boulevard Suite 301
Portland ME 04103
D 207-239-3857
rose.staples@hdrinc.com

hdrinc.com/follow-us

From: Gordus, Andy@Wildlife [mailto:Andy.Gordus@wildlife.ca.gov]
Sent: Tuesday, January 17, 2017 5:06 PM
To: Staples, Rose <Rose.Staples@hdrinc.com>
Subject: RE: La Grange Water Temp Subcommittee Dec 1 2016 Meeting Draft Notes Available for Review

Attached is our comment to the meeting notes. Also, please change Mr. Gordus to Dr Gordus.

Andy

Andrew G. Gordus, Ph. D.
Staff Toxicologist
California Department of Fish and Wildlife
1234 East Shaw Ave.
Fresno, CA 93710

(559) 243-4014 x 239
(559) 243-4020 Fax

From: Staples, Rose [mailto:Rose.Staples@hdrinc.com]
Sent: Thursday, January 12, 2017 4:43 PM
Cc: Deason, Jesse; Le, Bao; Johnson, Laura; Staples, Rose
Subject: La Grange Water Temp Subcommittee Dec 1 2016 Meeting Draft Notes Available for Review

Water Temperature Subcommittee,

DRAFT NOTES from the December 1, 2016 Water Temperature Subcommittee meeting have been uploaded to the licensing website www.lagrange-licensing.com in the DOCUMENTS section and also as an attachment to the December 1, 2016 date on the website calendar.

Please provide any comments on the meeting notes by Monday, February 13, 2017, to rose.staples@hdrinc.com. The Districts will incorporate any comments received and then post a final version of the meeting notes to the licensing website.

As a reminder, please provide any comments on the Water Temp/Timing Working Document to rose.staples@hdrinc.com by January 13, 2017.

Rose Staples, CAP-OM, MOS
Executive Assistant

HDR

970 Baxter Boulevard Suite 301
Portland ME 04103
D 207-239-3857
rose.staples@hdrinc.com

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Page 5.

Change:

Mr. Devine asked Mr. Gordus if 20°C to 22°C is considered to be not too stressful for fish in the upper river, why wouldn't that also be the case for fish in the lower river. Mr. Gordus said he did not have the authority to weigh in on that question.

To:

Mr. Devine asked Dr. Gordus if fish do well at temperatures in the upper reach that are warmer than the EPA 2003 recommended temperatures for below the dams, would California Department of Fish and Wildlife consider changing the criteria for the reach below the dams to the warmer temperatures. Ms Gretchen Murphy and Dr. Gordus stated they did not have the authority to weigh in on that question.

From: Staples, Rose
Sent: Friday, January 20, 2017 3:08 PM
To: 'William Foster - NOAA Federal' <william.foster@noaa.gov>
Subject: RE: Add William Foster to list of NMFS contacts for P-14581 & P-2299

Thank you for the advisory; I have added your email address to the general email groups for both projects (and at the same time removed John Wooster's).

I have also added your name (and removed John's) on the La Grange Project's Temperature Criteria Subcommittee. As you mentioned in your email, the next meeting of this subcommittee, jointly with the Reintroduction Goals Subcommittee, is scheduled for January 26.

The next general meeting is the USR meeting scheduled for February 16, where the topic of discussion will be the La Grange Project Updated Study Report, due to be released prior to the meeting (about February 1st).

Rose Staples, CAP-OM, MOS
D 207-239-3857

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From: William Foster - NOAA Federal [mailto:william.foster@noaa.gov]
Sent: Friday, January 20, 2017 12:37 PM
To: Staples, Rose <Rose.Staples@hdrinc.com>
Cc: Jean Castillo - NOAA Federal <jean.castillo@noaa.gov>; Edmondson, Steve <Steve.Edmondson@noaa.gov>; John Wooster - NOAA Federal <john.wooster@noaa.gov>
Subject: Add William Foster to list of NMFS contacts for P-14581 & P-2299

Dear Rose Staples:

I am replacing John Wooster as the NMFS contact for the
LaGrange / P-14581 and New Don Pedro / P-2299 Projects.

While John can still be reached via his email, he has moved out of the FERC Branch and over to the CA Coastal Office, Environmental Services Branch, Santa Rosa, CA., (Richard Wantuck, Supervisor).

I am interested in getting a copy of your Process Plan.

I am also interested in a schedule of any upcoming meetings, preferably notice of them several weeks out at least so that I can coordinate my time.

Please include me in any such email notices for both projects.

I will attend the Jan. 26 P-14581 meeting (1-4 in Modesto).

I note you have also scheduled an Updated Study Report (USR)
meeting for Feb 16 (times tbd). I will likely attend that as well.

The Feb. meeting appears to be the roll-out of the USR document? (as I have not found one yet).

Thanks

William E. Foster, M.S., Fishery Biologist
NOAA Fisheries, West Coast Region
California Central Valley Area Office
FERC Branch, Sacramento, CA
(916) 930-3617

From: Deason, Jesse
Sent: Monday, January 23, 2017 3:39 PM
To: 'John Wooster - NOAA Federal'; Le, Bao
Subject: RE: La Grange Updated Study Report - NMFS Studies

Hi John,

Yes, please do send me your two updates. Regarding the engineering study, do you have a point of contact we can reach out to directly for an update?

Thanks,

Jesse

Jesse Deason
D 206.826.4744 M 781.249.2452

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From: John Wooster - NOAA Federal [mailto:john.wooster@noaa.gov]
Sent: Monday, January 23, 2017 1:57 PM
To: Deason, Jesse <Jesse.Deason@hdrinc.com>; Le, Bao <ChiBao.Le@hdrinc.com>
Subject: Re: La Grange Updated Study Report - NMFS Studies

Hi Jesse:

I apologize in that I responded this morning without really reading the details of your email, as I figured your were just wondering where my updates were since I was delinquent in getting those out. In regards to your question about the NMFS Fish Passage engineering study, I'm not really involved and can't provide an update on that study - it isn't a science center contract and came on board after I moved branches.

So I have asked NMFS that are involved with that study to see if they can provide an update.

I did finish my two updates, and those are ready to go if you would rather just have those in the interim.

-John

On Sun, Jan 22, 2017 at 9:41 AM, Deason, Jesse <Jesse.Deason@hdrinc.com> wrote:

Hi John.

Related to the updates that you'll be providing of NMFS studies for La Grange Licensing, the Districts through one of their subcontractors learned that NMFS is conducting a Fish Passage Engineering Feasibility Study. We are hoping that you will provide an update of this study along with the habitat and genetics summaries since it has relevance to the Fish Passage Facilities Alternatives Assessment the Districts are conducting for La Grange Licensing.

Thanks,

Jesse

Jesse Deason

D 206.826.4744 M 781.249.2452

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From: John Wooster - NOAA Federal <john.wooster@noaa.gov>
Sent: Monday, January 23, 2017 8:42 AM
To: Deason, Jesse
Cc: Le, Bao
Subject: Re: La Grange Updated Study Report - NMFS Studies

Its coming today, from me, not Bill who contacted you on Friday....

John

On Sun, Jan 22, 2017 at 9:41 AM, Deason, Jesse <Jesse.Deason@hdrinc.com> wrote:

Hi John.

Related to the updates that you'll be providing of NMFS studies for La Grange Licensing, the Districts through one of their subcontractors learned that NMFS is conducting a Fish Passage Engineering Feasibility Study. We are hoping that you will provide an update of this study along with the habitat and genetics summaries since it has relevance to the Fish Passage Facilities Alternatives Assessment the Districts are conducting for La Grange Licensing.

Thanks,

Jesse

Jesse Deason

D 206.826.4744 M 781.249.2452

hdrinc.com/follow-us

From: Deason, Jesse
Sent: Wednesday, January 18, 2017 11:27 AM
To: 'John Wooster - NOAA Federal' <john.wooster@noaa.gov>
Cc: Le, Bao <ChiBao.Le@hdrinc.com>
Subject: RE: La Grange Updated Study Report - NMFS Studies

Hi John,

This is a friendly reminder to send us the NMFS study updates so we can add them to the USR.

Thanks,

Jesse

Jesse Deason

D 206.826.4744 **M** 781.249.2452

hdrinc.com/follow-us

From: Deason, Jesse
Sent: Monday, January 16, 2017 9:12 AM
To: 'John Wooster - NOAA Federal' <john.wooster@noaa.gov>
Cc: Le, Bao <ChiBao.Le@hdrinc.com>
Subject: RE: La Grange Updated Study Report - NMFS Studies

Hi John,

Thanks for the update on this. Regarding formatting, you do not need to format it, we will cut and paste your update in the USR document.

Jesse

Jesse Deason

D 206.826.4744 **M** 781.249.2452

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From: John Wooster - NOAA Federal [mailto:john.wooster@noaa.gov]
Sent: Friday, January 13, 2017 4:14 PM
To: Deason, Jesse <Jesse.Deason@hdrinc.com>
Cc: Le, Bao <ChiBao.Le@hdrinc.com>
Subject: Re: La Grange Updated Study Report - NMFS Studies

I didn't quite finish these today, but did manage to touch base with all the science center folks and only need to type one more update from the call I just had. Won't take long.

One question for you, should I send these along unformatted and you will cut and past into your document, or should I format these as a stand alone transmission that is coming from NMFS?

John

On Wed, Jan 4, 2017 at 10:43 AM, Deason, Jesse <Jesse.Deason@hdrinc.com> wrote:

It would be great to receive the status updates by Friday, January 13.

Jesse Deason

D 206.826.4744 M 781.249.2452

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From: Le, Bao
Sent: Wednesday, January 04, 2017 10:40 AM
To: Deason, Jesse <Jesse.Deason@hdrinc.com>; John Wooster - NOAA Federal (John.Wooster@noaa.gov) <John.Wooster@noaa.gov>
Subject: RE: La Grange Updated Study Report - NMFS Studies

Thanks, Jesse. When do you need John's feedback?

John, Happy New Year. Just a note that I have not forgotten about your last request via email. I've routed it to John and the Districts and haven't gotten any feedback yet (likely due to the holidays). I'll circle back when I hear something.

Thanks, Bao

From: Deason, Jesse
Sent: Wednesday, January 04, 2017 10:13 AM

To: John Wooster - NOAA Federal (John.Wooster@noaa.gov)
Cc: Le, Bao
Subject: RE: La Grange Updated Study Report - NMFS Studies

Hi John,

This a friendly reminder to please send us an update on the NMFS studies (habitat and genetics) for us to include in the USR.

Thanks,

Jesse

Jesse Deason

D 206.826.4744 **M** 781.249.2452

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From: John Wooster - NOAA Federal [mailto:john.wooster@noaa.gov]
Sent: Monday, November 28, 2016 1:29 PM
To: Deason, Jesse <Jesse.Deason@hdrinc.com>
Cc: Le, Bao <ChiBao.Le@hdrinc.com>; Borovansky, Jenna <Jenna.Borovansky@hdrinc.com>
Subject: Re: La Grange Updated Study Report - NMFS Studies

Sounds good, a reminder about a week out wouldn't be the worst idea...

-JW

On Mon, Nov 28, 2016 at 1:26 PM, Deason, Jesse <Jesse.Deason@hdrinc.com> wrote:

> Hi John,

Given that USR is due to FERC by February 1, if we could get your input by the mid-January (say by Friday, January 13), it would be much appreciated.

Jesse Deason

D 206.826.4744 M 781.249.2452

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From: Le, Bao
Sent: Monday, November 28, 2016 1:24 PM
To: John Wooster - NOAA Federal
Cc: Deason, Jesse; Borovansky, Jenna
Subject: RE: La Grange Updated Study Report - NMFS Studies

Excellent. Thanks, John.

For due date, I will defer to Jesse Deason since she is managing overall production schedule.

Bao

From: John Wooster - NOAA Federal [mailto:john.wooster@noaa.gov]
Sent: Monday, November 28, 2016 1:16 PM
To: Le, Bao
Cc: Deason, Jesse; Borovansky, Jenna
Subject: Re: La Grange Updated Study Report - NMFS Studies

I can provide update paragraphs, when is the due date?

-JW

On Sat, Nov 19, 2016 at 10:39 AM, Le, Bao <ChiBao.Le@hdrinc.com> wrote:

Hi John.

Similar to the Initial Study Report, the Updated Study Report (USR) will report upon the NMFS studies (habitat and genetics) since they are items that would inform the licensing process as cited in the Revised Study Plan. I've not touched base with you on the progress of these studies but given USR reporting is fast approaching I wanted to touch base on these studies. Are there progress or interim reports that can be shared as part of the USR? Or are you able to provide status updates on these studies (i.e., a few paragraphs describing objective, methods, field work, any preliminary analysis, and completion schedule)? Any of this would be really useful information to include in the USR.

Thanks,

Bao

Bao Le

Senior Fisheries Biologist

HDR

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John Wooster
Hydrologist
NOAA Fisheries West Coast Region
U.S. Department of Commerce
john.wooster@noaa.gov

From: Staples, Rose
Sent: Tuesday, January 24, 2017 11:09 AM
Cc: Deason, Jesse; Le, Bao; Staples, Rose; Johnson, Laura
Subject: Agenda-Meeting Materials for La Grange Jan 26 2017 Reintroduction Goals-Water Temp Subcommittees Joint Meeting
Attachments: 20170124_Temp Lit Review comment response table updated.pdf; 20170124_Upper TR Lifestage Temp Lit Review WT Sub_updated.pdf; 20170124_UTR Timing and Temp Working Document.pdf; 20170124_Water Temperature Considerations_Bougton.pdf; 20170124_LG UTR Framework WT_Reintro Joint Sub_Agenda.pdf; 20170124_LG UTR Reintro Goals_Draft Objectives Discussion.pdf; 20170124_Reintro Goal Statement comment response table.pdf

Reintroduction Goals and Water Temperature Subcommittee Members,

Please find attached the agenda and meeting materials for the upcoming meeting this Thursday, January 26th from 1:00pm to 4:00pm. The meeting will be held in Modesto Irrigation District's Multipurpose Room (refer to agenda for address). Please take time to review the materials in advance of the meeting.

For the Reintroduction Goals Subcommittee:
Meeting Agenda
Reintroduction Goals Statement Comment/Response Table
Draft Reintroduction Assessment Objectives Development Discussion

For the Water Temperature Subcommittee:
Meeting Agenda
Timing and Temperature Working Document
Comment/Response Table on Water Temperature Literature Review (updated)
Water Temperature Literature Review document (updated)
Water Temperature Consideration_Boughton (Districts action item)

Copies of these documents have also been uploaded to the www.lagrange-licensing.com website in the DOCUMENTS section as well as attachments to the meeting announcement on the CALENDAR.

Thank you.

Rose Staples, CAP-OM, MOS
Executive Assistant

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rose.staples@hdrinc.com

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TID/MID Response to Comments on the Water Temperature Literature Review

Comment No.	Organization / Source	Comment	Response
1.	CDFW 11/3/16 email	It would be helpful to include in the Glossary of Terms definitions for both **acute** and **chronic** especially in terms to timeframes and implications.	Acute and chronic terms in addition to other terms have been updated in The Glossary of Terms document.
2.	CDFW 11/3/16 email	The literature review contains temperatures in both English and Metric units which is confusing. In the interest of clarity and consistency with established scientific literature we request that all temperatures be available Celsius.	As noted in the introduction of the literature review, subcommittee members supported use of an already published review as the basis for this assessment (i.e., Appendix A of Bratovich et al. 2012). Much of the narrative text was cited "as-is" from the existing document. However, for each of the life history tables (which summarize the narrative text at the end of each life history stage section) included in the literature review, metric units have been added in parentheses alongside English units. Not all scientific or technical documents report temperature in °C. For example, the SWRCB's recently released Substitute Environmental Document uses °F. For future reference, we will make every effort to report in °F in whole integers, with °C provided in parentheses.
3.	CDFW 11/3/16 email	Water Temperature Indices - The literature review is unclear as to the purpose of water temperature index values. It is stated that they provide a gradation of potential effects but there is no indication as to what the index values will be used for.	As noted, the water temperature index values included in the literature review represent the gradation of potential effects. A primary objective of the water temperature subcommittee process is to identify a value (or set of values) and metrics that will be used to evaluate potential thermal habitat suitability for anadromous salmonid reintroduction in the Tuolumne River.

Comment No.	Organization / Source	Comment	Response
4.	CDFW 11/3/16 email	The inclusion of water temperature criteria for other rivers and the EPA is helpful for comparison but, clarification as to how the Upper Optimum Value and Upper Tolerable Value are applied in the Yuba River would be helpful.	The Yuba Salmon Forum (YSF) conducted a summary assessment of potential spring-run Chinook salmon and steelhead habitat in the Yuba River Basin to provide information for use in reviewing potential options that warrant further investigation regarding reintroduction into the North, Middle, and South Yuba rivers, as well as portions of the mainstem Yuba River. Evaluations conducted by the YSF (2013) emphasized water temperature habitat suitability determinations. These evaluations utilized water temperature index (WTI) values specific to each of the species' lifestages, and the time periods throughout the year during which they occur. The WTI values selected for evaluation corresponded to lifestage-specific Upper Optimum and Upper Tolerable WTI values. The maximum weekly average (daily) water temperature (MWAT) was the metric applied to water temperature monitoring and modeling data, for various years and water year types, to identify when and where WTI values were exceeded. The estimated location when MWAT exceeded the specified WTI value was then used to identify the number of river miles of thermally suitable habitat for a particular species/lifestage.
5.	CDFW 11/3/16 email	The inclusion of data obtained from the Lower Tuolumne River swim tunnel study is inappropriate. Results obtained during the study are based on an acute response to temperature which does little to inform a fish's response to a chronic condition. CDFW has provided extensive comments on this study to HDR Inc. in a letter dated August 31, 2016.	The researchers responsible for this study indicate that it is incorrect to classify the Swim Tunnel study as an investigation of acute response to water temperature. The comments provided by CDFW have been addressed and will be provided in the final study filed with FERC. The study represents the only site-specific study of thermal capability of wild juvenile *O. mykiss* in the Tuolumne River and is important to consider.
6.	CDFW 12/1/16 subcommittee meeting	Andrew Gordus requested that a figure describing the effects of temperature on juvenile or adult salmonids be added to the Water Temperature Literature Review document.	This figure has been added to the Water Temperature Literature Review document.

REARING JUVENILE STEELHEAD
WATER TEMPERATURE INDEX VALUES & BIOLOGICAL EFFECTS

In support of the Upper Tuolumne River Reintroduction Assessment Framework (Framework), the Turlock Irrigation District and Modesto Irrigation District (TID/MID, or the Districts) and licensing participants established a Water Temperature Subcommittee to investigate water temperature considerations pertinent to anadromous salmonid reintroduction opportunities in the Tuolumne River. On December 1, 2016, the Districts hosted the third subcommittee meeting, and in advance of the meeting distributed a comprehensive literature review[1] of regional and site-specific information to inform the selection of water temperature index (WTI) values to be used to evaluate water temperature-related reintroduction potential. The literature review identified lifestage-specific WTI values for Chinook salmon and steelhead.

Water temperature index values were identified to evaluate the combined steelhead rearing (fry and juvenile) and juvenile downstream movement lifestages, separate from the smolt lifestage. WTI values of 61°F, 63°F, 64°F, 65°F, 68°F, 72°F, 75°F, and 77°F were identified from the literature to represent a gradation of potential water temperature effects ranging between suitable to lethal conditions for steelhead juvenile rearing (see Table, below). The WTI values are intended to serve as the basis for continued discussions by the Water Temperature Subcommittee to evaluate water temperature-related reintroduction potential.

John Wooster (National Marine Fisheries Service [NMFS]) provided some additional references for the literature review as well as Boughton et al. (2015), which was distributed ahead of the December 1, 2016 meeting. Mr. Wooster characterized Boughton et al. (2015) as the approach that the NMFS Science Center (Science Center) will likely use to evaluate temperature suitability in the Tuolumne River.

Boughton et al. (2015) developed thermal indicators of habitat suitability to evaluate how water temperature was likely to affect southern California juvenile steelhead. They reported that a day is "*thermally suitable*" if maximum daily temperature stays below 29°C (84.2°F) and mean daily temperature stays below 25°C (77°F).

However, Boughton et al. (2015) also reported that laboratory estimates of incipient lethal temperature (50% mortality after long exposure) vary across studies but average around 25°C (77°F). That has been supported by the Water Temperature Subcommittee literature review:

- Rearing steelhead juveniles have an upper lethal limit of 75.0°F (NMFS 2001a).
- NMFS and EPA report that direct mortality to rearing juvenile steelhead results when stream temperatures reach 75°F (EPA 2002; NMFS 2001b).

[1] References are available in the literature review summary document titled *Lifestage-Specific Water Temperature Biological Effects and Index Temperature Values*, prepared for the Upper Tuolumne River Reintroduction Assessment Framework Water Temperature Subcommittee, November 2016.

- Water temperatures >77°F have been referred to as "lethal" to juvenile steelhead (FERC 1993; Myrick and Cech 2001).

- The upper incipient lethal temperature (UILT) for juvenile *O. mykiss* (rainbow trout), based on numerous studies, is between 75-79°F (Sullivan et al. 2000; McCullough 2001).

- The lower Tuolumne River *O. mykiss* population study (TID/MID 2014) reported that the UILT for *O. mykiss* juveniles has been estimated at 22.8–25.9ºC (73–79°F) (Threader and Houston 1983).
    - In the model, an initial mortality threshold of 25°C (77°F) daily average temperature was identified for *O. mykiss* juveniles, and that the fry rearing lifestage of *O. mykiss* also had a UILT value of 77°F to support the model.

Boughton et al. (2015) also report that a day is "*thermally stressful*" if temperature rises above 21°C (69.8°F) at any time, with the daily stress intensity quantified as degree-hours above 21°C (69.8°F). They estimated thermal growth potential of juvenile steelhead using a bioenergetics model, within which growth rate depends on fish size and food availability, but generally peaks in the range of 15–17°C (59-62.6°F) and becomes negative at temperatures above 22–24°C (71.6 – 75.2°F).

DISCUSSION

At the December 1, 2016 Water Temperature Subcommittee meeting a discussion by subcommittee members focused on trying to gain additional understanding on how the NMFS Science Center proposes to apply Boughton et al. (2015) as the approach to evaluate water temperature suitability in the Tuolumne River for anadromous salmonid reintroduction considerations. John Wooster noted that in addition to Boughton et al. (2015) which studies steelhead on the Santa Ynez River, the Science Center has used this approach to study steelhead in the Bay area (Russian River) and that this memo should be available soon and this memo provides more detail about the modeling approach. In order for the subcommittee to further evaluate the application of this methodology, it would be valuable to review the Russian River memo as soon as it is available.

Regarding reintroduction potential:

- It would be particularly helpful to further understand the context in which a day could be considered "*thermally suitable*" if mean daily temperature stays below 25°C (77°F), the temperature identified as lethal, or as incipient lethal - by definition the temperature which results in 50% mortality to the exposed population.

- Although the concept of a "*stress index*" could be a useful approach to address gradation of thermal effect, it would be informative to discuss how "*stressful*" water temperatures ranging from 21°C (69.8°F) to 25°C (77°F) could be considered potentially suitable for reintroduction when growth rate reportedly becomes negative at temperatures exceeding 22–24°C (71.6 – 75.2°F).

Steelhead Juvenile Rearing WTI Values and the Literature Supporting Each Value.

Index Value	Supporting Literature
61°F (16.1°C)	A water temperature of 61°F (7DADM) was identified as the value for steelhead juvenile rearing for the San Joaquin River (CALFED 2009).
63°F (17.2°C)	Preferred water temperature for wild juvenile steelhead is reportedly 63°F, whereas preferred water temperatures for juvenile hatchery steelhead reportedly range between 64-66°F. Myrick and Cech (2001)
64°F (17.8°C)	EPA Region 10 Guidance for Pacific Northwest State and Tribal Temperature Water Quality Standards identifies 64°F (7DADM) for "salmon and trout" juvenile rearing (EPA 2003b).
65°F (18.3°C)	Upper limit of 65°F preferred for growth and development of Sacramento River and American River juvenile steelhead (NMFS 2002a). Nimbus juvenile steelhead growth showed an increasing trend with water temperature to 66.2°F, irrespective of ration level or rearing temperature (Cech and Myrick 1999). The final preferred water temperature for rainbow fingerlings was between 66.2 and 68°F (Cherry *et al.* 1977). Nimbus juvenile steelhead preferred water temperatures between 62.6°F and 68.0°F (Cech and Myrick 1999). Rainbow trout fingerlings preferred or identified water temperatures in the 62.6°F to 68.0°F range (McCauley and Pond 1971). A water temperature of 65°F (daily average temperature) was identified as the value for steelhead juvenile rearing for the Lower American River (Water Forum 2007). A water temperature of 65°F (MWAT) was identified as the Upper Optimum Value for steelhead juvenile rearing for the Yuba Reintroduction Assessment (Bratovich *et al.* 2012).
68°F (20°C)	Nimbus juvenile steelhead preferred water temperatures between 62.6°F and 68.0°F (Cech and Myrick 1999). The final preferred water temperature for rainbow trout fingerlings was between 66.2°F and 68°F (Cherry *et al.* 1977). Rainbow trout fingerlings preferred or identified water temperatures in the 62.6°F to 68.0°F range (McCauley and Pond 1971). The upper avoidance water temperature for juvenile rainbow trout was measured at 68°F to 71.6°F (Kaya *et al*. 1977). FERC (1993) referred to 68°F as "stressful" to juvenile steelhead. Empirical fish population and water temperature data in the North Yuba, Middle Yuba, South Yuba, Middle Fork American, and Rubicon Rivers (Figure 4 of Bratovich *et al.* 2012) indicate a sharp reduction in O. *mykiss* population densities when temperatures exceed 68°F for greater than one week. Bioenergetics modeling of growth based on consumption (P value = 0.5) in the Middle Fork American River watershed (adjacent watershed) indicates that growth likely does not occur above 68°F (Figure 5 of Bratovich *et al.* 2012). A water temperature of 68°F (MWAT) was identified as the Upper Tolerable Value for steelhead juvenile rearing for the Yuba Reintroduction Assessment (Bratovich *et al.* 2012).
72°F (22.2°C)	Increased physiological stress, increased agonistic activity, and a decrease in forage activity in juvenile steelhead occur after ambient stream temperatures exceed 71.6°F (Nielsen *et al.* 1994). The upper avoidance water temperature for juvenile rainbow trout was measured at 68°F to 71.6°F (Kaya *et al.* 1977). Estimates of upper thermal tolerance or avoidance limits for juvenile rainbow trout (at maximum ration) ranged from 71.6°F to 79.9°F (Ebersole *et al.* 2001). A swim tunnel study conducted on the Lower Tuolumne recommended a conservative upper aerobic performance limit of 71.6°F for *O. mykiss* juvenile rearing (Verhille et al. 2016).
75°F (23.9°C)	The maximum weekly average water temperature for survival of juvenile and adult rainbow trout is 75.2°F (EPA 2002). Rearing steelhead juveniles have an upper lethal limit of 75.0°F (NMFS 2001a). Estimates of upper thermal tolerance or avoidance limits for juvenile rainbow trout (at maximum ration) ranged from 71.6 to 79.9°F (Ebersole *et al.* 2001). The UILT for juvenile rainbow trout, based on numerous studies, is between 75-79°F (Sullivan *et al*. 2000; McCullough 2001).
77°F (25°C)	In the model associated with the Lower Tuolumne River *O. mykiss* Population Study (TID/MID 2014), an initial mortality threshold of 77°F daily average temperature was identified for *O. mykiss* juveniles.

TID/MID Response to Comments on the Reintroduction Goals Statement[1]

Comment No.	Organization / Source	Comment	Response
1.	CSERC (John Buckley) 12/22/16 email	As a participant in the past in settlement discussions and the development of FERC licensing conditions, I believe that wording definitely matters to the success of a process. The updated draft narrative goal statement contains two words that are nebulous, non-measurable, and subjective. The word "reasonable" may at least have some broad consensus in that if measures result in costs that are staggering compared to the expected beneficial outcome, most FERC participants may generally agree that such measures are not "reasonable." But the inclusion of the word "fair" in any goal statement is not appropriate. It is unlikely there will ever be strong, broad agreement from all the participating interests as to how to define "fair" when it comes to the cost of reaching goals or implementing measures. This e-mail communication is simply intended to be helpful, and I can "live with" and accept whatever generalized draft narrative goal statement that the subcommittee selects. But as the FERC process unfolds, any choice to include highly subjective wording that can mean completely different things to different parties will not be helpful to the process.	The word "fair", is not only appropriate, but necessary to include. The idea of its inclusion is precisely because it has a different meaning to different people, and for everyone to hear what it means to different participants. Not every word in a broad "goals statement" has to have a scientific definition. "Fair", according to Webster, means "just" or "according to the rules". So exactly what rules apply here? The Districts look forward to further discussion on this topic. In addition, the subcommittee has discussed the development of more specific objective (corollary) statements that could support this broader goals statement. Development of these specific objective statements would be intended to further clarify elements of the goal statement.

[1] Per discussions at the December 1, 2016 joint subcommittee meeting, an updated draft Tuolumne River reintroduction goals narrative goal statement is as follows: *"Contribute to the recovery of ESA listed salmonids in the Central Valley by establishing viable populations in the Tuolumne River at fair and reasonable cost. Specific objectives consistent with the goal statement include the following:"*

UPPER TUOLUMNE RIVER REINTRODUCTION ASSESSMENT FRAMEWORK
WATER TEMPERATURE SUBCOMMITTEE

LIFESTAGE-SPECIFIC WATER TEMPERATURE BIOLOGICAL EFFECTS AND INDEX TEMPERATURE VALUES

Literature Review Summary

INTRODUCTION

The La Grange Hydroelectric Project (La Grange Project), owned and operated by the Turlock Irrigation District and Modesto Irrigation District (TID/MID, or the Districts), is currently undergoing the Federal Energy Regulatory Commission (FERC) Integrated Licensing Process. As part of this process, the Districts are implementing a FERC-approved Fish Passage Facilities Alternatives Assessment which consists of developing general design criteria and design considerations applicable to upstream and downstream fish passage facilities at the La Grange Project. Design criteria and considerations include items such as: site-specific physical and operational parameters; applicable regulatory requirements; National Marine Fisheries Service (NMFS), U.S. Fish and Wildlife Service (USFWS), and California Department of Fish and Wildlife (CDFW) biological and engineering design criteria; site-specific biological/habitat information relevant to the sizing and configuration of facilities; and any other information gaps that may affect siting, sizing, general design parameters, capital cost, and operating requirements of potential fish passage facilities.

To make certain that detailed, site-specific information is available to support and adequately inform decisions regarding fish reintroduction and fish passage, TID, MID, and licensing participants came to a consensus on the need for and utility of an Upper Tuolumne River Reintroduction Assessment Framework (Framework). The Framework is intended to provide a comprehensive, collaborative, and transparent approach for evaluating the full range of potential issues associated with the future reintroduction of anadromous salmonids to the upper Tuolumne River. In addition to considering aspects of the technical feasibility of building and operating fish passage facilities, the Framework considers the interrelated issues of ecological feasibility, biological constraints, economics, regulatory implications, and other considerations of reintroduction. Elements of the Framework are interconnected, with fish passage construction and operational requirements needing to properly reflect biological constraints, ecological considerations, and economic cost-benefit assessments.

Water temperature considerations are a primary component of assessing any potential anadromous salmonid reintroduction effort. In support of the Framework, the Districts and licensing participants established a Water Temperature Subcommittee to begin investigating water temperature considerations pertinent to anadromous salmonid reintroduction opportunities in the accessible reaches of the Tuolumne River upstream of Don Pedro Reservoir (upper Tuolumne River). On September 15, 2016, the Districts hosted the first conference call for the Water Temperature Subcommittee (draft meeting notes from this call were distributed on October 3 for a 30-day comment period). On the conference call, attendees discussed the need for a comprehensive literature review of regional and site-specific information to inform the selection of water temperature index (WTI) values to be used in an evaluation of the water temperature-related reintroduction potential in the reaches of the upper Tuolumne River. Meeting attendees agreed that the literature review performed for the Yuba Salmon Forum (Appendix A; Bratovich *et al.* 2012) to support the anadromous salmonid reintroduction assessment in this watershed coupled with site-specific temperature studies or data for the Tuolumne River, if available, would be a good basis for this effort. The following represents and updated literature review summary and is provided to the Water Temperature Subcommittee to support selection of water temperature index values for the Framework.

The WTI values presented herein represent a gradation of potential biological effects from optimal to lethal water temperatures for each lifestage. Literature on salmonid water temperature requirements generally reports water temperature thresholds using various descriptive terms including “optimal”, “preferred”, “suitable”, “suboptimal”, “tolerable”, “stressful – chronic and acute”, “sublethal”, “incipient lethal”, and “lethal”. Water temperature effects on salmonids are often discussed in terms of “lethal” and “sublethal” effects, and depend on the both the magnitude and the duration of exposure (Sullivan *et al.* 2000), as well as acclimation water temperature. Acute, chronic, and optimal growth zones are displayed in Figure 1.

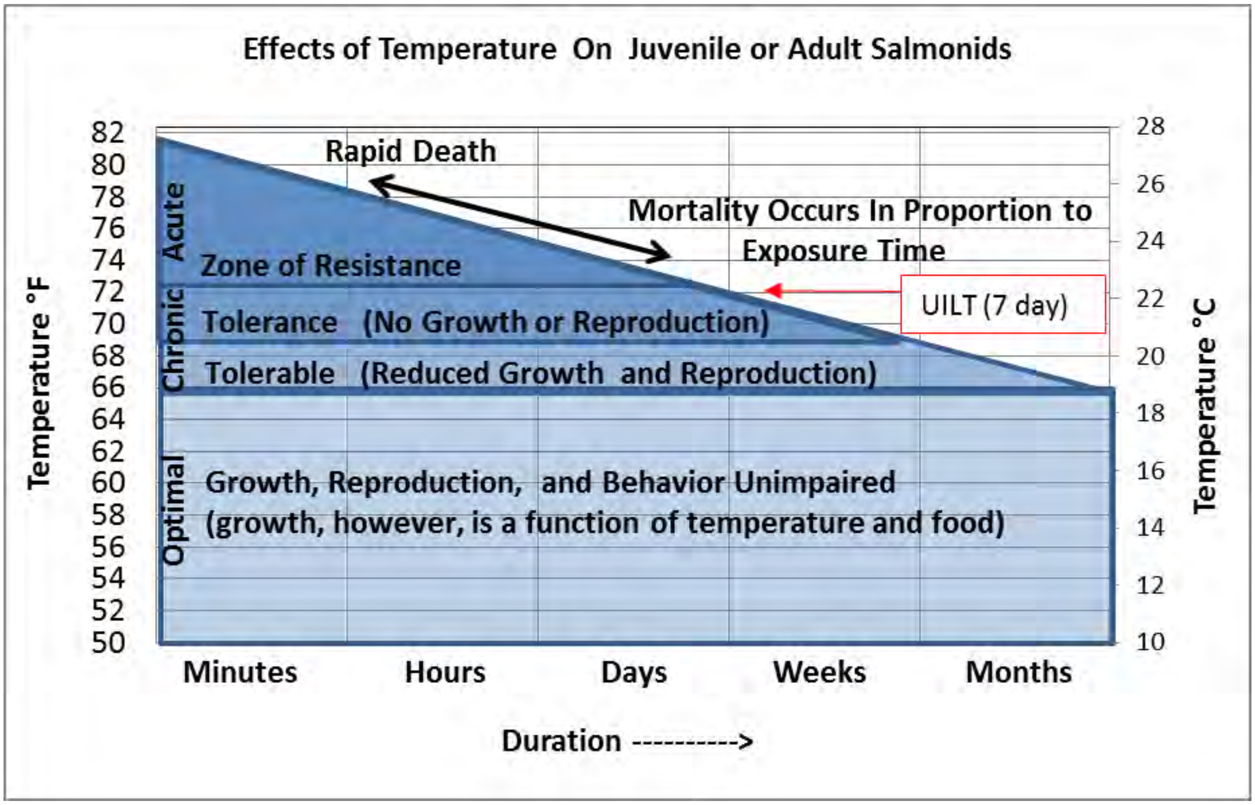

Figure 1. Illustration of acute, chronic, and optimal temperature zones (adapted from Sullivan et al. 2000).

STEELHEAD LIFESTAGE-SPECIFIC WATER TEMPERATURE INDEX VALUES

Adult Immigration and Holding

Water temperatures can control the timing of adult spawning migrations and can affect the viability of eggs in holding females. Yuba County Water Agency (YCWA) *et al.* (2007) suggests that few studies have been published examining the effects of water temperature on either steelhead immigration or steelhead holding, and none of the available studies were recent (Bruin and Waldsdorf 1975; McCullough *et al.* 2001). The available studies suggest that adverse effects occur to immigrating and holding steelhead at water temperatures exceeding the mid-50°F range, and that immigration will be delayed if water temperatures approach approximately 70°F (Table 1). WTI values of 52°F, 56°F, 61°F, 64°F, 65°F, 68°F and 70°F were identified because they provide a gradation of potential water temperature effects, and the available literature provided the strongest support for these values.

Because of the paucity of literature pertaining to steelhead adult immigration and holding, an evenly spaced range of WTI values could not be achieved. 52°F was identified as a WTI value because it has been referred to as a "recommended" (Reclamation 2003), "preferred" (McEwan and Jackson 1996; NMFS 2000; NMFS 2002), and "optimum" (Reclamation 1997a) water temperature for steelhead adult immigration. Increasing levels of thermal stress to this lifestage may reportedly occur above the 52°F WTI value. 56°F was identified as a WTI value because 56°F represents a water temperature above which adverse effects to migratory and holding steelhead begin to arise (Bruin and Waldsdorf 1975; Leitritz and Lewis 1980; McCullough *et al.* 2001; Smith *et al.* 1983). 50-59°F is referred to as the "preferred" range of water temperatures for California summer steelhead holding (Moyle *et al.* 1995). Water temperatures greater than 61°F may result in "chronic high stress" of holding Central Valley winter-run steelhead (USFWS 1995a). A water temperature of 64°F (7DADM) was identified as the value for steelhead adult lifestage for the San Joaquin River (CALFED 2009) and as the Upper Optimum Value for steelhead adult migration (MWAT) for the Yuba Reintroduction Assessment (Bratovich *et al.* 2012). EPA Region 10 Guidance for Pacific Northwest State and Tribal Temperature Water Quality Standards identifies 64°F (7DADM) for "salmon and trout" migration (EPA 2003b). 65°F was identified as a WTI value because steelhead (and fall-run Chinook salmon) encounter potentially stressful temperatures between 64.4-73.4°F (Richter and Kolmes 2005). Additionally, over 93% of steelhead detections occurred in the 65.3-71.6°F range, although this may be above the temperature for optimal immigration (Salinger and Anderson 2006) and/or may modify migration timing due to holding in coldwater refugia (High *et al.* 2006). A water temperature of 68°F (MWAT) was identified as the Upper Tolerable Value for steelhead adult migration for the Yuba Reintroduction Assessment (Bratovich *et al.* 2012). A water temperature of 68°F was found to drop egg fertility in vivo to 5% after 4.5 days (McCullough *et al*. 2001). Additionally, empirical adult *O. mykiss* population data from the North Yuba, Middle Yuba, South Yuba, Middle Fork American, and Rubicon rivers were collected in 2007-2009 were plotted against temperature (Figure 4 of Bratovich *et al*. 2012). The data show a population density break at about 68°F. Although smaller population densities occurred at higher temperatures, the largest population densities occurred at temperatures near 68.0°F or less. 70°F was identified as the highest WTI value because the literature suggests that water temperatures near and above 70.0°F may result in a thermal barrier to adult steelhead migrating upstream (McCullough *et al.* 2001) and are water temperatures referred to as "stressful" to upstream migrating steelhead in the Columbia River (Lantz 1971 as cited in Beschta *et al.* 1987). Further, Coutant (1972) found that the upper incipient lethal temperature (UILT) for adult steelhead was 69.8°F and temperatures between 73-75°F are described as "lethal" to holding adult steelhead in Moyle (2002).

As part of the Framework, TID and MID, in collaboration with stakeholders developed a table of WTI values from select salmon and steelhead programs in the Central Valley (Temperature Criteria Matrix; presented at the September 15, 2016 Water Temperature Subcommittee conference call). The table was developed to support the Framework's Water Temperature Subcommittee whose purpose is to establish a technical basis to evaluate water temperature regimes for target anadromous salmonid reintroduction into the Tuolumne River upstream of Don Pedro Reservoir. For steelhead adult immigration, the Temperature Criteria Matrix identified 64°F for the San Joaquin (CALFED 2009) and 64°F (Upper Optimum Value) and 68°F (Upper Tolerable Value) for the Yuba Reintroduction Assessment (Bratovich *et al.* 2012). For steelhead adult holding, the Temperature Criteria Matrix identified 61°F (Upper Optimum Value) and 65°F (Upper Tolerable Value) for the Yuba Reintroduction Assessment (Bratovich *et al.* 2012).

Table 1. Steelhead Adult Immigration and Holding WTI Values and the Literature Supporting Each Value.

Index Value	Supporting Literature
52°F (11.1°C)	Preferred range for adult steelhead immigration of 46.0°F to 52.0°F (NMFS 2000; NMFS 2001a; SWRCB 2003). Optimum range for adult steelhead immigration of 46.0°F to 52.1°F[1] (Reclamation 1997a). Recommended adult steelhead immigration temperature range of 46.0°F to 52.0°F (Reclamation 2003).
56°F (13.3°C)	To produce rainbow trout eggs of good quality, brood fish must be held at water temperatures not exceeding 56.0°F (Leitritz and Lewis 1980). Rainbow trout brood fish must be held at water temperatures not exceeding 56°F for a period of 2 to 6 months before spawning to produce eggs of good quality (Bruin and Waldsdorf 1975). Holding migratory fish at constant water temperatures above 55.4°F to 60.1°F may impede spawning success (McCullough *et al.* 2001).
61°F (16.1°C)	Water temperatures greater than 61°F may result in "chronic high stress" of holding Central Valley winter- run steelhead (USFWS 1995a). Preferred range of water temperature for holding California summer steelhead occurs between 50-59°F (Moyle 1995). A water temperature of 61°F was identified as the Upper Optimum Value for steelhead adult holding, MWAT, for the Yuba Reintroduction Assessment (Bratovich *et al.* 2012).
64°F (17.8°C)	Steelhead (and fall-run Chinook salmon) encounter potentially stressful temperatures between 64.4-73.4°F (Richter and Kolmes 2005). Over 93% of steelhead detections occurred in the 65.3-71.6°F, although this may be above the temperature for optimal immigration (Salinger and Anderson 2006). A water temperature of 64°F was identified as the value for steelhead adult lifestage, 7DADM, for the San Joaquin River (CALFED 2009) and as the Upper Optimum Value for steelhead adult migration, MWAT, for the Yuba Reintroduction Assessment (Bratovich *et al.* 2012). EPA Region 10 Guidance for Pacific Northwest State and Tribal Temperature Water Quality Standards identifies 64°F (7DADM) for "salmon and trout" migration (EPA 2003b).
65°F (18.3°C)	A water temperature of 65°F (MWAT) was identified as the Upper Tolerable Value for steelhead adult holding for the Yuba Reintroduction Assessment (Bratovich *et al.* 2012).
68°F (20°C)	A water temperature of 68°F (MWAT) was identified as the Upper Tolerable Value for steelhead adult migration for the Yuba Reintroduction Assessment (Bratovich *et al.* 2012). A water temperature of 68°F was found to drop egg fertility in vivo to 5% after 4.5 days (McCullough *et al.* 2001).
70°F (21.1°C)	Migration barriers have frequently been reported for pacific salmonids when water temperatures reach 69.8°F to 71.6°F (McCullough *et al.* 2001). Snake River adult steelhead immigration was blocked when water temperatures reached 69.8 (McCullough *et al.* 2001). The UILT for adult steelhead was determined to be 69.8°F (Coutant 1972).

[1] Similar to Bratovich *et al*. 2012, rounded whole integers were identified for index values to avoid unwarranted specificity.

Spawning and Embryo Incubation

Relatively few studies have been published directly addressing the effects of water temperature on steelhead spawning and embryo incubation (Redding and Schreck 1979; Rombough 1988). Because anadromous steelhead and non-anadromous rainbow trout are genetically and physiologically similar, studies on non-anadromous rainbow trout also were considered in the development of WTI values for steelhead spawning and embryo incubation (Moyle 2002; McEwan 2001). From the available literature, water temperatures in the low 50°F range appear to support high embryo survival, with substantial mortality to steelhead eggs reportedly occurring at water temperatures in the high 50°F range and above (Table 2). Water temperatures in the 45-50°F range have been referred to as the "optimum" for spawning steelhead (FERC 1993).

WTI values of 46°F, 52°F, 54°F, 55°F, 57°F, 59°F and 60°F were identified for two reasons. First, the available literature provided the strongest support for WTI values at or near these integers. Second, the index values reflect a gradation of potential water temperature effects ranging between optimal to lethal conditions for steelhead spawning and embryo incubation. Some literature suggests water temperatures ≤ 50°F are when steelhead spawn (Orcutt *et al.* 1968) and/or are optimal for steelhead spawning and embryo survival (FERC 1993; Myrick and Cech 2001; Timoshina 1972) and temperatures between 39-52°F are "preferred" by spawning steelhead (IEP Steelhead Project Work Team (no date); McEwan and Jackson 1996). Orcutt *et al.* (1968) reported that steelhead spawning in late spring in the Clearwater and Salmon Rivers, Idaho, occurred at temperatures between 35.6 and 46.4°F. A larger body of literature suggests optimal conditions occur at water temperatures ≤ 52°F (Humpesch 1985; NMFS 2000; NMFS 2001a; NMFS 2002; Reclamation 1997b; SWRCB 2003; USFWS 1995b). Further, water temperatures between 48-52°F were referred to as "optimal" (FERC 1993; McEwan and Jackson 1996; NMFS 2000) and "preferred" (Bell 1986) for steelhead embryo incubation. Therefore, 52°F was identified as the lowest WTI value. Increasing levels of thermal stress to the steelhead spawning and embryo incubation lifestage may reportedly occur above the 52°F WTI value.

54°F was identified as the next index value, because although most of the studies conducted at or near 54.0°F report high survival and normal development (Kamler and Kato 1983; Redding and Schreck 1979; Rombough 1988), some evidence suggests that symptoms of thermal stress arise at or near 54.0°F (Humpesch 1985; Timoshina 1972). Thus, water temperatures near 54°F may represent an inflection point between properly functioning water temperature conditions, and conditions that cause negative effects to steelhead spawning and embryo incubation. Further, water temperatures greater than 55°F were referred to as "stressful" for incubating steelhead embryos (FERC 1993). EPA Region 10 Guidance for Pacific Northwest State and Tribal Temperature Water Quality Standards identifies 55°F (7DADM) for "salmon and trout" spawning and egg incubation (EPA 2003b). For steelhead spawning and embryo incubation in the Yuba River, the Framework Temperature Criteria Matrix identified 54°F and 57°F for Upper Optimum and Upper Tolerable values, respectively (Bratovich *et al.* 2012). 57°F was identified as an index value because embryonic mortality increases sharply and development becomes retarded at incubation temperatures greater than or equal to 57°F. Velsen (1987) provided a compilation of data on rainbow trout and steelhead embryo mortality to 50% hatch under incubation temperatures ranging from 33.8°F to 60.8°F that demonstrated a two-fold increase in mortality for embryos incubated at 57.2°F, compared to embryos incubated at 53.6°F.

In a laboratory study using gametes from Big Qualicum River, Vancouver Island, steelhead mortality increased to 15% at a constant temperature of 59.0°F, compared to less than 4% mortality at constant temperatures of 42.8°F, 48.2°F, and 53.6°F (Rombough 1988). Also, alevins hatching at 59°F were considerably smaller and appeared less well developed than those incubated at the lower temperature treatments. From fertilization to 50% hatch, rainbow trout eggs from Ontario Provincial Normendale Hatchery had 56% survival when incubated at 59.0°F (Kwain 1975).

As part of the Don Pedro Hydroelectric Project FERC relicensing process, the Districts conducted an *O. mykiss* Population Study (TID/MID 2014) for the Lower Tuolumne River below La Grange Diversion Dam. The goal of the study is to provide a quantitative population model to investigate the relative influences of various factors on the lifestage-specific production of *O. mykiss* in the Tuolumne River including water temperature effects on population response for specific in-river lifestages. The study noted that although no literature information could be identified regarding upper temperature limits for spawning initiation, maximum temperature limits for spawning are assumed to be on the order of 15°C (59°F) inferred from egg mortality thresholds for resident *O. mykiss* (Velsen 1987) as well as steelhead (Rombough 1988). Similarly, for egg incubation, the model allowed for a broad range of flow and water temperature conditions using the completed model, an initial acute mortality threshold of 15°C (59°F) was included based upon a literature review by Myrick and Cech (2001).

From fertilization to 50% hatch, Big Qualicum River steelhead had 93% mortality at 60.8°F, 7.7% mortality at 57.2°F, and 1% mortality at 47.3°F and 39.2°F (Velsen 1987). Myrick and Cech (2001) similarly described water temperatures >59°F as “lethal” to incubating steelhead embryos, although FERC (1993) suggested that water temperatures exceeding 68°F were “stressful” to spawning steelhead and “lethal” when greater than 72°F.

Table 2. Steelhead Spawning and Embryo Incubation WTI Values and the Literature Supporting Each Value.

Index Value	Supporting Literature
46°F (7.8°C)	Orcutt *et al*. (1968) reported that steelhead spawning in late spring in the Clearwater and Salmon Rivers, Idaho, occurred at temperatures between 35.6 and 46.4°F.
52°F (11.1°C)	Rainbow trout from Mattighofen (Austria) had highest egg survival at 52.0°F compared to 45.0°F, 59.4°F, and 66.0°F (Humpesch 1985). Water temperatures from 48.0°F to 52.0°F are suitable for steelhead incubation and emergence in the American River and Clear Creek (NMFS 2000; NMFS 2001a; NMFS 2002a). Optimum water temperature range of 46.0°F to 52.0°F for steelhead spawning in the Central Valley (USFWS 1995b). Optimum water temperature range of 46.0°F to 52.1°F for steelhead spawning and 48.0°F to 52.1°F for steelhead egg incubation (Reclamation 1997a). Upper limit of preferred water temperature of 52.0°F for steelhead spawning and egg incubation (SWRCB 2003).
54°F (12.2°C)	Big Qualicum River steelhead eggs had 96.6% survival to hatch at 53.6°F (Rombough 1988). Highest survival from fertilization to hatch for *Salmo gairdneri* incubated at 53.6°F (Kamler and Kato 1983). Emergent fry were larger when North Santiam River (Oregon) winter steelhead eggs were incubated at 53.6°F than at 60.8°F (Redding and Schreck 1979). The upper optimal water temperature regime based on constant or acclimation water temperatures necessary to achieve full protection of steelhead is 51.8°F to 53.6°F (EPA 2001). From fertilization to hatch, rainbow trout eggs and larvae had 47.3% mortality (Timoshina 1972). Survival of rainbow trout eggs declined at water temperatures between 52.0 and 59.4°F (Humpesch 1985). The optimal constant incubation water temperature for steelhead occurs below 53.6°F (McCullough *et al.* 2001). A water temperature of 54°F (MWAT) was identified as the Upper Optimum Value for steelhead spawning and embryo incubation for the Yuba Reintroduction Assessment (Bratovich *et al.* 2012).
55°F (12.8°C)	EPA Region 10 Guidance for Pacific Northwest State and Tribal Temperature Water Quality Standards identifies 55°F (7DADM) for "salmon and trout" spawning and egg incubation (EPA 2003b). Water temperatures greater than 55°F were referred to as "stressful" for incubating steelhead embryos (FERC 1993).
57°F (13.9°C)	From fertilization to 50% hatch, Big Qualicum River steelhead had 93% mortality at 60.8°F, 7.7% mortality at 57.2°F, and 1% mortality at 47.3°F and 39.2°F (Velsen 1987). A sharp decrease in survival was observed for rainbow trout embryos incubated above 57.2°F (Kamler and Kato 1983). A water temperature of 57°F (MWAT) was identified as the Upper Tolerable Value for steelhead spawning and embryo incubation for the Yuba Reintroduction Assessment (Bratovich *et al.* 2012).
59°F (15°C)	Based on egg mortality thresholds for steelhead, maximum temperature limits for spawning are assumed to be 59°F (Rombaugh 1988 as cited in TID/MID 2014). A water temperature of 59°F was identified as the initial acute mortality threshold for steelhead egg incubation (Myrick and Cech 2001 as cited in TID/MID 2014). From fertilization to 50% hatch, rainbow trout eggs from Ontario Provincial Normendale Hatchery had 56% survival when incubated at 59.0°F (Kwain 1975).
60°F (15.6°C)	Water temperatures >59°F are described as "lethal" to incubating steelhead embryos (Myrick and Cech 2001), From fertilization to 50% hatch, Big Qualicum River steelhead had 93% mortality at 60.8°F, 7.7% mortality at 57.2°F, and 1% mortality at 47.3°F and 39.2°F (Velsen 1987).

Juvenile Rearing & Downstream Movement

Water temperature index values were developed to evaluate the combined steelhead rearing (fry and juvenile) and juvenile downstream movement lifestages. Some steelhead may rear in freshwater for up to three years before emigrating as yearling+ smolts, whereas other individuals move downstream shortly after emergence as post- emergent fry, or rear in the river for several months and move downstream as juveniles without exhibiting the ontogenetic characteristics of smolts. Presumably, these individuals continue to rear and grow in downstream areas and undergo the smoltification process prior to entry into saline environments. Thus, fry and juvenile rearing occur concurrently with post-emergent fry and juvenile downstream movement and are assessed in this Technical Memorandum using the fry and juvenile rearing WTI values.

The growth, survival, and successful smoltification of juvenile steelhead are controlled largely by water temperature. The duration of freshwater residence for juvenile steelhead is long relative to that of Chinook salmon, making the juvenile lifestage of steelhead more susceptible to the influences of water temperature, particularly during the over-summer rearing period. Central Valley juvenile steelhead have high growth rates at water temperatures in the mid-60°F range, but reportedly require lower water temperatures to successfully undergo the transformation to the smolt stage.

WTI values of 61°F, 63°F, 64°F, 65°F, 68°F, 72°F, 75°F, and 77°F were identified to represent a gradation of potential water temperature effects ranging between optimal to lethal conditions for steelhead juvenile rearing (Table 3). A water temperature of 61°F (7DADM) was identified as the value for steelhead juvenile rearing for the San Joaquin River (CALFED 2009). EPA Region 10 Guidance for Pacific Northwest State and Tribal Temperature Water Quality Standards (EPA 2003b) identifies 61°F (7DADM) for "salmon and trout" core juvenile rearing. The WTI value of 63°F was identified because Myrick and Cech (2001) describe 63°F as the "preferred" water temperature for wild juvenile steelhead, whereas "preferred" water temperatures for juvenile hatchery steelhead reportedly range between 64-66°F. EPA Region 10 Guidance for Pacific Northwest State and Tribal Temperature Water Quality Standards identifies 64°F (7DADM) for "salmon and trout" juvenile rearing (EPA 2003b). 65°F was also identified as a WTI value because NMFS (2000; 2002a) reported 65°F as the upper limit preferred for growth and development of Sacramento and American River juvenile steelhead. Also, 65°F was found to be within the optimum water temperature range for juvenile growth (i.e., 59-66°F) (Myrick and Cech 2001), and supported high growth of Nimbus strain juvenile steelhead (Cech and Myrick 1999). Increasing levels of thermal stress to this life stage may reportedly occur above the 65°F WTI value.

Kaya *et al.* (1977) reported that the upper avoidance water temperature for juvenile rainbow trout was measured at 68°F to 71.6°F. Cherry *et al.* (1977) observed an upper preference water temperature near 68.0°F for juvenile rainbow trout, duplicating the upper preferred limit for juvenile steelhead observed in Cech and Myrick (1999) and FERC (1993). Growth for 200 mm juvenile *O. mykiss* versus temperature for three food levels (percent of maximum consumption = 30%, 50%, and 70%) was evaluated. The average empirically derived percent of maximum consumption in the Middle Fork American Fork River was 50% (Hanson *et al.* 1997). Positive growth only occurs up to approximately 68°F. Because of the literature describing 68°F as both an upper preferred and an avoidance limit for juvenile *O. mykiss*, and because of the empirical fish population data and bioenergetics growth data, 68°F was identified as an upper tolerable WTI value.

A WTI value of 72°F was identified because symptoms of thermal stress in juvenile steelhead have been reported to arise at water temperatures approaching 72°F. For example, physiological stress to juvenile steelhead in Northern California streams was demonstrated by increased gill flare rates, decreased foraging activity, and increased agonistic activity as stream temperatures rose above 71.6°F (Nielsen *et al.* 1994). Also, 72°F was identified as a WTI value because 71.6°F has been reported as an upper avoidance water temperature (Kaya *et al.* 1977) and an upper thermal tolerance water temperature (Ebersole *et al.* 2001) for juvenile rainbow trout. The WTI value of 75°F was identified because NMFS and EPA report that direct mortality to rearing juvenile steelhead results when stream temperatures reach 75°F (EPA 2002; NMFS 2001b). Water temperatures >77°F have been referred to as "lethal" to juvenile steelhead (FERC 1993; Myrick and Cech 2001). The UILT for juvenile rainbow trout, based on numerous studies, is between 75-79°F (Sullivan *et al.* 2000; McCullough 2001).

A swim tunnel study conducted on the Lower Tuolumne River (Verhille et al. 2016) generated high quality field data on the physiological performance of Tuolumne River *O. mykiss* acutely exposed to a temperature range of 13 to 25°C (55.4°F to 77°F). The data indicated that wild juvenile *O. mykiss* represents an exception to the expected based on the 7DADM criterion for juvenile rearing set out by EPA (2003b) for Pacific Northwest *O. mykiss*. The study recommended that a conservative upper aerobic performance limit of 71.6°F, instead of 64.4°F (EPA), be considered in re-determining a 7DADM for this population.

The Lower Tuolumne River *O. mykiss* Population Study (TID/MID 2014) identified the UILT for *O. mykiss* juveniles has been estimated at 22.8–25.9ºC (73–79°F) (Threader and Houston 1983). In the model, an initial mortality threshold of 25°C (77°F) daily average temperature was identified for *O. mykiss* juveniles. Note also that both fry rearing and resident adult rearing lifestages of *O. mykiss* also had UILT values of 77°F to support the model.

For steelhead juvenile rearing, the Temperature Criteria Matrix identified 65°F for the Lower American River (Water Forum 2007); 61°F for the San Joaquin (CALFED 2009); and 65°F (Upper Optimum Value) and 68°F (Upper Tolerable Value) for the Yuba River Basin (Bratovich *et al.* 2012).

Table 3. Steelhead Juvenile Rearing WTI Values and the Literature Supporting Each Value.

Index Value	Supporting Literature
61°F (16.1°C)	A water temperature of 61°F (7DADM) was identified as the value for steelhead juvenile rearing for the San Joaquin River (CALFED 2009).
63°F (17.2°C)	Preferred water temperature for wild juvenile steelhead is reportedly 63°F, whereas preferred water temperatures for juvenile hatchery steelhead reportedly range between 64-66°F. Myrick and Cech (2001)
64°F (17.8°C)	EPA Region 10 Guidance for Pacific Northwest State and Tribal Temperature Water Quality Standards identifies 64°F (7DADM) for "salmon and trout" juvenile rearing (EPA 2003b).
65°F (18.3°C)	Upper limit of 65°F preferred for growth and development of Sacramento River and American River juvenile steelhead (NMFS 2002a). Nimbus juvenile steelhead growth showed an increasing trend with water temperature to 66.2°F, irrespective of ration level or rearing temperature (Cech and Myrick 1999). The final preferred water temperature for rainbow fingerlings was between 66.2 and 68°F (Cherry *et al.* 1977). Nimbus juvenile steelhead preferred water temperatures between 62.6°F and 68.0°F (Cech and Myrick 1999). Rainbow trout fingerlings preferred or identified water temperatures in the 62.6°F to 68.0°F range (McCauley and Pond 1971). A water temperature of 65°F (daily average temperature) was identified as the value for steelhead juvenile rearing for the Lower American River (Water Forum 2007). A water temperature of 65°F (MWAT) was identified as the Upper Optimum Value for steelhead juvenile rearing for the Yuba Reintroduction Assessment (Bratovich *et al.* 2012).
68°F (20°C)	Nimbus juvenile steelhead preferred water temperatures between 62.6°F and 68.0°F (Cech and Myrick 1999). The final preferred water temperature for rainbow trout fingerlings was between 66.2°F and 68°F (Cherry *et al.* 1977). Rainbow trout fingerlings preferred or identified water temperatures in the 62.6°F to 68.0°F range (McCauley and Pond 1971). The upper avoidance water temperature for juvenile rainbow trout was measured at 68°F to 71.6°F (Kaya *et al.* 1977). FERC (1993) referred to 68°F as "stressful" to juvenile steelhead. Empirical fish population and water temperature data in the North Yuba, Middle Yuba, South Yuba, Middle Fork American, and Rubicon Rivers (Figure 4 of Bratovich *et al.* 2012) indicate a sharp reduction in O. *mykiss* population densities when temperatures exceed 68°F for greater than one week. Bioenergetics modeling of growth based on consumption (P value = 0.5) in the Middle Fork American River watershed (adjacent watershed) indicates that growth likely does not occur above 68°F (Figure 5 of Bratovich *et al.* 2012). A water temperature of 68°F (MWAT) was identified as the Upper Tolerable Value for steelhead juvenile rearing for the Yuba Reintroduction Assessment (Bratovich *et al.* 2012).
72°F (22.2°C)	Increased physiological stress, increased agonistic activity, and a decrease in forage activity in juvenile steelhead occur after ambient stream temperatures exceed 71.6°F (Nielsen *et al.* 1994). The upper avoidance water temperature for juvenile rainbow trout was measured at 68°F to 71.6°F (Kaya *et al.* 1977). Estimates of upper thermal tolerance or avoidance limits for juvenile rainbow trout (at maximum ration) ranged from 71.6°F to 79.9°F (Ebersole *et al.* 2001). A swim tunnel study conducted on the Lower Tuolumne recommended a conservative upper aerobic performance limit of 71.6°F for *O. mykiss* juvenile rearing (Verhille et al. 2016).
75°F (23.9°C)	The maximum weekly average water temperature for survival of juvenile and adult rainbow trout is 75.2°F (EPA 2002). Rearing steelhead juveniles have an upper lethal limit of 75.0°F (NMFS 2001a). Estimates of upper thermal tolerance or avoidance limits for juvenile rainbow trout (at maximum ration) ranged from 71.6 to 79.9°F (Ebersole *et al.* 2001). The UILT for juvenile rainbow trout, based on numerous studies, is between 75-79°F (Sullivan *et al.* 2000; McCullough 2001).
77°F (25°C)	In the model associated with the Lower Tuolumne River *O. mykiss* Population Study (TID/MID 2014), an initial mortality threshold of 77°F daily average temperature was identified for *O. mykiss* juveniles.

Smolt Emigration

Laboratory data suggest that smoltification, and therefore successful emigration of steelhead smolts, is directly controlled by water temperature (Adams *et al.* 1975) (Table 4). WTI values of 52°F and 55°F were identified to evaluate the steelhead smolt emigration lifestage, because most literature on water temperature effects on steelhead smolting suggest that water temperatures less than 52°F (Adams *et al.*1975; Myrick and Cech 2001; Rich 1987a) or less than 55°F (EPA 2003a; McCullough *et al.* 2001; Wedemeyer *et al.* 1980; Zaugg and Wagner 1973) are required for successful smoltification to occur. Adams *et al.* (1973) tested the effect of water temperature (43.7°F, 50.0°F, 59.0°F or 68.0°F) on the increase of gill microsomal Na^+-, K^+-stimulated ATPase activity associated with parr-smolt transformation in steelhead and found a two-fold increase in Na^+-, K^+-ATPase at 43.7 and 50.0°F, but no increase at 59.0°F or 68.0°F. In a subsequent study, the highest water temperature where a parr-smolt transformation occurred was at 52.3°F (Adams *et al.* 1975). The results of Adams *et al.* (1975) were reviewed in Myrick and Cech (2001) and Rich (1987b), which both recommended that water temperatures below 52.3°F are required to successfully complete the parr-smolt transformation. Further, Myrick and Cech (2001) suggest that water temperatures between 43-50°F are the "physiologically optimal" temperatures required during the parr-smolt transformation and necessary to maximize saltwater survival. The 52°F WTI value identified for the steelhead smolt emigration lifestage is the index value generally reported in the literature as the upper limit of the water temperature range that provides successful smolt transformation thermal conditions. Increasing levels of thermal stress to this lifestage may reportedly occur above the 52°F WTI value.

Zaugg and Wagner (1973) examined the influence of water temperature on gill ATPase activity related to parr-smolt transformation and migration in steelhead. They found ATPase activity was decreased and migration reduced when juveniles were exposed to water temperatures of 55.4°F or greater. In a technical document prepared by the EPA to provide temperature water quality standards for the protection of Northwest native salmon and trout, water temperatures greater than 54.5°F were identified as an impairment to smoltification for juvenile steelhead (EPA 2003b). Water temperatures are considered "unsuitable" for steelhead smolts at >59°F (Myrick and Cech 2001) and "lethal" at 77°F (FERC 1993).

For steelhead smolt emigration, the Temperature Criteria Matrix identified 57°F for the San Joaquin (CALFED 2009) and 52°F (Upper Optimum Value) and 55°F (Upper Tolerable Value) for the Yuba River Basin (Bratovich et al. 2012). EPA Region 10 Guidance for Pacific Northwest State and Tribal Temperature Water Quality Standards (EPA 2003b) identifies 57°F (7DADM) for steelhead smoltification.

The Lower Tuolumne River *O. mykiss* Population Study (TID/MID 2014) identified an initial UILT mortality threshold of 77°F daily average temperature for *O. mykiss* smolts on the basis of literature reviews by Myrick and Cech (2001).

Table 4. Steelhead Smolt Emigration WTI Values and the Literature Supporting Each Value.

Index Value	Supporting Literature
52°F (11.1°C)	Steelhead successfully smolt at water temperatures in the 43.7°F to 52.3°F range (Myrick and Cech 2001). Steelhead undergo the smolt transformation when reared in water temperatures below 52.3°F, but not at higher water temperatures (Adams *et al.* 1975). Optimum water temperature range for successful smoltification in young steelhead is 44.0°F to 52.3°F (Rich 1987a). A water temperature of 52°F (MWAT) was identified as the Upper Optimum Value for steelhead smolt emigration for the Yuba Reintroduction Assessment (Bratovich *et al.* 2012).
55°F (12.8°C)	ATPase activity was decreased and migration reduced for steelhead at water temperatures greater than or equal to 55.4°F (Zaugg and Wagner 1973). Water temperatures should be below 55.4°F at least 60 days prior to release of hatchery steelhead to prevent premature smolting and desmoltification (Wedemeyer *et al.* 1980). In winter steelhead, a temperature of 54.1°F is nearly the upper limit for smolting (McCullough *et al.* 2001; Zaugg and Wagner 1973). Water temperatures less than or equal to 54.5°F are suitable for emigrating juvenile steelhead (EPA 2003b). Water temperatures greater than 55°F prevent increases in ATPase activity in steelhead juveniles (Hoar 1988). Water temperatures greater than 56°F do not permit smoltification in summer steelhead (Zaugg *et al.* 1972). A water temperature of 55°F (MWAT) was identified as the Upper Tolerable Value for steelhead smolt emigration for the Yuba Reintroduction Assessment (Bratovich *et al.* 2012).
57°F (13.9°C)	A water temperature of 57°F (7DADM) was identified as the value for steelhead smolt emigration for the San Joaquin River (CALFED 2009). EPA Region 10 Guidance for Pacific Northwest State and Tribal Temperature Water Quality Standards identifies 57°F (7DADM) for steelhead smoltification (EPA 2003b).
59°F (15°C)	Yearling steelhead held at 43.7°F and transferred to 59°F had a substantial reduction in gill ATPase activity, indicating that physiological changes associated with smoltification were reversed (Wedemeyer *et al.* 1980).
77°F (25°C)	A water temperature of 77°F (daily average temperature) was identified as UILT mortality threshold for *O. mykiss* smolts (Myrick and Cech 2001 as cited in TID/MID 2014).

CHINOOK SALMON LIFESTAGE-SPECIFIC WATER TEMPERATURE INDEX VALUES

It has been suggested that separate water temperatures standards should be developed for each run-type of Chinook salmon. For example, McCullough (1999) states that spring-run Chinook salmon immigrate in spring and spawn in 3rd to 5th order streams and, therefore, face different migration and adult holding temperature regimes than do summer- or fall-run Chinook salmon, which spawn in streams of 5th order or greater . However:(1) there is a general paucity of literature specific to each lifestage of each run-type; (2) there is an insufficient amount of data available in the literature suggesting that Chinook salmon run-types respond to water temperatures differently; (3) the WTI values derived from all the literature pertaining to Chinook salmon for a particular lifestage will be sufficiently protective of that lifestage for each run-type; and (4) all run- types overlap in timing of adult immigration and holding and in some cases are not easily distinguished (Healey 1991). Information distinctly applicable to spring-run or fall-run Chinook salmon is identified where run-specific information is available.

Adult Immigration and Holding

The adult immigration and staging lifestages for fall-run Chinook salmon are evaluated together, because they are believed to not spend significant amounts of time after immigrating and prior to spawning. The adult immigration and holding lifestages are evaluated separately for spring-run Chinook salmon, because of the potential extended duration of holding after immigrating and prior to spawning.

The WTI values reflect a gradation of potential water temperature effects that range between those reported as "optimal" to those reported as "lethal" for adult Chinook salmon during upstream spawning migrations and holding. The WTI values identified for the Chinook salmon adult immigration and holding lifestage are 60°F, 61°F, 64°F, 65°F, 68°F and 70°F (Table 5). Although 56°F is referenced in the literature frequently as the upper "optimal" water temperature limit for upstream migration and holding, the references are not foundational studies and often are inappropriate citations. For example, Boles *et al.* (1988), Marine (1992), and NMFS (1997b) all cite Hinze (1959) in support of recommendations for a water temperature of 56°F for adult Chinook salmon immigration. However, Hinze (1959) is a study examining the effects of water temperature on incubating Chinook salmon eggs in the American River Basin. Further, water temperatures between 38-56°F are considered to represent the "observed range" for upstream migrating spring-run Chinook salmon (Bell 1986).

The lowest WTI value identified was 60°F because in a previous NMFS biological opinion for the proposed operation of the Central Valley Project (CVP) and State Water Project (SWP), 59°F to 60°F is reported as…"*The upper limit of the optimal temperature range for adults holding while eggs are maturing*" (NMFS 2000). Also, NMFS (1997b) states…"*Generally, the maximum temperature of adults holding, while eggs are maturing, is about 59°F to 60°F*". Oregon Department of Environmental Quality (ODEQ; 1995) reports that "*…many of the diseases that commonly affect Chinook become highly infectious and virulent above 60°F*." Mature females subjected to prolonged exposure to water temperatures above 60°F have poor survival rates and produce less viable eggs than females exposed to lower water temperatures (USFWS 1995b).

Ward and Kier (1999) designated temperatures <60.8°F as an "optimum" water temperature threshold for holding Battle Creek spring-run Chinook salmon. EPA (2003a) chose a holding value of 61°F (7DADM) based on laboratory data various assumptions regarding diel temperature fluctuations. The 61°F WTI value identified for the Chinook salmon adult immigration and holding lifestage is the index value generally reported in the literature as the upper limit of the optimal range, and is within the reported acceptable range. Increasing levels of thermal stress to this lifestage may reportedly occur above the 61°F WTI value.

EPA Region 10 Guidance for Pacific Northwest State and Tribal Temperature Water Quality Standards (EPA 2003b) identifies 64°F (7DADM) for "salmon and trout" adult migration. A water temperature of 64°F (MWAT) was identified as the Upper Optimum Value for Chinook adult migration for the Yuba Reintroduction Assessment (Bratovich *et al*. 2012).

An index value of 65°F was identified because Berman (1990) suggests effects of thermal stress to pre-spawning adults are evident at water temperatures near 65°F. Berman (1990) conducted a laboratory study to determine if pre-spawning water temperatures experienced by adult Chinook salmon influenced reproductive success, and found evidence suggesting latent embryonic abnormalities associated with water temperature exposure to pre-spawning adults that ranged from 63.5°F to 66.2°F. During each of the years when Chinook salmon temperature mortality was not observed at Butte Creek (2001, 2004-2007), on average, daily temperature did not exceed 65.8°F for more than 7 days (Figure 6 of Bratovich *et al.* 2012). Tracy McReynolds (pers. comm. October 2011) suggested that an upper tolerable holding temperature of 65°F was reasonable. A water temperature of 65°F (MWAT) was identified as the Upper Tolerable Value for Chinook adult holding for the Yuba Reintroduction Assessment (Bratovich *et al.* 2012).

An index value of 68°F was identified because the Butte Creek data and the literature suggests that thermal stress at water temperatures greater than 68°F is pronounced, and severe adverse effects to immigrating and holding pre-spawning adults, including mortality, can be expected (Berman 1990; Marine 1997; NMFS 1997b; Ward *et al.* 2004).
Acceptable water temperatures for adults migrating upstream range from 57°F to 67°F (NMFS 1997b). For chronic exposures, an incipient upper lethal water temperature limit for pre-spawning adult salmon probably falls within the range of 62.6°F to 68°F (Marine 1992). Water temperatures of 68°F resulted in nearly 100% mortality of Chinook salmon during columnaris outbreaks (Ordal and Pacha 1963). Adult Chinook salmon migration rates through the lower Columbia River were slowed significantly when water temperatures exceeded 68°F (Goniea *et al.* 2006). A water temperature of 68°F (MWAT) was identified as the Upper Tolerable Value for Chinook adult migration for the Yuba Reintroduction Assessment (Bratovich *et al.* 2012).

Water temperatures between 70-77°F are reported as the range of maximum temperatures for holding pool conditions used by spring-run Chinook salmon in the Sacramento-San Joaquin system (Moyle *et al*. 1995). Migration blockage occurs for Chinook salmon at temperatures from 70-71+°F (McCollough 1999; McCullough *et al*. 2001; EPA 2003b). Strange (2010) found that the mean average body temperature during the first week of Chinook salmon migration on the Klamath River was 71.4°F. The UILT for Chinook salmon jacks is 69.8-71.6°F (McCullough 1999).
For spring-run Chinook salmon adult immigration, the Framework Temperature Criteria Matrix identified 64°F (Upper Optimum Value) and 68°F (Upper Tolerable Value) for the Yuba River Basin (Bratovich *et al*. 2012). For spring-run Chinook salmon adult holding, the Framework Temperature Criteria Matrix identified 61°F (Upper Optimum Value) and 65°F (Upper Tolerable Value) for the Yuba River Basin (Bratovich *et al.* 2012).

Table 5. Chinook Salmon Adult Immigration and Holding WTI Values and the Literature Supporting Each Value.

Index Value	Supporting Literature
60°F (15.6°C)	Maximum water temperature for adults holding, while eggs are maturing, is approximately 59°F to 60°F (NMFS 1997b). Upper limit of the optimal water temperature range for adults holding while eggs are maturing is 59°F to 60°F (NMFS 2000). Many of the diseases that commonly affect Chinook salmon become highly infectious and virulent above 60°F (ODEQ 1995). Mature females subjected to prolonged exposure to water temperatures above 60°F have poor survival rates and produce less viable eggs than females exposed to lower water temperatures (USFWS 1995b).
61°F (16.1°C)	A water temperature of 61°F (MWAT) was identified as the Upper Optimum Value for Chinook adult holding for the Yuba Reintroduction Assessment (Bratovich *et al.* 2012). Ward and Kier (1999) designated temperatures <60.8°F as an "optimum" water temperature threshold for holding Battle Creek spring-run Chinook salmon.
64°F (17.8°C)	A water temperature of 64°F (MWAT) was identified as the Upper Optimum Value for Chinook adult migration for the Yuba Reintroduction Assessment (Bratovich *et al.* 2012). EPA Region 10 Guidance for Pacific Northwest State and Tribal Temperature Water Quality Standards identifies 64°F (7DADM) for "salmon and trout" adult migration (EPA 2003b).
65°F (18.3°C)	Acceptable range for adults migrating upstream is from 57°F to 67°F (NMFS 1997b). Disease risk becomes high at water temperatures above 64.4°F (EPA 2003b). Latent embryonic mortalities and abnormalities associated with water temperature exposure to pre-spawning adults occur at 63.5°F to 66.2°F (Berman 1990). During each of the years when Chinook salmon temperature mortality was not observed at Butte Creek (2001, 2004-2007), on average, daily temperature did not exceed 65.8°F for more than 7 days (Figure 6 of Bratovich *et al.* 2012). A water temperature of 65°F (MWAT) was identified as the Upper Tolerable Value for Chinook adult holding for the Yuba Reintroduction Assessment (Bratovich *et al.* 2012).
68°F (20°C)	Acceptable water temperatures for adults migrating upstream range from 57°F to 67°F (NMFS 1997b). For chronic exposures, an incipient upper lethal water temperature limit for pre-spawning adult salmon probably falls within the range of 62.6°F to 68.0°F (Marine 1992). Water temperatures of 68°F resulted in nearly 100% mortality of Chinook salmon during columnaris outbreaks (Ordal and Pacha 1963). Adult Chinook salmon migration rates through the lower Columbia River were slowed significantly when water temperatures exceeded 68°F (Goniea *et al.* 2006). A water temperature of 68°F (MWAT) was identified as the Upper Tolerable Value for Chinook adult migration for the Yuba Reintroduction Assessment (Bratovich *et al.* 2012).
70°F (21.1°C)	Migration blockage occurs for Chinook salmon at temperatures from 70-71+°F (McCollough 1999; McCullough *et al.* 2001; EPA 2003b). Strange (2010) found that the mean average body temperature during the first week of Chinook salmon migration on the Klamath River was 71.4°F. The UILT for Chinook salmon jacks is 69.8-71.6°F (McCullough 1999).

Spawning and Embryo Incubation

The adult spawning and embryo (i.e., eggs and alevins) incubation lifestages share one set of WTI values because spawning and embryonic survival and development typically are considered concurrently in the literature on the effects of water temperature. Spawning and incubation evaluations are conducted separately due to differences in their temporal distributions.

The WTI values identified for the Chinook salmon spawning and embryo incubation lifestages are 55°F, 56°F, 58°F, 60°F, and 62°F (Table 6). Anomalously, FERC (1993) refers to 50°F as the "optimum" water temperature for spawning and incubating Chinook salmon. EPA Region 10 Guidance for Pacific Northwest State and Tribal Temperature Water Quality Standards identifies 55°F (7DADM) for "salmon and trout" spawning, egg incubation, and fry emergence (EPA 2003b). A water temperature of 55°F (7DADM) was identified as the value for Chinook incubation for the San Joaquin River fall-run Chinook salmon (CALFED 2009).

Additionally, for the adult spawning lifestage, FERC (1993) reports "stressful" and "lethal" water temperatures occurring at >60°F and >70°F, respectively, whereas for incubating Chinook salmon embryos, water temperatures are considered to be "stressful" at <56°F or "lethal" at >60°F. Much literature suggests that water temperatures must be less than or equal to 56°F for maximum survival of Chinook salmon embryos (i.e., eggs and alevins) during spawning and incubation. NMFS (1993b) reported that optimum water temperatures for egg development are between 43°F and 56°F. Similarly, Myrick and Cech (2001) reported the highest egg survival rates occur between water temperatures of 39-54°F. Reclamation (unpublished work) reports that water temperatures less than 56°F results in a natural rate of mortality for fertilized Chinook salmon eggs. Bell (1986) recommends water temperatures ranging between 42-57°F for spawning Chinook salmon, and water temperatures between 41-58°F for incubating embryos. USFWS (1995a) reported a water temperature range of 41°F to 56°F for maximum survival of eggs and yolk-sac larvae in the Central Valley of California. The preferred water temperature range for Chinook salmon egg incubation in the Sacramento River was suggested as 42°F to 56°F (NMFS 1997a). Alevin mortality is reportedly significantly higher when Chinook salmon embryos are incubated at water temperatures above 56°F (USFWS 1999). NMFS (2002a) reported 56°F as the upper limit of suitable water temperatures for spring-run Chinook salmon spawning in the Sacramento River. The 56°F WTI value identified for the Chinook salmon spawning and embryo incubation lifestage is the index value generally reported in the literature as the upper limit of the optimal range for egg development and the upper limit of the range reported to provide maximum survival of eggs and yolk-sac larvae in the Central Valley of California. Increasing levels of thermal stress to this lifestage may reportedly occur above the 56°F WTI value.

High survival of Chinook salmon embryos also has been suggested to occur at incubation temperatures at or near 58°F. For example, (Reclamation Unpublished Work) reported that the natural rate of mortality for alevins occurs at 58°F or less. Combs (1957) concluded constant incubation temperatures between 42.5°F and 57.5°F resulted in normal development of Chinook salmon eggs, and NMFS (2002a) suggests 53°F to 58°F is the preferred water temperature range for Chinook salmon eggs and fry. The model associated with the Chinook Salmon Population Model Study (TID/MID 2013), established an initial acute egg/alevin mortality threshold of 58°F. A water temperature of 58°F (MWAT) was identified as the Upper Tolerable Value for Chinook spawning and incubation for the Yuba Reintroduction Assessment (Bratovich *et al.* 2012).

Johnson (1953) found consistently higher Chinook salmon egg losses resulted at water temperatures above 60°F than at lower temperatures. In order to protect late incubating Chinook salmon embryos and newly emerged fry NMFS (1993a) determined that a water temperature criterion of less than or equal to 60°F be maintained in the Sacramento River from Keswick Dam to Bend Bridge from October 1 to October 31. Seymour (1956) provides evidence that

100% mortality occurs to late incubating Chinook salmon embryos when held at a constant water temperature greater than or equal to 60°F. For Chinook salmon eggs incubated at constant temperatures, mortality increases rapidly at temperatures greater than about 59-60°F (see data plots in Myrick and Cech 2001). Olsen and Foster (1957), however, found high survival of Chinook salmon eggs and fry (89.6%) when incubation temperatures started at 60.9°F and declined naturally for the Columbia River (about 7°F/month). The Chinook Salmon Population Model (TID/MID 2013) established an initial estimate of 60.4°F as the upper limit for initiation of spawning (Groves and Chandler 1999); also interpreted as the temperature at which spawning habitat will be considered usable by spawners.

The literature largely agrees that 100% mortality will result to Chinook salmon embryos incubated at water temperatures greater than or equal to about 62°F (Hinze 1959; Myrick and Cech 2003; Seymour 1956; USFWS 1999). Approximately 80% or greater mortality of eggs incubated at constant temperatures of 63°F or greater (see data plots in Myrick and Cech 2001). Geist *et al.* (2006) found low Chinook salmon incubation survival (1.7%) for naturally declining temperatures (0.36°F/day) when temperatures started at 62.6°F.

For Chinook salmon spawning and incubation, the Framework Temperature Criteria Matrix identified 60°F or less (as early in October as possible) and 56°F or less (as early in November as possible) as water temperature targets for lower American River fall-run Chinook salmon (Water Forum 2007); 64°F (spawning) and 55°F (incubation) for San Joaquin fall-run Chinook salmon (CALFED 2009); 56°F for Shasta River winter and spring-run Chinook salmon (SWRCB 2016); and 56°F (Upper Optimum Value) and 58°F (Upper Tolerable Value) in the Yuba River Basin (Bratovich *et al*. 2012).

Table 6. Chinook Salmon Spawning and Embryo Incubation WTI Values and the Literature Supporting Each Value.

Index Value	Supporting Literature
55°F (12.8°C)	EPA Region 10 Guidance for Pacific Northwest State and Tribal Temperature Water Quality Standards identifies 55°F (7DADM) for "salmon and trout" spawning, egg incubation, and fry emergence (EPA 2003b). A water temperature of 55°F (7DADM) was identified as the value for Chinook incubation for the San Joaquin River fall-run Chinook salmon (CALFED 2009).
56°F (13.3°C)	Less than 56°F results in a natural rate of mortality for fertilized Chinook salmon eggs (Reclamation Unpublished Work). Optimum water temperatures for egg development are between 43°F and 56°F (NMFS 1993b). Upper value of the water temperature range (i.e., 41°F to 56°F) suggested for maximum survival of eggs and yolk-sac larvae in the Central Valley of California (USFWS 1995b). Upper value of the range (i.e., 42°F to 56°F) given for the preferred water temperature for Chinook salmon egg incubation in the Sacramento River (NMFS 1997a). Incubation temperatures above 56°F result in significantly higher alevin mortality (USFWS 1999). 56°F is the upper limit of suitable water temperatures for spring-run Chinook salmon spawning in the Sacramento River (NMFS 2002a). Water temperatures averaged 56.5°F during the week of fall-run Chinook salmon spawning initiation on the Snake River (Groves and Chandler 1999). A water temperature of 56°F or less (daily average temperature), as early in November as possible, was identified as the value for fall-run Chinook salmon spawning and incubation for the lower American River (Water Forum 2007). A water temperature of 56°F (daily average temperature) was identified as the value for Chinook spawning and incubation for the Shasta River winter- and spring-run Chinook (SWRCB 2016). A water temperature of 56°F (MWAT) was identified as the Upper Optimum Value for Chinook spawning and incubation for the Yuba Reintroduction Assessment (Bratovich *et al.* 2012).
58°F (14.4°C)	Upper value of the range given for preferred water temperatures (i.e., 53°F to 58°F) for eggs and fry (NMFS 2002a). Constant egg incubation temperatures between 42.5°F and 57.5°F resulted in normal development (Combs and Burrows 1957). The natural rate of mortality for alevins occurs at 58°F or less (Reclamation Unpublished Work). The model associated with the Chinook Salmon Population Model Study, established an initial acute egg/alevin mortality threshold of 58°F (TID/MID 2013). A water temperature of 58°F (MWAT) was identified as the Upper Tolerable Value for Chinook spawning and incubation for the Yuba Reintroduction Assessment (Bratovich *et al.* 2012).

Index Value	Supporting Literature
60°F (15.6°C)	100% mortality can occur to late incubating Chinook salmon embryos (yolk-sac stage) if temperatures are 60°F or greater (Seymour 1956). An October 1 to October 31 water temperature criterion of less than or equal to 60°F in the Sacramento River from Keswick Dam to Bend Bridge has been determined for protection of late incubating larvae and newly emerged fry (NMFS 1993b). Mean weekly water temperature at first observed Chinook salmon spawning in the Columbia River was 59.5°F (Dauble and Watson 1997). Consistently higher egg losses resulted at water temperatures above 60°F than at lower temperatures (Johnson and Brice 1953). For Chinook Salmon eggs incubated at constant temperatures, mortality increases rapidly at temperatures greater than about 59-60°F (see data plots in Myrick and Cech 2001). Olsen and Foster (1957) found high survival of Chinook salmon eggs and fry (89.6%) when incubation temperatures started at 60.9°F and declined naturally for the Columbia River (about 7°F/month). A water temperature of 60°F or less (daily average temperature), as early in October as possible, was identified as a target value for Chinook spawning and incubation for the lower American River fall-run Chinook (Water Forum 2007). The model associated with the Chinook Salmon Population Model Study (TID/MID 2013), established an initial estimate of 60.4°F as the upper limit for initiation of spawning (Groves and Chandler 1999).
62°F (16.7°C)	100% mortality of fertilized Chinook salmon eggs after 12 days at 62°F (Reclamation Unpublished Work). Incubation temperatures of 62ºF to 64°F appear to be the physiological limit for embryo development resulting in 80 to 100% mortality prior to emergence (USFWS 1999). 100% loss of eggs incubated at water temperatures above 62°F (Hinze 1959). 100% mortality occurs during yolk-sac stage when embryos are incubated at 62.5°F (Seymour 1956). Approximately 80% or greater mortality of eggs incubated at constant temperatures of 63°F or greater (see data plots in Myrick and Cech 2001). Geist *et al*. (2006) found low Chinook salmon incubation survival (1.7%) for naturally declining temperatures (0.36°F/day) when temperatures started at 62.6°F.

Juvenile Rearing and Downstream Movement

WTI values were developed to evaluate the Chinook salmon rearing (fry and juvenile) and juvenile downstream movement lifestages. Some Chinook salmon juveniles, both fall-run and spring-run, move downstream shortly after emergence as post- emergent fry, or rear in the river for several months and move downstream as YOY juveniles without exhibiting the ontogenetic characteristics of smolts. Presumably, these individuals undergo the smoltification process prior to entry into saline environments. Thus, fry and juvenile rearing occur concurrently with post-emergent fry and juvenile downstream movement and are presented in this Technical Memorandum using the fry and juvenile rearing WTI values.

The WTI values of 60°F, 61°F, 64°F, 65°F, 68°F, 70°F,75°F, and 77°F were identified for the Chinook salmon juvenile rearing and downstream movement lifestage. The lowest index value of 60°F was identified because regulatory documents as well as several source studies, including ones conducted on Central Valley Chinook salmon fry and juveniles, report 60°F as an optimal water temperature for growth (Banks *et al.* 1971; Brett *et al.* 1982; Marine 1997; NMFS 1997b; NMFS 2000; NMFS 2001a; NMFS 2002; Rich 1987b) (Table 7). Water temperatures below 60°F also have been reported as providing conditions optimal for fry and fingerling growth, but were not identified as index values, because the studies were conducted on fish from outside of the Central Valley (Brett 1952; Seymour 1956). Studies conducted using local fish may be particularly important because *Oncorhynchus* species show considerable variation in morphology, behavior, and physiology along latitudinal gradients (Myrick 1998; Taylor 1990b; Taylor 1990a). More specifically, it has been suggested that salmonid populations in the Central Valley prefer higher water temperatures than those from more northern latitudes (Myrick and Cech 2000).

The 60°F WTI value identified for the Chinook salmon juvenile rearing and downstream movement lifestage is the index value generally reported in the literature as the upper limit of the optimal range for fry and juvenile growth and the upper limit of the preferred range for growth and development of spring-run Chinook salmon fry and fingerlings. NMFS (2002a) identified 60°F as the "preferred" water temperature for juvenile spring-run Chinook salmon in the Central Valley. Increasing levels of thermal stress to this lifestage may reportedly occur above the 60°F WTI value.

A water temperature of 61°F (7DADM) was identified as the value for Chinook juvenile rearing for the San Joaquin River (CALFED 2009). A water temperature of 61°F (MWAT) was identified as the Upper Optimum Value for Chinook juvenile rearing for the Yuba Reintroduction Assessment for both fall- and spring-run Chinook (Bratovich *et al.* 2012). EPA Region 10 Guidance for Pacific Northwest State and Tribal Temperature Water Quality Standards identifies 61°F (7DADM; early year) for salmon juvenile rearing (EPA 2003b).

EPA Region 10 Guidance for Pacific Northwest State and Tribal Temperature Water Quality Standards identifies 64°F (7DADM; late year) for salmon juvenile rearing (EPA 2003b). Recommended summer maximum water temperature of 64.4°F for migration and non-core rearing (EPA 2003b). Water temperatures greater than 64°F are considered not ″properly functioning" by NMFS in Amendment 14 to the Pacific Coast Salmon Plan (NMFS 1995). Fatal infection rates caused by *C. columnaris* are high at temperatures greater than or equal to 64°F (EPA 2001). Optimal range for Chinook salmon survival and growth from 53°F to 64°F (USFWS 1995b). Survival of Central Valley juvenile Chinook salmon declines at temperatures greater than 64.4°F (Myrick and Cech 2001).

The index value of 65°F was identified because it represents an intermediate value between 64°F and 66.2°F, at which both adverse and beneficial effects to juvenile salmonids have been reported to occur. For example, at temperatures approaching and beyond 65°F, sub-lethal effects associated with increased incidence of disease reportedly become severe for juvenile Chinook salmon (EPA 2003a; Johnson and Brice 1953; Ordal and Pacha 1963; Rich 1987a). Conversely, numerous studies report that temperatures between 64.0°F and 66.2°F provide conditions ranging from suitable to optimal for juvenile Chinook salmon growth (Brett *et al.* 1982; Cech and Myrick 1999; Clarke and Shelbourn 1985; EPA 2003a; Myrick and Cech 2001; NMFS 2002; USFWS 1995b). Maximum growth of juvenile fall-run Chinook salmon has been reported to occur in the American River at water temperatures between 56-59°F (Rich 1987b) and in Nimbus Hatchery spring-run Chinook salmon at 66°F (Cech and Myrick 1999). Bioenergetics modeling of growth based on consumption for 100 mm juvenile Chinook salmon in the Middle Fork American River watershed indicates that growth likely does not occur above about 65°F (Figure 5 of Bratovich *et al.* 2012). A water temperature of 65°F (MWAT) was identified as the Upper Tolerable Value for Chinook juvenile rearing for the Yuba Reintroduction

Assessment for both fall- and spring-run Chinook salmon (Bratovich *et al.* 2012).

A WTI value of 68°F was identified because, at water temperatures above 68°F, sub-lethal effects become severe such as reductions in appetite and growth of juveniles (Marine 1997; Rich 1987a; Zedonis and Newcomb 1997). Significant reductions in growth rates may occur when chronic elevated temperatures exceed 68°F (Marine 1997; Marine and Cech 2004). Juvenile spring-run Chinook salmon were not found in areas having mean weekly water temperatures between 67.1°F and 71.6°F (Burck *et al.* 1980; Zedonis and Newcomb 1997). Results from a study on wild spring-run Chinook salmon in the John Day River system indicate that juvenile fish were not found in areas having mean weekly water temperatures between 67.1°F and 72.9°F (McCullough 1999; Zedonis and Newcomb 1997).

Chronic stress associated with water temperature can be expected when conditions reach the index value of 70°F. For example, growth becomes drastically reduced at temperatures close to 70.0°F and has been reported to be completely prohibited at 70.5°F (Brett *et al.* 1982; Marine 1997). No growth at all would occur for Nechako River juvenile Chinook salmon at 70.5°F (Brett *et al.* 1982; Zedonis and Newcomb 1997). Juvenile spring-run Chinook salmon were not found in areas having mean weekly water temperatures between 67.1°F and 71.6°F (Burck *et al.* 1980; Zedonis and Newcomb 1997). Results from a study on wild spring-run Chinook salmon in the John Day River system indicate that juvenile fish were not found in areas having mean weekly water temperatures between 67.1°F and 72.9°F (McCullough 1999; Zedonis and Newcomb 1997). Increased incidence of disease, hyperactivity, reduced appetite, and reduced growth rates at 69.8 ± 1.8°F (Rich 1987b). In a laboratory study, juvenile fall-run Chinook salmon from the Sacramento River reared in water temperatures between 70°F and 75°F experienced significantly decreased growth rates and increased predation vulnerability compared with juveniles reared between 55°F and 61°F (Marine 1997; Marine and Cech 2004).

75°F was identified as a WTI value because high levels of direct mortality to juvenile Chinook salmon reportedly result at this water temperature (Cech and Myrick 1999; Hanson 1991; Myrick and Cech 2001; Rich 1987b). Other studies have suggested higher upper lethal water temperature levels (Brett 1952; Orsi 1971), but 75°F was identified because it was derived from experiments using Central Valley Chinook salmon and it is a more rigorous index value representing a more protective upper lethal water temperature level. Furthermore, the lethal level determined in Rich (1987b) was derived using slow rates of water temperature change and, thus, is ecologically relevant. The juvenile Chinook Salmon UILT based on numerous studies is 75-77°F (Sullivan *et al.* 2000; McCullough *et al.* 2001; Myrick and Cech 2001). Based upon information reviewed for Chinook salmon juvenile mortality (Brett 1952; Orsi 1971), the Chinook Salmon Population Model (TID/MID 2013) identified an initial UILT mortality threshold of 77°F for Chinook salmon juveniles as a daily average water temperature. Note that the model also identified this same value for fry mortality.

Table 7. Chinook Salmon Juvenile Rearing and Downstream Movement WTI Values and the Literature Supporting Each Value.

Index Value	Supporting Literature
60°F (15.6°C)	Optimum water temperature for Chinook salmon fry growth is between 55°F and 60°F (Seymour 1956). Water temperature range that produced optimum growth in juvenile Chinook salmon was between 54°F and 60°F (Rich 1987b). Water temperature criterion of less than or equal to 60°F for the protection of Sacramento River winter-run Chinook salmon from Keswick Dam to Bend Bridge (NMFS 1993b). Upper optimal water temperature limit of 61°F for Sacramento River fall-run Chinook salmon juvenile rearing (Marine 1997; Marine and Cech 2004). Upper water temperature limit of 60°F preferred for growth and development of spring-run Chinook salmon fry and fingerlings (NMFS 2000; NMFS 2002a). To protect salmon fry and juvenile Chinook salmon in the upper Sacramento River, daily average water temperatures should not exceed 60°F after September 30 (NMFS 1997b). A water temperature of 60°F appeared closest to the optimum for growth of fingerlings (Banks *et al.* 1971). Optimum growth of Nechako River Chinook salmon juveniles would occur at 59°F at a feeding level that is 60% of that required to satiate them (Brett *et al.* 1982). In a laboratory study, juvenile fall-run Chinook salmon from the Sacramento River reared in water temperatures between 70°F and 75°F experienced significantly decreased growth rates, and increased predation vulnerability compared with juveniles reared between 55°F and 61°F (Marine 1997; Marine and Cech 2004).
61°F (16.1°C)	A water temperature of 61°F (7DADM) was identified as the value for Chinook juvenile rearing for the San Joaquin River (CALFED 2009). A water temperature of 61°F (MWAT) was identified as the Upper Optimum Value for Chinook juvenile rearing for the Yuba Reintroduction Assessment for both fall- and spring-run Chinook (Bratovich *et al.* 2012). EPA Region 10 Guidance for Pacific Northwest State and Tribal Temperature Water Quality Standards identifies 61°F (7DADM; early year) for salmon juvenile rearing (EPA 2003b).
64°F (17.8°C)	EPA Region 10 Guidance for Pacific Northwest State and Tribal Temperature Water Quality Standards identifies 64°F (7DADM; late year) for salmon juvenile rearing (EPA 2003b). Recommended summer maximum water temperature of 64.4°F for migration and non-core rearing (EPA 2003b). Water temperatures greater than 64°F are considered not ″properly functioning" by NMFS in Amendment 14 to the Pacific Coast Salmon Plan (NMFS 1995). Fatal infection rates caused by *C. columnaris* are high at temperatures greater than or equal to 64°F (EPA 2001). Optimal range for Chinook salmon survival and growth from 53°F to 64°F (USFWS 1995b). Survival of Central Valley juvenile Chinook salmon declines at temperatures greater than 64.4°F (Myrick and Cech 2001).

Index Value	Supporting Literature
65°F (18.3°C)	Water temperatures between 45°F to 65°F are preferred for growth and development of fry and juvenile spring-run Chinook salmon in the Feather River (NMFS 2002a). Disease mortalities diminish at water temperatures below 65°F (Ordal and Pacha 1963). Fingerling Chinook salmon reared in water greater than 65°F contracted *C. columnaris* and exhibited high mortality (Johnson and Brice 1953). Water temperatures greater than 64.9°F identified as being stressful in the Columbia River Ecosystem (Independent Scientific Group 1996). Juvenile Chinook salmon have an optimum temperature for growth that appears to occur at about 66.2°F (Brett *et al.* 1982). Juvenile Chinook salmon reached a growth maximum at 66.2°F (Cech and Myrick 1999). Increased incidence of disease, reduced appetite, and reduced growth rates at 66.2 ± 1.4 °F (Rich 1987b). Bioenergetics modeling of growth based on consumption for 100 mm juvenile Chinook salmon in the Middle Fork American River watershed indicates that growth likely does not occur above about 65°F (Figure 5 of Bratovich *et al.* 2012). A water temperature of 65°F (MWAT) was identified as the Upper Tolerable Value for Chinook juvenile rearing for the Yuba Reintroduction Assessment for both fall- and spring-run Chinook salmon (Bratovich *et al.* 2012).
68°F (20°C)	Sacramento River juvenile Chinook salmon reared at water temperatures greater than or equal to 68°F suffer reductions in appetite and growth (Marine 1997; Marine and Cech 2004). Significant reductions in growth rates may occur when chronic elevated temperatures exceed 68°F (Marine 1997; Marine and Cech 2004). Juvenile spring-run Chinook salmon were not found in areas having mean weekly water temperatures between 67.1°F and 71.6°F (Burck *et al.* 1980; Zedonis and Newcomb 1997). Results from a study on wild spring-run Chinook salmon in the John Day River system indicate that juvenile fish were not found in areas having mean weekly water temperatures between 67.1°F and 72.9°F (McCullough 1999; Zedonis and Newcomb 1997).
70°F (21.1°C)	No growth at all would occur for Nechako River juvenile Chinook salmon at 70.5°F (Brett *et al.* 1982; Zedonis and Newcomb 1997). Juvenile spring-run Chinook salmon were not found in areas having mean weekly water temperatures between 67.1°F and 71.6°F (Burck *et al.* 1980; Zedonis and Newcomb 1997). Results from a study on wild spring-run Chinook salmon in the John Day River system indicate that juvenile fish were not found in areas having mean weekly water temperatures between 67.1°F and 72.9°F (McCullough 1999; Zedonis and Newcomb 1997). Increased incidence of disease, hyperactivity, reduced appetite, and reduced growth rates at 69.8 ± 1.8 °F (Rich 1987b). In a laboratory study, juvenile fall-run Chinook salmon from the Sacramento River reared in water temperatures between 70°F and 75°F experienced significantly decreased growth rates and increased predation vulnerability compared with juveniles reared between 55°F and 61°F (Marine 1997; Marine and Cech 2004).
75°F (23.9°C)	For juvenile Chinook salmon in the lower American River fed maximum rations under laboratory conditions, 75.2°F was determined to be 100% lethal due to hyperactivity and disease (Rich 1987b; Zedonis and Newcomb 1997). Lethal temperature threshold for fall-run juvenile Chinook salmon between 74.3°F and 76.1°F (McCullough 1999). In a laboratory study, juvenile fall-run Chinook salmon from the Sacramento River reared in water temperatures between 70°F and 75°F experienced significantly decreased growth rates, and increased predation vulnerability compared with juveniles reared between 55°F and 61°F (Marine 1997; Marine and Cech 2004). The juvenile Chinook Salmon UILT based on numerous studies is 75-77°F (Sullivan *et al.* 2000; McCullough *et al.* 2001; Myrick and Cech 2001).
77°F (25°C)	The model associated with the Chinook Salmon Population Model Study, established an initial UILT mortality threshold of 77°F (daily average temperatures) for Chinook salmon fry and juveniles (Brett 1952 and Orsi 1971, as cited in TID/MID 2013).

Smolt Emigration

Juvenile Chinook salmon that exhibit extended rearing in a riverine environment are assumed to undergo the smoltification process and volitionally emigrate from the river as smolts. WTI values of 57°F, 59°F, 63°F, 68°F 72°F, and 77°F were identified for the Chinook salmon smolt emigration lifestage (Table 8).

A water temperature of 57°F (7DADM) was identified as the value for Chinook smolt migration for the San Joaquin River (CALFED 2009). EPA Region 10 Guidance for Pacific Northwest State and Tribal Temperature Water Quality Standards identifies 59°F (7DADM; late year) for salmon smolts (EPA 2003b).

A WTI value of 63°F was identified because water temperatures at or below this value allow for successful transformation to the smolt stage, and water temperatures above this value may result in impaired smoltification indices, inhibition of smolt development, and decreased survival and successful smoltification of juvenile Chinook salmon. Laboratory experiments suggest that water temperatures at or below 62.6°F provide conditions that allow for successful transformation to the smolt stage (Clarke and Shelbourn 1985; Marine 1997; Zedonis and Newcomb 1997). 62.6°F was rounded and used to support an index value of 63°F. A water temperature of 63°F (MWAT) was identified as the Upper Optimum Value for Chinook smolt migration for the Yuba Reintroduction Assessment for both fall- and spring-run Chinook (Bratovich *et al.* 2012).

Indirect evidence from tagging studies suggests that the survival of fall-run Chinook salmon smolts decreases with increasing water temperatures between 59°F and 75°F in the Sacramento-San Joaquin Delta (Kjelson and Brandes 1989). A WTI value of 68°F was identified because water temperatures above 68°F prohibit successful smoltification (Marine 1997; Rich 1987a; Zedonis and Newcomb 1997). Significant inhibition of gill sodium ATPase activity and associated reductions of hyposmoregulatory capacity, and significant reductions in growth rates, may occur when chronic elevated temperatures exceed 68°F (Marine 1997; Marine and Cech 2004). Water temperatures supporting smoltification of fall-run Chinook salmon range between 50°F to 68°F, the colder temperatures represent more optimal conditions (50°F to 62.6°F), and the warmer conditions (62.6°F to 68°F) represent marginal conditions (Zedonis and Newcomb 1997). A water temperature of 68°F (MWAT) was identified as the Upper Tolerable Value for Chinook smolt migration for the Yuba Reintroduction Assessment for spring-run Chinook salmon (Bratovich *et al*. 2012).

Support for an index value of 72°F is provided from a study conducted by (Baker *et al.* 1995) in which a statistical model is presented that treats survival of Chinook salmon smolts fitted with coded wire tags in the Sacramento River as a logistic function of water temperature. Using data obtained from mark-recapture surveys, the statistical model suggests a 95% confidence interval for the upper incipient lethal water temperature for Chinook salmon smolts as 71.5°F to 75.4°F. In a laboratory study, juvenile fall-run Chinook salmon from the Sacramento River reared in water temperatures between 70°F and 75°F experienced significantly decreased growth rates, impaired smoltification indices, and increased predation vulnerability compared with juveniles reared between 55°F and 61°F (Marine 1997; Marine and Cech 2004).

Indirect evidence from tagging studies suggests that the survival of fall-run Chinook salmon smolts decreases with increasing water temperatures between 59°F and 75°F in the Sacramento-San Joaquin Delta (Kjelson and Brandes 1989).
Based upon information reviewed for Chinook salmon juvenile mortality (Brett 1952), the Chinook Salmon Population Model (TID/MID 2013) identified an initial mortality threshold of 77°F for Chinook salmon smolts as a daily average water temperature.

Table 8. Chinook Salmon Smolt Emigration WTI Values and the Literature Supporting Each Value.

Index Value	Supporting Literature
57°F (13.9°C)	A water temperature of 57°F (7DADM) was identified as the value for Chinook smolt migration for the San Joaquin River (CALFED 2009).
59°F (15°C)	EPA Region 10 Guidance for Pacific Northwest State and Tribal Temperature Water Quality Standards identifies 59°F (7DADM; late year) for salmon smolts (EPA 2003b).
63°F (17.2°C)	Acceleration and inhibition of Sacramento River Chinook salmon smolt development reportedly may occur at water temperatures above 63°F (Marine 1997; Marine and Cech 2004). Laboratory evidence suggest that survival and smoltification become compromised at water temperatures above 62.6°F (Zedonis and Newcomb 1997). Juvenile Chinook salmon growth was highest at 62.6°F (Clarke and Shelbourn 1985). A water temperature of 63°F (MWAT) was identified as the Upper Optimum Value for Chinook smolt migration for the Yuba Reintroduction Assessment for both fall- and spring-run Chinook (Bratovich *et al.* 2012).
68°F (20°C)	Significant inhibition of gill sodium ATPase activity and associated reductions of hyposmoregulatory capacity, and significant reductions in growth rates, may occur when chronic elevated temperatures exceed 68°F (Marine 1997; Marine and Cech 2004). Water temperatures supporting smoltification of fall-run Chinook salmon range between 50°F to 68°F, the colder temperatures represent more optimal conditions (50°F to 62.6°F), and the warmer conditions (62.6°F to 68°F) represent marginal conditions (Zedonis and Newcomb 1997). A water temperature of 68°F (MWAT) was identified as the Upper Tolerable Value for Chinook smolt migration for the Yuba Reintroduction Assessment for both fall- and spring-run Chinook (Bratovich *et al.* 2012).
72°F (22.2°C)	In a laboratory study, juvenile fall-run Chinook salmon from the Sacramento River reared in water temperatures between 70°F and 75°F experienced significantly decreased growth rates, impaired smoltification indices, and increased predation vulnerability compared with juveniles reared between 55°F and 61°F (Marine 1997; Marine and Cech 2004). Indirect evidence from tagging studies suggests that the survival of fall-run Chinook salmon smolts decreases with increasing water temperatures between 59°F and 75°F in the Sacramento-San Joaquin Delta (Kjelson and Brandes 1989).
77°F (25°C)	The model associated with the Chinook Salmon Population Model Study, established an initial mortality threshold of 77°F (daily average temperatures) for Chinook salmon smolts (Brett 1952 as cited in TID/MID 2013).

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La Grange Hydroelectric Project
Reintroduction Assessment Framework
Water Temperature/Reintroduction Goals Subcommittees – In-person Meeting

Thursday, January 26, 2017, 1:00 pm to 4:00 pm
Modesto Irrigation District
1231 11th St., Modesto, CA 95354

By Phone - Conference Line: 1-866-583-7984; Passcode: 814-0607

Meeting Objectives:

1. Review and discuss updated water temperature information based upon comments received.
2. Continue discussion of Boughton et al. approach in relation to current Updated Literature Review Summary.
3. Discuss next steps and schedule for WTI selection (Water Temperature Working Document).
4. Review and discuss comments received on draft narrative reintroduction goals statement and finalize statement.
5. Discuss developing objective/corollary statements in support of a reintroduction goals statement.

TIME	TOPIC
1:00 pm – 1:10 pm	Introduction of Participants (All) Review Agenda and Meeting Objectives (Districts)
1:10 pm – 2:30 pm	Water Temperature Subcommittee Topics (All) a. Updated Literature Review Summary – comments received (Districts) b. Boughton approach as applied to Updated Literature Review Summary (Districts) c. Water Temperature Working Document – discussion (All)
2:30 pm – 3:50 pm	Reintroduction Goals Subcommittee Topics (All) a. Additional discussion on current draft narrative reintroduction goals statement – comments received and finalization (All) b. Subcommittee discussion of further development of objective/corollary statements to support narrative goal statement (All)
3:50 pm – 4:00 pm	Next Steps (All) a. Schedule next call and agenda topics b. Action items from this call

	UOWTI	UTWTI	Incip Lethal WTI	Other WTI Values?	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Fall-run Chinook Salmon																
Adult Upstream Migration																
Adult Spawning																
Egg Incubation and Fry Emergence																
In-River Rearing (Age 0+)																
Smolt Outmigration																
Spring-run Chinook Salmon																
Adult Upstream Migration																
Adult Holding																
Adult Spawning																
Egg Incubation and Fry Emergence																
Fry Rearing																
Juvenile Rearing and Downstream Movement																
Smolt Outmigration																
Steelhead																
Adult Upstream Migration																
Adult Spawning																
Egg Incubation and Fry Emergence																
Fry Rearing																
Juvenile Rearing and Downstream Movement																
Smolt Outmigration																

UOWTI = Upper Optimum Water Temperature Index
UTWTI = Upper Tolerance Water Temperature Index

January 2017

PRELIMINARY DRAFT – FOR DISCUSSION PURPOSES ONLY
TUOLUMNE RIVER REINTRODUCTION GOALS STATEMENT AND DISCUSSION OF COROLLARY OBJECTIVES

Per discussions at the December 1, 2016 joint subcommittee meeting, the updated draft Tuolumne River reintroduction goals narrative statement is as follows:

"*Contribute to the recovery of ESA listed salmonids in the Central Valley by establishing viable populations in the Tuolumne River at fair and reasonable cost.*

Specific objectives consistent with the goal statement include the following:"

As discussed by the Reintroduction Goals Subcommittee, the narrative goal statement is intended to be a high level statement that represents the diverse interests of subcommittee participants. The development of additional objective/corollary statements to further define the narrative goal statement may be appropriate to clarify the overarching reintroduction goal statement. Ultimately, the Tuolumne River reintroduction goal statement and associated objectives are intended to guide the Reintroduction Assessment Framework and evaluation of reintroduction feasibility in the Tuolumne River. Below is an initial set of comments and/or questions to facilitate subcommittee discussions toward the development of objective/corollary statements:

"Contribute to the recovery of ESA listed salmonids…"

It has been suggested that goals and objectives for the Tuolumne River reintroduction assessment should be consistent and conform to the NMFS 2014 Recovery Plan for the Central Valley salmonids.

The excerpts provided below are from NMFS 2014 Recovery Plan for background:

- *Recovery of winter-run Chinook salmon, spring-run Chinook salmon, and steelhead across such a vast and altered ecosystem as the Central Valley will require a broadly focused, science-based strategy. The scientific rationale for the strategy in this plan focuses on two key salmonid conservation principles. The first is that functioning, diverse, and interconnected habitats are necessary for a species to be viable. That is, salmon and steelhead recovery cannot be achieved without providing sufficient habitat. The second salmonid conservation principle guiding the recovery strategy is that a species' viability is determined by its spatial structure, diversity, productivity, and abundance (McElhany et al. 2000).* (p 6-2 to 6-3)

- *Population-level criteria are used to determine whether a population is viable or not. A viable population is one with a low extinction risk in the wild over the long-term* (McElhany et al. 2000).

- *The Central Valley Technical Recovery Team (TRT) incorporated the four Viable Salmonid Population (VSP) parameters into [two] assessments of population viability (p 92)… The second set of criteria are simpler and do not require Population Viability Analysis (PVA) modeling results. These simpler extinction risk criteria are the basis of the population-level recovery criteria used in this Recovery Plan, with the low extinction risk levels defining what constitutes a viable population*. (p 93)

- *Census size (N) can be used if direct estimates of effective population size are not available. Census size is estimated as the product of the mean run size and the average generation time.* (p 93)

Questions/Discussion Topics:

1. Should "viable population with low extinction risk" as defined by the Recovery Plan serve as the basis to support development of objective statements to better define success of a reintroduction program?
2. Which is preferred if both sources of information are available --census size or effective population size? Would "census size" concept be similar to the abundance objectives associated with low extinction risk as defined for the Yuba River (assumed an average generation time of 3 years for spring run Chinook salmon resulting in a mean of 833 fish per year)?
3. How are factors outside of the reintroduction area accounted for in the reintroduction objectives? Is the objective to provide access to suitable habitat as compared to abundance of returning spawners?
4. How does one establish a cohort replacement rate (CRR)?
5. How is stock origin considered?
6. How is the influence of hatchery origin fish considered in the definition of low extinction risk?
7. Can the same application of "viable population with low extinction risk" be applied to both spring run Chinook and steelhead? What about fall-run Chinook?
8. How are rainbow trout considered in recovery since they may give rise to steelhead?
9. Confirm Tuolumne River steelhead would be considered a single population.
10. Rainbow trout occur both above and below Don Pedro Dam. It appears that rainbow trout below La Grange with access to the sea do not choose to migrate. Would providing more habitat be expected to result in more migration?
11. How is climate change considered in the evaluation of reintroduction feasibility and recovery?

Cost of Reintroduction (Socioeconomic)

Excerpts identified from the peer-reviewed journal article "Planning Pacific Salmon and Steelhead Reintroductions Aimed at Long-term Viability and Recovery" (Anderson et al. 2014) from NMFS Northwest Fisheries Science Center and colleagues:

- "*…despite considerable cost and effort, reintroduction efforts often fail to establish self-sustaining populations…..*"

- "*….socioeconomic cost-benefit analysis will be crucial for policy decisions regarding large-scale restoration projects.*"

- "*It is also important to remember that reintroduction is only one management option. In some cases, reintroduction may be essential for the conservation of a particular life history type or evolutionary lineage. In other cases, management strategies designed to improve the reproductive success, survival, and productivity of extant populations might offer a better return on the investment dollar than reintroduction.*"

NMFS acknowledges that cost considerations are critical when making decisions as to whether and how to undertake a reintroduction program. When evaluating a river basin or reach of river for possible reintroduction, the Recovery Plan states, "Due to the uncertainty of future budgets, priority will be given to measures that, once implemented, are self-sustaining. In cases in which necessary actions will need maintenance (e.g., reintroductions into habitat upstream of impassible dams), priority will be given to options that need the least intervention in the long term."

Questions/Discussion Topics:

1. What does "fair and reasonable" mean to participants? Are there existing methods or approaches to evaluate thresholds that might define "fair and reasonable"?
2. How are costs considered? What are metrics of economic feasibility?
3. Have other participants implemented cost-benefit approaches for large scale restoration, reintroduction or recovery programs/projects? If so, what?
4. What are elements that would inform cost analysis (e.g., foregone benefits such as water use, hydropower, existing recreation uses [reservoir recreation, angling, whitewater boating, etc.], fish passage infrastructure, other)?
5. What are elements that would inform benefit analysis? (e.g., Increased revenue associated with fishing, changes in tourism (visitor use days), other?)
6. Should consideration of cost-benefit occur by species?

Technical Feasibility of Fish Passage

If reintroduction to the upper Tuolumne River were to occur, both upstream and downstream fish passage structures/programs would likely need to be developed to support this action.

Questions/Discussion Topics:

1. Are objective statements needed to describe the need for a technically feasible alternative for both an upstream and downstream fish passage alternative?

Regulatory Feasibility of Fish Passage

Reintroduction in the Tuolumne River could be influenced by the regulatory context at a broader regional scale given the affected action area may involve public and private lands that are associated with a diverse array of entities (with jurisdictional authority) and/or management plans.

1. How to manage introduction of ESA listed species? Public and priority land uses surrounding the watershed may have additional regulatory obligations based on the status of species introduced? Is "take" a concern or would these populations be considered experimental, non-essential?
2. What are the potential impacts to existing management priorities (BLM, USFS, CDFW, etc.) with ESA listed species introductions (e.g., game fish vs. listed fish, impacts of recreation, etc.)?
3. Are there concerns/limitations with an action in the Wild & Scenic Area (construction of infrastructure, operation and maintenance activities, etc.)? The Clavey Designated Wild and Heritage Trout waters?
4. Does regulatory compliance need to be at best supportive of, and at the very least not inconsistent with, the goals and objectives of existing regulatory requirements in the action area? How do we identify (and address) conflicting state and federal agency goals for species, e.g., Chinook vs. steelhead?

From: Staples, Rose
Sent: Tuesday, January 24, 2017 11:38 AM
Cc: Deason, Jesse; Le, Bao; Borovansky, Jenna; Johnson, Laura
Subject: FW: Agenda-Meeting Materials for La Grange Jan 26 2017 Reintroduction Goals-Water Temp Subcommittees Joint Meeting

La Grange Licensing Participants,

The following message was sent earlier today to the members of the La Grange Reintroduction Goals and Water Temperature Subcommittees regarding the joint meeting to be held on Thursday, January 26, 2017 from 1:00 to 4:00 p.m. at the MID offices in Modesto. Copies of the AGENDA and the meeting materials can be viewed on the www.lagrange-licensing website as noted below.

Rose Staples, CAP-OM, MOS
D 207-239-3857

hdrinc.com/follow-us

From: Staples, Rose
Sent: Tuesday, January 24, 2017 2:09 PM
Cc: Deason, Jesse <jesse.deason@hdrinc.com>; 'Le, Bao' <Bao.Le@hdrinc.com>; Staples, Rose (Rose.Staples@hdrinc.com) <Rose.Staples@hdrinc.com>; Johnson, Laura <Laura.Johnson@hdrinc.com>
Subject: Agenda-Meeting Materials for La Grange Jan 26 2017 Reintroduction Goals-Water Temp Subcommittees Joint Meeting

Reintroduction Goals and Water Temperature Subcommittee Members,

Please find attached the agenda and meeting materials for the upcoming meeting this Thursday, January 26th from 1:00pm to 4:00pm. The meeting will be held in Modesto Irrigation District's Multipurpose Room (refer to agenda for address). Please take time to review the materials in advance of the meeting.

For the Reintroduction Goals Subcommittee:
Meeting Agenda
Reintroduction Goals Statement Comment/Response Table
Draft Reintroduction Assessment Objectives Development Discussion

For the Water Temperature Subcommittee:
Meeting Agenda
Timing and Temperature Working Document
Comment/Response Table on Water Temperature Literature Review (updated)
Water Temperature Literature Review document (updated)
Water Temperature Consideration_Boughton (Districts action item)

Copies of these documents have also been uploaded to the www.lagrange-licensing.com website in the DOCUMENTS section as well as attachments to the meeting announcement on the CALENDAR.

Thank you.

Rose Staples, CAP-OM, MOS
Executive Assistant

HDR

970 Baxter Boulevard Suite 301
Portland ME 04103
D 207-239-3857
rose.staples@hdrinc.com

hdrinc.com/follow-us

From: Steve Edmondson <steve.edmondson@noaa.gov>
Sent: Tuesday, January 24, 2017 4:28 PM
To: Boyd, Steve
Cc: Jean Castillo - NOAA Federal; John Wooster - NOAA Federal; Deason, Jesse; Le, Bao; William Foster - NOAA Federal
Subject: Re: La Grange Updated Study Report - NMFS Studies

Steve:

At the DPRSG meetings I've been providing regular status updates on our efforts to respond to the Districts and other stakeholders request for collaborative information sharing on fish passage. As you may recall we committed to provide: 1) a fish passage over high head dams technical workshop (to introduce interested parties to the various technologies currently employed and design considerations); 2) A California fish passage FAQ (to describe some of the management, policy, biological and engineering considerations in fish passage decision making); and 4) a Toulumne River, concept level, engineering feasibility study of fish passage. The first 2 items on the list above are complete. Regarding the last item, as I mentioned at the DPRSG meeting, our proposal was funded and we have a contractor on-board to start conducting the engineering feasibility study. Jean Castillo is a NMFS fish passage engineer and our POC for working with the contractor and would like to set up a site visit. I hope this is not inconvenient for you or your staff and of course you are very welcome to attend! Thanks for your consideration and please let us know if this is acceptable.-----Steve.

On 1/24/2017 11:16 AM, Jean Castillo - NOAA Federal wrote:

> Hi Jesse,
>
> The NMFS Fish Passage engineering study is just getting underway and is in the process of doing a literature review. We are also looking to tour the sites sometime during the week of March 13th. I was going to speak with Steve Boyd on Thursday to see if he would be able to take us to the La Grange Dam as the access roads are behind gates.
>
> See you Thursday,
> Jean
>
> **Jean M. Castillo,** MSCE, P.E.
> *Hydraulic/Fish Passage Engineer*
>
> *NOAA Fisheries West Coast Region*
> *U.S. Department of Commerce*
> *650 Capitol Mall, Suite 5-100*
> *Sacramento, California 95814-4700*
> Office: 916-930-3613
> jean.castillo@noaa.gov

On Tue, Jan 24, 2017 at 10:55 AM, John Wooster - NOAA Federal <john.wooster@noaa.gov> wrote:

> Points of contact for the engineering study should be Steve Edmondson and probably Jean Castillo as well - both cc here.
>
> I already forwarded them your update request from yesterday.
>
> Regards,
>
> John
>
> On Mon, Jan 23, 2017 at 3:39 PM, Deason, Jesse <Jesse.Deason@hdrinc.com> wrote:
>
>> Hi John,
>>
>> Yes, please do send me your two updates. Regarding the engineering study, do you have a point of contact we can reach out to directly for an update?
>>
>> Thanks,
>>
>> Jesse
>>
>> Jesse Deason
>>
>> **D** 206.826.4744 **M** 781.249.2452
>>
>> hdrinc.com/follow-us
>>
>> **From:** John Wooster - NOAA Federal [mailto:john.wooster@noaa.gov]
>> **Sent:** Monday, January 23, 2017 1:57 PM
>> **To:** Deason, Jesse <Jesse.Deason@hdrinc.com>; Le, Bao <ChiBao.Le@hdrinc.com>
>> **Subject:** Re: La Grange Updated Study Report - NMFS Studies
>>
>> Hi Jesse:
>>
>> I apologize in that I responded this morning without really reading the details of your email, as I figured your were just wondering where my updates were since I was delinquent in getting

those out. In regards to your question about the NMFS Fish Passage engineering study, I'm not really involved and can't provide an update on that study - it isn't a science center contract and came on board after I moved branches.

So I have asked NMFS that are involved with that study to see if they can provide an update.

I did finish my two updates, and those are ready to go if you would rather just have those in the interim.

-John

On Sun, Jan 22, 2017 at 9:41 AM, Deason, Jesse <Jesse.Deason@hdrinc.com> wrote:

Hi John.

Related to the updates that you'll be providing of NMFS studies for La Grange Licensing, the Districts through one of their subcontractors learned that NMFS is conducting a Fish Passage Engineering Feasibility Study. We are hoping that you will provide an update of this study along with the habitat and genetics summaries since it has relevance to the Fish Passage Facilities Alternatives Assessment the Districts are conducting for La Grange Licensing.

Thanks,

Jesse

Jesse Deason

D 206.826.4744 M 781.249.2452

hdrinc.com/follow-us

--

John Wooster
Hydraulic Engineer
NOAA Fisheries West Coast Region
U.S. Department of Commerce
john.wooster@noaa.gov

From: John Wooster - NOAA Federal <john.wooster@noaa.gov>
Sent: Wednesday, January 25, 2017 3:17 PM
To: Deason, Jesse
Cc: Le, Bao
Subject: Re: Study updates for USR
Attachments: Updates on NMFS Southwest Fisheries Science Center Projects pertaining to the Upper Merced and Upper Tuolumne watersheds.docx

Jesse:

Please find summaries of the genetics and habitat studies.

Regards,

John

On Wed, Jan 25, 2017 at 6:46 AM, Deason, Jesse <Jesse.Deason@hdrinc.com> wrote:

Hi John,

This is another reminder to send us the two complete study updates when you have a chance.

Thanks,

Jesse

Jesse Deason

Regulatory Specialist

HDR

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Seattle, WA 98101
D 206.826.4744 **M** 781.249.2452
jesse.deason@hdrinc.com

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--
John Wooster
Hydraulic Engineer
NOAA Fisheries West Coast Region
U.S. Department of Commerce
john.wooster@noaa.gov

Updates on NMFS Southwest Fisheries Science Center Projects pertaining to the Upper Merced and Upper Tuolumne watersheds. January 23, 2017

Genetic Evaluation of *O.mykiss* Populations in the Upper Tuolumne and Merced Watersheds

In 2015, NMFS initiated a field based study to collect Tuolumne and Merced River specific *O.mykiss* genetic data that will allow for population level genetic analyses and evaluate variation in genomic regions. NMFS collected field samples of *O.mykiss* populations in the upper Tuolumne and Merced watershed during the summers of 2015 and 2016. Samples were collected from the Tuolumne, Clavey, Merced, and South Fork Merced rivers, as well as several tributaries. A total of 835 unique samples were collected during the two field seasons. DNA has been extracted from all the samples. Genotyping and preliminary analyses are complete for all samples collected in 2015. Genotyping and analysis of samples collected in 2016 will be completed in spring of 2017; including further refinement of 2015 results based on additional information provided from 2016 samples. A technical memorandum detailing the methods and results is anticipated to be available in July 2017.

Estimation of Steelhead and Spring-run Chinook salmon Habitat Capacity in the Upper Tuolumne and Upper Merced Rivers

In 2014, NMFS initiated a study to estimate the present habitat capacity for steelhead and spring-run Chinook on the Upper Tuolumne River upstream of Don Pedro Reservoir and the Upper Merced River upstream of Lake McClure. Primary investigations of the study include estimating overall amount and extent of useable habitat for steelhead and spring-run Chinook, and estimating the population sizes of steelhead and spring-run Chinook that could be supported if this habitat was accessible. The first phase of the Study will characterize the available habitat using a combination of geospatial data analysis, field work, and numerical modeling. This phase is primarily complete. The one primary exception is related to numerical modeling of estimated gravel quantity and grain size. NMFS is hoping and anticipating to utilize spawning gravel data collected by the Districts in the summer of 2016 to help calibrate / validate numerical model predictions on the Tuolumne River. NMFS is hoping this data will be made available with release of the Updated Study Report. The second phase of the Study will simulate the habitat carrying capacity as a function of habitat types and quantity, thermal suitability and an estimated species density per habitat type. This phase is ongoing and expected to be completed in late spring 2017. A technical memorandum detailing the methods and results is anticipated to be available in July 2017.

From: Le, Bao
Sent: Thursday, January 26, 2017 4:15 PM
To: Chris Shutes
Cc: Deason, Jesse
Subject: Re: Spring-run timing

Thanks, Chris.

I'll run these by the technical folks for consideration.

Good to see you.

Bao

Sent from my iPhone

On Jan 26, 2017, at 3:49 PM, Chris Shutes <blancapaloma@msn.com> wrote:

Hi Bao,

As a reminder, I believe that the periodicity chart for spring-run should include June for migration (esp. in
wetter water years; this timing is characteristic of Butte Creek in wet years and of Yuba and Feather in almost all years.

It should also have holding extend at least into September. Presumably, the fish are holding until they spawn, and many are not spawning until October.

Thanks,

Chris

Chris Shutes
FERC Projects Director
California Sportfishing Protection Alliance
(510) 421-2405

From: Staples, Rose
Sent: Wednesday, February 01, 2017 2:20 PM
Cc: Deason, Jesse; Le, Bao; Staples, Rose; Johnson, Laura
Subject: Districts E-File La Grange Updated Study Report with FERC Today

To La Grange Licensing Participants:

Today the Districts e-filed the La Grange Updated Study Report (USR), a copy of which is available in the DOCUMENTS section of the La Grange licensing website (www.lagrange-licensing.com) and also on FERC E-Library (www.ferc.gov). If you have any difficulties in locating and/or downloading the 13 documents that make up the USR filing, please let me know.

The Districts will hold a USR Meeting on Thursday, February 16, 2017 at Modesto Irrigation District's office located at 1231 11th Street in Modesto, California. The meeting agenda and materials will be posted in the DOCUMENTS section of the La Grange licensing website (www.lagrange-licensing.com) prior to the meeting.

Rose Staples, CAP-OM, MOS
Executive Assistant

HDR
970 Baxter Boulevard Suite 301
Portland ME 04103
D 207-239-3857
rose.staples@hdrinc.com

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From: Staples, Rose
Sent: Monday, February 06, 2017 11:57 AM
Cc: Deason, Jesse; Le, Bao; Staples, Rose; Johnson, Laura
Subject: La Grange Project USR Meeting AGENDA for Feb 16 2017 Morning
Attachments: LaGrangeProject_USRMtg-Feb16-Morning_Agenda.pdf

The AGENDA for the February 16, 2017 La Grange Project UPDATED STUDY REPORT MEEING to be held from 8:30 a.m. to Noon at the MID Offices in Modesto is attached. A copy is also being uploaded to the licensing website at www.lagrange-licensing.com as an attachment to the meeting date and in the DOCUMENTS section.

Rose Staples, CAP-OM, MOS
Executive Assistant

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La Grange Hydroelectric Project (FERC No. 14581)
Updated Study Report Meeting

Thursday, February 16, 2017, 8:30 am to 12:00 pm
Modesto Irrigation District
1231 11th Street, Modesto, California
Phone: 866-583-7984; Passcode: 814-0607
Join Skype Meeting: https://meet.hdrinc.com/jenna.borovansky/3D64F0F5

Time*	Topic
8:30 am	Opening – Review Agenda and Purpose of the Meeting
8:45 am	Topographic Survey
9:00 am	La Grange Project Fish Barrier Assessment
9:20 am	Fish Presence and Stranding Assessment
9:40 am	Flow Records for Five Discharge Structures at the La Grange Project
10:00 am	Investigation of Fish Attraction to La Grange Powerhouse Draft Tubes
10:20 am	Cultural Resources Study
10:40 am	15-Minute Break
10:55 am	Recreation Access and Safety Assessment
11:15 am	Hatchery and Stocking Practices Review
11:35 am	Upper Tuolumne River Basin Fish Migration Barriers Study
12:00 pm	Meeting Adjourns

* Start times subject to change.

From: Le, Bao
Sent: Tuesday, February 07, 2017 12:19 PM
To: William.Foster@noaa.gov
Cc: John Wooster - NOAA Federal; Deason, Jesse; Devine, John
Subject: La Grange USR Meeting - NMFS studies

Hi Bill (and John).

We are beginning to make plans for the upcoming February 16th Updated Study Report (USR) meeting in Modesto. Since the two NMFS studies (ongoing) have summaries included in the USR, we wanted to reach out to see if you had an interest in presenting or providing an update at the meeting. Please let us know and we'll figure out the best way to work it into the agenda. Note that we will reference the studies in our introduction to the meeting and a description of the USR.

Thanks, Bao

Bao Le
Senior Fisheries Biologist

HDR
1001 SW 5th Avenue, Suite 1800
Portland, OR 97204-1134
Note new direct line:**D** 503.423.3828 **M** 503.309.9423
bao.le@hdrinc.com

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From: Le, Bao
Sent: Wednesday, February 08, 2017 8:24 AM
To: William Foster - NOAA Federal
Cc: John Wooster - NOAA Federal; Edmondson, Steve; Deason, Jesse
Subject: RE: NOAA Sci Ctr studies/Tuolumne

Thank you for the prompt response.

From: William Foster - NOAA Federal [mailto:william.foster@noaa.gov]
Sent: Tuesday, February 07, 2017 4:36 PM
To: Le, Bao
Cc: John Wooster - NOAA Federal; Edmondson, Steve
Subject: NOAA Sci Ctr studies/Tuolumne

Dear Le:

We do not have anything new to add other than what was written in the summaries.

Thanks
William E. Foster, M.S., Fishery Biologist
NOAA Fisheries, West Coast Region
California Central Valley Area Office
FERC Branch, Sacramento, CA
(916) 930-3617

February 8, 2017

Danielle Risse
Senior Cultural Resources Specialist HDR Engineering, Inc.
2379 Gateway Oaks Drive, Suite 200
Sacramento, CA. 95833

Dear, Ms Risse

The Buena Vista Rancheria of Me-Wuk Indians would like to thank HDR Engineering for the opportunity to comment on the "La Grange Hydroelectric Project" (FERC # 14581). As the Tribal Historic Preservation Officer (THPO) for the Buena Vista Rancheria of Me-Wuk Indians I have reviewed the notice that the tribe received regarding "La Grange Hydroelectric Project". Based on THPO review of this project and consultation with the Tribal council, the Buena Vista Rancheria of Me-Wuk Indians request that this project be deferred to the Tuolumne Band of Me-Wuk Indians.

Respectfully,

Robert C. Columbro
Tribal Historic Preservation Officer
Buena Vista Rancheria of Me-Wuk Indians

1418 20th Street, Ste. 200
Sacramento, CA 95811
Tel. 916.491.0011 Fax 916.491.0012
www.buenavistatribe.com

BUENA VISTA RANCHERIA
ME-WUK INDIANS
1418 20th Street, Suite 200
Sacramento, CA 95811

RECEIVED
FEB 13 2017
By ______

HDR Engineering, Inc.
2379 Gateway Oaks Drive, Suite 200
Sacramento CA. 95833

Attn: Danielle Risse

9583334239 R017

From: Staples, Rose
Sent: Wednesday, February 15, 2017 6:37 PM
Cc: Deason, Jesse; Le, Bao; Staples, Rose; Johnson, Laura
Subject: La Grange Updated Study Report (USR) Meeting Presentations

The presentations that will be used at the February 16, 2017 La Grange Updated Study Report (USR) Meeting to be held from 8:30 a.m. to Noon at the MID offices in Modesto have been uploaded to the licensing website (www.lagrange-licensing.com) both in the DOCUMENTS section of the website and also as attachments to the meeting announcement on the CALENDAR. The agenda for the meeting is also attached there.

If you are unable to locate and/or access the presentations, please let me know at rose.staples@hdrinc.com.

Thank you.

Rose Staples, CAP-OM, MOS
Executive Assistant

HDR
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D 207-239-3857
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From: Staples, Rose
Sent: Wednesday, February 15, 2017 3:30 PM
To: Jean Castillo - NOAA Federal
Cc: Deason, Jesse; Le, Bao; Johnson, Laura
Subject: RE: La Grange Project USR Meeting AGENDA for Feb 16 2017 Morning

Phone: 866-583-7984; Passcode: 814-0607

Presentation PDFs are being finalized and will be uploaded to the website (www.lagrange-licensing.com) before the end of today and all licensing participants will be notified where they will be (i.e. DOCUMENT TAB and attached to tomorrow's USR meeting announcement on the website's CALENDAR).

If the size of the presentations are not prohibitive to emailing, I'll send you some. Are there any in particular that are of interest—or all of them.

Rose Staples, CAP-OM, MOS
D 207-239-3857

hdrinc.com/follow-us

From: Jean Castillo - NOAA Federal [mailto:jean.castillo@noaa.gov]
Sent: Wednesday, February 15, 2017 6:26 PM
To: Staples, Rose <Rose.Staples@hdrinc.com>
Cc: Deason, Jesse <Jesse.Deason@hdrinc.com>; Le, Bao <ChiBao.Le@hdrinc.com>; Johnson, Laura <Laura.Johnson@hdrinc.com>
Subject: Re: La Grange Project USR Meeting AGENDA for Feb 16 2017 Morning

Hi Rose,

I will be calling into tomorrow's meeting.

Can you please remind me of what the call in number is?

Also will there be any presentations during the meeting? If yes is there anyway you can send me a pdf of the presentation ahead of time?

Thanks,
Jean
Jean M. Castillo, MSCE, P.E.
Hydraulic/Fish Passage Engineer

NOAA Fisheries West Coast Region
U.S. Department of Commerce
650 Capitol Mall, Suite 5-100
Sacramento, California 95814-4700
Office: 916-930-3613
jean.castillo@noaa.gov

On Mon, Feb 6, 2017 at 11:56 AM, Staples, Rose <Rose.Staples@hdrinc.com> wrote:

> The AGENDA for the February 16, 2017 La Grange Project UPDATED STUDY REPORT MEEING to be held from 8:30 a.m. to Noon at the MID Offices in Modesto is attached. A copy is also being uploaded to the licensing website at www.lagrange-licensing.com as an attachment to the meeting date and in the DOCUMENTS section.
>
> Rose Staples, CAP-OM, MOS
>
> *Executive Assistant*
>
> HDR
>
> 970 Baxter Boulevard Suite 301
> Portland ME 04103
> **D** 207-239-3857
> rose.staples@hdrinc.com
>
> hdrinc.com/follow-us

From: "Murphey, Gretchen@Wildlife" <Gretchen.Murphey@wildlife.ca.gov>
Subject: La Grange Weir Data
Date: February 16, 2017 at 2:16:51 PM PST
To: "guignard, jason@fishbio.com" <jasonguignard@fishbio.com>
Cc: "Tsao, Steve@Wildlife" <Steve.Tsao@wildlife.ca.gov>

Jason,
In answer to your question about the weir data:
We would like the 2015-16 data now, please.

Gretchen Murphey

Environmental Scientist, Tuolumne River
California Department of Fish and Wlidlife
La Grange Field Office
Office: (209) 853-2533 ex 3#
Cell: (209) 617-1903

From: Meg Layhee [mailto:megl@cserc.org]
Sent: Monday, February 27, 2017 2:10 PM
To: greg.dias@mid.org; seboyd@tid.org; James.Hastreiter@ferc.gov; Staples, Rose <Rose.Staples@hdrinc.com>
Cc: John Buckley <johnb@cserc.org>
Subject: USR Filing La Grange Hydroelectric Project FERC No. 14581

Good morning.

This is Meg Layhee, Aquatic Biologist with the Central Sierra Environmental Resource Center (CSERC). CSERC's Executive Director, John Buckley and I have read over the Updated Study Reports and appendices including FERC and voluntary studies conducted by MID and TID for the La Grange Hydroelectric Project FERC No. 14581, and we also attended the meeting on February 16 where MID and TID staff presented USR findings.

Attached is a comment letter in response to the USR reports. Our Center is not opposed to any of the completed studies in the USR, but we do have some comments related to specific findings or language used in the reports.

Sincerely,

Meg Layhee

CSERC, Aquatic Biologist
megl@cserc.org
phone 209-586-7440

Central Sierra Environmental Resource Center
Box 396, Twain Harte, CA 95383 • (209) 586-7440 • fax (209) 586-4986
Visit our website at: www.cserc.org or contact us at: johnb@cserc.org

February 27, 2017

USR Filing for La Grange Hydroelectric Project (FERC No. 14581)

The Central Sierra Environmental Resource Center (CSERC) submits this comment letter in response to the Updated Study Reports (USR) including FERC and voluntary studies conducted by Modesto Irrigation District (MID) and Turlock Irrigation District (TID) staff/consultants for the La Grange Hydroelectric Project FERC No. 14581.

CSERC is a non-profit environmental organization located in Tuolumne County and has worked to protect fish, wildlife, and water for 25 years in the Northern Yosemite Region including in the Tuolumne River watershed. Our Staff understands that several of the projects were required for the FERC relicensing process but appreciate the efforts made by researchers to conduct nine additional voluntary projects to better characterize existing habitat and ecosystem features in the Upper Tuolumne River watershed for the purposes of potential reintroduction, and also to better understand barriers, degree of suitable habitat and other existing conditions in the Lower Tuolumne River related to native anadromous salmonids.

Our Center is not opposed to any of the completed studies in the USR, but we do have some concerns and comments related to specific findings or language used in the reports in regards to study conclusions. Below are the detailed comments related to individual studies either completed or partially completed as of February 2017.

I. La Grange Fish Barrier Assessment

Based on the findings of the La Grange Fish Barrier Assessment Study at La Grange Diversion Dam and powerhouse from 2015-2016 data, the data appears to conclude that the dam and powerhouse are barriers to the upstream migration of adult fall-run Chinook salmon and steelhead, and that individual salmonids are displaying behavior that would indicate upstream movement is impeded by the dam structures for the following reasons:

Our Center believes that the presence of an adult at the tailrace or main channel video monitoring weirs at the LGDD and powerhouse is an indication that the individual fish is intending to continue moving upstream. The subsequent downstream movement of a fish from the weirs indicates that the habitat at the LGDD and powerhouse is not suitable, and since the

LGDD and powerhouse are upstream barriers, the individual fish has no option but to move back downstream to find suitable habitat for spawning. The impression from the presentation of the data in the report is that the preference for all but one individual was to move back downstream to spawn. Our Center does not believe this is case. Instead our staff see the presence of fish at the weirs as an indication that their intent is to continue to swim upstream of the weirs. This may be a matter of semantics, but it is an important point as the questions of fish passage and salmonid population enhancement measures are considered.

In addition, multiple, repetitive upstream and downstream passages through the weirs by individual salmon is an additional indication of the individuals intent to want to continue movement upstream, if it weren't for the barrier above the weirs.

Since 105 individual Chinook salmon passed the tailrace channel weir and 12 individual Chinook salmon passed the main channel weir, that means approximately 25% of the total escapement in the Tuolumne River of Chinook salmon, passed the weirs located at the LGDD and powerhouse. This is an indication to our Center that the LGDD is an upstream barrier to at least 25% of the Chinook salmon population in the Tuolumne River, and that these individuals would continue to move upstream to spawn. Given that the was an exceptionally low overall number of salmon returning up the river, it may be that a far higher number of salmon would continue upriver if prime redd sites lower downstream were occupied.

Our Center understands that this study is still in progress, and that results from the 2016-2017 have yet to be analyzed.

II. Topographic Survey

A better understanding of the habitat below the LGDD in the Tuolumne River provides important information on potential spawning habitat in this river reach. However, as was pointed out at the February 16 meeting, the recent events related to high precipitation levels in early 2017 in the region most likely have had a significant impact on water depths and geomorphic features within the reach. It may be valuable to note in the final report potential alterations that may have occurred after the completion of the study due to recent precipitation events in early 2017, and how river flows may have affected location and/or size of pools, river depths in both the mainstem and powerhouse channels, and also the impacts to features including ledges and outcroppings.

III. Fish Presence and Stranding Assessment

As noted at the recent meeting, one concern our Center has with the Fish Presence and Stranding Assessment study is potential variation in surveyor detection rates since FISHBIO biologist/technicians performed some of the surveys and TID project operators performed tailrace channel surveys.

Our Center understands that this project is still in progress, and that results from 2016-2017 have yet to be analyzed. We have no further comments at this time.

IV. Flow Records for Five Discharge Structures at the La Grange Project

Our Center has no comments at this time concerning the Flow Records for Five Discharge Structures at the La Grange Project study.

V. Investigation of Fish Attraction to La Grange Powerhouse Draft Tubes

Although our Center mostly agrees with the results of the Fish Attraction to La Grange Powerhouse Draft Tubes study in that there is most likely little risk of fish entering the powerhouse draft tubes, the data cannot conclusively state that fish are not entering the draft tubes because of the following:

Since continuous imaging sonar data was collected only between October-December 2015, and five additional 3-day sampling periods from January-April/May, the researchers cannot say with certainty that there were no fish that entered the draft tubes within the sampling period (September-May 2015).

In addition, since both draft tube units were not surveyed during the sampling period there is uncertainty as to whether there were any occurrences of individuals entering the draft tube that was not monitored.

VI. Effects of the Project and Related Activities on the Losses of Marine-Derived Nutrients in the Tuolumne River

The results of this study provide important insight into the annual mass of marine-derived nutrients reduced from historical levels in the Tuolumne River because of reduced salmon escapement levels in the watershed. This study demonstrates another reason why native salmonids are so critical to the local river ecology. It is vital that the data found in this study is considered in decision making for salmonid recovery in the Tuolumne River watershed.

VII. Cultural Resources

Our Center appreciates the efforts made in this study to understand the archaeological and built environmental resources within the project area, and we have no other comments related to the study.

VIII. Recreation Access and Safety Assessment

Our Center agrees that assessment of public safety assessment in the vicinity of the project area and understanding the current recreational use within the project area is critical for recreational and visitor safety. CSERC has no comments related to this study beyond comments previously submitted.

IX. Upper Tuolumne River Basin Fish Migration Barriers Study- Voluntary

The results of this study demonstrate that there are up to 32 river miles of habitat accessible to salmonids in the Upper Tuolumne River Basin upstream of Don Pedro. Our Center finds this data compelling and suggestive that wild salmonids, if given a means to reach the Upper Tuolumne River watershed through a reintroduction program, would have access to many miles of mainstem and tributary habitats. Our Center found the study methods and results sound.

X. Hatchery and Stocking Practices Review

Our staff agrees that there will be many issues that biologists and resource managers will have to address prior to the reintroduction of salmonids into the Upper Tuolumne including issues related to competition, predation, genetic impacts, and the potential to introduce or exacerbate various diseases into the Upper Tuolumne watershed.

Competition for spawning habitat with reproducing brown trout, brook trout, stocked kokanee, stocked Chinook salmon, or native rainbow trout in the Upper Tuolumne River watershed will most likely occur with the reintroduction of native salmonids. However, native salmonids currently face the same challenges in the Lower Tuolumne River. If native salmonid spawning habitat can be expanded into the Upper Tuolumne watershed, this may increase competition for spawning habitat with the existing fish assemblage in the upper watershed, but at the same time may alleviate some of the intraspecific competition for habitat in the Lower Tuolumne River watershed among native salmonids.

The risk of predation on reintroduced salmonid eggs, fry, and juveniles, if salmonids are to be reintroduced, by predatory fish in the Upper Tuolumne watershed is of concern. As the study pointed out there are several potential predators within the Upper Tuolumne fish assemblage including rainbow trout, brook trout, brown trout, and smallmouth bass. However, CSERC might point out that in the Lower Tuolumne River, native salmonids are faced with many of the same predators, and even more potential predators including striped bass, largemouth bass, bluegill, channel catfish, white catfish, and brown bullhead that developing native salmonids have to currently contend with in the Lower Tuolumne River. So the problem extends both below and above the dams.

Our staff also understands the potential for genetic effects of reintroducing fall-run and spring-run Chinook salmon into the Upper Tuolumne River watershed where currently, there is the potential for stocked Chinook salmon migrating up from Don Pedro (thought to be Klamath River fall-run Chinook salmon) to hybridize with reintroduced native Chinook salmon. In addition, there is the potential for hybridization between reintroduced steelhead and reproducing resident rainbow trout in the Upper Tuolumne River watershed. These are concerns that must be addressed prior to reintroduction efforts.

Our center agrees that transporting adult Chinook salmon and steelhead from the Lower Tuolumne River up to the Upper Tuolumne watershed for reintroduction purposes, poses the risk of introducing diseases that occur in the Lower Tuolumne fish assemblage into the Upper Tuolumne fish assemblage. Our Center agrees that this is a legitimate concern and should be addressed and carefully weighed prior to reintroduction efforts.

Respectfully submitted,

Meg Layhee
Aquatic Biologist

John Buckley
Executive Director

From: Staples, Rose
Sent: Wednesday, March 01, 2017 3:55 PM
Cc: Deason, Jesse; Le, Bao; Johnson, Laura; Staples, Rose
Subject: Final Notes La Grange Water Temp and Reintro Goals Subcommittees Dec 1 2016 Meeting Available for Viewing

La Grange Licensing Participants,

FINAL NOTES from the December 1, 2016 Water Temperature Subcommittee and Reintroduction Goals Subcommittee meetings have been uploaded to the licensing website www.lagrange-licensing.com in the DOCUMENTS section and also as attachments to the December 1, 2016 meeting date on the website calendar.

Please note that on January 12, 2017, the Districts provided to the Subcommittees DRAFT notes from the December 1 meeting and requested that the Subcommittees provide any comments on the meeting notes by February 13. No comments were received on the Reintroduction Goals Subcommittee meeting notes; therefore, these FINAL notes are the same as the draft notes originally provided on January 12. Minor comments were received on the Water Temperature Subcommittee meeting notes; therefore the draft meeting notes were revised accordingly and these FINAL notes reflect the comments received.

Please let me know if you have any trouble accessing these documents. Thank you.

Rose Staples, CAP-OM, MOS
Executive Assistant

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rose.staples@hdrinc.com

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From: Chris Shutes [redacted]
Sent: Thursday, March 02, 2017 6:19 PM
To: Le, Bao
Cc: Deason, Jesse
Subject: Re: Spring-run timing

Hi Bao,

Yes, upstream migration. Thanks.

Chris Shutes
FERC Projects Director
California Sportfishing Protection Alliance
(510) 421-2405

From: Le, Bao <ChiBao.Le@hdrinc.com>
Sent: Thursday, March 2, 2017 12:03 PM
To: Chris Shutes
Cc: Deason, Jesse
Subject: RE: Spring-run timing

Hi Chris.

Need to get this in front of our tech folks but had a question below….for the highlighted, you are referring to adult upstream migration, correct?

Sorry for the delay on this,
Bao

From: Chris Shutes [redacted]
Sent: Thursday, January 26, 2017 3:49 PM
To: Le, Bao
Subject: Spring-run timing

Hi Bao,

As a reminder, I believe that the periodicity chart for spring-run should include June for migration (esp. in wetter water years; this timing is characteristic of Butte Creek in wet years and of Yuba and Feather in almost all years.

It should also have holding extend at least into September. Presumably, the fish are holding until they spawn, and many are not spawning until October.

Thanks,
Chris

Chris Shutes
FERC Projects Director
California Sportfishing Protection Alliance
(510) 421-2405

From: Staples, Rose
Sent: Friday, March 03, 2017 11:03 AM
Cc: Deason, Jesse; Le, Bao; Johnson, Laura; Staples, Rose
Subject: Districts E-File with FERC Today the La Grange USR Meeting Summary

The Districts have e-filed with FERC today the Updated Study Report Meeting Summary, from the USR Meeting held in Modesto on February 16, 2017. A copy of the filing has been uploaded to the La Grange licensing website at www.lagrange-licensing.com--and it is also available on FERC's E-Library at www.FERC.com.

Rose Staples, CAP-OM, MOS
Senior Administrative Assistant

ONEHUNDRED
1917-2017

HDR
970 Baxter Boulevard Suite 301
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D 207-239-3857
rose.staples@hdrinc.com

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From: Chris Shutes [redacted]
Sent: Thursday, March 09, 2017 10:52 AM
To: Le, Bao
Cc: Johnson, Laura; Deason, Jesse; Devine, John
Subject: Re: Spring-run timing

Hi Bao,

I think you should consider that part of the migration corridor would be upstream of Don Pedro. It is completely reasonable to expect migration upstream of Don Pedro in June.

Chris Shutes
FERC Projects Director
California Sportfishing Protection Alliance
(510) 421-2405

From: Le, Bao <ChiBao.Le@hdrinc.com>
Sent: Thursday, March 9, 2017 10:38 AM
To: Chris Shutes
Cc: Johnson, Laura; Deason, Jesse; Devine, John
Subject: RE: Spring-run timing

Hi Chris.

We provided your spring run periodicity comments to our technical team. After their review and input, we've extended the spring-run adult holding period to mid-September as you have suggested. However, given their review of San Joaquin River temperature information in June, it is extremely rare to have suitable water temperatures for adult migration in this reach, even during wet water years. As such, the recommendation is to leave the adult upstream migration periodicity as-is. Attached is a revised periodicity table.

Thanks, Bao

From: Chris Shutes [redacted]
Sent: Thursday, January 26, 2017 3:49 PM
To: Le, Bao
Subject: Spring-run timing

Hi Bao,

As a reminder, I believe that the periodicity chart for spring-run should include June for migration (esp. in wetter water years; this timing is characteristic of Butte Creek in wet years and of Yuba and Feather in almost all years.

It should also have holding extend at least into September. Presumably, the fish are holding until they spawn, and many are not spawning until October.

Thanks,

Chris

Chris Shutes
FERC Projects Director
California Sportfishing Protection Alliance
(510) 421-2405

	UOWTI	UTWTI	Incip Lethal WTI	Other WTI Values?	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Fall-run Chinook Salmon																
Adult Upstream Migration																
Adult Spawning																
Egg Incubation and Fry Emergence																
In-River Rearing (Age 0+)																
Smolt Outmigration																
Spring-run Chinook Salmon																
Adult Upstream Migration																
Adult Holding																
Adult Spawning																
Egg Incubation and Fry Emergence																
Fry Rearing																
Juvenile Rearing and Downstream Movement																
Smolt Outmigration																
Steelhead																
Adult Upstream Migration																
Adult Spawning																
Egg Incubation and Fry Emergence																
Fry Rearing																
Juvenile Rearing and Downstream Movement																
Smolt Outmigration																

UOWTI = Upper Optimum Water Temperature Index
UTWTI = Upper Tolerance Water Temperature Index

January 2017

From: John Wooster - NOAA Federal <john.wooster@noaa.gov>
Sent: Thursday, March 09, 2017 2:42 PM
To: Le, Bao
Cc: William.Foster@noaa.gov; Jean Castillo - NOAA Federal (jean.castillo@noaa.gov); Devine, John; Deason, Jesse; Johnson, Laura
Subject: Re: Russian River Report
Attachments: NOAA-TM-NMFS-SWFSC-569.pdf

Hi Bao:

The Russian River memo is attached.

Regards,

John

On Thu, Mar 9, 2017 at 10:42 AM, Le, Bao <ChiBao.Le@hdrinc.com> wrote:

> Hi John.
>
> I hope you are enjoying your new position. I was unsure as to how much "succession" has occurred with Bill so I'm sending this email to both of you (and cc-ing Jean) regarding the availability of the Russian River Report that had been discussed at previous temperature subcommittee meetings. Is a final report available to share?
>
> Thanks, Bao
>
> Bao Le
>
> *Senior Fisheries Biologist*
>
> HDR
>
> 1001 SW 5th Avenue, Suite 1800
> Portland, OR 97204-1134
> Note new direct line:**D** 503.423.3828 **M** 503.309.9423
> bao.le@hdrinc.com
>
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>
> --
> **John Wooster**
> *Hydraulic Engineer*
> *NOAA Fisheries West Coast Region*
> *U.S. Department of Commerce*
> john.wooster@noaa.gov

doi:10.7289/V5/TM-SWFSC-569

NOAA Technical Memorandum NMFS

JANUARY 2017

SPATIAL STRUCTURE OF WATER-QUALITY IMPACTS AND FORAGING OPPORTUNITIES FOR STEELHEAD IN THE RUSSIAN RIVER ESTUARY: AN ENERGETICS PERSPECTIVE

David Boughton
Joshua Fuller
Gregg Horton
Eric Larson
William Matsubu
Charles Simenstad

NOAA-TM-NMFS-SWFSC-569

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
Southwest Fisheries Science Center

NOAA Technical Memorandum NMFS

doi:10.7289/V5/TM-SWFSC-569

NOAA Technical Memorandum NMFS
This TM series is used for documentation and timely communication of preliminary results, interim reports, or special purpose information. The TMs have not received complete formal review, editorial control, or detailed editing.

JANUARY 2017

SPATIAL STRUCTURE OF WATER-QUALITY IMPACTS AND FORAGING OPPORTUNITIES FOR STEELHEAD IN THE RUSSIAN RIVER ESTUARY: AN ENERGETICS PERSPECTIVE

David Boughton[1], Joshua Fuller[2], Gregg Horton[3], Eric Larson[4], William Matsubu[5], and Charles Simenstad[5]

[1] NOAA Fisheries, SW Fisheries Science Center, Fisheries Ecology Division, 110 McAllister Way, Santa Cruz, CA 95060

[2] NOAA Fisheries West Coast Region, California Coastal Office, U.S. Department of Commerce, 777 Sonoma Ave., Rm. 325, Santa Rosa, CA 95404

[3] Sonoma County Water Agency, 404 Aviation Blvd., Santa Rosa, California 95403

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Russian River, CA: River mouth closed

Russian River, CA: River mouth opened

Spring captured steelhead, Russian River Estuary, CA

Fall captured steelhead, Russian River Estuary, CA

Prepared for: NOAA's Habitat Blueprint ~ Russian River Habitat Focus Area, in partial fulfillment of the Russian River Habitat Focus Area Project:

Russian River Water Quality Modeling to Inform Time-Dependent Availability of Estuarine Habitat for Juvenile Salmonids

Abstract

Estuaries along the California coast are recognized as critical rearing habitat for juvenile salmonids, particularly because they provide abundant feeding opportunities that support rapid growth. However, these estuaries exhibit a high degree of spatial and temporal variability in both food availability and elements of risk such as predation risk and mediocre water quality, varying greatly in response to natural seasonal changes as well as anthropogenic effects and management. Physical models—such as a quantified conceptual model (QCM) developed by UC Davis for the Russian River Estuary—can be used to predict the spatially explicit response of Estuary water quality and quantity to seasonal change and management interventions. These predictions take the form of depth-profiles of temperature, dissolved oxygen and salinity throughout the Estuary, calibrated to sonde measurements collected as part of regular monitoring. To aid in the interpretation of the outputs of such models, here we synthesize a categorical rating scheme for how water quality and spatial location in the Estuary affects rearing steelhead in terms of foraging opportunity, predation risk, and physiological impacts of water quality. We adopt a bioenergetics perspective as a conceptual framework because energy provides a unifying framework for thinking about how behavioral and physiological responses to predation risk, water quality, and foraging opportunity translate to somatic growth of rearing salmonids. However, our review and synthesis indicates that the tradeoffs posed to rearing salmonids by an estuary—among foraging opportunities and the different dimensions of water-quality impacts, for example—is multidimensional and complex. Rather than propose explicit quantitative models of behavior and physiology that capture all this complexity—which is outside our scope and in any case requires further work—for simplicity we develop a categorical (or qualitative) scheme to make sense of this complexity. It is our hope that this scheme will aid fisheries managers in interpreting the complex output of physical estuary models, and point the way toward more focused development of coupled behavioral-bioenergetics models of salmonids rearing in estuaries. Such models will need to address the spatial and temporal structure of the tradeoffs, as well as the important role of induced physiological tolerance for salinity and possibly hypoxic conditions, and its relationship to strategies for feeding, growth efficiency, and predator avoidance. For convenience the qualitative rating scheme is summarized in a short appendix at the end of the text.

Introduction

In the Mediterranean-type climate of California, estuaries are recognized as critical habitat for juveniles[1] of many salmonid species. These estuaries exhibit a high degree of variability in both abiotic parameters and food availability – responding to natural seasonal changes as well as anthropogenic effects and management. Quantitative measures of habitat availability in time and space are needed to identify key factors influencing habitat conditions favorable to juvenile salmonids. Such measures would aid in identifying those management options that promote estuarine conditions beneficial to imperiled salmonid populations.

The University of California, Davis Bodega Marine Laboratory (BML) has developed a conceptual approach for quantifying the volume of salmonid estuarine habitats as a function of river inflow (discharge, temperature) and state of the estuary mouth (fully open, fully closed, perched). This "quantified conceptual model" (QCM) is a simple modeling approach that combines estuary bathymetry; empirical time-series on water level and depth-profiles of water quality parameters; a lagoon water balance; and a parametric model of the mouth and beach (Behrens et al. 2015). Salmonid habitats are characterized in terms of water quality metrics (*i.e.,* temperature, dissolved oxygen, salinity) indexed by spatial location in the estuary and depth below the current water level. The QCM developed for the Russian River Estuary can provide managers with a real-time, empirically based, spatiotemporal decision support tool for assessing the quantity and quality of juvenile salmonid habitat that is likely to result from various river mouth conditions. However, the output of the QCM is not in terms of salmonid habitat per se, but in terms of spatially explicit predictions for depth profiles of temperature, dissolved oxygen and salinity throughout the estuary, which can be summarized as total volumes of habitat with specific combinations of the water quality parameters and depths (distance from water surface, distance from estuary bottom). To close the gap between model outputs and predicted implications for salmonids, a team of fisheries and estuarine ecologists was assembled to develop a categorical rating scheme for evaluating outputs from the QCM. The rating scheme is developed in this Technical Memorandum based on a literature review and data on juvenile salmonid habitat use and invertebrate distribution in the Russian River Estuary. We also identify ways in which our simple categorical rating scheme is likely to be inadequate relative to fully-developed quantitative models of salmonid bioenergetics and behavior.

Juvenile salmonid water-quality preferences and tolerances vary by species. Additionally, the degree to which juveniles of a given species rely on estuarine habitat are influenced by spatiotemporal factors that can lead to short-term shifts in life history strategies, such as extended estuarine-rearing, as well as longer-term local adaptation. Although we recognize the potential importance of the estuary to juvenile coho and Chinook salmon, for clarity we focus this technical memorandum on steelhead occupying the estuary. However, the framework we describe here could serve as a template for future efforts that is populated with species-specific WQ and depth values to consider estuarine habitat conditions for juvenile coho and Chinook as they relate to inlet conditions.

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[1] We define the term juvenile as exogenous-feeding life stages prior to ocean entry; therefore, individuals that mature prior to the smolt stage (*e.g.,* precocious males) are included in this definition.

Background

Since 2004, Sonoma County Water Agency (SCWA) has continuously monitored water temperature, dissolved oxygen (DO), pH, salinity, and depth using datasondes deployed in the lower [0 - 1.7 river kilometer (rkm)], middle (1.7 - 5.0 rkm), and upper (5.0 - 12.0 rkm) reaches of the estuary (Brown's Riffle to the river mouth). The National Marine Fisheries Service's (NMFS) Russian River Biological Opinion (2008) requires SCWA to continue monitoring these water-quality parameters under changing estuary conditions during the lagoon management season (May 15 to October 15) and to evaluate changes in these water-quality parameters that result from lagoon adaptive management (*i.e.,* managing the estuary as a seasonal lagoon). However, SCWA is not required to provide additional synthesis and/or modeling of past, current, or future WQ data collected. Independent of regulatory requirements, NOAA has partnered with SCWA via the Russian River Habitat Focus Area, who has contracted with BML for collection and evaluation of data relating to estuarine hydrodynamics, water quality, and physical processes associated with river mouth conditions. SCWA has also contracted with Environmental Science Associates (ESA) and BML for the development of a FLOW3D model of water circulation and stratification that utilizes the water quality data collected by BML and SCWA.

Purpose of this Technical Memorandum

The water quality parameters used to inform habitat availability and productivity for juvenile salmonids in the estuary include temperature (° C), DO (mg/L), and salinity (‰). Suboptimal levels of these water quality parameters involve increased energy expenditure, slower growth, and eventually mortality at extreme levels, as indicated in the categorical rating scheme developed below and used to interpret the QCM outputs in terms consequences for rearing juvenile steelhead. However, the productivity and juvenile salmonid growth potential of available habitat involves complex interactions, such as higher oxygen demand at higher water temperatures or salinities that cannot be fully captured by a categorical rating scheme. Therefore, we have provided this technical memorandum to explain and support the rationale for each rating scheme, the complexities of salmonid physiology, bioenergetics and behavior, and the subsequent limitations of the modeling outputs and recommendations to address them (*e.g.,* bioenergetics models, partial life history model, *etc.*).

Additionally, water depth (m) is an output of the QCM and will be used to evaluate juvenile salmonid foraging opportunities, prey availability and predation risk that tend to be structured by water depth and characteristics of the benthic substrate. Water depth considerations also include tradeoffs between foraging opportunities (*i.e.,* location of prey availability) both vertically in the water column and horizontally across the width of the estuary in relation to potential avian and aquatic predation risk.

Figure 1. Example of a suspected freshwater-acclimated resident steelhead captured in the Russian River Estuary, CA.

Figure 2. Example of a suspected marine-acclimated resident steelhead captured the in the Russian River Estuary, CA.

A. PIT # B4E, captured 8/13/2012, 134 mm FL, Russian River Estuary at Jenner Gulch, CA.

B. PIT # B4E, re-captured 9/24/2012, 185 mm FL, Russian River Estuary at Jenner Gulch, CA.

C. PIT # B4E, recaptured 10/15/2012, 209 mm FL, Russian River Estuary at Jenner Gulch, CA.

Figure 3. Example of a juvenile steelhead captured and subsequenately re-captured in a stratified brackish to full strength seawater environement (mouth of Jenner Gulch, CA). Actual saltwater tolerances are unknown; however, this example portrays the potential range of some individuls to increase their capacity to excrete salt ions while continuing to grow.

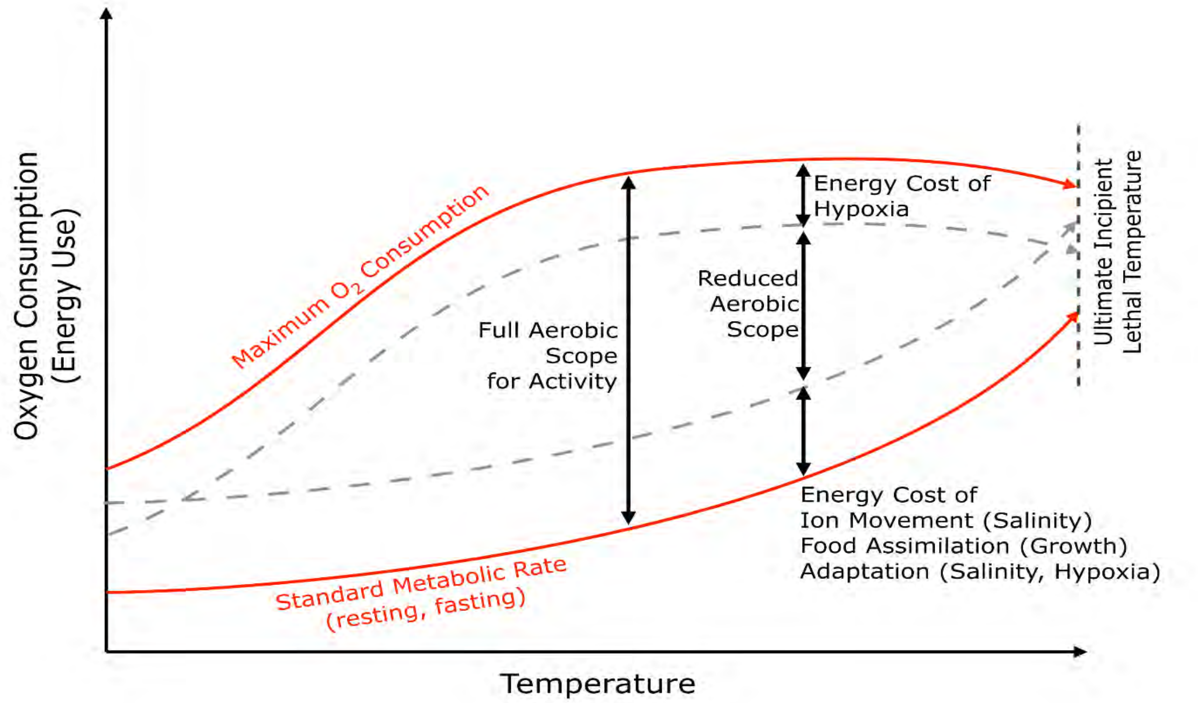

Figure 4. Schematic model of energetic costs of temperature, salinity and hypoxia for fishes, adapted from Farrell (2009) and Wang et al. (2009).

Life Stage Categories

Two juvenile steelhead life stage categories and their water quality tolerances have been selected to inform the water quality habitat and productivity components within the estuary during the dry season (generally spring through fall). We considered both categories as encompassing juveniles that rear in the estuary. Therefore, we did not focus on smolts[2] because they theoretically do not rear in the estuary, but instead spend a relatively brief period migrating through the estuary during a time (majority before June) when water quality conditions are generally suitable for salmonids that can tolerate full strength seawater.

1. **Freshwater-Acclimated Residents:** Individuals that rear in the estuary prior to smoltification, but are limited in their capacity to osmoregulate in seawater. These individuals may increase their capacity to excrete salt ions over time and therefore become fully marine-acclimated residents (Figures 1 and 3).
2. **Marine-Acclimated Residents:** Individuals that rear in the estuary prior to smoltification and have the capacity to osmoregulate in full strength seawater (Figures 2 and 3).

[2] We define the term smolt as juvenile salmonids that have gone through the parr-smolt transformation (*i.e.*, smoltification) via a suite of behavioral, morphological, and physiological changes as they migrate directly to sea for the first time (McCormick 2013). This downstream seaward migration generally occurs before June in the Russian River, CA.

Water Quality Tolerances for Juvenile Pacific Salmonids, an Energetics Perspective

From an evolutionary perspective, fish are a device to convert food energy and mass into more fish, via growth and reproduction. However, in doing so a fish incurs energetic "overhead:" energy used to maintain the living body and assimilate food in order to support adaptive behaviors such as feeding and predator avoidance; and, to support the energy cost of adaptive physiological responses to stressful environments. The ability of a fish to perform these functions is limited by the energy content of food, as well as the supply of oxygen available for converting food to energy via respiration. One way of conceptualizing these processes is the concept of *aerobic scope*, the difference between standard metabolic rate—the level of respiration necessary to maintain a fish at rest—and maximum metabolic rate, usually determined by the maximum capacity of the gills to absorb oxygen from the water or the maximum capacity of the heart to transport oxygen in the blood (Figure 4). Aerobic scope—sometimes called "scope for activity"—describes the power[3] available to the fish for life functions other than maintenance, and it is useful to categorize these functions in terms of evolutionary fitness: feeding, avoiding predation, food assimilation (*i.e.,* converting food into body mass and eggs), and mitigating physiological costs such as suboptimal water quality.

Poor water quality may incur energetic costs that reduce the aerobic scope significantly (Figure 4); yet, it still can be adaptive for a fish to move into poor water if the benefits of feeding, assimilation efficiency or predator avoidance outweigh the energetic costs of poor water quality. However, if aerobic scope is reduced too much there may be insufficient power to pursue behaviors such as feeding, or even to support the energy cost of food assimilation and growth. In this manner, energy provides a scientifically sound common currency for thinking about how evolution should adaptively structure the tradeoffs that fish experience between foraging opportunity, predation risk, and the cost of inhabiting poor water conditions. Normally functioning ecosystems may seldom provide fish with a habitat that is simultaneously optimal on all three axes, producing a selection pressure favoring fish that can evaluate and respond adaptively to the energetic tradeoffs presented by different available habitats over time. If these adaptive behaviors and physiological responses can be quantified and modeled, they would provide a predictive tool for how juvenile salmonids would have the opportunity to respond to novel habitat conditions, and thus could be a useful tool for habitat management.

The following is a review of the underlying physiological mechanisms and energetic considerations associated with three aspects of water quality relevant to salmonid fishes: water temperature, salinity, and DO. Additionally, field studies and lab experiments were reviewed on how fish respond behaviorally (*e.g.,* movement, foraging, and habitat use) to energetic tradeoffs involving water quality, occurrence of predators, and food availability.

Upper Thermal Limits of Steelhead

Upper temperature limits for survival of steelhead and rainbow trout (*i.e.,* anadromous and non-anadromous, *Oncorhynchus mykiss,* respectively) and other fish are estimated in the laboratory as either the Critical Thermal Maximum (CTM) or Incipient Lethal Temperature (ILT). CTM is the temperature at which fish lose ability to maintain upright posture after short exposure, taken to indicate impending death; ILT is the temperature for which long exposure produces 50%

[3] "power" here is the *rate* at which energy can be used, *i.e*. transformed to some other form of energy such as muscle movement.

mortality, and is assumed to be less than CTM (Jobling 1981). Estimates of both vary widely in literature reviews. Hasnain et al. (2013) found mean ILT for juvenile steelhead was 25° C [standard deviation (SD), 2.3° C] across studies from Canada and the northern USA; mean CTM was 22.1° C (SD, 6.5° C). Notice that mean ILT was greater than mean CTM, contrary to expectation, and SD of CTM across studies was rather wide (6.5° C). Myrick and Cech (2004) found estimates of ILT ranging from 22.8° C to 26° C. Steelhead from the American River (California) had CTMs of 27.5° C to 29.6° C depending on acclimation; and steelhead juveniles from the Feather River (California) had CTM of 30.8° C, considerably higher than the mean values in Hasnain et al. (2013). Bjorn and Reiser (1991) reported studies showing juvenile steelhead CTM of 29.4° C and ILT of 25° C. More recently, redband trout (*O. mykiss*) where found to have CTM of 29.4° C in southeast Oregon, leading Rodnick et al. (2004) to suggest that physiological mechanisms for CTM are highly conserved evolutionarily, but question its use as suitability criterion because other metabolic traits were more population-specific. Some variation in CTM may be due to variation in laboratory methods. For example, the acclimation temperature at which the fish is held prior to the experiment, and the rate at which temperature is increases can both strongly affect estimates of CTM. In a sense, CTM is not a true biological trait, but rather a hybrid trait that is determined by both the biology of the tested individuals and the experimental protocol.

Studies of the regional distribution of wild steelhead and rainbow trout have generally shown the species to occur over a broad thermal range. Dunham et al. (2007) found steelhead occurred over the full range of observed maximum daily stream temperatures (11.7° - 26.6° C) in the Boise River Basin, Idaho. Huff et al. (2005) observed steelhead at the warmest site in each ecoregion of Oregon they studied, up to the maximum observed temperature of 28.6° C (7-day average daily maximum) (see their Table 1). Redband trout in southwestern Idaho were observed in water with maximum temperatures ranging between 25.5° C and 29° C, but not in a downstream area with suitable habitat and flow but maximum temperatures > 29° C (Zoellick 1999). These studies did not ask if thermal refugia were available to the fish.

Under warm river temperatures, steelhead and rainbow trout often use thermal refugia if they are available. In a northern California creek, two-thirds of steelhead moved into thermally-stratified pools when ambient stream temperature rose into the range 23° - 28° C (Nielsen et al. 1994). In a nearby river, summer-run adult steelhead used stratified pools over the entire observed range of river temperatures 26° - 29° C, and pool bottoms were 3.5° cooler. In northeast Oregon, proportional use of thermal refugia rapidly increased when temperatures rose from below 21° to above 22° C mean daily maximum temperature (Ebersole et al. 2001), although nonzero densities were observed over the full range of observed temperatures (15.7° - 25.1° C mean daily maximum). Comparing river reaches with different amounts of cold-water habitat area, Ebersole et al. (2003) estimated that steelhead density in reaches increased only 10% with each doubling of cold-water patch area, rather than proportionately. This suggests that fish from a broader surrounding area crowd into pools as necessary, rather than that cold-water area strictly controls fish densities via territorial interactions within the cold-water patch. In the mainstem Klamath River (northern California), the occurrence of steelhead in thermal refugia increased above river temperatures of 22° - 23° C (Sutton et al. 2007). In late summer in tributaries of the Salinas River (Central California), steelhead were only observed in pools where mean water temperature stayed below 21.5° C and maximum temperature stayed below 26° C, presumably because most fish moved to cooler areas upstream (Thompson et al. 2012). In Sespe Creek (southern California), steelhead concentrated in sections of stratified pools with mean daytime temperatures < 20° C, when mean daytime temperatures elsewhere were 20° - 20.7° C (Matthews and Berg 1997).

Although steelhead and rainbow trout often use thermal refugia, it is not a universal behavior. In stratified pools in a Sierra Nevada stream, rainbow trout used temperatures up to 19.3° C (maximum temperature observed) even when cooler water was available (14.5° C), providing no evidence that trout selected the cooler water (Matthews et al. 1994). A few studies in southern California have shown that steelhead can persist at higher temperatures without the availability of thermal refugia. Spina (2007) found a lack of thermal refugia in a section of Topanga Creek (Santa Monica Mountains) occupied by steelhead, which presumably prevented the fish from behavioral thermoregulation when the creek ranged between 17.4° and 24.8° C over time. In Santa Paula Creek (Transverse Ranges), thermal refugia were rare and yet steelhead persisted in all pools that did not exceed 30° C maximum temperature, with a sharp threshold of elimination above 30°; however, feeding and agonistic behavior declined above ~24° C, presumably due to thermal stress (Sloat and Osterback 2013). For steelhead, Werner et al. (2005) found that the heat shock protein hsp72 of steelhead from northern California river, was induced by 25° C water in lab; in the river, they observed hsp72 in fish collected during conditions of 18° - 19° C mean daily temperature, or 20° - 22.5° C mean daily maximum.

The above body of work suggests that steelhead can persist in streams provided that short-term maximum temperatures remain below 30° C or perhaps 29° C (Zoellick 1999; Rodnick et al. 2004; Werner et al. 2005; Sloat and Osterback 2013), similar to laboratory estimates of CTM. However, above 22° - 24° C, feeding and agonistic behavior falls off (Sloat and Osterback 2013) and fish show signs of stress (Werner et al. 2005). Estimates of ILT (50% mortality after long exposure) vary across studies but tend toward 25° C. If thermal refugia are available, steelhead start to concentrate in them when temperatures exceed 21° C and almost completely retreat at temperatures around 24° C (Nielsen et al. 1994; Ebersole et al. 2001; Baird and Krueger 2003). Many streams in southern California that support steelhead do not provide such refugia, and steelhead actively feed in the presumably stressful temperature range of 21°- 24° C (Spina 2007; Sloat and Osterback 2013).

These findings suggest various temperature thresholds for steelhead that can summarize, at least to some degree, the underlying physiological and behavioral adaptations that shape species fitness at high temperatures. Here we assume three biological indicators: A day is *thermally suitable* if maximum daily temperature stays below 29° C *and* mean daily temperature stays below 25° C. In this usage suitability means that temperature will not necessarily kill fish over a short time period (hours to days), but the fish will not necessarily thrive and may be quite stressed or unable to devote food energy to growth or reproduction. We therefore additionally quantify thermal stress based on evidence of behavioral thermoregulation or physiological stress from our literature review: A day is *thermally stressful* if temperature rises above 21° C at any time, with the *stress intensity* quantified as degree-hours above 21° C [*i.e.* for each day, $\Sigma(T_t - 21)\Delta t$].

Thermal Growth Potential

Thermal growth potential is the maximum attainable growth of an individual fish as a function of the river's or estuary's thermal regime under an actual or constructed scenario of temperature and food availability. Thermal growth potential can be estimated using the bioenergetics model for steelhead, as described by Railsback and Rose (1999) and modified by Satterthwaite et al. (2010) and Arriaza (2013). This model is parameterized from results of standard laboratory respirometry studies on *O. mykiss* (Railsback and Rose 1999) in which ambient DO levels are close to saturation. Individual growth arises from the surplus between energy intake and energy expenditure (Rand et al. 1993; Railsback and Rose 1999; Satterthwaite et al. 2010), modeled as weight- and temperature-dependent functions for food consumption and respiration respectively. For weight W, growth rate is the difference

(1) $$\frac{dW}{dt} = \Psi\big(T(t)\big) f c W(t)^{0.86} \frac{a(t)}{\kappa(t)+a(t)} - \big(1 + a(t)\big) W(t) \alpha e^{0.071 \cdot T(t)}$$

where the first and second terms describe energy intake and expenditure, respectively. In the intake term, $\Psi(T(t)) fcW(t)^{0.86}$ describes maximum food consumption, composed of two functions and empirical scaling parameters. The function $W(t)^{0.86}$ is an empirical allometric relationship between maximum consumption and fish weight at time t. The function $\Psi(T(t))$ is a relationship between maximum consumption and temperature T at time t. The functional form of $\Psi(T(t))$ is hump-shaped for cold-water species, after Thornton and Lessem (1978), parameterized for California steelhead as in Railsback and Rose (1999). These functions are scaled by two constants: f, the relative energy density of food to fish tissue; and, c, the daily maximum weight of food that can be consumed by a 1 g fish under optimal temperature.

The expenditure term involves fish weight $W(t)$, a standard unit catabolic cost α, and an effect of temperature in catabolism, $e^{0.071T(t)}$ (Brett and Groves 1979). Parameters c, f, and α have been previously estimated for California steelhead (Central Valley) from laboratory studies (Rao 1968; 1971; Myrick 1998; Railsback and Rose 1999; Satterthwaite et al. 2010).

To appropriately characterize fish growth in the wild, these expressions for maximum food intake and respiration costs were scaled by two additional functions, energy cost of activity $a(t)$ and difficulty of finding food $\kappa(t)$, in accordance with recommended practices by Andersen and Riis-Vestergaard (2004) and Bajer et al. (2004). While higher activity increases consumption, total energetic cost also goes up. Here we assume that fish choose a unique activity level, $a^*(t)$, that optimizes growth given all other parameters. Differentiating (1) with respect to $a(t)$ and solving gives growth-optimized activity

(2) $$a^*(t) = \sqrt{\frac{\kappa(t)\Psi\big(T(t)\big) f c W(t)^{0.86}}{W(t)\alpha e^{0.071 \cdot T(t)}}} - \kappa(t)$$

at time t. In the resulting model, growth rate depends on fish size and food availability, but generally peaks in the range 15° - 17° C and becomes negative above 22° - 24° C.

Based on the above information, the following temperature (° C) rating scheme was used for freshwater- and marine-acclimated residents (Table 1; Appendix A):

Table 1. Temperature (° C) rating scheme for freshwater- and marine-acclimated residents.

Fastest growth	Positive growth	No or Negative growth	Unsuitable
14° - 18° C	< 14° or 18° - 21° C	21° - 25° C	> 25° C

Definitions:

Fastest growth: Temperature conditions that allow for the most rapid growth when food availability is unlimited.

Positive growth: Temperature conditions that allow for positive growth (weight gain) under most levels of DO, salinity, and food availability.

No or negative growth: Temperature conditions that usually produce high metabolic demand and negative growth (weight loss) even when food is readily available.

Unsuitable: Temperature conditions that are highly stressful and generally cannot sustain metabolic demand for more than a day without death or injury.

Salinity Tolerance

Tolerance for salinity derives from a fish's ability to maintain non-equilibrium salinity gradients between their blood plasma and the external water column, a form of homeostasis. Blood plasma typically has salinity around 8 - 10 ‰ whereas full-strength seawater is 30 ‰, that together drive a net diffusion of dissolved ions into the fish (toward the lower ionic concentration) and net diffusion of water the other way, out of the fish. Without a physiological mechanism to pump ions and/or water backwards against these concentration gradients, fish blood would become progressively saltier until it equilibrates with seawater, causing mortality. In fresh water, the gradients are reversed and fish tend to lose ions and gain water from their environment, diluting their blood past lethal limits in the other direction. Tolerance thus involves the maintenance of the internal milieu via physiological mechanisms that transport ions and/or water molecules from areas of low concentration to high concentration, a process that requires energy and regulation (McCormick 2013).

In principal, there is an isotonic environment around 8-10 ‰ in which external salinity matches internal salinity and no such active transport of ions or water need occur; at lower salinities fish need to actively import ions or export water to survive; at higher salinities, they must actively export ions and conserve water molecules (Morgan and Iwama 1991; Ern et al. 2014). In fact, Fu et al. (2010) argue that the initial function of gills in small larval rainbow trout is ion exchange rather than gas exchange.

Thus, we expect a fish in fresh water to express modest salinity tolerance (up to the isotonic point), simply by down-regulating its uptake of ions and export of water. But past the isotonic point, tolerance requires a qualitatively different ability to actively export ions and retain water. Anadromous salmonids typically develop this ability during a physiological transition known as smoltification, in which freshwater juvenile salmonids transform into a migratory form via changes in morphology, body coloration, swimming behavior, and saltwater tolerance. Saltwater tolerance develops prior to any exposure to salt water by way of hormone-triggered build-up of certain gill proteins that move Na^+ and K^+ ions across the gill from plasma to seawater (McCormick 2013). Other gill proteins and channel structures also develop that allow chloride (Cl^-) ions to passively follow the gradients set up by the active transport of Na^+ and K^+.

McCormick (1993) developed a non-lethal gill biopsy procedure, Na+ K+ ATPase (NKA), to measure the activity of the main protein involved in salinity tolerance and this biopsy procedure is now commonly used as an indicator of salinity tolerance in salmonids. NKA hydrolyzes the energy-bearing molecule adenosine triphosphate (ATP) that in the process uses the energy to transport Na+ and K+ ions against concentration gradients across the gill lamellae. Gills actually contain two isoforms of the molecule, known as NKA α1a and NKA α1b that are associated with freshwater tolerance (ion importing) and salinity-tolerance (ion exporting), respectively (McCormick 2001; Flores and Shrimpton 2012). In salmonids, the stress hormone cortisol plus growth hormone appears to stimulate production of NKA α1b, raising salinity tolerance; whereas, cortisol plus the hormone prolactin appears to stimulate production of NKA α1a and increasing freshwater tolerance (McCormick 2001; Flores and Shrimpton 2012). Thus, growth hormone and prolactin drive antagonistic interpretations of a cortisol increase. The biopsy procedure of McCormick (1993) does not distinguish between the two isoforms. However, the concentration of NKA α1b in saltwater-acclimated salmonids tends to be substantially greater than the concentration NKA α1a in freshwater-acclimated salmonids, perhaps because saltwater-acclimated fish are further from the isotonic point than freshwater-acclimated fish (Flores and Shrimpton 2012). Thus, total NKA activity can still function as "bulk" indicator of saltwater tolerance, with higher levels of activity generally indicating greater capacity to use metabolic energy (via ATP) to actively exports ions from the gills.

Smoltification vs. Induced Salinity Tolerance

The development of salinity tolerance during smoltification is anticipatory: it occurs while the fish is still in fresh water (McCormick 2013) and downstream migrants thus have elevated NKA activity prior to exposure to salt water (Hayes et al. 2012). It appears to be triggered by changes in photoperiod (Handeland and Stefansson 2002), conditional on the individual having grown to a threshold body size suitable for surviving in the ocean (Satterthwaite et al. 2009; Beakes et al. 2010). Downstream migration in anadromous salmonids is generally highly seasonal but varies among species and among geographic regions within species (Spence and Hall 2010), probably as a result of selective factors (niche differentiation and local adaptation, respectively). As such, the combination of threshold body size and photoperiod makes evolutionary sense as reliable cues, in which the precise day-length and body size that cues smoltification could be adjusted to local conditions by natural selection. Other environmental factors such as temperature, stream flow and lunar phase appear to combine with photoperiod to cue the timing of downstream migration after smoltification (Spence and Dick 2014).

Salinity tolerance can also be directly induced by exposure to salt water, a distinctly different cuing system than the anticipatory tolerance of smolts. Flores and Shrimpton (2012) introduced rainbow trout to 24 ‰ salt water (75% of full-strength seawater) and after 14 days found an increase in gill NKA activity, higher expression of mRNA for the α1b isoform of NKA, and changes in levels of the cuing hormones cortisol, growth hormone and prolactin that were similar to what is observed during smoltification (*e.g.*, McCormick 2013). Perry et al. (2006) conducted an experiment in which salt was added to the diet of experimental rainbow trout but not controls, both kept in fresh water. They found that gill NKA activity was 1.5 in controls, but 3.5 in fish with the high-salt diet. They also observed other biochemical and cellular changes consistent with salt-water gill structure. However, two elements of the saltwater phenotype were not observed: the disappearance of mitochondrial-rich cells from the gill lamellae and the development of "leaky junctions" between chloride cells and accessory cells.

Fuentes et al. (1996) found that the exposure of small (40 g) rainbow trout to isotonic (9 ‰) and seawater (28 ‰) induced greater NKA activity in the kidneys, but did not observe such a response in larger (180 g) fish. This suggests that kidneys can also be induced to regulate ions and that larger fish may be somehow more resistant to such induction, perhaps because larger body masses imply large volumes of plasma relative to ion intake.

Thus, exposure to salt water and consumption of salt both appear to directly induce the gills to develop salinity tolerance. Exposure to salt also induces ion regulation within the kidneys. The time-scale of such induction appears to be on the order of two to three weeks, but may vary more widely according to size of fish and other factors. Importantly, the literature is not clear on whether *Oncorhynchus* spp. can be directly induced to tolerate full-strength seawater. In their experiments, Flores and Shrimpton (2012) used 75% strength seawater, because "higher salinity levels can cause mortality," but they provide no data.

Energetic Costs of Salinity Tolerance

The active transport of ions across the gill membrane consumes metabolic energy, and the retooling of gill proteins during smoltification or direct induction presumably entails energetic "start-up" costs as well. Energy can be thought of as an internal currency that is allocated by the organism to capture food (additional energy) and convert it into survival, growth and reproduction via behavioral and physiological mechanisms (Sousa et al. 2010). Thus, it is worth knowing something about the magnitude of energetic costs for salinity tolerance, because this will give an idea of the situations in which it is adaptive for a species to volitionally enter salt water, self-induce tolerance, incur an energy cost, but presumably still benefit in some way due to better feeding opportunities (Webster and Dill 2006).

Scientific reviews (Morgan and Iwama 1991; Ern et al. 2014) of a broad array of fish taxa expected to find that the lowest energy costs where in isotonic salinities, for the reasons described earlier. They found this in some species but overall a more diverse and complex picture suggested that lowest energy costs were often for marine-fish in salt water and freshwater fish in fresh water. This suggests selective pressure for energy efficiency in the native habitat rather than natural energy efficiency at the isotonic point. However, there were many exceptions and it is possible that acclimation costs ("start-up costs") were not distinguished from the longer-term costs of maintaining plasma ion levels, and probably also from costs of various miscellaneous physiological responses to salinity.

Morgan and Iwama (1991) acclimated fry of resident *O. mykiss*, anadromous *O. mykiss*, and *O. tshawytscha* to a range of salinities, while providing equal food availability across all treatments. Survival, growth, metabolic rate, plasma Na+ and Cl- concentrations, and seawater adaptability were measured for 5 - 12 weeks, depending on the species. Growth of all three taxa was highest in fresh water and declined with increasing salinity. Metabolic rates increased with salinity and were inversely correlated with growth rates. Isotonic salinity did not offer significant metabolic or growth advantages to any of the fry. While plasma Na+ and Cl- concentrations varied among groups, *O. tshawytscha* fry tended to better maintain ionic homeostasis at higher salinities than the *O. mykiss*. Acclimation to the various dilute salinities did not influence the seawater adaptability of anadromous *O. mykiss* or *O. tshawytscha*. The results suggested that energetic cost of ion regulation increased with salinity and were sufficient to affect growth. However, attempts to quantify the cost were probably affected by additional metabolic processes that responded to salinity.

Morgan and Iwama (1998) conducted similar experiments on juvenile *O. kisutch* in three treatments: acclimated to fresh water, isotonic salinity (10 ‰) and full-strength seawater (28 ‰). Plasma levels of cortisol, glucose and ions (Na+, K+, Cl-), gill NKA activity, and oxygen consumption were sampled for six weeks. Following an initial adjustment period, plasma constituents in saltwater coho returned to near-freshwater values, indicating that the coho were acclimated to salt water by day 21. NKA activities on days 21 and 42 were lowest in isotonic water, higher in fresh water and highest in salt water. This result is consistent with the idea that less energy would be required to maintain ion balance in isotonic environments, and that salt water requires more energy expenditure on ion transport than fresh water. However, swimming coho (one body length per second) had similar oxygen consumption across the three test salinities after six weeks, suggesting that modest activity masks the costs of maintenance, at least in the presence of error levels typical of respirometry studies.

Morgan and Iwama (1999) estimated oxygen consumption in excised gill tissue of fresh water-adapted cutthroat trout (*O. clarki clarki*) with and without inhibitors of Na+/K+/H+ pumps. They estimated that these pumps accounted for 37% of total tissue respiration in fresh water-adapted gill tissue, and 1.8% of whole-animal oxygen consumption. Oxygen consumption of fresh water-adapted tissue was 33% higher than in seawater-adapted tissue. They estimated that total gill oxygen consumption accounted for 3.9% of resting metabolic rate in fresh water-adapted trout and 2.4% of seawater-adapted trout.

Maxime (2002) introduced juvenile Atlantic salmon (*Salmo salar*) to salt water at various points during the parr-smolt transition and found that the standard metabolic rate increased during that time. Prior to the transition, salt water actually decreased the standard metabolic rate, possibly due to effects of increased plasma-ions on gas exchange in the gills or oxygen affinity of hemoglobin.

Altinok and Grizzle (2001) found that juvenile *O. mykiss* (< 0.5 yr) in modest salinities (3 and 9 ‰) had higher specific growth rate and more efficient food conversion and energy absorption than in lower salinities (fresh water and 1 ‰), supporting the idea that costs go down near the isotonic point. Handeland and Stefansson (2002) conducted an experiment on Atlantic salmon (*S. salar*) pre-smolts in which they phase-advanced photoperiod followed some weeks later by transfer from fresh water to various salinities. They found that hypo-osmoregulatory ability improved in all groups during the first nine weeks of the photoperiod treatment, and that salinity was probably not necessary to stimulate hypo-osmoregulatory ability, but did have a negative effect (13% decrease) on post-smolt growth. Thus, the energy cost of salinity tolerance in smolts appears sufficient to affect growth, suggesting that tradeoffs between benefits of food availability and costs of saltwater tolerance would be of comparable magnitude in ecological situations.

Ecological Implications, Possible Indicators

In a non-migratory ecological setting where juveniles have the opportunity but not the necessity to use saltwater habitats, natural selection is only expected to favor movement and acclimation to salt water if the energetic cost is somehow offset by some gain, such as increased feeding ability (energy intake), more suitable temperatures (which affect metabolic rate and growth conversion efficiency), or realization of some other habitat preference such as water depths that are presumably defensive against predators (Webster and Dill 2006; 2007; Webster et al. 2007).

For example, Webster and Dill (2006) used salmonid habitat choice experiments, and in particular a "behavioral titration," to ask how juvenile *O. tshawytscha* respond to energetic tradeoffs between food availability and water temperature or water salinity. Age-0 salmon of size 70.2 + 8.2 mm (temperature trials) or 88.7 + 3.1 mm (salinity trials) were found to prefer brackish (15 ‰) and salt (27 ‰) water over fresh water. Food availability was increased in fresh water to determine if the strength of preference was explained purely by lower energetic costs in brackish and salt water, and this hypothesis was supported for brackish but only partially supported for full saltwater treatment. In addition, NKA activity increased in juvenile Chinook over the course of the experiment, but not in the brackish treatment. Webster and Dill (2006) interpreted this to mean that fish were isotonic to brackish water and no NKA response was elicited, whereas salt water elicited a continuous increase in gill NKA over the course of the experiment. They also concluded that energetic costs of non-preferred water temperatures (14° C vs. 9° C) were of similar magnitude as energetic costs of non-preferred salinities (fresh water and salt water versus preferred brackish water). This behavioral-titration method could have broad application for determining how fish volitionally enter habitats to trade-off the costs of salinity tolerance versus benefits of saltwater use, such as access to greater depths (protection from predators) in stratified freshwater-saltwater systems (Webster et al. 2007). It assumes such behavior reflects adaptive preferences within the local ecological niche space used by the species.

Hayes et al. (2012) observed juvenile *O. mykiss* moving downstream with elevated NKA levels (relative to non-movers) during all months of the year. The highest NKA levels were observed during smolting season (Apr-May), but elevated NKA levels were also observed in the summer and fall when further downstream access to the ocean was blocked by a seasonal sand-bar barrier. These juvenile *O. mykiss* moving downstream outside of the smolting season generally had NKA levels intermediate to smolts and non-moving juveniles, and subsequently resided in the estuary where heterogeneous salinities ranging between fresh and full strength seawater could be found. This suggests perhaps that the smoltification/induced-tolerance dichotomy, outlined earlier, is not the whole story.

Generally, while commonly observed and consistent with physiological studies of induced tolerance, the volitional entry of juvenile salmonids into brackish and sea water in the wild has actually received very little attention in the ecological literature. A notable exception is the work by Webster and Dill cited above, that conceives volitional movement between salt and fresh water as a laboratory choice experiment. This and other work suggests that salinity poses some level of stress on juvenile salmonids, triggering higher levels of the stress hormone cortisol, that in turn induces a remodeling of the gill physiology to actively export ions. Thus, stress for a juvenile salmonids in a saline habitat is not necessarily an indicator of poor habitat but rather a trigger for physiological adaptation to that habitat. The cost of such adaptation is simply energy and thus the habitat might actually be considered high-quality from the point of view of evolution if its benefits (food availability, safety from predators, etc.) outweigh the energy cost of induced tolerance.

For juveniles (not yet smolted) of the various species of *Oncorhynchus*, the above review suggests there are four energetic categories of salinity (Figure 5; Table 2): (1) hypotonic (< 10 ‰), used by juvenile salmonids in which the ion-importing pumps of the gill are available; (2) isotonic (10 – 15 ‰), available to all juvenile salmonids; (3) hypertonic (15 – 28 ‰), available to juvenile salmonids in which the ion-exporting pumps have been induced; and, (4) marine (> 28 ‰), which may be too salty for indefinite use of juvenile salmonids with induced tolerance. Note that this last category includes full-strength seawater. This categorization is too simplistic in a number of ways:

1) It is really unclear whether the threshold for unsuitable should be as low as 28 ‰, or in other words, whether juvenile salmonids can be directly induced to physiologically adapt to full-strength seawater solely through exposure.

2) Even if juveniles cannot be directly induced to physiologically adapt to full-strength seawater, they could probably still use it for shorter times in an ecological situation. For example, they could volitionally enter seawater to forage but exit before ion levels in their blood plasma became lethal. Presumably this would take longer in larger juvenile salmonids, and so larger individuals might have greater access to seawater habitats.

3) The distinction between ion-importing, isotonic and ion-exporting habitats is not a sharp threshold but rather a gradual transition.

4) This rating scheme does not account for the actual process of inducing tolerance (physiological adaptation), which indeed has not really been studied in the wild, where it would occur volitionally rather than as the result of a "seawater challenge." Perhaps wild juvenile salmonids have behavioral strategies to induce salinity tolerance that differ in important ways from laboratory techniques for doing so.

Based on the above information, the following salinity (‰) rating scheme was developed for freshwater- and marine-acclimated residents (Table 2; Appendix A):

Table 2. Salinity (‰) rating scheme for freshwater- and marine-acclimated residents.

Hypotonic	Isotonic	Hypertonic	Marine
< 10 ‰	10 - 15 ‰	15 - 28 ‰	> 28 ‰

Definitions:

Hypotonic: Fresh water to moderately saline conditions, with low energy cost of ion regulation. Allows high growth potential for both freshwater- and marine-acclimated residents.

Isotonic: Negligible energy cost of ion regulation for both freshwater-acclimated and marine-acclimated residents. Allows for most efficient transfer of food energy to growth.

Hypertonic: Highly saline conditions, but less saline than seawater. For freshwater-acclimated residents, stimulates physiological adaptation to salty water, incurring a high energetic cost in the process. After several weeks these juvenile steelhead become marine-acclimated with a low energy cost of ion regulation and positive to high growth potential.

Marine: Salinity similar to that of the sea. For freshwater-acclimated residents, unsuitable conditions probably causing death with sufficiently long exposure. For marine-acclimated residents, moderately energy demanding that somewhat impairs growth potential.

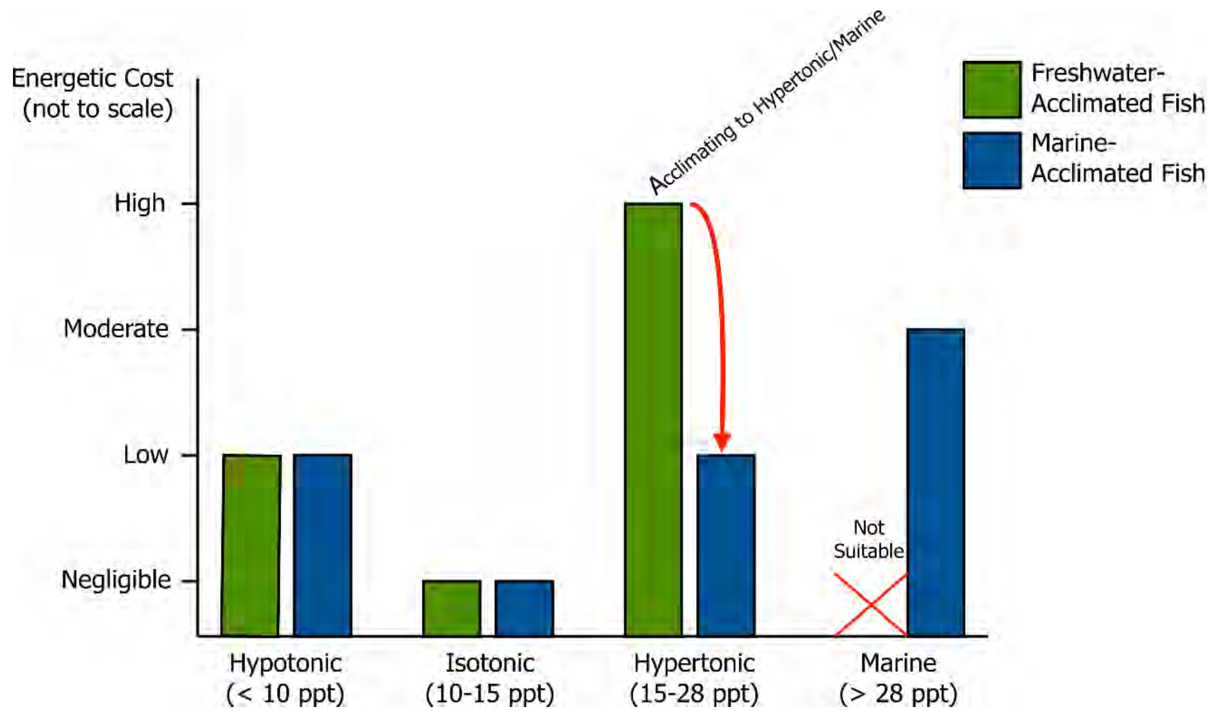

Figure 5. Salinity tolerance and associated energetic demand for freshwater- and marine-acclimated juvenile salmonids.

Dissolved Oxygen and Respiration

Wang et al. (2009) reviewed the physiology of hypoxia in fish, with an emphasis on the effects of hypoxia on growth rate. Although the physiological mechanisms are unclear, the main effect of hypoxia on fish is to reduce their growth rate, primarily by reducing appetite. Hypoxia also reduces the gills' assimilation of oxygen (because of lower oxygen gradients in the gills) and thus limits the maximum metabolic rate that can be maintained, with various effects on the fish. Hypoxia slows down the rate of digestion, although not the overall assimilation of food (it just takes longer). Hypoxia also stimulates a physiological adaption to lower oxygen levels, increasing the efficiency of the gills over the course of a few weeks. However, this adaptation process does consume energy, as does the digestion of food. The energetic costs of digestion, adaptation, and the lower oxygen assimilation all serve to narrow the aerobic scope of the fish, presumably reducing its ability to respond in behaviorally energetic ways to food and predators.

Saravanan et al. (2013) assessed food intake and oxygen consumption of *O. mykiss* fed to satiation with two diet treatments (balanced vs. imbalanced amino acids) and two oxygen treatments (hypoxia vs. normoxia). They found that *O.mykiss* consumed 29% less food under hypoxia than normoxia and reduced food intake by 11% and 16% respectively when fed the imbalanced diet. However, oxygen consumption per unit body mass was independent of diet under both hypoxia and normoxia. These results supported a hypothesis that food intake in fish is constrained by a set-point value of oxygen consumption.

Robertson et al. (2015) reported that *O. mykiss* exhibit an osmorespiratory compromise common in fishes, in which the branchial modifications that occur to improve O_2 uptake during hypoxia also result in an unfavorable increase in the fluxes of ions and water. This suggests that physiological adaptation to hypoxia increases the amount of energy required by the gills to actively transport ions across the gill surface to counteract the increased flux. Thus, physiological adaptation to hypoxia is likely to increase the energy cost of maintaining blood plasma ion concentrations for fish not in isotonic water, which includes both fresh water and seawater.

Burt et al. (2013) assessed the impact of moderate intermittent hypoxia (DO of 4 - 5.9 mg/L) on Atlantic salmon growth, food intake, appetite control and innate immunity. Salmon fed under hypoxic conditions ate 25% less food than salmon fed under normoxic conditions, and growth was 24% lower at the end of the experiment. They concluded that leucocyte characteristics suggested a negative impact of hypoxia on leucocyte function independent of feeding level, perhaps compromising the immune system.

Evans (2007) modeled the combined effects of temperature and DO on metabolic scope and power capacity in juvenile lake trout (*Salvelinus namaycush*). Maximum power output for sustained swimming of yearling lake trout occurred at 12 - 20° C and a DO concentration of > 7 mg/L. At 4° - 8° C, temperatures typical of the hypolimnetic summer habitat of juvenile lake trout, maximum power capacity was reduced by 33%, 67%, and 100% at ambient DO concentrations of 7 mg/L, 5 mg/L, and 3 mg/L, respectively. Analysis of power outputs, growth impairment, and recruitment success indicated that attainment of 3/4 power capacity would accommodate most daily life support activities of juvenile lake trout. At 4 - 14° C, the threshold DO concentration for attainment of 3/4 scope-for-activity varied from 7.5 mg/L to 6.6 mg/L, respectively, with a mean and standard deviation of 7.04 ± 0.33 mg/L. A DO criterion of 7 mg/L was recommended for protection of the hypolimnetic habitat of juvenile lake trout.

Behavioral and Ecological Response to Dissolved Oxygen Levels

Svendsen et al. (2012) observed that *O. mykiss* and other fish species make brief excursions from normoxia into areas of severe hypoxia, defined as DO levels below critical oxygen saturation (S_{crit}). S_{crit} is the DO threshold at which standard metabolic rate becomes limited by DO (aerobic scope declines to zero). Tests for *O. mykiss* showed that S_{crit} was 13.5% O_2 saturation. This would probably be temperature dependent since warmer water creates higher metabolic demand for DO. For fish exposed to 10% O_2 saturation for one hour, the peak metabolic rate during recovery was 253 mg O_2 kg^{-1} h^{-1} in normoxia (> 95% O_2 saturation) but only half that rate (127 mg O_2 kg^{-1} h^{-1}) in hypoxic conditions of 30% O_2 saturation. Metabolic recovery lasted nearly twice as long in hypoxia (9.8 h versus 5.2 h). However, the total extra oxygen consumed during recovery did not differ between the two treatments. Thus, slower recovery appears to be the main cost of recovering from severely hypoxic conditions (< S_{crit}) when the recovery is under moderately hypoxic conditions versus normal conditions. Such cost might affect fitness by affecting feeding or predator-avoidance behaviors.

In a whole-lake experiment, Barrow and Peters (2001) installed an aeration system to increase DO and used ultrasonic telemetry to determine movements, habitat use, and distribution of 51 rainbow trout (*O. mykiss*) before and after treatment. *O. mykiss* preferred areas with abundant food items, water less than 5 cm deep, DO > 6 mg/L, and temperatures < 20º C. Sixty-nine percent of all trout locations were in shallow areas where benthic macro-invertebrate densities were significantly higher than in other portions of the lake. Moore et al. (2014) describe a paired-whole-lake experiment on *O. mykiss* and *S. fontinalis*, in which a line diffuser was used to oxygenate the hypolimnion of one of the lakes to increase summer trout habitat. Volume of suitable habitat increased from a low of 0% pre-oxygenation, to 100% of the hypolimnion following oxygenation. Summer trout movements and habitat utilization were assessed for six years using ultrasonic telemetry, archival tags, gillnetting, and hydroacoustics. Trout utilized the oxygenated hypolimnetic habitat more frequently relative to pre-oxygenation years, and also relative to the other, oxygenated lake. Swim speeds significantly decreased with oxygenation. This seems counterintuitive; since the higher DO concentration should enable greater physical activity. However, the authors note that prior to oxygenation the trout were confined themselves to higher temperature water to escape the hypolimnetic DO deficit, increasing their metabolic rates. This necessitated that fish swim faster and farther in search of low-density zooplankton prey. The authors hypothesized that oxygenation allowed trout to use deeper, formerly anoxic waters with more favorable temperatures and more favorable prey conditions, permitting slower swim speeds and likely reducing stress.

To investigate carrying capacity and growth rates of rainbow trout in a lake, Blair et al. (2013a) used the Wisconsin bioenergetics model and field observations to assess how stocking rate, release timing, and prey abundance affected growth and feeding. Stocking timing had no effect: autumn releases were smaller than spring releases, but grew faster and had similar lengths and weights to spring cohorts after two years. The higher growth of autumn releases may have been due to: (1) temperature is more suitable for growth in autumn-winter than in spring-summer; and, (2) prey for small trout is abundant in autumn. This suggests that moderately productive warm-temperate lake ecosystems are highly suitable for trout growth and survival in winter but less so in summer, when lake stratification and high nutrient levels may create conditions suitable for algal blooms and hypolimnetic deoxygenation.

Blair et al. (2013b) analyzed long-term mark-recapture data on *O. mykiss* in nine closely-located, warm-temperate lakes of contrasting morphometry, stratification and mixing regime, and trophic state. In deep oligotrophic and mesotrophic lakes, trout growth rates increased with increasing indices of lake productivity. In shallow eutrophic lakes where fish habitat volume is constrained by temperature and DO, trout growth rates declined with increasing productivity. Growth rates were higher in lakes with greater volumes of favorable habitat (*i.e.,* DO > 6.0 mg/L and temperature < 21° C) and lower in lakes with increased turbidity, chlorophyll a, and nitrogen concentrations. Their findings suggest that increases in lake productivity and temperatures as a result of global climatic change are likely to be more detrimental to salmonid habitat quality in shallower, productive lakes.

Juvenile Atlantic salmon (*S. salar*) of different age classes exhibit different behavioral responses to elevated temperatures (> 23° C). Yearling (1+) and 2-year-old (2+) juvenile salmon often cease feeding, abandon territorial behavior, and swim continuously in aggregations in cool-water sites; whereas young-of-the-year continue foraging and defending territories. In a laboratory study, Breau et al. (2011) found that oxygen consumption of age 2+ fish increased with temperature and plateaued at 24° C, a temperature at which feeding ceases and lactate levels increase in muscle and blood (indicating anaerobic metabolism). By contrast, oxygen consumption in age 0+ fish did not plateau, feeding continued, and muscle lactate did not increase, even at the highest temperatures tested (28° C). Thus, older (larger) salmon in rising temperatures appear to lose aerobic scope at a lower temperature than younger (smaller salmon), and sacrifice feeding to retreat to thermal refugia sooner than smaller salmon. The likely reason is surface-to-mass scaling relationships that aerobically constrain basal metabolism at lower temperatures in larger salmon.

Plumb et al. (2014) coupled dynamic optimization and bioenergetics models to ask if lake trout (*S. namaycush*) depth distribution is structured by temperature, food availability, and predation risk, so as to maximize the reproductive mass by autumn spawning. The model was compared to data on depths occupied by acoustic-tagged trout and empirical daily thermal-depth profiles from a small boreal shield lake in Ontario. The depths and temperatures occupied by simulated fish most closely resembled those of the tagged fish when a shallow-water risk of predation was included in the model. Annual differences suggest that compared to years with cool surface water, in years with a warm thermal stratification pattern, lake trout show less use of shallow (warm), productive habitats, resulting in fish having markedly less reproductive mass during the year. The reason for staying in cooler deeper water appears to be avoidance of predation risk. The model suggested that in consequence, mass allocated to reproduction may be lower in these stratified years, yet survival may be higher because the fish avoid the warm, productive, yet risky surface waters and stay in cooler deeper conditions.

Plumb and Blanchfield (2009) compared the *in situ* habitat use of acoustic-tagged lake trout (*S. namaycush*) to the habitat volumes of the lake predicted from traditional combinations of temperature and DO boundaries. A widely used criterion of 8 - 12° C underestimated the habitat use of lake trout by 68%-80%. Instead, a criterion combining temperature (< 12° C) and DO (> 6 mg/L) most closely matched the observed habitat use by lake trout, and showed a similar seasonal trend in spatial distribution as the tagged fish.

Based on the above information, the following DO (mg/L) rating scheme was developed for freshwater- and marine-acclimated residents (Table 3; Appendix A):

Table 3. Dissolved oxygen (mg/L) rating scheme for freshwater- and marine-acclimated residents.

Minimal or no impairment	Moderate impairment	Severe impairment	Unsuitable
> 6 mg/L	4 – 6 mg/L	3 – 4 mg/L	< 3 mg/L

Definitions:

Minimal or no impairment: Dissolved oxygen has little to no effect on metabolism and growth potential.

Moderate impairment: Dissolved oxygen has minor impairment on growth potential, but positive growth (weight gain) is achievable depending on temperature, salinity, and food availability.

Severe impairment: Dissolved oxygen forces no or negative growth potential (weight loss) at most temperatures and salinities.

Unsuitable: Dissolved oxygen is severely limiting and cannot sustain metabolic demand under any circumstances, eventually causing death.

Inadequacy of the Water Quality Criteria

In general our scheme of water quality rating criteria should be applied with caution, due to likely complex interactions in how temperature, salinity and DO affect salmonid energetics and foraging behaviors stemming from those energetics. For example, because metabolic rate increases with water temperature, it is likely that some levels of DO that are sufficient to prevent impairment at low temperatures may not prevent impairment at high temperatures. Similarly, the energetic demand of physiologically adapting to high salinity may interfere with tolerance for high water temperatures, which also has high energetic demand. Thus, our categorical scheme does not fully capture the competing demands for unacclimated juveniles to forage in cool, food-abundant marine layers but retreat to warm fresh water layers when blood plasma ion concentrations reach dangerous levels. Understanding these sorts of interaction effects requires quantitative bioenergetic and foraging models, but developing and applying such models is beyond the scope of this report. We expect that the application of our categorical rating scheme to outputs of the QCM will likely suggest whether such development of quantitative models is warranted, and guide which sorts of interaction effects are most important to explicitly model.

Prey Availability in the Russian River Estuary and other California Estuaries

Excepting most insect larvae (which predominantly occupy benthic habitats or on submerged vegetation until they emerge as adults) and gastropods snails, all the amphipods, isopods, mysids and corixid beetles that form the dominant prey of juvenile steelhead display epibenthic behavior. The epibenthic macroinvertebrates live on top of or closely associated with the bottom substrate but can be found moving over it. The one variant on this generalization is that the Corophidae amphipods (e.g., *Americorophium* spp.) live in tubes in the surface of sand-mud bottom substrate (e.g., Miller 1984) and (predominantly the males) move out of the tubes to appear in the epibenthos. Estuarine epibenthic crustaceans such as *E. confervicolus* are known to a wide variety of substrates but have been characterized as having some habitat fidelity despite their dispersion capabilities (Pomeroy and Levings 1980; Stanhope and Levings 1985; Stanhope *et al.* 1992).

The prey observed in the diet of steelhead in the Russian River Estuary are primarily available to fish feeding in intertidal and shallow subtidal habitats. SCWA-UW studies of prey availability primarily use three methods to sample these potential foraging habitats: (1) benthic cores; (2) an epibenthic net; and, (3) an epibenthic (channel) sled (Seghesio 2011; Simenstad et al. *in review*). The epibenthic net ("net to shore") samples the water's edge within 10m of the shore and the epibenthic sled samples in the thalweg and shelf portions of the estuary channel. In earlier sampling (Seghesio 2011), insect fallout traps were also utilized to sample insects falling to the surface at the waters' edge, but these have not been deployed in recent years. We also monitor the vertical water column for zooplankton, but no planktonic prey have been found in the juvenile steelhead diet.

Generally, the highest densities of these prey were found in the benthic core samples, on the order of 1,000 - 50,000 organisms/m^2 for individual prey taxa (*e.g.,* Simenstad et al. *in review*). Much of these high densities may be attributed to high densities of *Ameriocorophium* spp. in their tubiculous colonies. In comparison, densities of these prey taxa in the epibenthic net from shallow waters along the estuary shoreline averaged an order of magnitude less, seldom over 1,000 organisms/m^2, except for the gastropod snails, which were estimated to average

~5,000 organisms/m^2 on some occasions. The epibenthic channel sled typically accounted for similar or relatively half the densities of the epibenthic net along the shoreline, commonly 200 - 600 organism/m^2 when most abundant. It should be noted that the sampling efficiencies of the two epibenthic net samplers is thought to be considerably less than the benthic core sampler because the net is constrained to pass over substrate, algae and other plants, were most of these epibenthic prey are nestled. However, we have personally observed dense concentrations of amphipods, isopods and corixids moving in with increasing water levels, and high ("cloud") concentrations of *N. mercedis* mysids, nestled in pockets along the bottom, suggesting behavioral affiliations with the substrate of intertidal/shallow subtidal habitat. As mentioned previously, basically no prominent prey of steelhead are captured in the insect fallout trap or the zooplankton sampling. Furthermore, we found densities of prey organisms to be higher early in the sampling period and diminish by roughly an order of magnitude by late summer. Compared to open-estuary conditions, during closed inlet conditions there is a relatively minor gradient of prey density distribution increasing from their deeper channel to shallower marginal habitats. Shortly after a closure, there appears to be a redistribution of prey into the increased shallow water habitat.

These prey are commonly found at high densities in the shallow intertidal and shallow subtidal zones of northeastern pacific estuaries (Needham 1940, Shapovalov and Taft 1954, Meyer et al. 1981, Robinson 1993, Seghesio 2011, Daly et al. 2014). Studying the benthic and epibenthic distribution of macroinvertebrates in Pescadero Lagoon, California, Robinson (1993) found prey abundance was low in the deep-water when DO levels were also low. They found *Chironomus* sp. in fresh shallow-water primarily during closed conditions and almost never during open conditions. When the estuary was open, *N. mercedis* was found to be abundant at all depths but more abundant in the shallow habitat when the estuary was closed. Although *G. insluare* were found to be more abundant deeper during open conditions, abundance during closed conditions increased in the shallower stations and sharply decreased at the deep stations. When the estuary was open, *Americorophium* spp. densities were highest at the stations not exposed during low tides and demonstrated a rapid colonization after a pesticide kill. Interestingly, these tubicolous amphipods have been found above the normal water line in moderate density (3500 organisms/m^2), suggesting an adaption to fluctuating lagoon levels (Needham 1940).

In their studies of differential growth of steelhead in riverine and estuarine reaches of Scott Creek, central California, Hayes et al. (2008) described similarly large numbers of *Eogammarus* spp., *Corophium* spp., *Neomysis* spp. and *Gnorimosphaeroma* spp. associated with algae in the Scott Creek Estuary during its closed phase.

Diet Composition in the Russian River Estuary and other California Estuaries

The analysis of 509 juvenile steelhead diets in the Russian River Estuary (2009 - 2015) has demonstrated extremely consistent prey spectra that are focused on a limited number of primarily epibenthic crustaceans (with only a few exceptions). Based on all metrics of dietary composition (frequency of occurrence, numerical and gravimetric composition), the predominant prey are the gammarid amphipods *Eogammarus confervicolus, Americorophium salmonis*, *A. spincorne*, and the isopod *Gnorimosphaeroma insulare* (Seghesio 2011, Simenstad et al., *in review*). Corixid beetles (water boatman) and chironomid insects (adult, larva and pupa), the mysid *Neomysis mercedis* and nereid polychaetes and gastropod snails (tentatively identified as the New Zealand mud snail, *Potamopyrgus jenkinsi*) constitute prey of relative secondary importance. Incidental prey were almost exclusively insects. Although, the predominant prey consisted of lower energy taxa, some of the secondary and incidental prey, especially corixid beetles, mysids and insects, have higher energy densities that can provide bioenergetic benefits (Seghesio 2011).

Overall, diversity of prey consumed tends to be higher early in the May to December sampling period, declining as summer moves into fall. Spatial differences in diet include increased occurrence of insects and corixid beetles in the upper reach and greater occurrence of mysids in the lower reach. During closed conditions, juvenile steelhead consumed gastropods and adult chironomids more often and mysids less often.

Published literature and other documentation of juvenile steelhead diet composition reflects similar diet composition, especially in comparable estuarine settings as the Russian River Estuary. In 1933, the diet composition of yearling juvenile steelhead in Waddell Creek Lagoon consisted of over 93% *E. confervicolus* (Needham 1940). Similar foraging behaviors were observed during the mid-1980's in the Pescadero Lagoon (Martin 1995). In addition to *E. confervicolus*, Martin (1995) found *Americorophium* spp., *G. insulare*, *Chironomus* sp., and *N. mercedis* commonly consumed by rearing juvenile steelhead. Furthermore, the stomach contents of Redwood Creek Lagoon salmon and trout (Chinook, coho, cutthroat, and steelhead) were dominated by amphipods (45%) and rarely consisted of prey items with a terrestrial origin (1.2%) (Ward and Sepulveda 2014).

Studies of the Mattole River Estuary and Lagoon by Zedonis (1992) characterized the diets of juvenile steelhead after lagoon formation as exhibiting "a benthic feeding strategy" where the dominant prey were identified as the epibenthic *Corophium* amphipods and isopods and aquatic insects (dipterans, tricopteran and ephemeropteran larvae). Prey dominance varied by region in the lagoon, where *Corophium* spp. dominated in the lower lagoon and tricopteran larvae in the upper lagoon.

Conceptual Habitat Zones: Foraging Habitat and Predation Risk

Limited information exists relative to the confounding factors associated with predation risk (or avoidance) and foraging behavior of riverine or estuarine rearing salmonids. However, it is commonly inferred in aquatic ecology that individual fish (*i.e.*, salmonids) are often confronted with weighing the gross benefits of exploiting high growth potential areas and feeding opportunities with the risk of being susceptible to avian and/or other aquatic predation. Dill and Fraser (1984) showed that juvenile coho exhibit less risky feeding behavior in the presence of predators, but when they were hungry they exhibited riskier feeding behavior in the presence of predators. Other evidence from the literature supports a balance between light penetration great enough to allow successful (visual) foraging but poor enough to reduce or minimize predation risk from visual predators. Harvey and Nakamoto (2013) suggested that multiple mechanisms linked predation risk to population dynamics, and therefore argued for additional effort to identify patterns of spatiotemporal variation in predation risk.

In the Russian River Estuary, unpublished data[4] show growth rates as high or higher than what has been reported in the literature for wild juvenile steelhead (Hayes et al. 2008). The subsurface (epibenthic) foraging habitat appears to provide very good opportunity for growth. Similarly, Fuller (2011) found that acoustically tagged and untagged juvenile steelhead within the estuary

[4] Unpublished data from Sonoma County Water Agency and University of Washington, Wetland Ecosystem Team.

also showed accelerated growth. Matsubu et al. (2016 *submitted*) found that acoustically tagged juvenile steelhead in the Russian River Estuary occupied a mean depth of 1.4 m ([open inlet = 1.4 m, closed inlet = 1.3 m], SD = 0.8 m; n = 25,663 detections from 67 individuals) with no differences in depth among reaches. Although the mechanisms are unknown, deeper habitats (> 5 m) with lower DO concentrations (< 4 mg/L) were not occupied. Additionally, Fuller (2011) detected acoustically tagged juvenile steelhead most often in habitat shallower than three meters and also observed foraging behavior along the littoral zone (< 1 m). Quiñones and Mulligan (2005) conducted snorkel surveys to determine the habitat use of juvenile salmonids in the Smith River Estuary, California. They found juvenile trout and steelhead (*O. clarkii clarkii* and *O. mykiss)* most often in the littoral zone of the estuary.

The extent to which predation may be occurring and therefore impacting survival is unknown in the estuary; however, the literature suggests that in cases where food is abundant and readily accessible, individuals are unlikely to be exhibiting risky foraging behavior (Dill 1983, Dill and Fraser 1984). Whether or not foraging opportunity has a greater influence on depth preferences than predator avoidance, we must recognize how predation risk may influence habitat use and the potential consequences of that risk on the populations.

The aforementioned review suggests that there are five foraging habitats (Figures 6 and 7) with four associated predation risk depths (Table 4) that make up conceptual habitat zones (Table 4) for the estuary. Moreover, these conceptual habitat zones are based on observed habitats occupied, foraging behavior, and productivity/prey availability: Shallow/shoal littoral (< 1 m total depth), high prey availability; surface limnetic (top 1 m where total depth > 1 m), low prey availability; subsurface epibenthic (total depth 1 - 5 m), high prey availability; subsurface limnetic (from 1 – 5 m where total depth > 5 m), low prey availability; and profundal (> 5 m to bottom), low prey availability. We emphasize however that these zones are conceptual models at this point, based on literature review rather than on predation data from the Russian River Estuary itself.

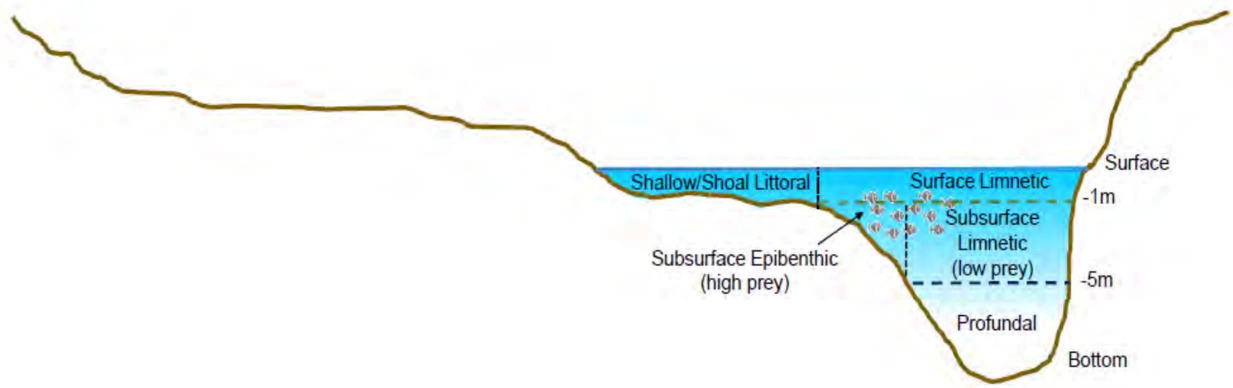

Figure 6. Foraging Zones open conditions for the Russian River Estuary, CA**.**

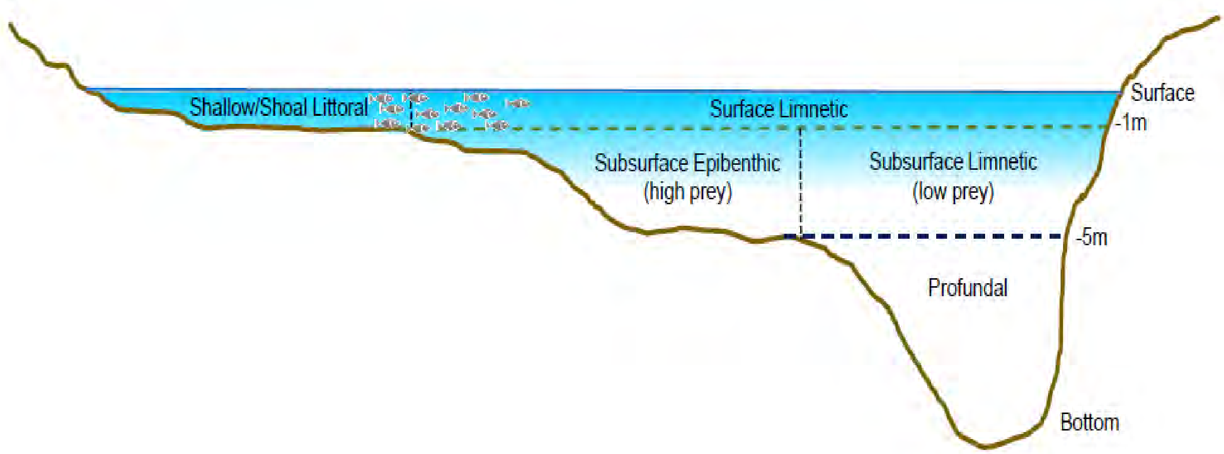

Figure 7. Foraging Zones closed/perched conditions for the Russian River Estuary, CA**.**

Table 4. Conceptual habitat zones for freshwater- and marine-acclimated residents.

Zone Depth	Total Depth	Habitat Conceptual Zone	Foraging Habitat	Predation Risk
0 – 1 m	**< 1 m**	Shallow/Shoal Littoral	Sunlight penetrates to bottom (high prey availability)	Shallow water risk: high avian predation risk, low aquatic predation risk
0 – 1 m	**> 1 m**	Surface Limnetic	Within depths of sunlight penetration (low prey availability)	Surface water risk: high avian predation risk, high aquatic predation risk
1 – 5 m	**> 1 m and ≤ 5 m**	Subsurface Epibenthic	Below surface foraging zone; within depths of sunlight penetration (high prey availability)	Subsurface open water risk: low avian predation risk, moderate aquatic predation risk
1 – 5 m	**≥ 5 m**	Subsurface Limnetic	Below surface foraging zone; within depths of sunlight penetration (low prey availability)	
5 m to bottom	**≥ 5 m**	Profundal (Stagnant)	Little or no light penetration and poor circulation (low prey availability or unsuitable due to hypoxia/anoxia and low light levels)	Unoccupied/no predation risk

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Appendix A

NOAA's Habitat Blueprint ~ Russian River Habitat Focus Area

Project: Russian River Water Quality Modeling to Inform Time-Dependent Availability of Estuarine Habitat for Salmonids

WQ Parameter and Habitat Productivity Technical Group: Dr. David Boughton (NMFS SWFSC); Joshua Fuller (NMFS WCR); Dr. Gregg Horton (SCWA); Dr. Eric Larson (CDFW Region 3); William Matsubu (University of Washington); Professor Charles ("Si") Simenstad (University of Washington).

Task: Develop a rating scheme for juvenile salmonids for evaluating output from the spatially-explicit Russian River Estuary Quantitative Conceptual Model (QCM; temperature, DO, salinity, depth). This initial criteria targets summer rearing juvenile salmonid productivity and growth associated with the identified water quality parameters.

Life Stage Categories: Two juvenile steelhead categories and their water quality tolerances have been selected to inform the water quality habitat and productivity components within the estuary during the dry season (generally spring through fall). We considered both categories as encompassing juvenile steelhead that rear in the estuary. Therefore, we did not focus on smolts[1] because they theoretically do not rear in the estuary, but instead spend a relatively brief period migrating through the estuary during a time (majority before June) when water quality conditions are generally suitable for salmonids that can tolerate full strength seawater.

1. **Freshwater-acclimated Residents:** Individuals that rear in the estuary prior to smoltification, but are limited in their capacity to osmoregulate in seawater. These individuals may increase their capacity to excrete salt ions over time and therefore become fully marine-acclimated residents.

2. **Marine-acclimated Residents:** Individuals that rear in the estuary prior to smoltification and have the capacity to osmoregulate in full strength seawater (> 28 ‰).

Water Quality Parameters: The water quality parameters used to inform habitat availability and productivity components for juvenile salmonids in the estuary include temperature (° C), Dissolved Oxygen or DO (mg/L), and salinity (‰). Suboptimal levels of these water-quality parameters involve increased energy expenditure, slower growth, and eventually mortality at higher levels, as summarized in the categorical rating scheme. They also involve complex interactions, such as higher oxygen demand at higher water temperatures or salinities, which cannot be fully captured by this categorical scheme. Therefore, we have provided a write-up that discusses our rationale for each rating scheme, the complexities of salmonid physiology and bioenergetics, and the subsequent limitations of the modeling outputs and recommendations to address them (*e.g.*, bioenergetics models, partial life history model, *etc.*).

Water depth (m) is an output of the QCM and will be used to evaluate juvenile salmonid foraging opportunities and prey availability, which tend to be structured by water depth and characteristics of the benthic substrate. Water depth considerations also include tradeoffs between foraging opportunities (location of prey availability) both vertically in the water column and horizontally across the width of the estuary in relation to avian and aquatic predation risk.

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[1] We define the term smolt as juvenile salmonids that have gone through the parr-smolt transformation (*i.e.*, smoltification) via a suite of behavioral, morphological, and physiological changes as they migrate directly to sea for the first time (McCormick 2013). This downstream seaward migration generally occurs before June in the Russian River.

1. **<u>Temperature (° C) rating scheme</u>**: Freshwater- and marine-acclimated residents

Fastest growth	Positive growth	No or Negative growth	Unsuitable
14° - 18° C	< 14° or 18° - 21° C	21°- 25° C	> 25° C

Fastest growth: Temperature allows for the most rapid growth when food availability is unlimited.

Positive growth: Temperature allows for positive growth (weight gain) under most levels of DO, salinity, and food availability.

No or negative growth: Usually produces high metabolic demand and negative growth (weight loss) even when food is available.

Unsuitable: Highly stressful and generally cannot sustain metabolic demand for more than a day without death or injury.

2. **<u>Dissolved Oxygen (mg/L) rating scheme</u>**: Freshwater- and marine-acclimated residents

Minimal or no impairment	Moderate impairment	Severe impairment	Unsuitable
> 6 mg/L	4 – 6 mg/L	3 – 4 mg/L	< 3 mg/L

Minimal or no impairment: Dissolved oxygen (DO) has little to no effect on metabolism and growth potential.

Moderate impairment: DO has minor impairment on growth potential, but positive growth (weight gain) is achievable depending on temperature, salinity, and food availability.

Severe impairment: DO forces no or negative growth potential (weight loss) at most temperatures and salinities.

Unsuitable: DO is severely limiting and cannot sustain metabolic demand under any circumstances, eventually causing death.

3. **<u>Salinity (‰) rating scheme</u>**: Freshwater- and marine-acclimated residents

Hypotonic	Isotonic	Hypertonic	Marine
< 10 ‰	10 - 15 ‰	15 - 28 ‰	> 28 ‰

Hypotonic: Fresh water to moderately saline conditions, with low energy cost of ion regulation. Allows high growth potential for both freshwater- and marine-acclimated residents.

Isotonic: Negligible energy cost of ion regulation for both freshwater-acclimated and marine-acclimated residents. Allows for most efficient transfer of food energy to growth.

Hypertonic: Highly saline conditions, but less saline than seawater. For freshwater-acclimated residents, stimulates physiological adaptation to salty water, incurring a high energetic cost in the process. After several weeks these juvenile steelhead become marine-acclimated with a low energy cost of ion regulation and positive to high growth potential.

Marine: Salinity similar to that of the sea. For freshwater-acclimated residents, unsuitable conditions probably causing death with sufficiently long exposure. For marine-acclimated residents, moderately energy demanding that somewhat impairs growth potential.

4. **<u>Conceptual Habitat Zones</u>**: Freshwater- and marine-acclimated residents

Zone Depth	Total Depth	Habitat Conceptual Zone	Foraging Habitat	Predation Risk
0 – 1 m	**< 1 m**	Shallow/Shoal Littoral	Sunlight penetrates to bottom (high prey availability)	Shallow water risk: high avian predation risk, low aquatic predation risk
0 – 1 m	**> 1 m**	Surface Limnetic	Within depths of sunlight penetration (low prey availability)	Surface water risk: high avian predation risk, high aquatic predation risk
1 – 5 m	**> 1 m and ≤ 5 m**	Subsurface Epibenthic	Below surface foraging zone; within depths of sunlight penetration (high prey availability)	Subsurface open water risk: low avian predation risk, moderate aquatic predation risk
1 – 5 m	**≥ 5 m**	Subsurface Limnetic	Below surface foraging zone; within depths of sunlight penetration (low prey availability)	
5 m to bottom	**≥ 5 m**	Profundal (Stagnant)	Little or no light penetration and poor circulation (low prey availability or unsuitable due to hypoxia/anoxia and low light levels)	Unoccupied/no predation risk

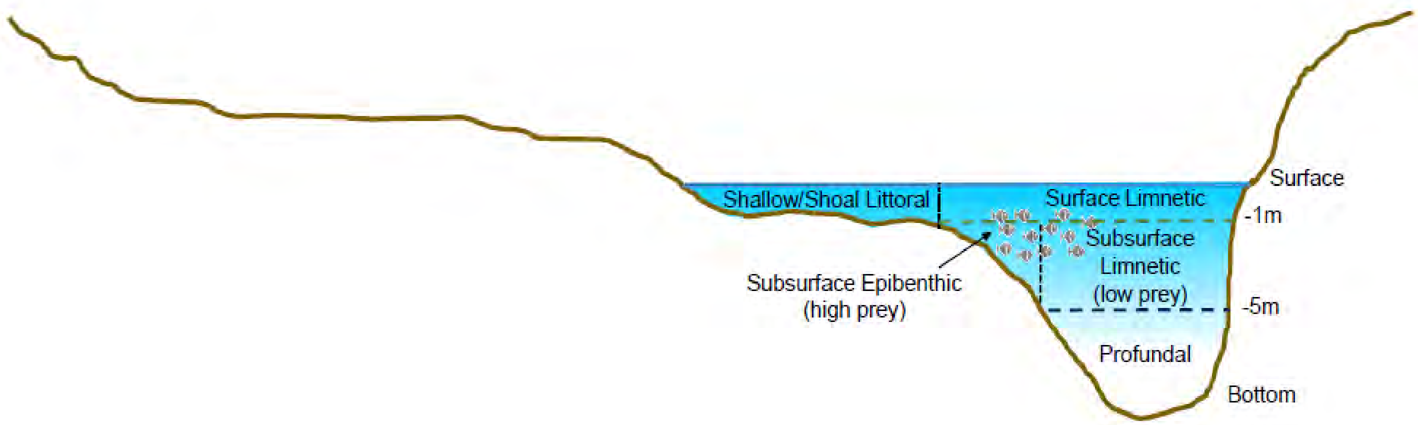

Figure 1. Foraging Zones open conditions for the Russian River Estuary, CA.

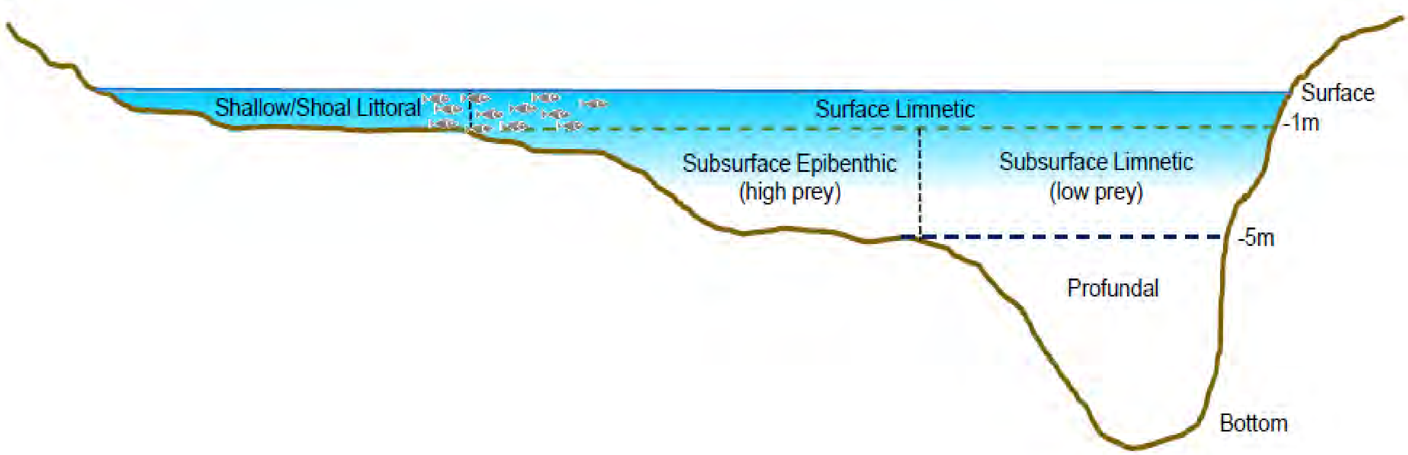

Figure 2. Foraging Zones closed/perched conditions for the Russian River Estuary, CA.

From: Staples, Rose
Sent: Monday, March 13, 2017 3:49 PM
Cc: Deason, Jesse; Le, Bao; Johnson, Laura; Staples, Rose
Subject: FW: La Grange Reintroduction Goals Subcommittee Jan 26 2017 Draft Meeting Notes Available for Review

La Grange Licensing Participants,

The following email was forwarded to members of the La Grange Reintroduction Goals Subcommittee today regarding the availability of the draft notes for the January 26, 2017 subcommittee meeting.

Rose Staples, CAP-OM, MOS
D 207-239-3857

hdrinc.com/follow-us

From: Staples, Rose
Sent: Monday, March 13, 2017 6:19 PM
Cc: Deason, Jesse <jesse.deason@hdrinc.com>; 'Le, Bao' <Bao.Le@hdrinc.com>; Johnson, Laura <Laura.Johnson@hdrinc.com>; Staples, Rose (Rose.Staples@hdrinc.com) <Rose.Staples@hdrinc.com>
Subject: La Grange Reintroduction Goals Subcommittee Jan 26 2017 Draft Meeting Notes Available for Review

Reintroduction Goals Subcommittee,

DRAFT NOTES from the January 26, 2017 Reintroduction Goals Subcommittee meeting have been uploaded to the licensing website www.lagrange-licensing.com in the DOCUMENTS section and also as an attachment to the January 26, 2017 date on the website calendar.

Please provide any comments on the meeting notes by Thursday, April 13, 2017, to rose.staples@hdrinc.com. The Districts will address any comments received and then post a final version of the meeting notes to the licensing website.

Rose Staples, CAP-OM, MOS
Senior Administrative Assistant

HDR
970 Baxter Boulevard Suite 301
Portland ME 04103
D 207-239-3857
rose.staples@hdrinc.com

hdrinc.com/follow-us

From: Staples, Rose
Sent: Monday, March 13, 2017 4:00 PM
Cc: Deason, Jesse; Le, Bao; Johnson, Laura; Staples, Rose
Subject: FW: La Grange Water Temperature Subcommittee Jan 26 2017 Draft Notes Available for Review

La Grange Licensing Participants,

The following email was sent today to the members of the La Grange Water Temperature Subcommittee regarding the availability of the draft notes for the January 26, 2017 meeting.

Rose Staples, CAP-OM, MOS
D 207-239-3857

hdrinc.com/follow-us

From: Staples, Rose
Sent: Monday, March 13, 2017 6:52 PM
Cc: Deason, Jesse <jesse.deason@hdrinc.com>; 'Le, Bao' <Bao.Le@hdrinc.com>; Johnson, Laura <Laura.Johnson@hdrinc.com>; Staples, Rose (Rose.Staples@hdrinc.com) <Rose.Staples@hdrinc.com>
Subject: La Grange Water Temperature Subcommittee Jan 26 2017 Draft Notes Available for Review

Water Temperature Subcommittee,

DRAFT NOTES from the January 26, 2017 Water Temperature Subcommittee meeting have been uploaded to the licensing website www.lagrange-licensing.com in the DOCUMENTS section and also as an attachment to the January 26, 2017 date on the website calendar.

Please provide any comments on the meeting notes by Thursday, April 13, 2017, to rose.staples@hdrinc.com. The Districts will address any comments received and then post a final version of the meeting notes to the licensing website.

Rose Staples, CAP-OM, MOS
Senior Administrative Assistant

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Meeting Notes

Project:	La Grange Hydroelectric Project – FERC No. 14581
Subject:	Field Visit with NMFS and Consultant Team
Date:	Tuesday, March 14, 2017
Location:	New Don Pedro and La Grange Project Facilities (see notes for specific destinations)
Attendees:	John Ferguson (Anchor QEA) Jesse Waldrip (Kleinschmidt) Mike Garello (HDR) Bill Paris (MID) Anna Brathwaite (MID) Steve Boyd (TID) Larry Swenson (NMFS retired) Bryan Nordland (NMFS retired) Steve Edmondson (NMFS) Jonathan Ambrose (NMFS) William Foster (NMFS) Jean Castillo (NMFS)

Overview

Representatives from the TID and MID relicensing team met with representatives from the National Marine Fisheries Service (NMFS) for the purpose of providing a guided site review of the Don Pedro Project and La Grange Project facilities.

Summary of Meeting Notes (all times are approximate)

1. 9:00 AM - Don Pedro Recreation Area Headquarters, 10201 Bonds Flat Road, La Grange, CA 95329
    a. Meeting participants gathered in the parking lot of the Don Pedro Recreation Area Headquarters, provided introductions, discussed individual roles, and presented objectives for the day.
    b. Steve Boyd provided an overview of suggested site visits and discussed travel logistics.
    c. All participants consolidated into fewer cars and proceeded to the first stop near the east abutment of Don Pedro Dam.
2. 9:20 AM - Unimproved access road to the Don Pedro Project off of Riley Ridge Road on the east abutment of Don Pedro Dam
    a. Participants parked their vehicles on Riley Ridge Road and walked down an unimproved access road approximately 500 to 700 feet to an overlook of the Don Pedro Project Powerhouse.
    b. Steve Boyd presented an overview of the original Don Pedro Dam, the Don Pedro Project Powerhouse power generation strategy, operational theory, and summary of operational flows. Key elements of major milestones, dam construction, and flood related reservoir operations were also discussed.
    c. La Grange approximately 2 miles downstream.
    d. Flood operations target flows of 9,000 cfs or less.
    e. All participants walked back up the access road, crossed Bonds Flat Road, and assembled at the upstream face of Don Pedro Dam near the power intake tunnel shaft and gate housing.
3. 9:45 AM - Don Pedro Dam

a. Steve Boyd presented an overview of the facilities that accommodate flow release and intake to the hydropower generation facility.
b. Participants observed the reservoir forebay immediately upstream of the dam and discussed opportunities for implementing a floating surface collector (FSC). When asked about reservoir fluctuation, Mike Garello responded that reservoir stage fluctuation could range up to approximately 200 feet. NMFS consultants agreed at the limited level of feasibility and technical difficulty associated with implementing an FSC in an environment with fluctuations of that magnitude.
c. J. Ferguson asked what fish species are to be passed and if lamprey or non-anadromous fish would be targeted for passage.
d. J. Ferguson asked if a reservoir transit study had been conducted or if one was planned and if the results would be available.
e. Participants discussed the overall distance, hydraulic/shoreline complexity, and temperature issues influencing reservoir transit of outmigrating fish to the Don Pedro Dam. TID and NMFS consultants discussed how existing conditions could impede fish transit through the reservoir and that there is a high level of uncertainty that fish would be able to cue on outflows from the dam and navigate successfully to the forebay.
f. J. Waldrip requested a schematic of the Don Pedro Dam, to include the depth, size, and location of various water pathways through the dam.
g. At a request by NMFS to observe the La Grange Powerhouse, attendees returned to their vehicles and a traveled downstream to the MID Diversion at La Grange Dam.

4. 10:15 AM - MID Diversion at La Grange Forebay
   a. MID representatives provided a brief overview of MID operations.
   b. Discussed purpose of La Grange Dam as diversion dam.
   c. Discussed minor water releases to plunge pool for the purpose of maintaining water quality.
   d. Observed the TID, La Grange Powerhouse from right bank.
   e. Discussed purpose of water release from TID's bifurcation facility on left bank above the La Grange Powerhouse.
   f. Attendees drove up to the La Grange Powerhouse
5. 11:00 AM - La Grange Hydroelectric Facility
   a. Attendees gathered at La Grange Powerhouse. Steve Boyd presented overview of operations.
   b. Attendees broke up into smaller groups and discussed a number of topics.
   c. NMFS consultants speculated/brainstormed methods to integrate a trap and haul facility at this location. There was some discussion related to the difficulty of stopping fish from bypassing this site and moving into the plunge pool. Without a channel-spanning barrier, there may be a passage delay at higher flows. Fish would need to fall back, seek, and discover the trap and haul facility inlet. One idea discussed was to focus on passage at lower flows and not incorporate a guidance barrier. The proportion of time that higher flows occur may not have a significant influence on passage efficiency.

d. There was discussion on whether or not fall-run Chinook should be a target species for passage. NMFS suggested that they would require the same facility and therefore they could be passed at no additional cost. M. Garello indicated that although the facility configuration and methods may be the same, their migration timing is different and passage of fall run would extend the operational time period which would result in higher annual O&M (i.e. there is a cost increase for considering fall-run).
e. S. Edmundson indicated that the decision to provide passage for fall-run Chinook was up to CDFW since they are not listed as a threatened or endangered species and are not a candidate for recovery under the NMFS Recovery Plan.
f. At one point NMFS consultants suggested that passing fall-run didn't make sense given that fall-run (in general) would likely spawn in the habitat available to them in the lower river.
g. The NMFS and TID consultant teams agreed that this site is relatively difficult to access and modification of the site may be required to accommodate a trap and transport facility.

6. 12:10 PM - North Old La Grange Road Bridge crossing of the lower Tuolumne River
   a. Steve Boyd introduced this location as the first area downstream of La Grange Dam, outside of the confined section of river valley, where a trap and transport facility could be considered. There is an accessible parcel with sloping bank on river right owned by CDFW just downstream of the bridge.
   b. NMFS Consultants discussed the difficulty of adding a guidance or barrier structure here. Any type of structure would impound water, potentially impact water surface elevations and widen the floodplain. Given the adjacency to privately owned land and structures, as well as the potential for altering the site hydraulics, it was discussed that this location may not be a suitable option for a new trap and transport facility.
7. 1:45 PM – Old Wards Ferry Bridge crossing of the Upper Tuolumne River
   a. Attendees traveled by car and followed one of the two primary routes to the Old Wards Ferry Bridge via Old Priest Grade and Buck Meadows. The Old Wards Ferry Bridge is the most upstream location accessible by car within the Don Pedro Project boundary and represents a potential release point for upstream migrating adults or a potential collection point for downstream migrating juveniles should fish passage be implemented.
   b. The 42-mile trip took over an hour and descended into the Tuolumne River canyon on a poorly maintained paved road with switchbacks and sections with only one lane.
   c. Upon arrival, attendees gathered on the bridge and discussed the initial reactions generated on the drive to this location. There was general concurrence that the road likely does not meet minimum safety requirements necessary to transport fish via large transfer truck during all seasons of the year. In the summer there is heavy recreational traffic. During winter there is snow and ice. Road improvements may be required to accommodate reliable access during each season of the fish migration period.

d. Boat accessibility could occur via Moccasin Point, but only when the reservoir water surface impounded water up to Wards Ferry Bridge. Therefore, boat access may also not a reliable means of transportation to this location. Boat access was discussed as a possibility to the head of reservoir, which could range from approximately RM 70 to RM 81.
e. NMFS Consultants concurred that this location and the distance that the head of reservoir may travel is substantial making downstream collection of juvenile fish in this area “almost infeasible.”
f. Additional ideas brainstormed during the site visit incorporated implementation of an “in-river” collection facility. Although details were not discussed at the time, there was mention that a new road may need to be constructed up to RM 81 to provide reliable access. Potential conflict with whitewater rafters that take out at Wards Ferry Bridge was discussed. M. Garello noted to the group that all project activities would need to remain in the current project boundary. Additional infrastructure, access roads, or impounded water would not be allowed upstream of RM 81.
g. There was discussion of debris composition and management. Steve Boyd described typical operations relative to debris capture, removal, and disposal. Heavy debris movement is experienced during seasonal freshets. Floating debris transported by river flows is generally composed of small and medium woody material. Debris was identified as an item that would also make fish collection difficult without active management and removal from a potential fish passage facility.

8. 3:00 PM - Jacksonville Bridge
   a. Attendees traveled by car to the north via Wards Ferry and Algerine Roads and traveled to the Jackson Road Bridge crossing over Don Pedro Reservoir (RM 72).
   b. The 14-mile trip took approximately 30 minutes and ascended the Tuolumne River canyon on a poorly maintained paved road with switchbacks and sections with only one lane.
   c. It was discussed that the head of the reservoir could be seen as far downstream as this crossing location during periods with very low reservoir storage.
   d. Access to the water appeared to be an issue as there were no roads that led down to a location where a facility could be constructed.
   e. Moccasin Point Recreation Area was identified as the closest point of water access if a boat were to be used for transportation to the head of reservoir.
   f. At the end of the day, NMFS consultants summarized some of the main take-a-way themes from the day’s site visit.
      i. The reservoir is large, complex, contains predators, and may not accommodate adequate reservoir transit efficiencies. Reservoir transit should be tested/studied. An FSC at the dam may not be feasible.
      ii. The head of reservoir is likely a better target for collection of downstream migrating fish. But, there are access, debris, recreation, electricity, and

reservoir fluctuation conflicts/concerns that create feasibility issues at the head of reservoir as well.

iii. Something like a floating surface collector could be deployed and operated near Moccasin Point and Jackson Road Bridge, but it is difficult to say if it would be effective. Pilot testing or small-scaled phased approach may be needed to determine if collecting downstream migrants at this location is feasible.

9. 3:35 PM - Adjourn

From: Jean Castillo - NOAA Federal [mailto:jean.castillo@noaa.gov]
Sent: Friday, March 17, 2017 2:11 PM
To: Staples, Rose <Rose.Staples@hdrinc.com>
Subject: Re: Tech Memos

Figured out, thanks.

Jean M. Castillo, MSCE, P.E.
Hydraulic/Fish Passage Engineer

NOAA Fisheries West Coast Region
U.S. Department of Commerce
650 Capitol Mall, Suite 5-100
Sacramento, California 95814-4700
Office: 916-930-3613
jean.castillo@noaa.gov

On Thu, Mar 16, 2017 at 7:58 AM, Staples, Rose <Rose.Staples@hdrinc.com> wrote:

> Let me check and get back to you on that.
>
>
> Rose Staples, CAP-OM, MOS
>
> D 207-239-3857
>
> ONEHDRED 1917-2017
>
> hdrinc.com/follow-us
>
>
> **From:** Jean Castillo - NOAA Federal [mailto:jean.castillo@noaa.gov]
> **Sent:** Wednesday, March 15, 2017 6:13 PM
> **To:** Le, Bao <ChiBao.Le@hdrinc.com>; Staples, Rose <Rose.Staples@hdrinc.com>
> **Subject:** Tech Memos

Hello,

Do either the La Grange or Don Pedro projects have a Technical Memo #7?

Thanks,

Jean

Jean M. Castillo, MSCE, P.E.
Hydraulic/Fish Passage Engineer

NOAA Fisheries West Coast Region
U.S. Department of Commerce
650 Capitol Mall, Suite 5-100
Sacramento, California 95814-4700
Office: 916-930-3613

jean.castillo@noaa.gov

From: Garello, Michael
Sent: Thursday, March 23, 2017 9:30 AM
To: Jean Castillo - NOAA Federal
Cc: Le, Bao; Staples, Rose; Devine, John
Subject: RE: La Grange - Reservoir Transit Study Plan filed with FERC Today

Hi Jean,

My apologies for taking so long to get back to you. I was in an all-day meeting yesterday on another high-dam project located up here in WA yesterday.

It's probably easiest to respond to each of your points separately. Please see my responses in **red** below.

Let me know if you have further questions.

Thank you,

Mike

Michael C. Garello, PE (CA, WA)
D 253.432.5031 **M** 253.304.7315

ONEHDRED
1917-2017

hdrinc.com/follow-us

From: Jean Castillo - NOAA Federal [mailto:jean.castillo@noaa.gov]
Sent: Tuesday, March 21, 2017 9:40 AM
To: Garello, Michael
Cc: Le, Bao; Staples, Rose; Devine, John
Subject: Fwd: La Grange - Reservoir Transit Study Plan filed with FERC Today

Hi Mike,

I was wondering, in Technical Memorandum #1 on Page 1-1, it states the TM1 is the first of three interim work products developed for the Fish Passage Alternative Facilities Assessment.

What are the other two work products for fish passage?
The three products were intended to be as follows:

TM 1: Primary objective is to confirm understanding of basic site and project information and request agencies' input and guidance on the biological and technical design criteria needed to proceed with the fish passage engineering alternatives study.
TM 2: Primary objective is to confirm the selection of potential fish passage alternative concepts based on information resulting from TM No. 1 and identify alternatives that would be developed further.
TM 3: Primary objective is to provide a draft report for review and comment on the alternatives assessment with alternative descriptions and draft fish passage facility configurations and cost estimates.

Have they been distributed? If yes can I please have a copy?
Only TM No. 1 has been distributed. TM No. 1 identified key data gaps and the information and input needed from resource agencies on biological design basis and assumptions to inform the study's next steps (TM 2, etc.). It was issued in September 2015 for review and requested the information needed to move forward with the study process; however, resource agencies (including NMFS) have not provided any of the requested information despite repeated requests for input. To try to make progress, we shifted our focus on the Reintroduction Assessment Framework as a means to develop some of the needed information gaps while also doing a more comprehensive evaluation of reintroduction since fish passage to the upper Tuolumne River is essentially a decision to "reintroduce" species.

Are there any future workshops that are scheduled for fish passage?
There is no future fish passage workshop currently proposed. However, there is some discussion about having a Reintroduction Assessment Framework Plenary Group workshop/meeting this spring.

What is the status of the fish passage study?
As noted in the La Grange Updated Study Report, the Districts must complete this study as part of the licensing process. Given that the Districts have not received input from the resource agencies, the Districts have notified FERC that regardless of the lack of resource agencies' input to TM No. 1, the Districts will make appropriate assumptions related to the information gaps in order to complete the study and include it in the La Grange Final License Application (to be filed in September).

I am just trying to catch up on where the fish passage study is at. We've been having meetings on temperature and reintroduction goal statement I haven't spent much time on the passage.

Thanks for any information you can send my way.

Respectfully,
Jean

Jean M. Castillo, MSCE, P.E.
Hydraulic/Fish Passage Engineer

NOAA Fisheries West Coast Region
U.S. Department of Commerce
650 Capitol Mall, Suite 5-100
Sacramento, California 95814-4700
Office: 916-930-3613
jean.castillo@noaa.gov

On Fri, Sep 16, 2016 at 1:38 PM, Staples, Rose <Rose.Staples@hdrinc.com> wrote:
The Districts filed with FERC today for the La Grange Project P-14581 the *Reservoir Transit Study Plan, Plan Amendment, and Response to Comments.* A copy of this document can be found on the licensing website (www.lagrange-licensing.com) under the DOCUMENTS tab—or on FERC's E-Library at www.FERC.gov.

Rose Staples, CAP-OM, MOS
Executive Assistant

HDR
970 Baxter Boulevard Suite 301
Portland ME 04103
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rose.staples@hdrinc.com

hdrinc.com/follow-us

From: Jason Guignard <jasonguignard@fishbio.com>
Subject: Re: La Grange Weir Data
Date: March 28, 2017 at 5:19:43 PM PDT
To: "Murphey, Gretchen@Wildlife" <Gretchen.Murphey@wildlife.ca.gov>

Gretchen,
That is the way that the video software wrote files. For each camera, hourly files were written into the daily folder. There will sometimes be 2 folders for a day, representing when data was downloaded and hard drives swapped.
I initially had our backup organized better, but unfortunately that drive went bad so I had to go back to the original drives.
Sorry the data wasn't organized better, but it was a battle to get all files onto the external drive.

Jason Guignard
FISHBIO

Sent from my iPhone

On Mar 28, 2017, at 4:27 PM, Murphey, Gretchen@Wildlife <Gretchen.Murphey@wildlife.ca.gov> wrote:

> Jason,
> Thanks,I got the hard drive, but am confused about how you have the files organized. Is there a reason why a day's data is in a particular folder?
>
> ---
>
> **From:** Jason Guignard [mailto:jasonguignard@fishbio.com]
> **Sent:** Monday, March 27, 2017 9:00 AM

To: Murphey, Gretchen@Wildlife
Subject: Re: La Grange Weir Data

Hi Gretchen,

Did you get the hard drive with La Grange video files on Friday? Let me know if you have any questions about the file structure.

Jason Guignard
Fisheries Biologist

FISHBIO
jasonguignard@fishbio.com
O: (209) 847-6300
C: (209) 840-9019
www.fishbio.com

On Mar 23, 2017, at 1:12 PM, Murphey, Gretchen@Wildlife <Gretchen.Murphey@wildlife.ca.gov> wrote:

Yes, someone will be around after about 8AM.

From: Jason Guignard [mailto:jasonguignard@fishbio.com]
Sent: Thursday, March 23, 2017 1:07 PM
To: Murphey, Gretchen@Wildlife; Scott Stocker
Cc: Tsao, Steve@Wildlife; Johnson, Laura
Subject: Re: La Grange Weir Data

Gretchen,
I will have Scott deliver it to you office. Will someone be around tomorrow morning if he drives it up there?

Jason Guignard
Fisheries Biologist

FISHBIO
jasonguignard@fishbio.com
O: (209) 847-6300
C: (209) 840-9019
www.fishbio.com

On Mar 23, 2017, at 9:20 AM, Murphey, Gretchen@Wildlife <Gretchen.Murphey@wildlife.ca.gov> wrote:

I'm sorry Jason I completely forgot about picking up data.
At this point I think shipping it here would be best.
Thanks,
Gretchen

From: Jason Guignard [mailto:jasonguignard@fishbio.com]
Sent: Thursday, March 23, 2017 9:15 AM
To: Murphey, Gretchen@Wildlife; Tsao, Steve@Wildlife
Cc: Johnson, Laura
Subject: Re: La Grange Weir Data

Hi Gretchen,

I wanted to follow up again regarding the hard drive with video files from the 2015/16 La Grange weir monitoring season. Let me know if you have someone that can stop by the office and pick it up. If you would prefer I can ship it to you, and we could discuss how the files are organized after you receive it.

Thanks,

Jason Guignard
Fisheries Biologist

FISHBIO
jasonguignard@fishbio.com
O: (209) 847-6300
C: (209) 840-9019
www.fishbio.com

> On Mar 13, 2017, at 9:16 AM, Jason Guignard <jasonguignard@fishbio.com> wrote:
>
> Hi Gretchen,
>
> We have the video files from 2015/2016 La Grange weir monitoring copied to an

external hard drive now. Let me know if you have someone available to stop by the office to pick it up. There are 12 TBs of video files, so it would probably be helpful for me to give them a quick run through of how files are organized.

Jason Guignard
Fisheries Biologist

FISHBIO
jasonguignard@fishbio.com
O: (209) 847-6300
C: (209) 840-9019
www.fishbio.com

On Feb 22, 2017, at 1:11 PM, Jason Guignard <jasonguignard@fishbio.com> wrote:

Gretchen,
We will work on getting this data transferred to a hard drive so we can send it to you. I think file size for the 2015-16 monitoring period is ~10 TB, so will take a while to get it copied.

Jason Guignard
Fisheries Biologist

FISHBIO
jasonguignard@fishbio.com
O: (209) 847-6300
C: (209) 840-9019
www.fishbio.com

On Feb 16, 2017, at 2:16 PM, Murphey, Gretchen@Wildlife <Gretchen.Murphey@wildlife.ca.gov> wrote:

Jason,
In answer to your question about the weir data: We would like the 2015-16 data now, please.

Gretchen Murphey

Environmental Scientist, Tuolumne River
California Department of Fish and Wlidlife
La Grange Field Office
Office: (209) 853-

2533 ex
3#
Cell:
(209)
617-
1903

Every
Californian
should
conserve
water.
Find
out
how at:

<image001.jpg>
SaveOurWater.com · Drought.CA.gov

From: Jason Guignard [mailto:jasonguignard@fishbio.com]
Sent: Thursday, March 30, 2017 9:34 AM
To: Johnson, Laura <Laura.Johnson@hdrinc.com>
Cc: Le, Bao <ChiBao.Le@hdrinc.com>
Subject: Re: La Grange Weir Data

- Did the drive contain all of the data through fall 2016 when the weir was removed? The drive contained video files from Year 1 monitoring Sept 2015-April 2016. We have not yet provided files from Year 2 monitoring period.
- Did you finish your review and QC of the data prior to providing it to CDFW, or does the drive contain raw data? The drive contains the raw video files. We have completed full QC for the Year 1 period, but copy of data sheets have not yet been requested or provided.
- I think that you or someone on your team hand-delivered the drive to CDFW. Is that the case? If so, can you provide the name of the person who delivered the drive, the date of delivery, and the name of the person who received the drive at CDFW? The drive was hand delivered to the La Grange CDFW office by Scott Stocker (FISHBIO) on 3/24. Did not get a name of who received it, but Gretchen Murphey has confirmed that she received it on March 28 via email (I will forward email exchange)
- Alternatively, if the drive was shipped to CDFW, can you provide a shipping receipt?

Jason Guignard
Fisheries Biologist

FISHBIO
jasonguignard@fishbio.com
O: (209) 847-6300
C: (209) 840-9019
www.fishbio.com

On Mar 29, 2017, at 11:42 AM, Johnson, Laura <Laura.Johnson@hdrinc.com> wrote:

Hi Jason,

We wanted to follow up on the completion of this action item with a few questions. Can you please answer the following:

- Did the drive contain all of the data through fall 2016 when the weir was removed?
- Did you finish your review and QC of the data prior to providing it to CDFW, or does the drive contain raw data?
- I think that you or someone on your team hand-delivered the drive to CDFW. Is that the case? If so, can you provide the name of the person who delivered the drive, the date of delivery, and the name of the person who received the drive at CDFW?
- Alternatively, if the drive was shipped to CDFW, can you provide a shipping receipt?

Thanks for providing the above information so we can close this out in our records.

Laura Johnson
D 206-826-4709 **M** 206-295-2405

hdrinc.com/follow-us

From: Jason Guignard [mailto:jasonguignard@fishbio.com]
Sent: Wednesday, March 29, 2017 8:42 AM
To: Johnson, Laura <Laura.Johnson@hdrinc.com>
Subject: Fwd: La Grange Weir Data

Hi Laura,

I just wanted to follow up on this and confirm that we delivered the 2015/2016 La Grange weir video files to CDFW staff (Gretchen Murphey)

Thanks,

Jason Guignard
Fisheries Biologist

FISHBIO
jasonguignard@fishbio.com
O: (209) 847-6300
C: (209) 840-9019
www.fishbio.com

Begin forwarded message:

From: Jason Guignard <jasonguignard@fishbio.com>
Subject: Re: La Grange Weir Data
Date: March 27, 2017 at 8:59:46 AM PDT
To: "Murphey, Gretchen@Wildlife" <Gretchen.Murphey@wildlife.ca.gov>

Hi Gretchen,

Did you get the hard drive with La Grange video files on Friday?
Let me know if you have any questions about the file structure.

Jason Guignard
Fisheries Biologist

FISHBIO
jasonguignard@fishbio.com

O: (209) 847-6300
C: (209) 840-9019
www.fishbio.com

On Mar 23, 2017, at 1:12 PM, Murphey, Gretchen@Wildlife <Gretchen.Murphey@wildlife.ca.gov> wrote:

Yes, someone will be around after about 8AM.

From: Jason Guignard [mailto:jasonguignard@fishbio.com]
Sent: Thursday, March 23, 2017 1:07 PM
To: Murphey, Gretchen@Wildlife; Scott Stocker
Cc: Tsao, Steve@Wildlife; Johnson, Laura
Subject: Re: La Grange Weir Data

Gretchen,
I will have Scott deliver it to you office. Will someone be around tomorrow morning if he drives it up there?

Jason Guignard
Fisheries Biologist

FISHBIO
jasonguignard@fishbio.com
O: (209) 847-6300
C: (209) 840-9019
www.fishbio.com

On Mar 23, 2017, at 9:20 AM, Murphey, Gretchen@Wildlife <Gretchen.Murphey@wildlife.ca.gov> wrote:

I'm sorry Jason I completely forgot about picking up data.
At this point I think shipping it here would be best.
Thanks,
Gretchen

From: Jason Guignard [mailto:jasonguignard@fishbio.com]
Sent: Thursday, March 23, 2017 9:15 AM
To: Murphey, Gretchen@Wildlife; Tsao,

Steve@Wildlife
Cc: Johnson, Laura
Subject: Re: La Grange Weir Data

Hi Gretchen,

I wanted to follow up again regarding the hard drive with video files from the 2015/16 La Grange weir monitoring season. Let me know if you have someone that can stop by the office and pick it up. If you would prefer I can ship it to you, and we could discuss how the files are organized after you receive it.

Thanks,

Jason Guignard
Fisheries Biologist

FISHBIO
jasonguignard@fishbio.com
O: (209) 847-6300
C: (209) 840-9019
www.fishbio.com

> On Mar 13, 2017, at 9:16 AM, Jason Guignard <jasonguignard@fishbio.com> wrote:
>
> Hi Gretchen,
>
> We have the video files from 2015/2016 La Grange weir monitoring copied to an external hard drive now. Let me know if you have someone available to stop by the office to pick it up. There are 12 TBs of video files, so it would probably be helpful for me to give them a quick run through of how files are organized.
>
> Jason Guignard
> Fisheries Biologist
>
> ***FISHBIO***

jasonguignard@fishbio.com
O: (209) 847-6300
C: (209) 840-9019
www.fishbio.com

On Feb 22, 2017, at 1:11 PM, Jason Guignard <jasonguignard@fishbio.com> wrote:

Gretchen,
We will work on getting this data transferred to a hard drive so we can send it to you. I think file size for the 2015-16 monitoring period is ~10 TB, so will take a while to get it copied.

Jason Guignard
Fisheries Biologist

FISHBIO
jasonguignard@fishbio.com
O: (209) 847-6300
C: (209) 840-9019
www.fishbio.com

On Feb 16, 2017, at 2:16 PM, Murphey, Gretchen@Wildlife <Gretchen.Murphey@wildlife.ca.gov> wrote:

Jason,
In

answer to your question about the weir data: We would like the 2015-16 data now, please.

Gretchen Murphey

Environmental Scientist, Tuolumne River
California Department of Fish and Wlidlife
La Grange Field Office
Office: (209) 853-2533 ex 3#
Cell: (209) 617-1903

Every Californian should conserve

water.
Find
out
how at:

<image001.jpg>
SaveOurWater.com · Drought.CA.gov

From: Le, Bao
Sent: Thursday, April 13, 2017 11:02 AM
To: Jean Castillo - NOAA Federal
Cc: Staples, Rose; Garello, Michael; Devine, John; Borovansky, Jenna; Deason, Jesse; Johnson, Laura
Subject: RE: La Grange and Don Pedro - Relicensing

Hi Jean.

I apologize for the delayed response; this email got buried in my inbox.

I would refer you to Mike Garello's email response on 3/23 regarding status of the study and approach moving forward. This approach was also summarized in the USR. As a side note, we're trying to finalize having a Plenary Group Meeting for the Reintroduction Assessment Framework in May and hope to be able to send out a Save the Date sometime next week.

Thanks, Bao

From: Jean Castillo - NOAA Federal [mailto:jean.castillo@noaa.gov]
Sent: Tuesday, April 04, 2017 2:51 PM
To: Le, Bao
Cc: Staples, Rose; Garello, Michael
Subject: La Grange and Don Pedro - Relicensing

Hello,

It is my understanding in reading TM #1, the Fish Passage Facilities Alternatives Assessment was to occur in two phases.

Phase 1 (conducted in 2015) will involve collaborative information gathering and evaluation of facility siting, sizing, general biological and engineering design parameters, and operational considerations.

Phase 2 (conducted in 2016) will involve the development of preliminary functional layouts and site plans, estimation of preliminary capital and O&M costs, and identification of any additional significant information needs for select passage alternatives.

To facilitate a collaborative process, the Districts will produce two TMs during Phase 1, each summarizing key results to date. Both TMs will be provided to LPs for review and comment, with the goal of soliciting feedback on the overall approach and findings and reaching a

consensus prior to initiating next steps in the study.

As I am new to NMFS and this project I missed many of the early meetings and workshops.

Can you tell me exactly where the Districts are in this process?

Thank you,

Jean

Jean M. Castillo, **MSCE, P.E.**
Hydraulic/Fish Passage Engineer

NOAA Fisheries West Coast Region
U.S. Department of Commerce
650 Capitol Mall, Suite 5-100
Sacramento, California 95814-4700
Office: 916-930-3613
jean.castillo@noaa.gov

From:	Jean Castillo - NOAA Federal
To:	Garello, Michael
Subject:	Tuolumne River Bed Profile
Date:	Monday, April 17, 2017 10:58:24 AM
Attachments:	TR River Mile 77 and up.pdf TR River Miles 0 to 81.pdf

Hi Mike,

Might you have the river bed profile from about River Mile 70 to River Mile 82 that you could send to me?

The attached maps show river miles I am asking about.

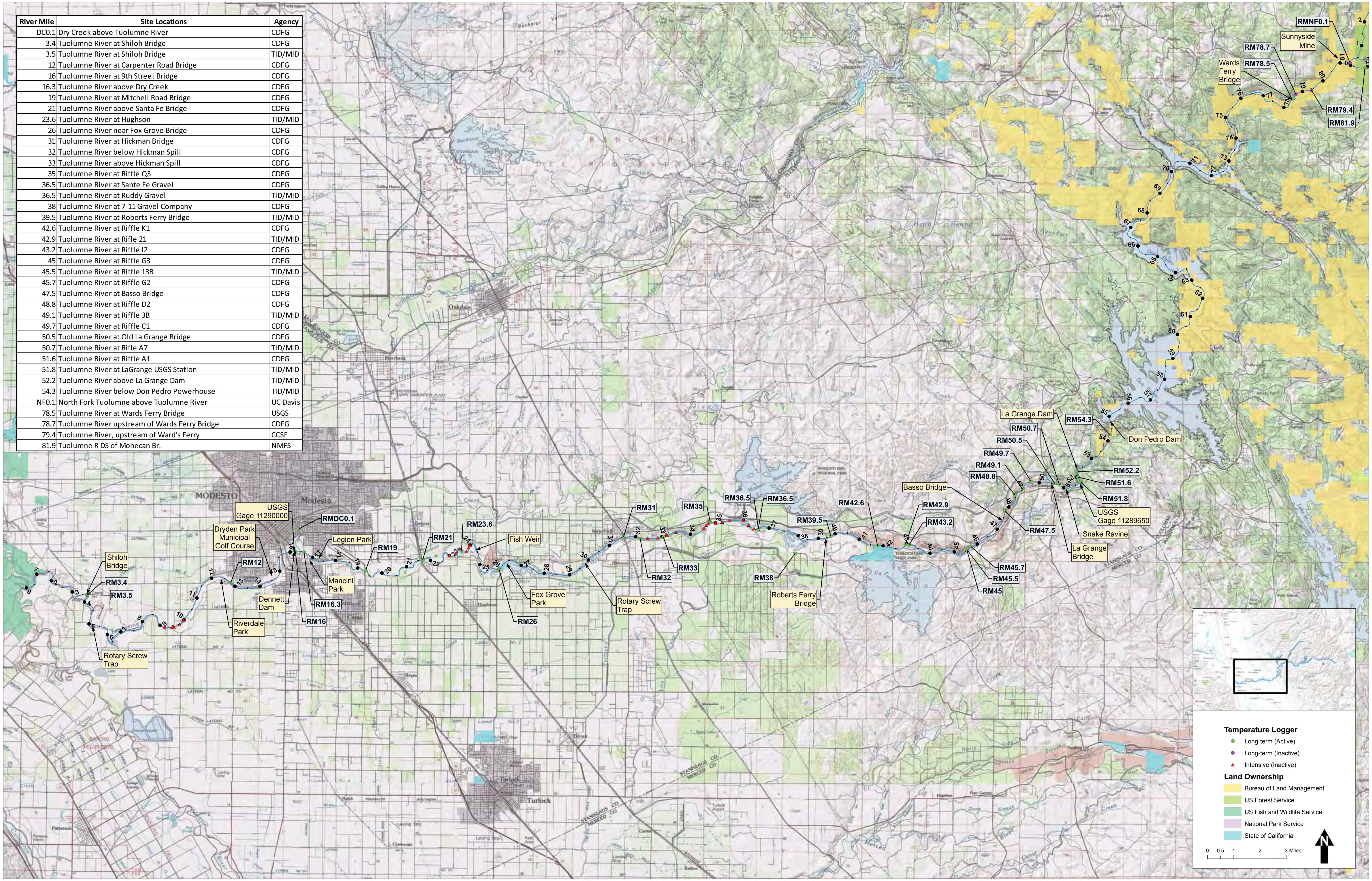
For reference, Moccasin Pt is around RM 72.5, WF Bridge is about RM 78.5 and the North Fork comes in at about RM 81.3.

Thanks,

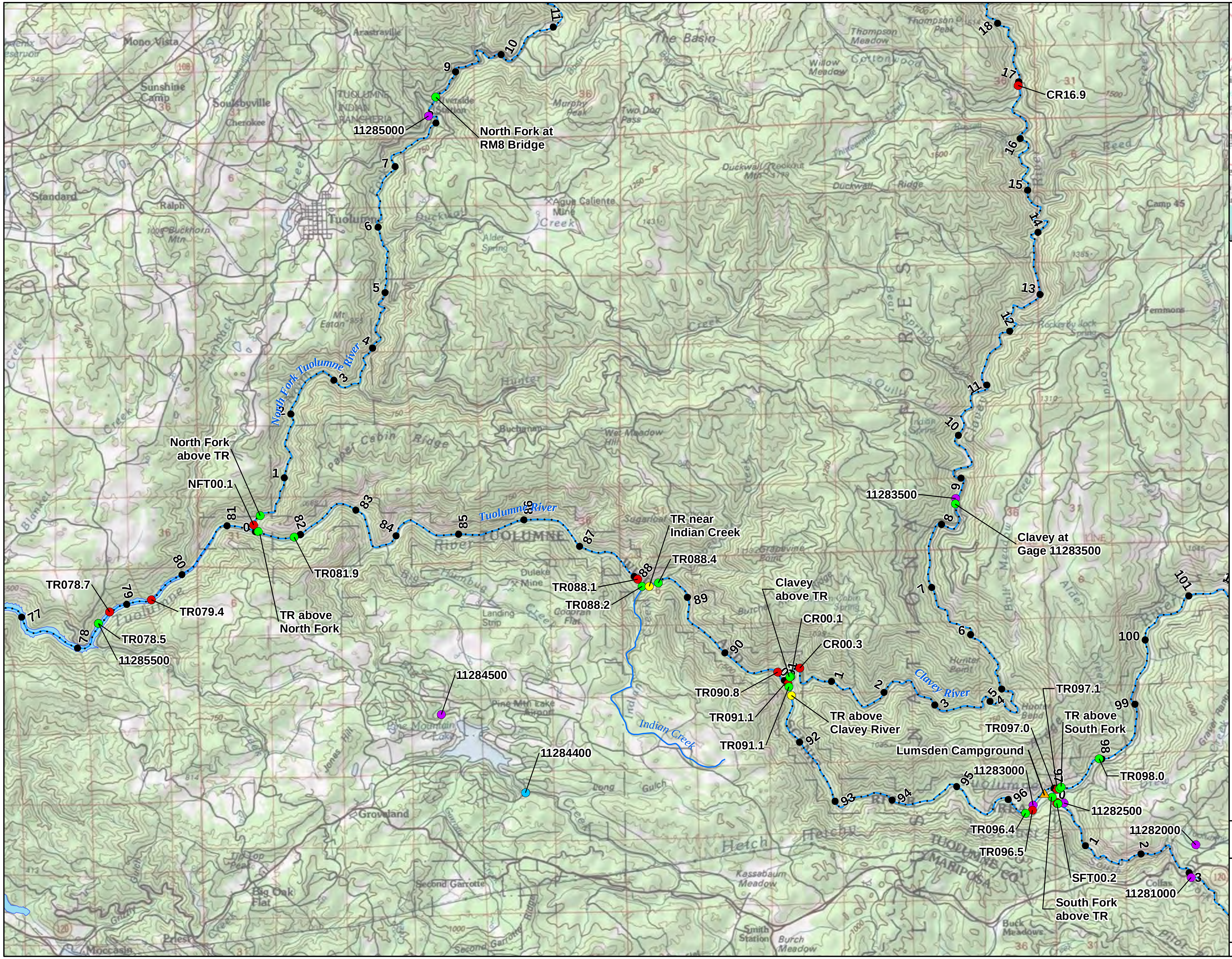
Jean

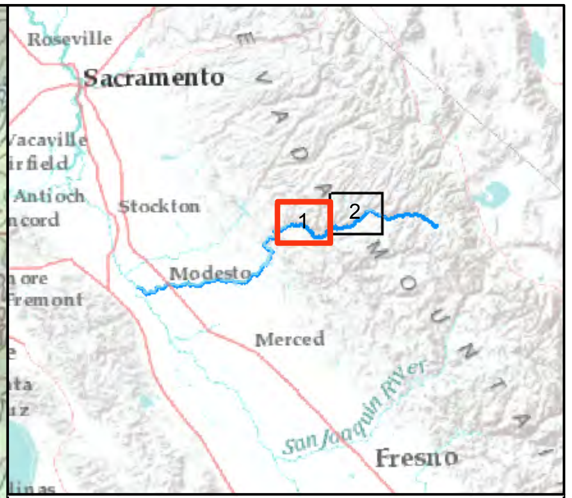
Jean M. Castillo, MSCE, P.E.
Hydraulic/Fish Passage Engineer

NOAA Fisheries West Coast Region
U.S. Department of Commerce
650 Capitol Mall, Suite 5-100
Sacramento, California 95814-4700
Office: 916-930-3613
jean.castillo@noaa.gov



River Mile	Site Locations	Agency
DC0.1	Dry Creek above Tuolumne River	CDFG
3.4	Tuolumne River at Shiloh Bridge	CDFG
3.5	Tuolumne River at Shiloh Bridge	TID/MID
12	Tuolumne River at Carpenter Road Bridge	CDFG
16	Tuolumne River at 9th Street Bridge	CDFG
16.3	Tuolumne River above Dry Creek	CDFG
19	Tuolumne River at Mitchell Road Bridge	CDFG
21	Tuolumne River above Santa Fe Bridge	CDFG
23.6	Tuolumne River at Hughson	TID/MID
26	Tuolumne River near Fox Grove Bridge	CDFG
31	Tuolumne River at Hickman Bridge	CDFG
32	Tuolumne River below Hickman Spill	CDFG
33	Tuolumne River above Hickman Spill	CDFG
35	Tuolumne River at Riffle Q3	CDFG
36.5	Tuolumne River at Sante Fe Gravel	CDFG
36.5	Tuolumne River at Ruddy Gravel	TID/MID
38	Tuolumne River at 7-11 Gravel Company	CDFG
39.5	Tuolumne River at Roberts Ferry Bridge	TID/MID
42.6	Tuolumne River at Riffle K1	CDFG
42.9	Tuolumne River at Rifle 21	TID/MID
43.2	Tuolumne River at Riffle I2	CDFG
45	Tuolumne River at Riffle G3	CDFG
45.5	Tuolumne River at Riffle 13B	TID/MID
45.7	Tuolumne River at Riffle G2	CDFG
47.5	Tuolumne River at Basso Bridge	CDFG
48.8	Tuolumne River at Riffle D2	CDFG
49.1	Tuolumne River at Riffle 3B	TID/MID
49.7	Tuolumne River at Riffle C1	CDFG
50.5	Tuolumne River at Old La Grange Bridge	CDFG
50.7	Tuolumne River at Rifle A7	TID/MID
51.6	Tuolumne River at Riffle A1	CDFG
51.8	Tuolumne River at LaGrange USGS Station	TID/MID
52.2	Tuolumne River above La Grange Dam	TID/MID
54.3	Tuolumne River below Don Pedro Powerhouse	TID/MID
NF0.1	North Fork Tuolumne above Tuolumne River	UC Davis
78.5	Tuolumne River at Wards Ferry Bridge	USGS
78.7	Tuolumne River upstream of Wards Ferry Bridge	CDFG
79.4	Tuolumne River, upstream of Ward's Ferry	CCSF
81.9	Tuolumne R DS of Mohecan Br.	NMFS





Stream / Flow Gage

Active   Inactive

Label	Agency	Active	Site Name
11281000	USGS	Inactive	SF TUOLUMNE R NR OAKLAND RECREATION CAMP CA
11282000	USGS	Inactive	M TUOLUMNE R A OAKLAND RECREATION CAMP CA
11282500	USGS	Inactive	SF TUOLUMNE R NR BUCK MEADOWS CA
11283000	USGS	Inactive	TUOLUMNE R NR BUCK MEADOWS CA
11283500	USGS	Inactive	CLAVEY R NR BUCK MEADOWS CA
11284400	USGS	Active	BIG C AB WHITES GULCH NR GROVELAND CA
11284500	USGS	Inactive	BIG C NR GROVELAND CA
11285000	USGS	Inactive	NF TUOLUMNE R AB DYER C NR TUOLUMNE CA
11285500	USGS	Active	TUOLUMNE R A WARDS FERRY BR NR GROVELAND CA

Water Temperature Logger

Active   Inactive   Proposed*

Label	Agency	Active	Site Locations
CR00.1	TID/MID	YES	Clavey above TR
CR00.1	NMFS	YES	Clavey R. just US of confluence
CR00.3	UC Davis	NO	Clavey River, upstream of Tuolumne River confluence
CR08.4	TID/MID	YES	Clavey River at USFS Bridge
CR16.9	CCSF	NO	Clavey River at 1N04 Bridge
NFT00.1	TID/MID	YES	North Fork above TR
NFT00.1	UC Davis	NO	North Fork Tuolumne above Tuolumne River
NFT08.0	TID/MID	YES	North Fork at RM8 Bridge
SFT00.1	TID/MID	YES	South Fork above TR
SFT00.2	CDFG	NO	South Fork of the Tuolumne River near confluence
SFT00.2	CCSF	NO	South Fork Tuolumne River near 1N10 Bridge
SFT00.2	NMFS	YES	S Fork Tuolumne R. just US of confluence
TR078.5	USGS	YES	Tuolumne River at Wards Ferry Bridge
TR078.7	CDFG	NO	Tuolumne River upstream of Wards Ferry Bridge
TR079.4	CCSF	NO	Tuolumne River, upstream of Ward's Ferry
TR081.3	TID/MID	YES	TR above North Fork
TR081.9	NMFS	YES	Tuolumne R DS of Mohecan Br.
TR088.1	UC Davis	NO	Tuolumne River, downstream of Indian Creek confluence
TR088.2	TID/MID	YES	Tuolumne River at Indian Creek Trail
TR088.4	NMFS	YES	Tuolumne R DS of Grapevine Cr.
TR090.8	UC Davis	NO	Tuolumne River, downstream of Clavey Creek confluence
TR091.1	UC Davis	NO	Tuolumne River, upstream of Clavey Creek confluence
TR091.1	NMFS	YES	Tuolumne R US of Clavey R.
TR096.4	NMFS	YES	Tuolumne R DS of Lumsden Campgorund
TR096.5	CDFG	NO	Tuolmune River below the South Fork
TR097.0	CDFG	NO	Tuolumne River above the South Fork
TR097.0	TID/MID	YES	TR above South Fork
TR097.1	CCSF	YES	Tuolumne River, upstream of South Fork
TR098.0	NMFS	YES	Tuolumne R DS of Lumsden Bridge

* Proposed logger locations will be added to table when exact coordinates are known.

0 0.5 1 2 Miles

N

Upper Tuolumne River Gages

Map information was compiled from the best available sources.
No warranty is made for its accuracy or completeness.
Data Sources: Gages - USGS, TID/MID
Copyright:© 2013 National Geographic Society, i-cubed
Sources: Esri, DeLorme, USGS, NPS
Sources: Esri, USGS, NOAA
Data is CA SPCS, Zone III, ft.

From: Staples, Rose
Sent: Wednesday, April 19, 2017 5:26 PM
Cc: Deason, Jesse; Le, Bao; Johnson, Laura; Staples, Rose
Subject: FW: La Grange Reintroduction Goals Subcommittee Jan 26 2017 Final Meeting Notes

La Grange Licensing Participants,

The following message was sent today to the members of the La Grange Reintroduction Goals Subcommittee regarding the availability of the final meeting notes from the subcommittee's January 26, 2017 meeting.

Rose Staples, CAP-OM, MOS
D 207-239-3857

From: Staples, Rose
Sent: Wednesday, April 19, 2017 8:18 PM
Cc: Deason, Jesse <jesse.deason@hdrinc.com>; 'Le, Bao' <Bao.Le@hdrinc.com>; Johnson, Laura <Laura.Johnson@hdrinc.com>; Staples, Rose (Rose.Staples@hdrinc.com) <Rose.Staples@hdrinc.com>
Subject: La Grange Reintroduction Goals Subcommittee Jan 26 2017 Final Meeting Notes

Reintroduction Goals Subcommittee,

FINAL notes from the January 26, 2017, Reintroduction Goals Subcommittee meeting have been uploaded to the licensing website www.lagrange-licensing.com under the DOCUMENTS section and also as an attachment to the January 26 date on the website calendar.

On March 13, 2017, the Districts provided draft notes from the January 26 Reintroduction Goals Subcommittee meeting to licensing participants and requested that any comments be provided by April 13, 2017. No comments were received; therefore, these FINAL notes are the same as the draft notes originally provided on March 13.

Rose Staples, CAP-OM, MOS
Senior Administrative Assistant

HDR
970 Baxter Boulevard Suite 301
Portland ME 04103
D 207-239-3857
rose.staples@hdrinc.com

From: Staples, Rose
Sent: Wednesday, April 19, 2017 4:27 PM
Cc: Deason, Jesse; Le, Bao; Johnson, Laura; Staples, Rose
Subject: FW: La Grange Water Temp Subcommittee Jan 26 2017 Final Meeting Notes Available

The following email was sent to members of the La Grange Water Temperature Subcommittee today regarding the availability of the final meeting notes from the January 26, 2017 subcommittee meeting.

Rose Staples, CAP-OM, MOS
D 207-239-3857

hdrinc.com/follow-us

From: Staples, Rose
Sent: Wednesday, April 19, 2017 7:04 PM
Cc: Deason, Jesse <Jesse.Deason@hdrinc.com>; Le, Bao <ChiBao.Le@hdrinc.com>; Johnson, Laura <Laura.Johnson@hdrinc.com>; Staples, Rose <Rose.Staples@hdrinc.com>
Subject: La Grange Water Temp Subcommittee Jan 26 2017 Final Meeting Notes Available

Water Temperature Subcommittee,

FINAL notes from the January 26, 2017, Water Temperature Subcommittee meeting have been uploaded to the licensing website www.lagrange-licensing.com under the DOCUMENTS section and also as an attachment to the January 26 date on the website calendar.

On March 13, 2017, the Districts provided draft notes from the January 26 Water Temperature Subcommittee meeting to licensing participants and requested that any comments be provided by April 13, 2017. No comments were received; therefore, these FINAL notes are the same as the draft notes originally provided on March 13.

Rose Staples, CAP-OM, MOS
Senior Administrative Assistant

HDR
970 Baxter Boulevard Suite 301
Portland ME 04103
D 207-239-3857
rose.staples@hdrinc.com

hdrinc.com/follow-us

From: Steve Edmondson [mailto:steve.edmondson@noaa.gov]
Sent: Wednesday, April 19, 2017 4:15 PM
To: Paris, Bill; Boyd, Steve; Anna Brathwaite
Cc: Le, Bao; Mark.Clifford@wildlife.ca.gov; Amanda Cranford - NOAA Federal; 'James Hastreiter'
Subject: Fish Passage Studies

Steve and Anna:

I wanted to thank you again for hosting the recent site visit to the Don Pedro Project. Our fish passage consultants and I were very impressed and appreciative of the cooperation and generosity extended by the districts. All in all, it was a very productive day (and beautiful weather!) and we look forward to continued collaboration.

Also, as a friendly reminder, if the districts intend to obtain triploid fish (1,500 fall-run Chinook salmon juveniles for the reservoir transit study) from CDFW you'll need to send in the application/request before August 1st to get on the list. Attached is CDFW's, hatchery fish request protocol. Lots of good information in there, including deadlines, dates, information needed and necessary caveats. The good news is that because you'll be using fall-run, you may only need a scientific collection permit, and FishBio probably already has one.

Thanks again and I sincerely hope I can escape from the office long enough to attend the reservoir transit study.

Regards, Steve.

PROTOCOL FOR CDFW HATCHERY ANADROMOUS FISH OR EGG REQUESTS

CDFW hatchery fish are raised with limited, dedicated funding. Fish and eggs allocated for research are those produced in excess of the mitigation requirement of each anadromous hatchery. For this reason it is necessary to have all requests known prior to spawning to so that surpluses for research can be accommodated. Unforeseen circumstances (such as drought) may effect production at hatcheries and may compromise CDFW's ability to supply requested fish/eggs.

To help the Department anticipate and accommodate egg and fish requests, REQUESTS FOR ANADROMOUS SPECIES MUST BE SUBMITTED **BY AUGUST 1st.**

A formal request letter on your company, agency or university letterhead is required and must include:

- A full proposal describing the proposed activity
  - Number of fish, eggs or fish products requested
  - Size or age
  - Species
  - Date(s) when fish, eggs or fish products are needed
  - Reason for request (i.e. intended use of requested fish or fish products)
  - Disposition of the fish, eggs or fish materials after the termination of experiments
  - Location where the tests will be conducted
  - Preferred hatchery source with explanation
    - If *any* hatchery is acceptable, please indicate so
  - Methods and anticipated results (data gathered)
    - Proposals for hatchery fish and fish products should identify the main intent of research and its relevance to fishery management issues
  - A Scientific Collecting Permit will be required for non-state listed species with the potential to interact with natural biota/ecosystems. A CESA MOU is required for all state listed species with the potential to interact with natural biota/ecosystems.
    - If applicable, include Scientific Collecting Permit number for the proposed activity.
  - All other applicable permitting (e.g. Federal) will still be required
  - Any other relevant information

CDFW Fisheries Branch, Hatchery and Regional staff will review proposals after the August 1st deadline and will make research allocation decisions at one meeting. Requests for anadromous fish received after August 1st will not be considered for the following spawning/incubation/production/release cycle.

Requests for public educational purposes will also be considered.

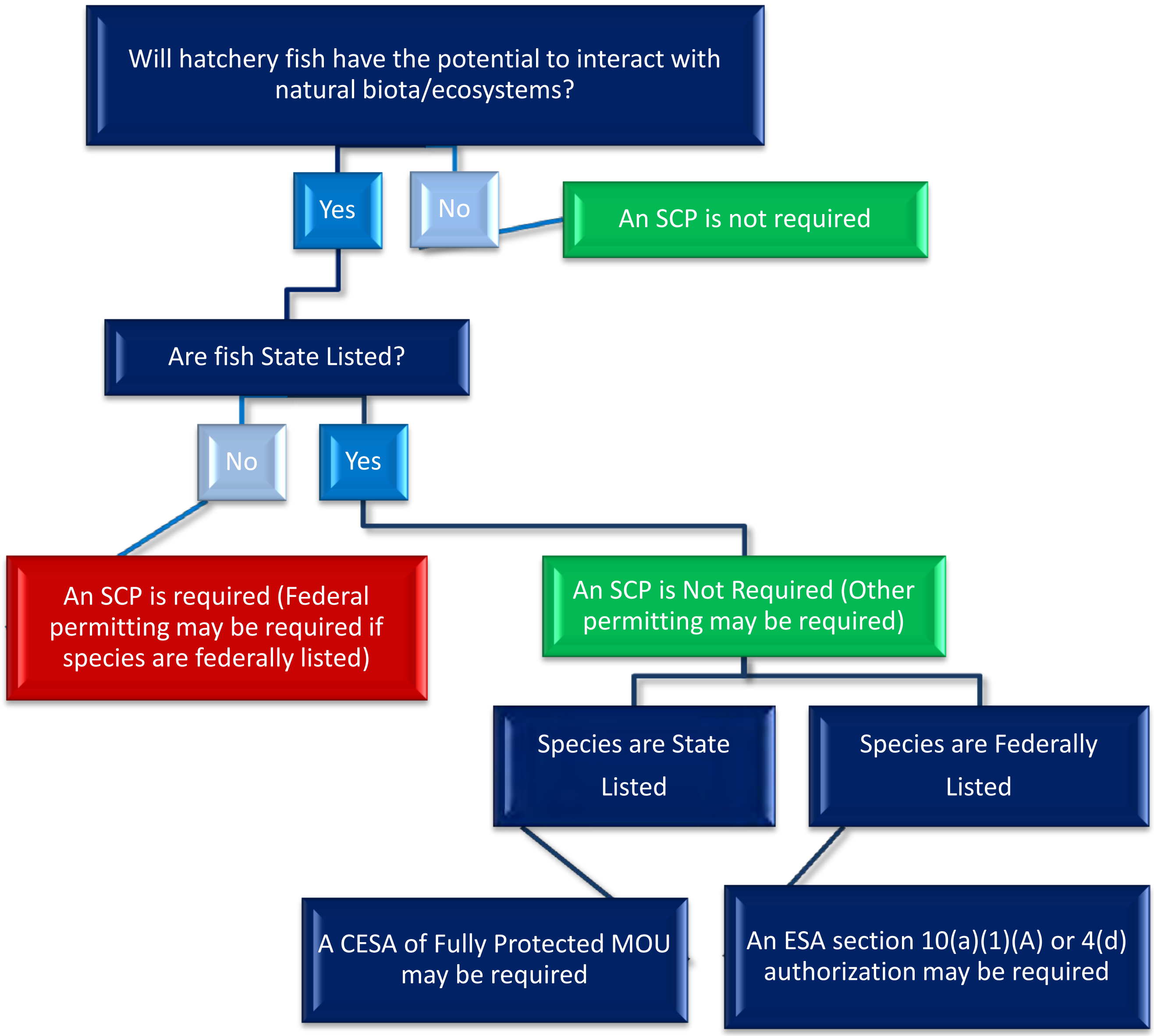
Following Department review of proposals, the Hatchery Coordinator will write a letter to the requestor to notify them of the decision to approve or denying the request.

Approved requests will require that researchers supply reports, data, and/or publications resulting from the conducted research to CDFW for discretional fishery management applications.

The request packet including proposal, summary of test results, and any publications or reports should be submitted (e-mailed preferred) to:

Dr. Mark Clifford
Hatchery Coordinator
California Dept of Fish and Wildlife
#3 North Old Stage Road
Mount Shasta, CA 96067
mark.clifford@wildlife.ca.gov

SCPs for Take of Fish from the Hatchery



Hatchery Fish - Any fish produced and raised in captivity (F&GC 1800).

Natural Origin Fish – Any fish produced in the wild that is brought into the hatchery.

From: Staples, Rose
Sent: Monday, April 24, 2017 7:25 AM
Cc: Deason, Jesse; Le, Bao; Staples, Rose; Johnson, Laura
Subject: La Grange DLA E-Filed with FERC Today

The Districts have e-filed with FERC today the La Grange Project DRAFT LICENSE APPLICATION (DLA). A copy of the filing can be found on FERC's E-Library (P-14581) at www.FERC.gov -- as well as on the licensing website at www.lagrange-licensing.com under the DOCUMENTS tab.

Rose Staples, CAP-OM, MOS
D 207-239-3857

hdrinc.com/follow-us

-----Original Message-----
From: eFiling@ferc.gov [mailto:eFiling@ferc.gov]
Sent: Monday, April 24, 2017 9:53 AM
To: Staples, Rose <Rose.Staples@hdrinc.com>; eFilingAcceptance@ferc.gov
Subject: FERC Acceptance for Filing in P-14581-000

Acceptance for Filing

The FERC Office of the Secretary has accepted the following electronic submission for filing (Acceptance for filing does not constitute approval of any application or self-certifying notice):

-Accession No.: 201704245084, 201704245085, 201704245086
-Docket(s) No.: P-14581-000
-Filed By: Turlock Irrigation District and Modesto Irrigation District -Signed By: Steve Boyd, Anna Brathwaite -Filing Type: ILP Preliminary Licensing Proposal -Filing Desc: ILP Draft License Application of Turlock Irrigation District and Modesto Irrigation District under P-14581-000 La Grange.
-Submission Date/Time: 4/23/2017 10:32:37 PM -Filed Date: 4/24/2017 8:30:00 AM

Your submission is now part of the record for the above Docket(s) and available in FERC's eLibrary system at:

http://elibrary.ferc.gov/idmws/file_list.asp?accession_num=20170424-5084

If you would like to receive e-mail notification when additional documents are added to the above docket(s), you can eSubscribe by docket at:

https://ferconline.ferc.gov/eSubscription.aspx

Thank you again for using the FERC Electronic Filing System. If you need to contact us for any reason:

E-Mail: efiling@ferc.gov mailto:efiling@ferc.gov (do not send filings to this address) Voice Mail: 202-502-8258.

From: Staples, Rose
Sent: Thursday, April 27, 2017 1:07 PM
Cc: Deason, Jesse; Le, Bao; Staples, Rose; Johnson, Laura
Subject: FW: Hold May 18 Morning for La Grange Reintro Assessment Framework Meeting

La Grange Licensing Participants,

The following message was sent to the members of the La Grange Project Tuolumne River Reintroduction Assessment Framework Plenary Group today regarding holding the morning of May 18, 2017 (from 9:00 a.m. to Noon) for the next group meeting.

Rose Staples, CAP-OM, MOS
D 207-239-3857

hdrinc.com/follow-us

From: Staples, Rose
Sent: Thursday, April 27, 2017 4:00 PM
Cc: Deason, Jesse <Jesse.Deason@hdrinc.com>; Staples, Rose <Rose.Staples@hdrinc.com>; Le, Bao <ChiBao.Le@hdrinc.com>; Johnson, Laura <Laura.Johnson@hdrinc.com>
Subject: Hold May 18 Morning for La Grange Reintro Assessment Framework Meeting

Members of the La Grange Project Tuolumne River Reintroduction Assessment Framework Plenary Group,

The next Plenary Group meeting will take place on **Thursday, May 18, 2017, from 9:00 am to 12:00 pm**. The meeting will be held at TID's C.C. Wright Hall (formerly the War Memorial Building), located at 247 East Canal Drive in Turlock, CA. As the date approaches, the Districts will circulate meeting materials, including an agenda.

Rose Staples, CAP-OM, MOS
Senior Administrative Assistant

HDR
970 Baxter Boulevard Suite 301
Portland ME 04103
D 207-239-3857
rose.staples@hdrinc.com

hdrinc.com/follow-us

From: Staples, Rose
Sent: Thursday, April 27, 2017 12:02 PM
To: Hildeburn, Chase@Waterboards
Subject: RE: La Grange Notifications

There should be notifications forthcoming within the day or so regarding upcoming meetings on both La Grange and Don Pedro. I will add your email address to the group list, so that you get those and any future announcements. Thank you.

Rose Staples, CAP-OM, MOS
D 207-239-3857

hdrinc.com/follow-us

From: Hildeburn, Chase@Waterboards [mailto:Chase.Hildeburn@Waterboards.ca.gov]
Sent: Wednesday, April 26, 2017 7:21 PM
To: Staples, Rose <Rose.Staples@hdrinc.com>
Subject: La Grange Notifications

Hi Rose,

I've joined the SWRCB recently working under Jeff Wetzel and have been assigned to the La Grange and Don Pedro Hydro projects. I am wondering if you could tell me if there are any upcoming meetings or calls scheduled for the La Grange project? I have looked through the final notes for the last WTI and Reintroduction Goals meetings and didn't see anything there. On that note, would you mind also adding me onto the list so that I'll be notified if there are any other updates in the future please? I'd appreciate it.

Thanks in advance,
Chase Hildeburn

Chase Hildeburn
Water Resource Control Engineer
State Water Resources Control Board
Water Quality Certification Unit
1001 I Street, 14th Floor | P.O. Box 2000
Sacramento, CA 95812
(916) 323-0358

From: Staples, Rose
Sent: Monday, May 1, 2017 6:44 PM
To: 'Jean Castillo - NOAA Federal' <jean.castillo@noaa.gov>
Subject: RE: La Grange

Appendix B of the La Grange PAD contains a set of project drawings.

In the DOCUMENTS section of the website, go to the third page of the index and the PAD, e-filed January 29, 2014, is the next to the last document.

When you click on the DOCUMENTS tab, go to the very bottom of the screen, where you will see the text 1 to 100 with an arrow icon. Click on the arrow and you will go to the second screen of the index, labeled at the bottom as 101 to 200. Click on the arrow and you will go to the third page, labeled 201 to 219.

Hopefully these drawings are what you are seeking; if not, please don't hesitate to contact me again.

Thank you.

Rose Staples, CAP-OM, MOS
D 207-239-3857

ONEHDRED
1917-2017

hdrinc.com/follow-us

From: Jean Castillo - NOAA Federal [mailto:jean.castillo@noaa.gov]
Sent: Monday, May 1, 2017 6:25 PM
To: Staples, Rose <Rose.Staples@hdrinc.com>
Subject: La Grange

Hi Rose,

I am still trying to navigate the http://www.lagrange-licensing.com/Document site.

What I am looking for is a copy of drawings for the La Grange Dam. Is this on the website? If yes can you direct me to the name of the document and the date it was filed?

Thanks
Jean

Jean M. Castillo, MSCE, P.E.
Hydraulic/Fish Passage Engineer

NOAA Fisheries West Coast Region
U.S. Department of Commerce
650 Capitol Mall, Suite 5-100
Sacramento, California 95814-4700
Office: 916-930-3613
jean.castillo@noaa.gov

From:	Jean Castillo - NOAA Federal
To:	Garello, Michael
Subject:	Fwd: Don Pedro
Date:	Monday, May 1, 2017 3:17:07 PM

Mike,

John and team lookded through the 2017 Updated Study Report and it also appears that there is LiDAR data available at La Grange which would be useful. Is that the data you are working with the get the stream profile? If yes can you send that also when you send the profile?

If no are you able to send it on now?

Thanks,
Jean

Jean M. Castillo, MSCE, P.E.
Hydraulic/Fish Passage Engineer

NOAA Fisheries West Coast Region
U.S. Department of Commerce
650 Capitol Mall, Suite 5-100
Sacramento, California 95814-4700
Office: 916-930-3613
jean.castillo@noaa.gov

From: Staples, Rose
Sent: Tuesday, May 02, 2017 1:00 PM
Cc: Deason, Jesse; Le, Bao; Staples, Rose; Johnson, Laura
Subject: Districts E-File with FERC Response to La Grange LP Comments on USR

Licensing participants,

The Districts have e-filed with FERC today their Response to Licensing Participants' Comments on the La Grange Updated Study Report. A copy of the filing is available on FERC's E-Library (www.FERC.gov) under docket P-14581—and it is also available on the La Grange licensing website www.lagrange-licensing.com under the DOCUMENTS tab.

Thank you.

Rose Staples, CAP-OM, MOS
Senior Administrative Assistant

ONEHDRED
1917-2017

HDR
970 Baxter Boulevard Suite 301
Portland ME 04103
D 207-239-3857
rose.staples@hdrinc.com

hdrinc.com/follow-us

From: Jean Castillo - NOAA Federal
To: Garello, Michael
Subject: La Grange Drawings
Date: Tuesday, May 2, 2017 11:16:18 AM
Attachments: la grange drawings.docx

Me again,

I wanted to keep the email requests separate for Don P and La G.

Below is request list from Anchor et.al. for the La Grange site. I looked in the PAD and copied out the attached drawings but they are hard to read. Lucas has asked if is possible to get the original drawings so the quality is better. They also asked for any additional drawings TID might have of the area and of course if already in AutoCAD all the better. Is this something you can assist me with or is it better to contact TID?

Thanks
Jean

Drawing Request List

1. • Tunnel Structure
2. • Forebay Structure at Upstream End of Cannel / Penstock
3. • Sluice Gates for Powerhouse Bypass
4. • Penstocks and Supports
5. • Bank Retaining Wall
6. • Switchyard / Substation Structure
7. • Overhead Utilities
8. • Underground Utilities and Grounding
9. • Powerhouse and Draft Tubes
10. • Tailrace Training Wall
11. • Topographic Survey
12. • Bathymetric Survey

Jean M. Castillo, MSCE, P.E.
Hydraulic/Fish Passage Engineer

NOAA Fisheries West Coast Region
U.S. Department of Commerce
650 Capitol Mall, Suite 5-100
Sacramento, California 95814-4700
Office: 916-930-3613
jean.castillo@noaa.gov

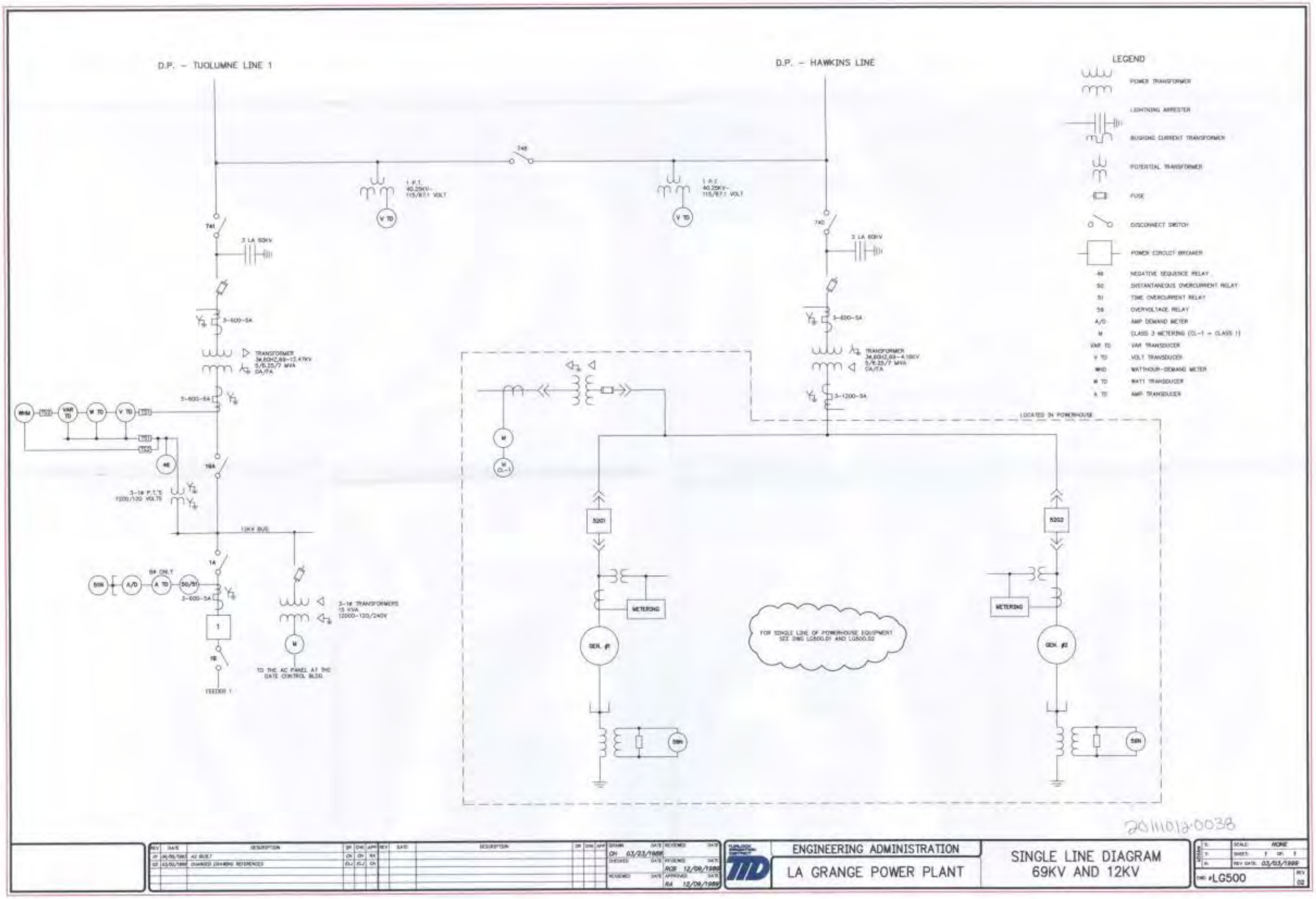


Figure 3.4.8-1 Single line diagram showing grid connection.

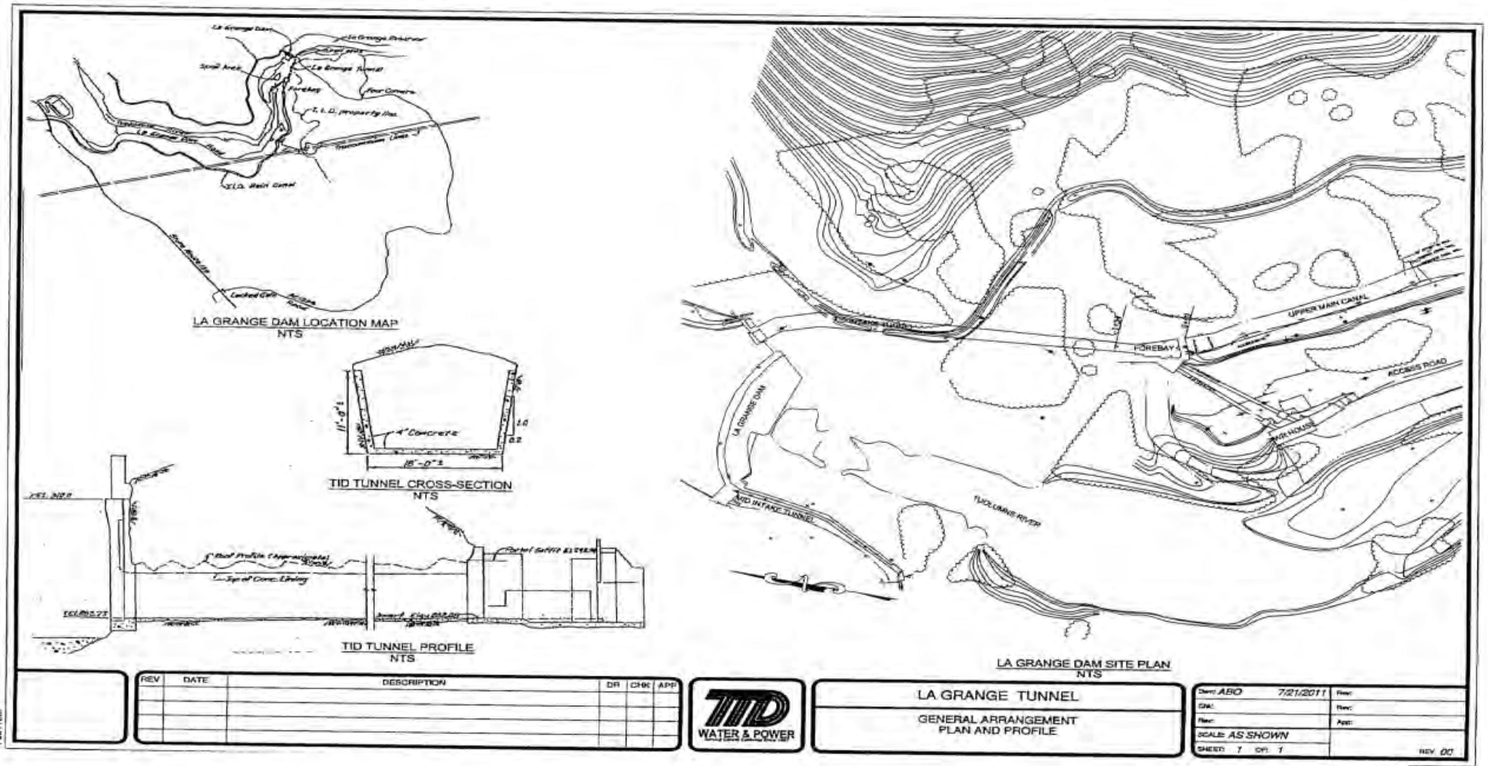


Figure 1. Site plan of La Grange diversion dam and facilities showing diversion dam, TID tunnel intake, tunnel location, penstocks, powerhouse, and Upper Main Canal.

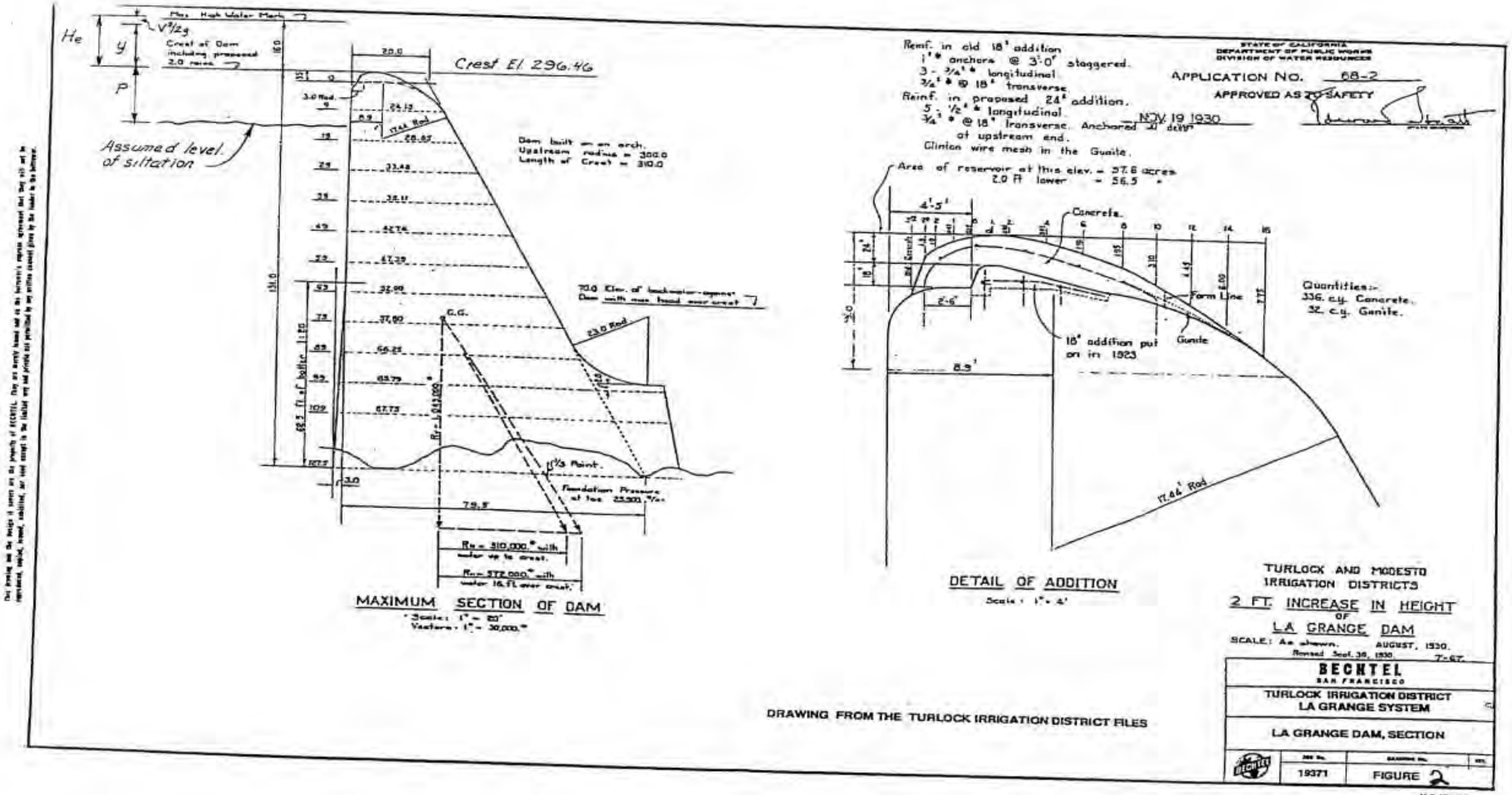


Figure 2. La Grange spillway section showing original crest and crest modification to present elevation of 296.5 feet.

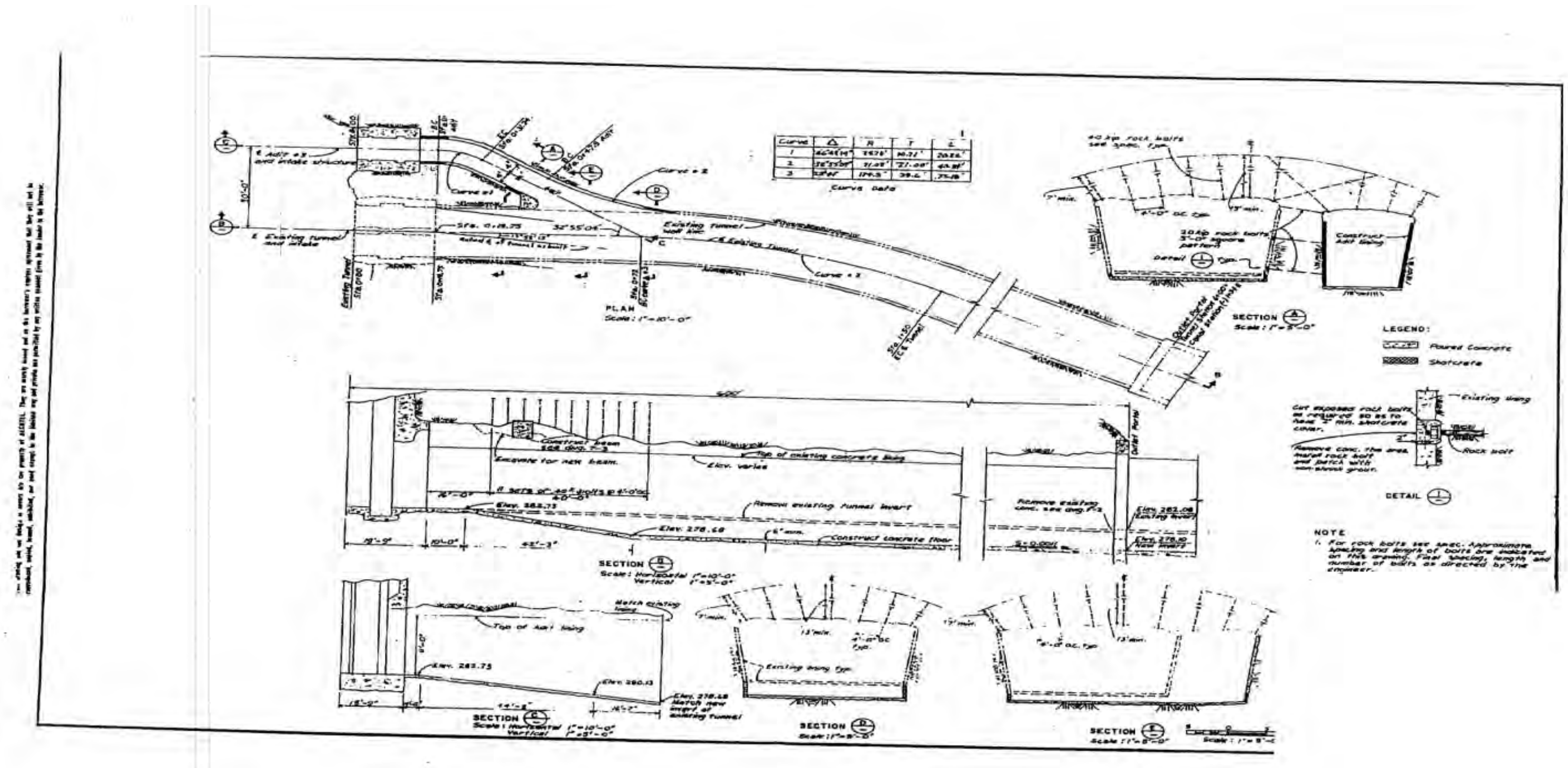


Figure 3. TID intake tunnel portals site plan and profile.

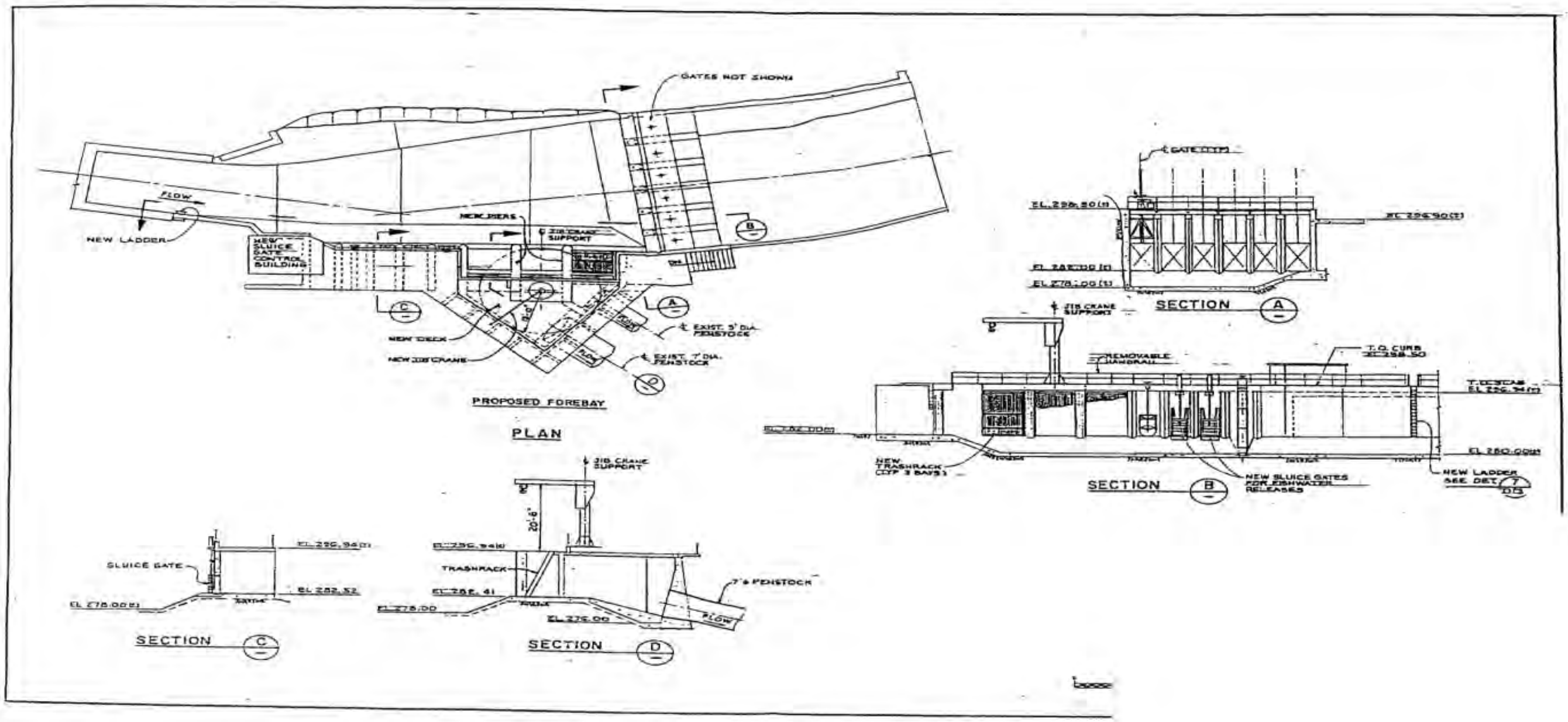


Figure 4. TID tunnel exit, forebay, and Upper Main Canal and powerhouse intakes.

GENERAL NOTES

(1) BATHYMETRIC DATA IS FROM A SURVEY CONDUCTED BY MERIDIAN SURVEYING ENGINEERING, INC. ON SEPTEMBER 12 AND 13, 2011 THIS REPRESENTS THE RIVER BOTTOM CONDITIONS ON THAT DATE.

(2) A TRIMBLE R8 REAL-TIME KINEMATIC GPS RECEIVER, AN INNERSPACE 465 ECHOSOUNDER WITH A SINGLE FREQUENCY TRANSDUCER AT 200 KHZ WERE USED FOR RIVER BOTTOM. A HYDROLITE ECHOSOUNDER WITH A SINGLE FREQUENCY TRANSDUCER WAS ASLO USED.

(3) THE CONTOURS SHOWN ARE INTERPOLATED FROM A 3 DIMENSIONAL MODEL CREATED FROM THE TRUE SOUNDINGS.

(4) SHORELINE CONTOURS PROVIDE BY TID.

BASIS OF COORDINATES AND ELEVATION

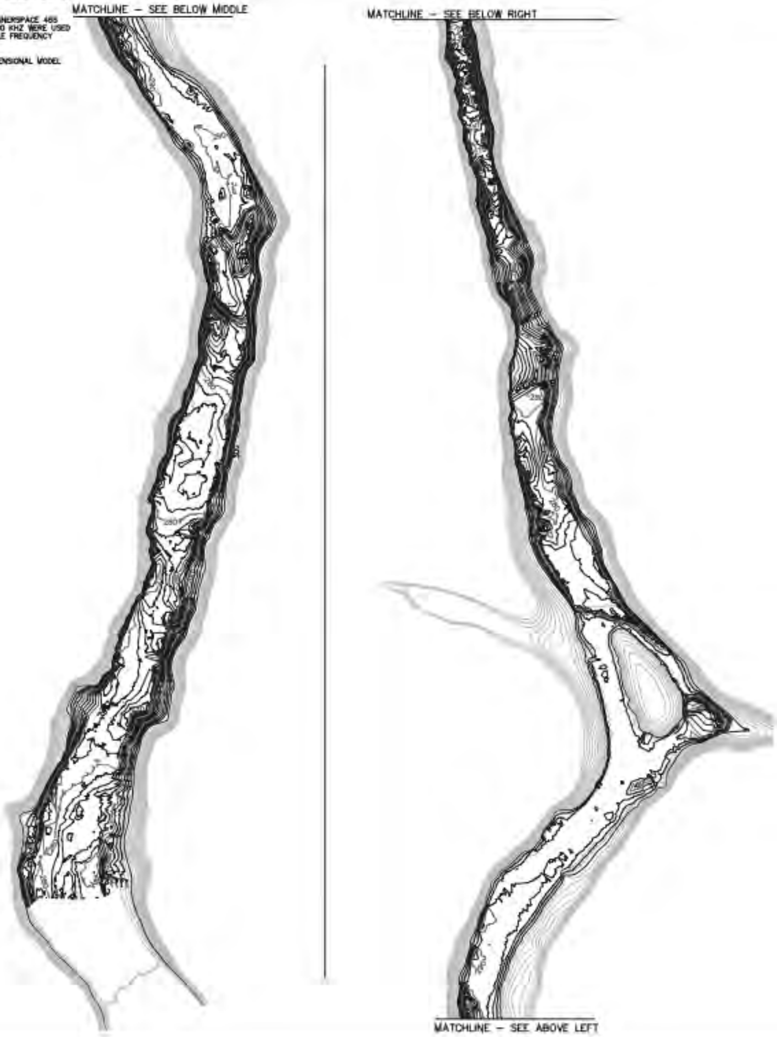
SURVEY WAS BASED ON TID POINT 102

ELEVATION OF THE RIVER SURFACE AT THE TIME OF SURVEY

DATE	TIME	ELEVATION
09/12/11	13:09	301.4'
09/13/11	11:06	298.4'
09/13/11	16:37	298.6'

MATCHLINE – SEE BELOW MIDDLE

MATCHLINE – SEE BELOW RIGHT



MATCHLINE – SEE ABOVE LEFT

MATCHLINE – SEE ABOVE MIDDLE

VICINITY MAP

LEGEND

N.T.S. NOT TO SCALE
TID TURLOCK IRRIGATION DISTRICT

CONTOUR INTERVAL: 2 FEET

PRELIMINARY RESULTS

HYDROGRAPHIC SURVEY

TOULUMNE RIVER
SECTION 16, 9 AND 10
TOWNSHIP 4 SOUTH
RANGE 14 EAST

PREPARED AT THE REQUEST OF
TID

TOULUMNE/STANISLAUS CO. CALIFORNIA
SEPTEMBER 2011

MERIDIAN SURVEYING ENGINEERING, INC.
1812 UNION STREET
SAN FRANCISCO 94123
(415) 440-4131
777 GRAND AVENUE, #202
SAN RAFAEL, CA 94901
(415) 456-5450

SHEET 1 OF 1

From: Staples, Rose
Sent: Wednesday, May 03, 2017 1:00 PM
Cc: Deason, Jesse; Le, Bao; Johnson, Laura; Staples, Rose
Subject: FW: LG Reintro Assessment Framework Water Temp Subcommittee: NMFS Russian River Memo

La Grange Licensing Participants,

The following message was sent to the members of the La Grange Reintroduction Assessment Framework Water Temperature Subcommittee today.

Rose Staples, CAP-OM, MOS
D 207-239-3857

hdrinc.com/follow-us

From: Staples, Rose
Sent: Wednesday, May 3, 2017 3:50 PM
Cc: Deason, Jesse <Jesse.Deason@hdrinc.com>; Le, Bao <ChiBao.Le@hdrinc.com>; Johnson, Laura <Laura.Johnson@hdrinc.com>; Staples, Rose <Rose.Staples@hdrinc.com>
Subject: LG Reintro Assessment Framework Water Temp Subcommittee: NMFS Russian River Memo

Reintroduction Assessment Framework Water Temperature Subcommittee members,

In response to an action item from the January 26, 2017 Temperature Subcommittee meeting, NMFS has provided a copy of the Russian River memo. The Districts have posted the memo to the La Grange Project licensing website (www.lagrange-licensing.com) under the DOCUMENTS tab.

Rose Staples, CAP-OM, MOS
Senior Administrative Assistant

HDR
970 Baxter Boulevard Suite 301
Portland ME 04103
D 207-239-3857
rose.staples@hdrinc.com

hdrinc.com/follow-us

From: Le, Bao
Sent: Thursday, May 04, 2017 12:04 PM
To: William.Foster@noaa.gov; Jean Castillo - NOAA Federal (jean.castillo@noaa.gov)
Cc: Johnson, Laura; Deason, Jesse
Subject: NMFS Agenda Item for May 18 Plenary Group meeting

Hi Bill and Jean,

The Districts will be hosting a Tuolumne River Reintroduction Assessment Framework Plenary Group meeting on Thursday, May 18, from 9:00 am to 12:00 pm at TID's C.C. Wright Hall. The Districts are currently working on finalizing an agenda for the meeting but plan to dedicate some time to presenting status updates on the ongoing upper river studies. Given this, the Districts request that NMFS provide a presentation of the status of its relevant studies to the collaborative plenary group covering your three upper Tuolumne River studies: the *O. mykiss* genetics study, the habitat assessment and carrying capacity study, and the fish passage engineering study. Please let me know if you are amenable and we'll plan accordingly.

Thanks,

Bao

Bao Le
Project Manager/Senior Fisheries Biologist
Hydropower Services

HDR
1001 SW 5th Ave.
Portland, OR 97204-1134
D 503-423-3828 **M** 503-309-9423
bao.le@hdrinc.com

hdrinc.com/follow-us

From: Staples, Rose
Sent: Friday, May 05, 2017 4:51 PM
Cc: Deason, Jesse; Le, Bao; Johnson, Laura; Staples, Rose
Subject: FW: La Grange Reintroduction Goals Subcommittee Narrative Statement

La Grange Licensing Participants,

The following message regarding the *Reintroduction Goals Narrative Statement* was send to the members of the subcommittee today.

Rose Staples, CAP-OM, MOS
D 207-239-3857

hdrinc.com/follow-us

From: Staples, Rose
Sent: Friday, May 5, 2017 7:45 PM
Cc: Deason, Jesse <jesse.deason@hdrinc.com>; 'Le, Bao' <Bao.Le@hdrinc.com>; Staples, Rose (Rose.Staples@hdrinc.com) <Rose.Staples@hdrinc.com>; Johnson, Laura <Laura.Johnson@hdrinc.com>
Subject: La Grange Reintroduction Goals Subcommittee Narrative Statement

Reintroduction Assessment Framework Reintroduction Goals Subcommittee,

On January 24, 2017, the Districts circulated to the Goals Subcommittee the updated draft Tuolumne River reintroduction goals narrative statement below for review. The statement is as follows:

"Contribute to the recovery of ESA listed salmonids in the Central Valley by establishing viable populations in the Tuolumne River at fair and reasonable cost."

As part of the Goals Statement, the Districts invited subcommittee members to suggest corollary statements to be added to the primary goals statement, by including the following:

"Specific objectives consistent with the goal statement include the following:……"

Also on January 24, the Districts circulated a preliminary draft of the Tuolumne River Reintroduction Goals Statement and Discussion of Corollary Objectives document, the purpose of which was to facilitate discussions regarding the development of these corollary statements. The Districts requested that any input, suggestions or recommendations for the corollary statements be provided by Friday, February 17, 2017. No input or feedback has been received.

The Districts thank the members of the Goals Subcommittee for their involvement and will submit the Goals Statement without corollary statements to the Plenary Group for discussion at the May 18 Plenary Group Meeting.

Rose Staples, CAP-OM, MOS
Senior Administrative Assistant

HDR

970 Baxter Boulevard Suite 301
Portland ME 04103
D 207-239-3857
rose.staples@hdrinc.com

hdrinc.com/follow-us

From: Staples, Rose
Sent: Friday, May 05, 2017 5:08 PM
Cc: Deason, Jesse; Le, Bao; Johnson, Laura; Staples, Rose
Subject: FW: Documents for La Grange Water Temp Subcommittee Review

La Grange Licensing Participants,

The following message was sent today to the members of the La Grange Water Temperature Subcommittee.

Rose Staples, CAP-OM, MOS
D 207-239-3857

ONEHUNDRED 1917-2017

hdrinc.com/follow-us

From: Staples, Rose
Sent: Friday, May 5, 2017 8:02 PM
Cc: Deason, Jesse <jesse.deason@hdrinc.com>; 'Le, Bao' <Bao.Le@hdrinc.com>; Staples, Rose (Rose.Staples@hdrinc.com) <Rose.Staples@hdrinc.com>; Johnson, Laura <Laura.Johnson@hdrinc.com>
Subject: Documents for La Grange Water Temp Subcommittee Review

Reintroduction Assessment Framework Water Temperature Subcommittee,

On November 29, 2016, the Districts circulated a water temperature and fish periodicity working document to Subcommittee members to generate recommendations for water temperature index (WTI) values to be used to evaluate thermal suitability of habitats in the upper Tuolumne River. No feedback was received by the January 13, 2017 comment deadline.

On January 24, 2017 the documents were circulated once again by the Districts to the subcommittee members requesting input. The California Sportfishing Protection Alliance provided comments related to one of the lifestage periodicities in the document, but no comments specific to water temperature indices were received. To date, no other feedback/input on WTI values written or verbal has been received.

In the absence of feedback from subcommittee members, the Districts have developed WTI values using the updated literature review summary circulated and discussed previously. These documents are available on the La Grange Project licensing website (www.lagrange-licensing.ww) on the May 18, 2017 date of the website calendar (CALENDAR tab) and will be presented to the Plenary Group at the May 18, 2017 meeting as the final reports of the subcommittee. Should you have any comments, please provide them by COB Wednesday, May 10, 2017, and we will add them to the subcommittee's reports to the Plenary Group.

Rose Staples, CAP-OM, MOS
Senior Administrative Assistant

ONEHUNDRED 1917-2017

HDR
970 Baxter Boulevard Suite 301
Portland ME 04103
D 207-239-3857
rose.staples@hdrinc.com

hdrinc.com/follow-us

From: Staples, Rose
Sent: Thursday, May 11, 2017 1:34 PM
Cc: Deason, Jesse; Le, Bao; Johnson, Laura; Staples, Rose
Subject: FW: Materials for La Grange May 18 2017 Plenary Group Meeting
Attachments: Map to Wright Hall.pdf

La Grange Licensing Participants,

The following message was sent today to members of the La Grange Reintroduction Assessment Framework Plenary Group regarding the agenda and other materials for the upcoming May 18, 2017 meeting in Turlock.

Rose Staples, CAP-OM, MOS
D 207-239-3857

hdrinc.com/follow-us

From: Staples, Rose
Sent: Thursday, May 11, 2017 4:28 PM
Cc: Deason, Jesse <jesse.deason@hdrinc.com>; 'Le, Bao' <Bao.Le@hdrinc.com>; Johnson, Laura <Laura.Johnson@hdrinc.com>; Staples, Rose (Rose.Staples@hdrinc.com) <Rose.Staples@hdrinc.com>
Subject: Materials for La Grange May 18 2017 Plenary Group Meeting

Members of the La Grange Project Tuolumne River Reintroduction Assessment Framework Plenary Group,

The next Plenary Group meeting will take place on **Thursday, May 18, 2017, from 9:00 am to 12:00 pm** at TID's **C.C. Wright Hall** (formerly the War Memorial Building), located at **247 East Canal Drive in Turlock, CA**.

An agenda and supporting materials for this meeting are now available on the La Grange Project licensing website (www.lagrange-licensing.com) as attachments to the May 18, 2017 date on the website calendar. With regard to the agenda, note that in preparation for this meeting, the Districts requested NMFS provide an update on the status of their upper river studies but have yet to receive confirmation. We remain hopeful that NMFS would be able to provide an update of their studies, so this item is still on the current agenda.

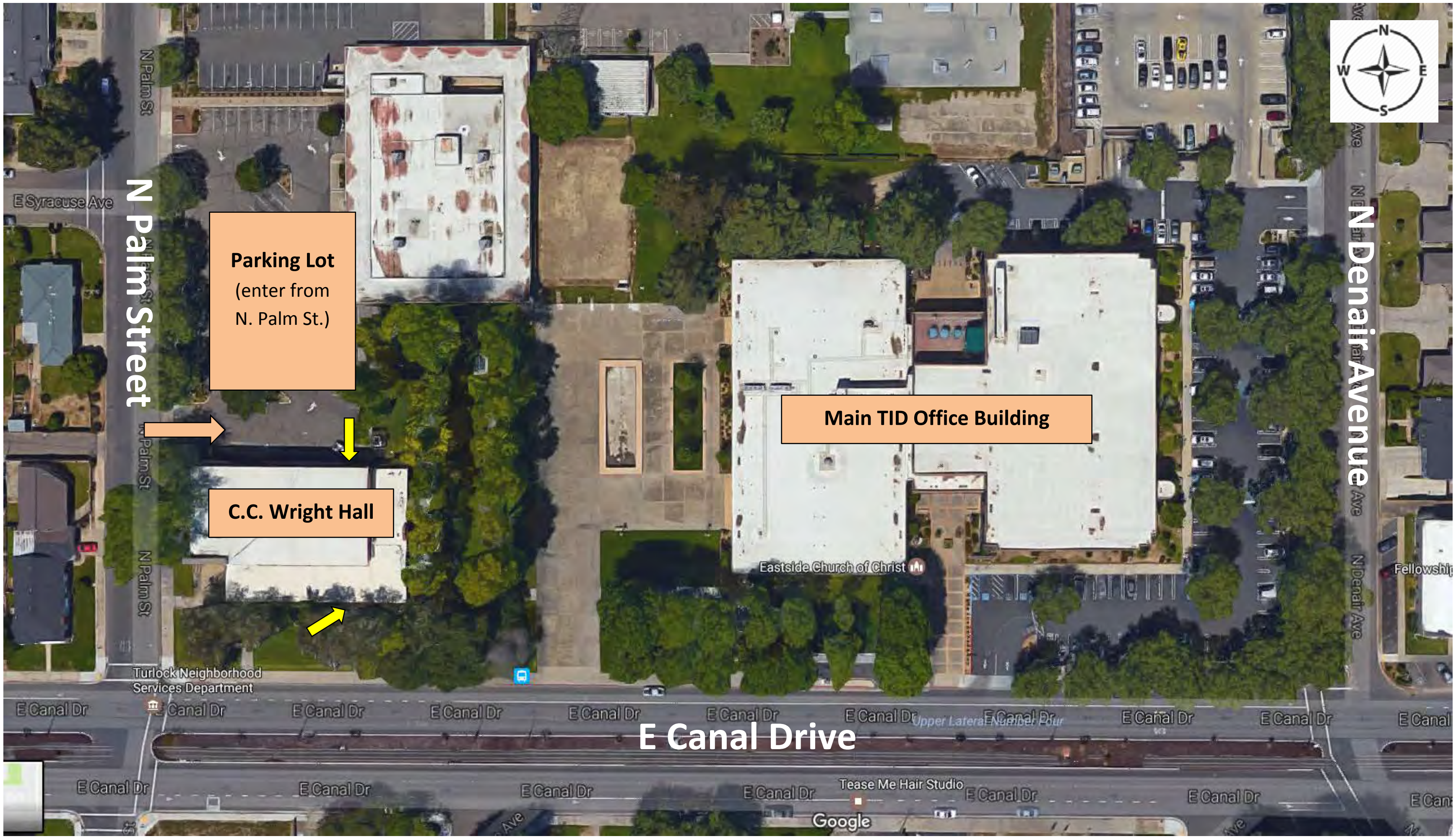
Please find attached a map of where C.C. Wright Hall is located and directions for parking. **The Districts strongly encourage participants to attend in-person; although a conference line will be available, acoustics in the room may make it difficult to hear the discussion.**

Rose Staples, CAP-OM, MOS
Senior Administrative Assistant

HDR
970 Baxter Boulevard Suite 301
Portland ME 04103
D 207-239-3857
rose.staples@hdrinc.com

hdrinc.com/follow-us

C.C. Wright Hall, 247 E Canal Drive, Turlock CA



The parking lot north of C.C. Wright Hall is free and open to the public. Individuals may enter C.C. Wright Hall using either the north entrance or the main entrance located off of E Canal Drive.

From: Staples, Rose
Sent: Monday, May 15, 2017 2:17 PM
Cc: Deason, Jesse; Le, Bao; Johnson, Laura; Staples, Rose
Subject: May 18 2017 Don Pedro Hydroelectric Project Modeling Tool Updates Meeting
Attachments: Map to Wright Hall.pdf; DPModelingMtgAgenda 20170518.pdf

Don Pedro Project Relicensing Participants,

On **Thursday, May 18, 2017, from 1:00 pm to 3:00 pm**, the Districts will be hosting a meeting with relicensing participants to present recent minor updates to the Project Operations Water Balance Model (W&AR-02), the Reservoir Temperature Model (W&AR-03), the Chinook Salmon Population Model (W&AR-06), the *O. mykiss* Population Model (W&AR-10), the Lower Tuolumne River Temperature Model (W&AR-16), and the Lower Tuolumne River Floodplain Hydraulic Assessment (W&AR-21). The meeting will be held at TID's C.C. Wright Hall (formerly the War Memorial Building), located at 247 East Canal Drive in Turlock, CA.

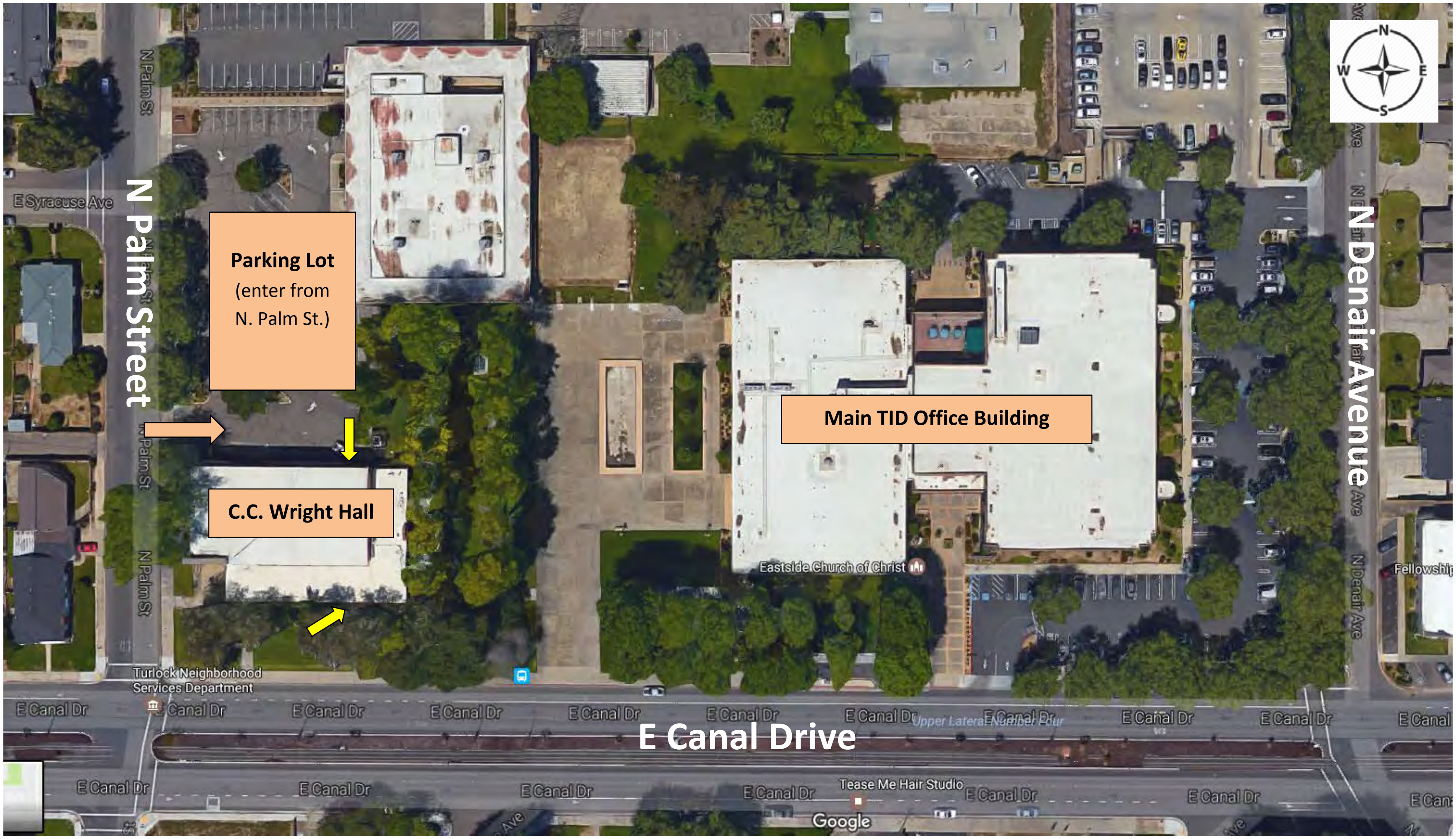
Please find attached the meeting agenda and a map of where C.C. Wright Hall is located and directions for parking. **The Districts strongly encourage participants to attend in-person; although a conference line will be available, acoustics in the room may make it difficult to hear the discussion.**

Rose Staples, CAP-OM, MOS
Senior Administrative Assistant

HDR
970 Baxter Boulevard Suite 301
Portland ME 04103
D 207-239-3857
rose.staples@hdrinc.com

hdrinc.com/follow-us

C.C. Wright Hall, 247 E Canal Drive, Turlock CA



The parking lot north of C.C. Wright Hall is free and open to the public. Individuals may enter C.C. Wright Hall using either the north entrance or the main entrance located off of E Canal Drive.

Don Pedro Relicensing

Modeling Tool Updates

Meeting Agenda

Thursday, May 18, 2017, 1:00 pm to 3:00 pm

C.C. Wright Hall (formerly the War Memorial Building)

247 East Canal Drive, Turlock, California

Conference Line: 1-866-583-7984, Passcode: 230-0743

Join Lync Meeting https://meet.hdrinc.com/jenna.borovansky/3D64F0F5

TIME	TOPIC
1:00 pm - 1:10pm	Introduction of Participants and Goals of Meeting
1:10 pm – 1:40 pm	Project Operations - Water Balance Model (W&AR-02)
1:40 pm – 2:00 pm	Don Pedro Reservoir Temperature Model (W&AR-03)
2:00 pm – 2:10 pm	Lower Tuolumne Temperature Model (W&AR-16)
2:10 pm – 2:50 pm	Chinook Salmon Population Model (W&AR-06)
	Oncorhynchus Mykiss Population Model (W&AR-10)
2:50 pm - 3:00 pm	Floodplain Hydraulic Analysis (W&AR-21)

From: Staples, Rose
Sent: Monday, May 15, 2017 8:02 AM
To: William Foster - NOAA Federal; Deason, Jesse; Le, Bao; Johnson, Laura
Cc: Edmondson, Steve; Jean Castillo - NOAA Federal
Subject: RE: Materials for La Grange May 18 2017 Plenary Group Meeting

Thank you; I will share with the Districts.

Rose Staples, CAP-OM, MOS
D 207-239-3857

hdrinc.com/follow-us

From: William Foster - NOAA Federal [mailto:william.foster@noaa.gov]
Sent: Monday, May 15, 2017 11:00 AM
To: Staples, Rose <Rose.Staples@hdrinc.com>; Deason, Jesse <Jesse.Deason@hdrinc.com>; Le, Bao <ChiBao.Le@hdrinc.com>; Johnson, Laura <Laura.Johnson@hdrinc.com>
Cc: Edmondson, Steve <Steve.Edmondson@noaa.gov>; Jean Castillo - NOAA Federal <jean.castillo@noaa.gov>
Subject: Re: Materials for La Grange May 18 2017 Plenary Group Meeting

Dear Rose and Others:

Below is an update on NMFS' upper Tuolumne River studies.

Status of NMFS' Upper Tuolumne River Studies, May 2017.

In response to requests made during the first and subsequent Fish Passage Workshops to better explain the fish passage decision making process and cooperate in conducting and paying for studies, NMFS competed annually for internal funds to assist in fish passage study efforts. To date we hosted a 2-day public workshop titled: "*Fish Passage Over High Head Dams Workshop*" (presentations posted on-line by the District's consultant); and publicly released the "*Reintroducing Fish Upstream of Rim Dams; Providing Passage to Advance Salmon Recovery in California's Central Valley - Frequently Asked Questions*" document (posted on NMFS web-site). In addition NMFS funded the following studies:

Habitat Assessment and Carrying Capacity Study:

NMFS expects a "non-Public" draft report to be completed in May or June for internal NMFS review.

Fish Passage Engineering Study:

NMFS had a site visit with the Districts and NMFS's consultant, ANCHOR QEA, LLC, on March 14th. Since then the consultant has been gathering, reviewing, and analyzing project data to develop fish passage feasibility concepts that will provide safe, timely, and efficient passage and contribute to the recovery of ESA-listed salmonids in the Central Valley. NMFS anticipates a "non-Public" draft of the conceptual designs from the consultant by the end of June for internal NMFS review.

***O. mykiss* Genetics Study**:

A “non-Public” draft report is expected at the end of June for internal NMFS review.

Thanks, see you at meeting

William E. Foster, M.S., Fishery Biologist
NOAA Fisheries, West Coast Region
California Central Valley Area Office
FERC Branch, Sacramento, CA
(916) 930-3617

From: Staples, Rose
Sent: Tuesday, June 06, 2017 7:41 AM
To: Andrew Morss
Subject: RE: Fish Guidance Systems

Thank you for your interest in the La Grange Licensing. I have added your email address to the Licensing Participants' Email Group.

I will also forward this email to the Districts--in regards to your query about other contacts.

Thank you.

Rose Staples, CAP-OM, MOS
D 207-239-3857

hdrinc.com/follow-us

From: Andrew Morss [redacted]
Sent: Tuesday, June 6, 2017 5:49 AM
To: Staples, Rose <Rose.Staples@hdrinc.com>
Subject: Fish Guidance Systems

Hi Rose

I have been reading about the La Grange project and am interested in registering for the email group.

I work for Fish Guidance Systems, the market leader in behavioural fish deflection and guidance systems.

Over the last 23 years the company has installed over 100 systems around the world, including systems in the USA, Canada, UK, Ireland, Spain, Portugal, Germany, Sweden, Netherlands, China and New Zealand.

One of the main systems supplied by FGS is a Synchronised Intense Light And Sound (SILAS) system combined with a BioAcoustic Fish Fence (BAFF) which provides an effective environmentally friendly solution for fish diversion and fish migration projects.

Our technology has been successfully trialled by the California Department of Water Resources (DWR), achieving an 81% deflection efficiency of Chinook Salmon at the head of Old River and a 91% deflection efficiency of Chinook Salmon at Georgiana Slough.

For each project that we are involved with, we undertake a detailed site survey and then design the exact specification of the required system using acoustic and/or hydraulic modelling, prior to installation and commissioning.

I would be grateful if you can advise if there are further contacts that I should make an introduction to at this stage.

I look forward to hearing from you.

Kind regards

Andy

Andy Morss
Sales Manager
Fish Guidance Systems Ltd
T: +44 (0)1489 880 420 | M: +44 (0)7507 054 094 |E: [redacted] **www.fish-guide.com**

Fish Guidance Systems Ltd, Company Registration Number: 2931612, VAT Number: 631 9251 49
Registered Address: 7 Swanwick Business Centre, Bridge Road, Lower Swanwick, Hampshire,SO31 7GB, UK

From: Staples, Rose
Sent: Monday, June 12, 2017 1:06 PM
To: John Buckley
Subject: RE: question about dates of any upcoming Don Pedro-LaGrange meetings

My apologies for taking so long to respond to your request. I have checked in with the Districts and no firm dates have been set yet for any upcoming meetings. I will let you know as soon as possible once I've been advised of any. Thank you.

Rose Staples, CAP-OM, MOS
D 207-239-3857

hdrinc.com/follow-us

-----Original Message-----
From: John Buckley [mailto:johnb@cserc.org]
Sent: Monday, June 5, 2017 11:40 AM
To: Staples, Rose <Rose.Staples@hdrinc.com>
Subject: Re: question about dates of any upcoming Don Pedro-LaGrange meetings

Hi, Rose:

I am trying to plan ahead to schedule items on my calendar. Do you have any dates of planned meetings for the Don Pedro-LaGrange relicensing process? I would be grateful to get them so I can try to avoid conflicts with other commitments.

Thank you,

John Buckley
CSERC
johnb@cserc.org

From: Andrew Morss [redacted]
Sent: Monday, June 12, 2017 2:28 AM
To: Melissa Williams
Cc: Devine, John; Deason, Jesse
Subject: RE: Fish Guidance Systems

That's great Melissa,

Many thanks

Andy

From: Melissa Williams [mailto:Melissa.Williams@mid.org]
Sent: 06 June 2017 17:48
To: Andrew Morss
Cc: John Devine (John.Devine@hdrinc.com); Staples, Rose; Deason, Jesse (Jesse.Deason@hdrinc.com)
Subject: RE: Fish Guidance Systems

Hi Andrew,
We can definitely add you to our La Grange Licensing email list. Thank you for the information!

Melissa Williams
Public Affairs Manager | Modesto Irrigation District
Office: 209.526.7390 | Cell: 209.652.5383 | www.mid.org

Follow MID on Twitter @mod_irrigation

Modesto Irrigation District
Water and Power

From: Andrew Morss [redacted]
Sent: Tuesday, June 06, 2017 2:51 AM
To: Melissa Williams
Subject: Fish Guidance Systems

Hi Melissa

I have been reading about the La Grange project and am interested in registering for the email group.

I work for Fish Guidance Systems, the market leader in behavioural fish deflection and guidance systems.

Over the last 23 years the company has installed over 100 systems around the world, including systems in the USA, Canada, UK, Ireland, Spain, Portugal, Germany, Sweden, Netherlands, China and New Zealand.

One of the main systems supplied by FGS is a Synchronised Intense Light And Sound (SILAS) system combined with a BioAcoustic Fish Fence (BAFF) which provides an effective environmentally friendly solution for fish diversion and fish migration projects.

Our technology has been successfully trialled by the California Department of Water Resources (DWR), achieving an 81% deflection efficiency of Chinook Salmon at the head of Old River and a 91% deflection efficiency of Chinook Salmon at Georgiana Slough.

For each project that we are involved with, we undertake a detailed site survey and then design the exact specification of the required system using acoustic and/or hydraulic modelling, prior to installation and commissioning.

I would be grateful if you can advise if there are further contacts that I should make an introduction to at this stage.

I look forward to hearing from you.

Kind regards

Andy

Andy Morss
Sales Manager
Fish Guidance Systems Ltd
T: +44 (0)1489 880 420 | M: +44 (0)7507 054 094 |E: [redacted] W: www.fish-guide.com

From: Garello, Michael
Sent: Tuesday, May 02, 2017 5:39 AM
To: Jean Castillo - NOAA Federal (jean.castillo@noaa.gov)
Subject: FW: Schematics of Don Pedro Dam

Jean,

Here is a schematic of the regulating outlet and power generation facility at Don Pedro Dam for your reference. If there are additional questions regarding this drawing, or anything else for that matter, just let me know.

Thank you,

Mike

Michael C. Garello, PE (WA,CA)
Senior Professional Associate - Fisheries

ONEHDRED
1917-2017

HDR
4717 97th Street NW
Gig Harbor, WA 98332-5710
D 253.432.5031 **M** 253.304.7315
mike.garello@hdrinc.com

hdrinc.com/follow-us

From: Jean Castillo - NOAA Federal [mailto:jean.castillo@noaa.gov]
Sent: Wednesday, April 05, 2017 10:21 AM
To: Garello, Michael
Cc: Steve Boyd; Le, Bao; Staples, Rose
Subject: Schematics of Don Pedro Dam

Hello,

When we were on site a conversation came up if we could get some schematics of Don Pedro and the regulating outlet. I remember that someone from the Districts said they would send some.

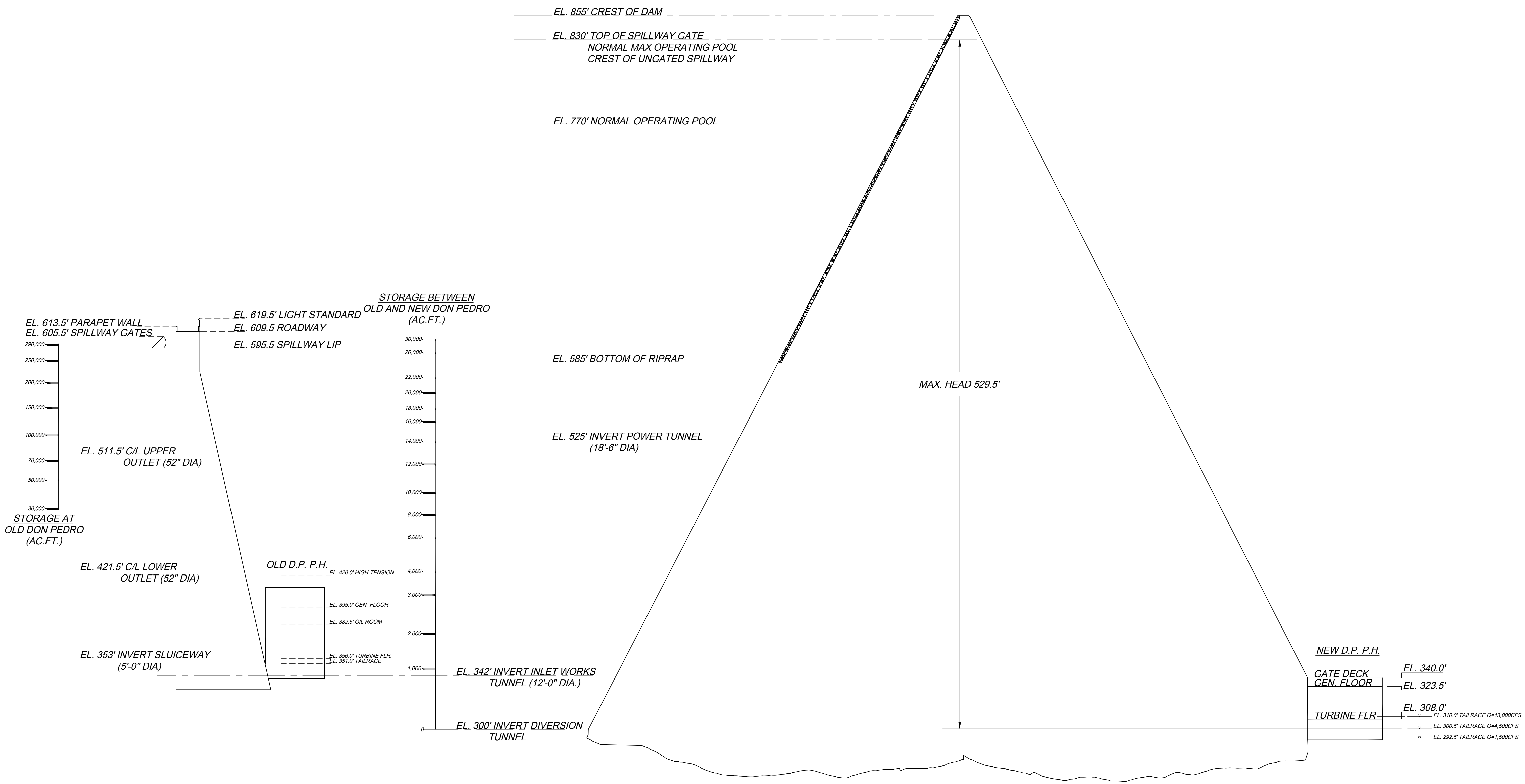
Is this still a possibility? If yes could you please send them to me?

Thank you,

Jean

Jean M. Castillo, MSCE, P.E.
Hydraulic/Fish Passage Engineer

NOAA Fisheries West Coast Region
U.S. Department of Commerce
650 Capitol Mall, Suite 5-100
Sacramento, California 95814-4700
Office: 916-930-3613
jean.castillo@noaa.gov



OLD DON PEDRO DAM

NEW DON PEDRO DAM

SCALE: 1"=40' VERT, NONE HORZ.

REV	DATE	DESCRIPTION	DR	CHK	APP
2	3-13-2013	CONVERTED DRAWING TO CAD DRAWING	ABO		
3	4-28-2013	ADDED MORE ELEV ON OLD DP DAM			
			ABO		

TID WATER & POWER
Serving Central California Since 1887

DON PEDRO

OLD DON PEDRO AND NEW DON PEDRO
ELEVATION COMPARISONS

Dwn: ABO MAR-13-2013
Chk:
Rev:
SCALE: AS-SHOWN
SHEET: 1 OF: 1
Rev:
Rev:
App:
REV 00

PLOTTED:

From: Staples, Rose
Sent: Friday, June 23, 2017 4:28 PM
Cc: Deason, Jesse; Le, Bao; Johnson, Laura; Staples, Rose
Subject: La Grange May 18, 2017 Plenary Group Draft Meeting Notes for Review and Comment

La Grange Licensing Participants,

DRAFT NOTES from the May 18, 2017 Plenary Group meeting have been uploaded to the La Grange Project licensing website www.lagrange-licensing.com in the DOCUMENTS section and also as an attachment to the May 18, 2017 meeting date on the website calendar. Please provide any comments on the draft meeting notes by Monday, July 24, 2017 to me at rose.staples@hdrinc.com.

If you have any difficulties locating and/or accessing the document, please let me know. Thank you.

Rose Staples, CAP-OM, MOS
Senior Administrative Assistant

HDR
970 Baxter Boulevard Suite 301
Portland ME 04103
D 207-239-3857
rose.staples@hdrinc.com

hdrinc.com/follow-us

From: Devine, John
Sent: Friday, June 23, 2017 10:41 AM
To: 'Jean Castillo - NOAA Federal'
Subject: RE: Source for bathymetric/bed profile data?

Hi Jean,

The bathymetry for this reach is part of what we are pulling together for NMFS. Unfortunately, we do not have a HEC-RAS model of this reach.

From: Jean Castillo - NOAA Federal [mailto:jean.castillo@noaa.gov]
Sent: Wednesday, June 21, 2017 5:54 PM
To: Devine, John
Subject: Fwd: Source for bathymetric/bed profile data?

Hi John,

Sorry for all of the requests.... but, do you have a the topographical information for the cross-sections in the attached image? Might you have a HEC-RAS model for this reach?

Sincere regards,
Jean

Jean M. Castillo, **MSCE, P.E.**
Hydraulic/Fish Passage Engineer

NOAA Fisheries West Coast Region
U.S. Department of Commerce
650 Capitol Mall, Suite 5-100
Sacramento, California 95814-4700
Office: 916-930-3613
jean.castillo@noaa.gov

---------- Forwarded message ----------
From: **Larry Swenson** [redacted]
Date: Tue, Jun 20, 2017 at 9:59 AM
Subject: Source for bathymetric/bed profile data?
To: "jean.castillo@noaa.gov" <jean.castillo@noaa.gov>

[redacted]

Hi, Jean

Check out the attached report. See Figure 2.0-1.

I have attached that table. See the area I marked out with the red lines. Could we get the data from those cross sections? Would be very helpful.

Thanks,

Larry

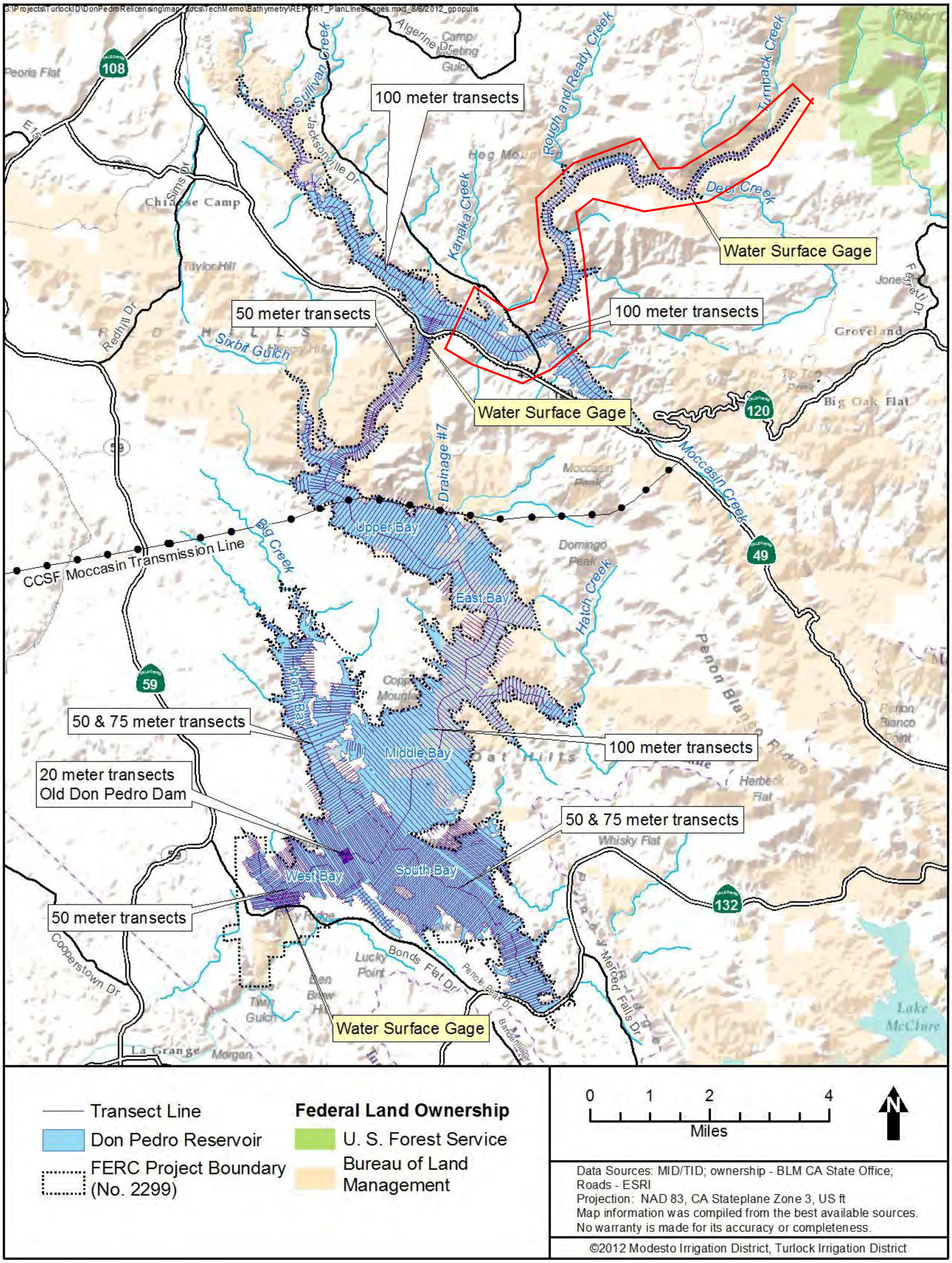
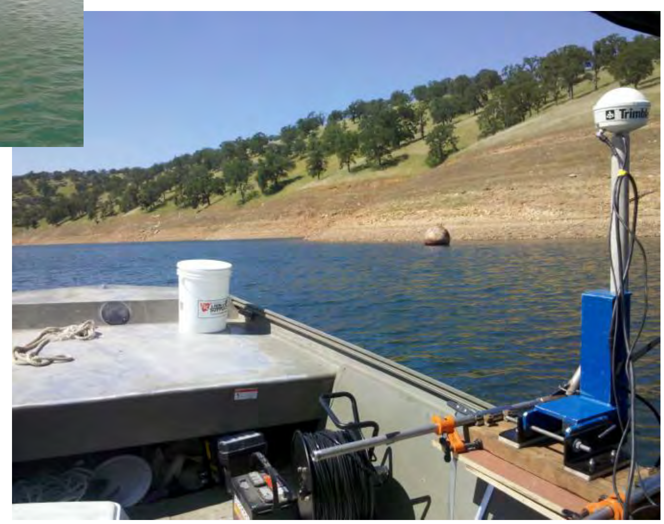


Figure 2.0-1. Don Pedro bathymetry survey plan transects and water surface gages.

DON PEDRO RESERVOIR BATHYMETRIC STUDY REPORT



Prepared for:

TURLOCK IRRIGATION DISTRICT
MODESTO IRRIGATION DISTRICT AND
Turlock and Modesto, California

Prepared by:

HDR ENGINEERING, INC.
Sacramento, California

October 2012

Don Pedro Project
FERC No. 2299

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BATHYMETRIC STUDY REPORT

1.0 Objectives

The objective of this study was to develop an accurate reservoir geometry for the Turlock Irrigation District and Modesto Irrigation District (collectively, the “Districts”) Don Pedro Reservoir (FERC No. 2299). The resulting reservoir geometry is also used to update the reservoir’s elevation-storage curve and provide data on existing conditions for inclusion in the three-dimensional (“3-D”) reservoir temperature model under development in support of the FERC relicensing of the Don Pedro Project (“Project”).

2.0 Study Area

The study area consists of Don Pedro Reservoir located in Tuolumne County, California, on the Tuolumne River (Figure 2.0-1). Based on Engineer’s estimates developed prior to the construction of the Project, at the normal maximum pool elevation of 830 feet (ft) (NGVD 29), Don Pedro Reservoir has a surface area of 12,960 acres and stores 2,030,000 acre-feet of water (ACOE 1972).

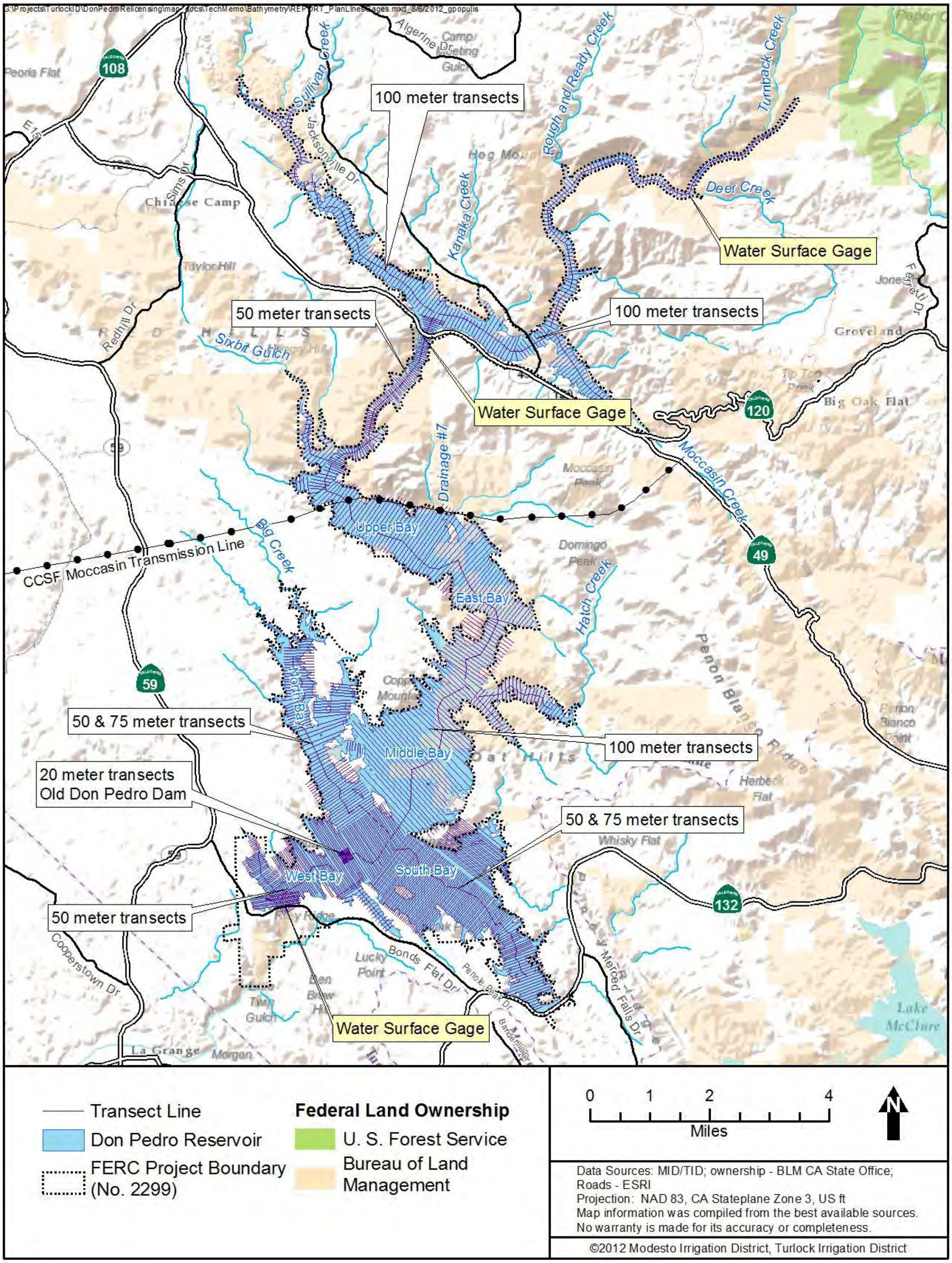

Figure 2.0-1. Don Pedro bathymetry survey plan transects and water surface gages.

3.0 Methods

Bathymetry below the full pool elevation of 830 ft was determined by two techniques: underwater surfaces were surveyed using field measurements (Section 3.1) and topographic information for surfaces above the water were obtained using radar technology (Section 3.2). Data obtained by the two techniques were synthesized into one surface using geographic information system (GIS) software (Section 3.3). Quality assurance and quality control practices are described in Section 3.4.

3.1 Field Survey

The field survey was performed over 16 days between May 1 and June 5, 2011, from a flat-bottom aluminum Johnboat with an outboard motor. This time period was selected due to the relatively high water levels, relatively calm weather, and low amount of recreational boater activity.

During the bathymetric data collection, Don Pedro Reservoir's water surface elevation ranged from approximately 792 ft to 805 ft. Depth data for Don Pedro Reservoir was collected using an Airmar B258 1-kW dual frequency transducer and a Foruno FCV-585 digital depth sounder (with real-time depth profile display) connected to a Trimble PRO-XR GPS and TSC1 Data Collector, capable of providing a real time differential Global Positioning System ("DGPS") data stream. The depth sounder's transducer was mounted onto the side of the boat and lowered 0.3 ft below the surface of the water. The GPS dome antenna was mounted on a platform above the level of the boat. The accuracy of the B258 transducer was ± 0.1 foot of depth (for depths roughly 4 ft or greater) and the accuracy of the PRO-XR GPS receiver was less than one meter of linear distance (with optimal satellite coverage).

Soundings were taken at approximately 1-second intervals and the boat speed was set to ensure that bottom features were appropriately sampled. The boat was navigated along the transect lines using the DGPS, and the position of each sounding was determined using the DGPS system. All depth and horizontal positioning data were recorded digitally in the field as a series of points with x-y-z coordinates, using a rugged field notebook personal computer, running Hypack Hydrographic Survey software.

A total of 1152 transects, spaced at 50, 75, 100 meter intervals and oriented approximately perpendicular to the longitudinal axis of the reservoir, were pre-located and created using Hypack. Areas of topographical concern, such as the Old Don Pedro Dam, were surveyed with greater density for added resolution. In addition to the standard transects, perpendicular "tie lines", oriented approximately parallel to the longitudinal axis of the reservoir and its tributary arms, were established to ensure inter-transect data consistency. A Furuno real-time depth profile display was deployed to identify and navigate areas of topographical concern including confined coves and bars that were found while performing routine grid transects. Transects covered the entire reservoir at the water surface elevation during the time of the field data collection (Figure 2.0-1).

Once all the data were collected, the sounder depth records were edited in Microsoft Excel to remove all but the necessary data to be matched up with a DGPS location and depths were corrected for submergence of the transducer, i.e. the "draft" or the depth from the water surface to the face of the transducer.

Reservoir water level elevations were measured throughout the study from three gages. Water surface elevations near the dam of the reservoir are routinely measured and recorded hourly by TID.[1] For this study, water surface elevation gages were also installed at two other locations, where existing benchmarks provided vertical control for combining all elevation data to a common datum: (1) the Highway 120/49 Bridge across Railroad Canyon (NGS E1389),[2] and (2) the Wards Ferry Bridge (NGS HS4439).[3] All vertical control measurements were then converted to match the vertical datum of the gage at Don Pedro Dam. These reservoir elevations were incorporated into the bathymetric model to adjust each reservoir depth measurement across the reservoir for changes in water surface elevation between the beginning and end of each survey period to the reservoir datum.

The potential existed for an energy slope to form on the surface of Don Pedro Reservoir, as relatively large rates of inflow were observed at the time of the survey.[4] (When an energy slope is present, a reservoir's water surface elevation increases from downstream to upstream.) Hence, on May 5, 2011, a water surface elevation logger (WSEL) was surveyed near the upper end of the reservoir using the monuments at the Highway 120/49 Bridge and at Wards Ferry Bridge. Water surface elevations as detected by the new logger were then compared to the water level as detected by the gage at Don Pedro Dam. After analyzing the collected water level information, it was determined that there was not a measurable energy gradient during the period of survey. Hence, for the purpose of this data collection effort, the water surface of Don Pedro Reservoir was assumed to be flat.

3.2 IFSAR

Topographic information above 792 ft was obtained by interferometric synthetic aperture radar (IFSAR), which was collected by the vendor Intermap during August 2004. The water surface of the reservoir at the time the IFSAR data were collected was 760 ft and the resulting Digital Terrain Model (DTM) extends upwards to well above the reservoir's full pool elevation of 830 ft.

3.3 Surface Model Generation

A contour line at the normal maximum water surface elevation of 830 ft was generated using a GIS contouring tool with the IFSAR DTM. It was visually checked and modified as needed using a horizontally more accurate hi-resolution aerial image.

1 http://www.tid.org/water/hydrological-data
2 http://www.ngs.noaa.gov/cgi-bin/ds_mark.prl?PidBox=HS1389
3 http://www.ngs.noaa.gov/cgi-bin/ds_mark.prl?PidBox=HS4439
4 Inflows to Don Pedro Reservoir ranged from 5,192 cfs to 12,652 cfs during this study (http://cdec.water.ca.gov/).

The bathymetric survey point data were imported into ESRI ArcGIS Desktop software where the point data was integrated with the IFSAR DTM data to make a continuous network of points below the normal maximum water surface contour. That network of points was used develop a network of bottom lines or thalwegs. The points, the bottom lines and the normal maximum water surface contour were then used as input for the ESRI surface interpolation tool "Topo to Raster". The Old Don Pedro Dam was located during the survey and construction drawings of that dam[5] were useful to integrate that feature into the interpolated surface. Contours at 10 ft intervals were then inferred using ESRI contouring tools. The result of this analysis was a continuous surface model that will be used as input to the 3-D reservoir temperature model.

3.4 Quality Assurance and Quality Control

Data quality was assured by following manufacturer's instructions and periodically verifying data values through an alternative measurement (in the field) and third-party review (in the office). Throughout the field survey, the depths measured by the sounder were periodically compared to the actual depth. The actual depth was measured by either lowering a "bar" beneath the sounder or by direct measurement of the bottom with a lead line or pole. Measurement of the "draft" or the depth from the water surface to the face of the transducer was also periodically recorded.

Quality Assurance of the bathymetric surface was performed by an independent reviewer following three steps. The first step consisted of a review of the field methods and materials. The second step consisted of checking the edited raw data. Finally, the third step consisted of verifying the methods used in the production of the final deliverable.

Review of field methods included a review of the "bar checks" performed in the field and described above. In addition, specifications of the sounder and DGPS used in the survey were reviewed to confirm the accuracy of the data as reported. The water surface elevation data at the three gages were also checked for consistency.

Next the processing of the raw data was checked. Any data with DGPS errors or sounding errors that had been flagged by the modeler were checked to confirm that the deletion was appropriate prior to interpolation. Soundings were spot checked for consistency. The crossing of transects and tie-lines was reviewed to ensure that the sounder recorded similar depths at the intersection of survey lines. If any sharp differences in depth at adjacent points were present, they were identified as either an error or a real feature.

The last step was check of the final bathymetric surface (Attachment A). Once the field methods and raw data were reviewed, the production of contours from a bathymetric surface was checked. Calculation of the bottom elevation from sounding depths was reviewed to ensure corrections for the draft and varying water surface elevation were properly accounted for. The method of interpolation and settings used in the interpolation was reviewed to ensure that reasonable contours were generated. Contours created using interpolation were checked against actual soundings to verify that the interpolated surface is reasonable. Finally, contours were checked

5 TID and MID 1920

against the original elevation-storage curve, as well as historical United States Geological Survey (USGS) maps.

4.0 Results and Analysis

Don Pedro Reservoir contours at 10-ft intervals are displayed along with a shaded relief of the surface in a series of maps at the end of this report (Figures 1 through 15 in Attachment B).

Using the survey data, reservoir volume was calculated in one-foot contour intervals from the bottom of the reservoir to the normal full pool elevation. The calculated storage using the new bathymetry data is compared to the original storage capacity information in Table 4.0-1 and Figure 4.0-1. The original elevation-storage curve indicated that Don Pedro Reservoir at the time of its construction had a total storage capacity of 2,030,000 acre-feet of water at elevation 830 ft (ACOE 1972), while the new bathymetric surface indicates the reservoir holds 2,014,306 acre-feet at that elevation—a difference of less than 1 percent.

Table 4.0-1. Don Pedro Reservoir volume comparison between original elevation storage curve and 2011 bathymetry survey data.

	Cumulative Volume (ac-ft)				Incremental	
Elevation (ft)	Original Storage Curve[1]	2011 Bathymetry Survey	Gain (Loss) in Total Storage[2]	Percent Gain/Loss of Total Storage	Gain (Loss) in Total Storage[2]	Percent
550	158731	158578	(153)	-0.01%	(153)	-0.10%
570	212870	211023	(1,847)	-0.09%	(1,694)	-0.80%
590	274760	272508	(2,252)	-0.11%	(405)	-0.15%
620	384060	382330	(1,730)	-0.09%	523	0.14%
650	517450	516849	(601)	-0.03%	1,129	0.22%
680	678950	677807	(1,143)	-0.06%	(542)	-0.08%
710	869700	867442	(2,258)	-0.11%	(1,116)	-0.13%
740	1094900	1090096	(4,804)	-0.24%	(2,545)	-0.23%
770	1359200	1350810	(8,390)	-0.41%	(3,586)	-0.26%
800	1669000	1657028	(11,972)	-0.59%	(3,582)	-0.21%
830	2030000	2014306	(15,694)	-0.77%	(3,722)	-0.18%

[1]ACOE 1972 Flood Control Manual
[2] Original Survey Volume at Elevation – 2011 Survey Volume at Same Elevation

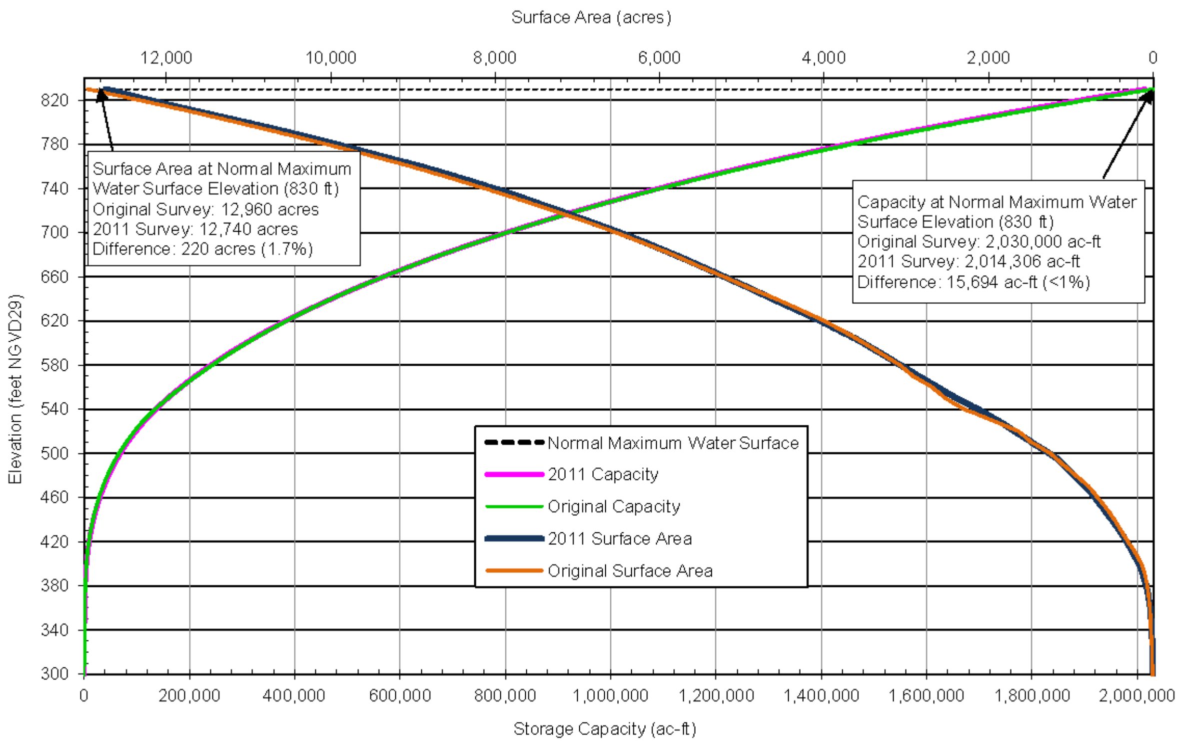

Figure 4.0-1. Don Pedro Reservoir area-capacity curves (reference data: ACOE 1972; 2011 bathymetry study).

5.0 Discussion

As demonstrated in Section 4.0, the storage volumes provided by the original elevation-storage curve and the new bathymetric surface differ by less than 1%. It is recognized that the two estimates were developed based on different survey methods and bathymetric surface calculation methodologies. Other than the elevation-storage curve itself, the input data used to generate the ACOE 1972 curve were not available. However, both methods relied on engineering standards for computations in use at the time of survey, indicating an appropriate level of computational rigor was applied to both estimates. Therefore, it is reasonable to conclude that, for all intents and purposes, the 2011 survey substantially confirms the 1972 elevation-storage information and that any loss of storage in the Don Pedro Reservoir since Project construction can be considered to be minimal.

6.0 References

ACOE. 1972. Report on Reservoir Regulation for Flood Control. Appendix A Flood Control Regulations. Don Pedro Dam and Lake, Tuolumne River, California. Department of the Army. Sacramento District, Corps of Engineers. Sacramento, California. August.

Barnes, D.H. 1987. The Greening of Paradise Valley. The first 100 years (1887-1987) of the Modesto Irrigation District. Commissioned by the Modesto Irrigation District in recognition of its centennial year. 233 pp. Available on line at: http://www.mid.org/about/history/default.html

Environmental Science Research Institute ArcGIS 10. Available online at: <http://help.arcgis.com/en/ arcgisdesktop/10.0/help/index.html>.

Intermap. Available online at: <http://www.intermap.com/>.

TID and MID, 1920. Don Pedro Dam. General Plan of Dam and Spillway. 1 inch = 20 and 40 feet. R.V. Miekle, Chief Engineer. Sheet Number 15 of 42. September. TID file 1-149.

From: Staples, Rose
Sent: Tuesday, June 27, 2017 3:02 PM
To: Castillo, Jean - NOAA <jean.castillo@noaa.gov>
Subject: Don Pedro - La Grange Projects Data Requests

Jean, information related to your recent data requests has been compiled and placed on a thumb drive which we will be mailing to you today via FEDEX two-day shipping. A letter summarizing the contents of this thumb drive is attached to this email. Regarding item no. 6 in the letter, given the clarification you provided on June 20, the bathymetric information provided on the thumb drive should satisfy your request.

Regarding the temperature information you requested on June 20, the Districts will follow up on this request via a separate email.

Thank you.

Rose Staples, CAP-OM, MOS
Senior Administrative Assistant

HDR
970 Baxter Boulevard Suite 301
Portland ME 04103
D 207-239-3857
rose.staples@hdrinc.com

hdrinc.com/follow-us

June 27, 2017

Jean M. Castillo
National Marine Fisheries Service
650 Capitol Mall
Suite 5-100
Sacramento, CA 95814-4700

Subject: Don Pedro Project and La Grange Project data request

Dear Ms. Castillo:

Per your request, a thumb drive (TD) containing data relevant to the Don Pedro Project and the La Grange Project has been prepared. This TD was mailed to you on June 27, 2017. The table below summarizes your recent data requests and the contents of this TD.

No.	Requested Data	Status
1	La Grange LiDAR and Survey Data from report	Data is on the TD. See folder **LG_LiDAR_Survey_Data**
2	Don Pedro bathymetry data and Don Pedro thalweg profile from RM 70 to 82	Data is on the TD. See file **Bathymetry_TuolumneRiver.pdf** Note: A Don Pedro thalweg profile may be derived from this data.
3	Schematics of Don Pedro Dam and the regulating outlet	Data is on the TD. See file **DP_Schematic.pdf**
4	Drawings of the following La Grange features: 1. Tunnel structure 2. Forebay structure at upstream end of penstock 3. Sluice gates for powerhouse bypass 4. Penstocks and supports 5. Bank retaining wall 6. Switchyard/substation structure 7. Overhead utilities 8. Underground utilities and grounding 9. Powerhouse and draft tubes 10. Tailrace training wall	Data request is no longer applicable. On June 22, Ms. Castillo confirmed she had already obtained these drawings from FERC.
5	La Grange tailwater rating curve for the powerhouse over a range of flows (50-7,500 cfs)	Data is on the TD. See file **Tailwater_at_LG_PH.jpg**
6	Profile of the river upstream of Don Pedro Reservoir and upriver from Wards Ferry	On June 19, the Districts sent an email to Ms. Castillo requesting clarification about this data request. Until a response is received, the Districts consider this data request to be on hold.

If you have any questions about this letter or the TD, please contact the individuals below.

Sincerely,

Steve Boyd
Turlock Irrigation District
P.O. Box 949
Turlock, CA 95381
(209) 883-8364
seboyd@tid.org

Anna Brathwaite
Modesto Irrigation District
P.O. Box 4060
Modesto, CA 95352
(209) 526-7384
anna.brathwaite@mid.org

From: Staples, Rose
Sent: Wednesday, July 05, 2017 8:56 AM
To: Castillo, Jean - NOAA
Subject: Don Pedro - La Grange Projects Data Requests
Attachments: TR above NFT_Tw_2015-16.pdf

In regards to the temperature information you requested on June 20th, please find attached water temperature data for the Tuolumne River above North Fork. It is my understanding that the data is for the period April 29, 2015 to October 4, 2016.

Rose Staples, CAP-OM, MOS
Senior Administrative Assistant

HDR
970 Baxter Boulevard Suite 301
Portland ME 04103
D 207-239-3857
rose.staples@hdrinc.com

hdrinc.com/follow-us

4/29/2015 9:30	15.855
4/29/2015 9:45	15.187
4/29/2015 10:00	15.187
4/29/2015 10:15	15.282
4/29/2015 10:30	15.378
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4/29/2015 12:30	16.523
4/29/2015 12:45	16.618
4/29/2015 13:00	16.713
4/29/2015 13:15	16.808
4/29/2015 13:30	16.903
4/29/2015 13:45	16.999
4/29/2015 14:00	17.094
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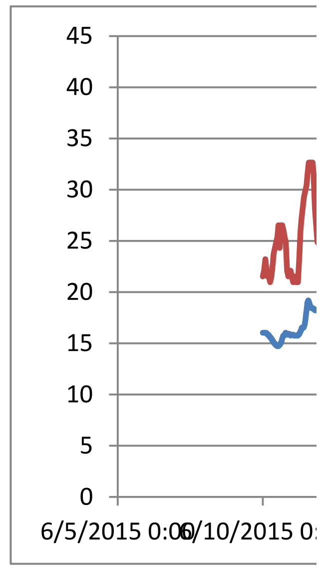

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6/16/2015 6:45	19.27	24.87375	6/15/2015 3:00
6/16/2015 7:00	19.175	24.87375	6/15/2015 4:00
6/16/2015 7:15	19.127	24.3182	6/15/2015 5:00
6/16/2015 7:30	19.056	26.54042	6/15/2015 6:00
6/16/2015 7:45	18.985	30.42931	6/15/2015 7:00
6/16/2015 8:00	18.913	32.09597	6/15/2015 8:00
6/16/2015 8:15	18.913	34.3182	6/15/2015 9:00
6/16/2015 8:30	19.008	33.76264	6/15/2015 10:00
6/16/2015 8:45	19.127	34.87375	6/15/2015 11:00

6/16/2015 9:00	19.199	35.42931	6/15/2015 12:00
6/16/2015 9:15	19.294	35.98486	6/15/2015 13:00
6/16/2015 9:30	19.436	35.42931	6/15/2015 14:00
6/16/2015 9:45	19.555	35.42931	6/15/2015 15:00
6/16/2015 10:00	19.77	34.87375	6/15/2015 16:00
6/16/2015 10:15	20.126	33.76264	6/15/2015 17:00
6/16/2015 10:30	20.341	32.65153	6/15/2015 18:00
6/16/2015 10:45	20.46	29.87375	6/15/2015 19:00
6/16/2015 11:00	20.507	27.09597	6/15/2015 20:00
6/16/2015 11:15	20.698	25.98486	6/15/2015 21:00
6/16/2015 11:30	20.913	25.98486	6/15/2015 22:00
6/16/2015 11:45	21.127	24.3182	6/15/2015 23:00
6/16/2015 12:00	21.294	23.76264	6/16/2015 0:00
6/16/2015 12:15	21.461	23.20709	6/16/2015 1:00
6/16/2015 12:30	21.581	23.76264	6/16/2015 2:00
6/16/2015 12:45	21.724	23.76264	6/16/2015 3:00
6/16/2015 13:00	21.843	23.76264	6/16/2015 4:00
6/16/2015 13:15	21.939	23.76264	6/16/2015 5:00
6/16/2015 13:30	22.034	25.42931	6/16/2015 6:00
6/16/2015 13:45	22.178	27.65153	6/16/2015 7:00
6/16/2015 14:00	22.274	31.54042	6/16/2015 8:00
6/16/2015 14:15	22.154	33.20709	6/16/2015 9:00
6/16/2015 14:30	22.226	35.98486	6/16/2015 10:00
6/16/2015 14:45	22.489	34.87375	6/16/2015 11:00
6/16/2015 15:00	22.537	34.3182	6/16/2015 12:00
6/16/2015 15:15	22.489	34.87375	6/16/2015 13:00
6/16/2015 15:30	22.537	35.42931	6/16/2015 14:00
6/16/2015 15:45	22.25	34.87375	6/16/2015 15:00
6/16/2015 16:00	22.082	35.42931	6/16/2015 16:00
6/16/2015 16:15	22.13	34.87375	6/16/2015 17:00
6/16/2015 16:30	22.178	33.76264	6/16/2015 18:00
6/16/2015 16:45	22.226	30.42931	6/16/2015 19:00
6/16/2015 17:00	22.25	28.20709	6/16/2015 20:00
6/16/2015 17:15	22.274	27.09597	6/16/2015 21:00
6/16/2015 17:30	22.25	26.54042	6/16/2015 22:00
6/16/2015 17:45	22.202	25.42931	6/16/2015 23:00
6/16/2015 18:00	22.178	25.42931	6/17/2015 0:00
6/16/2015 18:15	22.13	24.87375	6/17/2015 1:00
6/16/2015 18:30	22.058	24.3182	6/17/2015 2:00
6/16/2015 18:45	21.939	24.3182	6/17/2015 3:00
6/16/2015 19:00	21.748	23.76264	6/17/2015 4:00
6/16/2015 19:15	21.533	24.3182	6/17/2015 5:00
6/16/2015 19:30	21.342	26.54042	6/17/2015 6:00
6/16/2015 19:45	21.175	30.42931	6/17/2015 7:00
6/16/2015 20:00	21.032	30.98486	6/17/2015 8:00
6/16/2015 20:15	20.936	33.20709	6/17/2015 9:00
6/16/2015 20:30	20.865	35.98486	6/17/2015 10:00

6/16/2015 20:45	20.793	35.98486	6/17/2015 11:00
6/16/2015 21:00	20.746	36.54042	6/17/2015 12:00
6/16/2015 21:15	20.722	35.98486	6/17/2015 13:00
6/16/2015 21:30	20.698	36.54042	6/17/2015 14:00
6/16/2015 21:45	20.674	36.54042	6/17/2015 15:00
6/16/2015 22:00	20.65	36.54042	6/17/2015 16:00
6/16/2015 22:15	20.627	35.98486	6/17/2015 17:00
6/16/2015 22:30	20.603	34.87375	6/17/2015 18:00
6/16/2015 22:45	20.579	31.54042	6/17/2015 19:00
6/16/2015 23:00	20.555	29.3182	6/17/2015 20:00
6/16/2015 23:15	20.507	28.20709	6/17/2015 21:00
6/16/2015 23:30	20.436	27.65153	6/17/2015 22:00
6/16/2015 23:45	20.388	26.54042	6/17/2015 23:00
6/17/2015 0:00	20.341	25.98486	6/18/2015 0:00
6/17/2015 0:15	20.317	25.42931	6/18/2015 1:00
6/17/2015 0:30	20.269	24.87375	6/18/2015 2:00
6/17/2015 0:45	20.246	24.87375	6/18/2015 3:00
6/17/2015 1:00	20.246	24.87375	6/18/2015 4:00
6/17/2015 1:15	20.222	25.42931	6/18/2015 5:00
6/17/2015 1:30	20.198	26.54042	6/18/2015 6:00
6/17/2015 1:45	20.198	30.98486	6/18/2015 7:00
6/17/2015 2:00	20.198	32.09597	6/18/2015 8:00
6/17/2015 2:15	20.198	34.3182	6/18/2015 9:00
6/17/2015 2:30	20.198	34.87375	6/18/2015 10:00
6/17/2015 2:45	20.174	34.87375	6/18/2015 11:00
6/17/2015 3:00	20.174	35.42931	6/18/2015 12:00
6/17/2015 3:15	20.15	35.98486	6/18/2015 13:00
6/17/2015 3:30	20.126	37.09597	6/18/2015 14:00
6/17/2015 3:45	20.079	35.42931	6/18/2015 15:00
6/17/2015 4:00	20.031	34.87375	6/18/2015 16:00
6/17/2015 4:15	19.984	34.3182	6/18/2015 17:00
6/17/2015 4:30	19.936	32.65153	6/18/2015 18:00
6/17/2015 4:45	19.865	29.3182	6/18/2015 19:00
6/17/2015 5:00	19.793	26.54042	6/18/2015 20:00
6/17/2015 5:15	19.698	25.42931	6/18/2015 21:00
6/17/2015 5:30	19.627	24.87375	6/18/2015 22:00
6/17/2015 5:45	19.532	24.87375	6/18/2015 23:00
6/17/2015 6:00	19.46	24.3182	6/19/2015 0:00
6/17/2015 6:15	19.365	23.76264	6/19/2015 1:00
6/17/2015 6:30	19.294	24.3182	6/19/2015 2:00
6/17/2015 6:45	19.222	24.3182	6/19/2015 3:00
6/17/2015 7:00	19.175	23.20709	6/19/2015 4:00
6/17/2015 7:15	19.103	23.20709	6/19/2015 5:00
6/17/2015 7:30	19.032	25.42931	6/19/2015 6:00
6/17/2015 7:45	19.008	28.20709	6/19/2015 7:00
6/17/2015 8:00	18.985	32.09597	6/19/2015 8:00
6/17/2015 8:15	19.008	33.20709	6/19/2015 9:00

6/17/2015 8:30	19.032	34.3182	6/19/2015 10:00
6/17/2015 8:45	19.08	34.3182	6/19/2015 11:00
6/17/2015 9:00	19.175	35.42931	6/19/2015 12:00
6/17/2015 9:15	19.318	35.42931	6/19/2015 13:00
6/17/2015 9:30	19.436	35.98486	6/19/2015 14:00
6/17/2015 9:45	19.603	35.98486	6/19/2015 15:00
6/17/2015 10:00	19.817	36.54042	6/19/2015 16:00
6/17/2015 10:15	20.174	35.42931	6/19/2015 17:00
6/17/2015 10:30	20.46	33.76264	6/19/2015 18:00
6/17/2015 10:45	20.555	30.42931	6/19/2015 19:00
6/17/2015 11:00	20.531	27.65153	6/19/2015 20:00
6/17/2015 11:15	20.603	26.54042	6/19/2015 21:00
6/17/2015 11:30	20.603	25.98486	6/19/2015 22:00
6/17/2015 11:45	20.603	25.98486	6/19/2015 23:00
6/17/2015 12:00	20.65	25.42931	6/20/2015 0:00
6/17/2015 12:15	20.841	25.42931	6/20/2015 1:00
6/17/2015 12:30	21.223	25.42931	6/20/2015 2:00
6/17/2015 12:45	21.39	25.42931	6/20/2015 3:00
6/17/2015 13:00	21.557	25.42931	6/20/2015 4:00
6/17/2015 13:15	21.7	25.42931	6/20/2015 5:00
6/17/2015 13:30	21.795	26.54042	6/20/2015 6:00
6/17/2015 13:45	21.843	29.87375	6/20/2015 7:00
6/17/2015 14:00	21.987	32.09597	6/20/2015 8:00
6/17/2015 14:15	22.154	33.76264	6/20/2015 9:00
6/17/2015 14:30	22.25	34.87375	6/20/2015 10:00
6/17/2015 14:45	22.369	35.98486	6/20/2015 11:00
6/17/2015 15:00	22.537	35.98486	6/20/2015 12:00
6/17/2015 15:15	22.633	35.98486	6/20/2015 13:00
6/17/2015 15:30	22.705	37.65153	6/20/2015 14:00
6/17/2015 15:45	22.824	37.09597	6/20/2015 15:00
6/17/2015 16:00	22.92	36.54042	6/20/2015 16:00
6/17/2015 16:15	22.992	34.87375	6/20/2015 17:00
6/17/2015 16:30	23.016	32.65153	6/20/2015 18:00
6/17/2015 16:45	23.064	31.54042	6/20/2015 19:00
6/17/2015 17:00	23.088	28.76264	6/20/2015 20:00
6/17/2015 17:15	23.088	28.20709	6/20/2015 21:00
6/17/2015 17:30	23.04	27.65153	6/20/2015 22:00
6/17/2015 17:45	23.016	26.54042	6/20/2015 23:00
6/17/2015 18:00	22.944	27.65153	6/21/2015 0:00
6/17/2015 18:15	22.848	25.98486	6/21/2015 1:00
6/17/2015 18:30	22.753	27.09597	6/21/2015 2:00
6/17/2015 18:45	22.657	27.09597	6/21/2015 3:00
6/17/2015 19:00	22.561	25.42931	6/21/2015 4:00
6/17/2015 19:15	22.441	24.3182	6/21/2015 5:00
6/17/2015 19:30	22.298	24.87375	6/21/2015 6:00
6/17/2015 19:45	22.178	28.20709	6/21/2015 7:00
6/17/2015 20:00	22.082	30.42931	6/21/2015 8:00

6/17/2015 20:15	22.011	32.09597	6/21/2015 9:00
6/17/2015 20:30	21.939	32.65153	6/21/2015 10:00
6/17/2015 20:45	21.867	32.09597	6/21/2015 11:00
6/17/2015 21:00	21.843	32.65153	6/21/2015 12:00
6/17/2015 21:15	21.795	33.20709	6/21/2015 13:00
6/17/2015 21:30	21.724	33.76264	6/21/2015 14:00
6/17/2015 21:45	21.652	34.3182	6/21/2015 15:00
6/17/2015 22:00	21.628	33.76264	6/21/2015 16:00
6/17/2015 22:15	21.604	32.09597	6/21/2015 17:00
6/17/2015 22:30	21.581	30.42931	6/21/2015 18:00
6/17/2015 22:45	21.557	27.65153	6/21/2015 19:00
6/17/2015 23:00	21.509	24.87375	6/21/2015 20:00
6/17/2015 23:15	21.485	24.3182	6/21/2015 21:00
6/17/2015 23:30	21.39	24.3182	6/21/2015 22:00
6/17/2015 23:45	21.366	23.76264	6/21/2015 23:00
6/18/2015 0:00	21.294	22.65153	6/22/2015 0:00
6/18/2015 0:15	21.223	22.65153	6/22/2015 1:00
6/18/2015 0:30	21.175	22.65153	6/22/2015 2:00
6/18/2015 0:45	21.127	23.20709	6/22/2015 3:00
6/18/2015 1:00	21.079	22.65153	6/22/2015 4:00
6/18/2015 1:15	21.008	24.3182	6/22/2015 5:00
6/18/2015 1:30	20.913	25.42931	6/22/2015 6:00
6/18/2015 1:45	20.841	27.65153	6/22/2015 7:00
6/18/2015 2:00	20.793	29.87375	6/22/2015 8:00
6/18/2015 2:15	20.746	32.09597	6/22/2015 9:00
6/18/2015 2:30	20.722	33.76264	6/22/2015 10:00
6/18/2015 2:45	20.674	33.76264	6/22/2015 11:00
6/18/2015 3:00	20.627	34.3182	6/22/2015 12:00
6/18/2015 3:15	20.579	34.3182	6/22/2015 13:00
6/18/2015 3:30	20.531	34.3182	6/22/2015 14:00
6/18/2015 3:45	20.46	33.76264	6/22/2015 15:00
6/18/2015 4:00	20.412	34.3182	6/22/2015 16:00
6/18/2015 4:15	20.341	32.65153	6/22/2015 17:00
6/18/2015 4:30	20.269	32.09597	6/22/2015 18:00
6/18/2015 4:45	20.222	28.76264	6/22/2015 19:00
6/18/2015 5:00	20.126	25.98486	6/22/2015 20:00
6/18/2015 5:15	20.079	25.42931	6/22/2015 21:00
6/18/2015 5:30	20.079	24.87375	6/22/2015 22:00
6/18/2015 5:45	20.031	23.76264	6/22/2015 23:00
6/18/2015 6:00	19.984	23.76264	6/23/2015 0:00
6/18/2015 6:15	19.936	23.20709	6/23/2015 1:00
6/18/2015 6:30	19.841	23.20709	6/23/2015 2:00
6/18/2015 6:45	19.746	22.65153	6/23/2015 3:00
6/18/2015 7:00	19.698	22.65153	6/23/2015 4:00
6/18/2015 7:15	19.674	23.20709	6/23/2015 5:00
6/18/2015 7:30	19.651	24.87375	6/23/2015 6:00
6/18/2015 7:45	19.627	27.09597	6/23/2015 7:00

6/18/2015 8:00	19.651	30.98486	6/23/2015 8:00
6/18/2015 8:15	19.722	32.65153	6/23/2015 9:00
6/18/2015 8:30	19.865	33.76264	6/23/2015 10:00
6/18/2015 8:45	20.007	33.20709	6/23/2015 11:00
6/18/2015 9:00	20.15	33.20709	6/23/2015 12:00
6/18/2015 9:15	20.293	33.76264	6/23/2015 13:00
6/18/2015 9:30	20.436	33.76264	6/23/2015 14:00
6/18/2015 9:45	20.603	34.87375	6/23/2015 15:00
6/18/2015 10:00	20.817	35.42931	6/23/2015 16:00
6/18/2015 10:15	21.079	34.87375	6/23/2015 17:00
6/18/2015 10:30	21.318	32.65153	6/23/2015 18:00
6/18/2015 10:45	21.437	29.3182	6/23/2015 19:00
6/18/2015 11:00	21.461	27.09597	6/23/2015 20:00
6/18/2015 11:15	21.604	25.98486	6/23/2015 21:00
6/18/2015 11:30	21.772	25.42931	6/23/2015 22:00
6/18/2015 11:45	21.939	25.42931	6/23/2015 23:00
6/18/2015 12:00	22.106	24.87375	6/24/2015 0:00
6/18/2015 12:15	22.226	24.87375	6/24/2015 1:00
6/18/2015 12:30	22.369	24.3182	6/24/2015 2:00
6/18/2015 12:45	22.513	24.3182	6/24/2015 3:00
6/18/2015 13:00	22.657	23.76264	6/24/2015 4:00
6/18/2015 13:15	22.8	24.3182	6/24/2015 5:00
6/18/2015 13:30	22.92	25.42931	6/24/2015 6:00
6/18/2015 13:45	23.064	28.20709	6/24/2015 7:00
6/18/2015 14:00	23.256	30.98486	6/24/2015 8:00
6/18/2015 14:15	23.472	33.20709	6/24/2015 9:00
6/18/2015 14:30	23.641	33.76264	6/24/2015 10:00
6/18/2015 14:45	23.713	33.76264	6/24/2015 11:00
6/18/2015 15:00	23.809	35.42931	6/24/2015 12:00
6/18/2015 15:15	23.881	35.42931	6/24/2015 13:00
6/18/2015 15:30	23.689	35.42931	6/24/2015 14:00
6/18/2015 15:45	23.448	36.54042	6/24/2015 15:00
6/18/2015 16:00	23.593	37.09597	6/24/2015 16:00
6/18/2015 16:15	23.761	34.87375	6/24/2015 17:00
6/18/2015 16:30	23.93	33.76264	6/24/2015 18:00
6/18/2015 16:45	24.074	31.54042	6/24/2015 19:00
6/18/2015 17:00	24.195	29.3182	6/24/2015 20:00
6/18/2015 17:15	24.267	28.20709	6/24/2015 21:00
6/18/2015 17:30	24.315	27.65153	6/24/2015 22:00
6/18/2015 17:45	24.363	27.09597	6/24/2015 23:00
6/18/2015 18:00	24.363	27.09597	6/25/2015 0:00
6/18/2015 18:15	24.363	27.09597	6/25/2015 1:00
6/18/2015 18:30	24.291	26.54042	6/25/2015 2:00
6/18/2015 18:45	24.146	27.09597	6/25/2015 3:00
6/18/2015 19:00	23.93	26.54042	6/25/2015 4:00
6/18/2015 19:15	23.737	25.98486	6/25/2015 5:00
6/18/2015 19:30	23.521	28.20709	6/25/2015 6:00

6/18/2015 19:45	23.352	31.54042	6/25/2015 7:00
6/18/2015 20:00	23.208	33.76264	6/25/2015 8:00
6/18/2015 20:15	23.088	34.87375	6/25/2015 9:00
6/18/2015 20:30	22.968	37.09597	6/25/2015 10:00
6/18/2015 20:45	22.896	36.54042	6/25/2015 11:00
6/18/2015 21:00	22.848	39.3182	6/25/2015 12:00
6/18/2015 21:15	22.8	38.76264	6/25/2015 13:00
6/18/2015 21:30	22.753	40.42931	6/25/2015 14:00
6/18/2015 21:45	22.729	39.87375	6/25/2015 15:00
6/18/2015 22:00	22.705	39.3182	6/25/2015 16:00
6/18/2015 22:15	22.681	38.20709	6/25/2015 17:00
6/18/2015 22:30	22.633	36.54042	6/25/2015 18:00
6/18/2015 22:45	22.585	34.3182	6/25/2015 19:00
6/18/2015 23:00	22.513	31.54042	6/25/2015 20:00
6/18/2015 23:15	22.441	31.54042	6/25/2015 21:00
6/18/2015 23:30	22.369	30.42931	6/25/2015 22:00
6/18/2015 23:45	22.298	29.87375	6/25/2015 23:00
6/19/2015 0:00	22.226	29.3182	6/26/2015 0:00
6/19/2015 0:15	22.154	29.3182	6/26/2015 1:00
6/19/2015 0:30	22.082	29.87375	6/26/2015 2:00
6/19/2015 0:45	22.034	28.76264	6/26/2015 3:00
6/19/2015 1:00	21.963	28.76264	6/26/2015 4:00
6/19/2015 1:15	21.891	28.20709	6/26/2015 5:00
6/19/2015 1:30	21.819	29.87375	6/26/2015 6:00
6/19/2015 1:45	21.748	33.20709	6/26/2015 7:00
6/19/2015 2:00	21.676	35.42931	6/26/2015 8:00
6/19/2015 2:15	21.581	37.09597	6/26/2015 9:00
6/19/2015 2:30	21.461	38.76264	6/26/2015 10:00
6/19/2015 2:45	21.318	39.3182	6/26/2015 11:00
6/19/2015 3:00	21.27	38.20709	6/26/2015 12:00
6/19/2015 3:15	21.175	39.3182	6/26/2015 13:00
6/19/2015 3:30	21.103	41.54042	6/26/2015 14:00
6/19/2015 3:45	20.96	39.87375	6/26/2015 15:00
6/19/2015 4:00	20.865	37.65153	6/26/2015 16:00
6/19/2015 4:15	20.841	39.3182	6/26/2015 17:00
6/19/2015 4:30	20.746	37.09597	6/26/2015 18:00
6/19/2015 4:45	20.698	34.87375	6/26/2015 19:00
6/19/2015 5:00	20.674	32.65153	6/26/2015 20:00
6/19/2015 5:15	20.579	31.54042	6/26/2015 21:00
6/19/2015 5:30	20.531	30.98486	6/26/2015 22:00
6/19/2015 5:45	20.46	30.42931	6/26/2015 23:00
6/19/2015 6:00	20.365	29.87375	6/27/2015 0:00
6/19/2015 6:15	20.293	29.87375	6/27/2015 1:00
6/19/2015 6:30	20.222	29.3182	6/27/2015 2:00
6/19/2015 6:45	20.174	28.76264	6/27/2015 3:00
6/19/2015 7:00	20.103	28.20709	6/27/2015 4:00
6/19/2015 7:15	20.055	28.20709	6/27/2015 5:00

6/19/2015 7:30	19.984	30.98486	6/27/2015 6:00
6/19/2015 7:45	19.96	32.09597	6/27/2015 7:00
6/19/2015 8:00	19.936	33.76264	6/27/2015 8:00
6/19/2015 8:15	20.007	35.98486	6/27/2015 9:00
6/19/2015 8:30	20.126	36.54042	6/27/2015 10:00
6/19/2015 8:45	20.222	37.65153	6/27/2015 11:00
6/19/2015 9:00	20.341	36.54042	6/27/2015 12:00
6/19/2015 9:15	20.484	37.65153	6/27/2015 13:00
6/19/2015 9:30	20.603	37.65153	6/27/2015 14:00
6/19/2015 9:45	20.722	38.76264	6/27/2015 15:00
6/19/2015 10:00	20.889	35.98486	6/27/2015 16:00
6/19/2015 10:15	21.079	34.87375	6/27/2015 17:00
6/19/2015 10:30	21.246	33.20709	6/27/2015 18:00
6/19/2015 10:45	21.342	31.54042	6/27/2015 19:00
6/19/2015 11:00	21.413	30.42931	6/27/2015 20:00
6/19/2015 11:15	21.581	29.87375	6/27/2015 21:00
6/19/2015 11:30	21.748	30.42931	6/27/2015 22:00
6/19/2015 11:45	21.891	29.3182	6/27/2015 23:00
6/19/2015 12:00	21.987	28.76264	6/28/2015 0:00
6/19/2015 12:15	22.13	28.76264	6/28/2015 1:00
6/19/2015 12:30	22.178	28.76264	6/28/2015 2:00
6/19/2015 12:45	22.321	27.65153	6/28/2015 3:00
6/19/2015 13:00	22.417	27.09597	6/28/2015 4:00
6/19/2015 13:15	22.489	28.76264	6/28/2015 5:00
6/19/2015 13:30	22.609	28.20709	6/28/2015 6:00
6/19/2015 13:45	22.657	29.3182	6/28/2015 7:00
6/19/2015 14:00	22.8	32.09597	6/28/2015 8:00
6/19/2015 14:15	22.848	33.76264	6/28/2015 9:00
6/19/2015 14:30	22.944	35.42931	6/28/2015 10:00
6/19/2015 14:45	22.968	34.87375	6/28/2015 11:00
6/19/2015 15:00	23.04	33.20709	6/28/2015 12:00
6/19/2015 15:15	23.16	33.20709	6/28/2015 13:00
6/19/2015 15:30	23.208	33.20709	6/28/2015 14:00
6/19/2015 15:45	23.28	32.09597	6/28/2015 15:00
6/19/2015 16:00	22.8	34.3182	6/28/2015 16:00
6/19/2015 16:15	22.681	36.54042	6/28/2015 17:00
6/19/2015 16:30	22.681	31.54042	6/28/2015 18:00
6/19/2015 16:45	22.705	30.42931	6/28/2015 19:00
6/19/2015 17:00	22.705	28.76264	6/28/2015 20:00
6/19/2015 17:15	22.705	28.20709	6/28/2015 21:00
6/19/2015 17:30	22.705	28.76264	6/28/2015 22:00
6/19/2015 17:45	22.657	28.20709	6/28/2015 23:00
6/19/2015 18:00	22.585	27.65153	6/29/2015 0:00
6/19/2015 18:15	22.537	27.65153	6/29/2015 1:00
6/19/2015 18:30	22.465	27.09597	6/29/2015 2:00
6/19/2015 18:45	22.345	27.65153	6/29/2015 3:00
6/19/2015 19:00	22.178	27.65153	6/29/2015 4:00

6/19/2015 19:15	21.987	27.09597	6/29/2015 5:00
6/19/2015 19:30	21.772	28.20709	6/29/2015 6:00
6/19/2015 19:45	21.581	31.54042	6/29/2015 7:00
6/19/2015 20:00	21.413	32.65153	6/29/2015 8:00
6/19/2015 20:15	21.27	33.76264	6/29/2015 9:00
6/19/2015 20:30	21.127	36.54042	6/29/2015 10:00
6/19/2015 20:45	21.008	37.65153	6/29/2015 11:00
6/19/2015 21:00	20.889	37.09597	6/29/2015 12:00
6/19/2015 21:15	20.817	35.42931	6/29/2015 13:00
6/19/2015 21:30	20.77	36.54042	6/29/2015 14:00
6/19/2015 21:45	20.722	38.20709	6/29/2015 15:00
6/19/2015 22:00	20.698	36.54042	6/29/2015 16:00
6/19/2015 22:15	20.674	36.54042	6/29/2015 17:00
6/19/2015 22:30	20.674	36.54042	6/29/2015 18:00
6/19/2015 22:45	20.674	33.76264	6/29/2015 19:00
6/19/2015 23:00	20.65	31.54042	6/29/2015 20:00
6/19/2015 23:15	20.627	30.98486	6/29/2015 21:00
6/19/2015 23:30	20.603	30.42931	6/29/2015 22:00
6/19/2015 23:45	20.579	30.42931	6/29/2015 23:00
6/20/2015 0:00	20.579	29.87375	6/30/2015 0:00
6/20/2015 0:15	20.531	29.3182	6/30/2015 1:00
6/20/2015 0:30	20.507	29.3182	6/30/2015 2:00
6/20/2015 0:45	20.484	28.76264	6/30/2015 3:00
6/20/2015 1:00	20.46	28.76264	6/30/2015 4:00
6/20/2015 1:15	20.436	29.3182	6/30/2015 5:00
6/20/2015 1:30	20.412	29.87375	6/30/2015 6:00
6/20/2015 1:45	20.365	32.09597	6/30/2015 7:00
6/20/2015 2:00	20.341	33.76264	6/30/2015 8:00
6/20/2015 2:15	20.317	35.98486	6/30/2015 9:00
6/20/2015 2:30	20.269	37.65153	6/30/2015 10:00
6/20/2015 2:45	20.246	39.3182	6/30/2015 11:00
6/20/2015 3:00	20.198	40.42931	6/30/2015 12:00
6/20/2015 3:15	20.126	40.98486	6/30/2015 13:00
6/20/2015 3:30	20.103	40.98486	6/30/2015 14:00
6/20/2015 3:45	20.079	40.98486	6/30/2015 15:00
6/20/2015 4:00	20.079	39.3182	6/30/2015 16:00
6/20/2015 4:15	20.055	38.76264	6/30/2015 17:00
6/20/2015 4:30	20.031	37.09597	6/30/2015 18:00
6/20/2015 4:45	19.984	34.87375	6/30/2015 19:00
6/20/2015 5:00	19.96	33.76264	6/30/2015 20:00
6/20/2015 5:15	19.912	33.20709	6/30/2015 21:00
6/20/2015 5:30	19.865	32.65153	6/30/2015 22:00
6/20/2015 5:45	19.817	32.09597	6/30/2015 23:00
6/20/2015 6:00	19.817	31.54042	7/1/2015 0:00
6/20/2015 6:15	19.77	30.98486	7/1/2015 1:00
6/20/2015 6:30	19.746	30.98486	7/1/2015 2:00
6/20/2015 6:45	19.77	30.98486	7/1/2015 3:00

6/20/2015 7:00	19.746	30.42931	7/1/2015 4:00
6/20/2015 7:15	19.746	29.87375	7/1/2015 5:00
6/20/2015 7:30	19.746	31.54042	7/1/2015 6:00
6/20/2015 7:45	19.746	33.76264	7/1/2015 7:00
6/20/2015 8:00	19.77	33.20709	7/1/2015 8:00
6/20/2015 8:15	19.865	35.42931	7/1/2015 9:00
6/20/2015 8:30	19.984	36.54042	7/1/2015 10:00
6/20/2015 8:45	20.15	33.76264	7/1/2015 11:00
6/20/2015 9:00	20.269	34.87375	7/1/2015 12:00
6/20/2015 9:15	20.365	35.42931	7/1/2015 13:00
6/20/2015 9:30	20.507	38.20709	7/1/2015 14:00
6/20/2015 9:45	20.674	37.09597	7/1/2015 15:00
6/20/2015 10:00	20.841	39.87375	7/1/2015 16:00
6/20/2015 10:15	21.032	39.3182	7/1/2015 17:00
6/20/2015 10:30	21.199	38.76264	7/1/2015 18:00
6/20/2015 10:45	21.366	34.87375	7/1/2015 19:00
6/20/2015 11:00	21.461	33.20709	7/1/2015 20:00
6/20/2015 11:15	21.604	32.65153	7/1/2015 21:00
6/20/2015 11:30	21.795	32.65153	7/1/2015 22:00
6/20/2015 11:45	21.963	32.65153	7/1/2015 23:00
6/20/2015 12:00	22.058	29.3182	7/2/2015 0:00
6/20/2015 12:15	22.178	28.20709	7/2/2015 1:00
6/20/2015 12:30	22.274	29.3182	7/2/2015 2:00
6/20/2015 12:45	22.417	28.76264	7/2/2015 3:00
6/20/2015 13:00	22.537	29.87375	7/2/2015 4:00
6/20/2015 13:15	22.633	29.87375	7/2/2015 5:00
6/20/2015 13:30	22.753	30.98486	7/2/2015 6:00
6/20/2015 13:45	22.896	30.98486	7/2/2015 7:00
6/20/2015 14:00	23.04	30.98486	7/2/2015 8:00
6/20/2015 14:15	23.112	30.42931	7/2/2015 9:00
6/20/2015 14:30	23.184	33.20709	7/2/2015 10:00
6/20/2015 14:45	23.232	36.54042	7/2/2015 11:00
6/20/2015 15:00	23.256	35.98486	7/2/2015 12:00
6/20/2015 15:15	23.256	35.98486	7/2/2015 13:00
6/20/2015 15:30	23.28	33.20709	7/2/2015 14:00
6/20/2015 15:45	23.232	31.54042	7/2/2015 15:00
6/20/2015 16:00	23.232	30.42931	7/2/2015 16:00
6/20/2015 16:15	22.776	29.87375	7/2/2015 17:00
6/20/2015 16:30	22.729	30.42931	7/2/2015 18:00
6/20/2015 16:45	22.729	28.20709	7/2/2015 19:00
6/20/2015 17:00	22.753	26.54042	7/2/2015 20:00
6/20/2015 17:15	22.753	27.65153	7/2/2015 21:00
6/20/2015 17:30	22.729	27.65153	7/2/2015 22:00
6/20/2015 17:45	22.705	26.54042	7/2/2015 23:00
6/20/2015 18:00	22.633	26.54042	7/3/2015 0:00
6/20/2015 18:15	22.561	27.09597	7/3/2015 1:00
6/20/2015 18:30	22.489	25.98486	7/3/2015 2:00

6/20/2015 18:45	22.393	27.09597	7/3/2015 3:00
6/20/2015 19:00	22.298	25.98486	7/3/2015 4:00
6/20/2015 19:15	22.154	25.42931	7/3/2015 5:00
6/20/2015 19:30	21.963	26.54042	7/3/2015 6:00
6/20/2015 19:45	21.795	29.87375	7/3/2015 7:00
6/20/2015 20:00	21.604	32.09597	7/3/2015 8:00
6/20/2015 20:15	21.437	33.20709	7/3/2015 9:00
6/20/2015 20:30	21.294	34.87375	7/3/2015 10:00
6/20/2015 20:45	21.175	34.87375	7/3/2015 11:00
6/20/2015 21:00	21.056	35.42931	7/3/2015 12:00
6/20/2015 21:15	20.96	35.98486	7/3/2015 13:00
6/20/2015 21:30	20.889	37.09597	7/3/2015 14:00
6/20/2015 21:45	20.841	36.54042	7/3/2015 15:00
6/20/2015 22:00	20.793	37.09597	7/3/2015 16:00
6/20/2015 22:15	20.77	36.54042	7/3/2015 17:00
6/20/2015 22:30	20.746	34.87375	7/3/2015 18:00
6/20/2015 22:45	20.746	32.09597	7/3/2015 19:00
6/20/2015 23:00	20.722	29.87375	7/3/2015 20:00
6/20/2015 23:15	20.698	29.3182	7/3/2015 21:00
6/20/2015 23:30	20.698	28.76264	7/3/2015 22:00
6/20/2015 23:45	20.65	28.76264	7/3/2015 23:00
6/21/2015 0:00	20.65	28.20709	7/4/2015 0:00
6/21/2015 0:15	20.65	27.65153	7/4/2015 1:00
6/21/2015 0:30	20.627	27.65153	7/4/2015 2:00
6/21/2015 0:45	20.579	27.65153	7/4/2015 3:00
6/21/2015 1:00	20.555	27.09597	7/4/2015 4:00
6/21/2015 1:15	20.579	27.65153	7/4/2015 5:00
6/21/2015 1:30	20.579	29.3182	7/4/2015 6:00
6/21/2015 1:45	20.555	32.65153	7/4/2015 7:00
6/21/2015 2:00	20.531	33.76264	7/4/2015 8:00
6/21/2015 2:15	20.46	36.54042	7/4/2015 9:00
6/21/2015 2:30	20.412	36.54042	7/4/2015 10:00
6/21/2015 2:45	20.341	37.09597	7/4/2015 11:00
6/21/2015 3:00	20.293	37.65153	7/4/2015 12:00
6/21/2015 3:15	20.269	37.65153	7/4/2015 13:00
6/21/2015 3:30	20.293	37.09597	7/4/2015 14:00
6/21/2015 3:45	20.317	37.09597	7/4/2015 15:00
6/21/2015 4:00	20.293	38.20709	7/4/2015 16:00
6/21/2015 4:15	20.269	37.65153	7/4/2015 17:00
6/21/2015 4:30	20.222	35.42931	7/4/2015 18:00
6/21/2015 4:45	20.198	32.65153	7/4/2015 19:00
6/21/2015 5:00	20.174	30.42931	7/4/2015 20:00
6/21/2015 5:15	20.126	28.76264	7/4/2015 21:00
6/21/2015 5:30	20.103	28.20709	7/4/2015 22:00
6/21/2015 5:45	20.055	28.76264	7/4/2015 23:00
6/21/2015 6:00	20.031	27.65153	7/5/2015 0:00
6/21/2015 6:15	19.984	27.65153	7/5/2015 1:00

6/21/2015 6:30	19.96	27.65153	7/5/2015 2:00
6/21/2015 6:45	19.936	27.09597	7/5/2015 3:00
6/21/2015 7:00	19.912	27.09597	7/5/2015 4:00
6/21/2015 7:15	19.888	28.20709	7/5/2015 5:00
6/21/2015 7:30	19.817	29.3182	7/5/2015 6:00
6/21/2015 7:45	19.77	31.54042	7/5/2015 7:00
6/21/2015 8:00	19.817	33.20709	7/5/2015 8:00
6/21/2015 8:15	19.912	33.76264	7/5/2015 9:00
6/21/2015 8:30	20.055	35.42931	7/5/2015 10:00
6/21/2015 8:45	20.246	35.42931	7/5/2015 11:00
6/21/2015 9:00	20.46	35.42931	7/5/2015 12:00
6/21/2015 9:15	20.674	36.54042	7/5/2015 13:00
6/21/2015 9:30	20.865	35.42931	7/5/2015 14:00
6/21/2015 9:45	20.984	35.42931	7/5/2015 15:00
6/21/2015 10:00	21.127	35.42931	7/5/2015 16:00
6/21/2015 10:15	21.318	35.42931	7/5/2015 17:00
6/21/2015 10:30	21.509	34.3182	7/5/2015 18:00
6/21/2015 10:45	21.628	30.42931	7/5/2015 19:00
6/21/2015 11:00	21.724	27.65153	7/5/2015 20:00
6/21/2015 11:15	21.843	26.54042	7/5/2015 21:00
6/21/2015 11:30	22.034	27.09597	7/5/2015 22:00
6/21/2015 11:45	22.178	27.09597	7/5/2015 23:00
6/21/2015 12:00	22.345	25.42931	7/6/2015 0:00
6/21/2015 12:15	22.489	24.87375	7/6/2015 1:00
6/21/2015 12:30	22.633	24.3182	7/6/2015 2:00
6/21/2015 12:45	22.705	24.3182	7/6/2015 3:00
6/21/2015 13:00	22.848	24.3182	7/6/2015 4:00
6/21/2015 13:15	22.944	24.3182	7/6/2015 5:00
6/21/2015 13:30	23.04	25.98486	7/6/2015 6:00
6/21/2015 13:45	23.112	29.3182	7/6/2015 7:00
6/21/2015 14:00	23.16	31.54042	7/6/2015 8:00
6/21/2015 14:15	23.256	33.20709	7/6/2015 9:00
6/21/2015 14:30	23.376	33.20709	7/6/2015 10:00
6/21/2015 14:45	23.448	34.3182	7/6/2015 11:00
6/21/2015 15:00	23.497	34.3182	7/6/2015 12:00
6/21/2015 15:15	23.497	34.3182	7/6/2015 13:00
6/21/2015 15:30	23.521	34.3182	7/6/2015 14:00
6/21/2015 15:45	23.569	33.76264	7/6/2015 15:00
6/21/2015 16:00	23.28	34.3182	7/6/2015 16:00
6/21/2015 16:15	22.896	32.09597	7/6/2015 17:00
6/21/2015 16:30	22.848	30.98486	7/6/2015 18:00
6/21/2015 16:45	22.848	28.20709	7/6/2015 19:00
6/21/2015 17:00	22.848	25.42931	7/6/2015 20:00
6/21/2015 17:15	22.824	23.76264	7/6/2015 21:00
6/21/2015 17:30	22.776	22.65153	7/6/2015 22:00
6/21/2015 17:45	22.705	21.54042	7/6/2015 23:00
6/21/2015 18:00	22.609	21.54042	7/7/2015 0:00

6/21/2015 18:15	22.537	22.65153	7/7/2015 1:00
6/21/2015 18:30	22.465	22.65153	7/7/2015 2:00
6/21/2015 18:45	22.321	22.65153	7/7/2015 3:00
6/21/2015 19:00	22.154	23.20709	7/7/2015 4:00
6/21/2015 19:15	21.963	23.20709	7/7/2015 5:00
6/21/2015 19:30	21.772	25.98486	7/7/2015 6:00
6/21/2015 19:45	21.581	27.09597	7/7/2015 7:00
6/21/2015 20:00	21.39	29.87375	7/7/2015 8:00
6/21/2015 20:15	21.223	30.98486	7/7/2015 9:00
6/21/2015 20:30	21.079	31.54042	7/7/2015 10:00
6/21/2015 20:45	20.96	31.54042	7/7/2015 11:00
6/21/2015 21:00	20.841	32.09597	7/7/2015 12:00
6/21/2015 21:15	20.746	31.54042	7/7/2015 13:00
6/21/2015 21:30	20.674	33.20709	7/7/2015 14:00
6/21/2015 21:45	20.627	32.09597	7/7/2015 15:00
6/21/2015 22:00	20.579	33.76264	7/7/2015 16:00
6/21/2015 22:15	20.555	32.09597	7/7/2015 17:00
6/21/2015 22:30	20.531	29.87375	7/7/2015 18:00
6/21/2015 22:45	20.507	27.65153	7/7/2015 19:00
6/21/2015 23:00	20.46	24.87375	7/7/2015 20:00
6/21/2015 23:15	20.436	23.20709	7/7/2015 21:00
6/21/2015 23:30	20.412	22.65153	7/7/2015 22:00
6/21/2015 23:45	20.388	22.09597	7/7/2015 23:00
6/22/2015 0:00	20.365	22.65153	7/8/2015 0:00
6/22/2015 0:15	20.317	22.65153	7/8/2015 1:00
6/22/2015 0:30	20.293	21.54042	7/8/2015 2:00
6/22/2015 0:45	20.269	22.09597	7/8/2015 3:00
6/22/2015 1:00	20.246	22.09597	7/8/2015 4:00
6/22/2015 1:15	20.222	23.20709	7/8/2015 5:00
6/22/2015 1:30	20.198	23.76264	7/8/2015 6:00
6/22/2015 1:45	20.174	26.54042	7/8/2015 7:00
6/22/2015 2:00	20.15	27.09597	7/8/2015 8:00
6/22/2015 2:15	20.103	30.42931	7/8/2015 9:00
6/22/2015 2:30	20.055	27.65153	7/8/2015 10:00
6/22/2015 2:45	20.031	29.3182	7/8/2015 11:00
6/22/2015 3:00	19.984	29.87375	7/8/2015 12:00
6/22/2015 3:15	19.936	30.42931	7/8/2015 13:00
6/22/2015 3:30	19.912	28.76264	7/8/2015 14:00
6/22/2015 3:45	19.888	30.98486	7/8/2015 15:00
6/22/2015 4:00	19.841	30.42931	7/8/2015 16:00
6/22/2015 4:15	19.746	29.3182	7/8/2015 17:00
6/22/2015 4:30	19.651	28.20709	7/8/2015 18:00
6/22/2015 4:45	19.579	26.54042	7/8/2015 19:00
6/22/2015 5:00	19.532	22.65153	7/8/2015 20:00
6/22/2015 5:15	19.555	21.54042	7/8/2015 21:00
6/22/2015 5:30	19.579	22.65153	7/8/2015 22:00
6/22/2015 5:45	19.555	22.09597	7/8/2015 23:00

6/22/2015 6:00	19.532	20.98486	7/9/2015 0:00
6/22/2015 6:15	19.484	20.98486	7/9/2015 1:00
6/22/2015 6:30	19.46	20.42931	7/9/2015 2:00
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7/11/2016 22:45	18.533
7/11/2016 23:00	18.461
7/11/2016 23:15	18.414
7/11/2016 23:30	18.319
7/11/2016 23:45	18.247
7/12/2016 0:00	18.176
7/12/2016 0:15	18.081
7/12/2016 0:30	18.01
7/12/2016 0:45	17.915

7/12/2016 1:00	17.819
7/12/2016 1:15	17.724
7/12/2016 1:30	17.629
7/12/2016 1:45	17.558
7/12/2016 2:00	17.486
7/12/2016 2:15	17.415
7/12/2016 2:30	17.344
7/12/2016 2:45	17.296
7/12/2016 3:00	17.225
7/12/2016 3:15	17.177
7/12/2016 3:30	17.13
7/12/2016 3:45	17.106
7/12/2016 4:00	17.058
7/12/2016 4:15	17.011
7/12/2016 4:30	16.963
7/12/2016 4:45	16.939
7/12/2016 5:00	16.892
7/12/2016 5:15	16.868
7/12/2016 5:30	16.82
7/12/2016 5:45	16.796
7/12/2016 6:00	16.773
7/12/2016 6:15	16.749
7/12/2016 6:30	16.725
7/12/2016 6:45	16.701
7/12/2016 7:00	16.654
7/12/2016 7:15	16.63
7/12/2016 7:30	16.606
7/12/2016 7:45	16.582
7/12/2016 8:00	16.558
7/12/2016 8:15	16.558
7/12/2016 8:30	16.606
7/12/2016 8:45	16.63
7/12/2016 9:00	16.654
7/12/2016 9:15	16.701
7/12/2016 9:30	16.796
7/12/2016 9:45	16.868
7/12/2016 10:00	16.939
7/12/2016 10:15	17.011
7/12/2016 10:30	17.13
7/12/2016 10:45	17.225
7/12/2016 11:00	17.344
7/12/2016 11:15	17.486
7/12/2016 11:30	17.629
7/12/2016 11:45	17.772
7/12/2016 12:00	17.938
7/12/2016 12:15	18.081
7/12/2016 12:30	18.247

7/12/2016 12:45	18.366
7/12/2016 13:00	18.485
7/12/2016 13:15	18.604
7/12/2016 13:30	18.675
7/12/2016 13:45	18.723
7/12/2016 14:00	18.771
7/12/2016 14:15	18.818
7/12/2016 14:30	18.818
7/12/2016 14:45	18.794
7/12/2016 15:00	18.771
7/12/2016 15:15	18.747
7/12/2016 15:30	18.699
7/12/2016 15:45	18.675
7/12/2016 16:00	18.699
7/12/2016 16:15	18.723
7/12/2016 16:30	18.794
7/12/2016 16:45	18.866
7/12/2016 17:00	18.937
7/12/2016 17:15	18.985
7/12/2016 17:30	19.008
7/12/2016 17:45	19.032
7/12/2016 18:00	19.008
7/12/2016 18:15	18.985
7/12/2016 18:30	18.961
7/12/2016 18:45	18.866
7/12/2016 19:00	18.794
7/12/2016 19:15	18.699
7/12/2016 19:30	18.604
7/12/2016 19:45	18.533
7/12/2016 20:00	18.461
7/12/2016 20:15	18.366
7/12/2016 20:30	18.271
7/12/2016 20:45	18.176
7/12/2016 21:00	18.081
7/12/2016 21:15	17.938
7/12/2016 21:30	17.819
7/12/2016 21:45	17.677
7/12/2016 22:00	17.51
7/12/2016 22:15	17.368
7/12/2016 22:30	17.225
7/12/2016 22:45	17.082
7/12/2016 23:00	16.963
7/12/2016 23:15	16.868
7/12/2016 23:30	16.749
7/12/2016 23:45	16.654
7/13/2016 0:00	16.582
7/13/2016 0:15	16.511

7/13/2016 0:30	16.439
7/13/2016 0:45	16.392
7/13/2016 1:00	16.32
7/13/2016 1:15	16.296
7/13/2016 1:30	16.249
7/13/2016 1:45	16.225
7/13/2016 2:00	16.201
7/13/2016 2:15	16.177
7/13/2016 2:30	16.153
7/13/2016 2:45	16.129
7/13/2016 3:00	16.106
7/13/2016 3:15	16.082
7/13/2016 3:30	16.058
7/13/2016 3:45	16.034
7/13/2016 4:00	16.01
7/13/2016 4:15	15.986
7/13/2016 4:30	15.986
7/13/2016 4:45	15.963
7/13/2016 5:00	15.939
7/13/2016 5:15	15.915
7/13/2016 5:30	15.891
7/13/2016 5:45	15.867
7/13/2016 6:00	15.843
7/13/2016 6:15	15.796
7/13/2016 6:30	15.796
7/13/2016 6:45	15.772
7/13/2016 7:00	15.748
7/13/2016 7:15	15.748
7/13/2016 7:30	15.724
7/13/2016 7:45	15.724
7/13/2016 8:00	15.748
7/13/2016 8:15	15.772
7/13/2016 8:30	15.819
7/13/2016 8:45	15.867
7/13/2016 9:00	15.939
7/13/2016 9:15	15.986
7/13/2016 9:30	16.106
7/13/2016 9:45	16.201
7/13/2016 10:00	16.272
7/13/2016 10:15	16.368
7/13/2016 10:30	16.487
7/13/2016 10:45	16.606
7/13/2016 11:00	16.701
7/13/2016 11:15	16.844
7/13/2016 11:30	16.987
7/13/2016 11:45	17.13
7/13/2016 12:00	17.272

7/13/2016 12:15	17.439
7/13/2016 12:30	17.582
7/13/2016 12:45	17.701
7/13/2016 13:00	17.796
7/13/2016 13:15	17.915
7/13/2016 13:30	18.01
7/13/2016 13:45	18.081
7/13/2016 14:00	18.176
7/13/2016 14:15	18.247
7/13/2016 14:30	18.319
7/13/2016 14:45	18.39
7/13/2016 15:00	18.461
7/13/2016 15:15	18.509
7/13/2016 15:30	18.557
7/13/2016 15:45	18.604
7/13/2016 16:00	18.652
7/13/2016 16:15	18.675
7/13/2016 16:30	18.723
7/13/2016 16:45	18.747
7/13/2016 17:00	18.747
7/13/2016 17:15	18.747
7/13/2016 17:30	18.723
7/13/2016 17:45	18.699
7/13/2016 18:00	18.699
7/13/2016 18:15	18.675
7/13/2016 18:30	18.675
7/13/2016 18:45	18.652
7/13/2016 19:00	18.628
7/13/2016 19:15	18.628
7/13/2016 19:30	18.628
7/13/2016 19:45	18.652
7/13/2016 20:00	18.675
7/13/2016 20:15	18.723
7/13/2016 20:30	18.747
7/13/2016 20:45	18.747
7/13/2016 21:00	18.771
7/13/2016 21:15	18.771
7/13/2016 21:30	18.747
7/13/2016 21:45	18.699
7/13/2016 22:00	18.652
7/13/2016 22:15	18.58
7/13/2016 22:30	18.509
7/13/2016 22:45	18.438
7/13/2016 23:00	18.366
7/13/2016 23:15	18.271
7/13/2016 23:30	18.176
7/13/2016 23:45	18.081

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7/14/2016 0:15	17.938
7/14/2016 0:30	17.843
7/14/2016 0:45	17.772
7/14/2016 1:00	17.701
7/14/2016 1:15	17.629
7/14/2016 1:30	17.558
7/14/2016 1:45	17.51
7/14/2016 2:00	17.439
7/14/2016 2:15	17.391
7/14/2016 2:30	17.32
7/14/2016 2:45	17.272
7/14/2016 3:00	17.225
7/14/2016 3:15	17.201
7/14/2016 3:30	17.153
7/14/2016 3:45	17.106
7/14/2016 4:00	17.058
7/14/2016 4:15	16.987
7/14/2016 4:30	16.939
7/14/2016 4:45	16.868
7/14/2016 5:00	16.796
7/14/2016 5:15	16.725
7/14/2016 5:30	16.654
7/14/2016 5:45	16.582
7/14/2016 6:00	16.487
7/14/2016 6:15	16.415
7/14/2016 6:30	16.344
7/14/2016 6:45	16.272
7/14/2016 7:00	16.177
7/14/2016 7:15	16.106
7/14/2016 7:30	16.058
7/14/2016 7:45	15.986
7/14/2016 8:00	15.939
7/14/2016 8:15	15.915
7/14/2016 8:30	15.891
7/14/2016 8:45	15.891
7/14/2016 9:00	15.891
7/14/2016 9:15	15.915
7/14/2016 9:30	15.986
7/14/2016 9:45	16.034
7/14/2016 10:00	16.082
7/14/2016 10:15	16.129
7/14/2016 10:30	16.225
7/14/2016 10:45	16.32
7/14/2016 11:00	16.415
7/14/2016 11:15	16.534
7/14/2016 11:30	16.654

7/14/2016 11:45	16.796
7/14/2016 12:00	16.939
7/14/2016 12:15	17.082
7/14/2016 12:30	17.249
7/14/2016 12:45	17.368
7/14/2016 13:00	17.51
7/14/2016 13:15	17.629
7/14/2016 13:30	17.724
7/14/2016 13:45	17.772
7/14/2016 14:00	17.843
7/14/2016 14:15	17.867
7/14/2016 14:30	17.891
7/14/2016 14:45	17.915
7/14/2016 15:00	17.915
7/14/2016 15:15	17.938
7/14/2016 15:30	17.962
7/14/2016 15:45	17.962
7/14/2016 16:00	17.938
7/14/2016 16:15	17.938
7/14/2016 16:30	17.938
7/14/2016 16:45	18.01
7/14/2016 17:00	18.105
7/14/2016 17:15	18.2
7/14/2016 17:30	18.295
7/14/2016 17:45	18.39
7/14/2016 18:00	18.485
7/14/2016 18:15	18.557
7/14/2016 18:30	18.604
7/14/2016 18:45	18.628
7/14/2016 19:00	18.628
7/14/2016 19:15	18.628
7/14/2016 19:30	18.628
7/14/2016 19:45	18.652
7/14/2016 20:00	18.652
7/14/2016 20:15	18.675
7/14/2016 20:30	18.652
7/14/2016 20:45	18.652
7/14/2016 21:00	18.604
7/14/2016 21:15	18.557
7/14/2016 21:30	18.509
7/14/2016 21:45	18.414
7/14/2016 22:00	18.295
7/14/2016 22:15	18.176
7/14/2016 22:30	18.033
7/14/2016 22:45	17.891
7/14/2016 23:00	17.772
7/14/2016 23:15	17.629

7/14/2016 23:30	17.51
7/14/2016 23:45	17.368
7/15/2016 0:00	17.272
7/15/2016 0:15	17.153
7/15/2016 0:30	17.082
7/15/2016 0:45	16.987
7/15/2016 1:00	16.939
7/15/2016 1:15	16.868
7/15/2016 1:30	16.82
7/15/2016 1:45	16.796
7/15/2016 2:00	16.773
7/15/2016 2:15	16.749
7/15/2016 2:30	16.701
7/15/2016 2:45	16.701
7/15/2016 3:00	16.654
7/15/2016 3:15	16.654
7/15/2016 3:30	16.63
7/15/2016 3:45	16.606
7/15/2016 4:00	16.582
7/15/2016 4:15	16.558
7/15/2016 4:30	16.558
7/15/2016 4:45	16.534
7/15/2016 5:00	16.511
7/15/2016 5:15	16.511
7/15/2016 5:30	16.487
7/15/2016 5:45	16.463
7/15/2016 6:00	16.439
7/15/2016 6:15	16.439
7/15/2016 6:30	16.415
7/15/2016 6:45	16.415
7/15/2016 7:00	16.392
7/15/2016 7:15	16.392
7/15/2016 7:30	16.392
7/15/2016 7:45	16.392
7/15/2016 8:00	16.415
7/15/2016 8:15	16.439
7/15/2016 8:30	16.487
7/15/2016 8:45	16.534
7/15/2016 9:00	16.582
7/15/2016 9:15	16.654
7/15/2016 9:30	16.749
7/15/2016 9:45	16.844
7/15/2016 10:00	16.939
7/15/2016 10:15	17.034
7/15/2016 10:30	17.13
7/15/2016 10:45	17.249
7/15/2016 11:00	17.368

7/15/2016 11:15	17.486	
7/15/2016 11:30	17.605	
7/15/2016 11:45	17.772	
7/15/2016 12:00	17.938	
7/15/2016 12:15	18.081	
7/15/2016 12:30	18.2	
7/15/2016 12:45	18.39	
7/15/2016 13:00	18.485	
7/15/2016 13:15	18.628	Notes indicate logger uninstalled at 5pm.
7/15/2016 13:30	18.699	Logger 1081201 installed
7/15/2016 13:45	18.818	
7/15/2016 14:00	18.842	
7/15/2016 14:15	18.866	
7/15/2016 14:30	18.889	
7/15/2016 14:45	18.842	
7/15/2016 15:00	18.818	
7/15/2016 15:15	18.818	
7/15/2016 15:30	18.794	
7/15/2016 15:45	18.794	
7/15/2016 16:00	18.723	
7/15/2016 16:15	18.699	
7/15/2016 16:30	18.675	
7/15/2016 16:45	18.747	
7/15/2016 17:00	18.723	
7/15/2016 17:15	19.05	logger download gap filled by interpolation
7/15/2016 17:30	19.377	begin logger 1181201
7/15/2016 17:45	18.901	
7/15/2016 18:00	18.996	
7/15/2016 18:15	19.092	
7/15/2016 18:30	19.092	
7/15/2016 18:45	19.092	
7/15/2016 19:00	19.092	
7/15/2016 19:15	19.092	
7/15/2016 19:30	19.092	
7/15/2016 19:45	19.092	
7/15/2016 20:00	19.092	
7/15/2016 20:15	19.092	
7/15/2016 20:30	18.996	
7/15/2016 20:45	18.996	
7/15/2016 21:00	18.901	
7/15/2016 21:15	18.806	
7/15/2016 21:30	18.711	
7/15/2016 21:45	18.616	
7/15/2016 22:00	18.426	
7/15/2016 22:15	18.236	
7/15/2016 22:30	18.14	
7/15/2016 22:45	17.95	

7/15/2016 23:00	17.76
7/15/2016 23:15	17.57
7/15/2016 23:30	17.475
7/15/2016 23:45	17.284
7/16/2016 0:00	17.189
7/16/2016 0:15	17.094
7/16/2016 0:30	16.999
7/16/2016 0:45	16.903
7/16/2016 1:00	16.808
7/16/2016 1:15	16.808
7/16/2016 1:30	16.713
7/16/2016 1:45	16.713
7/16/2016 2:00	16.618
7/16/2016 2:15	16.618
7/16/2016 2:30	16.618
7/16/2016 2:45	16.523
7/16/2016 3:00	16.523
7/16/2016 3:15	16.523
7/16/2016 3:30	16.427
7/16/2016 3:45	16.427
7/16/2016 4:00	16.427
7/16/2016 4:15	16.427
7/16/2016 4:30	16.332
7/16/2016 4:45	16.332
7/16/2016 5:00	16.332
7/16/2016 5:15	16.332
7/16/2016 5:30	16.332
7/16/2016 5:45	16.237
7/16/2016 6:00	16.237
7/16/2016 6:15	16.237
7/16/2016 6:30	16.237
7/16/2016 6:45	16.237
7/16/2016 7:00	16.237
7/16/2016 7:15	16.237
7/16/2016 7:30	16.237
7/16/2016 7:45	16.237
7/16/2016 8:00	16.237
7/16/2016 8:15	16.332
7/16/2016 8:30	16.332
7/16/2016 8:45	16.427
7/16/2016 9:00	16.523
7/16/2016 9:15	16.523
7/16/2016 9:30	16.618
7/16/2016 9:45	16.713
7/16/2016 10:00	16.808
7/16/2016 10:15	16.903
7/16/2016 10:30	16.999

7/16/2016 10:45	17.094
7/16/2016 11:00	17.189
7/16/2016 11:15	17.284
7/16/2016 11:30	17.379
7/16/2016 11:45	17.57
7/16/2016 12:00	17.76
7/16/2016 12:15	17.855
7/16/2016 12:30	18.045
7/16/2016 12:45	18.236
7/16/2016 13:00	18.331
7/16/2016 13:15	18.521
7/16/2016 13:30	18.616
7/16/2016 13:45	18.711
7/16/2016 14:00	18.806
7/16/2016 14:15	18.806
7/16/2016 14:30	18.806
7/16/2016 14:45	18.806
7/16/2016 15:00	18.806
7/16/2016 15:15	18.806
7/16/2016 15:30	18.711
7/16/2016 15:45	18.711
7/16/2016 16:00	18.711
7/16/2016 16:15	18.616
7/16/2016 16:30	18.616
7/16/2016 16:45	18.616
7/16/2016 17:00	18.616
7/16/2016 17:15	18.711
7/16/2016 17:30	18.806
7/16/2016 17:45	18.806
7/16/2016 18:00	18.901
7/16/2016 18:15	18.996
7/16/2016 18:30	19.092
7/16/2016 18:45	19.092
7/16/2016 19:00	19.092
7/16/2016 19:15	19.092
7/16/2016 19:30	19.187
7/16/2016 19:45	19.187
7/16/2016 20:00	19.187
7/16/2016 20:15	19.187
7/16/2016 20:30	19.187
7/16/2016 20:45	19.282
7/16/2016 21:00	19.187
7/16/2016 21:15	19.187
7/16/2016 21:30	19.187
7/16/2016 21:45	19.187
7/16/2016 22:00	19.092
7/16/2016 22:15	19.092

7/16/2016 22:30	18.996
7/16/2016 22:45	18.901
7/16/2016 23:00	18.806
7/16/2016 23:15	18.711
7/16/2016 23:30	18.616
7/16/2016 23:45	18.521
7/17/2016 0:00	18.426
7/17/2016 0:15	18.236
7/17/2016 0:30	18.14
7/17/2016 0:45	18.045
7/17/2016 1:00	17.855
7/17/2016 1:15	17.76
7/17/2016 1:30	17.665
7/17/2016 1:45	17.57
7/17/2016 2:00	17.475
7/17/2016 2:15	17.379
7/17/2016 2:30	17.284
7/17/2016 2:45	17.189
7/17/2016 3:00	17.094
7/17/2016 3:15	16.999
7/17/2016 3:30	16.999
7/17/2016 3:45	16.903
7/17/2016 4:00	16.903
7/17/2016 4:15	16.808
7/17/2016 4:30	16.808
7/17/2016 4:45	16.713
7/17/2016 5:00	16.713
7/17/2016 5:15	16.713
7/17/2016 5:30	16.618
7/17/2016 5:45	16.618
7/17/2016 6:00	16.618
7/17/2016 6:15	16.618
7/17/2016 6:30	16.523
7/17/2016 6:45	16.523
7/17/2016 7:00	16.523
7/17/2016 7:15	16.523
7/17/2016 7:30	16.523
7/17/2016 7:45	16.523
7/17/2016 8:00	16.523
7/17/2016 8:15	16.618
7/17/2016 8:30	16.618
7/17/2016 8:45	16.713
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7/17/2016 9:15	16.808
7/17/2016 9:30	16.903
7/17/2016 9:45	16.999
7/17/2016 10:00	17.094

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7/17/2016 10:30	17.284
7/17/2016 10:45	17.379
7/17/2016 11:00	17.57
7/17/2016 11:15	17.665
7/17/2016 11:30	17.855
7/17/2016 11:45	18.045
7/17/2016 12:00	18.236
7/17/2016 12:15	18.426
7/17/2016 12:30	18.711
7/17/2016 12:45	18.901
7/17/2016 13:00	19.092
7/17/2016 13:15	19.282
7/17/2016 13:30	19.377
7/17/2016 13:45	19.567
7/17/2016 14:00	19.662
7/17/2016 14:15	19.758
7/17/2016 14:30	19.853
7/17/2016 14:45	19.948
7/17/2016 15:00	19.948
7/17/2016 15:15	19.948
7/17/2016 15:30	19.948
7/17/2016 15:45	19.853
7/17/2016 16:00	19.853
7/17/2016 16:15	19.758
7/17/2016 16:30	19.662
7/17/2016 16:45	19.662
7/17/2016 17:00	19.662
7/17/2016 17:15	19.662
7/17/2016 17:30	19.662
7/17/2016 17:45	19.662
7/17/2016 18:00	19.662
7/17/2016 18:15	19.662
7/17/2016 18:30	19.662
7/17/2016 18:45	19.662
7/17/2016 19:00	19.567
7/17/2016 19:15	19.567
7/17/2016 19:30	19.472
7/17/2016 19:45	19.472
7/17/2016 20:00	19.377
7/17/2016 20:15	19.377
7/17/2016 20:30	19.377
7/17/2016 20:45	19.377
7/17/2016 21:00	19.377
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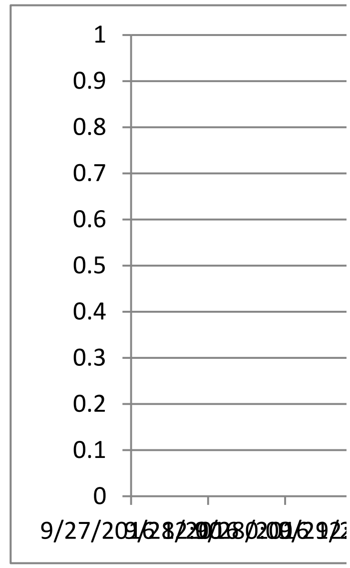

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9/28/2016 13:45	16.332
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9/29/2016 0:15	15.855
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9/29/2016 13:15		probably exposed; checked TR abv Clavey and this spike was not there.
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10/4/2016 10:30	11.236
10/4/2016 10:45	11.334
10/4/2016 11:00	11.431
10/4/2016 11:15	11.528
10/4/2016 11:30	11.625
10/4/2016 11:45	11.722
10/4/2016 12:00	11.819
10/4/2016 12:15	11.916
10/4/2016 12:30	12.013
10/4/2016 12:45	12.207
10/4/2016 13:00	12.304
10/4/2016 13:15	12.401
10/4/2016 13:30	12.497
10/4/2016 13:45	12.594
10/4/2016 14:00	12.69
10/4/2016 14:15	12.69
10/4/2016 14:30	12.787
10/4/2016 14:45	12.787
10/4/2016 15:00	12.883
10/4/2016 15:15	12.883
10/4/2016 15:30	12.98
10/4/2016 15:45	12.98
10/4/2016 16:00	13.076
10/4/2016 16:15	13.076
10/4/2016 16:30	13.076

From: Jean Castillo - NOAA Federal [mailto:jean.castillo@noaa.gov]
Sent: Wednesday, July 12, 2017 6:30 PM
To: Devine, John
Subject: Tuolumne - Fish Transit Study stuff

Hi John,

I have been meaning to ask you if you were able to get the application in to CDFW for the triploid fish? I believe Mark Clifford from CDFW said it needed to be in by August 1st to get on the list for the next round.

Mark said the plan is to fertilize and triploid the eggs at Feather River Hatchery, then transfer them for incubation to their quarantine facility (Silverado Fisheries Base) in early October, 2017. The fish would likely be ready for transfer/release around this time next year (April/May/June 2018). Attached is CDFW's fish request protocol. Lots of information in there, including deadlines, dates, information needed and necessary caveats. You probably have this document but since I had it at my fingertip I thought I'd send it along with this correspondence.

Sincere regards,
Jean

From: Staples, Rose
Sent: Thursday, July 20, 2017 11:37 AM
Cc: Deason, Jesse; Le, Bao; Johnson, Laura; Staples, Rose
Subject: Modified Upper Tuolumne River Water Temperature Index Literature Review Summary

La Grange Licensing Participants,

On May 11, 2017, the Districts circulated the water temperature index (WTI) literature review summary to the Plenary Group for review. At the May 18, 2017, Plenary Group meeting, attendees voted to adopt the WTI literature review and summary as presented to the Plenary Group. Following the meeting on May 18, the WTI literature review summary was modified as follows:

- Given that the FERC (1993) reference is a secondary or tertiary source of information, and not a primary source, references to FERC (1993) have been removed from the document (see pages 5 – 8, 10 – 11, 15, and 26).

- Several references to Marine and Cech (2004) were incomplete descriptions of the findings of the study; this has been corrected (see pages 20 – 24).

- Word processing errors were corrected (see pages 5 and 19 – 22).

The modified WTI literature review summary is now available on the La Grange licensing website as an attachment to the May 18, 2017 meeting announcement under the CALENDAR tab as well as in the DOCUMENTS section.

Rose Staples, CAP-OM, MOS
Senior Administrative Assistant

HDR
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hdrinc.com/follow-us

From: Jason Guignard [mailto:jasonguignard@fishbio.com]
Sent: Thursday, July 27, 2017 10:47 AM
To: Mark Clifford
Cc: Andrea Fuller; Le, Bao; Devine, John
Subject: Hatchery fish request- La Grange FERC request

Hi Mark,

Please find attached a request for hatchery fish associated with the La Grange Project FERC licensing (FERC No. 14581). This request is similar to what was submitted and approved last year, but ultimately fish were not available due to low returns to Iron Gate Hatchery.

Please let me know if any questions come up, or you need additional information during the review process.

Thank You,

Jason Guignard
Fisheries Biologist

FISHBIO
jasonguignard@fishbio.com
O: (209) 847-6300
C: (209) 840-9019
www.fishbio.com

From:	Clifford, Mark@Wildlife
To:	guignard, jason@fishbio.com
Subject:	RE: Hatchery fish request- La Grange FERC request
Date:	Thursday, July 27, 2017 10:53:39 AM
Attachments:	image001.png

FISHBIO
1617 S. Yosemite Avenue • Oakdale, CA 95361 • Phone: (209) 847-6300 • Fax: (209) 847-1925

July 27, 2017

Dr. Mark Clifford
Hatchery Coordinator
California Dept. of Fish and Game
#3 North Old Stage Road
Mount Shasta, CA 96067

Subject: Request for Test Fish for Studies Related to the La Grange Project Licensing (FERC No. 14581): Fish Transit Study

Dear Dr. Clifford:

FISHBIO is resubmitting this request for 1,500 Chinook salmon to be used on the upper Tuolumne River to support studies being conducted as part of the La Grange Hydroelectric Project (FERC No. 14581). The goal of this particular study would be to evaluate downstream (juvenile) movement of anadromous fish through Don Pedro Reservoir. Evaluating reservoir passage efficiency may help inform decisions related to the feasibility of providing a downstream passage facility. There is no existing information regarding migration and migration success rates of juvenile salmonids through Don Pedro Reservoir, as there are no anadromous populations occurring upstream. A final study plan for this study was submitted to FERC on September 16, 2016 (see Attachment).

The proposed study plan requires releases of acoustic tagged juvenile Chinook salmon in the upper Tuolumne River during spring 2018 to estimate migration success through reaches of the reservoir. The proposed release locations for these fish are at Lumsden (RM 96) and Wards Ferry (RM 78.5). Target size for tagging is approximately 105-125 mm, which is expected to correspond to individuals weighing at least 12 g to maintain a tag weight to body weight ratio of less than 5%. This is approximately 38 fish/lb and study fish would need to be available starting April 1, 2018.

Based on our original 2016/2017 fish request (Document Number 16/17-02) which was tentatively approved for use of triploid and disease-free certified Chinook salmon from the Iron Gate Hatchery (IGH), we again would like to request 1,500 juvenile Chinook salmon from IGH (note that on October 20, 2016, the original request was not approved due to low adult fall-run returns to the Iron Gate Hatchery). Contingent allocation of fall-run Chinook from another hatchery would also be acceptable, at the Department's discretion.

We appreciate your willingness to consider this request prior to the August 1 deadline. Due to time constraints associated with obtaining acoustic tags for this study, we request that a decision regarding allocation of these fish be made prior to January 1, 2018. Field data collection would occur during April-June 2018, with a final study report potentially issued to FERC in the last quarter of 2018.

My Scientific Collecting Permit (SCP) number is SC-9966, and FISHBIO is currently pursuing an Entity SCP under Principal Investigator Andrea Fuller (SC-2147). If you have any questions, or if any additional information is needed to process this request please contact me using the information below.

Sincerely,

Jason Guignard
Fisheries Biologist

FISHBIO
jasonguignard@fishbio.com
O: 209.847.6300
C: 209.840.9019
www.fishbio.com

TID WATER & POWER
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MID Modesto Irrigation District
The Power to Grow

September 15, 2016

Filed via Electronic Submittal (E-File)

Kimberly D. Bose, Secretary
Federal Energy Regulatory Commission
888 First Street NE
Washington, DC 20426

Subject: La Grange Hydroelectric Project, FERC Project No. 14581
Response to Comments on the Reservoir Transit Study Plan

Dear Secretary Bose:

On February 2, 2015, FERC issued the Study Plan Determination (SPD) for the La Grange Hydroelectric Project. In the SPD, FERC recommended that as part of the Fish Passage Facilities Alternatives Assessment (Assessment), the Districts evaluate the technical and biological feasibility of the movement of anadromous salmonids through La Grange and Don Pedro project reservoirs, if the results from Phase 1 of the Assessment indicate that the most feasible fish passage concepts involve passage through Don Pedro Reservoir or La Grange pool. FERC recommended that the Districts prepare a study plan and allow a minimum of 30 days for licensing participants to comment on the draft study plan before filing the study plan as part of the Initial Study Report.

As detailed in FERC's May 27, 2016, determination on requests for study modifications and new study, FERC approved the Districts' proposed modifications to the Assessment's Phase 1 and Phase 2 implementation schedule, thereby allowing Phase 1 to extend into 2016 and Phase 2 to occur in 2017. In accordance with this modified schedule, the Districts provided an anadromous fish reservoir transit study plan to licensing participants in July 2016 to advance the necessary planning and permitting to conduct such a study during Phase 2 in spring 2017.

On July 11, 2016, the Districts distributed the draft Reservoir Transit Study Plan to licensing participants for 30-day review and comment. On August 1, 2016, the Districts distributed an amendment to the study plan, which stated that if permits to acquire spring-run Chinook salmon test fish are denied or not issued in time to complete the Reservoir Transit Study (planned for spring 2017), fall-run Chinook salmon test fish would be pursued as an alternative. Comments on the study plan and study plan amendment were received from the Central Sierra Environmental Resource Center, the National Marine Fisheries Service, and Mr. Lonnie Moore, a private citizen. The Districts reviewed the comments and prepared a response document. No changes to the study plan or study plan amendment were necessary to address the comments. Please find attached the Reservoir Transit Study Plan, the Reservoir Transit Study Plan amendment, and the Districts' response to licensing participant comments.

The Districts appreciate this opportunity to respond to comments provided by licensing participants and look forward to continuing discussions during the licensing process.

Sincerely,

Steve Boyd
Turlock Irrigation District
P.O. Box 949
Turlock, CA 95381
(209) 883-8364
seboyd@tid.org

Greg Dias
Modesto Irrigation District
P.O. Box 4060
Modesto, CA 95352
(209) 526-7566
gregd@mid.org

cc: Licensing Participants E-Mail List

Enclosures: (1) Reservoir Transit Study Plan
(2) Reservoir Transit Study Plan amendment
(3) Districts' response to licensing participant comments on the study plan

STUDY PLAN

TURLOCK IRRIGATION DISTRICT
AND
MODESTO IRRIGATION DISTRICT

LA GRANGE HYDROELECTRIC PROJECT
FERC NO. 14581

Reservoir Transit Study

September 2016

1.0 Background

The Turlock Irrigation District (TID) and Modesto Irrigation District (MID) (collectively, the Districts) own the La Grange Diversion Dam (LGDD) located on the Tuolumne River in Stanislaus County, California. LGDD was constructed from 1891 to 1893 to replace Wheaton Dam, which was built by other parties in the early 1870s. The LGDD raises the level of the Tuolumne River to permit the diversion and delivery of water by gravity to irrigation systems owned by TID and MID. The Districts' irrigation systems currently provide water to over 200,000 acres of prime Central Valley farmland and drinking water to the City of Modesto and the community of La Grange. Built in 1924, the La Grange hydroelectric plant is located approximately 0.2 miles downstream of LGDD on the east (left) bank of the Tuolumne River and is owned and operated by TID. The powerhouse has a capacity of slightly less than five megawatts (MW). The La Grange Project operates in a run-of-river mode. The LGDD provides no flood control benefits, and there are no recreation facilities associated with the La Grange Project or the La Grange pool.

LGDD is 131 feet high and is located at river mile (RM) 52.2 at the exit of a narrow canyon, the walls of which contain the pool formed by the diversion dam. Under normal river flows, the pool formed by the diversion dam extends for approximately one mile upstream. When not in spill mode, the water level above the diversion dam is between elevation[1] 294 feet and 296 feet approximately 90 percent of the time. Within this 2-foot range, the pool storage is estimated to be less than 100 acre-feet of water.

The drainage area of the Tuolumne River upstream of LGDD is approximately 1,550 square miles. Tuolumne River flows upstream of LGDD are regulated by four upstream reservoirs: Hetch Hetchy, Lake Eleanor, Cherry Lake, and Don Pedro. The Don Pedro Hydroelectric Project (FERC No. 2299) is owned jointly by the Districts, and the other three dams are owned by the City and County of San Francisco (CCSF). Inflow to the La Grange pool is the sum of releases from the Don Pedro Project, located 2.6 miles upstream, and very minor contributions from two small intermittent streams downstream of Don Pedro Dam.

[1] All elevations in this document are referenced to 1929 National Geodetic Vertical Datum (NGVD 29).

As part of the Integrated Licensing Process (ILP) for the La Grange Project, the Districts are completing a phased, two-year Fish Passage Facilities Alternatives Assessment (Assessment) to identify and develop potentially viable, concept-level alternatives for upstream and downstream passage of Chinook salmon and steelhead at the La Grange and Don Pedro dams.

Specific objectives of the Assessment are to:

- Obtain available information to establish existing baseline conditions relevant to impoundment operations and siting passage facilities,
- Obtain and evaluate available hydrologic data and biological information for the Tuolumne River to identify potential types and locations of facilities, run size, fish periodicity, and the anticipated range of flows that correspond to fish migration,
- Formulate and develop preliminary sizing and functional design for select, alternative potential upstream and downstream fish passage facilities, and
- Develop Class-V opinions of probable construction cost and annual operations and maintenance (O&M) costs for select fish passage concept(s).

The Assessment consists of two phases. Phase 1 (conducted in 2015) involved collaborative information gathering and evaluation of facility siting, sizing, general biological and engineering design parameters, and operational considerations. Phase 2 (conducted in 2016) will involve the development of preliminary functional layouts and site plans, estimation of preliminary capital and O&M costs, and identification of any additional significant information needs for select passage alternatives.

As detailed in FERC's May 27, 2016 determination on requests for study modifications and new study, a proposed modification of the Assessment's Phase 1 and Phase 2 implementation schedule was approved by extending Phase 1 an additional year to 2016 and completing Phase 2 in 2017 to allow for further coordination with licensing participants on gathering necessary information to ensure that the fish passage facility design basis and resulting cost estimates reflect reliable and defensible information. As part of this determination, FERC also noted the Districts' proposal to develop an anadromous fish reservoir transit study plan and provide it to licensing participants by July 2016, to advance the necessary planning and permitting to conduct such a study during Phase 2 in spring 2017, should the Phase 1 results indicate that such a study is necessary.

2.0 Study Area

The Reservoir Transit study area will include the mainstem of the upper Tuolumne River from Lumsden (RM 96) downstream to Don Pedro Dam (RM 54.8) including Don Pedro Reservoir.

3.0 Study Goals

The goal of the Reservoir Transit Study is to evaluate the biological feasibility of downstream (juvenile) movement of anadromous fish through Don Pedro Reservoir. Evaluating reservoir passage efficiency is one component of assessing overall fish passage performance, and results

of this study will be used to help inform feasibility of a potential downstream passage facility. There is no existing information regarding migration and migration success rates of juvenile salmonids through Don Pedro Reservoir, as there are no anadromous populations occurring upstream. The purpose of the Reservoir Transit Study is to evaluate juvenile salmonid reservoir passage efficiency through the Don Pedro Project Reservoir by determining estimates of reach specific migration success.

4.0 Study Methods

Permitting and Study Fish Availability

Scientific Collector Permit Amendments will be required for this study to be conducted and applications for the amendments will be submitted during summer 2016. The use of hatchery fish will also be required for this study, and a request will be submitted to California Department of Fish and Wildlife (CDFW) in July 2016 for hatchery origin Chinook salmon to be allocated for this study during spring 2017. This request will be for spring-run Chinook salmon in a size range representing large young-of-the-year smolts and/or yearlings (95-120 mm). While spring-run Chinook salmon are preferred, it is recognized that these fish may not be available for a variety of reasons. Alternatively, fall-run Chinook salmon of a similar size could be used for this study as a surrogate to spring-run Chinook salmon (SJRRP 2011).

Releases of hatchery origin steelhead juveniles were also considered in development of the study design, but are not proposed due to the potential uncertainties that would be introduced related to the fact that the steelhead fish obtained would not actually be smolting, but simply of smolt-size. Therefore, these fish may not have the urge to sustain downstream migration behavior. While fish that moved upstream following release would be excluded from analyses of migration success, there is no guarantee that a juvenile steelhead that initially moves downstream for some distance does not stop migrating to take up temporary or permanent residence in the river or reservoir (Del Real et al. 2011, Plumb et al. 2006). A key assumption of the study design is that study fish will continue to try to migrate downstream through the river and reservoir. Due to potential sample losses due to upstream movement and/or temporary or permanent residency in the river or reservoir, compounded with the possibility of low migration success through many of the study reaches, including steelhead in the study was deemed infeasible.

Acoustic Telemetry

VEMCO acoustic technology (tags and receivers) likely represents the best technology given the study objectives and study site. Autonomous acoustic receivers (model VR2W – 180 kHz) are self-powered for 8 months and record and decode data automatically. Each receiver is capable of storing up to 1.6 million records. Under optimal acoustic conditions (e.g., no boat traffic and calm water), 180 kHz tags can be detected up to 250 m away (about 820 ft). However, it should be noted that in areas (near marinas or boat ramps) or periods (on weekends) with high boat traffic, detection range could be considerably less. Therefore, detection range testing will be performed to evaluate the appropriate spacing and configuration of receivers within arrays.

Tagging Methods

A total of 960 hatchery reared juvenile Chinook salmon will be surgically implanted with VEMCO acoustic transmitters. Chinook salmon, with average size ranging from 95-120 mm, will be implanted with V4-180 kHz tags (0.24 g). All tagging will be performed by experienced personnel following standard implantation procedures (Adams et al. 1998, Martinelli et al. 1998). The tag to body weight ratio will not exceed 5%.

Eight groups of 60 tagged juvenile Chinook salmon will be released at each of two release sites during the study period. Release sites have been identified at Lumsden (RM 96) and Wards Ferry (RM 78.5), as these are the only accessible sites near or upstream of the reservoir. While there is a preference to select a release location that ensures that fish travel through riverine habitat prior to entering the reservoir (e.g., Lumsden), there is also a desire to minimize loss of tagged fish prior to entering the reservoir by making releases near the head of the reservoir (e.g., Wards Ferry).

Following release of study fish, a combination of fixed and mobile receivers will be used to document movement of juvenile Chinook salmon through the Don Pedro Project Reservoir. Fixed receivers will be deployed near proposed locations of potential downstream fish collection facilities (Table 4-1; TID/MID 2016) to document travel time and reach specific migration success. Mobile tracking may be used to document locations of tagged fish between acoustic receiver locations.

Table 4-1. Proposed locations of acoustic receivers.

Site No.	Location	River Mile	Max Depth (ft)[1]	Max Width (ft)[1]
Release	Lumsden	96	--	--
Release	Wards Ferry	78.5	--	--
1	Abv. Wards Ferry	79	30	250
2	Below Wards Ferry	78	80	400
3	Abv. Moccasin Point	73.3	180	650
4	Jacksonville Rd. Bridge	72.5	200	1200
5	Railroad Canyon	70	280	1000
6	East Bay	60	330	1300
7	Abv. DP Dam	55	530	2000

[1] Maximum depth and width assume that Don Pedro Reservoir is at full pool (830’), based on bathymetry data from Don Pedro relicensing.

Array Design

The entire Don Pedro Reservoir acoustic array will consist of single- and double-gated arrays as shown in Figure 4-1. This particular arrangement of acoustic receivers will provide valuable information on the movement, migration success, and movement direction of tagged fish as well as the detection efficiency of specific locations and the entire array. Proposed array locations provide finer scale resolution near the head of reservoir to provide more information on movement patterns and migration success within this area.

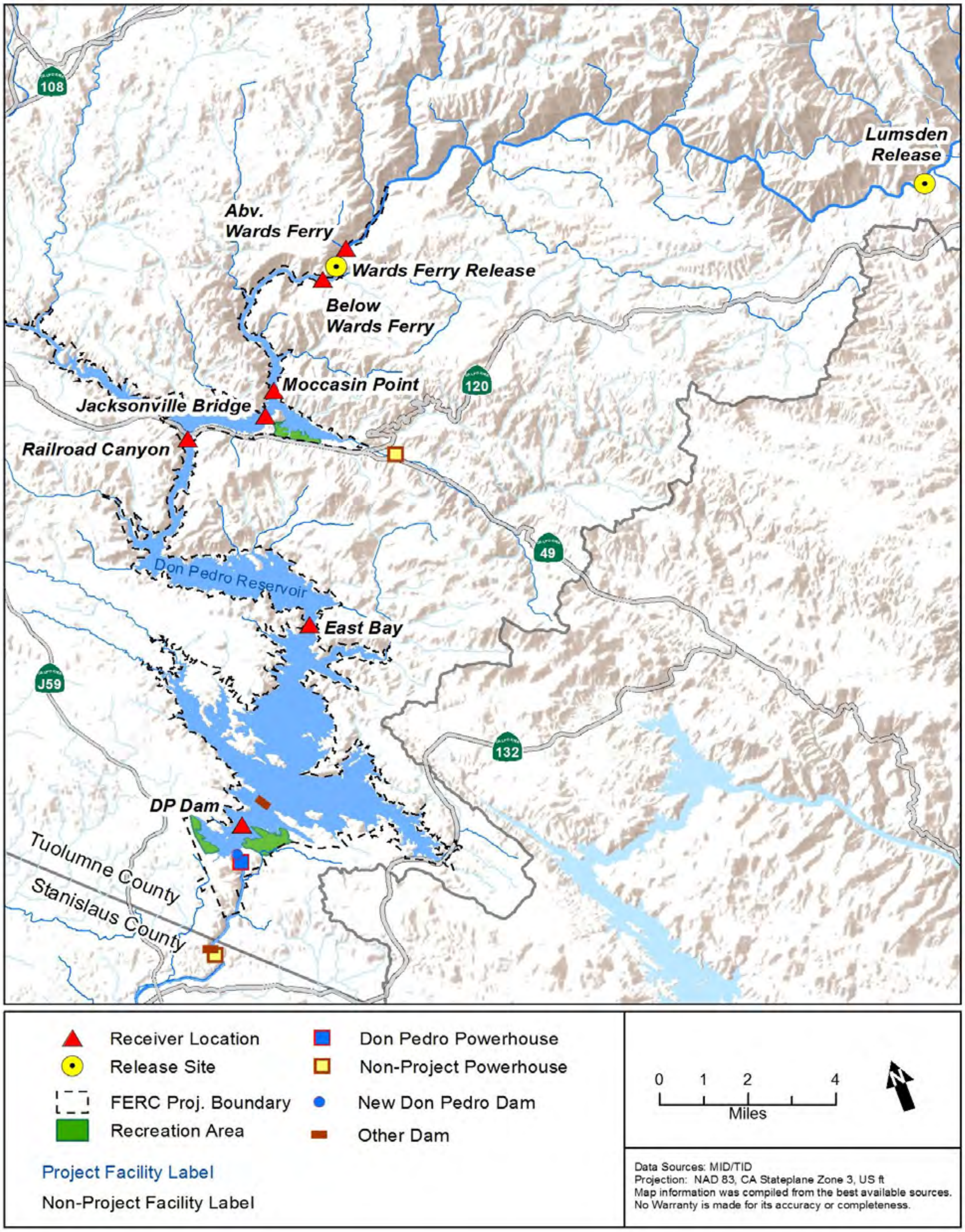

Figure 4-1. Proposed release and acoustic array locations in the upper Tuolumne River and Don Pedro Reservoir.

Based on the approximate dimensions of each monitoring site (shown in Table 4-1), the number of receivers per site will vary from 1 to 8 (Table 4-2). This proposed number at each site is based on the assumption of a detection range of about 330 ft, and allows for some overlap between detection fields of each receiver. Therefore, based on results from detection range testing, the actual number of receivers may differ (e.g., if detection range is reliably > 330 ft, potentially one less receiver could be used per array). An additional consideration for the number of receivers is the water level in Don Pedro Reservoir at the time of the study. If water level in the reservoir is significantly reduced from the assumed full pool (used to estimate dimensions), the number of receivers could be reduced further.

Table 4-2. Proposed number of acoustic receivers and number of arrays at each site (based on assumption of 330 ft detection range).

Site No.	Location	River Mile	No. of Arrays	No. of Receivers
Release	Lumsden	96	-	-
Release	Wards Ferry	78.5	-	-
1	Abv. Wards Ferry	79	1	1
2	Below Wards Ferry	78	2	1
3	Moccasin Point	73.3	2	2
4	Jacksonville Rd. Bridge	72.5	1	3
5	Railroad Canyon	70	2	4
6	East Bay	60	1	6
7	DP Dam	55	2	8

Range Testing

Estimating the range of detection through range testing will be an important first step in determining the spacing and configuration of receivers within acoustic arrays (Kessel et al. 2013). As noted above, detection range can vary by site, and through time within a site. A variety of factors can cause changes in detection range including, weather, boats, conductivity, temperature, depth, or temperature gradients, among others (Kessel et al. 2013). To conduct range testing, up to 8 receivers will be deployed at 100 ft increments away from a test tag(s). A test tag emits an acoustic pulse or signal every 30 seconds. Therefore, if a receiver 100 ft away was detecting at 100%, the number of detections in an hour for that tag should equal 120 (i.e., 2 pulses per minute * 60 = 120). Receivers close to the test tag should typically detect the tag with high detection rates, and then at increasing distance away from the tag, detection rates will decrease. The range test will be conducted for one week prior to the study and ideally represent typical ambient conditions at each site.

After the range test is completed, the number of detections on an hourly or daily basis will be plotted against distance away from the tag. Typically, the rate at which tag detection decreases with increasing distance follows a logistic function (Figure 4-2; from Figure 2 of Kessel et al. 2013). Using Figure 4-3 as an example, in order to achieve 50% detection probability, the receivers should be deployed approximately 1000 m apart (since the detection range represents the radius of a ~500 m circle around the receiver). A similar method will be used to determine the appropriate spacing for the receivers in each array in this study.

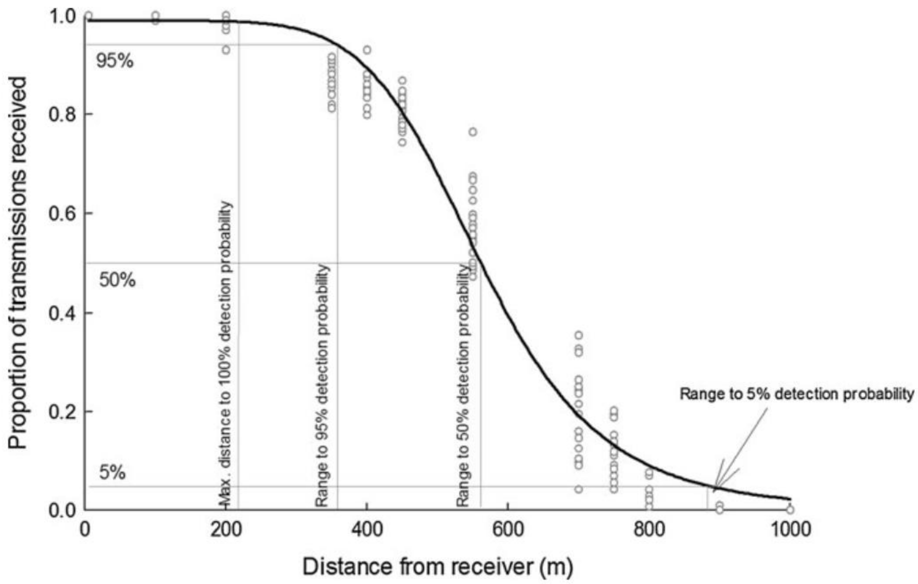

Figure 4-2. Conceptual diagram of collected data from range tests and method to determine appropriate spacing of receivers. From Figure 2 of Kessel et al. 2013.

Deployment Methods / Equipment

For deployments in the reservoir, acoustic receivers will be affixed to a mooring and buoy system, subject to approval by Don Pedro Recreation Agency and consistent with existing rules and regulations. Moorings will be constructed of concrete and weigh approximately 100 lbs each. The cabling will be secured to the underside of the buoy to minimize tampering. Acoustic receivers will be secured to 3/8" stainless steel cable with stainless steel hose clamps and will be deployed approximately 10 ft from the water surface to prevent tampering or loss from the public. Receivers deployed near the surface will be oriented to face downwards to maximize the detection range in the upper portion of the water column. In the deeper portions of the lake (Railroad Canyon, East Bay, and at Don Pedro Dam), two acoustic receivers will be deployed on the same mooring system. These will face upwards and will be deployed so that they are approximately 10 ft from the substrate.

Data Analysis

The proposed study design will determine, for any given study reach, the proportion of fish that migrated successfully to pass into the next downstream reach. The mechanisms via which any fish failed to arrive at the next reach will not be identified by this study but may include the following: some fish may have died, taken up residence, moved up into a tributary, turned around, or had a failed tag. Detection data will be analyzed using a Cormack-Jolly-Seber (CJS) framework and the commonly accepted CJS formulation (see Lebreton et al. 1992). A similar method was used by Skalski (1998), and the specific method was later described as a 'Single Release-Recapture Model' (Giorgi et al. 2010). These models simultaneously allow the estimation of detection probability at each receiver array, and the probability of successful passage between each array. Multiple detection arrays are required in order to tease-apart the effects of passage-success and detection-probability. Since no arrays exist downstream of the

last one, the detection efficiency of the last array cannot be determined, and because of that, the effects of successful passage and successful detection cannot be teased-apart in the last reach.

The Single Release-Recapture Model does not allow for handling effects to be controlled. Thus any latent handling related effects that manifest in a given study reach will contribute to the failure of some fish to reach the next detection point, and hence will be attributed as a loss to the reach itself. While a Paired Release-Recapture Model would avoid this issue (see Giorgi et al. 2010), these models require more tagged fish for releases to be made at the top of each study reach and *a priori* knowledge of reach-specific transit times which are not available. In this study, we propose to release fish at Lumsden, i.e., far enough upstream of the reservoir as to maximize the probability that any handling related effects are fully manifest by the time the tagged fish enter the first reach of interest at Wards Ferry. Since there is no available information to predict how many of these fish will survive to Wards Ferry or migrate successfully through each of the reservoir reaches, releases will also be made at Wards Ferry with the intent of bolstering the sample size of fish reaching the downstream reaches (i.e., the fish released at Wards Ferry will not have fully expressed any potential handling-related mortality to be useful for estimation of passage success through their first study reach, but if subsequent detection probabilities and passage success rates are comparable to those of the Lumsden fish, both release groups may be pooled for increased sample size in the lowest reaches).

Detection arrays will be deployed at Wards Ferry, Moccasin Point, Jacksonville Road Bridge, Railroad Canyon, East Bay, and two arrays in the forebay of Don Pedro Dam (Figure 4-3). The double array in the Don Pedro Forebay will allow estimation of passage-success through the last study reach without dealing with non-estimable parameters. At various other key locations in the Reservoir, we propose that double arrays be deployed. There is no *a priori* knowledge of reach-specific passage success, which could be low enough in some reaches as to make it difficult for the model to separate the effects of passage-success and detection-probability. Thus, while not strictly required for the analysis, especially if passage success is good, double arrays will add value by helping to resolve the models under certain scenarios.

All modeling will be carried out in the R computing environment (R Development Core Team 2015) using the RMark package (Laake 2013) to construct and fit models in Program MARK (White and Burnham 1999). In Figure 4-3, model parameters are mapped onto a conceptualized image of the river and reservoir, where the waterways have been simplified for the sake of the illustration as a linear system. The parameters that will be estimated are listed and defined in Table 4-3.

Table 4-3. List of model parameters, and their definitions.

Parameter	Definition
$\Phi_{L\text{-}W1}$	Probability of successfully passing between Lumsden and the first array at Wards Ferry
p_{W1}	Probability of detection at the first array at Wards Ferry
p_{W2}	Probability of detection at the second array at Wards Ferry
$\Phi_{W2\text{-}M1}$	Probability of successfully passing between the second array at Wards Ferry and the first array at Moccasin Point
p_{M1}	Probability of detection at the first array at Moccasin Point
p_{M2}	Probability of detection at the second array at Moccasin Point
$\Phi_{M2\text{-}J}$	Probability of successfully passing between the second array at Moccasin Point and Jacksonville Rd. Bridge
p_{J}	Probability of detection at Jacksonville Rd. Bridge
$\Phi_{J\text{-}R1}$	Probability of successfully passing between Jacksonville Rd. Bridge and the first array at Railroad Canyon
p_{R1}	Probability of detection at the first array at Railroad Canyon
p_{R2}	Probability of detection at the second array at Railroad Canyon
$\Phi_{R2\text{-}E}$	Probability of successfully passing between the second array at Railroad Canyon and East Bay
p_{E}	Probability of detection at East Bay
$\Phi_{E\text{-}D1}$	Probability of successfully passing between East Bay and the first array in the Don Pedro forebay
p_{D1}	Probability of detection at the first array in the Don Pedro forebay
$\lambda_{D1\text{-}D2}$	Probability of *both* successfully passing between the two arrays in the Don Pedro Forebay ($\Phi_{D1\text{-}D2}$) *and* being detected at the second array (p_{D2}). The two effects cannot be disentangled, thus are represented by a single parameter, $\lambda_{D1\text{-}D2}$

Note that passage success will be assumed to be 100% between paired arrays (where two sets of arrays are deployed together) at Wards Ferry, Moccasin Point and Railroad Canyon.

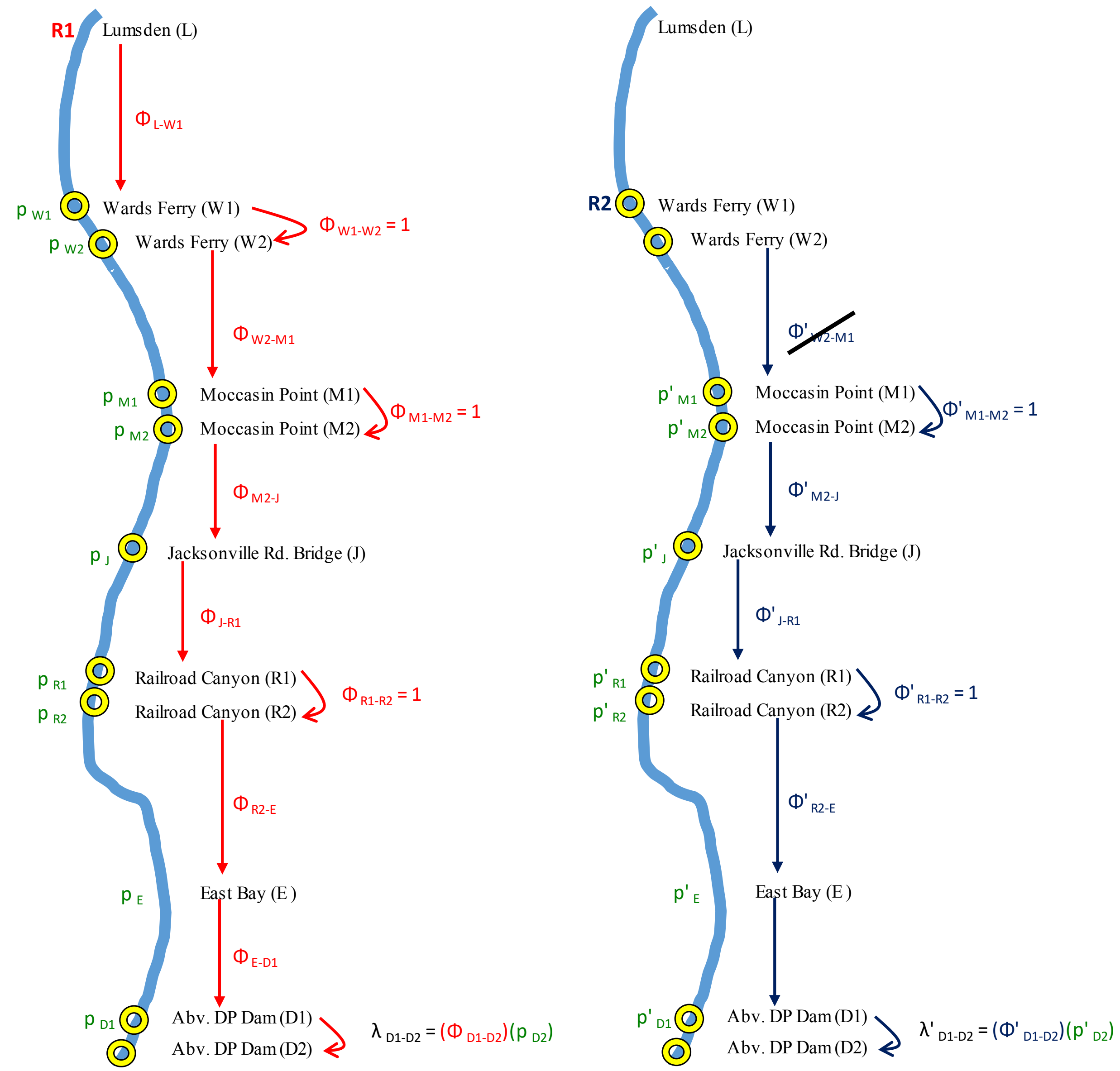

Figure 4-3. Model parameters mapped onto a simplified (conceptual) image of the river and reservoir, shown for the sake of the illustration as a linear system. Yellow circles show detection arrays. Parameters associated with the Lumsden releases (R1) will be estimated separately from their equivalents (marked with an apostrophe) for the Wards Ferry releases (R2), unless data pooling is required or unless model results suggest separation is not parsimonious. Definitions of parameter symbols are shown in Table 4-3.

5.0 Study Schedule

- Study Planning and Permitting ....May 2016 – December 2016
- Draft Study Plan to Licensing Participants ....July 2016
- Provide Interim Study Updates……………………………………….....February – May 2017
- Field Data Collection ....April – June 2017
- Data Entry Processing, and QA/QC .... February –July 2017
- Data Analysis…………………………………………………………......April – August 2017
- Report Preparation .... June - August 2017
- Draft Report for 30-day Review ....August 2017
- Final Report Issuance ....October 2017

6.0 References

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Amendment to Draft Reservoir Transit Study Plan
August 1, 2016

As part of the La Grange Hydroelectric Project (FERC No. 14581) Integrated Licensing Process, Turlock Irrigation District (TID) and Modesto Irrigation District (MID) (collectively, the Districts) submitted to Licensing Participants (LPs) a draft Reservoir Transit Study Plan (TID/MID 2016) for review on July 11, 2016. The goal of this particular study is to evaluate the downstream migration of juvenile anadromous fish through Don Pedro Reservoir. Evaluating reservoir passage efficiency is one component of assessing overall fish passage performance. There is no existing information regarding migration rates, routes and success of juvenile salmonids through Don Pedro Reservoir. The purpose of the Reservoir Transit Study is to evaluate juvenile salmonid reservoir passage efficiency through the Don Pedro Project Reservoir by estimating reach specific migration success.

The proposed study plan requires the release of acoustic tagged juvenile Chinook salmon in the spring of 2017 to estimate migration success through reaches of the reservoir. FISHBIO, consultant to the Districts, has submitted a formal request to the California Department of Fish and Wildlife (CDFW) to use spring-run juvenile Chinook salmon as test fish to support study implementation. Recognizing that spring-run are CESA and ESA listed, we are currently in the process of preparing the necessary CESA and ESA-related permits for the test fish. Should these permits not be issued in time, the use of fall-run Chinook salmon is proposed as an alternative to ensure the study can be completed by fall 2017. The Districts seek LP's comments on this proposed alternative by August 10, 2016. Please submit your comments to Rose Staples (rose.staples@hdrinc.com).

Turlock Irrigation District and Modesto Irrigation District (TID/MID). 2016. Reservoir Transit Study Plan. Prepared by HDR, Inc. Appendix to La Grange Hydroelectric Project Initial Study Report. July 2016.

Table 1.0 Districts' response to licensing participant comments on the draft study plan for the Reservoir Transit Study.

Comment No.	Comment	Districts' Response
CSERC – 01	The goal of the Reservoir Transit Study, as defined on pages 2-3 of the Draft Plan, is to determine efficiency of juvenile salmonid movement through Don Pedro Reservoir by estimating reach-specific migration success, in an effort to assess overall "feasibility of a potential downstream passage facility". CSERC's first question focuses on how the transit study results are intended to be used to determine whether downstream movement is feasible. "How will the results of the study define whether juvenile salmonids can actually successfully migrate through the reservoir? Specifically, what proportion of fish migrating through each study reach, and how many reaches, will be defined as 'successful' downstream passage? (What is the threshold for defining success and on what is it based?) And would low migration success through the study reaches negate a potential downstream passage facility? Or would low passage rates call for further data collection, since the lack of successful passage between study reaches could in fact be due to project errors such as mortality, handling effects, receiver detection error, etc.?"	Criteria that define "successful downstream passage" or "migration success" have not been explicitly identified nor is it an objective of the study. The study is being implemented in support of a broader collaborative framework to evaluate the feasibility of reintroducing anadromous salmonids into the upper Tuolumne River above Don Pedro Reservoir (i.e., Upper Tuolumne River Reintroduction Assessment Framework) and the La Grange Hydroelectric Project FERC licensing process. As such, the study results will be shared with licensing participants and FERC as a basis for future discussions on acceptable performance criteria and sources of existing information, possible factors affecting data quality and whether additional data is needed, and the feasibility and location of a potential downstream passage facility.
CSERC – 02	Brown et al. 2010 and others have described the negative impacts of acoustic receiver implants to growth and survival in juvenile Chinook salmon, especially to individuals < 90 mm with tag-to-body weight ratios greater than 5%. Therefore, CSERC agrees with the Reservoir Transit Studies proposal to use juvenile Chinook salmon in the range of 95-120 mm, with tag-to-body weight ratio < 5%.	The Districts agree with this comment. As noted in the study plan, tag-to-body weight ratio will be <5% for all test fish.
CSERC – 03	How much time (e.g. minutes, hours, days) will occur between each release of the 8 groups, consisting of 60-tagged juvenile salmonids per group, at each of the two release sites (refer to page 4, paragraph 2)? And will this allow a large enough window of time to collect passage data (which is stated to occur between April-June 2017)?	Groups of test fish will be released weekly during the period of time the smolt run would naturally occur. The first release is scheduled for April 1, but will be dependent on the availability of hatchery fish of appropriate size (95-120 mm). Based on previous experience with conducting telemetry studies in the Central Valley, there is potential that releases may be delayed until mid to late April. In the event that releases are delayed, we anticipate continuing with a schedule of conducting weekly releases.
CSERC – 04	Wouldn't an array just upstream of the Lumsden release site provide additional useful information related to downstream migration rates? For example if tagged fish move upstream or simply stay in the vicinity, wouldn't that be valuable information?	The objective of this study is evaluating reach-specific migration success through the reservoir, and reach locations have been designed to address survival to possible locations of downstream collection facilities. While additional receivers would provide useful information for behavioral analysis, these are not necessary to meet the objectives of the study.

Comment No.	Comment	Districts' Response
CSERC – 05	Would additional arrays within Don Pedro reservoir, specifically in different fingers of the reservoir, potentially provide additional data and insight into movement within the reservoir during the study period and/or additional insight concerning passage rate between reaches?	See response to CSERC – 04.
NMFS – 01	Regarding the reservoir temperature model for the Don Pedro Project, can the model help recommend when and under what conditions may be the best time to release these tagged fish, increasing the likelihood that they might show up downstream?	The study plan proposes to conduct the field component during the period of time when spring-run Chinook smolts would typically be migrating (April/May) and have presumably evolved to outmigrate during this time since flows are likely highest (we note that unimpaired flows are altered by CCSF's operation of the Hetch Hetchy system). The study does not have the ability to manipulate environmental conditions. Since we cannot manipulate conditions, we are planning to release fish at typical outmigration periods.
NMFS – 02	The genetic makeup of spring Chinook has helped the species to survive through the ages. They migrate downstream under higher spring flows and cooler water conditions, get to salt water as quick as possible and try to avoid predators. However, in this case, a large deep reservoir has been placed in their path, which is not their normal environment. To increase the potential of their migration survival, it would be wise to start releases of tagged fish in the tributary in early March, acting on the possibility that the freshet may be early and cooler conditions will increase downstream survival. However, please also plan to release groups through April and May, to allow for the comparison of release group behavior and survival as water heats and stratifies.	The study is designed to compare migration success between reaches, but not among release events or months. The survival model assumes the conditions are the same for all group releases. If we were to release some groups in the spring and some groups in the summer, we would no longer have the full compliment of groups in either season. This study has been designed for releases over the natural timing of the smolt run, with releases to occur through April and May. Releases in March are not feasible due to limitations on the availability of suitably-sized hatchery fish. In addition, March storms are usually in the form of snow in the upper watershed. Peak snowmelt does not begin until the April/May period. Spring storms may influence migration success from the release point at Lumsden to the reservoir, but are not expected to significantly influence conditions in, or migration success through Don Pedro Reservoir.
NMFS – 03	Plan fish releases over at least three springs, to cover a range of environmental conditions due to climate variation.	This study is being conducted as part of the La Grange Hydroelectric Project FERC licensing process. As detailed in FERC's May 27, 2016 determination on requests for study modifications and new study, FERC approved the Districts' proposed schedule modification of the Fish Passage Alternatives Assessment. Under this modified schedule, the Districts would provide an anadromous fish reservoir transit study plan to licensing participants by July 2016 to advance the necessary planning and permitting to conduct such a study during Phase 2 in spring 2017.

Comment No.	Comment	Districts' Response
		At this time, the Reservoir Transit Study is planned for one year only and will occur in 2017. This does not preclude further study if results from the 2017 work indicate the need for additional information. The licensing process allows for any licensing participant (including the licensee) to request additional information (including additional years of study) based upon an evaluation of the study results which will be available in fall 2017.
NMFS – 04	Can the 3-D CFD temperature model track a particle of water released in the tributary through the reservoir during (1) a normal winter when there is little or no stratification or thermocline, (2) the spring, with moderate stratification and, (3) the summer, with a strong thermocline? How does the model predict what becomes of the cooler, denser inflow and the downstream flow net at depths or streamlines throughout the reservoir, and not just cross-sectional velocities?	To clarify, the Don Pedro Reservoir Temperature Model is a hydrodynamic model, not a computational fluid dynamics (CFD) model. However, the model does have the ability to report x,y and z velocity components at reservoir locations. As a 3D temperature model, MIKE3 establishes density and temperature differences throughout the complex reservoir geometry.
NMFS – 05	Sufficient acoustic arrays throughout the reservoir, including at various depths and in the middle of the reservoir and along the sides, are necessary to understand fish behavior and where they may be queueing during passage, as well as passage progress and survival.	See response to CSERC – 04.
NMFS – 06	With the high population of predator fish in the reservoir, there needs to be a way to determine the difference in behavior between a predator with a tag it consumed and a salmon smolt.	Species of fish in the study area that are considered predators to outmigrating salmon juveniles are primarily black bass, which are resident with well-defined home ranges that are smaller than the distance between monitored reaches. As such, it is not anticipated that a predator will consume a test fish and be mistakenly detected as a smolt (i.e., a predator is unlikely to migrate an appreciable distance downstream to the next set of acoustic arrays). This behavioral difference would produce movement patterns in the dataset that are markedly different than what is anticipated for outmigrating smolts. A past mercury study in sportfish also supports these observations that black bass are resident and do not move far from their territories (Greenfield et al. 2002). The study reported that of 1,206 tag returns recorded by CDFW in the Sacramento-San Joaquin Delta, 65% of the fish were found within 1 mile of the site of release, 83% were within 5 miles, and the median distance was 0 miles.
NMFS – 07	The Study Plan states that eight groups of 60 fish will be released at two sites. However, other than describing that the releases will occur between April and June 2017, there is no detail provided as to the	See responses to CSERC – 03 and NMFS – 02.

Comment No.	Comment	Districts' Response
	frequency or timing of the releases. For examples, are the fish releases intended to occur at regular weekly or bi-weekly intervals? Will there be an effort to time releases with potential elevated flows due to storms, snowmelt, and/or releases from upstream hydroelectric facilities? NMFS requests that the Districts work with relicensing participants to develop a release schedule for the study fish, including potential adaptively managing the fish releases based on snowpack for the 2016-17 winter as well as spring storm activity.	
NMFS – 08	NMFS recommends that the Districts consider releasing fish in early March, when temperatures are cooler, and the potential for spring storms higher. While the precise timing of downstream migration for anadromous fish potentially reintroduced upstream of Don Pedro Reservoir is unknown, spring-run populations in other basins exhibit downstream migratory behavior as early as March and occasionally as early as February. If fish releases are made in early March, then it is likely that at least one, if not two additional groups of study fish are needed. NMFS recommends that additional fish release groups be added to the study plan and permitting process.	See responses to CSERC – 03 and NMFS – 02.
NMFS – 09	NMFS recommends installing additional arrays of acoustic receivers in order to maximize the information obtained from implementing the transit study. NMFS recommends installing additional arrays at the following locations: A) One location in the riverine reach of the Tuolumne River between the Lumsden release point and the Above Wards Ferry acoustic array. This gap between release point and first detection array is at least 17 miles, but likely closer to 19 miles. NMFS recommends installing an array near the Grapevine Creek confluence with the Tuolumne River, which is approximately halfway between Lumsden and Wards Ferry, and there is an adequate foot/horse trail down to the Tuolumne River from the south rim. B) NMFS recommends installing an acoustic array in the Woods Creek arm of Don Pedro Reservoir, which is just upstream of the Highway 120 Bridge and Railroad Canyon acoustic array installation site. An array in the Woods Creek reservoir arm, one of the most prominent tributary arms of Don Pedro Reservoir, will provide information as to the location and fate of fish detected near Moccasin Point but not found at Railroad Canyon. C) NMFS also recommends installing an additional array between Railroad Canyon and East Bay, which is proposed to be a 10 mile gap between	See responses to CSERC – 04 and NMFS – 05.

Comment No.	Comment	Districts' Response
	detection sites. NMFS recommends installing an additional array approximately halfway between these sites, such that the maximum distance between detection sites in Don Pedro Reservoir is about 5 miles.	
NMFS – 10	As detailed in the Study Plan Amendment, NMFS supports the use of hatchery fall-run juvenile Chinook in the event that hatchery spring-run Chinook are not available for use. Preliminary information available to NMFS suggests that hatchery spring-run juveniles will be in very low supply in 2017. NMFS recommends that the Districts begin the necessary procedures and permits to obtain fall-run hatchery at this point in time for study implementation.	The Districts have appreciated NMFS' consultation and support toward acquiring hatchery spring-run fish to best support the proposed study but do acknowledge the challenges as identified in their comments. The Districts, by email dated September 7, 2016, have received a determination to their Section 10(a)(1)(A) permit application denying the use of spring-run Chinook. At this time, the Districts continue to pursue acquisition of juvenile fall-run Chinook so that the study can be implemented in spring 2017.
Moore – 01	It would be helpful to see explanations of possible differences of the two proposals and results considering the use of spring-run Chinook salmon test fish compared to the use of fall-run Chinook salmon test fish.	The preference was to use juvenile spring-run Chinook however based upon recent feedback from NMFS, this is no longer an option (See response to NMFS – 10). As such, fall-run Chinook salmon will be pursued as a surrogate to support the study. The timing and frequency of releases would have been the same regardless of whether spring-run or fall-run are used. Also note that during the study, environmental information (e.g., river flows, reservoir elevation, and water temperature, etc.) will be collected.
Moore – 02	It would be helpful to see explanations of the possible differences and results of the two proposals with respect to water flows at the time the test fish are released.	See response to Moore – 01.
Moore – 03	It would be helpful to see explanations of the possible/expected issues, results, and problems involved for the two proposals considering both the range of water flows and whether spring-run or fall-run Chinook salmon are used as test fish.	See response to Moore – 01.
Moore – 04	It would be helpful to see explanations of the possible differences of the two proposals for natural and "man-made" deprivation/mortality of juvenile spring-run and fall-run Chinook salmon during two different release periods and conditions (Moore – 01 and Moore – 02, combined with downstream/lake habitat, availability of food sources, depths of water column, stream and reservoir recreational activities, etc.).	See response to Moore – 01.

REFERENCES

Greenfield, B. K., G. Ichikawa, M. Stephenson, and J. A. Davis. 2002. Mercury in Sport Fish from the Delta Region (Task 2A). Final Report Submitted to the CALFED Bay-Delta Program for the Project: An Assessment of the Ecological and Human Health Impacts of Mercury in the Bay-Delta Watershed. http://loer.tamug.edu/calfed/Report/Final/Task%202A%20Final%20Report.pdf.

Document Content(s)

Deason, Jesse

From: Staples, Rose
Sent: Friday, August 04, 2017 2:12 PM
Cc: Deason, Jesse; Le, Bao; Staples, Rose; Johnson, Laura
Subject: La Grange May 18 2017 Plenary Group Meeting Final Notes Available on the Licensing Website

La Grange Licensing Participants,

FINAL notes from the May 18, 2017, Plenary Group meeting have been uploaded to the La Grange Project licensing website www.lagrange-licensing.com in the DOCUMENTS section as well as on the website CALENDAR as an attachment to the May 18, 2017 date.

On June 23, 2017, the Districts provided draft notes from the May 18, 2017, Plenary Group meeting to licensing participants and requested that any comments be provided by July 24, 2017. No comments were received; therefore, these FINAL notes are the same as the draft notes originally provided on June 23.

Rose Staples, CAP-OM, MOS
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From: Devine, John
Sent: Tuesday, August 22, 2017 4:09 PM
To: 'Jean Castillo - NOAA Federal'
Subject: RE: Tuolumne - FishBio

Hi Jean,

The Habitat Assessment is a working draft and incomplete, and not released as final.

Thank you for your interest in the La Grange and Don Pedro licensing processes.

John Devine, P.E.
D 207-775-4495 **M** 207-776-2206

From: Jean Castillo - NOAA Federal [mailto:jean.castillo@noaa.gov]
Sent: Tuesday, August 22, 2017 3:11 PM
To: Devine, John
Subject: Tuolumne - FishBio

Hi John,

I am trying to determine if the Upper Tuolumne River Habitat Assessment report that FishBio prepared has been released?

Thanks,
Jean

Jean M. Castillo, MSCE, P.E.
Hydraulic/Fish Passage Engineer

NOAA Fisheries West Coast Region
U.S. Department of Commerce
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-----Original Message-----
From: Staples, Rose
Sent: Wednesday, August 23, 2017 3:34 PM
To: 'John Buckley' <johnb@cserc.org>
Subject: RE: question for Rose

Thank you for asking. At this time the Districts do not have any Don Pedro relicensing / La Grange licensing meetings scheduled.

Rose Staples, CAP-OM, MOS
D 207-239-3857

hdrinc.com/follow-us

-----Original Message-----
From: John Buckley [mailto:johnb@cserc.org]
Sent: Wednesday, August 23, 2017 3:05 PM
To: Staples, Rose <Rose.Staples@hdrinc.com>
Subject: Re: question for Rose

Hi, Rose:

I am checking to see if you know of any upcoming Don Pedro/LaGrange FERC meeting date that is formally scheduled? I do not see anything listed on the Calendar, but perhaps my computer is not appropriately synched up.

Are any meetings now scheduled?

Thanks,
John Buckley
CSERC

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Kimberly Ognisty
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August 25, 2017

VIA ELECTRONIC FILING

Kimberly D. Bose, Secretary
Federal Energy Regulatory Commission
888 First Street NE
Washington DC 20426

RE: La Grange Hydroelectric Project, FERC No. 14581
Request for Revised Filing Date for La Grange Original License Application

Don Pedro Hydroelectric Project, FERC No. 2299
Schedule for Filing Amended Don Pedro Application

Dear Secretary Bose:

Turlock Irrigation District and Modesto Irrigation District (collectively, the "Districts"), owners of the the La Grange ("La Grange") Hydroelectric Project No. 14581 and the Don Pedro Hydroelectric Project No. 2299 ("Don Pedro"), are completing their respective license applications to be filed with the Commission in the La Grange licensing proceeding and the Don Pedro relicensing proceeding. As public entities, the Districts' Boards of Directors must each approve the license applications, and this is to be accomplished simultaneously once the license applications are finalized. Given the schedule for the Districts' respective Board meetings, the earliest Board meeting at which the license applications can be approved after they are finalized is October 10, 2017.

Therefore, the Districts respectfully request an extension of the date for the filing of the application for an original license for the La Grange Hydroelectric Project from the Commission's current September 25, 2017 deadline to October 11, 2017.

Given the Commission's prior indication that it would move forward with a single Environmental Impact Statement for the La Grange Hydroelectric Project and the Don Pedro Hydroelectric Project, the Districts also plan to file the planned amendment to the final license application for the Don Pedro Hydroelectric Project, including all of the outstanding studies approved by the Commission and the Districts' Preferred Plan for the Future Operation of the Don Pedro Project, on October 11, 2017.

The Districts appreciate the Comission's consideration of this matter and look forward to continuing to work with Commission staff and interested parties through the remainder of the licensing proceedings.

Respectfully submitted,

/s/ Kimberly Ognisty

Kimberly Ognisty
1700 K Street N.W.
Washington, D.C. 20006

ATTORNEY FOR TURLOCK IRRIGATION DISTRICT AND MODESTO IRRIGATION DISTRICT

cc: Don Pedro Relicensing Participants' Email Group
La Grange Licensing Participants' Email Group

CERTIFICATE OF SERVICE

I hereby certify that I have this day served the foregoing document on the parties designated on the official service list compiled by the Secretary in the Project No. 2299 proceeding.

Dated at Washington, D.C., this 25th day of August, 2017.

/s/ Kimberly Ognisty

Kimberly Ognisty
1700 K Street N.W.
Washington, D.C. 20006

From: Staples, Rose
Sent: Friday, August 25, 2017 2:48 PM
Cc: Deason, Jesse; Le, Bao; Johnson, Laura; Dosch, Lisa; Staples, Rose
Subject: Districts File Request with FERC Today on La Grange License Application

The Districts have filed a request with FERC today for a revised filing date of October 11, 2017 for the La Grange Original License Application as well as the corresponding amendment to the Don Pedro Final License Application.

A copy of this filing has been uploaded to the La Grange Licensing website (www.lagrange-licensing.com) and Don Pedro Relicensing website (www.donpedro-relicensing.com) and it is also available on FERC's E-Library at www.ferc.gov.

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