FISH PASSAGE FACILITIES ALTERNATIVES ASSESSMENT STUDY REPORT

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 2017

Fish Passage Facilities Alternatives Assessment
Study Report

TABLE OF CONTENTS

List of Figures

List of Tables

List of Attachments

List of Acronyms and Abbreviations

ac-ft	acre-foot
AWS	auxiliary water supply
BLM	Bureau of Land Management
BOR	Bureau of Reclamation
CCSF	City and County of San Francisco
CDFG	California Department of Fish and Game, now CDFW
CDFW	California Department of Fish and Wildlife
cfs	cubic feet per second
CG	Conservation Group
CHTR	Collect, Handle, Transport, and Release
Districts	Turlock Irrigation District and Modesto Irrigation District
DSOD	Division of Safety of Dams
FERC	Federal Energy Regulatory Commission
FLA	Final License Application
FPA	Federal Power Act
FSC	Floating Surface Collector
GIS	geographic information system
ILP	Integrated Licensing Process
ISR	Initial Study Report
LGDD	La Grange Diversion Dam
M&I	municipal and industrial
MID	Modesto Irrigation District
NMFS	National Marine Fisheries Service
NPS	National Park Service
O&M	operation and maintenance
PAD	Pre-Application Document
PSP	Proposed Study Plan
QA/QC	quality assurance/quality control
RM	river mile
RSP	Revised Study Plan
SD2	Scoping Document 2
SPD	Study Plan Determination
TAF	thousand acre-feet
TID	Turlock Irrigation District
TM	technical memorandum
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
USR	Updated Study Report

1.0 INTRODUCTION

1.1 Background

The Turlock Irrigation District (TID) and Modesto Irrigation District (MID) (collectively, the Districts) jointly own the La Grange Diversion Dam (LGDD) located on the Tuolumne River in Stanislaus County, California (Figures 1.1-1 and 1.1-2). 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 headpond formed by the diversion dam. Under normal river flows, the headpond formed by the diversion dam extends for approximately two miles upstream. When not in spill mode, the water level upstream of the diversion dam is between elevation 294 feet and 296 feet approximately 90 percent of the time. Within this 2-foot range, the headpond storage is estimated to be less than 100 acre-feet (ac-ft) 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 reservoirs: Hetch Hetchy, Lake Eleanor, Cherry Lake (also known as Lake Lloyd), and Don Pedro. The Don Pedro Hydroelectric Project (Federal Energy Regulatory Commission [the Commission or 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) and operated by the San Francisco Public Utilities Commission. Inflow to the La Grange headpond is the sum of releases from the Don Pedro Project, located 2.3 miles upstream, and very minor contributions from two small intermittent drainageways downstream of Don Pedro Dam.

LGDD was constructed from 1891 to 1893 displacing Wheaton Dam, which was built by other parties in the early 1870s. 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 4.7 megawatts (MW). The La Grange Hydroelectric Project (Project; FERC No. 14581) operates in run-of-river mode. The LGDD provides no flood control benefits, and there are no existing recreation facilities associated with the Project or the La Grange headpond.

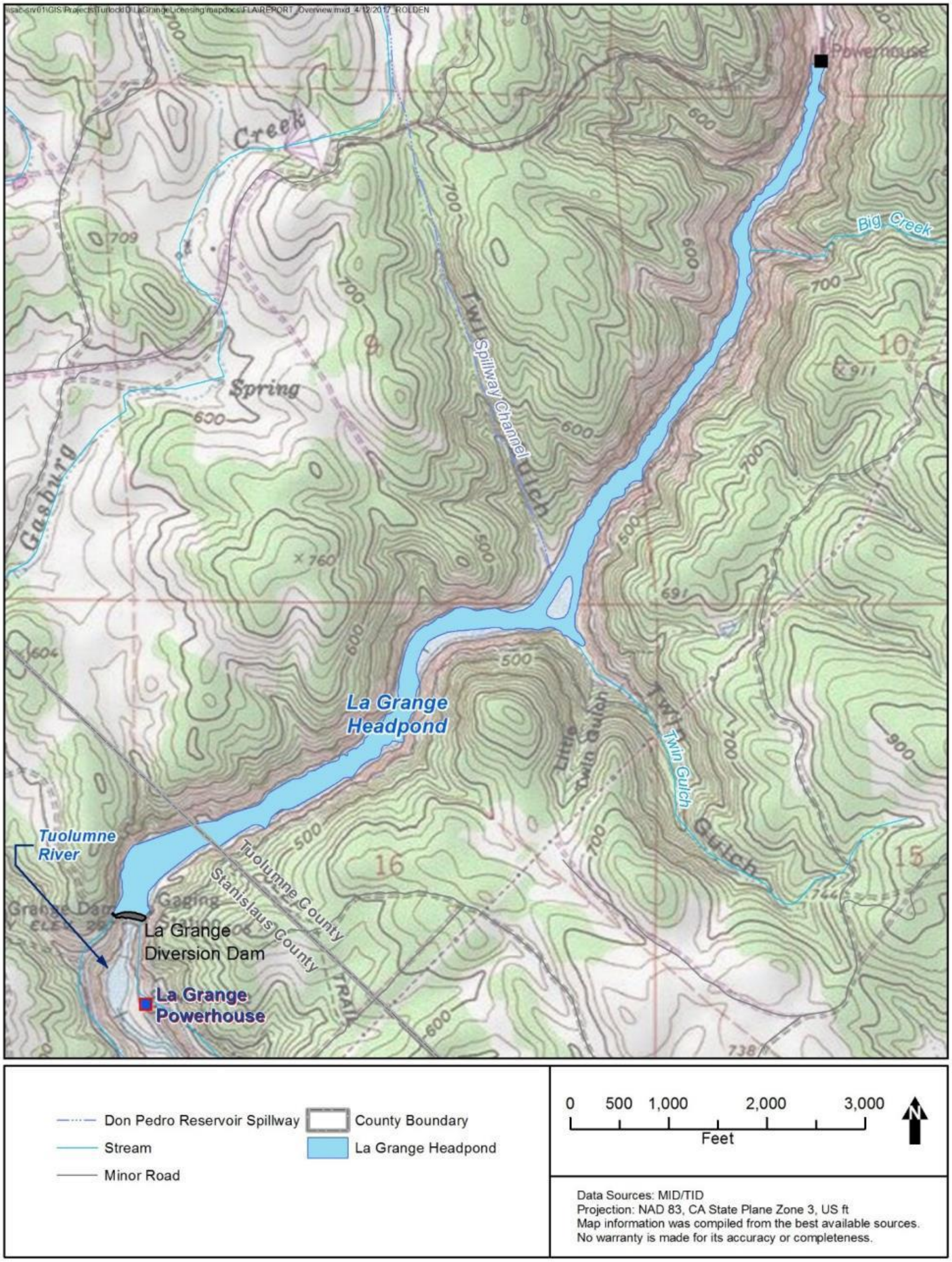


Figure 1.1-1. La Grange Hydroelectric Project location map.

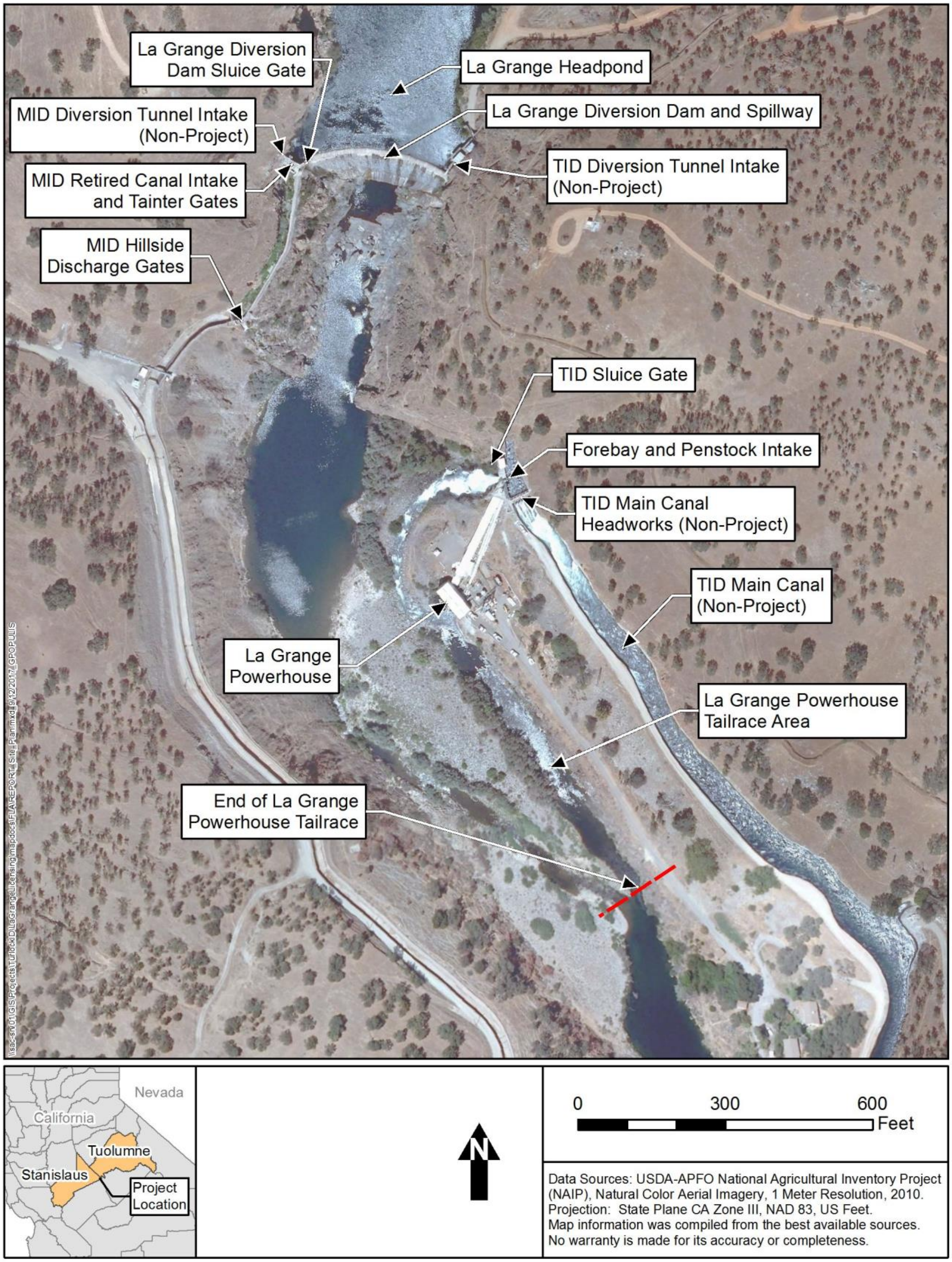


Figure 1.1-2. La Grange Hydroelectric Project site plan.

1.2 Licensing Process

In 2014, the Districts commenced the pre-filing process for the licensing of the La Grange Project by filing a Pre-Application Document with FERC[1]. On September 5, 2014, the Districts filed their Proposed Study Plan to assess Project effects on fish and aquatic resources, recreation, and cultural resources in support of their intent to license the Project. On January 5, 2015, in response to comments from licensing participants, the Districts filed their Revised Study Plan (RSP) containing three study plans: (1) Cultural Resources Study Plan; (2) Recreation Access and Safety Assessment Study Plan; and (3) Fish Passage Assessment Study Plan[2].

On February 2, 2015, FERC issued the Study Plan Determination (SPD), approving or approving with modifications six studies (Table 1.2-1). Of those six studies, five had been proposed by the Districts in the RSP. The Districts note that although FERC's SPD identified the Fish Passage Barrier Assessment, Fish Passage Facilities Alternatives Assessment, and Fish Habitat and Stranding Assessment below La Grange Diversion Dam as three separate studies, all three assessments are elements of the larger Fish Passage Assessment as described in the RSP. The sixth study approved by FERC, Effects of the Project and Related Activities on the Losses of Marine-Derived Nutrients in the Tuolumne River, was requested by the National Marine Fisheries Service (NMFS) in its July 22, 2014 comment letter.

Table 1.2-1. Studies approved or approved with modifications in FERC's Study Plan Determination.

No.	Study	Approved by FERC in SPD without Modifications	Approved by FERC in SPD with Modifications
1	Recreation Access and Safety Assessment		X
2	Cultural Resources Study		X
3	Fish Passage Barrier Assessment		X[1]
4	Fish Passage Facilities Alternatives Assessment		X
5	Fish Habitat and Stranding Assessment below La Grange Dam		X
6	Effects of the Project and Related Activities on the Losses of Marine-Derived Nutrients in the Tuolumne River	X[2]	

1 Page A-1 of Appendix A of FERC's SPD states that FERC approved with modifications the Fish Passage Barrier Assessment. However, the Districts found no modifications to this study plan in the SPD and page B-7 of the SPD states that "no modifications to the study plan are recommended."

2 FERC directed the Districts to conduct the study plan as proposed by NMFS.

In the SPD, FERC recommended that, as part of the Fish Passage Facilities Alternatives 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 that study indicate that the most feasible concept for fish passage would involve fish

[1] On December 19, 2012, Commission staff issued an order finding that the La Grange Hydroelectric Project is required to be licensed under Section 23(b)(1) of the Federal Power Act. Turlock Irrigation District and Modesto Irrigation District, 141 FERC ¶ 62,211 (2012), aff'd Turlock Irrigation District and Modesto Irrigation District, 144 FERC ¶ 61,051 (2013). On May 15, 2015, the U.S. Court of Appeals for the District of Columbia Circuit denied the Districts' appeal and affirmed the Commission's finding that the La Grange Hydroelectric Project requires licensing. Turlock Irrigation District, et al., v. FERC, et al., No. 13-1250 (D.C. Cir. May 15, 2015).

[2] The Fish Passage Assessment Study Plan contained a number of individual, but related, study elements.

passage through Don Pedro Reservoir or La Grange headpond. On September 16, 2016, the Districts filed the final study plan with FERC. On November 17, 2016, the Districts filed a letter with FERC after consulting with fish management agencies (i.e., NMFS and the California Department of Fish and Wildlife [CDFW]) regarding the availability of test fish and a determination that no fish would be available to support conducting this study in 2017. On January 12, 2017, the Districts filed a letter with FERC stating that with FERC's approval, they intend to conduct the study in 2018 if the results from the Fish Passage Facilities Alternatives Assessment indicate that upstream or downstream fish passage at La Grange and Don Pedro projects would require anadromous fish transit through one or both reservoirs.

In addition to the six studies noted in Table 1.2-1, the SPD required the Districts to develop a plan to monitor anadromous fish movement in the vicinity of the Project's powerhouse draft tubes to determine the potential for injury or mortality from contact with the turbine runners. The Districts filed the Investigation of Fish Attraction to La Grange Powerhouse Draft Tubes study plan with FERC on June 11, 2015, and on August 12, 2015, FERC approved the study plan as filed.

On February 2, 2016, the Districts filed the Initial Study Report (ISR) for the La Grange Hydroelectric Project. The Districts held an ISR meeting on February 25, 2016, and on March 3, 2016, filed a meeting summary. Comments on the meeting summary and requests for new studies and study modifications were to be submitted to FERC by Monday, April 4, 2016. One new study request was submitted; NMFS requested a new study entitled Effects of La Grange Hydroelectric Project Under Changing Climate (Climate Change Study). On May 2, 2016, the Districts filed with FERC a response to comments received from licensing participants and proposed modifications to the Fish Passage Facilities Alternatives Assessment and the La Grange Project Fish Barrier Assessment, and a revised pre-filing schedule. On May 27, 2016, FERC filed a determination on requests for study modifications and new study. The May 27, 2016 determination approved the Districts' proposed modifications and did not approve the NMFS Climate Change Study, and accepted the Districts' revised pre-filing schedule.

On February 1, 2017, the Districts filed the Updated Study Report (USR) for the La Grange Hydroelectric Project. The Districts held a USR meeting on February 16, 2017, and on March 3, 2017, filed a meeting summary. Comments on the meeting summary and requests for new studies and study modifications were to be submitted to FERC by Monday, April 3, 2017. Comments on the USR were received from the Central Sierra Environmental Resource Center on February 27, 2017, from NMFS on April 3, 2017, and from CDFW on April 13, 2017. On May 2, 2017, the Districts filed with FERC a response to comments received from licensing participants.

On April 24, 2017, the Districts filed the Draft License Application for the La Grange Hydroelectric Project. Comments on the Draft License Application were received from NMFS on May 12, 2017, from FERC on July 18, 2017, and from CDFW on August 18, 2017. The Districts' response to these comments is included in the La Grange Hydroelectric Project Final License Application (FLA). The FLA was filed with FERC on October 11, 2017, in accordance with the Districts' Request for Extension of Time granted by FERC on September 1, 2017.

This report describes the objectives, methods, and results of the Fish Passage Facilities Alternatives Assessment. Documents relating to the Project licensing are publicly available on the Districts' licensing website at www.lagrange-licensing.com/.

1.3 Voluntary Studies

To facilitate the Fish Passage Facilities Alternatives Assessment, the Districts provided to licensing participants Technical Memorandum (TM) No. 1 in September 2015. Information provided in TM No. 1 included a summary of relevant site, hydrologic, and biological background data and suggested design criteria that were to be used as a basis for development of alternative fish passage facility concepts. The purpose of this initial submittal of potential design criteria was to obtain needed input and direction from fisheries resource agencies on essential design parameters necessary to undertake the study.

TM No. 1 identified a number of information gaps critical to informing the biological and associated engineering basis of conceptual designs. When agency input on design parameters was not forthcoming, the Districts proposed in November 2015 to address these critical information gaps through a collaborative process with all licensing participants. Licensing participants and the Districts formed a Plenary Group and adopted a plan to implement the Upper Tuolumne River Fish Reintroduction Assessment Framework (Assessment Framework) intended to develop information needed to complete fish passage conceptual studies and to assess the overall viability of developing and sustaining anadromous salmonid populations in the upper Tuolumne River (TID/MID 2016). In support of the Assessment Framework, licensing participants agreed that site-specific studies of ecological, biological, and socioeconomic issues could help inform decision making regarding fish reintroduction and fish passage. In all, study plans were developed for the conduct of nine voluntary studies (Table 1.3-1), two of which -- Fish Migration Barriers Study and Water Temperature Monitoring and Modeling Study -- had been proposed by the Districts previously in its Revised Study Plan document, but were not required in FERC's Study Plan Determination. The remaining seven study plans were developed in collaboration with licensing participants in early 2016, and field data collection began in mid-2016.

Table 1.3-1. Voluntary studies that are proposed to be conducted by the Districts.[1]

No.	Study	Completed	Not Completed
1	Upper Tuolumne River Basin Fish Migration Barriers Study	X	
2	Upper Tuolumne River Basin Water Temperature Monitoring and Modeling Study	X	
3	Upper Tuolumne River Chinook Salmon and Steelhead Spawning Gravel Mapping Study		X
4	Upper Tuolumne River Habitat Mapping Assessment		X
5	Upper Tuolumne River Macroinvertebrate Assessment		X
6	Upper Tuolumne River Instream Flow Study		X
7	Hatchery and Stocking Practices Review	X	
8	Socioeconomic Scoping Study		X
9	Regulatory Context for Potential Anadromous Salmonid Reintroduction into the Upper Tuolumne River Basin		X

[1] As reported in the La Grange FLA Exhibit E, the Districts have concluded that the completion of these studies is not necessary.

On May 2, 2016, the Districts filed with FERC an updated pre-filing licensing schedule to allow time for the Districts to complete ongoing FERC-approved studies, for NMFS to complete its Upper Tuolumne River Habitat and Carrying Capacity Study and study of Tuolumne River *O. mykiss* genetics, and for the performance of a Fish Transit Study in parallel with the ongoing fish passage engineering study. On May 27, 2016, FERC filed a determination on requests for study modifications and new studies, and approved the revised schedule and Districts' study plan for the Fish Transit Study.

The Districts have since completed the Upper Tuolumne River Basin Fish Migration Barriers Study, the Upper Tuolumne River Basin Water Temperature Monitoring and Modeling Study, and the Hatchery and Stocking Practices Review Study. For more information, refer to Exhibit E of the La Grange Hydroelectric Project FLA (TID/MID 2017).

2.0 STUDY AREA, GOALS, AND OBJECTIVES

As established by FERC in the SPD, "the geographic scope of the Districts' proposed Fish Passage Facilities Alternatives Assessment includes the Tuolumne River downstream of La Grange dam at the confluence of the main river channel and the powerhouse tailrace channel to the upper Tuolumne River at the upper most extent of Don Pedro reservoir". This defines the study area (Figure 2.1-1).

The goal of the Fish Passage Facilities Alternatives Assessment is to investigate the feasibility of providing upstream and downstream passage of Chinook salmon and steelhead at the La Grange and Don Pedro dams, and includes identifying, developing, and evaluating concept-level passage alternatives. The functionality, configuration, performance and design of such fish passage facilities must be consistent with the resource agencies' goals, objectives, and standard performance criteria established for reintroduction[3] of Endangered Species Act (ESA)-listed anadromous fish. Specific objectives of this study include:

- obtain available information to establish existing baseline conditions relevant to La Grange and Don Pedro projects operations and siting passage facilities;
- obtain available hydrologic data and basic biological design criteria to identify potential types, configurations, and locations of fish passage facilities consistent with estimated run size, fish periodicity, life stage requirements, and anticipated passage efficiency and survival criteria for the selected species of interest;
- formulate and develop preliminary facility sizing and functional passage design for select, alternative potential upstream and downstream fish passage facilities in an attempt to meet agencies' anadromous fish reintroduction goals, objectives, and performance criteria; and
- develop opinions of probable construction cost, annual operations and maintenance costs, and summarize overall viability of fish passage concept(s).

2.1 Species of Interest

For this study, three species were considered for reintroduction to the upper Tuolumne River above the Don Pedro Project and two anadromous salmonid species were chosen for evaluation -- Central Valley (CV) Spring-Run Salmon (*O. tshawytscha*) and California Central Valley (CCV) Steelhead (anadromous *O. mykiss*). The federal Endangered Species Act (ESA) listing status for both species and additional information on fall-run Chinook is described below.

2.1.1 Central Valley Spring-Run Chinook Salmon

The Central Valley spring-run Chinook salmon Evolutionarily Significant Unit (ESU) was originally listed as a threatened species in 1999 (64 FR 50394). After the development of the NMFS hatchery listing policy, the status of the ESU was re-evaluated, and a final determination

[3] While the word "reintroduction" is used commonly herein to denote the study of establishing anadromous fish runs to the upper Tuolumne River, there is no documented, empirical evidence of either spring-run Chinook salmon or steelhead populations using the study reach of the Tuolumne River.

was made that reaffirmed the threatened species status for the ESU (70 FR 37204) (NMFS 2016a). NMFS proposed critical habitat for Central Valley spring-run Chinook salmon on December 10, 2004 (69 FR 71880) and published a final rule designating critical habitat for the ESU on September 2, 2005 (70 FR 52488) (NMFS 2016a). There is no CV spring-run Chinook salmon critical habitat in the Tuolumne River watershed. Per the Recovery Plan, both the Tuolumne River (below La Grange Diversion Dam) and the upper Tuolumne River (above the La Grange Diversion Dam) are considered candidate areas for reintroduction (NMFS 2014).

2.1.2 California Central Valley Steelhead

NMFS listed the CCV steelhead as a threatened species on March 19, 1998 (63 FR 13347), and on September 8, 2000, pursuant to a July 10, 2000 rule issued by NMFS under Section 4(d) of the ESA (16 USC § 1533(d)), statutory take restrictions that apply to listed species began to apply, with certain limitations, to CCV steelhead (65 FR 42422) (NMFS 2016b). On January 5, 2006, NMFS reaffirmed the threatened status of CCV steelhead and decided to apply the joint U.S. Fish and Wildlife Service-National Marine Fisheries Service Distinct Population Segment (DPS) policy (61 FR 4722). NMFS proposed critical habitat for CCV steelhead on February 5, 1999 (64 FR 5740) in compliance with Section 4(a)(3)(A) of the ESA. In the Tuolumne River, critical habitat for CCV steelhead extends from the confluence with the San Joaquin River upstream to La Grange Diversion Dam. Per the Recovery Plan, the Tuolumne River (below La Grange Diversion Dam) is considered a Core 2 population (i.e., meeting or having the potential to meet, the biological recovery standard for moderate risk of extinction). The upper Tuolumne River (above La Grange Diversion Dam) is considered a candidate area for reintroduction (NMFS 2014).

2.1.3 Fall-run Chinook Salmon

At the January 2016 Workshop for the Framework Plenary Group (described in section 1.3 above), NMFS stated an interest in the evaluating the reintroduction of both spring-run and fall-run Chinook and steelhead to the upper Tuolumne River Reach (La Grange Hydroelectric Project Reintroduction Assessment Framework Plenary Group 2016). After evaluation of this request, the Districts did not agree that evaluating reintroduction of fall-run Chinook to the upper Tuolumne River was appropriate.[4] Concerns with fall-run Chinook included the fact that they are not listed and are not consistent with a reintroduction program to advance the Recovery Plan; concerns regarding stress of non-volitional passage; competition, interbreeding and genetic effects with spring-run Chinook, disease transmission given a large proportion of fall-run Chinook are out-of-basin hatchery strays (TID/MID 2017), and adverse impacts to the source population if upper river activities were unsuccessful. Furthermore, the historical distribution of fall-run Chinook is believed to have been confined to lower elevations of the Sacramento and San Joaquin River tributaries (Yoshiyama et al. 2001). Since 1971, California Department of Fish and Wildlife has conducted annual salmon spawning surveys in the lower Tuolumne River. In addition to CDFW's work, the Districts have also studied fall-run Chinook salmon on the lower Tuolumne River through annual seine surveys conducted since 1986, annual snorkel surveys since 1982, adult fish weir counts since 2009, and more recently as part of the Don Pedro Hydroelectric Project relicensing. Historical data obtained through these efforts show that spawner estimates have

[4] At the February 16, 2016 Reintroduction Assessment Framework Technical Committee conference call, the Districts questioned the prudency of including fall-run Chinook and presented their concerns.

ranged from 40,300 in 1985 to 77 in 1991 (TID/MID 2010, Report 2009-2). Variation in numbers has been attributed to water quality and water availability in the San Joaquin River system as well as changes in ocean conditions. Studies conducted through the FERC relicensing of Don Pedro Hydroelectric Project have demonstrated that under the current flow regime, there are sufficient spawning gravels available in the lower Tuolumne River to support a spawning population of over 50,000 fall-run Chinook salmon and over 700,000 *O. mykiss* (TID/MID 2013a). As such, fall-run Chinook were not evaluated as part of this study.

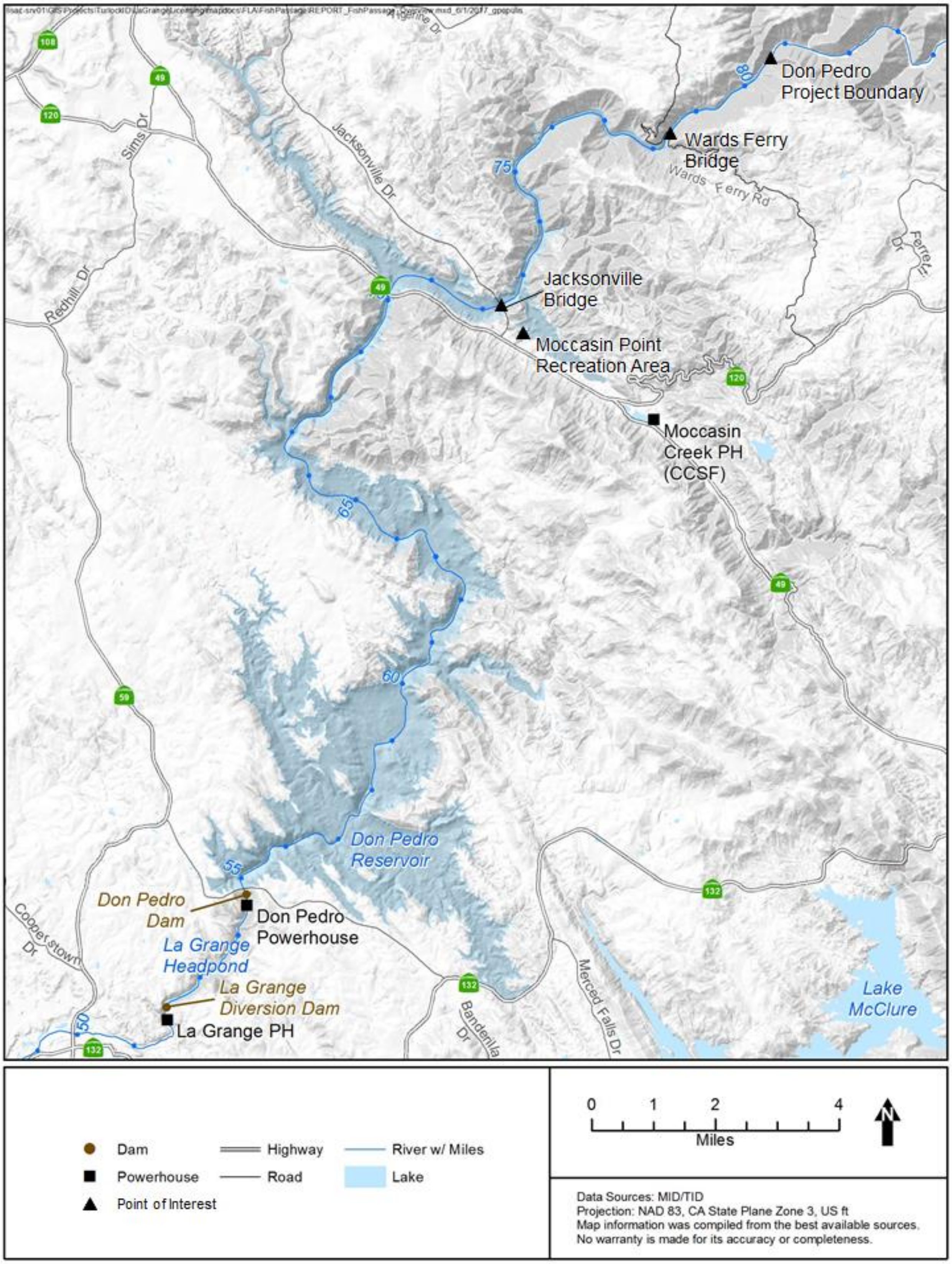


Figure 2.1-1. Overview of the Fish Passage Facilities Alternatives Assessment Study Area.

3.0 METHODOLOGY

In accordance with the Fish Passage Facilities Alternatives Assessment study plan, the work effort occurred in the two phases described below.

3.1 Phase 1 – Evaluation of General Biological and Engineering Design Parameters and Identification of Potential Fish Passage Facility Alternatives

Phase 1 of this study began in May 2015 and consisted of gathering information on facility siting, facility sizing, general biological and engineering design parameters, and operational considerations in a collaborative process with licensing participants. The collaborative process in 2015 included the completion of public Workshops and production of technical memoranda (TMs), the goals of which were to identify key information needs and solicit input and feedback from licensing participants. Identification of important data gaps and addressing these data gaps within a collaborative process was intended to be completed in Phase 1 of the study. This collaboration was viewed as essential to creating a common understanding of the project purpose, goals to be achieved, objectives, and expectations among the Districts and licensing participants. Results of this collaboration were intended to provide a common framework to develop potentially feasible fish passage conceptual alternatives that are capable of meeting clearly-defined anadromous fish reintroduction goals and objectives.

Throughout 2015 and 2016, the Districts reiterated that without additional input from licensing participants, numerous data gaps resulted in a lack of clarity relating to reintroduction targets. Further, a lack of input relating to the definition of performance expectations and feasibility thresholds inhibited the ability of the Districts to complete Phase 1 and subsequently begin Phase 2[5]. With no specific input on many of these data gaps from resource agencies, the Districts' commitment to complete the Fish Passage Facilities Alternatives Assessment on-schedule mandated that the study move forward absent the requested input from the licensing participants. As such, the Districts proceeded to Phase 2 using available information from the literature and suppositions generated from the judgment of the Districts' technical fish passage and biology professionals.

3.1.1 Simulation of Hydrologic and Operational Flow Data

As part of Phase I activities, the Districts evaluated watershed hydrology to characterize the anticipated river flows into Don Pedro Reservoir as well as those passing downstream of LGDD. To facilitate this, the Districts simulated data to create a continuous, long-term record of flow. Flow data from USGS gage stations upstream of Don Pedro Reservoir and downstream of LGDD provide limited information to characterize flow and operational data at locations that would be most appropriate to site potential fish passage facilities. In some cases, datasets are inconsistent

[5] Results from Workshops Numbers 1 through 4 in addition to Technical Memorandum No. 1 are presented in Section 4.1 of this document. Input was not received from the resource agencies until Workshop No. 4 in January 2016 where input was received on species of interest and general migration periodicities. To date, input relating to biological goals for reintroduction, population abundance, or facility performance expectations have not been received (all essential items for identifying the type, size, complexity, and cost of engineered fish passage facility concepts).

due to vandalism or damage caused by flood events. Therefore, flow simulations generated from the Tuolumne River Daily Operations Model were used to assess the potential frequency, magnitude, and duration of flow into Don Pedro Reservoir and downstream of the LGDD as well as mean daily reservoir surface elevations (TID/MID 2013b). The flow simulations provide a continuous set of mean daily values for all required locations sufficient to assess factors that may influence development of fish passage facility concepts.

The "Base Case" operational scenario (referred to throughout this document) simulates operational data (reservoir inflow, outflow, pool elevations, etc.) for the period of record beginning on October 1, 1970 and ending on September 30, 2012 (n=43). The Base Case results use historic watershed inputs and depict the anticipated operation of the Don Pedro Project in accordance with the current FERC license, U.S. Army Corps of Engineers (USACE) flood management guidelines, and TID and MID irrigation and municipal and industrial water management practices. Given that the Districts have changed operations at the Don Pedro Project over the historical record, the Base Case scenario provides estimated ranges of pool elevation for current operations over a longer period of record. The Base Case data therefore take into consideration more climactic variability and provide a better estimate of future pool conditions when considering the potential for implementation of future fish passage facilities. Detailed summaries of simulation development and resulting data are presented in Exhibit B, Appendix B-2 of the Don Pedro Hydroelectric Project Final License Application (TID/MID 2014). Select results from the Base Case operational scenario are referenced throughout this study.

3.2 Phase 2 – Preliminary Functional Layouts and Cost Estimates

In 2017, the Districts developed functional site layouts, facility sizing, general design parameters, expected fish capture and survival efficiencies, and opinions of probable construction, operation and maintenance costs for select fish passage alternatives. Considerations addressed during the development of preliminary functional layouts for upstream and downstream passage alternatives included: (1) major facility design elements, (2) operation and maintenance, (3) anticipated facility performance, and (4) facilities costs. The results of these tasks were then used to investigate the overall technical feasibility of each potential fish passage facility alternative. The following paragraphs summarize the methods used to develop project costs and to assess the feasibility of each alternative formulated for this report.

3.2.1 Development of Opinions of Probable Construction Costs

Order of magnitude Opinions of Probable Construction Costs (OPCC) were developed for all potential upstream and downstream fish passage facility alternatives formulated for this assessment. Cost estimates were based upon the anticipated labor, equipment, and materials required to construct the primary project elements described in Sections 4.3.1.2 (upstream facility) and 4.3.2 (downstream facility). The overall level of detail developed as part of this study is commensurate with a Class 5 cost estimating classification per AACE International (AACE 2003). Cost data generated as part of OPCC development is based upon cost data from other projects similar in nature, available vendor cost data, details from cost estimates prepared for other projects of similar scope, RS Means Cost data, and professional judgment. Where specific costs data or quantities were not available, parametric costs resulting from the construction of other similar facilities were used. Other factors considered in each calculated OPCC value include:

- A 50 percent contingency to account for undefined design items and construction contingencies that is typical of alternatives developed to a conceptual level of design; and
- Foreseen taxes imposed by local agencies or governments in California that include State Sales Tax (assumed to be 7.88 percent applied to materials and services) and State-mandated Corporate Business and Occupation Tax (B&O Tax). State B&O taxes are assumed to be 8.84percent. These costs are typically passed down from a contractor providing services to a project owner responsible for payment of said services.

All costs are presented in 2017 U.S. dollars without consideration of escalation. Cost uncertainty is addressed by presenting a high and low range of values and represents -25 percent and +40 percent of the calculated base OPCC. Cost assumptions and calculation details used to develop each OPCC are provided in Attachment B.

3.2.2 Development of Operation and Maintenance Costs

Operation and maintenance (O&M) costs include annual costs that are incurred continuously over the life of the project. Operational costs are based upon the anticipated annual period of operation, level of effort, staffing, resources, and equipment required to operate the facility in a manner that achieves the intended facility objectives. Maintenance costs are those associated with keeping system components functioning as intended, as well as actions that allow system components to achieve their optimal useful life. Maintenance activities include painting, lubrication of moving parts, repair of damage, replacement of broken or non-functional parts, and periodic inspection. The annual level of effort required to operate and maintain the facilities for each alternative is estimated using full-time equivalents (FTE) for operations, maintenance and technician personnel positions. Annual salaries and benefits for each position are developed based upon known salaries for full-time employees at similar facilities. Additional non-labor costs, such as electricity or fuel usage, are also estimated based upon calculated usage requirements for specified equipment and vehicles.

All O&M costs are presented in 2017 U.S. dollars without consideration of escalation or the time value of money. Cost assumptions and calculation details used to develop each annual O&M value are provided in Attachment B.

3.2.3 Assessment of Feasibility

A host of factors must be considered when studying the feasibility of fish passage at a project. Engineering projects customarily begin with an understanding of what is intended to be achieved, what constitutes a successful project, and what performance metrics must be met. Feasibility is taken as its common usage: “possible to achieve” (Webster 1992). For a project to be determined to be feasible, it must be able to achieve the objectives established by the project developer(s) and the standards of performance established for projects of a similar nature and purpose.

In the specific case of investigating the likelihood of success of introducing or reintroducing populations of anadromous fish to the reach of the Tuolumne River above the Don Pedro Project, consideration must be given to, among other things, the feasibility of building and operating fish passage facilities that will meet the required performance criteria (i.e., “technical feasibility”), biological and ecological factors affecting the establishment and maintenance of viable populations (i.e., “biological feasibility”), and overall life-cycle cost[6] and reasonable cost:benefit tests (socioeconomic effects, including impacts to existing uses). Although biological and socioeconomic feasibility are critical components in the comprehensive evaluation of a reintroduction/introduction action, this report evaluates only the question of "technical feasibility".[7]

For the purposes of determining if a potential alternative is technically feasible, alternative concepts were developed and examined using the evaluation factors defined below:

(1) Factor 1 – Ability to Meet Engineering, Constructability, and Operational Constraints: alternatives must be able to be engineered, constructed, and operated in the context of the existing physical make-up of the site geology, existing structures, site hydrology, reservoir operations, site constraints, and a host of operational and safety requirements.

(2) Factor 2 - Ability to Operate without Interference with Existing Uses: alternatives must be capable of being implemented without undue interference with existing facilities and uses.

(3) Factor 3 - Ability to Meet Usual and Customary Fish Passage Performance Standards: alternatives must be able to achieve the usual and customary performance standards established for similar facilities, such as collection efficiency, survival through a passage facility, and overall passage efficiency.

A determination of technical feasibility requires a finding that there is a high level of confidence the established project performance criteria for each evaluation factor are able to be achieved. If it is not realistic to expect that these goals or performance criteria can be met, the alternative is judged to be "not feasible." The designation of "not feasible," does not mean that there is no possibility of an alternative functioning at some level of performance; it simply means that it is unlikely to achieve the stated performance thresholds or is unproven given the context in which it is being applied. For example, if a technology is to be applied in a manner in which its performance cannot be reasonably estimated or assured, it is more properly identified as being "experimental". Experimental is defined as “an operation carried out to discover a fact”, or a “method adopted without knowing just how it would work” (Webster 1992). These designations are used in this report to designate whether an alternative is judged to be technically feasible, not feasible, or experimental.

[6] In accordance with 40 CFR 450.11(b)., the Environmental Protection Agency defines infeasible as not technologically possible, or not economically practicable and achievable in light of best industry practices.

[7] Biological and socioeconomic feasibility are discussed in Exhibit E of the La Grange Hydroelectric Project Final License Application.

4.0 DEVELOPMENT AND ASSESSMENT OF ALTERNATIVES

The following section summarizes the results of the Phase 1 and Phase 2 study activities. Section 4.1 addresses the results of the initial collaborative meetings with the licensing participants. Section 4.2 summarizes the project setting and identifies salient background information and design criteria applicable to the development of potential fish passage facilities. Section 4.3 describes the results of the alternative formulation process and provides a description of potential upstream and downstream fish passage facility alternatives. Section 4.3 also provides a discussion on the technical feasibility of each formulated alternative. Section 4.4 provides a summary of expected construction, operation and maintenance, and implementation costs for each identified alternative.

4.1 Collaboration with Licensing Participants

As defined in the FERC-approved RSP, Phase 1 of the Fish Passage Facilities Alternatives Assessment consisted of the development of general design criteria and considerations applicable to upstream and downstream fish passage facilities at the La Grange and Don Pedro projects. As outlined in the RSP, the Districts proposed to conduct a series of Workshops to discuss and obtain collaborative consensus on biological goals and technical design criteria. This information included site-specific physical and operational parameters; applicable regulatory requirements; NMFS, USFWS, and 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. As described below, the Districts held three collaborative Workshops in 2015 with participation from state and federal resource management agencies, non-governmental organizations, local and state government officials, representatives from local businesses and community organizations, and the general public.

4.1.1 Workshop No. 1

Workshop No. 1 was held on May 20, 2015. At this initial Workshop, the Districts provided an overview of the types of information needed to inform the development and evaluation of fish passage alternatives, and discussed current design criteria for anadromous fish passage facilities. The Districts presented examples of upstream and downstream passage facilities currently in operation at other projects throughout the northwestern U.S. Participants discussed the studies being conducted by NMFS regarding *Oncorhynchus mykiss* (*O. mykiss*) genetics, habitat and carrying capacity in the study area. In addition, NMFS presented an overview of the Federal Power Act (FPA), anadromous fish habitat availability in California rivers the San Joaquin watershed, and the Final Central Valley Salmonid Recovery Plan.

During the workshop, the Districts outlined the purpose and need for providing fish passage facilities in the broader context of the feasibility of anadromous fish reintroduction to the upper Tuolumne River. Because anadromous fish are not currently present in the upper Tuolumne River, the design, construction, and operation of fish passage facilities is intrinsically linked to the needs of the fish populations under consideration for reintroduction. The related question of the feasibility of fish reintroduction encompasses consideration of such issues as genetics of introduced and resident species, colonization strategy, source population, habitat suitability, carrying capacity, recreation impacts, socioeconomic effects, and compatibility with current uses, among other variables. Consideration of all these questions suggested the need for a broader reintroduction planning framework within which to evaluate the sizing, characteristics, configuration, operations, effectiveness and cost of fish passage facilities.

Workshop No. 1 resulted in two items of consensus. First, licensing participants agreed that the study process would benefit by active collaboration among the parties; and second, the design, construction and operation of fish passage facilities can be complex and costly, and therefore requires a sound and reliable design basis for facility cost estimation. As such, a thorough investigation of the engineering, biological, regulatory and socioeconomic issues was determined to be warranted. It was recognized that the absence of a thorough and rigorous approach from the outset of the study could result in a set of fish passage facilities that are based on a set of unfounded assumptions that do not reflect realistic biological and/or performance metrics applicable to the Tuolumne River and the Don Pedro and La Grange projects. Additional details about Workshop No. 1, including meeting notes, may be found in Attachment A.

4.1.2 Technical Memorandum No. 1

On September 4, 2015, TM No. 1 was provided to licensing participants for review, input, and comment. The goal of TM No. 1 was to identify the information, analysis, design, and facility performance criteria necessary to characterize site-specific, functional fish passage alternatives. The document summarized existing information relevant to site-specific design considerations that could form the basis for identifying fish passage alternatives to meet the reintroduction program's goals and objectives. More specifically, the document provided information about: (1) the physical characteristics of existing La Grange and Don Pedro project facilities, (2) project operations and potential constraints associated with those operations, (3) existing facilities and facility access, (4) the physical environment in the areas of potential fish passage facility locations, (5) Chinook and steelhead life-histories and periodicities[8], (6) basin hydrology as it pertains to fish periodicities and developing passage facilities, (7) potential land ownership issues, (8) applicable NMFS and CDFW fish passage facility biological and engineering design criteria and potential limitations resulting from adherence to those criteria, and (9) a summary of factors affecting siting, sizing, general design, and operation of fish passage facilities.

TM No. 1 also summarized existing data gaps and information needed to inform feasibility and the development of fish passage alternatives. TM No. 1 noted many data gaps that require feedback from licensing participants including: target species, verification of migration timing, recovery targets (expected population abundance), and anticipated performance expectations. Those data were identified as essential for carrying forth: (1) the development of alternative concepts based upon a common understanding of physical and biological conditions, and (2) creating defined thresholds that could be used to evaluate the feasibility of potential fish passage facility alternatives.

[8] Because there are no spring-run Chinook or steelhead populations in the Tuolumne River, periodicities were based on existing information from other nearby basins.

4.1.3 Workshop No. 2

Workshop No. 2 was held on September 17, 2015. Prior to the Workshop, the Districts released the planned Technical Memorandum (TM) No. 1 for review and discussion at the Workshop. The Districts' also presented a conceptual framework for considering fish passage feasibility and assessing overall reintroduction viability as advised by Anderson et al.(2014). The conceptual framework is intended to provide a comprehensive, collaborative, and transparent approach for evaluating the full range of potential questions and 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 at the Don Pedro and La Grange projects, the framework considers the interrelated issues of ecological feasibility, biological constraints, economics, regulatory implications, current uses of the resource, and other considerations relevant to reintroduction[9]. The Districts noted that reintroduction assessment frameworks are not a new concept and implementation would be consistent with ongoing processes in other watersheds in California (e.g., Bureau of Reclamation et al. 2016) and the Pacific Northwest and with recent peer-reviewed literature on reintroduction planning authored by resource management agencies(e.g., Anderson et al. 2014).

During Workshop No. 2, the Districts summarized engineering technical memorandum (TM) No. 1, which had been distributed on September 4, 2015. The Districts provided the TM to licensing participants in advance of the meeting to allow sufficient time for review and feedback. Key topics of discussion amongst licensing participants were the information gaps identified in TM No. 1. Such information was agreed to be critical to moving the Fish Passage Facilities Alternatives Assessment forward to functional design and cost estimation. At the Workshop, the Districts emphasized that input was needed on the biological goals and objectives of the reintroduction program to determine appropriate design criteria and constraints that would influence development of fish passage alternatives.[10] At that time, it was also believed that some of the information may be able to be provided from the results of ongoing studies being implemented by NMFS as well as through future Workshops for the reintroduction assessment framework.[11] The Districts also provided examples of how biological, ecological, and regulatory information had been used to inform the functional design of fish passage facilities at other projects.

The Districts closed the Workshop by noting the importance of the group reaching consensus on a path forward for evaluating fish passage and fish reintroduction feasibility, including consensus on the range and scope of issues to be considered and the information needed to address those issues. The Districts requested that licensing participants provide comments and feedback on the proposed conceptual framework process and the draft TM No. 1, which includes necessary information from licensing participants to advance fish passage functional designs and alternatives

---

[9] Lusardi and Moyle (2017) conclude that even high priority recovery strategies such as two-way trap and haul are not an unequivocal success and programs should proceed with extreme caution.

[10] Licensing participants agreed to provide comments on TM No. 1 and/or the information gaps identified for fish passage engineering study by October 23, 2015. Although indicated as a "reasonable" timeline by attendees to provide responses, no formal responses were received addressing this specific request for information.

[11] NMFS indicated that population estimates and peak rates of migration could be generated to a conceptual level as part of their Upper Tuolumne Habitat and Carrying Capacity Study (refer to NMFS Comments on the La Grange ISR included in Attachment A). This information was not available at the time this report was completed.

identification. Additional details about Workshop No. 2, including meeting notes, may be found in Attachment A.

4.1.4 Workshop No. 3

Workshop No. 3 was held on November 19, 2015. The Districts provided a review of the Fish Passage Facilities Alternatives Assessment process to date including the original objectives of the study, the previous two Workshops, the development of a structured reintroduction assessment framework, the further development of TM No. 1, and the need for currently unavailable site-specific information and biological goals to move the functional design process forward. The Districts again requested input and comments on TM No. 1 as needed to move forward with alternative assessments. The targeted purpose of this Workshop was to seek consensus on the need for a structured reintroduction decision-making framework to assess the feasibility and design of fish passage facilities that would meet the goals and objectives of the resource manager's anadromous fish reintroduction program.

Licensing participants unanimously indicated their support of and interest in a reintroduction decision-making framework process. Concerns were raised about the ability of the decision-making process to produce a consensus decision on reintroduction feasibility. The Districts indicated the intent of the process was not necessarily to yield a final, formal reintroduction decision but instead to work collaboratively through a process where all licensing participants have been involved in identifying issues, collecting and evaluating critical information needed to support the assessment of reintroduction and fish passage, and developing opinions as to the viability of reintroduction and fish passage based on this information. With consensus obtained, the group agreed to meet on January 27, 2016, to begin to implement the reintroduction decision-making framework process. Additional details about Workshop No. 3, including meeting notes, may be found in Attachment A.

4.1.5 Workshop No. 4

Workshop No. 4 was held on January 27, 2016. The Districts provided a review of the discussions in Workshops No. 2 and No. 3, including the idea that fish passage engineering was one of several key evaluation components of the Framework. Key components include ecological feasibility, biological constraints, and socioeconomic effects and potential regulatory issues. The Districts also presented the goals and schedule of the Upper Tuolumne River Reintroduction/Fish Passage Assessment Framework (Framework). The targeted purpose of this Workshop was to arrive at consensus on the implementation plan for the Framework presented and discussed in Workshops No. 2 and No. 3, the associated schedule, a preliminary studies[12] list (to address information gaps) to help define 2016 and 2017 activities, and the use of a smaller Technical Committee that would report to the Plenary Group. The licensing participants agreed to the formation of a Technical Committee[13] and that the first meeting was scheduled for February 16, 2016.

---

[12] NMFS is also conducting two studies, a Habitat and Carrying Capacity Assessment and an *O. mykiss* Genetics Study in support of an upper Tuolumne River reintroduction assessment; however, these studies were not available at the time of filing the La Grange Hydroelectric Project Final License Application.

[13] Note that the Technical Committee evolved into several Technical Subcommittees as the Framework progressed.

The Districts indicated that the Framework would require considerable effort and entail a phased approach. One goal of the Framework was to identify and develop an information base in which all parties agreed was critical to informing reintroduction feasibility. Another important component of evaluation reintroduction feasibility was the identification of a reintroduction program goal(s) that was currently lacking. As part of the Workshop, NMFS indicated that fall-run Chinook, spring-run Chinook, and steelhead should be considered for fish passage. CDFW participants also discussed the existing carrying capacity of the lower Tuolumne River for fall-run Chinook, how fall-run Chinook generally occupy habitat in the lower reaches of the river, and that only fall-run Chinook in good condition should be considered for passage. However, as described in Section 2.1, fall-run Chinook were not considered for evaluation in this study. Meeting notes and meeting materials relating to Workshop No.4 are provided in Attachment A.

4.2 Physical and Biological Factors Influencing Development of Fish Passage Alternatives

The following sections (4.2.1 through 4.2.3) include a review of existing, site-specific information that characterizes the biological and physical setting of the proposed study area. Factors selected for discussion in this document influence the overall applicability, selection, and configuration of potential fish passage facility alternatives. The information contained herein is based upon information available in the literature, previous studies conducted on the Tuolumne River, and additional sources of information from applicable studies in other regions of California and the Pacific Northwest. Section 4.2.1 describes a number of factors that influence both upstream and downstream fish passage technologies. Sections 4.2.2 and 4.2.3 describe those factors that are more specific to either upstream or downstream fish passage facility alternatives. Section 4.2.4 identifies existing fish passage facility performance standards. Available information is then used to establish specific design criteria and operational conditions that are used to establish facility type, size, and complexity to develop and assess the feasibility of potential fish passage alternatives (Section 4.3). Each of the alternatives and their primary design elements are then used as a basis of cost development, provided in Section 4.4.

4.2.1 Considerations that Influence both Upstream and Downstream Fish Passage

4.2.1.1 Life History of Species under Consideration for Fish Passage

Fish passage design must consider the species, and which life stages of those species, will be targeted for upstream and downstream passage. This study currently focuses on the development of fish passage alternatives for the upstream migration of adult spring-run Chinook salmon and adult steelhead in addition to the downstream migration of the juvenile life history stages for both species. Potential alternatives also consider the downstream passage of post-spawn adult steelhead. Upstream passage of juvenile salmonids and other resident fish species is not considered as a targeted objective in this report.

4.2.1.2 Migration Timing and Life History

Data is currently lacking to inform population-specific age-class, size, maturation, and migration timing for spring-run Chinook and steelhead life stages in the Tuolumne River watershed. In addition, no source population had been identified to use as a guide. Without this information, and given a lack of Tuolumne River source stock for any reintroduction efforts, these species, if introduced upstream of Don Pedro Reservoir, may be considered “experimental” pursuant to Section 10(j) of the ESA. Further, 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 compared to the fall-run Chinook that are currently monitored downstream of LGDD. Given that species-specific data are unavailable for the Tuolumne River, information from the San Joaquin and Sacramento rivers was reviewed to generate potential, but uncertain estimates of the life history timing of upstream and downstream migration (Bureau of Reclamation [BOR] et al. 2013; NMFS 2014). This regionally-based life history information was then provided to the reintroduction assessment framework collaborative for review and was approved at the May 18, 2017 meeting. Anticipated life history timing of target species is provided in Table 4.2-1.

Table 4.2-1. Anticipated life history timing of potential targeted species.

Species and Life Stage	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Spring-Run Chinook												
Adult Upstream Migration												
Smolt Outmigration												
Steelhead												
Adult Upstream Migration												
Smolt Outmigration												

Note: Dark shaded areas represent known peak periods for the specified lifestage whereas light shaded areas represent presence. The absence of dark shaded areas for any lifestage indicates that the Technical Committee did not identify any particular peak period based on the available data.

Monitoring of spring-run Chinook and steelhead in the Sacramento River tributaries, such as Mill and Butte creeks and the Feather River, indicates variation in the seasonal timing of migration among watersheds in response to variation in environmental conditions such as freshets, water temperature (BOR et al. 2013), and other seasonal cues. Data presented in Table 4.2-1 suggest that migration of adult target species may occur from November through May. Downstream migration of juveniles may occur from October through the end of May. The months of June through September are anticipated to exhibit relatively little activity with regard to adult upstream or juvenile downstream migration of targeted species. The life history timing presented in Table 4.2-1 is a generalization of typical species tendencies; however, actual migration timing of these species, should they occur in the Tuolumne River, may vary from these estimates.

4.2.1.3 Access to Collection and Release Locations

Accessibility to the LGDD and to the upper areas 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 the migration season. The ability to access each location, travel time between facilities, and road conditions, have a direct effect on construction costs as well as on long term operation costs. Trap and transport operations require daily transport of fish and therefore the safety of drivers, route reliability, and transport duration should also be factors in site selection. If access to optimum collection or release locations is not currently available, improvements to provide adequate access should be accounted for in fish passage facility development.

LGDD is accessible from the north via La Grange Road (J59) and from the south via Yosemite Boulevard (CA-132) and La Grange Road (J59). TID owns a 1.4 mile section of LGDD Road and an adjacent ancillary road that leads from the intersection of Yosemite Boulevard (CA-132) to the powerhouse at LGDD and TID flow bifurcation facilities on the south bank of the river. The presence of publicly-owned paved roads and the privately owned section of a TID 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 such events are rare and episodic. There is currently no public access to the tailrace areas below the La Grange powerhouse or the opposite shore at that location.

Access to the head of Don Pedro Reservoir is limited to four remote locations with varying levels of suitability: Wards Ferry Bridge, Jacksonville Road Bridge, Moccasin Point Bridge, and the CA-120/49 Bridge. Each of these locations is between 2 and 10 miles from RM 80.8 (the upper project boundary) and access to the actual head of reservoir changes as the reservoir water surface elevation fluctuates. No other points of access to the head of Don Pedro Reservoir currently exist.

- Wards Ferry Bridge is located at RM 78.4 and 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 are often one-lane and contain 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. Direct vehicular access to the reservoir surface is not available via this alternative route and would need to be established if such access was required. Construction of a road to the reservoir surface at this location would require a substantial undertaking with numerous engineering challenges given the steep hillslope and unknown geotechnical context.

- Jacksonville Road Bridge near RM 72.2 is accessed 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. A short 1.3 mile portion of River Road is privately owned and maintained with gravel surfacing. Existing parcels owned by the United States Bureau of Land Management (BLM) in the general area are also accessed via River Road. Despite the occasional rock fall, land slide, or ice, this route is likely accessible 365 days a year. Direct vehicular access to the reservoir surface is not available via this alternative route and would need to be established if such access was required. Construction of a road to the reservoir surface at this location would require a substantial undertaking with numerous engineering challenges given the steep hillslope and unknown geotechnical context.
- Moccasin Point Marina is located on an easterly branch of Don Pedro Reservoir near the point of confluence with Moccasin Creek. The main reservoir can be accessed from this location at RM 72.6. Moccasin Point Marina can be accessed from the intersection of CA 120 and Jacksonville Road. Facilities at the marina include a multi-lane boat ramp, general store, campgrounds, recreational facilities, parking, and electrical power.
- The CA-120/49 Bridge near RM 70.1 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 generally travelable year-round. Direct vehicular access to the reservoir surface is not available via this alternative route and would need to be established if such access was required. Construction of a road to the reservoir surface at this location would require a substantial undertaking with numerous engineering challenges given the steep hillslope and unknown geotechnical context.

4.2.1.4 Wild and Scenic River Designation

The current Don Pedro Project area is bounded upstream by lands currently owned and managed by the BLM and the United States Department of Agriculture, Forest Service (USFS). Congress designated 83 miles of the Tuolumne River as a Wild and Scenic River in 1984 (Public Law 98-425). The reach of the Tuolumne River just upstream of the project boundary at RM 80.8 is designated Wild and Scenic, and therefore development that affects the “free flowing” character of the designated reach is restricted. The Wild and Scenic designation applies to the section of river extending from the headwaters in Yosemite National Park to the impoundment at Lake Don Pedro (excluding the 8-mile segment through Hetch Hetchy Reservoir).

Projects proposed within those portions of the Tuolumne River designated as Wild and Scenic that may affect the river's free-flowing condition are subject to review under Section 7 of the Wild and Scenic Rivers Act (WSRA) (16 USC Section 1278). The WSRA preserves rivers in a free-flowing condition, which is defined in the act as a river flowing in its natural condition without impoundment, diversion, straightening, rip-rapping, or other modifications of the waterway (16 USC Sections 1271 and 1286). Congressional approval is typically required to modify development restrictions or recreational “outstandingly remarkable values” for a designated W&S river, as established in each river’s Wild and Scenic Comprehensive Management Plan. Therefore, altering the condition of the Tuolumne River or performing ground disturbing activities in a manner that would negatively influence the Wild and Scenic character of this river reach would constitute a fatal flaw. All potential fish passage facility alternatives are formulated in a manner that limits the apparent impact and eliminates any direct impact to this designated area.

4.2.1.5 Reservoir Operations and Hydrology of the Lower Tuolumne River

Data on the hydrologic conditions in Don Pedro Reservoir and below LGDD were evaluated to inform upstream and downstream fish passage design. Potential upstream fish passage design alternatives are influenced by the flows downstream of LGDD. Similarly, designs for the collection of outmigrating juvenile fish for downstream passage are influenced by a 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. Although the natural hydrograph may have the most impact during juvenile outmigration in wetter years, regulated flows may have the most impact in dry water years. During the winter, summer, and fall months, the hydrograph upstream of the study area will be dominated by operational flows regulated by CCSF facilities. As previously noted, the timing, complexity, and downstream migration triggers for juvenile life stages of the target species in the upper Tuolumne River are unknown, and may be considered experimental. These factors may vary from known life history patterns for target species that currently occupy other Central Valley rivers.

4.2.1.6 La Grange Headpond Operations

The primary purpose of the LGDD is the diversion and delivery of water by gravity to irrigation systems owned by TID and MID. Under normal river flows, the headpond formed by LGDD extends for approximately two miles upstream. When not spilling, the water level above the diversion dam is typically between elevation 294 feet and 296 feet approximately 90 percent of the time. Within this 2-foot range, the headpond storage is estimated to be less than 100 acre-feet of water. Inflow to the La Grange headpond 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 passing over the LGDD continues down the lower Tuolumne River.

4.2.1.7 Don Pedro Reservoir Operations

The Don Pedro Project is managed consistent with providing for reliable water supply for irrigation and municipal and industrial purposes, providing flood flow management, hydropower generation, recreation, and protection of downstream aquatic resources.

The primary purpose of the Don Pedro Reservoir is to provide a reliable water supply for the irrigation of over 200,000 acres of prime farmland in the Central Valley Region of California. The Project also provides substantial flood control storage. Meeting both of these purposes through wet and dry periods results in large seasonal and annual reservoir fluctuations. The reservoir is generally at its greatest storage volume in June and July. In above normal and wet water years, Don Pedro Reservoir is required to be lowered to at least elevation 801.9 feet by early October to provide flood control storage. During below normal, dry and critical water years, reservoir levels may not ever reach elevation 801.9 feet. During the typical course of each water year, Don Pedro

Reservoir is lowered further during late spring and winter months to provide required instream flow releases and possibly to make space for flood storage.

Predicted mean daily reservoir elevations were calculated with the Tuolumne River Daily Operations Model (TID/MID 2013b). The resulting water surface elevations from the Base Case dataset shown in Figure 4.2-1 illustrates pool elevation trends and variation over the available period of record.

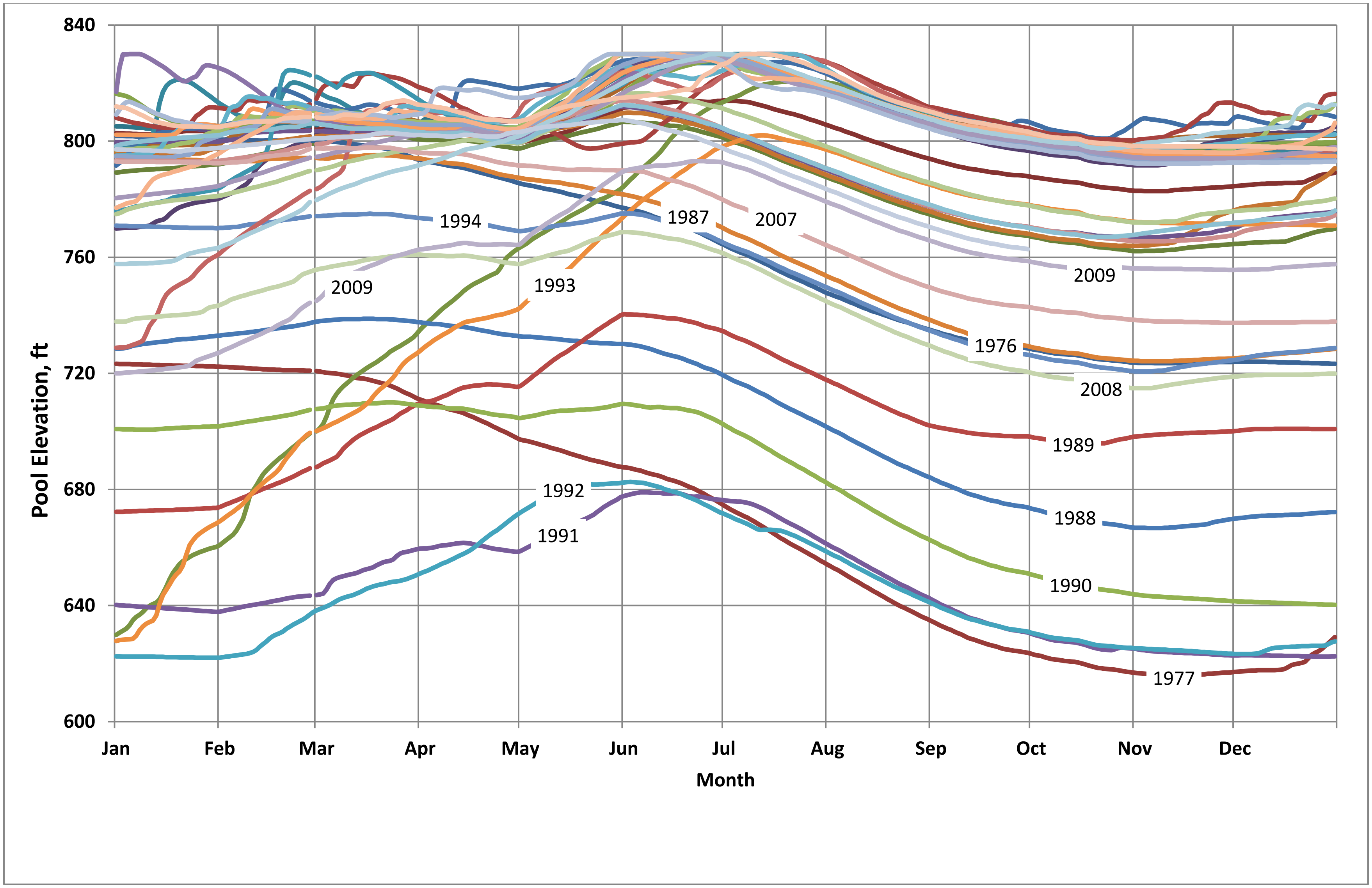


Figure 4.2-1. Mean daily pool elevation for existing (Base Case) Don Pedro Project operations.

Water Surface Fluctuation of Don Pedro Reservoir

The extent of reservoir fluctuation is a significant factor in determining the type, size, and complexity of upstream and downstream fish passage facilities. Upstream fish passage technologies require safe release or exit of fish to the reservoir. 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 technology must maintain some form of continuous hydraulic connection throughout the anticipated range of pool elevations. As the pool fluctuations become larger, so does the facility’s size and complexity. In many cases, certain fish passage technologies can be dismissed from evaluation due to their inability to accommodate an acceptable range of reservoir fluctuation while meeting performance criteria related to safe, timely and effective transport of fish.

Don Pedro Reservoir experiences a high level of seasonal and annual fluctuation with water surface elevations changes of up to 230 feet: substantially more than any fish passage facility currently in operation. Base Case scenario data for the anticipated migration periods of spring-run Chinook and steelhead was further evaluated to identify the potential fish passage facility requirements of target fish species. Table 4.2-2 provides Base Case percent exceedance of mean daily reservoir elevation for anticipated outmigration periods, while Table 4.2-3 provides Base Case results of the same analysis for anticipated upstream migration periods. The annual exceedance elevation data is also provided in each table for comparative purposes.

The Base Case operational scenario results suggest that both upstream and downstream fish passage facilities would need to be designed to be operational between elevations 616 feet and 830 feet. For completeness, a concept fish passage facility is also expected to safely handle reservoir elevations outside this range in times of extreme water conditions, but would be expected to perform fish passage operations within this historical range of reservoir conditions.

Table 4.2-2. 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 Spring-Run Chinook 01Oct – 31May	Outmigration Steelhead 01Dec – 30Apr
99.9%	616.3	616.1	617.6
99%	622.9	622.4	622.5
95%	654.8	645.2	650.3
90%	698.5	698.7	700.9
50%	797.4	796.0	797.4
10%	818.5	809.6	809.1
5%	825.3	814.2	812.5
1%	830.0	823.0	821.9
0.1%	830.0	829.9	829.8

Table 4.2-3. 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 Spring-Run Chinook 01Mar – 31May	Arriving Adult Steelhead 01Nov – 31Mar
99.9%	616.3	639.6	616.1
99%	622.9	650.1	622.1
95%	654.8	689.3	640.3
90%	698.5	710.0	685.8
50%	797.4	803.2	794.9
10%	818.5	814.6	808.0
5%	825.3	819.2	811.5
1%	830.0	824.5	821.9
0.1%	830.0	830.0	829.8

Table 4.2-4. Fish passage facility operational reservoir elevations for the anticipated period of migration for target fish species.

Facility Type (hydrologic scenario)	Low Fish Passage Design Reservoir Elevation (ft)	High Fish Passage Design Reservoir Elevation (ft)	Total Reservoir Fluctuation (ft)
Upstream Passage (Base Case)	616	830	214
Downstream Passage (Base Case)	616	830	214

Another important consideration, specifically for a head of reservoir fish passage facility, is evaluating where the head of reservoir is located and how it can vary throughout the range of anticipated reservoir elevations. Figure 4.2-2 provides a reservoir profile with the reservoir elevation exceedance curves for downstream fish migration. Don Pedro Reservoir has a current minimum pool elevation of 600 feet[14]. When the Don Pedro Reservoir is at elevation 600 feet the head of reservoir is located approximately at RM 70.5.[15] The maximum pool elevation is 830 feet, which extends the head of reservoir to approximately RM 79.5 (approximately 9 miles upstream). Any surface collection system floating on the reservoir surface would not only require accommodation of 230 feet of reservoir fluctuation, but would also need to consider that the head of reservoir would only extend to about RM 70.5. If located upstream of those locations, the facility location would need to be moved as the reservoir elevations recede below a level where there was adequate depth to accommodate the draft of the floating barge. The further upstream the facility was located, the more likely and more frequently it would need to be moved.

As an example, Figure 4.2-2 depicts the changing reach of the reservoir with elevation. The figure also provides the percent of time a given Don Pedro Reservoir water surface elevation is exceeded.

[14] Note that as part of the Don Pedro Hydroelectric Project amended Final License Application, there is a proposal to change the minimum pool elevation to 550 feet. At this elevation, the upstream extent of the head of reservoir would be located at approximately RM 68.8.

[15] All references to the upstream extent of the reservoir are based on USGS quadrangle maps. Estimated stream thalwegs are approximate and susceptible to large errors.

As shown, a facility located at Wards Ferry Bridge (RM 78.4) would experience water surface above elevation 760 feet approximately 78 percent[16] of the time on an annual basis. Conversely, it would also be expected that mean daily water surface elevations may be lower than elevation 760 feet 22 percent of the time annually. Therefore, the facility would likely need to be moved to a deeper location for 22 percent of the time[17]. As another example, a floating facility located at RM 72.2 (near Jacksonville Road Bridge) would experience daily water surface elevations above 627 feet over 95 percent of the time and lower than 627 feet approximately 5 percent of the time. This example shows how a facility at this location would still experience water surface elevations that are too shallow and may need to move, but with less duration and frequency than a facility located further upstream. Ultimately, a floating facility would need to be located downstream of RM 70.5, considering the barge draft needed, to have a fixed horizontal location over time.[18]

[16] This historical headwater duration curve may not be indicative of future reservoir levels. Higher instream flow requirements may significantly modify historical reservoir levels.

[17] This example is simplistic in nature to demonstrate the complexity of operating a facility at the head of reservoir. Floating facilities require depth (draft) upwards of 20 to 40 feet to operate and therefore would likely be required to be moved to deeper waters on a more frequent basis.

[18] The Districts have proposed a new minimum pool level of 550 ft, 50 ft lower than the current minimum.

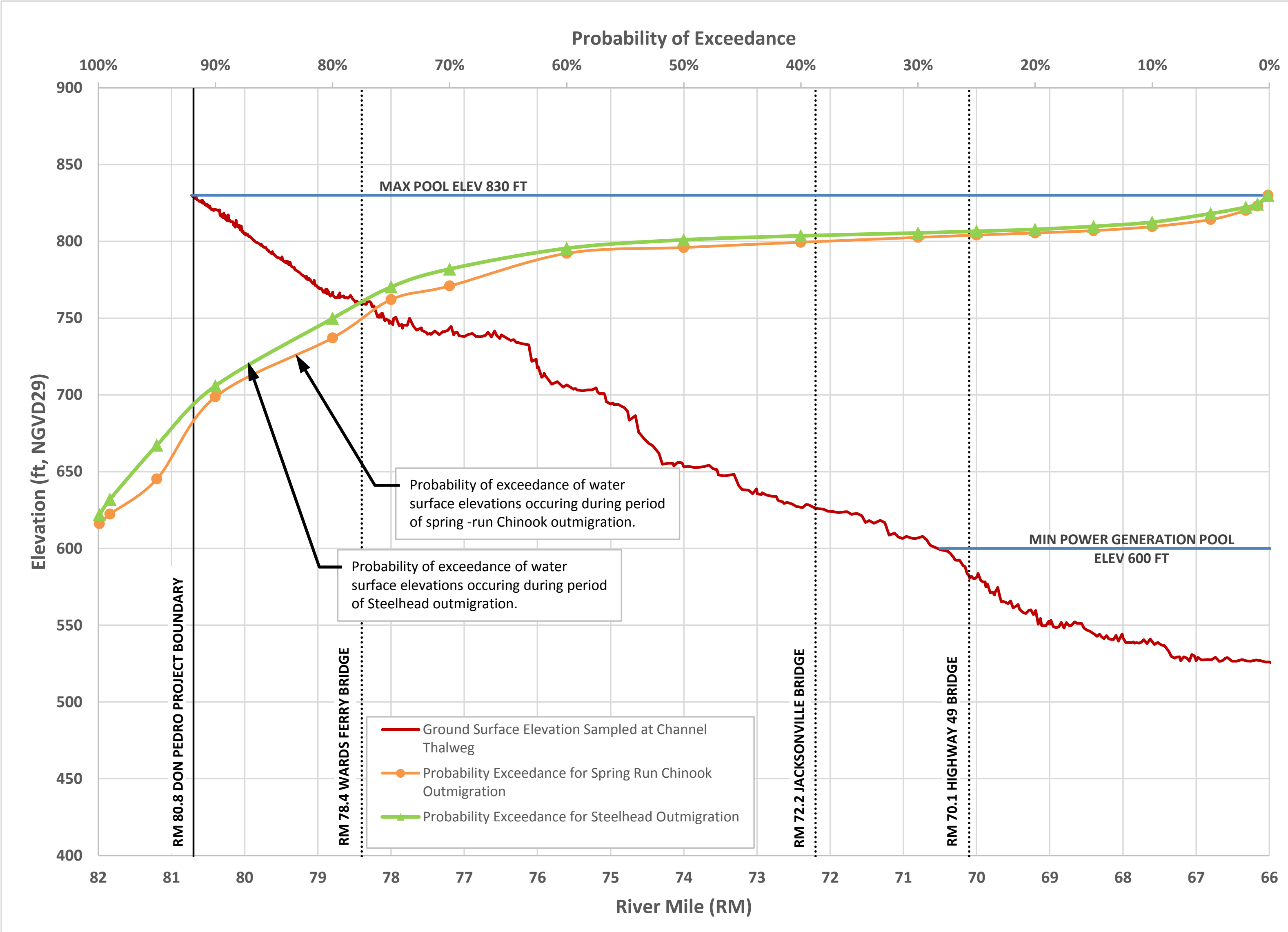


Figure 4.2-2. **Channel thalweg and Base Case reservoir water surface elevations anticipated during fish passage. Base Case data used for the exceedance analysis. Thalweg elevations are for diagrammatic purposes only.**

Don Pedro Reservoir Characteristics and Considerations for Reservoir Transit

Downstream migrating juvenile salmonids rely on a number of environmental factors for behavioral cues that motivate their movements and help direct them down a river channel, eventually to the ocean. The presence of reservoirs provides a physical barrier to downstream migration and may confound a fish's ability to use natural environmental cues to successfully navigate downstream through the impoundment to a dam or reservoir outlet. Reservoir conditions expose downstream migrants to a number of factors that may prolong their residence time in the reservoir. The higher residence time increases the probability of predation, residualization, exposure to false pathways, and greater chance of mortality. Juveniles exposed to these factors are no longer able to continue their migration downstream and complete their natural life-cycle, critical to population sustainability for anadromous salmonids. As an example, USGS tracked the survival/loss over time in several Willamette Basin reservoirs and determined that the highest loss rates were observed in reservoirs where migration rates were the slowest (Hansel et al. 2017). The results suggest that there is a steep loss rate of fish in the first 20 days of residence. Only 10 to 20 percent of the juveniles were ever found after experiencing a residence time of 40 to 80 days. Loss (or lack of detection) was attributed to multiple unknowns that could include residualization, predation, bi-directional migration, disease, mortality, or other factors.

Numerous studies are available that describe the movement of outmigrating spring-run Chinook and steelhead at reservoirs in the Pacific Northwest. USGS reports that over 116 documents have been published to describe fish passage evaluations of anadromous fish at USACE owned facilities alone since 1960 (Hansen et al, 2017). Results from these studies are useful when evaluating two critical factors associated with downstream passage success: (1) are juvenile fish likely to successfully navigate to a specific location where they can be collected, and (2) are factors known to influence their residence time, location, and potential for loss or mortality in the reservoir prior to collection likely to be significant in this case? Although the general migration behavior tends to be similar, the unique environmental conditions within a reservoir influence juvenile life histories and experience in the reservoir very differently.

In light of this, conditions within Don Pedro Reservoir were examined to determine if fish passage alternatives that include a reservoir transit component were likely to inhibit safe and timely migration through the reservoir. Initially, the physical characteristics of Don Pedro Reservoir were compared with other reservoirs where either fish passage performance of an existing passage facility is known or where there are study results available which demonstrate how environmental conditions within the reservoir influence fish behavior. Key factors to consider at a number of select reservoirs are presented in Table 4.2-5. The comparison demonstrates that Don Pedro Reservoir is substantially larger, longer, and more physically complex than reservoirs in the Pacific Northwest that have downstream passage programs, or have been studied for potential passage feasibility. Also of note is that of the reservoir information available, only four of the nine examples are multi-purpose reservoirs that may be operated for numerous objectives such as flood control, municipal/agricultural water supply, and environmental flows in addition to hydropower generation. Information from other reservoirs can be used to inform parameters, but must be considered in light of Don Pedro Reservoir's size, length, physical configuration and operational complexity. From even a qualitative comparison, it is clear that migration patterns in the Don

Pedro Reservoir would be significantly more challenging than in comparison to reservoirs where downstream passage programs are currently in operation.

Table 4.2-5. Comparison of selected example reservoirs to Don Pedro Reservoir.

Project	Dam Height (ft)	Surface Area (acres)	Reservoir Length (miles)	Storage Capacity (ac-ft)	Water Surface Fluctuation (ft)	Facility Type
Upper Baker Dam – Baker Lake, WA	312	4,980	9	285,371	50	Primarily Hydropower[1]
Lower Baker Dam – Lake Shannon, WA	285	2,190	8	161,470	68	Primarily Hydropower[2]
Cushman No. 1 – Lake Cushman, WA	235	4,010	8.6	453,349	20	Hydropower
River Mill Dam – Estacada Lake, OR	85		2.5	2,300	7	Hydropower
North Fork Dam – North Fork Reservoir, OR	207	220	4	19,000	5	Hydropower
Round Butte Dam – Lake Billy Chinook, OR	440	4,000	Metolius R: 13 mi. Deschutes R: 9 mi. Crooked R: 7 mi.	535,000	2	Hydropower
Swift Dam No. 1– Swift Reservoir, WA	512	4,620	9	755,600	122	Multipurpose
Cougar Dam – Cougar Reservoir, OR	519	1,280	5	219,000	167	Multipurpose
Detroit Dam – Detroit Reservoir, OR	463	3,500	9	455,000	119	Multipurpose
Don Pedro Dam – Don Pedro Reservoir, CA	580	13,000	26	2,030,000	230	Multipurpose

[1] Baker Lake is only required to provide 16,000 acre-feet of flood storage between October 15 and March 1 and up to an additional 58,000 acre-feet of flood storage during September 1 to April 15, as directed by the USACE.

[2] Lake Shannon is only required to provide up to 29,000 acre-feet of flood storage during October 1 to march 1, if directed by the USACE.

Velocity and temperature characteristics of Don Pedro Reservoir demonstrate how low velocities and strong development of thermal stratification occurs for large portions of the anticipated period of migration. Reservoir velocities estimated for Don Pedro Reservoir, reservoir temperatures, and reservoir predation are discussed below.

Reservoir Velocities

Velocity fields within reservoirs generally flow from the head of reservoir (upstream) toward the reservoir outlet (downstream) and provide a pathway for juvenile fish to follow as they migrate downstream. Larger reservoirs generally have larger cross-sectional areas and lower velocities with which to guide fish downstream. Similarly, narrower reservoirs with large hydropower generation flows result in higher more continuous velocities through the reservoir. Facilities with such characteristics tend to result in more favorable conditions for surface collection systems at the dam as the higher velocities provide sufficient migration cues that outmigrating fish can follow (Kock 2017).

Multi-purpose reservoirs store and release water for the purpose of water supply and may make storage adjustments based upon the need to provide flood control storage. These types of operations generally occur in a manner that disrupts the continuity of velocity pathways and inhibits the ability of outmigrating juveniles to find their way through the reservoir in a manner suited to timely outmigration. In addition to flows commensurate with changes in storage volume, temperature stratification, wind, and introduction of tributary flows all influence velocity direction and magnitude within a reservoir system. As flows decrease or as velocities change direction, the ability for fish to successfully follow the velocity field to the outlet of a reservoir diminishes. Velocity magnitudes of less than 0.1 feet per second (0.03 meters per second) are believed to result in juvenile "milling" or "seeking" behavior indicating an overall loss of direction or adequate velocity cue (Beeman et al. 2014a). These behaviors result in misdirection and increased residence times in the reservoir as fish may end up travelling the length of a reservoir multiple times looking for cues that might lead to a suitable outlet (Beeman et al. 2014b; Beeman and Adams 2015).

Seasonal velocity scenarios occurring within Don Pedro Reservoir were examined to evaluate the magnitude of velocities that a fish may experience during outmigration. For the purposes of this study, example inflows were selected to represent velocity fields potentially present within Don Pedro Reservoir. Calculations were performed over a calendar year assuming that the reservoir began at an initial full reservoir condition. Of the results examined, months of the year with the highest inflows exhibited the highest reservoir velocities. These example months were selected for the purposes of initial comparison. Results across three separate horizontal elevation planes were sampled from the three-dimensional model output: at the water surface, at 797 feet, and at elevation 784 feet. The resulting velocity fields are illustrated in Figure 4.2-3 through Figure 4.2-7.

As shown in Figure 4.2-3, example velocity fields representative of late winter conditions in Don Pedro Reservoir are greatest in the narrowest portions of the reservoir which occur at the head of reservoir (RM 79) and downstream of the Highway 49 Bridge near RM 68. Figure 4.2-4 illustrates a smaller scale view showing both velocity magnitude and direction. In these locations, calculated velocity estimates range from 0.05 meters per second (0.16 feet per second) to 0.03 meters per second (0.1 feet per second). Such low velocities (i.e., less than 0.03 m/s) may fail to cue outmigrating fish (Beeman et al. 2014b; Beeman and Adams 2015). In wider portions of the reservoir downstream of RM 68, velocities appear to diminish to 0.02 meters per second (0.06 feet per second). Downstream of RM 59, the reservoir widens and velocities are reduced further to 0.008 meters per second (0.03 feet per second) at RM 55. Overall, the results show a declining field of velocities as flow approaches Don Pedro Dam. When examining Figure 4.2-5 and Figure 4.2-6, the same overall trends appear but slight variations show how cooler water flowing in from the head of reservoir changes the overall velocity distribution in the water column. These results suggest that during certain time periods, there are adequate velocities within the reservoir to support downstream migration to a point within Don Pedro Dam near RM 68 but only when velocities are the highest. Downstream of this point, the reservoir cross-section widens significantly and velocities drop to 0.016 meters per second (0.05 feet per second). As these velocities diminish, the ability of outmigrating juvenile fish to seek and find an outlet is impeded.

Results also show that velocities simulated throughout the reservoir are significantly less during other months of the year. Figure 4.2-7 shows a series of velocity field plots representative of spring through early winter. Results from this data series illustrate that velocities downstream of RM 68 range from 0.000 to 0.024 meters per second (0.00 to 0.078 feet per second) in early spring and from 0.000 to .008 meters per second (0.00 to 0.026 feet per second) or less from late spring to early winter. These results are consistent with low velocity conditions that are known to impede downstream migration and which lead to milling behaviors and longer residence times.

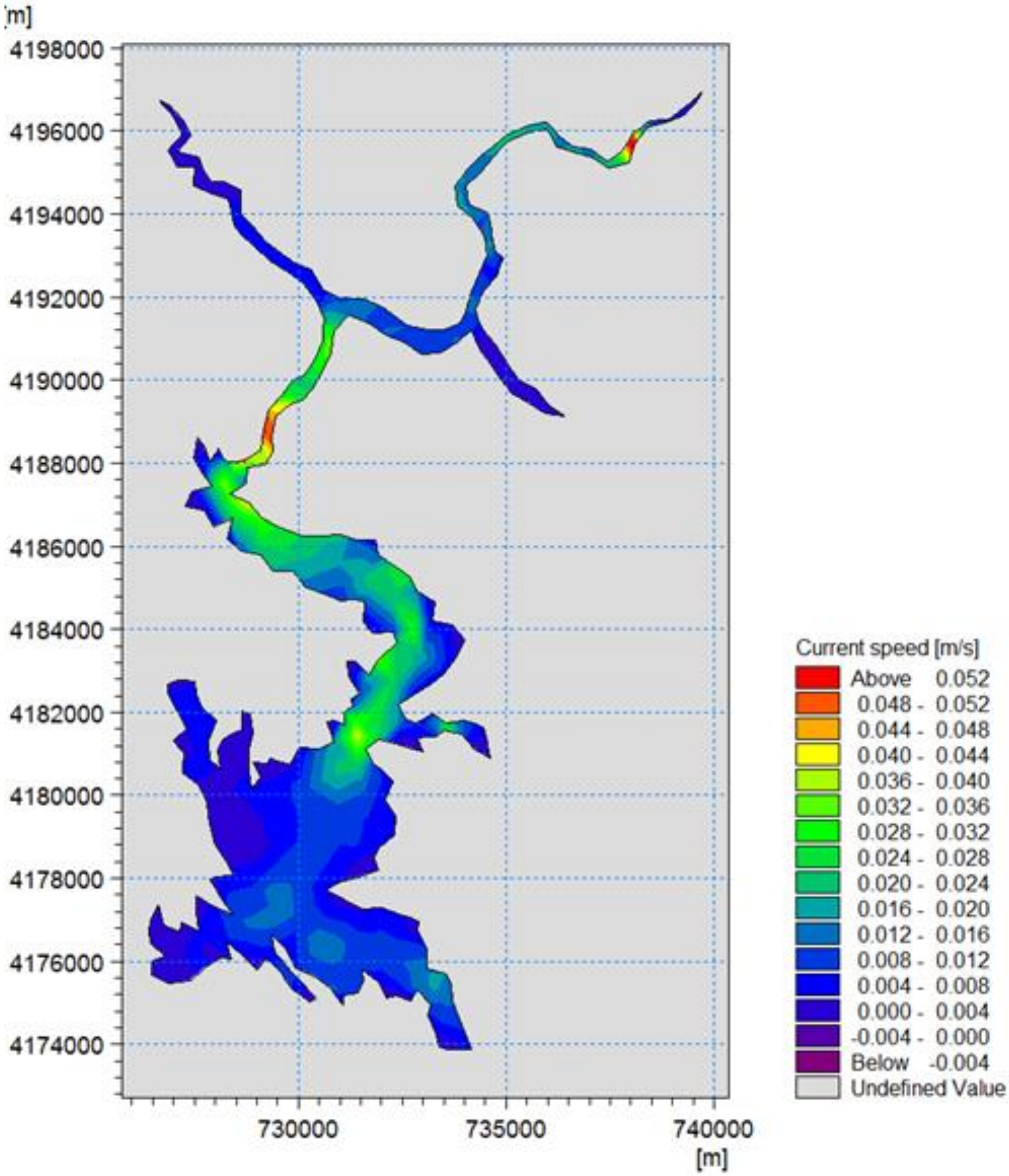


Figure 4.2-3. Reservoir velocity field simulation results for late winter and early spring at the water surface with horizontal coordinates shown in UTM Zone 10.

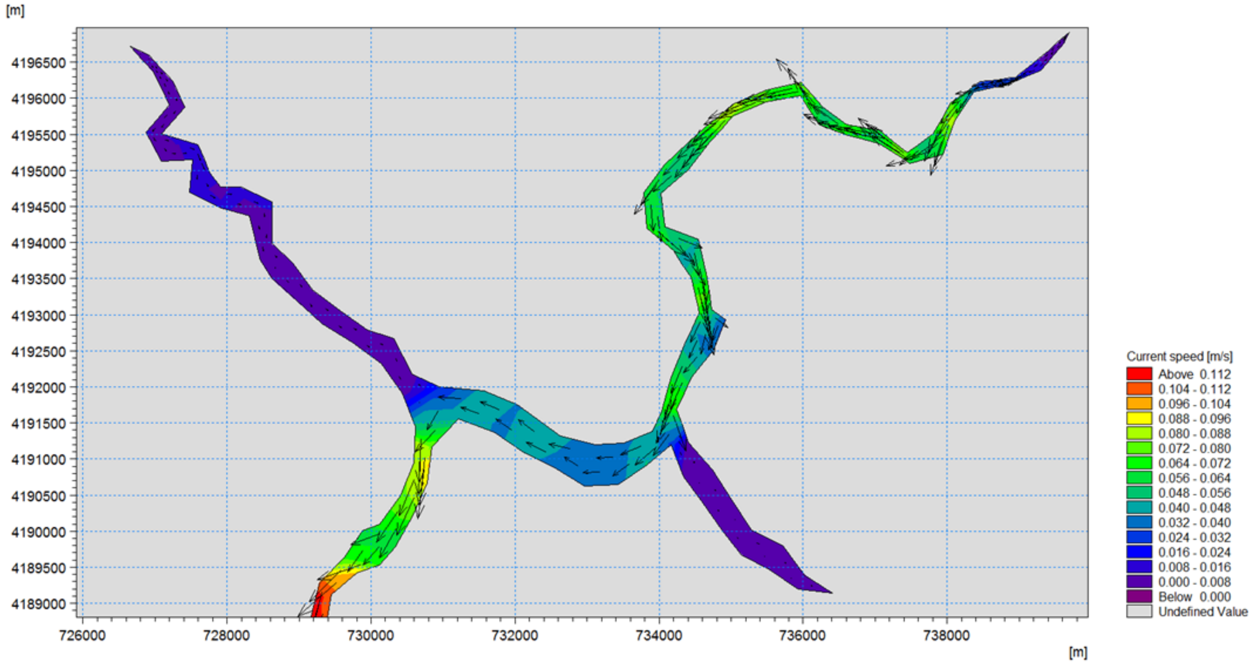


Figure 4.2-4. Reservoir velocity field simulation results for late winter and early spring (water column elevation 797 feet), RM 80.8 to RM 68.5 with horizontal coordinates shown in UTM Zone 10.

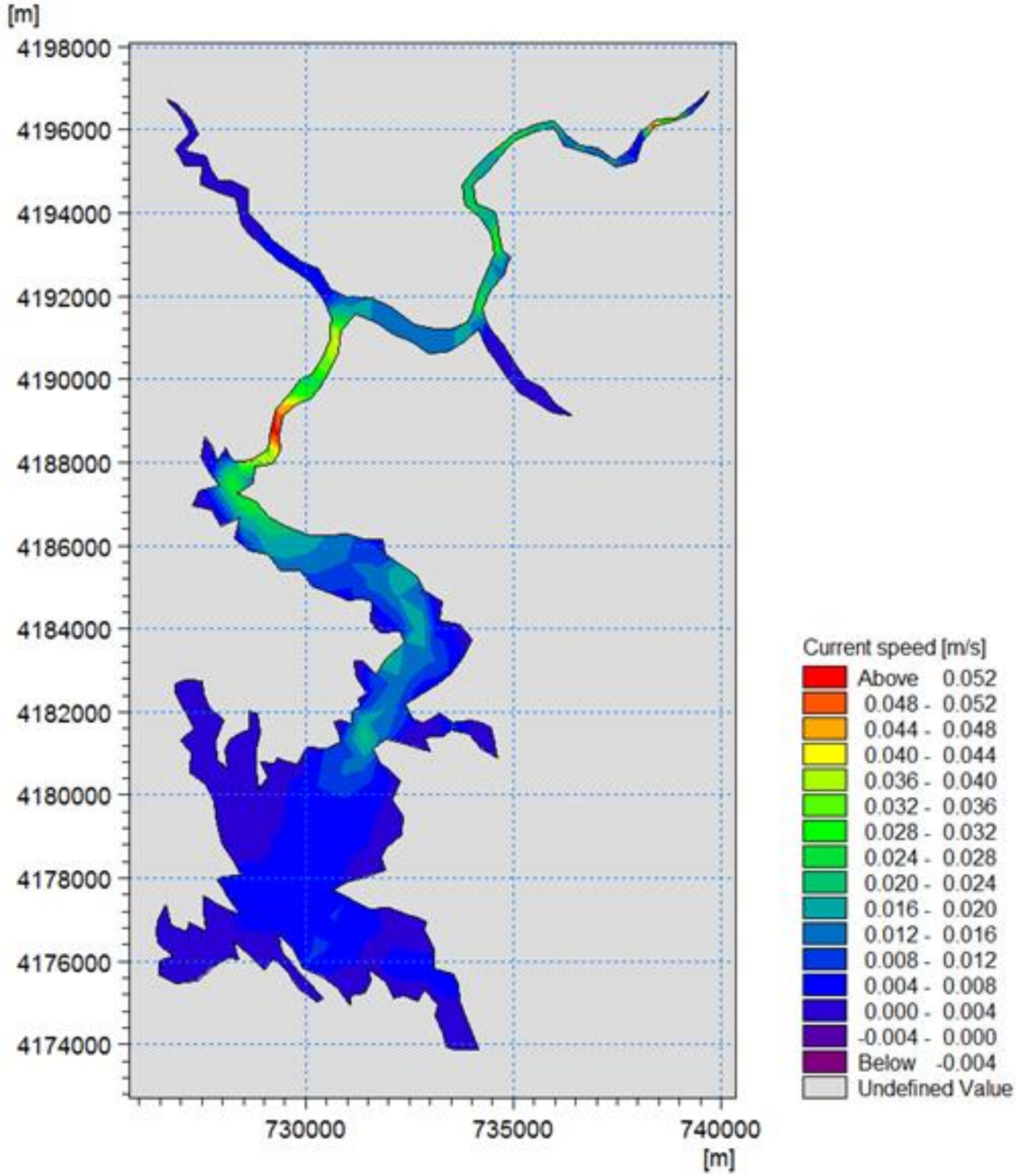


Figure 4.2-5. Reservoir velocity net simulation results for late winter and early spring (water column elevation 784 feet) with horizontal coordinates shown in UTM Zone 10.

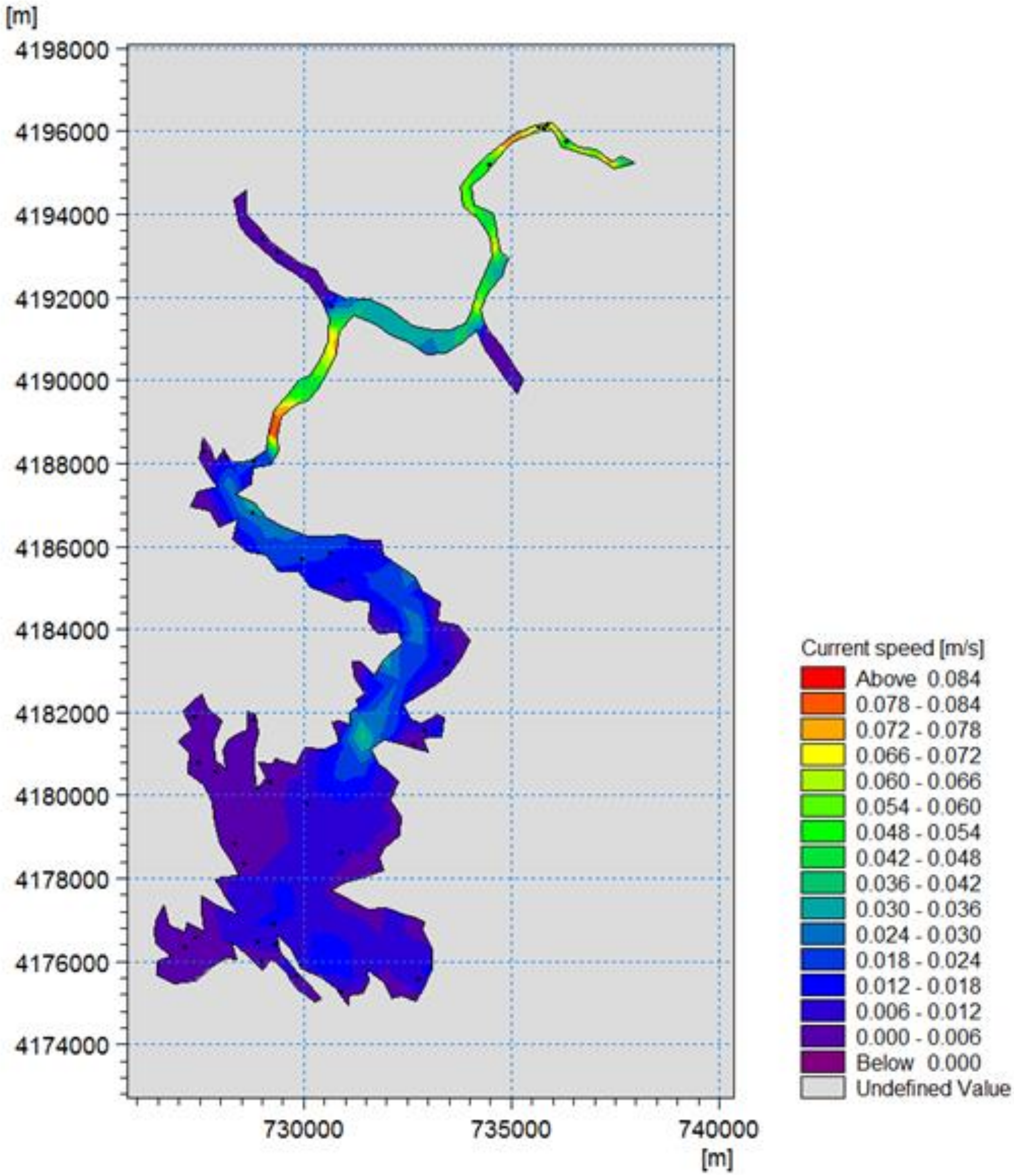


Figure 4.2-6. Reservoir velocity field simulation results for late winter and early spring (water column elevation 784 feet) with horizontal coordinates shown in UTM Zone 10.

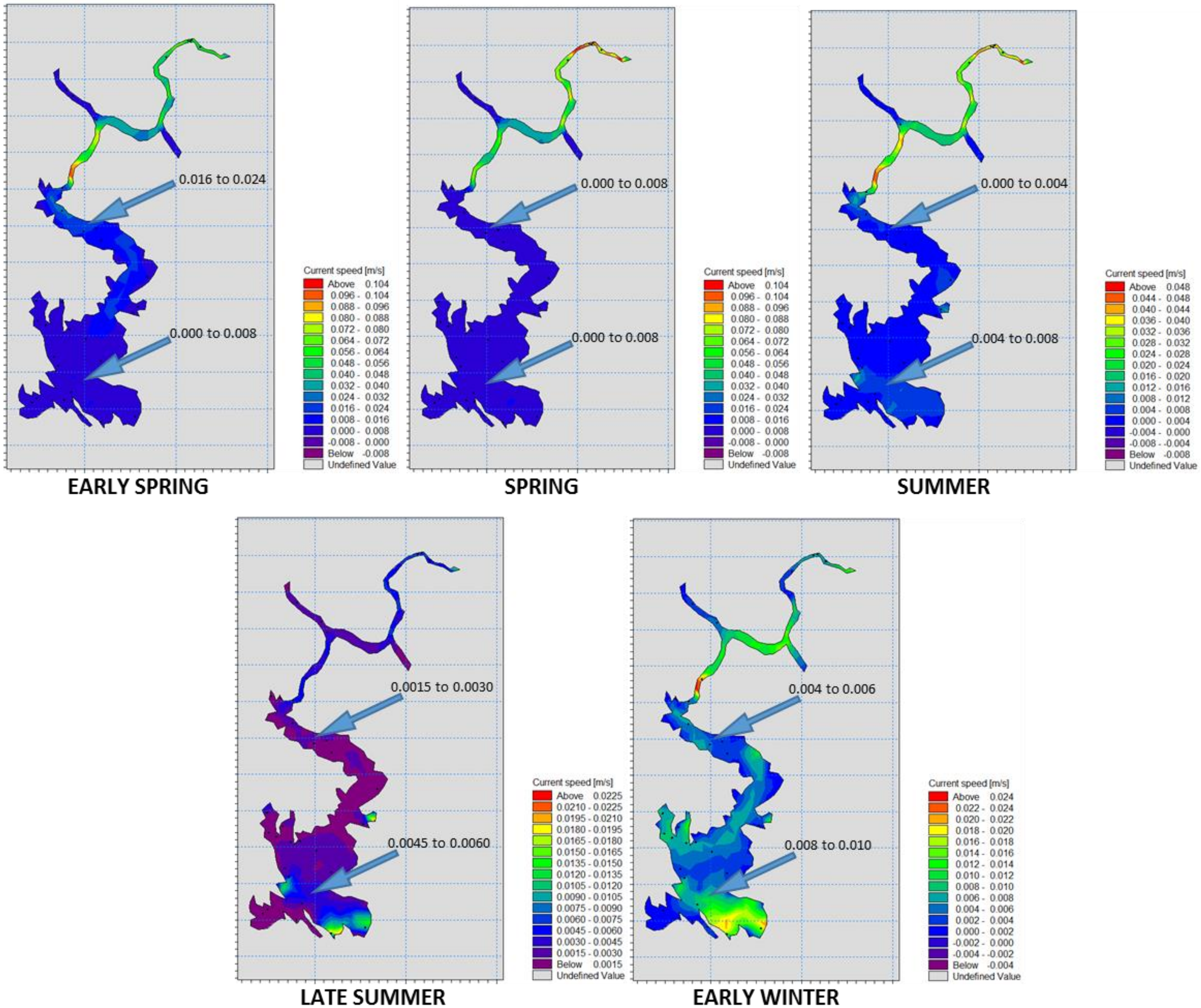


Figure 4.2-7. Time series of simulated velocity field plots (water column depth of 784 feet).

Reservoir Temperature and Thermal Complexity

Reservoir temperature and temperature stratification is shown to influence the vertical location of outmigrating smolts in the water column as well as access to suitable migration pathways. Studies on Willamette basin reservoirs in Oregon indicate that as the surface water temperatures increased during summer months, fish occupied deeper, cooler parts of the water column (Monzyk et al., 2012, 2013, Khan et al. 2012). During these periods of warm temperatures, outmigrating juveniles moved to areas where they couldn't be collected or moved downstream through available passage pathways (Hansen et al. 2017). Reports from 2015 and 2016 monitoring and evaluation activities at six different surface collection systems indicate that outmigrating juveniles move to lower depths in the water column as thermal stratification develops in multi-purpose reservoirs during the months of August, September, and October. During these months, many of the collection systems are shut down for maintenance activities due to lack of downstream movement and reduced number of fish collected (Kock 2017). PacifiCorp reported that 99 percent of the collected smolts pass before water temperatures reach 16 degrees Celsius (60.8 degrees Fahrenheit) (PacifiCorp 2017). As temperatures began to rise above 16 degrees Celsius, an increased percentage of the smolt were recorded sounding below the exclusion nets and passing downstream of the collection system in an effort to remain in acceptable temperature pathways as they migrated downstream.

Temperature data collected in Don Pedro Reservoir shows that warmer water temperatures that exceed an Upper Optimal Water Temperature Index (UOWTI) value of 63 degrees Fahrenheit for spring-run Chinook smolt outmigration occur each year to depths of 30 to 60 feet near the head of reservoir (RM 72.3), and to depths of 30 to 70 feet near Don Pedro Dam (RM 55.1). At some locations, such warm temperatures are recorded at depths up to 140 feet. Figure 4.2-8 summarizes the depth at which the UOWTI value is met or exceeded over the course of the year at RM 72.3 near Jacksonville Bridge, for years 2004 through 2016. In all twelve years examined, temperatures exceeded the UOWTI value at depths of 30 feet or more from as early as mid- May through as late as mid-November. This period coincides with the early and latter portions of the spring-run Chinook smolt outmigration period. Figure 4.2-9 provides a similar summary of data and shows how the UOWTI value is met or exceeded at depths of 30 feet or more from as early as the beginning of May through as late as mid-November. The data also suggests that the UOWTI value is met or exceeded each year at depths of up to 60 feet or more at both locations with 2015 exceeding depths of 140 feet.

The development of strong thermal stratification throughout Don Pedro Reservoir results in surface temperatures that exceed the smolt outmigration UOWTI value for spring-run Chinook. Available data shows that temperatures become unsuitable for outmigration in the upper 30 to 70 feet of the water column for all years observed and throughout a portion of the anticipated period of migration for spring-run Chinook. In general, these conditions will result in outmigrating juveniles seeking depths of 30 to over 100 feet to find suitable water temperatures throughout portions of their anticipated period of migration. As demonstrated at other floating surface collection systems currently in operation, collection of outmigrating fish at these depths with these types of temperature conditions is not effective, resulting in overall increases in juvenile residence times in Don Pedro Reservoir. When suitable temperatures exist at depths similar to the entrance of the collection facility, fish may find the entrance and be collected. If temperatures are unsuitable, fish will seek cooler, more suitable temperatures lower in the water column away from a collection facility entrance. At these depths, fish will continue to "mill" upstream of the entrance and any guide nets that may be present. For example, the Floating Surface Collector at Swift Dam No. 1 shuts down every summer when temperatures are too high. During these times, fish continue to migrate in the reservoir, but they seek cooler, more suitable temperatures lower in the water column and collection rates drop to near zero (PacifiCorp 2016 and 2017).

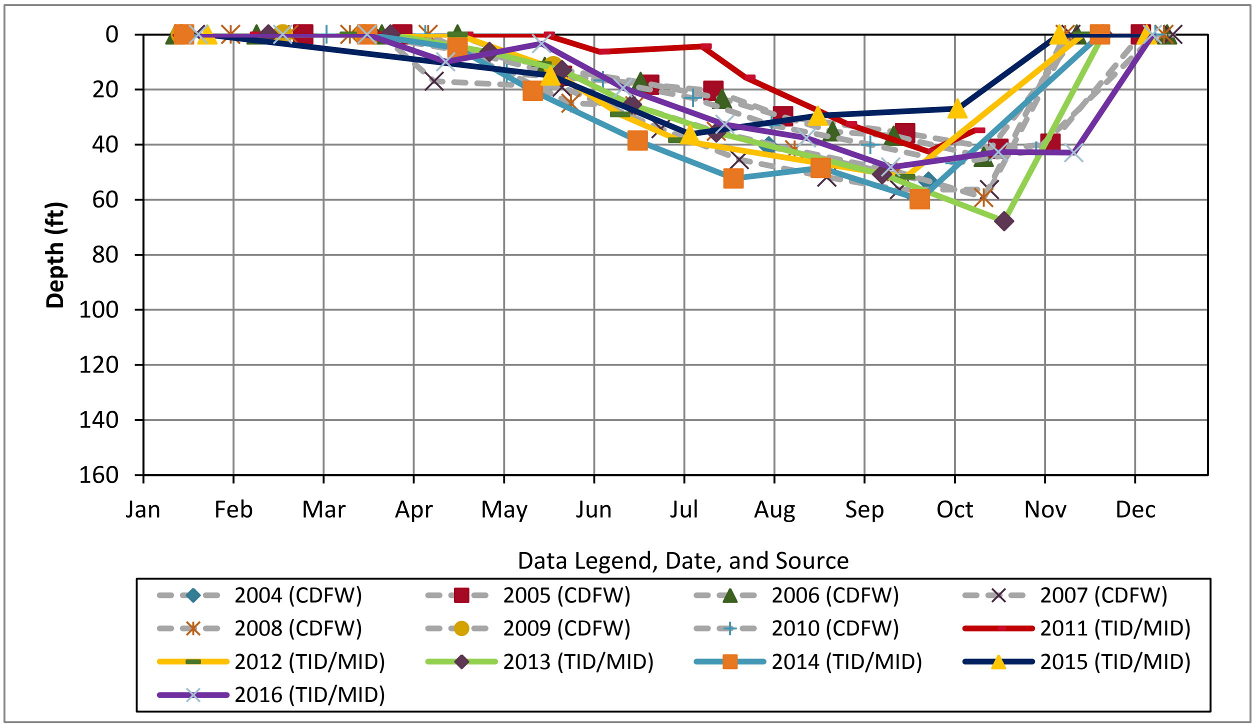


Figure 4.2-8. **Summary of depths where water temperatures met or exceeded the spring-run Chinook smolt outmigration UOWTI value of 63° Fahrenheit near Jacksonville Bridge RM 72.3.**

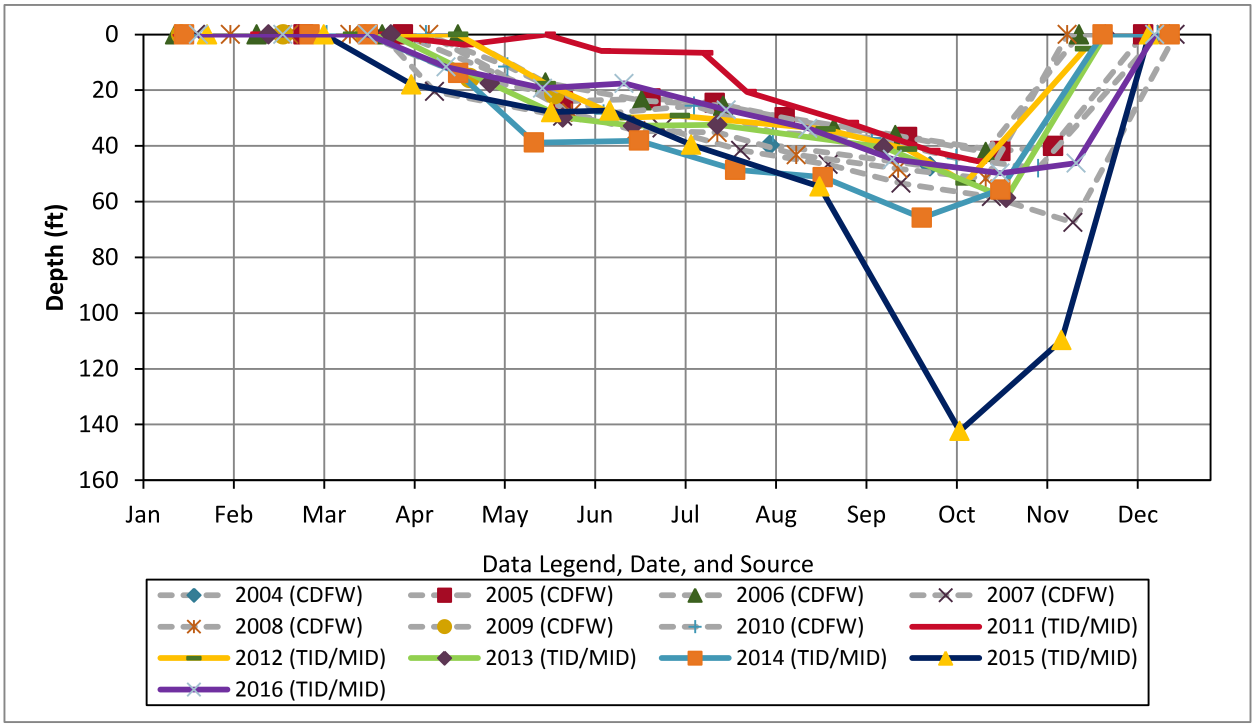


Figure 4.2-9. Summary of depths where water temperatures met or exceeded the spring-run Chinook smolt outmigration UOWTI value of 63° Fahrenheit near Don Pedro Dam, RM 55.1.

Predation

Predation on native salmonids in Don Pedro Reservoir will likely be significant and will negatively influence juvenile transit through the reservoir. Don Pedro Reservoir contains a diverse fish population, including both native and introduced fish populations that were established through stocking to support game fisheries. CDFW currently manages Don Pedro Reservoir for rainbow trout, Chinook salmon, kokanee, and black bass fisheries and is known to be one of the most successful warmwater fisheries in California. As an example, eleven different organizations are scheduled to hold 21 fishing tournaments at Don Pedro Reservoir in 2017 alone (Don Pedro Recreation Agency 2017). During extensive sampling of the Don Pedro Reservoir conducted in 2012, TID/MID (2013c) identified 14 fish species, including nonnative game species that may prey upon juvenile salmonids. The majority of sampled game fish were sunfishes (Family Centrarchidae), represented primarily by largemouth bass (*Micropterus salmoides*). Other frequently collected Centrarchids included green sunfish (*Lepomis cyanellus*), bluegill (*Lepomis macrochirus*) spotted bass (*M. punctulatus*), and smallmouth bass (*M. dolomieu)*. Unidentified black bass comprised a large portion of the sampled catch.

Although reservoir-specific data do not exist to document the degree of piscine predation on juvenile salmonids in Don Pedro Reservoir, a lower Tuolumne River predation study (TID/MID 2013c) found black bass to account for significant levels smolt predation. Predation rates (# of Chinook salmon per predator) were generally highest for striped bass, followed by smallmouth bass and largemouth bass. Based on this information, the presence of black bass and other documented piscivorous fish species in the reservoir indicates predation is a variable that must be considered as part of any fish passage or reintroduction effort.

Given the recreational fisheries that exist in the reservoir, predator presence must be considered as a possible constraint to use of the reservoir as a navigational pathway as well as for reintroduction as a whole. Negative interactions between introduced fish and preexisting species would need to be reduced through physical means for fish passage or reintroduction to have a reasonable chance of success. Nonnative game fishes in Don Pedro Reservoir will increase loss in the reservoir leading to a reduction in reservoir passage effectiveness. Juvenile fish will be vulnerable to size-selective predation in reservoirs (Poe et al. 1991; Fritts and Pearsons 2006) unless they are collected and routed around these "hazards" (Anderson et al. 2014).

4.2.1.8 Technical Design Criteria

Numerous fish passage guidelines and design criteria have been established by CDFW and NMFS to provide a framework for fish passage design. Other literature sources are available that provide design guidance and biological criteria for the collection, handling, and transport of fish. Although not explicitly referenced, applicable criteria are used in this report throughout the passage alternative formulation process. Some are specifically outlined in the alternative 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 1997).
- Anadromous Salmonid Passage Facility Design (NMFS 2011).
- Fisheries Handbook for Engineering Requirements and Biological Criteria. U.S. Army Corps of Engineers (Bell 1991).

4.2.2 Factors Influencing Upstream Passage of Fish

4.2.2.1 Population Abundance of Upstream Migrating Adult Fish

Fish abundance and upstream migration rates have a significant influence on the applicability, selection, sizing, and operational characteristics of potential fish passage facility alternatives. In general, abundance can be summarized in terms of peak annual and peak daily rates of migration. These values are used to size many components of upstream fish passage facilities and also have a strong influence on layout and operational complexity. Given the correlation to project size and operational effort, differences in abundance significantly influence capital and operation costs. For example, the peak daily number of fish expected to enter a facility will determine such factors as the volume of water for holding fish, specific flow rates required to support life, the number of holding facilities, the size and complexity of temporary holding vessels, and the cycle time of mechanical equipment, as applicable. Each of these factors can influence the layout of a facility, its complexity of operation, reliability, and cost. In terms of evaluating directive type facilities (as opposed to non-directive or fully volitional), consideration of these factors influences the size and capacity of transit vehicles (i.e., moving fish with a small cooler sized vessel is a small vehicle or multiple daily trips in a specially equipped, weight-rated, truck).

As described previously, populations of spring-run Chinook and steelhead do not currently exist in the Tuolumne River. In addition, there is no empirical evidence of a self-sustaining run or population of steelhead in the lower Tuolumne River (Zimmerman et al. 2000, CDFW 2017). Therefore, information related to Tuolumne River-specific population abundance is not available. In cases of population recovery or reintroduction, biological objectives and population targets for a given basin are typically examined and identified as part of a process that occurs prior to or in conjunction with an engineering feasibility study so that potential fish passage facilities, their features, and estimated costs adequately reflect known or agreed upon goals. As described in Section 4.1, the Districts, in collaboration with licensing participants, implemented a Framework for which to collect information to support this study and the overall evaluation of reintroduction feasibility. As part of this process, a reintroduction goal statement was established and approved by the Framework's Plenary Group on May 18, 2017. The final Tuolumne River reintroduction program goal statement was to *"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."* Further, "NMFS believes that design of conceptual fish passage facilities should be planned to handle, at a minimum, run sizes … sufficient to support self-sustaining, viable populations (Lindley et al. 2007)," (NMFS 2016c).

Consistent with the final Tuolumne River reintroduction program goal statement and NMFS' reference to Lindley et al.'s (2007) viable population definition in lieu of Tuolumne River-specific population abundance goals, the fish passage study team referenced the generalized minimum viable population index documented by Lindley et al. (2007) to develop concept population abundance estimates. As stated, in order for a population to be considered viable, it must meet the criteria for low extinction risk for Central Valley salmonids and exhibit a minimum population size of 2,500 individuals. Since this study reflects the passage requirements for both spring-run Chinook and steelhead, it is assumed that the population for each species would therefor require 2,500 returning adults (a combined total of 5,000 returning adult salmonids).

Given the information presented in the literature, peak daily counts can be estimated as 10 percent of the maximum annual run (Bates 1992). To be conservative, peak hourly migration was estimated as 20 percent of the peak daily count based on Bell (1991). If 20 percent of the peak daily count is used, and the peak day is calculated as being 10 percent of the annual run, then the peak hourly count is approximately 2 percent of the annual run. This methodology results in a peak daily count of 500 adult salmonids and a peak hourly count of 100 adult salmonids. These numbers are used to assess size, footprint, operational effort, and magnitude of cost required for certain fish passage technologies considered in this study.

4.2.2.2 Hydrology and Flow Releases Experienced Downstream of LGDD

Successful implementation of appropriate fish passage technologies relies on a detailed understanding of potential hydraulic conditions over the range of streamflows under which the targeted fish species and life stages are expected to migrate, either upstream or downstream. Understanding the recurrence and magnitude of streamflows is an important component in establishing the anticipated range of flows that directly influence the sizing and complexity of fish passage facilities.

Guidelines presented by NMFS (2011) are based on exceedance calculations (also known as a flow duration analysis) of mean daily 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 that a facility may experience during anticipated operational periods.

NMFS (2011) states that the high fish passage design flow shall be the mean daily 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 streamflow that is exceeded 95 percent of the time during periods when migrating fish may be present. These criteria are generally applied to facilities that are designed to collect adult anadromous salmonid and steelhead migrating upstream. Currently, there are no full scale downstream in-tributary or head-of-reservoir collection facilities for outmigrating juvenile fish and post-spawn adult fish. As such, there are no associated design flow guidelines. 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, the same 5 to 95 percent guidelines are assumed for downstream collection facilities.

The range of river flows anticipated to occur immediately downstream of LGDD are characterized using Base Case operational model results. The percent exceedance of flows below LGDD based upon the Base Case operational scenario is summarized in Table 4.2-6. The median inflow for this scenario is 250 cfs on an annual basis and ranges from 300 to 913 cfs during the anticipated migration periods of target fish species.

Table 4.2-6. 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 Spring-Run Chinook 01Mar – 31May	Arriving Adult Steelhead 01Nov – 31Mar
99%	50	150	145
95%	50	150	150
90%	50	150	150
50%	250	913	300
10%	3,884	5,591	4,183
5%	5,979	7,232	6,202
1%	8,747	8,844	8,807

Low and high fish passage flows for each individual species are presented in Table 4.2-7 for upstream migration. The fish passage facilities will need to be designed to meet the lowest of the low fish passage design flows and the highest of the high fish passage design flows. The anticipated low and high fish passage design flows for upstream and downstream collection facilities are summarized in Table 4.2-8.

Table 4.2-7. Fish passage flows calculated for upstream migration of each target species.

Species	Base Case	
	Low Fish Passage Design Flow (cfs)	High Fish Passage Design Flow (cfs)
Spring-Run Chinook	150	7,232
Steelhead	150	6,202

Table 4.2-8. 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 (Base Case)	150	7,232

Upstream fish passage facilities will need to accommodate a range of design flows from 150 cfs to 7,232 cfs based upon the Base Case operational models. These values are used during alternative formulation to set the minimum and maximum tailwater elevations required for normal operation at an upstream facility entrance, to establish maximum attraction flow requirements, and to scale any guidance structures that are required in the river. As the difference between the values increases and the magnitude of the high design flow increases, the scale and complexity of an upstream fish passage facility also increases. During flows above or below the range of design flows, compliance with fish passage criteria is not assured and is typically not expected by regulatory agencies. Assumptions formulated for tailwater elevations are presented in Section 4.2.2.3.

Minimum Releases to Support Aquatic Resources on the Tuolumne River

In addition to the NMFS (2011) fish passage design criteria, minimum releases on the Tuolumne River should be considered. In accordance with an agreement with the U.S. Department of the Interior, the San Francisco Public Utilities Commission (SFPUC) releases minimum stream flows from Hetch Hetchy Reservoir (CCSF 2008). Once made, these releases cannot be diverted below O'Shaughnessy Dam (i.e., at Early Intake); they flow down the Tuolumne River, are supplemented by flows from Cherry Creek, potential releases at Kirkwood powerhouse, and releases at Holm powerhouse and other 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 from June through August. For dry years, minimum flow releases are a minimum of 40 cfs in December and January to 110 cfs from 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 Hydroelectric Project is required to provide minimum stream flows in the lower Tuolumne River. By October 1 of each year, flows are adjusted to meet minimum flow and pulse flow requirements to benefit upstream migrating adult fall-run 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. 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.

Maximum Anticipated Flow Releases below LGDD

Flows resulting from low frequency, high magnitude flood events observed below LGDD are attenuated through Don Pedro Reservoir operations. Don Pedro Reservoir management includes the capture of both rain and snowmelt floods. The USACE Flood Control Manual states that flow in the Tuolumne River at Modesto (measured at the 9th Street Bridge) should not exceed 9,000 cfs. Another consideration for releases is that Dry Creek comes in to the Tuolumne River above Modesto 9th Street USGS river gage, and therefore Dry Creek flows must be taken into account when making releases from Don Pedro Dam.

Although flows of 9,000 cfs at Modesto are a guideline, it is recognized that flood flows of greater magnitude can occur on the Tuolumne River. Such flows must therefore be considered when designing fish passage facilities to protect facility capability and longevity during and after a flood event or series of flood events. The highest flow experienced at the new Don Pedro Project occurred in January 1997, the peak outflow from Don Pedro was estimated to be 59,462 cfs, with an estimated reservoir inflow of 120,935 cfs (TID/MID, 2014). The flood of record on the Tuolumne River is approximately 130,000 cfs and estimated to have occurred in January 1862 (TID/MID 2014).

Flood magnitude and chance of recurrence can also be evaluated using statistical methods and examination of historical flow data records. As part of other FERC studies at LGDD, a Log Pearson Type III analysis was performed to estimate the 100-year flow below LGDD. The Log Pearson Type III analysis resulted in an estimated 100-year flood flow (P=0.01) of 36,500 cfs.

4.2.2.3 Anticipated Tailwater Elevations at La Grange Powerhouse

Estimation of water surface elevations downstream of the LGDD are important for the purpose of siting potential fish passage facilities and understanding the range of water levels and depths that must be accommodated during targeted periods of migration or during significant flood events. An upstream fish passage facility must operate and meet specific NMFS and CDFW design guidelines throughout the range of flows when fish are anticipated to be migrating upstream. The anticipated range of design flows is developed in Section 4.2.2.2 and Table 4.2-8. In addition to specific operation parameters, a facility must also maintain structural integrity and be resilient to adverse conditions generated by significant flood events. Anticipated flows relative to typical flood operations as well as more significant and infrequent events are discussed in Section 4.2.2.2.

Given that the area nearest the existing La Grange Powerhouse appears to be the most suitable site for development of conceptual upstream fish passage facilities, tailwater surface elevations must be considered at this location for the purposed of alternative development. The anticipated range of tailwater elevations (Figure 4.2-10) was estimated by interpolating a rating curve at the La Grange Hydroelectric Powerhouse from a HEC-RAS model developed for the La Grange Dam Failure Analysis and Hazard Potential Analysis (HDR 2014). Based on this interpolation, the anticipated low fish passage design tailwater elevation at the La Grange Powerhouse is approximately 178 feet (corresponding to a flow of 150 cfs), and the high fish passage design tailwater elevation is approximately 188 feet (corresponding to a flow of 7,232 cfs). Fish passage facilities near the La Grange Powerhouse will therefore need to be designed to provide fish passage and meet fish passage design criteria when water surface elevations range from 178 to 188 feet.

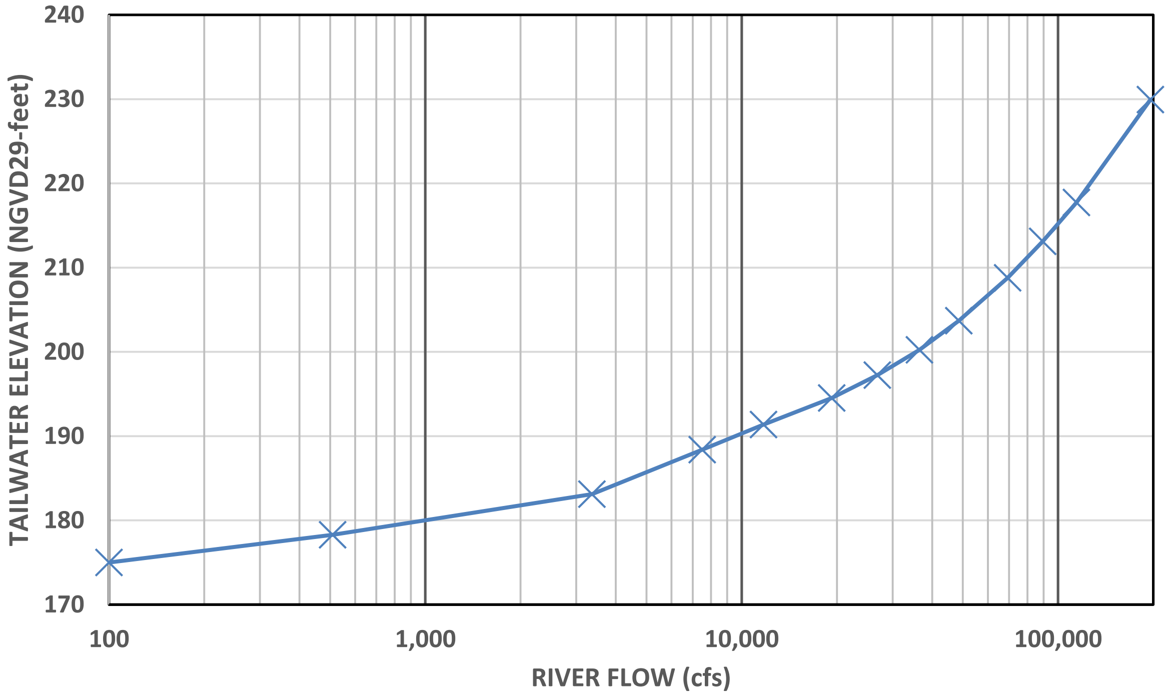


Figure 4.2-10. Anticipated water surface elevation versus river flow at TID's La Grange powerhouse.

NMFS (2011) suggests, at a minimum, to design fish passage facilities to have sufficient freeboard to minimize overtopping by 50-year flood flows. For the purposes of developing upstream fish passage facility concepts in this report, a 100-year flood flow was used as the design overtopping event. The 100-year tailwater elevation is estimated to be 200 feet at the La Grange Powerhouse. Using a selected freeboard requirement of 3 feet, an upstream fish passage would need to configure all buildings, critical isolation walls, and primary access corridors above an elevation of 203 feet.

4.2.3 Factors Influencing Downstream Passage of Fish

4.2.3.1 Population Abundance of Downstream Migrating Fish

Because many of the technologies considered in high dam applications require the use of trap and transport for successful downstream passage, a determination of population abundance is a necessary step in the alternative formulation process. The development of passive facilities that pass both water and fish downstream without the use of trap and transport mechanisms is not influenced by the number of fish passed downstream.

For active transport programs, the number of anticipated outmigrating smolts is used in alternative formulation for the purposes of estimating the relative size and associated footprint of potential holding facilities used for downstream trap and transport facilities. The associated number and weight of smolts are needed to determine the volume of holding galleries, hopper volumes, flow rates of life support systems, and ultimately the number of cycles that a transport activity must undertake during the peak periods of outmigration. The number and target age of species may also influence the need for multiple holding galleries, segregated areas to limit predation during holding periods, and for regular monitoring and evaluation of collection and passage performance metrics.

As indicated in previous sections of this document, there are no existing populations of the target species of outmigrating anadromous juvenile salmonids in the Tuolumne River to inform the alternative development process. In the absence of such data, concept level estimates were made based upon the number of adult fish anticipated to migrate upstream. This value was then used as a starting point to make simple stock-production type calculations representing several phases of juvenile development. Parameters selected for each phase of development were selected from the literature.

As presented in Section 4.2.2.1, 2,500 adult steelhead and 2,500 adult spring-run Chinook would be required to arrive to holding areas in the upper Tuolumne River to achieve minimum recovery targets for viable populations (Lindley et al. 2007). These adult target numbers neglect any additional losses from potential upstream facilities and transit through the reservoir. For simplicity, speciation was neglected given that periods of outmigration overlap significantly and simple ratios were applied to a total population of 5,000 individual adults. Values selected for this exercise are described in Table 4.2-9.

Table 4.2-9. Summary of parameters selected for simplistic stock-production calculations for estimating populations of downstream migrating smolt.

Parameter	Estimated Ratio or Value	Reference Source
Fraction female	0.6	Cramer and Demko 1997 (FRH)
Holding survival	0.9	Ward et al (2006) [Butte Cr.]
Eggs per female	3500	Healey 1991[1]
Embryo survival	0.48	Assumed[2]
Summer rearing survival	0.7	Table G-1 in Stillwater Sciences 2013 (Yuba)
Winter rearing survival	0.9	Van Dyke et al. 2009
Survival from smoltification to downstream collection facility	1	Assumed

1 Note that eggs per female was reduced to represent a combined average fecundity for both spring-run and steelhead.
2 Professional judgment based on observed gravel sizes and relations to survival to emergence (Tappel and Bjornn 1983).

Calculations were performed following the phases of development from egg production, to embryo survival, to summer and winter rearing survival, to arrival to a downstream fish passage facility. Overall, the use of the selected parameters results in the concept production of approximately 10.5 million eggs and an egg to smolt survival ratio of 30 percent.

Given the above assumptions, approximately 3.1 million smolts could potentially reach a downstream collection facility on an annual basis. Using a peak daily migration rate of 5 percent, the total number of smolts expected to migrate downstream in a single day could be as high as 155,000 individuals. In this progression, estimates for reservoir mortality were unknown and therefore neglected. This assumption results in an over prediction of the number of smolts that may reach a facility located in Don Pedro Reservoir or near Don Pedro Dam but is adequate for the purpose of concept-level estimation of holding facility volumes and layouts required for potential fish passage alternatives.

4.2.3.2 Hydrology and Flows Experienced as Inflow to Don Pedro Reservoir

Potential in-river downstream collection facilities located upstream of Don Pedro Reservoir would be subjected to a wide range of hydrologic conditions. Inflow into Don Pedro Reservoir is characterized using the Base Case operational model results for flows entering the head of Don Pedro Reservoir. The percent exceedance of flows into Don Pedro Reservoir based upon the Base Case operational scenario is summarized in Table 4.2-10. The median inflow for this scenario to Don Pedro is anticipated to be 860 cfs on an annual basis and ranges from 1,378 to 1,762 cfs during the anticipated migration periods of target fish species. Mean daily flows into Don Pedro Reservoir are expected to range from 101 to 11,449 cfs on an annual basis, and from 93 to 10,589 cfs during the anticipated period of time when outmigrating spring-run Chinook or steelhead are expected to be present. SPUC hydropower operations can cause within-day flow fluctuations year round but often in late summer and fall. Within-day fluctuations are generally in the range of 100 to 500 cfs during the anticipated periods of outmigration and are greater in magnitude (approximately 1,000 cfs) in late summer.

Table 4.2-10. 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 Spring-Run Chinook 01Oct – 31May	Outmigration Steelhead 01Dec – 30Apr
99%	101	93	112
95%	164	145	200
90%	235	203	291
50%	860	1,378	1,762
10%	5,828	5,820	4,786
5%	7,547	7,315	5,999
1%	11,449	10,353	10,589

4.2.4 Expectations for Fish Passage Facility Performance

Fish management agencies involved in the oversight of fish passage programs are responsible for designing solutions that facilitate “safe, timely and effective” fish passage through barriers (NMFS

2016). To evaluate whether a facility is achieving the safe, timely and effective passage of fish, numeric performance standards are developed by fish management agencies and applied to upstream and downstream passage facilities. In order to determine "usual and customary" performance standards established for similar facilities that could be used to assess technical feasibility, fish passage facility performance information for the upstream and downstream passage components of programs currently in operation were compiled and evaluated.

In general practice, high dams are those with hydraulic differentials exceeding 100 feet. Both upstream and downstream fish passage technologies applied at high dams are classified as evolving, innovative, and experimental (Northwest Power and Conservation Council 2016). Development of such technologies began over 60 years ago with the greatest advancements occurring in the past ten. Only facilities implemented in the strictest of regulatory environments (such as is the case for licensure with FERC when ESA related impacts exist) carry with them specified performance targets and are required to provide the results of more elaborate annual monitoring efforts. The following sections provide a summary of the type of performance standards that are required by the resources agencies at a selection of the most modern high-dam fish passage facilities currently in operation. These performance standards are representative of the standards that would be mandated for a new fish passage facility at the La Grange or Don Pedro projects.

Upstream Fish Passage

When specific performance criteria exist, full scale upstream fish passage facilities are expected to provide Adult Passage Efficiencies of 75 to 95 percent with survival standards of 95 to 98 percent (PacifiCorp 2016, 2017 and Northwest Power and Conservation Council 2016). Adult Passage Efficiency is defined as the number of marked or tagged fish passed or recaptured at a facility divided by the number of initial fish collected, marked or tagged, and released downstream of a passage facility.

Downstream Fish Passage

For downstream passage of juveniles, a list of downstream passage collection facilities and their required performance standards are provided in Table 4.2-11. Additional details and references associated with these facilities are provided in Attachment C. As demonstrated through review of FERC license documentation for these facilities, the expectation by the resource agencies indicates reservoir passage efficiencies must fall within a range of 75 to 85 percent, collection efficiencies must be as high as 95 percent, and survival of smolt through the passage facilities must be between 98 and 99.5 percent. The overall downstream fish passage efficiency for these existing facilities, as mandated by the resource agencies, is expected to range from 75 to 97 percent.

Table 4.2-11. Downstream fish passage facilities performance standards[19].

Facility Name and Location	First year of Operation	Reservoir Passage (R)	Collection (C)	Survival (S)	Overall Efficiency (RxCxS)
Baker Lake Project - Baker Lake, WA	2008	80%	95%	98%	75%
Baker Lake Project - Lake Shannon, WA	2013	80%	95%	98%	75%
Cushman Project – Lake Cushman, WA	2014	Unspecified	95%	Unspecified	95% target 75% min
Clackamas River Project – North Fork Reservoir, OR	2015	Unspecified	Unspecified	Unspecified	97%
Clackamas River Project (River Mill) – Estacada Lake, OR	2012	Unspecified	Unspecified	Unspecified	97%
Pelton Round Butte Project – Lake Billy Chinook, OR	2009	50% temp facility 75% permanent facility	Unspecified	93% temp facility 96% permanent facility	Unspecified
Lewis River Project – Swift Reservoir, WA	2012	Unspecified (Calculated as 85-86%)	95%	95% fry 99.5% smolt	80%
Cougar Dam – Cougar Reservoir, OR	2014	Unspecified	Unspecified	Unspecified	Unspecified

Note: See Attachment C for a full list of table citations and references.

4.3 Alternative Formulation and Feasibility Assessment

The following section describes the preliminary development of potential fish passage alternatives that were considered to address fish passage requirements at LGDD and Don Pedro Dam. This section also assesses the ability of or likelihood that each alternative can meet the feasibility evaluation factors defined in Section 3.2.3.

4.3.1 Upstream Fish Passage Technologies

Many types of fish passage technologies are used to provide upstream fish passage at dams throughout the world. Section 4.3.1.1 provides an overview of the technologies evaluated during the formulation of alternatives and discusses why some technologies were not considered further. Technologies were eliminated based on their applicability to the unique operational conditions identified for the study area. Section 4.3.1.2 describes technologies that were considered further in this study, and presents an assessment of each alternative's ability to meet the feasibility evaluation factors defined in Section 3.2.3.

[19] Reservoir Passage Efficiency (R) is calculated by dividing the number of fish that reach a designed zone of influence in the reservoir by the total number of fish released at a designated point near the head of reservoir. Collection Efficiency (C) is calculated by dividing the number of fish that are collected in a facility by the total number of fish that were released at the zone of influence. Survival (S) represents the number of fish released at a downstream release point divided by the number of fish that were collected.

4.3.1.1 Overview of Upstream Fish Passage Technologies Considered

The upstream passage technologies initially considered as part of this study included:

- Technical fish ladders;
- Nature-like channels or fishways;
- Fish lifts;
- Fish locks;
- Collection, handling, transport, and release (CHTR) facilities; and
- Whooshh fish transport tubes

Technical fish ladders consist of a series of ascending pools that must be "climbed" by the fish. A series of pools contained within the water passage acts to incrementally divide the height of the passage and to dissipate the energy in the water, thereby enabling fish to gradually climb the height required to pass over the obstacle. The number of pools contained within the fish ladder depends on the obstacle height and the vertical height between pools which is dependent upon fish swimming capability. Although there are multiple variations, three common technical fish ladder types are pool and weir, baffle, and vertical-slot. Each type of technical fish ladder creates different conditions that are suited to different fish swimming behaviors and water use requirements.

Nature-like fishways are designed to mimic steepened natural channels with gradients that typically range from 1 to 5 percent. They provide a roughened series of profile control features that maintain multiple fish migration pathways throughout the range of anticipated design flows. Nature-like fishways can be configured in a number of ways but typically incorporate rock weirs, rock ramps, rock chutes, log weirs, and other features that mimic natural steep channels. Nature-like fishways are typically used at barriers that are less than 10 to 15 feet in hydraulic height because of their low design slope and inherently long configuration at higher structures. For example, a nature-like fishway with 3 percent gradient ascending a 100-foot tall structure would require a linear distance of 3,000 feet whereas other smaller-scale options exist that would provide similar benefits with much less use of water, materials, and level of effort to construct. Given their applicability to lower head barriers, nature-like fishways were not considered any further in this study.

A fish lift works by attracting fish using flowing water to a collection area and transport vessel at the base of a dam. The fish swim into the vessel and are unable to find their way out. The transportation vessel is closed and moved to the top of the dam by either suspended cables, similar to a gondola lift, or pulled along rail tracks similar to a trolley system.

A fish lock consists of holding chambers at the upstream and downstream sides of a dam linked by a sloping or vertical shaft that is filled with water when immigrating fish enter the downstream chamber. Fish locks are commonly used as a lifting mechanism at CHTR facilities and are typically only on the order of 20 to 30 feet in height. Due to the height requirement at this project and the associated complexity of required hydraulic controls, this technology was not further considered.

CHTR facilities include the collection, transport, and release of fish. These operations may be performed at a range of frequencies depending upon the presence and migration tendencies of target fish species. Fish migrating upstream can be collected at a system analogous to a short fish ladder leading to a collection pool from which fish are removed, or a picket barrier or fish weir placed at a suitable location downstream of the passage barrier.

Whooshh is another new fish passage technology that has been adapted over the past decade to provide transport of live fish over distances of 1,700 feet at heights of over 250 feet with a theoretical capability of heights over 600 feet. The technology is undergoing extensive pilot testing throughout the Pacific Northwest and Northeastern United States on fish species ranging from salmon and steelhead to shad and sturgeon. Overall, the technology is gaining acceptance with some resource agencies as a viable and potentially permittable option for safe and timely passage of fish over high- and low- head barriers. The technology is currently being used successfully at hatcheries and aquaculture facilities around the world.

4.3.1.2 Description of Specific Upstream Fish Passage Alternatives

Five potential upstream fish passage alternatives representing four upstream technologies were evaluated as part of this study. Descriptions of the five alternatives considered for upstream fish passage are included in the following subsections, including a general overview of the alternative, a description of the major functional elements, and an assessment of technical feasibility for each.

- Alternative U1A: Technical Fish Ladder - Bypass
- Alternative U1B: Two Separate Technical Fish Ladders
- Alternative U2: Fish Lift with Technical Ladder at La Grange
- Alternative U3: CHTR Facility
- Alternative U4: Whooshh Fish Transport Tube

Alternatives U1A and U1B: Technical Fish Ladder Alternatives

Overview

Two potential fish ladder alternatives are considered in this study for the purposes of providing upstream fish passage. Alternative U1A includes a single continuous navigational pathway that bypasses both La Grange and Don Pedro dams. Alternative U1B includes two separate technical fish ladders: one that bypasses LGDD; and a second that bypasses Don Pedro Dam. Both alternatives are configured to facilitate fish passage from an approximate low tailwater elevation of 175 feet at the La Grange Powerhouse to a maximum pool elevation in Don Pedro Reservoir of 830 feet. Both fish ladder alternatives begin with a similar fish ladder entrance design at La Grange Powerhouse and both alternatives end with an experimental fish return flume exit in the Don Pedro Reservoir. The primary difference between the two alternatives is that U1A provides a continuous pathway at a lower overall slope while U1B requires that fish navigate a 2.6 mile long section of Tuolumne River between the LGDD and Don Pedro Dam before entering a second fish ladder at the Don Pedro powerhouse. The two alternatives are discussed in more detail in the following paragraphs.

Under both fish ladder alternatives, as fish migrate upstream, they would first encounter a channel-spanning migration barrier. The migration barrier would limit false attraction to the La Grange tailwater pool and would reduce passage delay by guiding fish directly to a fish ladder entrance located just upstream of the La Grange Powerhouse. The migration barrier could be configured as a concrete velocity barrier style structure and cold exhibit a crest that is cross-sloped or notched near the fish ladder exit to help create natural flow preference and attraction near the fish ladder entrance. An Auxiliary Water Supply (AWS) system would convey additional attraction water to diffusion chambers just upstream of the ladder entrance, creating a hydraulic jet that would extend out of the entrance and create greater levels of attraction during periods of higher river flow. Base operational flows within the fish ladder (25 to 35 cfs) and attraction water would be combined to accommodate 5 percent of the total high fish passage design river flow of 7,232 cubic feet per second – resulting in a total combined flow capacity of approximately 360 cubic feet per second. An illustration of the fish ladder entrance and lower reaches of Alternatives U1A and U1B is provided in Figure 4.3-1.

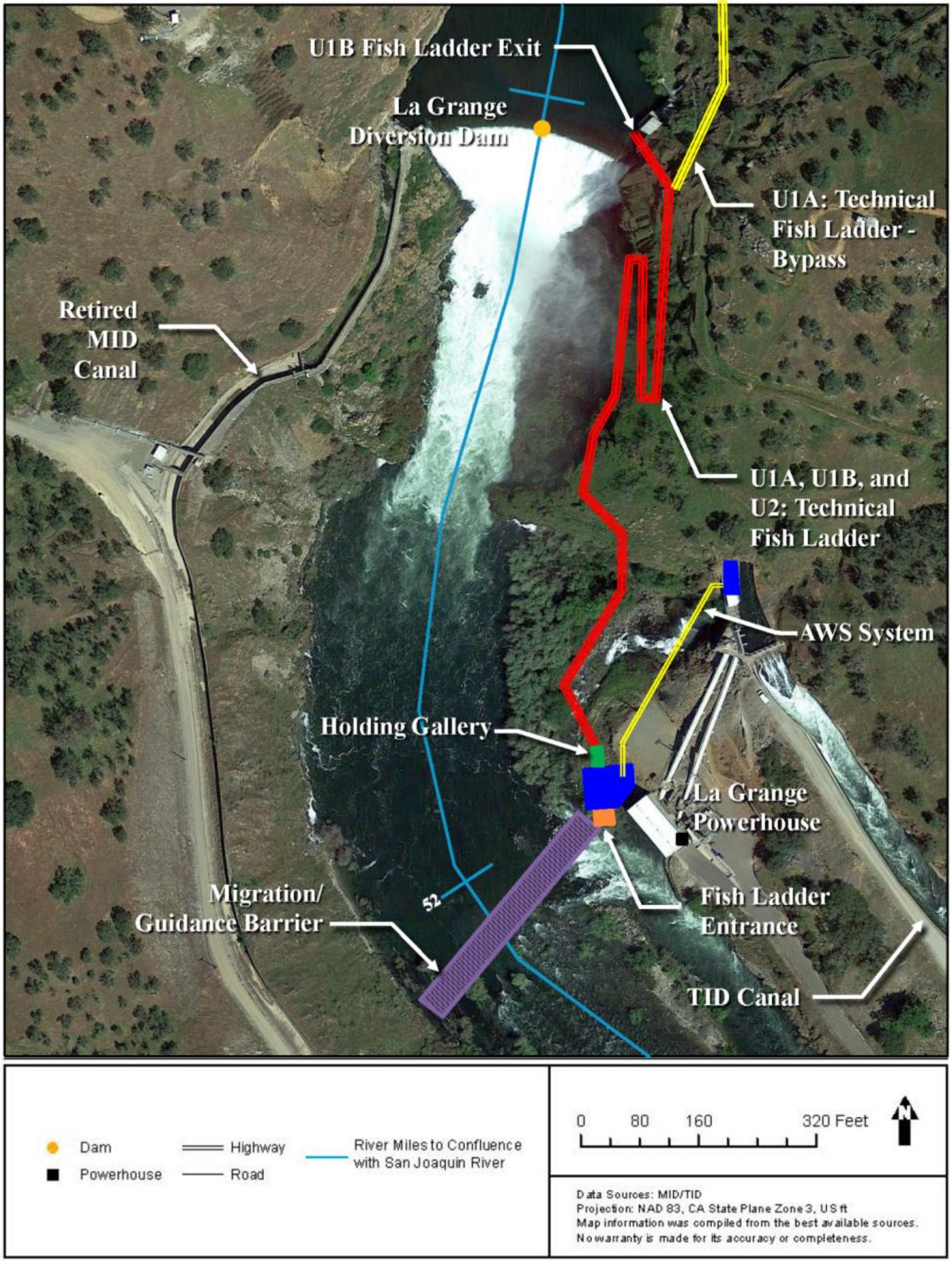


Figure 4.3-1. Illustration of entrance to Alternatives U1A: Technical Fish Ladder Bypass and U1B: Two Separate Technical Fish Ladders.

Once fish have entered the fish ladder entrance they would continue to ascend each pool of the technical fish ladder as they navigate upstream. Alternative U1A would bypass LGDD and would continue upstream, traversing the north hill slope above the existing reach of Tuolumne River until reaching the crest of Don Pedro Dam. This would result in a fish ladder designed to allow fish to ascend 680 vertical feet, from an approximate minimum tailwater elevation of 175 feet to the top of Don Pedro Dam elevation of 855 feet. The fish ladder would be approximately 3.1 miles in length assuming: a hydraulic pool-to-pool drop of 0.5 feet, pool length of 10 feet, resting pool required every 10 pools with a length of 20 feet, and approximate weir thickness of approximately 1-foot. A fish ladder of this length would require measures to ensure water quality parameters are maintained throughout the length of the ladder to prevent fish rejection. The primary water quality parameter of concern would be water temperature and would likely be addressed by injecting cooler water into the fish ladder at various locations along the length of the fish ladder. A conceptual overall layout of Alternative U1A is provided in Figure 4.3-2.

The first reach of Alternative U1B would ascend a hydraulic height of roughly 130 feet from the La Grange Powerhouse to the LGDD headpond. The fish ladder would be approximately 1,600 feet in length assuming: a hydraulic pool-to-pool drop of 1 foot, pool length of 10 feet, resting pool of 20 feet in length required every 100 feet, and each baffle having a thickness of approximately 1-foot. Near the ladder exit, ladder construction would require tunneling through the rock hill slope near the existing hydraulic inlet to the TID Canal. The tunnel would have an emergency bulkhead gate to prevent uncontrolled spill down the fish ladder in cases of extreme high flow. Given the limited level of fluctuation exhibited at the La Grange headpond (typically on the order of 2 feet), a more typical fish ladder exit composed of several vertical-slot baffled pools could be used. This component of the fish ladder would therefore be the only component that would remain fully volitional, as fish would have the ability to re-enter the fish ladder and pass downstream if so motivated.

As part of Alternative U1A, a second fish ladder would be constructed at Don Pedro Dam. The entrance would be located near the base of the dam and would have an AWS to improve guidance and fish attraction to the entrance. The hydraulic height of the fish ladder at Don Pedro would be approximately 555 feet to pass fish from Don Pedro Dam's tailwater to the dam crest. Using the same pool geometry assumptions for this fish ladder as the one at LGDD, the ladder would be approximately 6,700 feet in length. As noted earlier, a fish ladder of this length would require measures to ensure water quality parameters are maintained throughout the length of the ladder to prevent fish rejection. Similar the technical fish ladder as part of Alternative U1A, water would be injected at various locations throughout the length of the second most upstream fish ladder associated with Alternative U1B. Figure 4.3-3 provides an illustration of the upstream technical fish ladder for Alternative U1A and the exit configurations for both alternatives U1A and U1B.

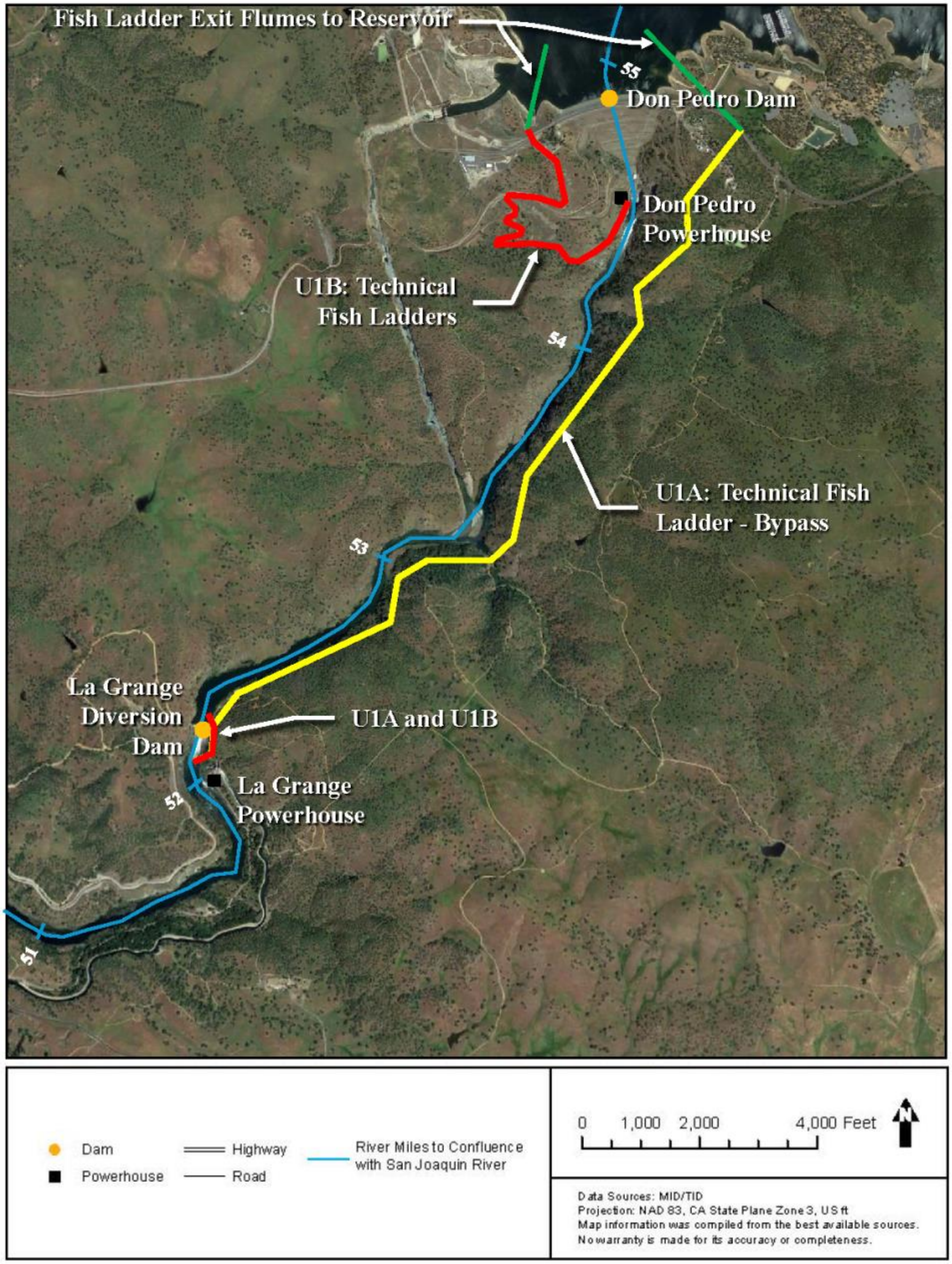


Figure 4.3-2. Overview of Alternatives U1A: Technical Fish Ladder Bypass and U1B: Two Separate Technical Fish Ladders.

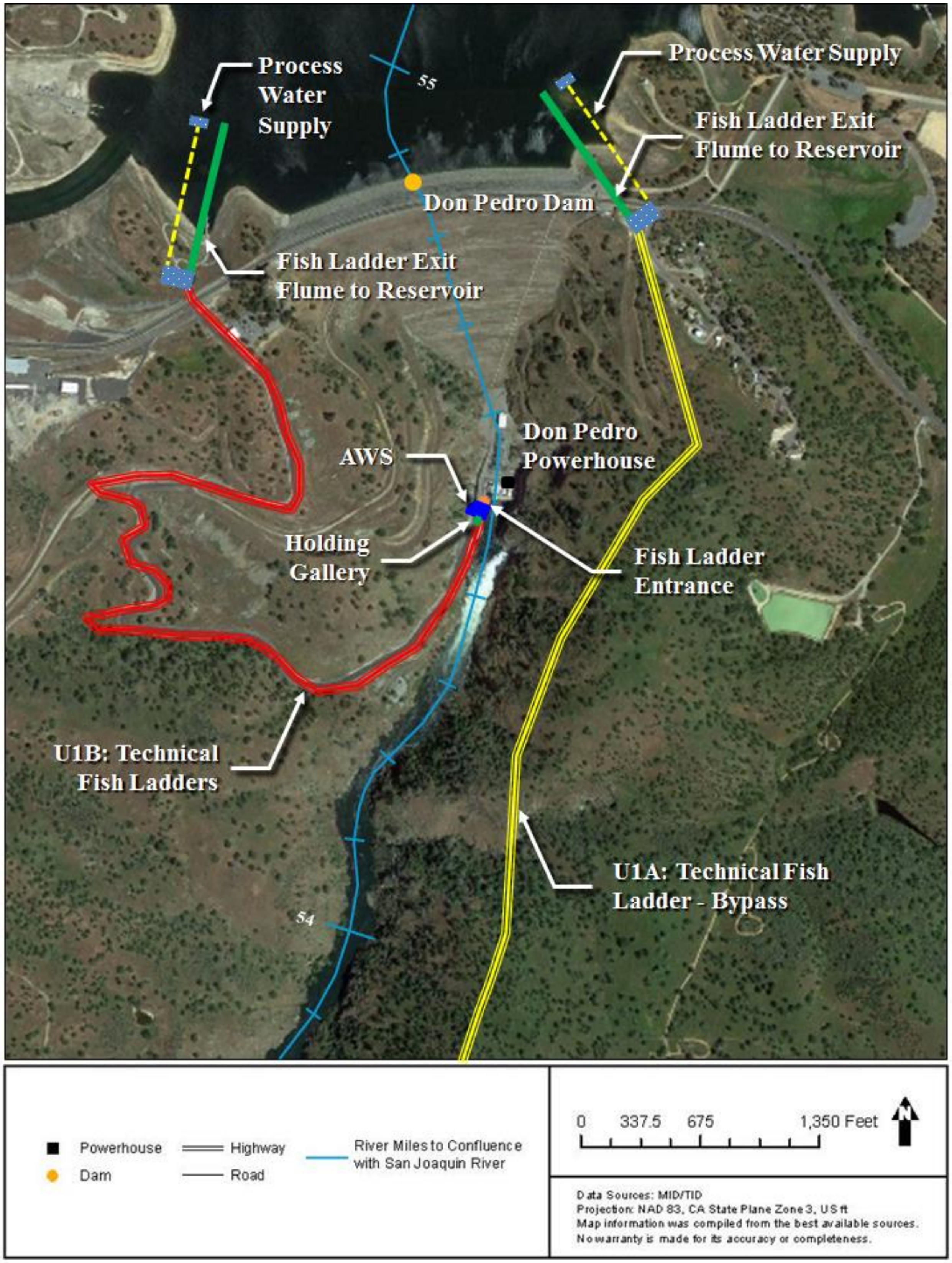


Figure 4.3-3. Upstream reaches and exit configurations for Alternatives U1A: Technical Fish Ladder Bypass and U1B: Two Technical Fish Ladders.

Typical fish ladder exits can accommodate approximately 10 feet of water surface fluctuation without implementation of complex multi-ported exits with hydraulic control systems such as gated outlets. Since Don Pedro Reservoir is anticipated to have a fluctuation of more than 200 feet, an experimental fish return flume or fish transport tube would need to be considered. For this study, the fish ladder exit at Don Pedro Dam would be similar for both alternative U1A and U1B. Because the fish ladder would be constructed above the reservoir elevation and near the dam crest, water would need to be pumped into the upstream end of the fish ladder to supply the fish ladder and the return flume. Once fish reach the most upstream pool they would pass over a false weir into a wetted return flume that passes them down to the reservoir surface. A volitional exit to Don Pedro Reservoir would be infeasible to design and construct given the potential for 213 feet of total reservoir fluctuation anticipated during the period of migration; therefore, alternatives U1A and U1B would be non-volitional fish ladders.

A bypass pipe return system common to many upstream and downstream fish passage facilities could not be used in this situation due to the need for release of fish throughout the full range of reservoir fluctuation. An enclosed pipe system would have one outlet elevation that would at times be submerged by up to 200 feet of water depth. Adding multiple exits would also be experimental and likely infeasible from engineering standpoint.

A fish transport tube system such as Whooshh could be used as an alternative to a fish return flume at the fish ladder exit. Using Whooshh, the release of fish back to Don Pedro Reservoir would be similar in that fish would pass over a false weir at the upstream end of the ladder and into the return system. At this point, fish would pass into the Whooshh scanner, pass through a system of diverter gates, and then enter an appropriately-sized fish transport tube. Fish would then be transported in the tube over a distance of approximately 1,000 feet to a floating release platform. At the platform, fish would exit the tube system and be released directly to the water surface. This return system would also be considered experimental in nature; however, results from several pilot-studies indicate that this distance of 1,000 feet is well within the system capability. Another advantage is that this type of technology uses far less water, which reduces the overall pumping requirements for the fish ladder exit system overall. Whooshh transport tube systems and their capabilities are discussed further in the description for Alternative U4: Whooshh Fish Transport Tube below.

Table 4.3-1 summarizes the anticipated functional elements that could be the basis of major design features for Alternative U1A – a single technical fish ladder that bypasses both La Grange and Don Pedro dams. Table 4.3-2 summarizes the anticipated functional elements that could be the basis of major design features for U1B – two separate technical fish ladders at LGDD and Don Pedro Dam.

Table 4.3-1. Summary of anticipated functional elements for U1A: Technical Fish Ladder - Bypass

Project Element	Function and Intent
Modification of plunge pool with migration barrier at downstream tailwater control	Improves guidance and attraction to the fish ladder entrance over the full range of fish passage flows. Provides a barrier so that fish are not able to pass beyond the fish ladder entrance. Improves hydraulic preference towards the ladder entrance under all flow conditions.

Project Element	Function and Intent
Entrance designed for adult salmonids	Targets collection and attraction by adult salmonids motivated to migrate upstream. Designed to accommodate diffusion of AWS to promote attraction.
Integration of gravity Auxiliary Water Supply (AWS)	Provides attraction water at the entrance to improve attraction under all potential fish passage conditions.
Technical concrete fish ladder	Single concrete fish ladder from below LGDD to above Don Pedro Dam. Provides provisions to either inject cool water or cool the water within the ladder to maintain appropriate water temperature.
Process water supply system	Water will be supplied to the upstream end of the fish ladder via pumped flow. The pump station will pump water from Don Pedro Reservoir into the upstream end of the fish ladder. Provides provisions to mix cooler water with surface water flowing to reduce ladder rejection and fall-back.
Fish ladder exit	An experimental fish flume or fish transport tube would be used to transfer fish from the upstream end of the fish ladder down to the reservoir surface.
Upgraded electrical service to the project location	Provides 3-phase power to the site. Provides the ability to operate more complex mechanical equipment associated with gate operation, monitoring, motorized valves, and flow control.

Table 4.3-2. Summary of anticipated functional elements for U1B: Two Technical Fish Ladders

Facility	Project Element	Function and Intent
La Grange Fish Ladder	Modification of tailwater pools and migration barrier	Improves guidance and attraction to the fish ladder entrance over the full range of fish passage flows. Provides a barrier so that fish are not able to pass beyond the fish ladder entrance. Creates hydraulic preference towards the ladder entrance under all flow conditions.
	Entrance designed for adult salmonids	The entrances would target collection and attraction of adult salmonids motivated to migrate upstream. The entrance would be designed to accommodate diffusion of AWS to promote attraction.
	Integration of gravity Auxiliary Water Supply (AWS)	Provides attraction water at the entrance to improve attraction under all potential fish passage conditions. Provides provisions to mix cooler water with surface water flowing to reduce entrance rejection and fall-back.
	Technical concrete fish ladder	Concrete fish ladder from below LGDD to above La Grange. Provides provisions to either inject cool water or cool the water within the ladder to maintain appropriate water temperature.
	Fish ladder exit	Two exit structures will be required, one at each fish ladder. The La Grange fish ladder will consist of multi exits in order to provide continuous hydraulic connection to the reservoir surface, providing volitional passage. The Don Pedro fish ladder will be an experimental structure, either a flume or fish transport tube that would be used to pass fish from the upstream end of the fish ladder at the dam crest to the reservoir surface.
	Provisions for emergency shutoff in extreme hydrologic conditions	The La Grange fish ladder would require the capability to stop water from flowing down the ladder through the dam abutment for the purposes of preserving life, safety, and property of downstream residents. This would be accomplished by incorporating a bulkhead within the tunnel around La Grange that the fish ladder would pass through.
Don Pedro Fish Ladder	Modification of tailwater pools	Similar to La Grange Fish Ladder except that there is not a migration barrier at Don Pedro Dam as it does not have spillway flow plunging into the tailwater pool.

Facility	Project Element	Function and Intent
	Entrance designed for adult salmonids	Same as description of La Grange Fish Ladder
	Integration of gravity AWS	Same as description of La Grange Fish Ladder
	Technical concrete fish ladder	Similar to LGDD Fish Ladder except that the fish ladder would be longer, due to its higher elevation gain.
	Process water supply system	Water will be supplied to the upstream end of the fish ladder via pumped flow. The pump station will pump water from Don Pedro Reservoir into the upstream end of the fish ladder. Provides provisions to mix cooler water with surface water flowing to reduce ladder rejection and fallback.
	Fish ladder exit	An experimental fish flume or fish transport tube would be used to transfer fish from the upstream end of the fish ladder down to the reservoir surface.
	Upgraded electrical service to the project location	Provides 3-phase power to the site. Provides the ability to operate more complex mechanical equipment associated with gate operation, monitoring, motorized valves, and flow control.

Assessment of Feasibility

Both Alternatives U1A: Technical Fish Ladder – Bypass and U1B: Two Separate Technical Fish Ladders were determined to be technically infeasible when compared to the three feasibility evaluation factors defined in Section 3.2.3 of this report. These alternatives exhibit numerous engineering challenges, experimental design elements, and lack of truly comparable examples to inform performance. This determination is discussed further in the paragraphs below.

<u>Feasibility Factor 1. Ability to Meet Engineering, Constructability, and Operational Constraints</u>

The fish ladders would be constructed on very steep hillsides in rock and would require bridges to span the multiple drainages. The geotechnical and structural challenges will be significant. Implementation of a fish return flume to accommodate 213 feet of total vertical reservoir fluctuation at the ladder exit is experimental; therefore, the engineering challenges are also relatively substantial compared to ladders with more typical volitional exits. This fish exit strategy diminishes the volitional aspects of the fish ladder and requires a substantial pumping array to feed water in to the fish ladder and return flume structures.

<u>Feasibility Factor 2. Ability to Operate without Interference with Existing Uses</u>

Both Alternatives U1A: Technical Fish Ladder – Bypass and U1B: Two Separate Technical Fish Ladders are expected to be able to operate as intended without foreseeable impact to the required functions of other existing facilities. Water use through the bypass fish ladder and auxiliary water system will require that 25 to 360 cfs is bypassed and unavailable for power generation. Power generation will be reduced by this amount until river flow exceeds maximum generation flow plus attraction flow. This flow will contribute to meeting the minimum instream flow requirements.

<u>Feasibility Factor 3. Ability to Meet Usual and Customary Fish Passage Performance Standards</u>

Alternative U1A and the longer most upstream reach of Alternative U1B are not expected to meet the minimum performance standards required at other upstream passage facilities. A limited number of fish ladders of similar length and total elevation gain are available to inform performance, and the examples have mixed performance results. Only two fish ladders of similar length exist in the United States: the 1.9 mile long North Fork fish ladder on the Clackamas River, and the 2.8 mile Pelton-Round Butte fish ladder on the Deschutes River (CDWR 2013). Neither of these existing technical fish ladders have comparable heights to Alternatives U1A or U1B. Although the North Fork fish ladder performs well for spring-run Chinook, steelhead and bull trout (Tim Shibahara, Portland General Electric pers comm.), the Pelton-Round Butte fish ladder was permanently shut down shortly after it began operating due to fish rejection in the middle of the ladder. Other ladders of similar length and total elevation gain in other parts of the world suffer from numerous operational, water quality, and biomechanical issues that are known to reduce their overall performance to provide safe, timely and effective passage. These include the 6.2 mile long fish ladder on the Parana River in Brazil as well as numerous other facilities constructed in China.

No fish ladder exits currently exist that accommodate the range of reservoir fluctuation exhibited at Don Pedro Reservoir. Fish return flumes are commonly used to return fish to reservoirs or tailwaters downstream of smaller dam facilities, however, fish damage and disorientation has been observed when fish enter the downstream water body at high velocities or where significant hydraulic jumps occur within the return channel. Due to Don Pedro Reservoir fluctuations, a fish return flume would experience adverse velocities and hydraulic jumps within the channel. Because of this, and the lack of similar facilities currently in operation, such a flume would be considered experimental. To avoid high velocities and hydraulic jumps, length must be increased and slope decreased. This requires an exceptionally long facility that creates additional technical challenges and results in increased cost. A Whooshh-type fish return system may be an alternative exit technology that could provide superior performance compared to a flume for the given reservoir fluctuation. However, a Whooshh fish transport tube fish return has never been constructed for this large of a reservoir fluctuation and NMFS currently considers the Whooshh fish passage technology as experimental; it is not currently a viable alternative for use on ESA-listed species. As such, the Districts are unable to evaluate the performance of a Whooshh-type fish return system. Given the uncertainties and lack of performance evaluation potential, this option is not considered feasible.

Transit in Don Pedro Reservoir is anticipated to have a significant negative impact on overall passage performance. Low velocities through the reservoir also decrease the ability of migrating fish to detect velocity and olfactory cues that would otherwise guide them to upstream spawning grounds. The lack of cues coupled with the size and shape of the Don Pedro reservoir are likely to create significant delays to upstream migration or result in fish loss in the reservoir. Extended reservoir residence times, high temperatures, and low velocities also increase stress and the risk of contracting diseases during reservoir migration.

Alternative U1B: Two Separate Technical Fish Ladders, includes the use of two fish passage facilities rather than one. The use of two separate facilities increases operation and maintenance requirements, as well as decreases overall fish passage efficiency. Fish passage efficiency is decreased with the need to attract, capture, and pass fish at two facilities. For example, assume one facility has a 92 percent overall passage efficiency. If a second facility (that must be passed after the first) is introduced with a 92 percent overall passage efficiency, the total system passage efficiency decreases from 92 percent to approximately 85 percent.

Alternative U2: Fish Lift with Technical Ladder at La Grange

Overview

This alternative combines two fish passage methodologies at the two dams similar to the previous alternative, U1B. At LGDD a fish ladder would be utilized in the exact method described in the U1B: Two Separate Technical Fish Ladders Alternative. The difference from Alternative U1B is that a fish lift would be used as the means of passing fish from the Don Pedro Dam tailwater to Don Pedro Reservoir.

The entrance to the fish lift would be similar to that of the technical fish ladder. It would include an AWS to improve attraction and guidance. After fish have passed through the entrance they would enter a holding gallery where they would be crowded into a transportation vessel. The transportation vessel would require a life support system and means to offload fish in case of mechanical failure. The transportation vessel would then be transported to the top of the dam either by suspended cables, similar to a gondola lift, or pulled along rail tracks similar to a trolley system. A fish lift would include design and construction of hoists, concrete foundations, rails, structural members, ramps, pumps, and piping along the face of (or adjacent to) the dam. Once at the top of the dam, fish would be released into another holding gallery. Fish would then leap over a false weir into a flume or fish transport tube that passes the fish down to the reservoir surface. The return flume would be similar to the concept described for Alternatives U1A and U1B. Considering the large fluctuations in surface water elevation at Don Pedro Reservoir, and because no flumes currently operate under similar conditions, this exit technology is considered experimental.

Table 4.3-3 summarizes the anticipated functional elements that could be the basis of major design features for a fish lift. Conceptual layouts of this alternative for LGDD and Don Pedro Dam are provided in Figure 4.3-4 and Figure 4.3-5, respectively.

Table 4.3-3. Summary of anticipated functional elements for U2: Fish Lift with a Technical Ladder at La Grange.

	Project Element	Function and Intent
La Grange Fish Ladder	Modification of tailwater pools and migration barrier	Improves guidance and attraction to the fish ladder entrance over the full range of fish passage flows. Provides a barrier so that fish are not able to pass beyond the fish ladder entrance. Creates hydraulic preference towards the ladder entrance under all flow conditions.
	Entrance designed for adult salmonids	The entrances would target collection and attraction of adult salmonids motivated to migrate upstream. The entrance would be designed to accommodate diffusion of AWS to promote attraction.
	Integration of gravity AWS	Provides attraction water at the entrance to improve attraction under all potential fish passage conditions. Provides provisions to mix cooler water with surface water flowing to reduce entrance rejection and fall-back.
	Technical concrete fish ladder	Concrete fish ladder from below LGDD to above La Grange. Provides provisions to either inject cool water or cool the water within the ladder to maintain appropriate water temperature.

	Project Element	Function and Intent
	Fish ladder exit	Two exit structures will be required, one at each fish ladder. The La Grange fish ladder will consist of multi exits in order to provide continuous hydraulic connection to the reservoir surface, providing volitional passage. The Don Pedro fish ladder will be an experimental structure, either a flume or fish transport tube that would be used to pass fish from the upstream end of the fish ladder at the dam crest to the reservoir surface.
	Provisions for emergency shutoff in extreme hydrologic conditions	The La Grange fish ladder would require the capability to stop water from flowing down the ladder through the dam abutment for the purposes of preserving life, safety, and property of downstream residents. This would be accomplished by incorporating a bulkhead within the tunnel around La Grange that the fish ladder would pass through.
Don Pedro Fish Lift	Modification of plunge pool	Similar to La Grange Fish Ladder except that there is not a migration barrier at Don Pedro Dam as it does not have spillway flow plunging into the tailwater pool.
	Entrance designed for adult salmonids	Same as description of La Grange Fish Ladder
	Integration of gravity AWS	Same as description of La Grange Fish Ladder
	Technical concrete fish ladder entrance	Short fish ladder providing transition from the Tuolumne River to a holding gallery.
	Holding gallery, crowder system, and attraction flow diffusers	Provides a large holding pool where fish reside until the next transport cycle is initiated. Attraction flow is provided in wall and/or floor diffusers to attract fish into the transport vessel area. When the transport cycle is initiated, a crowding device will motivate the fish to swim into the transport vessel and the transport vessel door is closed.
	Cable, tram, or hydraulic lock transport system	Transports fish to the designated release point via enclosed transport vessel. The transport vessel would be moved via cable or rail system. Emergency life support systems such as oxygen are installed on the transport vessel in case of mechanical failure.
	Release to reservoir	An experimental fish flume or fish transport tube would be used to transfer fish from the dam crest to the reservoir surface.

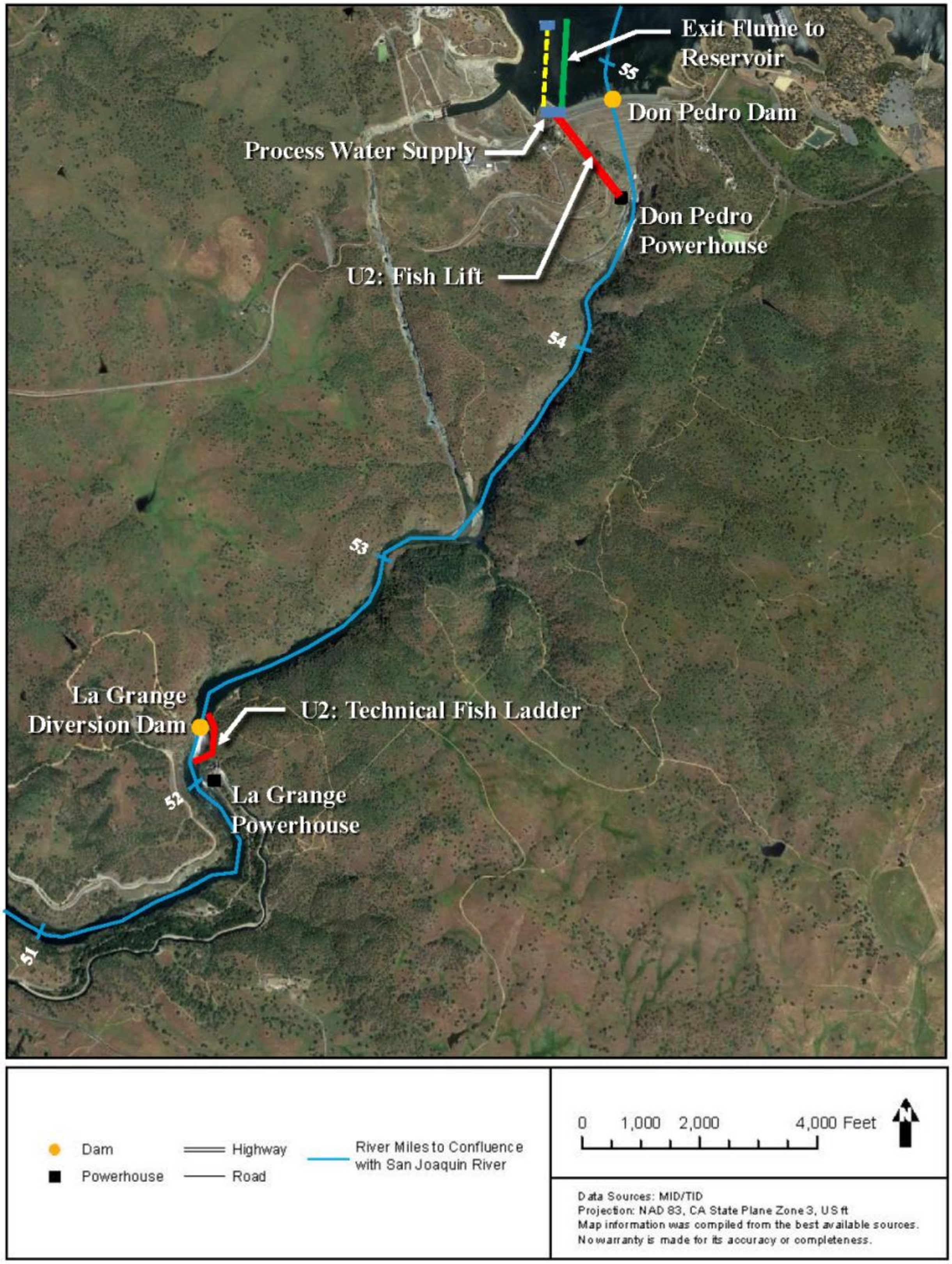


Figure 4.3-4. Conceptual Layout of Alternative U2: Fish Lift with Technical Ladder at La Grange Diversion Dam.

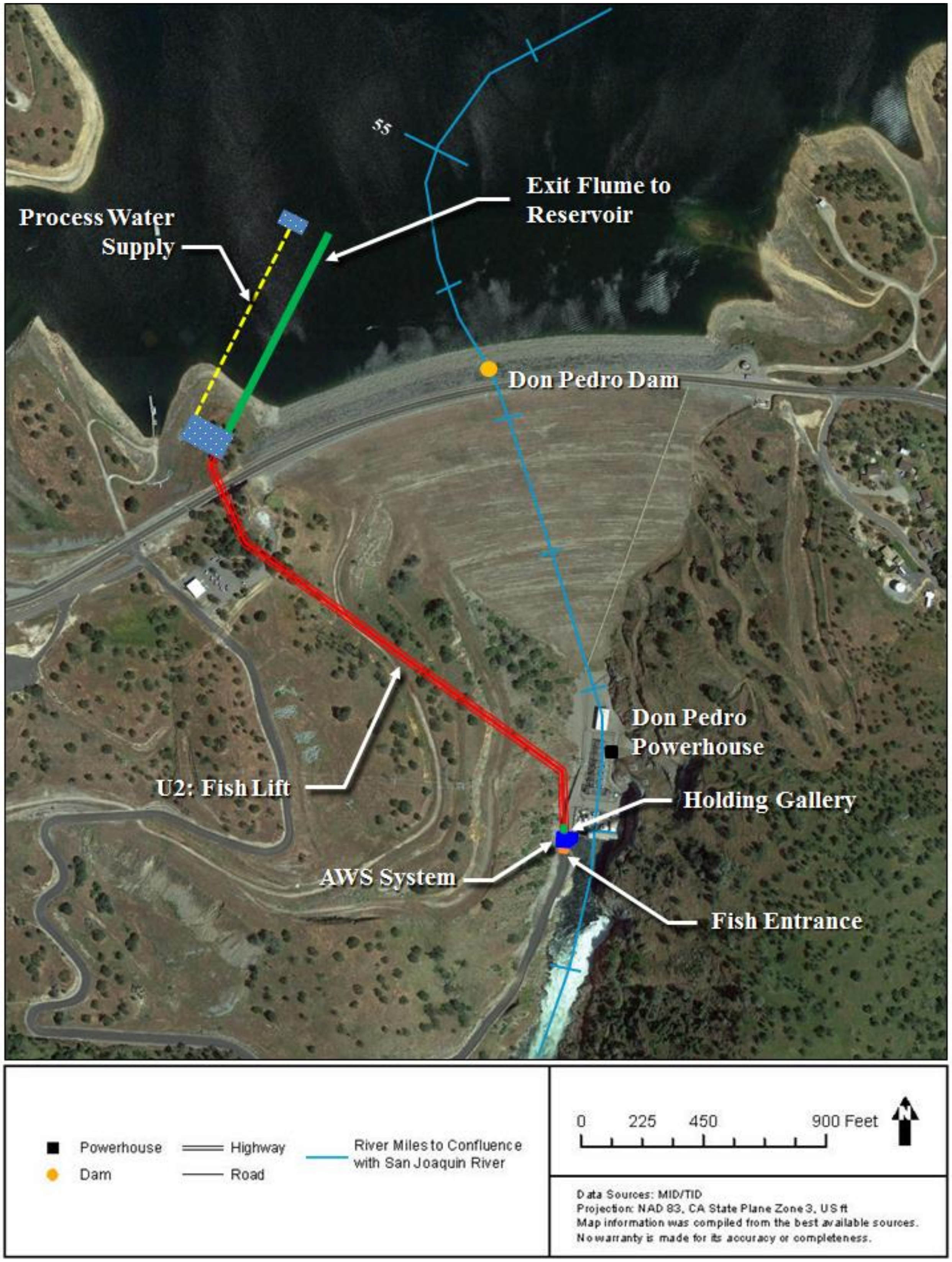


Figure 4.3-5. Conceptual Layout of Alternative U2: Fish Lift Configuration at Don Pedro Dam.

Assessment of Feasibility

Alternative U2: Fish Lift with Technical Fish Ladder at LGDD was determined to be technically infeasible when compared to the feasibility evaluation factors defined in Section 3.2.3of this report. This alternative exhibits numerous engineering challenges, experimental design elements, and lack of truly comparable examples to inform performance. This determination is discussed further in the paragraphs below.

<u>Feasibility Factor 1. Ability to Meet Engineering, Constructability, and Operational Constraints</u>

The bypass fish ladder at LGDD would be constructed on very steep hillsides in rock and would require tunneling through a portion of the bedrock near the left abutment. The geotechnical and structural elements will be significant and are accounted for in the form of "risk cost" in the OPCC. Constructability issues would need to be resolved during engineering design. Implementation of a fish return flume to accommodate 213 feet of total vertical reservoir fluctuation at the apex of the mechanical fish lift is experimental and therefore the engineering challenges are also relatively substantial compared to other operational environments with less reservoir fluctuation.

This alternative exhibits numerous engineering challenges, experimental design elements, and lack of truly comparable examples. The few fish lifts of similar height and length present in other parts of the world typically have low performance. The use of two separate facilities decreases the overall passage efficiency of this alternative. This alternative is not anticipated to meet the adult passage efficiency standards required of other upstream fish passage facilities in the U.S. Further, pumping station power demand assumes a 90 horsepower pump operating for the entire upstream migration period of 7 months.

<u>Feasibility Factor 2. Ability to Operate without Interference with Existing Uses</u>

This facility can be operated as intended without foreseeable impact to the required functions of other existing facilities. Water use through the bypass fish ladder and auxiliary water system will require that 25 to 360 cfs is bypassed and unavailable for power generation. Power generation will be reduced by this amount until river flow exceeds maximum generation flow plus attraction flow. This flow will contribute to meeting the minimum instream flow requirements.

<u>Feasibility Factor 3. Ability to Meet Usual and Customary Fish Passage Performance Standards</u>

Very few fish lifts of comparable length and height currently operate at multi-purpose reservoirs around the world. Of the existing fish lift facilities located at high dam structures, all of them exhibit relatively low performance, and do not provide safe, timely and effective passage. Similarly, as stated for Alternative U1A and U1B, no other fish ladders currently accommodate the level of reservoir fluctuation exhibited at Don Pedro Reservoir. Implementation of a fish return flume to accommodate 213 feet of total vertical reservoir fluctuation at the ladder exit is experimental.

Survival within the fish ladder entrance, capture, and holding tank portions of comparable upstream passage facilities is typically high and non-passage events are documented as either fallback at the entrance or rejection due to water quality issues. However, the survival of fish in a non-volitional experimental return flume is uncertain as there are no comparable examples in operation to inform design. Upstream migration of adults through Don Pedro Reservoir is expected to be low, which also impedes the ability of this alternative to meet typical regulatory performance standards for passage.

Few fish lift systems are operated at high head dams around the world. Of those that are currently in operation, the lifts at Touvedo Dam on the Lima River in Portugal (140 ft lift), the Tallowa Dam on the Shoalhaven River in Australia (141 ft lift), and the Funil Dam on the Grande River in Brazil (164 ft lift) operate under elevation ranges that are 50 to 70 feet less than that exhibited at Don Pedro Reservoir. Although little data is available on the performance of these fish lifts, the performance data that is available indicates a relatively low level of performance due to challenging site conditions and mechanical failures. Lessons learned from the challenges experienced at other fish lift facilities and the history of high performance for fish ladder entrances and AWS facilities indicate that survival through this alternative would be higher than comparable facilities currently operating. An anticipated moderate to high level of survival through the fish lift facility may be achieved but performance for this alternative is anticipated to be low due to factors other than the physical fish passage facilities.

Similar to the technical fish ladder Alternatives U1A and U1B, adult migration through the reservoir is anticipated to have a negative influence on fish survival and overall passage performance. In addition, the use of two separate fish passage facilities inherently reduces fish passage performance as a whole.

Alternative U3: CHTR Facility

Overview

A CHTR facility is generally composed of four main project features including a fish entrance, a collection and holding facility, a vehicle with a transport vessel (tank of water), and a designated release location or locations. The fish entrance would be located adjacent to the upstream edge of the existing La Grange powerhouse, where a migration barrier would be used to promote hydraulic preference toward the fish entrance. Its orientation near the powerhouse tailrace and integration of an AWS would be used to enhance attraction to the CHTR facility. After fish are collected at the entrance, they would enter a holding gallery designed to hold fish up to 24 hours per the 2011 NMFS guidelines. When operators are on-site, a fish lock or lift would be used to raise fish to a sorting area where fish could be evaluated or simply passed to a holding tank.

The collection facility would require expansion of the existing power house facility and adjacent access areas. The area north of the powerhouse would be expanded northward using significant geotechnical and structurally engineered solutions. Access would be improved by widening and deepening the existing roadway that passes underneath the penstocks so that larger equipment and trucks can gain access to the site to the north end of the powerhouse. The existing flow bypass channel would be moved north and reconfigured against the north wall of the fish passage facility. The bypass channel would return to the tailrace area at the edge of the fish ladder entrance.

After fish are sorted into the holding tanks they can be transferred to a transport truck via a water-to-water transfer. Vehicles used for this purpose are sized for the number and size of fish that are anticipated to be collected on a daily basis in addition to the water that is required to safely accommodate them. Each vehicle is equipped with life sustaining and water conditioning equipment to maintain adequate temperature, dissolved oxygen, and carbon dioxide levels during transfer. At a minimum, fish are typically transferred upstream once every 24-hour period. A schematic diagram of the CHTR process is provided in Figure 4.3-6.

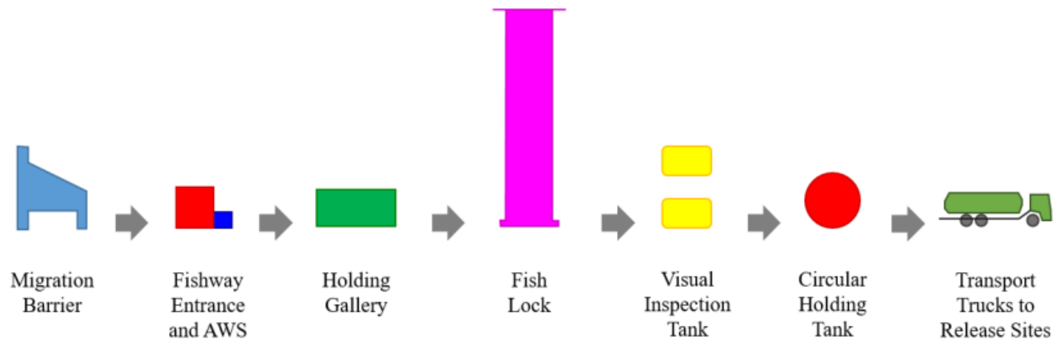


Figure 4.3-6. Schematic process diagram of CHTR facility.

Fish collected in the CHTR facility and transported past the dam must be released to a selected location at the head of reservoir to eliminate the challenges associated with routing adult migrating fish through the reservoir. This alternative includes the transfer of fish from the collection facility to Moccasin Point Recreation Area near RM 72.5, followed by use of a water-based transport vehicle from Moccasin Point Recreation Area to the point of release at the immediate head of reservoir. Releases from the floating transport vessel could occur via a fixed pipe to a floating acclimation net pen or directly to the river near the head of reservoir. Water-based release strategies at this location could also be performed coincident with other potential directive type downstream fish passage alternatives located near the head of reservoir and discussed in Section 4.3.2 (i.e., dual-use).

A conceptual layout of this alternative is provided in Figure 4.3-7. Table 4.3-4 summarizes the anticipated functional elements that could be the basis of major design features for a CHTR facility.

Table 4.3-4. Summary of anticipated functional elements for U3: CHTR Facility.

Project Element	Function and Intent
Modification of plunge pool with migration barrier at downstream tailwater control	Improves guidance and attraction to the CHTR entrance over the full range of fish passage flows. Provides a barrier so that fish are not able to pass beyond the fish ladder entrance. Improves hydraulic preference towards the CHTR entrance under all flow conditions.
Integration of gravity AWS	Provides attraction water at the entrance to improve attraction under all potential fish passage conditions. Provides provisions to mix cooler water with surface water flowing to reduce entrance rejection and fall-back.
Entrance designed for adult salmonids	Targets collection and use by adult salmonids motivated to migrate upstream. Accommodates diffusion of AWS to promote attraction.
Fish lock	A fish lock, or possibly a short technical fish ladder, would be used to raise fish up to the handling, sorting, and transfer facility.

Project Element	Function and Intent
Holding, sorting, and transfer facility	Facility designed to hold, sort, and transfer fish safely within 24 hours of capture using NMFS guidelines.
Transport vehicles	Transports collected fish from facility to the desired point of release near the immediate head of reservoir. The transport vessel will include life support systems such as oxygen and temperature control. A land based and water-based transport vehicle are required to accommodate the transport strategy described for this alternative.
Upgraded electrical service to the project location	Provides 3-phase power to facility electrical systems. Provides the ability to operate more complex mechanical equipment associated with gate operation, monitoring, motorized valves, and flow control.

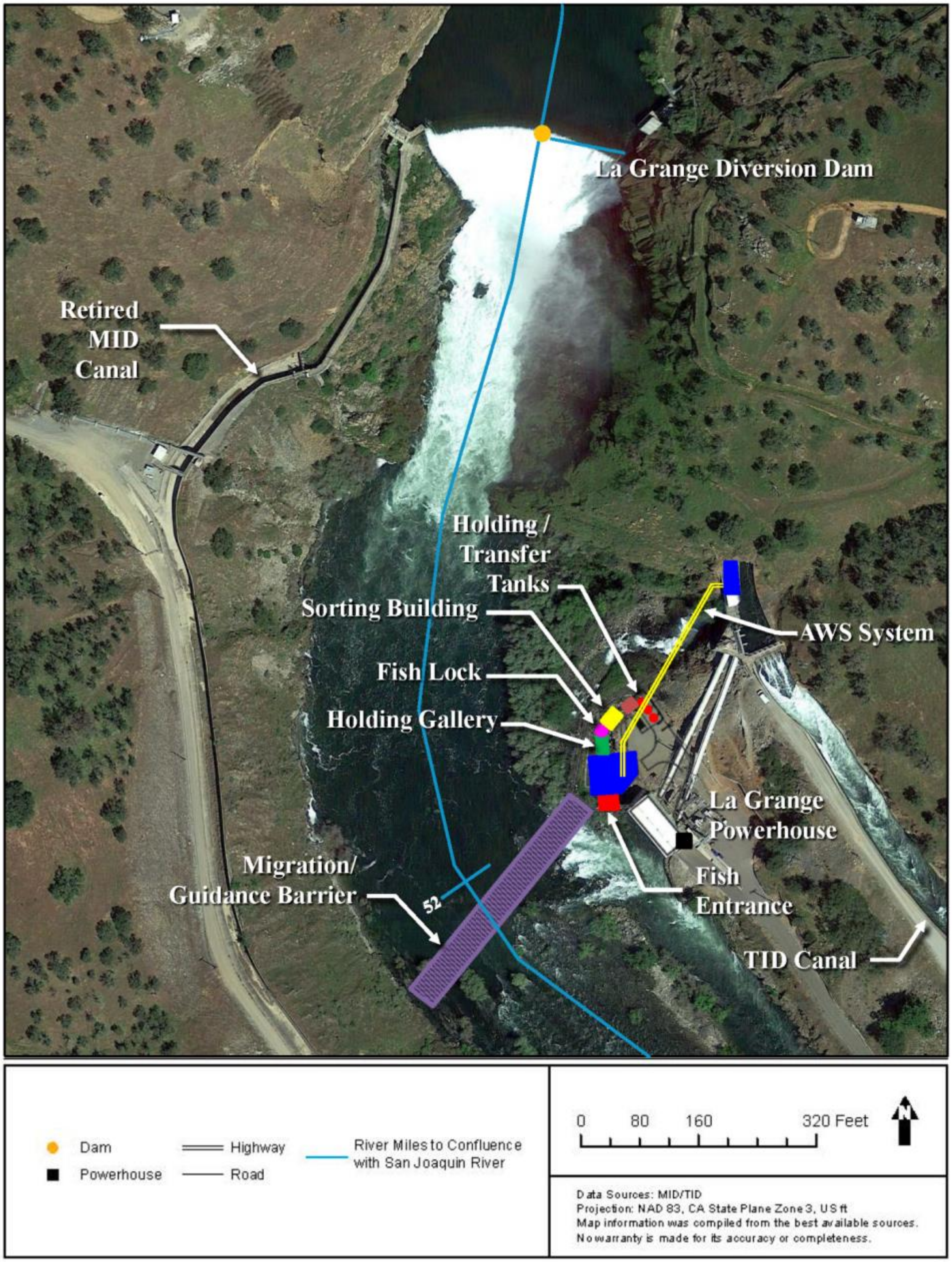


Figure 4.3-7. Illustration of CHTR facility and primary components.

Assessment of Feasibility

Although Alternative U3: CHTR Facility would require extensive modification of existing structures upstream of the La Grange Hydroelectric Project powerhouse, it was determined to be technically feasible when compared to the feasibility evaluation factors defined in Section 3.2.3 of this report. Overall, there are numerous examples of similar facilities at high dams with long track records of performance and survival data to inform design and future performance expectations. This determination is discussed further in the paragraphs below.

Feasibility Factor 1. Ability to Meet Engineering, Constructability, and Operational Constraints

The fish ladder entrance and sorting and holding facilities would be constructed in an existing open area and on somewhat level rock adjacent to the LGDD Powerhouse. The geotechnical and structural elements will be standard and are accounted for in the OPCC. Coordination with operation and space requirements for the powerhouse would need to be resolved during engineering design. Transfer and release of fish upstream would be accommodated primarily using existing roads to Moccasin Point Recreation Area and water craft to the head of reservoir to eliminate concerns with reservoir transit or the construction of new roads.

Transport of fish is assumed to take one round trip per day from the CHTR facility to Moccasin Point Recreation Area by truck (28 miles and 45 minutes each way) and then via water transport to the point of release near the head of reservoir (up to 8.3 miles and 30 minutes each way). The total round trip would require 56 miles by road, 16.6 miles via water craft, and a travel time of no less than 2.5 hours without consideration of transfer and release times along the way.

Feasibility Factor 2. Ability to Operate without Interference with Existing Uses

Although construction of this alternative would require extensive modification of existing structures upstream of the La Grange Hydroelectric Project powerhouse, once constructed, this facility could be operated as intended without long-term impacts on the required functions of other existing facilities. Water use through the bypass fish ladder and auxiliary water system will require that 25 to 360 cfs is bypassed and unavailable for power generation. Power generation will be reduced by this amount until river flow exceeds maximum generation flow plus attraction flow. This flow will contribute to meeting the minimum instream flow requirements. There are times when the existing canals would need to be offline. Provisions for water supply would need to be incorporated into the design to keep the CHTR Facility operational during these water outages.

Feasibility Factor 3. Ability to Meet Usual and Customary Fish Passage Performance Standards

This alternative represents a relatively proven technology with numerous similar facilities in operation that, in general, exhibit high overall fish passage performance characteristics meeting resource agency performance criteria. When sited and designed to accommodate the unique site-specific conditions exhibited at LGDD, this alternative is expected to meet performance criteria. Numerous examples of CHTR facilities exist in the Pacific Northwest that collect and transport adult spring-run Chinook and steelhead with high levels of performance and low levels of injury or direct mortality. In general, these facilities are expected to provide adult passage collection efficiencies of 60 to 95 percent with survival standards of 95 to 100 percent. Table 4.3-5 provides example facilities that are used as a basis of comparison. At comparable sites, survival within the fish ladder entrance, capture, holding tank, and transport portions of comparable CHTR facilities is typically high and non-passage events are documented as either fallback at the entrance or rejection due to water quality issues.

Table 4.3-5. List of selected CHTR type facilities currently in operation.

Facility	Owner	Location
Merwin Dam Adult Collection Facility	PacifiCorp	Lewis River, Washington
North Fork Adult Sorting Facility	Portland General Electric	North Fork Clackamas River, Oregon
Lower Baker Adult Collection Facility	Puget Sound Energy	Baker River, Washington
Cougar Dam Adult Collection Facility	United States Army Corps of Engineers	South Fork McKenzie River, Oregon
Cowlitz Adult Collection Facility	Tacoma Power	Cowlitz River, Washington
White River Diversion Dam Adult Collection Facility	Grant County Public Utility District	White River, Washington
Minto Adult Collection Facility	United States Army Corps of Engineers	North Santiam River, Oregon
Foster Fish Collection Facility	United States Army Corps of Engineers	South Santiam River, Oregon
Fall Creek and Dexter Adult Fish Collection Facilities	United States Army Corps of Engineers	Willamette River, Oregon

Alternative U4: Whooshh Fish Transport Tube

Overview

Alternative U4 consists of two separate fish transport tube systems (i.e. Whooshh), one at each dam. Both facilities would be comprised of an entrance with an AWS, short technical fish ladder, holding gallery, scanning and sorting system, Whooshh transport tube, and floating release platform.

The entrance at LGDD would be similar to the entrances at LGDD in all of the previous alternatives. The entrance would be located adjacent the La Grange Powerhouse and have a migration barrier and AWS to improve attraction and guidance to the entrance. After fish swim into the entrance they begin to ascend the short fish ladder that provides a transition from the Tuolumne River to the holding gallery. The holding gallery would be sized to hold fish for 24 hours in case of an error in the system, technicians need to collect biometrics on individuals, or to perform more traditional trap and transport operations. Once in the holding gallery, fish will leap over a false weir into a dewatered flume. Within the flume a scanning and sorting system would scan for PIT tags, obtain photographs for monitoring purposes, sort by size, and guide fish to the appropriate size transport tube. Different tube diameters are required to transport different sized fish. Therefore it is expected that a system accommodating adult migrating salmonids at this site would require a multiple tube system.

The fish transport tube system at LGDD would be approximately 1,500 feet in length and pass fish from the La Grange tailwater pool to above headpond above LGDD. This system consists of a flexible plastic tube that is connected to an air pump. A pressure differential of about 1 to 2 pounds per square inch is induced in the tube between the front and the back of the fish, thus pulling and pushing the fish through the tube. Once in the tube, fish travel at a speed of approximately 15 to 30 feet per second and exit the tube directly into the reservoir. Misters are located within the tube and keep the inside surface of the tube wet and relatively frictionless. The end of the transport tube would be connected to a floating platform that would allow fish to exit the tube only a few feet above the water surface.

Once fish re-enter the river above LGDD, they will navigate upstream through the LGDD headpond to the base of Don Pedro Dam. An entrance similar to that described in Alternatives U1B and U2 would be constructed to attract and collect fish at the Don Pedro powerhouse. Once fish enter the system they would ascend a short technical fish ladder to a holding gallery, similar to the one previously described at the La Grange powerhouse. Once in the transport tube, fish would be transported approximately 5,000 feet along a pathway that maintains a maximum gradient of approximately 25 to 35 percent. Similar to the downstream system, fish would be released to a floating platform in Don Pedro Reservoir that would accommodate the reservoir fluctuation.

Table 4.3-6 summarizes the anticipated functional elements that could be the basis of major design features for a Whooshh Fish Transport Tube System. A conceptual layout of this alternative is provided in Figure 4.3-8, Figure 4.3-9, and Figure 4.3-10.

Table 4.3-6. Summary of anticipated functional elements for U4: Whooshh Fish Transport Tube.

Facility	Project Element	Function and Intent
La Grange Whooshh System	Modification of plunge pool with migration barrier at downstream tailwater control	Improves guidance and attraction to the fish ladder entrance over the full range of fish passage flows. Provides a barrier so that fish are not able to pass beyond the fish ladder entrance. Improves hydraulic preference towards the ladder entrance under all flow conditions.
	Entrance designed for adult salmonids	Targets collection and use by adult salmonids motivated to migrate upstream. Accommodates diffusion of AWS to promote attraction.
	Integration of gravity AWS	Provides attraction water at the fish ladder entrance to improve attraction to the ladder entrance under all potential fish passage conditions. Provides provisions to mix cooler water with surface water flowing to reduce entrance rejection and fall-back.
	Technical concrete fish ladder	Provides transition from the Tuolumne River to an above-ground holding gallery that leads to the entrance of the Whooshh system.
	Holding gallery	Provides a gallery capable of holding fish for a 24-hour period should an error in the system occur, technicians choose to collect biometrics on individuals, or to perform more traditional trap and transport operations.
	Scanning and sorting system	Scans for PIT tags, obtains photographs for monitoring purposes, sorts by size, and guides fish to the appropriate size Whooshh tube.

Facility	Project Element	Function and Intent
	Whooshh transport tube	Transports collected salmonids in tube via pressure differential. Misters are located within the tube and keep the inside surface of the tube wet.
	Floating release platform	Accommodates water surface fluctuation and allows for safe transition from the Whooshh tube to the water body.
Don Pedro Whooshh System	Modification of plunge pool	Similar to La Grange Fish Ladder except that there is not a migration barrier at Don Pedro Dam as it does not have spillway flow plunging into the tailwater pool.
	Entrance designed for adult salmonids	Same as description of La Grange Whooshh System
	Integration of gravity AWS	Same as description of La Grange Whooshh System
	Technical concrete fish ladder	Same as description of La Grange Whooshh System
	Holding gallery	Same as description of La Grange Whooshh System
	Sorting flume, diverter gates, and tube entrance	Same as description of La Grange Whooshh System
	Whooshh transport tube	Same as description of La Grange Whooshh System
	Floating release platform	Same as description of La Grange Whooshh System

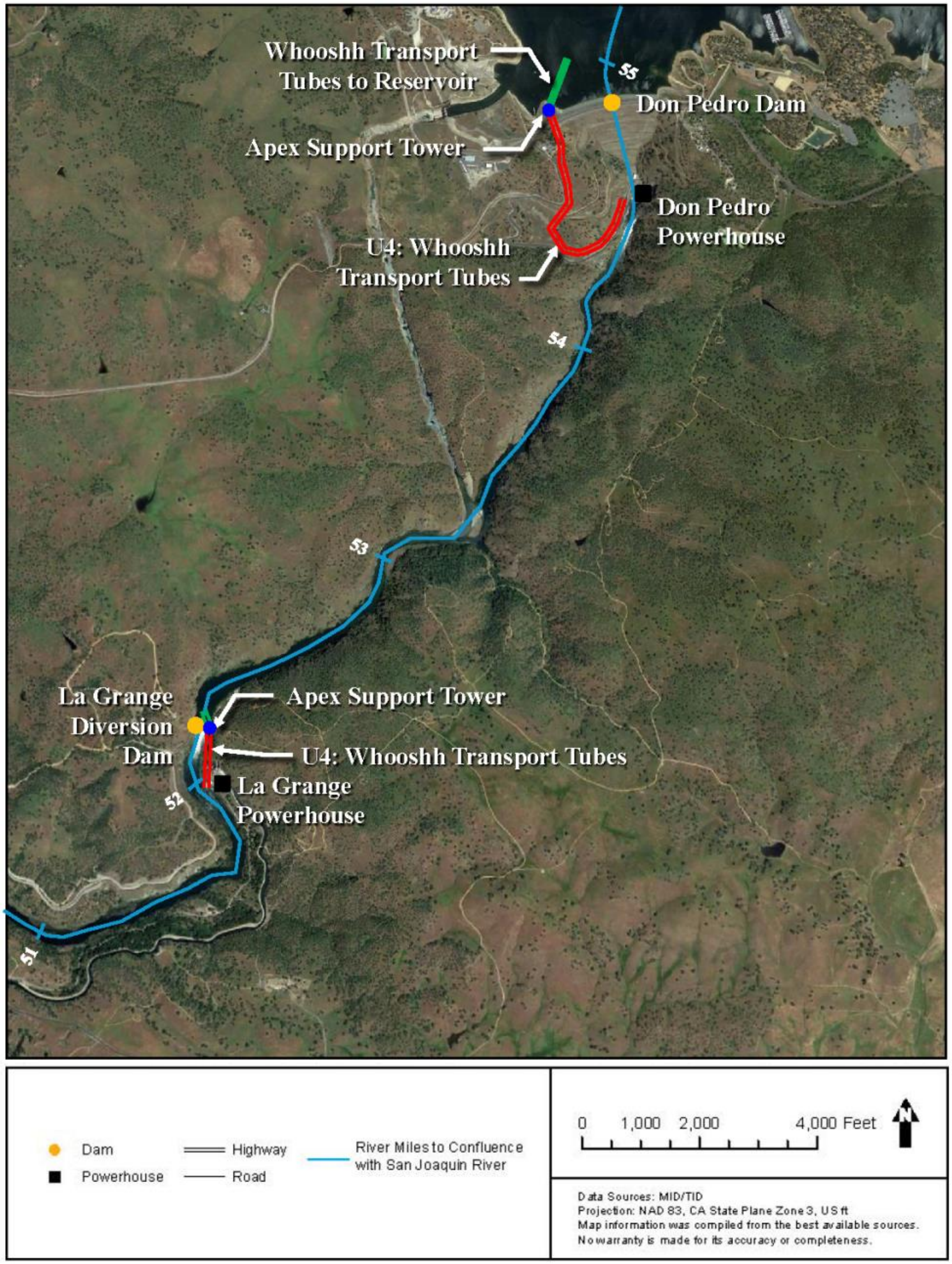


Figure 4.3-8. Overview of Alternative U4: Whooshh Fish Transport Tube.

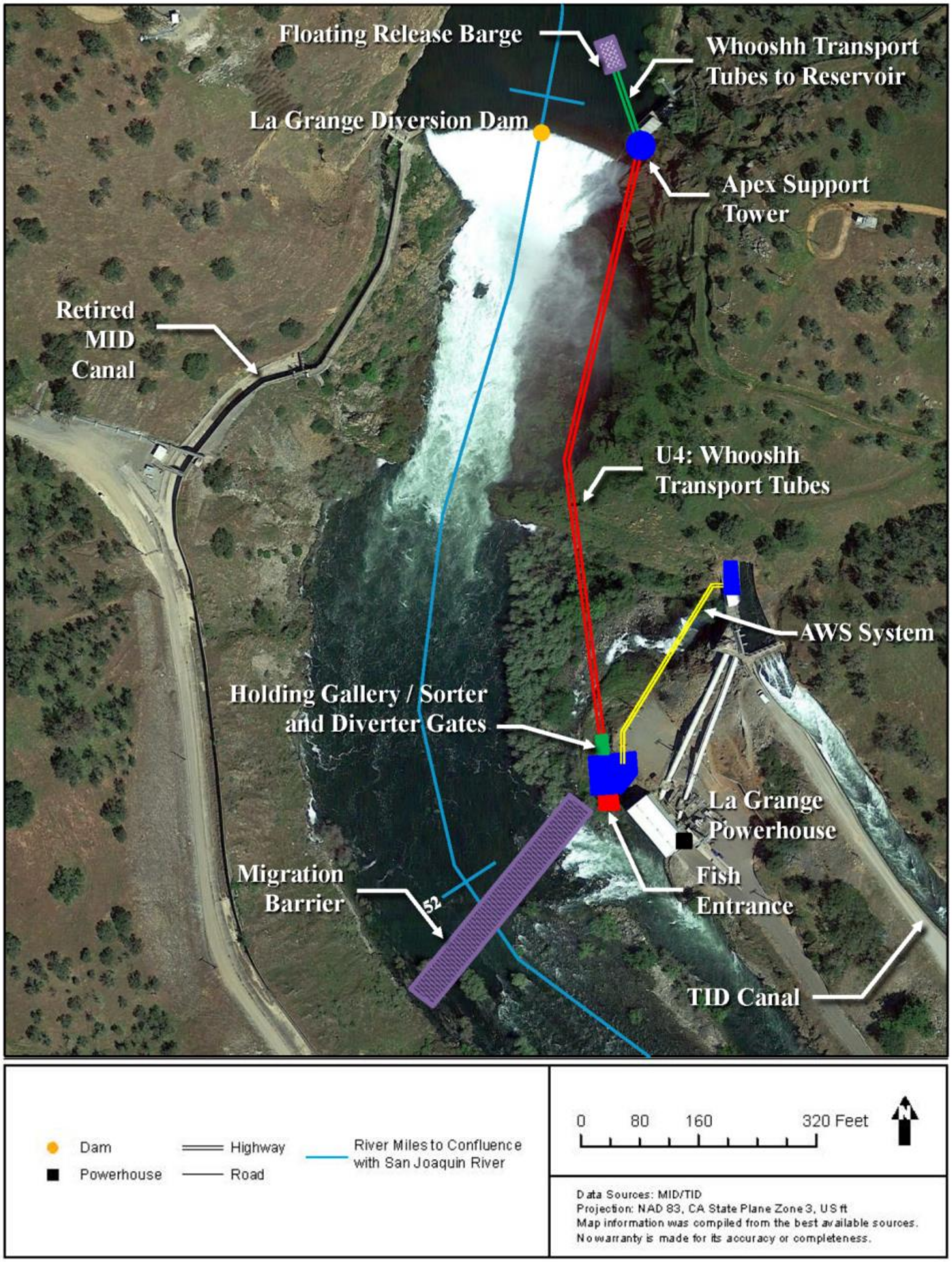


Figure 4.3-9. Downstream reach of U4: Whooshh Fish Transport Tube bypassing LGDD.

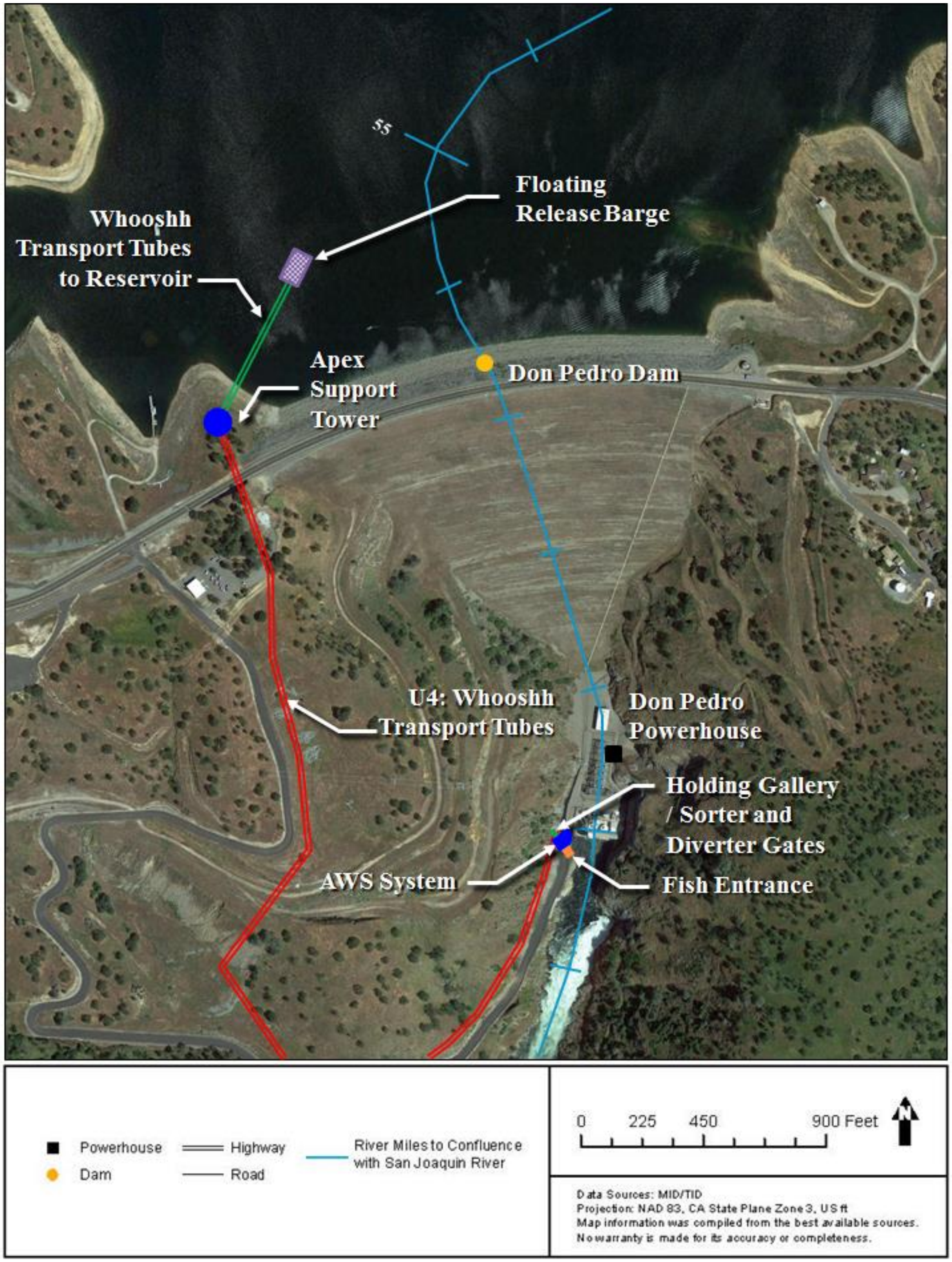


Figure 4.3-10. Upstream reach of U4: Whooshh Fish Transport Tube with Exit at Don Pedro Reservoir.

Assessment of Feasibility

Alternative U4: Whooshh Fish Transport Tube was determined to be infeasible when compared to the feasibility evaluation factors defined in Section 3.2.3 of this report. Although it is believed that this alternative can be implemented in a manner that meets both engineering and operational aspects of this project, this technology would rely on the transit of adult fish through Don Pedro Reservoir which is believed to reduce its potential overall passage efficiency below standards that are required by facilities of its kind. Further, there are currently no full-scale volitional systems in operation to provide permanent upstream fish passage and therefore it would be considered an experimental technology. This determination is discussed further in the paragraphs below.

<u>Feasibility Factor 1. Ability to Meet Engineering, Constructability, and Operational Constraints</u>

The fish ladder entrance and holding facilities would be constructed in the parking area and on somewhat level rock adjacent to the La Grange and Don Pedro powerhouses. The Whooshh tube support towers will be located on steep, hard rock hillsides with difficult access. The geotechnical and structural elements will be standard but installation will be challenging. These are accounted for in the OPCC. Coordination with operation and space requirements for the powerhouse would need to be resolved during engineering design.

<u>Feasibility Factor 2. Ability to Operate without Interference with Existing Uses</u>

Similar to Alternative U3, although construction of this alternative would require extensive modification of existing structures upstream of the La Grange Hydroelectric Project powerhouse, once constructed, this facility could be operated as intended without long-term impact on the required functions of other existing facilities. Water use through the bypass fish ladder and auxiliary water system will require that 25 to 360 cfs is bypassed and unavailable for power generation. Power generation will be reduced by this amount until river flow exceeds maximum generation flow plus attraction flow. This flow will contribute to meeting the minimum instream flow requirements. There are times when the existing canals would need to be offline. Provisions for water supply would need to be incorporated into the design to keep a portion of the AWS system operational during these water outages.

<u>Feasibility Factor 3. Ability to Meet Usual and Customary Fish Passage Performance Standards</u>

Multiple installations of this technology are in use at fish hatcheries and private fish passages around the world; however, no Whooshh fish passage systems currently operate to provide permanent upstream passage. Although the existing Whooshh systems in use have demonstrated a high level of survival with very low levels of fish injury or direct mortality, they are all either temporary or pass non-ESA-listed salmonids and steelhead. There are no comparable permanent installations in operation to inform long-term survival expectations, and few existing installations are comparable with regard to height, distance, and reservoir fluctuation. Further, NMFS currently considers Whooshh fish passage technology experimental, particularly in the context of ESA-listed fish. It is unknown when NMFS may accept this technology as a safe, timely, and efficient upstream passage mechanism for ESA-listed fish.

The ability of this alternative to meet performance standards is low because of factors other than the physical aspects of the fish passage facilities. In addition to its experimental application as a permanent upstream passage facility for ESA-listed salmonids, contributing physical factors (i.e., passage through Don Pedro Reservoir) indicate that this alternative is not capable of meeting the performance standards defined under Feasibility Factor 3. Similar to the technical fish ladder Alternatives U1A and U1B, adult migration through the reservoir is anticipated to have a negative influence on fish survival and overall passage performance. Reservoir migration of adults through Don Pedro Reservoir is expected to be low, which diminishes the ability of this alternative to meet regulatory compliance standards. In addition, the use of two separate fish passage facilities inherently reduces fish passage performance as a whole.

4.3.2 Downstream Fish Passage Technologies

Section 4.3.2.1 presents an overview of technologies evaluated during the formulation of alternatives for downstream fish passage, and discusses why some technologies were not considered further. Technologies were eliminated based on their applicability to the unique operational conditions identified for the study area. Section 4.3.2.2 describes technologies that were considered further in this study, and presents an assessment of each alternative's ability to meet the feasibility evaluation factors defined in Section 3.2.3.

4.3.2.1 Overview of Downstream Fish Passage Technologies

The types of downstream passage technologies initially considered as part of this study include:

- Surface spills;
- Fixed surface collectors;
- Floating surface collectors;
- In-river collectors; and
- Turbine passages

Surface spills can be made from any number of structures that consist of an overflow channel that is integrated into the dam crest. From the dam crest, fish and water are conveyed via open channel flume to the tailrace below the dam. The flume is usually designed to facilitate depths and velocities that reduce the risk of harm to downstream migrants. Surface spills require very minimal change in reservoir fluctuation and have only been proven effective on dams of less than 200 feet. Therefore, surface spill was not further considered.

Fixed collectors are generally optimized for a small range of pool elevations and can be stationary on a dam face, shoreline, or other structure. However, one variation of the fixed collector that is applicable to this project due to the wide range of Don Pedro Reservoir fluctuation is a fixed multi-port collector with a helical bypass, commonly referred to as the helix. It consists of an array of multiple fixed inlets at different elevations, a helical free-surface fish bypass channel, and an outfall downstream of the dam. The intake tower has multiple ports that allow the facility to operate at varying reservoir elevations. Once fish enter a port they are transported to the helical fish passage channel that spirals down toward the base of the dam, at which point the fish continue in a bypass pipe through a tunnel around the dam and are released downstream of the dam back to the river.

Floating surface collectors refer to a general category of floating facilities that are used to attract and collect outmigrating fish. Floating surface collectors rise and fall with fluctuating reservoir elevation. These types of collectors can hold and/or rout fish to a bypass facility that safely transitions them downstream to the tailrace of a dam via bypass conduit or via transport vehicle. Floating surface collectors have been installed at, or near, dams located at the downstream end of reservoirs in several existing installations; however, another configuration considered for this project is to place the floating surface collector near the head of reservoir, eliminating reservoir passage concerns.

In-river collection is a technique of collecting fish prior to entering the reservoir. The current and most common technique for collecting outmigrating juveniles in-river is a rotary screw trap. Such a trap is designed to collect only a small portion of juvenile outmigrants. The proposed technique selected for alternative consideration in this study is to create a small impoundment via an adjustable dam (bladder dam or Obermeyer dam) in the Tuolumne River upstream of the dam impoundment, and to screen the entire river flow up to a predetermined flow.

Turbine passage was not considered as a potentially viable option on its own. Documented passage through turbine facilities may contribute to downstream passage but are not known to achieve levels of survival that are consistent with the overall passage and survival performance standards required by the resource agencies. Given the relatively poor documented performance of turbine passage at high-dam passage facilities throughout the Pacific Northwest, it is not considered as a viable stand-alone option, and was not evaluated further in this report.

4.3.2.2 Descriptions of Downstream Fish Passage Alternatives

Four potential downstream fish passage alternatives representing three technologies were considered:

- Alternative D1: Fixed Multi-Port Collector with Helical Bypass near Don Pedro Dam
- Alternative D2A: Floating Surface Collector near Don Pedro Dam
- Alternative D2B: Floating Surface Collector near Head of Reservoir
- Alternative D3: Fixed In-River Collector

Descriptions of the four alternatives considered for downstream fish passage are included in the following subsections, including a general overview of the alternative, a description of the major functional elements, and an assessment of technical feasibility for each.

Alternative D1: Fixed Multi-Port Collector with Helical Bypass

Overview

This alternative is configured similar to the experimental "Helix" facility that is currently being constructed by USBR at the Cle Elum Dam in central Washington State. This alternative uses an array of fixed inlets set at different elevations to maintain a continuous hydraulic connection to the reservoir surface throughout the range of reservoir surface fluctuations. To accommodate the 230 feet of anticipated reservoir fluctuation, 23 inlets, each 10.5 feet in height would be required. Each inlet possesses an independently operated hydraulic control gate that allows conveyance of a designated amount of flow. This flow may range from 100 to upwards of 400 cubic feet per second and is typically designed to provide sufficient attraction flow to motivate outmigrating juvenile fish to enter the inlet as they search for a reservoir outlet[20]. As fish are attracted to the open surface-oriented inlet, they are conveyed to the helical bypass channel. The helical bypass channel spirals down toward the base of the dam, at which point fish and water are then conveyed in free-surface bypass pipe around the Don Pedro Dam abutment and downstream of the Don Pedro powerhouse. A cross-section of this concept is provided in Figure 4.3-11.

In this concept, the bypass pipe could bypass both Don Pedro Dam and LGDD. The bypass pipe would therefore continue to convey fish downstream for approximately 2.8 miles and release fish downstream of the LGDD.

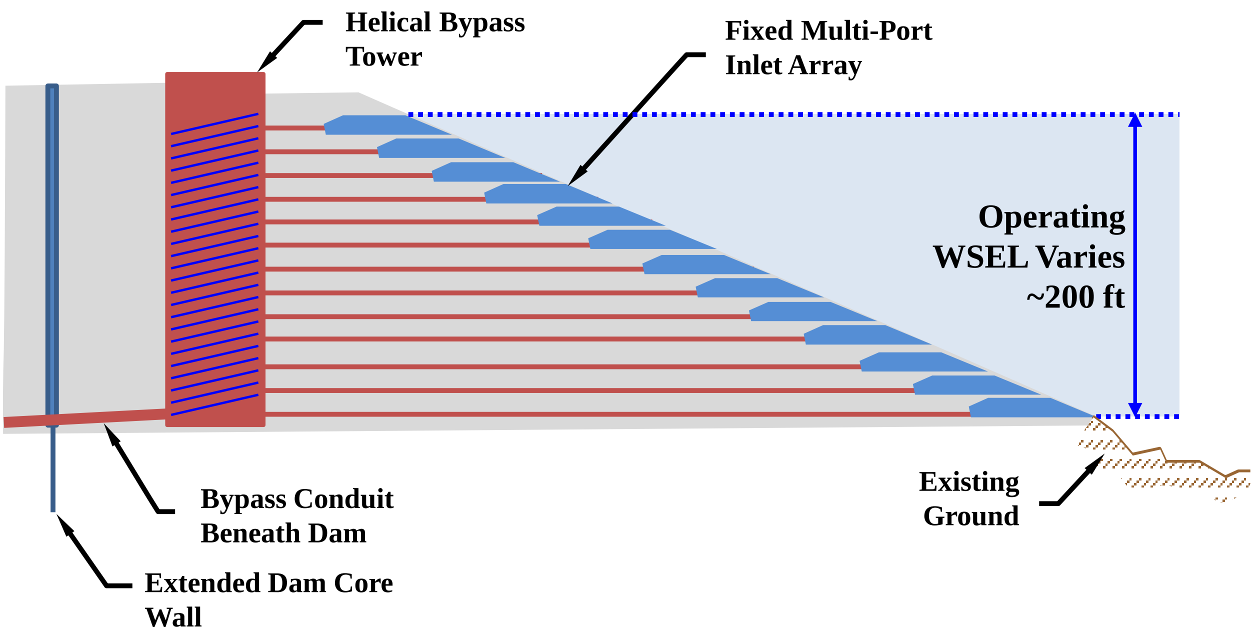


Figure 4.3-11. Cross-section schematic of fixed multi-port inlet with helical bypass.

[20] The actual attraction flow required may be greater than 400 cubic feet per second, but would require further analysis during scoping and preliminary design should an alternative such as this one move forward to advanced stages of consideration.

Table 4.3-7 summarizes the anticipated functional elements that could be the basis of major design features for a fixed multi-port collector with helical bypass. A general overview of a fixed multi-port inlet with helical bypass in the study area is depicted in Figure 4.3-12.

Table 4.3-7. Summary of anticipated functional elements for D1: Fixed Multi-Port Collector with Helical Bypass.

Project Element	Function and Intent
Debris management systems	Acts as the initial line of defense to deflect and route incoming woody debris to a location where it can be passed safety downstream or storage onshore.
Full exclusion guidance and barrier nets	Guides all downstream migrants to the collector. Improves detection of migration cues. Provides a barrier that inhibits passage of migrants downstream through other facilities not designed for fish passage.
Intake tower	The intake tower follows the bank-line and has multiple overlapping intakes to accommodate reservoir elevations anticipated during fish migration.
Helical fish passage channel	Fish passage channel that descends to the base of the dam.
Tunnel around dam abutment	Tunnel around the dam for the fish passage channel. Transports fish around the dam without impacting the existing dam structure.
Bypass channel or pipe	Carries fish from the downstream end of the helical structure to a release point located downstream of LGDD
Outfall downstream of dam	Manipulate the channel at the outfall to provide sufficient pool geometry and depth to prevent fish injury at the outfall.

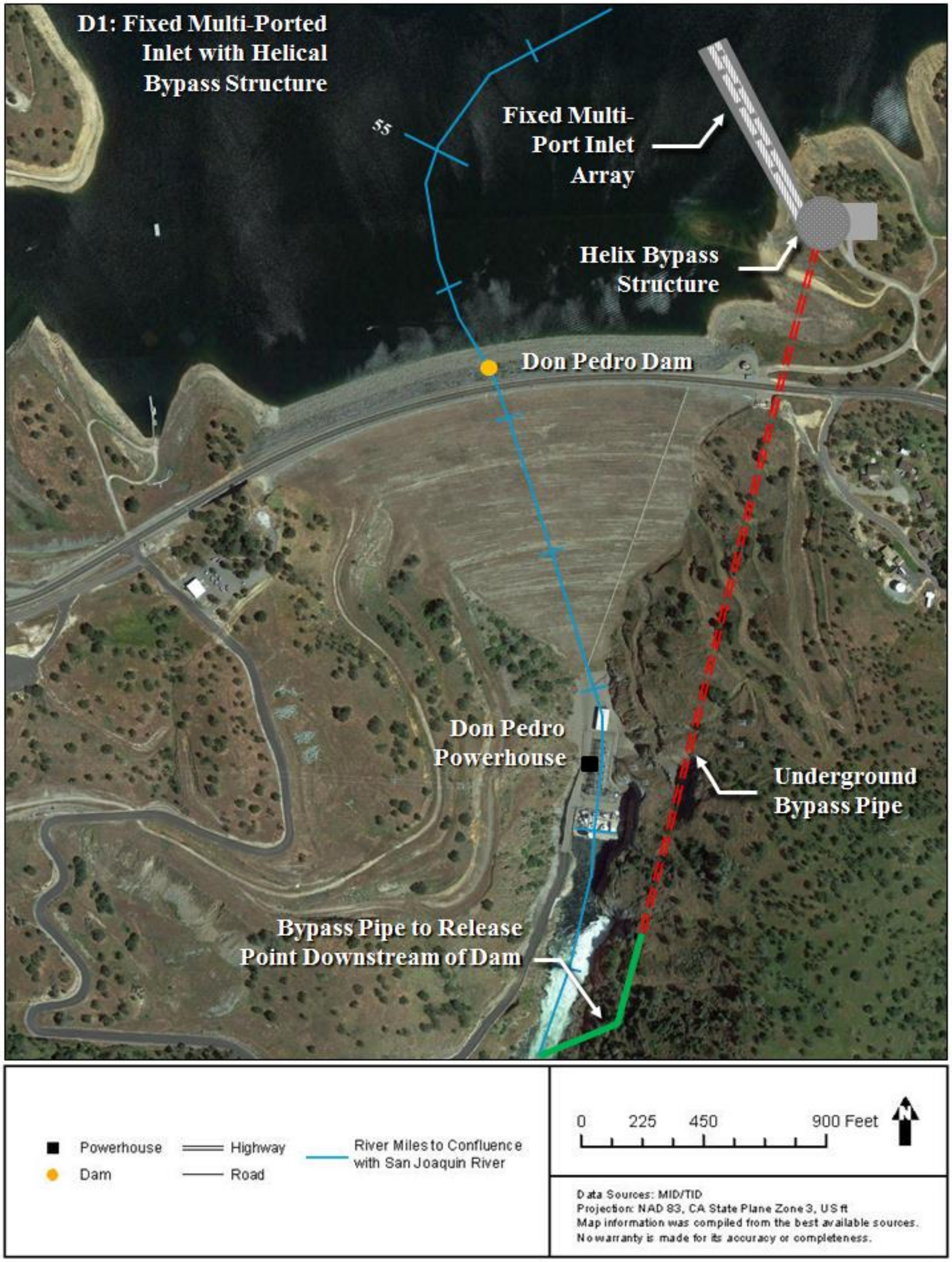


Figure 4.3-12. Overview schematic of fixed multi-port inlet with helical bypass.

Assessment of Feasibility

Alternative D1: Fixed Multi-Port Inlet with Helical Bypass was determined to be technically infeasible when compared to the feasibility evaluation factors defined in Section 3.2.3 of this report. Although this alternative is believed to meet survival performance requirements typically imposed by the resource agencies for similar downstream facilities, it is not anticipated to meet the overall fish passage efficiencies given that it relies on the ability of outmigrating fish to transit through Don Pedro Reservoir. Further, this alternative is experimental in nature given that there are no other similar facilities currently in operation. Significant engineering and operational challenges with this alternative also do not meet the defined thresholds for technical feasibility. This determination is discussed further in the paragraphs below.

<u>Feasibility Factor 1. Ability to Meet Engineering, Constructability, and Operational Constraints</u>

This alternative exhibits numerous engineering challenges and complex construction methods. The geotechnical and structural elements will be significant and are accounted for in the form of "risk cost" in the OPCC. Significant constructability issues would need to be resolved during engineering design. No other facilities of this kind have been completed to inform the design and construction process, and, as such, implementation of such a facility at Don Pedro Dam is considered experimental in nature.

<u>Feasibility Factor 2. Ability to Operate without Interference with Existing Uses</u>

This alternative operates with flows up to 400 cfs that will bypass the Don Pedro and La Grange dams. Therefore, long-term water storage targets and/or the ability to generate power at capacity would be impacted any time inflows to Don Pedro Reservoir are less than the combined flows required to generate power and operate the downstream passage facility.

<u>Feasibility Factor 3. Ability to Meet Usual and Customary Fish Passage Performance Standards</u>

Although there are many examples of fixed surface collection facilities, the application of multiple inlet ports with a helical bypass has not been implemented to date and is therefore experimental. Only one example had been proposed and it is currently under construction at Cle Elum Dam in central Washington. Although the Cle Elum project modeled the ability of the facility to meet NMFS (2011) passage criteria, no empirical data exist to date on performance standards and none will be available until the facility is operational for several years. Therefore, due to its experimental nature and a lack of operational performance data, it is considered infeasible with respect to this factor.

High residence times in the reservoir, high temperatures, and low velocities also increase the risk of residualization, predation, and mortality. Reservoir transit at Don Pedro is anticipated have a significant negative impact on overall passage performance and survival of outmigrating smolts from the upper Tuolumne River. As presented in Section 4.2.1.7, high temperatures in the upper water column of Don Pedro Reservoir may exceed UOWTI values for outmigrating smolts during portions of the outmigration period. When thermal stratification develops in reservoirs, juveniles typically seek cooler temperatures that occur at depths greater than the collector entrance, which is located within 10 to 12 feet of the water's surface. During these periods, juveniles tend to mill in the reservoir until water temperatures in the upper portions of the water column become cooler. Once temperatures drop, juveniles will ascend in the reservoir and locate the collection entrance. Although guide nets can be used to direct fish to the lower portions of a multi-port collector (where water is cooler and suitable for juvenile migration) only the upper-most entrance to the helical collector are open, near the water's surface. Therefore, even if fish are guided to the lower entrances, they cannot enter the collector through them. Further, low velocities through the reservoir also decrease the ability of migrating fish to detect velocity cues that would otherwise lead them downstream. The lack of cues coupled with the size and dendritic shape of the Don Pedro Reservoir are likely to significantly delay upstream migration or result in fish never migrating out of the reservoir, thus resulting in a failure to achieve customary performance standards for safe, timely, and effective passage. Finally, as discussed in Section 4.2.1.7, a relatively robust population of non-native piscivores exists in the reservoir, and may contribute to overall smolt mortality or loss prior to collection.

Floating Surface Collection System Alternatives D2A and D2B

Two potential floating surface collector (FSC) alternatives are considered in this study for the purposes of providing downstream fish passage. Alternative D2A includes an FSC near Don Pedro Dam. Alternative D2B includes an FSC at the head of reservoir. Alternative D2B represents an experimental technology because FSCs have not historically been operated at the head of reservoir and no similar facilities exist to inform design, operation, or performance. Both floating surface collection alternatives are intended to create conditions that resemble a hydraulic outlet from Don Pedro Reservoir that cues the natural behavior of an outmigrating fish to continue their movement downstream. These conditions are created with use of a system of specifically designed components arranged to attract fish to a desired location, guide fish to the entrance of a facility inlet, safely collect fish, and provide a means of transport downstream of a dam.

The FSC resembles a floating, barge-like device that serves as a platform for numerous mechanical, structural, and electrical systems required to induce a hydraulic flow path to attract fish as well as to collect and transfer fish to holding areas. Floatation tanks and buoyancy control features are used to regulate the position of the FSC in the water column and allow the FSC to rise and fall with changes in water surface elevation. A collection channel composed of V-shaped vertical flat-plate dewatering screens is oriented down the center of the FSC, with the widest section located at the FSC entrance, and gradually constricting in the downstream direction. For this application, it is assumed that a minimum of 500 cubic feet per second enters the collection channel and is gradually reduced as velocity is gradually increased along the length of the device, with 2-10 cubic feet per second remaining (along with collected fish) at the downstream end that flows into the holding galleries. The collection channel is divided into primary and secondary dewatering screens, as depicted in Figure 4.3-13. Configuration of the dewatering screens carefully targets a gradually varied change in flow, flow velocity, acceleration, depth, and wetted cross-section. The change in hydraulic parameters due to these dewatering screens occurs at a designed rate of change to limit rejection by fish that are targeted for collection.

The Net Transition Structure (NTS) attaches at the front end of the FSC and the downstream end of an exclusion or guide net. The NTS is a large narrowing channel created from a steel superstructure covered with an impermeable membrane. An inclined floor provides a gradual physical and hydraulic transition from a deeper portion of the reservoir water column to the shallow FSC entrance. It extends the entrance of the FSC to encompass the predominant range of migration depths for downstream-migrating fish (0-50 feet). The NTS establishes initial approach conditions removing flow discontinuities and controlling acceleration and velocity leading to the primary screens of the FSC.

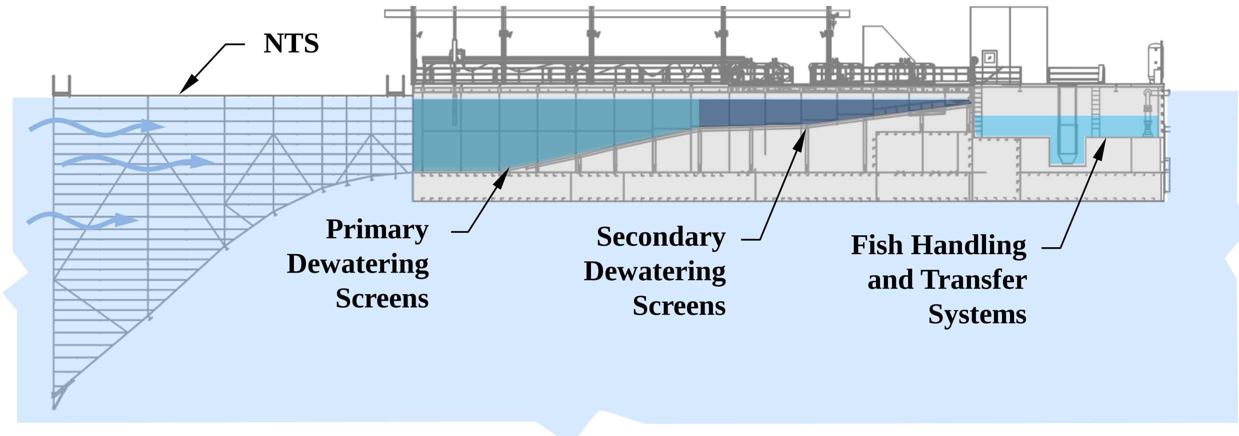


Figure 4.3-13. Schematic profile of floating surface collector.

Fish that are passed to the downstream end of the collection channel are crowded into transport hoppers, barged or lifted via crane to a shore facility, transferred to a transport vehicle, and transported to a release location downstream of LGDD. The transport vehicle would be equipped with life support equipment that regulates oxygen and temperature.

Anchorage systems are fashioned in a specific way that maintains the desired horizontal location, orientation with respect to flow paths, and distance from critical infrastructure while accommodating the vertical change in elevation of the water body. These systems can be composed of steel pilings, mechanical drag anchors, fixed rock anchors, tensioned cables, and structural elements affixed directly to a dam face. As the potential fluctuation of a water body increases, so does the complexity and scale of its anchoring system.

Exclusion nets are typically deployed between the collector entrance and dam to prevent fish from approaching the dam and passing via alternate routes. Guide nets are deployed upstream from the collector and terminate near the collector entrance, which funnels fish toward the entrance. Exclusion and guide nets typically extend from the water surface to the forebay floor, providing a total barrier to fish passage. Lead nets guide fish towards the collector entrance. They begin upstream of the collector and terminate near the middle of the collector entrance.

Debris management and screen cleaning systems are also critical to maintaining the performance, reliability, and operational longevity of surface collection systems. Logs, sticks, leaves, seed husks, and other materials can obstruct openings, occlude dewatering screens, and increase the potential for fish injury and mortality in fish handling and holding components. Surface collection systems employ primary, secondary, and tertiary systems to reduce the amount of debris that may enter the collection channel entrance, and remove the majority of debris that is collected on the dewatering screens. An illustration of the surface collection system arrangement showing the debris boom, exclusion nets, NTS, and FSC is shown in Figure 4.3-14.

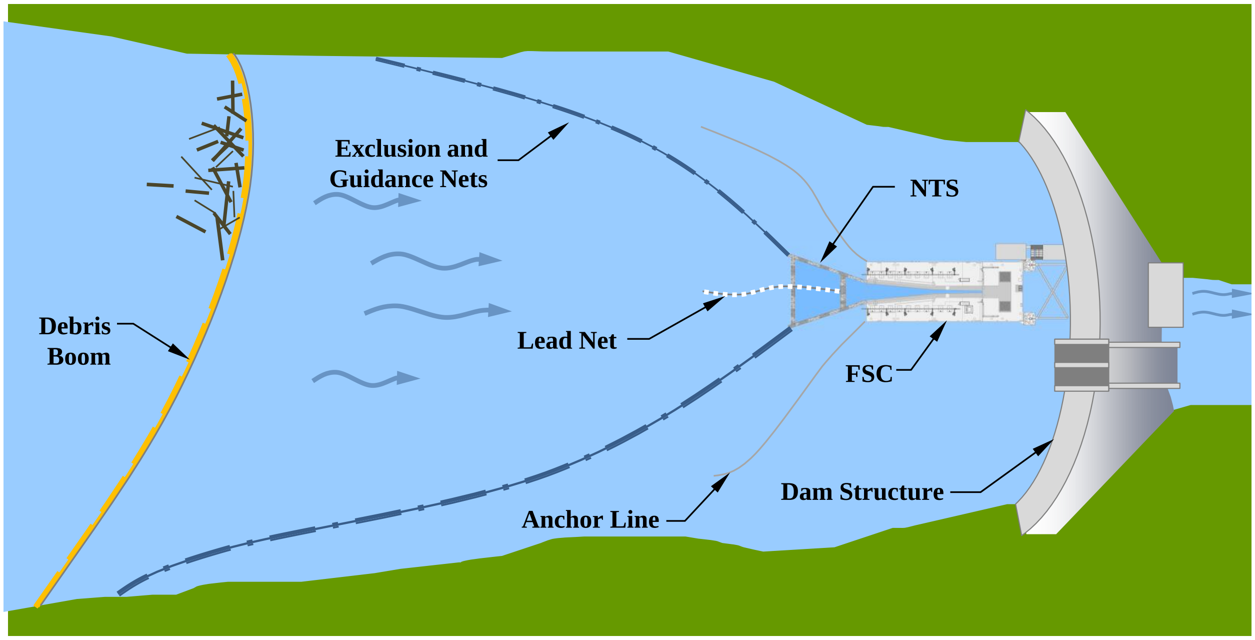


Figure 4.3-14. Overview illustration of surface collection and FSC system components.

Collector location and siting can vary dependent upon operating environment, accessibility, and other factors. A profile of the channel thalweg and potential reservoir levels is provided in Figure 4.2-2. As shown, the head of reservoir can vary between RM 80.8 at the maximum reservoir pool elevation of 830 feet to RM 70.5 at the low power pool elevation of 600 feet; a distance of over 10 miles. Three additional locations were considered in addition to the Don Pedro Dam for deployment of a floating surface collection system: Wards Ferry Bridge at RM 78.4, location north of Jacksonville Road Bridge and Moccasin Point Recreational Area at RM 72.8, and near the Highway 49 Bridge at RM 70.1. Advantages and disadvantages for potential FSC locations in Don Pedro Reservoir were evaluated at four specific sites and are summarized in Table 4-3.8.

Table 4.3-8. Summary of tradeoffs for potential FSC sites.

Sites	Advantages	Disadvantages
Wards Ferry Bridge (RM 78.4)	• Most upstream location reduces reservoir navigational requirements of downstream migrants which would improve reservoir passage survival. • Narrow banks and shallower depths decreases guidance net length and depth.	• Experimental location. No current facilities operating under conditions of such high levels of reservoir fluctuation. FSCs have not historically been operated at the head of reservoir. No like facilities to inform design, operation, or performance. • Head of reservoir is regularly downstream of this location (22 percent of the time), requiring collection facility to be moved annually when location becomes too shallow. • Higher difficulty in managing debris close to riverine system. • Will impact both recreational boating traffic and whitewater rafting use. • Collection from other tributaries would not occur. • 3-phase electrical service would have to be brought to location. • Access road improvements would be required to make this a safe, all-season transfer route. Alternatively boat transport could occur. • Longest transfer times of all locations considered.
Near Jacksonville Bridge (RM 72.3)	• Upstream location reduces reservoir navigational requirements of downstream migrants which would improve reservoir passage survival. • Close access via boat from Moccasin Point Recreational Area or road via River Road. • Easier location for management of debris.	• Experimental location. No current facilities operating under conditions of such high levels of reservoir fluctuation. FSCs have not historically been operated at the head of reservoir. No like facilities to inform design, operation, or performance. • Head of reservoir is infrequently downstream of this location (2% of the time), will require that the collection facility moved when location becomes too shallow. • Will impact recreational boating traffic. • Collection from other tributaries would not occur. • 3-phase electrical service would have to be brought to location. • Long transfer times to release location downstream of LGDD my impact overall survival.

Sites	Advantages	Disadvantages
Highway 49 Bridge (RM 70.1)	• Downstream of lowest anticipated reservoir elevation, eliminates requirement to move the collection facility. • Allows collection of fish from other tributaries if applicable. • Easier management of debris in reservoir upstream of facility. • Narrow banks and shallower depths decreases guidance net length and depth.	• Experimental location. No current facilities operating under conditions of such high levels of reservoir fluctuation. FSCs have not historically been operated at the head of reservoir. No like facilities to inform design, operation, or performance. • High level of boating traffic. • Requires partial reservoir navigation by downstream migrants. • 3-phase electrical service would have to be brought to location. • Poor access to this location. Possible access via boat from Moccasin Point Recreational Area.
Don Pedro Dam (RM 54.8)	• Other similar full scale FSCs can inform design and potential performance. • Less difficulty with debris compared to other locations. • Can generally collect fish from all contributing tributaries if applicable. • Better proximity to service power. • Easier access near dam with reduced transfer times which will improve survival.	• Requires that outmigrants transit through Don Pedro Reservoir. • Greater likelihood of passage delay or loss due to a number of factors in the reservoir. • Exposes fish to temperature barriers, false pathways, predation, disease, residualization, and mortality. • More difficult access location with longer transfer times. • Impact to boating traffic as they will require navigation through designated passage through the exclusion nets.

Table 4.3-9 summarizes the anticipated functional elements that could inform the basis of major design features for Alternative D2A: FSC located at the dam. Figure 4.3-15 shows an overview of the proposed alternative D2A. An FSC located at a dam is a technology that has been previously implemented at other dams; however, no existing facilities operate in environments that are subject to the high levels of reservoir fluctuation exhibited at Don Pedro Reservoir (230 feet). Given that it has not been done before, implementation of this technology in such an environment would be experimental. FSCs are typically located at or near the dam for three primary reasons: ability to collect fish from all tributaries to the reservoir, proximity to power, and simplified access and moorage at the dam. One of the disadvantages of an FSC located at the dam is that it requires downstream migrating fish to navigate the entire reservoir before entering the collection system. As suggested in Section 4.2.1.7, it will be difficult for downstream migrants to sense velocity cues in Don Pedro Reservoir. This is expected to result in passage delay or fish loss in the reservoir. In addition to navigational difficulties through a reservoir, Don Pedro Reservoir has a large non-native predator population that can further contribute to target species loss, and ultimately hinder downstream migration success. An FSC at this location exposes outmigrating fish to temperature barriers, false pathways, predation, disease, residualization, and ultimately higher mortality and loss.

Table 4.3-10 summarizes the anticipated functional elements that could inform the basis of major design features for Alternative D2B – FSC at Head of Reservoir. Figure 4.3-16 illustrates an overview of the proposed alternative D2B. Many of the functional elements required for Alternative D2B are similar to Alternative D2A: FSC near dam alternative. This alternative would have the same power requirement as an FSC near the dam. However, it will include additional cost to bring power to this alternative location because the facility would not be located as close to existing sufficient power infrastructure. Boats would be used to transport fish in transport tanks from the collector to an offloading station located at the existing Moccasin Point Recreation Area boat ramps. The new offloading station would consist of a dock with a jib crane to lift the fish transport tank off the boat and onto a transport truck. A transport truck would transport outmigrating fish to a designated release point downstream of LGDD.

An FSC located at the head of reservoir has not been previously implemented and would be experimental, resulting in a high level of uncertainty for this alternative. The potential advantage to this location is that the alternative could potentially minimize fish transit, residualization, predation, and mortality in the reservoir.

One important aspect when considering a FSC located near the head of reservoir is that the location of the head of reservoir throughout the full range of operational reservoir elevations varies over time. As discussed in Section 4.2.1.7 the location of the head of reservoir will vary by as much as 10 miles as shown in Figure 4.3-17. Such variations will necessitate deployment of an FSC: (1) at a single location downstream of the lowest reservoir elevation, or (2) design of multiple anchorage locations so that the facility can be moved downstream as water surface elevations recede or moved upstream as water surface elevations increase. The second option would result in a number of tradeoffs that would make it overly complicated, cost-prohibitive, and impractical to implement due to the need for service power and variation of reservoir conditions at each point of anchorage. The facility would need to be shut down, detached from any guide net or anchorage system, and moved over a duration of 4 to 6 days. Guide net systems would also need to be moved and different reservoir widths would change the effective approach angle of the nets at each different point of anchorage. Each of these factors would result is loss of collection efficiency if such moves needed to be moved during the period of migration.

Table 4.3-9. Summary of anticipated functional elements for D2A: Floating Surface Collector near Don Pedro Dam.

Project Element	Function and Intent
Debris management systems	Acts as the initial line of defense to deflect and route incoming woody debris to a location where it can be passed safety downstream or storage onshore without interruption of fish collection operations. Helping maintain clean screens in the collection inlet.
Full exclusion guidance and barrier nets	Guides all downstream migrants to a central point in front of the collector inlet within the hydraulic zone of influence. Improves detection of migration cues. Provides a barrier that inhibits passage of migrants downstream through other facilities not designed for fish passage.
Net transition structure	A structure that gradually increases velocities prior to the collection barge. The guidance nets are connected to the upstream end and the collection barge is connected at the downstream end.

Project Element	Function and Intent
Floating fish collection barge	Acts as a floating platform that houses all hydraulic, mechanical, electrical, fish collection, and control systems. Accommodates the full design range of reservoir water surface floatation.
Screened collection inlet	Provides a defined collection channel which gradually increases velocity, safety decreases flow volume, and guides fish to a capture zone where they are collected and conveyed to holding galleries.
Attraction flow pumping array	Provides an artificial attraction flow and velocity net in the reservoir that stimulates detection of outflow pathways and continued downstream movement of migrating fish.
Anchorage system	Anchorage for the floating collection barge into a fixed horizontal position while accommodating vertical changes in reservoir water surface elevation.
Fish transfer and transport equipment and facilities	Facilitates the transport of collected fish to the dam, or shore, and then transport and release downstream of the LGDD.
Ship-to-shore personnel access	Provides personnel and minor equipment access to the floating collection barge.
Upgraded electrical service to the project location and emergency backup generators	Provides 480V, 3-phase power to the site and collection barge. Emergency backup generators would allow for continued operation of fish life support, floatation systems, and other integral safety systems during power outages via standby generator.

Table 4.3-10. Summary of anticipated functional elements for D2B: Floating Surface Collector near Head of Reservoir.

Project Element	Function and Intent
Debris management systems	Acts as the initial line of defense to deflect and route incoming woody debris to a location where it can be passed safety downstream or storage onshore without interruption of fish collection operations. Helping maintain clean screens in the collection inlet.
Full exclusion guidance and barrier nets	Guides all downstream migrants to a central point in front of the collector inlet within the hydraulic zone of influence. Improves detection of migration cues. Provides a barrier that inhibits passage of migrants downstream into the remainder of the reservoir.
Net transition structure	A structure that gradually increases velocities prior to the collection barge. The guidance nets are connected to the upstream end and the collection barge is connected at the downstream end.
Floating fish collection barge	Acts as a floating platform that houses all hydraulic, mechanical, electrical, fish collection, and control systems. Accommodates the full design range of reservoir water surface floatation.
Screened collection inlet	Provides a defined collection channel which gradually increases velocity, safety decreases flow volume, and guides fish to a capture zone where they are collected and conveyed to holding galleries.
Attraction flow pumps	Provides an artificial attraction flow and velocity net in the reservoir that stimulates detection of outflow pathways and continued downstream movement of migrating fish.
Anchorage system	Anchorage for the floating collection barge into a fixed horizontal position while accommodating vertical changes in reservoir water surface elevation. System must also accommodate the need to move the collector back and forth along the reservoir when the head of the reservoir changes over a distance of 10 miles.
Fish transfer and transport equipment and facilities	Facilitates the transport of collected fish to the dam, or shore, and then transport and release downstream of the La Grande Dam.
Ship-to-shore personnel access	Provides personnel access and small equipment to the floating collector via boat.

Project Element	Function and Intent
Upgraded electrical service to the project location and emergency backup generators	Provides 480V, 3-phase power to the site and collection barge. Emergency backup generators would allow for continued operation of fish life support, floatation systems, and other integral safety systems during power outages via standby generator.

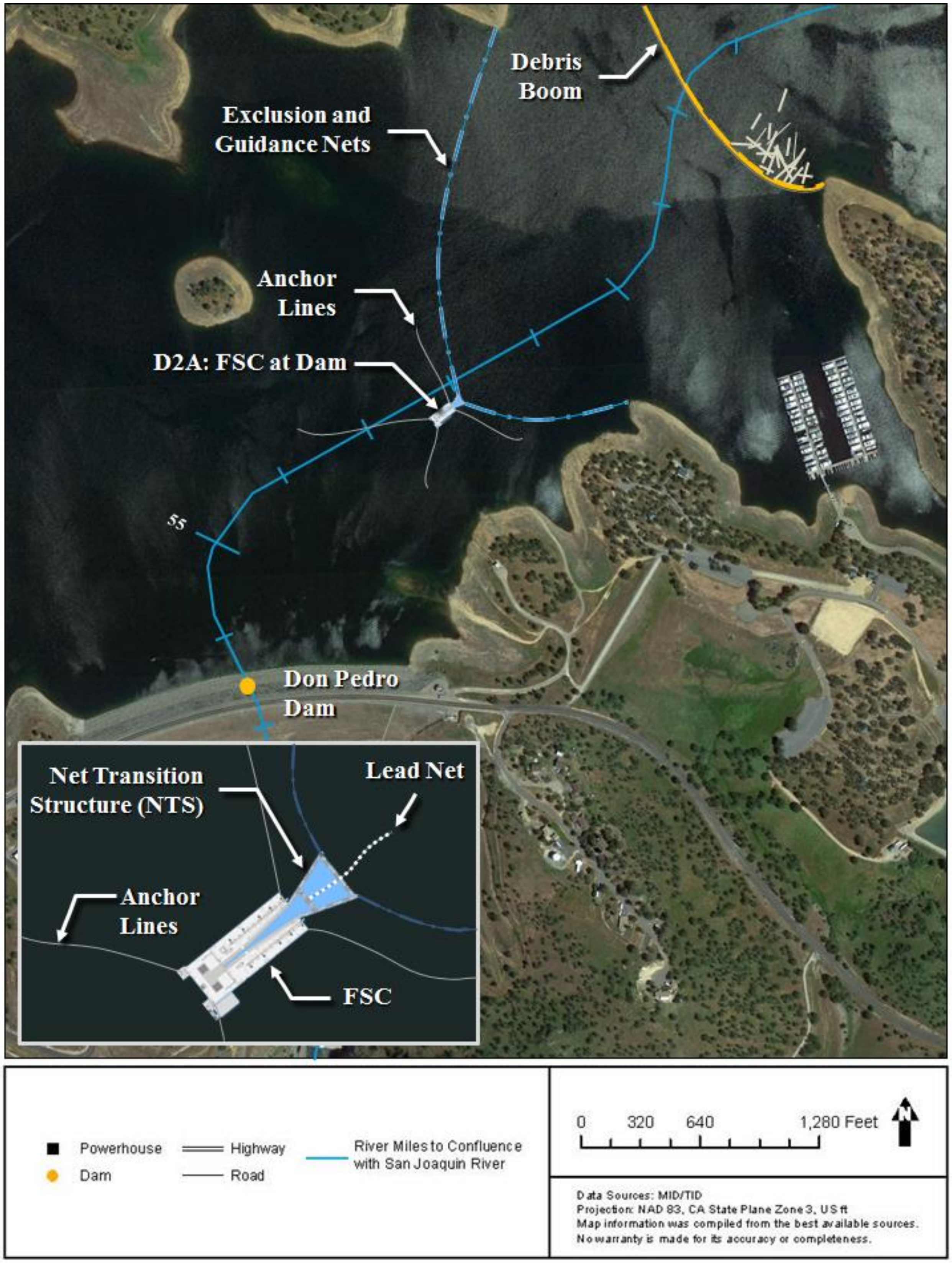


Figure 4.3-15. Overview of FSC system at Don Pedro Dam.

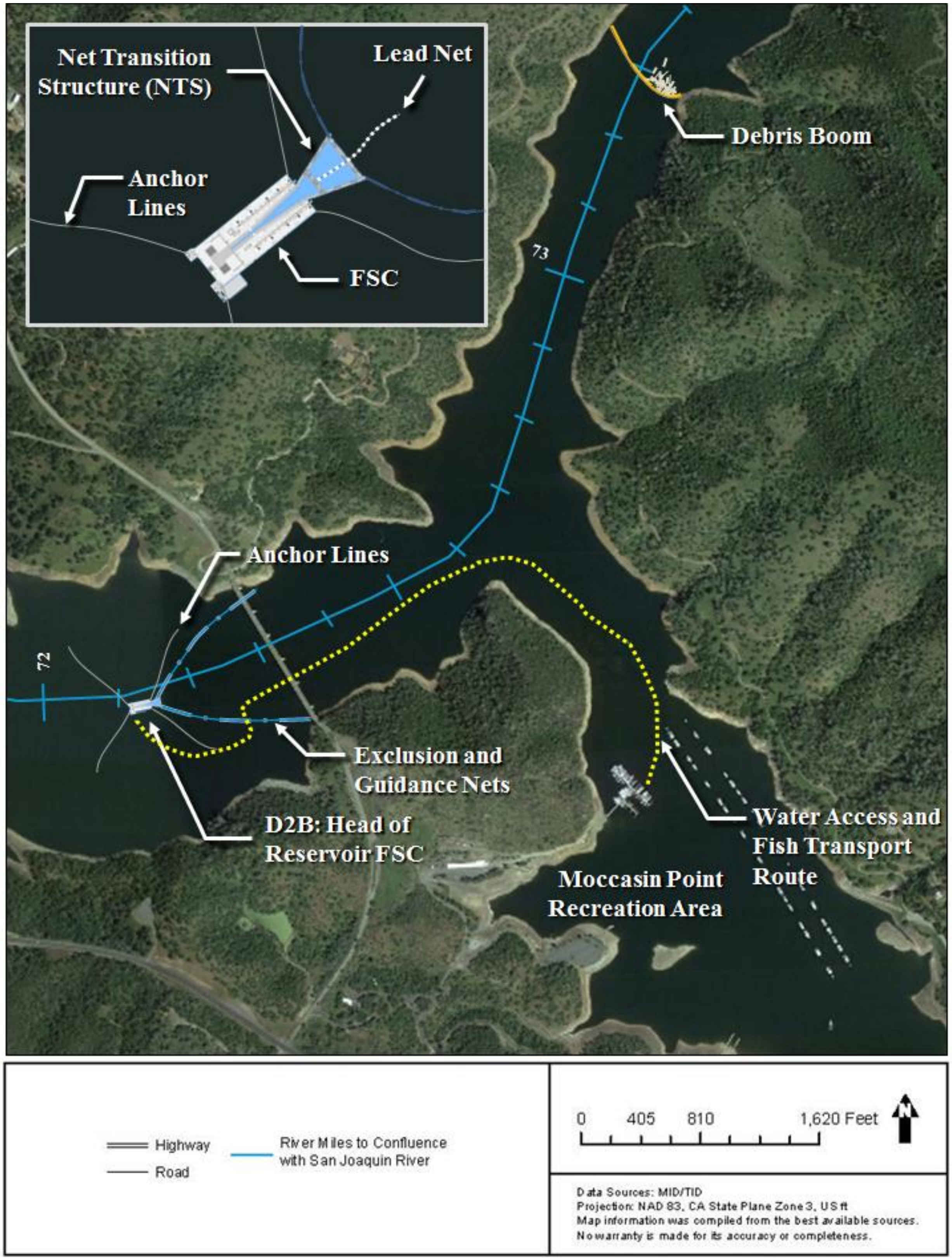


Figure 4.3-16. Overview illustration of FSC system at head of reservoir

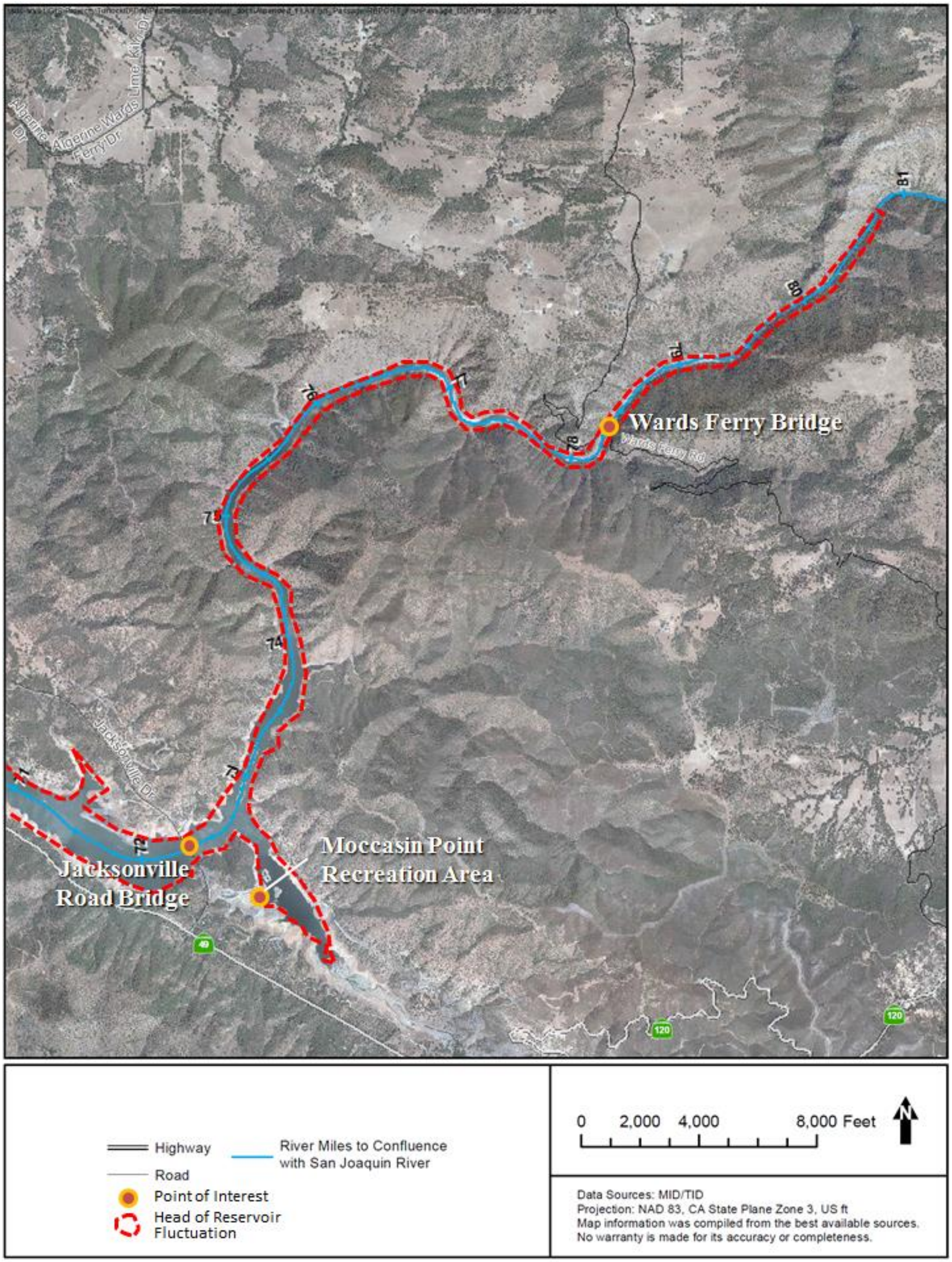


Figure 4.3-17. Variation in head-of-reservoir conditions at the Don Pedro.

Assessment of Feasibility

Alternatives D2A and D2B are determined to be technically infeasible when applying the evaluation factors defined in Section 3.2.3 of this report. Alternative D2A and D2B are not anticipated to meet the overall fish passage performance criteria placed on similar operating facilities. In both cases, application of this technology in such an environment with over 200 feet of total reservoir fluctuation would be impractical and costly and very likely require years of experimentation and trial-and-error efforts leading to additional costly facility modifications without any assurance of ever achieving performance requirements. This determination is discussed further in the paragraphs below.

<u>Feasibility Factor 1. Ability to Meet Engineering, Constructability, and Operational Constraints</u>

Relative to Alternative D2A, other structures of like function have been successfully designed and constructed; however, they operate in environments that exhibit far less reservoir fluctuation. There are currently six full-scale examples of FSCs at the dam forebay in operation. Each exhibits a limited history of performance ranging from only 1 to 9 years. Relative to Alternative D2B, there are currently no surface collection facilities similar in scale, function or location that operate at the head of reservoirs. Relative to both FSC alternatives, there are no full-scale systems operating in a similar operating environment with reservoir fluctuations of 230 feet. Application of this technology in such an environment would be experimental, impractical, and costly.

<u>Feasibility Factor 2. Ability to Operate without Interference with Existing Uses</u>

Neither alternative option would impact current water supply or power generation objectives of the existing facilities. However, in addition to the experimental nature of such alternatives in a reservoir with such pronounced changes in elevation, debris booms and guide nets would result in a moderate nuisance to existing recreational activities on the lake. This is particularly relevant to Alternative D2B, given the dramatic nature of the reservoir and the changing location of "head of reservoir" throughout the hydrograph. Further, with regard to Alternative D2B, depending on the location of "head of reservoir", facility features (e.g., guide nets) may infringe upon outstandingly remarkable values designated in Wild and Scenic reaches of the Tuolumne River. Pathways for boat passage can be provided in the form of breaks in boom structures, etc. but such crossings may negatively impact the boating experience on the reservoir.

<u>Feasibility Factor 3. Ability to Meet Usual and Customary Fish Passage Performance Standards</u>

This alternative is considered infeasible because the overall fish passage performance of this alternative is not anticipated to meet the regulatory performance standards that have been placed on similar operating facilities. The potential performance of a FSC in Don Pedro Reservoir for the La Grange and Don Pedro projects is complex and is influenced by a number of tradeoffs. The technology itself is evolving and there are no facilities currently in operation at sites that are similar to Don Pedro Reservoir. Table 4.3-11 provides a list of existing facilities and their measured levels of performance. Of the facilities listed, the surface collection facilities located at Cushman Reservoir, Swift Reservoir, Cougar Reservoir, and Lake Billy Chinook are most similar to Don Pedro although their associated reservoirs are much smaller in size and exhibit far less water surface fluctuation. They are located in much smaller, multi-purpose reservoirs that accommodate water supply and/or flood control operations in addition to hydro power generation. None of the examples, however, have the same thermal, outflow, reservoir shoreline complexity, or reservoir fluctuation characteristics that Don Pedro exhibits. Therefore, they are relevant examples, but their performance is not directly comparable if such technology is applied at Don Pedro Dam or head of reservoir locations. As one example, none of them exhibit a potential reservoir fluctuation over 213 feet during the anticipated period of migration. Monitoring reports were reviewed and measured collection efficiencies for these facilities ranged from less than 1 percent to 62 percent. Survival associated with collection and release activities ranged from 89 percent to 100 percent, with the exception of the Pelton-Round Butte project which reports an overall survival value of 55 to 67 percent for steelhead and Chinook. Overall passage efficiencies for these facilities ranged from less than 1 percent to as high as 33 percent. Many factors contribute to their level of performance.

Table 4.3-11. Summary of performance metrics for existing downstream fish passage facilities.

Facility Name and Location	First year of Operation	Reservoir Passage (R)	Collection (C)	Survival (S)	Overall Efficiency (RxCxS)
Baker Lake Project - Baker Lake, WA	2008	Not evaluated	Coho: 90.4% Sockeye: 85.4%	Species combined: Exceeds 98%	Not evaluated
Baker Lake Project - Lake Shannon, WA	2013	Not evaluated	Coho: 92.1% Sockeye: 87.3%	Species combined: 99.2%	Not evaluated
Cushman Project – Lake Cushman, WA	2014	Coho: 20%	Coho FCE: 32%	Coho: 89%	Coho SS: 18%
Clackamas River Project – North Fork Reservoir, OR	2015	Coho: 98.9% Chinook: 99.1% Steelhead: 96.4%	FGE: Coho: 98.9% Chinook: 98.3% Steelhead: 97.5%	Coho: 100% Chinook: 100% Steelhead: 100%	Calculated: Coho: 97.8% Chinook: 97.4% Steelhead: 94.0%
Pelton Round Butte Project – Lake Billy Chinook, OR	2009	Chinook: 23.8% Steelhead: 26.8%	Chinook: 62%: Steelhead 39%	Chinook: 67% Steelhead: 55%	Calculated: Chinook: 10% Steelhead: 5.7%
Lewis River Project – Swift Reservoir, WA	2012	Coho: 89.7% Chinook: 33.3% Steelhead: 70%	Coho: 30.6% Chinook: <1% Steelhead 23.5%	100% (fry) 97.6% (smolt) Injury: 0.0% (fry) 0.7% (smolt)	Coho: 33% Chinook: <1% Steelhead: 15%
Cougar Dam – Cougar Reservoir, OR	2014	Chinook RPE x FBE: 90.2%	Not measured	Chinook DE: 48% EE: 1.3%	Chinook <1%

Note: See Attachment D for a full list of table definitions, citations, and references

As shown, other facilities located at Upper Baker, Lower Baker, and North Fork exhibit collection efficiencies ranging from 85.4 to 98.9 percent with the reservoir passage at North Fork measured to be between 94 and 97.8 percent. These facilities are located in reservoirs that are operated primarily for hydropower generation and exhibit an operating environment more favorable for collection of juvenile outmigrants such as cooler water temperatures, very low reservoir fluctuation during normal years, narrower more simplified reservoir complexity, and a high outflow among numerous other factors. In each case, the reservoir flow patterns, fish behavior in the reservoir, and the operating environment were evaluated for decades prior to implementation of full-scale facilities. Upper Baker included the implementation of a small-scale facility called a "gulper" for almost 40 years. North Fork operated surface outflow facility for a similar amount of time. All of these factors lead to their high levels of performance. Even with such a high level of performance, these facilities rarely meet their regulatory performance requirements.

There are tradeoffs associated with the application of this technology near the Dam (Alternative D2A) and near the head of reservoir (Alternative D2B). Performance for Alternative D2A would be diminished due to loss of fish associated with long residence times, potential for predation, and thermal complexity. Performance for Alternative D2B is unknown given the experimental application of the technology and the challenges associated with vertical forebay fluctuation and longitudinal variation of Don Pedro Reservoir. Given what is known regarding other facilities in operation, a surface collection facility operated in Don Pedro Reservoir at any location will likely be unable to meet regulatory performance requirements associated with collection efficiency and overall passage efficiency.

Alternative D3: Fixed In-River Collector

Another downstream passage alternative is an in-river collector, located near the upstream end of the project extent. An in-river type collector is a fixed, screened-type in-stream collection structure that, in this case, would be located near the upstream end of the head of reservoir. The collector was not located above the head of reservoir (RM 80.8), due to the Wild and Scenic designation of the Tuolumne River upstream of the reservoir. It was assumed that any impacts, including water surface impacts, upstream of RM 80.8 would not be permittable. Therefore, the proposed facility would create a small impoundment near the upstream end of the Don Pedro Project area. The impoundment would be managed so that water surface elevations are no higher than 830 feet, the current maximum pool elevation.

The impoundment would be created by an adjustable weir system (bladder dam or Obermeyer-weir) that would direct a portion of the river flow through a screened juvenile collection facility. The overall size and flow capacity of the screens are constrained by the available space in the river canyon as well as by NMFS (2011) design guidelines that dictate the required effective screen area for a given flow. Preliminary calculations performed during alternative formulation led to the selection of a flow capacity on the order 2,000 cfs. This is consistent with other large screening facilities already in operation at other screened surface water diversions and juvenile collection facilities. Once inside the collection facility, water would be screened off through vertical flat-plate screens while fish would continue downstream in the collection channel. At the end of the channel, fish would be mechanically segregated by size through floor screens and routed into holding tanks.

The holding tanks would include mechanical crowders to move fish into a transport hopper. Once fish are transferred to the hopper, the hopper would be lifted and placed onto a transport vehicle. The hopper of vehicle would be equipped with life support systems to maintain water quality during the transportation of fish. The transport vehicle would then transport fish to a desired location downstream of LGDD release them directly into the river or into an acclimation pond that would allow them to volitionally swim into the Tuolumne River.

The collector would only be effective for the first 2,000 cfs. When flows exceed the design capacity, the remainder of the water would flow into the reservoir without any fish collection, reducing collection efficiency at times when juvenile migration is potentially occurring. Another possibility is when the reservoir elevation is at or near the maximum of 830 feet, the screening facility would not have the necessary water head differential required to screen 2,000 cfs. This would mean that when the reservoir is within a few feet of the maximum pool elevation, the screens will become backwatered and unable to screen the entire design capacity of 2,000 cfs. Further development of this alternative would need to consider the timing, frequency, and magnitude of high flow events and the relationship between the rate of fish migration and flow to properly access the passage efficiency and to refine the magnitude of the design flow.

Table 4.3-12 summarizes the anticipated functional elements that could inform the basis of major design features for a fixed in-river collector. Figure 4.3-18 illustrates an overview of an in-river collection system.

Table 4.3-12. Summary of anticipated functional elements for D3: Fixed In-River Collector.

Project Element	Function and Intent
Debris management systems	Acts as the initial line of defense to deflect and route incoming woody debris to a location where it can be passed safety downstream or storage onshore without interruption of fish collection operations. Helping maintain clean screens.
Adjustable bladder dam or weir	Guides fish and incoming flow to the screened collection inlet structure throughout a defined range of operational flow conditions. Impounds flow at desired water surface elevation and depth which allows for safe screening of flow and collection of outmigrating fish.
Fish ladder	Provides a volitional pathway for the upstream migration of adult spring-run Chinook and steelhead while the juvenile facility is in operation.
Fixed, screened collection inlet structure	Provides a defined collection channel which gradually increases flow velocity, safely decreases flow volume, and guides fish to a capture zone where they are collected and conveyed to holding tanks.
Holding tanks	Provides safe holding area for collected fish for a desired period of time and allows for safe and efficient transfer to hoppers.
Hopper	Temporarily contains and lifts fish in small vessel configured for water to water transfer to transport vehicle.
Transport trucks	Vehicle and transport vessel used to transport collected fish to a specified release point downstream of dam.
Road improvements and associated hill slope stabilization	Reliable all weather travel surface that provides access to the collection facility throughout all seasons of the year.

Project Element	Function and Intent
Upgraded electrical service to the project location and emergency backup generators	Provides 3-phase power to the collection facility. Emergency backup generators would allow for continued operation of facility during power outages via standby generators.

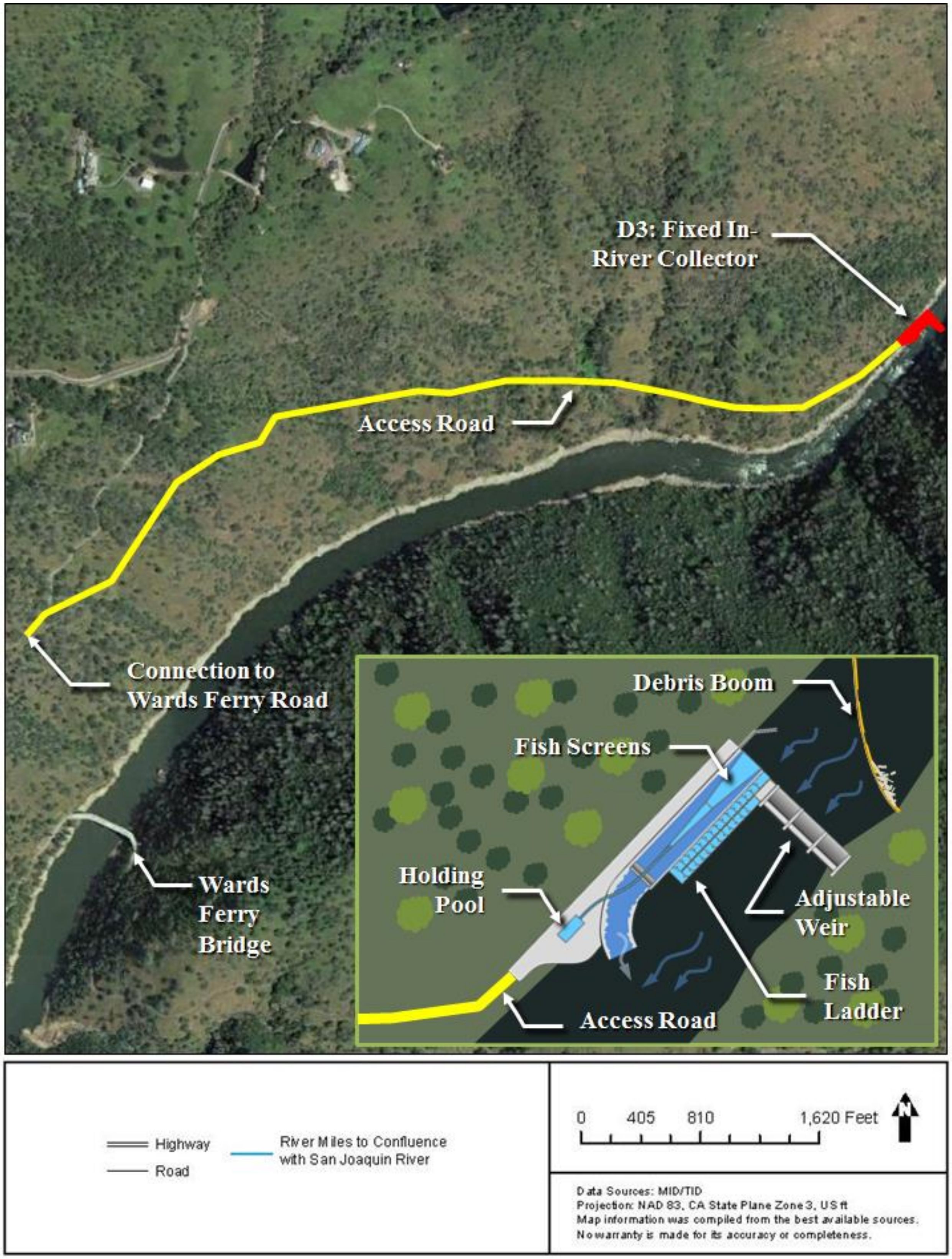


Figure 4.3-18. Overview of In-River Collection System.

Assessment of Feasibility

Alternative D3: Fixed In-River Collector was determined to be technically infeasible when compared to the feasibility evaluation factors defined in Section 3.2.3 of this report. As with other downstream passage alternatives, this alternative is believed to meet survival performance requirements typically imposed by the resource agencies for like downstream facilities. However; it is not anticipated to meet the overall fish passage efficiencies given that must bypass a portion of the river when flow magnitudes exceed the available design capacity. Further, a channel spanning structure implemented at this location will result in a significant alteration of the Wild and Scenic experience for whitewater rafters seeking to navigate to the Wards Ferry Bridge take-out location. This determination is discussed further in the paragraphs below.

<u>Feasibility Factor 1. Ability to Meet Engineering, Constructability, and Operational Constraints</u>

Alternative D3 is infeasible relative to Feasibility Factor 1 because it could not be designed to screen flows exceeding 2,000 cfs. This would result in a failure to collect smolts over the entire migration period when higher flows may occur. The overall size and flow capacity of the screens are constrained by the available space in the river canyon as well as by NMFS (2011) design guidelines that dictate the required effective screen area for a given flow.

<u>Feasibility Factor 2. Ability to Operate without Interference with Existing Uses</u>

This alternative is not anticipated to impact current water supply or power generation objectives of the existing facilities. However, a channel-spanning structure implemented at this location will result in a significant nuisance to the whitewater rafting community. Pathways for passage can be provided but the structure itself will result in a negative impact to the recreational experience sought after by the rafting community on the Tuolumne River, and, depending upon specific location, may not be permittable as a water resource project give the location's proximity to reaches of the river designated as Wild and Scenic under the WSRA.

<u>Feasibility Factor 3. Ability to Meet Usual and Customary Fish Passage Performance Standards</u>

There are no other similar facilities in operation that collect outmigrating smolts to inform the design, operation, and performance of such a structure. Screened collection technologies are integrated into surface collection systems, dam bypass systems, and surface water diversions frequently; however, they have not been implemented to collect outmigrating fish in a riverine environment upstream of or at the head of reservoir. Based upon the lack of existing facilities and associated performance data, this alternative is considered experimental.

Although survival is expected to meet regulatory compliance standards, this alternative is considered infeasible because the overall fish passage performance of this alternative is unknown. Further, given the limits on functionality over the full outmigration period, is not anticipated to meet typical regulatory compliance standards for juvenile collection efficiency. These are both factors that influence the overall fish passage performance.

Performance of in-river collectors is highly dependent upon the cues that motivate out-migrating fish unique to the upper Tuolumne River. Outmigrants can be motivated by freshets or by periodicity (seasonality or time of year) and in many cases it is a combination of both. If migration primarily occurs on the basis of freshet response, fish collection may occur during periods of higher flow regime (above the design flow of 2,000 cfs). During these higher flows a lower proportion of the flow enters the collection channel and a larger portion of the flow passes over the adjustable weir. Those fish that are passed over the weir would travel to the reservoir and not be collected. In this case, collection efficiency will be low. However, not all populations exhibit an outmigration response specifically to freshets alone. Water temperature, diel effects, foraging conditions, other water qualify factors like dissolved oxygen or turbidity, and fish age also play a factor. In these scenarios, fish may be motivated to migrate downstream based upon periodicity which may occur at a more uniform rate over specific periods of time rather than during specific flow events. If fish are migrating out at lower flow conditions, a higher proportion of water would be routed through the collection channel and higher collection efficiency would be realized.

The daily fluctuation in flows in the upper Tuolumne River due to upstream hydropower operations will also have a significant, but unknown, influence on outmigration.

4.4 Anticipated Costs for Potential Fish Passage Facilities

The following section summarizes anticipated costs associated with the implementation of potential upstream and downstream fish passage alternatives. Costs are broken into four discrete components as summarized in the following list:

- Anticipated Operation and Maintenance Costs – Anticipated annual costs of labor, equipment, and supplies necessary to operate and maintain a potential fish passage facility.
- Opinion of Probable Construction Costs – Estimated cost of constructing the potential fish passage facility.
- Implementation Costs – Cost values accounting for administration, studies, engineering, permitting, and construction management efforts required prior to construction of a potential fish passage facility.

4.4.1 Anticipated Operation and Maintenance Costs

Based on project components requiring operation and maintenance (O&M) found in the alternative descriptions, estimates of annual O&M costs for the upstream passage facilities are anticipated to be on the order of $294,000 to $388,000 per year. Downstream fish passage annual O&M costs are anticipated to be on the order of $322,000 to $537,000. Table 4.4-1 provides a summary of the anticipated upstream and downstream fish passage O&M annual costs.

The major differentiator in annual O&M costs between alternatives is power demand and then monitoring and evaluation effort. For upstream passage, monitoring and evaluation effort increases with two facilities as both facilities would need to monitor their collection and survival efficiency. Downstream passage alternatives that require reservoir transit will require additional monitoring and evaluation efforts to assess reservoir transit efficiency. Typically, higher operations and maintenance costs are expected for alternatives such as U3: CHTR which require daily trap and transport operations. However, none of the proposed alternatives are fully volitional and many of them require either higher levels of pumping for operations and/or trap and transport operations. In some cases, alternative anticipated performing such activities at two separate facilities (i.e. Alternatives).

Table 4.4-1. Anticipated annual O&M costs for fish passage alternatives.

Alternative	Annual O&M
Upstream Fish Passage Facility Alternatives	
U1A: Technical Fish Ladder - Bypass	$324,000
U1B: Two Separate Technical Fish Ladders	$388,000
U2: Fish Lift with Technical Ladder at La Grange	$377,000
U3: CHTR	$294,000
U4: Whooshh Fish Transport Tube	$319,000
Downstream Fish Passage Facility Alternatives	
D1: Fixed Multi-Port Collector with Helical Bypass	$286,000
D2A: Floating Surface Collector near Dam	$529,000
D2B: Floating Surface Collector near Head of Reservoir	$537,000
D3: Fixed In-River Collector	$322,000

Each alternative will require periodic refinement, modification, and/or replacement of project components to continuously improve collection and passage performance. These types of costs are prevalent for all high-dam fish passage facilities in operation and are normally significantly underestimated (Anderson et al. 2014). Costs ranging from $350,000 to $1.5 million will likely occur every year for the first two to four years of operation and then on the order of once in every 5 years thereafter. These types of costs are not currently represented in the base operation and maintenance estimates presented, but should be considered when evaluating life cycle costs over the duration of the project.

4.4.2 Capital Cost

Table 4.4-2 provides a summary of estimated OPCCs for the proposed fish passage alternatives. The U3: CHTR facility is anticipated to be the least expensive upstream passage facility to construct, while the U1A: Technical Fish Ladder – Bypass is anticipated to be the most expensive. The least expensive downstream passage facility to construct is the D3: Fixed In-River Collector, however it needs to be noted that the cost assumes the facility is not designed to provide downstream passage during all fish passage design flows. D1: Fixed Multi-Port Collector with Helical Bypass is the most expensive downstream alternative to construct.

Table 4.4-2. Summary of concept OPCC costs for fish passage alternatives ($US Million).

Alternative	Low OPCC (-25%)	Base OPCC	High OPCC (+40%)
Upstream Fish Passage Facility Alternatives			
U1A: Technical Fish Ladder - Bypass	$220,617,000	$294,156,000	$411,818,000
U1B: Two Separate Technical Fish Ladders	$135,890,000	$181,186,000	$253,660,000
U2: Fish Lift with Technical Ladder at La Grange	$65,494,000	$87,325,000	$122,255,000
U3: CHTR	$25,226,000	$33,635,000	$47,089,000

Alternative	Low OPCC (-25%)	Base OPCC	High OPCC (+40%)
U4: Whooshh Fish Transport Tube	$39,089,000	$52,118,000	$72,965,000
Downstream Fish Passage Facility Alternatives			
D1: Fixed Multi-Port Collector with Helical Bypass	$213,837,000	$285,116,000	$399,162,000
D2A: Floating Surface Collector near Dam	$61,343,000	$81,791,000	$114,507,000
D2B: Floating Surface Collector near Head of Reservoir	$62,526,000	$83,368,000	$116,715,000
D3: Fixed In-River Collector	$37,051,000	$49,401,000	$69,161,000

4.4.3 Implementation Cost

Every project requires investment in both time and expense to account for staff administration fees, consultant engineering fees, permitting costs, and other such costs as listed in Table 4.4-3. For the purposes of this exercise, a percent of the total construction cost was used to approximate implementation costs for the proposed upstream and downstream passage facilities.

Table 4.4-3. Implementation costs as a percentage of the OPCC.

Project Implementation Costs	Percentage of OPCC
Construction Management	8.00%
APS Procurement	4.00%
Engineering/Consulting	12.00%
Permitting	8.00%
Bond and Insurance	2.50%
Project Administrative	10.00%
Total Percentage of OPCC	**44.5%**

Implementation costs are assumed to be 44.5 percent of the base OPCC and are intended to include costs leading up to or occurring during construction including: Engineering/Consulting, Permitting, Owner Construction Management, Procurement, and Bonds and Insurance. Owner administration costs are not included in these estimates.

5.0 DISCUSSION AND FINDINGS

As defined in the FERC-approved RSP, Phase 1 of the Fish Passage Facilities Alternatives Assessment consisted of gathering information on facility siting, facility sizing, general biological and engineering design parameters, and operational considerations in a collaborative process with licensing participants. The collaborative process in 2015 included the completion of public Workshops and production of technical memoranda (TMs), the goals of which were to identify key information needs and solicit input and feedback from licensing participants. Identification of important data gaps and addressing these data gaps within a collaborative process was intended to be completed in Phase 1 of the study. Results of this collaboration were intended to provide a common framework to evaluate feasible fish passage conceptual alternatives that are capable of meeting clearly-defined anadromous fish reintroduction goals and objectives. Throughout 2015 and 2016, the Districts requested additional input from licensing participants to resolve numerous data gaps and to establish clear definable goals for the potential reintroduction of anadromous fish to the upper Tuolumne River and performance expectations for fish passage facility alternatives. The lack of input relating to the definition of performance expectations and feasibility thresholds inhibited the ability of the Districts to complete Phase 1 and subsequently begin Phase 2 in 2016.

In 2017, the Districts proceeded to Phase 2 using available information from the literature and suppositions generated from the judgment of the Districts' technical fish passage and biology professionals. As part of Phase 2, the Districts developed functional site layouts, facility sizing, general design parameters, expected fish collection and survival efficiencies, opinions of probable construction costs, and operation and maintenance costs for select fish passage alternatives. Considerations addressed during the development of preliminary functional layouts for upstream and downstream passage alternatives included: (1) a clear description of major facility design elements, (2) an assessment of technical feasibility, and (3) facilities costs.

A review of salient, site-specific information was performed to characterize the biological and physical setting of the study area. Key factors that influenced the overall applicability, selection, and configuration of potential fish passage facility alternatives were identified and discussed. Available information was then used to establish specific design criteria and operational conditions that were used to formulate the potential fish passage alternatives.

Unique site-specific factors of importance to the consideration of fish passage facility alternatives applicability, operational complexity, and performance are summarized in the following list:

- Access to the head of Don Pedro Reservoir is limited to four remote locations with only one having access to the water's surface. Any consideration of accessing potential fish passage facilities, fish release, or fish collection locations in the head of reservoir would require construction of new roads or travel via water craft from an exiting boat launch;
- The reach of the Tuolumne River just upstream of the project boundary at RM 80.8 is designated Wild and Scenic, and therefore any use or development that affects the "free flowing" character of this designated reach is restricted and would constitute a fatal flaw.
- Don Pedro Reservoir experiences large water surface fluctuations of up to 213 feet during the anticipated period of upstream and downstream migration of target fish species. This

magnitude of fluctuation is greater than all other fish passage facilities currently in operation at high-dams.

Characterization of conditions within Don Pedro Reservoir shows that low velocities, strong thermal stratification, and predation will result in higher residence times, loss of navigational cues to the reservoir outlet, and mortality of outmigrating juvenile fish. Each of these factors results in the loss of fish and overall reduction in reservoir passage effectiveness when reservoir transit is part of an upstream or downstream fish passage strategy.

- Upstream fish passage facilities located below the La Grange Hydroelectric Project will need to operate throughout a range of river flows from 150 cfs to 7,232 cfs and will require AWS systems that can accommodate a minimum of 360 cfs.
- Downstream fish passage facilities located at the head of Don Pedro Reservoir will need to accommodate inflows ranging from 93 to 10,589 cfs during the anticipated period of time when outmigrating spring-run Chinook or steelhead are expected to be present. SPUC hydropower operations cause within-day flow fluctuations in the range of 100 to 500 cfs during the anticipated periods of outmigration and up to approximately 1,000 cfs in late summer.

Facilities implemented in response to FERC licensure carry with them strict performance standards when ESA related impacts exist and are required to provide annual results of monitoring efforts. Performance standards that are required by the resources agencies at modern high-dam fish passage facilities are representative of the standards that would likely be mandated for a new fish passage facility at the La Grange or Don Pedro Projects. As demonstrated through review of FERC license documentation upstream fish passage facilities are expected to provide Adult Passage Efficiencies of 75 to 95 percent with survival standards of 95 to 98 percent. Performance of downstream fish passage facilities are measured using three separate metrics. Reservoir passage efficiencies must fall within a range of 75 to 85 percent, collection efficiencies must meet a standard of 95 percent, and survival of smolt through the facilities must be between 98 and 99.5 percent. The overall downstream fish passage efficiency for these existing facilities, is expected to range from 75 to 97 percent. Although many upstream fish passage facilities located in the Pacific Northwest may comply with both Adult Passage Efficiency and survival standards (some do not), none of the downstream collection facilities located in multi-purpose reservoirs (hydropower, flood control, and water supply similar in function as Don Pedro) are documented to meet the reservoir, collection, or overall fish passage standards.

Potential upstream and downstream fish passage facility alternatives were developed to a conceptual level of design and then examined based upon their ability to meet three evaluation factors to determine technical feasibility:

(1) The alternative must be able to be engineered, constructed, and operated in the context of the existing physical make-up of the site geology, existing structures, site hydrology, reservoir operations, site constraints, and a host of operational and safety requirements;

(2) The alternative must be capable of being implemented without undue interference with existing facilities and uses; and

(3) The alternative must be able to achieve the usual and customary performance standards established for similar facilities, such as collection efficiency, survival through a passage facility, and overall passage efficiency.

Five potential upstream fish passage facility alternatives were developed to a conceptual level of design:

- Alternative U1A: Technical Fish Ladder - Bypass
- Alternative U1B: Two Separate Technical Fish Ladders
- Alternative U2: Fish Lift with Technical Ladder at La Grange
- Alternative U3: CHTR Facility
- Alternative U4: Whooshh Fish Transport Tube

After an assessment of major functional elements, advantages, disadvantages, and assessment of technical feasibility based upon the evaluation factors defined above, only Alternative U3: CHTR Facility was determined to be technically feasible. The remaining four alternatives were not determined to be technically feasible based upon the evaluation factors defined in Section 3.2.3 of this report. Of the alternative concepts developed, none of the alternatives investigated that were volitional in nature could be considered likely to meet performance standards given the 213 feet of total reservoir fluctuation that can occur at Don Pedro Reservoir during the anticipated period of migration. Both the fish ladder and fish lift alternatives would require the integration of an experimental fish return flume or fish transport tube system at the fish passageway exit that would accommodate release of upstream migrating fish into Don Pedro Reservoir. Alternatives U1A, U1B, U2, and U4 also rely on adult upstream migration through Don Pedro Reservoir which is very likely to significantly reduce their overall Adult Passage Efficiency.

Four potential downstream fish passage facility alternative were also developed to a conceptual level of design:

- Alternative D1: Fixed Multi-Port Collector with Helical Bypass near Don Pedro Dam
- Alternative D2A: Floating Surface Collector near Don Pedro Dam
- Alternative D2B: Floating Surface Collector near Head of Reservoir
- Alternative D3: Fixed In-River Collector

None of the downstream alternatives were determined to be technically feasible based upon the evaluation factors defined in Section 3.2.3 of this report. Of the technologies evaluated only one alternative has examples of facilities that are currently in operation: Alternative D2A. The remaining alternatives represent types of downstream fish passage technologies that are yet to be applied in practice at a full scale, and it cannot be known how or whether such a facility will work. Therefore, these alternatives are experimental. In each case, there are no facilities in existence to provide an adequate operational history that can adequately inform the engineering, operational, or performance aspects of the alternatives. For all alternatives, the anticipated reservoir passage efficiency and collection efficiency standards are not likely to meet the performance standards required at other high dam facilities in operation.

For all alternatives, including D2A, the anticipated Don Pedro reservoir passage efficiency and facility collection efficiency standards are highly unlikely to provide safe and effective juvenile passage, or achieve the performance standards required at other high dam facilities in operation. Operation of a floating surface collector near Don Pedro Dam is highly unlikely to provide timely or effective downstream fish passage for outmigrating anadromous salmonids. The high head nature of the dam combined with the dramatic (i.e., up to 213 feet) fluctuations in reservoir surface elevation in Don Pedro Reservoir and associated seasonal changes in temperature and velocity create challenging conditions for fish collection. No existing collection facilities currently operate under such dynamic conditions, as discussed in Section 4.3.2, and operation of a juvenile downstream collection facility at the head of reservoir would be experimental in nature.

In the SPD, FERC recommended that, as part of the Fish Passage Facilities Alternatives Assessment, the Districts evaluate the technical and biological feasibility of the movement of anadromous salmonids through La Grange and Don Pedro project reservoirs only if the results of the assessment indicate that the most feasible concept for fish passage would involve fish passage through Don Pedro Reservoir or La Grange headpond. Because the only feasible upstream passage option is CHTR, which bypasses the reservoir, and none of the downstream passage options were determined to be feasible based upon the evaluation factors in Section 3.2.3 (and as summarized above), the Districts are not conducting a study on anadromous salmonid movement through the reservoirs.

Base opinions of probable construction costs for potential upstream fish passage facility alternatives are estimated to range from $33 to $294 million with annual operations and maintenance costs of up to $400,000 per year. Base opinions of probable construction costs for potential downstream fish passage facility alternatives are estimated to range from $49 to 285 million with annual operations and maintenance costs of up to $500,000 per year. Costs developed for these alternatives do not include implementation costs or costs associated with the periodic refinement, modification, and/or replacement of project components to continuously improve collection and passage performance which are prevalent with existing facilities currently in operation at high dams.

6.0 STUDY VARIANCES AND MODIFICATIONS

There were no variances or modifications from the original study plan required while completing this study.

7.0 REFERENCES

61 FR 4722. National Marine Fisheries Service. Notice of Policy: Policy Regarding the Recognition of Distinct Vertebrate Population Segments Under the Endangered Species Act. Federal Register 61: 4722-4725. February 7, 1996.

63 FR 13347. National Marine Fisheries Service. Final Rule: Endangered and Threatened Species: Threatened Status for Two ESUs of Steelhead in Washington, Oregon, and California. Federal Register 63: 13347-13371. March 19, 1998.

64 FR 50394. National Marine Fisheries Service. Final Rule: Endangered and Threatened Species: Threatened Status for Two Chinook Salmon Evolutionarily Significant Units (ESUs) in California. Federal Register 64: 50394-50415. September 16, 1999.

64 FR 5740. National Marine Fisheries Service. Proposed Rule: Designated Critical Habitat: Proposed Critical Habitat for Nine Evolutionarily Significant Units of Steelhead in Washington, Oregon, Idaho, and California. Federal Register 64: 5740-5754. February 5, 1999.

65 FR 42422. National Marine Fisheries Service. Final Rule: Endangered and Threatened Species; Final Rule Governing Take of 14 Threatened Salmon and Steelhead Evolutionarily Significant Units (ESUs). Federal Register 65: 42422-42481. July 10, 2000.

69 FR 71880. National Marine Fisheries Service. Proposed Rule: Endangered and Threatened Species; Designation of Critical Habitat for Seven Evolutionarily Significant Units of Pacific Salmon (*Oncorhynchus tshawytscha*) and Steelhead (*O. mykiss*) in California. Federal Register 69: 71880-72017. December 10, 2004.

70 FR 37204. National Marine Fisheries Service. Final Policy: Policy on the Consideration of Hatchery-Origin Fish in Endangered Species Act Listing Determinations for Pacific Salmon and Steelhead. Federal Register 70: 37204-37216. June 28, 2005.

70 FR 52488. National Marine Fisheries Service. Final Rule: Designation of Critical Habitat for Seven Evolutionarily Significant Units of Pacific Salmon and Steelhead in California. Federal Register 70: 52488-52627. September 2, 2005.

AACE International Recommended Practice Number 17R-97: Cost Estimate Classification System. Revised 2003.

Anderson, J.A., G.R. Pess, R. W. Carmichael, M. J. Ford, T. D. Cooney, C. M. Baldwin, and M. M. McClure. 2014. Planning Pacific Salmon and Steelhead Reintroductions Aimed at Long-Term Viability and Recovery.

Bates, K. 1992. Fishway Design Guidelines for Pacific Salmon. Washington Department of Fish and Wildlife. Working Paper. No. 1.6.

Beeman, J.W., and N.S. Adams, eds. 2015. In-reservoir behavior, dam passage, and downstream migration of juvenile Chinook salmon and juvenile steelhead from Detroit Reservoir and Dam to Portland, Oregon, February 2013–February 2014: U.S. Geological Survey Open-File Report 2015-1090.

Beeman, J.W., H.C. Hansel, A.C. Hansen, S.D. Evans, P.V. Haner, T.W. Hatton, E.E. Kofoot,, J.M. Sprando, C.D. and Smith. 2014a. Behavior and dam passage of juvenile Chinook salmon at Cougar Reservoir and Dam, Oregon, March 2012–February 2013: U.S. Geological Survey Open-File Report 2014-1177.

______. 2014b. Behavior and dam passage of juvenile Chinook salmon and juvenile steelhead at Detroit Reservoir and Dam, Oregon, March 2012–February 2013: U.S. Geological Survey Open-File Report 2014-1144.

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

Bureau of Reclamation (BOR). 2013. Public Review Draft of the Bay Delta Conservation Plan Draft Environmental Impact Report/ Environmental Impact Statement. http://baydeltaconservationplan.com/EnvironmentalReview/EnvironmentalReview/2013-2014PublicReview/2013PublicReviewDraftEIR-EIS.aspx. Accessed December 2015.

_____. 2016. Shasta Dam Fish Passage Evaluation – Draft Pilot Study Implementation Plan. December 2016.

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

_____. 2009. California Salmonid Stream Habitat Restoration Manual Part XII Fish Passage Design and Implementation.

California Department of Fish and Wildlife (CDFW). 2017. California Department of Fish and Wildlife, Central Region's Comments on the Draft License Application for the La Grange Hydroelectric Project, Federal Energy Regulatory Commission Project No. P-14581, Tuolumne River, California. August 2017.

California Department of Water Resources (CDWR). 2013. Draft – Technologies for Passing Fish at Large Dams. June 2013.

City and County of San Francisco (CCSF). 2008. Final Program Environmental Impact Report for the San Francisco Public Utilities Commission Water System Improvement Program: Volume 3 of 8. October, 30, 2008.

Don Pedro Recreation Agency. 2017. Don Pedro Lake website, Fishing/Hunting. 2017 Don Pedro Lake Bass and Fishing Tournament Schedule. http://www.donpedrolake.com/sites/default/files/2017%20fishing%20tournaments%206-1-17.pdf. Accessed July 2017.

Fritts, A.L., and T.N. Pearsons. 2006. Effects of predation by nonnative Smallmouth Bass on native salmonid prey: the role of predator and prey size. Transactions of the American Fisheries Society 135:853–860.

Hansen, A.C., T.J. Kock, and G.S. Hansen. 2017. Synthesis of downstream fish passage information at projects owned by the U.S. Army Corps of Engineers in the Willamette River Basin, Oregon: U.S. Geological Survey Open File Report 2017-1101.

Khan F., G.E. Johnson, I.M. Royer, N.R. Phillips, J.S. Hughes, E.S. Fischer, K.D. Ham, and G.R. Ploskey. 2012. Acoustic Imaging Evaluation of Juvenile Salmonid Behavior in the Immediate Forebay of the Water Temperature Control Tower at Cougar Dam, 2010. PNNL-20625, final report submitted to the U.S. Army Corps of Engineers, Portland District, Portland, Oregon, by Pacific Northwest National Laboratory, Richland, Washington.

Kock, T.J. 2017. Surface Collectors in the Pacific Northwest: Operating Characteristics and Collection Success. Short Course – Downstream Passage of Fish at High Head Dams. June 18, 2017.

La Grange Hydroelectric Project Reintroduction Assessment Framework Plenary Group. 2016. Meeting Notes for Workshop No. 4 held on January 27, 2016. [Online] URL: http://lagrange-licensing.com/Documents/20160303_WorkshopNo4_MtgNotes_160303%20Upload.pdf. Accessed September 22, 2017.

Lindley, S.T., R.S. Schick, E. Mora, P.B. Adams, J.J. Anderson, S. Greene, C. Hanson, B.P. May, D. McEwan, R.B. MacFarlane, C. Swanson, and J.G. Williams. 2007. Framework for Assessing Viability of Threatened and Endangered Chinook Salmon and Steelhead in the Sacramento-San Joaquin Basin. San Francisco Estuary & Watershed Science Volume 5, Issue 1. Article 4: California Bay-Delta Authority Science Program and the John Muir Institute of the Environment.

Lusardi, R., and P. Moyle. 2017. Two-Way Trap and Haul as a Conservation Strategy for Anadromous Salmonids. Fisheries. Vol. 42, No. 9. September 2017.

New Webster's Dictionary and Thesaurus of the English Language (Webster). 1992. Definition of "Feasible". Lexicon Publications.

Monzyk, F.R., J.D. Romer, R. Emig, and T.A. Friesen. 2012. Life-history characteristics of juvenile spring Chinook salmon rearing in Willamette Valley reservoirs: Report of Oregon Department of Fish and Wildlife, Corvallis, prepared for U.S. Army Corps of Engineers, Portland, Oregon, contract W9127N-10-2-0008-0007.

Monzyk, F.R., R. Emig, J.D. Romer, and T.A. Friesen. 2013. Life-history characteristics of juvenile spring Chinook salmon rearing in Willamette Valley reservoirs: Report of Oregon Department of Fish and Wildlife, Corvallis, prepared for U.S. Army Corps of Engineers, Portland, Oregon, contract W9127N-10-2-0008-0007.

National Marine Fisheries Service (NMFS). 1997. Fish Screening Criteria for Anadromous Salmonids. Southwest Region.

_____. 2011. Anadromous Salmonid Passage Facility Design. NMFS, Northwest Region, Portland, Oregon.

_____. 2014. Recovery Plan for the Evolutionarily Significant Units of Sacramento River Winter-run Chinook Salmon and Central Valley Spring-run Chinook Salmon and the Distinct Population Segment of California Central Valley Steelhead. California Central Valley Area Office. July 2014.

_____. 2016a. Central Valley Recovery Domain 5-Year Review: Summary and Evaluation Central Valley Spring-run Chinook Salmon Evolutionarily Significant Unit. Protected Resources Division, 1201 NE Lloyd Blvd., Suite 1100, Portland, OR 97232 and Central Valley Office, 650 Capitol Mall, Suite 5-100, Sacramento, CA 95814-4706.

_____. 2016b. Central Valley Recovery Domain 5-Year Review: Summary and Evaluation California Central Valley Steelhead Distinct Population Segment. Prepared by N. Alston, M. Rea, S. Rumsey, and B. Ellrott. Central Valley Office, 650 Capitol Mall, Suite 5-100, Sacramento, CA 95814-4706.

_____. 2016c. Enclosure A: Recommendations to Modify or Clarify the Commission-Approved Study Plan of Letter Regarding Comments of NOAA's National Marine Fisheries Service on the Initial Study Report for the La Grange Hydroelectric Project; and Proposed New Information Gathering or Study for the La Grange Hydroelectric Project, P-14581-000. Submitted to Secretary Kimberly D. Bose, FERC, April 4, 2016.

Northwest Power and Conservation Council. 2016. Staff Paper: Review of Fish Passage Technologies at High-Head Dams. Document Number 2016-14. December 2016.

PacifiCorp. 2016. Lewis River Fish Passage Program 2015 Annual Report. Prepared for PaciCorp and Public District No. 1 of Cowlitz County. April 15, 2016.

_____. 2017. Lewis River Fish Passage Program 2016 Annual Report. Prepared for PaciCorp and Public District No. 1 of Cowlitz County. April 4, 2017.

Poe, T. P., H.C. Hansel, S. Vigg, D.E. Palmer, and L.A. Prendergast. 1991. Feeding of predaceous fishes on outmigrating juvenile salmonids in John Day Reservoir, Columbia River. Transactions of the American Fisheries Society 120:405–420.

Tappel, P.D., and T.C. Bjornn. 1983. A new method of relating size of spawning gravel to salmonid embryo survival. North American Journal of Fisheries Management. 3: 123-135.

Turlock Irrigation District and Modesto Irrigation District (TID/MID). 2010. Report 2009-2: Spawning survey summary update. Prepared by Tim Ford, Turlock and Modesto Irrigation Districts and Steve Kirihara, Stillwater Sciences, Berkeley, CA. March 2010.

_____. 2013a. Spawning Gravel in the Lower Tuolumne River Study Report (W&AR-04). Prepared by Stillwater Sciences. December 2013.

_____. 2013b. Project Operations/Water Balance Model Study Report (W&AR-02). Prepared by Dan Steiner. December 2013.

_____. 2013c. Salmonid Population Information Integration and Synthesis Study Report (W&AR-05). Prepared by Stillwater Sciences. January 2013.

_____. 2014. Don Pedro Hydroelectric Project Final License Application. April 2014.

_____. 2016. Fish Passage Facilities Alternatives Assessment Progress Report. Prepared by HDR, Inc. Appendix to La Grange Hydroelectric Project Initial Study Report. February 2016.

_____. 2017. La Grange Project Fish Barrier Assessment Study Report. Prepared by FISHBIO. September 2017.

Yoshiyama, R.M., E.R. Gerstung, F.W. Fisher, and P.B. Moyle. 2001. Historical and present distribution of Chinook salmon in the Central Valley drainage of California. Pages 71–176 in R.L. Brown, editor. Contributions to the biology of Central Valley salmonids. California Department of Fish and Game Bulletin 179.

Zimmerman, C.E. and G.H. Reeves. 2000. Population structure of sympatric anadromous and non-anadromous *Oncorhynchus mykiss*: evidence from spawning surveys and otolith microchemistry. Canadian Journal of Fisheries and Aquatic Sciences 57: 2152–2162.

FISH PASSAGE FACILITIES ALTERNATIVES ASSESSMENT

STUDY REPORT

ATTACHMENT A

MEETING NOTES FROM RESULTING COLLABORATION WITH LICENSING PARTICIPANTS

CONSULTATION WITH LICENSING PARTICIPANTS

- **FISH PASSAGE ASSESSMENT WORKSHOP NO. 1 (MAY 20, 2015)**
- **FISH PASSAGE FACILITIES ALTERNATIVES ASSESSMENT WORKSHOP NO. 2 (SEPTEMBER 17, 2015)**
- **FISH PASSAGE FACILITIES ALTERNATIVES ASSESSMENT WORKSHOP NO. 3 (NOVEMBER 19, 2015)**
- **FISH PASSAGE FACILITIES ALTERNATIVES ASSESSMENT WORKSHOP NO. 4 (JANUARY 27, 2016)**
- **NMFS APRIL 4, 2016 COMMENT LETTER ON THE LA GRANGE PROJECT INITIAL STUDY REPORT**

La Grange Hydroelectric Project Licensing (FERC No. 14581)
Fish Passage Assessment Workshop No. 1
Modesto Irrigation District
1231 11th Street, Modesto, California

Wednesday, May 20, 2015
9:00 am to 12:00 pm

Meeting Notes

On May 20, 2015, Turlock Irrigation District (TID) and Modesto Irrigation District (MID) (collectively, the Districts) hosted the first of a series of Workshops for the La Grange Hydroelectric Project Fish Passage Facilities Assessment (the Study). This document summarizes discussions during the meeting. It is not intended to be a transcript of the meeting. Attachment A to this document includes the following meeting documents: agenda, sign-in sheet, presentations, and handouts.

Mr. John Devine of HDR, Inc. (HDR), consultant to the Districts, welcomed meeting attendees. Attendees went around the room and introduced themselves. Attendees on the phone introduced themselves; Mr. Tom Engstrom of Sierra Pacific and Mr. Bob Hughes of CDFW were the only two individuals participating remotely (see Attachment A: meeting sign-in sheet).

Mr. Devine provided an introduction to the Workshop. He stated that this is the first of three planned collaborative workshops on the subject of evaluating the various factors regarding the feasibility of implementing upstream and downstream anadromous fish passage at the La Grange Diversion Dam and the Don Pedro Dam. Among today's attendees, there is a wide range of expertise and knowledge related to the topic of fish passage, the issues involved in the investigation of fish passage, and the regulatory process surrounding fish passage decision-making. In light of this, Mr. Devine said this first Workshop would primarily be focused on educating participants on the potential scope and scale of fish passage facilities, what these facilities might look like, and examples of fish passage at other facilities. The National Marine Fisheries Service (NMFS) will present a description of the agency's Federal Power Act Section 18 mandatory conditioning authority which is the primary regulatory mechanism for prescribing fish passage at hydroelectric facilities as part of the Federal Energy Regulatory Commission (FERC) licensing proceedings. Mr. Devine said that the meeting would also touch on the suitability of habitat above Don Pedro Dam for anadromous fish and other information needs that may be valuable in the overall fish passage decision-making process. The Districts encourage an open and collaborative dialogue at today's meeting; anyone with thoughts or questions is encouraged to speak up.

Mr. Devine stated that the purpose of anadromous fish passage at the La Grange Diversion Dam and Don Pedro Dam is to provide anadromous fish access to river reaches upstream of Don Pedro Dam between Early Intake and Don Pedro Reservoir in order to increase populations of Central Valley spring-run Chinook salmon and steelhead. Mr. Devine noted that the Districts have questions about whether fall-run Chinook salmon are also to be considered as part of this assessment. Mr. Devine noted that the Districts hope to get clarification on this today. Mr. Devine also noted that Mr. Jim Hastreiter, the FERC Project Manager, would not be able to participate in the Workshop due to NMFS' filing of a Request for Rehearing on one of the studies NMFS requested but FERC rejected. According to FERC, the Request for Rehearing triggers FERC's legal protocols governing *ex parte* communications and thereby prevents Mr. Hastreiter, or any other FERC staff members, from participating in this Workshop.

Mr. Devine said that the design, construction and operation of fish passage facilities at high-head dams can be very complex and costly. The Districts hope that through the series of workshops and the La Grange Fish Passage Facilities Assessment, a thorough investigation of the engineering, biological, regulatory, and economic issues surrounding fish passage will be completed. As currently proposed, the Study will be a two-year process. Through these workshops, the Districts' role is to develop an understanding of design criteria for fish passage facilities at La Grange and Don Pedro dams, evaluate what facilities would be most appropriate, and prepare detailed cost estimates. Mr. Devine reiterated that this is a two-year process and that during this first year, the goal is for all parties to come together as a group to thoroughly discuss the feasibility of providing fish passage by getting all the issues related to the reintroduction of anadromous fish to the river above Don Pedro Reservoir on the table. He noted that providing fish passage would result in anadromous fish having access to the upper Tuolumne River where they are currently not present. The use of this reach by anadromous fish will constitute another managed use of the existing resource.

Mr. Devine presented introductory slides. Mr. Devine described the La Grange Project and gave an overview of the La Grange Project Integrated Licensing Process (ILP). The Fish Passage Facilities Assessment is one component of a larger study about fish passage. Mr. Devine reviewed the objectives of the overall Fish Passage Facilities Assessment as well as the study area and schedule for reporting. Mr. Devine briefly discussed FERC's February 2, 2015, Study Plan Determination, noting that while FERC required the Districts to develop a study of alternative fish passage facilities and associated cost estimates, FERC indicated it was the responsibility of the resource agencies, and not the Districts, to evaluate the suitability of upstream habitat and preparation of a full anadromous fish life-cycle model, as requested by the agencies. Mr. Devine stated that the Districts were very willing to assist the agencies with certain tasks as they had indicated in their Revised Study Plan, even though not required to do so. He then reviewed the Workshop agenda and introduced Mr. Steve Edmondson of NMFS.

Mr. Edmondson presented slides on the history of hydropower regulation, the Federal Power Act, and details on FERC's environmental analysis and decision-making process. Mr. Edmondson explained that FERC requires studies to understand a project's impacts on developmental and non-developmental resources. He described how other federal legislation plays into the licensing process as well as general methodology for fisheries studies. He reviewed the resource issues commonly raised in FERC relicensing proceedings and the number of FERC hydro projects with fish passage. Lastly, Mr. Edmonson presented on the amount of riverine habitat estimated by NMFS in the overall Central Valley region that had been made unavailable because of dam construction.

Mr. Devine thanked Mr. Edmondson for the presentation. He noted that Mr. Edmondson reviewed the information FERC will use to conduct their environmental analysis and prepare their environmental document. However, as part of the La Grange Hydroelectric Project Licensing, NMFS had indicated a need for significant amounts of information to support fish passage decision-making as detailed in their study requests during the study planning process. Of the studies requested by NMFS, some had been approved by FERC and some had not been approved. Mr. Devine asked that Mr. Edmondson speak to NMFS' Section 18 Authority, as included in the Workshop agenda, and how the information and studies NMFS has requested will be used to decide whether or not to exercise that authority to require fish passage as part of the license proceeding.

Mr. Edmondson responded that NMFS is going to take a hard look at the information in FERC's EIS and from there NMFS would be able to identify the information gaps. NMFS does not require the information requested by studies to make fish passage recommendations. FERC determined the scope of impacts to be from the Golden Gate Bridge to the Tuolumne River headwaters; therefore, FERC will look at the developmental and non-developmental impacts in that reach. Mr. Edmondson noted that FERC included a study about fish passage in the Study Plan Determination because FERC needs basic information about fish passage to undertake its assessment. FERC may itself include fish passage in the license. Mr. Edmonson said that NMFS can recommend fish passage through various parts of the Federal Power Act, including Sections 10(a), 10(j), or 18. In addition to the Federal Power Act, there are according to NMFS other regulatory avenues for requiring fish passage. For example, fish passage may be required under California state law 5937, the Clean Water Act, or the Coastal Zone Management Act, or by federal land management agencies under Section 4(e) of the FPA. Fish passage may also be included in a settlement agreement. Mr. Edmondson stated that NMFS had never required fish passage in California under Section 18. He reiterated that at this time he could not be certain about what information NMFS would need because the information gaps were not yet known.

Mr. Devine said that many individuals attending the workshop do not understand what process NMFS follows under the FPA's Section 18 mandatory conditioning authority. He said it would be helpful for Mr. Edmondson to explain what the prescription is; that it is a mandatory authority (i.e., FERC must accept any Section 18 fishway prescriptions as part of a new license regardless of what FERC determines in its environmental analysis); what information NMFS, as the agency possessing this authority, would use to decide whether to prescribe fishways; and how the decision would be made (e.g., what is the process, how is the information used, are there criteria, is it collaborative, how does NMFS involve all interested parties; what role does economics play, etc.). Mr. Devine noted that both NMFS and the U.S. Fish and Wildlife Service (USFWS) have Federal Power Act Section 18 prescription authority.

Mr. Edmondson replied that it was relatively unusual for the prescription authority to be exercised in California. NMFS had never exercised its Section 18 mandatory conditioning authority in California and, except for the Klamath Project, the USFWS had also never exercised Section 18 authority in the state. The more usual routes for requiring fish passage at a project are by FERC or through settlement. Regarding Section 18 prescription, Mr. Edmondson said NMFS has no specific information requirements and that essentially NMFS uses the best available information. Mr. Edmondson cited the Edwards Dam Project, in which the best available information indicated that the cost of fish passage outweighed the benefit and the decision was made by FERC to instead remove the dam. Mr. Devine clarified that the Edwards Project dam removal was based on a settlement that was driven politically and not for any inability of the project to pass target species of fish. FERC never issued an order requiring removal of the dam.

Mr. Steve Boyd (TID) thanked Mr. Edmondson for his presentation. He noted that a diverse audience was in attendance today with varying degrees of familiarity with the relicensing process and appreciated what Mr. Edmondson presented. However, Mr. Boyd said that the specific details on how Section 18 was implemented had still not been discussed as contained in the agenda and that the audience would appreciate if NMFS could give an overview of Section 18, what information is required to support the process, and how that information informs a decision to require or not require fish passage.

Mr. Edmondson replied that he thought this meeting was looking at the fish passage engineering study. He said that Section 18 is a section of the Federal Power Act that gives NMFS and USFWS mandatory conditioning authority for fish passage. Mr. Edmondson noted that the bar for prescribing fish passage is fairly low and that a project that provides a barrier to fish going to or from spawning or rearing habitat may trigger Section 18 authority. Mr. Edmondson reiterated that fish passage may also be required under Section 401 of the Clean Water Act, CDFW code, the Coastal Zone Management Act, and by FERC or through settlement. Regarding a decision to require fish passage, Mr. Edmondson said that we are all in the information gathering process and it is unknown where the process will lead.

Mr. Devine said that on the projects he had worked on in the past, including projects all across the country, resource agencies with prescription authority provided their preliminary prescriptions for fish passage during the development of FERC's NEPA document. Once FERC has enough information to start its environmental review, the agencies have 60 days to provide recommendations, including preliminary prescriptions under Section 18. In other words, the preliminary prescriptions are considered early in the process before preparation of the environmental document. At this stage of the process, there is supposed to be sufficient information available for NMFS or USFWS to make their decision, though preliminary, about whether to prescribe fish passage. Mr. Devine stated that he was not familiar with any project where the initial agency fish passage prescriptions did not occur until after FERC issued the EIS. In fact, the ILP requires the initial prescriptions be filed early in the FERC review process.
Mr. Edmondson said that after FERC issues a notice of Ready for Environmental Analysis (REA), NMFS provides preliminary terms and conditions for use in the NEPA process. At this time it is unknown whether other agencies or FERC will use their authorities. It is unknown what the available information will be at the time. Those decisions are down the road; it is not even known yet whether it is possible to provide fish passage.

Mr. Edmondson said that the first cut at the information would be to determine if there is historical habitat above Don Pedro Dam. Considering the Lindley analysis (Lindley 2007), it appears that fish used to be able to reach the headwaters and now they cannot. The second cut would determine if fish passage is possible and feasible through engineering and whether fish passage is consistent with agency management plans. Just because something can be done does not mean it should be done. The final step is FERC would weigh the developmental and non-developmental effects to determine if fish passage makes sense. This process happens in the "black box" at FERC, according to NMFS.

Mr. Devine requested that Mr. Edmondson touch on the NMFS Recovery Plan (NMFS 2014) and the relationship of the recovery plan to the species being considered for fish passage. Mr. Edmondson replied that Section 4 of the Endangered Species Act required NMFS to publish a recovery plan. A team of 20 individuals with various backgrounds (biology, business, etc.) reviewed existing information and drafted recommendations for recovery criteria. Congress directed NMFS to identify what the standards would be to delist a species. Mr. Edmondson said that the goal of all resource agencies is to delist species. In the recovery plan, the goal for the San Joaquin River is to sustain populations of Chinook salmon and steelhead below the dams and to secure access to habitat for these species above the dams.

Mr. Devine asked what fish species the Study should investigate. He noted that the NMFS recovery plan refers to spring-run Chinook salmon and steelhead. Mr. Edmondson replied that spring-run Chinook salmon and steelhead are the two listed species in the Tuolumne River but are not the only anadromous species in the river. Most fish passage facilities at other projects are for non-listed species and even non-native species. Mr. Edmondson said that there are not currently populations of either spring-run Chinook salmon or steelhead below the dam. Due to federal law resulting from the San Joaquin settlement, NMFS cannot prescribe fishways specifically for spring-run Chinook in the Tuolumne River until 2025.

Meeting took a 10-minute break. Meeting resumed.

Mr. Devine thanked Mr. Edmondson for his presentation and his description of the FERC process. He noted that it was important for participants to understand that both NMFS and USFWS can require fish passage facilities at FERC-licensed projects, whether or not FERC agrees with the need for such facilities. Mr. Devine said that in his experience, FERC had not ordered a licensee to build extensive upstream and downstream fish passage facilities unless required by an agency mandatory condition. He added that even if FERC, through its own analysis, determines that a fishway is unnecessary, the agencies may still require that a fishway be built since Section 18 prescriptions are mandatory.

Mr. Devine introduced Mr. Bao Le (HDR). Mr. Le is the project lead for the Study and has a background in fish biology.

Mr. Le said that the purpose of his presentation was to begin exploring whether consideration of fish passage at La Grange Diversion Dam and Don Pedro Dam was better addressed through a larger and more robust reintroduction evaluation framework since the focal species to be considered as part of any Tuolumne River fish passage program would be comprised of spring-run Chinook and steelhead to comply with the NMFS recovery plan, both of which are reported to have accessed the upper Tuolumne River (above Don Pedro Reservoir) historically, but are not currently present in this reach. As such, any decision by NMFS to require fish passage at La

Grange and Don Pedro would fundamentally be a decision to reintroduce these fish species back to the upper Tuolumne River. Mr. Le stated that his presentation was intended to focus on this idea of reintroduction, the types of information deemed to be critical to informing the planning and decision-making process, and whether agency guidelines existed to implement such a framework. Mr. Le said that after he concludes his presentation, Mr. Chuck Hanson (Hanson Environmental, consultant to the Districts) would present his views about specific information needs for decision-making.

Mr. Le presented slides. Mr. Le reviewed the fish passage study requests and provided an overview of the Anderson et al. paper (Anderson 2014) on planning Pacific salmon and steelhead reintroductions. Mr. Le described the information needed to inform reintroduction (and therefore, fish passage) decision-making. Mr. Hanson presented slides on the general life cycle specific information needs to consider when evaluating fish passage and reintroduction.

Regarding the term "volitional fish passage," Mr. Peter Drekmeier (Tuolumne River Trust (TRT)) asked what the term "volitional" meant. Mr. Devine replied that volitional means that fish can move upstream and/or downstream under their own power and motivation. For example, fish must "decide", and be sufficiently fit, to climb a fish ladder in order to migrate upstream past a barrier. In contrast, "trap and haul" fish passage requires that fish be collected, transported, and released under a schedule imposed by human intervention.

Mr. Devine said the Districts thought it would be valuable to provide examples of fish passage facilities at other high-head dam projects. He noted that to his knowledge there are no examples of fish passage facilities at high-head dams in California, but there are a few examples in the Pacific Northwest.

Mr. Michael Garello (HDR) presented slides to introduce the process of developing fish passage engineering concepts. Mr. Garello summarized general design criteria needs for fish passage facilities and provided examples of upstream and downstream fish passage facilities at other projects for anadromous fish.

Referring to slide 12, Mr. Larry Byrd (MID Board Member and area landowner) asked if the downstream fish passage facility screens could become clogged with debris in the river. Mr. Garello replied that the screens had very small openings and could become clogged with debris. He added that in general, screens are cleaned regularly by an automated system and that precautions are often taken upstream to prescreen debris, before the debris can reach the entrance to the fish passage facilities.

Mr. Byrd asked what the fish passage success rate was at the Upper Baker Project. Mr. Garello replied that at that particular project, the licensee had been experimenting with fish passage technology since the 1980s. Over time and through trial and error, the licensee had worked to improve how the fish were guided to collection facilities. To determine the fish collection success rate for downstream passage, fish are tagged and then placed in the reservoir upstream of the entrance to the fish passage facility. The number of tagged fish collected by the fish passage facility helps to determine the collection efficiency. Today, projects are often expected to achieve fish passage efficiencies as high as 98%. When fish passage facilities are first commissioned, the efficiency is generally lower. Through trial and error and tweaks to operations, efficiencies may be improved. Mr. Devine added that fish passage facilities at high-head dams are still largely experimental and therefore it is hard to predict what the performance will be when the facilities are built. Although resource agencies may require a specific performance metric, because the facilities are experimental, it is difficult to know whether this metric can be achieved. Mr. Devine said that the purpose of Mr. Garello's presentation was to provide a sense of the scope and scale of fish passage facilities that would likely be considered in the feasibility study to be conducted for Don Pedro and La Grange.

A meeting attendee asked what project has the most successful fish passage facilities. Mr. Garello replied that every project is different and how success is defined varies from project to project.

Regarding the experimental nature of fish passage facilities at high-head dams, Mr. Devine said upstream passage facilities are much less experimental and there are many examples of successful upstream passage facilities. In contrast, downstream passage facilities at high-head dam projects like Don Pedro are much more difficult to engineer. For downstream passage, young fish need to be guided toward facilities, collected and then moved downstream. For projects like Don Pedro where the reservoir is large, spatially complex, and experiences very significant water level fluctuations (greater than 200 ft), it would likely be very challenging to build a facility that could collect the juvenile fish. The facilities necessary to do this work would be considered experimental, in his opinion.

Mr. Thomas Orvis (Stanislaus County Farm Bureau) added that because Don Pedro Reservoir can fluctuate well over 150 ft, reservoir fluctuation would need to be considered for upstream passage as well, such as where and how the fish would be released into the reservoir. Mr. Garello agreed that reservoir fluctuation was one of many issues to be considered. Given the reservoir fluctuation, downstream fish passage facilities may need to be sited upstream of the reservoir. Mr. Garello said that of the five or six fish passage facilities that exist at projects of similar size to Don Pedro Dam, all the facilities collect fish for downstream passage directly at the dam, not at the head of reservoir. Mr. Garello said he did not know of any high- head dam projects where the downstream fish passage facility was permanent and located at the head of the reservoir. Mr. Garello reiterated that while he knew of temporary facilities located at the head of the reservoir for data collection, he did not know of any permanent facilities.

Mr. Orvis said that the drought had resulted in changes to temperatures in the reservoir, and that reservoir water temperatures would also need to be considered in this study. Mr. Garello agreed that water temperature would be among the issues requiring evaluation.

Referring to what Mr. Garello said about facility performance metrics, Mr. Devine noted performance metrics are specified by the resource agencies and will likely include how many fish, of all the fish moving downstream, must be collected and safely transported downstream. To achieve a 90% collection efficiency or greater in Don Pedro Reservoir, it would likely be insufficient to collect fish using only a collection facility. Fish would need to be directed toward the facility with guidance systems using large nets that span the entire depth and width of the reservoir at any collection location. Mr. Orvis noted that such nets would also likely have issues with debris blockage. Mr. Devine added that collecting fish upstream of the reservoir was also not without potential issues. For example, the large variability of spring runoff may be a problem at this collection location. All potential issues must be examined.

Mr. Byrd asked how it is determined when the nets will be dropped to corral the fish into the collection facilities. Mr. Garello replied that the guide nets are left out, and as the fish assemble near the nets, the nets are drawn in, moving the fish to one central location (i.e., collection facility). Mr. Devine said that the guide nets could also have implications for recreational use of the reservoir.

Regarding where fish are released downstream, Mr. Orvis asked if fish predators eventually learn where the fish are released. Mr. Devine replied that such a problem had occurred at other projects and that predator removal was required. A predator removal program would also need to be considered here. According to a study completed for the Don Pedro relicensing (TID/MID 2013), there is a high predation rate in the river below La Grange Diversion Dam. Fish released below La Grange Diversion Dam would be at high risk of predation. These factors would need to be considered, especially in terms of performance metrics. Mr. Devine reiterated that given the high cost of fish passage facilities, it is very important to know the performance metrics at the earliest planning of design. For example, designing for a performance metric of 50% would yield a much different facility than designing for a performance metric of 90%.

Referring to the meeting attendees, Mr. Orvis noted that there were not many TID or MID ratepayers in attendance at the meeting and that it would be the ratepayers who would ultimately be paying the cost for fish passage facilities. Mr. Devine said it was important to note that there are only five or six juvenile downstream collectors currently in existence, and that each was built by an entity, like PacifiCorp or Portland General Electric, with a large number of ratepayers. The Districts collectively have far fewer ratepayers to shoulder the cost of upstream and downstream fish passage facilities. Mr. Devine noted that just the capital costs of such facilities can be in the range of $100 million.

Mr. Garello resumed his presentation. Mr. Garello presented slides related to capital costs of other potentially somewhat similar installations. Slide 18 indicated that construction costs at several fish passage facilities in the Pacific Northwest ranged from $10.4 million to $60 million. Mr. Garello noted that the 2015 Northwest Hydroelectric Association (NWHA) annual conference had included a three-member panel discussion about fish passage. Each individual on the panel worked for a licensee with a recent large fish passage project. Regarding the cost of fish passage facilities, Mr. Garello said that each panelist had noted that, for each of their respective projects, the fish passage facilities had cost 30 – 40% more than had been originally estimated indicating the challenges of designing and operating such facilities.

Mr. Devine said that in his experience, if fish passage facilities are not thoroughly and rigorously evaluated from the very beginning of planning, the resulting design are likely not to achieve the performance metrics required by the agencies. Therefore, it was very important to know from the very beginning what those performance metrics would be so that the fishway could be planned accordingly. Given the high cost of the facilities, it would be unsatisfactory to build something only to determine that the facility could not achieve the performance metric.

Mr. Devine reiterated the importance of producing realistic cost estimates and the types and level of information needed to do so early in the process. Mr. Byrd asked what the schedule was for producing a cost estimate for this project. Referring to the Study schedule, Mr. Devine replied that a good cost estimate was approximately two years away. He added that to produce an accurate cost estimate, the Districts needed information from the agencies now. For example, if the Districts assume a certain performance metric in the planning, but down the road the agencies provide a different performance metric, the reliability of the cost estimate would be jeopardized.

Mr. Orvis asked what happens if the cost estimate is very high. Mr. Devine asked Mr. Edmondson if the agencies consider costs in their decision-making. Mr. Edmondson replied that FERC considers costs relative to the benefits, but did not indicate how NMFS considers cost. Mr. Devine asked how a determination is made by NMFS that a project is too costly. Mr. Edmondson replied that all the issues needed to be weighed. Mr. Devine asked if Mr. Edmondson could share examples of assessments where the agencies considered cost and the cost was deemed to be too expensive. Mr. Edmondson replied that the Edwards Dam Project is an example where the cost to change the project to meet environmental standards was more than the cost to remove the dam, so the project was removed. Mr. Devine, who was involved in that project, disagreed with Mr. Edmondson's characterization of the Edwards Dam project, stating that the decision to remove the dam was instead politically motivated, and that FERC had never ordered the dam to be removed. Mr. Devine said that the two target migratory species, American shad and alewife, could have been easily passed at the dam (Note: Edwards Dam was only 18 ft high).

Mr. John Shelton (CDFW) said it was disingenuous to say that the agencies make the decision about whether or not to build fish passage. Most of the time, the applicants help make the decision. In the settlement process, the agencies look to the applicants to weigh-in on the decision; the agencies do not come in and force a settlement. The applicants have a big part in the decision and what the feasibility of fish passage is, given the information. Mr. Shelton said that, similar to what Mr. Edmondson said happens at NMFS, at CDFW, the process of gathering the information is key. Mr. Shelton said he agreed completely that at this time the costs are unknown as well as what the efficiencies should be and what the benefits would be. These are all issues to be worked through. Mr. Shelton said that from what he had seen in California, fish passage is usually decided on among the parties during settlement. Mr. Shelton added that he could only speak to the ecology side of the process, and that any political motivations in the equation were beyond CDFW's part in the process. Mr. Edmondson agreed with Mr. Shelton that the agencies do not make a unilateral decision about fish passage. Instead, the agencies work closely with the licensee and stakeholders to work through the information and make a judgment call. Mr. Edmondson added that he was not familiar with a project where the agencies made a unilateral decision about fish passage.

Mr. Devine thanked Mr. Shelton and Mr. Edmondson for their commitments to a collaborative decision-making process that takes into account all parties' concerns. Mr. Devine added that he hoped the resource agencies would be active participants in the study and share information early on to help support the development of reliable fish passage cost estimates.

Mr. Edmondson said that a big part of the decision process is knowing the condition of the habitat above Don Pedro Dam and the ability of that habitat to support a new fish population. Mr. Edmonson said that habitat suitability was not a small issue.

Mr. Devine said that NMFS had made several study requests related to upstream habitat suitability and production not adopted by FERC. Although the Districts had volunteered to complete some of these studies, other studies were not being completed by the Districts. Mr. Devine said that in the NMFS study request, NMFS had noted that they needed the information provided by these studies. Mr. Devine asked who would complete those studies, to get the information that NMFS needed. Mr. Edmondson clarified that NMFS had not stated they needed the information from the requested studies. Instead, the studies were recommendations to FERC about what studies should be completed. FERC would use the results of those studies to inform their decision. Regarding the studies that FERC did not require the Districts to complete, Mr. Edmondson was under the impression that NMFS was completing some of those studies. In particular, he noted that NMFS was completing an *O. mykiss* genetics study and an upper river temperature study.

Mr. Devine said that from the La Grange study dispute resolution process, the Districts understood that NMFS did not have enough funding to complete a genetics study. Mr. Devine asked if that had changed. Mr. John Wooster (NMFS) affirmed that NMFS was moving forward with a genetics study. Mr. Devine asked if there was a study plan for the genetics study that could be shared with the Districts and participants. Mr. Wooster replied that there was not a study plan similar to a study plan document drafted for a FERC licensing process. Mr. Wooster added that although there was not a written study plan, he could provide a written description of the study. Mr. Devine said that during the study dispute resolution technical conference, there was a thorough discussion about the number of samples to be collected and where those samples would have to be collected. Mr. Devine said it would be helpful to know what studies the agencies were completing and what the schedules are for completing those studies.

Regarding the genetics study, Mr. Wooster said that NMFS had actually taken some samples last week and would continue to take samples through the summer and into the fall. NMFS staff was performing most of the work and was receiving some help from NGOs. In response, Mr. Devine said that Mr. Larry Thompson (NMFS) had said at the dispute resolution technical conference that the genetics information would be used early on in the decision process to point to whether or not it would be appropriate for fish to be passed. Mr. Devine asked when the results from the genetics study, and subsequently NMFS' decision about the genetic suitability for passage of *O. mykiss* would be available. Mr. Wooster replied that the report is due from the NMFS science center in early 2017. He added that NMFS had not said they needed to have the information, only that the information was helpful to inform the decision.

Referring to slide 8 (Information Needs to support Reintroduction Planning) of Mr. Hanson's presentation, Mr. Wooster said the "substrate" habitat suitability study was a component of the

NMFS LiDAR/hyperspectral study. Regarding a study of stream flow, Mr. Wooster said he hoped that existing information and the Districts' upcoming temperature modeling work would suffice. Mr. Wooster said that at this time, NMFS did not plan to conduct a study about channel morphology, sediment budget, large woody debris or cover, and that the hope was that existing information would suffice for these items as well.

Mr. Wooster asked if the City and County of San Francisco (CCSF) had studied any of these upstream reaches. Mr. Bill Sears (CCSF) replied that CCSF had not studied these reaches. Referring to McBain and Trush (2007), Mr. Wooster asked if CCSF was implementing any of the report's recommendations for monitoring. Mr. Sears replied that CCSF had not implemented those recommendations and that at this time CCSF had no plans to implement those recommendations.

Mr. Noah Hume (Stillwater Sciences, consultant to the Districts) asked if NMFS would be completing some habitat typing as part of the LiDAR/hyperspectral study. Mr. Wooster affirmed that NMFS would be completing some habitat typing as part of the study and that the schedule for completing that study was April 2016.

Mr. Le said that in its study request, NMFS had requested that the Districts develop a life cycle model however FERC had not required the Districts to develop the model. Mr. Le asked if NMFS was planning to build a life cycle model per its own request. Mr. Wooster replied that NMFS was planning to complete work on this subject, but it would not exactly be a life cycle model. Instead, NMFS was planning to calculate the carrying capacity of the upper river using the habitat data and LiDAR/hyperspectral study results and the thermal suitability data produced by the Districts' modeling work. Mr. Le asked if the scope and methods NMFS was planning to use to calculate carrying capacity would be made available to the public for review and comment. Mr. Wooster said that making the methods available for public comment was up for discussion. Mr. Le requested that NMFS provide the methods for review and comment.

Mr. Orvis asked how a Biological Opinion would tie into the decision-making process. Mr. Wooster replied that the information generated in this process would be fed into the Biological Opinion for the project. Mr. Devine asked if the Biological Opinion could recommend to FERC that the Districts build fish passage. Mr. Wooster replied that fish passage could be recommended in the Biological Opinion as a reasonable and prudent measure (RPM). Mr. Edmondson added that fish passage could also be recommended as a measure under section 10(j) and 10(a).

Mr. Chris Shutes (California Sportfishing Protection Alliance or CSPA) asked what the schedule was for public consultation in the future. Mr. Devine reviewed the schedule for 2015. He said that the Districts needed input from the resource agencies to inform the facility design planning process. For example, the Districts needed to know what fish species would be passed, how large the fish runs would be, the timing of the runs, the performance criteria, etc. Mr. Devine said that, going forward, the hope was to be able to have comprehensive discussions of the full suite of engineering and biological criteria as appropriate to a fish reintroduction plan. The Districts would use the results from those discussions to formulate alternative design possibilities consistent with FERC's Determination to be shared with licensing participants. At Workshop No. 2, the Districts would hope to go through the design basis/design criteria document and leave that Workshop with agreement on the fundamental design basis. To facilitate that, the Districts will issue a draft Design Basis Report prior to the Workshop. At Workshop No. 3, alternatives that meet the design basis would be put forward for consideration with the goal of narrowing the options to a single or a couple of the most appropriate options for the projects. For 2016, the Districts plan to develop detailed sizing, configurations, and preliminary engineering designs for the option(s) selected and perform detailed cost estimates. Regarding the dates for Workshops No. 2 and No. 3, Mr. Devine said that the Districts would circulate some possible dates shortly to find out what works best for everyone's schedules.

Mr. Byrd said that as a local rancher, he has been on the Tuolumne River for 35 years. There was a lot of science talk in today's Workshop. After coming to lots of these types of meetings, Mr. Byrd said he was starting to understand the scientific issues involved. He had direct experience with salmon in the Tuolumne by virtue of living along the river. Mr. Byrd said that when salmon get to the upper end of the spawning reach at Basso Bridge, the fish are nearly spent. There is no fish passage facility in the world that could make a difference to these fish. Mr. Byrd stated that the Tuolumne River system is different from the other projects covered into today's presentations. No one wants to see these greater numbers of fish more than him. Mr. Byrd suggested that someone should film what happens when the salmon lay their eggs. He has seen the suckers and pikeminnows eat the newly-laid eggs. He said that juvenile fish do not make it down the river because the eggs are being eaten before they can hatch. In Mr. Byrd's opinion, until the predator fish and suckers are dealt with, the runs will never return to their historic sizes.

Mr. Patrick Koepele (Tuolumne River Trust or TRT) asked how the public could submit comments on the Workshop and any notes that are provided. Ms. Jenna Borovansky (HDR) replied that the Districts would set something up on the La Grange Project licensing website to allow individuals to submit comments. Also, individuals are welcome to email their comments to Ms. Rose Staples (HDR) (rose.staples@hdrinc.com), and Ms. Staples would distribute the comments to the Districts and all interested parties.

Mr. Koepele asked if notes from today's meeting would be circulated for review and entered into the record. Mr. Devine replied that, unlike the Don Pedro relicensing process, the La Grange licensing process does not have a formal Consultation Workshop process required by FERC. Although the Districts were not required to provide notes from today's workshop, Mr. Devine said that the Districts would pull together notes from the meeting and post these notes on the La Grange licensing website.

Mr. Edmondson said that NMFS had contracted for a documentary about fish passage. The documentary looked specifically at projects in the Pacific Northwest and includes interviews with licensees and operators about the decision to build fish passage at their facilities. Mr. Edmondson said that NMFS would like to make that link available to folks who would like to view the documentary. Mr. Devine replied that the Districts would make that link available.

Mr. Devine thanked Mr. Edmondson for his presentation and said he was pleased to hear that NMFS is committed to a collaborative process and that the final decision on fish passage would be made collaboratively among all the interested parties.

Mr. Shutes asked what information the Districts needed to answer the questions covered in the presentations, including what species the Districts should consider for fish passage. Mr. Devine replied that the Districts would circulate a draft design criteria/design basis document prior to the next Workshop and it would contain a list of questions needing to be addressed, and that this would be discussed at the next workshop.

Meeting concluded at 12:10 pm.

ACTION ITEMS

1. NMFS will provide a written description of its Tuolumne River *O. mykiss* genetics study plan and methods.

2. The Districts will circulate to licensing participants potential dates for the next two Fish Passage Assessment workshops.

3. The Districts will provide a way for licensing participants to submit comments on the La Grange Licensing Website.

4. The Districts will post notes from Workshop No.1 on the La Grange Licensing Website.

5. The Districts will make available a link to the NMFS fish passage documentary.

6. The Districts will circulate the design criteria document prior to the next Workshop.

7. NMFS will provide a copy of its presentation.

REFERENCES

Anderson, Joseph H., George R. Pess, Richard W. Carmichael, Michael J. Ford, Thomas D. Cooney, Casey M. Baldwin & Michelle M. McClure. 2014. Planning Pacific Salmon and Steelhead Reintroductions Aimed at Long-Term Viability and Recovery. North American Journal of Fisheries Management, 34:1, 72-93.

Lindley, Steven T., Robert S. Schick, Ethan Mora, Peter B. Adams, James J. Anderson, Sheila Greene, Charles Hanson, Bernie P. May, Dennis McEwan, R. Bruce MacFarlane, Christina Swanson and John G. Williams. 2007. Framework for Assessing Viability of Threatened and Endangered Chinook Salmon and Steelhead in the Sacramento–San Joaquin Basin. San Francisco Estuary and Watershed Science, 5(1).

McBain and Trush, Inc., and RMC Environmental, 2007. Upper Tuolumne River: Description of River Ecosystem and Recommended Monitoring Actions Final Report. Technical Memorandum prepared for San Francisco Public Utilities Commission, San Francisco, California.

NMFS. 2014. Recovery Plan for the Evolutionarily Significant Units of Sacramento River Winter Run Chinook Salmon and Central Valley Spring-run Chinook Salmon and the Distinct Population Segment of Central Valley Steelhead. NMFS, West Coast Region, Sacramento, CA. July 2014.

Turlock Irrigation District and Modesto Irrigation District. 2013. Predation Study Report (W&AR-07). Attachment to Don Pedro Hydroelectric Project Updated Study Report. December 2013.

ATTACHMENT A

La Grange Hydroelectric Project
Fish Passage Assessment Workshop No. 1

Wednesday, May 20, 9:00 am to 12:00 pm
MID Office, 1231 11th Street, Modesto, California
Conference Line: 1-866-994-6437, Passcode: 8140607
Join Lync Meeting https://meet.hdrinc.com/jesse.deason/8DZ4VNVN

Meeting Objectives:
1. Introduce the fish passage evaluation concept, process/framework, and relevant information needs.
2. Present and discuss the Tuolumne River Fish Passage Evaluation Framework.
3. Confirm schedule/tasks, subsequent workshops, and opportunities for collaboration.

TIME	TOPIC
9:00 am – 9:10 am	Introduction of Participants (All)
9:10 am – 9:30 am	Background/Overview of Tuolumne River Anadromous Fish Passage Facilities Assessment Collaborative (Districts)
9:30 am – 10:30 am	Overview of FPA, Section 18 Authority (Fish Passage Prescription), and NMFS' Section 18 Decision Process (NMFS) a. Description of FERC study process, FPA and Section 18 Authority b. Section 18 Decision Framework and how/where an engineering feasibility of fish passage evaluation fits in c. Discussion of additional studies being undertaken (NMFS sponsored and Districts) that will support Section 18 Decision Process d. Discussion of NMFS' Recovery Plan and how it relates to the Tuolumne River
10:30 am – 11:15 am	Overview of the Tuolumne River Fish Passage Evaluation Framework (Districts) a. Review fish passage evaluation process b. Information needs and key resource considerations c. Available data, data gaps, and potential data sources
11:15 am – 11:45 am	Overview of Examples of Anadromous Fish Passage Facilities (Districts) a. Key fish passage considerations b. Upstream passage types and related facilities c. Downstream passage types and related facilities
11:45 am – 12:00 pm	Tuolumne River Passage Assessment Schedule and Next Steps (All) a. Schedule: Opportunities for collaboration and incorporation of feedback b. Workshops 2 and 3 – confirm dates and content

Modesto Irrigation District

La Grange Fish Passage
Workshop No. 1
Wednesday, May 20, 2015
9:00 a.m. – 12:00 p.m.

WATER & POWER
Serving Central California since 1887

PLEASE SIGN IN

	Name	Organization	Telephone No.	E-mail	Time In	Time Out
1.	Amanda Theis	Turlock Chamber of Commerce			8:45a	
2.	Mario Moreno	LCR			8:45	
3.	Alison McNally	CSU Stanislaus			8:49	
4.	Ronald Yoshiyama	San Francisco			8:49	
5.	Daniel Richardson	Tuolumne County CAO			8:51	
6.	Zac Jackson	USFWS			8:53	
7.	Jake Oosterman	WUD			8:57	
8.	Bob Hackamack	TRT			855	
9.	Jean					
10.	Allison Boucher	TR Conservancy			9:02 band.com	
11.	John Wooster	NMFS			9:00	
12.	John Henderson	U.S. Fish & Wildlife Svc			9:00a	

Modesto Irrigation District

La Grange Fish Passage
Workshop No. 1
Wednesday, May 20, 2015
9:00 a.m. – 12:00 p.m.

WATER & POWER
Serving Central California since 1887

PLEASE SIGN IN

	Name	Organization	Telephone No.	E-mail	Time In	Time Out
13.	Theresa Simsiman	AW			8:45	
14.	Alfred Souza	Y.F.C.			8:46	
15.	Gretchen Murphey	CDFW			0845	
16.	William Sears	SFPUC			8:45	
17.	Brandon McMillan	TurlockCityNews.com			8:50	
18.	Josh Weimer	TID			8:55	
19.	Dave Boucher	Tuolumne Conservancy			8:55	
20.	Tom Holley	NMFS			8:55	
21.	Calvin Curtin	TID			8:55	
22.	Peter Barnes	SWRCB			8:55	
23.	Paul Zeek	Asm. Kristin Olsen			9:00	
24.	Peter Drekmeier	TRT			9:00	

Modesto Irrigation District

La Grange Fish Passage
Workshop No. 1
Wednesday, May 20, 2015
9:00 a.m. – 12:00 p.m.

WATER & POWER
Serving Central California since 1887

PLEASE SIGN IN

	Name	Organization	Telephone No.	E-mail	Time In	Time Out
25 ~~37.~~	Chris Shutes	CSPA	(		9 —	
26 ~~38.~~	Jim Alves	City of Modesto			9	
27 ~~39.~~	[illegible]	Self			9	
28 ~~40.~~	Rotimi Odeh	CSU Stanislaus			9:00	
29 ~~41.~~	John Holland	Modesto Bee			9	
30 ~~42.~~	Patrick Koepele	TAT				
31 ~~43.~~	Dan [illegible]	CCSF			org	
32 ~~44.~~	Ray Campana[illegible]	Alliance	(		iance.com	
33 ~~45.~~	Jim [illegible]	Sierra Pacific	(		9:10	
34 ~~46.~~	Steve Edmonds	NMFS			9:10	
35 ~~47.~~						
36 ~~48.~~						

Modesto Irrigation District

La Grange Fish Passage
Workshop No. 1
Wednesday, May 20, 2015
9:00 a.m. – 12:00 p.m.

WATER & POWER
Serving Central California since 1887

PLEASE SIGN IN

	Name	Organization	Telephone No.	E-mail	Time In	Time Out
37 ~~25.~~	DAVE SIGOUR	TID DPRA			9:09	
38 ~~26.~~	John Shelton	DFW			9:44	
39 ~~27.~~	Kob GRASSO	Yosemite NP			9:43	
40 ~~28.~~	DR Dow Swatman	Public			9:45	
41 ~~29.~~	Leonard Van Eldere	Yosemite Farm Cred			10:05	
42 ~~30.~~	Helen Condit	Senator Cannella		.ca.gov		1pm
43 ~~31.~~						
44 ~~32.~~						
45 ~~33.~~						
46 ~~34.~~						
47 ~~35.~~						
48 ~~36.~~						

TURLOCK IRRIGATION DISTRICT | MODESTO IRRIGATION DISTRICT

La Grange Hydroelectric Project
FERC No. 14581

Fish Passage Assessment -
Concept Level Passage Alternatives
Workshop #1

TURLOCK IRRIGATION DISTRICT | MODESTO IRRIGATION DISTRICT

La Grange Project History

La Grange Diversion Dam

- La Grange Diversion Dam was constructed from 1891 to 1893
- The dam is owned jointly by Turlock Irrigation District and Modesto Irrigation District
- Purpose is to divert irrigation and municipal and industrial (M&I) water
- La Grange powerhouse was constructed in 1924. The powerhouse is owned by TID

Overview of La Grange Project ILP

ILP Milestone	Schedule
Pre-Application Document (PAD)	January 2014
Scoping and study plan development	January 2015
FERC Study Plan Determination	February 2015
NMFS Request for Rehearing	April 2015
Study plan dispute resolution	May 2015
Study plan implementation	2015/2016
Initial Study Report	February 2016
Updated Study Report	February 2017
Final license application	June 2016

TURLOCK IRRIGATION DISTRICT | MODESTO IRRIGATION DISTRICT

Revised Study Plan

Study Components

Fish Passage Facilities Assessment

- Concept-Level Fish Passage Alternatives
- La Grange Project Fish Barrier Assessment

Upper Tuolumne River Basin Habitat Assessment

- Barriers to Upstream Anadromous Salmonid Migration
- Water Temperature Monitoring and Modeling
- Upstream Habitat Characterization

Habitat Assessment and Fish Stranding Observations below LGDD and Powerhouse

- Develop Hydrologic Data for Flow Conduits at the La Grange Project
- Collect Topographic, Depth, and Habitat Data in the Vicinity of the La Grange Project Facilities
- Assess Fish Presence and Potential for Stranding

Concept-Level Fish Passage Alternatives - Objectives

- Identify and develop concept-level alternatives for upstream and downstream passage of Chinook salmon and steelhead at the La Grange and Don Pedro dams

- For select upstream and downstream alternatives:
  - Identify, formulate and develop preliminary design basis, design criteria, sizing and configuration
  - Develop capital costs and O&M costs

Study Area

- Downstream of La Grange Diversion Dam (confluence of powerhouse tailrace channel and Tuolumne River mainstem) to the upper Tuolumne River at the upper most extent of Don Pedro Reservoir
- Study area scope defined in FERC's February 2, 2015 Study Plan Determination

TURLOCK IRRIGATION DISTRICT | MODESTO IRRIGATION DISTRICT

Overview of Tuolumne River Fish Passage Study Phase I (2015)

- Three collaborative workshops to identify and discuss biological and engineering passage parameters and alternatives, including implementation sequence.

- Gather information on project facilities/operations, environment, target species, biological criteria, run timing and size, basin hydrology, agency regulations/criteria, and land ownership.

- Initial sizing, siting and layouts developed and collaboratively selected based upon criteria including accessibility, costs, impacts to other resources (e.g., recreation, boating, etc.), predation, land ownership, etc.

TURLOCK IRRIGATION DISTRICT | MODESTO IRRIGATION DISTRICT

Overview of Tuolumne River Fish Passage Study Phase II (2016/2017)

- Develop site layouts, general design parameters and capital and O&M costs for select alternatives (from 2015 work) – both upstream and downstream.
- Investigate siting/sizing, water supply, collection/acclimation/holding, transport, debris management, attraction flows, instrumentation/controls, compliance with regulatory criteria, timing of implementation, etc.
- Identify additional information needs [e.g., reservoir study may be necessary if 2015 process identifies concept involving passage through the project reservoir(s)].

Reporting

- The Initial Study Report (February 2016) will include all Phase I activities.

- The Updated Study Report (February 2017) will include:
  - A summary of biological, engineering, and cost considerations
  - Identification of fish passage alternatives
  - Functional layouts, sizing and siting information for selected alternatives
  - Capital and annual O&M cost estimates for selected alternatives

Study Team

- Study Lead: Bao Le (HDR)
- Salmon/Steelhead Technical Advisors: Chuck Hanson (Hanson Environmental) and Paul Bratovich (HDR)
- Lead Fish Passage Engineer: Mike Garello, HDR

TURLOCK IRRIGATION DISTRICT | MODESTO IRRIGATION DISTRICT

Workshop #1 Agenda

- Background/Overview of Tuolumne River Anadromous Fish Passage Facilities Assessment (Districts)
- Overview of FPA, Section 18 Authority (Fish Passage Prescription), and NMFS' Section 18 Decision Process (NMFS)
- Overview of the Tuolumne River Fish Passage Evaluation Framework (Districts)
- Examples of Anadromous Fish Passage Facilities (Districts)
- Tuolumne River Passage Assessment Schedule and Next Steps (All)

Tuolumne Fish Passage Study Workshop

History of Non-federal Hydropower Regulation

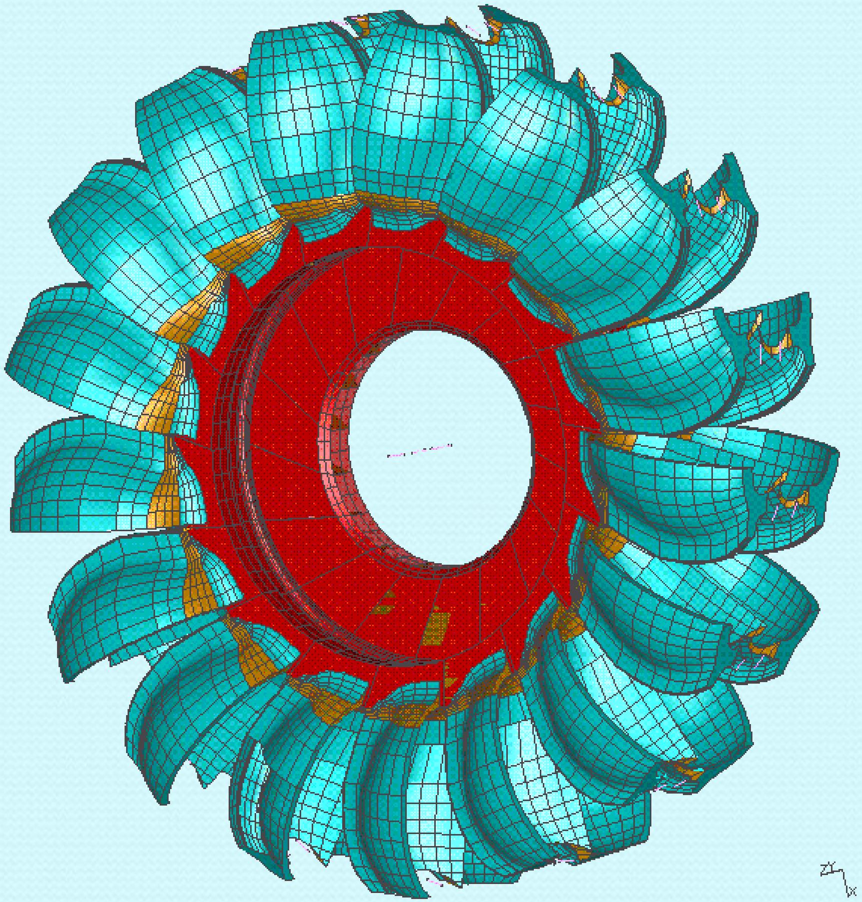
- **<u>Before passage of the Federal Water Power Act in 1920, developers needed a special act of Congress to build and operate a hydroelectric power plant on navigable streams, or federal lands.</u>**
- **Congress had authorized construction of the first hydroelectric project in 1884.**
- **Demand for electric power suddenly increased during World War I.**
- **In 1920, Congress responded to this demand by enacting the Federal Water Power Act, which established the Federal Power Commission (FPC).**
- **The FPC was responsible for licensing non-federal hydroelectric power projects that affect navigable waters, occupy federal lands, use water or water power at a government dam, or affect the interests of interstate commerce.**

- **1935, Congress amended the Federal Water Power Act of 1920 as Part 1 of the Federal Power Act extending the FPC's authority to regulate interstate aspects of the electric power industry.**
- **1977, Congress abolishes the FPC and creates the Federal Energy Regulatory Commission (FERC). FERC's authority includes the licensing of non-federal hydroelectric power projects.**
- **1978, Public Utilities Regulatory Policies Act (PURPA), required public utilities to purchase power produced by qualifying facilities at the utilities avoided costs.**
- **1980, Energy Resource Act and Energy Security Act, provided financial and regulatory incentives that made small hydro attractive to entrepreneur developers.**

- 1986, Congress passed the Electrical Consumers Protection Act (ECPA), which amended the Federal Power Act:
  - required FERC to base its license conditions on the recommendations from federal and state fish & wildlife agencies, and to negotiate disagreements with agencies (10j).
  - requires equal consideration to environmental, recreation, fish and wildlife, and other non-power values.
- 1992, Congress enacts the National Energy Policy Act
  - prohibits licensees from using eminent domain in parks, recreational areas or wildlife refuges.
  - provided for third party contracts for environmental documents.
  - recovery of agency costs incurred in licensing process.

Most recently, Energy Policy Act of 2005 included review of mandatory conditions and filing alternatives

FERC Requires Studies to understand Project impacts on Developmental and non-Developmental Resources



Project Effects on Non-Developmental Resources

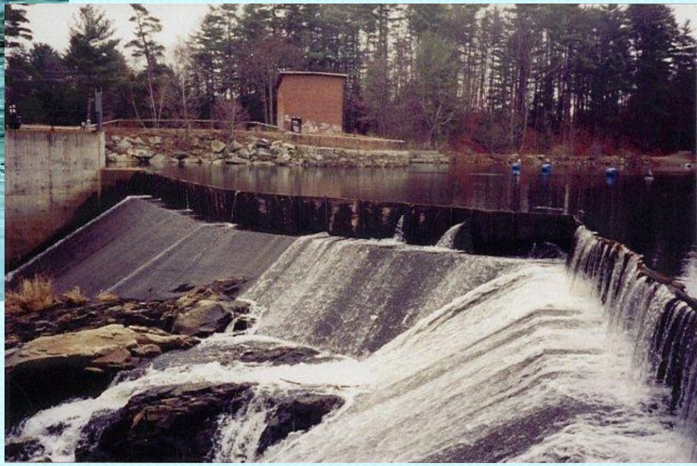
- Water Quality
  - Dissolved Oxygen
  - Temperature
- Fisheries
  - Aquatic Habitat
  - Passage
- Wildlife
  - ROW clearing
  - Transmission line and avian interactions

Developmental Resources

- Flood Control
- Navigation
- Water Supply
- Energy Production
- Irrigation

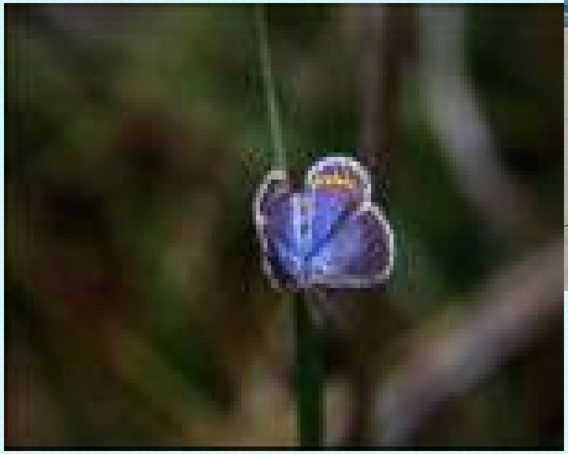
FERC's Study Needs - Licensing

- Fish and Wildlife Coordination Act
- Magnuson-Stevens Fishery Conservation and Management Act
- National Historic Preservation Act



Other Elements of Licensing

- Clean Water Act – Section 401
- Coastal Zone Management Act of 1972
- Endangered Species Act of 1973
- National Environmental Policy Act of 1972



AGENCY COOPERATION

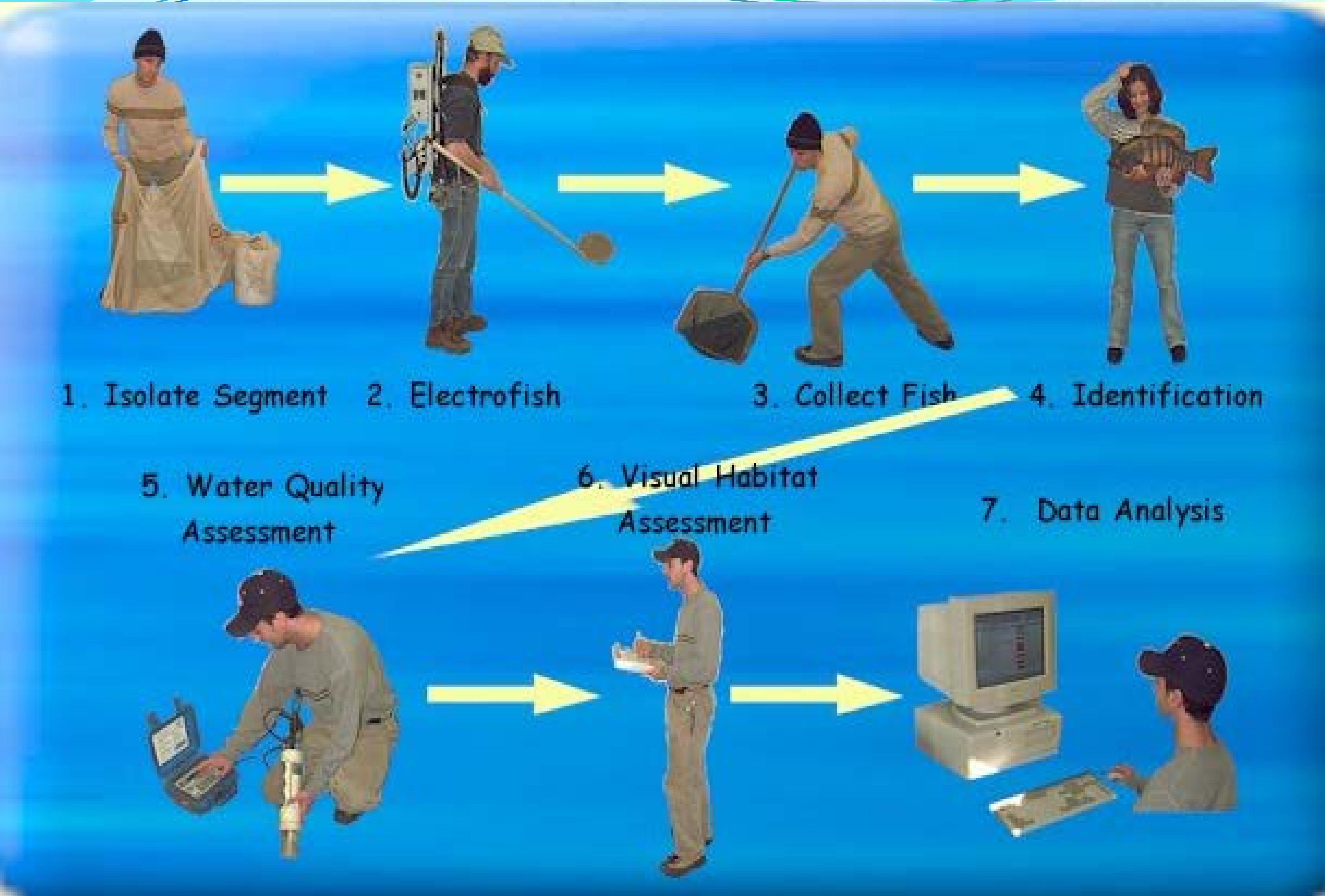
IN FERC RELICENSING

Recommending Studies to Support Licensing

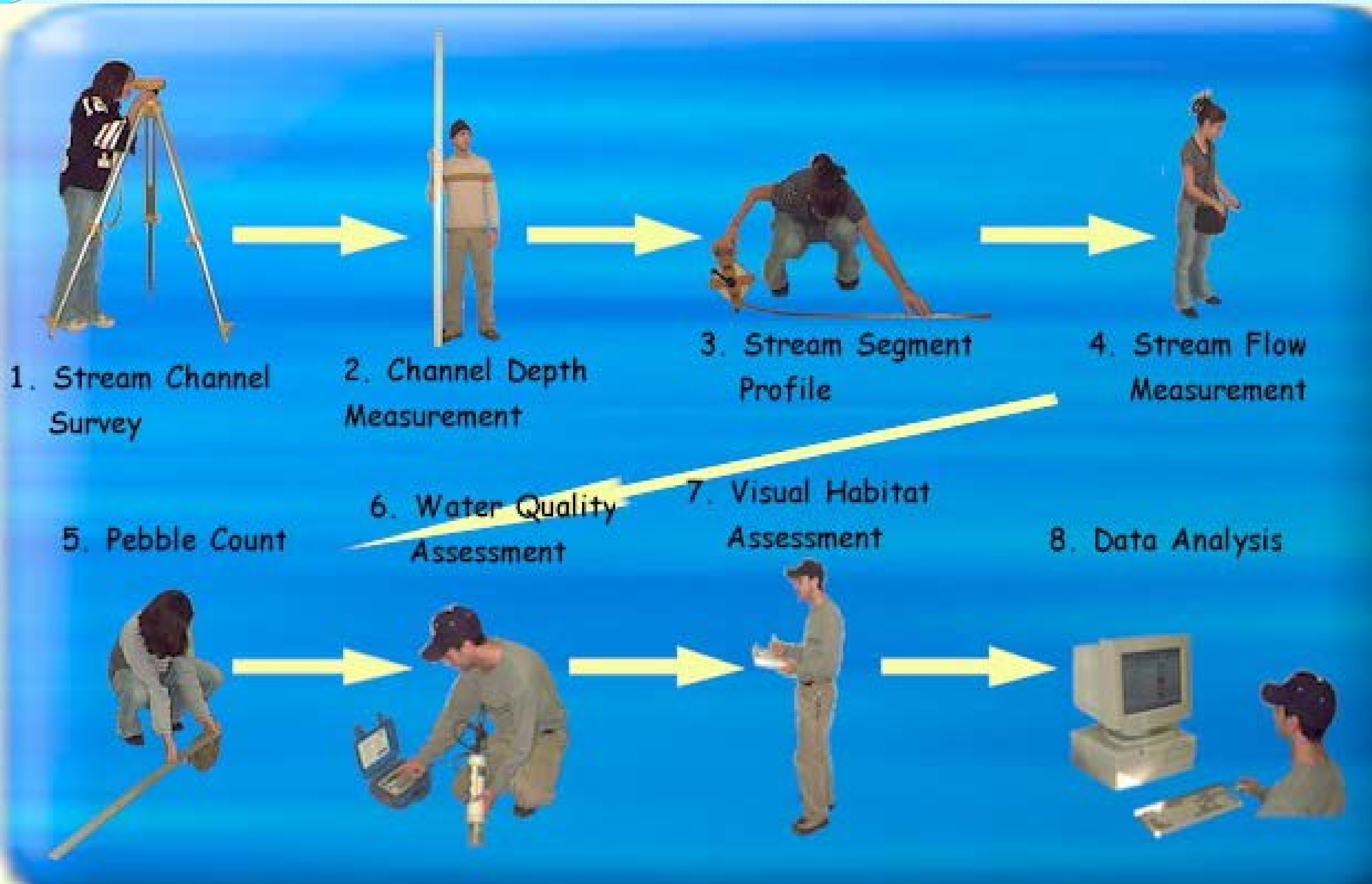
Under §§ 14 and 15 of the FPA, FERC must make the same inquiries in a relicensing proceeding as in an initial licensing determination and there is no question that fishery protection is among the licensing issues that must be addressed when evaluating all beneficial water uses as required by § 10(a) of the FPA.[1] [2]

[1] Confederated Tribes and Bands of the Yakima Indian Nation et al. V. FERC, Nos. 82-7561 et al. (9th Cir. June 7, 1984.
[2] Id. At 11-12 (citing16 U.S.C. § 803 (a) and Udall v. FPC, 387 U.S. 428, 440, 450 (1967)).

FISHERIES ASSESSMENT

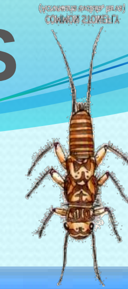


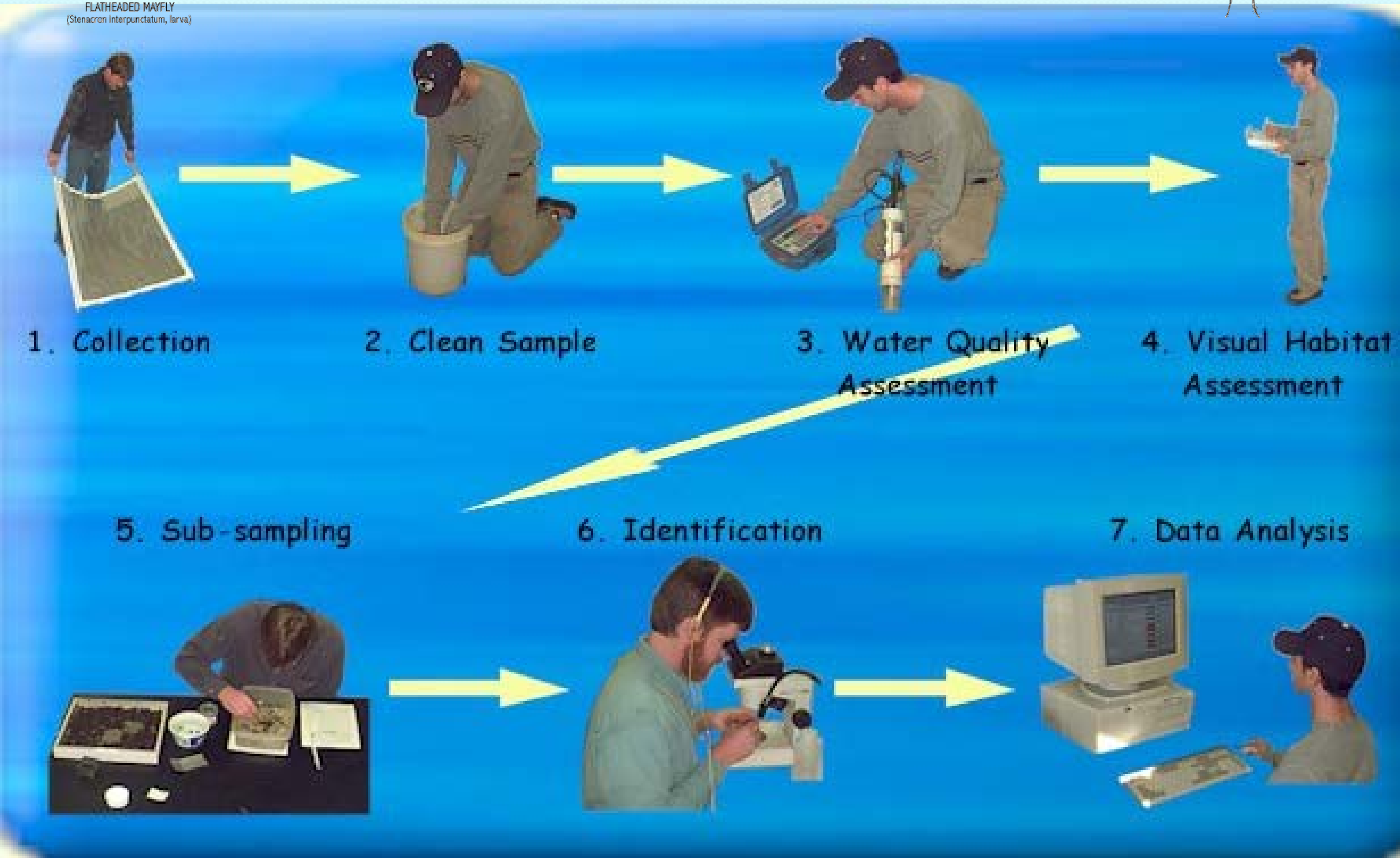
PHYSICAL HABITAT ASSESSMENT



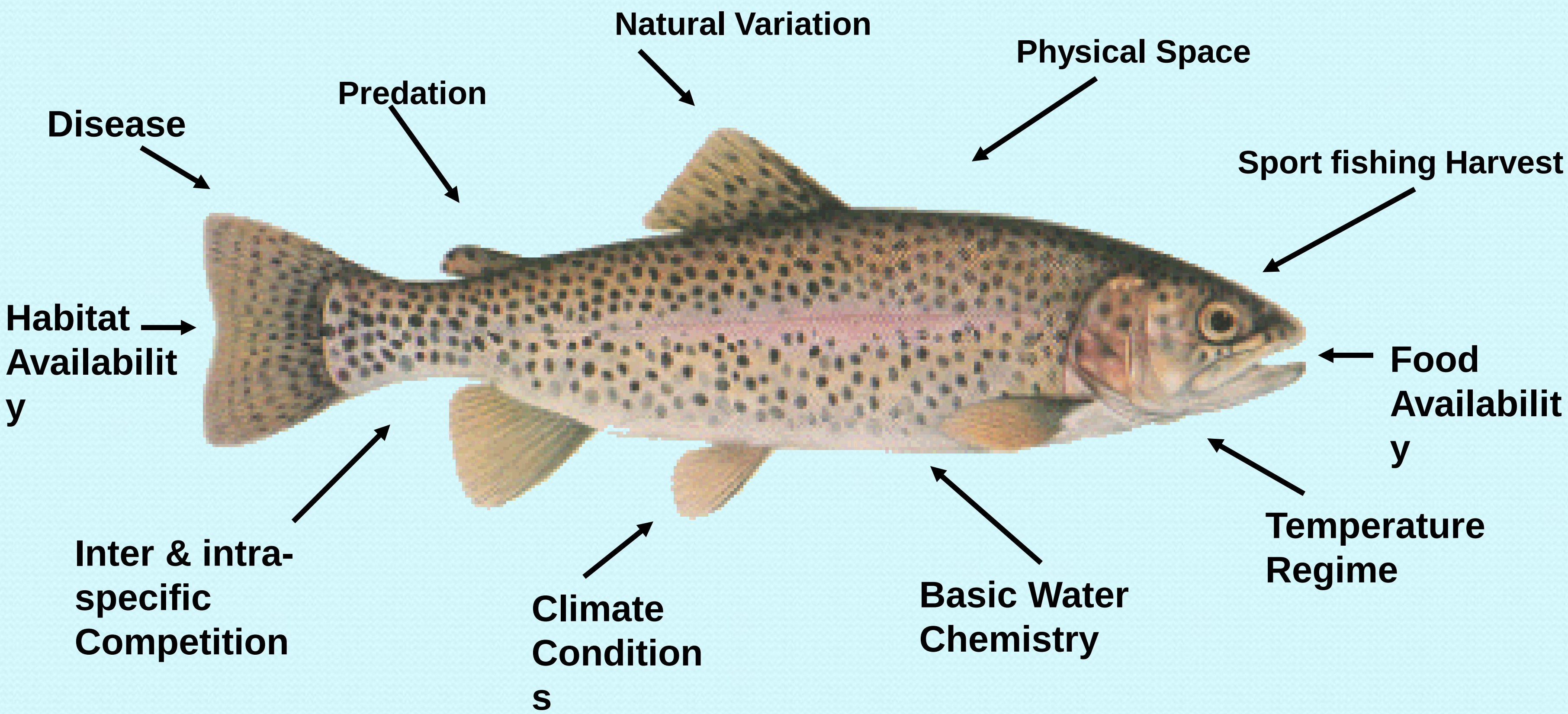
STREAM MACROINVERTEBRATES AS STREAM HEALTH INDICATORS

FLATHEADED MAYFLY
(Stenacron interpunctatum, larva)

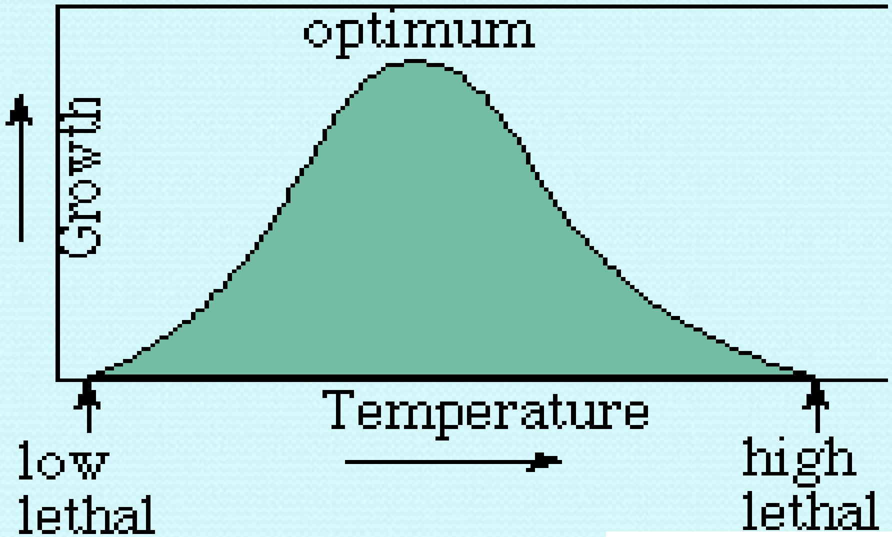




UNDERSTANDING THE ECOLOGICAL FACTORS

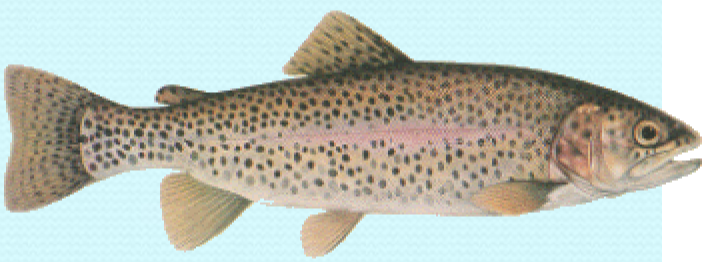


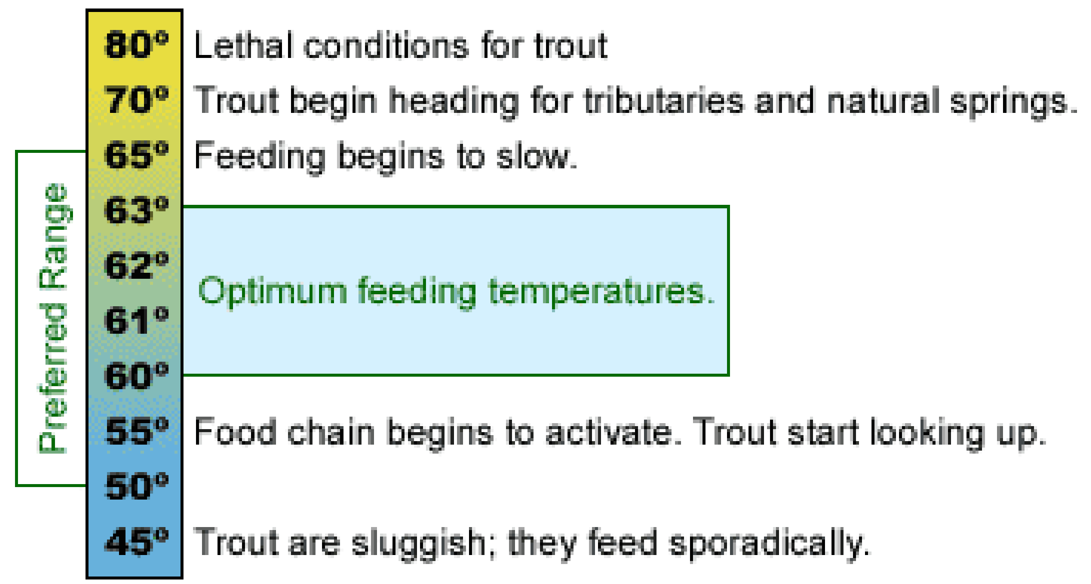
WATER TEMPERATURE MANAGEMENT AND THE HEALTH OF AQUATIC ORGANISMS



WATER TEMPERATURE DATA LOGGER

TROUT ACTIVITY AND WATER TEMPERATURE





RESOURCE ISSUES COMMONLY RAISED IN FERC RELICENSING PROCEEDINGS

HYDROLOGY

- **Historical data (unimpaired hydrology)**
- **Impaired hydrology (mean daily, monthly & average annual)**
- **Adequate gauging stations**
- **Reservoir data (minimum pool & seasonal fluctuations)**

OTHER FLOW RELATED ISSUES

- **Flows to protect instream biological resources (fish/macros)**
- **Flows necessary for on-water recreation**
- **Ramping criteria**
- **Run-of-River vs Peaking Operations**

RIVERINE PROCESSES

- Flows necessary to maintain riverine ecosystem processes
    - channel maintenance, gravel recruitment & sediment budgets
    - maintain riparian vegetation corridors
- Timing of flows
    - replicates natural hydrograph
    - ramping criteria

WATER QUALITY

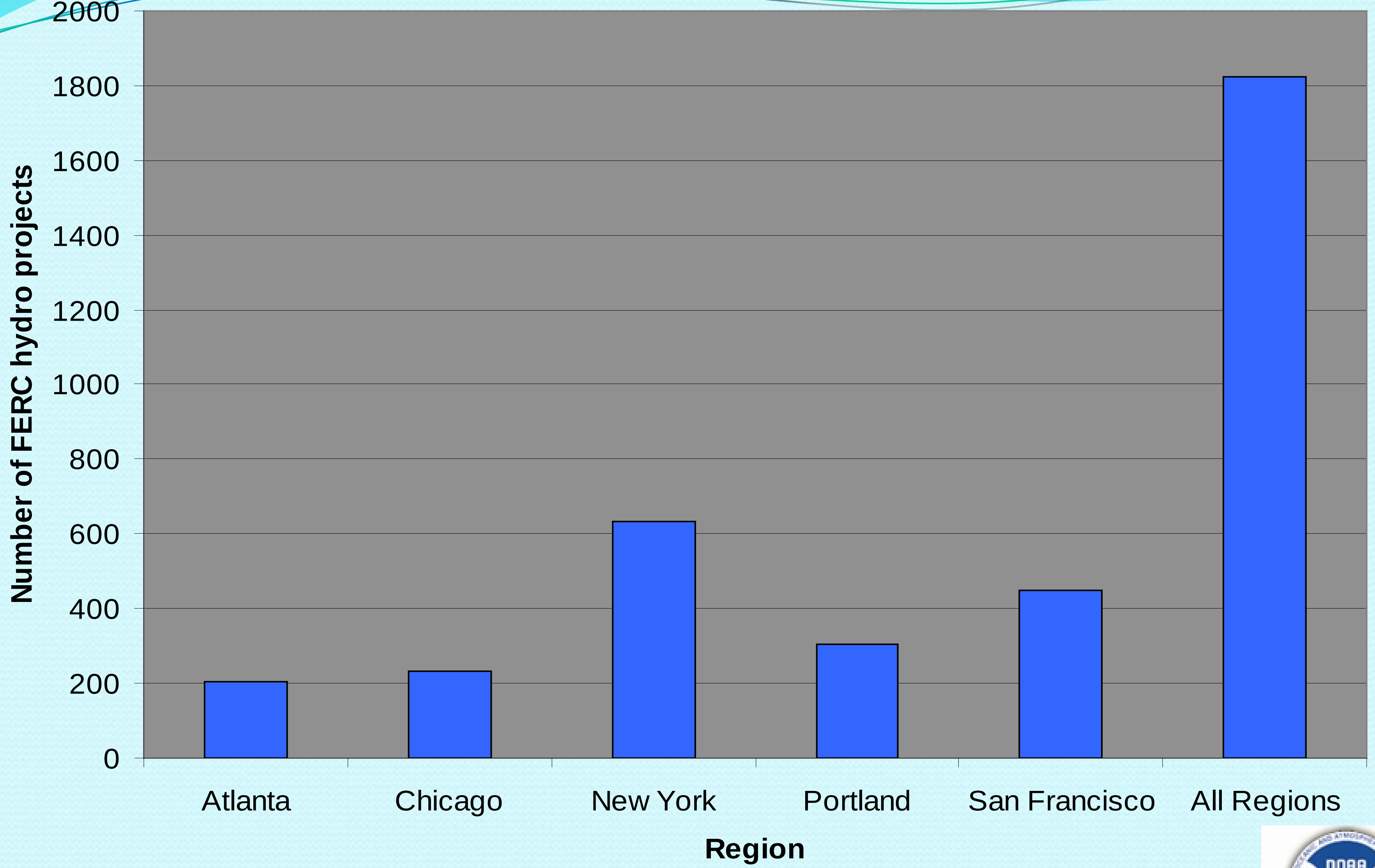
- Basin Plan Beneficial Uses and Objectives
- Historical data-Background water quality
- Current water quality with project (project related impairment)
- Controllable Factors

WATERSHED SCALE ISSUES

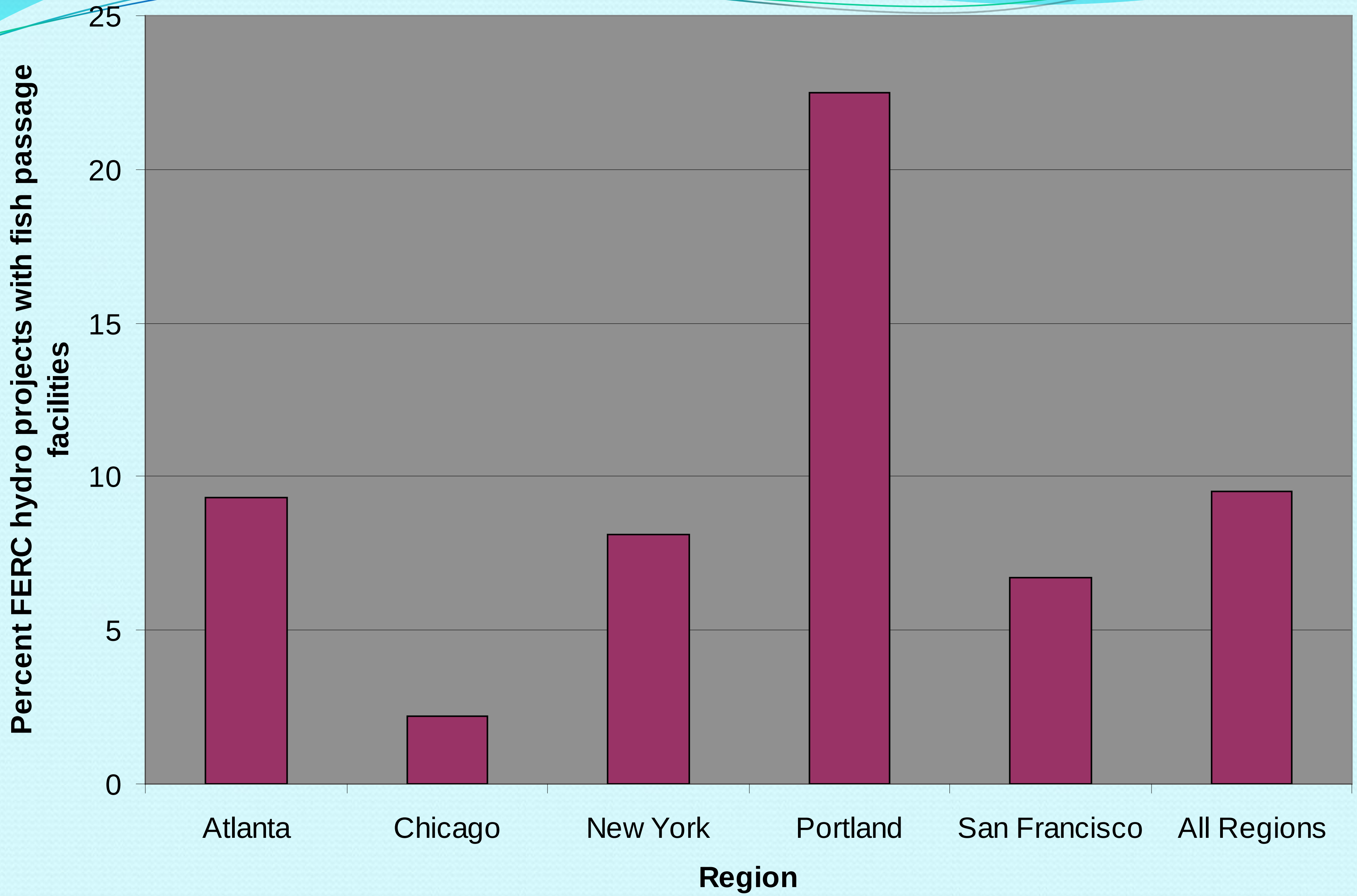
- Land Management Practices (historic and current)
- Multiple Licensees vs Coordinated Watershed Operations

FERC PROCESS ISSUES

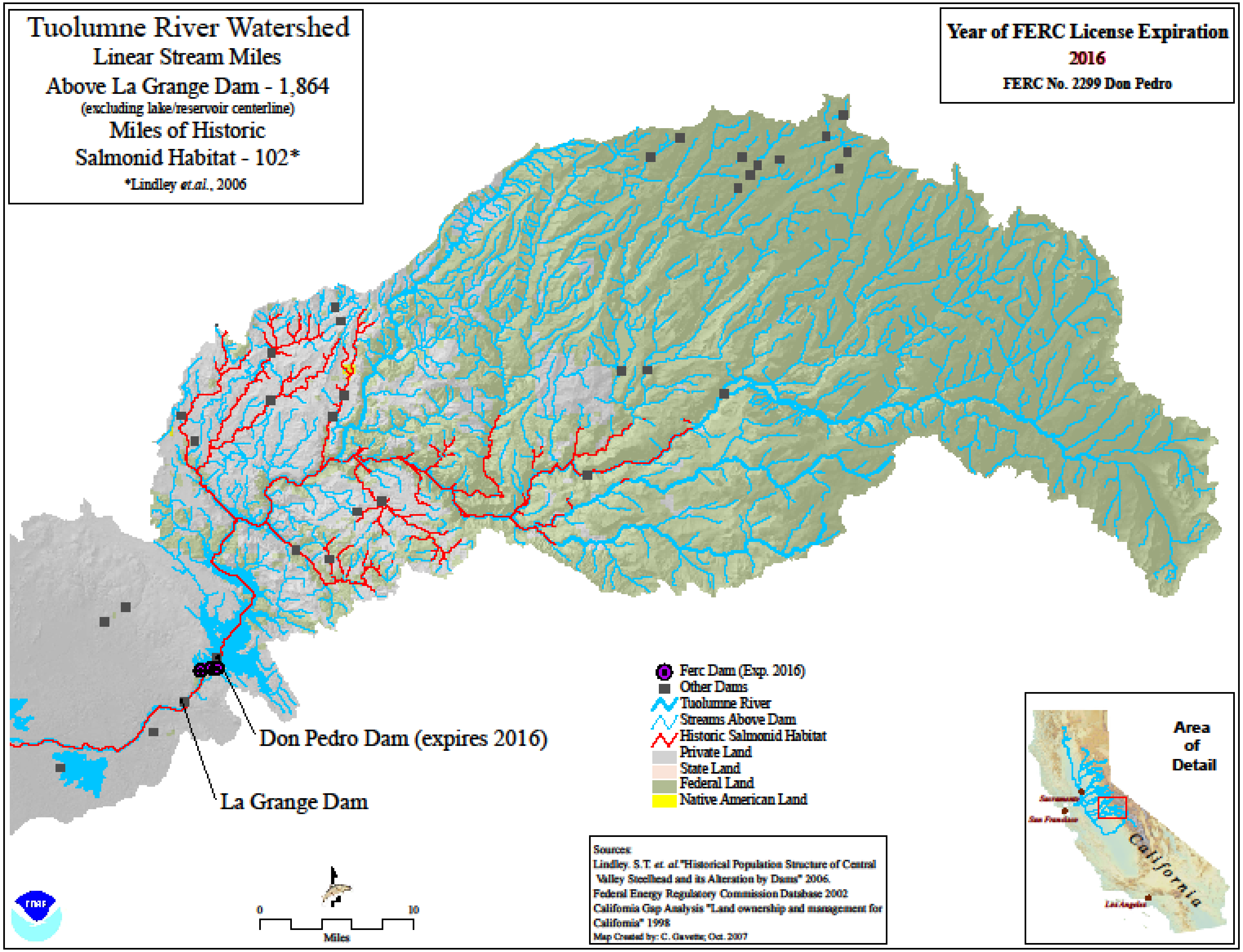
- Environmental Baseline for Relicensing
- Study Protocols and Timing
- Timing Requirement for filing the 401 Request
- Cumulative Impact Assessment
- Timing of Environmental Analysis
- Timing of Licensing Actions
- Identification and Participation of appropriate Stakeholders
- FERC Staff Participation



NOAA
NMFS-SWR
Habitat Conservation Division


Percent FERC hydro projects with fish passage facilities
25
20
15
10
5
0
Atlanta
Chicago
New York
Portland
San Francisco
All Regions
Region

For instance, in California's Central Valley (Sacramento and San Joaquin Watersheds) dams block as much as 95% of historic salmonid spawning habitat. As a result, anadromous salmon are extirpated from approximately 5,700 miles of their historic habitat in the Central Valley. In most cases the habitat remaining is of much lower quality than the habitat lost and is subject to further degradation by direct and indirect impacts of hydroelectric operations. According to a FERC review a total of 149 FERC licensed and exempted projects are located in the Central Valley. Although most of the 149 projects are small (114 have capacities less than 5 MW), total reservoir storage is about 40 percent of all surface water storage in the Central Valley. Most storage is located at relatively few projects. Twenty nine projects account for 95 percent of the FERC-licensed storage in the Valley.



Tuolumne River Watershed
Linear Stream Miles
Above La Grange Dam - 1,864
(excluding lake/reservoir centerline)
Miles of Historic
Salmonid Habitat - 102*
*Lindley et.al., 2006
Year of FERC License Expiration
2016
FERC No. 2299 Don Pedro
Don Pedro Dam (expires 2016)
La Grange Dam
Ferc Dam (Exp. 2016)
Other Dams
Tuolumne River
Streams Above Dam
Historic Salmonid Habitat
Private Land
State Land
Federal Land
Native American Land
Area
of
Detail
California
Sources:
Lindley. S.T. et. al."Historical Population Structure of Central Valley Steelhead and its Alteration by Dams" 2006.
Federal Energy Regulatory Commission Database 2002
California Gap Analysis "Land ownership and management for California" 1998
Map Created by: C. Gavette; Oct. 2007
0
10
Miles

Generic List of Types of Passage Facilities Employed at FERC Hydro Projects

Upstream

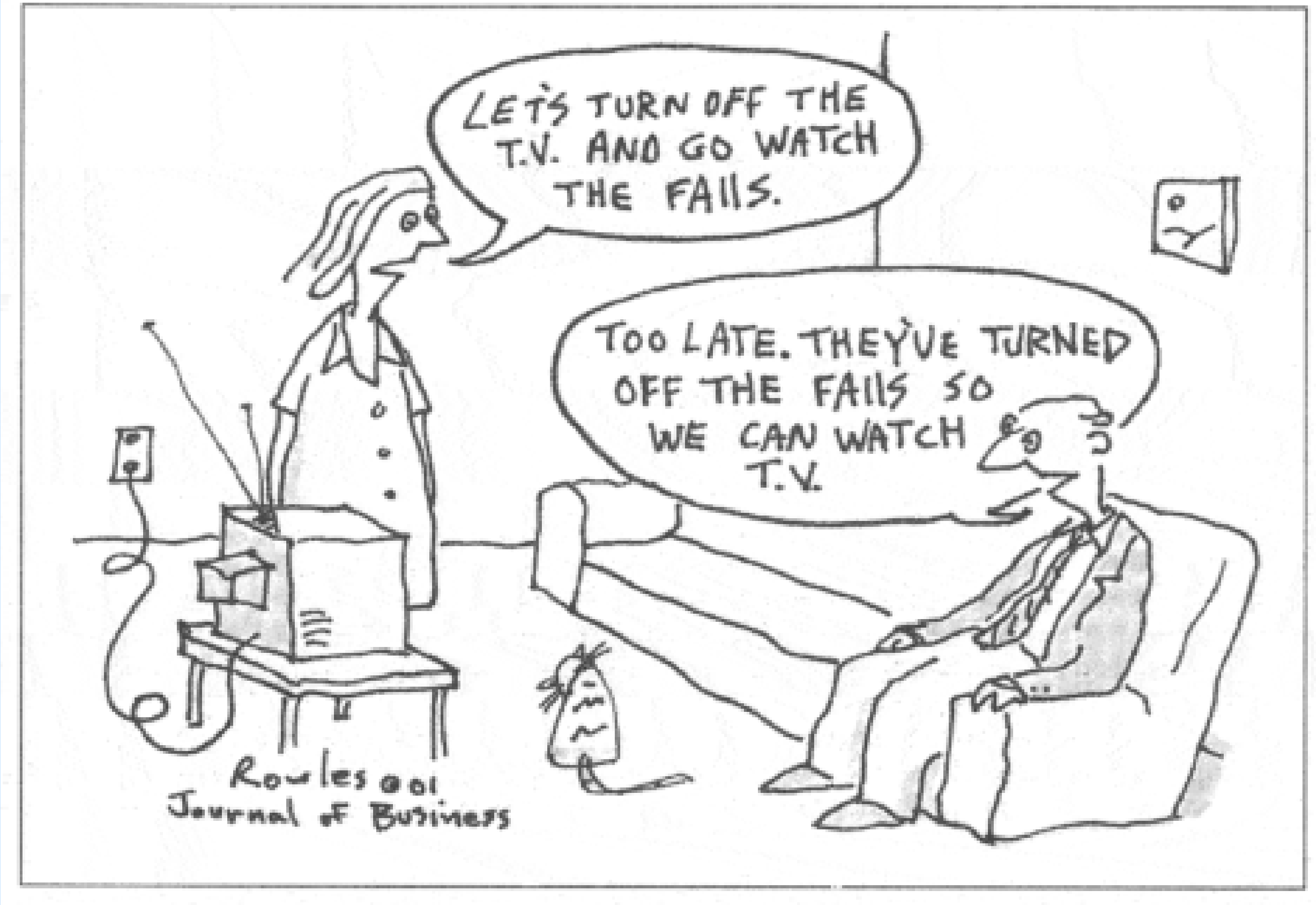
Passive
- fish ladders
- canals
- dam removal

Directed
- fish lifts
- trap and haul

Downstream

Passive
- fish ladders
- canals
- flumes
- screens (v-screens, barrier nets, eichers, angled bar racks)
- notches
- spill
- behavioral guidance
- louvers
- dam removal

Directed
- trap and haul
- surface collection (traps, gulpers, salvage devices)


LET'S TURN OFF THE T.V. AND GO WATCH THE FAllS.
TOO LATE. THEY'VE TURNED OFF THE FAllS SO WE CAN WATCH T.V.
Rowles ©01 Journal of Business

TURLOCK IRRIGATION DISTRICT | MODESTO IRRIGATION DISTRICT

Overview of the Tuolumne River Fish Passage Evaluation Framework

TURLOCK IRRIGATION DISTRICT | MODESTO IRRIGATION DISTRICT

Overview of Fish Passage at Don Pedro and La Grange

- Section 18 of Federal Power Act (FPA) gives the Dept. of Commerce (NMFS) and Dept. of Interior (USFWS) the authority to prescribe fishways

- NMFS has not made a decision on whether to exercise Section 18 authority

- In this instance, any Section 18 fishway prescription would be to support the reintroduction of extirpated species to the Upper Tuolumne River

TURLOCK IRRIGATION DISTRICT | MODESTO IRRIGATION DISTRICT

Fish Passage Study Requests at La Grange and Don Pedro

"NMFS' Recovery Plan identifies the Upper Tuolumne River above Don Pedro Reservoir as a candidate area for reintroduction of steelhead and spring-run Chinook salmon to further recovery of these species (NMFS 2014)."

- NMFS Study Request #3 (Enclosure F, page 35, July 22, 2014)

"Results from NMFS' upper Tuolumne information request (see NMFS' Study Request #3) shall be used to estimate carrying capacity and population sizes at various life-stages in the upper Tuolumne habitats, to inform design criteria for fish passage facilities."

- NMFS Study Request #1 (Enclosure F, page 9, July 22, 2014)

Overview of Tuolumne River Fish Passage

- Anderson et al., "Planning Pacific Salmon and Steelhead Reintroductions Aimed at Long-Term Viability and Recovery," North American Journal of Fisheries Management, 2014.

- Peer-reviewed paper co-authored by NMFS Northwest Fisheries Science Center, state departments of fish and wildlife (Oregon and Washington) and the Colville Tribe (Washington).

- Presents a framework for planning reintroductions designed to promote recovery of salmonids listed under ESA.

Overview of Tuolumne River Fish Passage

- “[R]eview of the salmonid reintroduction literature […] suggests that there are large uncertainties in the success of reintroduction in establishing self-sustaining populations, particularly for programs employing active colonization strategies.” (Anderson et al., page 88)

- “Rigorous scientific evaluation is particularly important for projects at large dams or those using active colonization strategies because they face the highest constraints and greatest risks.” (Anderson et al., page 89)

Overview of Tuolumne River Fish Passage Info Needs to Inform Section 18 Prescription

- NMFS study requests and recommendations of Anderson et al. applied to the Tuolumne River:
  - Genetics (*O. mykiss*) – NMFS Study Request #4
  - Upper Tuolumne River Studies – NMFS Study Request #3/Anderson et al.
  - Fish Passage Engineering Concept Alternatives – NMFS Study Request #1/Anderson et al.
  - Colonization Strategy (natural, transplant, or hatchery releases) – Anderson et al.
  - Source Populations – Anderson et al.
  - Socioeconomics (effects to existing uses; cost-benefit analysis) – Anderson et al.

General Life Cycle Considerations

Downstream Habitat

Juvenile Downstream Migration
- Trap and Haul
- Volitional Passage

Adult Migration
- Flow/Depth
- Temperature
- Barriers/Impediments
- Harvest

Adult Upstream Migration
- Trap and Haul
- Volitional Passage
- Barriers/Impediments

Upstream Habitat (Reintroduction Area)

Adult Holding Habitat
- Area
- Depth
- Temperature
- Density (capacity)
- Harvest

Spawning/Egg Incubation
- Flow/Depth/Flow Fluctuations
- Redd Dewatering
- Velocity
- Dissolved Oxygen
- Spawning Gravel
- Temperature
- Density (capacity)

Fry Emergence/Rearing
- Flow/Depth/Flow Fluctuations
- Stranding
- Velocity
- Cover
- Temperature
- Prey Base
- Predators
- Dissolved Oxygen
- Density (capacity)

Juvenile Rearing
- Flow/Depth/Flow Fluctuations
- Stranding
- Velocity
- Cover
- Temperature
- Prey Base
- Predators
- Dissolved Oxygen
- Density (capacity)

Juvenile Migration
- Flow/Depth
- Velocity
- Cover
- Temperature
- Predation
- Barriers/Impediments

Information Needs Specific to the Tuolumne River

Information Needs	Lead Entity	Schedule
Genetics Testing (*o. mykiss*)	NMFS	??
Identify Target Species (fall-run Chinook, spring-run Chinook, steelhead)	NMFS	June 2015
Define Upstream Reaches	FERC	Feb 2015 (Complete)
Compile Existing and Historical Habitat Information	NMFS/Districts	Feb 2016
Habitat Suitability Studies		
• Migration Barriers Assessment	Districts	Feb 2017
• Channel morphology/sediment budget	NMFS	??
• Substrate	NMFS	??
• Cover and LWD	NMFS	??
• Habitat features (e.g., holding pools, riffles)	NMFS	??
• Streamflow (Hetch Hetchy Operations)	NMFS	??
• Water temperature monitoring/modeling	Districts	Feb 2017
• LiDAR/Hyperspectral Study	NMFS	April 2016

Information Needs Specific to the Tuolumne River

Information Needs		Lead Entity	Schedule
Recolonization Strategy • Source population (genetics/ecology) • Passive or active reintroduction	• Disease • Climate change	NMFS	??
Fish Community • Current assemblage and abundance • Species interactions • CDFW's Heritage and Wild Trout Program designation (e.g., Clavey River)		??	??
Regulatory and Recreation Issues • CCSF peaking operations • Whitewater boating • ESA (NEEP designation, take requirements) • Wild and Scenic designation • Tribal consultation • Forest management plan	• Public land use • Private land use • Harvest • Fishing regulations • Don Pedro Reservoir fishery management • Moccasin Hatchery	??	??
Concept-level fish passage alternatives and capital and O&M cost estimates for upstream and downstream passage		Districts	Feb 2017

TURLOCK IRRIGATION DISTRICT | MODESTO IRRIGATION DISTRICT

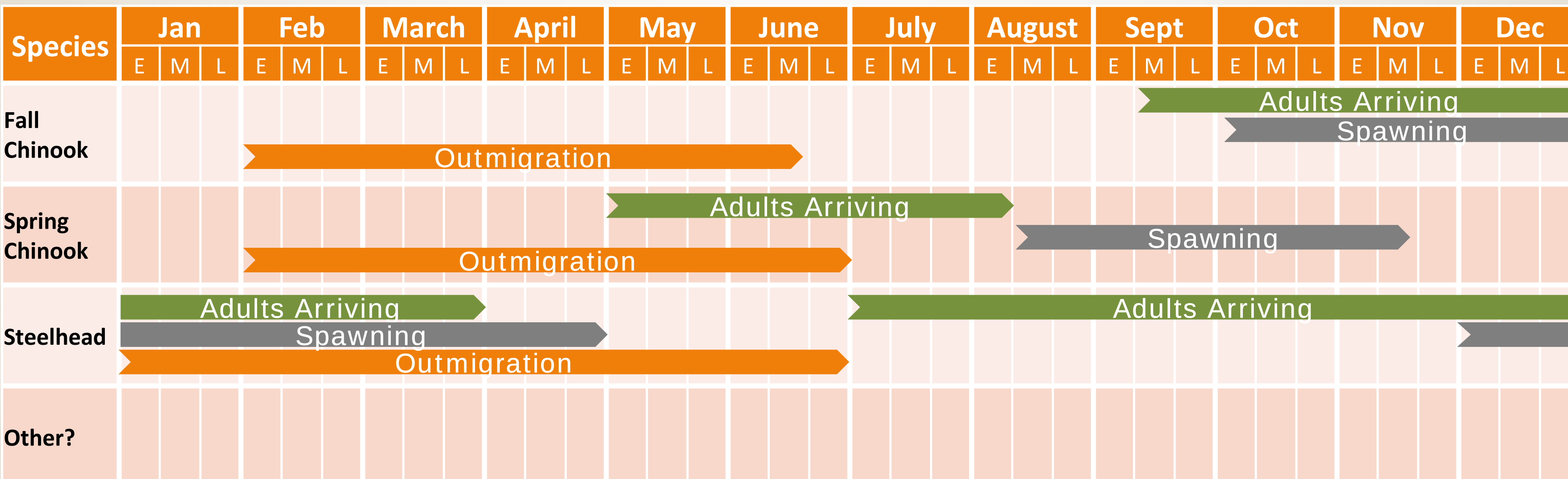
Overview and Examples of Anadromous Fish Passage Facilities

General Design Criteria

- **Target fish species**
- **Peak run characteristics (numbers and timing)**
- **Reservoir passage considerations**
- **Performance expectations**
- Reservoir operations and hydrology
- Specific design guidance by NMFS and CDFW: barriers, fishways, bypass systems, collection, holding, etc.
- Access and transportation corridors
- Monitoring requirements

TURLOCK IRRIGATION DISTRICT | MODESTO IRRIGATION DISTRICT

Example Migration Timing (Periodicity)



Examples of Upstream Fish Passage

- Fishways
- Lifts, Locks, and Elevators
- CHTR – Collect, Handle, Transfer, Release (“Trap and Haul”)
- Bypass Facilities
- Other Technologies such as Transport Tube Systems (“Whoosh”)

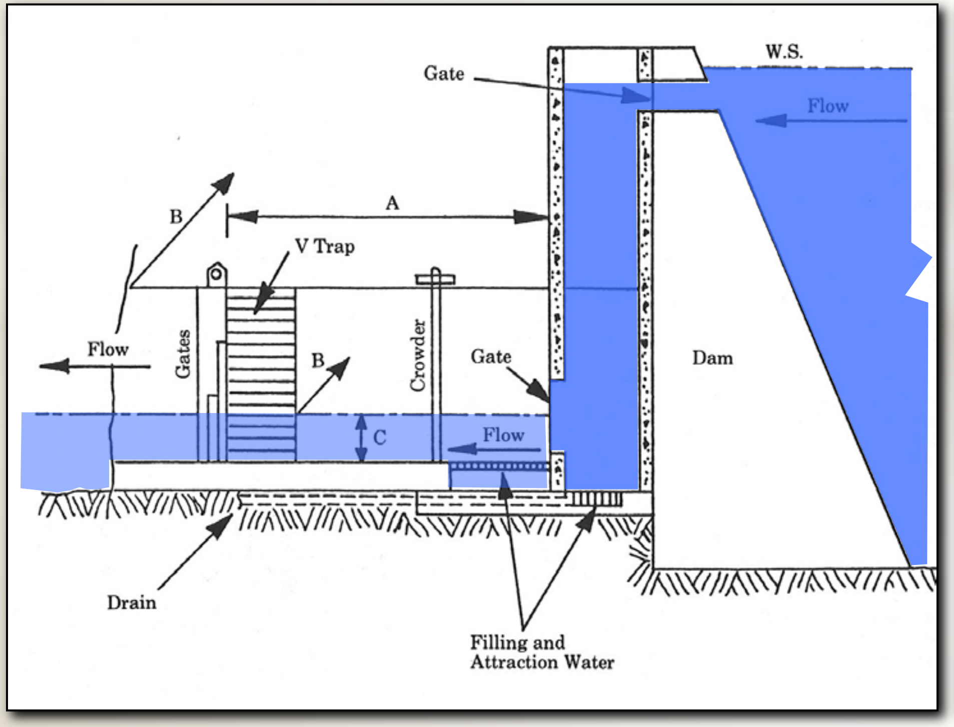
Upstream Passage - Fishways

- Nature Like Fishway
  Weber Dam, NV

- Ice Harbor Style Fishway
  Ice Harbor Dam, WA

Upstream Passage - Lifts, Locks, and Elevators

- Typical Fish Lock or Elevator at Dam



- Example Fish Lift Mounted on Rails Paradise Dam, Australia

TURLOCK IRRIGATION DISTRICT | MODESTO IRRIGATION DISTRICT

Upstream Passage - CHTR

- Fish Transport Truck
  Lower Granite Adult Collection Facility, WA

- Upstream CHTR Facility
  Cougar Dam, OR

TURLOCK IRRIGATION DISTRICT | MODESTO IRRIGATION DISTRICT

Downstream Fish Passage

- Forebay Collectors (fixed or floating)
- Surface Spill Facilities
- Turbine Passage
- Head of Reservoir or Tributary Collection
- Many Facilities are Combined with CHTR and/or Bypass Components

TURLOCK IRRIGATION DISTRICT | MODESTO IRRIGATION DISTRICT

Downstream Passage – Forebay Collectors

- Fixed Forebay Surface Collector
  Pelton Round Butte, OR

- Floating Forebay Surface Collector
  Upper Baker Dam, WA

Inlet to Baker Surface Collector being moved into position during construction (Puget Sound Energy)

TURLOCK IRRIGATION DISTRICT | MODESTO IRRIGATION DISTRICT

Floating Collection Barge prior to deployment (PacifiCorp)

TURLOCK IRRIGATION DISTRICT | MODESTO IRRIGATION DISTRICT

Entrance to Pelton Round Butte Fixed Surface Collector under construction (PGE)

Downstream Passage – Surface Spill

- Juvenile Surface Spill Bypass Unit
  Priest Rapids Dam, WA

- Juvenile Surface Spill Facility
  Wanapum Dam, WA

TURLOCK IRRIGATION DISTRICT | MODESTO IRRIGATION DISTRICT

Downstream Passage – Bypass Facilities

- 14,000 ft Juvenile Bypass
  Clackamas River, North Fork Dam, OR

- Juvenile Bypass Conduit Outlet
  Rocky Reach, WA

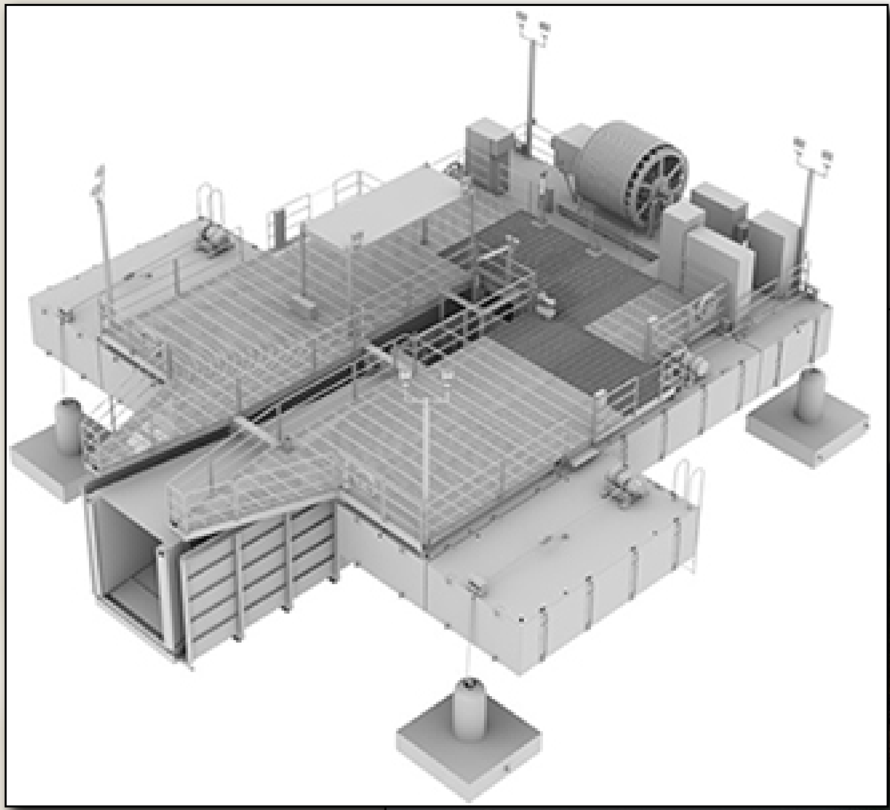
TURLOCK IRRIGATION DISTRICT | MODESTO IRRIGATION DISTRICT

More Downstream Passage

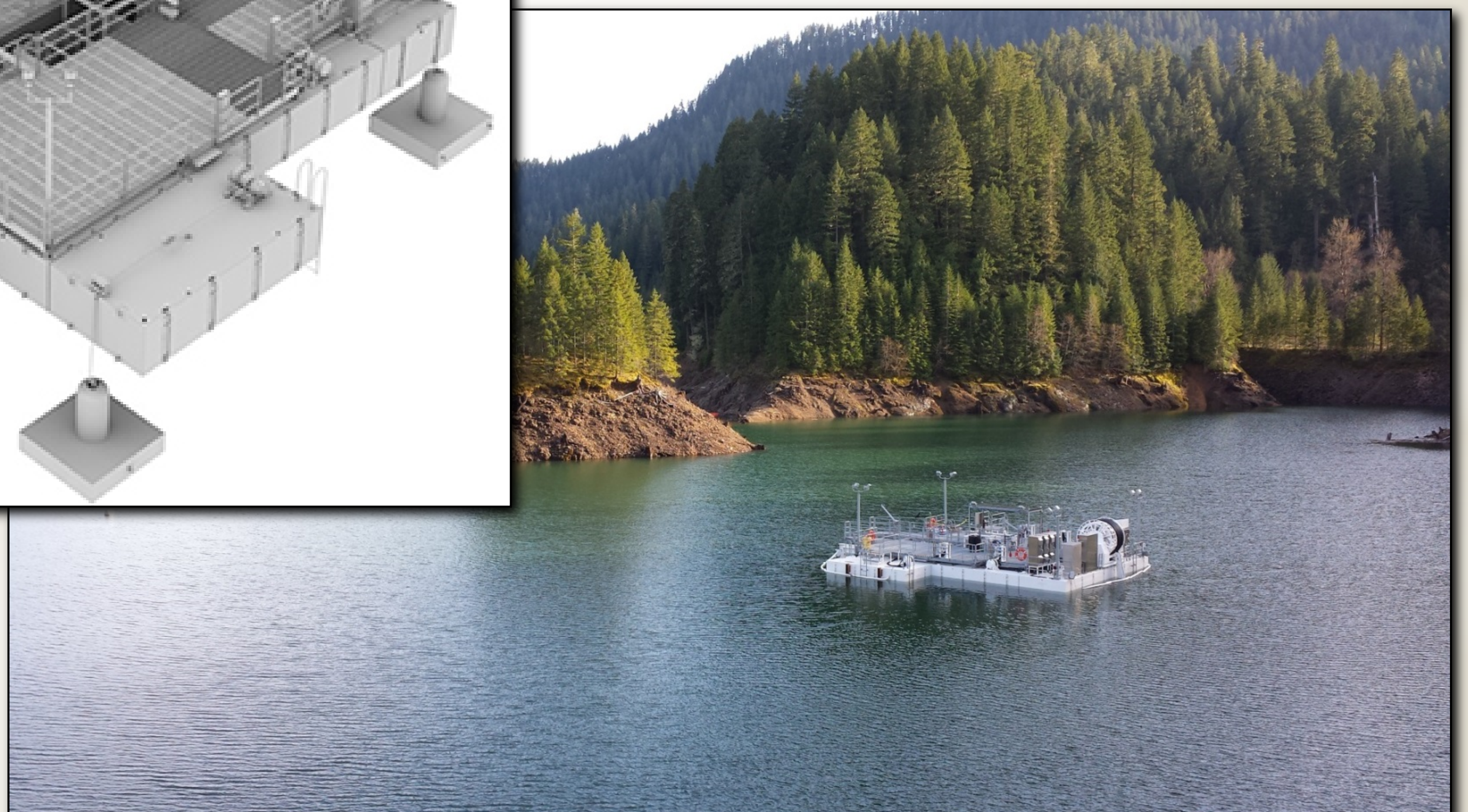
Rotary Screw Trap

Portable Floating Fish Collector
Cougar Dam, OR

Temporary Guide Panels with Trap



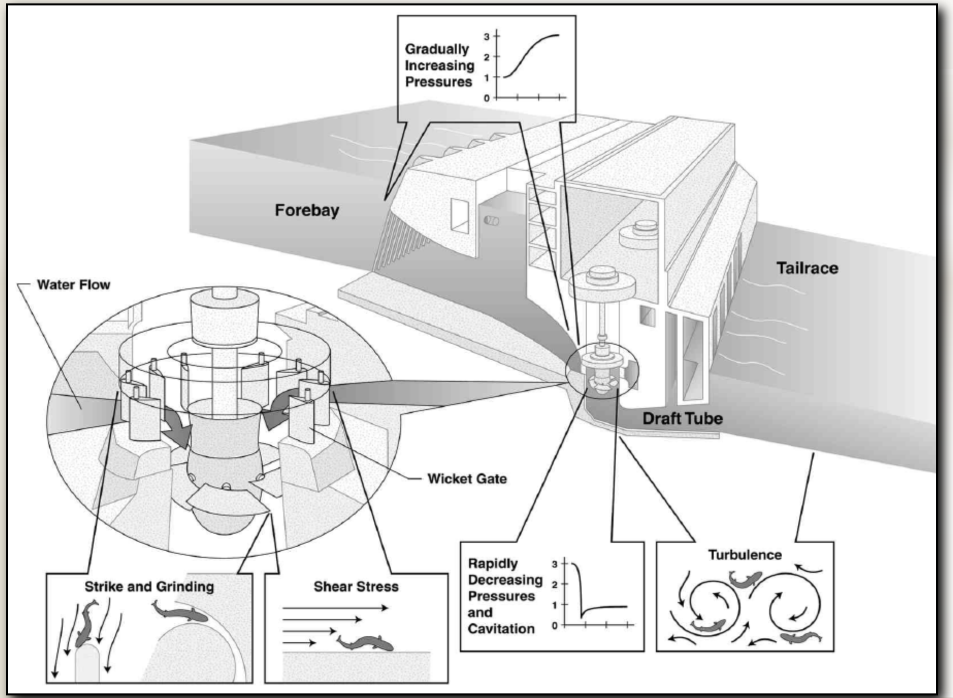
Portable Floating Fish Collector deployed at Cougar Dam, Oregon (USACE)



TURLOCK IRRIGATION DISTRICT | MODESTO IRRIGATION DISTRICT

Downstream Passage – Turbine Passage

- Potential Fish Injuries Through Turbines



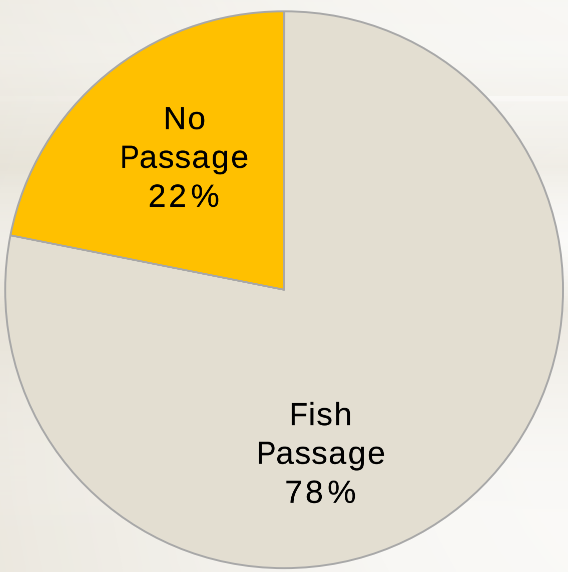
- Voith Minimum Gap Runner (MGR) Turbine
  Wanapum Dam, WA

Example Costs of New Fish Passage Facilities or Retrofits to Existing Facilities

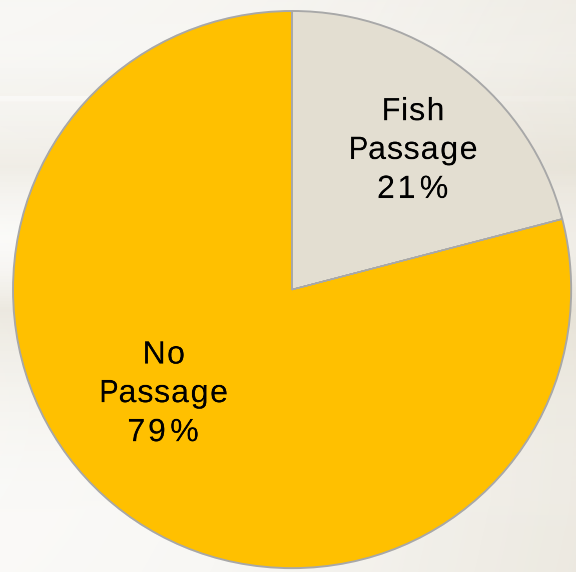
Facility	Available Construction Cost Data
Round Butte FSC	$110M
Swift FSC	$60M
Upper and Lower Baker	$50M Each
Priest Rapids Retrofit	$28M
Cougar Adult Collection	$10.4M
Minto Adult Collection Rebuild	$27.4M

Background and Facility Research – Western US

- Results - case studies of 32 dams between 50 and 150 ft within WA, OR, ID, and CA

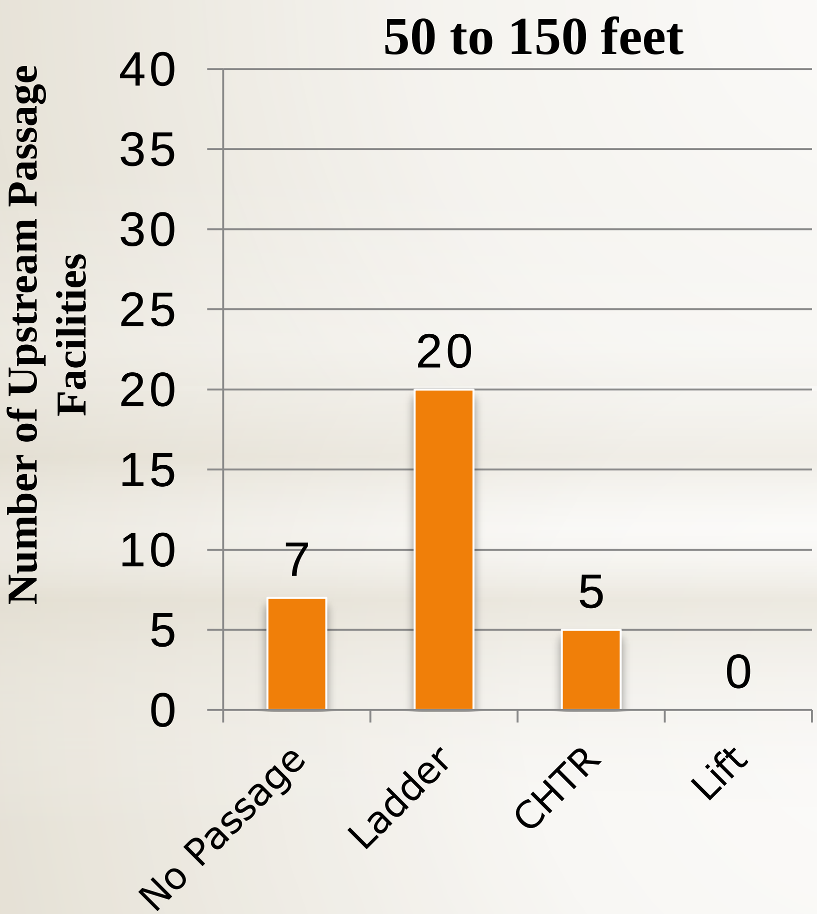


- Results - case studies of 45 dams over 150 ft within WA, OR, ID, and CA

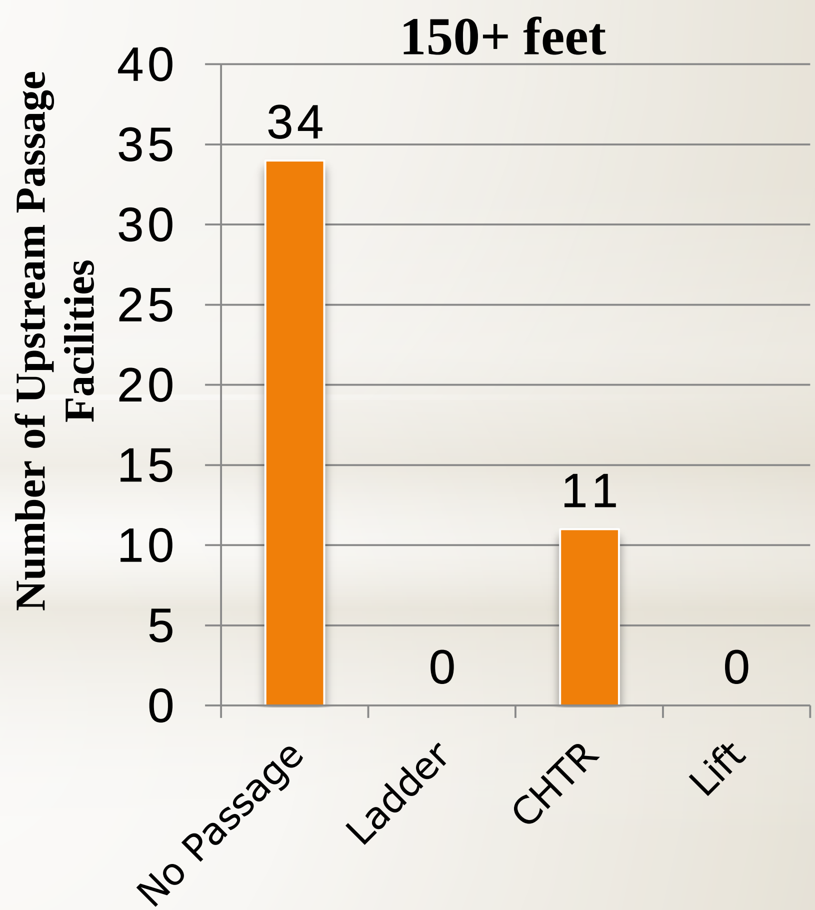


TURLOCK IRRIGATION DISTRICT | MODESTO IRRIGATION DISTRICT

Background and Facility Research – Western US



32 Projects Included in Survey



45 Projects Included in Survey

Examples of Recent Fish Passage Projects in the Pacific NW

- Lower and Upper Baker Dams on Baker River, WA
- River Mill, Faraday, and North Fork Dams on Clackamas River, OR
- Pelton and Round Butte Dams on Deschutes River, OR
- Merwin and Swift Dams on Lewis River, WA
- Mayfield and Cowlitz Falls Dams on Cowlitz River, WA

TURLOCK IRRIGATION DISTRICT | MODESTO IRRIGATION DISTRICT

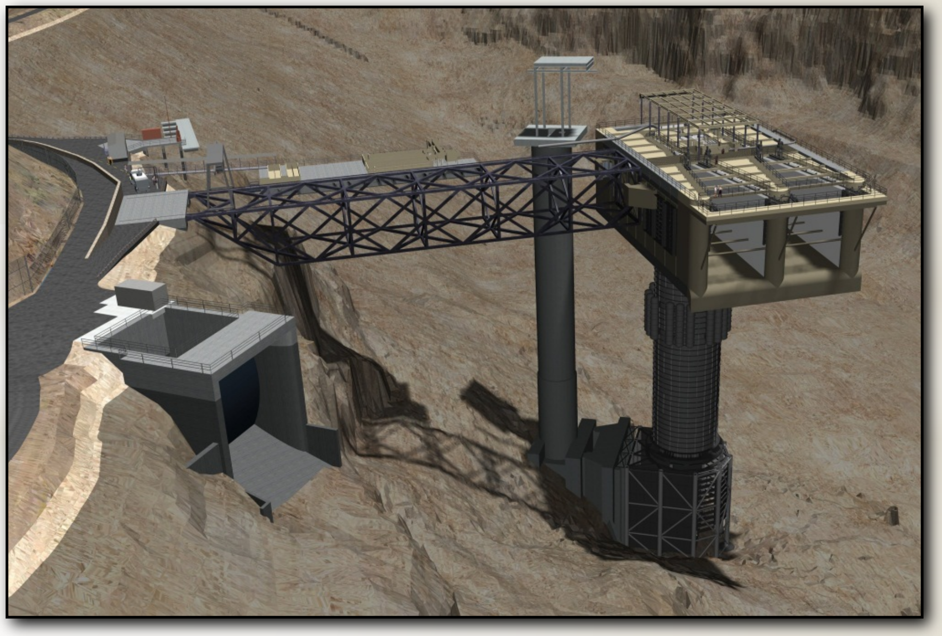
Deschutes River, OR - Project Overview

Dams: Downstream to Upstream

- Reregulating Dam – hydraulic height 25 ft
- Pelton Dam – hydraulic height 204 ft
- Round Butte Dam – hydraulic height 425 ft

Current Facilities

- Upstream Passage: CHTR from below Reregulating Dam to reservoir above Round Butte Dam
- Downstream Passage: Forebay collector with CHTR to below Reregulating Dam ($110 Million)



Tower collection facility.

TURLOCK IRRIGATION DISTRICT | MODESTO IRRIGATION DISTRICT

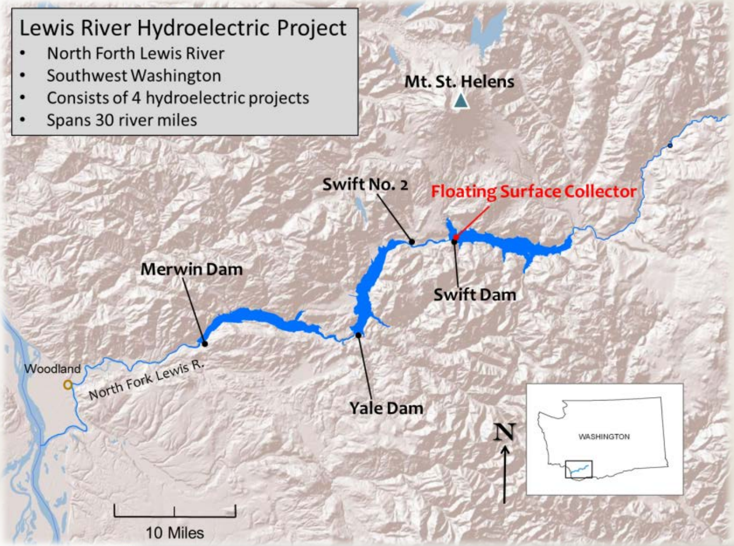
Lewis River, WA - Project Overview

Dams: Downstream to Upstream

- Merwin Dam – hydraulic height 230 ft
- Yale Dam – hydraulic height 309 ft
- Swift Dam – hydraulic height 400 ft

Current Facilities

- Upstream Passage: Currently Constructing CHTR from below Merwin Dam to reservoir above Swift Dam (estimated >$50 Million)
- Downstream Passage: Floating forebay collector with CHTR to below Merwin Dam (>$60 Million)



Swift Floating Surface Collector. Photo and Figure from PacifiCorp

Cowlitz River, WA - Project Overview

Dams: Downstream to Upstream

- Mayfield Dam – hydraulic height 230 ft
- Mossyrock Dam – hydraulic height 366 ft
- Cowlitz Falls Dam – hydraulic height 120 ft

Current Facilities

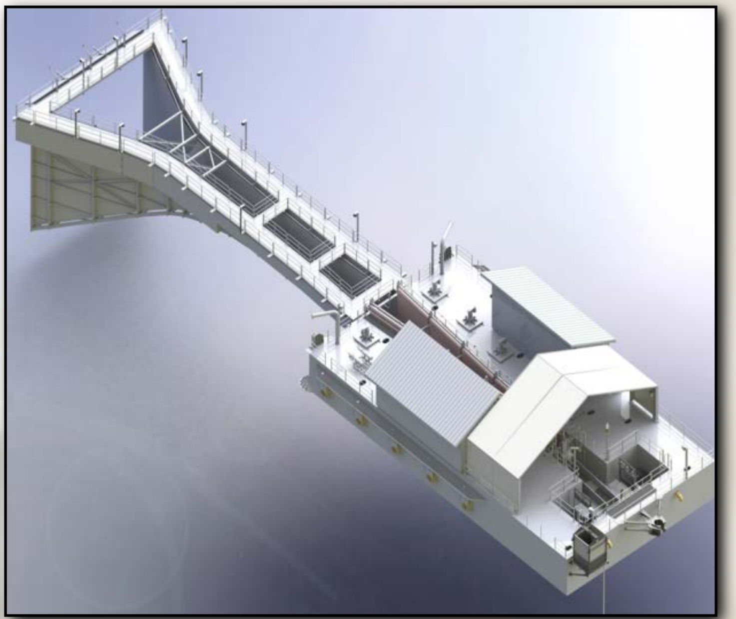
- Upstream Passage: CHTR from below Mayfield Dam to Tilton River upstream of Mayfield Dam and upstream of Cowlitz Falls Dam
- Downstream Passage: Surface collection flume at Cowlitz Dam with CHTR to downstream of Mayfield Dam. Two louvered intake facilities at Mayfield Dam with bypass pipe to river downstream

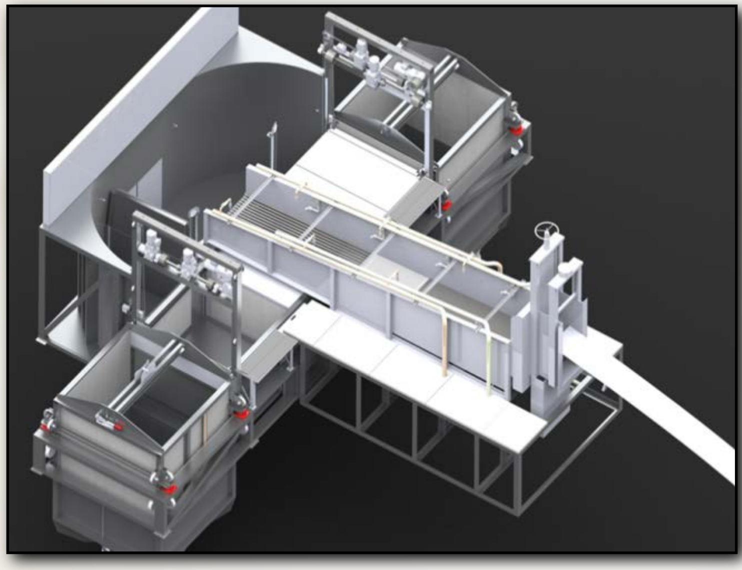
Mayfield CHTR. Photo from Google Maps

TURLOCK IRRIGATION DISTRICT | MODESTO IRRIGATION DISTRICT

Pacific NW Technology Assessment

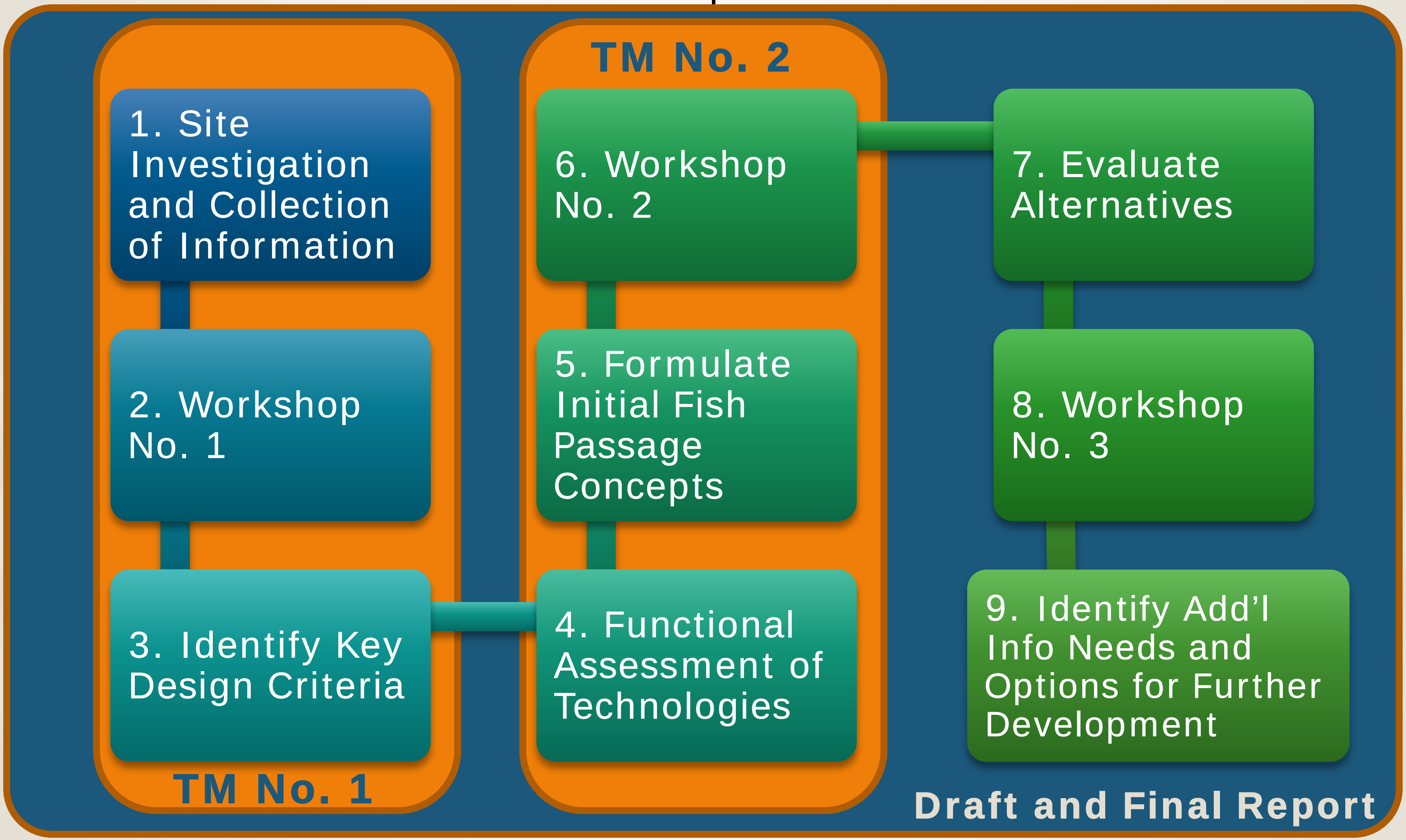
- Most projects at high head dams in Pacific Northwest use CHTR for upstream passage
- Constructed projects in California?





Cushman Surface Collector and Fish Handling Equipment.
Figures by Tacoma Power

TURLOCK IRRIGATION DISTRICT | MODESTO IRRIGATION DISTRICT



Process Coordination and Feedback – Workshops

Meeting / Deliverable	Schedule
Consultation Workshop No. 1	May 2015
Interim Work Product – TM No. 1	July 2015
Consultation Workshop No. 2	August 2015
Interim Work Product – TM No. 2	October 2015
Draft Fish Passage Facility Report	December 2015
Consultation Workshop No. 3	January 2016
Initial Study Report document	February 2016
Final Fish Passage Facility Report	March 2016

North American Journal of Fisheries Management
Publication details, including instructions for authors and subscription information:
http://www.tandfonline.com/loi/ujfm20

Planning Pacific Salmon and Steelhead Reintroductions Aimed at Long-Term Viability and Recovery

Joseph H. Anderson [a e], George R. Pess [a], Richard W. Carmichael [b], Michael J. Ford [a], Thomas D. Cooney [c], Casey M. Baldwin [d f] & Michelle M. McClure [a]

[a] National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Northwest Fisheries Science Center, 2725 Montlake Boulevard East, Seattle, Washington, 98112, USA

[b] Oregon Department of Fish and Wildlife, Eastern Oregon University, 203 Badgley Hall, One University Boulevard, La Grande, Oregon, 97850, USA

[c] National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Northwest Fisheries Science Center, 1201 Northeast Lloyd Boulevard, Portland, Oregon, 97232, USA

[d] Washington Department of Fish and Wildlife, 3515 State Highway 97A, Wenatchee, Washington, 98801, USA

[e] Washington Department of Fish and Wildlife, 600 Capitol Way North, Olympia, Washington, 98501, USA

[f] Colville Confederated Tribes, Fish and Wildlife Department, 470 9th Street Northeast, Suite 4, East Wenatchee, Washington 9, 8802, USA

Published online: 30 Jan 2014.

To cite this article: Joseph H. Anderson, George R. Pess, Richard W. Carmichael, Michael J. Ford, Thomas D. Cooney, Casey M. Baldwin & Michelle M. McClure (2014) Planning Pacific Salmon and Steelhead Reintroductions Aimed at Long-Term Viability and Recovery, North American Journal of Fisheries Management, 34:1, 72-93

To link to this article: http://dx.doi.org/10.1080/02755947.2013.847875

North American Journal of Fisheries Management 34:72–93, 2014

ISSN: 0275-5947 print / 1548-8675 online
DOI: 10.1080/02755947.2013.847875

ARTICLE

Planning Pacific Salmon and Steelhead Reintroductions Aimed at Long-Term Viability and Recovery

Joseph H. Anderson*[1] and George R. Pess
National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Northwest Fisheries Science Center, 2725 Montlake Boulevard East, Seattle, Washington 98112, USA

Richard W. Carmichael
Oregon Department of Fish and Wildlife, Eastern Oregon University, 203 Badgley Hall, One University Boulevard, La Grande, Oregon 97850, USA

Michael J. Ford
National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Northwest Fisheries Science Center, 2725 Montlake Boulevard East, Seattle, Washington 98112, USA

Thomas D. Cooney
National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Northwest Fisheries Science Center, 1201 Northeast Lloyd Boulevard, Portland, Oregon 97232, USA

Casey M. Baldwin[2]
Washington Department of Fish and Wildlife, 3515 State Highway 97A, Wenatchee, Washington 98801, USA

Michelle M. McClure
National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Northwest Fisheries Science Center, 2725 Montlake Boulevard East, Seattle, Washington 98112, USA

Abstract
Local extirpations of Pacific salmon *Oncorhynchus* spp. and steelhead *O. mykiss*, often due to dams and other stream barriers, are common throughout the western United States. Reestablishing salmonid populations in areas they historically occupied has substantial potential to assist conservation efforts, but best practices for reintroduction are not well established. In this paper, we present a framework for planning reintroductions designed to promote the recovery of salmonids listed under the Endangered Species Act. Before implementing a plan, managers should first describe the benefits, risks, and constraints of a proposed reintroduction. We define benefits as specific biological improvements towards recovery objectives. Risks are the potential negative outcomes of reintroductions that could worsen conservation status rather than improve it. Constraints are biological factors that will determine whether the reintroduction successfully establishes a self-sustaining population. We provide guidance for selecting a recolonization strategy (natural colonization, transplanting, or hatchery releases), a source population, and a method for providing passage that will maximize the probability of conservation benefit while minimizing risks. Monitoring is necessary to determine whether the reintroduction successfully achieved the benefits and to evaluate the impacts on nontarget

*Corresponding author: joseph.anderson@dfw.wa.gov
[1]Present address: Washington Department of Fish and Wildlife, 600 Capitol Way North, Olympia, Washington 98501, USA.
[2]Present address: Colville Confederated Tribes, Fish and Wildlife Department, 470 9th Street Northeast, Suite 4, East Wenatchee, Washington 98802, USA.
Received September 10, 2012; accepted August 30, 2013

species or populations. Many of the benefits, especially diversity and the evolution of locally adapted population segments, are likely to accrue over decadal time scales. Thus, we view reintroduction as a long-term approach to enhancing viability. Finally, our review of published salmonid reintroduction case studies suggests that large uncertainties remain in the success of reintroduction in establishing self-sustaining populations, particularly for programs employing active methods.

Reintroducing species to areas from which they have been extirpated is a common and sometimes successful approach to conserving biodiversity. Indeed, reintroductions played a prominent role in some of the most spectacular success stories in conservation, including species that have recovered from the brink of extinction such as the Arabian oryx *Oryx leucoryx* (Spalton et al. 1999) and alpine ibex *Capra ibex ibex* (Stüwe and Nievergelt 1991). However, despite considerable cost and effort, reintroduction efforts often fail to establish self-sustaining populations (Wolf et al. 1996; Fischer and Lindenmayer 2000). A recent proliferation of reintroduction literature suggests that scientifically based management principles can improve the efficacy of these efforts (Seddon et al. 2007; Armstrong and Seddon 2008).

Conceptually, reintroductions offer an enormous potential to benefit the conservation of Pacific salmon *Oncorhynchus* spp. and steelhead *O. mykiss* (anadromous Rainbow Trout). For many anadromous salmonid populations, the primary cause of local extirpation is easily identified: obstructed access to suitable spawning and rearing habitats due to dams or other stream blockages. Large barriers are responsible for extirpation from nearly 45% of the habitat historically occupied by Pacific salmon and steelhead in the western contiguous United States (McClure et al. 2008a). Numerous smaller structures, such as irrigation diversion dams and culverts, also limit access to anadromous salmonid habitat (Gibson et al. 2005). Impassable dams are only one cause of declining salmonid populations and local extirpations (NRC 1996), but they are widespread. The removal or circumvention of dams and other barriers, therefore, provides many opportunities for the reestablishment of natural populations of Pacific salmon.

Despite the potential benefits of reintroduction, regional recovery planners must grapple with a variety of challenges in selecting and implementing such projects. Which populations should be prioritized for reintroduction? What methods should be used to reintroduce anadromous salmonids? How should managers evaluate whether efforts have been successful? Although previous authors have provided general guidelines for fish reintroductions (Williams et al. 1988; Minckley 1995; George et al. 2009; Dunham et al. 2011), the unique biology and management of Pacific salmon and steelhead merit special consideration.

In this paper, we provide recommendations for planning reintroductions of anadromous salmonids, focusing primarily on Pacific salmon and steelhead. Our guidelines are intended to help resource managers design reintroduction programs that contribute to the recovery of Pacific salmon and steelhead listed under the U.S. Endangered Species Act (ESA) by establishing or expanding self-sustaining natural populations. Thus, we present recommendations couched in the terminology, scientific concepts, and broad conservation objectives guiding ongoing salmonid recovery efforts under the ESA (McElhany et al. 2000). The International Union for the Conservation of Nature (IUCN 1998) defined reintroduction as "an attempt to establish a species in an area which was once part of its historical range, but from which it has been extirpated." Using this broad definition, we consider a suite of management approaches to reintroduction, including passive strategies, such as barrier removal followed by natural colonization, and active strategies, such as transplanting or hatchery releases.

Reintroductions alter patterns of connectivity among populations. We therefore first develop a metapopulation framework to describe the ecological processes governing population connectivity and their evolutionary consequences. We then broadly overview a set of planning concepts (benefits, risks, and constraints) to help guide scoping efforts and determine if a proposed reintroduction has conservation merit. Next, we describe methods of executing reintroductions that increase the likelihood of achieving benefits while overcoming constraints and reducing risks, including a review of examples in which these methods have been employed. Finally, monitoring is essential to assess whether the effort was successful and, if not, how the program should be modified. Throughout, we focus on biological issues, acknowledging that a socioeconomic cost-benefit analysis will be crucial for policy decisions regarding large-scale restoration projects.

A METAPOPULATION PERSPECTIVE

A regional, landscape perspective is important for effective salmonid recovery (ISAB 2011). We therefore present our recommendations within a metapopulation conceptual framework. A metapopulation is a collection of spatially structured populations inhabiting discrete habitat patches, with dispersal between patches providing some level of connectivity between populations (Hanski and Gilpin 1997). Reintroductions intentionally alter connectivity among populations, so it is important to consider the consequences of such actions on the demography, ecology, and evolution of the metapopulation at large.

The metapopulation concept is readily applied to anadromous salmonids (Schtickzelle and Quinn 2007) and especially the case of population colonization. Pacific salmon have a strong tendency to return to their natal stream but also "stray" and breed in nonnatal streams (Hendry et al. 2004), providing the interpopulation dispersal characteristic of metapopulations. Dispersal, combined with variation in population growth rate, can lead to source–sink dynamics whereby populations with net demographic deficits (i.e., "sinks") are supported by immigration from populations with net demographic excesses (i.e., "sources") (Pulliam 1988). For colonizing Pacific salmon, source population dynamics will, in large part, determine the rate of numerical and spatial expansion (Pess et al. 2012).

Salmonid metapopulations might adopt a variety of different structural configurations depending on the spatial arrangement of habitat, heterogeneity in habitat quality among patches, and connectivity between populations (Schtickzelle and Quinn 2007; Fullerton et al. 2011). Metapopulation structure is useful to conceptualize the potential outcomes of reintroductions (Figure 1). Furthermore, an assessment of metapopulation structure might inform reintroduction methods. For example, a reintroduction that expands an existing population (Figure 1A) or establishes a new well-connected population (Figure 1B) might achieve success through passive natural colonization, whereas active methods might be required for more isolated reintroduction sites (Figure 1C).

Metapopulation structure, and the degree of connectivity among populations, also affects the evolution of locally adapted traits. Spatially structured populations experiencing different selection regimes within a heterogeneous landscape will tend to evolve traits advantageous in each environment, a process that is counterbalanced by connectivity between populations, which tends to homogenize gene pools (Barton and Whitlock 1997). Local adaptation is a fundamental aspect of salmonid population structure (Taylor 1991; Fraser et al. 2011). Furthermore, life history diversity exhibited by locally adapted populations buffers salmonid species against environmental variation, increasing stability and resilience (Greene et al. 2010; Schindler et al. 2010) while reducing extinction risk (Moore et al. 2010).

Increasing population connectivity, an implicit goal of all reintroduction programs, can have both positive and negative consequences on species viability. Some level of connectivity is beneficial because it can lead to the colonization of new habitat (Pess et al. 2012), demographically rescue extant populations experiencing periods of low productivity or abundance (Pulliam 1988), and provide new genetic material essential for fitness in populations suffering from fragmentation (Tallmon et al. 2004). However, excessive connectivity can have negative consequences such as genetic homogenization (Williamson and May 2005) and demographic synchrony (Liebhold et al. 2004), both of which would tend to reduce resilience.

For administering listing and recovery of Pacific salmon under the ESA, the National Marine Fisheries Service (NMFS) uses an explicitly defined population structure. For vertebrates,

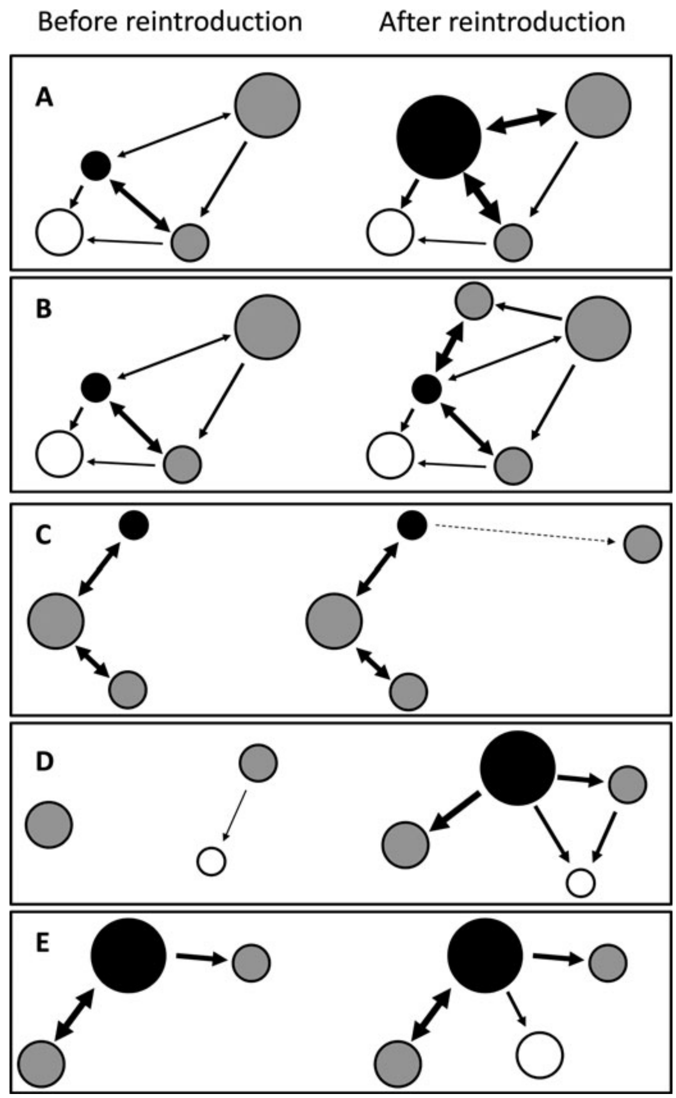


FIGURE 1. Possible effects of reintroduction on metapopulation structure are as follows: **(A)** increase the abundance of the existing population, **(B)** establish a new, independent population well connected to the metapopulation, **(C)** establish a new, independent population isolated from the other populations, **(D)** establish a new, independent mainland population in a historic mainland–island metapopulation, and **(E)** establish a new, independent sink population in a historic mainland–island metapopulation. In these diagrams, the size of the circle represents habitat capacity, the shade represents population density (darker shades are more dense), the thickness of the arrows represents the magnitude of connectivity, and the dashed lines indicate intermittent connectivity. These scenarios are not intended to represent all possible outcomes.

the ESA allows listing of Distinct Population Segments (DPSs), subspecies, or entire species. For Pacific salmon, the NMFS has defined a DPS to be an Evolutionary Significant Unit (ESU), which is a population or group of populations that is both substantially reproductively isolated from other populations and represents an important component of the evolutionary legacy of the species (Waples 1991). For steelhead, the NMFS uses the joint NMFS–U.S. Fish and Wildlife Service DPS definition

(NMFS 2006). We refer to both Pacific salmon ESUs and steelhead DPSs as ESUs in this paper for consistency and brevity. Similar to metapopulations, most Pacific salmon ESUs contain multiple independent populations that interact through dispersal (e.g., Myers et al. 2006; Ruckelshaus et al. 2006). Furthermore, metapopulation concepts are explicitly considered in the criteria used to evaluate the viability of Pacific salmon and steelhead ESUs and the populations within them (McElhany et al. 2000).

PLANNING CONCEPTS: BENEFITS, RISKS, AND CONSTRAINTS

Before implementing a reintroduction, it is essential to comprehensively consider the potential outcomes. Poorly planned reintroduction efforts might waste resources that would be better invested in other conservation approaches or, worse, impair the viability of an extant population. In evaluating a potential reintroduction, there are three primary concepts to consider: the benefits if the reintroduction is successful, the risks of causing biological harm to extant populations, and the constraints that might prevent population establishment. Weighing the potential benefits against the risks and constraints will help determine whether or not to implement a proposed reintroduction (Figure 2).

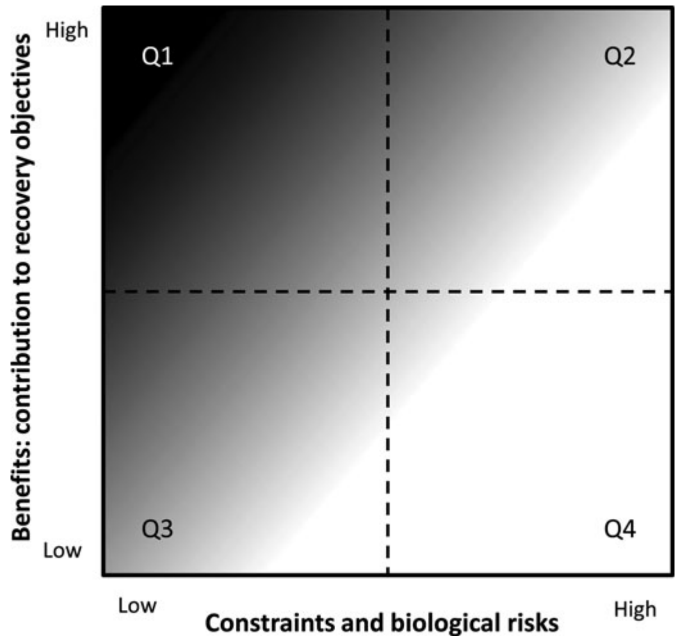


FIGURE 2. Framework for gauging the net benefit of reintroduction options, with darker colors representing a higher likelihood of contributing to conservation and recovery goals. In each case, the benefits are weighed against the constraints and risks of the project. In quadrant 1 (Q1), the benefits are high and the overall constraints and risks are low, providing the best opportunity for reintroduction to effectively contribute to the recovery objectives. Quadrant 2 (Q2) also has a high potential benefit, but either the difficulty in implementation or the risk of a negative outcome makes projects in this region less attractive. Both quadrants 3 (Q3) and 4 (Q4) have relatively low benefits; some in quadrant 3 may be selected owing to the low risk and ease of execution, whereas those in quadrant 4 will generally be avoided.

Benefits

Due to our focus on ESA-listed salmonids, we assess benefits with the same criteria used to evaluate recovery under the ESA. The biological viability of salmonid ESUs and the populations within them is dependent upon four characteristics: abundance, productivity, spatial structure, and diversity (McElhany et al. 2000). We use these same attributes for evaluating the potential benefits of a reintroduction that successfully establishes a self-sustaining population (Table 1). Abundance, productivity, and spatial structure (i.e., connectivity) are variables in metapoulation models useful for guiding salmonid management (Cooper and Mangel 1999; Fullerton et al. 2011; Pess et al. 2012), and diversity promotes resilience at a broad, regional (hence metapopulation) scale (Moore et al. 2010; Schindler et al. 2010).

Numerical increases in abundance and productivity are perhaps the most obvious benefits afforded by reintroductions.

TABLE 1. Potential benefits of a successful reintroduction.

Type	Definition	Potential benefit afforded by reintroduction
Abundance	Total number of naturally spawned fish in a population or ESU	Increase the carrying capacity of an existing population or establish a new, discrete, demographically independent population
Productivity	Numerical ratio of recruits in generation t to the spawners that produced them in generation $t - 1$	Increase average vital rates (e.g., reproductive success, survival) of an extant population or ESU by reestablishing occupancy of high quality habitat
Spatial structure	Geographic arrangement of fish across the landscape and connectivity of populations linked by dispersal	Reduce isolation of extant populations, thereby restoring natural patterns of dispersal and connectivity within the metapopulation
Diversity	Variation in morphological, behavioral, and genetic traits within a population or ESU	Reestablish occupancy of habitats that are rare or underrepresented within the extant distribution, thereby promoting ecological and evolutionary processes responsible for local adaptation and diverse life histories

Increased abundance has several beneficial consequences, including shielding a population from extinction due to stochastic variability (Lande 1993), minimizing genetic processes that can reduce fitness in small populations (Allendorf and Luikart 2007), exceeding thresholds for depensatory density-dependent processes (Liermann and Hilborn 2001), and providing marine-derived nutrient subsidies to aquatic and riparian ecosystems (Gende et al. 2002). Status evaluations of ESA-listed Pacific salmon and steelhead populations focus on numerical productivity (Ford 2011), or population growth rate as it is known in the ecological literature, so recruits per spawner is also an important variable to consider. Reintroductions can have either positive or negative impacts on the productivity of a given population or ESU, depending on the quality of the new habitat and survival through migration and ocean rearing. In general, a reintroduction resulting in a "sink" has far less value for long-term viability than a reintroduction yielding a self-sustaining population. Indeed, reintroduction to a sink would result in a net loss if the animals would have been more productive in their natal habitat. However, in highly connected metapopulations, sinks may increase the stability of the entire system by promoting higher abundance in source populations (Foppen et al. 2000).

Reintroductions that reduce the isolation of formerly connected extant populations will benefit spatial structure (Figure 1). In practice, this can be estimated as the extent to which a newly established population would reduce gaps between spawning areas or populations that were not historically separated. Given the spatial arrangement, models of dispersal, and estimates of habitat capacity, reintroduction could target areas that might have a significant role in metapopulation connectivity and serve as sources supporting less productive populations (Figure 1D; Fullerton et al. 2011; Pess et al. 2012). In addition, at the ESU scale, dispersion of populations across the landscape helps reduce vulnerability to catastrophic events (Good et al. 2008), so increasing spatial complexity via successful reintroduction will reduce ESU extinction risk.

Reintroductions can enhance salmonid diversity through a variety of mechanisms. Dams often selectively block access to certain habitat types, particularly snowmelt-dominated headwater streams (Beechie et al. 2006; McClure et al. 2008a). Therefore, reintroductions into habitats that are rare or underrepresented within the extant species distribution may promote unique local adaptations and life history traits. Barrier removal may provide seaward access for populations of facultatively migratory species (e.g., *O. mykiss*) that historically had anadromous components (Brenkman et al. 2008b). Reintroductions to large watersheds with multiple tributaries and subbasins also offer opportunities to enhance diversity through the evolution of population substructure and local adaptation to distinct spawning areas. In general, a reintroduction that establishes a new locally adapted population will provide a greater benefit to diversity than one that expands an existing population (Figure 1A, 1B).

Outlining the time frame required to achieve reintroduction benefits will help set expectations and establish benchmarks for monitoring. Some reintroductions may provide immediate benefits within a generation or two, but those requiring adaptation to new habitat will likely take decades. If an implemented project suffers initial setbacks and lacks a scientifically based timeline of expectations, it might be unnecessarily abandoned or altered before it has a chance to succeed. In general, reintroduction can provide benefits to viability characteristics that change on ecological time scales (abundance, productivity, and spatial structure) faster than benefits to diversity, which will accumulate over generations as a reintroduced population becomes demographically independent and evolves in response to local selective pressures. Salmonids have developed population structure within 20 years of introduction to new environments (Ayllon et al. 2006); evidence that such divergence is adaptive has been found after 50–100 years (Hendry et al. 2000; Quinn et al. 2001; Koskinen et al. 2002).

Moreover, in some cases adaptive evolution might be necessary to observe significant increases in abundance. Indeed, there is often a time lag from the initial introduction of an invading species to population growth that might be explained by evolutionary processes required to increase population fitness (Sakai et al. 2001). Dams have altered the evolution of traits such as adult spawn timing, embryonic development rate, and juvenile migration strategies (Angilletta et al. 2008; Williams et al. 2008), so some level of adaptive evolution may be necessary to overcome this "Darwinian debt" if reintroduction includes restoration of the natural flow regime (Waples et al. 2007b).

Risks

We define risks as unintended or undesirable negative consequences for nontarget species or nontarget populations of the reintroduced species (Table 2). Minimizing those risks is important if a reintroduction is to have a positive overall conservation effect (George et al. 2009). Here we outline the concepts underlying four categories of risk: evolutionary, demographic, ecological, and disease. More details on minimizing them are provided below in the Executing a Reintroduction section.

In terms of evolutionary risks, reintroduction could result in genetic homogenization, reduced fitness, or both. Transfers of fish between basins and large-scale hatchery releases, historically common practice throughout the Pacific Northwest, have eroded population structure that is essential for the local adaptation and hence fitness of salmonid populations (Williamson and May 2005; Eldridge and Naish 2007; McClure et al. 2008b). Hatchery fish often have lower fitness than wild fish when both groups breed sympatrically (Araki et al. 2008). Thus, although hatchery releases may provide short-term demographic benefits, they may compromise fitness in the long term, thereby limiting the probability of recovery (Bowlby and Gibson 2011). In many cases, populations or spawning areas near the reintroduction site are of conservation concern. Fish

TABLE 2. Summary of the major reintroduction risks, defined as unintended or undesirable negative consequences for nontarget species, nontarget populations, spawning areas, or life history types of the reintroduced species.

Type	Description	Methods of minimizing risk
Evolutionary	Homogenized population structure and reduced fitness within reintroduction site and adjacent areas	Avoid geographically and genetically distant source populations; opt for natural colonization rather than hatchery releases or transplanting; design passage facilities to minimize straying to adjacent areas
Demographic	Depletion of source population via removal of adults or gametes for reintroduction	Ensure that source population can sustain removal for multiple successive years or opt for natural colonization rather than hatchery releases or transplanting
Ecological	Invasion by nonnative species and suppression of preexisting native species within reintroduction site	Design passage facilities with selective access; avoid hatchery releases that alter density-dependent ecological interactions
Disease	Spread of pathogens	Establish baseline disease levels prior to reintroduction; screen individuals for pathogens prior to release

released into the reintroduction site, and their offspring, may not return there as adults, so fitness reductions and the erosion of population structure of the wild populations in adjacent spawning areas are potential consequences of excessive straying.

Reintroductions also pose demographic risks because the removal of individuals from the source population may harm its viability. If reintroduced fish experience poor reproductive success, the new habitat may become a sink that depletes an extant population but fails to provide the benefit of a newly established self-sustaining population. Transplanting or collecting broodstock from wild populations will exacerbate this risk, but it applies in concept to natural colonization as well. Ensuring that the population donating colonists has a net demographic excess (i.e., it is a true “source” in metapopulation source–sink dynamics) will help reduce demographic risks.

Nonnative fishes present a serious conservation threat to salmonids in the Pacific Northwest (Sanderson et al. 2009) and may invade the reintroduction site following barrier removal (Fausch et al. 2009). Invasion might not only reduce the likelihood of reintroduction success but also threaten preexisting native species. A careful examination of the likelihood of nonnative dispersal into the new habitat entails identifying any proximate populations of nonnative fishes and evaluating habitat suitability above the barrier. It is also important to consider whether reintroduction might suppress preexisting native species (which might be threatened or endangered themselves) through competition or predation. The few empirical assessments of reintroduction impacts have found little effect on preexisting native species (Pearsons and Temple 2007; Buehrens 2011).

Finally, reintroductions have potential to spread disease (Viggers et al. 1993). Colonists may serve as vectors of disease spread within the species they are intended to benefit, thereby hindering conservation efforts (Walker et al. 2008), or transmit pathogens to other species or resident life history types currently occupying the target site. Hatchery fish in particular, due to the crowded conditions in which they are typically reared, may act as vectors of disease transfer to wild populations (reviewed in Naish et al. 2008). Reintroduced animals might also be vulnerable to endemic pathogen strains within new habitat, and this could decrease the likelihood of successful population establishment if the effect is severe. Establishing a baseline of pathogen densities within the area prior to reintroduction will permit monitoring of disease during reintroduction (Brenkman et al. 2008a), and screening captively reared or transplanted animals prior to release will minimize the risk of spreading disease. Both are important components of reintroduction.

Constraints

We define a constraint as a factor limiting the ability of colonists to establish a self-sustaining population (Table 3). In some cases, an extirpated area may have a high potential to benefit long-term recovery, but current conditions do not support a reintroduction. Evaluating whether the original causes of the extirpation have been adequately ameliorated is an important step in determining whether a site is “reintroduction ready” (IUCN 1998). Importantly, more than one factor may have led to the original extirpation, and in many cases determining a logical sequence of restoring functioning conditions will be an important component of the reintroduction effort. Here, we describe the primary constraints affecting the ability of colonists to reach the reintroduction site, their reproductive success, and the survival of their offspring.

In many cases, migration barriers are the most obvious constraint to the reestablishment of a natural population. Evaluating the best methods for providing passage at barriers is heavily dependent on engineering and social considerations such as the geological setting, human benefits derived from the barrier, and expense. Furthermore, many river systems with reintroduction opportunities have more than one blockage to anadromous

TABLE 3. Summary of constraints to reintroductions, defined as factors that might limit the ability of colonists to establish a self-sustaining population.

Type	Description	Required action
Barriers	Engineering issues; prioritization among multiple blockages in a watershed or region	Removal or circumvention
Habitat quality	Poor habitat quality will limit reproductive success of colonists and survival of their offspring	Restoration prior to reintroduction
Migratory and ocean survival	Poor survival along migration corridor and during ocean residence	Improve survival through downstream dams; estuary restoration; wait for favorable ocean conditions or scale expectations to match poor ocean conditions
Harvest	Reduces number of potential colonists and survival of their offspring	Reduce fishing pressure on potential source population(s) during colonization
Interactions with other species and populations	Competition and predation from native and nonnative species	Suppress predator population or transport fish during migration to avoid predators
Changing conditions	Climate and land-use change will alter geographic patterns of habitat suitability	Prioritize reintroductions that enhance diversity, are likely to serve as refuges in a warming climate, or are located in river networks whose high connectivity will allow species distributions to shift in response to climate change

passage, requiring prioritization among multiple removal or circumvention options.

The quality of habitat in the reintroduction site will have a large effect on colonist productivity. In gauging habitat quality within an area targeted for reintroduction, planners should consider the requirements of all life phases. Spatially explicit models incorporating known fish–habitat relationships (e.g., Scheuerell et al. 2006; Burnett et al. 2007; Pess et al. 2008) can help identify potentially productive streams; determining the anthropogenic degradation of habitats can draw on the many efforts (largely expert opinion) to identify degraded habitat (e.g., subbasin or recovery plans). Where habitat quality is low due to anthropogenic disturbance, habitat restoration may be necessary for successful reintroduction and premature efforts to put fish into degraded habitat may simply be a waste of resources. For example, liming of rivers affected by acidification (Hesthagen and Larsen 2003) and reducing pollution (Perrier et al. 2010; Kesler et al. 2011) were necessary components of reestablishing Atlantic Salmon *Salmo salar* runs in Europe. When restoration is necessary, process-based restoration will maximize the long-term sustainability of habitat improvements (Beechie et al. 2010).

Interactions with existing species in the target area could influence the likelihood of a successful reintroduction. Dams that block salmonid habitat often create the warm, lentic reservoirs preferred by nonnative fishes (e.g., Channel Catfish *Ictalurus punctatus*, Smallmouth Bass *Micropterus dolomieu*, Yellow Perch *Perca flavescens*, and Walleye *Sander vitreus)* and "native invaders" (e.g., Northern Pikeminnow *Ptychocheilus oregonensis*), species that consume a considerable quantity of salmonids (Sanderson et al. 2009; Carey et al. 2012). Competition and predation from preexisting species might not be confined to reservoirs or degraded habitats. Nonnative Brook Trout *Salvelinus fontinalis*, for example, have invaded relatively pristine, free-flowing streams throughout the Pacific Northwest (Sanderson et al. 2009) and may have suppressed populations of ESA-listed Chinook Salmon *O. tshawytscha* (Levin et al. 2002). Slimy Sculpin *Cottus cognatus*, a native generalist predator, reduced the recruitment success of reintroduced Atlantic Salmon (Ward et al. 2008).

Due to climate forcing (Mantua et al. 2010) and alterations in land use (Bilby and Mollot 2008), salmonid habitat quality is likely to change over the time required for a reintroduction to result in a self-sustaining population. Thus, the likely future condition of the reintroduction site is an important consideration in reintroduction planning efforts. Climate and land-use models can inform restoration opportunities (Battin et al. 2007; Lohse et al. 2008) but have been applied to relatively few watersheds. In the absence of large-scale predictive models, two qualitative guidelines for reintroductions warrant consideration. First, dams selectively block access to certain habitat types (Beechie et al. 2006; McClure et al. 2008b), suggesting that reintroduction to mountain headwater reaches with higher elevations and cooler temperatures may provide refuges in a warming climate. Second, maintaining a diversity of habitat types will buffer against uncertainty in the response of salmonid populations to climate change (Schindler et al. 2008), suggesting that reintroduction should target habitats that are unique, rare, or underrepresented in the current species distribution.

High mortality during migration and ocean rearing due to impaired migratory corridor, poor ocean conditions, or harvest pressure may limit reintroduction success. Passage through

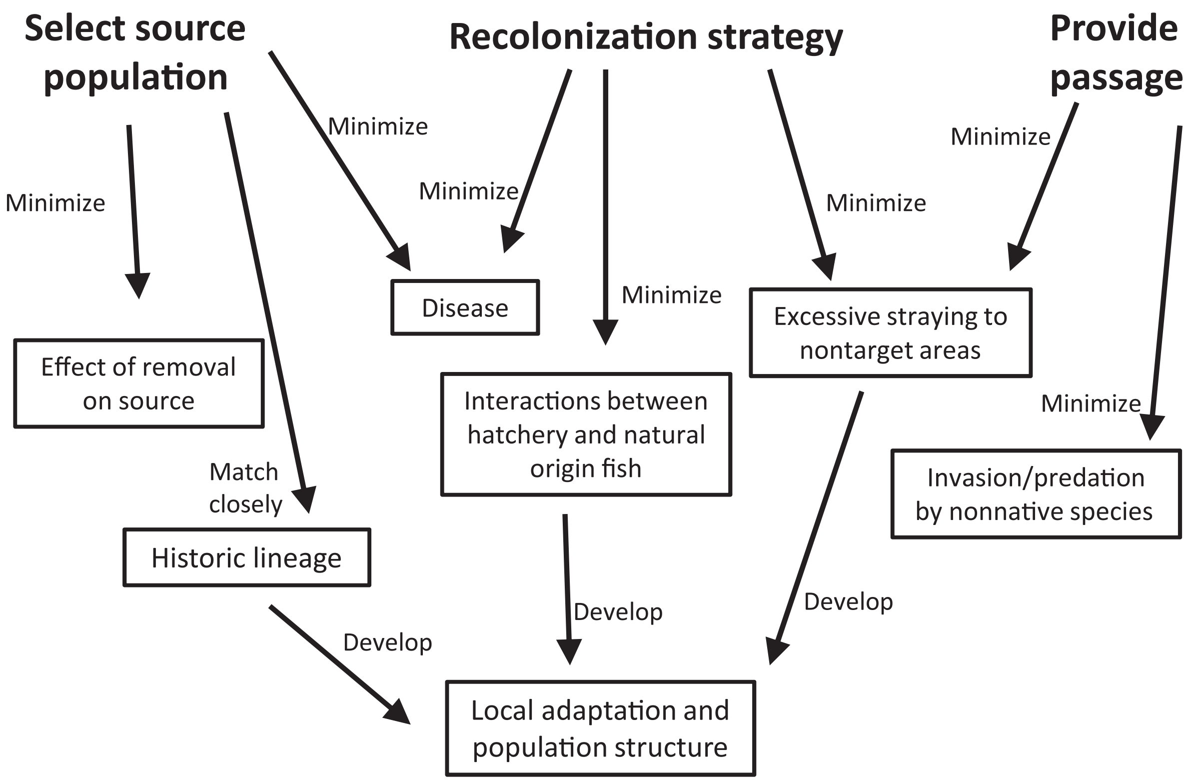


FIGURE 3. Minimizing biological risks in reintroduction planning. Biological risks are unintended negative consequences that may harm nontarget species, other populations, spawning areas, or life history types of the reintroduced species.

downstream dams, for example, may reduce the migratory survival of juveniles, either directly or through delayed effects that manifest in subsequent life stages (Budy et al. 2002; Schaller and Petrosky 2007). Dams may also cause the delay and eventual failure of upstream-migrating adults (Caudill et al. 2007). It is possible to improve survival through dams, even large ones (Ferguson et al. 2007), and this may be an essential action prior to reintroduction. Marine survival patterns are also a major determinant of salmonid population productivity. Ocean survival responds to long-term climatic processes such as the Pacific Decadal Oscillation (Mantua et al. 1997), as well as short-term processes such as interannual variation in sea surface temperature, marine upwelling, and river conditions experienced during migration (Mueter et al. 2005; Scheuerell and Williams 2005; Scheuerell et al. 2009; Petrosky and Schaller 2010). As our ability to identify favorable ocean and river conditions improves (e.g., Burke et al. 2013), there may be opportunities to time reintroduction efforts to favorable conditions. Harvest rates vary among ESUs and in some cases may limit recolonization potential. Fishing quotas set on aggregate stocks may constrain the ability to selectively reduce harvest rates on individual colonizing populations and their sources.

EXECUTING A REINTRODUCTION: COLONIZATION, SOURCE POPULATION, AND PASSAGE

In this section, we discuss the strategies for recolonization, the choice of a source population, and, in the case of reintroductions involving barriers, the techniques used to provide passage. Decisions related to these three execution elements will largely determine reintroduction risks (Figure 3). We define the colonization strategy as the mechanism of fish movement into the reintroduction site; it can be either passive (natural colonization) or active (transplanting or hatchery releases). We suggest that it is important to consider the colonization strategy and source population as two separate planning decisions. For example, even in cases where a hatchery stock is the source, it may be possible to reduce evolutionary risks by allowing hatchery adults to colonize naturally rather than planting hatchery-produced juveniles.

Colonization Strategy

The three basic types of colonization strategies are natural, transplant, and hatchery release. Importantly, these approaches differ in the effects on the viability parameters that will ultimately be used to judge the success or failure of a reintroduction. In general, natural colonization is the lowest-risk approach because it minimizes the interruption of natural biological processes. Transplanting and hatchery releases can immediately place fish in the reintroduction site, but tend to increase the risks associated with reintroduction relative to natural colonization. Fortunately, active reintroduction strategies will be most necessary for isolated reintroduction sites (e.g., Figure 1C), the very situations where evolutionary risks of straying to neighboring extant populations are the lowest. In general, a precautionary

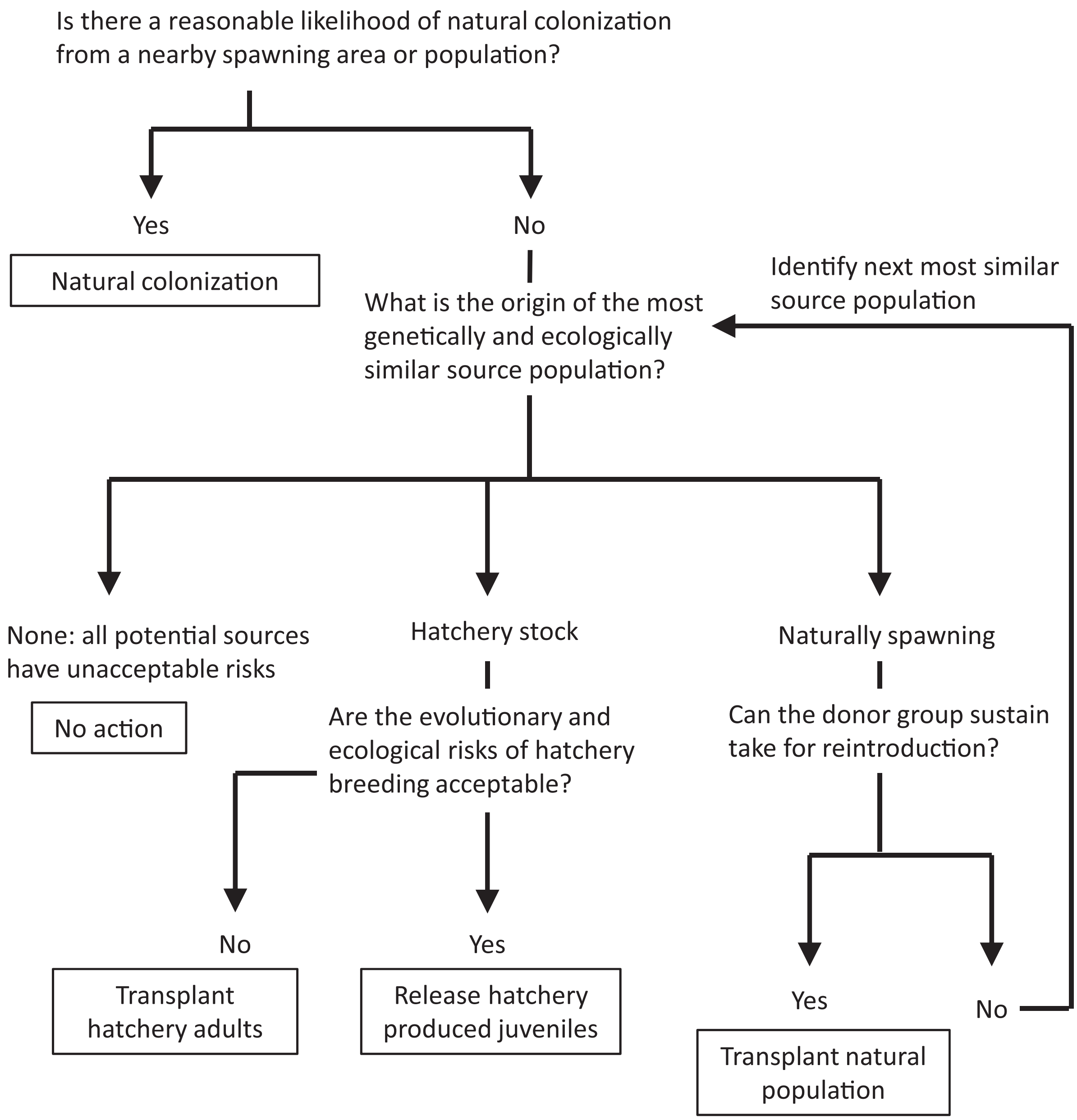


FIGURE 4. Decision framework for selecting a low-risk colonization strategy and source population. This diagram does not encompass every possibility but is intended to highlight the key decisions affecting reintroduction risks. Boxes indicate decision endpoints.

approach, outlined in Figure 4, adopts the lowest risk colonization strategy that has a reasonable chance of promoting long-term improvement in population and ESU viability.

What is the minimum number of fish necessary to establish a self-sustaining population? This is a crucial question applicable to all three colonization strategies whenever the goal is to establish a new population (e.g., Figures 1B–1E). On one hand, depensatory processes (Allee effects) may depress productivity at low densities through a variety of mechanisms (Courchamp et al. 1999; Liermann and Hilborn 2001) and, if the effect is severe, prevent population establishment following reintroduction (Deredec and Courchamp 2007). On the other hand, reintroduced species, particularly those with an extensive stream-rearing juvenile phase, may be released from density-dependent processes during colonization and enjoy high survival due to the lack of competition (Pess et al. 2011). Although the ultimate result will depend heavily on the constraints (Table 3), the choice of colonization strategy will have a strong influence on the number of fish that reach the reintroduction site. Here, we outline the benefits and risks of each colonization strategy, providing empirical examples if they are available.

Natural colonization.—Pacific salmon can rapidly exploit newly accessible habitat through natural colonization, which we define as volitional dispersal into a reintroduction site without human-assisted transport. Following construction of a fishway circumventing an anthropogenic blockage, Pink Salmon *O. gorbuscha* naturally dispersed upstream and established self-sustaining populations in multiple subbasins of the Fraser River, British Columbia, within a decade (Pess et al. 2012). Chinook Salmon and Coho Salmon *O. kisutch* immediately colonized habitat made accessible by modification of a dam on the Cedar River, Washington (Kiffney et al. 2009; Burton et al. 2013), and both species produced a significant number of returning adult offspring that bypassed the dam in the next generation (Anderson et al. 2010; Anderson et al. 2013a). In this system, extensive dispersal by juvenile Coho Salmon, including immigration into a tributary where survival was relatively high, contributed to colonization success (Pess et al. 2011; Anderson et al. 2013b). Steelhead and fluvial Rainbow Trout accessed Beaver Creek, Washington, in the very first season after barrier removal (Weigel et al. 2013). Atlantic Salmon naturally colonized rivers in Estonia, Norway, England, and France following improvements in water quality (Hesthagen and Larsen 2003; Perrier et al. 2010; Griffiths et al. 2011; Kesler et al. 2011), and some of these examples resulted from long-distance dispersal. Dam removal promoted natural colonization of the Upper Salmon River, New Brunswick, by Atlantic Salmon, though this population later crashed to near zero abundance for unknown reasons (Fraser et al. 2007).

In some cases, increasing water releases from dams has promoted natural colonization. In the Bridge River, British Columbia, Coho Salmon, Chinook Salmon, and steelhead were observed immediately following restoration of flow to a 4-km reach that had been dewatered for decades (Decker et al. 2008). Experimental water releases from dams on the Alouette and Coquitlam rivers, British Columbia, led to the reappearance of Sockeye Salmon *O. nerka* after 90 years of extirpation, and genetic and otolith analysis confirmed that the anadromous adults were the offspring of resident kokanee (lacustrine Sockeye Salmon) (Godbout et al. 2011).

Natural disturbances and circumvention of natural barriers provide additional examples of natural colonization. Steelhead recolonized the Toutle River, Washington, to relatively high densities 7 years after a catastrophic destruction following the eruption of Mount Saint Helens (Bisson et al. 2005). Natural colonization tends to proceed more slowly (e.g., decades) in initially barren glacial emergent streams, as evidenced by rates of Coho Salmon and Pink Salmon colonization in Glacier Bay, Alaska (Milner and Bailey 1989; Milner et al. 2008). Several salmonid species rapidly colonized Margaret Creek, Alaska, following construction of a fish ladder at a falls, although the Coho Salmon and Sockeye Salmon populations were supplemented by hatchery releases (Bryant et al. 1999).

Establishing a self-sustaining population via natural colonization is contingent on a reasonable likelihood of natural dispersal into the new habitat. The probability of colonization, in turn, is determined by metapopulation attributes such as the location of the potential source population, abundance of the source population, and stray rate (i.e., connectivity) as a function of distance (Pess et al. 2012). Despite these observations, it is difficult to predict precise colonization rates following barrier removal. Most examples of natural colonization by Pacific salmon in Table 4 had nearby, relatively robust source populations, but colonization rates of isolated reintroduction sites are likely to be much lower. Furthermore, one might predict colonization rate to vary by species, but there are few multispecies comparisons to guide expectations (Table 4). In this situation, habitat preferences and life history patterns offer a means to make species-specific predictions (Pess et al. 2008).

Natural colonization minimizes anthropogenic disturbance to biological processes during population establishment and expansion. Natural colonization provides the greatest opportunity for the evolution of locally adapted traits through natural selection on individuals that disperse into the new habitat, sexual selection during reproduction of the initial colonists, and natural selection on their offspring. In many cases, evolution resulting from the novel selection pressures during colonization may increase population fitness and the likelihood of establishment (Kinnison and Hairston 2007). In the Cedar River, Washington, strong selection on the breeding date and body size of Chinook Salmon and Coho Salmon colonists emphasized the importance of natural and sexual selection in promoting local adaptation during reintroduction (Anderson et al. 2010, 2013a).

Transplanting adults.—In areas that are isolated or distant from extant populations, long-distance dispersal from extant populations may be unlikely. In these cases, transplanting can ensure that an adequate number of adult fish reach the reintroduction site. Under this strategy, adult fish are trapped at one location then transported to the reintroduction site, where they are released to breed naturally. Here, we describe the process and consequences of transplanting from both hatchery and wild sources.

Although stock transfers have been common for Pacific salmon, there are relatively few examples in which only adults were released (Withler 1982). In programs that combined transplanted adults with hatchery releases (e.g., Burger et al. 2000; Spies et al. 2007), it is difficult to isolate the effects of each strategy. In a reintroduction or supplementation context, transplants often involve surplus hatchery adults. For example, hatchery-origin spring Chinook Salmon were transplanted to Shitike Creek, Oregon because the habitat was considered underseeded 15 years after dam removal and produced a significant fraction of the juveniles captured the following spring (Baumsteiger et al. 2008). Atlantic Salmon that had spent their entire lives in captivity successfully spawned following release into Wilmot Creek, Ontario (Scott et al. 2005b). Transplanting adults is frequently used to circumvent large dams and reservoirs in a “trap and haul” strategy (Table 5), and we discuss this approach further in the Providing Passage section below.

TABLE 4. Examples of anadromous salmonid reintroductions from the published literature.

Location	Date initiated	Species	Colonization strategy	Passage provision	References
Fraser River, British Columbia	1947	Pink Salmon	Natural colonization	Fishway	Pess et al. 2012
Clearwater River, Idaho	1960	Chinook Salmon	Hatchery juveniles	Dam removal	Narum et al. 2007
Upper Salmon River, New Brunswick	Mid-1960s	Atlantic Salmon	Natural recolonization	Dam removal	Fraser et al. 2007
Connecticut River, Connecticut, Massachusetts, Vermont, and New Hampshire	1967	Atlantic Salmon	Hatchery juveniles	Fishways	Gephard and McMenemy 2004; Ward et al. 2008
River Thames, England	1975	Atlantic Salmon	Natural colonization and hatchery juveniles	None	Griffiths et al. 2011
Rivers Rhine, Ems, Weser, and Elbe, Germany	1978	Atlantic Salmon	Hatchery juveniles	Primarily fishways	Monnerjahn 2011; Schneider 2011
Point Wolfe River, New Brunswick	1982	Atlantic Salmon	Hatchery juveniles	Dam removal	Fraser et al. 2007
Sawtooth Valley lakes, Idaho	1993	Sockeye Salmon	Hatchery juveniles	None	Griswold et al. 2011; Kalinowski et al. 2012
Middle Fork Willamette River, Oregon	1993	Chinook Salmon	Transplanted adults	Trap and haul	Keefer et al. 2010, 2011
Various Norwegian rivers	Mid-1990s	Atlantic Salmon	Natural colonization and hatchery juveniles[a]	None	Hesthagen and Larsen 2003
Seine River, France	Mid-1990s	Atlantic Salmon	Natural colonization	None	Perrier et al. 2010
River Selja, Estonia	Mid-1990s	Atlantic Salmon	Natural colonization and hatchery juveniles[b]	None	Väsemagi et al. 2001
Bridge River, British Columbia	2000	Chinook Salmon, Coho Salmon, steelhead	Natural colonization	Increased water releases from dam	Decker et al. 2008
Wilmot Creek, Ontario	2000	Atlantic Salmon	Transplanted adults	None	Scott et al. 2005a, 2005b
Salmon River, New York	2000	Atlantic Salmon	Hatchery juveniles	None	Coghlan and Ringer 2004
Shitike Creek, Oregon	2002	Chinook Salmon	Transplanted adults	Dam removal	Baumsteiger et al. 2008
Cedar River, Washington	2003	Chinook Salmon, Coho Salmon	Natural colonization	Fishway	Kiffney et al. 2009; Anderson et al. 2010, 2013a, 2013b; Pess et al. 2011; Burton et al. 2013
Various Lake Ontario tributaries, New York	2003	Atlantic Salmon	Hatchery juveniles	None	Coghlan et al. 2007

TABLE 4. Continued.

Location	Date initiated	Species	Colonization strategy	Passage provision	References
Alouette and Coquitlam rivers, British Columbia	2005	Sockeye Salmon	Natural colonization	Increased water releases from dams	Godbout et al. 2011
River Purtse, Estonia	2005	Atlantic Salmon	Natural colonization and hatchery juveniles[c]	None	Kesler et al. 2011
Beaver Creek, Washington	2005	Steelhead	Natural colonization	Fishways	Weigel et al. 2013

[a]Colonization strategy varied by river.
[b]Genetic analysis indicates that natural dispersal, not hatchery releases, were primarily responsible for colonization.
[c]Hatchery releases commenced after natural colonization was observed.

Conceptually, transplanting allows for natural patterns of natural and sexual selection within the new habitat and thus has many of the benefits of natural colonization. The offspring of any adults that successfully spawn will spend the entire freshwater phase, from embryonic incubation to the smolt migration, within the reintroduction site. Compared with hatchery releases, this will increase their exposure to natal odors and local geomorphic, hydrologic, and biotic conditions, all of which are likely to promote local adaptation. However, transplanting introduces artificial selection of the individuals that reach the reintroduction site. In some cases, natural selection during migration could be important for the evolution of traits (i.e., body morphology or energy reserves) that are advantageous for a particular migration route (i.e., long or steep) (Quinn et al. 2001). Thus, considering the run timing, size, and other phenotypic traits of individuals selected for transplantation is an important component of minimizing the negative, unintended consequences of transplanting.

The number and frequency of transplants is an important consideration. Reintroductions with many individuals are more likely to be successful (Wolf et al. 1996; Fischer and Lindenmayer 2000), but with few salmonid examples, it is difficult to provide precise guidance on the number to transplant. Metapopulation structure might provide guidance, as reintroduction sites isolated from the regional metapopulation are unlikely to receive large numbers of natural colonists and, therefore, will require a greater number of transplanted fish than those connected to potential source populations. Williams et al. (1988) observed that 50 individuals (25 males and 25 females, annually) is the absolute minimum for establishing a hatchery population in a controlled setting, so transplanting to a dynamic river environment will certainly require a greater number of fish. Some fraction of transplanted adults may die prior to spawning (Keefer et al. 2010) or depart the release site because they fail to detect natal odors (Blair and Quinn 1991). Continuing transplants for a full generation and into a second generation provides additional reproductive potential and new genetic material that may reduce the impact of a genetic bottleneck (e.g., Hedrick and Fredrickson 2010). In addition, selecting the highest quality habitat within the reintroduction site for the release site may increase the reproductive success of the colonists.

We suggest that reintroduction should maximize the total number of fish transplanted while minimizing the risks (Table 2), which are likely to increase as the number of fish transplanted increases. Given the same total number of transplanted fish, risks might be reduced by releasing a small number of fish each year for many years rather than many fish for a short period. The release strategy will affect density-dependent processes, which in turn will affect both the performance of the reintroduced species and the ecological risks of reintroduction. For example, it may be possible to reduce density-dependent processes by dispersing colonists among several release sites (Einum et al. 2008). With few empirical examples, the outcomes of these risks are difficult to precisely predict a priori, highlighting the importance of a well-designed monitoring program.

Hatchery releases.—The third colonization strategy is a hatchery reintroduction that stocks artificially propagated juvenile fish or eggs within the reintroduction site. There are a number of examples of reintroductions releasing hatchery-produced juveniles (Table 4). In the Clearwater River, Idaho, out-of-basin stocks were used to reintroduce ocean- and stream-type Chinook Salmon; these hatchery populations are now sustained by returns to the Clearwater River, and the naturally produced juveniles of the two run types are genetically distinct (Narum et al. 2007). Hatchery releases of Atlantic Salmon reintroduced to the Connecticut River (flowing through Connecticut, Massachusetts, Vermont, and New Hampshire) are also sustained by local returns (Gephard and McMenemy 2004). However, abundances in the Connecticut River and in other reintroduced New England populations have continued to decline despite heavy stocking, and there is very little natural spawning because most returning adults are bred in captivity (Wagner and Sweka 2011). A captive broodstock hatchery program has played an essential role in the persistence of Snake River Sockeye Salmon, which reached critically low abundances in the mid-1990s (Griswold

TABLE 5. Examples of proposed, ongoing, or relatively recent reintroduction programs for Pacific salmon, steelhead, and Bull Trout *Salvelinus confluentus*.

River basin	Species	Comments on execution
Elwha River, Washington	Chinook Salmon, steelhead, Coho Salmon, Pink Salmon, Chum Salmon *O. keta*, Sockeye Salmon, Bull Trout	Removal of Elwha and Glines Canyon dams; for some species, adults trapped within lower Elwha River relocated above former dam site
Umbrella Creek and Big River, Ozette Lake, Washington	Sockeye Salmon	Hatchery releases for both locations; some natural colonization of Big River prior to hatchery releases
Cowlitz River, Washington	Chinook Salmon, Coho Salmon, steelhead	Hatchery releases, trap and haul above Mayfield, Mossyrock, and Cowlitz Falls dams
Clackamas River, Oregon	Bull Trout	Transplanted juvenile and adult fish from Metolius River
North Santiam River, Oregon	Chinook Salmon, steelhead	Trap and haul adults above Big Cliff and Detroit dams
South Santiam River, Oregon	Chinook Salmon, steelhead	Trap and haul adults above Foster and Green Peter dams
Calapooia River, Oregon	Chinook Salmon, steelhead	Removal of Brownsville, Sodom, and Shearer dams
McKenzie River, Oregon	Chinook Salmon	Trap and haul adults above Cougar and Trail Bridge dams
White Salmon River, Washington	Chinook Salmon, steelhead, Coho Salmon	Removal of Condit Dam
Hood River, Oregon	Chinook Salmon	Removal of Powerdale Dam; hatchery releases derived from neighboring Deschutes River
Deschutes River, Oregon	Chinook Salmon, steelhead, Sockeye Salmon	Hatchery releases for Chinook Salmon and steelhead; passage for adults and juveniles around Reregulation, Pelton, and Round Butte dams
Umatilla River, Oregon	Chinook Salmon, Coho Salmon	Hatchery releases
Yakima River, Washington	Sockeye Salmon, Coho Salmon	Sockeye Salmon: adults captured at Priest Rapids Dam transplanted above Cle Elum Dam; Coho Salmon: hatchery releases
Wenatchee River, Washington	Coho Salmon	Hatchery releases
Methow River, Washington	Coho Salmon	Hatchery releases
Okanogan River, Washington	Chinook Salmon, Sockeye Salmon	Hatchery releases for both species; passage above McIntyre Dam for Sockeye Salmon
Walla Walla River, Washington	Chinook Salmon	Hatchery releases
Lookingglass Creek, Oregon	Chinook Salmon	Hatchery releases derived from nearby Catherine Creek
Big Sheep Creek, Oregon	Chinook Salmon	Transplant surplus hatchery adults captured in adjacent Imnaha River
Pine Creek, Oregon	Chinook Salmon, steelhead	Transplant surplus hatchery adults captured at Hells Canyon Dam
Klamath River, California and Oregon	Chinook Salmon, Coho Salmon, steelhead	Proposed removal of Iron Gate, Copco 1, Copco 2, and J.C. Boyle dams
San Joaquin River, California	Chinook Salmon	Proposed under San Joaquin River Restoration Settlement Act

et al. 2011). Although this population is demographically dependent on the hatchery, abundance has grown substantially in recent years and progress has been made towards the reestablishment of natural reproduction. The hatchery has retained approximately 95% of the genetic diversity present in the founders of the captive broodstock program (Kalinowski et al. 2012).

There are also examples of hatchery reintroductions, mainly of Atlantic Salmon, that have failed, or that have had insufficient time, to generate persistent returns of hatchery fish. Despite decades of stocking nonlocal Atlantic Salmon on the Thames River, most adult Atlantic Salmon observed recently have dispersed naturally from nearby river systems (Griffiths et al. 2011). Although some Atlantic Salmon returned to Point Wolfe Creek, New Brunswick, following 4 years of hatchery releases, the population subsequently crashed, similar to neighboring populations in the inner Bay of Fundy (Fraser et al. 2007). Atlantic Salmon have been reintroduced to several rivers in Germany, but these populations are still demographically reliant on importing nonlocal eggs and fry despite some observations of natural spawning (Monnerjahn 2011). Finally, the initial phase of

Atlantic Salmon reintroduction to tributaries of Lake Ontario in New York State has focused on experimental testing of various release strategies and sites in an effort to maximize survival (Coghlan and Ringler 2004; Coghlan et al. 2007).

Overall, despite initial successes in establishing hatchery populations in some systems, we found no clear-cut examples in which a reintroduction employing hatchery releases yielded a self-sustaining naturalized population. Importantly, even the most successful programs to date continue to release hatchery fish, so it is largely uncertain whether any natural spawning would persist without supplementation. It is worth noting, however, that hatchery releases have been used to introduce self-sustaining salmonid populations to new locations not previously inhabited by the species in question. Out-of-basin hatchery releases established multiple self-sustaining populations of Sockeye Salmon in Lake Washington, Washington, but it is uncertain whether these areas historically supported anadromous fish (Gustafson et al. 1997; Spies et al. 2007). Other examples include Sockeye Salmon in Frazer Lake, Alaska (Burger et al. 2000), Pink Salmon in the Great Lakes (Kwain 1987), and Chinook Salmon in New Zealand (Quinn et al. 2001). Collectively, these results suggest that it is possible to establish runs of anadromous fish through hatchery releases, and perhaps failed reintroduction efforts did not adequately solve the problems that caused extirpation in the first place (i.e., constraints).

Employed in a conservation setting, hatcheries generally aim to reduce the early life mortality that occurs in the egg incubation and juvenile-rearing phase relative to that of natural spawning (Waples et al. 2007a). Thus hatchery releases have the potential to approach juvenile-rearing carrying capacities faster than the other two approaches, and this may ultimately lead to a greater number of adults returning to the reintroduction site within a generation or two of reintroduction. In addition, hatchery releases may provide opportunities to test the effectiveness of new passage facilities without risking wild fish from a low-abundance source population.

However, even if managed properly, hatchery releases pose significant evolutionary and ecological risks. Domestication selection, or adaptation to a captive-breeding environment, can reduce the fitness of animals released into the wild (Frankham 2008) as well as the fitness of the wild component of a supplemented population (Ford 2002). Indeed, hatchery fish often have lower reproductive success than naturally spawned fish when both groups breed sympatrically in the wild (Araki et al. 2008), and domestication selection, which can occur in a single generation, seems a likely mechanism (Christie et al. 2012; Ford et al. 2012). Large-scale hatchery programs tend to erode population structure more than small ones (Eldridge and Naish 2007), so the risk of genetic homogenization is likely to be proportional to the number of fish released. In terms of ecological risks, hatchery releases could induce density-dependent processes that would limit the growth, survival, and other vital rates of naturally produced fish (Buhle et al. 2009; Kostow 2009).

These risks apply not only to the incipient population within the reintroduction site but also to any nearby extant populations. Hatchery reintroduction programs should therefore aim to minimize straying to proximate extant populations. Acclimating juvenile hatchery fish in the target area prior to release may improve the precision of homing (Dittman et al. 2010). Hatchery fish released into a reintroduction site may also interact ecologically with juvenile wild fish originating from proximate spawning areas in downstream rearing habitats, potentially competing for limited resources. The specific breeding protocols and rearing practices will influence the severity of these ecological and evolutionary effects, but some level of risk is unavoidable.

An important consideration for hatchery reintroductions is the length of time over which supplementation is planned. Evolutionary and ecological risks will tend to increase with the duration and magnitude of hatchery releases. A precautionary model would aim for a brief release of one to two generations, followed by cessation for at least a similar time frame, accompanied by a monitoring program to track performance. Such a pulsed release would provide the initial demographic boost to establish a population in an area unlikely to be colonized naturally and subsequently permit natural and sexual selection to shape local adaptation and the expression of natural diversity patterns. In the event that more than a generation or two of supplementation is needed to rebuild the run, specifying a timeline for phasing out releases in a detailed plan prior to reintroduction will help prevent hatchery efforts from becoming institutionalized. Abundance targets for naturally spawned fish would indicate when the incipient population has sufficient reproductive potential without supplementation. Contingencies for short-term environmental trends would permit flexibility in the timeline should poor migratory or ocean survival delay population establishment.

Choice of Source Population

Source populations with life history, morphological, and behavioral traits compatible with the target area will increase the probability of successful reintroduction. Anadromous salmonids are frequently adapted to local environmental conditions (Taylor 1991; Fraser et al. 2011), and so some source populations may be more successful than others during colonization. For example, following circumvention of a natural barrier, multiple populations of Sockeye Salmon were introduced to Fraser Lake, Alaska, and each preferentially colonized the habitats most similar to the source (Burger et al. 2000). Reintroductions employing transplants or hatchery releases must explicitly choose a source population; evaluating potential sources of natural colonization will help predict patterns of population expansion (Pess et al. 2008) and interpret reintroduction results (Burton et al. 2013). We suggest that reintroduction planners consider the genetic and ecological characteristics of potential source populations.

In general, selecting a source genetically similar to the historic population that inhabited the reintroduction site would maximize the benefits and reduce the risks of a reintroduction. Matching the genetic lineage of the extirpated population or spawning area as closely as possible helps ensure that following a successful reintroduction, regional population structure would accurately represent natural patterns of evolutionary diversity and thus contribute to long-term ESU viability. The evolutionary risks of straying to adjacent populations during reintroduction will be reduced if the source is genetically similar to these populations. In practice, genetic analysis may not be possible, so one might assume an isolation-by-distance model (e.g., Matala et al. 2011) and use the distance along the river corridor between the reintroduction site and source as a coarse guide for comparing options. Regardless of the specific criteria, ESUs were designated to comprise lineages with a distinct evolutionary legacy (Waples 1991), so reintroductions using sources with out-of-ESU ancestry would rarely, if ever, be expected to provide clear conservation benefits to an ESU.

Ecological considerations should focus on the morphological and behavioral traits of the source population and whether they are well suited for the reintroduction site. One approach is to assume that similar habitats promote the evolution of similar traits and evaluate metrics such as elevation, precipitation, and hydrologic patterns or composite indices such as the U.S. Environmental Protection Agency's ecoregions. However, sometimes genetic and ecological patterns will be in conflict. Some coastal rivers, for example, contain both fall- and spring-run Chinook Salmon populations, which are more genetically similar to each other than to other populations of the same run type in different major rivers (Waples et al. 2004). In these cases, selecting a source population will involve some degree of compromise.

Potential source populations affected by hatchery production require special consideration. Three main factors will determine the ecological and genetic suitability of a hatchery stock. The first is its origin. Stocks that were founded with individuals collected near the reintroduction site, preferably within the same basin, present less evolutionary risk than more distantly related stocks. Many of the most widespread hatchery stocks are mixed-lineage, composite-origin stocks with significant contributions from several populations, sometimes from separate ESUs (Busby et al. 1996; Myers et al. 1998). Although these stocks are probably the most available, and hence logistically practicable for reintroductions, they also pose much greater evolutionary risks than locally derived stocks. A second consideration is the current breeding protocol. Programs that operate under an integrated model by consistently incorporating wild or naturally spawned broodstock (without posing demographic risks to that population) will reduce (but not eliminate) domestication selection compared with segregated programs (Mobrand et al. 2005). A final consideration is the number of generations that the stock has been artificially propagated. Domestication selection accumulates over time, making populations that have been artificially propagated for many generations less similar to their wild counterparts than stocks that have been in captivity for few generations (Araki et al. 2008; Frankham 2008). In some cases, a hatchery stock directly derived from native fish that inhabited the reintroduction site may retain the only genetic legacy of the extirpated population and may be desirable for that reason.

What are the options if there is an unacceptable demographic risk of depleting the most attractive source population? In some cases, managers must either wait for the most appropriate stock to recover to levels that could sustain removal or select a less desirable stock that can immediately provide sufficient donors. This is a difficult trade-off, especially if recovery of depleted potential source populations is uncertain or is expected to take several generations even under optimistic scenarios. When removal does occur, monitoring should track the source population abundance during reintroduction to ensure that it remains healthy. If a single population cannot sustain removal for reintroduction, it may be possible to combine individuals from several sources. From a genetic perspective, this could have either positive or negative consequences. On one hand, mixing sources could benefit the genetic diversity of the colonist group, but on the other, it could lower fitness via outbreeding depression (Huff et al. 2010).

Finally, for facultatively migratory species, the presence of resident conspecifics may provide additional reproductive potential and serve as a source population. For example, resident Rainbow Trout frequently spawn with anadromous steelhead (McMillan et al. 2007; Pearsons et al. 2007). In fact, *O. mykiss* often exhibit partial anadromy in which a single, panmictic, interbreeding population contains both resident and migratory individuals (McPhee et al. 2007; Heath et al. 2008). Resident populations isolated by dams may retain significant anadromous ancestry and the physiological traits of smoltification (Clemento et al. 2009; Godbout et al. 2011; Holecek et al. 2012). However, if selection against anadromy has occurred in the resident population, it is also possible that secondary contact with reintroduced anadromous fish might decrease the rate of anadromy in the combined population. Life history models (Satterthwaite et al. 2009, 2010) offer one method of predicting the complicated interactions between resident fish and reintroduced anadromous populations. Regardless, we suggest that promoting the persistence and reproductive contribution of resident fish directly descended from formerly anadromous populations inhabiting the reintroduction site will ultimately contribute to local adaptation, diversity, and long-term viability.

Providing Passage

Providing passage is relevant to all reintroductions involving barriers regardless of the colonization strategy or the choice of source population. This must include passage for adults migrating upstream to spawning grounds as well as juveniles migrating downstream towards the ocean. Plans for passage can be categorized as either volitional or active transport (i.e., trap and haul).

Under volitional passage, a barrier is modified or removed such that fish arrive at the site under their own power, swimming through or around and eventually past the former blockage. Primary examples include culvert replacements, dam removals, engineered step-pools, fish ladders, increased releases from upstream dams, and screened bypass facilities for juveniles. Volitional fish passage facilities have advantages over more managed methods because they operate constantly, require little if any handling, are less stressful to the fish, are mechanically less likely to break, and are less costly to maintain and operate. A primary biological consideration is the degree to which passage structures reduce juvenile and adult migrant survival relative to a free-flowing river. Unnaturally high mortality imposed by passage at barriers will have to be compensated for elsewhere in the lifecycle to maintain a self-sustaining population. Furthermore, depending on the design, water velocity and gradient may restrict passage to certain species or size-classes, reducing the diversity of the incipient population. If poorly designed, passage facilities could increase the risk of straying into nontarget populations or spawning areas.

Barrier or dam removal is a special case of volitional passage that will provide substantial ecological benefits beyond salmonid recovery. Dam removal can repair riverine ecosystem processes, such as natural flow regime, sediment and wood transport, and nutrient cycling, that create and maintain habitat for many plants and animals (Poff and Hart 2002; Roni et al. 2008). The rehabilitation of these processes, especially where they have been substantially altered, will certainly provide long-term benefits for the Pacific salmon and steelhead populations targeted for reintroduction. However, in the short term, dam removal is a disturbance that may increase turbidity and deposit fine sediment downstream or mobilize toxic-laden materials (Stanley and Doyle 2003). Therefore, it is an approach most appropriate for enhancing long-term viability rather than rapid increases in abundance, and these "side effects" are important considerations for the planning process. Several recent dam removals (Table 5) provide important opportunities to study the salmonid response to dam removal.

In some cases, it may be possible to incorporate selective access into a volitional passage strategy. This would involve a weir, gate, or trap such that fish are handled prior to upstream passage. Such structures increase operation and maintenance costs and may adversely affect adults due to increased handling. However, they also allow managers to exclude fish that could undermine reintroduction objectives. For example, excluding the homogenizing influence of hatchery colonists may benefit diversity and excluding nonnative fish would reduce the ecological risks of reintroduction. Such structures would also assist research and monitoring because they would permit precise counts and measurements of fish.

Active transport, sometimes called trap and haul, is most appropriate for situations in which volitional passage is not logistically, technically, or biologically possible. Large dams, especially several occurring in sequence, are more likely to require trap and haul than small structures due to engineering and socioeconomic constraints. Particularly for juveniles, impoundments may present challenges that cannot be overcome with volitional passage, such as low water velocity that disrupts fish migration, predators that reduce survival below acceptable levels, or downstream passage routes that cannot be engineered to be safe and effective. Selection or exclusion of particular groups of fish will be fundamentally simple. Passage via trap and haul is similar in concept to a transplanting colonization strategy and thus has many of the same benefits, risks, and consequences.

Trap and haul, often combined with hatchery releases, is employed in several ongoing large-scale reintroduction efforts (Table 5). These examples will provide crucial case studies to evaluate the success and refine the methods of reintroducing Pacific salmon and steelhead above large, high-head dams. Research on the Middle Fork Willamette River, Oregon, has found significant prespawn mortality related to poor condition of spring Chinook Salmon adults prior to release and warm temperatures encountered in the migration corridor (Keefer et al. 2010). In addition, juvenile mortality at dams was high and deep-water passage routes severely restricted passage in the spring, when Chinook Salmon would ordinarily migrate downstream but reservoirs were filling rapidly (Keefer et al. 2011).

Despite few published examples, we suspect that at high-head dams, transporting adults upstream is much easier (and less expensive) than providing safe, efficient downstream passage for their offspring. Juvenile fish will be vulnerable to size-selective predation in reservoirs (Poe et al. 1991; Fritts and Pearsons 2006) and dam passage mortality unless they are collected and routed around these hazards. Survival rates will vary by species, life stage, and timing of migration but are likely to depend on the efficiency of juvenile collection methods and the design of engineered bypasses at dams. In some cases, successful reintroduction will require a mechanistic understanding of dam passage mortality, but this is difficult to predict generally and varies substantially by dam. For example, some studies have found greater mortality in small fish (Ferguson et al. 2007) while others found greater mortality in large fish (Keefer et al. 2011). Consequently, detailed studies of route-specific juvenile mortality rates are likely to be an essential component of reintroductions involving active transport (Keefer et al. 2011).

Execution Overview

One thing is clear—each case will be unique, and reintroduction planners will face trade-offs between the benefits and risks in selecting a colonization strategy, choosing a source population, and providing passage. These options need not be mutually exclusive, as a carefully planned reintroduction program may decide to use multiple colonization strategies. A precautionary model would initially adopt a low-risk approach and monitor its success, thereby permitting a scientific evaluation of whether higher-risk strategies are necessary. For active reintroduction strategies, planners could view an initially small release as a pilot study to assess reintroduction benefits and risks prior to full implementation.

Our review of the salmonid reintroduction literature (e.g., Table 4) suggests that there are large uncertainties in the success of reintroduction in establishing self-sustaining populations, particularly for programs employing active colonization strategies. Despite the increased risks of methods such as transplanting adults and hatchery releases, we found no direct evidence that these approaches have established a demographically independent, self-sustaining natural population. It is possible that situations in which active methods have been employed are inherently more difficult, but a lack of rigorous scientific evaluation precludes us from describing the benefits, risks, and constraints more explicitly or quantitatively. We strongly encourage managers of reintroduction efforts to disseminate results so that we may build on lessons learned in planning future programs.

MONITORING

Monitoring is an essential component of any reintroduction program (Williams et al. 1988; IUCN 1998; George et al. 2009), permitting an assessment of whether or not the reintroduction was successful. Monitoring before, during, and after the reintroduction provides information on both the target and neighboring populations that is needed to evaluate modifications to the program execution in an adaptive management feedback loop. In addition, monitoring provides the data that is essential for the effective planning of future programs.

We suggest that the monitoring program focus on the benefits, risks, and constraints likely to have a large impact on the success of the project. First, in order to quantify the benefits and determine if the goals have been achieved, unambiguously stating project objectives at the outset will help identify specific monitoring metrics (Tear et al. 2005). Second, for reintroductions in which the initial planning efforts identified some risks (Table 2), there must be monitoring in order to determine whether the benefits outweighed the risks. Third, monitoring constraints will promote a mechanistic understanding of why a reintroduction succeeded or failed. Even where barriers block migration, other factors may have contributed to extirpation. Consequently, although some biological constraints (Table 3) may have been addressed prior to reintroduction, others may persist that will limit project success. Identifying factors that limit survival and reproductive success will provide insight towards alternative reintroduction strategies that might lessen a negative impact. The specific monitoring methods will vary depending on the benefits, risks, and constraints of the reintroduction effort; Roni (2005), Johnson et al. (2007), and Schwartz (2007) provide guidance on establishing a robust monitoring program.

It is difficult to provide general criteria on whether a reintroduction effort has succeeded or failed because every situation is likely to be different. However, writing a detailed reintroduction plan, including specific viability targets or benchmarks, is a crucial component of project implementation. This will simplify interpretation of monitoring data, clarify any need for adaptive management during the program, and prevent the institutionalization of actions (e.g., hatchery releases) that impose risk to nontarget populations or spawning areas. In deriving targets and benchmarks, the reintroduction plan should explicitly consider patterns in annual abundance, productivity, and survival of comparable populations. We strongly urge all entities conducting or planning reintroductions to write a publicly available implementation plan that includes robust monitoring because it is essential to a scientifically rigorous reintroduction effort and will improve our ability to effectively conserve species in the future.

CONCLUSIONS

We have based our approach to planning, executing, and monitoring reintroductions upon the broad conservation goals and scientific principles guiding the recovery of ESA-listed Pacific salmon and steelhead populations. We acknowledge that there are other possible goals for reintroductions, including providing harvest opportunities, which might lead to different approaches than those described here. Although our recommendations are specifically designed for ESA recovery, more generally they are intended to promote the natural demographic, ecological, and evolutionary processes essential to the conservation benefit of all reintroductions, regardless of formal listing status. Even in cases where ESA recovery is not the primary goal, the concepts discussed here will help evaluate the overall conservation value of a reintroduction (Figure 5).

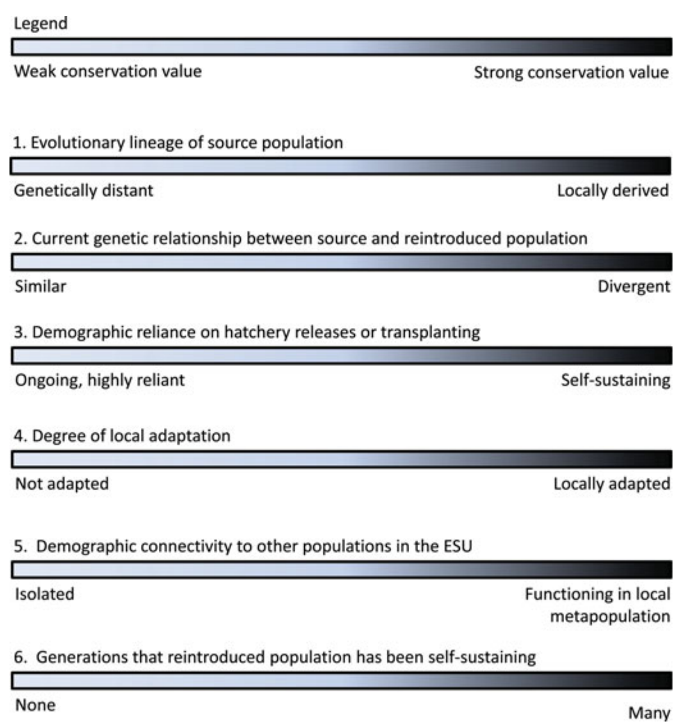


FIGURE 5. Factors to consider in evaluating the conservation value of reintroductions. Each bar is intended to represent a gradient of outcomes in between the extremes described at either end. The extent to which natural demographic, ecological, and evolutionary processes operate uninterrupted will strongly influence the overall conservation value of a reintroduction.

Despite the number of salmonid reintroductions (e.g., Tables 4 and 5), the science of reestablishing previously extirpated salmonid populations is still in its infancy. We found few direct assessments of reintroduction benefits, risks, and constraints, forcing us to provide general, qualitative rather than specific, quantitative recommendations. If reintroduction is to become a successful recovery tool, it is essential that monitoring and dissemination of results become standard practice in nearly every program. Rigorous scientific evaluation is particularly important for projects at large dams or those using active colonization strategies because they face the highest constraints and greatest risks.

The number and scale of Pacific salmon and steelhead extirpations suggest that reintroduction offers great potential to advance salmon recovery. However, complicated trade-offs, challenging obstacles, and uncertainty over the ultimate result confront reintroduction planners. Combined with the multiple generations probably required to achieve potential benefits, this suggests that reintroduction will rarely be a quick fix for improving the status of an ESU or population at immediate risk of extinction. 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. We suggest that evaluating the potential benefits, risks, and constraints is necessary to weigh reintroduction against other management options and ensure that reintroductions contribute to long-term population and ESU viability.

ACKNOWLEDGMENTS

Funding support for J.H.A. was provided by the U.S. National Research Council's Research Associateship Program. Discussions with the Recovery Implementation Science Team contributed to the concepts presented in this paper. We thank Lynne Krasnow, Ritchie Graves, Rick Gustafson, and four anonymous reviewers for helpful comments on earlier drafts of the manuscript.

REFERENCES

Allendorf, F. W., and G. Luikart. 2007. Conservation and the genetics of populations. Blackwell Scientific Publications, Oxford, UK.

Anderson, J. H., P. L. Faulds, W. I. Atlas, G. R. Pess, and T. P. Quinn. 2010. Selection on breeding date and body size in colonizing Coho Salmon, *Oncorhynchus kisutch*. Molecular Ecology 19:2562–2573.

Anderson, J. H., P. L. Faulds, W. I. Atlas, and T. P. Quinn. 2013a. Reproductive success of captively bred and natural origin Chinook Salmon colonizing newly accessible habitat. Evolutionary Applications 6:165–179.

Anderson, J. H., G. R. Pess, P. M. Kiffney, T. R. Bennett, P. L. Faulds, and T. P. Quinn. 2013b. Dispersal and tributary immigration by juvenile Coho Salmon contribute to spatial expansion during colonization. Ecology of Freshwater Fish 22:30–42.

Angilletta, M. J., E. A. Steel, K. K. Bartz, J. G. Kingsolver, M. D. Scheuerell, B. R. Beckman, and L. G. Crozier. 2008. Big dams and salmon evolution: changes in thermal regimes and their potential evolutionary consequences. Evolutionary Applications 1:286–299.

Araki, H., B. A. Berejikian, M. J. Ford, and M. S. Blouin. 2008. Fitness of hatchery-reared salmonids in the wild. Evolutionary Applications 1:342–355.

Armstrong, D. P., and P. J. Seddon. 2008. Directions in reintroduction biology. Trends in Ecology and Evolution 23:20–25.

Ayllon, F., P. Davaine, E. Beall, and E. Garcia-Vazquez. 2006. Dispersal and rapid evolution in Brown Trout colonizing virgin Subantarctic ecosystems. Journal of Evolutionary Biology 19:1352–1358.

Barton, N. H., and M. C. Whitlock. 1997. The evolution of metapopulations. Pages 183–210 *in* I. A. Hanski and M. E. Gilpin, editors. Metapopulation biology: ecology, genetics, and evolution. Academic Press, San Diego, California.

Battin, J., M. W. Wiley, M. H. Ruckelhaus, R. N. Palmer, E. Korb, K. K. Bartz, and H. Imaki. 2007. Projected impacts of climate change on salmon habitat restoration. Proceedings of the National Academy of Sciences of the United States of America 104:6720–6725.

Baumsteiger, J., D. M. Hand, D. E. Olson, R. Spateholts, G. FitzGerald, and W. R. Ardren. 2008. Use of parentage analysis to determine reproductive success of hatchery-origin spring Chinook Salmon outplanted into Shitike Creek, Oregon. North American Journal of Fisheries Management 28:1472–1485.

Beechie, T., E. Buhle, M. Ruckelshaus, A. Fullerton, and L. Holsinger. 2006. Hydrologic regime and the conservation of salmon life history diversity. Biological Conservation 130:560–572.

Beechie, T. J., D. A. Sear, J. D. Olden, G. R. Pess, J. M. Buffington, H. Moir, P. Roni, and M. M. Pollock. 2010. Process-based principles for restoring river ecosystems. BioScience 60:209–222.

Bilby, R. E., and L. A. Mollot. 2008. Effect of changing land use patterns on the distribution of Coho Salmon (*Oncorhynchus kisutch*) in the Puget Sound region. Canadian Journal of Fisheries and Aquatic Sciences 65:2138–2148.

Bisson, P. A., C. M. Crisafulli, B. R. Fransen, R. E. Lucas, and C. P. Hawkins. 2005. Responses of fish to the 1980 eruption of Mount St. Helens. Pages 163–182 *in* V. H. Dale, F. R. Swanson, and C. M. Crisafulli, editors. Ecological responses to the 1980 eruption of Mount St. Helens. Springer, New York.

Blair, G. R., and T. P. Quinn. 1991. Homing and spawning site selection by Sockeye Salmon (*Oncorhynchus nerka*) in Iliamna Lake, Alaska. Canadian Journal of Zoology 69:176–181.

Bowlby, H. D., and A. J. F. Gibson. 2011. Reduction in fitness limits the useful duration of supplementary rearing in an endangered salmon population. Ecological Applications 21:3032–3048.

Brenkman, S. J., S. L. Mumford, M. House, and C. Patterson. 2008a. Establishing baseline information on the geographic distribution of fish pathogens endemic in Pacific salmonids prior to dam removal and subsequent recolonization by anadromous fish in the Elwha River, Washington. Northwest Science 82:142–152.

Brenkman, S. J., G. R. Pess, C. E. Torgersen, K. K. Kloehn, J. J. Duda, and S. C. Corbett. 2008b. Predicting recolonization patterns and interactions between potadromous and anadromous salmonids in response to dam removal in the Elwha River, Washington State, USA. Northwest Science 82:91–106.

Bryant, M. D., B. J. Frenette, and S. J. McCurdy. 1999. Colonization of a watershed by anadromous salmonids following the installation of a fish ladder in Margaret Creek, Southeast Alaska. North American Journal of Fisheries Management 19:1129–1136.

Budy, P., G. P. Thiede, N. Bouwes, C. E. Petrosky, and H. Schaller. 2002. Evidence linking delayed mortality of Snake River salmon to their earlier hydrosystem experience. North American Journal of Fisheries Management 22:35–51.

Buehrens, T. W. 2011. Growth, movement, survival and spawning habitat of coastal cutthroat trout. Master's thesis. University of Washington, Seattle.

Buhle, E. R., K. K. Holsman, M. D. Scheuerell, and A. Albaugh. 2009. Using an unplanned experiment to evaluate the effects of hatcheries and environmental variation on threatened populations of wild salmon. Biological Conservation 142:2449–2455.

Burger, C. V., K. T. Scribner, W. J. Spearman, C. O. Swanton, and D. E. Campton. 2000. Genetic contribution of three introduced life history forms of Sockeye Salmon to colonization of Frazer Lake, Alaska. Canadian Journal of Fisheries and Aquatic Sciences 57:2096–2111.

Burke, B. J., W. T. Peterson, B. R. Beckman, C. Morgan, E. A. Daly, and M. Litz. 2013. Multivariate models of adult Pacific salmon returns. PloS One 8:e54134.

Burnett, K. M., G. H. Reeves, D. J. Miller, S. Clarke, K. Vance-Borland, and K. Christiansen. 2007. Distribution of salmon habitat potential relative to landscape characteristics and implications for conservation. Ecological Applications 17:66–80.

Burton, K. D., L. G. Lowe, H. B. Berge, H. K. Barnett, and P. L. Faulds. 2013. Comparative dispersal patterns for recolonizing Cedar River Chinook Salmon above Landsburg Dam, and the source population below the dam. Transactions of the American Fisheries Society 142:703–716.

Busby, P. J., T. C. Wainwright, G. J. Bryant, L. J. Lierheimer, R. S. Waples, F. W. Waknitz, and I. V. Lagomarsino. 1996. Status review of West Coast steelhead from Washington, Idaho, Oregon and California. NOAA Technical Memorandum NMFS-NWFSC-27.

Carey, M. P., B. L. Sanderson, K. A. Barnas, and J. D. Olden. 2012. Native invaders: challenges for science, management, policy and society. Frontiers in Ecology and the Environment 10:373–381.

Caudill, C. C., W. R. Daigle, M. L. Keefer, C. T. Boggs, M. A. Jepson, B. J. Burke, R. W. Zabel, T. C. Bjornn, and C. A. Peery. 2007. Slow dam passage in adult Columbia River salmonids associated with unsuccessful migration: delayed negative effects of passage obstacles or condition-dependent mortality? Canadian Journal of Fisheries and Aquatic Sciences 64:979–995.

Christie, M. R., M. L. Marine, R. A. French, and M. S. Blouin. 2012. Genetic adaptation to captivity can occur in a single generation. Proceedings of the National Academy of Sciences of the United States of America 109:238–242.

Clemento, A. J., E. C. Anderson, D. Boughton, D. Girman, and J. C. Garza. 2009. Population genetic structure and ancestry of *Oncorhynchus mykiss* populations above and below dams in south-central California. Conservation Genetics 10:1321–1336.

Coghlan, S. M., M. J. Connerton, N. H. Ringler, D. J. Stewart, and J. V. Mead. 2007. Survival and growth responses of juvenile salmonines stocked in eastern Lake Ontario tributaries. Transactions of the American Fisheries Society 136:56–71.

Coghlan, S. M., and N. H. Ringler. 2004. A comparison of Atlantic Salmon embryo and fry stocking in the Salmon River, New York. North American Journal of Fisheries Management 24:1385–1397.

Cooper, A. B., and M. Mangel. 1999. The dangers of ignoring metapopulation structure for the conservation of salmonids. Fishery Bulletin 97:213–226.

Courchamp, F., T. Clutton-Brock, and B. Grenfell. 1999. Inverse density dependence and the Allee effect. Trends in Ecology and Evolution 14:405–410.

Decker, A. S., M. J. Bradford, and P. S. Higgins. 2008. Rate of biotic colonization following flow restoration below a diversion dam in the Bridge River, British Columbia. River Research and Applications 24:876–883.

Deredec, A., and F. Courchamp. 2007. Importance of the Allee effect for reintroductions. Ecoscience 14:440–451.

Dittman, A. H., D. May, D. A. Larsen, M. L. Moser, M. Johnston, and D. Fast. 2010. Homing and spawning site selection by supplemented hatchery- and natural-origin Yakima River spring Chinook Salmon. Transactions of the American Fisheries Society 139:1014–1028.

Dunham, J., K. Gallo, D. Shively, C. Allen, and B. Goehring. 2011. Assessing the feasibility of native fish reintroductions: a framework applied to threatened Bull Trout. North American Journal of Fisheries Management 31:106–115.

Einum, S., K. H. Nislow, S. Mckelvey, and J. D. Armstrong. 2008. Nest distribution shaping within-stream variation in Atlantic Salmon juvenile abundance and competition over small spatial scales. Journal of Animal Ecology 77:167–172.

Eldridge, W. H., and K. A. Naish. 2007. Long-term effects of translocation and release numbers on fine-scale population structure among Coho Salmon (*Oncorhynchus kisutch*). Molecular Ecology 16:2407–2421.

Fausch, K. D., B. E. Rieman, J. B. Dunham, M. K. Young, and D. P. Peterson. 2009. Invasion versus isolation: trade-offs in managing native salmonids with barriers to upstream movement. Conservation Biology 25:859–870.

Ferguson, J. W., B. P. Sandford, R. E. Reagan, L. G. Gilbreath, E. B. Meyer, R. D. Ledgerwood, and N. S. Adams. 2007. Bypass system modification at Bonneville Dam on the Columbia River improved the survival of juvenile salmon. Transactions of the American Fisheries Society 136:1487–1510.

Fischer, J., and D. B. Lindenmayer. 2000. An assessment of the published results of animal relocations. Biological Conservation 96:1–11.

Foppen, R. P. B., J. P. Chardon, and W. Liefveld. 2000. Understanding the role of sink patches in source-sink metapopulations: reed warbler in an agricultural landscape. Conservation Biology 14:1881–1892.

Ford, M., A. Murdoch, and S. Howard. 2012. Early male maturity explains a negative correlation in reproductive success between hatchery-spawned salmon and their naturally spawned progeny. Conservation Letters 5:450–458.

Ford, M. J. 2002. Selection in captivity during supportive breeding may reduce fitness in the wild. Conservation Biology 16:815–825.

Ford, M. J., editor. 2011. Status review update for Pacific salmon and steelhead listed under the Endangered Species Act: Pacific Northwest. NOAA Technical Memorandum NMFS-NWFSC-113.

Frankham, R. 2008. Genetic adaptation to captivity in species conservation programs. Molecular Ecology 17:325–333.

Fraser, D. J., M. W. Jones, T. L. McParland, and J. A. Hutchings. 2007. Loss of historical immigration and the unsuccessful rehabilitation of extirpated salmon populations. Conservation Genetics 8:527–546.

Fraser, D. J., L. K. Weir, L. Bernatchez, M. M. Hansen, and E. B. Taylor. 2011. Extent and scale of local adaptation in salmonid fishes: review and meta-analysis. Heredity 106:404–420.

Fritts, A. L., and T. N. Pearsons. 2006. Effects of predation by nonnative Smallmouth Bass on native salmonid prey: the role of predator and prey size. Transactions of the American Fisheries Society 135:853–860.

Fullerton, A. H., S. T. Lindley, G. R. Pess, B. E. Feist, E. A. Steel, and P. McElhany. 2011. Human influence on the spatial structure of threatened Pacific salmon metapopulations. Conservation Biology 25:932–944.

Gende, S. M., R. T. Edwards, M. F. Willson, and M. S. Wipfli. 2002. Pacific salmon in aquatic and terrestrial ecosystems. Bioscience 52:917–928.

George, A. L., B. R. Kuhajda, J. D. Williams, M. A. Cantrell, P. L. Rakes, and J. R. Shute. 2009. Guidelines for propagation and translocation for freshwater fish conservation. Fisheries 34:529–545.

Gephard, S., and J. R. McMenemy. 2004. An overview of the program to restore Atlantic Salmon and other diadromous fishes to the Connecticut River with notes on the current status of these species in the river. Pages 287–317 *in* P. M. Jacobson, D. A. Dixon, W. C. Leggett, B. C. Marcy, Jr., R. R. Massengill, editors. The Connecticut River Ecological Study (1965–1973) revisited: ecology of the lower Connecticut River 1973–2003. American Fisheries Society, Monograph 9, Bethesda, Maryland.

Gibson, R. J., R. L. Haedrich, and C. M. Wernerheim. 2005. Loss of fish habitat as a consequence of inappropriately constructed stream crossings. Fisheries 30:10–17.

Godbout, L., C. C. Wood, R. E. Withler, S. Latham, R. J. Nelson, L. Wetzel, R. Barnett-Johnson, M. J. Grove, A. K. Schmitt, and K. D. McKeegan. 2011. Sockeye Salmon (*Oncorhynchus nerka*) return after an absence of nearly 90 years: a case of reversion to anadromy. Canadian Journal of Fisheries and Aquatic Sciences 68:1590–1602.

Good, T. P., J. Davies, B. J. Burke, and M. H. Ruckelshaus. 2008. Incorporating catastrophic risk assessments into setting conservation goals for threatened Pacific salmon. Ecological Applications 18:246–257.

Greene, C. M., J. E. Hall, K. R. Guilbault, and T. P. Quinn. 2010. Improved viability of populations with diverse life-history portfolios. Biology Letters 6:382–386.

Griffiths, A. M., J. S. Ellis, D. Clifton-Dey, G. Machado-Schiaffino, D. Bright, E. Garcia-Vazquez, and J. R. Stevens. 2011. Restoration versus recolonisation: the origin of Atlantic Salmon (*Salmo salar* L.) currently in the River Thames. Biological Conservation 144:2733–2738.

Griswold, R. G., A. E. Kohler, and D. Taki. 2011. Survival of endangered Snake River Sockeye Salmon smolts from three Idaho lakes: relationships with parr size at release, parr growth rate, smolt size, discharge, and travel time. North American Journal of Fisheries Management 31:813–825.

Gustafson, R. G., T. C. Wainwright, G. A. Winans, F. W. Waknitz, L. T. Parker, and R. S. Waples. 1997. Status review of Sockeye Salmon from Washington and Oregon. NOAA Technical Memorandum NMFS-NWFSC-33.

Hanski, I. A., and M. E. Gilpin. 1997. Metapopulation biology: ecology, genetics, and evolution. Academic Press, San Diego, California.

Heath, D. D., C. M. Bettles, S. Jamieson, I. Stasiak, and M. F. Docker. 2008. Genetic differentiation among sympatric migratory and resident life history forms of Rainbow Trout in British Columbia. Transactions of the American Fisheries Society 137:1268–1278.

Hedrick, P. W., and R. Fredrickson. 2010. Genetic rescue guidelines with examples from Mexican wolves and Florida panthers. Conservation Genetics 11:615–626.

Hendry, A. P., V. Castric, M. T. Kinnison, and T. P. Quinn. 2004. The evolution of philopatry and dispersal: homing versus straying in salmonids. Pages 52–91 *in* A. P. Hendry and S. C. Stearns, editors. Evolution illuminated: salmon and their relatives. Oxford University Press, Oxford, UK.

Hendry, A. P., J. K. Wenburg, P. Bentzen, E. C. Volk, and T. P. Quinn. 2000. Rapid evolution of reproductive isolation in the wild: evidence from introduced salmon. Science 290:516–518.

Hesthagen, T., and B. M. Larsen. 2003. Recovery and re-establishment of Atlantic Salmon, *Salmo salar*, in limed Norwegian rivers. Fisheries Management and Ecology 10:87–95.

Holecek, D. E., D. L. Scarnecchia, and S. E. Miller. 2012. Smoltification in an impounded, adfluvial redband trout population upstream from an impassable dam: does it persist? Transactions of the American Fisheries Society 141:68–75.

Huff, D. D., L. M. Miller, and B. Vondracek. 2010. Patterns of ancestry and genetic diversity in reintroduced populations of the slimy sculpin: implications for conservation. Conservation Genetics 11:2379–2391.

ISAB (Independent Scientific Advisory Board). 2011. Using a comprehensive landscape approach for more effective conservation and management. ISAB 2011-4 for the Northwest Power and Conservation Council, Columbia River Basin Indian Tribes, and National Marine Fisheries Service, Portland, Oregon.

IUCN (International Union for the Conservation of Nature). 1998. IUCN guidelines for re-introductions. Information Press, Oxford, UK.

Johnson, D. H., B. M. Shrier, J. S. O'Neal, J. A. Knutzen, X. Augerot, T. A. O'Neil, and T. N. Pearsons. 2007. Salmonid field protocols handbook: techniques for assessing status and trends in salmon and trout populations. American Fisheries Society, Bethesda, Maryland.

Kalinowski, S. T., D. M. Van Doornik, C. C. Kozfkay, and R. S. Waples. 2012. Genetic diversity in the Snake River Sockeye Salmon captive broodstock program as estimated from broostock records. Conservation Genetics 13:1183–1193.

Keefer, M. L., G. A. Taylor, D. F. Garletts, G. A. Gauthier, T. M. Pierce, and C. C. Caudill. 2010. Prespawn mortality in adult spring Chinook Salmon outplanted above barrier dams. Ecology of Freshwater Fish 19:361–372.

Keefer, M. L., G. A. Taylor, D. F. Garletts, C. K. Helms, G. A. Gauthier, T. M. Pierce, and C. C. Caudill. 2011. Reservoir entrapment and dam passage mortality of juvenile Chinook Salmon in the Middle Fork Willamette River. Ecology of Freshwater Fish 21:222–234.

Kesler, M., M. Kangur, and M. Vetemaa. 2011. Natural re-establishment of Atlantic Salmon reproduction and the fish community in the previously heavily polluted River Purtse, Baltic Sea. Ecology of Freshwater Fish 20:472–477.

Kiffney, P. M., G. R. Pess, J. H. Anderson, P. Faulds, K. Burton, and S. C. Riley. 2009. Changes in fish communities following recolonization of the Cedar River, WA, USA by Pacific salmon after 103 years of local extirpation. River Research and Applications 25:438–452.

Kinnison, M. T., and N. G. Hairston. 2007. Eco-evolutionary conservation biology: contemporary evolution and the dynamics of persistence. Functional Ecology 21:444–454.

Koskinen, M. T., T. O. Haugen, and C. R. Primmer. 2002. Contemporary fisherian life-history evolution in small salmonid populations. Nature 419:826–830.

Kostow, K. 2009. Factors that contribute to the ecological risks of salmon and steelhead hatchery programs and some mitigating strategies. Reviews in Fish Biology and Fisheries 19:9–31.

Kwain, W. 1987. Biology of Pink Salmon in the North American Great Lakes. Pages 57–65 *in* M. J. Dadswell, R. J. Klauda, C. M. Moffitt, R. L. Saunders, R. A. Rulifson, and J. E. Cooper, editors. Common strategies of anadromous and catadromous fishes. American Fisheries Society, Symposium 1, Bethesda, Maryland.

Lande, R. 1993. Risks of population extinction from demographic and environmental stochasticity and random catastrophes. American Naturalist 142:911–927.

Levin, P. S., S. Achord, B. E. Feist, and R. W. Zabel. 2002. Non-indigenous Brook Trout and the demise of Pacific salmon: a forgotten threat? Proceedings of the Royal Society B 269:1663–1670.

Liebhold, A., W. D. Koenig, and O. N. Bjornstad. 2004. Spatial synchrony in population dynamics. Annual Review of Ecology Evolution and Systematics 35:467–490.

Liermann, M., and R. Hilborn. 2001. Depensation: evidence, models and implications. Fish and Fisheries 2:33–58.

Lohse, K. A., D. A. Newburn, J. J. Opperman, and A. M. Merenlender. 2008. Forecasting relative impacts of land use on anadromous fish habitat to guide conservation planning. Ecological Applications 18:467–482.

Mantua, N., I. Tohver, and A. Hamlet. 2010. Climate change impacts on streamflow extremes and summertime stream temperature and their possible consequences for freshwater salmon habitat in Washington State. Climatic Change 102:187–223.

Mantua, N. J., S. R. Hare, Y. Zhang, J. M. Wallace, and R. C. Francis. 1997. A Pacific interdecadal climate oscillation with impacts on salmon production. Bulletin of the American Meteorological Society 78:1069–1079.

Matala, A. P., J. E. Hess, and S. R. Narum. 2011. Resolving adaptive and demographic divergence among Chinook Salmon populations in the Columbia River basin. Transactions of the American Fisheries Society 140:783–807.

McClure, M. M., S. M. Carlson, T. J. Beechie, G. R. Pess, J. C. Jorgensen, S. M. Sogard, S. E. Sultan, D. M. Holzer, J. Travis, B. L. Sanderson, M. E. Power, and R. W. Carmichael. 2008a. Evolutionary consequences of habitat loss for Pacific anadromous salmonids. Evolutionary Applications 1:300–318.

McClure, M. M., F. M. Utter, C. Baldwin, R. W. Carmichael, P. F. Hassemer, P. J. Howell, P. Spruell, T. D. Cooney, H. A. Schaller, and C. E. Petrosky. 2008b. Evolutionary effects of alternative artificial propagation programs: implications for viability of endangered anadromous salmonids. Evolutionary Applications 1:356–375.

McElhany, P., M. H. Ruckelshaus, M. J. Ford, T. C. Wainwright, and E. P. Bjorkstedt. 2000. Viable salmon populations and the recovery of evolutionary significant units. NOAA Technical Memorandum NMFS-NWFSC-42.

McMillan, J. R., S. L. Katz, and G. R. Pess. 2007. Observational evidence of spatial and temporal structure in a sympatric anadromous (winter steelhead) and resident Rainbow Trout mating system on the Olympic Peninsula, Washington. Transactions of the American Fisheries Society 136:736–748.

McPhee, M. V., F. Utter, J. A. Stanford, K. V. Kuzishchin, K. A. Savvaitova, D. S. Pavlov, and F. W. Allendorf. 2007. Population structure and partial anadromy in *Oncorhynchus mykiss* from Kamchatka: relevance for conservation strategies around the Pacific Rim. Ecology of Freshwater Fish 16:539–547.

Milner, A. M., and R. G. Bailey. 1989. Salmonid colonization of new streams in Glacier Bay National Park, Alaska. Aquaculture and Fisheries Management 20:179–192.

Milner, A. M., A. L. Robertson, K. A. Monaghan, A. J. Veal, and E. A. Flory. 2008. Colonization and development of an Alaskan stream community over 28 years. Frontiers in Ecology and the Environment 6:413–419.

Minckley, W. L. 1995. Translocation as a tool for conserving imperiled fishes: experiences in the western United States. Biological Conservation 72:297–309.

Mobrand, L. E., J. Barr, L. Blankenship, D. E. Campton, T. T. P. Evelyn, T. A. Flagg, C. V. W. Mahnken, L. W. Seeb, P. R. Seidel, and W. W. Smoker. 2005. Hatchery reform in Washington State: principles and emerging issues. Fisheries 30:11–23.

Monnerjahn, U. 2011. Atlantic Salmon (*Salmo salar* L.) re-introduction in Germany: a status report on national programmes and activities. Journal of Applied Ichthyology 27:33–40.

Moore, J. W., M. McClure, L. A. Rogers, and D. E. Schindler. 2010. Synchronization and portfolio performance of threatened salmon. Conservation Letters 3:340–348.

Mueter, F. J., B. J. Pyper, and R. M. Peterman. 2005. Relationships between coastal ocean conditions and survival rates of northeast Pacific salmon at multiple lags. Transactions of the American Fisheries Society 134:105–119.

Myers, J., C. Busack, D. Rawding, A. Marshall, D. Teel, D. M. Van Doornik, and M. T. Maher. 2006. Historic population structure of Pacific salmonids in the Willammette River and lower Columbia River basins. NOAA Technical Memorandum NMFS-NWFSC-73.

Myers, J. M., R. G. Kope, G. J. Bryant, D. J. Teel, L. J. Lierheimer, T. C. Wainwright, W. S. Grant, F. W. Waknitz, K. Neely, S. Lindley, and R. S. Waples. 1998. Status review of Chinook Salmon from Washington, Idaho, Oregon, and California. NOAA Technical Memorandum NMFS-NWFSC-35.

Naish, K. A., J. E. Taylor III, P. S. Levin, T. P. Quinn, J. R. Winton, D. Huppert, and R. Hilborn. 2008. An evaluation of the effects of conservation and fishery enhancement hatcheries on wild populations of salmon. Advances in Marine Biology 53:61–194.

Narum, S. R., W. D. Arnsberg, A. J. Talbot, and M. S. Powell. 2007. Reproductive isolation following reintroduction of Chinook Salmon with alternative life histories. Conservation Genetics 8:1123–1132.

NMFS (National Marine Fisheries Service). 2006. Endangered and threatened species: final listing determinations for 10 distinct population segments of West Coast steelhead. Federal Register 71:3(5 January 2006):834–862.

NRC (National Research Council). 1996. Upstream: salmon and society in the Pacific Northwest. National Academy Press, Washington, D.C.

Pearsons, T. N., S. R. Phelps, S. W. Martin, E. L. Bartrand, and G. A. McMichael. 2007. Gene flow between resident and anadromous rainbow trout in the Yakima basin: ecological and genetic evidence. Pages 56–64 *in* R. K. Schroeder and J. D. Hall, editors. Redband trout: resilience and challenge in a changing landscape. American Fisheries Society, Oregon Chapter, Corvallis.

Pearsons, T. N., and G. M. Temple. 2007. Impacts of early stages of salmon supplementation and reintroduction programs on three trout species. North American Journal of Fisheries Management 27:1–20.

Perrier, C. P., G. Evanno, J. Belliard, R. Guyomard, and J.-L. Baglinière. 2010. Natural recolonization of the Seine River by Atlantic Salmon (*Salmo salar*) of multiple origins. Canadian Journal of Fisheries and Aquatic Sciences 67:1–4.

Pess, G. R., R. Hilborn, K. Kloehn, and T. P. Quinn. 2012. The influence of population dynamics and environmental conditions on Pink Salmon recolonization after barrier removal in the Fraser River, British Columbia, Canada. Canadian Journal of Fisheries and Aquatic Sciences 69:970–982.

Pess, G. R., P. M. Kiffney, M. C. Liermann, T. R. Bennett, J. H. Anderson, and T. P. Quinn. 2011. The influences of body size, habitat quality, and competition on the movement and survival of juvenile Coho Salmon during the early stages of stream recolonization. Transactions of the American Fisheries Society 140:883–897.

Pess, G. R., M. L. McHenry, T. J. Beechie, and J. Davies. 2008. Biological impacts of the Elwha River dams and potential salmonid responses to dam removal. Northwest Science 82:72–90.

Petrosky, C. E., and H. A. Schaller. 2010. Influence of river conditions during seaward migration and ocean conditions on survival rates of Snake River Chinook Salmon and steelhead. Ecology of Freshwater Fish 19:520–536.

Poe, T. P., H. C. Hansel, S. Vigg, D. E. Palmer, and L. A. Prendergast. 1991. Feeding of predaceous fishes on outmigrating juvenile salmonids in John Day Reservoir, Columbia River. Transactions of the American Fisheries Society 120:405–420.

Poff, N. L., and D. D. Hart. 2002. How dams vary and why it matters for the emerging science of dam removal. Bioscience 52:659–668.

Pulliam, H. R. 1988. Sources, sinks, and population regulation. American Naturalist 132:652–661.

Quinn, T. P., M. T. Kinnison, and M. J. Unwin. 2001. Evolution of Chinook Salmon (*Oncorhynchus tshawytscha*) populations in New Zealand: pattern, rate, and process. Genetica 112–113:493–513.

Roni, P. 2005. Monitoring stream and watershed restoration. American Fisheries Society, Bethesda, Maryland.

Roni, P., K. Hanson, and T. Beechie. 2008. Global review of the physical and biological effectiveness of stream habitat rehabilitation techniques. North American Journal of Fisheries Management 28:856–890.

Ruckelshaus, M. H., K. P. Currens, W. H. Graeber, R. R. Fuerstenberg, K. Rawson, N. J. Sands, and J. B. Scott. 2006. Independent populations of Chinook Salmon in Puget Sound. NOAA Technical Memorandum NMFS-NWFSC-78.

Sakai, A. K., F. W. Allendorf, J. S. Holt, D. M. Lodge, J. Molofsky, K. A. With, S. Baughman, R. J. Cabin, J. E. Cohen, N. C. Ellstrand, D. E. McCauley, P. O'Neil, I. M. Parker, J. N. Thompson, and S. G. Weller. 2001. The population biology of invasive species. Annual Review of Ecology and Systematics 32:305–332.

Sanderson, B. L., K. A. Barnas, and A. M. W. Rub. 2009. Nonindigenous species of the Pacific Northwest: an overlooked risk to endangered salmon? Bioscience 59:245–256.

Satterthwaite, W. H., M. P. Beakes, E. M. Collins, D. R. Swank, J. E. Merz, R. G. Titus, S. M. Sogard, and M. Mangel. 2009. Steelhead life history on California's Central Coast: insights from a state-dependent model. Transactions of the American Fisheries Society 138:532–548.

Satterthwaite, W. H., M. P. Beakes, E. M. Collins, D. R. Swank, J. E. Merz, R. G. Titus, S. M. Sogard, and M. Mangel. 2010. State-dependent life history models in a changing (and regulated) environment: steelhead in the California Central Valley. Evolutionary Applications 3:221–243.

Schaller, H. A., and C. E. Petrosky. 2007. Assessing hydrosystem influence on delayed mortality of Snake River stream-type Chinook Salmon. North American Journal of Fisheries Management 27:810–824.

Scheuerell, M. D., R. Hilborn, M. H. Ruckelshaus, K. K. Bartz, K. M. Lagueux, A. D. Haas, and K. Rawson. 2006. The Shiraz model: a tool for incorporating anthropogenic effects and fish-habitat relationships in conservation planning. Canadian Journal of Fisheries and Aquatic Sciences 63:1596–1607.

Scheuerell, M. D., and J. G. Williams. 2005. Forecasting climate-induced changes in the survival of Snake River spring/summer Chinook Salmon (*Oncorhynchus tshawytscha*). Fisheries Oceanography 14:448–457.

Scheuerell, M. D., R. W. Zabel, and B. P. Sandford. 2009. Relating juvenile migration timing and survival to adulthood in two species of threatened Pacific salmon (*Oncorhynchus* spp.). Journal of Applied Ecology 46:983–990.

Schindler, D. E., X. Augerot, E. Fleishman, N. J. Mantua, B. Riddell, M. Ruckelshaus, J. Seeb, and M. Webster. 2008. Climate change, ecosystem impacts, and management for Pacific salmon. Fisheries 33:502–506.

Schindler, D. E., R. Hilborn, B. Chasco, C. P. Boatright, T. P. Quinn, L. A. Rogers, and M. S. Webster. 2010. Population diversity and the portfolio effect in an exploited species. Nature 465:609–613.

Schneider, J. 2011. Review of reintroduction of Atlantic Salmon (*Salmo salar*) in tributaries of the Rhine River in the German federal states of Rhineland-Palatinate and Hesse. Journal of Applied Ichthyology 27:24–32.

Schtickzelle, N., and T. P. Quinn. 2007. A metapopulation perspective for salmon and other anadromous fish. Fish and Fisheries 8:297–314.

Schwartz, M. K., G. Luikart, and R. S. Waples. 2007. Genetic monitoring as a promising tool for conservation and management. Trends in Ecology & Evolution 22:25–33.

Scott, R. J., K. A. Judge, K. Ramster, D. L. G. Noakes, and F. W. H. Beamish. 2005a. Interaction betwen naturalised exotic salmonids and reintroduced Atlantic Salmon in a Lake Ontario tributary. Ecology of Freshwater Fish 14:402–405.

Scott, R. J., R. Kosick, D. L. G. Noakes, and F. W. H. Beamish. 2005b. Nest site selection and spawning by captive bred Atlantic Salmon, *Salmo salar*, in a natural stream. Environmental Biology of Fishes 74:309–321.

Seddon, P. J., D. P. Armstrong, and R. F. Maloney. 2007. Developing the science of reintroduction biology. Conservation Biology 21:303–312.

Spalton, J. A., M. W. Lawrence, and S. A. Brend. 1999. Arabian oryx reintroduction in Oman: successes and setbacks. Oryx 33:168–175.

Spies, I. B., E. C. Anderson, K. Naish, and P. Bentzen. 2007. Evidence for the existence of a native population of Sockeye Salmon (*Oncorhynchus nerka*) and subsequent introgression with introduced populations in a Pacific Northwest watershed. Canadian Journal of Fisheries and Aquatic Sciences 64:1209–1221.

Stanley, E. H., and M. W. Doyle. 2003. Trading off: the ecological effects of dam removal. Frontiers in Ecology and the Environment 1:15–22.

Stüwe, M., and B. Nievergelt. 1991. Recovery of alpine ibex from near extinction: the result of effective protection, captive breeding, and reintroductions. Applied Animal Behaviour Science 29:379–387.

Tallmon, D. A., G. Luikart, and R. S. Waples. 2004. The alluring simplicity and complex reality of genetic rescue. Trends in Ecology and Evolution 19:489–496.

Taylor, E. B. 1991. A review of local adaptation in Salmonidae, with particular reference to Pacific and Atlantic salmon. Aquaculture 98:185–207.

Tear, T. H., P. Kareiva, P. L. Angermeier, P. Comer, B. Czech, R. Kautz, L. Landon, D. Mehlman, K. Murphy, M. Ruckelshaus, J. M. Scott, and G. Wilhere. 2005. How much is enough? The recurrent problem of setting measurable objectives in conservation. Bioscience 55:835–849.

Väsemagi, A., R. Gross, T. Paaver, M. Kangur, J. Nilsson, and L. O. Eriksson. 2001. Identification of the origin of Atlantic Salmon (*Salmo salar* L.) population in a recently recolonized river in the Baltic Sea. Molecular Ecology 10:2877–2882.

Viggers, K. L., D. B. Lindenmayer, and D. M. Spratt. 1993. The importance of disease in reintroduction programs. Wildlife Research 20:687–698.

Wagner, T., and J. A. Sweka. 2011. Evaluation of hypotheses for describing temporal trends in Atlantic Salmon parr densities in northeast U.S. rivers. North American Journal of Fisheries Management 31:340–351.

Walker, S. F., J. Bosch, T. Y. James, A. P. Litvintseva, J. A. O. Valls, S. Pina, G. Garcia, G. A. Rosa, A. A. Cunningham, S. Hole, R. Griffiths, and M. C. Fisher. 2008. Invasive pathogens threaten species recovery programs. Current Biology 18:R853–R854.

Waples, R. S. 1991. Pacific salmon, *Oncorhynchus* spp., and the definition of "species" under the Endangered Species Act. Marine Fisheries Review 53:11–22.

Waples, R. S., M. J. Ford, and D. Schmitt. 2007a. Empirical results of salmon supplementation in the Northeast Pacific: a preliminary assessment. Pages 483–403 *in* T. M. Bert, editors. Ecological and genetic implications of aquaculture activities. Kluwer Academic Publishers, Norwell, Massachusetts.

Waples, R. S., D. J. Teel, J. M. Myers, and A. R. Marshall. 2004. Life-history divergence in Chinook Salmon: historic contingency and parallel evolution. Evolution 58:386–403.

Waples, R. S., R. W. Zabel, M. D. Scheuerell, and B. L. Sanderson. 2007b. Evolutionary responses by native species to major anthropogenic changes to their ecosystems: Pacific salmon in the Columbia River hydropower system. Molecular Ecology 17:84–96.

Ward, D. M., K. H. Nislow, and C. L. Folt. 2008. Do native species limit survival of reintroduced Atlantic Salmon in historic rearing streams? Biological Conservation 141:146–152.

Weigel, D. E., P. J. Connolly, K. D. Martens, and M. S. Powell. 2013. Colonization of steelhead in a natal stream after barrier removal. Transactions of the American Fisheries Society 142.

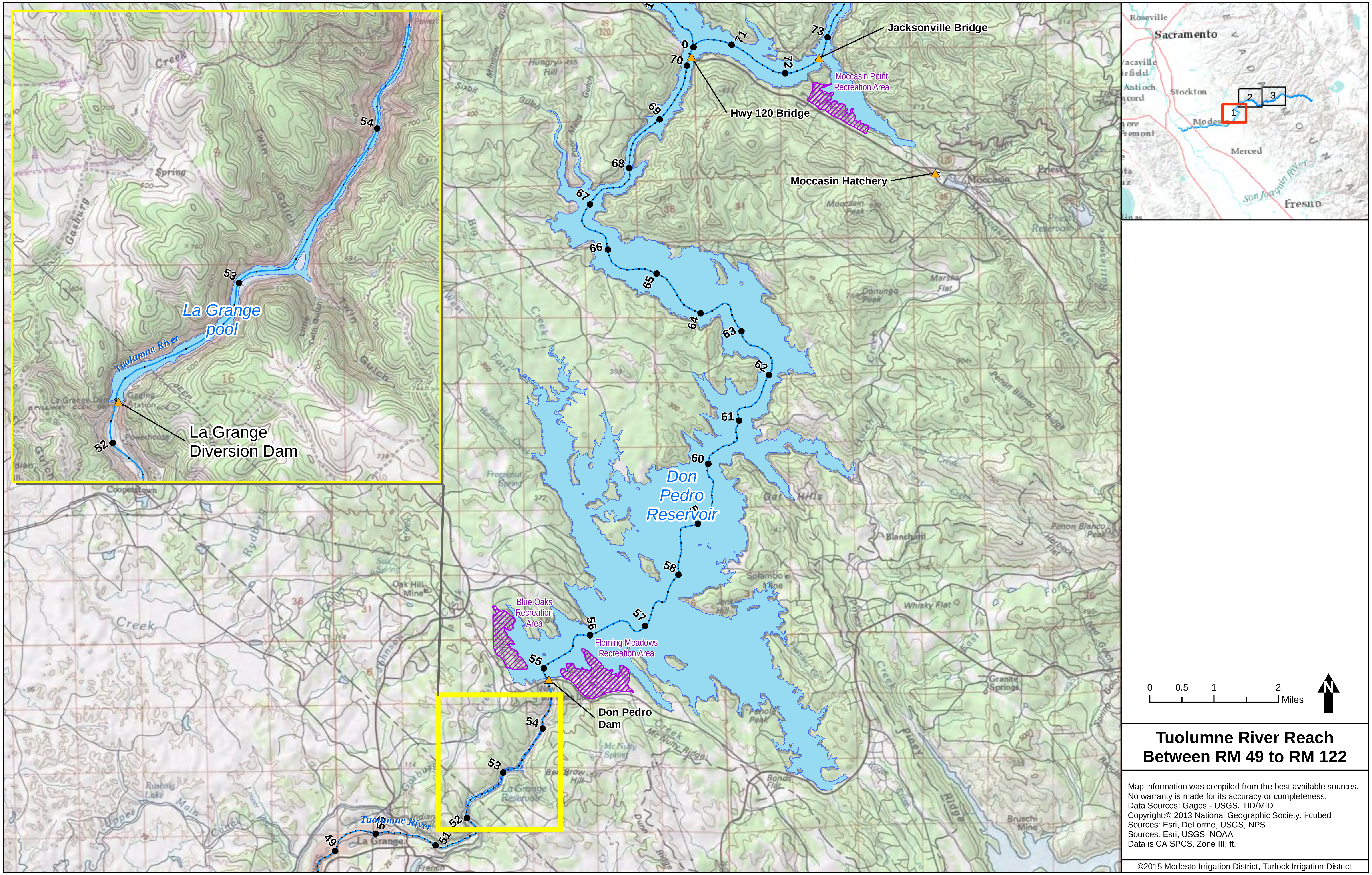
Williams, J. E., D. W. Sada, and C. D. Williams. 1988. American Fisheries Society guidelines for introductions of threatened and endangered fishes. Fisheries 13:5–11.

Williams, J. G., R. W. Zabel, R. S. Waples, J. A. Hutchings, and W. P. Connor. 2008. Potential for anthropogenic disturbances to influence evolutionary change in the life history of a threatened salmonid. Evolutionary Applications 1:271–285.

Williamson, K. S., and B. May. 2005. Homogenization of fall-run Chinook Salmon gene pools in the Central Valley of California, USA. North American Journal of Fisheries Management 25:993–1009.

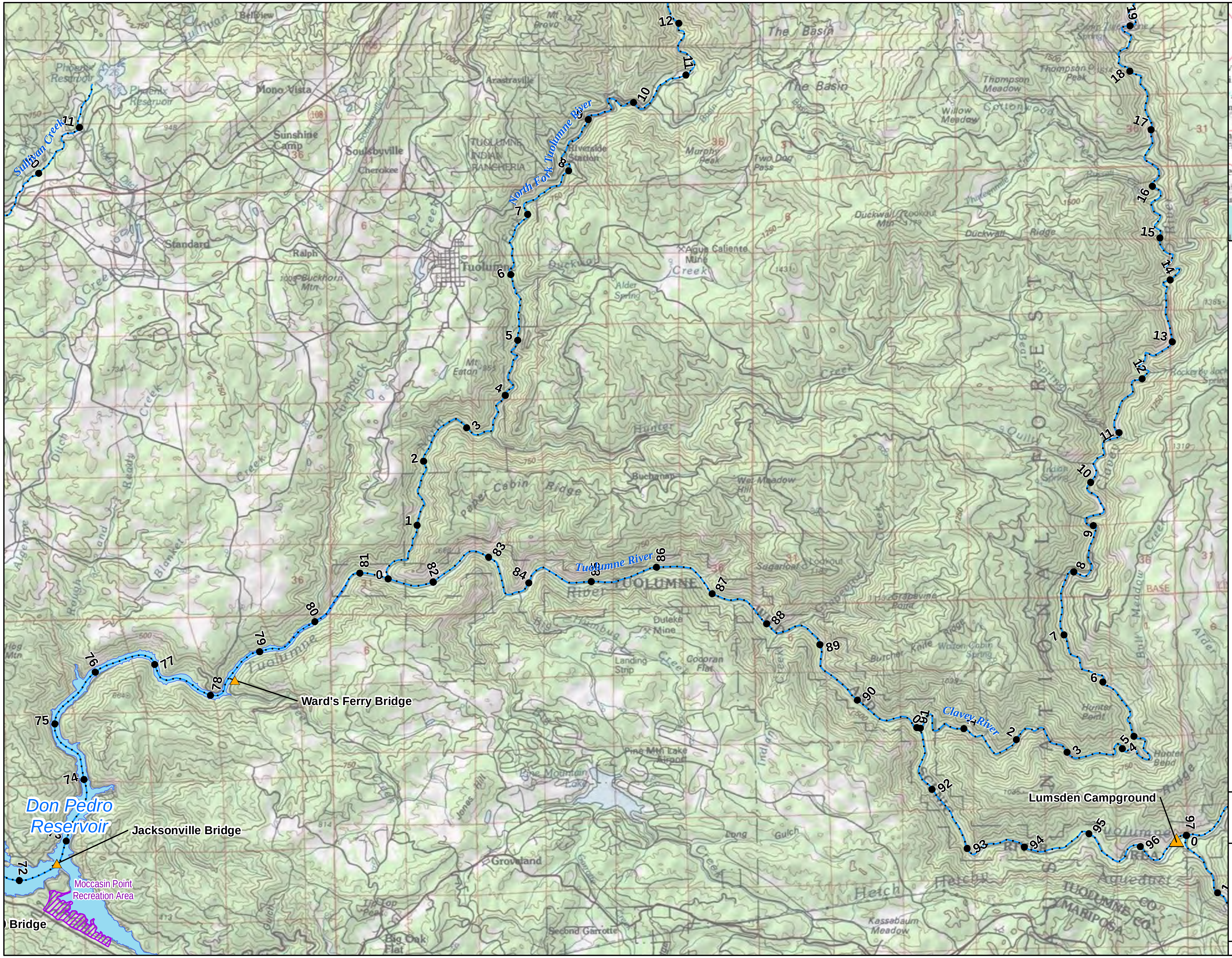
Withler, F. C. 1982. Transplanting Pacific salmon. Canadian Technical Report of Fisheries and Aquatic Sciences 1079.

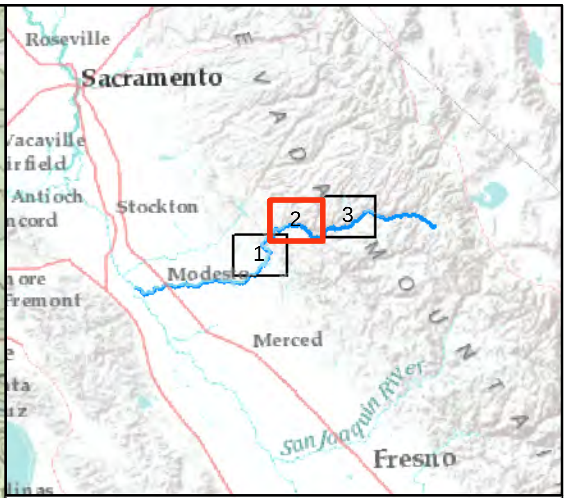
Wolf, C. M., B. Griffith, C. Reed, and S. A. Temple. 1996. Avian and mammalian translocations: update and reanalysis of 1987 survey data. Conservation Biology 10:1142–1154.



Tuolumne River Reach Between RM 49 to RM 122

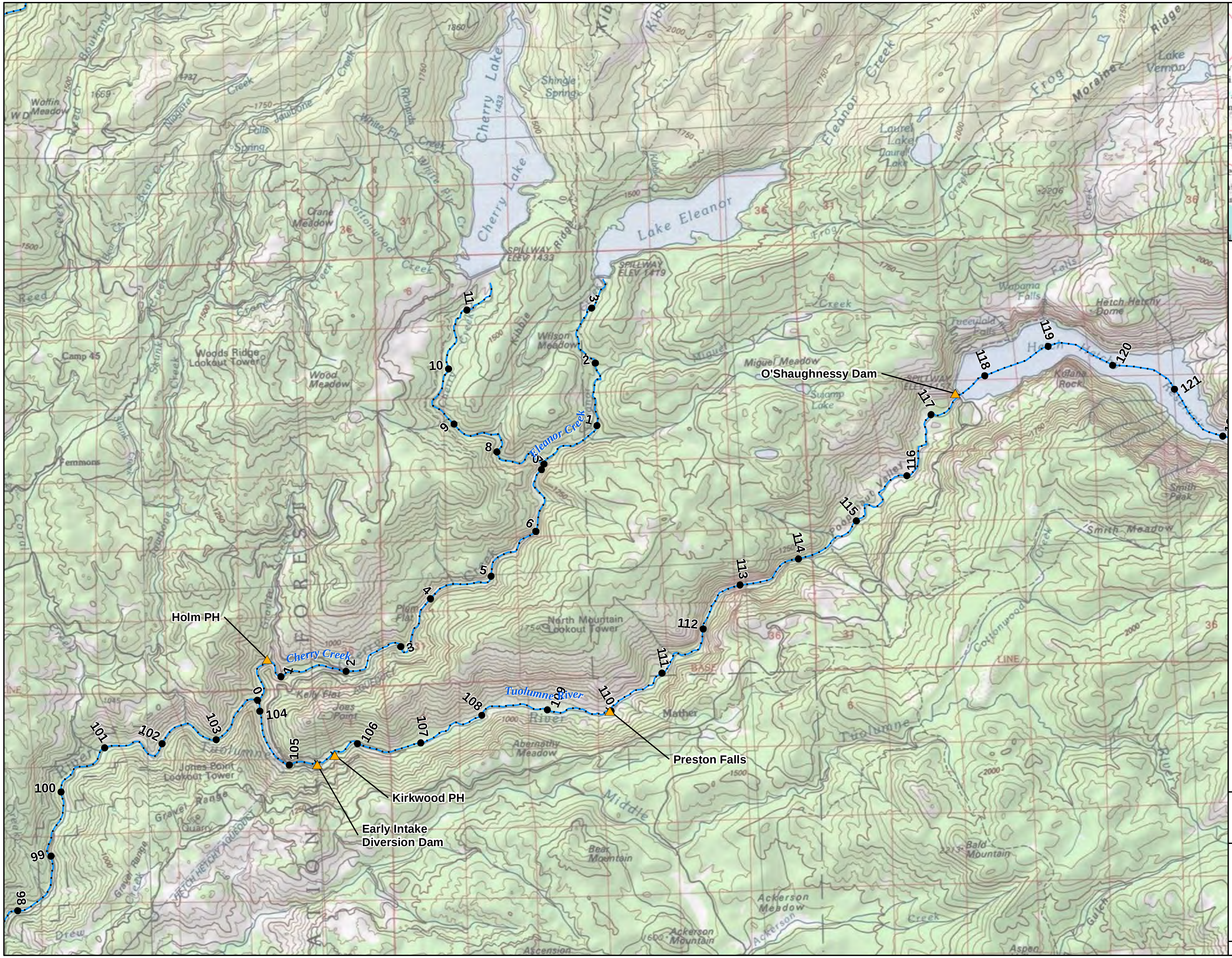
Map information was compiled from the best available sources.
No warranty is made for its accuracy or completeness.
Data Sources: Gages - USGS, TID/MID
Copyright:© 2013 National Geographic Society, i-cubed
Sources: Esri, DeLorme, USGS, NPS
Sources: Esri, USGS, NOAA
Data is CA SPCS, Zone III, ft.

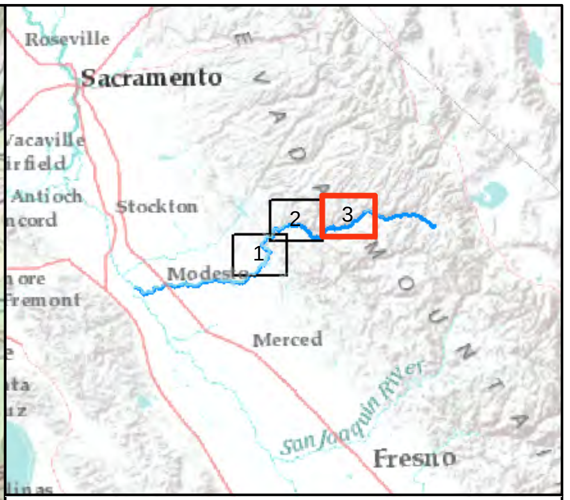




Tuolumne River Reach Between RM 49 to RM 122

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.





Tuolumne River Reach Between RM 49 to RM 122

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.

La Grange Hydroelectric Project Licensing (FERC No. 14581)
Fish Passage Facilities Alternatives Assessment
Workshop No. 2

Thursday, September 17, 2015
9:00 am to 12:00 pm

Meeting Notes

On September 17, 2015, Turlock Irrigation District (TID) and Modesto Irrigation District (MID) (collectively, the Districts) hosted the second Workshop (Workshop No. 2) for the La Grange Hydroelectric Project Fish Passage Facilities Alternatives Assessment (Fish Passage Assessment). This document summarizes discussions during the meeting. It is not intended to be a transcript of the meeting. Attachment A to this document includes the following meeting documents: agenda, sign-in sheet, presentations, and handouts.

Mr. John Devine of HDR, Inc. (HDR), consultant to the Districts, welcomed meeting attendees. Attendees in the room and on the phone introduced themselves. Messrs. Noah Hume and Wayne Swaney of Stillwater Sciences, Mr. Matt Oh and Ms. Jenna Borovansky of HDR, and Mr. Peter Barnes of the State Water Resources Control Board participated remotely. Mr. Chris Shutes (California Sportfishing Protection Alliance) initially joined the meeting by phone and then arrived in person.

Mr. Devine summarized the meeting handouts and visuals placed around the meeting room. He reviewed the meeting agenda, which had been provided to meeting participants on September 4. Mr. Devine noted the 9:10 am and 9:30 am agenda items will be switched, but other than that the agenda remained the same. Mr. Roger VanHoy (MID) asked to be able to make some introductory remarks. Mr. Devine added he was remiss in not inviting opening remarks from anyone that would like to make them. Mr. Devine invited anyone interested to make opening remarks. There were no volunteers.

Mr. Devine presented introductory slides. He provided background on the La Grange Hydroelectric Project (La Grange Project) and summarized the licensing process to date. Mr. Devine described the Fish Passage Assessment and reviewed the status of action items from Workshop No. 1, held on May 20, 2015. He also covered the objectives of Workshop No. 2 and the schedule moving forward after Workshop No. 2.

Mr. VanHoy provided opening remarks. He said the Districts are considering the potential for fish passage at their facilities very seriously with a desire to understand the full scope of needed facilities and their cost, which is why the Districts are hosting this series of Workshops. The Districts hope to come through this process with a better understanding of the agencies' goals, what it may cost to construct and operate fish passage facilities, and the financial implications for the Districts' and their ratepayers. Mr. VanHoy noted that the Districts are putting substantial resources into this study, with the hope of facilitating engagement with the meeting attendees through the Workshops. Mr. VanHoy said that although there are many experts in attendance today, there are many non-experts too, people like himself and others from the business and legislative communities. He encouraged non-expert, community interests to become engaged as well. The Districts' goal is to understand the risks, benefits, costs, impacts and the probability of success of a fish passage/reintroduction program on the Tuolumne River. The Districts hope there is a strong interest and high level of participation in the process. Furthermore, the Districts realize and accept that there may be diverging opinions on the likelihood of success.

Mr. VanHoy said he came from a background in power and that the scale of a fish passage facility can be immense and for those unfamiliar with such facilities, it may be difficult to envision. Referring to Technical Memorandum (TM) No. 1 (available online here), Mr. VanHoy said the footprint of a floating surface collector for downstream passage could be as big as the footprint of the MID conference room. The collector would be a floating laboratory on the Don Pedro Reservoir, using nets and vacuums to guide and collect small fish. The collector would be part of a barge that would have to float up and down with reservoir fluctuations. The process of scoping and engineering a fish passage facility of this type is an intensive effort.

Mr. VanHoy reiterated the importance of coming to a common understanding about costs. He added that with some luck, meeting participants will also come to a common understanding about whether the fish passage facilities would be successful.

Mr. Devine thanked Mr. VanHoy for his remarks and asked if anyone else would like to make opening remarks. There were no volunteers.

Mr. Devine said the Districts hope to use the Workshops to move the Fish Passage Assessment through an open and collaborative process that will produce the information required to make a well-informed decision about whether fish passage facilities should be built at the La Grange Project and the Don Pedro Project to support fish reintroduction. To this end, the Districts developed a draft reintroduction decision-making framework to share with Workshop participants. The intent of the framework is to evaluate all the potential issues, not only fish passage engineering feasibility, associated with fish reintroduction into the upper Tuolumne River.

Mr. Devine said an overview of this comprehensive framework was made available to Workshop participants on September 4. Additional handouts and materials describing the decision-making framework were made available at the Workshop. It is apparent that the question of whether or not to build fish passage on the Tuolumne River is a challenging one, but the engineering of fish passage is just one element of a much broader question regarding the feasibility of fish reintroduction. However, this question has been tackled on other projects and the draft reintroduction decision-making framework presented here is not new; instead, it was adapted from processes used at other California projects to inform decision-making on reintroduction and fish passage facilities. In addition to drawing on criteria used at other projects, the decision-making framework being presented here uses concepts and approaches from peer-reviewed literature, including literature produced by the National Marine Fisheries Service (NMFS). Mr. Devine reiterated that the proposed framework draws on materials and sources that have been used at other projects.

Mr. Devine indicated the Districts recognize that this topic is complex and the goal today is not to make a decision. The goal of Workshop No. 2, as contained in the previously distributed agenda, is to discuss a potential reintroduction decision-making framework and TM No. 1 (distributed on September 4) and see if consensus on a path forward can be reached. Recognizing that very complex questions lie ahead, the Districts believe there is a need for a structured decision-making framework that is comprehensive, collaborative, and transparent, which are the goals of the draft reintroduction decision-making framework presented today.

Mr. Devine introduced Mr. Paul Bratovich (HDR) and Dr. Chuck Hanson (Hanson Environmental, Inc.) to present the conceptual reintroduction decision-making framework..

Mr. Bratovich summarized his educational and professional background. Paul Bratovich holds a Bachelor of Science degree in Fisheries from the University of Washington and a Master of Science degree in

Fisheries Resources from the University of Idaho. Mr. Bratovich reported that he was the Lead Investigator on numerous technical studies for the Oroville Project relicensing, including the development and application of a Fish Passage Assessment Model for the Feather River. He was also the lead biologist for the North Yuba Reintroduction Initiative, and Yuba County Water Agency's fisheries representative for the multi-party Yuba Salmon Forum.

Mr. Bratovich noted that the reintroduction decision-making framework is comprised of four main components: (1) Ecological Feasibility, (2) Biological Constraints, (3) Technical Fish Passage Considerations, and (4) Economic, Regulatory and Additional Key Considerations.

Mr. Devine said earlier he had failed to describe the difference between what is meant by "fish passage" and what is meant by "reintroduction". He asked Mr. Bratovich to give an overview of the difference. Mr. Bratovich replied that "reintroduction" means an overall program of introducing fish back into historical habitat, after having been extirpated from those habitats. For example, if spring-run Chinook were historically in a reach of river, and as the result of something happening, such as the construction of dam, the fish were no longer in that reach of river, bringing that same fish species back into this reach is termed "reintroduction." In contrast, "fish passage" describes the methods by which fish are moved upstream or downstream around an impediment in the river.

Mr. Bratovich summarized the elements of each of the four limbs in the reintroduction decision-making framework. At a high level, Mr. Bratovich described what types of questions should be addressed in each limb. Regarding the fourth limb, Mr. Bratovich emphasized the importance of determining what role economics would play in this process. Does economics even play a role in this process? Mr. Bratovich noted that different stakeholders may have different opinions about the role of economics in this decision process.

Dr. Hanson summarized his educational and professional background. Dr. Hanson has a Ph.D. in Ecology and Fisheries Biology from UC Davis and has over 35 years of experience working on fisheries issues in the Central Valley. Dr. Hanson participated in the NMFS Central Valley Salmonid Technical Recovery Team and the U.S. Fish and Wildlife Service Native Delta Fishes Recovery Team as well as the Bradbury Dam Technical Advisory Committee (TAC) reintroduction feasibility study on the Santa Ynez River and the San Joaquin River TAC salmon restoration/reintroduction program downstream of Friant Dam. Dr. Hanson also participated in the relicensing processes for both the Oroville and Klamath River hydroelectric projects where the feasibility of reintroducing anadromous salmon upstream of existing dams was assessed.

Dr. Hanson reported he had been tasked by the Districts with providing independent feedback on Mr. Bratovich's reintroduction decision-making framework. Dr. Hanson said that to complete this task, he had first compiled and reviewed studies that took place over the last 15 years that examined the feasibility of reintroducing salmonids in California and the Pacific Northwest. Specific projects he reviewed included projects on the Santa Clara River, Yuba River, Feather River, Santa Ynez River and Snake River and projects in the Upper Columbia River Basin. Dr. Hanson noted that as he reviewed these studies, he was struck by the commonalities between Mr. Bratovich's approach and the other processes. Commonalities included consideration of the interplay between biological, ecological, and engineering feasibility and consideration of variables such as species behavior, the quality and availability of suitable habitat for spawning and rearing, and how the quantity of habitat varies by season and water year. Dr. Hanson noted that predation was a key issue, both in terms of the upstream tributaries where juvenile rearing would occur and downstream where the juveniles would be released. The location of upstream barriers had an influence on the availability of habitat and on release locations. Limiting factor analysis and the identification of carrying capacity came up repeatedly in the studies Dr. Hanson had reviewed; these factors formed the basis for developing estimates of juvenile productivity and subsequently, adult productivity (i.e., adult returns). Dr. Hanson noted that defined biological goals and objectives were commonplace in the studies he had reviewed. Dr. Hanson said that Mr. Bratovich's reintroduction decision-making framework was not new and had been shaped by work completed at other projects over the last 15 years, and that in his opinion Mr. Bratovich's reintroduction decision-making framework was well-founded.

Mr. Devine thanked Mr. Bratovich and Dr. Hanson for their presentations. Mr. Devine said the question for the participants is how to move forward. The reintroduction decision-making framework is a potential process for informing reintroduction, and therefore, fish passage decision-making, and is based on other recent reintroduction processes. The Districts' goal is to try to obtain consensus for a path forward and offered this draft decision-making framework, or something like it, for the overall process, because it covers the full scope of issues and concerns that need to be answered regarding reintroduction such as the costs, the risks, the constraints, the benefits, and the potential for success. As a path forward, the Districts asked licensing participants to look at this material and provide the Districts with feedback on the material presented today, so that consensus can be reached on the information that needs to be collected and the issues that need to be considered. The Districts asked that licensing participants take some time to absorb the material, perhaps over the next four or five weeks, and then provide comments.

Mr. Wooster (NMFS) said he was confused on the Districts' proposed process. The Fish Passage Assessment Study Plan corresponds with the orange boxes (technical, engineering fish passage considerations) in the decision-making framework. The orange boxes appear as only one piece of the overall decision-making framework. Do the Districts want to cover the entire decision-making framework within the context of the study identified in the study plan? Mr. Wooster noted that a series of three Workshops is planned and already this group is at Workshop No. 2. There are two years of study and the study is already halfway through the first year. Mr. Wooster indicated that it sounds like the Districts are proposing a multi-party collaborative reintroduction forum, similar to the Yuba Salmon Forum. Mr. Wooster asked if that is what the Districts are proposing. Mr. Wooster asked for clarification about the scale of what the Districts are proposing.

Mr. Devine replied that from the Districts' perspective, the answers to many of the biological and ecological questions that Mr. Bratovich and Dr. Hanson raised are critical to informing the engineering assessment and serve to demonstrate the interconnected nature displayed in the reintroduction decision-making framework. While FERC's direction was to assess fish passage, the Districts always supported the idea that many issues and data needs were raised by the question of reintroduction. The Districts' issue in the FERC study plan determination process was solely which party should be responsible for collecting the needed information. A number of important questions needed for a well-informed engineering assessment are identified in the various limbs of the decision-making framework. Consensus on this information is needed in order to move forward with the engineering study. Mr. Devine likened the engineering study to a study about constructing a building. One cannot simply say "build a building". First, factors must be known such as how many people the building needs to fit, how many offices should there be, and what the soil composition is at the site. The answers to these questions must be known in order to prepare a well-informed design and, therefore, an accurate and reliable cost estimate.

Mr. Devine noted that earlier in the meeting, Mr. VanHoy had mentioned that the Districts want to do this study right. It is important to the Districts that there is a solid foundation of information on which to build a reliable and real cost estimate. The first step is to work through this structured reintroduction decision-making framework. This is just a draft and the Districts welcome comments, feedback, and modification.

Ms. Alison Willy (U.S. Fish and Wildlife Service) asked where in the reintroduction decision-making framework is the decision point for choosing to pursue assisted passage or volitional passage. Mr. Devine described the differences between volitional and assisted passage and indicated Mr. Mike Garello (HDR) would cover this very topic during his presentation. Mr. Devine noted that TM No. 1 is the beginning step to identifying the information needed to support the process of selecting and designing appropriate fish passage facilities. In his presentation, Mr. Garello would be discussing TM No. 2, the goal of which is to develop potential upstream and downstream passage alternatives and then select those facility alternatives that are consistent with fish passage program goals (yet to be defined).

Ms. Willy noted that some fish passage facilities in the northwest have combinations of assisted passage and volitional passage. Some of these facilities utilize existing project structures and facilities. For example, the fish passage structure might utilize a project bypass originally built during dam construction. Ms. Willy asked if this study would consider options like that. Mr. Devine replied that the study will look at all facilities that could be useful for fish passage. He noted that as the study progresses, decisions to eliminate facilities from consideration will be made in consultation with this Workshop group. First, a draft document will be provided for review that explains the logic and reason behind any proposed decisions. The Districts' desire is to develop consensus during each step moving forward. However, to continue progressing forward, someone needs to take a first shot at the analysis – that was the purpose of TM No. 1. The Districts want to move forward on a consensus basis about what makes sense to study in detail. But as a first matter the goals and objectives of the fish passage program must be known to inform what would be appropriate to design, construct and operate.

Mr. Bao Le (HDR) noted the importance of knowing the goals and objectives and having sound information, or assumptions based on sound information, at the outset of the process. Without that information, there is a risk of moving forward with the design process and then needing to go back and re-design if new and/or more accurate information became available. This would have implications for cost and schedule.

Mr. John Shelton (California Department of Fish and Wildlife [CDFW]) noted that many ecological feasibility questions are not simple "yes" or "no" questions. Mr. Shelton agreed that questions about technical feasibility or economic feasibility may be binary; for example, technical feasibility may be a "yes" or "no" question. Mr. Shelton said that when he had participated in these types of processes in the past, the first step was to decide on goals and objectives and then to see which fish passage alternatives are feasible. Goals and objectives must be decided first, which often requires a stakeholder process. From there, alternatives are prepared. That is when Ms. Willy's question about volitional or assisted passage comes in. Mr. Shelton said he would caution against having an engineering concept already in mind and then building backwards. The concept will come out of the alternatives analysis. If there is already a concept in mind, there cannot be an objective stakeholder process.

Mr. Garello (HDR) said the approach proposed here aligned very much with what Mr. Shelton said. He noted that the arrows in the decision-making framework point both ways, meaning that the various limbs create an integrated whole and feed into each other. Regarding determining fish passage technical feasibility and what technologies would be appropriate, the Districts have not gone down that road yet. The study is in the information gathering phase now. Mr. Garello said the Districts need input on the biological goals and objectives of the reintroduction program to determine appropriate design criteria and constraints for fish passage alternatives.

Mr. Tom Holley (NMFS) noted the Districts are currently undertaking two studies that FERC did not order the Districts to complete. These studies focus on upstream habitat. Mr. Holley asked if the results of those studies would feed the engineering study alone or if they would inform the entire reintroduction decision-making framework. Mr. Holley noted that studying just the upstream habitat in the Yuba Project took four years and meetings were held frequently. The process was fairly involved. Mr. Holley said it did not seem like the stakeholders would have the opportunity to have the same level of involvement in the Districts' upstream studies as they had had in the Yuba studies.

Mr. Devine responded that the results of any upstream studies would be useful for the entire decision-making framework. Mr. Devine indicated that the Districts are voluntarily performing certain studies NMFS requested but which FERC said the Districts were not required to do under the FERC study criteria. These studies are underway and the Districts will share results when they are available, which is likely at the time of the ISR. However, it does seem that an important first step is developing a reasonable process to arrive at a consensus decision on all the questions raised by reintroduction. From there you can determine what kind of information is needed, what will be involved to get the information, and what the schedule will be. The Districts fully intend to foster a collaborative process with the upstream studies as well. These studies will not be completed in a vacuum. The Districts think the results of the upstream studies will play a role in answering questions about carrying capacity and habitat availability, but many other questions remain. Some of these will be critical to informing the engineering component of the framework since all various limbs of the reintroduction decision-making framework are interconnected. The first step is achieving consensus on using this process, developing a schedule, and then trying to understand what each party can achieve and in what time frame. There is a lot of money at stake, complex decisions to be made, and potential impacts; this process needs to be done right.

Mr. Wooster said he did not think his first question was answered. What are the Districts proposing? While there is a lot of biological information needed to do the engineering study properly, there is also a lot of biological information noted in the reintroduction decision-making framework that is not needed to design the facilities. Mr. Wooster asked if the Districts are proposing to identify only the items in the framework that are needed to do the engineering study or if the Districts are proposing to look at every single item identified in the framework.

Mr. Bratovich said that from his perspective, the process should entail looking at each item in the decision-making framework. A benefit of this structured decision framework is that it provides transparency. Many of the biological issues included in the framework may not intuitively relate to engineering feasibility. However, Mr. Garello's presentation will show how some of those items are important inputs into the engineering design. Mr. Bratovich noted that over the last several weeks, Mr. Garello had asked Mr. Bratovich about many biological issues because those topics relate to the engineering work. Mr. Bratovich said he had not had the answers to many of those questions, several of which related to carrying capacity and productivity potential.

Mr. Wooster said that while there were clear examples of biological information that is important for Mr. Garello to know, such as carrying capacity or the number of fish, there is other information in the reintroduction decision-making criteria that would not be important for him to know. Genetics is one example. Genetics are important but the availability of information on genetics should not delay Mr. Garello as he develops fish passage alternatives. Mr. Wooster said he could go through the reintroduction decision-making framework and find other such examples. Mr. Wooster asked if Districts are trying to identify what is needed for the engineering feasibility study or if the proposal is to work methodically through a broader, more comprehensive reintroduction decision–making framework.

Regarding the example of genetics raised by Mr. Wooster, Mr. Devine responded that this may actually play a significant role in the type and timing of engineering facilities. If the genetic study underway by NMFS on *O. mykiss* found that passage of steelhead was not desired, as NMFS pointed out in the FERC study dispute resolution process, then the fish passage facilities design and operation would not have to accommodate the needs and requirements of steelhead. This would likely be a much different design and operation plan for fish passage if steelhead had to be considered. The Districts are planning to work through the broader, more comprehensive assessment using a collaborative process. The framework identifies information needed to support a well-informed decision on reintroduction. One goal of this effort is to estimate the cost of the required facilities and associated operational requirements. Mr. Devine said that industry experience so far with high-dam passage is that the actual cost to build and operate these fish passage facilities has far exceeded the initial estimates. Typically, this is because the information used to generate the initial cost estimates had changed dramatically or had not been well-informed early-on. It is in all parties' interest to avoid this problem. Since the Districts and their ratepayers will be responsible for these costs, it is absolutely critical to establish a solid foundation of information to inform any cost estimates.

Mr. Wooster said he thinks that the Districts need to develop a process to work through the decision-making framework, and to not try to cram the whole framework into the engineering study. Mr. Devine replied that the engineering study is one component of the overall framework, and that various elements identified in the other three components will help define the fish passage facilities needed and when they are needed in the reintroduction program. Mr. Wooster replied that he does not know what Mr. Garello needs for the engineering study. Mr. Devine asked Mr. Wooster to review the reintroduction decision-making framework and provide his opinion about what he thinks would be useful for the engineering study. Mr. Garello added that his presentation later in the meeting will provide more detail on what initial information is needed specific to the fish passage engineering element.

Mr. Bratovich said that Mr. Wooster had made good points. Some of the biological constraints in the reintroduction decision-making framework do not intuitively link to the engineering, and that some elements are needed more than others. Mr. Bratovich noted that his presentation stated that the decision was not just about fish passage, but the broader concept of fish reintroduction which is applicable to the upper Tuolumne River. Broader issues and concerns have been raised about reintroduction that extend beyond just the engineering feasibility of fish passage.

Mr. Shutes said it seems as though there are some questions in particular that are crucial for informing the engineering study. Mr. Shutes said that it looks like Mr. Garello will not be able to get answers to all the questions in the decision-making framework and still be able to abide by the study report schedule. It may be worth flagging some of the key questions and seeing if there are opportunities to make a decision on those. Some will need to be contingencies. For example, the answer to what species should be studied (steelhead and/or fall-run Chinook and/or spring-run Chinook) may need to be a contingency. Mr. Shutes said he was certainly sympathetic if folks think one of those species is not in the picture. Not answering big questions like that could potentially lead to a lot of unnecessary work for Mr. Garello.

Mr. Shutes said that some of the issues in the decision-making framework may be design issues, such as whether the facility operates year-round or only during a specific time period. An issue like that will certainly have an effect on cost, as this group knows from dealings with Yuba and other projects. Here, that issue may have to be a contingency. Mr. Devine said that the Districts realize that some assumptions will have to be made. However, the basis for these assumptions must be sound, and be based on something other than an arbitrary choice.

Mr. Peter Drekmeier (Tuolumne River Trust) said that at the beginning of today's discussion, there was a lot of focus on a collaborative process. He appreciates this. This group works well together and they are respectful of one another. However, he is not sure this group will be able come to a consensus agreement in the end. There are some people in this room who are really rooting for a fish passage program and others that are skeptical about fish passage or opposed because of the cost. It will be a challenge. Right now in the Bay area, the utilities, agencies and conservation groups have come together collaboratively around the importance of water conservation. Utilities participated because they wanted to make sure they have enough water. The conservation groups are hoping that some of the water saved will end up benefitting the fish. A cap was agreed to and has been successful. Mr. Drekmeier said this area of the state is in much better shape because of that collaboration. Mr. Drekmeier asked if there could be an incentive for everyone in this group to make progress on the Tuolumne, perhaps on the issue of fish passage or about something else. Depending on the goals, if there were incentives for the Districts to meet the goals, or penalties if the goals were not met, that could help the process. The cost of fish passage is very expensive, and maybe some feel it could be done in a less expensive way. The Districts have already spent millions on the relicensing of Don Pedro and it did not amount to anything positive for the river.

Mr. Devine said that in his conversations with the Districts, the decision about fish passage is of great interest and importance to many people and the only way to arrive at a common understanding of the issues is to have a collaborative process. Having a collaborative process does not mean that in the end agreement is reached, but it does mean that everyone works together and at least agrees with the information that has been collected. The Districts are committed to working in an open and direct way. However, this does not guarantee agreement about whether or not fish passage is feasible or appropriate. But working through a collaborative process is the best chance to ensure that the information that is identified, collected and evaluated for decision-making is supported by all participants. The Districts want to work with all parties with the goal that an agreed-upon data base is developed. Mr. Devine added that in the end everyone may not all agree, but hopefully at least participants will understand why those differences exist.

Mr. Drekmeier said he was wondering what could be learned from other similar projects that had been successful. He noted he was not really familiar with all the issues being discussed here, and that it might make sense upfront in the process and be cost-effective to look at how successful processes have been implemented elsewhere. Or, maybe this group could consider how the resources to be used in this effort would be better used to improve the river.

Mr. Ray Dias, a member of the public and an engineer, said he would like to second what Mr. Drekmeier said. The reintroduction decision-making framework is complex but he thought it was necessary and would work. As a member of the public, Mr. Dias said he is concerned about the economics, but as an engineer he knows best practices could be used to streamline the process. It would greatly benefit the overall process if best practices could be leveraged from other projects where this has been done successfully in the past.

Mr. Marco Moreno (Latino Community Roundtable [LCR]) said that whatever this participant group decides to do, the poor people of this area are going to pay the costs. Mr. Moreno said that LCR asks that this group make the best decision that will benefit the fish and the people. The LCR is working on a study with the University of the Pacific that is looking at how a $50 million or $100 million project may affect the poor in this area. There are people in this area that make $12,000 a year, and these are the people that will have to pay for fish passage. Mr. Moreno said that the decision-makers need to be aware of this. At the last meeting, costs of $1 million, $2 million, and $3 million were discussed to help the fish. Mr. Moreno said everyone can agree that something must be done for the fish but that decision-makers cannot forget that this is not Washington State, Los Angeles, or San Francisco – this is the Valley, the Appalachia of the West. There is 20% poverty in this county, with people here making as little as $12,000 or $15,000 or $20,000 a year. Mr. Moreno said that decision-makers could decide to build a fish passage project but that they must remember who would be paying for it. The University of the Pacific study will show how this multimillion dollar investment will affect the poor.

Mr. Shelton said that CDFW realizes that the Latino communities are a large and important constituency. CDFW recognizes that the agency plays a very important role for this constituency and takes this very seriously. CDFW provides low-cost recreation opportunities, and the economics show that these opportunities benefit people in the Valley. Mr. Shelton said that he himself had grown up in the Valley and knew all about the communities in this region. CDFW believes that serving these populations is very important. Costs must be a component of any feasibility analysis. There has barely been any discussion about how fish passage might affect recreation such as bass fishing. If participants are really going to have a collaborative process, this group must agree on the goals and objectives and the biological issues. One cannot work through a reintroduction decision framework without first knowing the goals and objectives of the program. There is a lot of work to be done, but a lot to be gained. Without going through this framework process as a group, or something like it, Mr. Shelton said it will be very difficult to come to a common understanding or arrive at common goals and objectives.

Mr. Devine said those were excellent comments. Regarding Mr. Dias' comments, Mr. Devine said that the engineering analysis will include applying standard design criteria to the project. However, it is the Districts' thought that there is other design information needed, and a process is needed to acquire that information. A consensus is needed on starting down the path of a process.

Meeting breaks for 10 minutes. Meeting resumes at 11:15 am.

Mr. Devine reconvened the meeting. He said that just before the break, several individuals had asked questions about engineering feasibility. Those were excellent questions and segue to Mr. Garello's presentation.

Mr. Garello gave a summary of his professional background. Mr. Garello has 15 years of experience working as a Senior Resource Engineer at HDR's Fisheries Design Center. Mr. Garello has been the Engineer of Record for numerous fish passage projects in California and has worked on upstream and downstream fish passage projects across the United States and Canada.

Mr. Garello said the study is currently in the information gathering phase and would look at physical baseline conditions, the biological design basis, and operational requirements. Mr. Garello explained how these three information areas link to one another and then provided examples from other projects of how this type of information has important design implications.

Referring to one of Mr. Garello's slides, Ms. Willy asked what the change in reservoir level is at that Cougar Dam facility and how fish are retrieved from the floating mobile collector. Mr. Garello replied that the U.S. Army Corps of Engineers built the facility so that it was portable and could be moved around the reservoir. The facility can remain in one spot and accommodate 160 feet of forebay fluctuation. A really challenging issue at this project is that the reservoir can change up to 50 feet in one day. Regarding how fish are removed, this facility is a "trap and haul" facility. After the fish are collected, there is a small holding pool and hopper. The hopper raises the fish to deck level where staff can net the fish and put them in containers. The service barge brings the fish to shore where a truck picks them up and transports them downstream. The Cougar facility is a pilot project, gathering real time research level information not obtainable through desk-top study.

A meeting attendee asked about how fish would be colonized in the upper river. Mr. Bratovich replied that colonization could be achieved in a variety of ways. For example, eggs could be planted in boxes. Or, adults could be planted from a hatchery. Colonization could begin using any number of life stages or be based on other considerations such as location or time of year. Mr. Garello that the colonization decision could affect what passage facilities are provided at what point in the reintroduction process, which affects cost.

Ms. Dana Ferreira (Office of U.S. Congressman Jeff Denham) asked what input is needed. Mr. Garello discussed the information needed for the engineering study. Mr. Devine said he believed that the information needed will come primarily from the resource agencies, such as information included in agency recovery plans and overall management plans. However, input from the conservation groups and others will also be helpful and welcome.

Referring to the introductory slide summarizing the status of action items from Workshop No. 1, Ms. Ferreira noted that the slide mentioned that NMFS had not provided a written description of the genetics study. She asked when that description will be provided. Mr. Wooster replied that he can answer any questions about the genetics study today. Ms. Ferreira again asked when a *written* description will be provided. Mr. Wooster replied that he would draft something up about the study. Mr. Devine said that it was not necessary for Mr. Wooster to provide a written description today, but hopefully sometime soon. Mr. Devine added that genetics are important to this process. As NMFS noted during the La Grange Project Study Dispute Resolution Panel Meeting and Technical Conference, the results of the genetics work could indicate definitively if it is undesirable to move *O. mykiss* into the upper watershed. The Districts are interested to know the schedule because if the genetics work shows that introducing *O. mykiss* into the upper watershed would be inappropriate, *O. mykiss* could be excluded from further study.

Ms. Ferreira asked if Mr. Wooster could provide a schedule for providing a written description of the study. Mr. Wooster volunteered to provide details about the study now. He said that researchers started sampling in May of this summer. To date, three sampling trips have been completed. Another trip is planned for this fall. The trips have been very successful. Over 500 samples have been collected from throughout the upper watershed. NMFS is hoping to do a second year of sampling, with this sampling being informed by the results from the first year's samples. Regarding schedule, the fall trip will be in early October. The lab will process the samples over the winter. Once they are processed, the data will be run through computer algorithms. The hope is that there will be preliminary results available by mid-spring, around April, to inform the second year of sampling, so that the sampling in the second year can be more targeted. If a second year of sampling is completed, Mr. Wooster said that the schedule for processing and analyzing samples in the second year would likely mirror the schedule from the first year; therefore, results would be available around April 2017.

Mr. Devine asked when Mr. Wooster thought the genetics study would be far enough along that a go/no-go decision could be made about the reintroduction of *O. mykiss*. Mr. Wooster replied that he did not know the answer and that he would have to look to the experts at the Science Center. Mr. Wooster said that was something he could not weigh-in on and that he did not know how much the lab expected to know after the second year. Mr. Wooster said he could see the study taking the full two years.

Mr. Shelton asked if Mr. Devine had said the genetic results were *necessary* for the decision-making process. Mr. Devine replied that the results were important and could substantially affect the reliability of the cost estimate. Mr. Shelton said that the Districts had said during the study development phase of the FERC licensing that the genetics study was not necessary, and that is why the Districts are not collecting the information themselves. Mr. Devine replied that that characterization was incorrect. The Districts said they did not offer to do the study because, given the FERC study criteria and FERC regulations, the study did not meet the criteria necessary for FERC to require the Districts to perform the study. The Districts are on record saying the study is important, but that it is NMFS's responsibility to perform the study and not the Districts'. The Districts think the study is important because the data could result in a "yes" or "no" answer about the genetic suitability of *O. mykiss* for reintroduction. If the genetics study is extended for two more years, the Districts may still need to make some assumptions about *O. mykiss* passage but it may not be informed by sound information.

Mr. Shelton asked who makes the decision about *O. mykiss*. The biological goals and objectives should be set during this stakeholder process. Regarding the species to be considered in this process, Mr. Shelton said that CDFW would not want to make a decision about that on its own, and would want input from others like NMFS, the conservation groups, and all entities and individuals with a stake in this process. Mr. Devine said the Districts agree with Mr. Shelton in that input should be considered from all stakeholders, and not only the resources agencies.

Mr. Larry Byrd (MID Director and local rancher) asked Mr. Wooster if the NMFS study had found anything indicating that steelhead are in the upper Tuolumne River. Mr. Wooster replied that the sampling had only been conducted in the upper watershed, meaning above Don Pedro Dam, and that the question about steelhead was not really part of the genetics study. The study analysis will show if the samples have markers that point to migratory behavior; however, the samples have not yet been analyzed. Mr. Wooster added that the study is not testing for anadromy versus non-anadromy. Fish would have to be killed to test for this. Because the study is only looking at fish that do not have access to the ocean, it is already known that those fish are not steelhead.

Mr. Byrd said the presentations noted the importance of not spending time studying things that did not need to be studied. Mr. Byrd said it seems like studying spring-run Chinook or steelhead would be slowing down the process, and that it would make the most sense to focus the study on fall-run Chinook.

Mr. Shelton said that the question of whether spring-run Chinook and steelhead are in the Tuolumne River *now* is much different than the question of whether those species were in the system *historically*. It is important that nothing be done to keep them out of the river. Mr. Shelton said it is known that steelhead and spring-run Chinook are in the system and that as the San Joaquin River Restoration Program moves forward, the potential for a spring-run Chinook or a steelhead run will increase. If there continues to be no screen to the river, there will always be a chance for a run. Mr. Shelton said that the Tuolumne River may not necessarily have a viable population and fishery of steelhead or spring-run Chinook or fall-run Chinook, but that is what is trying to be achieved, and that will influence what type of fish passage facilities should be built. Those are the biological goals and objectives. Mr. Shelton reiterated that CDFW's position is that if there are fish in the system, those fish should be allowed to thrive. He does not want the Tuolumne River to be a population sink, where every fish that comes into the system dies. He did not think that is what the Districts are trying to say. Mr. Shelton asked if resources should be put into the populations that are viable on their own. Or, perhaps resources should be focused on achieving a fishery that produces a lot of juveniles. Or, efforts should only be focused during the good water years, and the bad water years would be written-off and instead a conservation hatchery would be utilized. There are many decisions to be made and the decisions are very complex. Getting back to the reintroduction decision-making framework, Mr. Shelton said a lot of those issues are simply not just "yes" or "no" answers. There is a lot of nuance to them. Although fish may not be present this year, fish may be present in future years. Mr. Shelton said that he is a fisheries biologist, and as a fisheries biologist he would not want to make any decisions based on just one year of studies which occurred during a prolonged drought. That would not be a good time to make a decision.

Mr. Byrd asked if there is scientific proof that salmon existed historically in the reach above Don Pedro Dam. Mr. Drekmeier replied that yes, there is evidence that salmon existed there. Mr. Drekmeier said he will provide some articles from when Wheaton Dam was built. The articles say that when Wheaton Dam was constructed, individuals in the area were concerned that the salmon migration would be cut-off. A lawsuit was filed regarding this concern. Mr. Devine requested that Mr. Drekmeier send the articles to him also, so that they can be sent out to the whole group. Mr. Drekemeir said he will do that. Mr. Drekmeier noted the presence in the Workshop of Dr. Yoshiyama of UC Davis, the recognized expert on historical fish runs and asked if there were actual scientific documentation of anadromous fish in the upper Tuolumne River. Dr. Yoshiyama indicated there was no documentation of spring-run Chinook or steelhead in the upper river.

Mr. John Buckley (Central Sierra Environmental Resource Center) said that it was apparent there are many complex questions to be answered by many people. Some of those in attendance today are more informed than others. It may make sense for those with the greatest amount of expertise to take the first shot at answering these questions raised by the decision-making framework. The resource agencies may want to develop the first draft of biological goals and objectives. What would be a realistic timeframe for the resource agencies to provide answers to some of these questions? Individuals do not necessarily need to limit answers to just one answer – instead, it may make sense to provide two or three alternative answers for the group to consider, with the understanding that different answers would result in different outcomes and costs. Without knowing the desired goals and objectives from the outset, participants will be trying to develop answers to unclear questions.

Mr. Devine said the Districts agree with that. The Districts suggest a timeline of four or possibly six weeks to submit initial comments on TM No. 1, the draft reintroduction decision-making framework, and biological goals and objectives. With respect to more Workshops, Mr. Devine said that Districts will have as many Workshops as it takes to work through these discussions.

Referring to the reintroduction decision-making framework, Mr. Shelton said that he believes many of the questions in the framework amount to judgment calls. Many do not have clear “yes” or “no” answers. It is not realistic that a “no” for some of the questions will end the process outright. Mr. Shelton said that if participants are going to have a collaborative process, it may be that there are clear “no” answers but that participants continue to move forward in the process. Mr. Shelton said he doubted that people here want to rewrite the decision framework. What is more important is how this process can move forward but not be bound to such strict consequences for “no” answers.

Mr. Byrd said he can assure the group that the Districts want to work collaboratively. The Districts would like to see a salmon run in the lower Tuolumne River. Mr. Bryd said that speaking for himself, he does not want to end up with a fish passage facility or a reintroduction that is not successful. Mr. Byrd said he thinks that a fish ladder at the La Grange Diversion Dam is probably infeasible. He noted that his property borders seven miles of the Tuolumne River and that when the fish arrive, they are in very poor condition. In Mr. Byrd’s opinion, there is no ladder in the world that will help. Mr. Byrd said that he would like to echo Mr. Moreno and note that he too is worried that those who cannot afford to pay would be the ones to shoulder the cost of fish passage. Mr. Byrd said that he would be approaching the decision of fish passage differently if it was known that fish passage would be effective on the Tuolumne River and would make a large difference in the fish populations. However, Mr. Bryd said he did not see fish passage resulting in that kind of success. Mr. Byrd added that he looked forward to receiving the information promised here today.

Mr. Drekemeier said he appreciated the presentations made today and asked if the presentations would be made available. Mr. Devine replied that the presentations are available as of this morning on the La Grange Project Licensing Website (presentations are available online here).

Mr. Devine asked NMFS for a schedule for initial comments on the information shared today. Mr. Wooster asked whether Mr. Devine meant comments on the design criteria presented in Mr. Garello’s presentation or on the overarching reintroduction decision-making framework. Mr. Devine replied that the

Districts would like to receive comments on the information Mr. Garello had listed in his presentation and that getting that information could serve as a starting place. That information is a subset of the information identified in the overarching framework. However, the Districts think it is important to work through all limbs of the reintroduction decision-making framework, as they will all have an impact on the decision process.

Mr. Shutes asked when will the Districts be moving down those paths and if the process will align with the FERC timeline. Mr. Devine replied that the first question is can consensus be reached on using this process. Once participants provide comments on the process, the group can meet to discuss the information needed and the information that is already available. From there a schedule can be prepared. Mr. Devine added that he believes that FERC wants a valid and realistic assessment of fish passage and its cost, and that FERC is also looking for good and reliable cost estimates not built on arbitrary assumptions. If there is a collective sense about what this group would like to accomplish, and those ideas were then presented to FERC with the explanation that the group would like to move through a process to support a fishway decisions and develop reliable information, Mr. Devine said he thought FERC could be approached and might be amenable to extending the schedule.

Mr. Shutes asked if Mr. Devine is envisioning a series of meetings with the whole group or if the technical issues would be broken out and covered in individual meetings. Mr. Devine responded that like similar forums, sub-groups may be appropriate for this process. However, that is up for discussion. Mr. Devine said he envisions a series of information-sharing meetings, where a schedule for producing information would be developed along with a description of the parties responsible for collecting the information.

Mr. Shutes said he thinks it will be helpful if there is a process to go along with the reintroduction decision-making framework. Mr. Shutes noted that he has participated in something similar on the Yuba River. Although that process took several years, Mr. Shutes said he thinks the process for this project could probably be done in less time. If that is the model Mr. Devine is thinking of, Mr. Shutes said it will be important to first gauge the level of interest because that type of process requires a significant time commitment from the participants. The process will also likely need financial resources. Mr. Shutes noted that although the conservation groups do not have a lot of financial resources to contribute, they do have staff time.

Mr. Shutes reiterated that it will be helpful to have a process to go along with the reintroduction decision-making framework. Mr. Devine responded that the Districts or another entity can prepare a first draft of the process. Mr. Wooster said that that seems like a reasonable first step. He said the Districts seem to be the main author and that the process can be built on what happened with the Yuba Salmon Forum. Mr. Wooster added that he agrees that the reintroduction decision-making framework needs a process to go along with it and that he is supportive of what the Districts are proposing.

Regarding what species Mr. Garello should consider in the engineering feasibility study, Mr. Shutes said he is not sure that fall-run Chinook would be an appropriate species to consider because historically, according to his understanding, that species has not been upstream. Mr. Shutes said that he does not know if that is something the agencies can go along with. Mr. Devine said that would make for a good discussion. Mr. Shutes said that the group may just have to make assumptions about species and that there may not be definitive decisions.

Mr. Devine summarized next steps. First, the Districts will put together an initial process with which to implement the reintroduction decision-making framework. He said the Districts will aim to get something out to the group two to three weeks before the next Workshop. Referring to the information gaps and questions included in Mr. Garello's presentation, Mr. Devine said the Districts would like to get feedback from the group on those. Mr. Devine said it would be perfectly fine if participants, upon reviewing some of those questions, decided that a decision cannot be made at this point in time. Mr. Devine asked if four weeks is enough time for individuals to provide feedback on Mr. Garello's information gaps.

Mr. Wooster noted that Mr. Le said earlier that if the details are not determined now, problems may occur later when estimating cost. Mr. Wooster said by nature, the engineering study is intended to be at a conceptual level, and NMFS' feedback would be conceptual as well. Consider peak run values as an example. In the Northwest, projects are sized to handle 10% of the run in any given day. Mr. Wooster said that that could constitute NMFS' feedback for Mr. Garello's study but that it would not be very precise. This group can discuss ways to estimate a potential run size, and the estimate can be bracketed, but it still may not be very precise. Mr. Wooster added that four weeks to provide feedback seems reasonable.

A meeting participant noted that the schedule in the presentation has January 16, 2016 for the next Workshop and asked if that is correct. Mr. Devine responded that the next Workshop date will hinge on when individuals can provide feedback. If feedback can be provided by October 19, it seems reasonable that the next Workshop could be held in early November. Ms. Willy asked if the Districts would accept feedback up until October 23, just in case there was a government shutdown. Mr. Devine said that comments due by October 23 would be acceptable.

Regarding the dates for the next Workshop, Mr. Devine said the workshop will likely be scheduled for early- or mid-November. He said the Districts will provide some dates following this meeting.

Mr. Devine thanked everyone for their comments and participation. He said the Districts will make available meeting notes from today.

Meeting adjourned.

ACTION ITEMS

1. Mr. Wooster will provide a written description of the NMFS genetics study.

2. Mr. Drekmeier will provide articles from when Wheaton Dam was built.

3. The Districts will prepare a first cut at a process for implementing the reintroduction decision framework.

4. By Friday, October 23, licensing participants will provide comments on TM No. 1, the reintroduction decision framework, and/or the information gaps identified for fish passage engineering study. This information may be found here on the La Grange Project Licensing website.

5. The Districts will provide some dates for the next Workshop. This Workshop will likely be scheduled for early- or mid-November.

6. The Districts will provide Workshop No. 2 meeting notes.

La Grange Hydroelectric Project Workshop No. 2

Meeting Notes

Attachment A

TID WATER & POWER
Serving Central California since 1887

MID Modesto Irrigation District
The Power to Grow

La Grange Hydroelectric Project
Fish Passage Assessment Workshop No. 2

Thursday, September 17, 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/jesse.deason/8DZ4VNVN

Workshop Objectives:

1. Discuss and receive feedback on the fish passage/reintroduction decision-making framework concept.
2. Review Technical Memorandum No. 1 and address information needs.
3. Confirm schedule/tasks, subsequent workshop date, and opportunities for collaboration.

TIME	TOPIC
9:00 am – 9:10 am	Introduction of Participants (All)
9:10 am – 9:30 am	Opening Statements (Districts) Brief review of Tuolumne River Anadromous Fish Passage Facilities Assessment Collaborative (Districts) Review agenda, workshop objectives, and action items from previous workshop (Districts)
9:30 am – 10:30 am	Overview of Conceptual Tuolumne River Fish Passage/Reintroduction Decision-Making Framework (All) a. Review and discuss fish passage/reintroduction decision-making framework b. Information needs, key resource considerations, linkages to design process c. Available data, data gaps, and potential data sources related to fish passage/reintroduction decision-making
10:30 am – 11:30 am	Fish Passage Facility Assessment - Technical Memorandum #1 (All) a. Key physical and biological design criteria b. Fish passage design and operations criteria c. Links between information needs and design concept d. Discussion of information needs and input from Licensing Participants
11:30 am – 12:00 pm	Tuolumne River Passage Assessment Schedule and Next Steps (All) a. Schedule: Opportunities for collaboration and incorporation of feedback b. Workshop No. 3 – confirm date and content

Modesto Irrigation District

La Grange Fish Passage Workshop No. 2

Thursday, September 17, 2015

9:00 a.m. – 12:00 p.m.

TID WATER & POWER

PLEASE SIGN IN

	Name	Organization	Telephone No.	E-mail	Time In	Time Out
1.	Paul Zeek	Asm. Kristin Olsen			8:45	10:00
2.	Mike Wade	CA Farm Water Coalition			8:47	
3.	John Buckley	CSERC			8:50	
4.	Chuck Hanson	Hanson Env.		nv.com	8:50	
5.	Josh Weimer	TID			8:50	
6.	Alison Willy	USFWS			8:51	
7.	Gretchen Murphey	CDFW		ca.gov	08:55	
8.	Tom Orvis	SCFB		.org		
9.	Peter Drekmeier	TRT			8:55	
10.	Ray Dias	N/A			8:58	
11.	Steve Rank	MOD CHAMP		.ccc		1100
12.	Brandi LaPorte	CWIA		l.com	8:55a	1100

Modesto Irrigation District

La Grange Fish Passage Workshop No. 2
Thursday, September 17, 2015
9:00 a.m. – 12:00 p.m.

TID WATER & POWER

PLEASE SIGN IN

	Name	Organization	Telephone No.	E-mail	Time In	Time Out
13.	[illegible]	FARMER			8:45	12:40
14.	Alfred A. Souza	YFC			8:46	
15.	Mario Moreno	LCR			mail.com	8.48 / 11:16
16.	DANA FERREIRA	REA DONHAM			8:45	
17.	Brandon McMillan	TID				
18.	Ron Yoshiyama	San Francisco			8:48	
19.	Daniel Richardson	Tuolumne County			8:50	
20.	Bill Ketscher	Farmer			9:00	
21.	John Shelton	DFW			9:00	
22.	William Sears	SFPUC			9	
23.	Leonard Van Elde	Yosemite Farm Credit				11:15
24.	Rob GRASSO	Yosemite Nat'l Park				

Modesto Irrigation District

La Grange Fish Passage
Workshop No. 2
Thursday, September 17, 2015
9:00 a.m. – 12:00 p.m.

WATER & POWER

PLEASE SIGN IN

	Name	Organization	Telephone No.	E-mail	Time In	Time Out
25.	Allen Zanker	local property owner	2		9am	12:40
26.	Ellen Levin	SF				
27.	Donn Furman	SF				
28.	Jonathan Kranz	SF				
29.	[illegible]	NMFS			9:15	1:00
30.	Tom Holley	"			9:15	1:00
31.	John Holland	Modesto Bee			9:30	
32.	Chris Shutes	CSPA			9:40	
33.	Pamela [illegible]	CWA			952	1109
34.	ART GODWIN	TID			11:15	
35.						
36.						

TURLOCK IRRIGATION DISTRICT | MODESTO IRRIGATION DISTRICT

La Grange Hydroelectric Project
FERC No. 14581

Fish Passage Assessment

Workshop No. 2

TURLOCK IRRIGATION DISTRICT | MODESTO IRRIGATION DISTRICT

La Grange Project

La Grange Diversion Dam

- La Grange Diversion Dam was constructed from 1891 to 1893
- The dam is owned jointly by Turlock Irrigation District and Modesto Irrigation District
- Purpose is to divert irrigation and municipal and industrial (M&I) water
- La Grange powerhouse was constructed in 1924. The powerhouse is owned by TID

Workshop No. 2 Background

- Request for studies: July 2014
- Districts' Revised Study Plan: December 2014
- FERC Determination: February 2015; study's geographic scope
- Dispute Resolution Determination: May 1, 2015
- Workshop No. 1: May 20, 2015

Workshop No. 1 Summary

- Introduction to fish passage and fish passage decision making process
- Discussed scope of fish passage facilities assessment as part of anadromous fish reintroduction decision
- Parties committed to collaborative decision-making process
- Discussed other related studies underway

TURLOCK IRRIGATION DISTRICT | MODESTO IRRIGATION DISTRICT

Action Items from Workshop No. 1

No.	Action Item	Status
1	NMFS will provide a written description of its Tuolumne River O. mykiss genetics study plan and methods.	Incomplete
2	The Districts will circulate to licensing participants potential dates for the next two Fish Passage Assessment workshops.	Partially complete
3	The Districts will provide a way for licensing participants to submit comments on the La Grange Licensing Website.	Complete
4	The Districts will post notes from Workshop No. 1 on the La Grange Licensing Website.	Complete
5	The Districts will make available a link to the NMFS fish passage documentary.	Complete
6	The Districts will circulate the design criteria document prior to the next Workshop.	Complete
7	NMFS will provide a copy of its presentation.	Complete

Workshop No. 2 Objectives

- Share and discuss potential fish passage/reintroduction framework
- Share and discuss TM No. 1
- Updates on related studies
- Confirm schedules and path forward to Workshop No. 3
- Other opportunities for collaboration

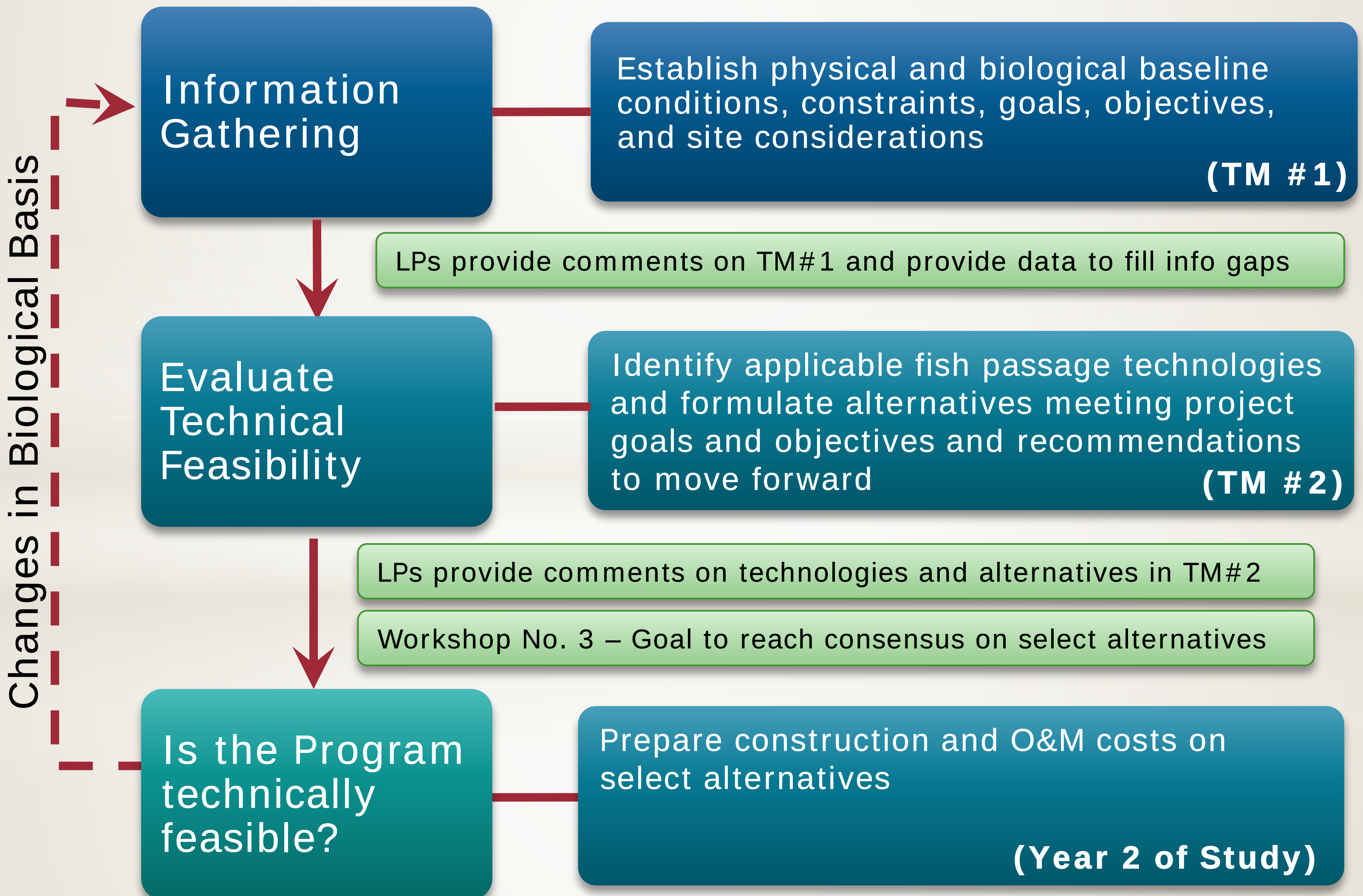
TURLOCK IRRIGATION DISTRICT | MODESTO IRRIGATION DISTRICT

La Grange Hydroelectric Project
FERC No. 14581

Fish Passage Facilities Alternatives Assessment
Workshop No. 2

September 17, 2015

TURLOCK IRRIGATION DISTRICT | MODESTO IRRIGATION DISTRICT



TURLOCK IRRIGATION DISTRICT | MODESTO IRRIGATION DISTRICT

Information Gathering

Physical Baseline Conditions

- Physical boundary of study area
- Basic physical characteristics of existing facilities
- Access to facilities and study area
- Existing facility operations
- River flow into Don Pedro Reservoir
- River flow in the Lower Tuolumne River
- Reservoir fluctuation
- Other beneficial uses (e.g., recreation)

Biological Design Basis

- Target species and life stages requiring passage
- Migration timing
- Population abundance and peak rate of migration
- Colonization method

Operational Requirements

- Performance expectations

TURLOCK IRRIGATION DISTRICT | MODESTO IRRIGATION DISTRICT

Tuolumne River Fish Passage Facility Alternatives Assessment

Engineering and Biological Linkages

Why are biological linkages important to the engineering and economic feasibility?

Facility type, size, location, configuration, and operational requirements

Biological Design Considerations

- Target species and life stages requiring passage
- Migration timing
- Population abundance and peak rate of migration
- Colonization method

Operational Requirements

- Performance expectations

Example: Influence Of Population Size And Peak Run On Fish Transport

Multiple species
Multiple release locations
Thousands of fish per day

Single species
Single release location
Under 100 fish per year

Example: Influence Of Population Size And Peak Run On Fish Collection

Multiple species
Thousands of fish per day

Single species
Under 100 fish per year

Example: Influence Of Population Size And Peak Run On Downstream Passage Facility Configuration

Holding capacity = 76,000 smolt
Pumping capacity = 1,000 cfs
Performance criteria = 75%
$60M – 70’ x 120’ barge

Holding capacity = 200 smolt
Pumping capacity = 100 cfs
Performance criteria = R&D
$10M – 40’ x 60’ barge

TURLOCK IRRIGATION DISTRICT | MODESTO IRRIGATION DISTRICT

Biological Design Considerations For The Tuolumne River

- Target species
- Life stages requiring passage
- Migration timing
- Population abundance
- Peak rate of migration
- Colonization method
- Operational performance criteria

Target Species And Life Stages For Consideration

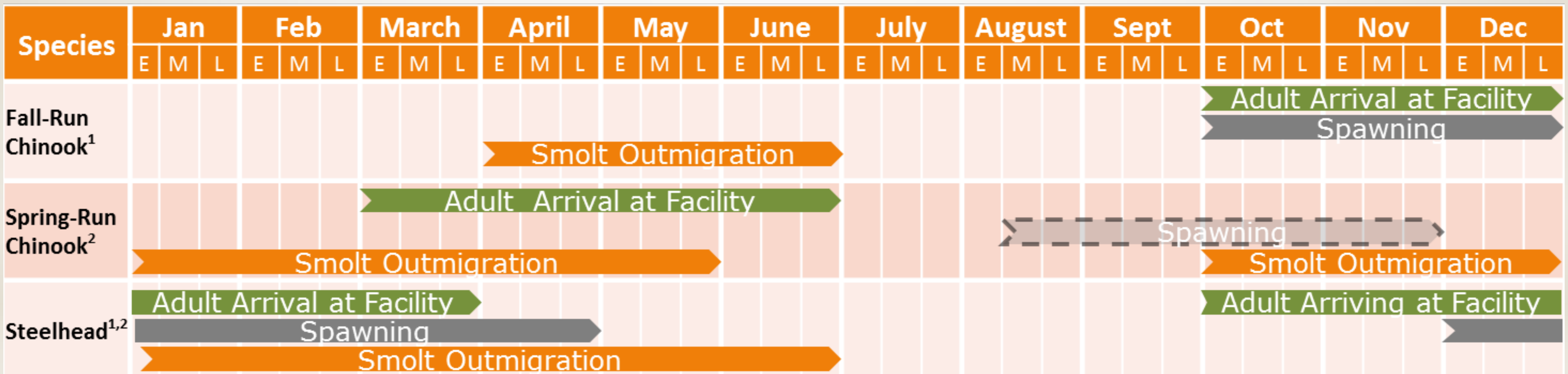
- Fall-run Chinook present in lower river.
- Spring-run Chinook not currently present.
- Steelhead population not currently present.

Target Fish Species	Life Stage
Fall-run Chinook Salmon	Upstream Adults Downstream Smolts and/or Fry
Spring-run Chinook Salmon	Upstream Adults Downstream Smolts and/or Fry
Steelhead	Upstream Adults Downstream Kelts, Smolts and/or Fry

- All three species require reintroduction to the Upper Tuolumne River.

TURLOCK IRRIGATION DISTRICT | MODESTO IRRIGATION DISTRICT

Initial Estimate Of Migration Timing For The Tuolumne River



[1](TID/MID, 2013)
[2](NMFS, 2014 Central Valley salmonid recovery plan)

Requires confirmation from licensing participants.

Population Abundance And Peak Rate Of Migration In The Tuolumne River

- Current estimates of population abundance and peak rate of migration do not exist on the Upper Tuolumne River.
- The current method of colonization is unknown.
- Operational performance criteria is unknown.
- Typically provided as a biological basis of design.
- **Input needed from licensing participants.**

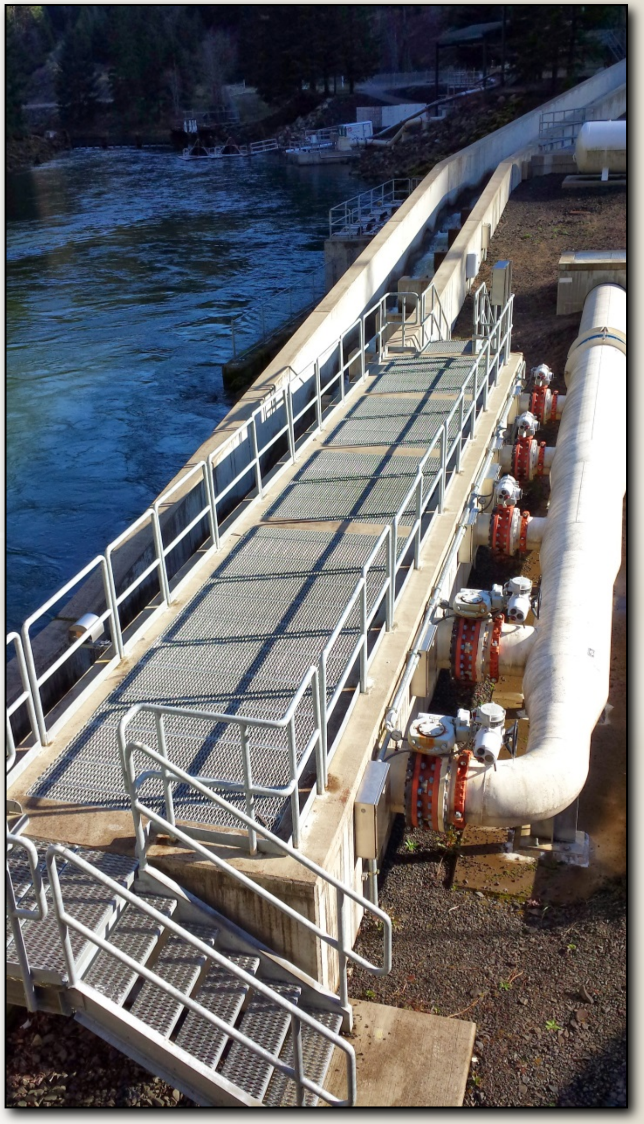
Turlock Irrigation District | Modesto Irrigation District

Physical Basis of Design

- River flow into Don Pedro Reservoir
- River flow in the Lower Tuolumne River
- Reservoir fluctuation

Example: Influence of Design Flows on Fish Passage Facility Size and Configuration

- Guidance structures and attraction flows are necessary to facilitate movement of fish into passage facilities
- For design of ladders, NMFS guidelines suggests that attraction flow should be 10% of the total river flow
- Conceptually, flows in fish ladders could range from 5 to 50 cfs
- With streamflow of 5,000 cfs, attraction flow out of a ladder may be 500 cfs
- Auxillary water systems required to meet attraction flow requirements



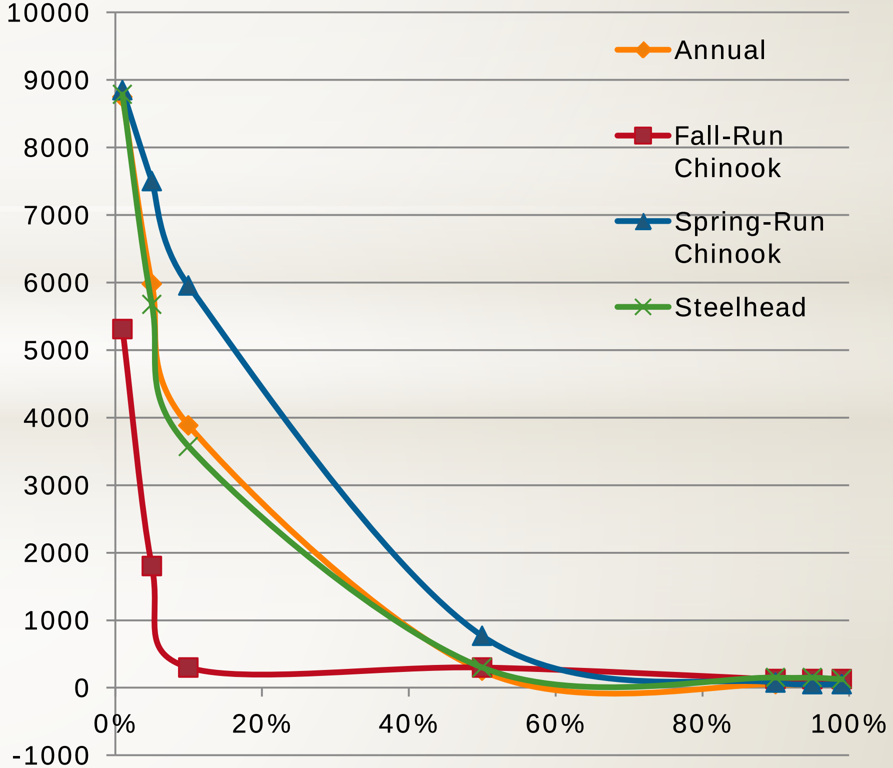
How are fish passage design flows established?

- Examination of historical daily flow information
- High Design Flow = Mean daily average streamflow that is exceeded 5% of the time when target fish species is anticipated to be present
- Low Design Flow = Mean daily average streamflow that is exceeded 95% of the time when target fish species is anticipated to be present

Estimates Of Fish Passage Design Flows In The Lower Tuolumne River

Approximately 50 – 7,500 cfs

Percent of Time Exceeded	Base Case Tuolumne River Flows in the Lower Tuolumne River (cfs)			
	Annual	Arriving Fall-Run Chinook	Arriving Spring-Run Chinook	Arriving Steelhead
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

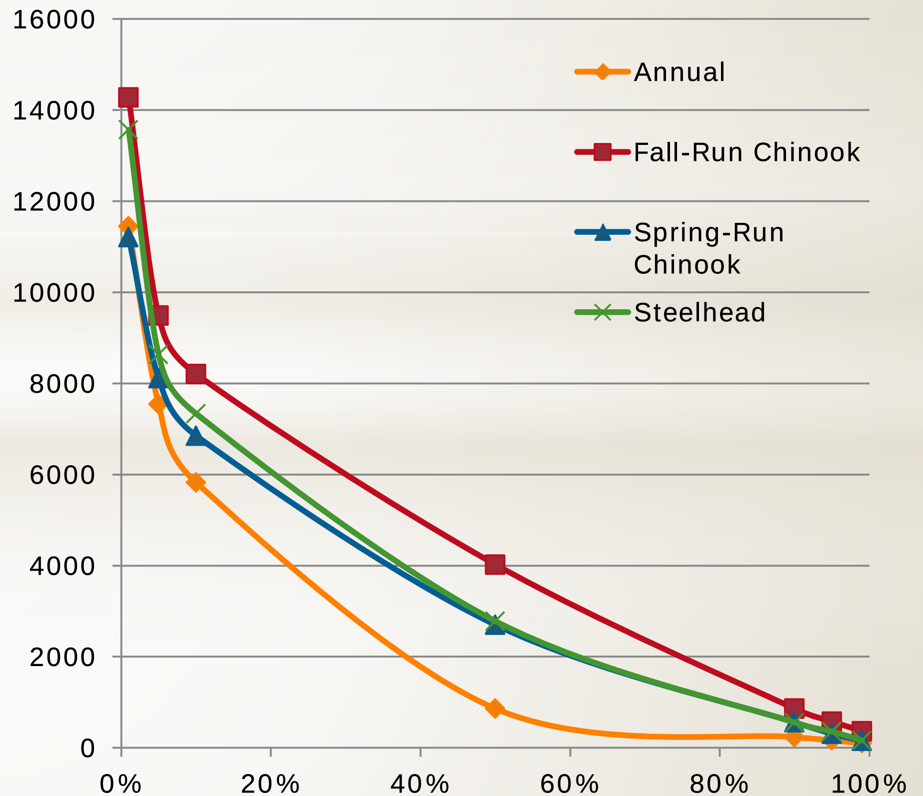


TURLOCK IRRIGATION DISTRICT | MODESTO IRRIGATION DISTRICT

Estimates of Fish Passage Design Flows into Don Pedro Reservoir

Approximately 310 – 9,500 cfs

Percent of Time Exceeded	Base Case Tuolumne River Flows into Don Pedro Reservoir (cfs)			
	Annua l	Outmigratio n Fall-Run Chinook	Outmigration Spring-Run Chinook	Outmigration Steelhead
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%	11,44 9	14,277	11,210	13,568



Example: Influence of Reservoir Fluctuation on Fish Passage Facility Size and Configuration

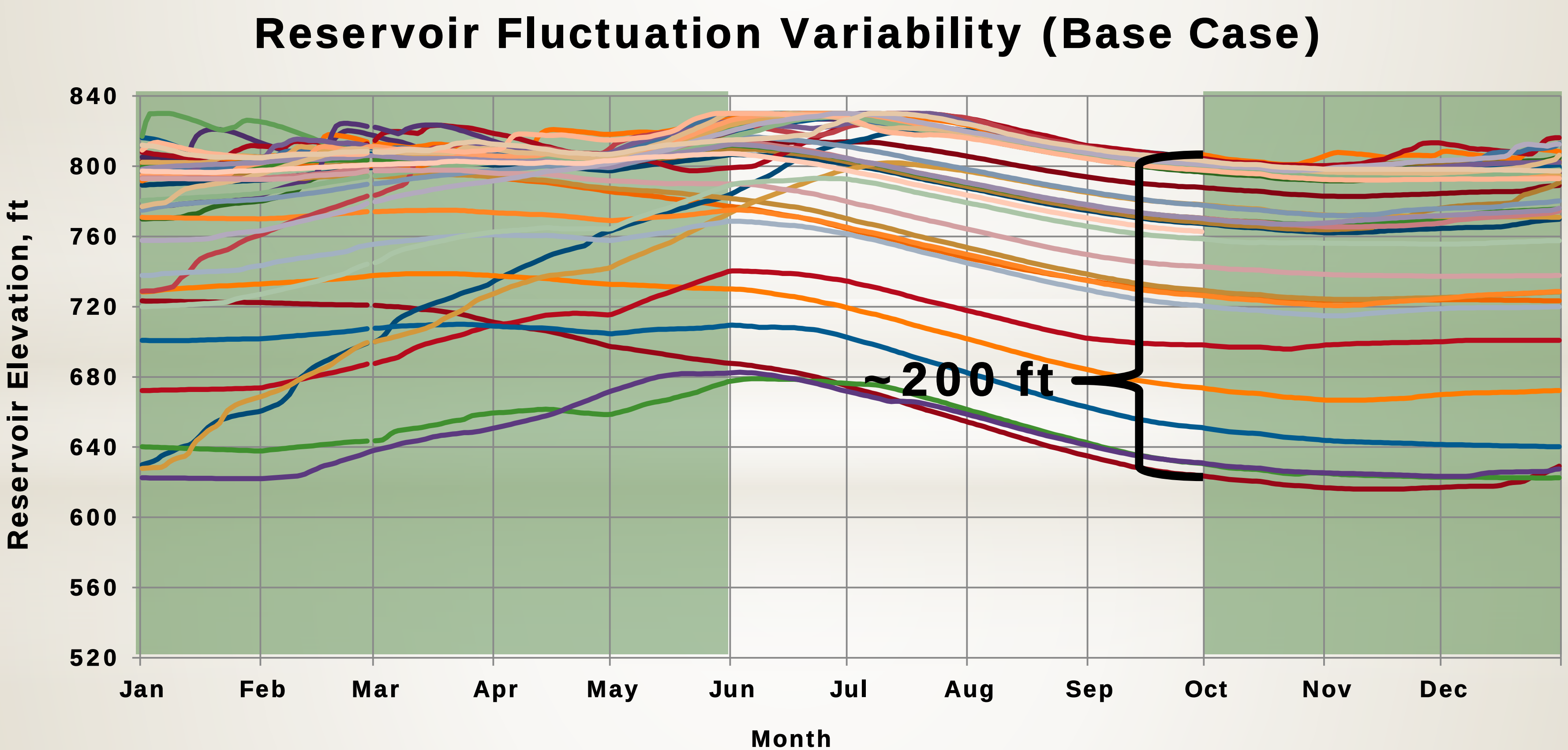
Swift FSC, Lewis River, WA
~100 ft reservoir fluctuation
$60M


Source: PacificCorps

Example: Influence of Reservoir Fluctuation on Fish Passage Facility Size and Configuration

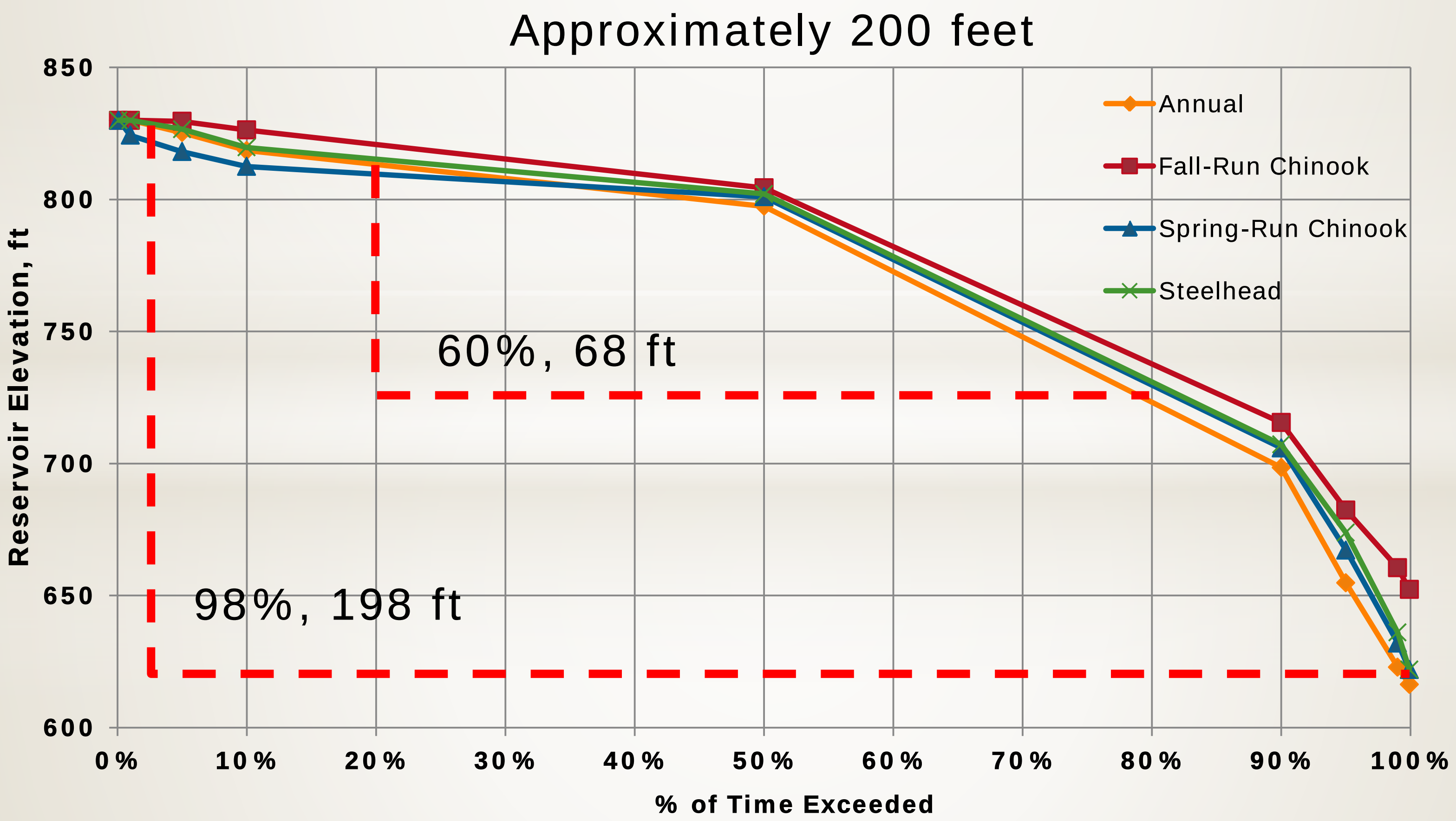
Fixed Collector, Clackamas River, OR
~10 ft reservoir fluctuation
$12M

TURLOCK IRRIGATION DISTRICT | MODESTO IRRIGATION DISTRICT



TURLOCK IRRIGATION DISTRICT | MODESTO IRRIGATION DISTRICT

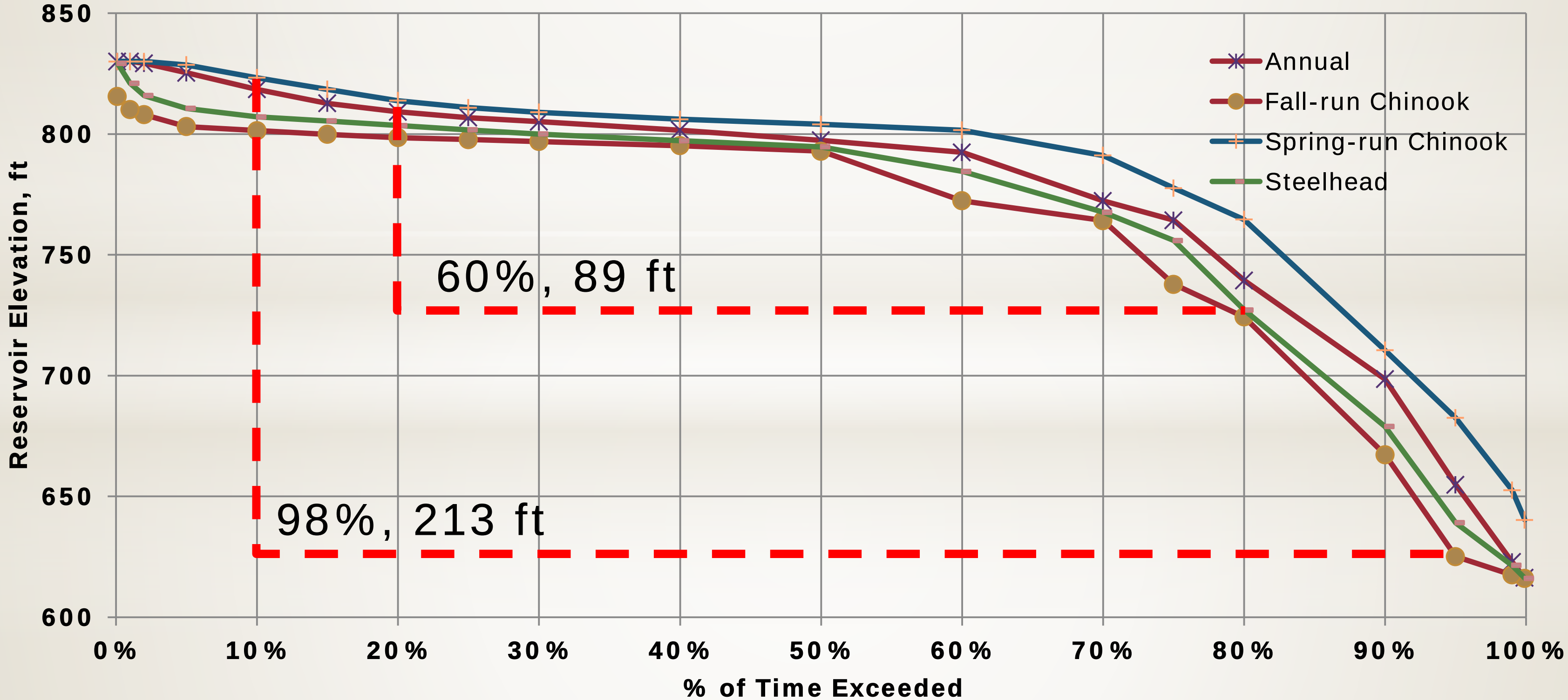
Estimates Of Don Pedro Reservoir Fluctuation When Fish Would Be Migrating Downstream



TURLOCK IRRIGATION DISTRICT | MODESTO IRRIGATION DISTRICT

Estimates Of Don Pedro Reservoir Fluctuation When Fish Would Be Migrating Upstream

Approximately 230 feet



Initial Findings

- Downstream fish passage facilities
  - Operational period October through June
  - Reservoir fluctuations of approximately 200 ft
  - River flows ranging from 310 to 9,500 cfs
- Upstream fish passage facilities
  - Operational period October through June
  - Reservoir fluctuations of approximately 230 ft (pertaining only to fish ladders)
  - River flows ranging from 50 to 7,500 cfs
- **Input needed on biological design basis to confirm initial findings.**

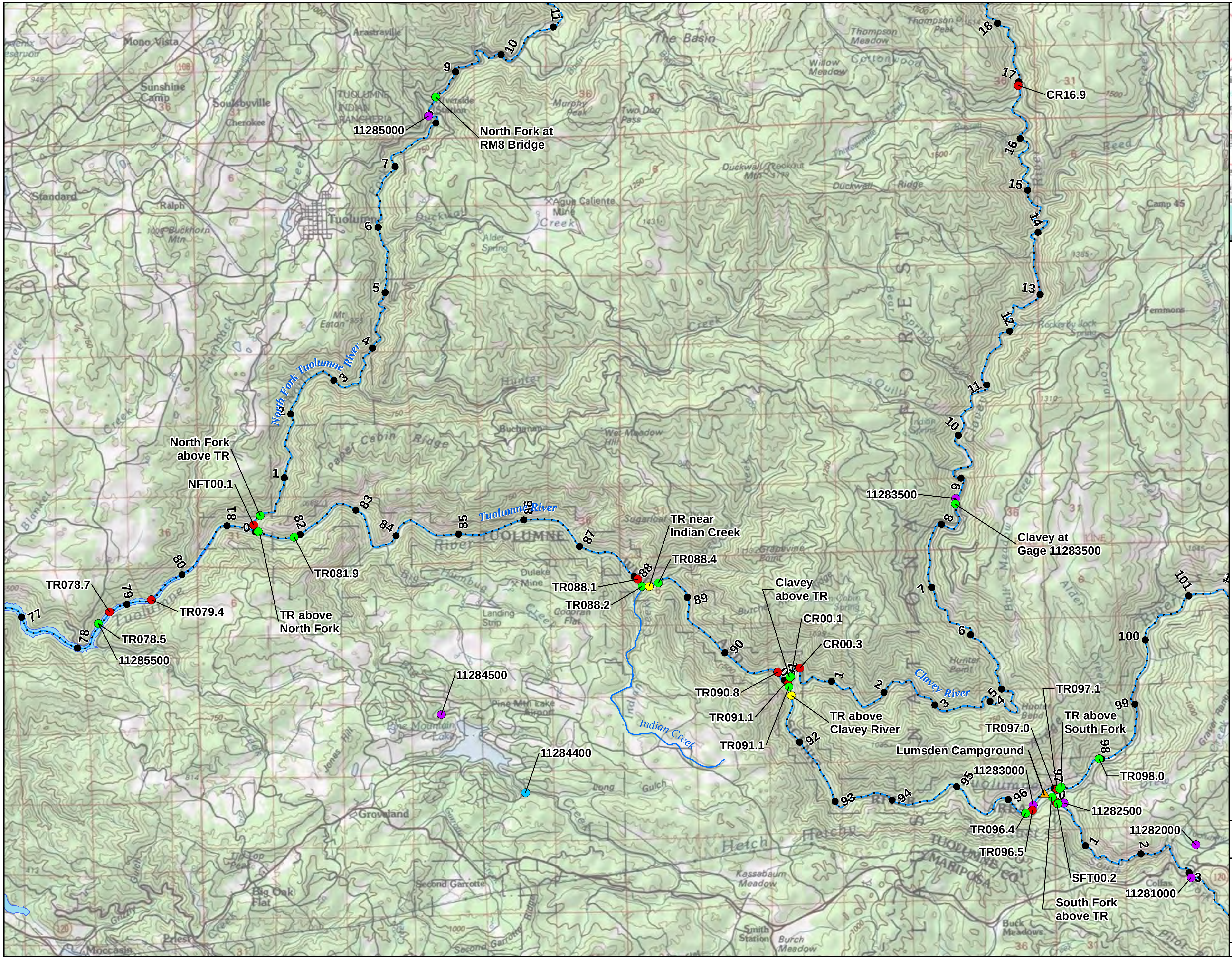
Data Gaps And Information Needs

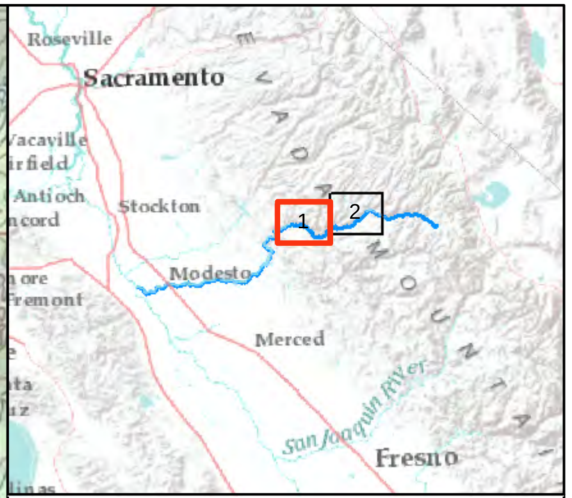
- **Input needed from licensing participants:**
  - Confirmation of target species
  - Life stages to be passed
  - Migration timing
  - Population size
  - Peak run values
  - Colonization method
  - Operational performance criteria

Process Feedback

Meeting / Deliverable	Schedule
Consultation Workshop No. 1	May 20, 2015
Interim Work Product – TM No. 1	September 4, 2015
Consultation Workshop No. 2	September 17, 2015
Feedback and Comments Due on Decision Framework and TM No. 1	*October 19, 2015 (??)*
Final TM No. 1 and Decision Framework Distributed	*December 1, 2015 (??)*
Draft TM No. 2 Distributed	*December 16, 2015 (??)*
Consultation Workshop No. 3	*January 14, 2015 (??)*
Initial Study Report document	February 2, 2016


Google earth





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.

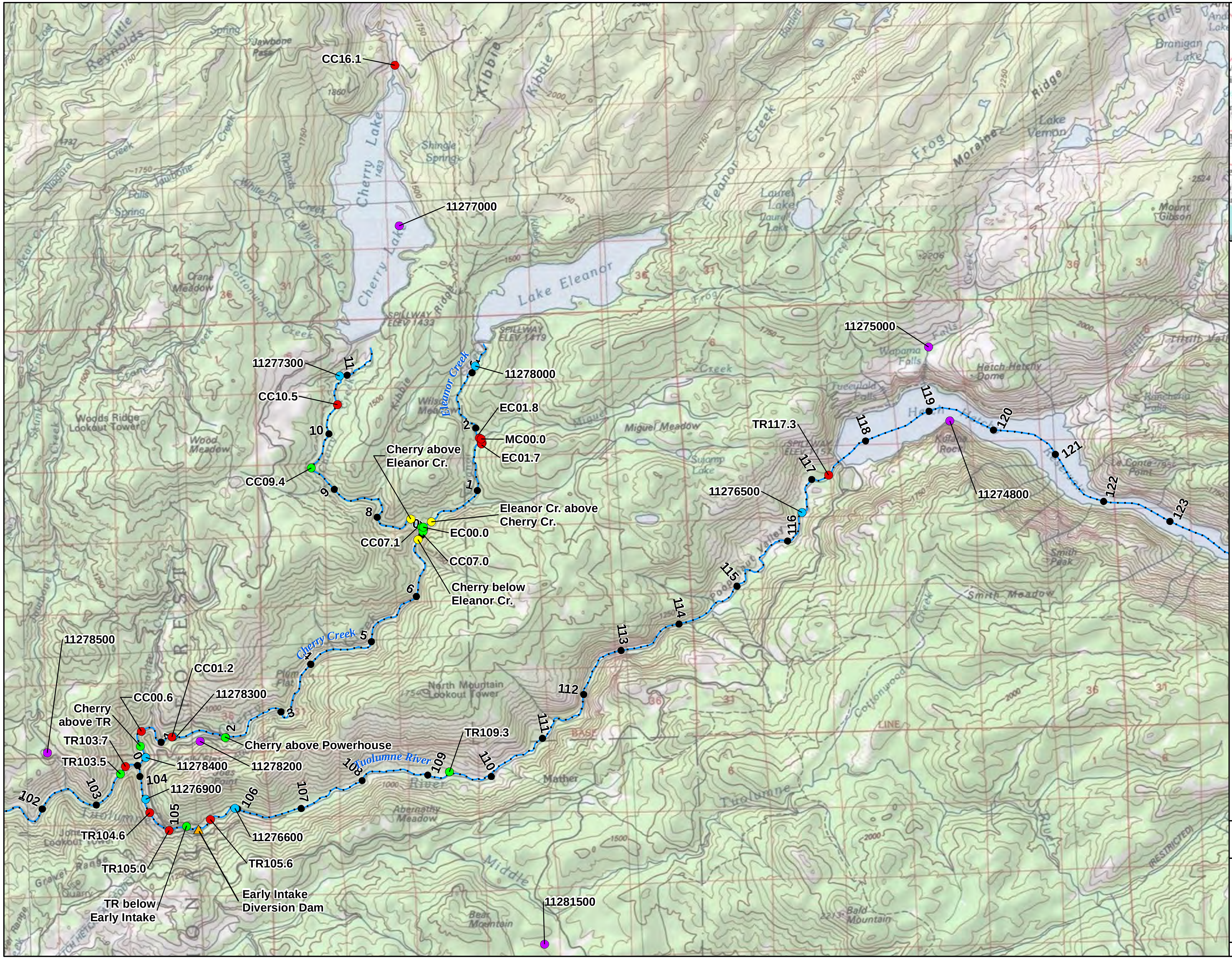
0 0.5 1 2 Miles

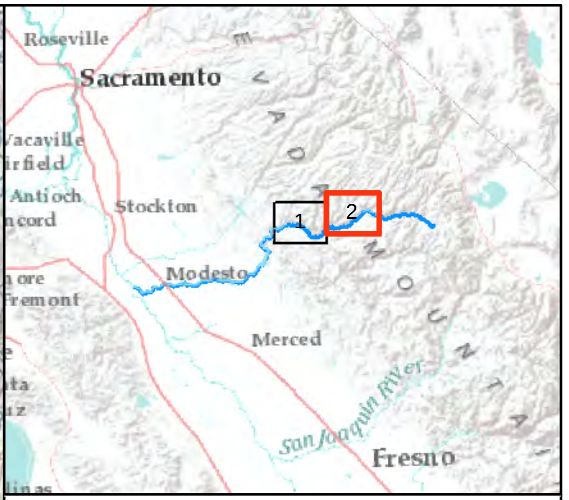
N

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

Sources: Esri, DeLorme, USGS, NPS
Sources: Esri, USGS, NOAA
Data is CA SPCS, Zone III, ft.





Stream / Flow Gage

Active Inactive

Label	Agency	Active	Site Name
11274800	USGS	Inactive	TUOLUMNE R AT HETCH HETCHY NR SEQUOIA CA
11275000	USGS	Inactive	FALLS C NR HETCH HETCHY CA
11275500	USGS	Active	HETCH HETCHY RES A HETCH HETCHY CA
11276500	USGS	Active	TUOLUMNE R NR HETCH HETCHY CA
11276600	USGS	Active	TUOLUMNE R AB EARLY INTAKE NR MATHER CA
11276900	USGS	Active	TUOLUMNE R BL EARLY INTAKE NR MATHER CA
11277000	USGS	Inactive	CHERRY C NR HETCH HETCHY CA
11277200	USGS	Active	CHERRY LK NR HETCH HETCHY CA
11277300	USGS	Active	CHERRY C BL VALLEY DAM NR HETCH HETCHY CA
11277500	USGS	Active	LK ELEANOR NR HETCH HETCHY CA
11278000	USGS	Active	ELEANOR C NR HETCH HETCHY CA
11278200	USGS	Inactive	CHERRY C CN NR EARLY INTAKE CA
11278300	USGS	Active	CHERRY C NR EARLY INTAKE CA
11278400	USGS	Active	CHERRY C BL DION R HOLM PH, NR MATHER CA
11278500	USGS	Inactive	JAWBONE C NR TUOLUMNE CA
11281500	USGS	Inactive	M TUOLUMNE R NR MATHER CA

Water Temperature Logger

Active Inactive Proposed*

Label	Agency	Active	Site Locations
CC00.6	TID/MID	YES	Cherry above TR
CC00.6	CDFG	NO	Cherry Creek Power House
CC01.2	CCSF	NO	Cherry Creek, upstream of Dion Holm Powerhouse
CC07.0	CCSF	YES	Cherry Creek, downstream of confluence with Eleanor Creek
CC07.1	CCSF	YES	Cherry Creek, upstream of Eleanor Creek confluence
CC09.4	CCSF	YES	Cherry Creek, downstream of Cherry Dam
CC01.2	TID/MID	YES	Cherry above Powerhouse
CC10.5	CCSF	NO	Cherry Creek, downstream of Cherry Dam
CC16.1	CCSF	NO	Upstream of Cherry Lake
EC00.0	CCSF	YES	Eleanor Creek, upstream of Cherry Creek confluence
EC01.7	CCSF	NO	Eleanor Creek, downstream of Miguel Creek confluence
EC01.7	CCSF	NO	Eleanor Creek, downstream of Miguel Creek confluence
EC01.7	CCSF	NO	Eleanor Creek, downstream of Miguel Creek confluence
EC01.8	CCSF	NO	Eleanor Creek, upstream of Miguel Creek confluence
MC00.0	CCSF	NO	Miguel Creek, upstream of Eleanor Creek confluence
TR103.5	CCSF	YES	Tuolumne River, downstream of Cherry Creek confluence
TR103.7	CCSF	NO	Tuolumne River, downstream of Cherry Creek confluence
TR104.6	CCSF	NO	Tuolumne River, downstream of Early Intake Diversion Dam
TR105.0	CDFG	NO	Tuolumne River at Early Intake
TR105.2	TID/MID	YES	TR below Early Intake
TR105.6	CCSF	NO	Tailrace of Kirkwood Powerhouse
TR109.3	CCSF	YES	Tuolumne River, downstream of Preston Falls
TR117.3	CCSF	NO	Tuolumne River, downstream of O'Shaughnessy Dam

* Proposed logger locations will be added to table
when exact coordinates are known.

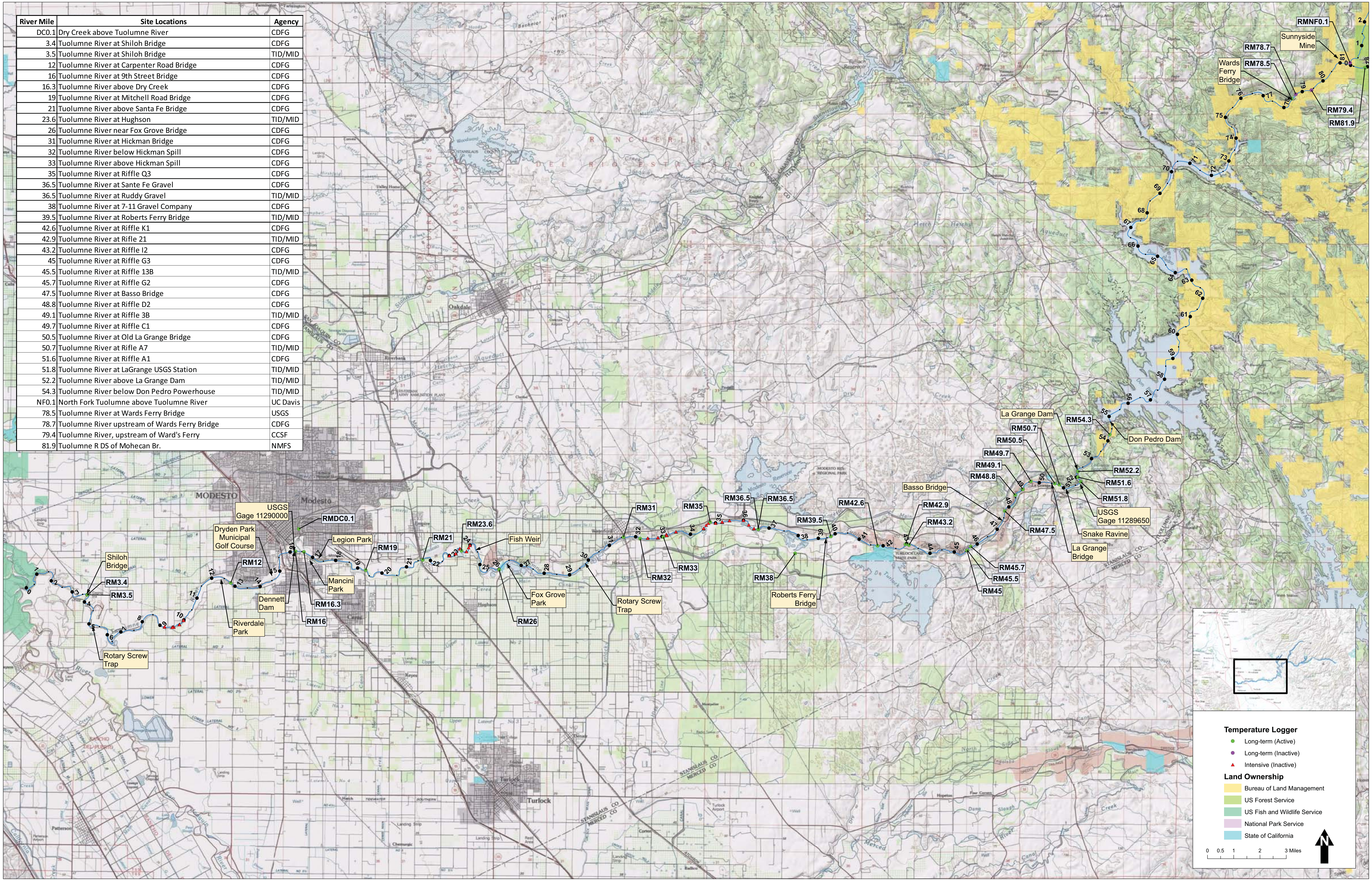
0 0.5 1 2 Miles

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

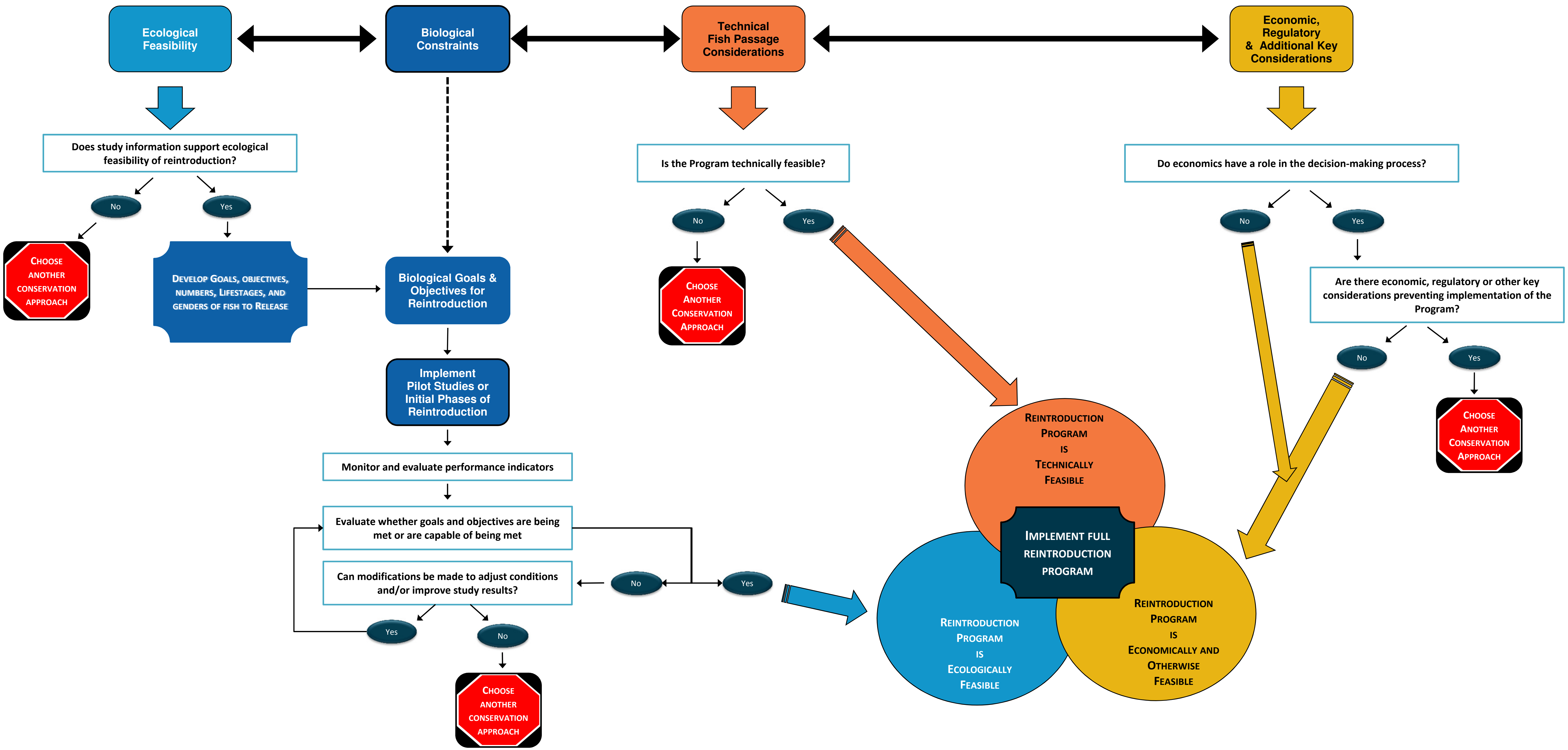
Sources: Esri, DeLorme, USGS, NPS
Sources: Esri, USGS, NOAA
Data is CA SPCS, Zone III, ft.



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

Reintroduction Decision Criteria

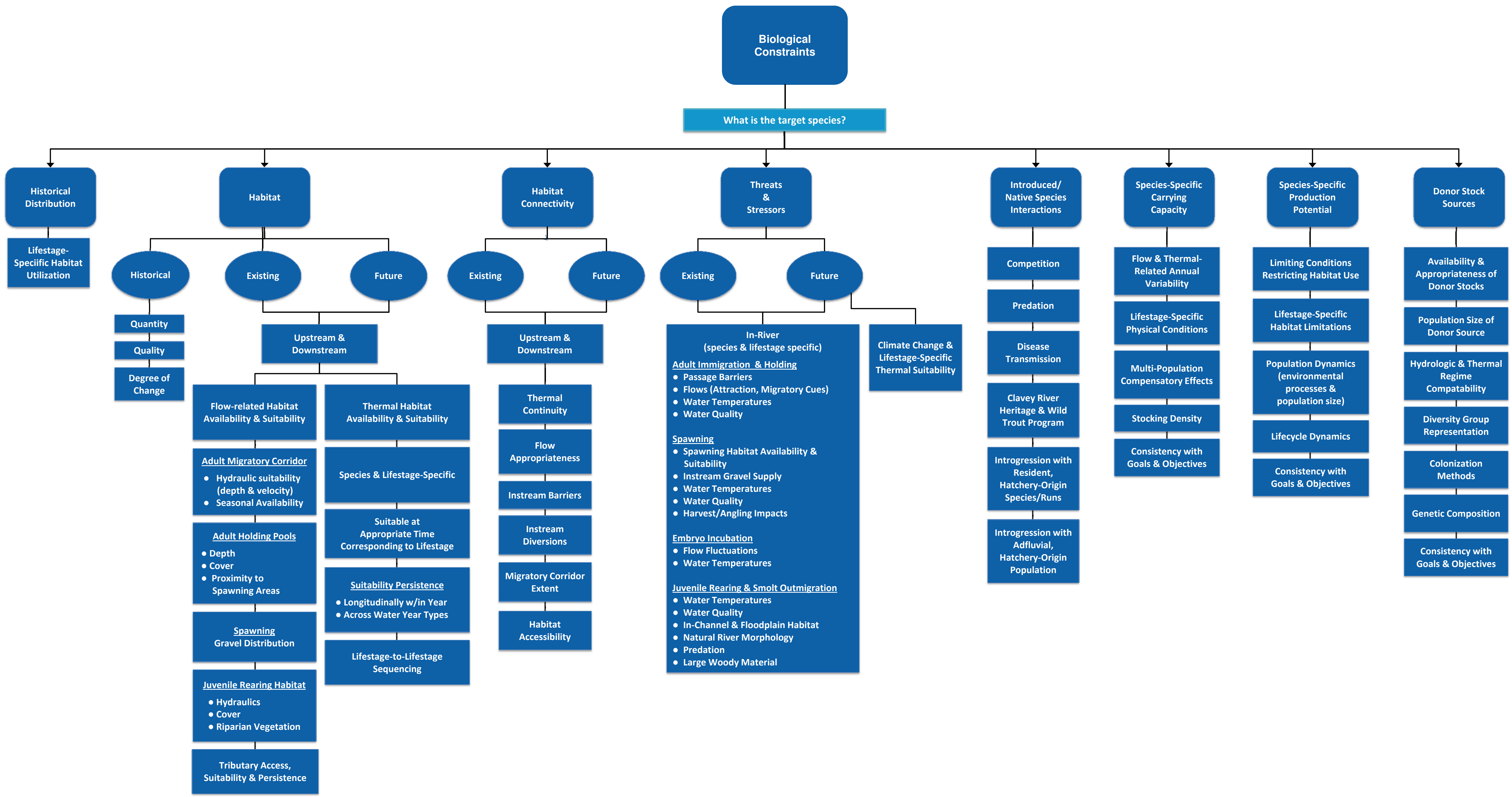
Decision Tree Overview



La Grange Hydroelectric Project
Fish Passage Alternatives Assessment
Workshop No. 2 – September 17, 2015

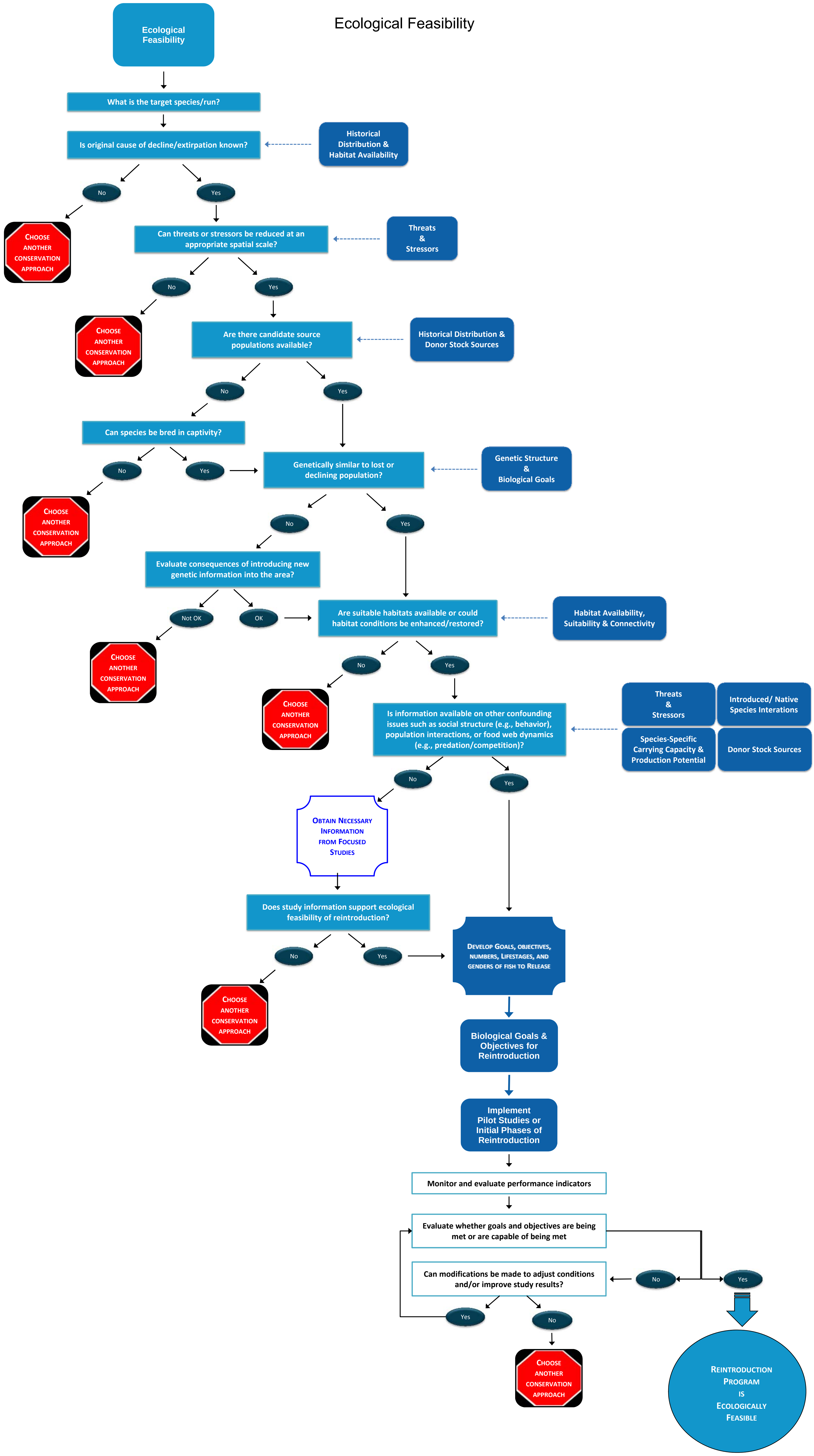
Reintroduction Decision Criteria

Biological Constraints



Reintroduction Decision Criteria

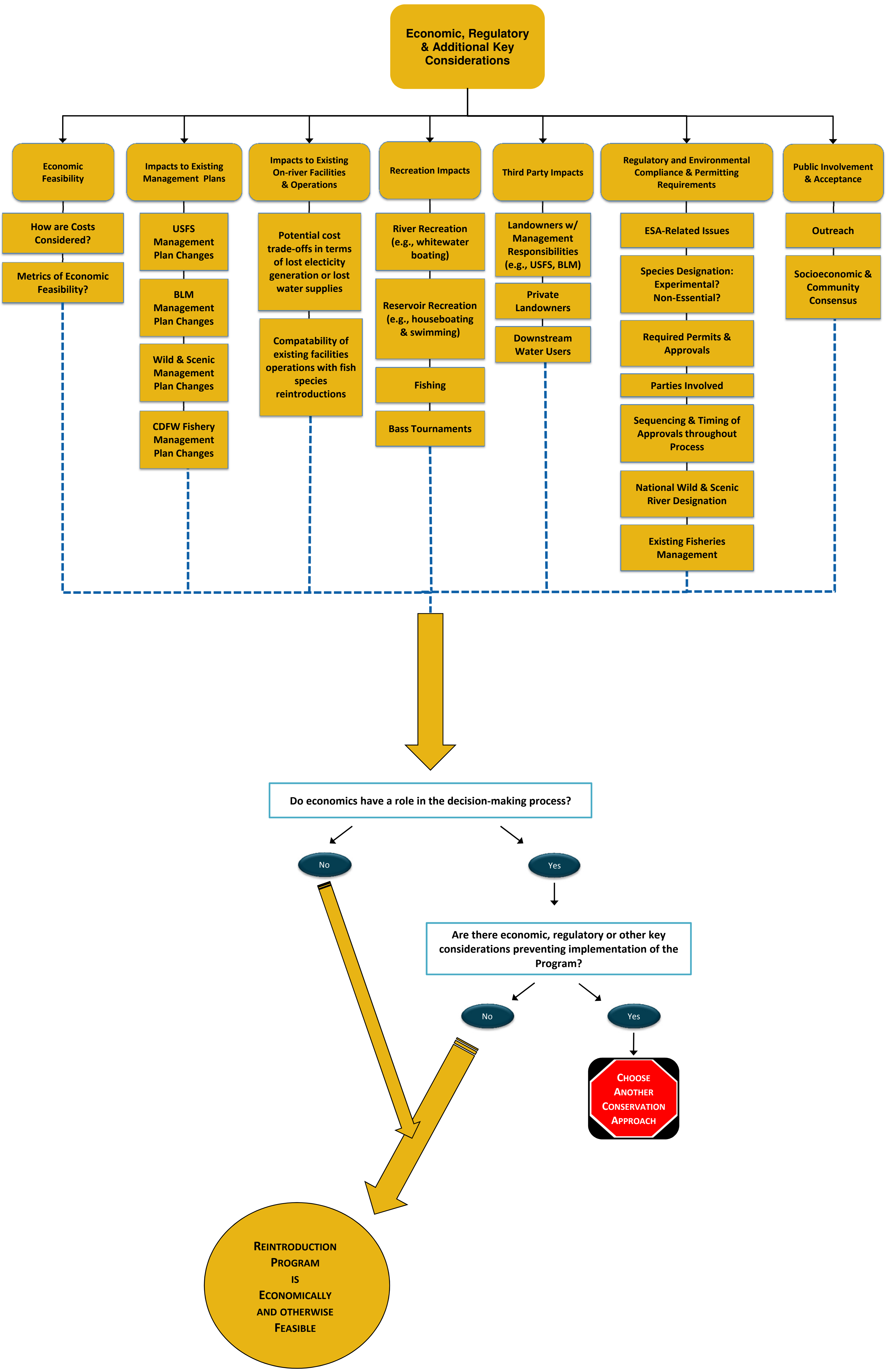
Ecological Feasibility



La Grange Hydroelectric Project
Fish Passage Alternatives Assessment
Workshop No. 2 – September 17, 2015

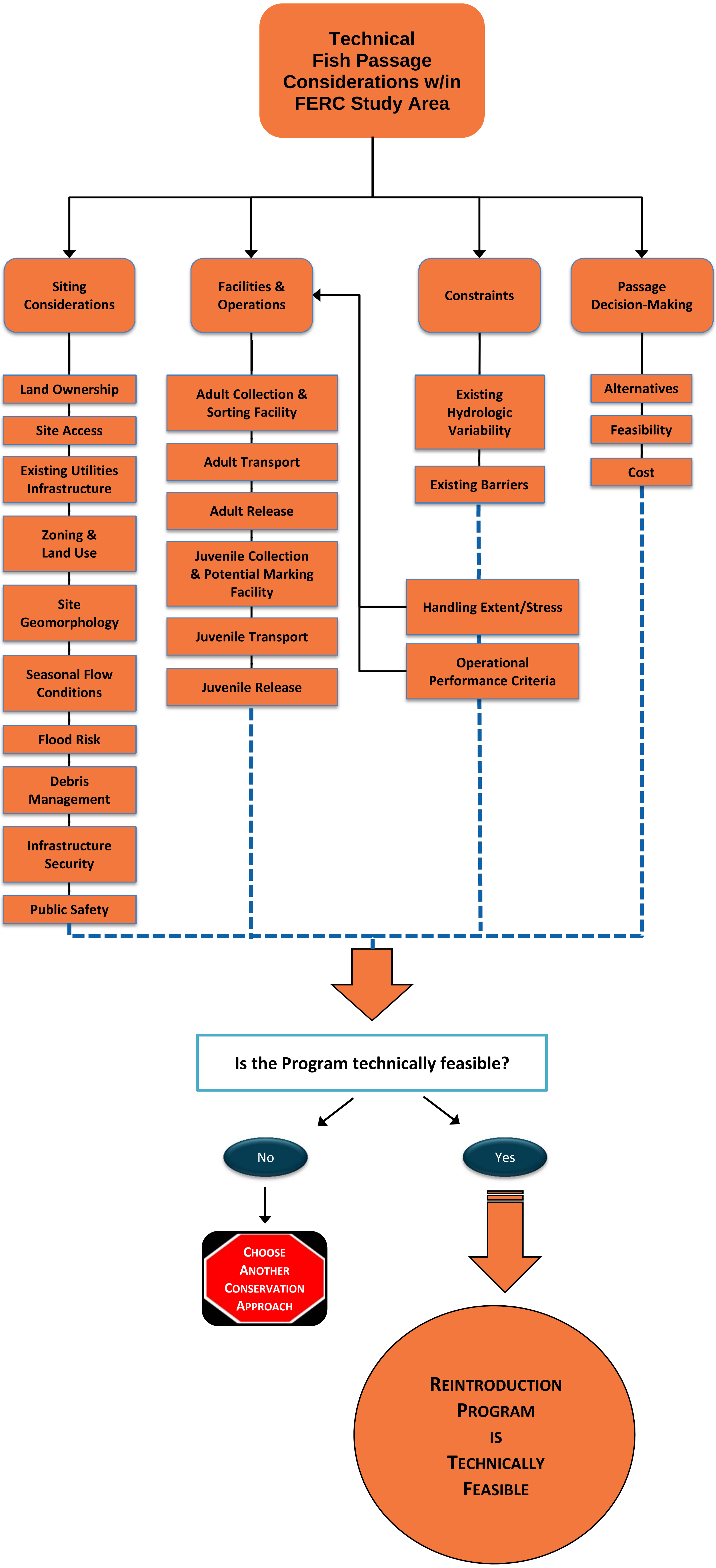
Reintroduction Decision Criteria

Economic, Regulatory & Other Considerations



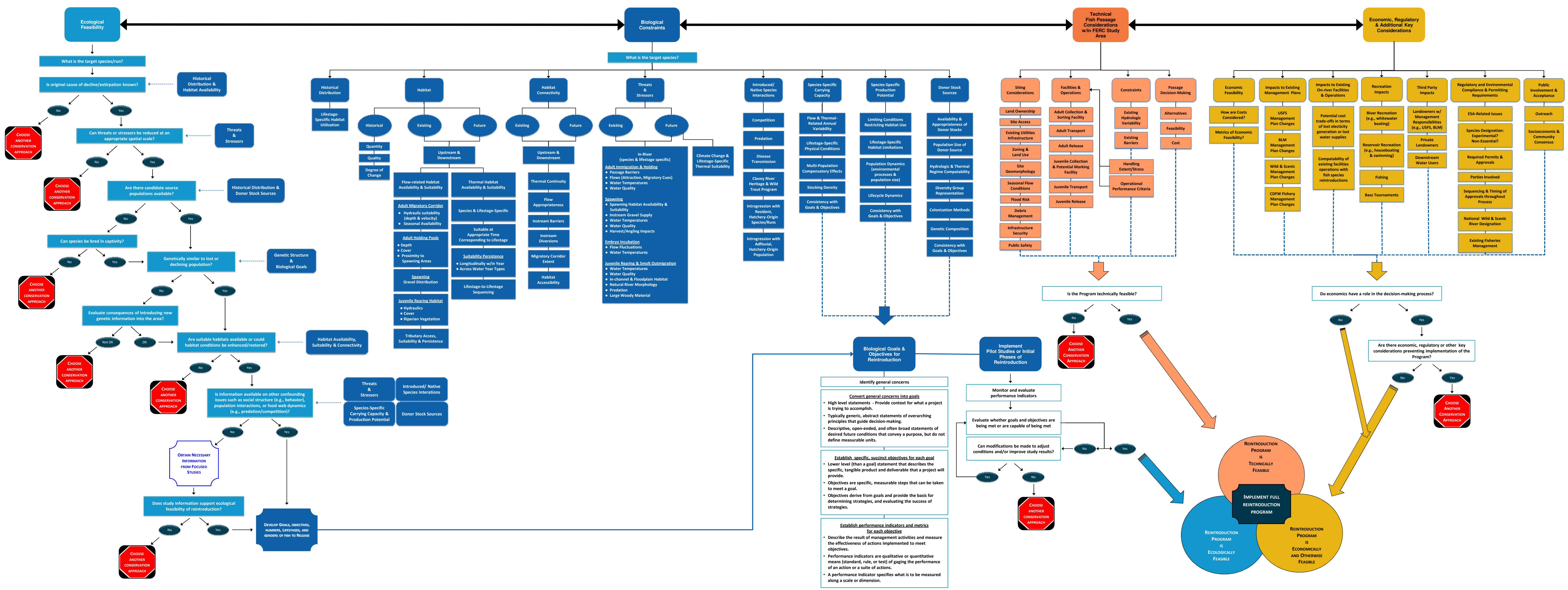
Reintroduction Decision Criteria

Technical Passage Feasibility



Reintroduction Decision Criteria

Integrated Decision Tree



La Grange Hydroelectric Project
Fish Passage Alternatives Assessment
Workshop No. 2 – September 17, 2015

FISH PASSAGE FACILITIES ALTERNATIVES ASSESSMENT
TECHNICAL MEMORANDUM NO. 1
EXISTING SITE CONSIDERATIONS AND DESIGN CRITERIA

LA GRANGE HYDROELECTRIC PROJECT
FERC NO. 14581

Prepared for:
Turlock Irrigation District – Turlock, California
Modesto Irrigation District – Modesto, California

Prepared by:
HDR, Inc.

September 2015

TABLE OF CONTENTS

Section No.	Description	Page No.

List of Figures

List of Tables

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).

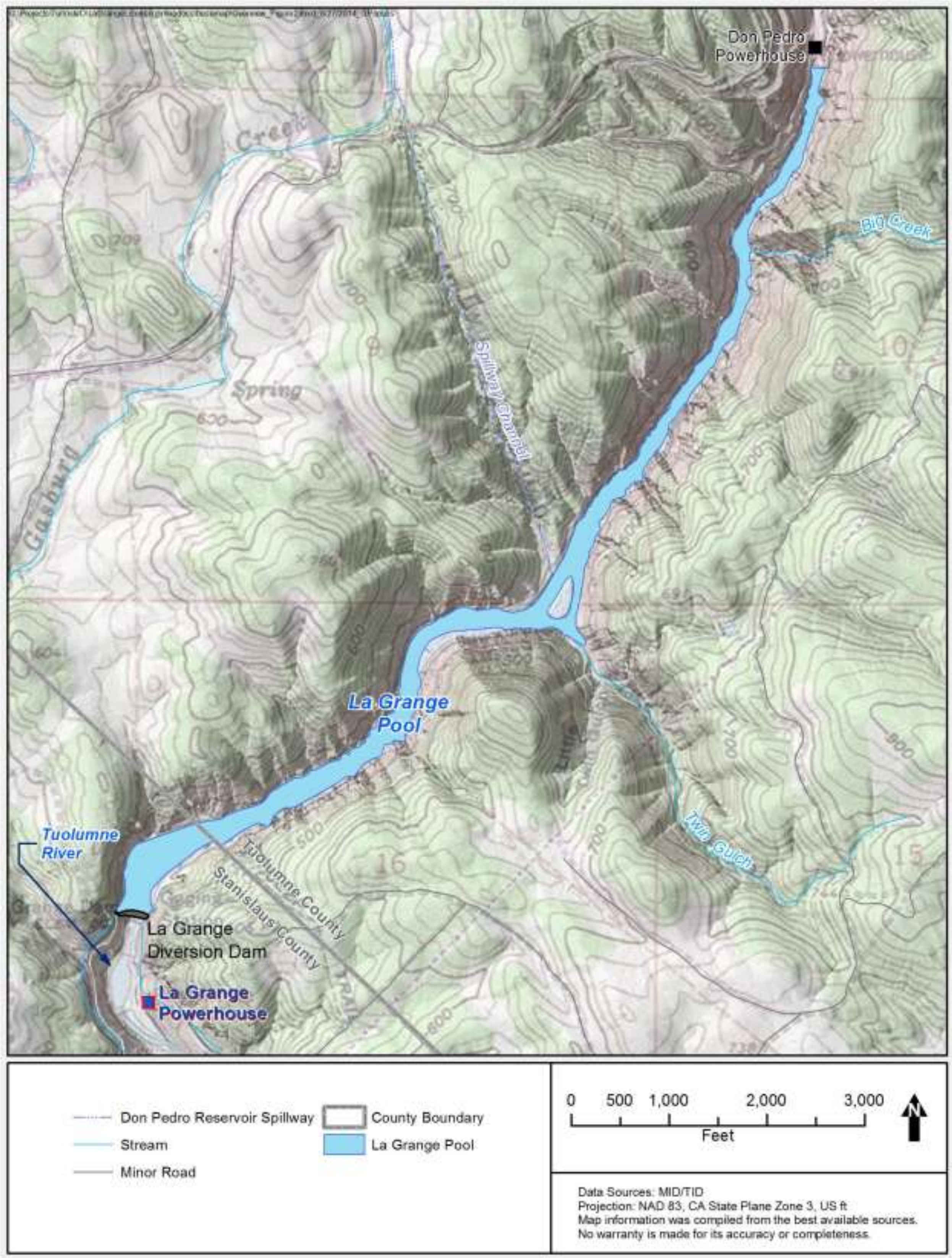


Figure 1.1-1. Site and vicinity of La Grange Diversion Dam.

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.

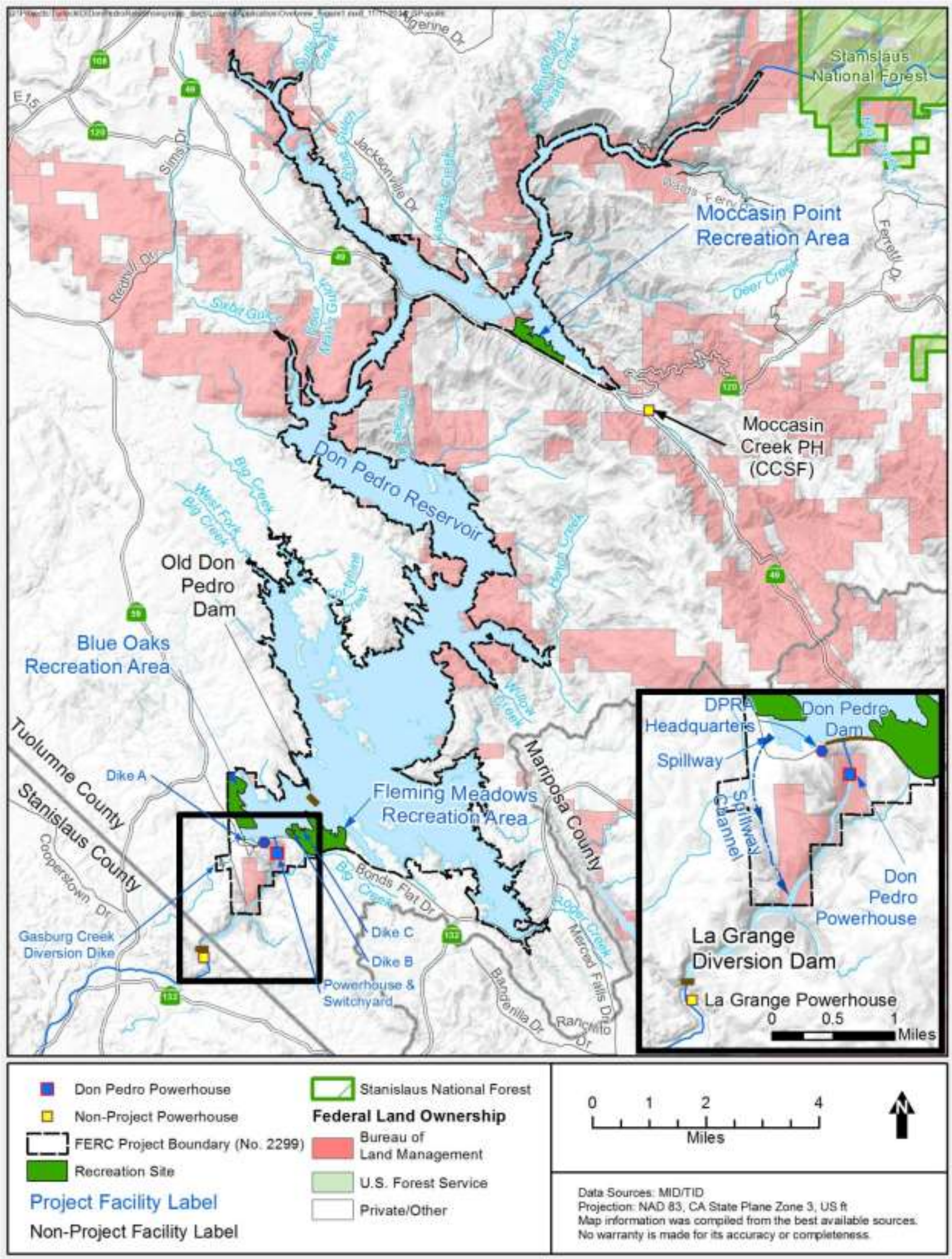


Figure 1.2-1 Overall study area for the Fish Passage Facilities Alternatives Assessment.

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.

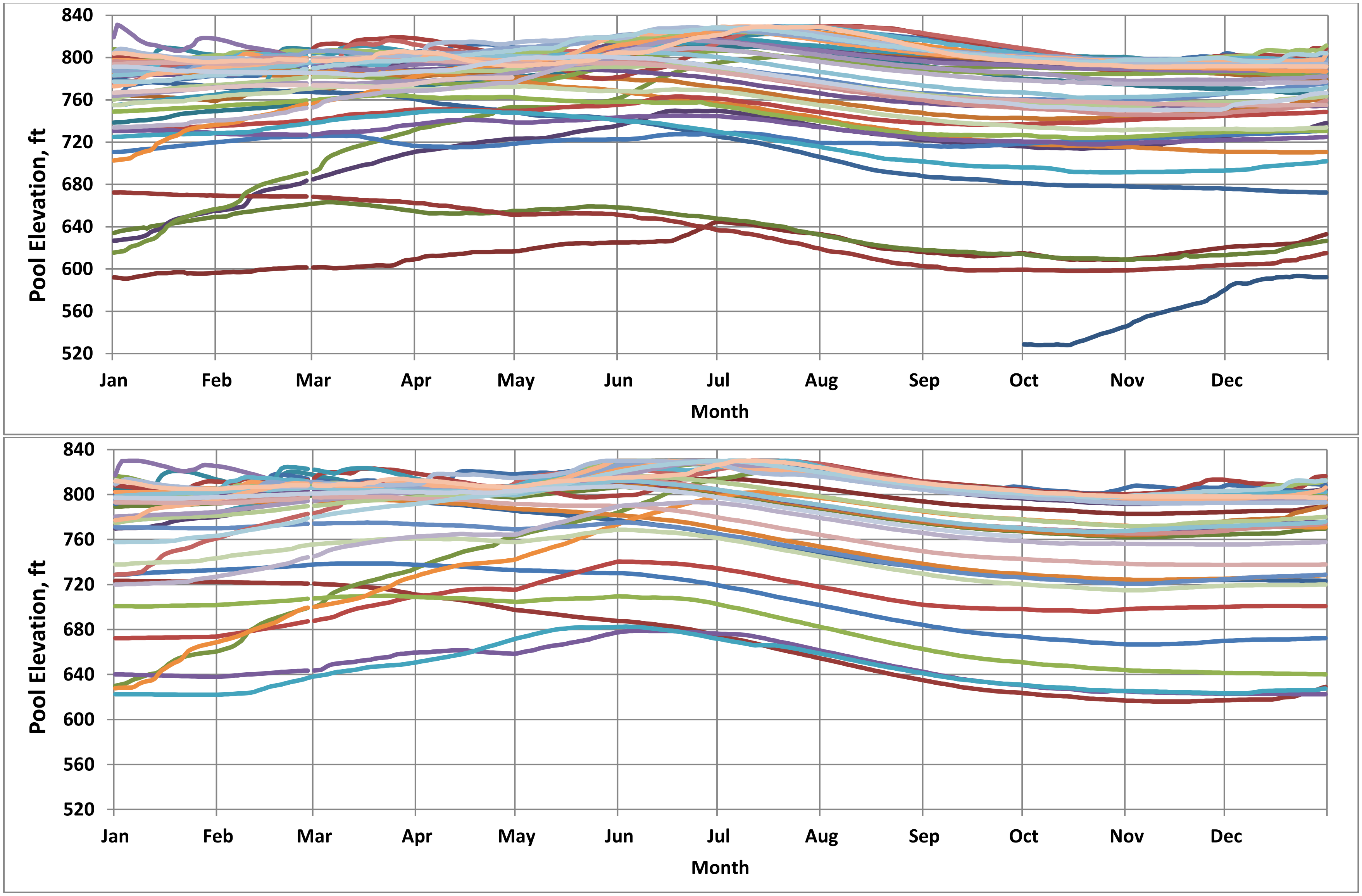


Figure 2.5-1 Mean daily pool elevation for the Historical (top) and Base Case (bottom) Don Pedro Dam operational scenarios.

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

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.

_____. 2009. California Salmonid Stream Habitat Restoration Manual Part XII Fish Passage Design and Implementation.

City and County of San Francisco (CCSF). 2008. Final Program Environmental Impact Report for the San Francisco Public Utilities Commission Water System Improvement Program: Volume 3 of 8. October, 30, 2008.

FISHBIO. 2008 to 2010. San Joaquin Basin Update. Volume 1, Issue 1 through Volume 5, Issue 1.

Moyle, P.B. 2002. Inland fishes of California. University of California Press, Berkeley, California. 408 pp.

National Marine Fisheries Service (NMFS). 1997. Fish Screening Criteria for Anadromous Salmonids. Southwest Region.

_____. 1999. Endangered and Threatened Species; Threatened Status for Two Chinook Salmon Evolutionarily Significant Units (ESUs) in California. Final Rule. Federal Register 64, No. 179 (September 16, 1999): 50394-50415.

_____. 2011. Anadromous Salmonid Passage Facility Design. NMFS, Northwest Region, Portland, Oregon.

_____. 2014. Recovery Plan for Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, and Central Valley steelhead. July 2014

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.

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

mne Independent.

SS FOR TUOLUMNE CO.

...y, 16th—Columbia and Sono-
...t. Collection for orphans, in

T. PHILLIPS, Rector.
Service in Columbia, next Sab-
...id at 7:30 p. m., in Sonora.
A. H. CROCO.

...sday, two daughters of ...ia, residing near Grove- ...n from a horse they were ... The oldest, aged nine ...a fracture of the right hip. ...ttending her.

... road is finished from ...ga, and teams are hurrying ... for winter use as fast as ...assed through Chinese on ...

...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. ...w that he owes Tuolumne ...ese acknowledgments of ...t.

...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 o... mine.... M. B. Harriman ... surfeiting with delights of ... turned. The Judge gaine... day.... In the way of ... Sears has just finished pai... on the school house. He ... tract for a number of fine ... San Francisco.... Rattle... 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 i... to exist by such means, we ... establishment and lose th... by the local papers, that ... Goods' firms have eviden... 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.

Recipe for Consumption.

La Grange Hydroelectric Project Licensing (FERC No. 14581)
Fish Passage Facilities Alternatives Assessment
Workshop No. 3

Thursday, November 19, 2015
10:00 am to 12:00 pm

Meeting Notes

On November 19, 2015, Turlock Irrigation District (TID) and Modesto Irrigation District (MID) (collectively, the Districts) hosted the third Workshop (Workshop No. 3) for the La Grange Hydroelectric Project (La Grange Project) Fish Passage Facilities Alternatives Assessment. This document summarizes discussions during the meeting. It is not intended to be a transcript of the meeting. Attachment A to this document includes the following meeting documents: agenda, sign-in sheets, presentation slides, and handouts.

Mr. John Devine (HDR, Inc. [HDR]), consultant to the Districts, welcomed meeting attendees. Attendees in the room and on the phone introduced themselves. The following individuals participated remotely: (1) Mr. Peter Barnes (State Water Resources Control Board [SWRCB]), (2) Ms. Leigh Bartoo (U.S. Fish and Wildlife Service [USFWS]), (3) Ms. Jenna Borovansky (HDR), (4) Ms. Jesse Deason (HDR), (5) Ms. Suzy Driver (Negotiation Guidance Associates), (6) Mr. Steve Edmondson (National Marine Fisheries Service [NMFS]), (7) Mr. Tom Holley (NMFS), (8) Mr. Chris Shutes (California Sportfishing Protection Alliance), and (9) Mr. John Wooster (NMFS).

Mr. Devine provided background information on the La Grange Project and described the upper Tuolumne River habitat-related studies the Districts are conducting voluntarily. Mr. Devine said NMFS is also doing some work related to habitat and asked that Messrs. Edmondson and Wooster provide an update later in the meeting on the progress of the study. Mr. Devine noted the La Grange Project Initial Study Report (ISR) will be filed with the Federal Energy Regulatory Commission (FERC) on February 2, 2016 and that later in the meeting he would like to discuss with the group the possibility of getting an extension of time for the ISR meeting.

Mr. Devine provided an overview of the Fish Passage Facilities Alternatives Assessment schedule into 2016. He indicated that the study plan identifies the task of reviewing existing information and assessing data gaps before moving forward with the 2016 study year. The Districts propose that this data gap assessment be conducted collaboratively as an approach to identifying studies that may be needed in 2016. Relatedly, he stated the primary purpose of Workshop No. 3 is to determine if there is consensus on whether the Districts and licensing participants (LPs) will proceed forward with pursuing a fish reintroduction decision-making framework (decision framework or framework). Mr. Devine introduced Mr. Bao Le (HDR) to provide a summary of previous workshops and how the discussions during these engagements have led up to Workshop No. 3.

Mr. Le provided a brief overview of Workshops No. 1 (held on May 20, 2015; meeting notes and materials available here on the La Grange Project Licensing Website) and No. 2 (held on September 17, 2015; meeting notes and materials available here). He stated Workshop No. 1 focused on three specific topics; (1) an overview of the Federal Power Act and Section 18 Fishway Authority as presented by NMFS, (2) an introduction to fish passage engineering and design, including an overview of information needs, general design criteria, and examples of currently operable facilities (primarily in the Pacific Northwest) to convey the potential size and scale of fish passage projects, and (3) an introduction of a broader discussion of the issue of fish passage on the Tuolumne River and how in this case, a decision to develop fish passage is fundamentally a decision to proceed with the introduction or reintroduction of anadromous fish to the upper Tuolumne River. To this last point, Mr. Le stated that evaluating fish passage in the broader context of reintroduction was consistent with other ongoing, similar processes in CA, and current reintroduction /recovery literature. Workshop No. 1 ended with a discussion of the types of information that would be necessary to support a reintroduction assessment, including but not limited to engineering and that elements of this information would be critical in the development of reliable and defensible fish passage design concepts and associated cost estimates. He also noted that a key agreement arrived at in Workshop No. 1 was that the fish passage/reintroduction process should be a collaborative and transparent process. At Workshop No. 2, the Districts presented a conceptual process identifying the scope of a comprehensive Fish Passage Facilities Assessment process, which focused not only on engineering technical feasibility, but also the related ecological, biological, socioeconomic and regulatory aspects of reintroduction decision-making. This conceptual process was presented diagrammatically as a Fish Passage/Reintroduction Decision Making Framework (decision framework). In addition to this conceptual framework, the Districts developed and distributed Technical Memorandum No. 1 (TM 1) to LPs in advance of the Workshop. TM 1 provided information and analysis of site-specific considerations necessary to inform the facility design process. To date, Mr. Le stated that no comments or input on TM 1 had been received from LPs.

Mr. Shutes asked if target species have been established. Mr. Devine said the question of target species is still outstanding and the Districts would like to get feedback on that topic today, if possible. Mr. Devine noted that input from resource agency managers on target species was one of a number of information needs identified in TM 1.

Mr. Paul Bratovich (HDR) provided an overview of the decision framework concept presented by the Districts in Workshop No. 2. Mr. Bratovich reminded LPs that the framework is an approach to providing a clear and structured process to guide efforts moving forward. The decision framework has four interrelated components: (1) Ecological Feasibility, (2) Biological Constraints, (3) Technical Fish Passage Considerations, and (4) Economic, Regulatory and Additional Key Considerations. Mr. Bratovich noted the components are highly integrated and interrelated and each "limb" has ramifications for the others. Mr. Bratovich reviewed current data gaps such as migration timing, habitat suitability, the goals and objectives of the reintroduction program, and how success is defined. Mr. Bratovich said without this information, it is impossible to move forward with the fish passage program and assess whether it could be successful. Mr. Bratovich reiterated the decision framework is intended to be a draft concept and feedback is invited and welcome.

Mr. John Buckley (Central Sierra Environmental Resource Center) described a seven-year process he had been involved with that was collaborative and successful. He believes the process was successful because the full spectrum of diverse interests was considered in the decision-making process. Mr. Buckley suggested that the fundamental questions in this process are whether there were anadromous fish in the upper Tuolumne River before La Grange Diversion Dam was built and whether there is an opportunity to put fish back in that stretch of river. Mr. Buckley said a decision framework can be highly valuable as a guide for participants and as a tool to help inform decision-making. He said he had not yet made up his mind about the question of fish passage viability on the Tuolumne River. Mr. Buckley said he is worried the group could work through the decision framework and end up with a result with exorbitant costs. Mr. Buckley said he would not want the group to be burdened with a binding decision and said he thinks the decision framework would be more valuable if it were viewed as a guidance tool. However, he added the decision framework process identifies important questions that should be answered.

Ms. Jennifer Carlson Shipman (Manufacturer's Council of the Central Valley) said she represents many food and beverage manufacturers and processors and disagrees with Mr. Buckley's comment regarding the framework being a tool for decision-making versus guidance. She thinks collaboration and transparency are integral and the decision framework is critical and necessary. Ms. Shipman said sometimes guidelines are followed and sometimes they are ignored and this framework should require a commitment to embark upon a structured process to establish program goals and objectives, collect information to evaluate the feasibility of those objectives, and reach a decision upon pursuing or not pursuing a program.

Mr. Peter Drekmeier (Tuolumne River Trust) requested clarification on the intended role of the decision framework. Mr. Drekmeier said ultimately FERC is going to make the decision about fish passage unless this group comes to a consensus. Mr. Devine said FERC will make a judgment about fish passage facilities in the Environmental Impact Statement, but there are other entities with the independent legal authority to make decisions on fish reintroduction/fish passage, including NMFS, USFWS, and SWRCB. FERC cannot override the authority of these entities. In addition, other agencies under different statutes have authorities independent of FERC. In response to Mr. Buckley's comments, Mr. Devine said the purpose of the framework is not necessarily to arrive at a decision that everyone agrees on. The framework primarily is intended to provide a platform through which all participants may interact in a collaborative way to identify items and issues that should be addressed so that all parties are aware of the full impacts, benefits, and concerns related to reintroduction and fish passage. Mr. Devine said it is possible that entities end up interpreting information differently, which is not uncommon in licensing proceedings. However, the benefit of using the framework is that everyone is using the same information base and there is consensus on the manner of developing the information and its usefulness. Mr. Devine said the framework is a guideline that allows the group to identify, acquire, and evaluate information. Groups may interpret the information differently and a consensus is not guaranteed. Mr. Devine said committing to the framework is committing to a process to get the information in a collaborative way, but it does not guarantee anything else.

Mr. Shutes said in addition to the regulatory pathways identified by Mr. Devine, there may also be a collaborative path to implement something. Mr. Shutes noted that at a previous Workshop, Mr. Edmondson described a scenario in which a decision is reached through a settlement. Mr. Shutes said the apparent disagreement between Ms. Shipman and Mr. Buckley is not about the content of the framework but is instead about how deterministic the decision process would be. Mr. Shutes said the framework suggests a "go/no-go" approach, but the actual process may be more complex than that. For example, instead of a "go/no-go" answer, the answer might be "this could be done if" decision. Mr. Shutes said he thinks it would be helpful to identify key items in the framework and then to move forward. He added he believes most of the relevant concepts are included in the framework, but he would like a better understanding of the process for making progress.

Mr. Wooster said he agrees with Mr. Shutes' suggestion. Mr. Wooster said it is unclear what the Districts are proposing. The FERC study plan is fairly clear but this proposal is essentially a reintroduction forum. Mr. Devine said the Districts tried to explain the various connections between the biological constraints and the engineering process at Workshop No. 2. For example, understanding the colonization strategy for reintroduction would be important to know as it would have significant potential implications for siting and sizing an acclimation facility. The question of whether steelhead reintroduction would rely on using pre-spawn adults or introduction of fry to grow in the upper Tuolumne substantially affects facility design considerations. Mr. Devine gave examples of high dam fish passage projects in the Pacific Northwest where a lack of reliable information had resulted in cost estimates that greatly underestimated the actual cost to build and operate the fish passage facilities. Mr. Shutes said he agrees with what Mr. Devine is saying but it is unclear how we start to answer these questions.

Mr. Buckley said calling the framework a “decision” framework may be a misnomer. A better term may be “assessment” framework. Mr. Buckley said at this point, the group needs to move quickly to identify key questions and information needs. Mr. Buckley added he does not believe anybody is advocating for building a $150 million project. The group needs to agree on how to get started with this process.

Mr. Paul Campbell (MID) said that as an MID Board Member, he is obligated to understand and consider the total potential costs of any facilities required by others and to be built and operated by the Districts. He would not hide the costs from the citizens he represents. Mr. Campbell said he believes a decision framework is critical for having an open and transparent process. It is apparent that the customers of MID and TID and the City and County of San Francisco will be the ones who pay these costs. Mr. Campbell said the reality of this situation is that a project of the potential magnitude being considered will be hugely expensive.

Mr. Devine said he believes a next logical step to move the process forward is to develop a draft structure and schedule which would include steps for identifying goals and objectives and the information necessary to assess the biological constraints, ecological feasibility, and potential impacts to other users of the water resource. Mr. Devine said as a starting point, the Districts are willing to provide existing information, take a first cut of potential information gaps, and identify what studies might be needed to address these gaps. If the group can provide feedback and come to an agreement on information needs, the Districts would finalize the approach and develop a draft list of additional information needs for 2016, which would be a key study year for collecting this information. Regarding the word “decision” in the title of the framework, Mr. Devine said “decision” refers to the many decisions that should be explored and addressed because they are interconnected. “Decision” is not meant to refer to just a bottom-line decision, but all the decisions along the path of the conceptual framework. Mr. Devine said the Districts would suggest having a meeting in mid-January to discuss more concrete process steps and schedule, and what studies should be conducted, in order to document with FERC the overall study schedule and course of action.

Mr. Shutes said he supports this path forward. He said all parties are aware of the potential costs and are concerned about costs. Mr. Shutes said he does not think the Districts and San Francisco would bear the entire cost of a reintroduction program. Others may able to provide support in the form of dollars or resource personnel. Mr. Shutes added he hopes the Conservation Groups can participate and contribute in a productive way to help answer these important questions.

Mr. Wooster asked for clarification on the role of the January meeting. Mr. Devine replied the role of the meeting would be to establish an assessment framework and overall schedule, identify information needs and studies, make decisions on topics such as target species, and to come to consensus on the goals and objectives of the reintroduction program. The Districts will bring suggestions to the January meeting. Mr. Devine noted that the Districts have consistently agreed with the need for information about the upper Tuolumne River as it relates to fish passage and reintroduction, but only questioned who, under the rules of the FERC ILP, should be responsible for collecting the information. Mr. Devine added the Districts are committed to participating and potentially funding some studies.

Ms. Dana Ferreira (Office of U.S. Congressman Jeff Denham) asked if the group could make progress today, such as deciding on the target species. Mr. Devine said a decision on target species would need to come from the resource agencies. He asked if any agency personnel at the meeting would like to speak to that. Mr. Wooster said spring-run Chinook and steelhead are definitely on the list of target species. Regarding fall-run Chinook, Mr. Wooster said NMFS needs to discuss this internally and more discussion is needed with the California Department of Fish and Wildlife (CDFW) and USFWS before NMFS can provide feedback. Mr. Wooster said those discussions could take place ahead of the January workshop.

Mr. Tom Orvis (Stanislaus County Farm Bureau) said he has spent considerable time talking with constituents. Mr. Orvis said very few fish are running in the Tuolumne River this year, while the Stanislaus River is seeing thousands. Mr. Orvis said water hyacinth may be having a negative effect on the Tuolumne River run and any fish passage program must also include more comprehensive river management. Ms. Gretchen Murphy (CDFW) confirmed water hyacinth is in both the Tuolumne River and San Joaquin River and said fish are able to swim past it. Mr. Drekmeier noted fish passage is one component of licensing but other issues can be addressed by flow or non-flow measures. He said pulse flows on the Stanislaus River have helped with the hyacinth issues there.

Mr. Larry Byrd (MID) asked for confirmation that "reintroduction" means reintroducing salmon in the upper Tuolumne River and asked what science is available that proves spring-run Chinook existed upstream of La Grange Diversion Dam before the dam was built. Mr. Drekmeier said he previously provided an article to this group from the Sonora Inquirer about this topic. Mr. Drekmeier and Mr. Byrd disagreed about whether the article confirmed the existence of spring-run Chinook in the upper Tuolumne River.

Mr. Byrd said he would like to see this process speed up and he agreed that predation and water hyacinth issues in the lower river must be addressed, and questioned the benefit of fish passage if the young fish can't make it out of the Tuolumne, San Joaquin, Delta and Bay because of predation. Mr. Byrd said he is also concerned that building fish passage would leave a huge debt for our children and grandchildren. He added the FERC process or the SWRCB process will likely require the Districts to increase flows even though the last time flows were increased, there was not a corresponding increase in fish production. Mr. Drekmeier disagreed with this statement and said the data show a correlation between increased flows and production. Mr. Byrd said fish passage is a multi-million dollar investment and would be a waste of resources because these fish do not exist in the upper river. Mr. Drekmeier said nobody is proposing fish passage at any cost. He believes Mr. Byrd's thoughts on individual measures have merit and spending future dollars on concrete items like river restoration may be better than continuing with more meetings and more studies. Mr. Byrd said it is frustrating how slow this process is moving. He added the low-income folks in the community would be the ones to bear the heaviest burden of paying for fish passage facilities.

Mr. Buckley said he appreciates Mr. Byrd's thoughts and said he believes these meetings and forums do allow for progress to be made. Mr. Buckley said the participants in these meetings hear and understand there is concern about cost. Mr. Bill Paris (MID) said he disagreed with Mr. Buckley that everyone is in agreement that costs must be considered. Mr. Paris said he has not heard any of the agency personnel say they consider costs and until they do, the issue of cost is relevant. Mr. Wooster said economics is considered in Section 18 Fishway Prescriptions. Mr. Wooster said NMFS has economists on staff and often funds economic studies. Mr. Paris said saying economics is part of the process is different than explaining exactly how economics is applied in the decision process. Mr. Paris said economic considerations at NMFS appear to occur in a black box. Mr. Wooster replied that several months ago Mr. Edmondson sent a letter to Representative Kristen Olsen that described a little about how NMFS makes decisions. Mr. Wooster said there is no equation or threshold that determines whether a project is a "go" or not from an economic perspective. Mr. Wooster said NMFS keeps data on project costs and there is somewhat of a ratio between the cost of fish passage and megawatts of generation.

Ms. Shipman said there has been a lot of discussion about the unknowns and this seems like justification for implementing a framework that is open and transparent. Mr. Shutes cautioned against goals and objectives with too many details so as not to slow down the process at the outset, but agreed that it is important to have, at the very least, general goals and objectives of the fish reintroduction up front.

Mr. Ray Dias (a member of the public and an engineer) said this process should start with defining the goals and objectives to be attained, and should not back into these down the road. Mr. Dias said he is not seeing any progress being made and it is frustrating. He said whatever the process is called, we must ensure it is open and transparent.

Mr. Devine said there appears to be agreement among the group to go forward with the framework. He asked if the individuals on the phone agree. Mr. Shutes replied he supports this process and believes a list of priority items is critical to moving forward. Mr. Shutes said this list should include what species should be reintroduced, a desktop study of the history of salmon and steelhead in the Tuolumne River, and gathering information on thermal suitability, migration barriers, spawning gravels, and flow regimes. Mr. Shutes said he is not sure the group is ready to develop goals and objectives and perhaps this could be informed by a study of habitat carrying capacity. Mr. Wooster said NMFS agrees to gather and evaluate information and is open to a reintroduction forum that evaluates this issue. However, NMFS does not agree to the framework as a decision-making process. Ms. Bartoo, Ms. Murphy, and Mr. Barnes all confirmed their respective agencies would continue to participate in the process envisioned by the conceptual framework.

Mr. Buckley said it is important to note that most agency representatives in attendance can contribute to the process with their expertise but do not have the authority to sign-off on major decisions. Mr. Buckley said it is also important to note that these processes take time and he understands that folks are frustrated at the perceived lack of progress. Mr. Buckley noted fish passage cannot be considered in a vacuum and the process will consider a range of other issues and options as well. The big picture approach requires sensitivity to a wide range of participants.

Ms. Shipman said she does not want this group to make up the process as they go along. Instead, she would like to see a very direct, thoughtful, and precise path forward. She said such a process is necessary given the important implications fish passage would have on the region.

Mr. Jim Alves (City of Modesto) said the City of Modesto concurs with using a process such as this for moving forward because it is open and transparent and provides an opportunity for everyone to participate. Mr. Alves said cost is a major concern and effects on those who will pay for these efforts must be considered.

Mr. Orvis said he agrees with Mr. Buckley that agency participants may not have decision-making authority. Mr. Orvis said that in order to ensure a productive decision framework process, agency participants must keep their agency management and decision-makers apprised of the process and be ready to provide input that is representative of their agency.

Mr. Shutes asked who will be the point person for managing this process. Mr. Devine said the Districts and HDR will take on managing the process. Mr. Devine reiterated Mr. Orvis' feedback on the importance of all participants coming to the meetings and being prepared and ready to interact and take action. Mr. Devine said there will be many decisions along the way and parties must provide feedback for progress to be made. Participants must ensure that decision points and requests for feedback are communicated to the appropriate management personnel.

Mr. Devine said it appears a consensus has been reached to move forward with this general process. No participants spoke in disagreement. Mr. Devine proposed January 27, 2016 for the date of the next Workshop. Participants agreed with this date. Mr. Devine said the Districts will send out materials ahead of the meeting.

Mr. Devine said the La Grange Project ISR is due to FERC by February 2, 2016. Per FERC's regulations, the Districts must hold the ISR meeting within 15 days of filing the ISR, which would mean holding the meeting on or before February 17. Mr. Devine said due to scheduling conflicts, the Districts would like to have the meeting instead on Thursday, February 25. Mr. Devine asked if meeting attendees are available to attend on that date. No participants objected to having the ISR meeting on February 25. Mr. Devine said the Districts will submit a letter to FERC requesting a delay in holding the ISR meeting and noting that this group did not object to having the meeting on February 25.

Meeting adjourned.

ACTION ITEMS

1. The Districts will circulate materials in advance of the meeting scheduled for Wednesday, January 27, 2016.

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

Modesto Irrigation District

La Grange Fish Passage
Workshop No. 3
Thursday, November 19, 2015
10:00 a.m. – 12:00 p.m.

WATER & POWER
Serving Central California since 1887

PLEASE SIGN IN

	Name	Organization	Telephone No.	E-mail	Time In
13.	Brandon McMillan	TID			
14.	Bill Ketscher	Farmer			
15.	Peter Drekmeier	TRT			
16.	Gavin Bruce	Stanislaus Business Alliance			
17.	Fred Souza	YFC			
18.	Adrianne Carr	BAWSCA			
19.	Tim Heyne	DFW			
20.	John Holland	Bee			
21.					
22.					
23.					
24.					

Modesto Irrigation District

La Grange Fish Passage
Workshop No. 3
Thursday, November 19, 2015
10:00 a.m. – 12:00 p.m.

WATER & POWER
Serving Central California since 1887

PLEASE SIGN IN

	Name	Organization	Telephone No.	E-mail	Time In
1.	Bill Paris	MID			
2.	Jennifer Carlson	MCCV			
3.	Gretchen Murphy	CDFW			
4.	Josh Weimer	TID			
5.	Tom Orvis	SCFB			
6.	Calvin Curtin	TID			
7.	Dana Ferreira	Rep. Denham			
8.	John Buckley	CSERC			
9.	[illegible]	Asm Kristin Olsen			
10.	Jim Alves	City of Modesto			
11.	Ray Dias	Public			
12.	Anna Eddings	Senator Cannella			

TURLOCK IRRIGATION DISTRICT | MODESTO IRRIGATION DISTRICT

Overview of Tuolumne River Reintroduction Structured Decision-Making Framework

Reintroduction Decision-Making

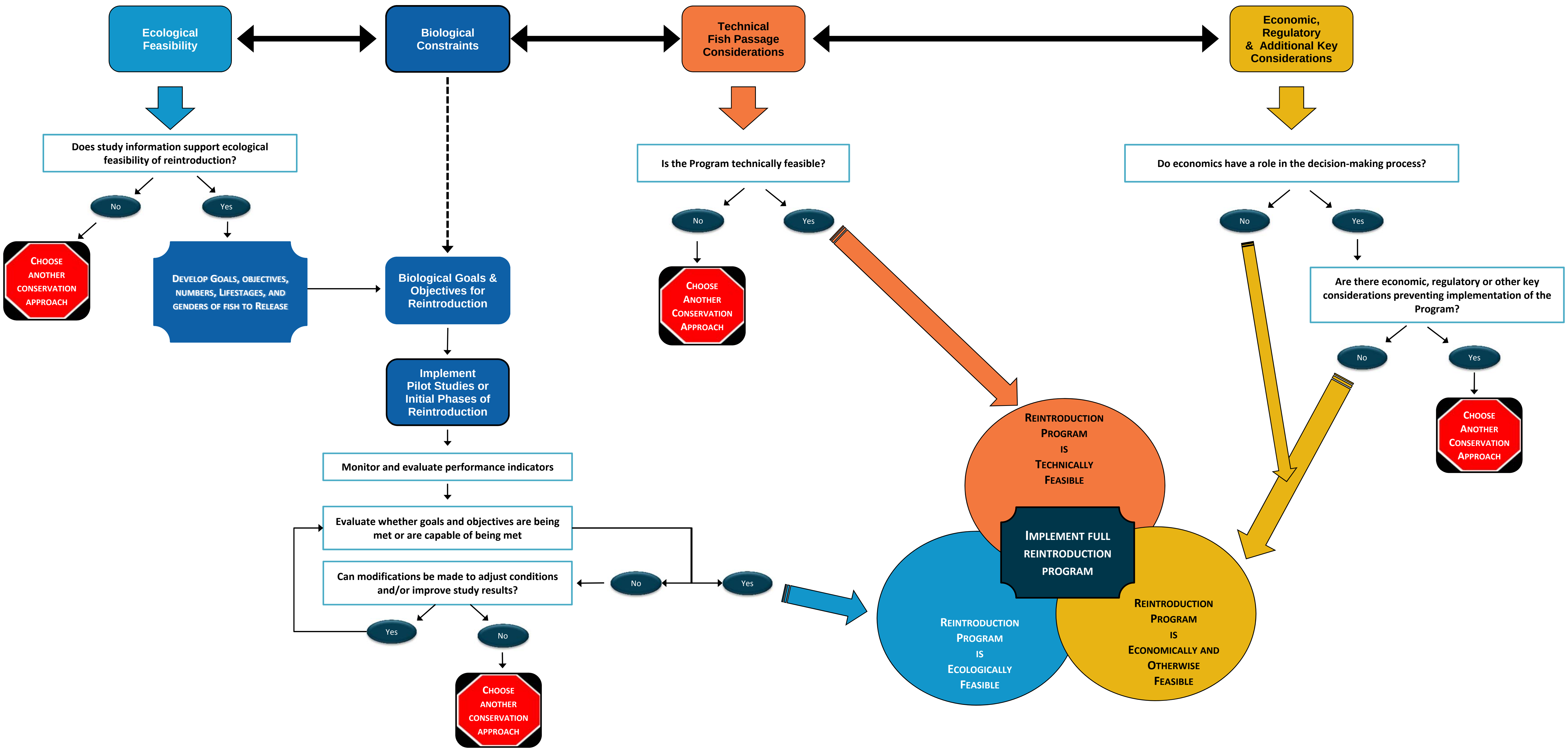
- Fish reintroduction involves numerous complex considerations
- There are extensive and complicated interactions among reintroduction considerations
- Structured decision-making requires careful analysis of complex interactions
- Identify the numerous issues to develop an agreed-upon framework for structured decision-making

TURLOCK IRRIGATION DISTRICT | MODESTO IRRIGATION DISTRICT

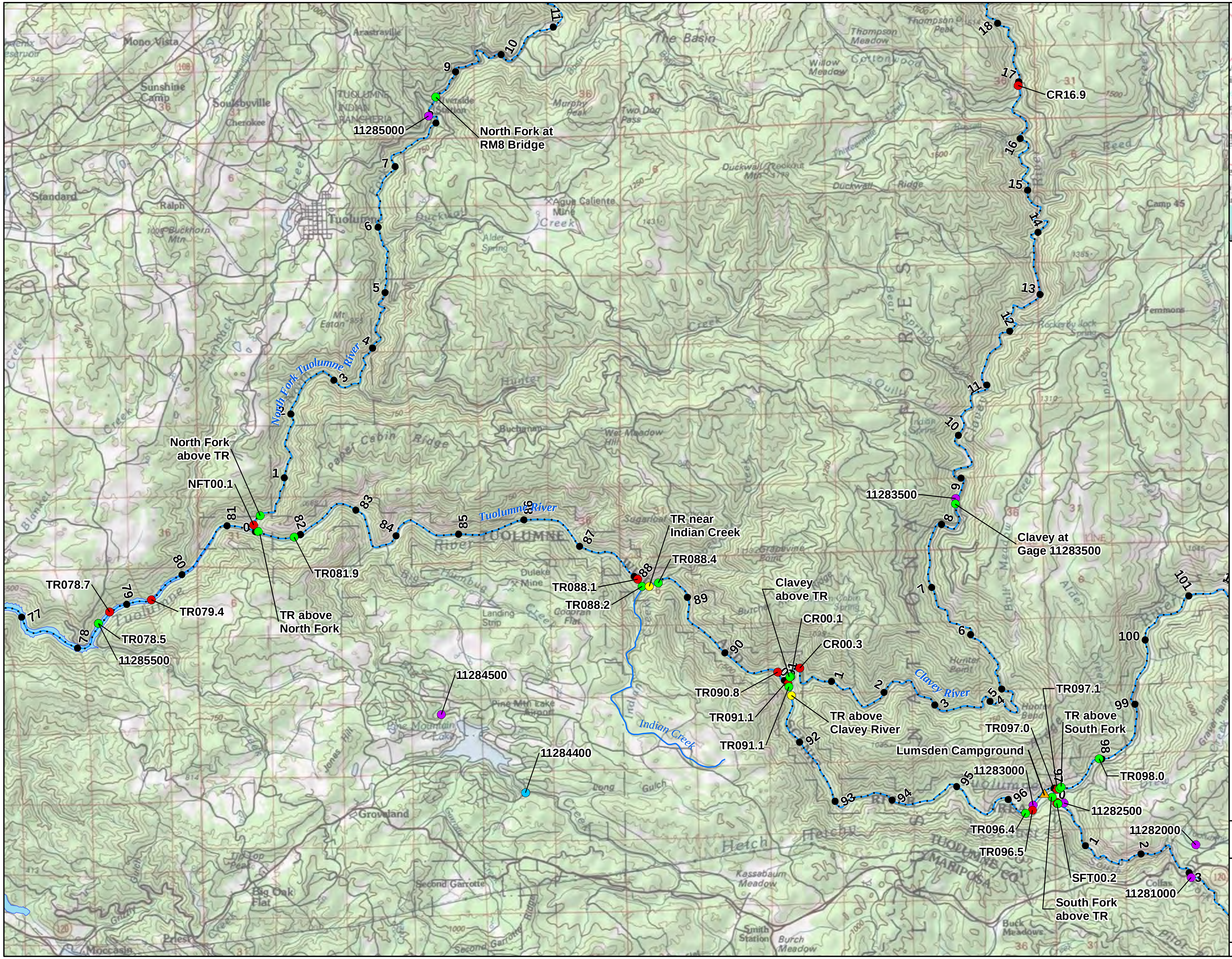
Integrated Decision Tree

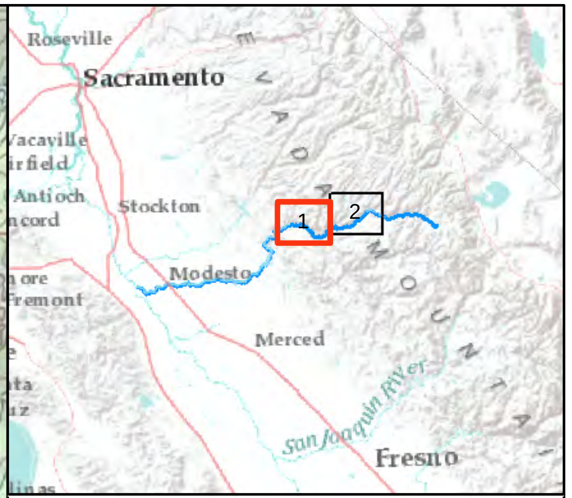
- An example of how structured decision-making can be approached regarding Tuolumne River reintroduction considerations
- Comprised of 3 distinct (but related) decision trees
    - ❖ Ecological Feasibility (with input from Biological Constraints)
    - ❖ Technical Fish Passage Feasibility
    - ❖ Economic, Regulatory & Other Key Considerations
- Informed by Biological Constraints & considerations
- A detailed work-flow would need to accompany the structured decision-making framework

Reintroduction Decision Criteria
Decision Tree Overview



La Grange Hydroelectric Project
Fish Passage Alternatives Assessment
Workshop No. 3 – November 19, 2015





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

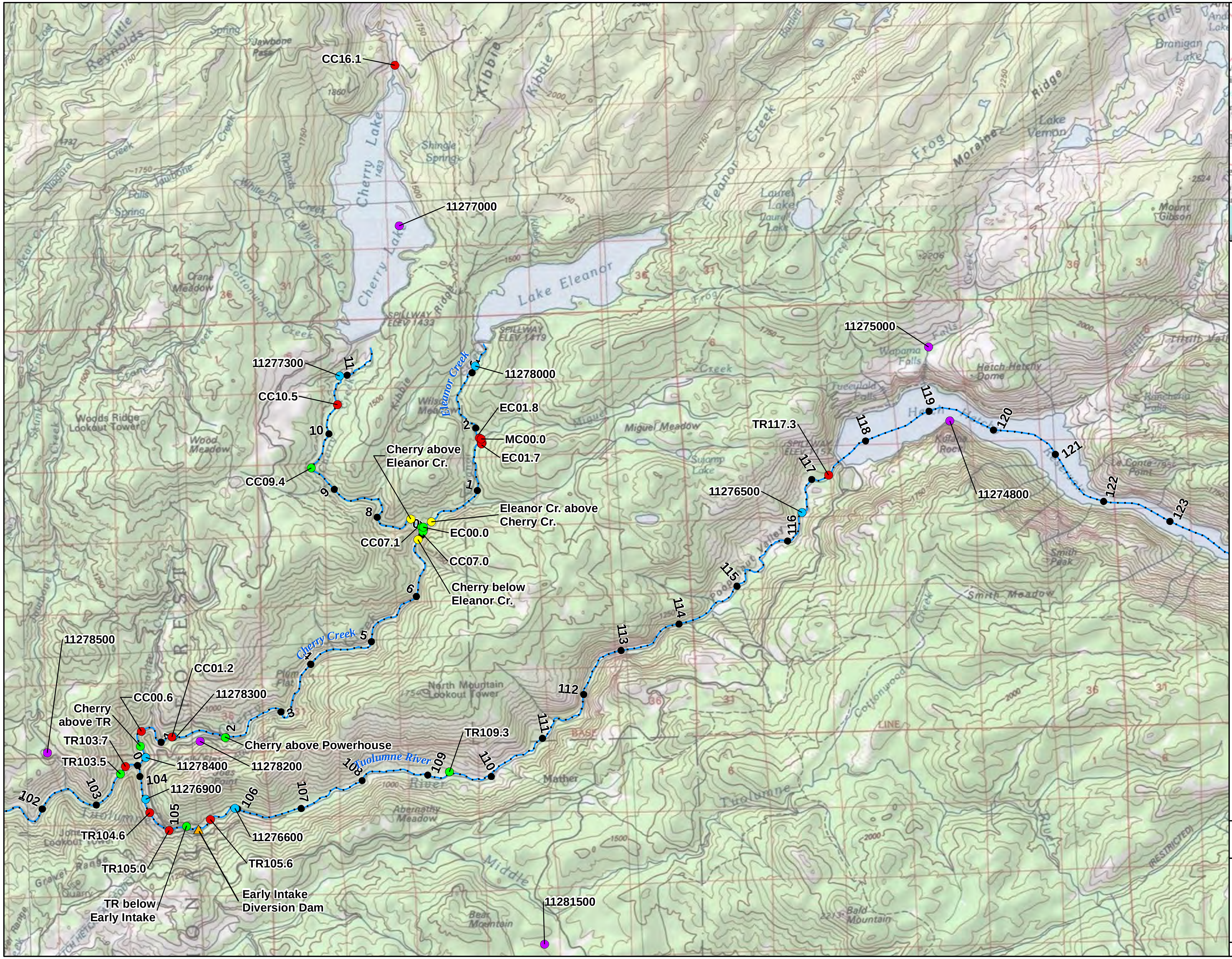
* Proposed logger locations will be added to table when exact coordinates are known.

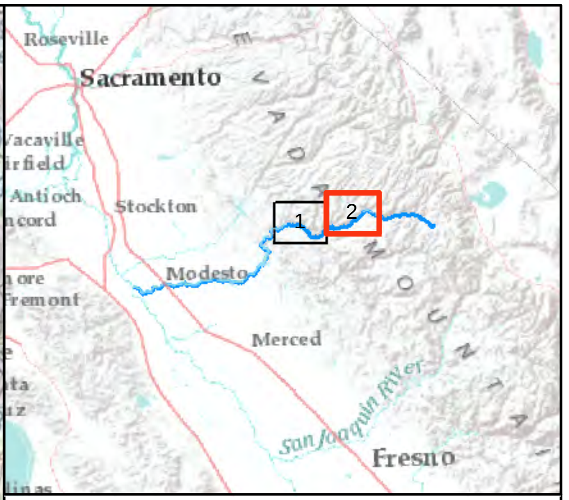
0 0.5 1 2 Miles

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.





Stream / Flow Gage

Active Inactive

Label	Agency	Active	Site Name
11274800	USGS	Inactive	TUOLUMNE R AT HETCH HETCHY NR SEQUOIA CA
11275000	USGS	Inactive	FALLS C NR HETCH HETCHY CA
11275500	USGS	Active	HETCH HETCHY RES A HETCH HETCHY CA
11276500	USGS	Active	TUOLUMNE R NR HETCH HETCHY CA
11276600	USGS	Active	TUOLUMNE R AB EARLY INTAKE NR MATHER CA
11276900	USGS	Active	TUOLUMNE R BL EARLY INTAKE NR MATHER CA
11277000	USGS	Inactive	CHERRY C NR HETCH HETCHY CA
11277200	USGS	Active	CHERRY LK NR HETCH HETCHY CA
11277300	USGS	Active	CHERRY C BL VALLEY DAM NR HETCH HETCHY CA
11277500	USGS	Active	LK ELEANOR NR HETCH HETCHY CA
11278000	USGS	Active	ELEANOR C NR HETCH HETCHY CA
11278200	USGS	Inactive	CHERRY C CN NR EARLY INTAKE CA
11278300	USGS	Active	CHERRY C NR EARLY INTAKE CA
11278400	USGS	Active	CHERRY C BL DION R HOLM PH, NR MATHER CA
11278500	USGS	Inactive	JAWBONE C NR TUOLUMNE CA
11281500	USGS	Inactive	M TUOLUMNE R NR MATHER CA

Water Temperature Logger

Active Inactive Proposed*

Label	Agency	Active	Site Locations
CC00.6	TID/MID	YES	Cherry above TR
CC00.6	CDFG	NO	Cherry Creek Power House
CC01.2	CCSF	NO	Cherry Creek, upstream of Dion Holm Powerhouse
CC07.0	CCSF	YES	Cherry Creek, downstream of confluence with Eleanor Creek
CC07.1	CCSF	YES	Cherry Creek, upstream of Eleanor Creek confluence
CC09.4	CCSF	YES	Cherry Creek, downstream of Cherry Dam
CC01.2	TID/MID	YES	Cherry above Powerhouse
CC10.5	CCSF	NO	Cherry Creek, downstream of Cherry Dam
CC16.1	CCSF	NO	Upstream of Cherry Lake
EC00.0	CCSF	YES	Eleanor Creek, upstream of Cherry Creek confluence
EC01.7	CCSF	NO	Eleanor Creek, downstream of Miguel Creek confluence
EC01.7	CCSF	NO	Eleanor Creek, downstream of Miguel Creek confluence
EC01.7	CCSF	NO	Eleanor Creek, downstream of Miguel Creek confluence
EC01.8	CCSF	NO	Eleanor Creek, upstream of Miguel Creek confluence
MC00.0	CCSF	NO	Miguel Creek, upstream of Eleanor Creek confluence
TR103.5	CCSF	YES	Tuolumne River, downstream of Cherry Creek confluence
TR103.7	CCSF	NO	Tuolumne River, downstream of Cherry Creek confluence
TR104.6	CCSF	NO	Tuolumne River, downstream of Early Intake Diversion Dam
TR105.0	CDFG	NO	Tuolumne River at Early Intake
TR105.2	TID/MID	YES	TR below Early Intake
TR105.6	CCSF	NO	Tailrace of Kirkwood Powerhouse
TR109.3	CCSF	YES	Tuolumne River, downstream of Preston Falls
TR117.3	CCSF	NO	Tuolumne River, downstream of O'Shaughnessy Dam

* Proposed logger locations will be added to table when exact coordinates are known.

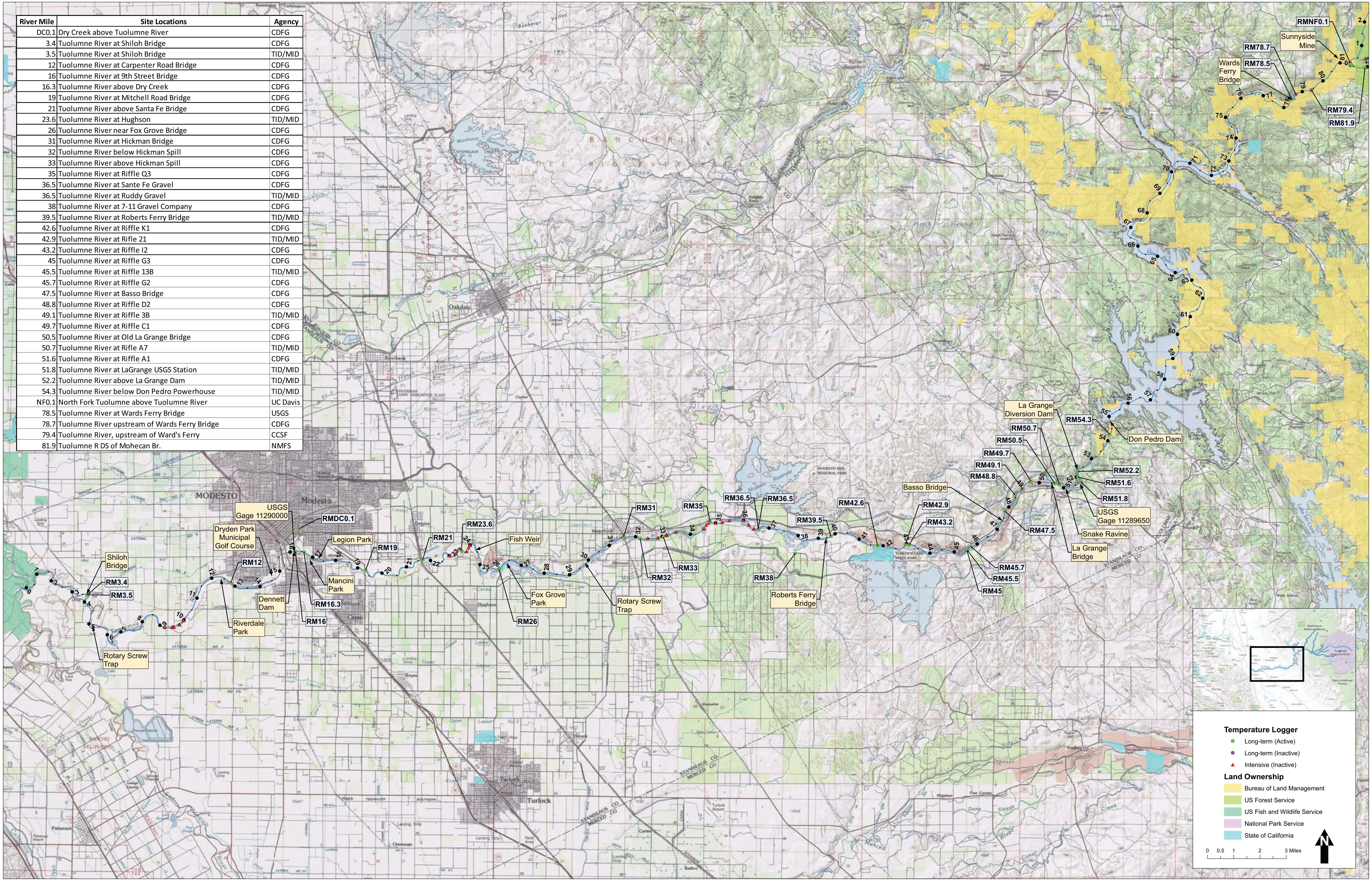
0 0.5 1 2 Miles

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.

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



Fish Passage on the Tuolumne River

Overview

In the Federal Energy Regulatory Commission's (FERC) Study Plan Determination for La Grange Hydroelectric Project licensing, Modesto Irrigation District (MID) and Turlock Irrigation District (TID) were directed to undertake an assessment of fish passage facility alternatives at the La Grange Project and Don Pedro Hydroelectric Project. The cost of upstream and downstream fish passage can exceed $100 million. Since MID and TID are public utilities, any fish passage costs will ultimately be paid by our customers.

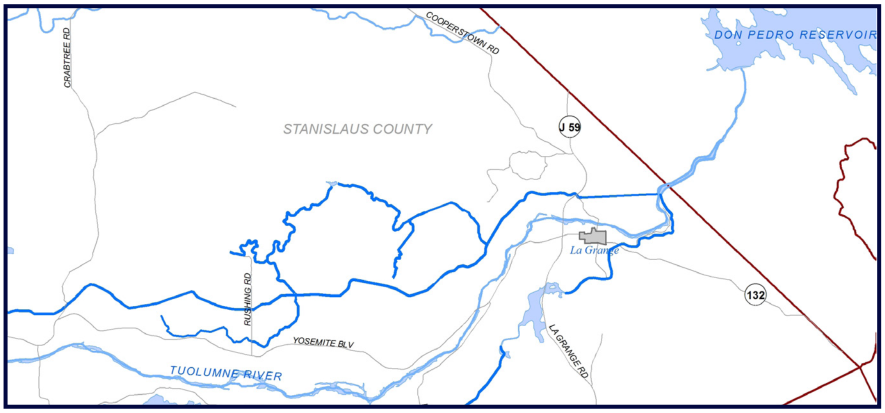
Providing fish passage on the Tuolumne River would be a major undertaking for MID, TID and its customers, both financially and logistically. Fish passage has become one of the key issues in the La Grange licensing process.

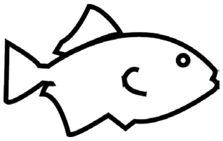
What is fish passage?

Fish passage is the movement of fish past existing barriers. Fish passage can be accomplished by constructing ladders or other structures that allow the fish to swim past the barrier or that capture the fish and transport them past the barrier.

What would a fish passage program be used for on the Tuolumne River?

A fish passage program would move upstream migrating anadromous fish from below the La Grange Diversion Dam to above Don Pedro Dam. Upstream migrating fish return from the ocean and move through the Delta, San Joaquin River and Tuolumne River to La Grange Diversion Dam. Any fish passage program would also transport young outmigrating offspring of these returning fish downstream from above Don Pedro Dam to below La Grange Diversion Dam.





Since the target fish species for a fish passage program don't currently exist in the Upper Tuolumne River, there are many questions that need to be answered before decisions are made to reintroduce salmon or steelhead to the area above Don Pedro Dam.

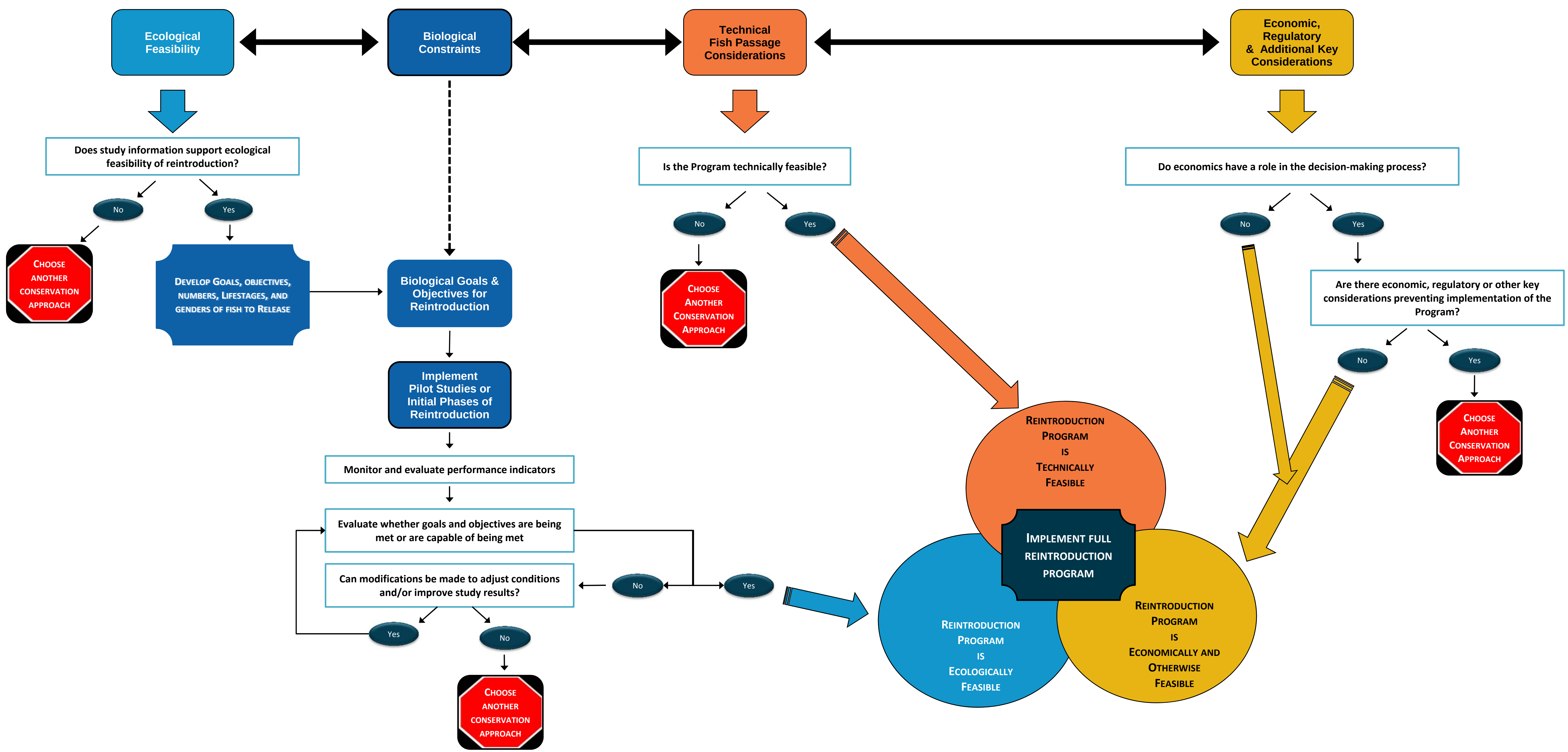
$$$

Fish passage can be an expensive endeavor. When assessing a potential fish passage program, MID and TID must take into consideration permitting, design and construction, operation and maintenance, and monitoring and evaluation costs. These costs will directly impact MID and TID customers.

?

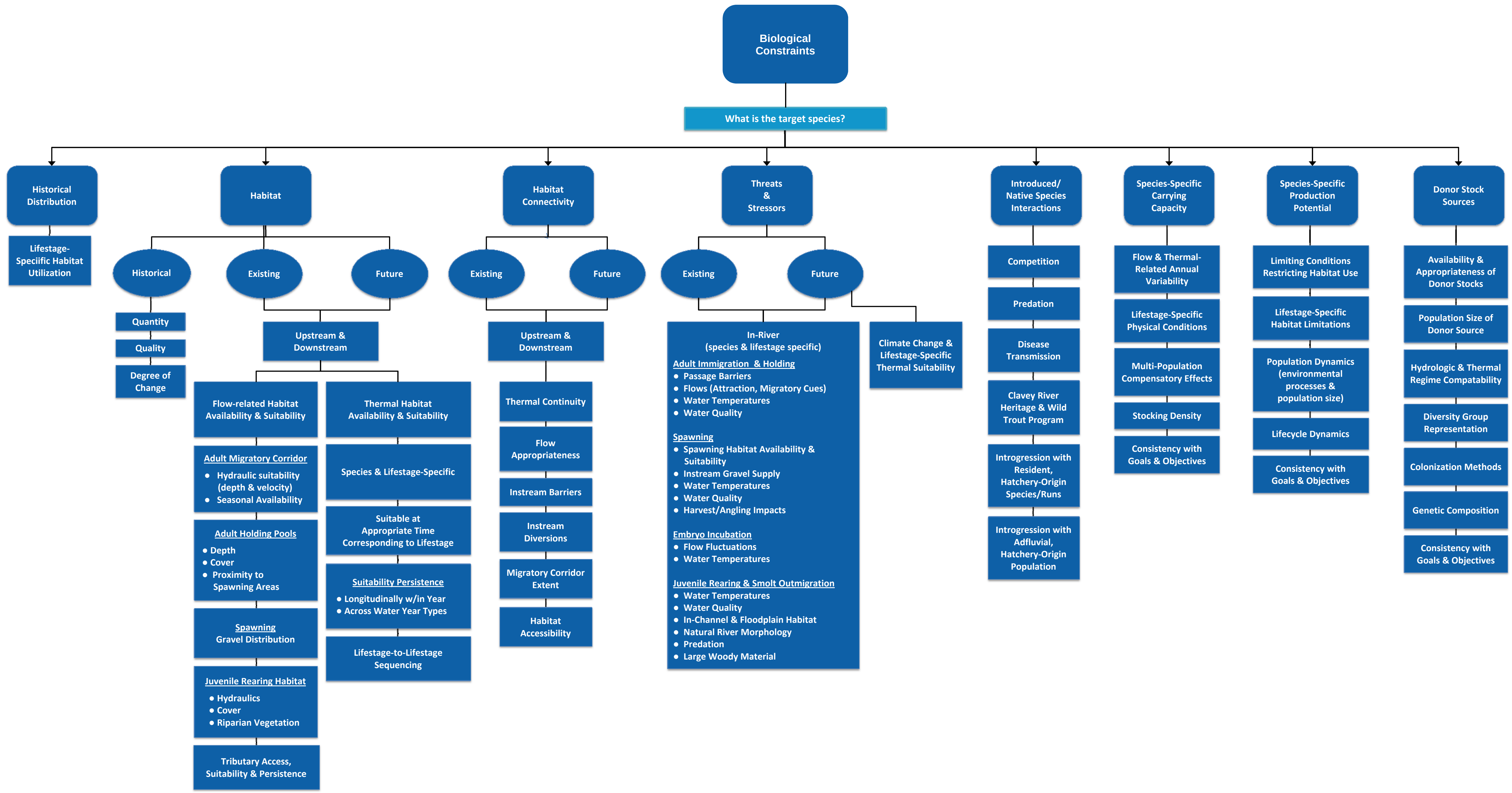
Currently, little information exists to know what fish facilities might be appropriate or if the habitat above Don Pedro Dam is sufficient to support reintroduction goals. To encourage a collaborative process, a series of workshops are being held to identify, collect and share information.

Reintroduction Decision Criteria
Decision Tree Overview

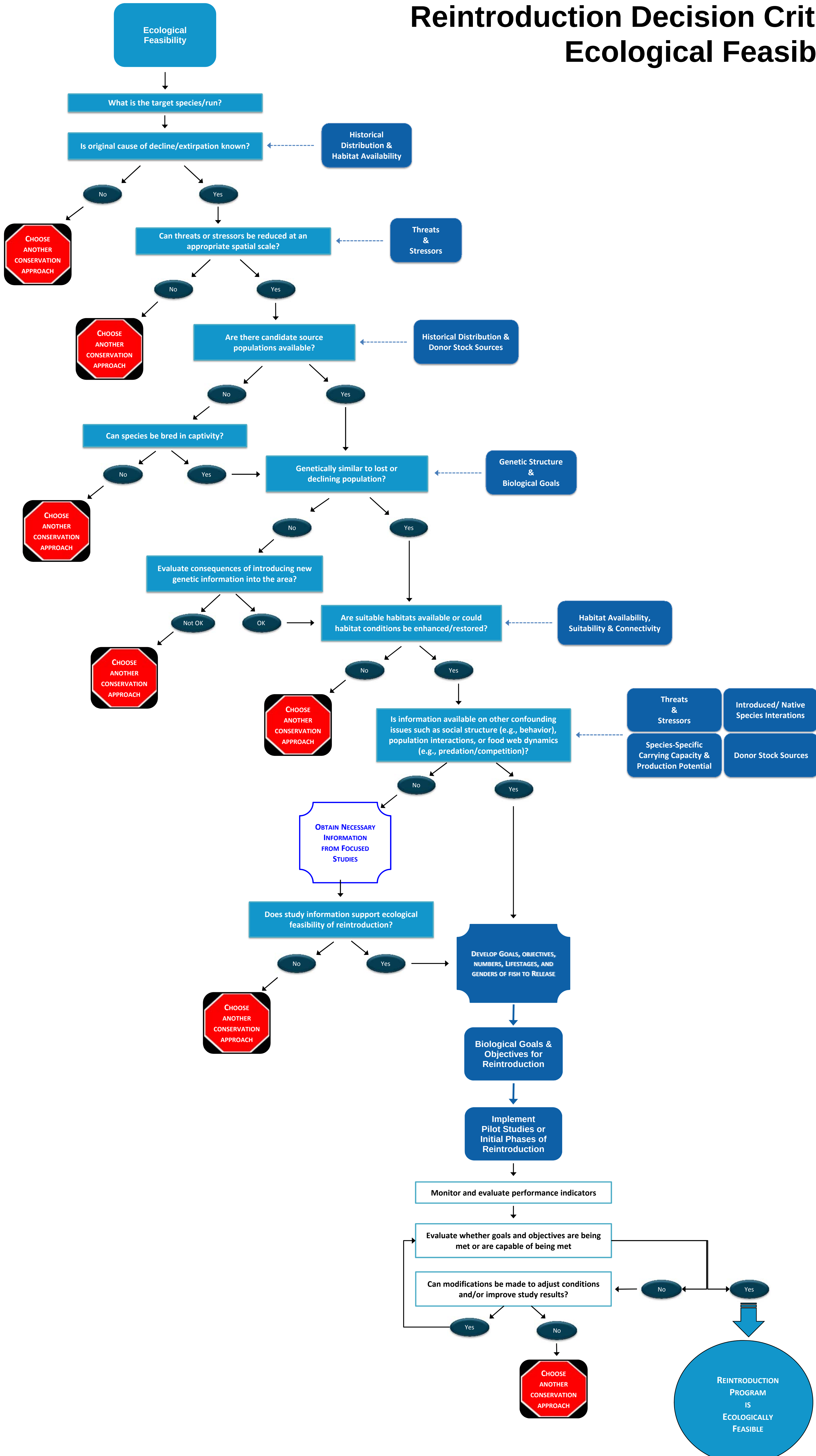


La Grange Hydroelectric Project
Fish Passage Alternatives Assessment
Workshop No. 3 – November 19, 2015

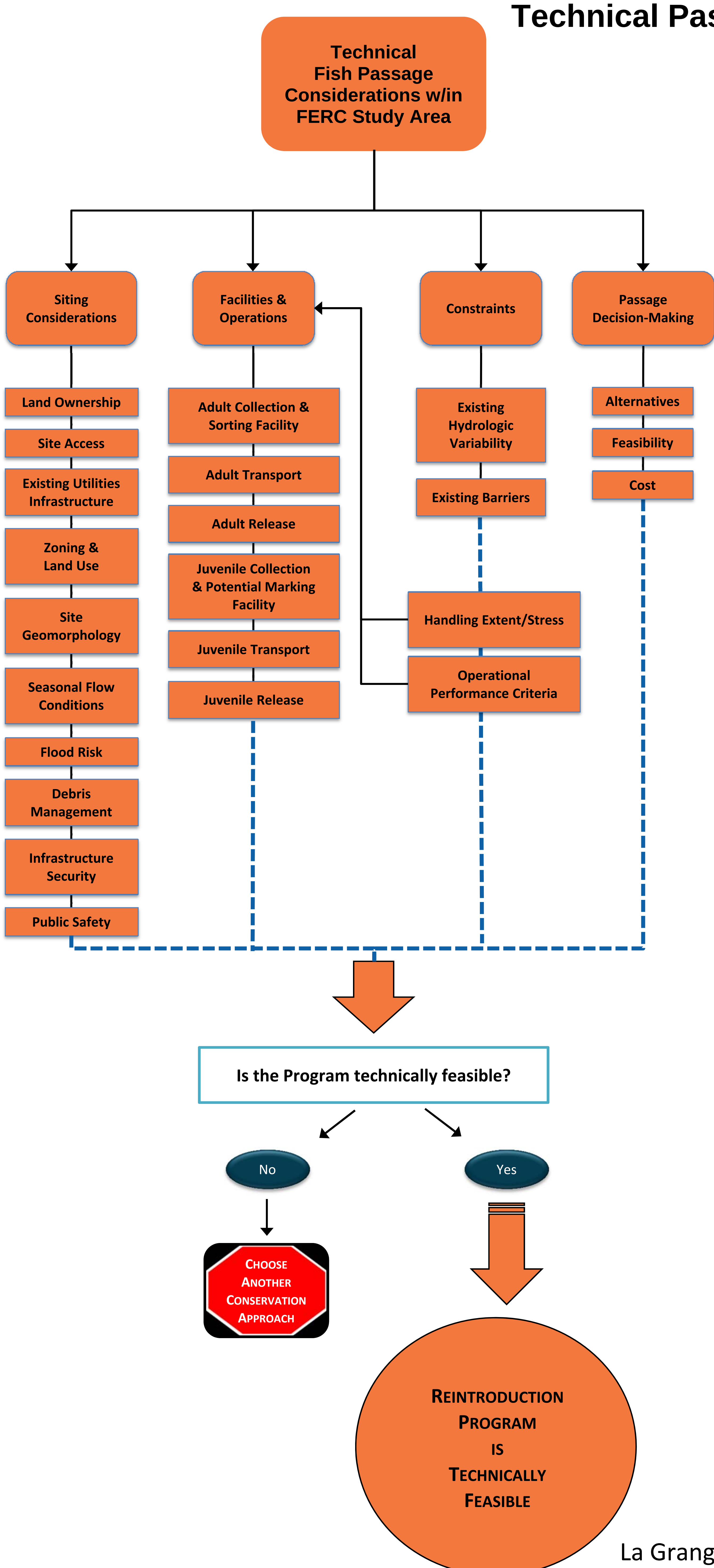
Reintroduction Decision Criteria
Biological Constraints



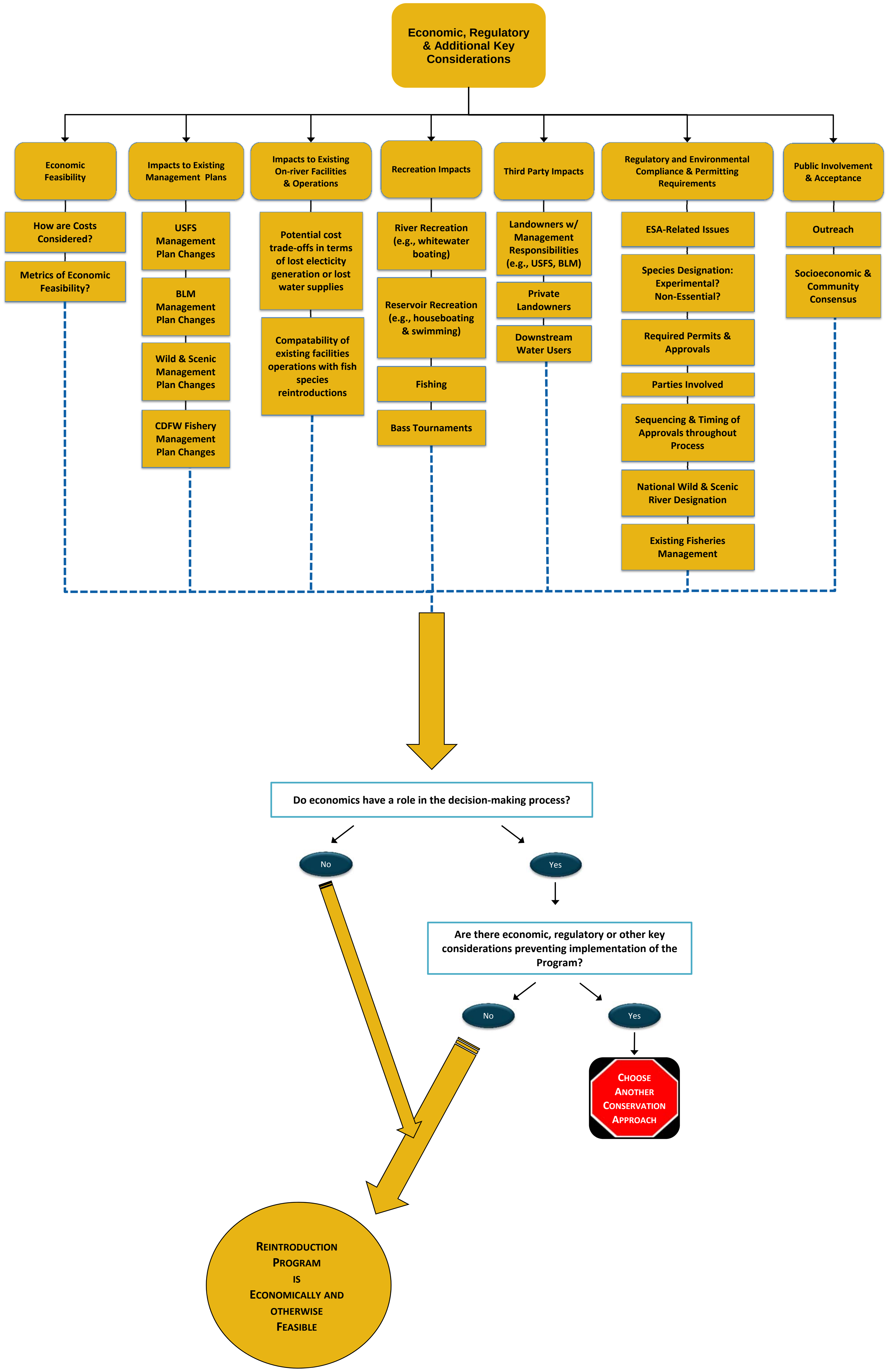
Reintroduction Decision Criteria
Ecological Feasibility



Reintroduction Decision Criteria
Technical Passage Feasibility



Reintroduction Decision Criteria
Economic, Regulatory and Other Considerations



La Grange Hydroelectric Project Licensing (FERC No. 14581)
Fish Passage Facilities Alternatives Assessment
Workshop No. 4

Wednesday, January 27, 2016
9:00 am to 12:00 pm

Meeting Notes

On January 27, 2016, Turlock Irrigation District (TID) and Modesto Irrigation District (MID) (collectively, the Districts) hosted the fourth Workshop (Workshop No. 4) for the La Grange Hydroelectric Project (La Grange Project) Fish Passage Facilities Alternatives Assessment (the Study). This document summarizes discussions during the meeting. It is not intended to be a transcript of the meeting. Attachment A to this document includes the following meeting documents: agenda, sign-in sheets, presentation slides, and handouts.

Mr. John Devine (HDR, Inc. [HDR]), consultant to the Districts, welcomed Workshop participants. Attendees in the room and on the phone introduced themselves. The following individuals participated remotely: (1) Mr. Peter Barnes (State Water Resources Control Board); (2) Ms. Adrianne Carr (Bay Area Water Supply and Conservation Agency); (3) Ms. Jesse Deason (HDR); (4) Mr. Steve Edmondson (National Marine Fisheries Service [NMFS]); (5) Mr. Tim Heyne (California Department of Fish and Wildlife [CDFW]); (6) Mr. Tom Holley (NMFS); (7) Ms. Trudi Hughes (California League of Food Processors) and; (8) Mr. John Wooster (NMFS).

Mr. Devine asked if any Workshop participants would like to make opening remarks. No participants volunteered. Mr. Devine reviewed the meeting agenda. He stated that today's meeting is a follow-up to Workshop No. 3 (held on November 19, 2015; meeting notes and materials are available here on the La Grange Project Licensing Website), in which attendees agreed to begin implementation of an Upper Tuolumne River Reintroduction/Fish Passage Assessment Framework (Framework) as described and discussed at Workshop No. 2 (held on September 17, 2015; meeting notes and materials available here). Mr. Devine said that in Workshop No. 3, the Districts proposed a plan to implement the Framework; one of the items on today's agenda is to discuss and reach consensus on implementing that process.

Mr. Devine said implementing the Framework will require a fair amount of technical work, including preparing study plans and reviewing study reports. As such, the Districts are suggesting that a Technical Committee, made up of volunteers from this larger group (Plenary Group), be formed to assume some of the technical responsibilities of implementing the Framework. The Technical Committee would report to the Plenary Group (i.e., all Framework participants).

Mr. Devine said another purpose of today's meeting is to discuss studies to complete in 2016 to support the Framework. The Districts prepared a list of potential studies and had provided a list with abstracts prior to the Workshop. Mr. Devine added that this list of studies is intended to jump-start discussion about which studies would be most relevant to support the Framework. It is not intended that all studies be conducted. Mr. Devine said today's meeting also includes a presentation of what data exist for the reach under consideration for reintroduction, which is defined as the mainstem Tuolumne River upstream of the Don Pedro Reservoir to Early Intake and associated tributaries (accessible reaches of these tributaries) within this reach.

Mr. Devine asked for thoughts or comments on his remarks. There were none.

Mr. Devine summarized the discussions at Workshops No. 2 and No. 3 and noted that consensus had been reached on implementing the Framework. The Framework considers fish passage engineering to be but one of several key components of assessing fish reintroduction. The other components are ecological feasibility; biological constraints; and economic, regulatory, and effects on other uses.

Mr. Devine introduced Mr. Bao Le (HDR). Mr. Le presented slides on the goals of and schedule for the Framework. Mr. Le said the overarching goal of the Framework is to evaluate the feasibility of reintroducing anadromous salmonids into the upper Tuolumne River by applying a structured assessment process. The process is an integrated evaluation of ecological, biological, engineering, economic, regulatory, and other key considerations related to reintroduction. Mr. Le said that HDR estimates that implementing the Framework would require considerable effort and entail a phased approach. In order to be respectful of the level of effort asked of all participants, the Framework considers the use of a Technical Committee that reports to the Plenary Group. Mr. Le summarized activities proposed for Phase 1 and Phase 2. Mr. Le said the Districts would like to arrive at a consensus at today's meeting on use of the Framework implementation plan, the associated schedule, and use of a Technical Committee.

Mr. Devine said one goal of the Framework is to arrive at an information base that was developed through studies where all parties agreed on the study scope, methods, and data collected. Mr. Devine said the goal is to achieve this by providing all parties the opportunity to participate in study development, implementation, and reporting.

Mr. Le reviewed the Upper Tuolumne River Reintroduction/Fish Passage Assessment Framework Flow Chart (Flow Chart). Phase 1 and Phase 2 would each occur over approximately a one-year period.

Ms. Dana Ferreira (Office of U.S. Congressman Jeff Denham) asked who would participate on the Technical Committee. Mr. Le said all are welcome to participate on the Technical Committee. Individuals who are interested in participating should email Ms. Rose Staples (HDR) (Rose.Staples@hdrinc.com). Ms. Ferreira asked how a diverse and representative Technical Committee could be ensured if it is made up only of volunteers. Mr. Le said that, depending on who volunteers, the Districts may ask additional individuals to participate to ensure a broad representation.

Mr. John Buckley (Central Sierra Environmental Resource Center [CSERC]) said participation on the Technical Committee may not be possible for small organizations, such as CSERC, that have small staff sizes and do not have the resources to fund consultants to participate on their behalf. Mr. Buckley asked if support will be available for such groups to participate. Mr. Devine said the Technical Committee would meet via conference call, instead of in person, to help minimize the time commitment. Mr. Buckley said participation on the Technical Committee will require working with and discussing highly technical subject matter, such as PHABSIM and weighted usable area, and individuals who are considering participating on the Technical Committee should be aware of this.

Mr. Le reviewed the Flow Chart, Information Needs, and Potential Studies Table (Studies Table). In the beginning of 2016, the Plenary Group would identify which studies would be completed and which entity(ies) would be responsible for completing each study. Mr. Le stated that study plans would be developed and the studies would be completed from spring through fall. Also in 2016, the Technical Committee would need to develop reintroduction goals. Mr. Le said by the end of 2016, the results from the studies would be available to begin evaluating whether the reintroduction goals identified could be met (i.e., is reintroduction feasible?).

Mr. Edmondson asked how decisions will be made in the Technical Committee, such as by unanimous or majority vote, and what the relationship will be between the Technical Committee and the Plenary Group. Mr. Edmondson asked if the findings of the Technical Committee will be considered as binding or as recommendations. Mr. Devine said the Technical Committee will provide technical feedback to the Plenary Group and will make decisions internally by majority vote. The Technical Committee is a venue for collaboration; it cannot compel agreement, nor can it require or limit any parties' activities. Mr. Devine said there will likely be differences of opinion among Technical Committee members and it will be important that those differing opinions be documented. Mr. Devine said feedback from the Technical Committee would be considered by the Plenary Group as information sharing and there would not be a formal governance structure. Mr. Edmondson asked how the role and structure of the Technical Committee will be documented. Mr. Devine suggested that the Workshop No. 4 meeting notes be used to document this discussion. No individuals disagreed with Mr. Devine's suggestion.

An individual asked if the final Study Report will include a decision about fish reintroduction or if the report will simply present the issues and document the process. Mr. Devine said the latter is a more likely outcome, but the former would be ideal.

Mr. Le resumed his presentation. He noted that in order to remain on the proposed Framework schedule, the next Plenary Group meeting will be in mid-April.

Mr. Edmondson suggested that the Technical Committee's discussions and decisions be documented so that individuals who do not participate may still be kept aware of what happens on the Technical Committee. Mr. Devine agreed. Mr. Shelton (CDFW) said his staff is spread thin and completing some of the work via Technical Committee may make for more efficient meetings, but may also make it more difficult for small organizations to participate. Ms. Jennifer Shipman (Manufacturer's Council of the Central Valley) agreed with Mr. Shelton. Ms. Shipman said she supports the Framework and believes having a Technical Committee will result in a more transparent and efficient approach. Ms. Shipman suggested that individuals be allowed to provide written comments after Technical Committee meetings, to allow individuals unable to attend a chance to provide input to the process. No party disagreed with this.

Mr. Wooster asked Mr. Devine to summarize the relationship between the Framework and the Study. Mr. Devine explained that Technical Memorandum (TM) No. 1 issued in September 2015 (available online here) identified a number of information gaps that are required to move forward with developing engineering alternatives and reliable cost estimates. Mr. Devine provided examples of data gaps described in TM No. 1, such as what target fish species and population sizes should be considered when developing engineering alternatives. Mr. Devine said that by the end of 2016, the goal is to have all the information needed to produce the concept-level facility layouts that are realistic and defensible. In 2017, more detailed engineering alternatives assessments could be produced and modified if there were additional studies needed in 2017. Mr. Wooster asked how completing engineering alternatives analyses in 2017 will align with the La Grange Project Federal Energy Regulatory Commission (FERC) schedule. Mr. Devine said that once the Districts were provided the basic information requested in TM No. 1, issued to licensing participants in September 2015, they could begin conceptual engineering of alternatives. These could be sufficiently complete in 2016 to determine if a reservoir transit study is warranted. The FERC study schedule, as outlined in FERC's February 2, 2015 Study Plan Determination (SPD), adopted a two-year (2015 and 2016) study schedule, but also acknowledged that additional studies may be needed, presumably in 2017. Mr. Devine pointed out that the FERC-approved two-year La Grange barrier study already extends to September 2017 (see page B-6 of the SPD). Mr. Devine said the proposed schedule for implementing the Framework is not inconsistent with that FERC study schedule. Mr. Devine noted that FERC has not issued a schedule yet for submittal of a Draft or Final License Application. Mr. Devine said the Districts anticipate that FERC would be amenable to this process if the collaborative group is in agreement and working together. Mr. Devine indicated that he believes FERC is seeking cost estimates and concepts for fish passage that are realistic, reliable, and not built simply on a series of assumptions.

Mr. Wooster said the schedule in the Study Plan states engineering alternatives will be developed in 2016. Mr. Wooster said now that the engineering alternatives will not be developed until 2017, and therefore the reservoir transit study may not occur until 2018, this would be at odds with the schedule in the SPD. Mr. Devine said the reservoir transit study may possibly occur in 2018 but it is more likely that engineering alternatives can be sufficiently far along by the end of 2016/early 2017 to allow any reservoir transit study to take place in 2017, possibly along the same schedule as the FERC-approved La Grange barrier study. .

Mr. Edmondson said he sees a risk in FERC not concurring with a change to the schedule and the Plenary Group should have a good reason for changing the schedule. Mr. Devine stated that there currently is no FERC-specified schedule for filing a Draft and Final License Application for the La Grange Project. Mr. Devine pointed to the December 7, 2015 letter the Districts filed with FERC noting the inconsistency between the schedule in Scoping Document 2 and the SPD. He added that one reason for holding Workshop No. 4 prior to the La Grange Project Initial Study Report (ISR) meeting, scheduled for February 25, is to have the Plenary Group potentially come to agreement on an implementation schedule and then be able to document this agreement in Workshop No. 4 meeting notes and present the agreed-upon path forward at the ISR meeting and in the ISR meeting notes, which will all be filed with FERC. Mr. Devine said this would create an opportunity for FERC to accept this process and for FERC to understand the level of support for this process by the Workshop participants. Mr. Wooster said he believes the engineering-related Study should remain on track to reach a decision in 2017, regardless of whether a reservoir transit study is completed. Mr. Wooster said many studies proposed for 2016 will help refine the engineering analysis, but will not prevent the engineering analysis from moving forward at least conceptually. Mr. Devine said the Districts would entertain continuing to move ahead with engineering where possible, but that key questions remain, for example, the performance standards and expectations for the passage facilities. Mr. Devine said he believes the Plenary Group can arrive at answers based on good information prior to 2017 so that the Districts can move forward with all aspects of the engineering. Mr. Wooster reiterated he believes that the conceptual engineering can move forward without having to deviate from the schedule in the SPD.

Mr. Buckley said a challenging aspect of this schedule is the current lack of reintroduction goals. Mr. Buckley said the Districts would like an end result that minimizes cost and the amount of water that must be provided downstream, while other entities, such as the fish agencies, would like a significant improvement to the viability of salmon and steelhead in the Tuolumne River and increased flows. Mr. Buckley said that without a consensus on goals, it is difficult to come to agreement on schedule. Mr. Devine said the Districts agree with that, and hope that reintroduction goals will be established by mid-2016.

Mr. Edmondson said it may be helpful for some individuals at this meeting if Mr. Devine reviewed the steps in the engineering design process. Mr. Devine provided an overview of the engineering design process that will occur for the Study and described different types of volitional and non-volitional fish passage facilities.

Ms. Shipman asked when in the process the issue of predation will be considered. Mr. Devine said that if a floating surface collector was considered for Don Pedro Reservoir, predation in the reservoir would be evaluated to help estimate the likely success of the facility. Predation in the river below La Grange Diversion Dam would also be considered when estimating the likelihood of successful outmigration.

Ms. Shipman asked if fall-run Chinook salmon, spring-run Chinook salmon, and steelhead could use the same fish passage facilities. Mr. Devine said different species may be able to use the same facilities, but the facilities would need to be able to operate at different flow conditions because different species would arrive to the facilities at different times of the year. Mr. Devine said because fish size varies among species, the facilities would also need to be able to accommodate different fish sizes and run sizes.

Mr. Larry Byrd (MID) asked for clarification on the difference between "volitional" and "non-volitional" fish passage facilities. Mr. Devine replied that volitional means that fish can move upstream and/or downstream under their own power and motivation. For example, fish must "decide", and be sufficiently fit, to climb a fish ladder in order to migrate upstream past a barrier. In contrast, "trap and haul" fish passage requires that fish be collected, transported, and released under a schedule imposed by active intervention. Mr. Byrd said it may not be necessary to consider volitional upstream passage facilities, such as a fish ladder, because the fish that arrive at La Grange Diversion Dam do not have the energy to use such a facility. Mr. Devine said different species of upstream migrating fish will likely arrive at the facility in different conditions, which is another consideration of facilities design. Workshop participants discussed the possibility of using a combination of volitional and non-volitional facilities at a single project.

Mr. Buckley said the results of 2016 studies may be affected by the ongoing drought and effects of the Rim Fire. Mr. Buckley said because of the current anomalous conditions, study results may not be representative of what could be expected to occur over the course of a FERC license period. Mr. Devine said he agreed and that all parties would need to be cognizant of current conditions.

Mr. Devine reviewed the Flow Chart and Studies Table. Studies with an "X" are ongoing and studies with a "P" are suggested by the Districts' technical team. Mr. Le said the table does not differentiate between Phase 1 and Phase 2 studies, but the Districts think that studies deemed to be high priority for Phase 1 would be accomplished in 2016. Mr. Devine said the cost estimates are not firm but only indicative of the effort required to collect these data. Regarding the Habitat Typing and Characterization Study, Mr. Wooster said NMFS is conducting a study using remote sensing data and that some of the remote sensing depth data will be ground-truthed. Given NMFS' study, Mr. Wooster thought the Studies Table could be revised to state that this study is ongoing, and not proposed, with the caveat that depending on the study results, more habitat ground-truthing may be recommended. Mr. Wooster said the NMFS LiDAR study will assess the availability of holding pools and results will be available by the end of August 2016. While the NMFS LiDAR study will also complete a cursory assessment of spawning gravels, Mr. Wooster recommended that the Plenary Group still consider a separate spawning gravel study, as proposed by the Districts. Mr. Devine said that Workshop participants agreed to try to keep to a two-year timeframe. Workshop participants also agreed to implement the Technical Committee.

Mr. Patrick Koepele (Tuolumne River Trust [TRT]) said the question of what studies to complete seems like a question for the Technical Committee. Mr. Devine said the intent of the Technical Committee is to flesh out in greater detail the technical components of agreed-to studies through study plan development and, ultimately, review of study reports. Mr. Devine said the Plenary Group should consider the Studies Table and discuss what studies should occur in Phase 1.

Mr. Chris Shutes (California Sportfishing Protection Alliance) asked if there is existing data about benthic macroinvertebrates (BMI) for the study reach. Mr. Devine said there is very little information available and the information that does exist is dated.

Mr. Peter Drekmeier (TRT) said the City and County of San Francisco (CCSF) has completed many studies on the Early Intake stretch of the Tuolumne River and that results from those studies may be helpful for this effort. Mr. Devine said he has reviewed some of these studies and he believes that most of CCSF's work was completed upstream of Early Intake which is beyond the scope of the reintroduction assessment area. Mr. Bill Sears (CCSF) agreed with Mr. Devine's statement.

Mr. Buckley asked if the resource agencies requested the Swim Tunnel Study noted in the Studies Table. Mr. Devine said the study was placed in the list by the Districts' technical team and resource agency input was welcome. Mr. Le reiterated that the list of studies is not intended to be anything more than a set of ideas for discussion, not study recommendations from the Districts. Mr. Shelton said that while the Swim Tunnel study completed for the Don Pedro Project was good scientific research, it would not be used to inform decision-making in the relicensing proceeding. Mr. Shelton said performing similar swim tunnel studies on other rivers and tributaries would help to create a database of good scientific information, which then may help to give the results broad applicability.

Workshop participants agreed to have the first Technical Committee conference call on Tuesday, February 16, at 11:00 am Pacific. Mr. Devine said the purpose of this call will be to try to decide on what studies will be completed in 2016. Workshop participants decided against reserving the same day each month for Technical Committee calls.

Mr. Wooster proposed that an assessment of the potential impacts of climate change to the upper and lower Tuolumne River be added to the Studies Table. Mr. Wooster agreed to provide an abstract for this study.

Meeting breaks for 15 minutes.

Mr. Devine presented slides on the information currently available on the study reach. Mr. Shutes said the Technical Committee should research the historical presence of the target species in the upper Tuolumne River, as part of consolidating the existing information for the study reach. Mr. Shutes said this issue will likely come up in the future and it would be helpful to know which target species originally inhabited this stretch of river. Mr. Shutes and Mr. Lonnie Moore (citizen) volunteered to lead this effort. Workshop participants discussed the validity and value of using anecdotal historical information to determine historical presence and the importance of documenting how decisions are made regarding whether or not a species existed historically. Mr. Devine said that regardless of whether species may or may not have been present in the reach in the distant past, and in what numbers, the reintroduction success depends on the current and future conditions of the reach under study. Many changes have occurred in the watershed over the last 150 years, so anecdotal information would not be very useful. There was no objection to compiling that information and Mr. Devine asked Mr. Shutes if he would take the lead, and Mr. Shutes agreed.

Mr. Devine asked what target species NMFS thinks should be considered. Mr. Edmondson said NMFS believes fall-run Chinook salmon, spring-run Chinook salmon, and steelhead should be considered. Mr. Edmondson said there is no evidence to suggest that fall-run Chinook were not historically in the study reach, and the extent of demarcation between fall-run Chinook and spring-run Chinook is unknown, therefore NMFS could not find a reason to not include fall-run Chinook. Mr. Devine asked if NMFS had considered the generally poor condition fall-run Chinook are in at the end of their upstream migration to the Lower Tuolumne River and what additional effects the stress of collecting and trucking the fish may have on survival and/or productivity. Mr. Shelton said CDFW agrees that the condition of fall-run Chinook at the end of their upstream migration is indicative of the condition of Tuolumne River. Mr. Shelton said CDFW believes that in most years, fall-run Chinook at the end of the run are in poor condition; however, with more water and non-flow measures, the condition of the fish will improve. Mr. Shelton said CDFW agrees that this process should look at all three fish species. Mr. Shelton said CDFW is cognizant that the Districts do not have unlimited funding and CDFW would like to help defer costs. Mr. Shutes said he had spoken with commercial fishermen and they are interested in reintroducing fall-run Chinook to the upper Tuolumne River. Mr. Shutes said the study should consider capturing fall-run Chinook further downstream than the other two species and should consider passing only those fish in good condition. Mr. Shutes said the study should also consider that fall-run Chinook will likely spawn further downstream than spring-run Chinook, which means that fall-run Chinook will not have to travel as far to get to the downstream passage facility. Mr. Devine stated that in order to more fully explore this proposal, it may be appropriate to move this item into the Technical Committee. Mr. Devine asked if there were concerns about interbreeding between fall-run and spring-run Chinook and competition for limited spawning habitat. Mr. Wooster indicated the resource agencies had meetings on this subject and decided that all three species should be considered. The basic reasoning came down to "why wouldn't we consider" fall-run.

Ms. Ferreira asked NMFS to describe how the agency considers economics and cost when deciding to require fish passage at a project. Mr. Edmondson said that NMFS requests studies through the FERC process and that licensees generally conduct the studies as part of the proceeding. Mr. Edmondson said NMFS provided a summary of how it considers economics in the July 7, 2015 letter to California State Assembly Member Kristin Olsen. Mr. Edmondson said in these types of processes, NMFS first determines whether there is a barrier to fish passage and whether providing passage around the barrier would produce a benefit. Mr. Edmondson said the next step is studying the availability of suitable habitat and whether fish passage is necessary for species recovery, recreational or commercial fishing purposes, or to prevent species extinction. Mr. Edmondson said NMFS's analysis is qualitative in nature. Mr. Edmondson said NMFS performed an economic analysis for the Klamath Project (FERC No. 2802) but that this analysis was part of a Secretarial Determination and different from the FERC process. He will provide a link to reports.

Mr. Devine presented slides describing the information the Districts have been able to locate relevant to the resources and conditions in the study reach (Attachment A). After the presentation, the Workshop adjourned.

ACTION ITEMS

1. Mr. Wooster will provide an abstract for the proposed assessment of climate change impacts to the Tuolumne River.
2. Mr. Shutes will take the lead on compiling information about the historical presence of target species in the upper watershed.
3. Mr. Edmondson will provide a link to the Klamath Project economic analysis and the Districts will send this link to Workshop participants (complete; link to Klamath Project economic analysis).

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

Modesto Irrigation District

La Grange Fish Passage
Workshop No. 4
Wednesday, January 27, 2016
9:00 a.m. – 12:00 p.m.

WATER & POWER

PLEASE SIGN IN

	Name	Organization	Telephone No.	E-mail	Time In
1.	Ron Yoshiyama	San Francisco			
2.	George Morrow	Jim Brisco Ent			46
3.	Gretchen Murphey	CDFW			08Y
4.	Brandon McMillan	TID			46
5.	Scott Wilcox	Stillwater			47
6.	Jennifer Shipman	MCCV			3
7.	Ray Durr	Public			53
8.	W. Sears	SF.			55
9.	John Buckley	CSERC			55
10.	Peter Drekmeier	TRT			57
11.	Garth Stapley	BOE			9
12.	Connie Moore	Citizen			

l.com

Modesto Irrigation District

La Grange Fish Passage
Workshop No. 4
Wednesday, January 27, 2016
9:00 a.m. – 12:00 p.m.

TID WATER & POWER
Serving Central California since 1887

PLEASE SIGN IN

	Name	Organization	Telephone No.	E-mail	Time In
13.	MARCO MORENO	WCR			
14.	Joe Sallaberry				
15.	Paul Zeek	Asm. Kristin Olsen			
16.	Allen Zanker	Zanker Farms			
17.	John Shelton	CDFW			
18.	DANA FERREIRA	CONG. DENHAM			
19.	Chris Shutes	CSPA			
20.	DAVID WHITE	ALLIANCE			
21.	Helen Condit	Senator Cannella			
22.	[illegible]	Farmer			
23.	Zac Jackson	USFWS			05
24.	Patrick Koepele	TRT			45

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	

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 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.

<u>Reservoir Transit Study</u>

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.

<u>Interactions with Existing Aquatic Communities</u>

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.

<u>Source Population Assessment</u>

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.

<u>Method of Colonization Assessment</u>

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.

<u>Genetics Assessment of Existing and Source Populations</u>

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

<u>Habitat Typing and Characterization</u>

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.

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

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.

TURLOCK IRRIGATION DISTRICT | MODESTO IRRIGATION DISTRICT

La Grange Hydroelectric Project

Upper Tuolumne River Reintroduction/Fish Passage Assessment Framework

Goals and Schedule

TURLOCK IRRIGATION DISTRICT | MODESTO IRRIGATION DISTRICT

Overarching Framework Goal

Evaluate feasibility of reintroducing anadromous salmonids into the Upper Tuolumne River by applying a structured assessment process. The process is an integrated evaluation of ecological, biological, engineering, economic, regulatory, and other key considerations related to the reintroduction.

TURLOCK IRRIGATION DISTRICT | MODESTO IRRIGATION DISTRICT

Framework Implementation

- Framework implementation over 2.5 years
- Phased approach to information/data collection and analysis
- Phased approach allows for key assessment points over the implementation period
- Use of technical subcommittee

TURLOCK IRRIGATION DISTRICT | MODESTO IRRIGATION DISTRICT

Framework Goals By Year

- **2016 (Phase 1)**
  - Compile and share existing information, identify data gaps and needed studies
  - Implement 2016 studies – ecological, biological, regulatory and potential uses/user impacts
  - Develop overall reintroduction goals related to ESA Recovery planning
  - Develop Phase 1 evaluation approach

Framework Goals By Year

- **2017 (Phase 1/2)**
  - 2016 studies information available
  - Conduct Phase 1 reintroduction evaluation using study results and developed reintroduction goals
  - **Key Assessment Milestone** – can ESA reintroduction goals be met (i.e., can success be achieved?)

Framework Goals By Year

- **2017 (Phase 2)**
  - If reintroduction deemed achievable based on Phase 1 (i.e., no fatal flaws), move to Phase 2.
  - Scope/conduct 2017 studies – additional biological, ecological studies, re-engage fish passage engineering, socioeconomics, other resource/user impacts
  - Develop Phase 2 evaluation approach

TURLOCK IRRIGATION DISTRICT | MODESTO IRRIGATION DISTRICT

Framework Goals By Year

- **2018 (Phase 2 continued)**
  - 2017 studies information available
  - Conduct Phase 2 reintroduction evaluation
  - **Key Assessment Milestone** – can ESA reintroduction goals be met (i.e., can success be achieved?)
  - Final reporting

TURLOCK IRRIGATION DISTRICT | MODESTO IRRIGATION DISTRICT

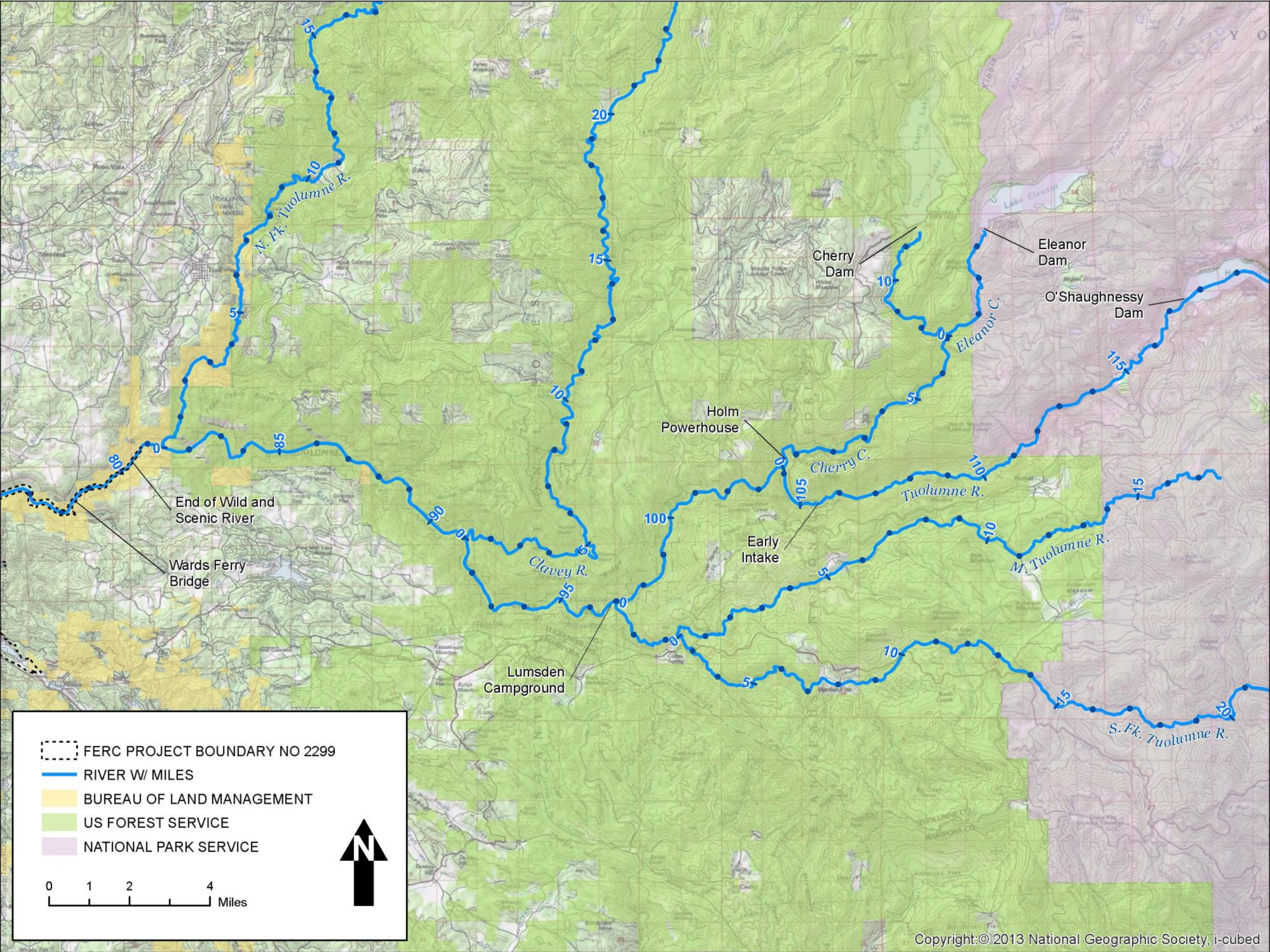
Discussion and Decisions

- **Framework implementation approach**
- **Schedule and meetings**
- **Use of a technical subcommittee**

TURLOCK IRRIGATION DISTRICT | MODESTO IRRIGATION DISTRICT

La Grange Hydroelectric Project
FERC No. 14581

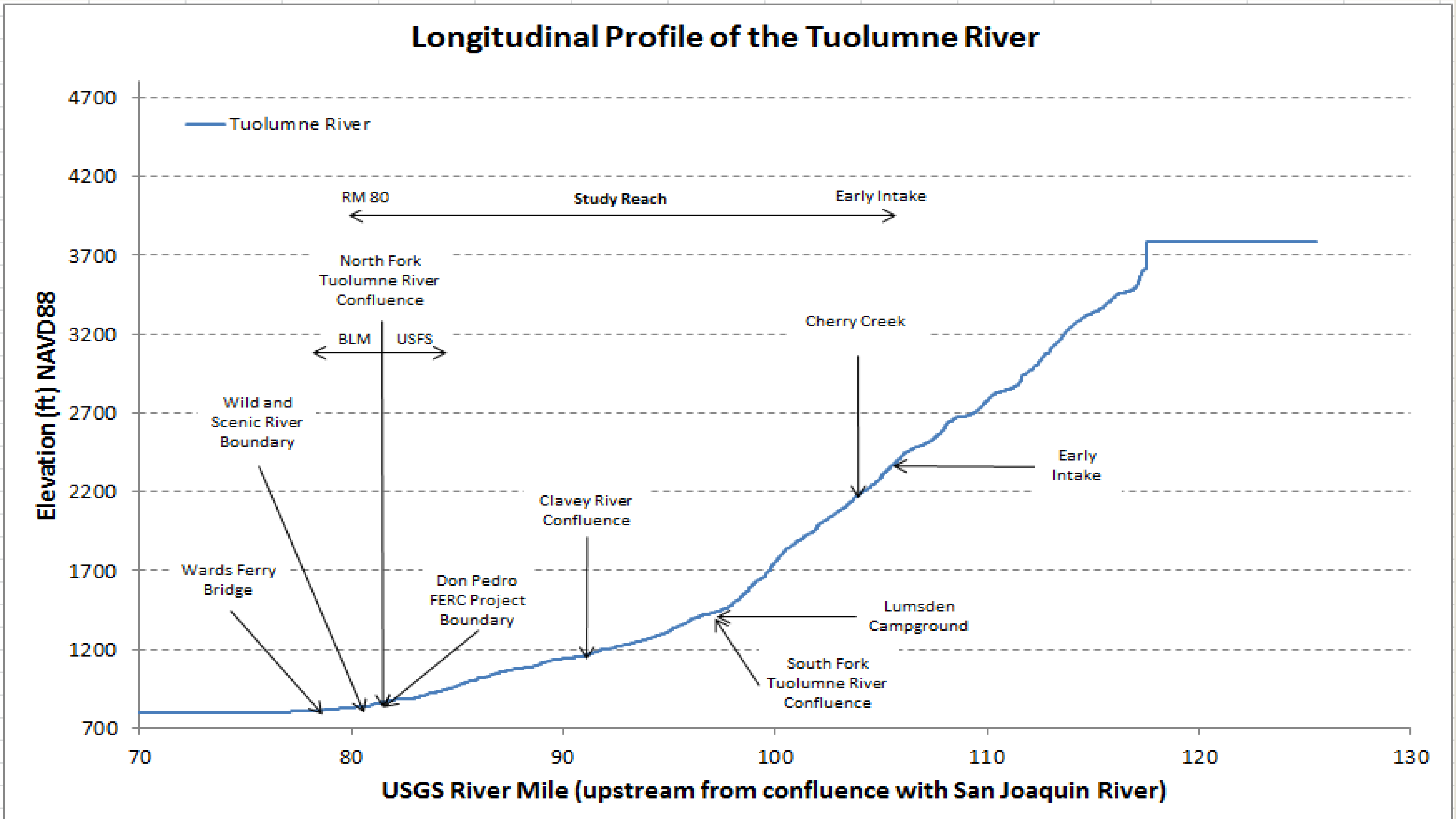
Description of Existing Environment



N. Fk. Tuolumne R.
Clavey R.
Cherry Dam
Eleanor Dam
O'Shaughnessy Dam
Eleanor C.
Holm Powerhouse
Cherry C.
Tuolumne R.
Early Intake
M. Tuolumne R.
S. Fk. Tuolumne R.
End of Wild and Scenic River
Wards Ferry Bridge
Lumsden Campground
FERC PROJECT BOUNDARY NO 2299
RIVER W/ MILES
BUREAU OF LAND MANAGEMENT
US FOREST SERVICE
NATIONAL PARK SERVICE
N
0 1 2 4
Miles
Copyright:© 2013 National Geographic Society, i-cubed

Geomorphology

TURLOCK IRRIGATION DISTRICT | MODESTO IRRIGATION DISTRICT



TURLOCK IRRIGATION DISTRICT | MODESTO IRRIGATION DISTRICT

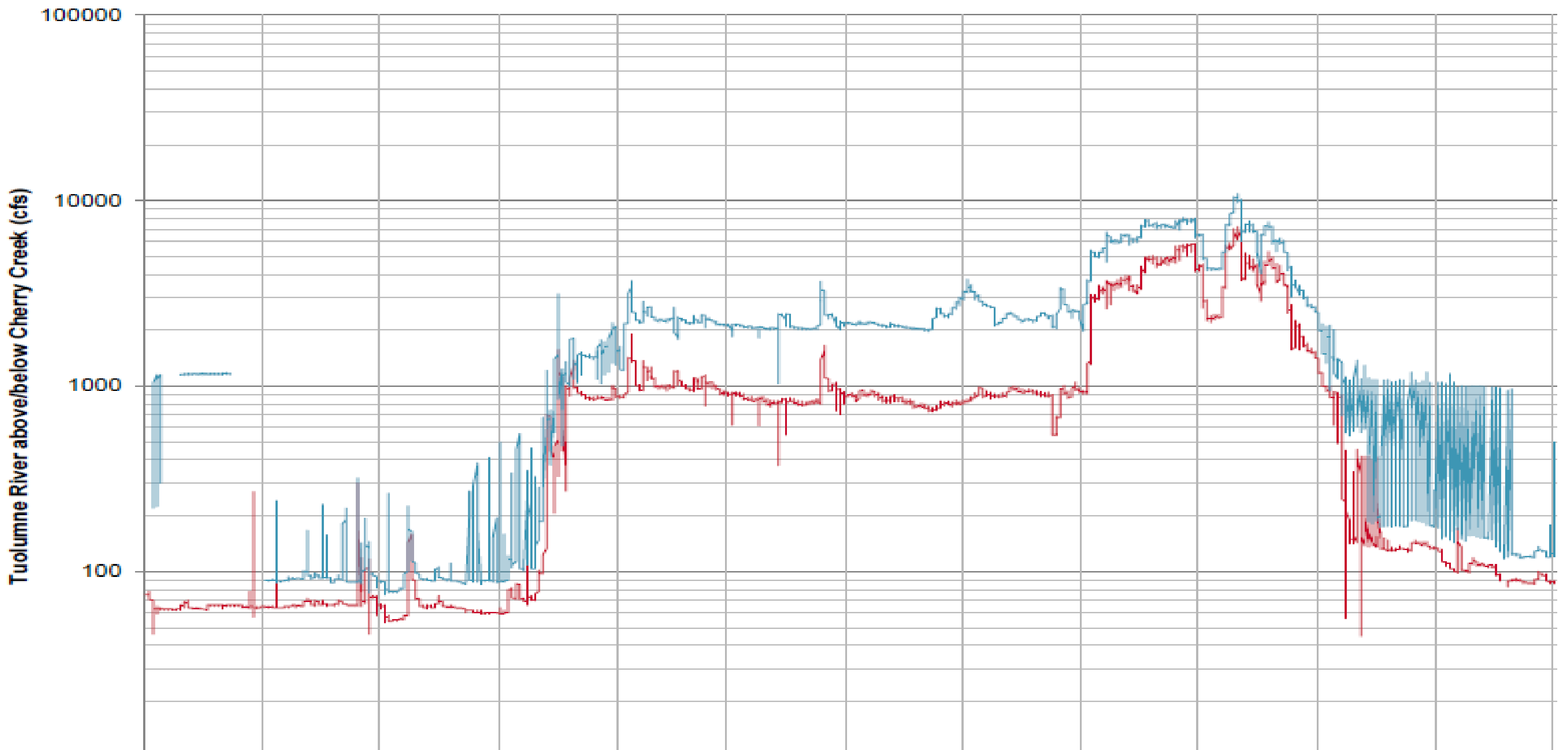
Mainstem TR Geomorphological Zones Table

PRELIMINARY

Main Stem Tuolumne River Geomorphological Zones					
Subreach	**RM**	**Length (mi)**	**Approx Change in Elev**	**Channel Gradient (%)**	**Description**
Wards Ferry to Clavey River	78.4 - 91	12.6	400 ft	0.6	Channel becomes semi-alluvial; large boulder bars and side channels are more common here than in upstream reaches.
Clavey River to South Fork Tuolumne River	91 - 97	6	300 ft	0.9	Boulder cascades separated by medium-length pools.
South Fork Tuolumne River to Early Intake	97 - 105.5	8.5	1100 ft	2.5	Deep pools separated by boulder cascades; confined by steep, bedrock canyon walls; some boulder alternate bars and few side channels.

Hydrology

Mainstem TR Hydrology – Wet Year (WY 1998)

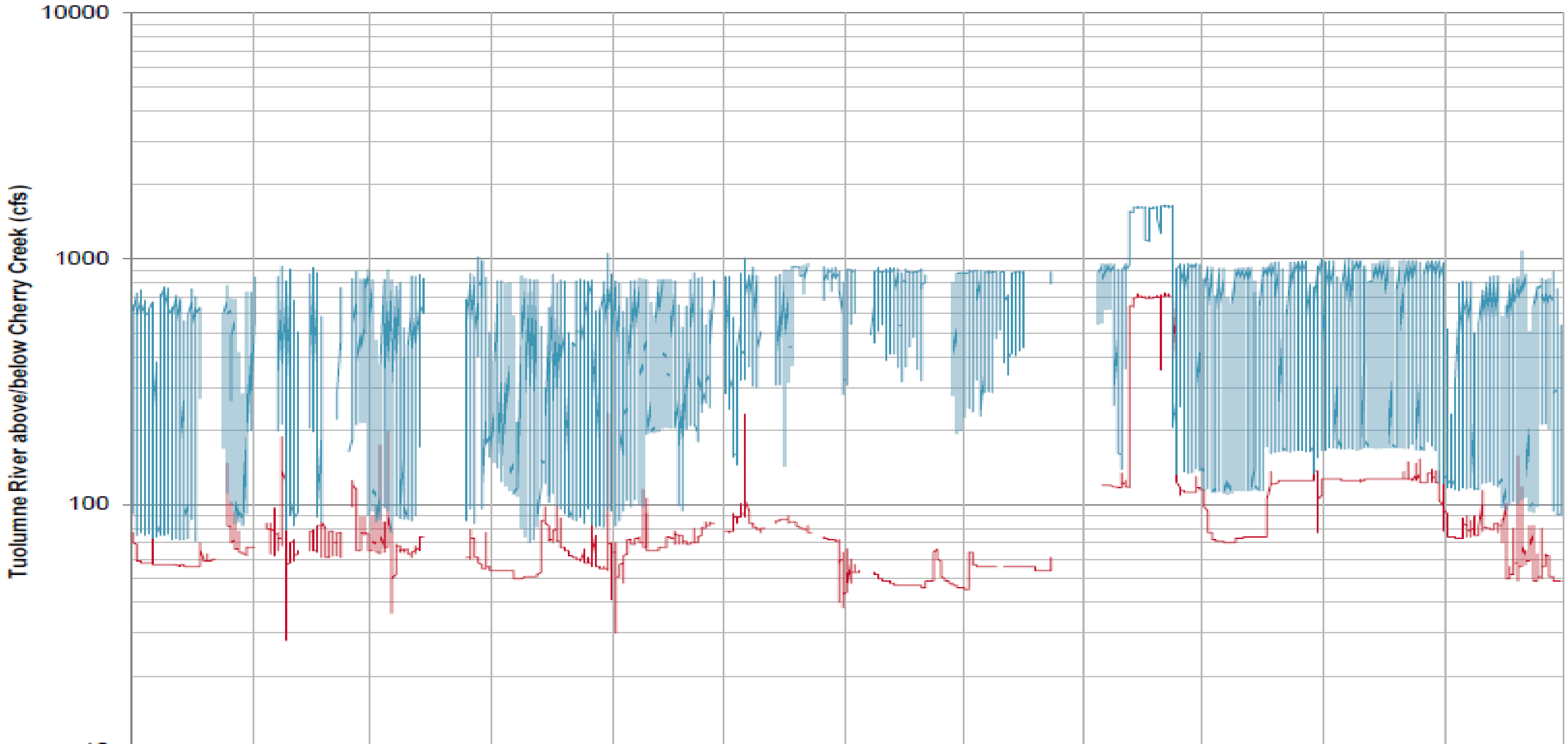


	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Above	4,001AF	4,085 AF	3,961AF	34,560 AF	57,717 AF	53,619 AF	49,670 AF	55,435 AF	242,666 AF	218,828 AF	18,939 AF	5,736 AF
Below	32,936 AF	5,936 AF	6,625 AF	58,303 AF	128,050 AF	133,769 AF	133,505 AF	156,443 AF	389,723 AF	335,667 AF	51,260 AF	17,580 AF

Water Year 1998 - 749,215 AF Above and 1,449,797 AF Below Cherry Creek

TURLOCK IRRIGATION DISTRICT | MODESTO IRRIGATION DISTRICT

Mainstem TR Hydrology – Dry Year (WY 1990)

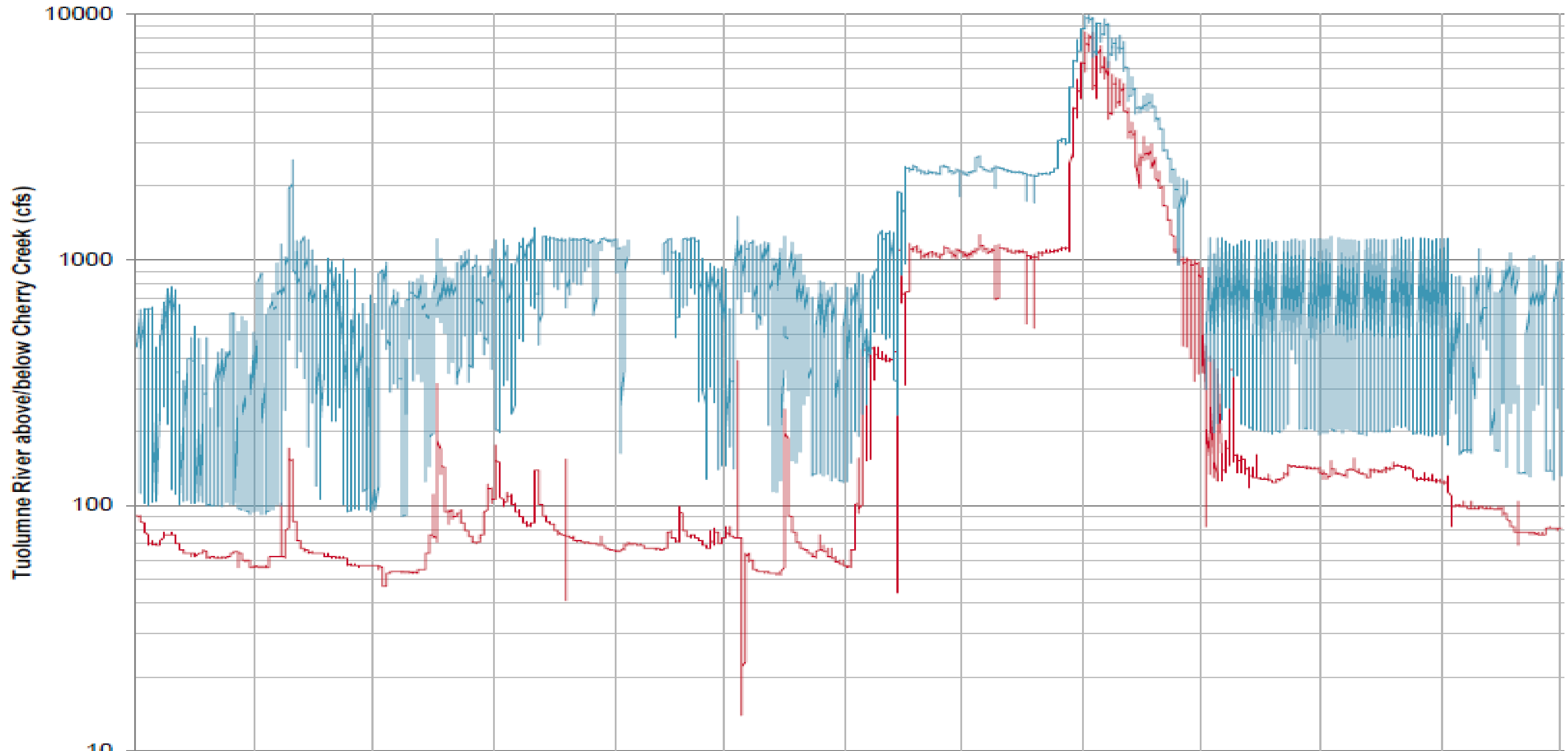


	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Above	3,515 AF	3,180 AF	2,713 AF	3,794 AF	3,589 AF	3,825 AF	2,647 AF	2,414 AF	19,020 AF	5,944 AF	7,734 AF	4,053 AF
Below	20,756 AF	16,088 AF	18,995 AF	27,515 AF	23,193 AF	30,834 AF	26,708 AF	20,286 AF	54,756 AF	34,719 AF	37,040 AF	28,241AF

Water Year 1990 - 62,428 AF Above and 339,133 AF Below Cherry Creek

TURLOCK IRRIGATION DISTRICT | MODESTO IRRIGATION DISTRICT

Mainstem TR Hydrology – Normal Year (WY 2003)



	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Above	4,081 AF	3,911 AF	4,878 AF	5,171 AF	3,978 AF	4,117 AF	42,832 AF	97,516 AF	190,194 AF	9,694 AF	8,329 AF	5,355 AF
Below	22,125 AF	39,352 AF	41,473 AF	63,332 AF	33,095 AF	42,842 AF	94,437 AF	189,684 AF	264,308 AF	32,092 AF	28,804 AF	32,047 AF

Water Year 2003 - 380,056 AF Above and 883,592 AF Below Cherry Creek

CCSF Minimum Flow Regimes

1982 Streamflow Stipulation for Eleanor Creek below Lake Eleanor Dam

Month	Minimum Flow (cfs)	
	Pumping	Not Pumping
Jan	5	5
Feb	5	5
Mar	10	5
April 1 - 14	10	5
April 15 - 30	20	5
May	20	5
June	20	5
July	20	15.5
Aug	20	15.5
Sept 1 - 15	20	15.5
Sept 16 - 30	10	15.5
Oct	-	5
Nov	5	5
Dec	5	5

1950 Streamflow Stipulation for Cherry Creek below Cherrry Valley Dam

Month	Minimum Flow (cfs)
Jan	5
Feb	5
Mar	5
April	5
May	5
June	5
July	15.5
Aug	15.5
Sept	15.5
Oct	5
Nov	5
Dec	5

1985 Streamflow Stipulation for the Tuolumne River below O'Shaughnessy Dam

Month	Minimum Flow (cfs)				
	A (60%)	A (60%)	B(32%)	B (32%)	C (8%)
Jan	50	114	40	104	35
Feb	60	124	50	114	35
Mar	60	124	50	114	35
April	75	139	65	129	35
May	100	164	80	144	50
June	125	189	110	174	75
July	125	189	110	174	75
Aug	125	189	110	174	75
Sep 1 - 15	100	164	80	144	75
Sep 16 - 30	80	144	65	129	50
Oct	60	124	50	114	35
Nov	60	124	50	114	35
Dec	50	114	40	104	35

Source: RMC Water and Environment and McBain & Trush, Inc. 2007.

TURLOCK IRRIGATION DISTRICT | MODESTO IRRIGATION DISTRICT

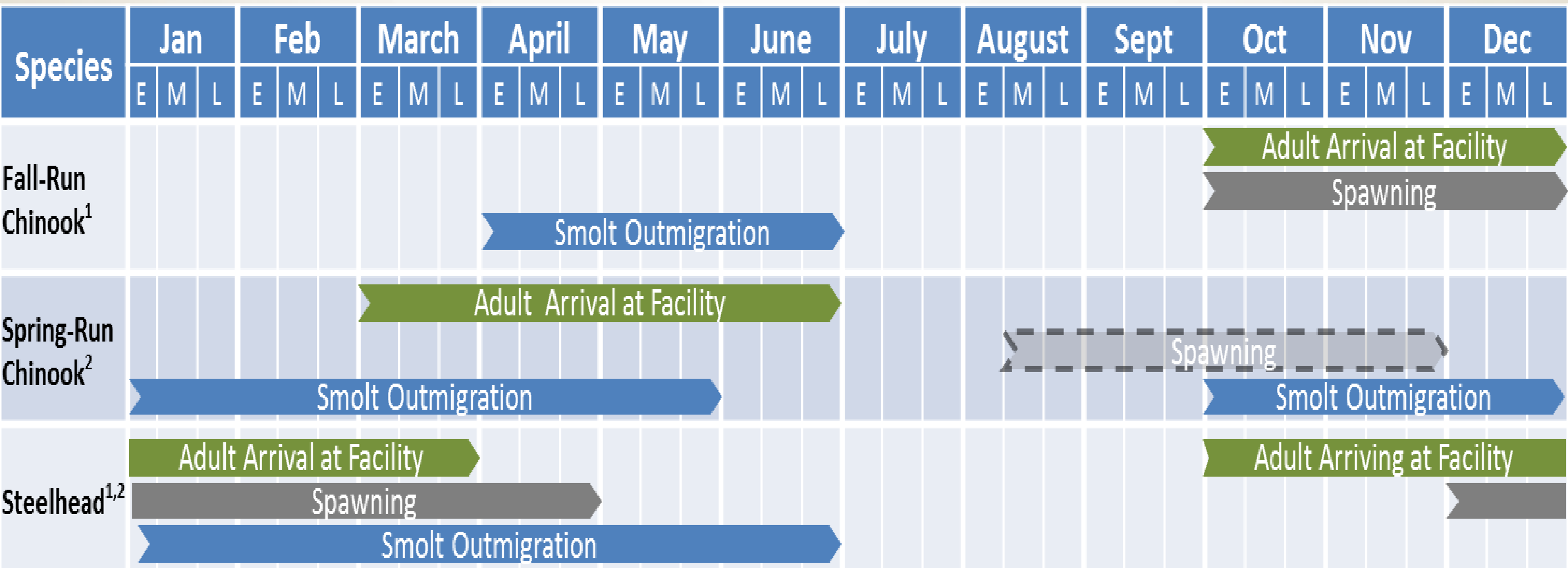
Anadromous Fish Species Being Considered For Reintroduction

Species of Interest

Steelhead	Spring-run Chinook	Fall-run Chinook
☑	☑	?

Turlock Irrigation District | Modesto Irrigation District

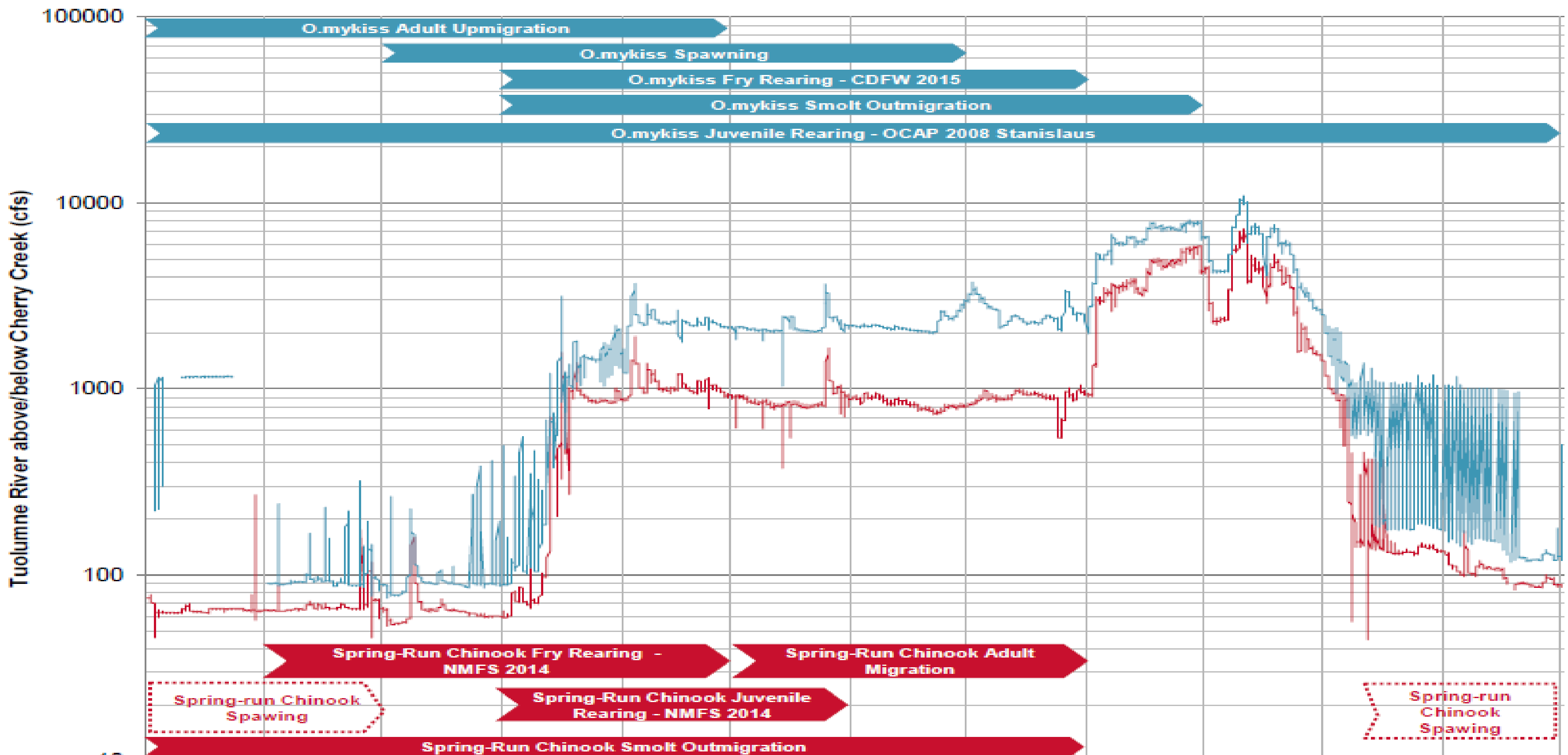
Species of Interest
Anticipated Life History Timing



[1] TID/MID 2013b.
[2] BOR et al. 2013 and NMFS 2014

TURLOCK IRRIGATION DISTRICT | MODESTO IRRIGATION DISTRICT

TR Abv/Bel Cherry Creek – Wet WY (WY 1998)

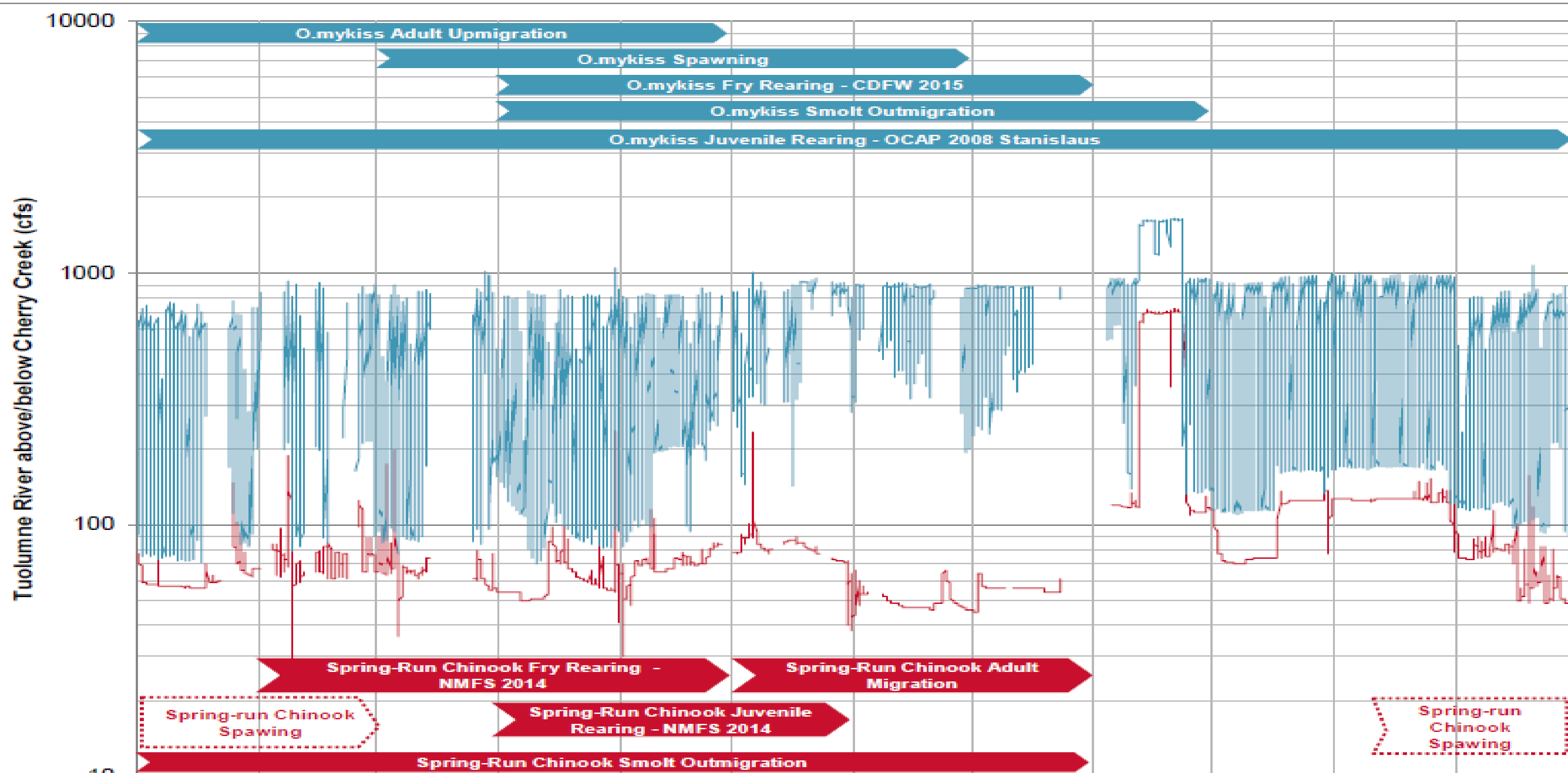


	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Above	4,001 AF	4,085 AF	3,961 AF	34,560 AF	57,717 AF	53,619 AF	49,670 AF	55,435 AF	242,666 AF	218,828 AF	18,939 AF	5,736 AF
Below	32,936 AF	5,936 AF	6,625 AF	58,303 AF	128,050 AF	133,769 AF	133,505 AF	156,443 AF	389,723 AF	335,667 AF	51,260 AF	17,580 AF

Water Year 1998 - 749,215 AF Above and 1,449,797 AF Below Cherry Creek

TURLOCK IRRIGATION DISTRICT | MODESTO IRRIGATION DISTRICT

TR Abv/Bel Cherry Creek – Dry WY (WY 1990)

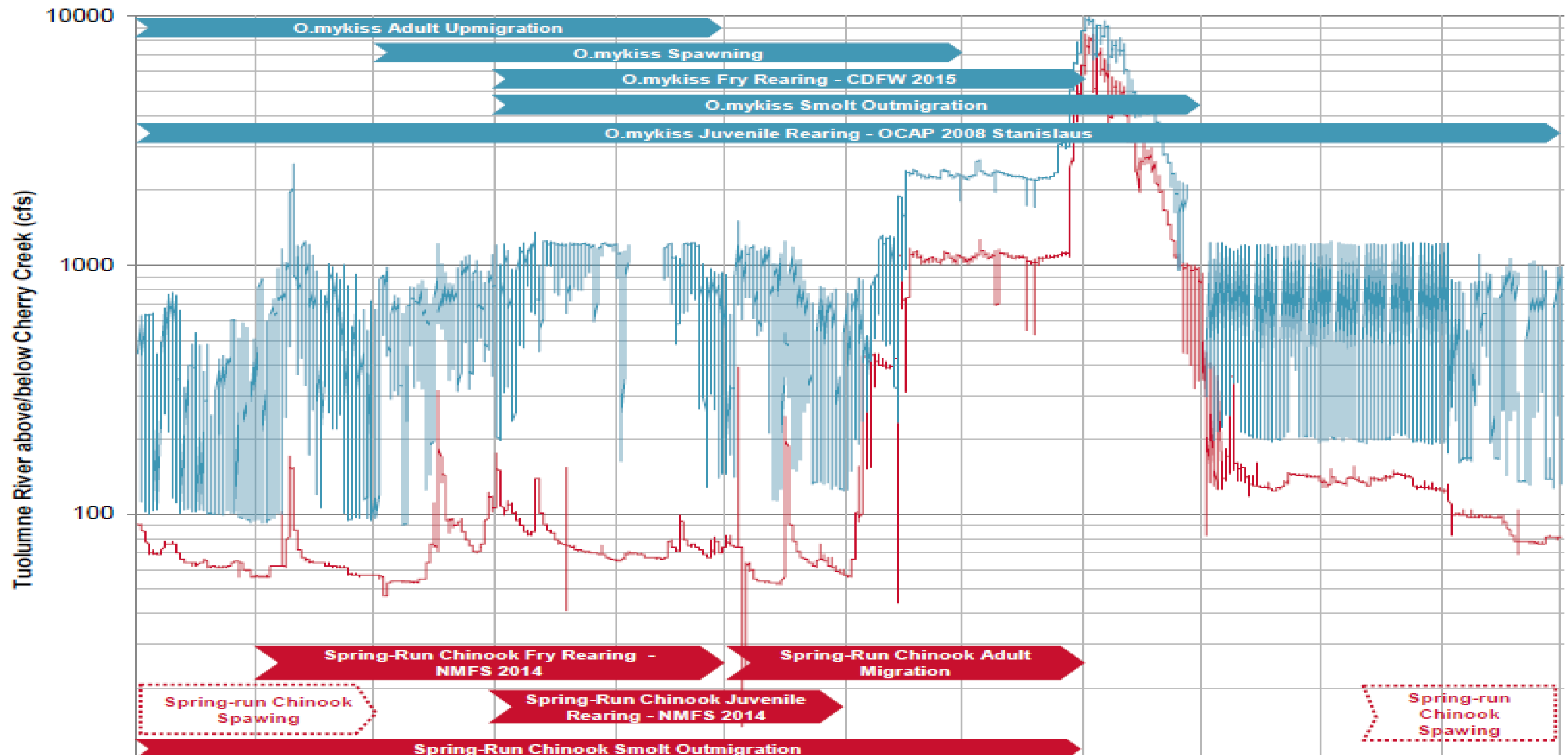


	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Above	3,515 AF	3,180 AF	2,713 AF	3,794 AF	3,589 AF	3,825 AF	2,647 AF	2,414 AF	19,020 AF	5,944 AF	7,734 AF	4,053 AF
Below	20,756 AF	16,088 AF	18,995 AF	27,515 AF	23,193 AF	30,834 AF	26,708 AF	20,286 AF	54,756 AF	34,719 AF	37,040 AF	28,241AF

Water Year 1990 - 62,428 AF Above and 339,133 AF Below Cherry Creek

TURLOCK IRRIGATION DISTRICT | MODESTO IRRIGATION DISTRICT

TR Abv/Bel Cherry Creek – Normal WY (WY 2003)



	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Above	4,081 AF	3,911 AF	4,878 AF	5,171 AF	3,978 AF	4,117 AF	42,832 AF	97,516 AF	190,194 AF	9,694 AF	8,329 AF	5,355 AF
Below	22,125 AF	39,352 AF	41,473 AF	63,332 AF	33,095 AF	42,842 AF	94,437 AF	189,684 AF	264,308 AF	32,092 AF	28,804 AF	32,047 AF

Water Year 2003 - 380,056 AF Above and 883,592 AF Below Cherry Creek

TURLOCK IRRIGATION DISTRICT | MODESTO IRRIGATION DISTRICT

Upper Tuolumne River Studies

TURLOCK IRRIGATION DISTRICT | MODESTO IRRIGATION DISTRICT

Goals of Upper Tuolumne River Studies

Upper River Barriers Study	Water Temp. Monitoring and Modeling	Anadromous Fish Habitat Reconnaissance

• Determine potential limits of anadromy by identifying physical features classified as total barriers on TR mainstem and tribs upstream of Don Pedro Project Boundary	• Use existing data and collect additional data (as necessary) to characterize thermal regimes of upper TR and tribs from Early Intake to above DP Reservoir
	• Develop and test a computer model to simulate existing thermal conditions in TR from below Early Intake to above DP Reservoir
		• Reconnaissance level investigation of habitat suitability for anadromous fish
		  • TR (downstream of Meral's Pool), S.F. Tuolumne River, Clavey River
		• Habitat elements for consideration
		  • Holding pools (mainstem)
		  • Spawning gravel (tributaries)
		  • Habitat unit diversity
		  • Summer thermal conditions
		  • Stranding potential (mainstem)

Upper River Barriers Study

- Observed via watercraft on August 2 – 4 and observed by foot on August 5 – 6 and October 26 – 27
- Surveys conducted on mainstem TR (downstream of Lumsden Falls and upstream of Cherry Creek confluence), South Fork TR, Clavey River, and Cherry Creek
- Each observed during lower flow of about 350 cfs and two-unit Holm powerhouse flow of about 1,000 cfs
- More information available in ISR

Temp. Monitoring and Modeling Study

Summary of 2015 Activities

- Existing data through 2014 compiled and evaluated
- 2015 monitoring locations for additional data identified
- Loggers deployed in spring 2015 and downloaded fall 2015
- QA/QC of 2015 field data is near completion
- Additional data will be presented in ISR

TURLOCK IRRIGATION DISTRICT | MODESTO IRRIGATION DISTRICT

Anadromous Fish Habitat Reconnaissance

- Habitat reconnaissance conducted in concert with barriers work in similar locations and reaches
- Habitat elements for consideration
  - Holding pools (mainstem)
  - Spawning gravel (tributaries)
  - Habitat unit diversity
  - Summer thermal conditions
  - Stranding potential (mainstem)
- Preliminary observations downstream of barriers suggest limited habitat in tributaries
- Additional mainstem habitat information (e.g. thermal regime, flow regime, spawning gravel, holding pools) is needed to evaluate suitability for anadromous salmonids

Next Steps For Upper Tuolumne River Studies

Upper River Barriers Study	Water Temp. Monitoring and Modeling	Anadromous Fish Habitat Reconnaissance

• Complete remaining initial field surveys on North Fork and Tuolumne River mainstem between Lumsden and Cherry Creek Confluence (RM 97.3 to 104.0)
• Perform more detailed assessment of barriers identified in 2015.
	• Coordinate with barrier study team to identify potential limits to upstream migration
	• Confirm life history presence/absence in space and time through study area
	• Characterize temperature on a reach-by-reach basis
	  • Field data
	  • Models
		• Select studies for 2016 calendar year

TURLOCK IRRIGATION DISTRICT | MODESTO IRRIGATION DISTRICT

Benthic Macroinvertebrates

Benthic Macroinvertebrates

- Data Availability
  - Numerous BMI samples were collected in study reach for Ponderosa Project
  - A limited number of samples were analyzed

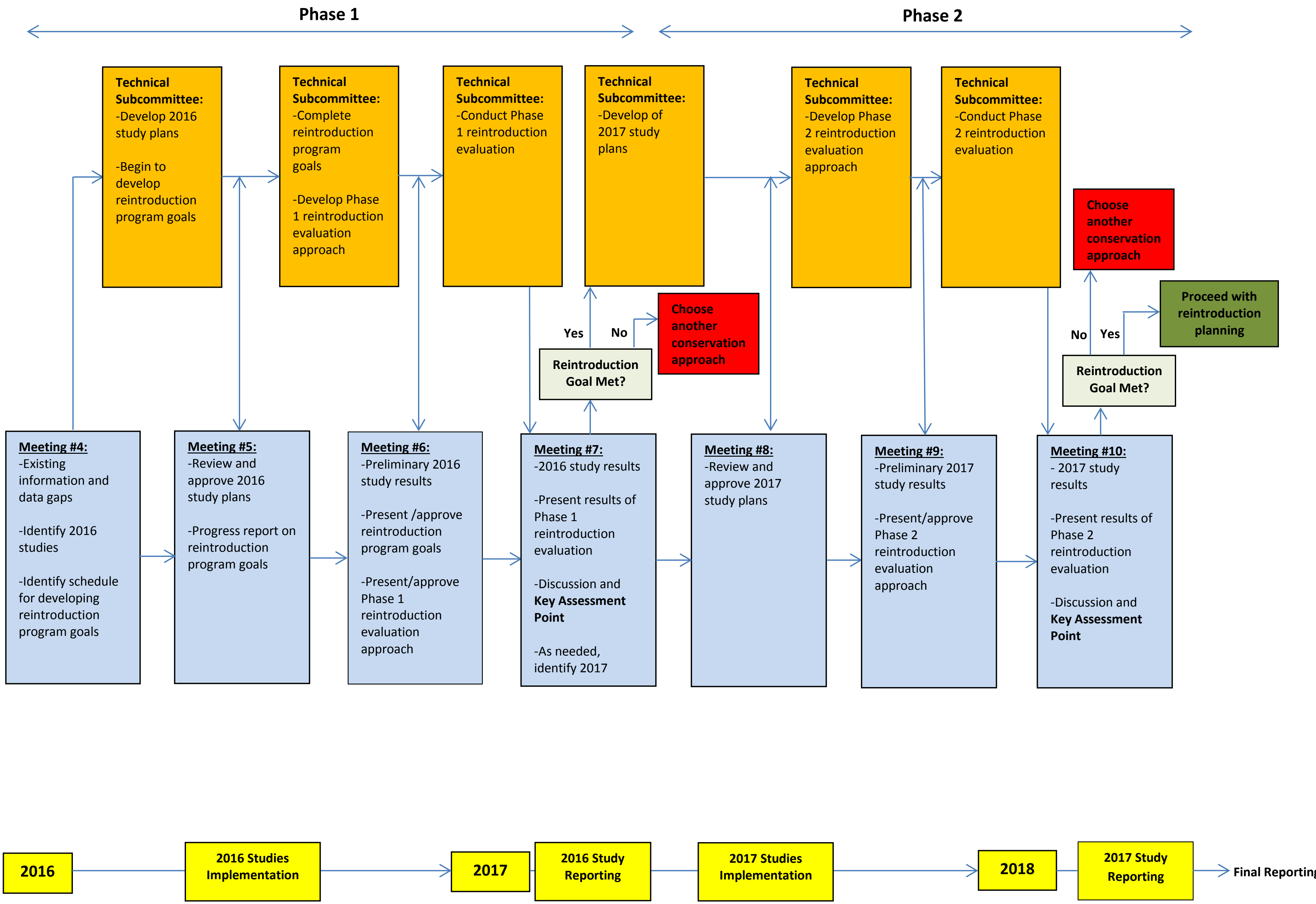
- Preliminary Results (from McBain & Trush 2007)
  - "Species diversity (richness) downstream of Early Intake to Wards Ferry was moderate overall but low when compared to sites above Early Intake in the tributaries to the mainstem, probably due to hypolimnial releases from Holm PH"
  - "Plecoptera (stoneflies) and Elmidea (riffle beetles) were notably absent from the samples in the Lumsden Reach, which could be an indicator of environmental stress"
  - BMI "abundance was low at all sites in the reach"

Other Water Uses/ Affected Resources/ Potential Impacts

Other Water Uses/ Affected Resources/ Potential Impacts

Environmental Issues		Regulatory Issues
• Impacts caused by or to other fish species: river and reservoir predator abundance (rainbow trout; pikeminnow; smallmouth bass); Clavey River Wild Trout and Heritage Trout designation; competition for spawning habitat; interbreeding resident/ anadromous *O. mykiss*; interbreeding stocked Chinook and introduced Chinook; • Impacts to/effects of Don Pedro stocking of salmonids (kokanee; Chinook; coho; rainbows)	• *O. mykiss* genetic considerations • Impacts caused by or to whitewater boating • Impacts caused by or to recreational fishing • Fishing regulations in affected reaches and Don Pedro Reservoir • Effects on watershed forest harvest practices • Juvenile mortality in lower Tuolumne River	• Designations under ESA • USFS whitewater boating annual permits (need ESA protection – each year?, BiOps, NEPA compliance) • USFS Forest Plan changes due to introduction of listed species • BLM Mngt Plan changes • W&S River designation compatibility • Installation of passage facilities in W&S reaches? • CCSF operations – need ESA authorization and "take" permits?

Upper Tuolumne River Reintroduction/Fish Passage Assessment Framework – Flow Chart



La Grange Hydroelectric Project Licensing
Upper Tuolumne River Reintroduction Assessment Framework
Proposed Meetings/Schedule 2016-2017

DRAFT Programmatic Process Steps and Goals by Year
2016 (Phase 1):
- Share and assess existing information relevant to assessing reintroduction in the upper Tuolumne River (includes past studies/information, ongoing studies related to licensing, and agency-led studies).
- Identify data gaps/additional information needs and scope priority studies in 2016 to address data gaps. 2016 studies constitute Phase 1 of the assessment framework with a focus on preliminary biological/ecological, regulatory, and other uses/user impact information needs.
- Conduct 2016 studies.
- Develop reintroduction program goal (i.e., criteria for success) in order to evaluate reintroduction (in combination with available/collected information).
- Develop Phase I reintroduction evaluation approach that addresses biological/ecological and regulatory areas (last quarter of 2016).

2017 (end Phase 1, begin Phase 2):
- Review and finalize 2016 study reporting and make information available for Phase I reintroduction evaluation.
- Conduct Phase I reintroduction evaluation using relevant program goal (developed in 2016) and existing/collected information. Collaborative discussion of evaluation results and whether reintroduction program goal can be met (i.e., key assessment point).
- If Phase I reintroduction evaluation results and subsequent discussions support proceeding forward with assessment framework, scope 2017 studies that constitute Phase 2 and are focused on additional biological/ecological information (as needed), re-engaging fish passage engineering design (using more accurate biological information), socio-economic and cost-benefit analysis, etc.).
- Reservoir Transit Study as identified in FERC's Study Plan Determination.
- Conduct 2017 studies.
- Develop Phase II reintroduction evaluation approach that addresses additional biological/ecological, engineering, and social and economic areas of consideration (last quarter of 2017).

2018:
- Review and finalize 2017 study reporting and make information available for Phase II reintroduction evaluation.
- Conduct Phase II reintroduction evaluation using relevant program goal (developed in 2016) and existing/collected information. Collaborative discussion of evaluation results and whether reintroduction program goal can be met (i.e., key assessment point).

2016 Phase 1 Schedule:

1. **Workshop 4 - January 27, 2016 (Wednesday): 9am to 12pm.**
    a. Objectives:
        i. Present and reach agreement upon framework and schedule (Phased approach including 2016 meetings).
        ii. Discuss and identify approach/schedule for developing goals of reintroduction program.
        iii. Summarize existing information and begin scoping potential 2016 studies that address key Phase 1 elements of assessment framework and can be used to assess reintroduction program success (goal).
        iv. Approve the use of a technical subcommittee as a means to implement technical tasks approved by the plenary group to minimize the numbers of workgroup meetings.
    b. Materials to be distributed in advance:
        i. Agenda
        ii. Draft Reintroduction Framework schedule and flow diagram
        iii. Studies list

2. **Workshop 5 – April 13 or 20, 2016**

a. Objectives:
    i. Review and approve 2016 study plans developed by technical subcommittee.
    ii. Progress report on task to develop reintroduction program goals.
b. Materials to be distributed in advance:
    i. 2016 study plans – for review/approval as identified from meeting 1
    ii. Reintroduction goal materials - TBD

3. May 2016 to November 2016 – Implementation of 2016 studies

a. No meetings planned until November during study implementation but could have a progress update via optional conference call, if desired.
b. June/July: complete development of reintroduction program goals.
c. July/August: begin technical subcommittee development of Phase I reintroduction evaluation approach.

4. Workshop 6 – November 17, 2016 (Thursday)

a. Objectives:
    i. 2016 study updates.
        1. Share preliminary information.
        2. Reporting schedule.
    ii. Present reintroduction program goal (completed in June/July 2016).
    iii. Present/approve Phase I reintroduction evaluation approach.
b. Materials to be distributed in advance:
    i. Agenda
    ii. TBD

2017 End Phase 1/Phase 2 Schedule: Detailed meeting schedule TBD; high level ideas for consideration below:

- 2016 study reporting will likely be final in first quarter of 2017 depending upon specific study scope and schedule.
- Priority in 1st quarter of 2017 is to conduct Phase I reintroduction evaluation to inform next steps of reintroduction assessment framework. – **Key Assessment Point.**
- If information shows that reintroduction goal can be met, 2017 Phase 2 studies would focus on additional biological/ecological information (if needed), and non-biological/ecological considerations such as socio-economics, impacts to other uses, etc. 2017 study scoping and study plan development would occur in the late first quarter/early second quarter of 2017.
- If reintroduction from a biological, ecological and regulatory perspective is supported, information could be available to re-engage in a more detailed concept-level fish passage engineering design process so this could occur in 2017.
- 2017 study updates.
- Development of a Phase 2 reintroduction evaluation approach to inform next key assessment point will be required toward the end of the year.

2018 – Detailed schedule TBD

- 2017 reporting completed.
- Complete Phase II reintroduction evaluation, second **Key Assessment Point** and final conclusion developed.

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

April 4, 2016

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

Re: Comments of NOAA's National Marine Fisheries Service on the Initial Study Report for the La Grange Hydroelectric Project; and Proposed New Information Gathering or Study for the La Grange Hydroelectric Project, P-14581-000.

Dear Secretary Bose:

NOAA's National Marine Fisheries Service (NMFS) timely provides the following for the Don Pedro Hydroelectric Project (Project), under Federal Energy Regulatory Commission (FERC or Commission) regulations at 18 CFR § 5.15 (c) (4), § 5.15 (d), and § 5.15 (e):

- Proposed new information gathering or study, not currently in the Study Plan.

NOAA's National Marine Fisheries Service (NMFS) reviewed the Initial Study Report (ISR) filed by the Turlock Irrigation District and Modesto Irrigation District (Districts) on February 2, 2016. The Districts are the applicants for an original license for the La Grange Hydroelectric Project, P-14581 (Project). NMFS' initially submitted study requests and descriptions of our statutory responsibilities, and goals and objectives on July 22, 2014 in this ILP. NMFS previously filed comments December 5, 2014 on the Districts' Proposed Study Plan, and on January 20, 2015 on the Districts' Revised Study Plan; NMFS refers the Commission to these past comments as well. NMFS also attended the February 25, 2016, Initial Study Report Meeting, where we provided oral comments on the ISR as well as explanations and clarifications regarding NMFS' concerns to the Districts and Commission staff.

As part of this filing, NMFS is submitting a new study request: Effects of La Grange Hydroelectric Project Under Changing Climate. NMFS requests this new information collection or study according to the regulations implementing the ILP, 18 C.F.R. § 5.15 (e). Significant new information, material to the study objectives, has become available since NMFS' initial study requests were submitted on July 22, 2014, in the form of climate change study methods and application (detailed in Enclosure B). Additionally, environmental conditions have changed, as California experienced record drought conditions from 2012 to 2015, culminating in snowpack levels in 2015 that are estimated to be the lowest in 500 years (Belmecheri et al., 2016).

NMFS is also requesting one study modification, an additional survey to be added to the Districts' Study: Topographic Survey Downstream of La Grange Diversion Dam. As part of this study, the Districts surveyed water depths in channels in the vicinity of the La Grange Powerhouse; however, they were unable to survey water depth in 2015 in the TID Sluice Gate Channel – a location NMFS believes has potential to strand anadromous and resident fish. The Districts' intend to survey water depth in the sluice gate channel in 2016 at a typical flow (about 75 to 90 cfs). NMFS is now aware (due to information reported in the 2016 ISR) that the Districts routinely discharge about 5 cfs into this channel at all times through a separate pipe. NMFS requests that the Districts also conduct water depth surveys at 5 cfs in order to evaluate habitat, fish passage into and out of the sluice gate channel, and potential stranding risks at 5 cfs, a discharge that is reported to occur all of the time. NMFS has also requested electronic copies of data pertaining to two studies (Historical Flow Records for Five Discharge Structures at the La Grange Project; and Topographic Survey Downstream of La Grange Diversion Dam), in order to fully evaluate the initial results and provide more detailed feedback to the Districts and the Commission.

In each of our requests, including the new study request submitted in this filing, NMFS is seeking information or study of the Project's effects on the anadromous fishes and habitats under our jurisdiction. In each case, the information or study requested by NMFS directly pertains to gaining a fuller understanding of the Project's effects on: anadromous fishes, Endangered Species Act (ESA) designated critical habitat, and Magnuson-Stevens Fishery Conservation and Management Act (MSA) identified essential fish habitat (EFH) for Chinook salmon. These resources are identified and discussed in NMFS' filing of July 22, 2014. NMFS submitted its requests for information or study according to the content regulations for the ILP. 18 CFR § 5.9 (a); § 5.9 (b). The information or results of the study from NMFS' requests are intended to be used to:

- Inform NMFS, FERC, other ILP participants and the public about the Project's effects on anadromous fish passage, to assist NMFS in the exercise of its Federal Power Act (FPA) § 18 authority, to either: 1) prescribe fishways at the Project, (2) not prescribe, or (3) reserve the prescriptive authority over the license term;

- Inform NMFS, FERC, other ILP participants and the public regarding future FPA § 10 (j) and § 10 (a) recommendations for protection, mitigation, and enhancement measures related to anadromous fishes or habitats affected by the Project;

- Inform NMFS, FERC, other ILP participants and the public regarding recommended measures during MSA consultation between the Commission and NMFS about the effects of the Project on Chinook salmon EFH;

- Inform future ESA § 7 consultation between the Commission and NMFS regarding Project effects on threatened species and designated critical habitats in the Tuolumne River, and in areas downstream.

NMFS notes that its July 2014 *Recovery Plan for the Evolutionarily Significant Units of Sacramento River Winter-run Chinook Salmon and Central Valley Spring-run Chinook Salmon and the Distinct Population Segment of California Central Valley Steelhead* (Recovery Plan) was filed on the Project docket as a comprehensive plan, and it describes recovery planning actions directly applicable to areas upstream and downstream of the Project in the Tuolumne River. NMFS anticipates the need for consultations between our agency and the Commission under section 7 of the ESA, as well as the MSA, over the Project's effects to anadromous species and their habitats. Therefore, NMFS recommends avoiding the inefficiencies and delays that might result from insufficient study or information gathering during this ILP.

The attached enclosures include:

- Enclosure A: NMFS' comments on the Districts' Initial Study Report, and

- Enclosure B: A new study request from NMFS; Effects of La Grange Hydroelectric Project Under Changing Climate

Thank you for the opportunity to provide comments. If you have questions regarding NMFS' response, please contact Mr. John Wooster of my staff, at 916-930-3616.

Sincerely,

Steve Edmondson
FERC Branch Supervisor
NMFS, West Coast Region

Enclosures

cc: Service List P-14581

Enclosure A

UNITED STATES OF AMERICA
FEDERAL ENERGY REGULATORY COMMISSION

RECOMMENDATIONS TO MODIFY OR CLARIFY
THE COMMISSION-APPROVED STUDY PLAN

La Grange Hydroelectric Project	**)**	**P-14581**
Turlock Irrigation District and Modesto Irrigation District	**)**	
____	**)**	

The Districts filed an ISR for the La Grange Hydroelectric Project on February 2, 2016. The ISR included initial results on nine studies or study components organized as Appendices A through I. NMFS provides comments on these initial study results below.

Fish Passage Facilities Assessment (ISR Appendix A)

As of March 2016, the Districts have held four workshops pertaining to the Fish Passage Facilities Assessment. These workshops have presented broad overviews of fish passage facilities on other projects and have highlighted the informational needs to develop plans for fish passage facilities. The workshops have also focused heavily on the information and data gaps pertaining to developing fish passage facilities on the Tuolumne River. In workshops #2, #3, and #4, the Districts used the majority of the time to propose an Upper Tuolumne Reintroduction/Fish Passage Assessment Framework Process, which significantly expands and broadens the scope beyond the original Fish Passage Facilities Assessment Study Plan. This has resulted in the delay of the original Fish Passage Facilities Study Plan, as Phase 1 of this study was scheduled to be completed in February 2016 and the completion of initial Fish Passage Facility Report in March 2016 (timelines presented at Workshop #1 May 20, 2015). Phase 2 of the Study Plan was scheduled to be conducted in 2016 and 2017; however, with Phase 1 not complete Phase 2 cannot proceed.

Phase 1 elements of the Fish Passage Facilities Assessment Study Plan included developing initial sizing, siting, and layouts of potential fish passage facilities and recommending a couple of preferred fish passage facilities designs. If the preferred fish passage facilities designs included either upstream or downstream movement of fish through Don Pedro Reservoir, then Phase 2 study elements would include reservoir transit studies of the relevant fish life-stages through the reservoir (e.g., adults moving upstream through the reservoir and/or juveniles/smolts moving downstream). A reservoir transit study requires significant lead time to design, prepare, and permit. A reservoir transit study will obviously not be conducted in 2016; however, in order to conduct a reservoir transit study in 2017 (if deemed necessary) planning for this study element likely needs to begin no later August/September 2016. Thus, Phase 1 of the Fish Passage Facilities Assessment Study Plan needs to be completed by the end of summer of 2016 in order to determine what studies are needed as part of Phase 2. If Phase 1 is not completed by this timeframe, a reservoir transit study, if needed, would likely be delayed until 2018.

In workshop #2, the Districts proposed a Reintroduction/Fish Passage Assessment Process coupled with a complex Integrated Reintroduction Decision Tree that contains greater than 100 flow chart elements (ISR Appendix A on approximately page 227). NMFS agrees with the Districts that developing and conducting additional studies could provide valuable information for evaluating reintroduction and fish passage in the Tuolumne River. To this end, NMFS has agreed to work collaboratively with the Districts and other relicensing participants to identify and prioritize informational needs, and collectively identify methods and means to develop this information where feasible. NMFS has not agreed to nor adopted the Districts proposed Integrated Reintroduction Decision Tree, which includes nine different off-ramps to not pursue reintroduction and one decision point to pursue a full reintroduction program. Relicensing participants agreed in Workshop #2 that likelihood of coming to consensus on what an Integrated Reintroduction Decision Tree as proposed by the Districts should look like, including both the number and content of flow chart elements as well as their implied timeline order, interrelation and dependence, was extremely low and likely not a valuable use of limited available time. Instead, relicensing participants agreed in Workshop #2 that the more valuable path forward was to work collaboratively to identify and prioritize informational needs that could be used in developing fish passage facilities and used in informing reintroduction decisions. How each relicensing participant choose to use the available information would dependent on each entities mandates, goals, and objectives.

As part of the proposed Reintroduction/Fish Passage Assessment Process several informational needs were identified and the Districts have proposed conducting additional studies to supplement and fill some of these data needs. Currently, five additional studies are being proposed by the Districts to be conducted in 2016. NMFS has worked collaboratively with the Districts to identify studies for 2016 and is currently reviewing draft study plans for these five studies. Several additional studies have been identified as potential second round 2017 studies, depending in part on results from 2016 studies. NMFS appreciates the Districts willingness to conduct additional studies in 2016, and looks forward to working collaboratively with them on developing these study plans and participating in study implementation to the extent possible.

As described above, NMFS believes that Phase 1 of the Fish Passage Assessment Study Plan needs to be completed by the end of summer 2016 in order for Phase 2 to be completed in 2017. NMFS feels that there is sufficient information available through studies being conducted as part of the La Grange ILP, studies already completed in the Don Pedro Project ILP, studies currently being conducted by NMFS, and existing literature and information from other Projects for the Phase 1 to be completed in the next 5 months. While the Districts presented a wide range of potential fish passage facilities at their workshops, NMFS believes the range of potential fish passage facilities to move fish upstream and downstream of La Grange and Don Pedro dams and associated reservoirs is relatively narrow due to: the height of Don Pedro Dam, the large size and complex nature of Don Pedro Reservoir, and the relatively high level of reservoir stage fluctuation in Don Pedro. Furthermore, the target species for conceptual level fish passage designs have been identified: spring-run Chinook, fall-run Chinook, and CV steelhead. The general run timing for each species and life stage has been developed in ISR Appendix A. NMFS is currently conducting an Upper Tuolumne Habitat and Carrying Capacity Study; a study that when completed should provide estimates on the population sizes that the habitat upstream of Don Pedro can support. NMFS is anticipating this study will be completed in October 2016. In the interim to completing the habitat carrying capacity estimates, NMFS believes that design of conceptual fish passage facilities should be planned to handle, at a minimum, run sizes of all three target species sufficient to support self-sustaining, viable populations (Lindley et al., 2007). While some of the information used to complete Phase 1 may be updated as other studies are completed, NMFS believes that the overall timeline to complete the Fish Passage Alternatives Assessment by 2017 should be adhered to and requests that the Commission support its original timeline.

La Grange Project Fish Barrier Assessment (ISR Appendix B)

The ISR for this study describes the installation of two fish counting weirs on the Tuolumne River in the vicinity of the LGDD: one weir placed in the powerhouse tailrace channel and the other weir placed in the main channel opposite the powerhouse. The ISR presents results from September 23, 2015 through October 31, 2015, which is a relatively small sample of the intended field sampling through the 2016 and 2017 field season. Due to the limited time period of results available at this time, NMFS will only provide preliminary observations at this time and will provide detailed comments when additional results become available. Table 5.2-2 of ISR Appendix B describes the *O.mykiss* detections in the tailrace weir, which reports four upstream and nine downstream *O.mykiss* detections for the period of available data. This implies that the detection efficiency of the counting weir is relatively low, at least in the upstream direction for *O.mykiss*, as it appears that at least five out of the nine upstream passages were missed. Note, the location of the tailrace weir is immediately downstream of the powerhouse, resulting in very limited channel length for fish upstream of the weir. This lack of physical space coupled with the amount of disturbance that installing the channel spanning weir would have created, makes it highly unlikely that any *O.mykiss* were holding upstream of the tailrace weir at the onset of video surveillance. Additionally, the first *O.mykiss* detection (which was in the downstream direction) was on October 6, 2015 – nearly two weeks after surveillance initiated.

Upper Tuolumne River Basin Fish Migration Barriers Study (ISR Appendix C)

The goals of this study included characterizing and documenting the physical structure of each barrier under base flow and high flow (i.e. spring runoff) conditions. NMFS believes that information should be collected during high flows as specified in the study plan before classifying certain features as "total" barriers. See specific reaches below:

Mainstem Tuolumne River:

NMFS agrees with the Districts assessment that Clavey falls is likely a "passable" feature based on the information in the study report as well as snorkel survey information that observed Chinook salmon likely migrated from Don Pedro Reservoir upstream of Clavey falls (Weaver and Mehalik 2009).

The conclusions of the draft Study report recommend further data collection during 2016 on Lumsden Falls:

> "A more-detailed, second field survey will be conducted to collect additional data at Lumsden Falls. Upon collection of more detailed data at Lumsden Falls, a desktop analysis will be performed to determine whether passage is anticipated at various ranges of river flow conditions." (ISR Appendix C pg. 6-5)

NMFS agrees that the ability to pass Lumsden Falls on the mainstem Tuolumne River will have a quantifiable impact on the quantity of habitat accessible by spring-run Chinook and steelhead and that further analysis should consider the full range of flows occurring during spring-run Chinook and Steelhead migration windows, not just the hydropower peaking flows (~1000-1200 cfs) observed during the summer months.

If velocity is used to inform whether a feature is passable, it should be only when flow is concentrated in a chute and the velocity over its combined length overcomes the fish's swimming ability or when the geometry of the channel does not enable the fish to leap over or otherwise avoid the chute.

South Fork Tuolumne River:

NMFS agrees that the waterfall identified at RM 1.9 on the South Fork Tuolumne River is a total barrier to upstream salmonid migration. The other 17 features identified downstream from the total barrier classified as "potential" barriers in the draft report would all require more detailed investigation to determine at what flows the features become passable. NMFS agrees with the Districts that such investigations would require a great effort, would have to be conducted at high flows, and would provide little additional information given the maximum amount of habitat in the South Fork is already known to be 1.9 miles. Therefore, we recommend the features be categorized as potential "partial" barriers.

However, NMFS does not necessarily agree with statements characterizing the habitat in the lower 1.9 miles of habitat in the South Fork Tuolumne made on page 6-1:

> "Survey results and subsequent analysis indicate that the limits of anadromy will be confined to the lower two miles of the Clavey River and South Fork Tuolumne River. However, even within these lower two miles of both tributaries, the habitat conditions observed by the survey team's fishery biologists indicate that the Clavey and the South Fork Tuolumne rivers lack sufficient amounts and/or patch sizes of spawnable sized gravel to provide significant spawning opportunities." (ISR Appendix C pg 6-1)

It is premature to characterize this reach as unsuitable for spawning salmonids at this point. If reaches are to be eliminated from consideration as salmonid habitat based on presence and extent of suitable spawning gravel, all the pertinent data should be examined and presented. This data would likely consist of areal extent and particle size composition which would likely comprise its own study and not be appropriate for inclusion in a migration barriers study.

It is also inappropriate to make determinations of thermal suitability in this study without further analysis:

> "Thermal conditions in the South Fork Tuolumne River appeared at best, considerably less than optimal for anadromous salmonids… The Upper Tuolumne River Basin Water Temperature Monitoring and Modeling Study (TID/MID 2016) corroborates these field observations based upon past and current (i.e., 2015 monitoring data) temperature datasets. At the South Fork Tuolumne River confluence, maximum daily temperatures routinely exceed 20ºC in July of 2010. In 2015, temperature data were similar to historical data where temperatures warm in the spring and remain warm throughout the summer" (ISR Appendix C pg 6-1)

A thermal suitability criteria for reintroduction of salmonids has not been agreed to by the licensing participants. Although many criteria for salmonid are near 20˚C for certain life-stages, the intensity, duration, and diurnal variation of high temperatures can affect suitability. No analysis of South Fork water temperatures over multiple water year types and salmonids life stages has occurred. Furthermore, anadromous salmonid life-stages occur in freshwater during all seasons; Adult Steelhead usually complete upstream migration and spawning in the fall/winter when water temperatures are coolest. Juvenile salmonids can then migrate to find suitable water temperatures if the South Fork becomes too warm during the summer months.

Until a more complete examination of thermal suitability across all life stages occurs, NMFS does not recommend characterizing the lower 1.9 miles of the South Fork as unsuitable for salmonid spawning or rearing. In fact, direct observation of many *O. mykiss* in this reach by NMFS during hook and line sampling (NMFS unpublished data 2014) indicates that it currently supports *O. mykiss* populations, and it is likely suitable for many if not all anadromous salmonid life-stages.

Clavey River:

The study report classifies a feature at RM 2.05 as a "total" barrier to adult salmonid passage. "The primary impediments to fish passage include: high leap height, complete channel obstructions, and shallow and obstructed launching and landing conditions. The feature is therefore a barrier at high and lowflow conditions."

This boulder field is a complex feature over 400 feet long: "Flow through this reach weaves under, around, over and between boulders throughout the length of the feature with intermittent pools." (Appendix C pg 5-21). Pictures of this feature indicate a highly complex flow path and it is unclear how the path would change during high flows because the large interlocking boulder field would have numerous hydraulic controls at different flows. Alternate pathways may appear at higher flows that are not present during the low flow surveys.

Unlike the features on the South Fork, a significant amount of salmonid habitat may be available on the Clavey if they are able to migrate upstream of the feature at RM 2.05. The next upstream barrier was listed as a "large magnitude falls" at RM 9-10, although no measurements appear to have been made of this feature (or documented).

Although the level of effort is high for field crews to reach this area, given the possible amount of habitat available upstream, NMFS suggests that at least observational data be collected of the feature at RM 2.05 during high flows characteristic of winter or spring-time conditions. Options include low-altitude helicopter flight or unmanned aerial vehicle flights to the features. During these flights, additional data at high-flow can be collected at the features identified at RM 0.2 (CR-1) and 1.15 (CR-2).

For the same reasons described above for the South Fork, NMFS disagrees with the characterization of spawning habitat suitability and thermal habitat suitability in the lower 2.05 miles of the Clavey River. That determination, without adequate data to support it, is premature and inappropriate for this study.

Adult Steelhead usually complete upstream migration and spawning in the winter or spring when water temperatures are coolest. No analysis is provided that examines the thermal suitability during the upstream migration and spawning life-stages. Once spawning and incubation is complete, if the lower reaches of the Clavey become too warm during the summer months the juveniles could migrate downstream to the mainstem to find suitable water temperatures.

Similar to the South Fork, NMFS does not recommend characterizing the lower 2.05 miles of the Clavey as unsuitable for salmonid spawning or rearing. Direct observation of many *O. mykiss* in upstream reaches which also have summertime water temperatures above 20˚ C by NMFS during hook and line sampling (NMFS unpublished data 2014), indicates the Clavey River and its tributaries currently support significant *O. mykiss* populations, and are likely suitable for many if not all anadromous salmonid life-stages.

Upper Tuolumne River Basin Water Temperature Monitoring and Modeling Study (ISR Appendix D)

Data collected for the Upper Tuolumne Water Temperature Monitoring and Modeling Study includes stage data at multiple locations. Table 4.1-4 lists all of the stage recorders that the Districts have deployed. NMFS appreciates the Districts' effort to collect this additional information, as well as their efforts to develop stage-discharge relationships. Although it is unclear which sites the Districts will develop these relationships for and what discharges they will be able to successfully measure, NMFS hopes that meaningful stage-discharge relationships are developed at each monitoring site on the South Fork, North Fork and the Clavey River. The long-term flow record at these sites will then consist of both measured and synthesized data for use in the temperature model.

To ensure the long-term flow records are consistent, NMFS recommends that the "HDR proration" method of determining historic discharge from ungagged tributaries be checked against measured stage/discharges, at least during the summer and fall months when reliable discharge measurements can be obtained and used to validate predictions. When possible, the measured stage-discharge data should be used in the temperature model over the synthetic data derived from the "HDR proration" method. If the synthetic dataset is consistently significantly different than the measured data, the “HDR proration” method for synthesizing should be revised and calibrated to match the empirical data.

It appears as though the water temperature data for the Clavey River in ISR Appendix D Figure 5.2-12 is incorrectly labeled. The water temperature stations should be reversed.

Topographic Survey (ISR Appendix E)

The Topographic Survey report describes data collection methods and results for topographic and water surface data collection in the immediate vicinity of the LGDD Project. This study appears to be largely conducted as intended in the Study Plan. NMFS herein requests a copy of the survey data (x, y, z coordinate data), as well as the longitudinal profile and water surface data. NMFS has the following two requests regarding the Appendix E report and study progress:

1. The water depth data appears to be collected as intended per the Study Plan; however, the water depth data is not presented nor described in the report in a useful matter. Water depths are summarized by mixing all habitat types (e.g., pools and riffles), providing depth ranges, average depths, and median depths. The request for water depth data was in part to specifically look at the water depths at hydraulic control points, and water depths within specific habitat units (e.g., the predominant spawning riffle in the tailrace riffle, the pool at the La Grange powerhouse tailrace, pools in the mainstem channel opposite the powerhouse, etc.). Water depth data should be provided for every habitat unit identified in Appendix F (range, min, max, median, and depth at hydraulic control point if applicable) and the water depth data should be plotted on all longitudinal profiles.

2. Water depth data was not collected in the TID sluice gate channel because no flow was present at the time of survey. This is somewhat confusing and contradictory to Appendix H Flow Records at Five Conduits at La Grange Project that states on page 3-2: “TID currently maintains in an open position an 18-inch pipe that continuously delivers flow from the TID forebay to the channel downstream of the sluice gates…. The flow quantity is not measured and is unknown, but is roughly estimated to be about 5 cfs.” Appendix E states that the Districts will collect water depth data in the sluice gate channel at 2016. NMFS’ understanding was this water depth data would be collected at about 75 to 90 cfs, a typical summer / fall base flow released through the sluice gates. NMFS herein requests that the water depth data also be collected at the discharge when only the 18-inch pipe that continuously delivers flow to the sluice gate channel is open. This is estimated by the Districts to be approximately 5 cfs, which should be enough discharge to support continuous flow throughout the sluice gate channel. NMFS was previously unaware that this 18-inch pipe continuously supplied water to the sluice gate channel, this is why a request for water depth data related to this feature was not previously made.

Salmonid Habitat Mapping (ISR Appendix F)

This study describes results from field mapping of salmon habitat mapping in the vicinity of the Project, from approximately LGDD to the confluence of the tailrace channel with the mainstem Tuolumne River. NMFS has three comments related to the spawning suitability assessment and extrapolation to population estimates:

1. Page 5-8 of Appendix F states: “For Chinook salmon, the total area of suitable spawning gravel within the tailrace channel was estimated to be 13,610 ft2”. This appears to be the entire area of Riffle Habitat Unit 16. However, Table 5.2-1 of Appendix F divides Riffle Unit 16 into two different sediment facies, one suitable for Chinook spawning (facies #6) and one not suitable for spawning (facies #7). Thus, it would appear the total suitable spawning gravel area input into the IFIM to determine suitable depth and velocity is over estimated by the area of facies #7.
2. The theoretical estimated maximum population size presented in Table 5.3-1 is merely calculated by dividing the suitable spawning area by an average redd size in order to get the number of theoretical redds (and multiplying each redd by 2 for male and female). This approach is over-simplified and likely greatly exaggerates the number of Chinook redds the tailrace channel could support. The calculation completely ignores the need for defensible space around each redd, a value often estimated at 4X the size of each redd. A defensible space requirement of 4X each redd has been used in published Chinook salmon population modeling on the Tuolumne River (Jager and Rose 2003).
3. The spawning gravel size limits used for *O.mykiss* are too narrow, particularly for larger anadromous steelhead. Recent literature illustrates the CV steelhead would be able to utilize the estimated grain size in facies #6, Riffle Habitat Unit 16 in the tailrace channel for spawning (Overstreet et al., 2016).

Flow Records for Five Discharge Structures at the La Grange Project (ISR Appendix H)

The ISR for this study describes the methodology for calculating flows and flow data plots flow for the following periods: 1) January 2014 through October 2015; and 2) January 2005 through December 2013. The methods for calculating flows for the two periods varies due to availability of data. Flow data is plotted by month. NMFS appreciates the Districts’ efforts to compile this data, as it is very useful in understanding how flow is routed through the many conduits at the La Grange Project and delivered to the lower Tuolumne River. NMFS requests that the hourly flow data used to generate the plots in the ISR Technical Report be provided to relicensing participants in spreadsheet format. This data should include any sub-columns of data used to generate the combined flow conduits depicted in the plots; for example, “MID total” should include both the MID hillside gate and Portal 1 discharge amounts. Providing the actual data to relicensing participants will allow for more in-depth review of the flow data as well as facilitate calculation of frequency and magnitude of operation of flow conduits during periods of interest.

NMFS notes that the FERC's SPD and the District's Revised Study Plan called for flow monitoring over a two year period at all of the LGDD flow conduits. This included flow monitoring at MID's hillside gates, leakage from their gates / canals, and flow discharged through the portals or sluice gates on LGDD itself. As far as NMFS can discern, the ISR technical report does not contain any actual flow data measured or monitored on MID's facilities. ISR Appendix H page 3-1 states that for the period of 2014/2015: "The flows at the MID hillside and Portal 1 gates were estimated from the MID operator's narrative notes of gate changes." NMFS assumes that 2-years of flow monitoring data at all of the flow conduits will be made available in the final technical report for this study, despite that the ISR implies that the Districts will only be conducting one additional year (2016) of flow monitoring.

Appendix H states that a minimum flow of at least 10 cfs was estimated to occur at all times from the MID hillside gate at all times (page 3-2). However, based on the plots for the period of 2005 to 2013, this assumption does not appear universal as there are many periods where the "MID Total" appears plotted as 0 cfs, particularly in 2007. The "MID Total" essentially represents what is released to the Tuolumne River main channel upstream of the powerhouse whenever LGDD is not spilling, which has been reported to NMFS on multiple occasions as a minimum flow in the 20 to 25 cfs range. Nonetheless, the time periods where the "MID Total" goes to zero would appear to be a by-product when flows calculated out of the powerhouse units and/or TID sluice equal or exceed the flow reported at the USGS gage immediately downstream (an improbable situation given the proximity of the USGS gage to the Project and the leakage from MID hillside gate). The final technical report on the flow records should present a detailed discussion on specific periods where flow releases (or lack thereof) through the various flow conduits are artifacts of the back calculation methodology. For example, in July, August, and September 2007, if the unit 1 discharge is not greater the USGS (as depicted in the ISR plots) and the MID Total is not zero cfs (as depicted) then this should be highlighted in the report.

Effects of the Project and Related Activities on the Losses of Marine-Derived Nutrients in the Tuolumne River Study Report (ISR Appendix I)

NMFS reviewed "Effects of the Project and Related Activities on the Losses of Marine-Derived Nutrients in the Tuolumne River" (Report), filed in the licensing docket of the La Grange Hydroelectric Project (P-14581). Staff of the NMFS also attended the Initial Study Report Meeting on February 25, 2016.

Fall-run Chinook salmon:

Fall-run Chinook salmon returning from the Pacific Ocean have access to the lower 52 miles of the Tuolumne River, downstream of the Project's La Grange Dam (the upstream terminus of fish passage). While fall-run likely migrated past the present-day location of the La Grange Dam (to elevations near or a short distance above the upstream end of the New Don Pedro Reservoir), their potential presence in that river segment is not included in our comments.

We believe HRD did a good job of estimating the ranges of historical and recent Chinook salmon runs to complete NMFS' information request. We acknowledge the numbers are estimates, computed for the purpose of gaging the loss of salmon carcass food and nutrients to the upper and lower Tuolumne basins.

Direct and indirect "feedbacks" occur whereby this salmon-borne "fertilizer" improves the quality of spawning and rearing habitat, and thus the reproductive success of subsequent generations of salmon (Quinn 2005). For example, Wiplfi et al. (1998) found reaches of a creek accessible to salmon had 25 times higher densities of benthic macro invertebrates than reaches of the creek not accessible to salmon. This would benefit juvenile salmon, which eat primarily insects during much of their lives in streams (Quinn 2005). Bilby et al. (1998) demonstrated additional benefits when they examined gut contents of young salmon and learned they eat not only insects but salmon eggs and the flesh from salmon carcasses. The ecosystem services provided by dead salmon remain important and economically significant, and have been demonstrated even in the impaired watersheds of the California Central Valley (Merz and Moyle 2006).

The Report estimated that up to approximately 108,000 to 130,000 fall-run Chinook salmon may have historically returned annually to the Tuolumne River; four estimates were provided for the current annual escapement of fall-run Chinook salmon to the lower Tuolumne River:

8,782 (peak 2001-2010)
2,261 (avg. 2001-2010)
1,926 (peak 2005-2014)
655 (avg. 2005-2014)

With respect to the fall-run Chinook escapement estimates, the Report contained the following qualifying text:

> "In addition to the speculative nature of historical annual escapement estimates, current escapement estimates of fall-run Chinook salmon to the Tuolumne River are influenced by numerous non-Project related factors. A few of these include ocean conditions (e.g., annual variability in coastal upwelling and food availability), Bay-Delta conditions, harvest practices (e.g., commercial and sport fishing), historical and current industrial development, downstream water uses, habitat impacts, invasive species and predation by non-native fish. Consequently, differences between historical and current escapement estimates, and associated estimates of marine-derived N, cannot be completely attributed

> to the Project. Because of the speculative nature of historical annual escapement estimates and the influence of numerous non-project related factors, use of the information provided in this study report should be undertaken in a very cautious manner." (ISR Appendix I p. 6-1).

NMFS noted the Report provided no guidance on how to determine the proportion of the cumulative effect (on reduced fall-run Chinook escapement) due only to the Project.

Using the Report's Table 5.4-1, and the 5.62% N per carcass, we "back-calculated" to estimate that the salmon carcass mass lost to the 52 miles of the lower Tuolumne River ranges from 300,000 to 3 million pounds – per year.

The NMFS recommends this information, along with the calculations of lost nitrogen (and other nutrients), be used for determining a protection, mitigation, or enhancement measure for the new license, to be applied in the lower Tuolumne River. Placement of a manufactured salmon carcass analogue (Kohler et al. 2008) is a reasonable treatment option for the lower Tuolumne. It is our understanding that a California-based company now manufactures salmon carcass analogues from raw materials sourced from out-of-state hatcheries, and these have been placed in the Russian River, California. Additional raw materials could be obtained from California salmon hatcheries, which dispose of tons of their carcasses (Merz and Moyle 2006). We recommend the staff of the California State Water Quality Control Board become engaged on this issue, to understand how it can be incorporated within a Clean Water Act section 401 permit for the Project.

Spring-run Chinook salmon:

Based largely on Yoshiyama et al. (2001), the Report estimates <u>spring-run</u> Chinook salmon historically had access to ~52 miles of the Tuolumne River upstream of the present-day Don Pedro Dam. Based on approximations of historical spring-run Chinook salmon annual escapement to the Tuolumne River, the Report estimated the historical annual escapement to the upper Tuolumne River ranged from 16,000 to 114,000 adult fish.

The Report estimated a range of 12 to 23 pounds for the average mass of an adult Chinook salmon, so the carcass mass lost to the 52 miles of the upper Tuolumne River ranges from 192,000 to 2.6 million pounds – per year.

When completed in 1894, the La Grange Dam permanently cut off access by spring-run Chinook salmon to their former spawning areas (Yoshiyama et al. 2001, p. 101). Based on 120 years of blocked fish passage, the existing (baseline) condition in the upper Tuolumne is a cumulative effect over this period; the loss of spring-run carcass mass over this interval can be estimated to range from 20 to 300 million pounds.

This information, along with the calculations of lost nitrogen (and other nutrients), is now available for determining protection, mitigation, or enhancement measures for the new license. While spring-run Chinook salmon no longer reach the upper Tuolumne, it is reasonably foreseeable they could be reintroduced over the new license term. The ecosystem services benefits to the upper Tuolumne watershed are described above.

Fish Presence and Stranding Assessment (ISR Appendix G) and Investigation of Fish Attraction to La Grange Powerhouse Draft Tubes

Both of these studies are investigating the presence, behavior, and potential stranding and/or entrainment of fish in the immediate vicinity of the La Grange Powerhouse. Both of these studies are ongoing with additional monitoring in 2016 and limited field / video data was processed by the time of the ISR filing. Due to the limited amount of data available at this time, NMFS will not comment on these studies now and will provide comment once additional information is made available. Both of these studies are very time and effort intensive, and NMFS appreciates the Districts and their consultants for their continued efforts to monitor salmonids in the vicinity of the powerhouse. NMFS was very encouraged by the preliminary ARIS camera footage displayed at the ISR meeting.

Literature Cited

Bilby, R.E., Fransen, B.R., Bisson, P.A., and J.K. Walter. 1998. Response of juvenile coho salmon (*Oncorhynchus kisutch*) and steelhead (*Oncorhynchus mykiss*) to the addition of salmon carcasses to two streams in southwestern Washington, USA. Canadian Journal of Fisheries and Aquatic Sciences 55:1909-1918.

Jager, H.I. and K.A. Rose. 2003. Designing optimal flow patterns for fall Chinook salmon in a Central Valley, California River. North American Journal of Fisheries Management 23:1-21.

Kohler, A. E., Rugenski, A., and D. Taki. 2008. Stream food web response to a salmon carcass analogue addition in two central Idaho, U.S.A. streams. Freshwater Biology 53: 446-460.

Lindley, S. T., et al. 2007. Framework for Assessing Viability of Threatened and Endangered Chinook salmon and Steelhead in the Sacramento-San Joaquin Basin San Francisco Estuary and Watershed Science 5, Issue 1, Article 4

Merz, J.E. and P.B. Moyle. 2006. Salmon, wildlife, and wine: marine-derived nutrients in human-dominated ecosystems of central California. Ecological Applications 16(3):999-1009.

Overstreet, B. T., Riebe, C. S., Wooster, J. K., Sklar, L. S., and Bellugi, D. 2016 Tools for gauging the capacity of salmon spawning substrates. Earth Surf. Process. Landforms, 41: 130–142. doi: 10.1002/esp.3831.

Quinn, T.P. 2005. The Ecology of Dead Salmon, Chapter 7 in *The Behavior and Ecology of Pacific Salmon and Trout*. University of Washington Press. Seattle.

Weaver, J., and Mehalik, S. 2009. Tuolumne River 2009 Summary Report. State of California. Natural Resources Agency. Department of Fish and Game. Heritage and Wild Trout Program. October 12, 2009.

Wipfli, M. S., Hudson, J. P., and J. P. Caouette. 1998. Influence of salmon carcasses on stream productivity: response of biofilm and benthic macroinvertebrates in southeastern Alaska, USA. Canadian Journal of Fisheries and Aquatic Sciences 55:1503-1511.

Yoshiyama, R.M., E.R. Gerstung, F.W. Fisher, and P.B. Moyle. 2001. Historical and Present Distribution of Chinook Salmon in the Central Valley Drainage of California in Contributions to the Biology of Central Valley Salmonids. Vol. 1. California Department of Fish and Game, Fish Bulletin 179, R.L. Brown, ed.

Enclosure B

UNITED STATES OF AMERICA
FEDERAL ENERGY REGULATORY COMMISSION

PROPOSED NEW INFORMATION GATHERING OR STUDY
NOT CURRENTLY IN THE COMMISSION-APPROVED STUDY PLAN

La Grange Hydroelectric Project	**)**	**P-14581**
Turlock Irrigation District and Modesto Irrigation District	**)**	
________________________________	**)**	

The Commission-approved Study Plan for the Project does not order evaluation of the Project's effects in the light of future climate change. NMFS proposes this new information collection or study according to the regulations implementing the ILP, 18 C.F.R. § 5.15 (e), for good cause. Significant new information, material to the study objectives has become available, in the form of climate change study methods and application developed since NMFS' initial study requests were submitted on July 22, 2014. Additionally, California has experienced record drought conditions from 2012 to 2015, culminating in snowpack levels in 2015 that are estimated to the be lowest in 500 years (Belmecheri et al., 2016). This information suggests that climate change is currently affecting the Project area and will continue to do so over the term of any new license issued to the Project.

NMFS provides further explanation of good cause below, as required under the regulations.

§ 5.15 (e) (1): *Any material changes in the law or regulations applicable to the information request;*

NMFS does not find this criterion applicable here.

§ 5.15 (e) (2): *Why the goals and objectives of any approved study could not be met with the approved study methodology;*

The existing Commission-approved Study Plan does not order evaluation of the Project's effects in the light of future climate change. The existing Commission-approved Study Plan uses historical and static flow and water temperature conditions to evaluate the Project's effects. This approach limits the usefulness of assessments of Project effects on anadromous fishes and their habitats, including habitats downstream of La Grange Dam on the lower Tuolumne River, as well as in areas upstream of the Project where reintroductions may occur.

§ 5.15 (e) (3): *Why the request was not made earlier;*

Significant new information material to the study objectives has become available; the downscaled data from latest global climate models (GCMs), new climate change study methods, and the application of these new data and models as generally accepted practices by water infrastructure managers, are all developments occurring since NMFS' initial requests were submitted. Specifically, the GCMs for the 2013 Fifth Assessment (IPCC) have now become available as both statistical and dynamically downscaled data and hydrologic analyses, which are at scales appropriate for analyses of the Tuolumne basin, and for use in improved methods for considering the range of plausible futures, or uncertainty, among the GCMs. These methods are outlined in detail in the Study Request #6 below, specifically in study elements 3 through 5; section § 5.9 (b): 4.0 Existing Information and Need for Additional Information; and § 5.9 (b): 6.0 Consistency with Generally Accepted Practice.

The Commission has previously denied all NMFS' study requests pertaining to climate change, typically dismissing them as speculative in nature and relying on methodology not yet proven to reliably quantify climate change effects. However, the Commission's analysis or rationale for these decisions has not been published or made public for review by the science community. NMFS urges the Commission to reevaluate this approach, using the methods outlined in Study Request #6 below; we also urge consideration in the context of the record drought that California experienced from 2012 to 2015.

§ 5.15 (e) (4): *Significant changes in the project proposal or that significant new information material to the study objectives has become available;*

Significant new information, material to the study objectives has become available. The study objectives include climate change information that could change the outcome or conclusions drawn from several other ILP evaluations of anadromous fishes and their habitats, including hydrology and water temperature in areas upstream and downstream of the La Grange Dam. We are now making the Commission aware that new climate change study techniques are available and workable, and can be applied in a FERC ILP.

California has experienced record drought conditions from 2012 to 2015, culminating in snowpack levels in 2015 that are estimated to be the lowest in 500 years (Belmecheri et al., 2016). These drought conditions witnessed unprecedented reservoir lows since dam construction throughout California, including storage in Don Pedro Reservoir. These extreme drought conditions resulted in FERC granting minimum flow variances on several California FERC Projects (e.g., Merced Project P-2179 and Yuba River Development Project P-2246) as well granting variances to go below minimum reservoir pool storage (e.g., Merced Project P-2179). Fish rescue or salvage operations had to occur for several populations attempting to survive below dams, including on the Merced River downstream of FERC Project P-2179 where attempts were made to collect the entire *O.mykiss* population during the summer of 2014, and relocate them to temperature-controlled hatchery tanks due to the warm, unsuitable thermal downstream of FERC Project P-2179. NMFS notes that FERC Project P-2179 is located on the San Joaquin tributary immediately south of the Tuolumne River and the La Grange Hydroelectric Project.

Based on this new information, NMFS urges the Commission to revise its existing Study Plan to order the NMFS' requests for information or study of the Project's climate-change related effects, so this information can in turn be applied to study of the potential Project effects on anadromous fishes and their habitats, including upstream of the La Grange Dam.

The future draft license application must contain a discussion of past, present, and future actions, and their effects on resources based on the new license term (30-50 years). It must describe how resources are cumulatively affected, and highlight the effect on the cumulatively affected resources from reasonably foreseeable future actions. § 5.18 (b) (2). Climate changes are likely to occur over the term of any new license for the Project, and interact with Project operations and facilities to exert effects on anadromous fishes and their habitats and many other resources in the Project area.

NMFS requests the Director carefully consider how, absent information from evaluation of the Project's effects in the light of future climate change, the draft license application will be able to meet the requirements for content. § 5.18. NMFS requests that the Director fully explain how this situation will be resolved when issuing a decision regarding a new or amended Study Plan for the Project.

§ 5.15 (e) (5): *Why the new study request satisfies the study criteria in §5.9(b).*

NMFS provides a detailed explanations of how all the § 5.9 (b) criteria are met for Study Request #6 in the Study Request below.

NMFS Request #6
Request for Information or Study
Effects of La Grange Hydroelectric Project Under Changing Climate
April 4, 2016

The National Oceanic and Atmospheric Administration's, National Marine Fisheries Service (NMFS) hereby files this request for additional information and study with the Federal Energy Regulatory Commission (Commission or FERC) for Modesto Irrigation District and Turlock Irrigation District (Applicants) La Grange Hydroelectric Project (Project), FERC Project No.14581, Tuolumne County, California.

Background:

The goal of this study request is to analyze the effects of natural variability and changing climate conditions on NMFS' trust resources. In order to do so, NMFS must obtain and apply the best available science, data and techniques to assess the potential effects of the proposed project on riverine processes, fish, and fish habitat. NMFS needs to understand the likely effects of changing climate on hydrology, anadromous fishes and their habitats in order to develop license terms and conditions that are optimally protective of fish and their habitats, and also to comply with legal requirements under Magnuson-Stevens Act, ESA, NEPA, and Executive Orders. NMFS is requesting information or study of the effects of the Project and its operations and related facilities including the Don Pedro Reservoir. The combined project and climate change effects could include the following:

- Increased air temperatures and decreased snowpack that are likely to result in changes in the hydrologic regime (water timing, quantity, and quality), including reduced summertime stream flows, and higher stream and reservoir temperatures in the Tuolumne watershed. This will affect NMFS trust resources, including ESA listed species, and their habitat and may have implications on operations needed to meet license conditions.
- Changes in extreme events, and earlier spring and later fall, as a result of warming climate.
- Increased stream temperature and decreased summer flows could cause harmful or even lethal effects to fish and aquatic invertebrates (Kyle and Brabets 2001). Flows are likely to change during much of the year - increased spring and late summer flows are likely to occur because melting of the snowpack occurs earlier due to warming.
- Changes in vegetation and secondary changes to the hydrologic regime and riverine habitat quality.

An understanding of changes in the hydrologic regime (water timing, quantity, and quality) in combination with project operations will inform post project monitoring needs. This will include stream temperature measurements, assessment of fish habitat conditions under changing conditions, instream flow throughout the system to assess changes in flow contribution from tributaries, and stream temperature monitoring in the reservoir and downstream.

Climate projections can be used to predict the likely effects of climate change, and then we will be able to assess the combined effects of climate and the reservoir on the resources to develop license terms and conditions that are optimal under current and future conditions of changing climate. While neither FERC nor the applicant can control climate change, they can mitigate how much the project would additionally stress - or alternately, protect - the resource from this non-project current situation. Temperature and precipitation data from Global Climate Models (GCMs) that is downscaled to relevant scales will be used to provide a range of future scenarios for the Tuolumne River basin. The results will be used to inform analyses of Project operations and potential instream flow requirements and other license conditions. The uncertainty associated with the scenario analysis and downscaled temperature and precipitation projections will be considered into long-term planning and assessment by using scenario based risk assessment.

FERC has a standard that the applicant's proposed study plan must demonstrate that any proposed study methodology "is consistent with generally accepted practice in the scientific community" (18 CFR § 5.11(d)(5)). The current "generally accepted" practices for water management recommend moving beyond the concept of a stationary climate and hydrology (Milly 2005) to consider a range of possible future climate and hydrologic scenarios, as we will describe below, including those that are consistently represented in the GCM projections and data spatially downscaled from the GCMs to regional and local scales, such as the Tuolumne basin. Downscaled temperature and precipitation data are now routinely analyzed to assess future risks, and can provide a range of future likely scenarios for the Tuolumne River basin hydrologic regime considering all inputs, including precipitation, temperature, soil moisture, evaporation and transpiration and a range of plausible futures of these variables. The state of the art of GCMs and the existing information about climate risks for the Central/southern Sierras region are described below in § 5.9(b) 4.

Numerous studies have developed methods to incorporate this uncertain information into long-term planning processes. The examples range from scenario-based sensitivity studies to complex regional modeling (see Brekke et al 2009 for examples).

Thus, the use of a range of plausible climate futures in a risk assessment framework have become the generally accepted practice in the scientific and water management communities as strategies for using climate projections; this study request will describe the current practices for the use of climate projections in a risk management framework, in use and mandated by other federal and non-federal water management, resource and infrastructure planning processes. These climate risk assessment strategies include scenario planning and robust decision making.

Applying these recent advances in climate science and the use of climate science in long-range planning to the project analysis will result in more informed resource decision making (Reclamation, 2016; Viers, 2011; Vicuna et al., 2010; Brekke, 2009; Fowler 2007) that reflects a range of plausible risks to the project. A climate change study request was approved in the recent ILP for Susitna (FERC Project #P-14241) (2013), which was limited to review of existing literature relevant to glacial retreat, and summarizing the understanding of potential future changes in runoff associated with glacier wastage and retreat. FERC has expressed concerns about the utility, accuracy and uncertainty of climate projections, as in its 2009 rejection of a climate change study request in relicensing the Yuba-Bear Drum-Spaulding (P-2266) hydroelectric facilities. Recent advances in the application of climate science address FERC's concerns, by developing risk assessment strategies for considering a range of plausible futures in a risk assessment framework [e.g., Groves, et al 2013 , Reclamation 2016, 2011]. However, the concept of a stationary environmental baseline with fluctuations (high and low water years) around a relatively stationary mean (as previously used by FERC and other regulators) is an outdated concept given the current level of scientific certainty of climate change (Milly et al. 2008; Viers 2011). The recent scientific advances are now part of generally accepted practice, as described below in § 5.9(b) 6.

The proposed study will allow NMFS to incorporate the projected risks of climate change in the current climate science into comprehensive decision making, and provide information NMFS can use to develop: proposed measures and plans to protect, mitigate, or enhance environmental resources; Federal Power Act (FPA) section 18 fishway prescriptions for passage of anadromous fish; FPA section 100) recommendations to protect, mitigate damages to, and enhance fish and wildlife resources; and develop FPA section 10(a) recommendations to ensure that the project is best adapted to comprehensive plans for developmental and non-developmental resources. These provisions, in turn, will enable FERC to base its licensing decision on substantial supporting evidence. A simple literature review is insufficient to adequately incorporate the projected risks of climate change into these license conditions.

A detailed list of NMFS' statutory authorities and responsibilities, ESA and MSA consultation procedures, and resource managements goals and objectives were provided in Enclosures A, B, C, and G filed on July 22, 2014 in this ILP Proceeding (Project #14581).

Study Request:

Methodologies for the climate study should be based on those used in numerous published, peer-reviewed studies either using the same techniques in different areas (e.g., downscaling) or similar studies for other parts of California. The methodologies set forth herein are consistent with and well-anchored in generally accepted scientific practices, and are currently being used to inform other agency and long-term water management actions, as described in this section. Although NMFS is not aware of climate change study that FERC has approved, beyond the aforementioned literature review, and thus cannot provide an example of a FERC precedent for a climate change study, NMFS must continue to request studies adequate to meet its requirements for a hydropower licensing proceeding.

NMFS proposes the following studies and study elements be conducted for the project:

1 Review existing climate change literature relevant to Central California and the Tuolumne watershed.
2. Document the historic climate and hydrology in the Tuolumne basin
3. Acquire or develop and evaluate downscaled climate projections for the Tuolumne basin.
4. Acquire or develop and evaluate climate change projections of natural streamflow and stream temperature in the Tuolumne basin.

5. Analyze the joint impacts of projected climatic and hydrologic projections the Tuolumne River basin and La Grange Dam operations on the species of interest
6. Summarize potential climate change effects in a Climate Change Technical Report.

Request Element 1: Review existing climate change literature relevant to Central California Sierras and the Tuolumne watershed

- Review existing literature relevant to climate and hydrologic change in the Central California Sierra Nevada Mountains and the Tuolumne watershed. The literature survey will summarize the current understanding of the magnitudes of historic trends, attribution of these trends to anthropogenic climate change, as well potential future systematic changes in surface air temperature, precipitation, snowpack (percentage of precipitation falling as snow, snow water equivalent), runoff and streamflow volume and timing, stream temperature and other relevant climatic drivers and hydrologic impacts. Studies such as Abatzoglou et al. (2009) document the climatic similarity of the entire western side of the Sierra Nevada range, and therefore regional studies (e.g. Bonfils et al, 2008) have relevance for the Tuolumne basin and should be included in the literature review. In addition, adjacent or nearby drainage basins with maximum elevation > 3000m and snowmelt-dominated hydrology in the current climate provide hydrologic analogs for the Tuolumne Basin to establish the scientific foundation for studying the effects of climate change.

- Review existing literature on climate change impacts on ecosystems in this region, and in particular any literature relating to the effects of climate change on species identified below in reference to **18 CFR § 5.9 (a),** as well as the critical habitat for these species.

Request Element 2: Document the historic climate and hydrology in the Tuolumne basin

Compile a dataset that includes available air temperature, precipitation, snow water equivalent, streamflow data from observing sites within the Tuolumne basin to establish a baseline for evaluation of downscaled projection products, and to establish an environmental baseline. The period or record should for station data should, if possible, exceed 30 years with 80% data coverage, with data continuing to within 5 years of the present. Compile stream temperature data from observing sites with a long enough period of record to establish a temporal average for the recent climate. If diversions and operation of reservoirs in the Tuolumne above Don Pedro are deemed to have a significant impact on the flow in critical habitat or in the total inflow into Don Pedro Reservoir, then naturalization of the flows should be done. This compiled dataset will include the stream flow and temperature records referred to below in § 5.9 (b): 4.0 Existing Information and Need for Additional Information, which will likely cover the majority of Request Element 2.

Request Element 3: Acquire existing downscaled climate projections and evaluate for the Tuolumne basin.

Downscaled GCM historic simulations and future projections are routinely used for hydrologic and ecologic impacts studies of climate change (e.g., Brekke 2009). There are strengths and weaknesses inherent in the choice of downscaling methodology (e.g. Fowler et al. 2007; Salathe et al. 2007, Miller et al, 2009) with the main decision being between dynamical downscaling (also known as regional climate modeling) and statistical/empirical downscaling. The criteria for choosing a downscaling method for this study are as follows:

- Downscaling to spatial scales that will be used in the hydrologic modeling and are adequate for simulating snowpack in mountainous regions.
- Downscaling of the historic period simulations of the GCMs must produce monthly climatological averages that have small biases. This is important in order that the hydrologic simulations proposed below for the baseline period have realistic magnitude and timing of streamflows. This may be accomplished with an explicit bias correction or adjustment step.
- Ability to downscale multiple GCMs that adequately sample the range of future climates in this region within reasonable cost and effort.
- Produce as output daily values of daily maximum temperature, daily minimum temperature, and daily precipitation. Downscaling methods that produce other hydrologic drivers such as wind speed, humidity, and net radiation can also be used.
- Analysis should use downscaled products with adequate validation and documentation in the peer-reviewed literature. Downscaled simulations should also be compared statistically to the historic observed data identified in Element 2.

NMFS recommends the use of statistical downscaling for the Tuolumne basin because of the need for both high resolution of the mountain climate and the need to broadly sample the range of climate projections at reasonable cost and effort. Some statistical methods that meet these criteria include the Reclamation Bias-Corrected and Spatially Downscaled Surface Water Projections (BCSD, http://gdo-dcp.ucllnl.org/downscaled_cmip_projections) (Reclamation 2014), the Multivariate Adaptive Constructed Analogs (MACA, http://maca.northwestknowledge.net/index.php) (Abatzoglou and Brown, 2012), and the LOCA Statistical Downscaling (Localized Constructed Analogs, http://loca.ucsd.edu/) (Pierce et al 2014).

NMFS recognizes that there are dynamical downscaling products available. For example, the use of dynamical downscaling results coordinated by the CORDEX-North America (https://na-cordex.org/) is not precluded, provided adequate evaluation of the data in this region is performed. Miller (2009) documents the strengths and weaknesses of several dynamical and one statistical methods for California and notes that the dynamical downscaling has difficulty producing realistic snowpack evolution largely because of systematic biases in the simulation of precipitation. Therefore it is likely that any dynamical downscaling would not produce reliable enough hydrologic output, and would need further statistical adjustment and downscaling in order to be usable in a hydrologic simulation.

Climate scenarios from the GCMs to be downscaled should be selected with the following criteria:

- Selected from model simulations accepted by the Coupled Model Intercomparison Project Phase 5 (CMIP5) archive, or when available Phase 6 (CMIP6).
- Consider multiple scenarios that sample a range of projected temperature and precipitation changes for the region, for example as determined by the difference of 30 year averages.
- Alternatively, a large (> 50 member) ensemble of hydrologic simulations is available, such as in the Reclamation/LLNL archive (http://gdo-dcp.ucllnl.org/downscaled_cmip_projections) , and would allow the exploration of the range of hydrologic behavior in terms of total streamflow volume and timing, along with the range in temperature change.

Request Element 4: Acquire existing climate change projections of natural streamflow and stream temperature in the Tuolumne basin and evaluate.

Acquire (Reclamation data, or alternate if available) historic simulations and projections for snowpack, streamflow, and stream temperature. These projections should be derived from the downscaled projections from Element 3. The following criteria are required:

- Streamflow and temperature should be simulated with adequate temporal resolution to support stream temperature and reservoir modeling, usually weekly or finer.
- Streamflow and temperature simulated at existing gaging stations and at other locations in the Tuolumne River basin to support modeling of habitat suitability, and for total inflow into Don Pedro Reservoir.
- Stream temperature modeling may be performed concurrently with streamflow modeling or separately; Isaak et al (2016) new dataset for the region may be appropriate.
- Baseline simulations should be performed using both the downscaled historical GCM simulations and the gridded observational data used for development of the statistical downscaling.
- If study resources are significantly constrained, a “delta-method” or “hybrid-delta method” can be used in which historical gridded observations are used as drivers of the hydrologic model in the historical period, and these drivers are then modified through change factors in order to approximate the changes seen in a range of GCM projections.

NMFS recommends the use of a physically-based distributed hydrologic model with adequate representation of hydrologic processes that are likely to be affected by anthropogenic climate change. To represent snow processes, we recommend a hydrologic model that uses an energy balance snow model and that represents the spatial scales of snow processes in mountainous regions, either explicitly or through the inclusion of elevation bands within the model grids. It is also recommended that a physically based calculation of evapotranspiration be used, either through a full energy balance or through Penman-Monteith potential evapotranspiration methods that are adjusted for a changing climate. The Variable Infiltration Capacity (VIC) hydrologic model has been run in a configuration that meets these criteria, and a large archive of hydrologic projections is available. It should be cautioned that application of this data in other regions has required a secondary bias adjustment on the streamflows (Reclamation, 2012).

Stream temperature modeling should ideally be based on spatial statistical modeling (Isaak et al. 2010) or direct physically based modeling of stream temperature (e.g. Null et al, 2013). However, Isaak et al. (2016) caution against a simple interpretation of the result of models that show large stream temperature changes, as stream temperature gradients must also be taken into account, and points to the potential for the persistence of cold refugia in high mountain streams in the presence of general climate warming.

NMFS recognizes that there are several hydrologic models available that meet the above criteria, and that choice of hydrologic model structure and parameters. We are most interested that any model used provide an understanding and characterization of the hydrology and temperature dynamics in the Tuolumne basin so that measures can be developed so as to inform the development of specific project license operating terms and conditions necessary to maintain healthy anadromous fish populations and supporting habitat throughout the project-affected range.

Request Element 5: Analyze the impacts of projected climatic and hydrologic change on the species of interest

Assess the potential impacts of climate change on the Tuolumne watershed and ecosystems, including how anticipated seasonal, annual and long-term changes in temperature and precipitation can be expected to impact the river and its habitat. This element consists of three parts: 5a) assess the effect of climate change on the critical habitat for the identified species in the Tuolumne River basin above Don Pedro Reservoir, 5b) assess the joint ecological impacts of climate change and proposed La Grange Dam operations, specifically on ESA-related species in and below Don Pedro and La Grange Dams, including potential impacts on the Bay-Delta system, and 5c) assess the effect of climate change on the efficiency and longevity of the proposed hydropower project and project operations including the robustness of proposed operations under climate change.

5a: The streamflow and temperature baseline and projections developed above are to be used in an assessment of habitat suitability for the species of interest above Don Pedro Reservoir. This analysis will also include consideration the potential persistence of cold water refugia (see for example, Isaak et al., 2016). The analysis will include a range of hydrologic projections derived from the range of climate projections described above.

5b: Based on projected time series of inflow into Don Pedro Reservoir and proposed operations, develop a model adequate for simulation of flow and stream temperature downstream. This will include a reservoir simulation model for the combined Don Pedro and La Grange systems that will allow the simulation of the cold water pool dynamics in project reservoirs based on the atmospheric temperature, the temperature of inflowing water and the pattern of downstream releases. NMFS believes that the reservoir temperature model developed as part of the Don Pedro P#2299 ILP (W&AR-03) will by and large suffice to fulfill this study element, or will only require minimal modification to accomplish this task. Similarly, NMFS believes that the stream temperature model for the Lower Tuolumne River developed as part of the Don Pedro P#2299 ILP (W&AR-16) will by and large by able to fulfill this study element, or will only require minimal modification to accomplish this task. Apply this model to the identified climate and hydrologic scenarios to generate time series of flow and temperature and use this information in a generally accepted ecosystem impact framework (such as Moyle et al, 2013) to assess the impact on the species of interest, which includes fall and spring-run Chinook, CV steelhead, and resident *O.mykiss*. The biological assessment should include an analysis of all life stage requirements for each species, including spawning, egg incubation, juvenile rearing, juvenile and smolt outmigration, and adult emigration.

5c: Use the reservoir simulation model to assess the effect of climate change on the efficiency and longevity of the proposed hydropower project. This will include an analysis of the robustness of proposed water-year types under the above-defined climate and hydrologic change scenarios and an analysis of operational options to maintain stream temperature and flow to support the species of interest. For example, forecast-based reservoir operations including the use of weather forecasts, and seasonal climate forecasts, may allow mitigation of increased stream temperature due to heat waves that are projected to increase in frequency in a warmer climate. Forecast informed reservoir operations allowing for a dynamic determination of flood rule curves may allow the storage of more water during drought periods for later releases to support critical habitat.

Request Element 6: Summarize potential climate change effects in a Climate Change Technical Report.

This technical report should include a description of the assumptions made, models used, and other background information. The report will provide interpretation and guidance on the science knowledge developed, in order to translate them into useable knowledge, through syntheses and translational products developed to address the hydropower, water, and fisheries needs. Additionally this report will include an analysis of the impacts of projections on the project nexus, and hydropower facilities. The report will include an electronic supplement that makes the data used in this study available for the use of other studies.

This request is submitted in accordance with Title 18 of the Federal regulations *Conservation of Power and Water Resources*; Part 5 *Integrated License Application Process*; Section 5.9 *Comments and information or study requests*.

<u>18 CFR § 5.9 (a):</u>

Comments, including those by Commission staff, must be accompanied by any information gathering and study requests, and should include information and studies needed for consultation under section 7 of the Endangered Species Act

The information or study resulting from this Request would inform future ESA consultation between NMFS and the Commission because the Project and related facilities and operations could affect ESA-listed fishes, and/or their ESA-designated critical habitats, in the Tuolumne River and in locations downstream.

The following ESA-protected anadromous fishes and habitats (ESA resources) that could be the subject of ESA consultation regarding the Project licensing are also the subject of this Request:

1) Central Valley (CV) spring-run Chinook salmon Evolutionarily Significant Unit (ESU) (*Oncorhynchus tshawytscha*), threatened (June 28, 2005, 70 FR 37160);

2) CV spring-run Chinook salmon designated critical habitat (September 2, 2005, 70 FR 52488);

3) CV steelhead Distinct Population Segment (DPS) (*O. mykiss*), threatened (January 5, 2006, 71 FR 834);

4) CV steelhead designated critical habitat (September 2, 2005, 70 FR 52488);

5) Southern DPS of North American green sturgeon (*Acipenser medirostris*), threatened (April 7, 2006, 71 FR 17757);

6) Southern DPS of North American green sturgeon designated critical habitat (October 9, 2009, 74 FR 52300);

ESA resources that occur downstream in the Sacramento-San Joaquin Delta, and San Francisco Bay could also be affected by the Project and related facilities and operations.

NMFS also identified the presence of an anadromous resource in the Tuolumne River that is not listed under the ESA, but is a Federal Species of Concern (those species about which NMFS has concerns regarding status and threats, but for which insufficient information is available to indicate a need to list the species under the ESA):

7) CV fall/late-fall run Chinook salmon ESU, Species of Concern (April 15, 2004, 69 FR 19975; October 17, 2006, 71 FR 61022).

This Federal Species of Concern also occurs downstream in the Sacramento-San Joaquin Delta and San Francisco Bay, and could also be affected by the Project. While the fall/late-fall run Chinook ESU has no formal protection under the ESA, discussions with NMFS regarding effects to this species usually occurs during ESA consultation.

Please note NMFS is requesting information or study of the effects of the Project <u>and its operations</u> <u>and related facilities including Don Pedro Reservoir</u>. While the Commission does not consider some of these facilities or operations to be part of the licensed Project, the regulations at 18 CFR 5.9(a) require NMFS' requests to include information and studies to be used for consultation under section 7 of the ESA. For ESA purposes, the action, action area, and the effects of an action are defined broadly, and are not restricted to the "Project facilities" or "Project area", and the effects of an action are defined more broadly (the direct, indirect, and cumulative effects of the action must be evaluated). NMFS refers the Commission and Applicant to the definitions below

50 CFR § 402.02 Definitions.

Action means all activities or programs of any kind authorized, funded, or carried out, in whole or in part, by Federal agencies in the United States or upon the high seas. Examples include, but are not limited to:

(a) actions intended to conserve listed species or their habitat;
(b) the promulgation of regulations;
(c) the granting of licenses, contracts, leases, easements, rights-of-way, permits, or grants-in-aid; or
(d) actions directly or indirectly causing modifications to the land, water, or air.

Action area means all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action.

Effects of the action refers to the direct and indirect effects of an action on the species or critical habitat, together with the effects of other activities that are interrelated or interdependent with that action, that will be added to the environmental baseline. The environmental baseline includes the past and present impacts of all Federal, State, or private actions and other human activities in the action area, the anticipated impacts of all proposed Federal projects in the action area that have already undergone formal or early section 7 consultation, and the impact of State or private actions which are contemporaneous with the consultation in process. Indirect effects are those that are caused by the proposed action and are later in time, but still are reasonably certain to occur. Interrelated actions are those that are part of a larger action and depend on the larger action for their justification. Interdependent actions are those that have no independent utility apart from the action under consideration.

§ 5.9 (b): 1.0 _Goals and Objectives of Request

Describe the goals and objectives of each study proposal and the information to be obtained;

The goal of this study request is to analyze the effects of changing climate conditions on NMFS' trust resources. The main objective of this study request is to assess the ongoing project effects combined with a range of plausible risks of climate change on the Tuolumne watershed ecosystem in order to condition the project license in anticipation of these changes. The proposed project is designed for long-term utility and is located in an area vulnerable to climate change. Therefore, understanding the cumulative impacts from the project and climate change is necessary to develop license conditions that protect anadromous fish species and their habitat. Without this understanding, project operations would be considered in context of static future climate and hydrologic conditions.

The objectives of the study are:

1) Document the scientific foundation for climate change studies in the study area through a review of existing literature relevant to climate change in the Central California Sierras and the Tuolumne watershed including past and projected trends, impacts on hydrology, on the ESA-related species identified above, and on their critical habitat.
2) Develop a range of quantitative climate change scenarios and associated hydrologic change scenarios based on climate model projections
3) Assess the potential impacts of climate change on the critical habitat for ESA-related species in the Tuolumne watershed.
4) Assess how climate change can be expected to impact the efficiency, longevity and ecological impacts of the proposed hydropower project and project operations.
5) Assess the joint impacts of climate change and proposed Project operations on ESA-related species in and downstream from Don Pedro and La Grange reservoirs.
6) Summarize potential climate change effects in a Climate Change Technical Report, including electronic access to time series of historic and projected climate and hydrology, and make these results available for incorporation in the other riverine studies being conducted as part of the La Grange ILP, as well as the Don Pedro ILP (P-2299).
7) Identify project design and operational options that can be used to develop mitigation for any adverse project environmental effects. These options will address the specific NMFS resource management goals.
8) Support and inform further analysis. The results of the study will provide data and a modeling framework for additional analysis of options including:

    - Informing the definition, structure and application of alternative water year types;
    - Informing the development and implementation of monitoring plans for streamflow, temperature and habitat quality;
    - Contributing to the development of possible adaptive management components of a new license to mitigate the impacts of climate change and reservoir operations. These may include forecast-based reservoir operations under climate change and pulse flow requirements to mitigate the impacts of increasing heat waves on stream temperature;
    - Assisting in timely identification and planning for possible modifications to management or infrastructure necessary to respond to or take advantage of climate change;
    - Informing the implementation or interpretation of other study plans or results, including further water temperature monitoring and modeling, detailed identification of cold water refugia, reservoir cold pool management, and instream flows.

§ 5.9 (b): 2.0 Resource Management Goals of NMFS

If applicable, explain the relevant resource management goals of the agencies or Indian tribes with jurisdiction over the resource to be studied;

For a complete review of NMFS' resource management goals and objectives, NMFS refers the Commission and Applicant to Enclosure G of this filing. NMFS' Resource Management Goal and Objectives, provided in full as Enclosure G (NMFS' Resource Management Goals and Objectives filed in this ILP on July 22, 2014), apply with respect to species listed under the and Magnuson-Stevens Fishery Conservation and Management Act (MSA) (16 U.S.C. §1801 *et seq.*) and the Endangered Species Act (ESA) (16 U.S.C. §1531 *et seq.*), as well as anadromous species that are not currently listed but are affected by continuing operations of the Project or may require listing in the future. Thus, our requests for information or study are linked with NMFS' Resource Management Goals and Objectives. If NMFS' requests are included in the Districts' Study Plan and approved in the Commission's Study Plan Determination, then successfully implemented, the results would inform:

(A) Whether and how NMFS may exercise its Federal Power Act Section 18 authority, to either prescribe fishways at the Project or to reserve its prescriptive authority;

(B) NMFS' decisions regarding its future Federal Power Act Section 10(j) and 10(a) proposals for protection, mitigation, and enhancement measures;

(C) NMFS' decisions regarding its future recommended measures to improve EFH for Chinook salmon in the upper and lower Tuolumne, as well as areas downstream to the Bay/Delta;

(D) The ESA § 7 consultations (informal and formal) regarding effects on threatened species and designated critical habitats potentially affected by the Project.

The fulfillment of NMFS' request is consistent with the following NMFS' Resource Goals and Objectives for anadromous fishes and habitats in the Tuolumne River and downstream (Enclosure G, filed July 22, 2014):

5.1 - Protect, conserve, enhance, and recover native anadromous fishes and their habitats by providing access to suitable habitats and by restoring fully functioning habitat conditions for related rearing and feeding (see 6.1-6.4), migration (see 6.5), spawning (See 6.6), and adjoining riparian and benthic macroinvertebrate (BMI) habitats (see 6.7).

5.2 - Identify and implement measures to protect, mitigate or minimize direct, indirect, and cumulative impacts to, and enhance native anadromous fish resources, including related rearing and feeding (see 6.1-6.4), migration (see 6.5), spawning (See 6.6), riparian and BMI habitats (see 6.7), protection from adverse Fish Hatchery operations (see 6.8) and predation (see 6.9), and ensure coordination within and outside of the Project (see 6.10) to minimize risk to anadromous fishes.

6.1-Flows; 6.2-Flow Ramping; 6.3-Water Quality; 6.4-Water Availability; 6.9-Predation; and 6.10-Coordination.

<u>§ 5.9 (b): 3.0 Relevant Public Interest Considerations</u>

If the requester is not a resource agency, explain any relevant public interest considerations in regard to the proposed study;

This content requirement is not applicable, as NMFS is a resource agency.

<u>§ 5.9 (b): 4.0 Existing Information and Need for Additional Information</u>

Describe existing information concerning the subject of the study proposal, and the need for additional information;

Existing information on climate change in California/Central Sierras/Tuolumne Basin

Although there has been considerable study of climate trends and futures in California, much of it funded by the California Energy Commission (e.g. Cayan et al 2012; Ackley et al 2012; Thorne et al 2012) and California Department of Water Resources (e.g. CDWR, 2015, including studies to support the 2013 California Water Plan and cited therein), and the U.S. Bureau of Reclamation (Van Lienden et al 2014), additional analyses of existing climate projections and their downscaled products is needed to assess climate impacts on the Tuolumne basin specifically, and to understand the impacts on flows and habitats both upstream and downstream of the combined Don Pedro and La Grange projects. The previous standard of a stationary environmental baseline with fluctuations (high and low water years) around a relatively stationary mean is now considered an outdated concept given the current level of scientific certainty of climate change (Milly et al. 2008; Viers 2011).

Observed changes in climate

California as a whole has experienced a warming trend of +1.7-2.87 °F/100 years (Figure 1), according to the California Climate Data Archive (http://www.calclim.dri.edu/). The Tuolumne headwaters above La Grange are part of a statistically covarying climate region that Abatzouglu et al (2009) call the sierra region, covering the foothills and higher elevations along the west slope to the crest of the Sierra Nevada south of 40.8N. This region has a strong difference in temperature with lower areas in the adjoining San Joaquin Valley and Sacramento-Delta regions. The regions identified by Abatzouglu et al (2009) have been adopted as rigorous for analyses by scientists, and are widely used in studies supporting water policy, including the California Water Plan. The sierras region has experienced an increase in temperature of ~1-2 °F since 1895 (CDWR, 2015). Warming in California, including the Sierras, is part of a larger warming trend throughout most of the southwestern U.S. with high confidence, and the period since 1950 has been warmer than any period in the past 600 years (Hoerling et al 2013).

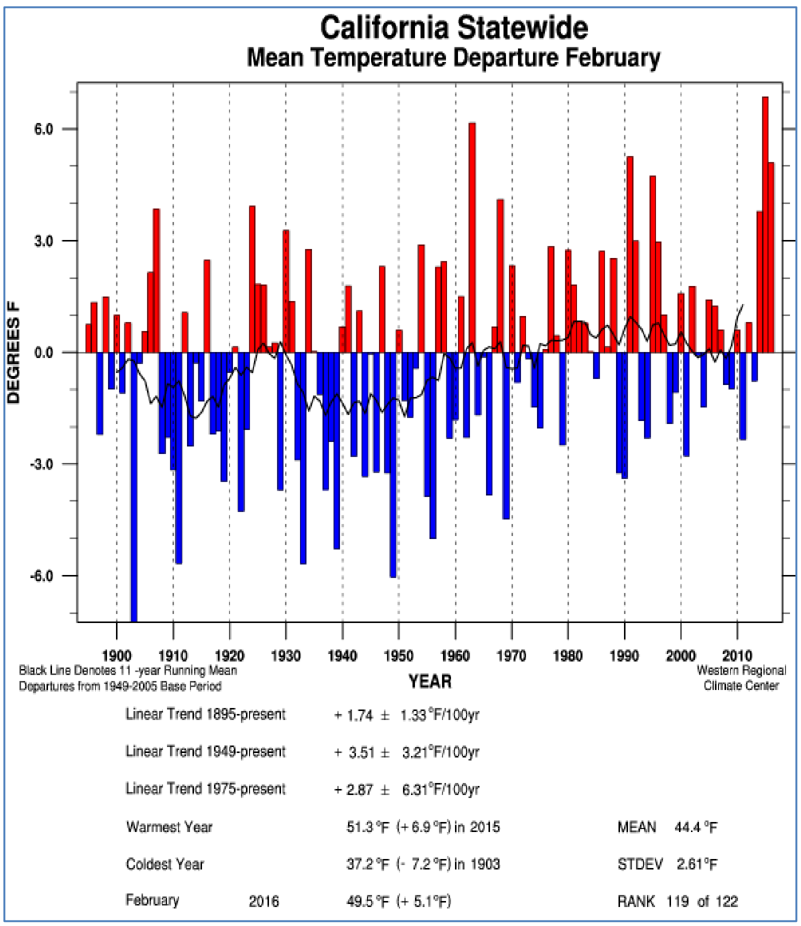


Figure 1. Trends in California Temperature, 1895-present, from http://www.calclim.dri.edu/

There is no trend in precipitation for any of the watershed zones analyzed by Cuthbertson et al. (2014), based on an analysis of PRISM data, including the zone that has Upper Tuolumne in their analysis, nor is there a trend in average snow. Current precipitation is quite variable, making it difficult to distinguish a trend from the noise of variable data. However, there may be trends -- and future changes, in the percentage of precipitation falling as snow (and thus seasonally stored) vs rain. While there is there is evidence in northern California of a trend toward a greater fraction of annual precipitation falling as rain (Figures 6 and 7 in Cuthbertson et al 2015), the Upper Tuolumne is part of the higher elevation central and southern Sierras analyses zone (Figures 8 and 9 in Cuthbertson et al 2015), which tend to remain at colder temperatures, and show no trend in the rain-snow proportion; however, this analysis groups the Tuolumne with other basins. Nunn et al (2010) find that the southernmost Sierras are the least vulnerable to change because of their higher elevation, but that analysis also does not break out the Tuolumne. There is a need to understand the crucial proportioning of snow vs rain for the Tuolumne watershed itself.

Streamflow volume has decreased in many gauges in the Southwest (Hoerling et al 2013) and California. Peak streamflow timing has shifted to earlier in the year in the Sierras, for example nearly a month earlier in the Sacramento River (CADWR 2015), part of a trend across the southwest (Hoerling 2013). The change in timing of runoff has major implications, discussed below in the Projections section.

Environmental baseline

There are relatively robust existing data sets that characterize flow, water temperature, and meteorological data for the proposed study area. The Districts are currently developing a study for use in this ILP titled Upper Tuolumne River Basin Water Temperature Monitoring and Modeling. This study includes a water temperature monitoring program as well as developing a water temperature model for the Upper Tuolumne River. The Districts filed a progress report for this study on February 2, 2016 as part of their Initial Study Report. The progress report for this study included an extensive list of active and inactive flow gauging stations in the area, lists of locations and dates of historical and active water temperature monitoring locations, and locations of metrological stations in the surrounding area. This effort, to both locate and compile, existing and historical flow, water temperature, and metrological data in the study data will be invaluable to this proposed study and represents a substantial time and cost savings. Some of the relevant USGS gages in the Upper Tuolumne River include:

- 11276600 TUOLUMNE R AB EARLY INTAKE NR MATHER CA
- 11276900 TUOLUMNE R BL EARLY INTAKE NR MATHER CA
- 11285500 TUOLUMNE R A WARDS FERRY BR NR GROVELAND CA
- 11277300 CHERRY C BL VALLEY DAM NR HETCH HETCHY CA
- 11278300 CHERRY C NR EARLY INTAKE CA
- 11278400 CHERRY C BL DION R HOLM PH, NR MATHER CA
- 11278000 ELEANOR C NR HETCH HETCHY CA

For the Lower Tuolumne River (i.e., downstream of La Grange Diversion Dam), similar baseline flow, water temperature, and metrological data were compiled in the Don Pedro (P-2299) ILP in order to construct the water temperature and operations model in that proceeding. While some of the data sets for the active stations may need to be updated in order to provide comparable time periods of record as the Upper Tuolumne records, extensive lists of data sources and locations are already developed. Relevant information can be found in the following technical reports from the Don Pedro ILP (P# 2299):

- W&AR-02 Project Operations Water Balance Model Study Report
- W&AR-03 Reservoir Temperature Model Report
- W&AR-16 Lower Tuolumne River Temperature Model Report

Projections of the future

As described above, there is a significant literature about the impacts of anthropogenic climate change on California and its mountains and watersheds. These analyses are based on the global climate model output of the Intergovernmental Panel on Climate Change 4th (IPCC 2007) and 5th Assessments (IPCC 2013), downscaled to provide information relevant to the region, as well as hydrologic projections that are the result of running high resolution or downscaled GCM data through hydrology models. California statewide mean temperature is projected to increase by 3.4 to 4.9 °F by 2060-2069 than in the period 1985-94 (analysis by Scripps Institution of Oceanography in CADWR 2015). Seasonal trends indicate a greater increase in the summer months (4.1 to 6.5 °F) than in winter months (2.7 to 3.6 °F) by 2060-2069. There is high confidence in this projection as part of a broader southwestern warming pattern (Cayan et al 2013).

There is less confidence in precipitation projections than in those for temperature, and in the Tuolumne region, the models are about evenly split between increasing and decreasing annual average precipitation. Figure 2 shows the results of two GCMs that have been downscaled for California & used in impacts studies. Even with no change in precipitation, the significant increase in temperature will result in an increase in evaporation and evapotranspiration. The alteration of rain and snowfall timing and intensity, evapotranspiration and groundwater and surface flows, translates into changes in the annual hydrograph and potentially less water availability.

However, scientists have confidence in projected changes in snowpack, runoff, and soil moisture, and changes in the timing of streamflow because these variables reflect both the influence of the increase in temperature, as well as changes in precipitation. Although the projections of precipitation change range from decreases to increases, the impact of increasing temperature alone has important effects on snowpack, streamflow, and runoff timing as well as soil moisture. These hydroclimate variables all have potential impacts on the operations of La Grange and on the habitats upstream and downstream. According to Cuthbertson et al (2014), there has been a trend toward more rain than snow in the total precipitation volume in the sierras, which factor plays a role in reducing total snowpack regionally. The Tuolumne Basin is in a transition zone between southern CA, where most climate model precipitation projections anticipate drier conditions, and Northern CA where more models project heavier and warmer winter precipitation (CADWR 2015).

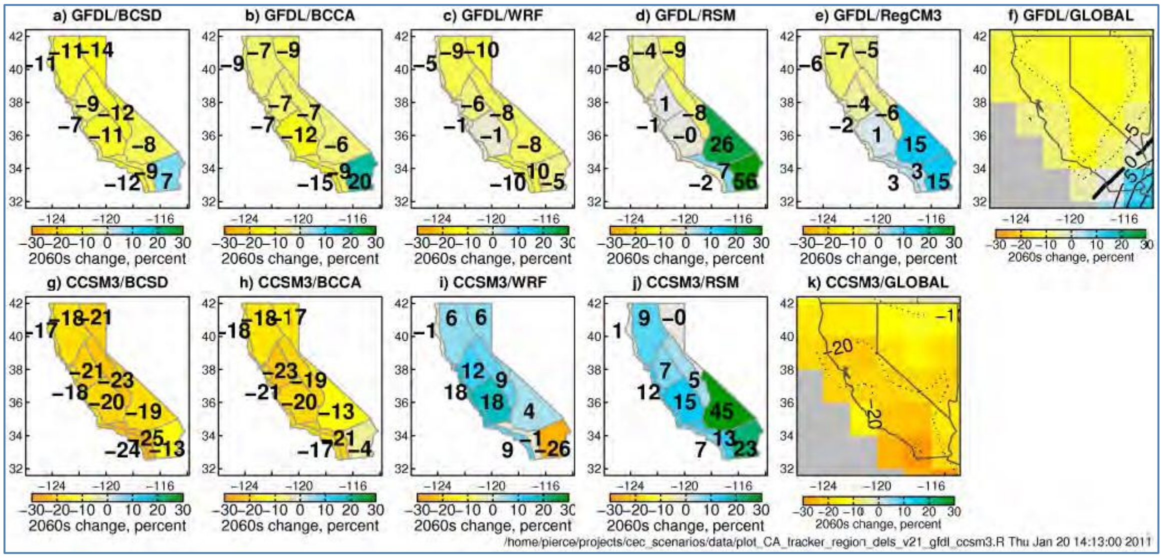


Figure 2. Annual precipitation change (%, 2060–2069 compared to 1985–1994 baseline) from several statistical (a-c and g-h) and dynamical (d-e and i-j) downscaling techniques applied to the GFDL 2.1 (top row) and CCSM3 (bottom row) GCMs. The annual precipitation changes from the GCMs are shown in panels f and k, for comparison. (Figure 14 from Pierce et al, 2011, shown in Cayan et al 2012).

Snowpack is projected to decrease dramatically in the Sierras (CDWR 2015). By the late 21st century, the Sierra snowpack may experience a 48-65 percent loss from the 1961- 1990 average (based on modeling at Scripps Institution of Oceanography, CDWR 2015). As the northern Sierra's peaks are relatively lower than the southern Sierra, a warmer climate is projected to cause greater snowpack reduction in the state's northern mountains (Figure 2). The Tuolumne basin also is in a transition zone between the lower elevation Sierras north (with relatively larger decreases in snowpack due to changing temperature) and higher elevation Sierras in the south, with relatively smaller decreases projected, because the snowpack is above the elevation zone expected to be at or around freezing as temperatures increase. The Tuolumne basin, with its relatively high elevation headwaters, may be in a region with relatively less vulnerability (Null et al 2010). Therefore, analysis of the existing GCM runs & hydrology output are needed focused specifically on the basin, to assess the vulnerability of the snowpack in this basin, and its potential impact on changes in streamflow volume and timing. The increase in temperature also tends to shorten the snow accumulation season and affect the proportion of rain falling as snow.

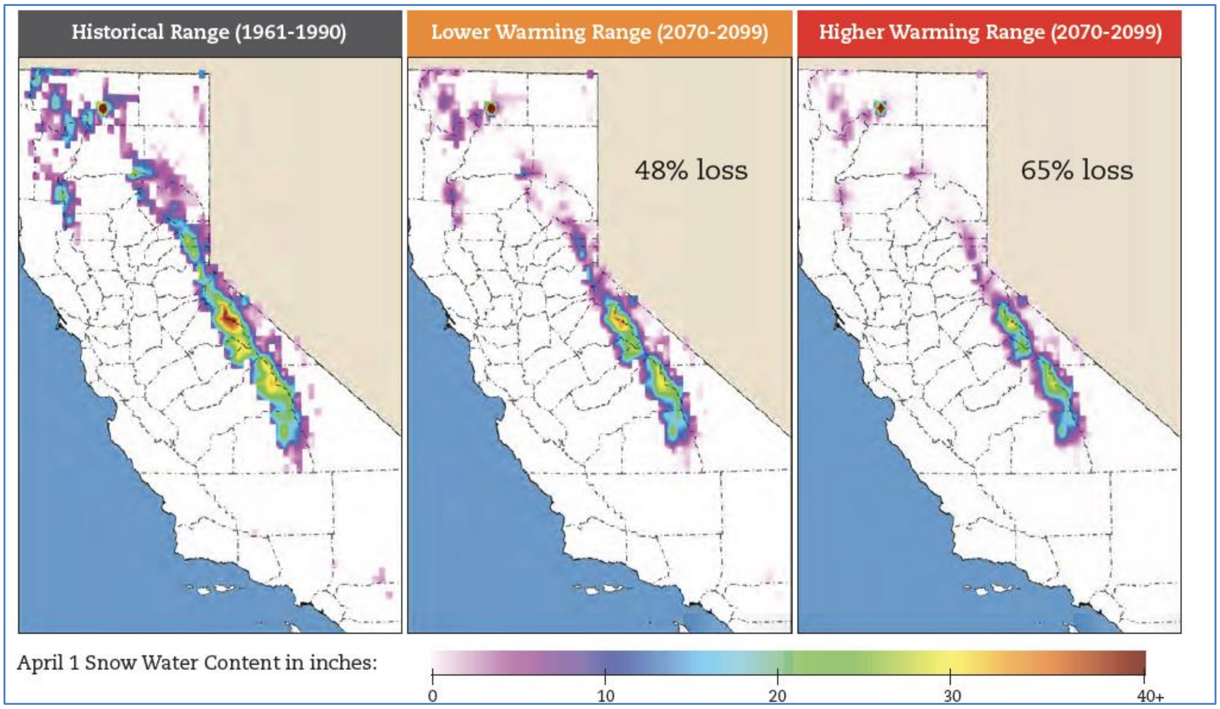
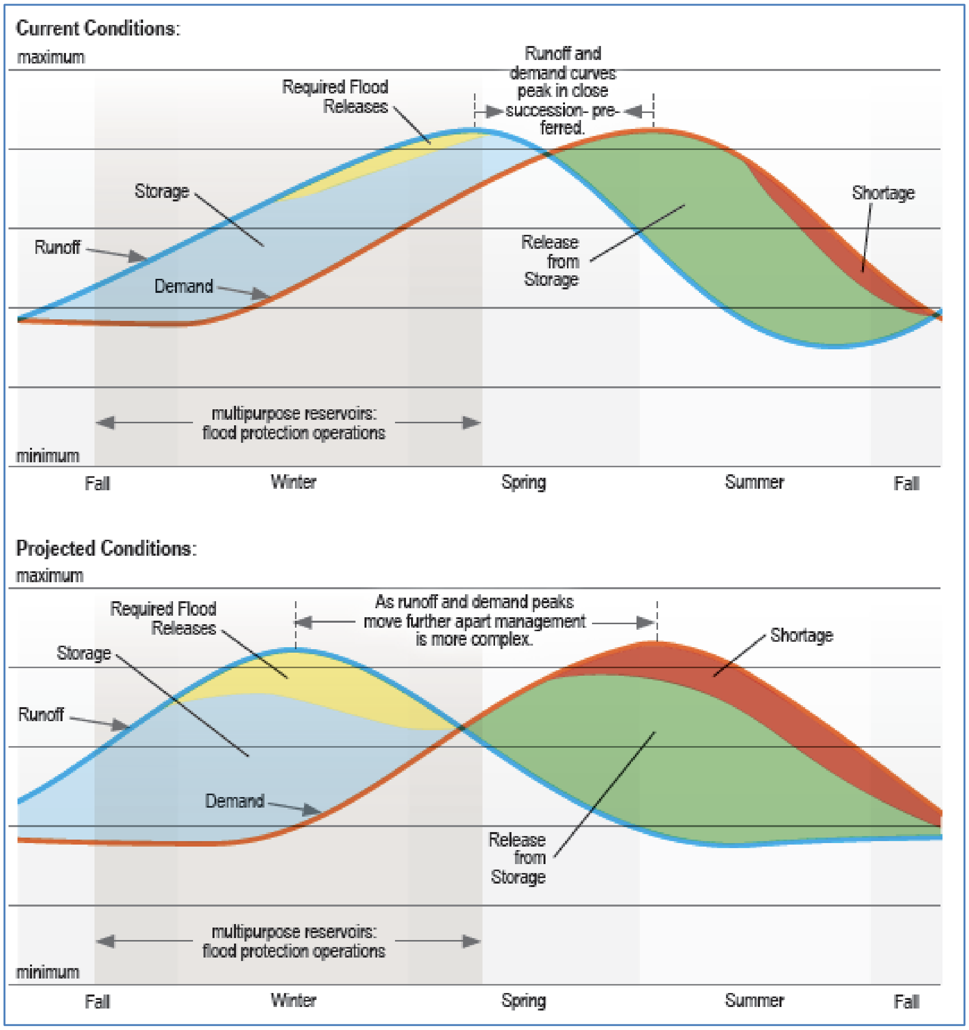


Figure 3. Historical and projected April 1 Snow Water content for the Sierra for lower and higher warming scenarios depicting the effect of human generated greenhouse gases and and aerosols on climate. By the end of this century, the Sierra snowpack is projected to experience a 48 to 65 percent loss from its average at the end of the previous century. (From CDWR 2014, p. 5)

Earlier runoff is already occurring (Hoerling et al 2013), a trend that is expected to continue across the Southwest (Cayan et al 2013). A figure from the California Dept of Water Resources, reproduced below, provides a conceptual illustration of the impacts of earlier runoff and increased summertime water demand in the two curves (Figure 4). The curves show the general shape and timing of runoff and demand in California (individual watersheds will each have unique characteristics). Under "Current Conditions" (top box) runoff peaks in early spring only a few months before demand peaks in early summer. Reservoirs such as those on the Tuolumne capture the spring high runoff, and that storage is used to meet demands later in spring and summer. Under "Projected Conditions" (lower box) runoff peaks in mid-winter, months before demand peaks in spring and summer. Summer-time demand is higher due to higher temperatures and high demand lasts longer into early fall due to longer growing seasons. Earlier runoff can confound traditional storage operations, because if runoff arrives while reservoirs are being managed for flood protection, much of the runoff must be released to maintain flood protection storage space in reservoirs. In spring and summer demand far exceeds runoff and releases from storage, and may make shortages much more common. Viers (2011) point, dry years, more water is dedicated to agriculture and human uses management; whereas it is in wetter years that there is more water for environmental flows.



.
Figure 4. How earlier runoff affects water availability. The curves show the general shape and timing of runoff and demand in California (individual watersheds will each have unique characteristics). Under "Current Conditions" (top box) runoff peaks in early spring. Under "Projected Conditions" (lower box) runoff is projected to peak earlier, shown here in mid-winter. From CDWR 2014, p. 10

Need for additional information

These existing scientific advances provide an opportunity to improve long term project planning. The latest climate projections and downscaled climate change projections for the 30-50 year term of the proposed license, and potential future relicensing extending the life of the project, allow for assessment of the impacts of changing climate on the proposed project and the resources affected by the project. FERC has typically relied on historical data and project-specific studies to evaluate project effects. Considering a static environmental baseline in project planning will not capture these projected changes, therefore, an analysis of projected changes in the climate and hydrology -- and subsequent ecological effects -- is needed for consideration in project planning. However, the best available science includes the presently observed and projected future impacts of climate change on water resources, as demonstrated by Congress directing the Secretary of Interior, via the Secure Water Act, to coordinate with NOAA and its programs to ensure access to the best available information on climate change [§9503 (c)(4) of the SECURE Water Act]. Seasonal climate prediction capability has also advanced, and may provide opportunities for enhancing operations on monthly to seasonal and annual timescales.

In summary, while there is a body of peer-reviewed, publicly available climate projections to work from, and numerous studies at regional and watershed-scale studies referenced above provide a valuable scientific foundation to understand this complex topic, they are not adequate to provide the detailed information necessary to understand: a) how climate change will influence Project facilities and operations; and b) how Project effects on beneficial public uses and public trust resources of the Tuolumne watersheds will be altered under climate change; and c) what strategies might be necessary to respond to these effects.

Additional analyses of existing climate projections and their downscaled products is needed to assess climate impacts on the Tuolumne basin specifically, and to understand the impacts on flows and habitats both upstream and downstream of the combined Don Pedro and La Grange projects. In particular, because the Upper Tuolumne watershed is at higher elevation, there is a need to study this basin specifically, to understand how the snowpack and runoff will evolve given projected temperature changes. There is a need for assessment of the integrated hydrologic effects of climate change in the Tuolumne watershed and an assessment of the potential ecological impacts of climate change and the La Grange and Don Pedro projects.

Unless we adequately address these gaps, any license issued in these proceedings will not adequately protect the public interest. To address these gaps, three additional steps are required. First, mutually acceptable information needs to be developed related to the likely climate change effects Tuolumne hydrology and the ecology of NMFS trust resources. Second, information needs to be developed that describes how the Projects will affect beneficial public uses in Project-affected river reaches. Third, effective license conditions or fish passage methods need to be identified and evaluated for adapting to, avoiding, minimizing or mitigating the effects of climate change. The study methods and analysis described below are designed to address the identified gaps.

§ 5.9 (b): 5.0 Nexus Between Project Operations and Effects on the Resource Studied, and How the Study Results would Inform the Development of License Requirements

Explain any nexus between project operations and effects (direct, indirect, and/or cumulative) on the resource to be studied, and how the study results would inform the development of license requirements;

In past licensings, FERC needed to know the range of variability around a hydrologic baseline by approving study requests that analyzed the magnitude, duration, frequency, and variability of available hydrologic records. Given the advances in science, FERC must now understand changing hydroclimatic conditions and the background effects of climate change on resources that will also be affected by the project in order to assess the effects of the proposed La Grange Project operations and to draft appropriate license articles. In addition to the documented warming climate conditions occurring in California and the Tuolumne watershed, the La Grange project in conjunction with other projects in the system will alter the magnitude, duration, frequency, and temperature of flow releases to the lower Tuolumne River. These direct project effects, when combined with the warming associated with climate change, will exacerbate warm water temperatures in the lower Tuolumne River, with likely detrimental effects to fish productivity for incubating, rearing and spawning anadromous and resident fish species. It is necessary to study how climate change is likely to affect habitat resources to predict how the fish resources may be stressed or may change their behavior. With this information, NMFS can develop recommended license conditions that effectively manage our trust resources, by accurately accounting for the effects of climate change on anadromous fish and habitat resources that are additive to the effects of the project.

Given the current trends (described above in existing information), there is need to document the environmental baseline of the project, and to develop a realistic projection of the range of potential future trends in order to effectively evaluate the impacts of the project on NMFS resources and allow NMFS to make accurate conservation recommendations, license terms and conditions, and to develop recommended protection, mitigation and enhancement measures to address likely project effects.

Without this understanding, FERC will be unable to order a license that properly balances the factors that require assessment under Section 4(e) of the FPA, including the efficiency, longevity and cumulative ecological impacts of the proposed hydropower project and project operations. The agencies, including NMFS and FERC, should assess these particular effects given the reasonably close causal relationship between the environmental effect and the alleged cause (Public Citizen, 541 U.S. at 767).

This information on climate change is needed to inform the nexus between project operations and NMFS ability to perform our duties and exercise our authorities under FPA, MSA, MMPA, and to some extent, ESA. This information includes a range of projected hydrologic changes informed by state of the art GCMs and downscaled climate projections, and detailed changes in hydrologic processes including snowpack evolution, streamflow volume and timing, and stream temperature, and the ecological effects of those changes.

The Tuolumne Basin's freshwater resources are increasingly at risk from climate change. Thus, the proposed study is needed to connect the trends and projected changes in climate and hydrology to variables needed for project planning. The results of the study will provide data and a modeling framework for additional analysis of options to condition the license including:

- Informing the definition, structure and application of alternative water year types;
- Informing the development and implementation of monitoring plans for streamflow, temperature and habitat quality;
- Contributing to the development of possible adaptive management components of a new license to mitigate the impacts of climate change and reservoir operations. These may include forecast-based reservoir operations under climate change and pulse flow requirements to mitigate the impacts of increasing heat waves on stream temperature;
- Assisting in timely identification and planning for possible modifications to management or infrastructure necessary to respond to or take advantage of climate change;

• Informing the implementation or interpretation of other study plans or results, including further water temperature monitoring and modeling, detailed identification of cold water refugia, reservoir cold pool management, and instream flows.

§ 5.9 (b): 6.0 Consistency with Generally Accepted Practice

Explain how any proposed study methodology (including any preferred data collection and analysis techniques, or objectively quantified information, and a schedule including appropriate field season(s) and the duration) is consistent with generally accepted practice in the scientific community or, as appropriate, considers relevant tribal values and knowledge;

In past licensing proceedings, FERC has voiced concerns that analyzing the effects of climate change under all alternatives would be too speculative given the state of science at this time (Enloe Project, Scoping Document 2 5/7/09) or that climate change models do not yet have the accuracy that would be needed to predict specific resource impacts and inform license conditions (York Haven Project, Revised Scoping Document 11/13/09; Conowingo and Muddy Run Projects, Revised Scoping Document 8/24/09; Yuba-Bear and Drum Spaulding Projects, Study Plan Determination 2/23/09). However, the state of climate science has advanced significantly, and climate models, typically downscaled with statistical methods or using regional modeling techniques are now routinely being used by federal agencies and water utilities (as described above) including use for project level analysis (USFS 2009), and are included in the Council on Environmental Quality recommendations for NEPA analysis (CEO 2010). The concept of a stationary environmental baseline with fluctuations (high and low water years) around a relatively stationary mean (as previously used by FERC and other regulators) is an outdated concept given the current level of scientific certainty of climate change (Milly et al. 2008; Viers 2011). Thus, as described in this section, current best practices for water management recommend moving beyond the concept of a stationary future, and consider a range of possible future scenarios, including those that are consistently represented in the GCMs and downscaled projections.

Consideration of the risks of climate change in water and hydropower management, including the use of downscaled climate projections and hydrologic simulations based on those projections

The study methodology proposed considers the risks of climate change because, as documented in this section, it is now a generally accepted practice for hydropower, dam and water management projects in the United States and around the world to consider projections of climate variability and climate change in project planning and operations. To assume a static baseline could result in incorrectly attributing all resource effects to project operations, when a significant degree of resource effects are likely to be caused or exacerbated by climate change rather than by the project alone.

Many scientifically defensible, published, and peer-reviewed methodologies and practices have been developed and used by agencies to study the potential impacts on water supplies from climate change and to provide tools to resources managers to adapt to those changes (SECURE Water Act, Means et al. 2010; Brekke et al. 2009). Furthermore, the downscaled projection datasets and hydrology simulations recommended above for use in the study are all from peer-reviewed published research, and were developed for use in natural resource management, including water, including the studies described in this section. Studies articulating how to use the IPCC models, and the downscaled products based on their input, in water management include:

1) Guidelines on the use of climate scenarios developed from statistical and regional climate model experiments (Mearns et. al. 2003; Wilby et al. 2004).
2) Studies of the strengths and weaknesses inherent in the choice of downscaling methodology (e.g. Fowler et al. 2007; Salathe et al. 2007, Miller et al, 2009)
3) Assessment of the use of downscaled GCM historic simulations and future projections are for hydrologic and ecologic impacts studies of climate change (e.g., Brekke 2009).
4) Use of uncertain information in water utility planning (Barsugli et al 2012)
5) Methods to account for the bias in climate models, the spread of projected climate change, and to account for local circumstances (for example through downscaling or high-resolution hydrologic modeling) (Brekke et al, 2011).
6) Furthermore, numerous studies have developed methods to incorporate this uncertain information into long- term planning processes, and documented these methods and strategies in the peer-reviewed literature, including the need to shift from a “predict then act” framework described by Weaver et al (2013), and prevalent in FERC. They describe using climate knowledge as part of a shift to a risk framework (paradigm 2 in Weaver et al 2013).
7) Use of scenario analysis and planning as one method to deal with complex, uncertain systems, as reviewed in Brekke et al (2009, chapter 4). Traditional scenario analysis uses a small number of scenarios (Schwartz 1991). These scenarios could be defined relative to climate projections, demographic outlooks, and other planning drivers. Such scenarios might be cast as "top down," contrasted with "bottom up" scenarios (Ray et al. 2008) that are defined within a sensitivity analysis where thresholds of operations flexibility are revealed by incremental adjustment of planning drivers. These approaches are not necessarily exclusive. Miller and Yates (2006) recommendations for using climate modeling in decision making include using the downscaled results in such a risk and scenario framework (Brekke 2009).

NEPA requires federal agencies taking certain actions to consider climate change impacts – those the agency’s project may contribute to, and, as in this case, those affecting the proposed project – in the EIS (NEPA § 102(2)(C); 42 U.S. C. § 4332(2)(C)). A study of the use of climate change information in EIS’s found that, “Climate impacts in the project region are often discussed in order to consider their effect on a resource which the project might also impact,” (Woolsey 2012, p 8). The study found that EISs for reservoir projects *in California* routinely analyze the potential impacts of climate change on water resources in detail, addressing decreased precipitation and runoff, and that this analysis predicted that several rivers will not be able to meet their minimum flow requirements and that water usage plans will need to be reevaluated. The author notes that USFWS EISs address the effects of climate change on the habitat, food resources and behavior of individual species, especially those federally listed as endangered or threatened. (Woolsey 2012).

In the last several years, federal agencies have increasingly considered the risks of climate change (e.g. Udall 2013). A growing body of U.S. policy requires and provides guidance on consideration of climate risks, and use of climate information by agencies. This guidance on consideration of climate risks has moved beyond that in EIS's initiated several years ago (Woolsey's study ends with EIS complete in Dec 2011). In comments for the DEIS for the Middle Fork American River hydroelectric license, the EPA rated the DEIS as having provided insufficient information, in part, because it did not address potential cumulative effects of climate change on the project area and how this may affect future conditions (EPA 2012). The *best available science* (Ray 2016) now includes the presently observed and projected future impacts of climate change on water resources, as demonstrated by Congress directing the Secretary of Interior, via the Secure Water Act, to coordinate with NOAA and its programs to ensure access to the best available information on climate change [(§) 9503 (c)(4) of the SECURE Water Act.

Specific federal policy guidance on the use of climate projections includes, beginning in 2009:

1) Executive Order 13514 (2009), Section 8(i) required that as part of the formal Strategic Sustainability Performance Planning process, each federal agency evaluate agency climate change risks and vulnerabilities to manage both the short- and long-term effects of climate change on the agency's mission and operations. Another section, Sec. 16., articulates Agency Roles in Support of the Federal Adaptation Strategy. The CEQ Climate Change Adaptation Task Force issued implementing instructions for the strategy in March, 2011 (CEQ 2011). This E.O. was replaced by E.O 13693, described below.
2) Executive Order (EO) 13693, Planning for Federal Sustainability in the Next Decade, was signed by President Obama on 19 March 2015. This EO revokes 13514, but further expands agency interests in climate change resiliency and preparation. According to the 13693 implementation guidance, agencies are required to annually update Strategic Sustainability Plans (SSPP) describing specific agency strategies to accomplish, *inter alia*, the consideration of the effects of climate change on the agency's operations and programs.
3) The U.S. Forest Service (USFS) has recommended consideration of climate change in project level NEPA analysis (USFS 2009), and in a letter to the Forest Service National Leadership Team dated February 15, 2008, Forest Service Chief Abigail R. Kimbell characterized the Agency's response to the challenges presented by climate change as "one of the most urgent tasks facing the Forest Service," and stressed that "...as a science-based organization, we need to be aware of this information and to consider it any time we make a decision regarding resource management, technical assistance, business operations, or any other aspect of our mission."
4) In 2011, the U.S. Bureau of Reclamation and the Army Corps of Engineers released a report that identifies the needs of local, state, and federal water management agencies for climate change information and tools to support long-term planning (Brekke et al. 2011). In the accompanying press release, Reclamation Commissioner Michael Connor is quoted, "Climate change impacts to water and water- dependent resources challenge water management agencies throughout the country, ...Close collaboration by water resource managers and scientists will improve the tools and information needed to help make future decisions that support the sustainable use of water." U.S. Army Corps of Engineers Director

of Civil Works, Steve Stockton, is also quoted, "This document takes a step toward communicating a collective expression of needs from the water resources community to the science community, ...we hope the science community will rally around these needs with collaborative research and fill the gaps that have been identified," (http://www.usbr.gov/newsroom/newsrelease/detail.cfm?RecordID=34803).

5) Reclamation also issued a "planning directive," Manual CMP-0902, signed 09/13/2012, that states, “The potential impacts of climate change will be considered when developing projections of environmental conditions, water supply and demand, and operational conditions at existing facilities as part of the without-plan future condition.”
6) The Department of Interior Climate Change Adaptation policy (DOI 2012) effective, 12/20/12.
7) BLM’s National Operations Center (NOC) is requiring study of climate change as a “change agent” in each of its “Rapid Ecoregional Assessments,” (http://www.blm.gov/wo/st/en/prog/more/Landscape_Approach/reas.html)
8) The Executive Order 13690 (2015) on Planning for Flooding requires that elevation and flood hazard area be defined in a study using a climate-informed science approach that uses the best-available, actionable hydrologic and hydraulic data and methods that integrate current and future changes in flooding based on climate science. (https://www.whitehouse.gov/the-press-office/2015/01/30/executive-order-establishing-federal-flood-risk-management-standard-and-)
9) The Aug 2015 NOAA Fisheries Climate Science Strategy identifies a number of ways NOAA should incorporate climate science into operations and policy (Link et al 2015.). This includes Objective 7: Build and maintain the science infrastructure needed to fulfill NOAA Fisheries mandates under changing climate conditions. It also suggests designing scientifically sound review-evaluation protocols that could ensure consideration of climate change as a standard part of living marine resource management advice. (https://www.st.nmfs.noaa.gov/Assets/ecosystems/climate/documents/NCSS_Final.pdf)

Water managers and planners outside the federal government are also considering risks of climate change and incorporating this in their long-range planning. The Water Utility Climate Alliance (WUCA), ten of the Nation's largest water providers, formed to provide leadership and collaboration on climate change issues affecting the country's water agencies. In January 2010, WUCA released a white paper that "outlines planning approaches to help water utilities adapt to climate change. Planning methods are necessary because many water utilities cannot afford to delay significant decisions and wait until the range of potential climate change impacts is substantially narrowed." The report, "Decision Support Planning Methods: Incorporating Climate Change Uncertainties into Water Planning," was produced to help water utilities consider and evaluate traditional and emerging planning techniques for use in their own climate adaptation efforts. WUCA and its member cities have continued their interest in the use of projections, including a set of case studies in how climate change is shifting water utility planning (Stratus Consulting and Denver Water 2015) and about producing actionable climate information for utility modeling applications (Vogel et al 2015).

Thus, the requested analyses of climate projections is consistent with generally accepted practice, as well as their use in in a risk assessment framework, including the consideration of a range of plausible risks, is now the generally accepted practice in the scientific and management community, supply and infrastructure planning processes, by Federal and non-federal water management, resource and infrastructure planning the U.S. and the world.

§ 5.9 (b): 7.0 Considerations of Level of Effort and Cost

Describe considerations of level of effort and cost, as applicable, and why any proposed alternative studies would not be sufficient to meet the stated information needs.

This proposed study is estimated to require a one-year study involving ~1.3-2 person years of effort including a primary investigator with preferably post-doctoral experience the field of applied climate projections to design and direct the study, along with assistant researchers capable of conducting portions of the study's different topics. A lower level of effort (~1.3 person-years) is feasible if there are existing datasets available and deemed appropriate as input for all the elements described above; if not, a higher level of effort as reflected in the following estimates may be required. Our estimate of time needed includes a literature assessment of existing water and hydropower studies (Request Element 1, estimate 1 person-months (p-m)), documenting historic climate (Request Element 2, 1.5 p-m), acquiring and analyzing projections of climate and streamflow (Request Elements 3 and 4, each 3-4 p-m), analyzing the impacts on species of interest (Request Element 5, 3-6 p-m), and documenting the results in a technical report and archiving and making the data available to others (Request Element 6, 2-3 p-m) as well as interfacing with other studies planned for the project, including one trip to collaborate in person (1.5 p-m). While there are existing downscaled and hydrological studies (see above), we are unsure, for example, if streamflow temperature projections are available (a product by Isaak for the Sierras is anticipated this year, building on published work for the NWUS), or if there are models for reservoir operations. If effort were needed on these models and data analysis and documentation, the effort would expand to ~2 person years. This year of study is estimated to cost between $250,000 to $350,000.

Literature Cited

Abatzoglou J.T. and Brown T.J. 2012. A comparison of statistical downscaling methods suited for wildfire applications. International Journal of Climatology doi: 10.1002/joc.2312.

Abatzoglou, J. T., K. T. Redmond, L. M. Edwards, 2009. Classification of Regional Climate Variability in the State of California. *J. Appl. Meteor. Climatol.*, 48, 1527-41.

ACIS, 2004. Impacts of a Warming Arctic: Arctic Climate Impacts Assessment. Cambridge University Press. http:// www.acia.uaf.edu, accessed 21 May 2012.

Barsugli, J.J., J.Vogel, L. Kaatz, J. Smith, M. Waage, and C.A. Anderson. 2012. Two faces of uncertainty: climate science and water utility planning methods, *J. Water Resour. Plann. Manage.* 138: 389–395.

Belmecheri S., F. Babst, E. R. Wahl, D. W. Stahle, and V. Trouet. 2016. Nature Climate Change 6, 2–3 (2016) doi:10.1038/nclimate2809

Brekke, Levi, B.L. Thrasher, E.P. Maurer, T. Pruitt. 2013. Downscaled CMIP3 and CMIP5 Climate Projections: Release of Downscaled CMIP5 Climate Projections, Comparison with Preceding Information and Summary of User Needs. U.S. Department of Interior, Bureau of Reclamation, Tech. Rep. (2013) 116 pp

Brekke, L. D., E. P. Maurer, J. D. Anderson, M. D. Dettinger, E. S. Townsley, A. Harrison, and T. Pruitt. 2009a, Assessing reservoir operations risk under climate change, Water Resour. Res., 45, W04411, doi:10.1029/2008WR006941

Brekke, L.D., Kiang, J.E., Olsen, J.R., Pulwarty, R.S., Raff, D.A., Turnipseed, D.P., Webb, R.S., and White, K.D., 2009b, Climate change and water resources management-A federal perspective: USGS Circular 1331, 65 p. Available at http://pubs.usgs.gov/circ/1331. Accessed 25 May 2012.

Brekke, L. et al. 2011. Addressing Climate Change in Long-Term Water Resources Planning and Management User Needs for Improving Tools and Information. U.S. Army Corps of Engineers Civil Works Technical Series CWTS-10-02, available at: http://www.usbr. gov/climate/userneeds/ accessed 20 May 2012.

Brown, Ross D., Philip W. Mote, 2009: The Response of Northern Hemisphere Snow Cover to a Changing Climate. *J. Climate,* 22, 2124-45. doi: http://dx.doi.org/10.1175/2008JCLl2665.l

Bryant, J.A. 2009. Global climate change and potential effects on Pacific Salmonids in freshwater ecosystems of southeast Alaska. Climatic Change 95:169-193

Biirger, G., J. Schulla, and A. T. Werner (2011), Estimates of future flow, including extremes, of the Columbia River headwaters, Water Resour. Res., 47, W10520, doi:10.1029/2010WR009716.

California Dept. of Water Resources, 2015. California Climate Science and Data for Water Resources Management. June 2015. Available at: http://www.water.ca.gov/climatechange/docs/CA_Climate_Science_and_Data_Final_Release_June_2015.pdf

Cayan, D. R., Tyree, M., Kunkel, K. E., Castro, C., Gershunov, A., Barsugli, J., Ray, A. J., Overpeck, J. T., Anderson, M., Russell, J., Rajagopalan, B., Rangwala, I., and Duffy, P., "Future Climate: Projected Average", in Assessment of Climate Change in the Southwest United States: A Report Prepared for the National Climate Assessment, Washington D.C.: Island Press, 2013.

Cayan, D., M. Tyree, D. Pierce, and T. Das (Scripps Institution of Oceanography). 2012. Climate Change and Sea Level Rise Scenarios for California Vulnerability and Adaptation Assessment. California Energy Commission. Publication number: CEC-500-2012-008.

CEQ, 2011. Federal agency climate change adaptation planning: Implementing Instructions , March 4, 2011 http://www.whitehouse.gov/sites/default/files/microsites/ceq/adaptation_final_impl ement ing_instructions_3_3.pdf, accessed 20 May 2012.

CEQ, 2010. Draft NEPA guidance on consideration of the effects of climate change and greenhouse gas emissions, available at: http://www.whitehouse.gov/sites/default/files/microsites/ceq/201 00218-nepa-consideration-effects-ghg-draft-guidance.pdf, accessed 20 May 2012.

Cherry, J.E., S. Walker, N. Fresco, S. Trainor, A. Tidwell. 2010. Impacts of Climate Change and Variability on Hydropower in Southeast Alaska: Planning for a Robust Energy Future, available at: http://www.iarc. uaf.edu/sites/default/files/seak_report_final.pdf

Christensen, J.H., B. Hewitson, A., Busioc, A. Chen X. Gao, I.Held, R. Jones, R.K. Kolli, W.T. Kwon, R. Laprise, V. Magana Rueda, L. Mearns, C.G. Menendez, J. Raisaned, A. Rinke, Sarr, and P. Whetton, 2007. Regional Climate Projection. In: Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Solomon, S. D., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor, and H.L. Miller (eds.)]. Cambridge University Press, Cambridge, United Kingdon and New York, NY, USA.

Cuthbertson, A, Elissa Lynn, Mike Anderson, and KTRedmond. 2014. Estimating Historical California Precipitation Phase Trends Using Gridded Precipitation, Precipitation Phase, and Elevation Data. Report for the CA Dept of Water Resources, available at: http://www.water.ca.gov/climatechange/docs/Estimating%20Historical%20California %20Precipitation%20DWR%20CWP%207-7-2014%20FINAL.pdf

Environmental Protection Agency, Comments to the Draft Environmental Impact Statement for Hydropower Licence, Middle Fork American River Hydroelectric Project FERC Project No. 2079-069, California (CEQ# 20120250), 2 October 2012

Executive Order No. 13514, Federal Leadership in Environmental, Energy, and Economic Performance, 74 Fed. Reg. 194 (Oct. 8, 2009).

Executive Order 13690, Establishing a Federal Flood Risk Management Standard [FFRMS] and a Process for Further Soliciting and Considering Stakeholder Input (2015) amends E.O. 11988, Floodplain Management (1977).

Executive Order No. 13693, Planning for Federal Sustainability in the Next Decade, Implementing Instructions for Executive Order 13693, 80 Fed. Reg. 57 (March 25, 2015). See also, Implementing Instructions issued June 10, 2015.

Federal Energy Regulatory Commission Documents:
Enloe Project, Scoping Document 2, 5/7/09
York Haven Project, Revised Scoping Document, 11/13/09;
Conowingo and Muddy Run Projects, Revised Scoping Document, 8/24/09;
Yuba-Bear and Drum Spaulding Projects, Study Plan Determination, 2/23/09
Susitna-Watana Hydroelectric Project, Study Plan Determination, 2/1/13; Director's Formal Study Dispute Determination, 4/26/13; Glacier and Runoff Changes Study, Study Plan 7.7 Initial Study Report - Literature Review, June 2014

Federal Power Act 1995. Public Law 114-38. Federal Regulation and Development of Power. 18 CFR Section 5.11(b)(5).

Fitzpatrick, J., R.B. Alley, J. Brigham-Grette, G.H. Miller, L. Polyak, and M. Serreze, 2008: Preface: Why and how to use this synthesis and assessment report. In:Past Climate Variability and Change in the Arctic and at High Latitude. Synthesis and Assessment Product 1.2. USGS. Reston, VA, pp. 8-21.

Fowler, H.J., Blenkinsop, S., and Tebaldi, C., 2007, Review: Linking climate change modeling to impacts studies-Recent advances in downscaling techniques for hydrological modeling: International Journal of Climatology, v. 27, p. 1547-1578.

Groves, David G., Jordan R. Fischbach, Evan Bloom, Debra Knopman and Ryan Keefe. Adapting to a Changing Colorado River: Making Future Water Deliveries More Reliable Through Robust Management Strategies. Santa Monica, CA: RAND Corporation, 2013. http://www.rand.org/pubs/research_reports/RR242.html. Also available in print form.

Hoerling, M. P., M. Dettinger, K. Wolter, J. Lukas, J. Eischeid, R. Nemani, B. Liebmann, and K. E. Kunkel. 2013. Present Weather and Climate: Evolving Conditions, pp 74–100 in: *Assessment of Climate Change in the Southwest United States: A Report Prepared for the National Climate Assessment*, edited by G. Garfin, A. Jardine, R. Merideth, M. Black, and S. LeRoy, A report by the Southwest Climate Alliance. Washington, DC: Island Press. Available at: http://swcarr.arizona.edu/chapter/5.

Intergovernmental Panel on Climate Change (IPCC) 2013: Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Stocker, T.F., D. Qin, G.-K. Plattner, M. Tignor, S.K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex and P.M. Midgley (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 1535 pp.

Intergovernmental Panel on Climate Change (IPCC), 2007, Climate change 2007—The physical science basis, in Solomon, S., Qin, Dahe, Manning, Martin, Chen, Zhenlin, Marquis, Melinda, Averyt, K.B., Tignor, Melinda, and Miller, H.L., Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change: Cambridge, United Kingdom, Cambridge University Press, 996 p.

Isaak D. J. , et al., 2010. Effects of climate change and wildfire on stream temperatures and salmonid thermal habitat in a mountain river network. Ecol Appl 20(5): 1350–1371

Isaak, D., M. Young, C. Luce, S. Hostetler, S. Wenger, E. Peterson, J. Ver Hoef, M. Groce, D. Horan, and D. Nagel. 2016. Slow climate velocities of mountain streams portend their role as refugia for cold-water biodiversity. Proceedings of the National Academy of Sciences. doi:10.1073/pnas.1522429113

Karl, Thomas R., Jerry M. Melillo, and Thomas C. Peterson, (eds.). 2009. Global Climate Change Impacts in the United States, Cambridge University Press.

Kyle, R.E. and T. Brabets, 2001. Water Temperature of Streams in the Cook Inlet Basin, Alaska, and Implications of Climate Change. USGS. Water-Resource Investigations Report 01- 4109.

Kunkel, K.E., Stevens, L.E., Stevens, S.E., Sun, Liqiang, Janssen, Emily, Wuebbles, Donald, Redmond, K.T. and T.R., Dobson, J.G., 2013. Climate of the Southwest U.S., National Oceanic and Atmospheric Administration Technical Report NESDIS 142-5, accessed Sept 16, 2015 at http://www.nesdis.noaa.gov/technical_reports/NOAA_NESDIS_Tech_Report_142-5-Climate_of_the_Southwest_U.S.pdf

Link, J.S., Griffis, R, and Busch S., 2015. NOAA Fisheries Climate Science Strategy. NOAA Technical Memorandum NMFS-F/SPO-155, Available at https://www.st.nmfs.noaa.gov/Assets/ecosystems/climate/documents/NCSS_Final.pdf

McBeath, Jennifer H. Editor, Juday, Glenn P., Weller, Gunter, Associate Editors, and Mayo Murray, Technical Editor. 1984. The Potential Effects of Carbon Dioxide-Induced Climatic Changes in Alaska, The Proceedings of a Conference. Ag. Exp. Sta. Misc. Publication 83-1. Univ. of Alaska. 208 pp.

Mearns, L.O., F. Giorgi, P. Whetton, D. Pabon, M. Hulme, M. Lal. 2003. Guidelines for Use of Climate Scenarios Developed from Regional Climate Model Experiments. IPCC document, available at: http:ijwww.ipcc-data.org/guidelines/, accessed 23 May 2012.

Means, E. et al. 2010. Decision Support Planning Methods: Incorporating Climate Change Uncertainties into Water Planning Prepared for: Water Utility Climate Alliance, Available at http://www.wucaonline.org/assets/pdf/pubs_whitepaper_012110.pdf, accessed 25 March 2016.

Miller, K., and Yates, D., 2006, Climate change and water resources-A primer for municipal water providers: Denver, Colo., American Water Works Association, 83 p.

Miller, N. L., J. Jin, N. J. Schlegel, M. A. Snyder, T.O’Brien, L. C. Sloan, P. B. Duffy, H. Hidalgo, H. Kanamaru, M. Kanamitsu, K. Yoshimura, D.R. Cayan, 2009. An Analysis of Simulated California Climate Using Multiple Dynamical and Statistical Techniques. California Energy Commission Report #CEC-500-2009-017-F (August 2009). 35 pp.

Milly et al. Stationarity Is Dead: Whither Water Management? Science 1 February 2008: 319: 5863 pp. 573-574 DOI: 10.1126/science.1151915

Mortsch, L.D., Alden, M., Klaassen, J., 2005. Development of Climate Change Scenarios for Impact and Adaptation Studies in the Great Lakes - St. Lawrence Basin, report prepared for the International Joint Commission-International Lake Ontario St. Lawrence River Study Board, 29 p.

Moyle PB, Kiernan JD, Crain PK, Quiñones RM (2013) Climate Change Vulnerability of Native and Alien Freshwater Fishes of California: A Systematic Assessment Approach. PLoS ONE 8(5): e63883. doi:10.1371/journal.pone.0063883

Null SE, Viers JH, Mount JF (2010) Hydrologic Response and Watershed Sensitivity to Climate Warming in California's Sierra Nevada. PLoS ONE 5(4): e9932. doi:10.1371/journal.pone.0009932

Null, S. E., Viers, J. H., Deas, M. L., Tanaka, S. K., & Mount, J. F. (2013). Stream temperature sensitivity to climate warming in California's Sierra Nevada: impacts to coldwater habitat. *Climatic Change*, *116*: 149-170.

O'Brien & Loya, Climate Change Impacts on Water Availability in Alaska. University of Alaska Fairbanks, 2009

Pierce, DW, DR Cayan, and BL Thrasher. 2014. Statistical downscaling using Localized Constructed Analogs (LOCA). Journal of Hydrometeorology 15: 2558-2585.

Pierce, DW, Das T, Cayan DR, Maurer EP, Miller NL, Bao Y, Kanamitsu M, Yoshimura K, Snyder MA, Sloan LC, Franco G, Tyree M. 2013. Probabilistic estimates of future changes in California temperature and precipitation using statistical and dynamical downscaling. Climate Dynamics. 40:839-856. DOI: 10.1007/s00382-012-1337-9

Ray, A.J. 2016. Providing Climate Science to Real-World Policy Decisions: A Scientist's View from the Trenches, pp 141-160 in: Water Policy and Planning in a Variable and Changing Climate, Eds. K.A. Miller, A.F. Hamlet, D.S. Kenney, K.T. Redmond, CRC Press.

Ray, A.J., J.J. Barsugli, K.B Averyt, K.Wolter, M. Hoerling, 2008. Colorado Climate Change: A Synthesis To Support Water Resource Management and Adaptation, a report for the Colorado Water Conservation Board by the NOAA-CU Western Water Assessment, available at: www.cwcb. State.co.us

Reclamation (Bureau of Reclamation). 2016. SECURE Water Act Section 9503(c) – Reclamation Climate Change and Water. Prepared for United States Congress. Denver, CO: Bureau of Reclamation, Policy and Administration. Available at: http://www.usbr.gov/climate/secure/docs/2016secure/2016SECUREReport.pdf, accessed 28 March 2016.

Reclamation, 2014. 'Downscaled CMIP3 and CMIP5 Climate and Hydrology Projections: Release of Hydrology Projections, Comparison with preceding Information, and

Summary of User Needs', prepared by the U.S. Department of the Interior, Bureau of Reclamation, Technical Services Center, Denver, Colorado. 110 pp.

Reclamation, 2011. SECURE Water Act Section 9503(c) - Reclamation Climate Change and Water 2011, Prepared for United States Congress. Available at http://www.usbr.gov/climate, accessed 20 May 2012.

Reclamation, 2012. Colorado River Basin Water Supply and Demand Study : Study Report (December 2012). 89 pp.

Robinson, D.A. 1993. Monitoring northern hemisphere snow cover. *Snow Watch '92: Detection Strategies for Snow and Ice.* Glaciological Data Report, GD-25, 1-25.

Salathe, E.P., Mote, P.W., and Wiley, M.W., 2007. Review of scenario selection and downscaling methods for the assessment of climate change impacts on hydrology in the United States Pacific Northwest: International Journal of Climatology, v. 27, p. 1611- 1621.

Schwartz, Peter, 1991. The art of the long view: New York, Currency Doubleday, 272 p.

Stratus Consulting and Denver Water. 2015. Embracing Uncertainty: A Case Study Examination of How Climate Change is Shifting Water Utility Planning. Prepared for the Water Utility Climate Alliance (WUCA), the American Water Works Association (AWWA), the Water Research Foundation (WRF), and the Association of Metropolitan Water Agencies (AMWA) by Stratus Consulting Inc., Boulder, CO (Karen Raucher and Robert Raucher) and Denver Water, Denver, CO (Laurna Kaatz). 99 pp. Available at: http://www.wucaonline.org/html/, accessed 22 Feb 2012

U.S. Forest Service. 2009. Climate Change Considerations in Project Level NEPA Analysis. Available at: http://www.fs.fed.us/emc/nepa/climate_change/includes/cc_nepa_guidance.pdf

Van Lienden, Brian, Munévar, Armin, and Das, Tapash. 2014. Sacramento and San Joaquin Basins Climate Impact Assessment. Prepared for the U.S. Bureau of Reclamation by CH2M HILL. Available at: http://www.usbr.gov/watersmart/wcra/docs/ssjbia/ssjbia.pdf

Vicuna, S., J.A. Dracup, J.R. Lund, L.L. Dale, and E.P. Maurer, 2010. Basin-Scale Water System Operations With Uncertain Future Climate Conditions: Methodology and Case Studies.Water Resources Research 46:W04505, doi: 10.1029/2009 WR007838.January 13, 2009, available at http://www.ts.fed.us/emc/nepa/climate _change/includes/cc_ nepa_guidance.pdf accessed 20 May 2012.

Viers, Joshua H., 2011. Hydropower Relicensing and Climate Change, Journal of the American Water Resources Association (JAWRA) 1-7. DOI: 10.1111/j.1752-1668.2011.00531.x

Vogel J, et al. 2015. Actionable Science in Practice: Co-producing Climate Change Information for Water Utility Vulnerability Assessments. Final Report of the Piloting

Utility Modeling Applications (PUMA) Project, for the Water Utility Climate Alliance. 59 pp. Available at: http://www.wucaonline.org/html/, accessed 22 Feb 2012

Weaver, C.P., R.J. Lempert, C. Brown, et al. 2013. Improving the contribution of climate model information to decision making: the value and demands of robust decision frameworks. *WIREs Clim Change* 4: 39-60. doi:10.1002/wcc.202

Wilby, R.L. et al. 2004. Guidelines for Use of Climate Scenarios Developed from Statistical Downscaling Methods. IPCC document, available at: http:ijwww.ipcc-data.org/guidelines/, accessed 23 May 2012.

Williams, B. K., and E. D. Brown. 2012. Adaptive Management: The U.S. Department of the Interior Applications Guide. Adaptive Management Working Group, U.S. Department of the Interior, Washington, DC.

Woolsey, P. 2012. *White Paper on the Consideration of Climate Change in Federal EISs, 2009-2011*. Sabin Center for Climate Change, Columbia Law School. http://web.law.columbia.edu/climate-change/resources/nepa-and-state-nepa-eis-resource-center.

Udall, B. “Water: Impacts, Risks, and Adaptation”, in Assessment of Climate Change in the Southwest United States: A Report Prepared for the National Climate Assessment, Washington D.C.: Island Press, 2013.

Decision Support Planning Methods: Incorporating Climate Change Uncertainties into Water Planning," Brown, ed. WUCA white paper. Available at: http://www.wucaonline.org/assets/pdf/pubs_whitepaper_012110.pdf

Enclosure C

UNITED STATES OF AMERICA
FEDERAL ENERGY REGULATORY COMMISSION

CERTIFICATE OF SERVICE

La Grange Hydroelectric Project	**)**	**P-14581**
Turlock Irrigation District and Modesto Irrigation District	**)**	
__________________________________	**)**	

I hereby certify that I have this day served, by first class mail or electronic mail, a letter to Secretary Bose, Federal Energy Regulatory Commission, containing the National Marine Fisheries Service's Comments on the Initial Study Report; Proposed Modifications to the Commission's Study Plan; and Proposed New Information Gathering or Study for the La Grange Hydroelectric Project. This Certificate of Service is served upon each person designated on the official P-14581 Service List compiled by the Commission in the above-captioned proceeding.

Dated this 4th day of April, 2016

____
John Wooster
National Marine Fisheries Service

FISH PASSAGE FACILITIES ALTERNATIVES ASSESSMENT

STUDY REPORT

ATTACHMENT B

OPINIONS OF PROBABLE CONSTRUCTION COSTS, OPERATION AND MAINTENANCE COSTS, AND LIFECYCLE COST DATA

MODESTO AND TURLOCK IRRIGATION DISTRICTS
FISH PASSAGE FACILITIES ALTERNATIVE ASSESSMENT
SUMMARY OF FISH PASSAGE ALTERNATIVE COSTS ($US, 2017)

Table 1 - Project implementation costs for all alternatives shown as a percentage of the OPCC.

PROJECT IMPLEMENTATION COSTS	PERCENTAGE OF OPCC
CONSTRUCTION MANAGEMENT	8.00%
APS PROCUREMENT	4.00%
ENGINEERING/CONSULTING	12.00%
PERMITTING	8.00%
BONDS AND INSURANCE	2.50%
PROJECT ADMINISTRATION	10.00%
TOTAL PERCENTAGE OF OPCC	**44.50%**

Table 2 - Summary of concept OPCC (rounded to $100,000).

ALTERNATIVE	BASE OPCC W/ CONT
UPSTREAM FISH PASSAGE	
U1A: TECHNICAL FISH LADDER - BYPASS	$294,156,000
U1B: TECHNICAL FISH LADDERS	$181,186,000
U2: FISH LIFT WITH TECHNICAL LADDER AT LA GRANGE	$87,325,000
U3: CHTR FACILITY	$33,635,000
U4: WHOOSHH FISH TRANSPORT TUBE	$52,118,000
DOWNSTREAM FISH PASSAGE	
D1: FIXED MULTI-PORT COLLECTOR WITH HELICAL BYPASS	$285,116,000
D2A: SURFACE COLLECTOR - DAM	$81,791,000
D2B: SURFACE COLLECTOR - HEAD OF RESERVOIR	$83,368,000
D3: FIXED IN-RIVER COLLECTOR	$49,401,000

Table 3 - Summary of OPCC, implementation cost, and total project costs for each concept (rounded to $100,000).

ALTERNATIVE	BASE OPCC	IMPLEMENTATION COST	TOTAL PROJECT COST
UPSTREAM FISH PASSAGE			
U1A: TECHNICAL FISH LADDER - BYPASS	$294,156,000	$130,900,000	$425,056,000
U1B: TECHNICAL FISH LADDERS	$181,186,000	$80,700,000	$261,886,000
U2: FISH LIFT WITH TECHNICAL LADDER AT LA GRANGE	$87,325,000	$38,900,000	$126,225,000
U3: CHTR FACILITY	$33,635,000	$15,000,000	$48,635,000
U4: WHOOSHH FISH TRANSPORT TUBE	$52,118,000	$23,200,000	$75,318,000
DOWNSTREAM FISH PASSAGE			
D1: FIXED MULTI-PORT COLLECTOR WITH HELICAL BYPASS	$285,116,000	$126,900,000	$412,016,000
D2A: SURFACE COLLECTOR - DAM	$81,791,000	$36,400,000	$118,191,000
D2B: SURFACE COLLECTOR - HEAD OF RESERVOIR	$83,368,000	$37,100,000	$120,468,000
D3: FIXED IN-RIVER COLLECTOR	$49,401,000	$22,000,000	$71,401,000

Table 4 - Summary of anticipated Operations and Maintenance Costs (rounded to $1,000).

ALTERNATIVE	BASE O&M COST
UPSTREAM FISH PASSAGE	
U1A: TECHNICAL FISH LADDER - BYPASS	$324,000
U1B: TECHNICAL FISH LADDERS	$388,000
U2: FISH LIFT WITH TECHNICAL LADDER AT LA GRANGE	$377,000
U3: CHTR FACILITY	$294,000
U4: WHOOSHH FISH TRANSPORT TUBE	$319,000
DOWNSTREAM FISH PASSAGE	
D1: FIXED MULTI-PORT COLLECTOR WITH HELICAL BYPASS	$286,000
D2A: SURFACE COLLECTOR - DAM	$529,000
D2B: SURFACE COLLECTOR - HEAD OF RESERVOIR	$537,000
D3: FIXED IN-RIVER COLLECTOR	$322,000

MODESTO AND TURLOCK IRRIGATION DISTRICTS
FISH PASSAGE FACILITIES ALTERNATIVE ASSESSMENT
ENGINEER'S OPINION OF PROBABLE CONSTRUCTION COSTS
UPSTREAM FISH PASSAGE: TECHNICAL FISH LADDER - BYPASS (U1A)

ITEM	QUANTITY	UNIT	UNIT COST	AMOUNT	TOTAL
MOBILIZATION AND DEMOBILIZATION (10%)	**1**	**LS**	**$12,925,000**	**$12,925,000**	**$12,925,000**
GENERAL CONDITIONS (20%)	**1**	**LS**	**$25,849,000**	**$25,849,000**	**$25,849,000**
DEMOLITION AND DECOMISSIONING	0	NA	$0	$0	**$0**
SITEWORK AND ACCESS IMPROVEMENTS	**1**	**LS**		**$3,072,552**	**$3,072,552**
LA GRANGE MIGRATION BARRIER	**1**	**LS**		**$8,576,179**	**$8,576,179**
LA GRANGE FISH ENTRANCE	**1**	**LS**		**$475,290**	**$475,290**
LA GRANGE AUXILIARY WATER SUPPLY	**1**	**LS**		**$2,281,950**	**$2,281,950**
FISHWAY	**1**	**LS**		**$103,224,000**	**$103,224,000**
FISH LADDER EXIT	**1**	**LS**		**$1,267,335**	**$1,267,335**
PUMP STATION	**1**	**LS**		**$7,076,000**	**$7,076,000**
COLD WATER SUPPLY PIPING	**1**	**LS**		**$2,016,000**	**$2,016,000**
BASE ELECTRICAL EQUIPMENT	**1**	**LS**		**$1,257,000**	**$1,257,000**
SUBTOTAL CONSTRUCTION COSTS					**$168,020,000**
UNDEFINED DESIGN AND CONSTRUCTION ITEMS (50%)					**$84,010,000**
SUBTOTAL W/ CONTINGENCY					**$252,030,000**
TOTAL TAXES AND FEES					**$42,126,000**
State Sales Tax	7.88%	of	$252,030,000	$19,847,000	
B&O Tax	8.84%	of	$252,030,000	$22,279,000	
TOTAL OPCC					**$294,156,000**

MODESTO AND TURLOCK IRRIGATION DISTRICTS
FISH PASSAGE FACILITIES ALTERNATIVE ASSESSMENT
ENGINEER'S OPINION OF PROBABLE CONSTRUCTION COSTS
UPSTREAM FISH PASSAGE: TWO TECHNICAL FISH LADDERS (U1B)

ITEM	QUANTITY	UNIT	UNIT COST	AMOUNT	TOTAL
MOBILIZATION AND DEMOBILIZATION (10%)	1	LS	$7,961,000	$7,961,000	$7,961,000
GENERAL CONDITIONS (20%)	1	LS	$15,922,000	$15,922,000	$15,922,000
DEMOLITION AND DECOMISSIONING	0	NA	$0	$0	$0
SITEWORK AND ACCESS IMPROVEMENTS	1	LS		$1,679,735	$1,679,735
LA GRANGE UPSTREAM PASSAGE					
LA GRANGE MIGRATION BARRIER	1	LS		$8,576,179	$8,576,179
LA GRANGE FISH ENTRANCE	1	LS		$475,290	$475,290
LA GRANGE AUXILIARY WATER SUPPLY	1	LS		$2,281,950	$2,281,950
LA GRANGE FISHWAY	1	LS		$9,455,875	$9,455,875
LA GRANGE FISH LADDER EXIT	1	LS		$1,011,562.50	$1,011,563
DON PEDRO UPSTREAM PASSAGE					
DON PEDRO FISH ENTRANCE	1	LS		$475,290	$475,290
DON PEDRO AUXILIARY WATER SUPPLY	1	LS		$2,281,950	$2,281,950
DON PEDRO FISHWAY	1	LS		$42,156,125	$42,156,125
DON PEDRO FISH LADDER EXIT	1	LS		$1,337,680	$1,337,680
DON PEDRO PUMP STATION	1	LS		$6,901,000	$6,901,000
DON PEDRO COLD WATER SUPPLY PIPING	1	LS		$1,103,000	$1,103,000
BASE ELECTRICAL EQUIPMENT	1	LS		$1,873,000	$1,873,000
SUBTOTAL CONSTRUCTION COSTS					$103,492,000
UNDEFINED DESIGN AND CONSTRUCTION ITEMS (50%)					$51,746,000
SUBTOTAL W/ CONTINGENCY					$155,238,000
TOTAL TAXES AND FEES					$25,948,000
State Sales Tax	7.88%	of	$155,238,000	$12,225,000	
B&O Tax	8.84%	of	$155,238,000	$13,723,000	
TOTAL OPCC					$181,186,000

MODESTO AND TURLOCK IRRIGATION DISTRICTS
FISH PASSAGE FACILITIES ALTERNATIVE ASSESSMENT
ENGINEER'S OPINION OF PROBABLE CONSTRUCTION COSTS
UPSTREAM FISH PASSAGE: FISH LIFT WITH TECHNICAL LADDER AT LA GRANGE (U2)

ITEM	QUANTITY	UNIT	UNIT COST	AMOUNT	TOTAL
MOBILIZATION AND DEMOBILIZATION (10%)	**1**	**LS**	**$3,837,000**	**$3,837,000**	**$3,837,000**
GENERAL CONDITIONS (20%)	**1**	**LS**	**$7,674,000**	**$7,674,000**	**$7,674,000**
DEMOLITION AND DECOMISSIONING	0	NA	$0	$0	**$0**
SITEWORK AND ACCESS IMPROVEMENTS	**1**	**LS**		**$1,585,000**	**$1,585,000**
LA GRANGE UPSTREAM PASSAGE					
LA GRANGE MIGRATION BARRIER	**1**	**LS**		**$8,576,179**	**$8,576,179**
LA GRANGE FISH ENTRANCE	**1**	**LS**		**$475,290**	**$475,290**
LA GRANGE AUXILIARY WATER SUPPLY	**1**	**LS**		**$2,281,950**	**$2,281,950**
LA GRANGE FISHWAY	**1**	**LS**		**$9,455,875**	**$9,455,875**
LA GRANGE FISH LADDER EXIT	**1**	**LS**		**$1,011,563**	**$1,011,563**
FISH LIFT					
DON PEDRO FISH ENTRANCE	**1**	**LS**		**$475,290**	**$475,290**
DON PEDRO AUXILIARY WATER SUPPLY	**1**	**LS**		**$2,281,950**	**$2,281,950**
DON PEDRO HOLDING GALLERY	**1**	**LS**		**$590,300**	**$590,300**
FISH LOCK	**1**	**LS**		**$368,600**	**$368,600**
GONDOLA				**$1,825,000**	**$1,825,000**
DON PEDRO FISH LADDER EXIT	**1**	**LS**		**$744,190**	**$744,190**
DON PEDRO PUMP STATION	**1**	**LS**		**$6,674,000**	**$6,674,000**
FISH TRANSPORT				**$150,000**	**$150,000**
BASE ELECTRICAL EQUIPMENT	**1**	**LS**		**$1,873,000**	**$1,873,000**
SUBTOTAL CONSTRUCTION COSTS					**$49,879,000**
UNDEFINED DESIGN AND CONSTRUCTION ITEMS (50%)					**$24,940,000**
SUBTOTAL W/ CONTINGENCY					**$74,819,000**
TOTAL TAXES AND FEES					**$12,506,000**
State Sales Tax	7.88%	of	$74,819,000	$5,892,000	
B&O Tax	8.84%	of	$74,819,000	$6,614,000	
TOTAL OPCC					**$87,325,000**

MODESTO AND TURLOCK IRRIGATION DISTRICTS
FISH PASSAGE FACILITIES ALTERNATIVE ASSESSMENT
ENGINEER'S OPINION OF PROBABLE CONSTRUCTION COSTS
UPSTREAM FISH PASSAGE: CHTR FACILITY (U3)

ITEM	QUANTITY	UNIT	UNIT COST	AMOUNT	TOTAL
MOBILIZATION AND DEMOBILIZATION (10%)	1	LS	$1,478,000	$1,478,000	$1,478,000
GENERAL CONDITIONS (20%)	1	LS	$2,956,000	$2,956,000	$2,956,000
DEMOLITION AND DECOMISSIONING	0	NA	$0	$0	$0
SITEWORK AND ACCESS IMPROVEMENTS				$402,000	$402,000
LA GRANGE UPSTREAM PASSAGE					
LA GRANGE MIGRATION BARRIER	1	LS		$8,576,179	$8,576,179
LA GRANGE FISH ENTRANCE	1	LS		$475,290	$475,290
LA GRANGE AUXILIARY WATER SUPPLY	1	LS		$2,281,950	$2,281,950
FISH LOCK	1	LS		$568,600	$568,600
HOLDING & SORTING FACILITIES					
HOLDING GALLERY	1	LS		$590,300	$590,300
SORTING FACILITY	1	LS		$617,000	$617,000
FISH TRANSPORT VEHICLE				$185,000	$185,000
BASE ELECTRICAL EQUIPMENT	1	LS		$1,082,000	$1,082,000
SUBTOTAL CONSTRUCTION COSTS					$19,212,000
UNDEFINED DESIGN AND CONSTRUCTION ITEMS (50%)					$9,606,000
SUBTOTAL W/ CONTINGENCY					$28,818,000
TOTAL TAXES AND FEES					$4,817,000
State Sales Tax	7.88%	of	$28,818,000	$2,269,000	
B&O Tax	8.84%	of	$28,818,000	$2,548,000	
TOTAL OPCC					$33,635,000

MODESTO AND TURLOCK IRRIGATION DISTRICTS
FISH PASSAGE FACILITIES ALTERNATIVE ASSESSMENT
ENGINEER'S OPINION OF PROBABLE CONSTRUCTION COSTS
UPSTREAM FISH PASSAGE: WHOOSHH FISH TRANSPORT TUBE (U4)

ITEM	QUANTITY	UNIT	UNIT COST	AMOUNT	TOTAL
MOBILIZATION AND DEMOBILIZATION (10%)	**1**	**LS**	**$2,290,000**	**$2,290,000**	**$2,290,000**
GENERAL CONDITIONS (20%)	**1**	**LS**	**$4,580,000**	**$4,580,000**	**$4,580,000**
DEMOLITION AND DECOMISSIONING	0	NA	$0	$0	**$0**
SITEWORK AND ACCESS IMPROVEMENTS				**$497,000**	**$497,000**
LA GRANGE WHOOSHH					
LA GRANGE MIGRATION BARRIER	**1**	**LS**		**$8,576,179**	**$8,576,179**
LA GRANGE FISH ENTRANCE	**1**	**LS**		**$475,290**	**$475,290**
LA GRANGE AUXILIARY WATER SUPPLY	**1**	**LS**		**$2,281,950**	**$2,281,950**
LA GRANGE HOLDING GALLERY	**1**	**LS**		**$590,300**	**$590,300**
LA GRANGE WHOOSHH SYSTEM	**1**	**LS**		**$1,657,000**	**$1,657,000**
DON PEDRO WHOOSHH					
DON PEDRO FISH ENTRANCE	**1**	**LS**		**$475,290**	**$475,290**
DON PEDRO AUXILIARY WATER SUPPLY	**1**	**LS**		**$2,281,950**	**$2,281,950**
DON PEDRO HOLDING GALLERY	**1**	**LS**		**$590,300**	**$590,300**
DON PEDRO WHOOSHH SYSTEM	**1**	**LS**		**$3,601,000**	**$3,601,000**
BASE ELECTRICAL EQUIPMENT	**1**	**LS**		**$1,873,000**	**$1,873,000**
SUBTOTAL CONSTRUCTION COSTS					**$29,769,000**
UNDEFINED DESIGN AND CONSTRUCTION ITEMS (50%)					**$14,885,000**
SUBTOTAL W/ CONTINGENCY					**$44,654,000**
TOTAL TAXES AND FEES					**$7,464,000**
State Sales Tax	7.88%	of	$44,654,000	$3,517,000	
B&O Tax	8.84%	of	$44,654,000	$3,947,000	
TOTAL OPCC					**$52,118,000**

MODESTO AND TURLOCK IRRIGATION DISTRICTS
FISH PASSAGE FACILITIES ALTERNATIVE ASSESSMENT
ENGINEER'S OPINION OF PROBABLE CONSTRUCTION COSTS
DOWNSTREAM FISH PASSAGE: FIXED MULTI-PORT COLLECTOR WITH HELICAL BYPASS (D1)

ITEM	QUANTITY	UNIT	UNIT COST	AMOUNT	TOTAL
MOBILIZATION AND DEMOBILIZATION (10%)	**1**	**LS**	**$12,527,000**	**$12,527,000**	**$12,527,000**
GENERAL CONDITIONS (20%)	**1**	**LS**	**$25,055,000**	**$25,055,000**	**$25,055,000**
DEMOLITION AND DECOMISSIONING	0	NA	$0	$0	**$0**
SITEWORK AND ACCESS IMPROVEMENTS	**1**	**LS**		**$16,864,000**	**$16,864,000**
DEBRIS MANAGEMENT SYSTEM	**1**	**LS**		**$1,463,000**	**$1,463,000**
PHYSICAL FISH GUIDANCE SYSTEM	**1**	**LS**		**$4,480,000**	**$4,480,000**
SHORING SYSTEMS AND SLOPE RETAINAGE	**1**	**LS**		**$7,324,000**	**$7,324,000**
INTAKE STRUCTURE	**1**	**LS**		**$12,985,000**	**$12,985,000**
HELICAL BYPASS STRUCTURE	**1**	**LS**		**$24,865,000**	**$24,865,000**
BYPASS TUNNEL TO CORE WALL	**1**	**LS**		**$52,114,000**	**$52,114,000**
ACCESS PORTAL AND BUILDING	**1**	**LS**		**$1,639,000**	**$1,639,000**
OUTFALL STRUCTURE	**1**	**LS**		**$989,000**	**$989,000**
MECHANCIAL EQUIPMENT AND HYDRUALIC CONTROL STRUCTURES	**1**	**LS**		**$1,028,000**	**$1,028,000**
ARCHITECTURAL	**1**	**LS**	$125,000	**$125,000**	**$125,000**
BASE ELECTRICAL EQUIPMENT	**1**	**LS**		**$1,398,000**	**$1,398,000**
SUBTOTAL CONSTRUCTION COSTS					**$162,856,000**
UNDEFINED DESIGN AND CONSTRUCTION ITEMS (50%)					**$81,428,000**
SUBTOTAL W/ CONTINGENCY					**$244,284,000**
TOTAL TAXES AND FEES					**$40,832,000**
State Sales Tax	7.88%	of	$244,284,000	$19,237,000	
B&O Tax	8.84%	of	$244,284,000	$21,595,000	
TOTAL OPCC					**$285,116,000**

MODESTO AND TURLOCK IRRIGATION DISTRICTS
FISH PASSAGE FACILITIES ALTERNATIVE ASSESSMENT
ENGINEER'S OPINION OF PROBABLE CONSTRUCTION COSTS
DOWNSTREAM FISH PASSAGE: FLOATING SURFACE COLLECTOR - DAM (D2A)

ITEM	QUANTITY	UNIT	UNIT COST	AMOUNT	TOTAL
MOBILIZATION AND DEMOBILIZATION (10%)	1	LS	$3,594,000	$3,594,000	$3,594,000
GENERAL CONDITIONS (20%)	1	LS	$7,187,000	$7,187,000	$7,187,000
DEMOLITION AND DECOMISSIONING	0	NA	$0	$0	$0
SITEWORK AND ACCESS IMPROVEMENTS	1	LS		$2,467,000	$2,467,000
DEBRIS MANAGEMENT SYSTEM	1	LS		$1,400,000	$1,400,000
PHYSICAL FISH GUIDANCE SYSTEM	1	LS		$4,480,000	$4,480,000
NET TRANSITION STRUCTURE	1	LS		$3,900,000	$3,900,000
FLOATING SURFACE COLLECTOR AND FISH COLLECTION MODU	1	LS		$10,646,000	$10,646,000
FISH ATTRACTION PUMPING ARRAY	1	LS		$2,820,000	$2,820,000
FLOATING SURFACE COLLECTOR TRANSPORT/ASSEMBLE	1	LS		$4,845,000	$4,845,000
FISH TRANSFER SYSTEM	1	LS		$305,000	$305,000
FISH TRANSPORT VEHICLE	1	LS		$150,000	$150,000
BOAT LAUNCH IMPROVEMENTS	1	LS		$1,500,000	$1,500,000
ON-BOARD MONITORING AND EVALUATION	1	LS		$670,000	$670,000
SHORE-BASED ELECTRICAL SERVICE SUPPLY SYSTEM	1	LS		$2,754,000	$2,754,000
SUBTOTAL CONSTRUCTION COSTS					$46,718,000
UNDEFINED DESIGN AND CONSTRUCTION ITEMS (50%)					$23,359,000
SUBTOTAL W/ CONTINGENCY					$70,077,000
TOTAL TAXES AND FEES					$11,714,000
State Sales Tax	7.88%	of	$70,077,000	$5,519,000	
B&O Tax	8.84%	of	$70,077,000	$6,195,000	
TOTAL OPCC					$81,791,000

MODESTO AND TURLOCK IRRIGATION DISTRICTS
FISH PASSAGE FACILITIES ALTERNATIVE ASSESSMENT
ENGINEER'S OPINION OF PROBABLE CONSTRUCTION COSTS
DOWNSTREAM FISH PASSAGE: FLOATING SURFACE COLLECTOR - HEAD OF RESERVOIR (D2B)

ITEM	QUANTITY	UNIT	UNIT COST	AMOUNT	TOTAL
MOBILIZATION AND DEMOBILIZATION (12%)	**1**	**LS**	**$4,329,000**	**$4,329,000**	**$4,329,000**
GENERAL CONDITIONS (20%)	**1**	**LS**	**$7,215,000**	**$7,215,000**	**$7,215,000**
DEMOLITION AND DECOMISSIONING	0	NA	$0	$0	**$0**
SITEWORK AND ACCESS IMPROVEMENTS	**1**	**LS**		**$2,365,000**	**$2,365,000**
DEBRIS MANAGEMENT SYSTEM	**1**	**LS**		**$900,000**	**$900,000**
PHYSICAL FISH GUIDANCE SYSTEM	**1**	**LS**		**$4,800,000**	**$4,800,000**
NET TRANSITION STRUCTURE	**1**	**LS**		**$3,900,000**	**$3,900,000**
FLOATING SURFACE COLLECTOR AND FISH COLLECTION MODU	**1**	**LS**		**$10,646,000**	**$10,646,000**
FISH ATTRACTION PUMPING ARRAY	**1**	**LS**		**$2,820,000**	**$2,820,000**
FLOATING SURFACE COLLECTOR TRANSPORT/ASSEMBLE	**1**	**LS**		**$4,845,000**	**$4,845,000**
FISH TRANSFER SYSTEM	**1**	**LS**		**$305,000**	**$305,000**
FISH TRANSPORT VEHICLE	**1**	**LS**		**$150,000**	**$150,000**
BOAT LAUNCH IMPROVEMENTS	**1**	**LS**		**$1,500,000**	**$1,500,000**
ON-BOARD MONITORING AND EVALUATION	**1**	**LS**		**$670,000**	**$670,000**
SHORE-BASED ELECTRICAL SERVICE SUPPLY SYSTEM	**1**	**LS**		**$3,174,000**	**$3,174,000**
SUBTOTAL CONSTRUCTION COSTS					**$47,619,000**
UNDEFINED DESIGN AND CONSTRUCTION ITEMS (50%)					**$23,810,000**
SUBTOTAL W/ CONTINGENCY					**$71,429,000**
TOTAL TAXES AND FEES					**$11,939,000**
State Sales Tax	7.88%	of	$71,429,000	$5,625,000	
B&O Tax	8.84%	of	$71,429,000	$6,314,000	
TOTAL OPCC					**$83,368,000**

MODESTO AND TURLOCK IRRIGATION DISTRICTS
FISH PASSAGE FACILITIES ALTERNATIVE ASSESSMENT
ENGINEER'S OPINION OF PROBABLE CONSTRUCTION COSTS
DOWNSTREAM FISH PASSAGE: FIXED IN-RIVER COLLECTOR (D3)

ITEM	QUANTITY	UNIT	UNIT COST	AMOUNT	TOTAL
MOBILIZATION AND DEMOBILIZATION (15%)	**1**	**LS**	**$3,135,000**	**$3,135,000**	**$3,135,000**
GENERAL CONDITIONS (20%)	**1**	**LS**	**$4,180,000**	**$4,180,000**	**$4,180,000**
DEMOLITION AND DECOMISSIONING	0	NA	$0	$0	**$0**
SITEWORK AND ACCESS IMPROVEMENTS	**1**	**LS**		**$1,554,000**	**$1,554,000**
DEBRIS MANAGEMENT SYSTEM	**1**	**LS**		**$175,000**	**$175,000**
LA GRANGE MIGRATION BARRIER	**1**	**LS**		**$6,585,283**	**$6,585,283**
LA GRANGE FISH ENTRANCE	**1**	**LS**		**$475,290**	**$475,290**
LA GRANGE AUXILIARY WATER SUPPLY	**1**	**LS**		**$1,991,950**	**$1,991,950**
LA GRANGE FISHWAY	**1**	**LS**		**$1,865,875**	**$1,865,875**
FIXED IN-RIVER COLLECTOR	**1**	**LS**		**$8,254,842**	**$8,254,842**
HOLDING GALLERY	**1**	**LS**		**$590,300**	**$590,300**
SORTING FACILITY	**1**	**LS**		**$612,000**	**$612,000**
FISH TRANSPORT VEHICLE	**1**	**LS**		**$185,000**	**$185,000**
ENERGY DISSIPATION CHANNEL	1	LS	$5,000,000	**$5,000,000**	**$5,000,000**
BASE ELECTRICAL EQUIPMENT	**1**	**LS**		**$1,882,000**	**$1,882,000**
SUBTOTAL CONSTRUCTION COSTS					**$28,217,000**
UNDEFINED DESIGN AND CONSTRUCTION ITEMS (50%)					**$14,109,000**
SUBTOTAL W/ CONTINGENCY					**$42,326,000**
TOTAL TAXES AND FEES					**$7,075,000**
State Sales Tax	7.88%	of	$42,326,000	$3,333,000	
B&O Tax	8.84%	of	$42,326,000	$3,742,000	
TOTAL OPCC					**$49,401,000**

MODESTO AND TURLOCK IRRIGATION DISTRICTS
FISH PASSAGE FACILITIES ALTERNATIVE ASSESSMENT
OPINION OF OPERATION AND MAINTENANCE COSTS
UPSTREAM FISH PASSAGE: TECHNICAL FISH LADDER - BYPASS (U1A)

Item	Quantity	Unit	Unit Cost	Amount	Total
LABOR	**1**	**LS**		**$220,907**	**$220,907**
1- Fisheries Manager	0.5	FTE	$122,500	$61,250	
(full time year-round, half cost assigned to U/S and half to D/S alternatives)					
Benefits @1.15 labor cost	0.5	FTE	$140,875	$70,438	
1- Fisheries technician direct labor cost	0.5	FTE	$60,000	$30,000	
(Half time, all year-round)					
Benefits @ 1.15 labor cost	0.5	FTE	$69,000	$34,500	
1 - Seasonal technician direct labor cost	0.292	FTE	$24,000	$7,000	
(average 20 hrs/week for operating period)					
Seasonal Benefits @ 0.85 labor cost	0.292	FTE	$20,400	$5,950	
Annual inspections and Maintenance	0.138	FTE	$85,000	$11,769	
(assume 3 people for quarterly (4) 3-day periods)					
FTE = Full time equivalent					
MONITORING & EVALUATION - PLACEHOLDER	**1**	**LS**		**$43,288**	**$43,288**
1- Fisheries technician direct labor cost	0.146	FTE	$60,000	$8,750	
(average 10 hrs/week for operating period)					
Benefits @ 1.15 labor cost	0.146	FTE	$69,000	$10,063	
1- Seasonal technicians direct labor cost	0.146	FTE	$24,000	$3,500	
(average 10 hrs/week for operating period)					
Seasonal Benefits @ 0.85 labor cost	0.146	FTE	$20,400	$2,975	
Associated science costs (e.g. - lab tests, etc.)	1	LS	$18,000	$18,000	
EXPENDABLES AND REPLACEMENT COSTS	**1**	**LS**		**$15,000**	**$15,000**
ELECTRICAL	**1**	**LS**		**$44,182**	**$44,182**
General year-round operation	14600	kWh	$0.09	$1,314	
Pumping costs	476315.88	kWh	$0.09	$42,868	
TOTAL ANTICIPATED OPERATIONS AND MAINTENANCE COSTS					**$323,377**

MODESTO AND TURLOCK IRRIGATION DISTRICTS
FISH PASSAGE FACILITIES ALTERNATIVE ASSESSMENT
OPINION OF OPERATION AND MAINTENANCE COSTS
UPSTREAM FISH PASSAGE: TWO TECHNICAL FISH LADDERS (U1B)

Item	Quantity	Unit	Unit Cost	Amount	Total
LABOR	**1**	**LS**		**$258,576**	**$258,576**
1- Fisheries Manager	0.5	FTE	$122,500	$61,250	
(full time year-round, half cost assigned to U/S and half to D/S alternatives)					
Benefits @1.15 labor cost	0.5	FTE	$140,875	$70,438	
1- Fisheries technician direct labor cost	0.5	FTE	$60,000	$30,000	
(Half time, all year-round)					
Benefits @ 1.15 labor cost	0.5	FTE	$69,000	$34,500	
3- Seasonal technician direct labor cost	0.875	FTE	$24,000	$21,000	
(average 20 hrs/week for operating period)					
Seasonal Benefits @ 0.85 labor cost	0.875	FTE	$20,400	$17,850	
Annual inspections and Maintenance	0.277	FTE	$85,000	$23,538	
(assume 3 people for quarterly (4) 3-day periods for each facility)					
FTE = Full time equivalent					
MONITORING & EVALUATION - PLACEHOLDER	**1**	**LS**		**$68,575**	**$68,575**
2- Fisheries technician direct labor cost	0.292	FTE	$60,000	$17,500	
(average 10 hrs/week for operating period)					
Benefits @ 1.15 labor cost	0.292	FTE	$69,000	$20,125	
2- Seasonal technicians direct labor cost	0.292	FTE	$24,000	$7,000	
(average 10 hrs/week for operating period)					
Seasonal Benefits @ 0.85 labor cost	0.292	FTE	$20,400	$5,950	
Associated science costs (e.g. - lab tests, etc.)	1	LS	$18,000	$18,000	
EXPENDABLES AND REPLACEMENT COSTS	**1**	**LS**		**$15,000**	**$15,000**
ELECTRICAL	**1**	**LS**		**$45,496**	**$45,496**
General year-round operation	29200	kWh	$0.09	$2,628	
Pumping costs	476315.88	kWh	$0.09	$42,868	
TOTAL ANTICIPATED OPERATIONS AND MAINTENANCE COSTS					**$387,647**

MODESTO AND TURLOCK IRRIGATION DISTRICTS
FISH PASSAGE FACILITIES ALTERNATIVE ASSESSMENT
OPINION OF OPERATION AND MAINTENANCE COSTS
UPSTREAM FISH PASSAGE: FISH LIFT WITH TECHNICAL LADDER AT LA GRANGE (U2)

Item	Quantity	Unit	Unit Cost	Amount	Total
LABOR	**1**	**LS**		**$258,576**	**$258,576**
1- Fisheries Manager	0.5	FTE	$122,500	$61,250	
(full time year-round, half cost assigned to U/S and half to D/S alternatives)					
Benefits @1.15 labor cost	0.5	FTE	$140,875	$70,438	
1- Fisheries technician direct labor cost	0.5	FTE	$60,000	$30,000	
(Half time, all year-round)					
Benefits @ 1.15 labor cost	0.5	FTE	$69,000	$34,500	
3- Seasonal technician direct labor cost	0.875	FTE	$24,000	$21,000	
(average 20 hrs/week for operating period)					
Seasonal Benefits @ 0.85 labor cost	0.875	FTE	$20,400	$17,850	
Annual inspections and Maintenance	0.277	FTE	$85,000	$23,538	
(assume 3 people for quarterly (4) 3-day periods for each facility)					
FTE = Full time equivalent					
MONITORING & EVALUATION - PLACEHOLDER	**1**	**LS**		**$68,575**	**$68,575**
2- Fisheries technician direct labor cost	0.292	FTE	$60,000	$17,500	
(average 10 hrs/week for operating period)					
Benefits @ 1.15 labor cost	0.292	FTE	$69,000	$20,125	
2- Seasonal technicians direct labor cost	0.292	FTE	$24,000	$7,000	
(average 10 hrs/week for operating period)					
Seasonal Benefits @ 0.85 labor cost	0.292	FTE	$20,400	$5,950	
Associated science costs (e.g. - lab tests, etc.)	1	LS	$18,000	$18,000	
EXPENDABLES AND REPLACEMENT COSTS	**1**	**LS**		**$15,000**	**$15,000**
ELECTRICAL	**1**	**LS**		**$34,779**	**$34,779**
General year-round operation	29200	kWh	$0.09	$2,628	
Pumping costs	357236.91	kWh	$0.09	$32,151	
TOTAL ANTICIPATED OPERATIONS AND MAINTENANCE COSTS					**$376,930**

MODESTO AND TURLOCK IRRIGATION DISTRICTS
FISH PASSAGE FACILITIES ALTERNATIVE ASSESSMENT
OPINION OF OPERATION AND MAINTENANCE COSTS
UPSTREAM FISH PASSAGE: CHTR FACILITY (U3)

Item	Quantity	Unit	Unit Cost	Amount	Total
LABOR	**1**	**LS**		**$220,907**	**$220,907**
1- Fisheries Manager	0.5	FTE	$122,500	$61,250	
(full time year-round, half cost assigned to U/S and half to D/S alternatives)					
Benefits @1.15 labor cost	0.5	FTE	$140,875	$70,438	
1- Fisheries technician direct labor cost	0.5	FTE	$60,000	$30,000	
(Half time, all year-round)					
Benefits @ 1.15 labor cost	0.5	FTE	$69,000	$34,500	
1- Seasonal technician direct labor cost	0.292	FTE	$24,000	$7,000	
(average 20 hrs/week for operating period)					
Seasonal Benefits @ 0.85 labor cost	0.292	FTE	$20,400	$5,950	
Annual inspections and Maintenance	0.138	FTE	$85,000	$11,769	
(assume 3 people for quarterly (4) 3-day periods)					
FTE = Full time equivalent					
TRANSPORT (1 Diesel Vehicle at 10 MPG and $4/gallon)	**1**	**LS**		**$12,495**	**$12,495**
Assume 80 Mile Round Trip to a Release Site Above Resevoir (Fuel)	17033	MILES	$0	$7,495	
Assume 1 Trip per day for each day of operation					
Annual Maintenance	1	LS	$5,000	$5,000	
MONITORING & EVALUATION - PLACEHOLDER	**1**	**LS**		**$43,288**	**$43,288**
1- Fisheries technician direct labor cost	0.146	FTE	$60,000	$8,750	
(average 10 hrs/week for operating period)					
Benefits @ 1.15 labor cost	0.146	FTE	$69,000	$10,063	
1 - Seasonal technicians direct labor cost	0.146	FTE	$24,000	$3,500	
(average 10 hrs/week for operating period)					
Seasonal Benefits @ 0.85 labor cost	0.146	FTE	$20,400	$2,975	
Associated science costs (e.g. - lab tests, etc.)	1	LS	$18,000	$18,000	
EXPENDABLES AND REPLACEMENT COSTS	**1**	**LS**		**$15,000**	**$15,000**
ELECTRICAL	**1**	**LS**		**$1,314**	**$1,314**
General year-round operation	14600	kWh	$0.09	$1,314	
TOTAL ANTICIPATED OPERATIONS AND MAINTENANCE COSTS					**$293,003**

MODESTO AND TURLOCK IRRIGATION DISTRICTS
FISH PASSAGE FACILITIES ALTERNATIVE ASSESSMENT
OPINION OF OPERATION AND MAINTENANCE COSTS
UPSTREAM FISH PASSAGE: WHOOSHH FISH TRANSPORT TUBE (U4)

Item	Quantity	Unit	Unit Cost	Amount	Total
LABOR	**1**	**LS**		**$232,676**	**$232,676**
1- Fisheries Manager	0.5	FTE	$122,500	$61,250	
(full time year-round, half cost assigned to U/S and half to D/S alternatives)					
Benefits @1.15 labor cost	0.5	FTE	$140,875	$70,438	
1- Fisheries technician direct labor cost	0.5	FTE	$60,000	$30,000	
(Half time, all year-round)					
Benefits @ 1.15 labor cost	0.5	FTE	$69,000	$34,500	
1- Seasonal technician direct labor cost	0.292	FTE	$24,000	$7,000	
(average 20 hrs/week for operating period)					
Seasonal Benefits @ 0.85 labor cost	0.292	FTE	$20,400	$5,950	
Annual inspections and Maintenance	0.277	FTE	$85,000	$23,538	
(assume 3 people for quarterly (4) 3-day periods for each facility)					
FTE = Full time equivalent					
MONITORING & EVALUATION - PLACEHOLDER	**1**	**LS**		**$68,575**	**$68,575**
2- Fisheries technician direct labor cost	0.292	FTE	$60,000	$17,500	
(average 10 hrs/week for operating period)					
Benefits @ 1.15 labor cost	0.292	FTE	$69,000	$20,125	
2- Seasonal technicians direct labor cost	0.292	FTE	$24,000	$7,000	
(average 10 hrs/week for operating period)					
Seasonal Benefits @ 0.85 labor cost	0.292	FTE	$20,400	$5,950	
Associated science costs (e.g. - lab tests, etc.)	1	LS	$18,000	$18,000	
EXPENDABLES AND REPLACEMENT COSTS	**1**	**LS**		**$15,000**	**$15,000**
ELECTRICAL	**1**	**LS**		**$2,628**	**$2,628**
General year-round operation	29200	kWh	$0.09	$2,628	
TOTAL ANTICIPATED OPERATIONS AND MAINTENANCE COSTS					**$318,879**

MODESTO AND TURLOCK IRRIGATION DISTRICTS
FISH PASSAGE FACILITIES ALTERNATIVE ASSESSMENT
OPINION OF OPERATION AND MAINTENANCE COSTS
DOWNSTREAM FISH PASSAGE: FIXED MULTI-PORT COLLECTOR WITH HELICAL BYPASS (D1)

Item	Quantity	Unit	Unit Cost	Amount	Total
LABOR	**1**	**LS**		**$222,757**	**$222,757**
1- Fisheries Manager	0.5	FTE	$122,500	$61,250	
(full time year-round, half cost assigned to U/S and half to D/S alternatives)					
Benefits @1.15 labor cost	0.5	FTE	$140,875	$70,438	
1- Fisheries technician direct labor cost	0.5	FTE	$60,000	$30,000	
(Half time, all year-round)					
Benefits @ 1.15 labor cost	0.5	FTE	$69,000	$34,500	
1 - Seasonal technicians direct labor cost	0.333	FTE	$24,000	$8,000	
(average 20 hrs/week for operating period)					
Seasonal Benefits @ 0.85 labor cost	0.333	FTE	$20,400	$6,800	
Annual inspections and Maintenance	0.138	FTE	$85,000	$11,769	
(assume 3 people for quarterly (4) 3-day periods)					
FTE = Full time equivalent					
MONITORING & EVALUATION - PLACEHOLDER	**1**	**LS**		**$46,900**	**$46,900**
1- Fisheries technician direct labor cost	0.167	FTE	$60,000	$10,000	
(average 10 hrs/week for operating period)					
Benefits @ 1.15 labor cost	0.167	FTE	$69,000	$11,500	
1- Seasonal technicians direct labor cost	0.167	FTE	$24,000	$4,000	
(average 10 hrs/week for operating period)					
Seasonal Benefits @ 0.85 labor cost	0.167	FTE	$20,400	$3,400	
Associated science costs (e.g. - lab tests, etc.)	1	LS	$18,000	$18,000	
EXPENDABLES AND REPLACEMENT COSTS	**1**	**LS**		**$15,000**	**$15,000**
ELECTRICAL	**1**	**LS**		**$1,314**	**$1,314**
General year-round operation	14600	kWh	$0.09	$1,314	
TOTAL ANTICIPATED OPERATIONS AND MAINTENANCE COSTS					**$285,971**

MODESTO AND TURLOCK IRRIGATION DISTRICTS
FISH PASSAGE FACILITIES ALTERNATIVE ASSESSMENT
OPINION OF OPERATION AND MAINTENANCE COSTS
DOWNSTREAM FISH PASSAGE: FLOATING SURFACE COLLECTOR - DAM (D2A)

Item	Quantity	Unit	Unit Cost	Amount	Total
LABOR	**1**	**LS**		**$249,397**	**$249,397**
1- Fisheries Manager	0.5	FTE	$122,500	$61,250	
(full time year-round, half cost assigned to U/S and half to D/S alternatives)					
Benefits @1.15 labor cost	0.5	FTE	$140,875	$70,438	
1- Fisheries technician direct labor cost	0.5	FTE	$60,000	$30,000	
(Half time, all year-round)					
Benefits @ 1.15 labor cost	0.5	FTE	$69,000	$34,500	
2 - Seasonal technicians direct labor cost	0.933	FTE	$24,000	$22,400	
(average 28 hrs/week for operating period)					
Seasonal Benefits @ 0.85 labor cost	0.933	FTE	$20,400	$19,040	
Annual inspections and Maintenance	0.138	FTE	$85,000	$11,769	
(assume 3 people for quarterly (4) 3-day periods)					
FTE = Full time equivalent					
TRANSPORT (1 Diesel Vehicle at 10 MPG and $4/gallon)	**1**	**LS**		**$12,784**	**$12,784**
Assume 20 Mile Round Trip to a Release Site Below Dam (Fuel)	4867	MILES	$0.44	$2,141	
Assume 1 Trip per day for each day of operation					
Boat Fuel - 1 miles round trip	487	MILES	$1.32	$642	
Annual Maintenance Truck	1	LS	$5,000	$5,000	
Annual Maintenance Boat	1	LS	$5,000	$5,000	
MONITORING & EVALUATION - PLACEHOLDER	**1**	**LS**		**$61,560**	**$61,560**
1- Fisheries technician direct labor cost	0.200	FTE	$60,000	$12,000	
(average 12 hrs/week for operating period)					
Benefits @ 1.15 labor cost	0.200	FTE	$69,000	$13,800	
2- Seasonal technicians direct labor cost	0.400	FTE	$24,000	$9,600	
(average 12 hrs/week for operating period)					
Seasonal Benefits @ 0.85 labor cost	0.400	FTE	$20,400	$8,160	
Associated science costs (e.g. - lab tests, etc.)	1	LS	$18,000	$18,000	
EXPENDABLES AND REPLACEMENT COSTS	**1**	**LS**		**$15,000**	**$15,000**
ELECTRICAL	**1**	**LS**		**$189,521**	**$189,520.85**
General year-round operation	14600	kWh	$0.09	$1,314	
Pumping costs (assume 8 60 HP attraction pumps)	2091187.2	kWh	$0.09	$188,207	
TOTAL ANTICIPATED OPERATIONS AND MAINTENANCE COSTS					**$528,261**

MODESTO AND TURLOCK IRRIGATION DISTRICTS
FISH PASSAGE FACILITIES ALTERNATIVE ASSESSMENT
OPINION OF OPERATION AND MAINTENANCE COSTS
DOWNSTREAM FISH PASSAGE: FLOATING SURFACE COLLECTOR - HEAD OF RESERVOIR (D2B)

Item	Quantity	Unit	Unit Cost	Amount	Total
LABOR	**1**	**LS**		**$249,397**	**$249,397**
1- Fisheries Manager	0.5	FTE	$122,500	$61,250	
(full time year-round, half cost assigned to U/S and half to D/S alternatives)					
Benefits @1.15 labor cost	0.5	FTE	$140,875	$70,438	
1- Fisheries technician direct labor cost	0.5	FTE	$60,000	$30,000	
(Half time, all year-round)					
Benefits @ 1.15 labor cost	0.5	FTE	$69,000	$34,500	
2 - Seasonal technicians direct labor cost	0.933	FTE	$24,000	$22,400	
(average 28 hrs/week for operating period)					
Seasonal Benefits @ 0.85 labor cost	0.933	FTE	$20,400	$19,040	
Annual inspections and Maintenance	0.138	FTE	$85,000	$11,769	
(assume 3 people for quarterly (4) 3-day periods)					
FTE = Full time equivalent					
TRANSPORT (1 Diesel Vehicle at 10 MPG and $4/gallon)	**1**	**LS**		**$20,600**	**$20,600**
Assume 90 Mile Round Trip to a Release Site Below Dam (Fuel)	21900	MILES	$0.44	$9,636	
Assume 1 Trip per day for each day of operation					
Boat Fuel - 3 miles round trip	730	MILES	$1.32	$964	
Annual Maintenance Truck	1	LS	$5,000	$5,000	
Annual Maintenance Boat	1	LS	$5,000	$5,000	
MONITORING & EVALUATION - PLACEHOLDER	**1**	**LS**		**$61,560**	**$61,560**
1- Fisheries technician direct labor cost	0.200	FTE	$60,000	$12,000	
(average 12 hrs/week for operating period)					
Benefits @ 1.15 labor cost	0.200	FTE	$69,000	$13,800	
2- Seasonal technicians direct labor cost	0.400	FTE	$24,000	$9,600	
(average 12 hrs/week for operating period)					
Seasonal Benefits @ 0.85 labor cost	0.400	FTE	$20,400	$8,160	
Associated science costs (e.g. - lab tests, etc.)	1	LS	$18,000	$18,000	
EXPENDABLES AND REPLACEMENT COSTS	**1**	**LS**		**$15,000**	**$15,000**
ELECTRICAL	**1**	**LS**		**$189,521**	**$189,520.85**
General year-round operation	14600	kWh	$0.09	$1,314	
Pumping costs (assume 8 60 HP attraction pumps)	2091187.2	kWh	$0.09	$188,207	
TOTAL ANTICIPATED OPERATIONS AND MAINTENANCE COSTS					**$536,077**

MODESTO AND TURLOCK IRRIGATION DISTRICTS
FISH PASSAGE FACILITIES ALTERNATIVE ASSESSMENT
OPINION OF OPERATION AND MAINTENANCE COSTS
DOWNSTREAM FISH PASSAGE: FIXED IN-RIVER COLLECTOR (D3)

Item	Quantity	Unit	Unit Cost	Amount	Total
LABOR	**1**	**LS**		**$237,557**	**$237,557**
1- Fisheries Manager	0.5	FTE	$122,500	$61,250	
(full time year-round, half cost assigned to U/S and half to D/S alternatives)					
Benefits @1.15 labor cost	0.5	FTE	$140,875	$70,438	
1- Fisheries technician direct labor cost	0.5	FTE	$60,000	$30,000	
(Half time, all year-round)					
Benefits @ 1.15 labor cost	0.5	FTE	$69,000	$34,500	
2 - Seasonal technicians direct labor cost	0.667	FTE	$24,000	$16,000	
(average 20 hrs/week for operating period)					
Seasonal Benefits @ 0.85 labor cost	0.667	FTE	$20,400	$13,600	
Annual inspections and Maintenance	0.138	FTE	$85,000	$11,769	
(assume 3 people for quarterly (4) 3-day periods)					
FTE = Full time equivalent					
TRANSPORT (1 Diesel Vehicle at 10 MPG and $4/gallon)	**1**	**LS**		**$13,565**	**$13,565**
Assume 80 Mile Round Trip to a Release Site Below Dam (Fuel)	19467	MILES	$0	$8,565	
Assume 1 Trip per day for each day of operation					
Annual Maintenance	1	LS	$5,000	$5,000	
MONITORING & EVALUATION - PLACEHOLDER	**1**	**LS**		**$54,300**	**$54,300**
1- Fisheries technician direct labor cost	0.167	FTE	$60,000	$10,000	
(average 10 hrs/week for operating period)					
Benefits @ 1.15 labor cost	0.167	FTE	$69,000	$11,500	
2- Seasonal technicians direct labor cost	0.333	FTE	$24,000	$8,000	
(average 10 hrs/week for operating period)					
Seasonal Benefits @ 0.85 labor cost	0.333	FTE	$20,400	$6,800	
Associated science costs (e.g. - lab tests, etc.)	1	LS	$18,000	$18,000	
EXPENDABLES AND REPLACEMENT COSTS	**1**	**LS**		**$15,000**	**$15,000**
ELECTRICAL	**1**	**LS**		**$1,314**	**$1,314.00**
General year-round operation	14600	kWh	$0.09	$1,314	
TOTAL ANTICIPATED OPERATIONS AND MAINTENANCE COSTS					**$321,736**

FISH PASSAGE FACILITIES ALTERNATIVES ASSESSMENT

STUDY REPORT

ATTACHMENT C

DATA, REFERENCES, AND CITATIONS FOR CURRENT DOWNSTREAM COLLECTION FACILITIES

This Page Intentionally Left Blank.

PACIFIC NORTHWEST HYDROPOWER PROJECTS
DOWNSTREAM FISH PASSAGE FACILITIES PERFORMANCE STANDARDS AND EVALUATION

			Compliance Standard				Measured Performance			
Facility Type (floating, fixed, etc.)	**Reservoir Geometry**	**Allowable Operating Range (ft)**	**Reservoir Passage (R)**	**Collection (C)**	**Survival (S)**	**Efficiency (overall survival; RxCxS)**	**Reservoir Passage (R)**	**Collection (C)**	**Survival (S)**	**Efficiency (overall survival; RxCxS)**
Baker Lake Project (P-2150), Washington, Puget Sound Energy (PSE) - *Upper*										
Floating Surface Collector with guide nets from surface to bottom	Baker Lake Long (8.5 miles), narrow (max depth of 300 ft)	727.77 max 685 min	80%[1]	95%	98%	75%	Not evaluated	Coho: 90.4%[2] Sockeye: 85.4%	Species combined: Exceeds 98%[3]	Not evaluated

Notes
Operational in 2008; 5 years of performance evaluation (2008-2012); 4 years into long-term monitoring (2013-2016); 2 phases, first 500 cfs attraction flow, and second 1,000 cfs attraction flow

If collection efficiency less than the target, PSE, NMFS, and other collaborators will assess the deficiency and recommend modifications to PSE.

Sources
- Settlement Agreement, 11/30/04
- NMFS BO and related Errata, 7/2/08 and 10/20/08, respectively
- License Order, 10/17/08
- Biological Evaluation, Upper Baker Downstream Fish Passage FSC, 2009 Study Report (January 2010)
- Post-Construction Evaluation Plan (Lower Baker), 10/12/12
- SA Article 105, Downstream Fish Passage 2015 Annual Report, 11/15/16 (most recent report)

Baker Lake Project (P-2150), Washington, PSE – *Lower*										
Floating Surface Collector with guide nets from surface to bottom	Lake Shannon Long (7.5 miles), narrow (max depth of 280 ft)	442.35 max 389 min	80%[4]	95%	98%	75%	Not evaluated	Coho: 92.1%[5] Sockeye: 87.3%	Species combined: 99.2%[6]	Not evaluated

Notes
Operational in 2013; 3 years of performance evaluation (2013-2015); 1 year into long-term monitoring (2016); 2 phases, first 500 cfs attraction flow, and second 1,000 cfs attraction flow

If collection efficiency less than the target, PSE, NMFS, and other collaborators will assess the deficiency and recommend modifications to PSE.

Sources
- *See Upper Baker.*
- 2013 Biological Evaluation Study Report, Lower Baker Downstream Fish Passage FSC (December 2013)

[1] Performance standards per NMFS BO and subsequent errata.
[2] Values for upper Baker are mean performance recapture rate (including non-migrants and predation) for study years 2008-2015. Evaluation of re-capture of PIT-tagged, released fish; no mention of survival or reservoir passage evaluations in the annual report. Source: Downstream Fish Passage 2015 Annual Report (Table 3).
[3] Based on one year of study, for the initial year of operation. Source: 2009 Upper Baker Downstream Fish Passage FSC Biological Evaluation Report.
[4] Performance standards per NMFS BO and subsequent errata.
[5] Values for lower Baker are mean performance recapture rate (including non-migrants and predation) for study years 2013-2015. Evaluation of re-capture of PIT-tagged, released fish; no mention of survival or reservoir passage evaluations in the annual report. Source: Downstream Fish Passage 2015 Annual Report (Table 4).
[6] Based on one year of study, for the initial year of operation. Source: 2013 Lower Baker Downstream Fish Passage FSC Biological Evaluation Report.

Facility Type (floating, fixed, etc.)	Reservoir Geometry	Allowable Operating Range (ft)	Compliance Standard: Reservoir Passage (R)	Compliance Standard: Collection (C)	Compliance Standard: Survival (S)	Compliance Standard: Efficiency (overall survival; RxCxS)	Measured Performance: Reservoir Passage (R)	Measured Performance: Collection (C)	Measured Performance: Survival (S)	Measured Performance: Efficiency (overall survival; RxCxS)
Cushman Project (P-460), Washington, Tacoma Public Utilities – *Cushman No. 1*										
Floating, Surface Collector with barrier nets	Lake Cushman Long (8.5 miles), narrow	738 ft max 735-738 ft (Tacoma Datum) min Memorial Day to Labor Day 690 ft min Nov 1-March 31	Unspecified	FCE:[7] 95%	Unspecified	SS:[8] 95% target 75% minimum	Coho: 20%[9]	Coho FCE: 32%[10]	Coho: 89%[11]	Coho SS: 18%[12]

Notes

Operational in 2014; 2 (of 9) demonstration years; 2 phases, first 250 cfs attraction flow, and second 500 cfs attraction flow

Phase One: The Licensee may operate the Phase One FSC for up to nine demonstration years to satisfy Performance Standards. If, in any of these nine (9) years, the FSC satisfies either of the Performance Standards, the Licensee will enter a two-year verification period to verify that the Performance Standard is sustained as described in the paragraph below. If performance is not achieved during a demonstration year or not sustained during a verification period, then the Licensee shall make non-attraction-flow improvements in consultation with the Fisheries and Habitat Committee. Phase One includes up to, but no more than, two verification periods. The Licensee has a minimum of nine years to operate the FSC at 250 cfs, and a maximum of thirteen (13) years if the verification periods are triggered. The Licensee may opt to move to Phase Two at any time prior to expiration of the time limit for operation within Phase One.

Verification shall be measured at a 90% confidence level with a standard error of the estimate that shall be not more than plus or minus 5% (i.e., 10% error), unless otherwise agreed to by the Fisheries and Habitat Committee.

If neither of the Performance Standards are demonstrated and verified within the timeframes provided for the Phase One Demonstration and Verification Periods, Phase One will end. If Phase One ends, the Phase Two FSC will be installed and operational prior to the start of the second fish passage season after Phase One ends. If, however, NMFS, USFWS and BIA believe that one or more of the extenuating factors listed below is likely the cause of the FSC not meeting the performance standards, then NMFS, USFWS, and BIA may approve continued operation of the collector at 250 cfs until such factors are addressed. Extenuating factors may include: (1) environmental conditions (such as predation or disease mortality) that prevent the collector from attaining System Survival (SS) or Fish Collection Efficiency (FCE); (2) technical issues related to measurement of SS or FCE; or (3) other similar surface collection systems not meeting performance criteria.

If FCE is demonstrated and verified but SS is not demonstrated and verified, the Licensee shall continue to operate the Phase One FSC and not develop Phase Two so long as FCE is maintained (see Performance Standard Monitoring, section 7). As long as FCE is maintained, increases in FSC discharge will not be required. However, within twelve (12) months of verifying FCE, the Licensee shall develop a plan for determining factors which may be limiting its ability to demonstrate and verify SS, in consultation

with the Fisheries and Habitat Committee, and shall implement appropriate measures for improving SS as soon thereafter as possible.

If SS is demonstrated, verified and maintained but FCE is not, the Licensee shall make non-attraction flow modifications to the FSC as determined necessary by the Fisheries and Habitat Committee.

Phase Two: The FSC shall be redesigned to produce a 500 cfs attraction flow, unless otherwise agreed to by NMFS, USFWS, and BIA, provided the total attraction flow shall not exceed 500 cfs. If the Phase Two FSC does not satisfy Performance Standards, the Licensee shall implement appropriate non-attraction flow measures for improving SS and FCE in consultation with the Fisheries and Habitat Committee and based upon the performance monitoring conducted pursuant to Article 416.

Sources

- Settlement Agreement, 01/12/09
- Order on Remand and on Offer of Settlement, Amending License, Authorizing New Powerhouse, and Lifting Stay, 7/15/10
- Downstream Fish Passage Plan, 1/7/11
- Approval of Downstream Fish Passage Plan, 8/16/11
- Approval of Downstream Fish Passage Final Designs, 6/6/12
- Downstream Fish Passage Monitoring 2016 Annual Report, 6/2/17 (most recent report)
- FSC as a mechanism for fish collection in trap and haul fish passage operations in the Pacific Northwest, 5/17/17 Presentation, Blue Leaf

[7] Per Cushman Settlement Agreement, proposed Article 414 Downstream Fish Passage, Section 6.2. Fish collection efficiency (FCE) is percentage of tagged group of smolts detected at the log boom (360 ft upstream of dam) and are successfully collected in the floating surface collector (FSC) and safely passed downstream of the Cushman Project.
[8] Per Cushman Settlement Agreement, proposed Article 414 Downstream Fish Passage, Section 6.1. System survival (SS) is percentage of marked group of smolts released near the upstream end of Lake Cushman that is successfully collected by the FSC and safely passed downstream of the Cushman Project.
[9] Average of study years 2015-2016; release TOR to FSC. Source: Blue Leaf PowerPoint presentation, slide 21 (derived from 2015 and 2016 annual reports).
[10] Average of study years 2015-2016; release zone of influence (ZOI) to FSC and FSC to sorting facility (SF). Source: Blue Leaf PowerPoint presentation, slide 21 (derived from 2015 and 2016 annual reports).
[11] Average of study years 2015-2016; FSC to sorting facility (combined PIT and Acoustic/PIT tag results). Source: Blue Leaf PowerPoint presentation, slide 21 (derived from 2015 and 2016 annual reports).
[12] Note that this value is not RxCxS, likely due to the combination of data collected by variable means (PIT tags and acoustic/PIT tags).

			Compliance Standard				Measured Performance			
Facility Type (floating, fixed, etc.)	**Reservoir Geometry**	**Allowable Operating Range (ft)**	**Reservoir Passage (R)**	**Collection (C)**	**Survival (S)**	**Efficiency (overall survival; RxCxS)**	**Reservoir Passage (R)**	**Collection (C)**	**Survival (S)**	**Efficiency (overall survival; RxCxS)**
Clackamas River Project (P-2195), Oregon, Portland General Electric (PGE) – *North Fork*										
Floating, Surface Collector with barrier net	North Fork Reservoir Long (4.6 miles), narrow (max depth of 180 ft)	389 max 386 min 382.5 extreme min	Unspecified	Unspecified	Unspecified	97%[13] Injury rate:[14] ≤2% (smolts) ≤4% (fry)	Coho: 98.9%[15] Chinook: 99.1% Steelhead: 96.4%	FGE: [16] Coho: 98.9% Chinook: 98.3% Steelhead: 97.5%	Coho: 100%[17] Chinook: 100% Steelhead: 100%	

Notes

Operational in late 2015; 1 year of data collected (2016); first, per “A/B Measures”, 1,000 cfs attraction flow, second, per “D Measure”, 3,000 cfs attraction flow

Tier 1 of initial (A and B measures) and additional (C and D measures), no additional measures if survival standard met. Related to A and B measure implementation, Tier 2 is if survival is 88-<97%, C Round 1 measures to be implemented. Tier 3 is if survival is <88%, D measures to be implemented. Related to C Round 1 measures, Tier 4 is if survival is 91-<97%, C Round 2 measures to be implemented. Tier 5 is if survival is <91%, D measures to be implemented. Related to C Round 2 measures, Tier 6 is if survival is 95-<97%, population level look at all salmonid runs to determine if going to D measures is warranted; if not, Licensee consults w/ Fish Committee regarding other feasible passage measures or a mitigation requirement. Tier 7 is if survival is <95%, implement D measures. Related to D measures, Tier 8 is if survival is <97% Licensee to consult w/ Fish Committee regarding additional passage measures or mitigation measures beyonf D measures; if agreement is not reached, any party may request FERC to require additional passage or mitigation measures.

Sources

- Settlement Agreement, 3/30/06
- Order Issuing New License, 12/21/10
- Downstream Fish Passage Studies Schedule, 7/28/11
- 2016 Annual Report: Implementation of the Clackamas Project Fish Passage and Protection Plan, 4/21/17
- Evaluation of Juvenile Salmonid Passage through North Fork, 2016 Progress Report, 2/27/17

Clackamas River Project (P-2195), Oregon, PGE – *River Mill*										
Fixed, Surface Collector with exclusion nets	Estacada Lake Long (2.8 miles), narrow (max depth of 80 ft)	665 max 660 normal min 640 extreme min	Unspecified	Unspecified	Unspecified	97%[18] Injury rate: [19] <2% (smolts) <4% (fry)	Coho:98.7%[20] Steelhead: 100.5%	FGE:[21] Coho: 94.5% Steelhead: 93.6%	96.9%[22]	

Notes

Operational in late 2012; 4 years of data collected (2013-2016); 500 cfs attraction flow

Sources

- *See North Fork*
- Evaluation of Juvenile Salmonid Passage through River Mill, 2016 Progress Report, 4/21/17

[13] Survival Standard. Per Settlement Agreement, Article 23 Downstream Fish Passage Standards, Table 1.
[14] Per Settlement Agreement, Article 24 Juvenile Salmonid Injury Standards, subpart (a).
[15] Average of study years 2013-2016. Source: River Mill Fish Passage Evaluation, 2016 Annual Report, Table 11.
[16] FGE is Fish Guidance Efficiency; average of study years 2013-2016. Source: River Mill Fish Passage Evaluation, 2016 Annual Report, Table 8.
[17] 2016 only. Source: River Mill Fish Passage Evaluation, 2016 Annual Report, Section 3.3.
[18] Survival Standard. Per Settlement Agreement, Article 23 Downstream Fish Passage Standards, Table 1.
[19] Per Settlement Agreement, Article 24 Juvenile Salmonid Injury Standards, subpart (a).
[20] Source: North Fork Fish Passage Evaluation, 2016 Annual Report, Table 13.
[21] FGE is Fish Guidance Efficiency. No testing of Chinook has been completed yet. Source: North Fork Fish Passage Evaluation, 2016 Annual Report, Table 7.
[22] Source: North Fork Fish Passage Evaluation, 2016 Annual Report, Section 3.3.

Facility Type (floating, fixed, etc.)	Reservoir Geometry	Allowable Operating Range (ft)	Compliance Standard: Reservoir Passage (R)	Compliance Standard: Collection (C)	Compliance Standard: Survival (S)	Compliance Standard: Efficiency (overall survival; RxCxS)	Measured Performance: Reservoir Passage (R)	Measured Performance: Collection (C)	Measured Performance: Survival (S)	Measured Performance: Efficiency (overall survival; RxCxS)
Pelton Round Butte Project (P-2030), Oregon, PGE – *Round Butte*										
Selective Water Withdrawal Fish Capture Facility	Lake Billy Chinook Long, complex (3 fingers)	1,945 max 1,944 min summer 1,925 min winter	Capture:[23] >50% (temporary facility averaged over 4 years of study) >75% (permanent facility rolling 4-yr average during the first 12 years)	Unspecified	Downstream Passage Facility Survival:[24] 93% (temporary facility during first 5 years of operation)[25] 96% (permanent facility)[26]	Unspecified	Chinook: 23.8%[27] Steelhead: 26.8%	--	Chinook: 67%[28] Sockeye: 51% Steelhead: 55%	--

Notes/Sources Documents

Operational in 2009; 7 years of data collected (2010-2016); construction of temporary and permanent downstream passage facilities is part of Phase III out of IV related to fish passage, known as the Interim Passage Phase.

Downstream Passage Survival: The Licensee will take any feasible measures or implement modifications within their control that are necessary to meet the 93 percent survival standard for the temporary facility, and 96 percent survival standard for the permanent facility. After correcting facilities, the Licensee will re-test the facilities to ensure compliance. Additional re-testing will only be required if deficiencies are observed.

Reservoir Downstream Passage Survival: Actions will be taken, as appropriate, based on the results of the Testing and Verification studies evaluated according to the measures of success (i.e., performance standards) as follows: If >50 percent standard is achieved at the temporary downstream collection facility, then the Licensee will construct the permanent downstream migrant collection facility in accordance with the schedule setforth in Fish Passage Plan, Appendix VI (Settlement Agreement, Exhibit D). If >50 percent standard is not achieved, then the Licensee will further investigate the cause, and, in consultation with Fish Committee, the Licensee will take any feasible measures or implement modifications within their control that are necessary to meet or exceed the >50 percent objective. Seven years after construction of the temporary downstream migrant collection facility, if the >50 percent standard is not achieved, the Liensee shall provide a comprehensive report, for review, and approval by the Fish Committee, discussing the results of studies to date, the modifications that have been made as a result of those study results and recommendations, if any, for additional modifications. If after the completion of at least four years of study, the >50 percent standard has not been achieved and all steps to improve collection efficacy and reservoir passage or survival have been taken, the Licensee will initiate the appropriate consultation actions.

If >75 percent standard is achieved, then the Licensees' Testing and Verification studies involving tributary trapping will end for that tributary. After the >75 percent standard has been met, the Licensee will continue to monitor smolt emigration numbers at the permanent facility through the remainder of the license period. If the numbers of smolts captured at Round Butte Dam trend down, the Licensee in consultation with Fish Committee, will investigate the causes, including reevaluation of reservoir passage survival and take any feasible measures or implement modifications within the Licensees' control to increase smolt production. If >75 percent standard is not achieved, the Licensee will consult the Fish Committee regarding possible adjustments in study efforts to investigate the cause(s), including the identification of mortality factor(s), and regarding the implementation of any feasible measures or modifications within the Licensees' control necessary to meet or exceed the >75 percent standard.

Sources:
- Settlement Agreement, 8/4/04 (Fish Passage Plan in Exhibit D)
- License Order, 6/21/05
- 2015 Juvenile Migration Test and Verification Study, Annual Report, 6/17/162016 Fish Passage Annual Report 5/22/17 (most recent report)

[23] Per Settlement Agreement, Proposed License Article 18 Fish Passage Criteria and Goals, subpart (b). Capture in the Round Butte forebay of marked smolts (released at the heads of each of the tributary arms of Lake Billy Chinook) from any of the three tributaries.
[24] Per Settlement Agreement, Proposed License Article 18 Fish Passage Criteria and Goals, subpart (b). From Round Butte collection to lower Deschutes River release point (~100 miles downstream of dam).
[25] Statistically significant sample of tagged outmigrants.
[26] Pit-tagged smolts.
[27] Values are from the 2015 study year. Source: 2015 Juvenile Migration Test and Verification Study, Annual Report, Executive Summary.
[28] Values are from the 2015 study year. Source: 2015 Juvenile Migration Test and Verification Study, Annual Report, Executive Summary.

Facility Type (floating, fixed, etc.)	Reservoir Geometry	Allowable Operating Range (ft)	Compliance Standard				Measured Performance			
			Reservoir Passage (R)	Collection (C)	Survival (S)	Efficiency (overall survival; RxCxS)	Reservoir Passage (R)	Collection (C)	Survival (S)	Efficiency (overall survival; RxCxS)
Lewis River Project (P-2111), Oregon, PacifiCorp – *Swift No. 1*										
Floating Surface Collector with guide nets from surface to bottom	Swift Reservoir Long (11.5 miles), narrow	1,000 max 878 min	Unspecified (calculated as 85-86%)	CE: [29] 95%	CS:[30] 98% (fry) 99.5% (smolt) Injury rate of 2%	ODS:[31] 80%[32]	Coho: 89.7%[33] Chinook: 33.3% Steelhead: 70%	Coho: 30.6% Chinook: <1% Steelhead 23.5%	100% (fry) 97.6% (smolt) Injury: 0.0% (fry) 0.7% (smolt)	Coho: 33% Chinook: <1% Steelhead: 15%

Notes/Sources Documents
Operational in 2012; 4 years of evaluation; 600 cfs collector flows

Downstream fish passage at Swift No. 1 part of Phase 1 of reintroduction program; decisions on downstream fish passage facilities at Yale and Merwin TBD in subsequent phases (to be built by 13th (2021) and 17th (2025) years of license, respectively); prior to later of 27th year of new license (2035) or 12th year after reintroduction of anadromous fish above Swift No. 1 Dam, the Services to determine metrics for determining success of reintroduction outcome goals.

Facility adjustments/modifications are to made to achieve the relevant performance standards as soon as practicable as follows: If ODS is not being met, (1) If the CE is less than 95% and greater than or equal to 75% or the CS for smolts is less than 99.5% and greater than or equal to 98%, or the CS for fry is less than 98% and greater than or equal to 96%, or Injuries to juvenile Transported Anadromous Species caused by downstream collection and transport are greater than 2% but less than 4%, PacifiCorp shall make Facility Adjustments directed by the Services to achieve the performance standard or standards that are not being met, but shall not be required to make Facility Modifications; or (2) If the CE is less than 75%, or the CS for smolts is less than 98%, or the CS for fry is less than 96%, or Injuries to juvenile Transported Anadromous Species caused by downstream collection and transport are greater than or equal to 4%, PacifiCorp shall make the Facility Modifications directed by the Services to achieve the performance standard or standards that are not being met; provided that if the Services believe a Facility Adjustment will likely achieve the performance standard or standards that are not being met, then PacifiCorp shall first make Facility Adjustments as directed by the Services. If the ODS is being met but the CE is less than 95%, the CS for smolts is less than 99.5%, the CS for fry is less than 98%, or Injury to juvenile Transported Anadromous Species caused by downstream collection and transport is greater than 2%, PacifiCorp shall make Facility Adjustments directed by the Services to downstream facilities but shall not be required to make Facility Modifications to achieve the performance standard or standards that are not being met.

Sources:
- Settlement Agreement, 11/30/04
- Order on Offer of Settlement and Issuing New License, 6/26/08
- Request for Extension of Time (6 months) regarding fish passage decision, 1/30/17 (includes several evaluations to support the decision)
- Monitoring and Evaluation Plan, First Revision, 2/28/17
- Lewis River Fish Passage Program Annual Report, 4/4/17 (most recent report)

Cougar Dam, Oregon, U.S. Corps of Engineers (USACE)										
Floating Surface Collector	Cougar Reservoir Long (5 miles), narrow	1,690 max 1,532 min	Unspecified	Unspecified	Unspecified	Unspecified	Chinook RPE: 94%[34]	Chinook FBE: 96%[35]	Chinook DE: 48%[36] EE: 1.3%[37]	Chinook <1%[38]

Notes/Sources Documents
Operational in 2014; completed 2-year research project, then Portable Floating Fish Collector (PFFC) to be moved to Detroit or Lookout Point reservoirs.

Sources:
- Evaluation of the Biological and Hydraulic Performance of the Portland Floating Fish Collector at Cougar Reservoir and Dam, Oregon 2014
- Evaluation of the Biological and Hydraulic Performance of the Portland Floating Fish Collector at Cougar Reservoir and Dam, Oregon, September 2015-January 2016

[29] Per Settlement Agreement, Section 4.1.4, subpart (b). Performance Standards, part Collection efficiency (CE) is the percentage of juvenile salmonids emigrating from Swift Reservoir that is available for collection (i.e., detectedwithin the zone of influence [ZOI], which is area 150 ft diameter by 20 feet deep in front of the exclusion net) and that is actually collected.
[30] Per Settlement Agreement, Section 4.1.4, subpart (b). Collection survival (CS) is the percentage of juvenile anadromous fish of each species collected that leave Release Ponds alive.
[31] Overall downstream survival is percentage of juvenile anadromous fish of each species that enters the reservoir from natal streams and that survive to enter the Lewis River below Merwin Dam by collection, transport, and release vis the juvenile fish passage system, passage via turbines, or some combination thereof.
[32] Per Settlement Agreement, Section 4.1.4, subpart (a). ODS reduced to 75% at such time as the Yale Downstream Facility is built or the In Lieu Fund in lieu of the Yale Downstream Family becomes available.
[33] Values are from 2016 study year. Source: Lewis River Fish Passage Program, 2016 Annual Report, Executive Summary table.
[34] Average for research years 2014 and 2015/2016. Reservoir passage efficiency (RPE) is number detected at log boom / number released. Source: Biological and Hydraulic Performance Evaluations for 2014 and 2015/16, Tables 9-10 and 8-9, respectively.
[35] Average for research years 2014 and 2015/2016. Forebay passage efficiency (FBE) is number detected in cul-de-sac / number detected at log boom. Source: Biological and Hydraulic Performance Evaluations for 2014 and 2015/16, Tables 9-10 and 8-9, respectively.
[36] Average for research years 2014 and 2015/2016; average the values for low and high “treatments” (i.e., inflows into the PFCC) within a given study year. Discovery efficiency (DE) is number positioned within 10m from PFCC at 0-6 deep / number positioned in cul-de-sac. Source: Biological and Hydraulic Performance Evaluations for 2014 and 2015/16, Tables 9-10 and 8-9, respectively.
[37] Average for research years 2014 and 2015/2016; average the values for low and high “treatments” (i.e., inflows into the PFCC) within a given study year. Entrance efficiency (EE) is number collected at PFCC / number positioned within 10m fromroute at 0-6 m deep.
[38] Average for research years 2014 and 2015/2016. FCE = RPE x FBE x DE x EE. Source: Biological and Hydraulic Performance Evaluations for 2014 and 2015/16, Tables 9-10 and 8-9, respectively.