LA GRANGE PROJECT
FISH BARRIER ASSESSMENT
STUDY REPORT

LA GRANGE HYDROELECTRIC PROJECT
FERC NO. 14581

Prepared for:
Turlock Irrigation District – Turlock, California
Modesto Irrigation District – Modesto, California

Prepared by:
FISHBIO

September 2017

TABLE OF CONTENTS

List of Figures

List of Tables

List of Attachments

List of Acronyms and Abbreviations

CCSF..........................City and County of San Francisco
CDFW........................California Department of Fish and Wildlife
CFM ....Constant Fractional Marking Program
cfs..............................cubic feet per second
CI...............................confidence interval
cm..............................centimeter
Districts......................Turlock Irrigation District and Modesto Irrigation District
FERC..........................Federal Energy Regulatory Commission
FLA ....Final License Application
ISR ....Initial Study Report
LGDD ....La Grange Diversion Dam
mg/L...........................milligram per liter
MID............................Modesto Irrigation District
MW ....megawatt
n.................................number
NMFS.........................National Marine Fisheries Service
RM ....river mile
RSP ....Revised Study Plan
SD2 ....Scoping Document 2
SPD ....Study Plan Determination
TID.............................Turlock Irrigation District
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 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.

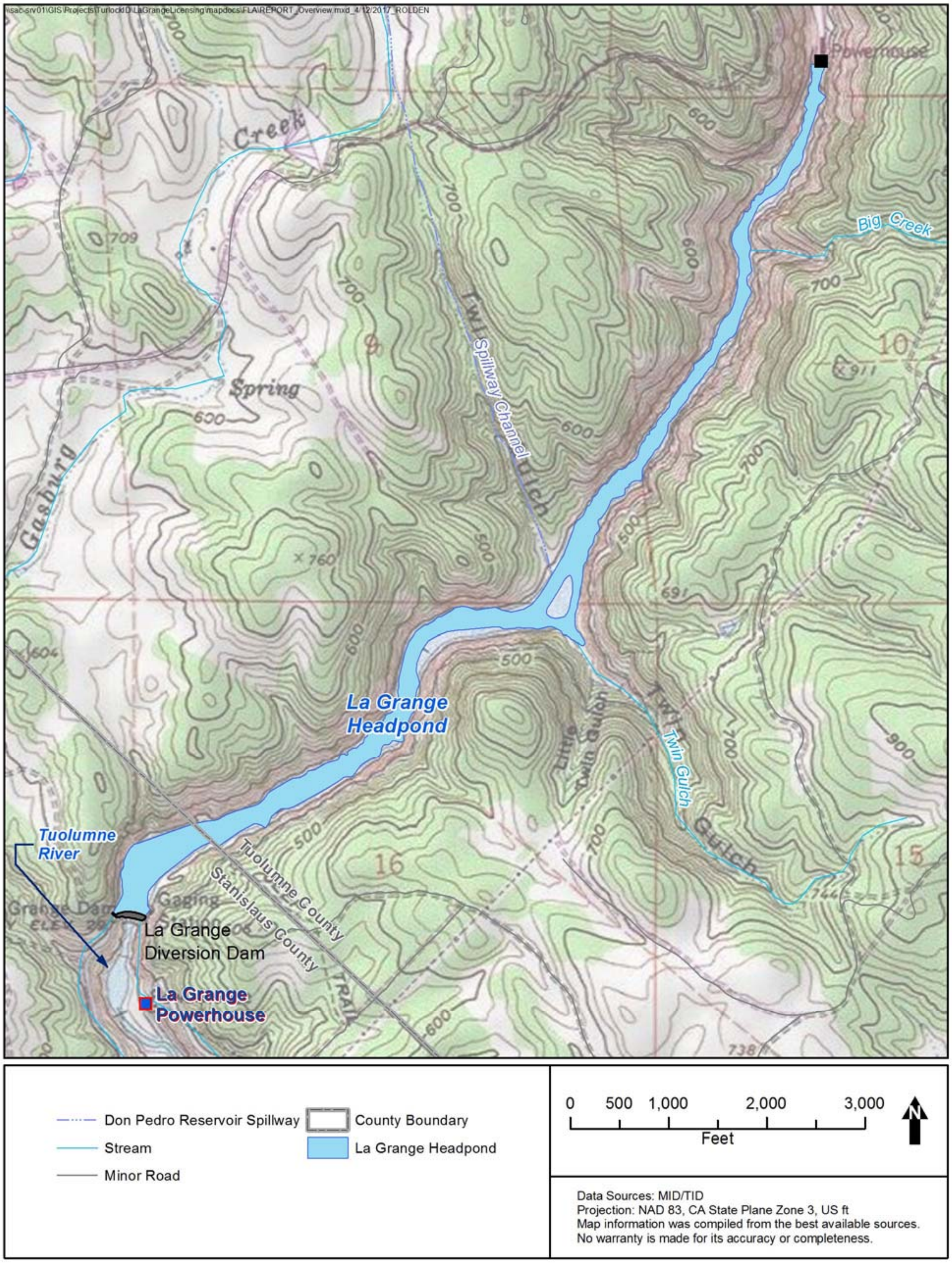

Figure 1.1-1. La Grange Hydroelectric Project location map.

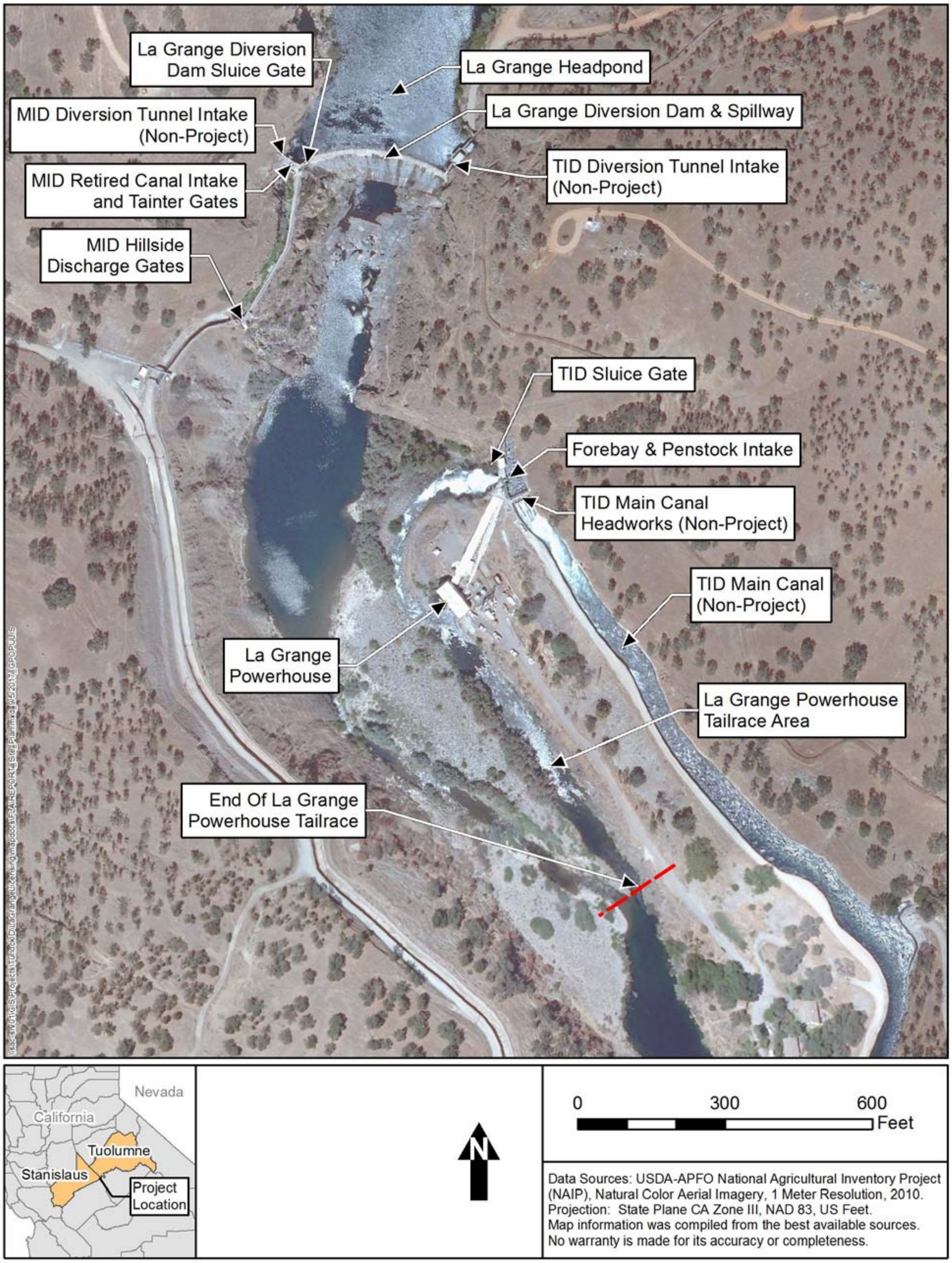

Figure 1.1-2. La Grange Hydroelectric Project site plan.

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 "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

---

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.

Phase 1 of that study indicate that the most feasible concept for fish passage would involve fish 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 study report describes the objectives, methods, and results of the La Grange Project Fish Barrier Assessment (herein referred to as the Fish Barrier Assessment), which is one component of the Fish Passage Facilities Assessment as implemented by the Districts in accordance with the SPD. Documents relating to the Project licensing are publicly available on the Districts' licensing website at www.lagrange-licensing.com/.

1.3 Study Plan

FERC's Scoping Document 2 (SD2) issued on September 5, 2014 identified potential effects of Project operations on the upstream migration of anadromous fish.

FERC's SPD approved without modification the Districts' Fish Barrier Assessment as proposed in the RSP. In comments on the Pre-Application Document, NMFS, CDFW, and the Conservation Groups state that LGDD and the La Grange powerhouse are barriers to upstream anadromous fish migration, and a study to evaluate whether the dam and powerhouse are barriers is not needed. However, FERC staff approved the study stating that the information collected in this study would help define the nature and degree to which the dam and powerhouse are barriers or impediments to the upstream migration of anadromous salmonids. No comments were filed in response to the Fish Barrier Assessment as proposed in the RSP.

2.0 STUDY GOALS AND OBJECTIVES

The purpose of the Fish Barrier Assessment is to evaluate the extent to which the LGDD and the La Grange powerhouse act as as barriers to the upstream migration and spawning of adult fall-run Chinook salmon (*Oncorhynchus tshawytscha*) and, if they occur, steelhead (*O. mykiss*). This includes documenting the proportion of the fall-run Chinook salmon population that may migrate upstream to these facilities and evaluating potential impacts to the spawning of these fish. Objectives of this study are to:

- determine the number of fall-run Chinook salmon and steelhead migrating upstream to LGDD and the La Grange powerhouse during the 2015/2016 and 2016/2017 migration seasons;
- compare the number of fall-run Chinook salmon and steelhead migrating upstream to the LGDD and the La Grange powerhouse to total escapement during the 2015/2016 and 2016/2017 migration seasons;
- document carcass condition (egg retention) to evaluate pre-spawn mortality rates of fall-run Chinook salmon and steelhead migrating upstream to LGDD and the La Grange powerhouse, which do not move back downstream to spawn; and
- implement formal documentation of incidental fish observations in the vicinity of LGDD, La Grange powerhouse tailrace, and TID sluice gate channel. Note that this objective is being addressed as part of the Fish Presence and Stranding Assessment (TID/MID 2017a).

3.0 STUDY AREA

The study area includes the Tuolumne River from LGDD (RM 52.2) downstream to the mainstem channel fish counting weir, and the La Grange powerhouse tailrace channel downstream to the tailrace channel fish counting weir (Figure 3.0-1). Daily boat surveys were conducted in both channels from LGDD to 0.3 miles downstream of the weir locations to document potential fish stacking or pre-spawn mortality. This study also includes data collected from monitoring conducted at a fish counting weir operated by the Districts at RM 24.5.

Figure 3.0-1. Location of main channel weir and tailrace channel weir.

4.0 METHODOLOGY

4.1 Weir Configurations

Two fish counting weirs were installed in the Tuolumne River near the La Grange facilities. One weir segment was placed downstream of the large pool below LGDD in the Tuolumne River main channel, and the second segment was placed just below the La Grange powerhouse in the tailrace channel (Figure 3.0-1). Each weir structure consisted of rigid weir panels that directed fish passage through a passing chute that was continuously monitored by a video system. Each weir panel was constructed of steel angle and horizontal pipe with 1 1/8-inch spacing and secured in-channel diagonal to the river flow.

The passing chute of the main channel weir (Figure 4.1-1) consisted of a 3-foot-wide by 4-foot-long white high-density polyethylene floor that was secured to the substrate. An overhead camera and an underwater side-view camera were positioned to view the entire passing chute. The tailrace weir (Figure 4.1-2) consisted of a 6-foot wide by 6-foot long high-density polyethylene passing chute equipped with an overhead camera and two underwater side-view cameras. Each passing chute was equipped with an infrared lighting system for 24-hour monitoring. Similar video systems have been operated by CDFW to monitor the passage of Chinook salmon and steelhead on Sacramento River tributaries (Killiam and Johnson 2008).

The overhead cameras at each weir provided full coverage of the passing chute area and were used to detect fish passage events. Underwater cameras were used to assist with species identification for each passage event. A multi-camera video surveillance application (SecuritySpy) was used to route footage to computers for storage. Hourly video files from each camera were saved to external hard drives and downloaded daily for data back-up. Additionally, motion detection settings in the video surveillance application were used to create five-second clips of all potential passage events.

4.2 Weir Operations

The weirs were cleaned, weir performance was documented, and video footage was downloaded daily (generally between 8:00 am and 11:00 am each day). Environmental data collected during each weir check included dissolved oxygen (mg/L), stream stage (feet), turbidity (nephelometric turbidity units [NTU]), and water velocity (feet per second [ft/sec]) at the opening of the fish passage chute. Provisional daily average flow data for the Tuolumne River at La Grange was obtained from U.S. Geological Survey (USGS) Gage 11289650 (http://waterdata.usgs.gov/ca/nwis). Hourly water temperature data were obtained from Hobo Pro v2 water temperature data loggers (Onset Computer Corporation) maintained at each weir site. Visual assessments were also conducted daily to ensure that fish were not stacking on either side of the weir, as required by the CDFW scientific collection permit amendment. Boat surveys were conducted in both channels from LGDD to 0.3 miles downstream of the weir locations. Any spawning activity, live fall-run Chinook salmon (*Oncorhynchus tshawytscha*) or *Oncorhynchus mykiss* (*O. mykiss*), or carcasses observed upstream or downstream of the weir were recorded. Daily stacking counts were reported to CDFW three times per week ("stacking" was defined as 30 or more individuals on either side of the weir).

Figure 4.2-1. Upstream view of main channel weir and passing chute.

Figure 4.2-2. Overhead view of tailrace channel weir and passing chute.

4.3 Video Review

A fisheries biologist or technician with prior video review training and experience reviewed digital video footage to determine passage events. Video review was limited to a group of five individuals to ensure consistency through the review period. To expedite video review, a motion detection system was initially used in 2015/2016 to capture five-second motion detection clips from the overhead camera to determine fish presence, estimated length, and direction of passage. However, a high number of missed passages and/or false detections were identified during review of the video files. With the motion detection system found to be ineffective, all overhead video files were reviewed at 10x speed to identify fish passage events. Passage date, time, direction of passage, species, and estimated fish size were recorded for each passage event. Underwater camera views were also used to aid in species identification, sex determination, and presence of an adipose fin. The certainty of each fish observation was recorded as high, medium, or low. A high certainty rating signified complete confidence in determining species and the presence or absence of an adipose fin; medium suggested confidence in determining species but sex and/or presence of an adipose fin was unknown; and low suggested uncertainty in determining species.

Video review quality assurance procedures consisted of an independent review of a subsample of video data by a different fisheries biologist or technician than had originally reviewed the video. Data selected for a second review included species identified as unknown, passages with a low observational certainty, and all passages initially identified as *O. mykiss*.

Raw data were summarized to determine daily upstream and downstream weir counts and the total numbers of individual Chinook moving through the weir (i.e., generating passage events) Note that the number of passage events is not equal to the numbers of individual fish since a single fish can produce multiple passage events. When possible, individual fish were identified based on estimated fish length, sex, and general morphological characteristics. The total number of individual Chinook identified at the tailrace and main channel weirs was divided by total escapement determined at the lower weir (at RM 24.5) to estimate the proportion of the fall-run Chinook escapement that may migrate upstream to the La Grange facilities.

4.4 Statistical Analysis

4.4.1 Statistical Inference for the 2016/2017 Monitoring Year

The two monitoring years were quite different with respect to environmental conditions (higher discharges in 2016/2017) and overall numbers of Chinook salmon present in the Tuolumne River. Greater numbers of fish and associated passage events prevented identification of unique individuals in 2016/2017. Therefore, statistical inference was used to estimate the total number of individuals present in the vicinity of the La Grange facilities in 2016/2017 based on the number of uniquely identified fish and passage events recorded for the 2015/2016 season. A principle assumption with this approach was that the 2015/2016 data was representative of the 2016/2017 data with respect to number of passages per individual and sex ratios (i.e., it assumes that descriptive statistics from 2015/2016 accurately describe 2016/2017 as well). Thus it was necessary to start by comparing the distribution of total unidirectional passage events (upstream or downstream weir counts) between monitoring years (statistically, if the two distributions were different between years than the principle assumption was no longer valid). In addition, because sex could not always be determined for a passage event (this occurred in both 2015/2016 and 2016/2017), the number of passage events for which sex could be determined versus events where sex was undetermined was also compared. This second comparison was to evaluate if environmental factors influenced the ability to identify sex of Chinook. If the ratio of identified to unidentified sex was different between years, then passage counts for those years might not be directly comparable and the principle assumption would no longer be valid.

4.4.1.1 Inference Method #1: All 2015/2016 Chinook Combined

After comparing the distribution of passage events between years, the next step was to characterize the number of passages per uniquely identified individual observed in 2015/2016. A total of 105 individual Chinook accounted for 2,329 passage events at the tailrace weir and 12 Chinook accounted for 935 passage events at the main channel weir. To estimate the number of individual Chinook present in 2016/2017 at both weirs, the total number of passage events in 2016/2017 was expanded by dividing the mean and median number of passages per individual at each weir in 2015/2016.

4.4.1.2 Inference Method #2: 2015/2016 Chinook Grouped by Sex

Estimating the total number of individuals in 2016/2017 based on summary statistics from all 2015/2016 individuals combined assumes that males and females have a similar propensity of movement (inference method #1). However, if males and females have different rates of movement, then sex-specific summary statistics would be needed to estimate the total number of individuals from passage events. A Student's t-test was used to test if 2015/2016 males and females exhibited differences in number of passages. The number of passages per individual was log_{10} transformed to meet normality assumptions. Estimates of the number of male and female Chinook present in 2016/2017 at each weir were derived in the same manner as for all individuals combined, except that the total number of passage events was first apportioned into male or female events. Using the 2016/2017 passage events for which sex could be assigned, the proportions of male and female passage events were used to assign sex to passage events where sex was undetermined. For example, if females made up 25 percent of the passages that could be assigned a sex, then it was assumed that 25 percent of the passages of unknown sex were female. The numbers of male and female 2016/2017 passages were then expanded by dividing their respective mean and median number of passages per individual calculated from 2015/2016 males and females.

4.5 Lower Tuolumne River Weir

The Districts operate a fish counting weir at RM 24.5, which is located downstream of the fall-run Chinook salmon spawning reach. Monitoring objectives at this weir location include determining total escapement of fall-run Chinook salmon and *O. mykiss* to the Tuolumne River through direct counts. This weir has been operated annually since 2009 (Becker et al. 2016; Sonke 2017), and monitoring occurred continuously during the period that the La Grange weirs were operated.

4.6 Pre-spawn Mortality Evaluation

Salmon encountering barriers to migration may experience pre-spawn mortality. During carcass surveys conducted to estimate salmon escapement, CDFW examines female Chinook salmon carcasses for egg retention to estimate pre-spawn mortality. Assessments of pre-spawn mortality have been conducted in several Central Valley streams in some years; however, these assessments have been intermittent and inconsistent due to a lack of available funding and staff. CDFW has conducted pre-spawn mortality evaluations in 1993, 1999, 2008, 2013, and 2014-2016 and documented low levels of pre-spawn or partial-spawn mortality of fall-run Chinook in the Tuolumne River (CDFW 2014, Gretchen Murphey, CDFW pers. comm.). Of the years evaluated, the maximum annual occurrence of pre-spawn or partial-spawn mortality documented was five individuals (2013).

To evaluate the effect of LGDD and the La Grange powerhouse on the spawning success of upstream migrants and thereby, the productivity of the Tuolumne River population, daily surveys above the counting weir were conducted to assess the presence/absence of live Chinook salmon, spawning activity, or carcasses. Chinook carcasses were visually assessed for egg retention, and all fish carcasses observed were collected, frozen, and delivered to CDFW LA Grange staff. CDFW also conducted pre-spawn mortality evaluations throughout the spawning reach as part of their annual fall-run Chinook salmon escapement surveys (Gretchen Murphey, CDFW pers. comm.).

5.0 STUDY RESULTS

This section summarizes all data collected during the 2015/2016 and 2016/2017 monitoring seasons.

5.1 Weir Operations

5.1.1 2015/2016 Monitoring Season

During the 2015/2016 monitoring season, both weirs operated almost continuously between September 23, 2015 and April 15, 2016. Two high-debris flow events on October 17 and October 28 washed out a portion of the tailrace channel rigid weir structure. Sections of the rigid weir were temporarily removed and reinstalled resulting in the system being inoperable for 40.8 hours and 27.0 hours on October 17 and October 28, respectively. On eight other occasions the tailrace weir video monitoring system was inactive (i.e., video was not recorded due to camera or computer malfunctions), with outage times ranging from 3.3 hours to 30.7 hours (mean 14.1 hours). Overall the tailrace video system recorded video footage for 97.3 percent of the monitoring period. The main channel weir video system was inactive on 22 occasions, with outage times ranging from two hours to 35.6 hours (mean 15.7 hours) (Table 5.1-1). System outages at the main channel weir were associated with extended periods with minimal sunlight resulting in the computer turning off due to low battery voltage. Overall the main channel video system recorded video footage for 91.2 percent of the monitoring period.

During the monitoring period, average daily flow recorded at La Grange ranged from 91 to 175 cfs (Figure 5.1-1). River flow through the main channel weir was provided by the MID hillside discharge and was estimated to be 5 to 10 cfs throughout the study period (TID/MID 2017b). Instantaneous water velocity recorded in the main channel fish counting weir passage chute ranged from 0.3 to 2.4 feet per second (ft/sec) (mean 0.9 ft/sec). The remainder of the flow recorded at La Grange facilities originated from the powerhouse and/or TID sluice gate channel and flowed through the tailrace channel fish counting weir.[3] Instantaneous water velocity recorded at the tailrace channel fish counting weir passage chute ranged from 0.6 ft/sec to 4.7 ft/sec (mean 2.6 ft/sec).

Average daily water temperatures recorded at each weir site ranged from 50.1°F to 64.2°F (10.1°C to 17.9°C) in the tailrace channel and 48.7°F to 67.4°F (9.3°C to 19.7°C) in the main channel (Figure 5.1-1). Instantaneous turbidity ranged from 0.69 NTU to 14.06 NTU (mean 2.82 NTU) in the tailrace channel and from 0.54 NTU to 11.96 NTU (mean 2.44 NTU) in the main channel. Instantaneous dissolved oxygen ranged from 4.03 mg/L to 13.93 mg/L (mean 9.34 mg/L) in the tailrace channel and from 8.96 mg/L to 14.24 mg/L (mean 10.97 mg/L) in the main channel.

[3] During the monitoring season TID maintained an 18-inch pipe in an open position that continuously delivers flow of approximately 5 to 10 cfs to the channel downstream of the sluice gates. This water flows into the tailrace just upstream of the powerhouse.

Table 5.1-1. Summary of video recording outage periods during the 2015/2016 monitoring season.

Weir	Date	Time Outage Began	Date	Time Outage Ended	Outage Duration (hours)
Tailrace	10/17/15[1]	23:12	10/19/15	16:00	40.8
Tailrace	10/28/15[1]	13:00	10/29/15	16:00	27.0
Main Channel	11/24/15	3:13	11/24/15	8:40	5.5
Main Channel	11/24/15	23:23	11/25/15	8:44	9.4
Main Channel	11/25/15	8:53	11/26/15	9:18	24.4
Main Channel	12/2/15	21:48	12/4/15	9:23	35.6
Main Channel	12/5/15	7:05	12/5/15	9:37	2.5
Main Channel	12/5/15	22:18	12/6/15	11:21	13.1
Main Channel	12/11/15	23:42	12/12/15	9:09	9.5
Main Channel	12/13/15	6:52	12/13/15	9:16	2.4
Main Channel	12/13/15	12:23	12/14/15	10:11	21.8
Main Channel	12/19/15	9:33	12/20/15	10:58	25.4
Main Channel	12/20/15	18:49	12/21/15	11:59	17.2
Main Channel	12/21/15	17:24	12/22/15	9:04	15.7
Main Channel	12/22/15	20:39	12/23/15	10:52	14.2
Main Channel	12/24/15	6:13	12/24/15	10:29	4.3
Main Channel	12/24/15	23:26	12/25/15	9:41	10.3
Tailrace	1/3/16	19:51	1/4/16	11:25	15.6
Main Channel	1/4/16	20:13	1/5/16	11:45	15.5
Main Channel	1/5/16	15:32	1/6/16	9:44	18.2
Main Channel	1/17/16	11:19	1/18/16	14:38	27.3
Tailrace	1/19/16	5:00	1/19/16	11:55	6.9
Tailrace	1/24/16	6:00	1/24/16	9:20	3.3
Tailrace	1/31/16	6:00	2/1/16	12:39	30.7
Main Channel	2/2/16	10:19	2/3/16	10:15	23.9
Main Channel	2/6/16	12:49	2/7/16	9:59	21.2
Tailrace	2/27/16	3:47	2/27/16	10:52	7.1
Tailrace	2/27/16	11:29	2/28/16	10:19	22.8
Main Channel	3/11/16	9:07	3/12/16	11:07	26.0
Tailrace	3/20/16	13:00	3/21/16	9:53	20.9
Tailrace	4/10/16	5:00	4/10/16	10:50	5.8
Main Channel	4/14/16	8:32	4/14/16	10:33	2.0

[1] A portion of the weir was temporarily removed due to high-debris flow events.

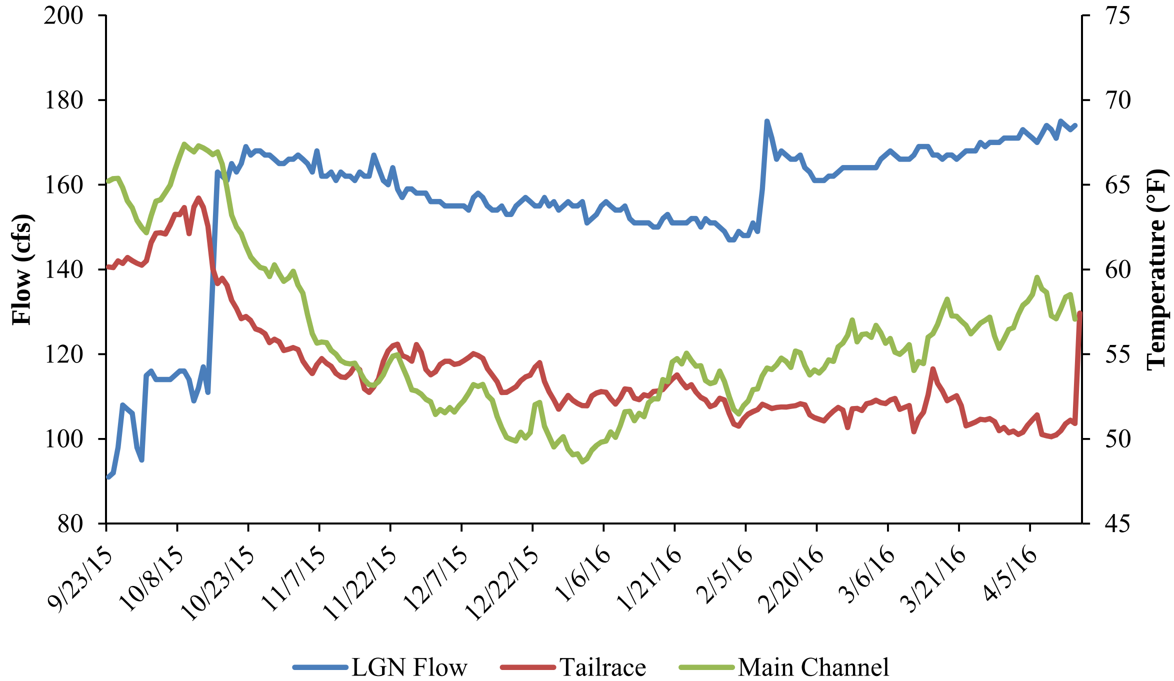

Figure 5.1-1. Mean daily flow (cfs) at the USGS gage (11289650) and mean daily water temperatures at the tailrace channel weir and the main channel weir during the 2015/2016 monitoring season.

5.1.2 2016/2017 Monitoring Season

During the 2016/2017 monitoring season, both weirs were installed on September 15, 2016. After a brief testing period, the video monitoring system was fully functional on September 20, 2016. Monitoring was suspended and all equipment removed from the river on January 2, 2017 due to the onset of flood control releases from Don Pedro Reservoir, with flow recorded at La Grange ranging from 1,770 cfs to 13,900 cfs through April 30, 2017. The tailrace weir was temporarily removed from October 12 through November 4 (554.7 hours), due to flow operations that exceeded the operational capability of the weir structure. On seven other occasions the tailrace weir video monitoring system was inactive (i.e., video was not recorded due to camera or computer malfunctions), with outage times ranging from 10.9 hours to 18.4 hours (mean 13.7 hours).

Overall, the tailrace video system recorded video footage for 74.1 percent of the monitoring period. The main channel weir video system was inactive on 18 occasions, with outage times ranging from 1.3 hours to 178.8 hours (mean 26.1 hours) (Table 5.1-2). System outages at the main channel weir between October 14 and November 1 were associated with extended periods when access to the site was limited due to high flows. System outages during the remainder of the monitoring period were often associated with minimal sunlight resulting in the computer turning off due to low battery voltage. Overall, the main channel video system recorded video footage for 81.2 percent of the monitoring period.

Table 5.1-2. Summary of video recording outage periods during the 2016/2017 monitoring season.

Weir	Date	Time Outage Began	Date	Time Outage Ended	Outage Duration (hours)
Tailrace	9/20/16[1]	19:32	9/21/16	6:26	10.9
Tailrace	9/21/16	19:32	9/22/16	6:18	10.8
Main Channel	9/24/16[1]	15:28	9/25/16	8:45	17.3
Main Channel	9/25/16	14:31	9/26/16	9:40	19.2
Tailrace	9/26/16	18:59	9/27/16	11:53	16.9
Tailrace	9/27/16	17:23	9/28/16	9:18	15.9
Main Channel	9/27/16	14:09	9/28/16	9:34	19.4
Tailrace	9/28/16[1]	19:12	9/29/16	6:35	11.4
Main Channel	9/28/16	14:12	9/29/16	9:05	18.9
Tailrace	9/29/16[1]	19:12	9/30/16	6:35	11.4
Main Channel	9/29/16	15:19	9/30/16	9:14	17.9
Tailrace	10/12/16[2]	8:44	11/4/16	11:25	554.7
Main Channel	10/14/16[3]	4:48	10/20/16	11:48	151.0
Main Channel	10/24/16[3]	5:57	10/24/16	9:16	3.3
Main Channel	10/24/16[3]	22:06	11/1/16	8:54	178.8
Main Channel	11/2/16[3]	4:49	11/2/16	8:56	4.1
Main Channel	11/3/16[2]	5:48	11/3/16	8:57	3.2
Main Channel	11/4/16	6:17	11/4/16	9:04	2.8
Main Channel	11/5/16	5:30	11/5/16	9:02	3.5
Main Channel	11/6/16	4:43	11/6/16	9:14	4.5
Main Channel	11/6/16	20:38	11/7/16	8:46	12.1
Main Channel	11/8/16	2:36	11/8/16	8:05	5.5
Main Channel	11/9/16	3:40	11/9/16	8:09	4.5
Main Channel	11/10/16	6:08	11/10/16	8:10	2.0
Main Channel	11/11/16	6:43	11/11/16	8:01	1.3
Tailrace	11/20/16	9:38	11/21/16	4:00	18.4

1 No night video due to camera malfunction.
2 The tailrace weir was temporarily removed due to flow operations that exceeded the operational capability of the weir structure.
3 Access was limited to the main channel weir due to high flows in the tailrace and sluicegate channels.

During the reporting period, average daily flow recorded at La Grange ranged from 83 to 1,150 cfs (Figure 5.1-2). Instantaneous water velocity recorded in the main channel fish counting weir passage chute ranged from 0.8 to 2.9 feet per second (ft/sec) (mean 1.8 ft/sec). Instantaneous water velocity recorded at the tailrace channel fish counting weir passage chute ranged from 1.2 to 6.5 ft/sec (mean 2.3 ft/sec).

Average daily water temperatures recorded at each weir site ranged from 52.2°F to 53.6°F in the tailrace channel and 52.5°F to 56.2°F in the main channel (Figure 5.1-2) through November 15, 2016. Water temperature data are only available through November 15, 2016, as data loggers have not been retrieved due to flood control releases. Instantaneous turbidity ranged from 0.38 to 6.39 NTU (mean 1.20 NTU) in the tailrace channel and from 0.59 to 3.30 NTU (mean 1.28 NTU) in the main channel. Instantaneous dissolved oxygen ranged from 7.06 to 10.93 mg/L (mean 8.45 mg/L) in the tailrace channel and from 10.25 to 11.62 mg/L (mean 10.86 mg/L) in the main channel.

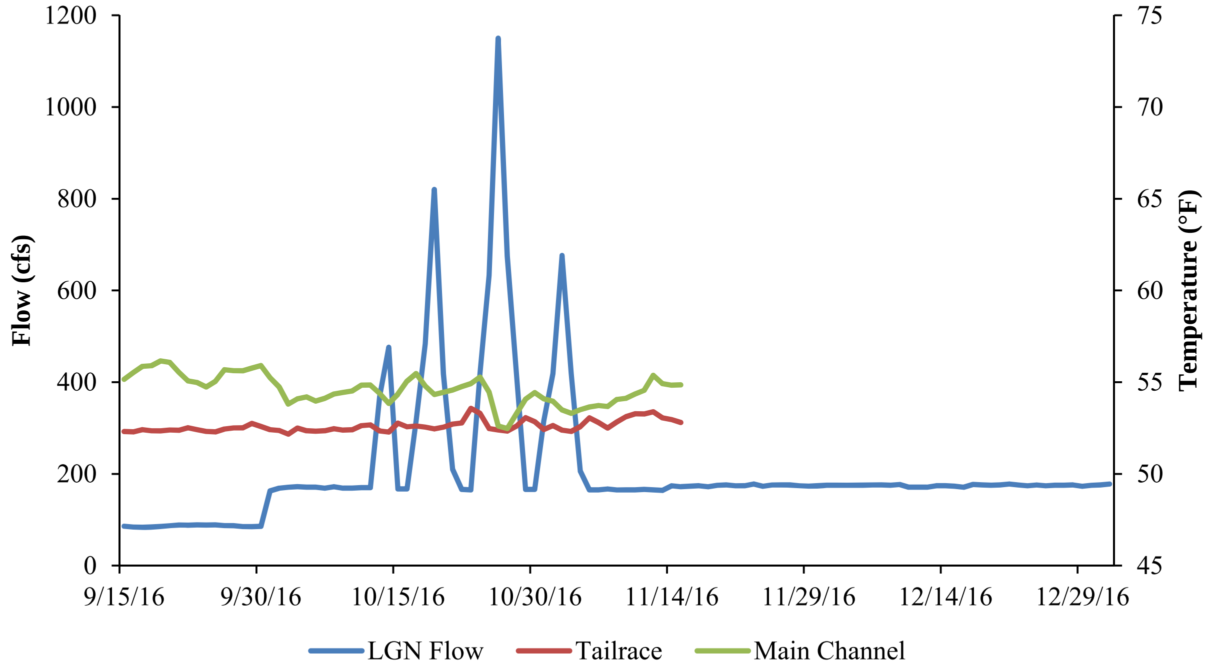

Figure 5.1-2. Mean daily flow (cfs) at the USGS gage (LGN) and daily mean water temperatures at the tailrace channel weir and the main channel weir during the 2016/2017 monitoring season.

5.2 Fish Passage at Counting Weirs

5.2.1 Chinook Salmon Near La Grange Facilities: 2015/2016 Monitoring Season

Based on data collected between September 23, 2015 and April 14, 2016, a total of 3,264 fall-run Chinook salmon passage events (1,617 upstream, 1,647 downstream) were detected at the tailrace and main channel weirs (Attachment A). The first Chinook salmon upstream passage event was observed September 23, 2015, and the last Chinook salmon passage event was observed February 15, 2016. The majority of passage events (89.7 percent) occurred during November and December accounting for 48.0 percent and 41.7 percent of Chinook salmon passages, respectively (Figure 5.2-1).

Individual fish were identified based on estimated fish length, sex, and general morphological characteristics. This classification resulted in a total of 105 individual Chinook salmon accounting for the 2,329 passage events at the tailrace channel weir, and a total of 12 Chinook salmon accounting for the 935 passages at the main channel weir. Although sex was assigned for the majority of passage events, it was not always assigned if the video reviewer was uncertain of the individual's sex. For 2015/2016, 69.7 percent of passage events were assigned a sex. Of the passages that could be assigned a sex, the ratio of female to male events was 0.21. This resulted in 35 females and 82 males, with 28.2 percent (n=33) of the fish having a clipped adipose fin (ad-clipped) indicating hatchery origin[4]. Given the close proximity between the main channel and tailrace monitoring locations, it is likely that some individuals may have been detected at both weirs. Evaluation of these movements between the two channels was not evaluated, as it was beyond the scope of this study.

Individual Chinook salmon often made multiple, consecutive upstream and downstream passages. The mean number of upstream/downstream passage events for individual salmon at the tailrace weir was 10.8 (range: 1 to 54 passages), and at the main channel weir was 38.8 (range: 1 to 111 passages). At the tailrace weir, the median time from initial passage event through final passage event was 101.5 hours (4.23 days), and ranged from 0.37 hours to 823.89 hours (34.33 days). At the main channel weir, the median time from initial passage event through final passage event was 153.65 hours (6.40 days), and ranged from 4.83 hours to 491.28 hours (20.47 days).

The maximum time observed between initial passage and final passage was a male Chinook salmon that made multiple upstream and downstream passages in the tailrace channel over a 34 day period between September 23, 2015 and October 27, 2015. Female salmon were not observed at the weirs until October 21, and within six days of arrival of the first female salmon, this male was no longer detected. It is likely that this fish was holding in the area below La Grange powerhouse waiting for the arrival of a mate. As this fish was observed before the Tuolumne River weir (RM 24.5) was installed on September 28, 2015, it is unknown when this fish moved into the spawning reach.

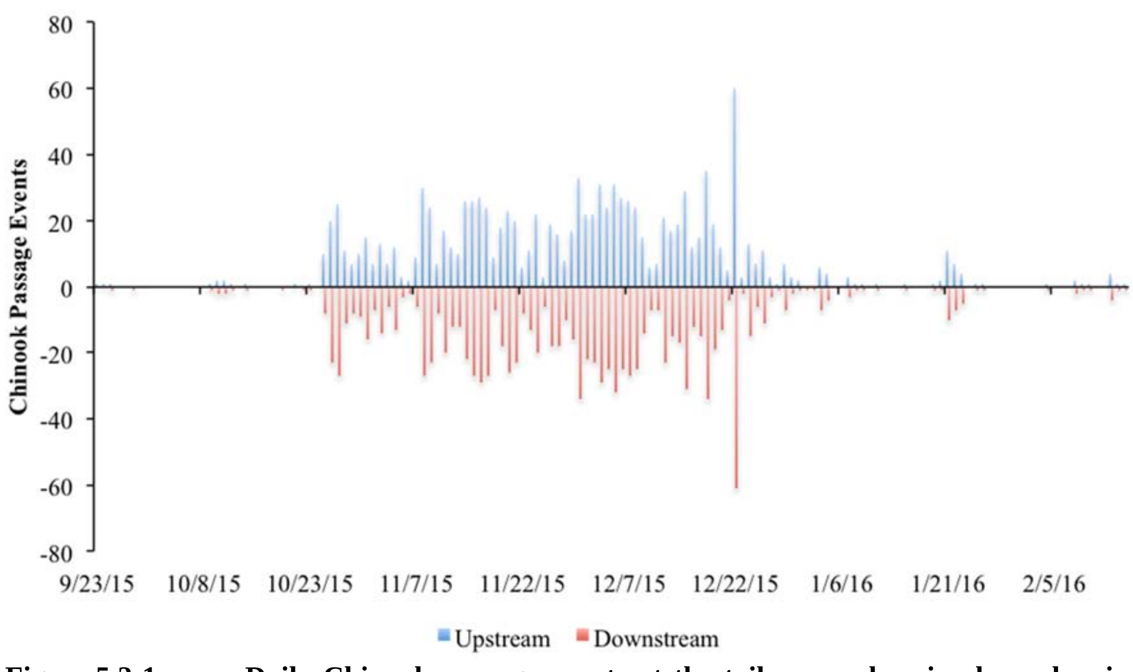

Figure 5.2-1. Daily Chinook passage events at the tailrace and main channel weirs during the 2015/2016 monitoring season.

[4] The Central Valley Constant Fractional Marking Program (CFM) was initiated in 2007 to estimate the relative contribution of hatchery production. Beginning with Brood year 2006 fall-run Chinook, the program has marked a minimum of 25 percent of releases from the Central Valley hatcheries each year (Buttars 2013).

5.2.2 Chinook Salmon Near La Grange Facilities: 2016/2017 Monitoring Season

High flows prevented weir operation from October 12, 2016 to November 4, 2016, and sampling was suspended for the season on January 2, 2017. Despite having a shorter sample season, daily passages were much greater during the 2016/2017 monitoring season than during the 2015/2016 monitoring season.

Based on data collected between September 15, 2016 and January 1, 2017, a total of 11,239 fall-run Chinook salmon passage events (5,485 upstream, 5,754 downstream) were detected at the tailrace weir and 10,544 Chinook passage events (5,248 upstream, 5,296 downstream) at the main channel weir (Figure 5.2-2; Attachment B, Tables B-1 and B-2, available upon request). The first Chinook salmon passage event was October 8, 2016, and Chinook salmon were observed through January 1, 2017.

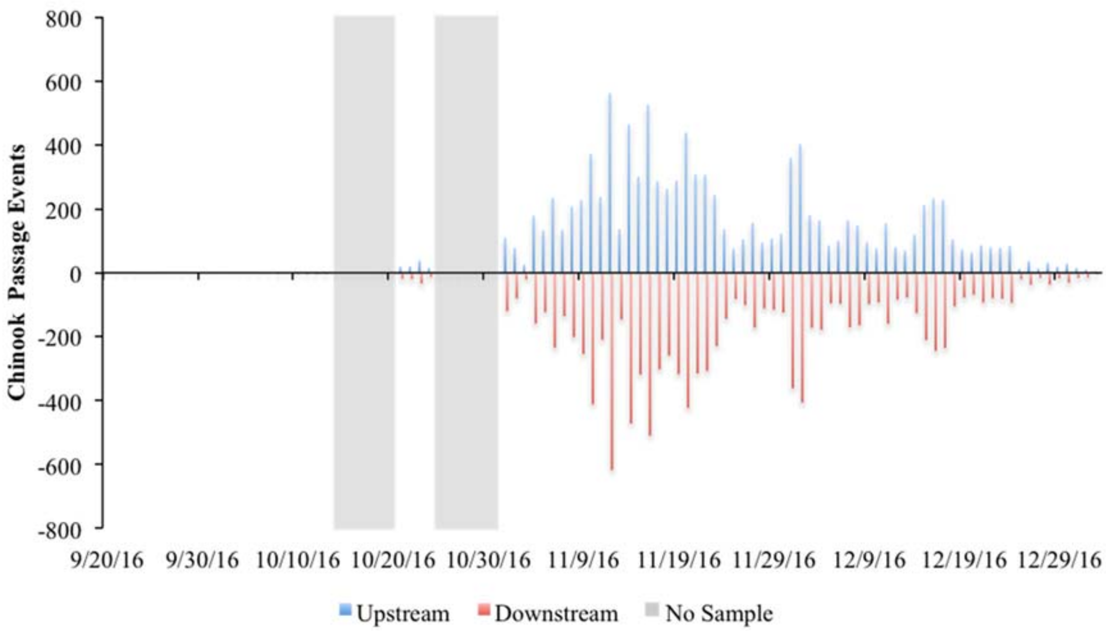

Figure 5.2-2. Daily Chinook passage events at the tailrace and main channel weirs during the 2016/2017 monitoring season.

In 2016/2017, 74.8 percent of passage events at the tailrace weir were assigned a sex. Of those passage events, the ratio of female to male passage events was 0.19, roughly similar to the one female for every five male passages that was observed in 2015/2016. The high number of passage events at both weir sites prevented the accurate identification of unique individuals based on video review. Therefore statistical inference as described in Section 4.4.1 above was used to estimate the total number of individuals present.

5.2.3 Inferring Number of Chinook Salmon in 2016/2017

5.2.3.1 Passages by Unique Individuals in 2015/2016

A total of 105 uniquely identified individuals were observed in 2015/2016 at the tailrace weir and were responsible for 2,329 unidirectional passage events. Of these fish, 74 (70 percent) were male and 31 (30 percent) were female. At the main channel weir, 12 individuals (four females and eight males) were responsible for 935 passage events.

Because unique individuals could be identified and monitored in 2015/2016, it was possible to use the distribution of passage events per individual to help infer the number of unique individuals present at each weir in 2016/2017. The distribution was highly right skewed (Figure 5.2-3), meaning that even though the mean number of passage events per individual in 2015-2016 was 21.8 (95 percent confidence interval =17.5-26.1), most individuals had 14.0 (10.0-20.0) or fewer passage events. Therefore the median value provided a better representation of the number of passages per individual than the mean, thus results presented were based on median values. The mean number of unidirectional passages per individual at the main channel weir was 77.7 (42.0-113.3) and the median was 65.5 (14.0-108.0). The number of identified individuals at the main channel weir, some of which were also responsible for passage events at the tailrace weir, was too small to compare the distributions between weirs or compare number of passages between males and females. Although results are presented for both weirs in the text, figures present the results of the tailrace analysis.

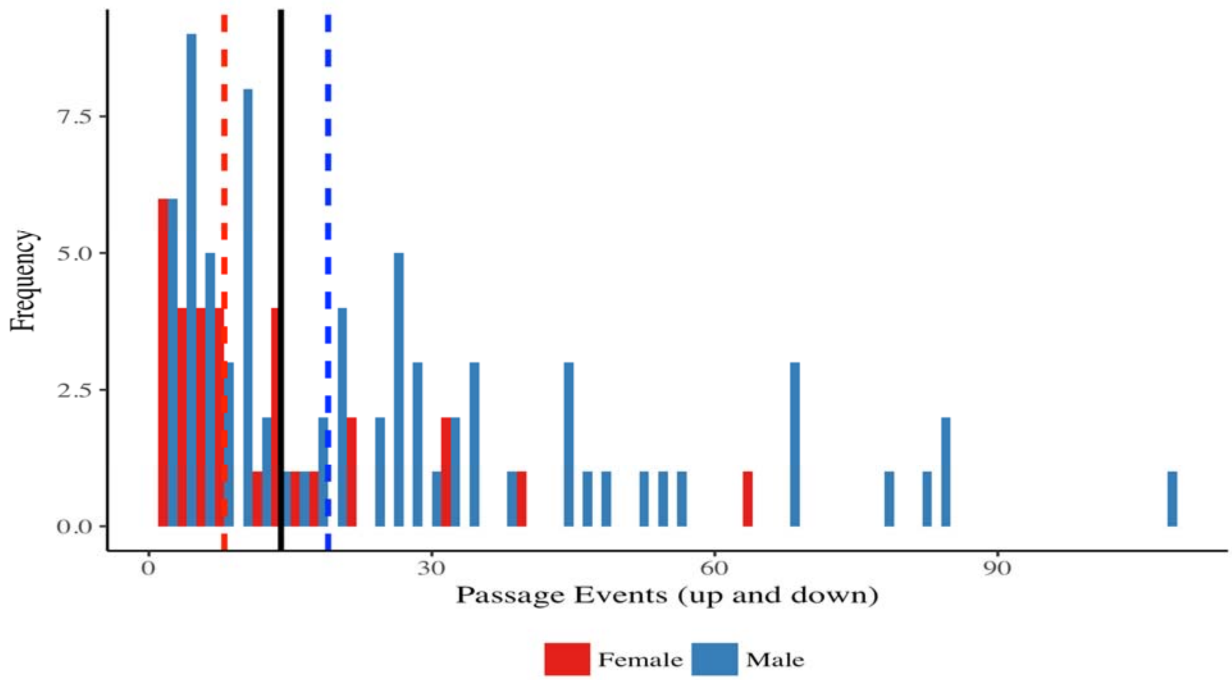

Figure 5.2-3. Number of passages per male and female Chinook salmon near the La Grange facilities in 2015/2016. The solid black line represents the median value of males and females combined. Dashed lines are female (red) and male (blue) medians, respectively.

5.2.3.2 Inference Method #1: All Individuals Combined

Based on a total of 11,239 passages at the tailrace weir for 2016/2017 and using the median number of passages per fish from 2015/2016, the total number of unique individuals present in 2016/2017 was approximately **802** (562–1,124 95 percent confidence interval [CI]) fish (Table 5.2-1). Assuming that the sex ratio was consistent between years, this would translate to roughly **241** females and **561** males. At the main channel weir, a total of 10,276 passages in 2016/2017 would equate to approximately **160** (95–734) individuals using the median number of passages per fish observed in 2015/2016.

5.2.3.3 Inference Method #2: Individuals Grouped by Sex

The above estimation method makes the assumption that males and females behave similarly with respect to how much they move and that the number of passages between males and females is similar. However, males and females from 2015/2016 did show a significant difference in number of passages (Figure 5.2-4). Males at the tailrace weir had a significantly greater number of passages than females ($P = 0.006$) based on a Student's t-test. The number of passage events was also more variable for males relative to females. The number of males and females at the main channel weir was too small for assessing sex specific differences.

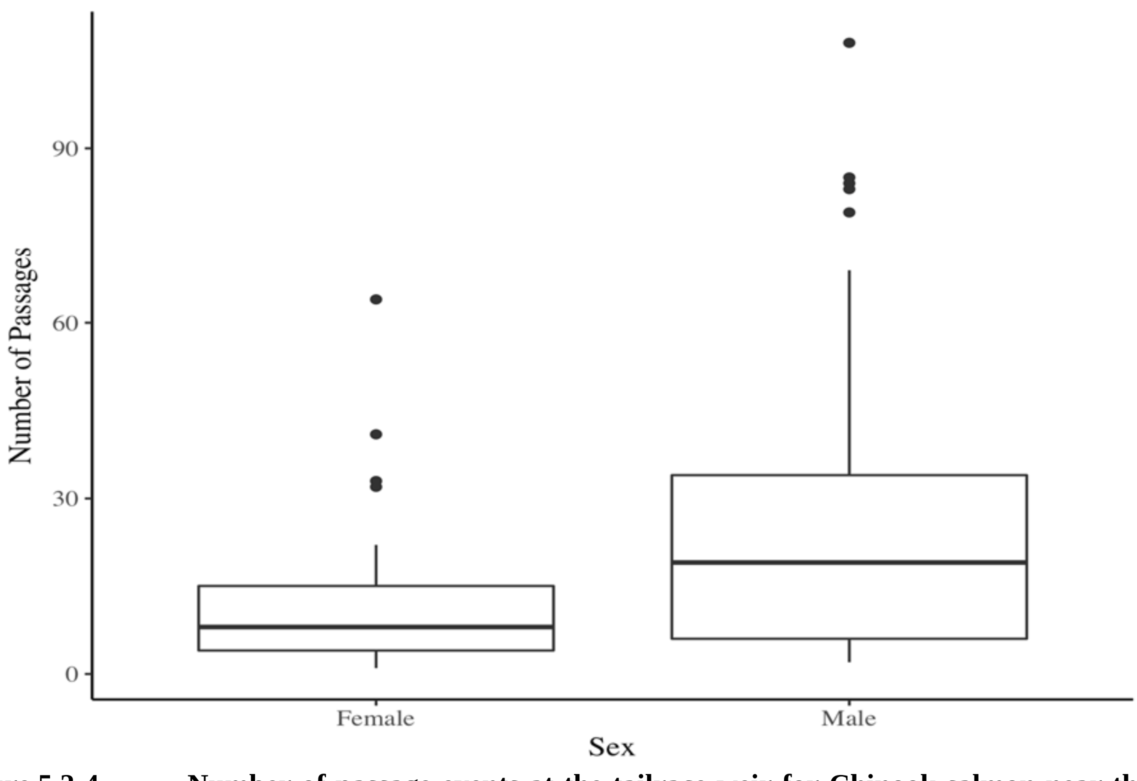

Figure 5.2-4. Number of passage events at the tailrace weir for Chinook salmon near the La Grange facilities during 2015/2016 monitoring

Since it appeared that sex could influence the number of passages per individual at the tailrace weir, an alternative method to estimating the number of individuals in 2016/2017 was to use different median number of passages at the tailrace weir for males and females. The median number of passages for females was eight (5–14 95 percent CI) and the median number of passages for males was 19 (10–26 95 percent CI) (Table 5.2-1). At the main channel weir, the median number of passages was 27 (0–218) for females and 81 (2–118) for males.

Table 5.2-1. Sex-specific values used to estimate the number of unique Chinook at the tailrace and main channel weirs in 2016/2017 from the number of passages.

Weir	Inference Method	Sex	Proportion of Passages	Number of Passages	Median	Estimate	95% CI
Tailrace	1	Male & Female	1.0	11,239	14.0	802.0	562 – 1,124
	2	Female	0.16	1,798.2	8.0	224.8	128 – 360
	2	Male	0.84	9,440.8	19.0	496.9	363 – 944
Main Channel	1	Male & Female	1.0	10,276	64.5	159.3	95 – 734
	2	Female	0.34	3,525	27.0	130.6	16 – Infinity
	2	Male	0.66	6,751	81.0	83.3	57 – 3,375

Because the percentage of sex-assigned passages at the tailrace weir was similar in 2015/2016 to 2016/2017 (69.7 percent and 74.8 percent, respectively), and the ratio of female to male passages of known sex was also similar (0.21 and 0.19, respectively), the total number of passages in 2016/2017 (11,239) were apportioned into males and females based on the proportion of each sex for the passage events where sex could be assigned (Table 5.2-1). Applying the sex-specific median number of passages to the total number of passages provided an estimate of approximately **225** (128–360 95 percent CI) females and **497** (363–944 95 percent CI) males for a total of **722** individual fall-run Chinook (491–1304 95 percent CI) present at the tailrace weir. Sex specific estimates for the main channel weir were **130** females (16–infinity 95 percent CI) and **83** males (57–3376 95 percent CI) for a total of approximately **213** individuals. The low number of individuals at the main channel weir in 2015/2016 resulted wider median confidence intervals that led to wider 95 percent confidence intervals of the estimates.

5.2.4 *O. mykiss* Near La Grange Facilities: 2015/2016 Monitoring Season

A total of 270 *O. mykiss* passage events (140 upstream, 130 downstream) were detected at the tailrace weir during the 2015/2016 monitoring period. No *O. mykiss* were detected at the main channel weir. Estimated lengths of *O. mykiss* observed ranged from 10 cm to 60 cm. Adult-sized *O. mykiss* (>30 cm) accounted for 141 of these passage events (68 upstream, 73 downstream) (Figure 5.2-5, Attachment A). Adult *O. mykiss* were first observed on October 6, 2015, and last observed on March 29, 2016 (Figure 5.2-6). The majority of adult *O. mykiss* detections occurred during the November through January period, accounting for 83.5 percent of the passage events. Unlike Chinook salmon, it was not possible to identify the total number of individual *O. mykiss* (<40 cm) as there was much less variability in fish length, sex, and general morphological characteristics.

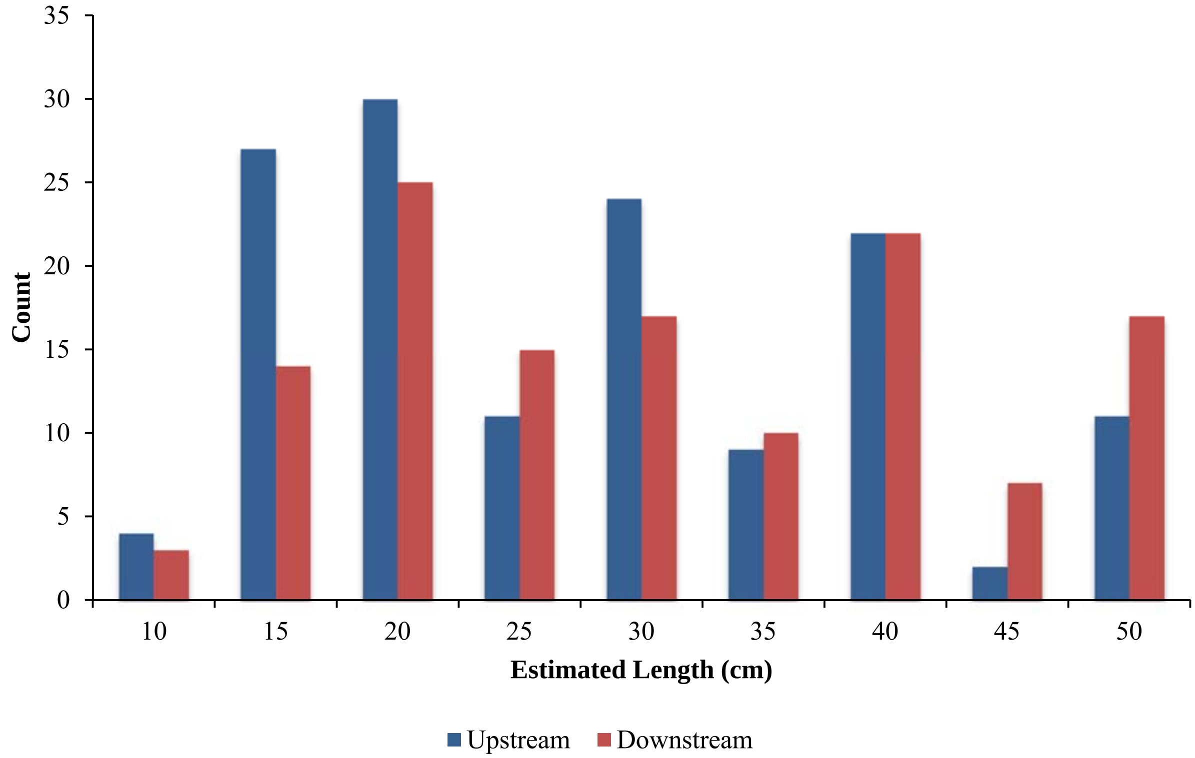

Figure 5.2-5. Length histogram of *O. mykiss* passage events at the tailrace channel weir during the 2015/2016 monitoring season.

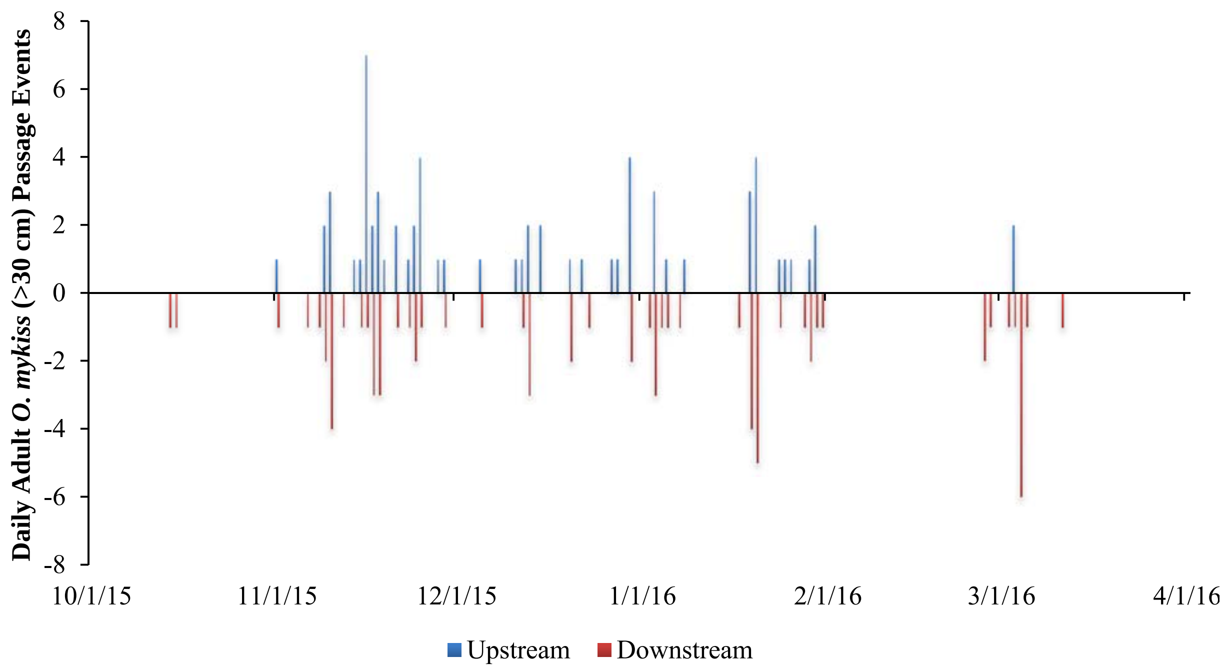

Figure 5.2-6. Daily adult *O. mykiss* (>30 cm) passage events at the tailrace channel weir during the 2015/2016 monitoring season.

Large *O. mykiss* (>40 cm) accounted for 81 passage events (35 upstream, 46 downstream) during the 2015/2016 monitoring season. Passages of large *O. mykiss* were reviewed to identify individuals based on time of subsequent passages, estimated length, and general morphological characteristics. It was determined that 11 individuals accounted for 74.1 percent of the large *O. mykiss* passage events. The remaining passages could not be identified as individuals due to poor image quality (often associated with low light conditions). Two observations of ad-clipped *O. mykiss* were made on February 19 and February 24. Based on estimated length (~50 cm) and general morphological characteristics, these two observations were likely of a single fish. The absence of an adipose fin represents a hatchery-origin fish.

5.2.5 *O. mykiss* Near La Grange Facilities: 2016/2017 Monitoring Season

A total of 919 *O. mykiss* passage events (437 upstream, 482 downstream) were detected at the tailrace weir during the 2016/2017 monitoring period. Estimated lengths of *O. mykiss* observed ranged from 10 cm to 50 cm (Figure 5.2-7). Adult-sized *O. mykiss* (>30 cm) accounted for 125 of these passage events (46 upstream, 79 downstream) (Figure 5.2-8, Attachment B). The first adult *O. mykiss* detection occurred on October 1, 2016, and the last passage event occurred on December 31, 2016. Sixty-two percent (n=78) of the adult *O. mykiss* passage events occurred in December. Unlike Chinook salmon, it was not possible to identify the total number of individual *O. mykiss* (<40 cm) as there was much less variability in fish length, sex, and general morphological characteristics.

Large *O. mykiss* (>40 cm) accounted for 51 passage events (19 upstream, 32 downstream) during the 2016/2017 monitoring season. Passages of large *O. mykiss* were reviewed to identify individuals based on time of subsequent passages, estimated length, and general morphological characteristics. It was determined that five individuals accounted for 60.8 percent of the large *O. mykiss* passage events. The remaining passages could not be identified as individuals due to poor image quality (often associated with low light conditions). Eight passage events (four upstream, four downstream) of ad-clipped *O. mykiss* were observed between December 24 and December 31. Based on estimated length (40-50 cm) and general morphological characteristics, these observations were likely of a single fish. The absence of an adipose fin represents a hatchery-origin fish.

A total of 831 *O. mykiss* passage events (344 upstream, 487 downstream) were detected at the main channel weir. Estimated lengths of *O. mykiss* observed ranged from 10 cm to 30 cm. Passage at the main channel weir was dominated by juvenile sized fish, with a single adult sized *O. mykiss* (30 cm) detected moving upstream, and subsequently downstream, on December 14, 2016.

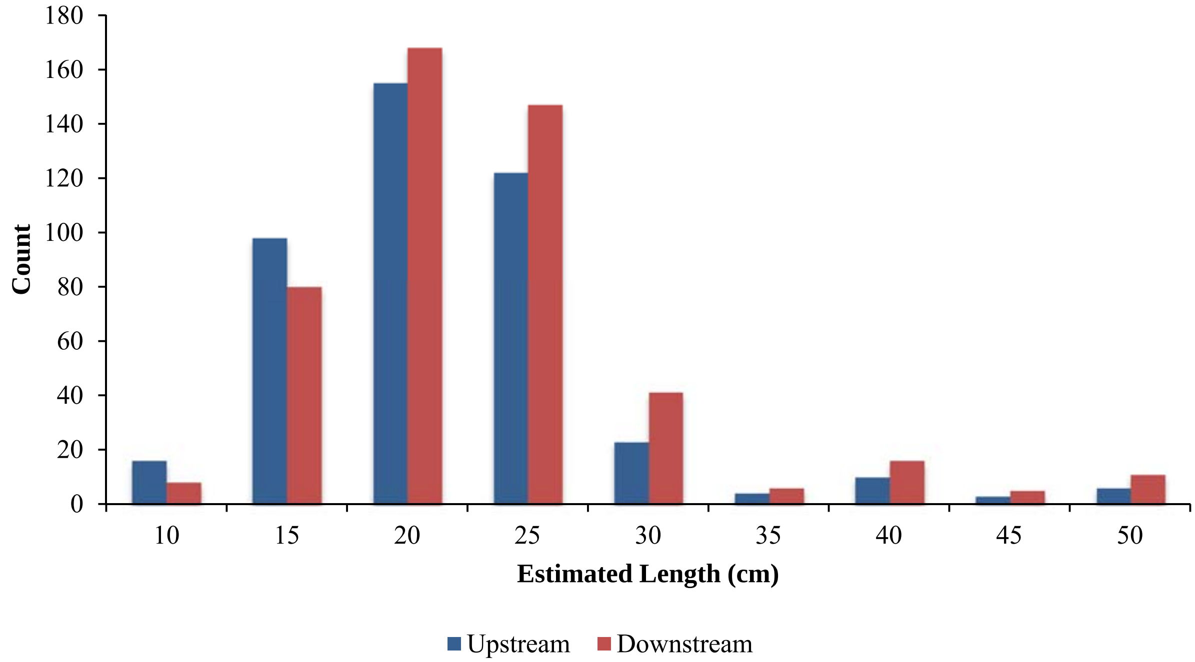

Figure 5.2-7. **Length histogram of *O. mykiss* passage events at the tailrace channel weir during the 2016/2017 monitoring season.**

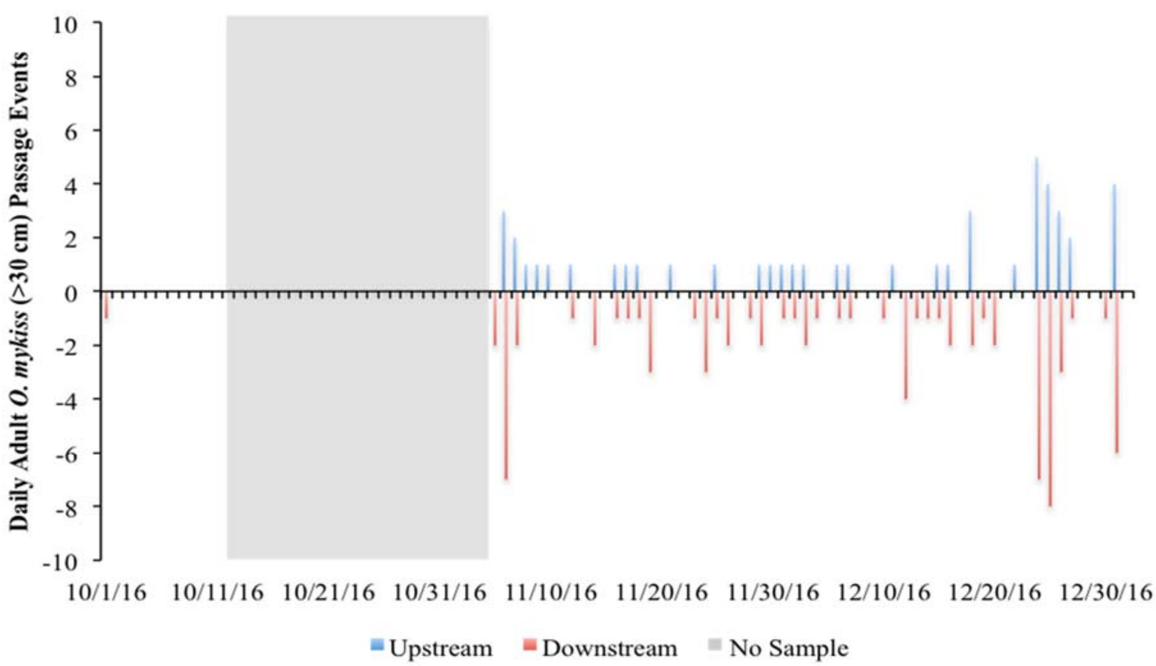

Figure 5.2-8. **Daily adult *O. mykiss* (>30 cm) passage events at the tailrace channel weir during the 2016/2017 monitoring season.**

5.2.6 Non-target Species near La Grange Facilities: 2015/2016 Monitoring Season

Non-target fish species observed near the La Grange facilities during the 2015/2016 monitoring period included bluegill (*Lepomis macrochirus*), carp (*Cyprinus carpio*), goldfish (*Carassius auratus*), largemouth bass (*Micropterus salmoides*), Sacramento pikeminnow (*Ptychocheilus grandis*), Sacramento sucker (*Catostomus occidentalis*), and striped bass (*Morone saxatilis*) (Table 5.2-2). Mammals observed included beaver (*Castor canadenis*) and river otter (*Lontra canadenis*).

Previous monitoring on the Tuolumne River has documented non-native centrachids (bluegill and largemouth bass) below RM 48.0, with striped bass observed upstream to RM 51.8 (Stillwater Sciences 2012). This study provided the first formal documentation of these three species directly below the La Grange powerhouse. On multiple occasions during the 2015/2016 monitoring period, attempted predation events by striped bass were observed within the tailrace weir passing chute.

Table 5.2-2. Non-target fish species observed passing the tailrace and main channel weirs during the 2015/2016 monitoring season.

Species	Location	Estimated Length Range (cm)	First Passage Date	Last Passage Date	Passage Events	
					# Up	# Down
Striped Bass	Tailrace	45-90	9/18/15	4/7/16	701	682
Carp/Goldfish	Tailrace	20-90	12/24/15	4/11/16	645	407
Sacramento Pikeminnow	Tailrace	15-90	9/23/15	4/15/16	277	267
	Main Channel	20-40	9/27/15	2/25/16	9	5
Bluegill/ Sunfish	Tailrace	5-20	9/21/15	2/21/16	67	13
	Main Channel	10-20	9/27/15	10/28/15	12	1
Sacramento Sucker	Tailrace	45-60	10/2/15	1/24/16	3	4
largemouth Bass	Tailrace	25-60	11/2/15	2/26/16	3	1
Unidentified Adult	Tailrace	30-90	10/2/15	4/13/16	212	102
	Main Channel	30-50	10/21/15	10/31/15	7	5
Unidentified Juvenile	Tailrace	10-25	9/22/15	3/25/16	57	36
	Main Channel	10-25	9/23/15	4/13/16	52	110

5.2.7 Non-target Species near La Grange Facilities: 2016/2017 Monitoring Season

Non-target fish species observed near the La Grange facilities during the 2016/2017 monitoring period included Sacramento pikeminnow, Sacramento sucker, striped bass; as well as black bass (*Micropterus* spp.), sculpin (*Cottus* spp.), and sunfish (*Lepomis* spp.) that could not be identified to genus (Table 5.2-3). Mammals observed included beaver and river otter.

Table 5.2-3. Non-target fish species observed passing the tailrace and main channel weirs during the 2015/2016 monitoring season.

Species	Location	Estimated Length Range (cm)	First Passage Date	Last Passage Date	Passage Events	
					# Up	# Down
Striped Bass	Tailrace	50-90	11/14/16	1/1/17	224	210
Sacramento Pikeminnow	Tailrace	15-80	9/23/16	12/31/16	75	61
	Main Channel	10-25	11/7/16	11/26/16	3	3
Sacramento Sucker	Tailrace	20-60	10/6/16	12/30/16	12	20
Sculpin	Main Channel	8-10	10/21/16	12/30/16	11	3
Black Bass	Tailrace	30	12/10/16	12/11/16	3	1
Sunfish	Tailrace	15	10/8/16		1	0
Unidentified Adult	Tailrace	30-70	10/6/16	1/1/17	30	44
	Main Channel	30-65	10/21/16	12/15/16	5	9
Unidentified Juvenile	Tailrace	10-25	9/23/16	12/26/16	151	171
	Main Channel	10-25	10/21/16	12/15/16	297	304

5.2.8 Passage at the Lower Tuolumne Weir: 2015/2016 Monitoring Season

Total escapement into the Tuolumne River was determined to be 421 adult fall-run Chinook salmon based on weir counts at RM 24.5 between September 28, 2015 and December 31, 2015 (Becker et al. 2016). An additional 14 Chinook salmon passages were recorded during the winter/spring period (January 1, 2016 to May 13, 2016). Overall, 7.6 percent of passages (n=33) occurred during October, 49.7 percent (n=216) during November, and 39.5 percent (n=172) during December (Figure 5.2-9). Sex was determined for nearly all passages and consisted of 50 percent (n=212) males and 49 percent (n=207) females. Ad-clips were observed in 23.9 percent (n=104) of the Chinook salmon passages at the lower Tuolumne weir.

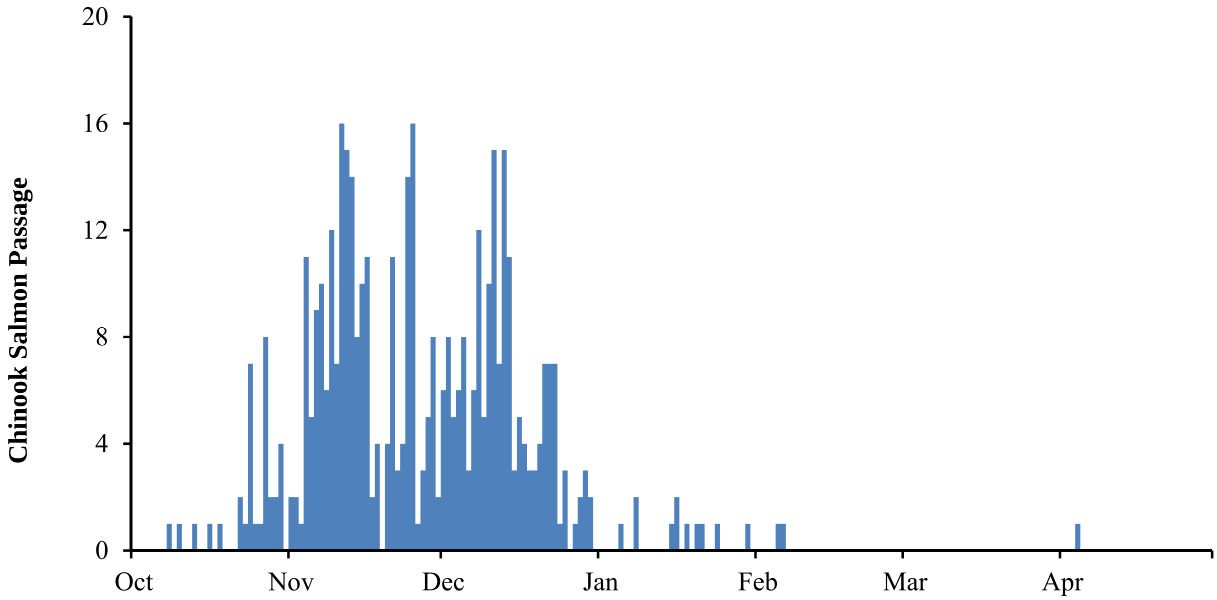

Figure 5.2-9. Count of daily upstream Chinook salmon passages at the Tuolumne River weir (RM 24.5) for the 2015/2016 monitoring season.

Three *O. mykiss* were recorded passing the weir during the 2015/2016 monitoring period (Table 5.2-4).

Table 5.2-4. Lower Tuolumne weir (RM 24.5) *O. mykiss* passage information for the 2015/2016 and 2016/2017 monitoring seasons.

Sample Date	Passage Time	Passage Direction	Estimated Length (cm)	Ad-Clip
1/27/16	14:37	Up	34	Unknown
1/29/16	13:53	Up	42	Yes
3/13/16	22:58	Up	40	No
12/19/16	21:55	Up	38	Yes

5.2.9 Passage at the Lower Tuolumne Weir: 2016/2017 Monitoring Season

Total escapement into the Tuolumne River was determined to be 3,555 adult fall-run Chinook salmon based on weir counts at RM 24.5 between September 19, 2016 and December 31, 2016 (Sonke 2017). The first salmon passage was detected on September 28, with a peak daily passage of 289 individual Chinook observed on October 28. Overall, 0.1 percent (n=2) of passages occurred during September, 55.8 percent (n=1983) occurred during October, 33.0 percent (n=1172) during November, and 11.2 percent (n=398) during December (Figure 5.2-10). Sex was determined for nearly all passages and consisted of 59 percent (n=2,109) male and 39 percent (n=1,383) female, and 62 fish could not be identified by gender. Ad-clips were observed in 24 percent (n=848) of the Chinook salmon passages at the lower Tuolumne weir; similar to the ratio of ad-clipped fish the prior year.

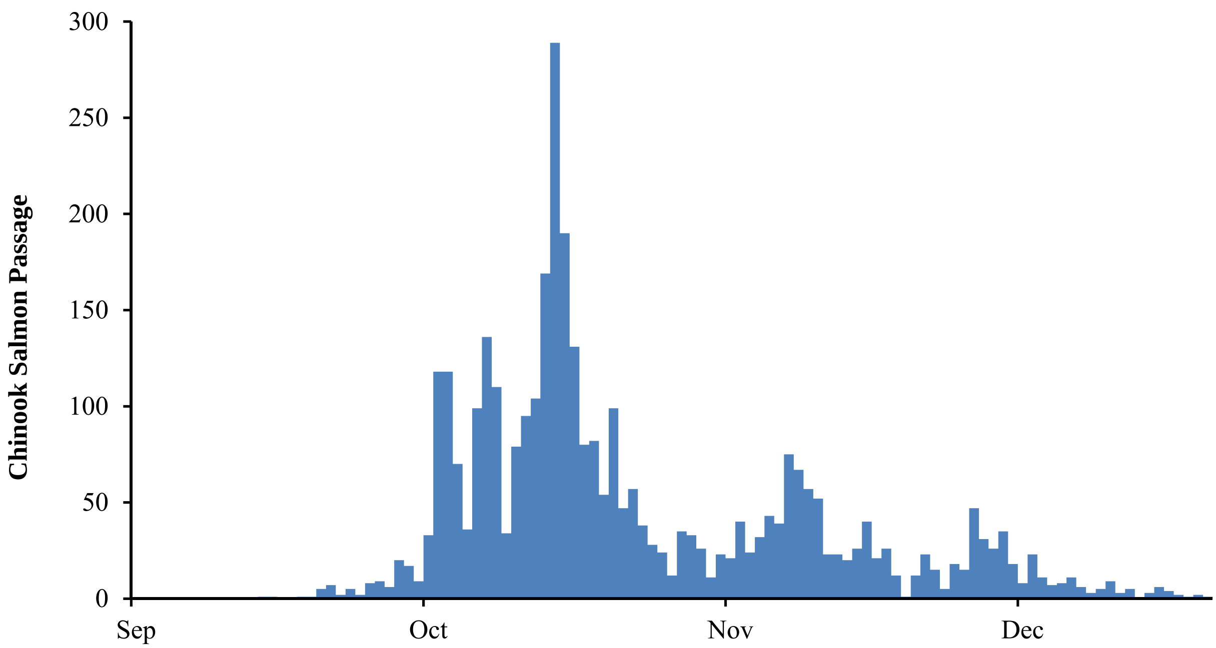

Figure 5.2-10. Count of daily upstream Chinook salmon passages at the Tuolumne River weir (RM 24.5) for the 2016/2017 monitoring season.

One *O. mykiss* was recorded passing the weir during the 2016/2017 monitoring period (Table 5.2-4).

5.3 Pre-spawn Mortality

5.3.1 2015/2016 Monitoring Season

Based on daily observations during the 2015/2016 monitoring season, there was no Chinook salmon or *O. mykiss* spawning activity upstream of the tailrace channel weir or the main channel weir. A single, unspawned Chinook salmon carcass was recovered in the sluice gate channel on December 25, 2015 (TID/MID 2017a). After evaluation for egg retention, this carcass was frozen and delivered to CDFW La Grange staff. CDFW escapement surveys conducted in the Tuolumne River did not document any pre-spawn or partial spawn Chinook salmon mortalities during the 2015 fall-run monitoring period (Gretchen Murphey, CDFW, pers. comm., January 2017)[5].

5.3.2 2016/2017 Monitoring Season

Based on daily observations during the 2016/2017 monitoring season, there was no Chinook salmon or *O. mykiss* spawning activity upstream of the tailrace channel weir. Two unspawned female Chinook salmon carcasses were recovered above the tailrace weir on November 19, 2016. After evaluation for egg retention, the heads were removed, the carcasses were frozen and then delivered to CDFW La Grange staff. Three additional Chinook salmon carcasses were also recovered in the sluicegate channel between November 24 and November 25, and were all determined to be fully spawned males (TID/MID 2017a).

Two active Chinook salmon redds were identified just upstream of the main channel weir between November 16 and November 22, 2016 (TID/MID 2017a). During this period, one unspawned female Chinook salmon carcass and two male carcasses that appeared to be fully spawned were recovered near the redd locations. CDFW escapement surveys conducted in the Tuolumne River did not document any pre-spawn or partial spawn Chinook salmon mortalities during the 2016 fall-run monitoring period (Gretchen Murphey, CDFW pers. comm., July 2017).

[5] In comments filed on the La Grange Hydroelectric Project Draft License Application (CDFW 2017), CDFW requested the following statement be added to the study results: “The report should also mention that CDFW only tagged 8 fish that year, which constitutes a very small sample size and as such, no definitive statements regarding pre-spawn mortality can be concluded based upon this data set.”

6.0 DISCUSSION AND FINDINGS

6.1 Chinook Salmon

Based on 2015/2016 weir counts, 117 adult Chinook salmon were observed at the La Grange counting weirs between September 23, 2015 and April 15, 2016. The proportion of the Chinook salmon escapement that was observed to be in the vicinity of the La Grange facilities was 26.9 percent (117/435). Of the individual salmon observed during the 2015/2016 monitoring season, most (85.5 percent) spent less than 10 days near the La Grange facilities, with 21.4 percent (n=25) spending less than 24 hours near the La Grange facilities (Figure 6.1-1). This is consistent with typical observations of a lag of one to two weeks between arrival on the spawning grounds and spawning as documented by comparison of weir counts and redd mapping conducted by the Districts (Becker et al. 2016; FISHBIO unpublished) and by live counts and redd counts reported by CDFW (O'Brien 2008).

During the 2016/2017 monitoring period it was estimated using statistical inference that 935-962 Chinook salmon were observed at the La Grange counting weirs between September 20, 2016 and January 2, 2017. During this same period, 3,555 salmon moved upstream of the lower weir site (RM 24.5). The estimated proportion of the Chinook salmon escapement that was in the vicinity of the La Grange facilities was 26.3-27.0 percent. This estimate is biased low, due to the period (October 12, 2016 to November 4, 2016) when high flows prevented weir operations during the fall-run migration period. There was no attempt to estimate passage during these periods that sampling was not conducted.

The goal of this study was to determine the total number of fish exhibiting persistent upstream migration (i.e., as defined in the RSP, fish that move upstream to the La Grange facilities and do not return to downstream spawning habitat) to estimate the extent to which the La Grange facilities are actually a barrier to upstream migration and subsequent spawning. During the 2015/2016 monitoring season, only a single salmon met the criterion of exhibiting persistent upstream migration, a female recovered in the sluice gate channel during an event when the powerhouse tripped offline. During the 2016/2017 monitoring period, three unspawned salmon carcasses were found upstream of the La Grange weirs. Based on passages at the two monitoring locations, less than one percent of the total fall-run escapement exhibited persistent upstream migration during the two years of monitoring as defined by the study criteria.

Considering that all but one (2015/2016) and three (2016/2017) of the Chinook salmon approaching the facilities moved downstream to spawn, the La Grange facilities were not found to be barriers to persistent upstream migration. Also, given the relatively low rates of pre-spawn mortality observed in the lower Tuolumne River[6] (CDFW 2014, Gretchen Murphey, CDFW, pers. comm.), it does not appear that the La Grange facilities affected Chinook salmon production during the 2015/2016 and 2016/2017 study periods.

[6] During the 2015 and 2016 escapement surveys, CDFW did not observe any evidence of pre-spawn or partial spawn activity.

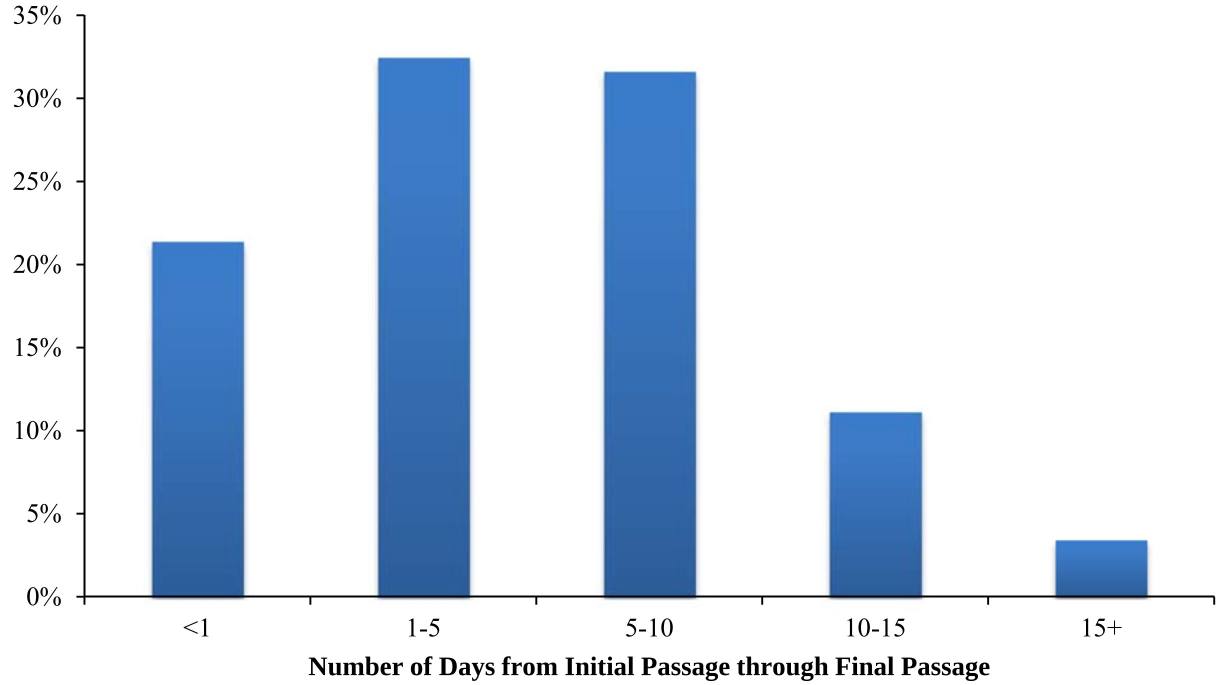

Figure 6.1-1. Proportional distribution of the number of days from initial weir passage through final passage for individual salmon at the tailrace and main channel weirs during the 2015/2016 monitoring season.

The Constant Fractional Marking Program (CFM) was initiated in 2007 as a means of effectively estimating hatchery production (Buttars 2013). Analysis of 2010-2012 recovered coded wire tags (Kormos et al. 2012; Palmer-Zwahlen and Kormos 2013, 2015) found that hatchery-origin Chinook salmon comprised 49 percent, 73 percent and 36 percent of the Tuolumne River fall-run spawning population, respectively. Overall, 28.5 percent (n=33) of Chinook salmon observed at the tailrace and main channel weirs were ad-clipped, signifying hatchery origin, during the 2015/2016 monitoring season.

Additionally, 23.9 percent of Chinook passing the lower Tuolumne weir (RM 24.5) were ad-clipped. CFM has not released analysis of coded wire tag data for 2015 or 2016; however, given that 25 percent of Central Valley fall-run Chinook salmon hatchery production is marked annually, and that there is no hatchery in the Tuolumne River, this suggests that nearly all Chinook salmon entering the lower Tuolumne River and in the vicinity of the La Grange facilities during the study period were hatchery strays. A review of California's anadromous fish hatchery programs found that off-site releases promote straying among populations (California HSRG 2012). As most salmon return at three years of age, the majority of adult salmon observed in the Tuolumne River during fall 2015 and 2016 were likely from brood years 2012 and 2013. During those brood years, 98-100% of juvenile Chinook salmon born at hatcheries on the Merced, Mokelumne, and Feather rivers were transported to off-site locations for release (Regional Mark Processing Center 2017).

Boggs et al. (2005) found that fallback percentages of adult Chinook were nearly three to 13 times greater for transported vs. non-transported Snake River Chinook. Similar patterns were also seen with transported vs. non-transported steelhead, suggesting that transportation of migrating juveniles disrupts the sequential imprinting for efficient homing to spawning tributaries. It is likely that the number of individual Chinook identified near the La Grange facilities during the study period was due to the high percentage of hatchery origin Chinook salmon strays in the Tuolumne River, as out-of basin strays would have no site fidelity to the Tuolumne River spawning reach.

Okland et al. (2001) identified three migration phases of Atlantic salmon migrating in a free-flowing river. The most common phase was "search", characterized as movements both upstream and downstream at or close to the position of spawning. Given the number of consecutive upstream and downstream passages by individual Chinook salmon at the tailrace and main channel weirs, it is possible that a similar "search" pattern was observed in the Tuolumne River.

6.2 *O. mykiss*

Due to the low number of upstream migrating *O. mykiss* observed at the downstream weir, the majority of adult (>30 cm) *O. mykiss* passage events detected at the La Grange weirs during the monitoring period, predominantly represent movement of "resident" *O. mykiss* rearing in and around the La Grange powerhouse tailrace. During the 2015/2016 and 2016/2017 monitoring periods 83.5 percent (n=90) and 62.4 percent (n=78) of the adult *O. mykiss* passage events occurred prior to the first *O. mykiss* detection at the lower weir site, respectively. Additionally, snorkel surveys (Stillwater Sciences 2010, 2012) have regularly identified adult *O. mykiss* (30-50 cm) in the upper reaches of the lower Tuolumne River.

Furthermore, Zimmerman et al. (2008) evaluated 147 otoliths from *O. mykiss* collected in the lower Tuolumne River and detected only a single fish expressing a steelhead migratory history and nine additional individuals with maternal steelhead origin. Review of the data indicates that size alone is not an effective indicator of anadromy, as 38 fish sampled were equal to or greater than 40 cm, with only 2.6 percent (one of 38 fish) expressing a steelhead migratory history. The majority of these larger *O. mykiss* (≥40 cm) were resident fish.

An objective of this study was to enumerate potential steelhead migrating upstream to the La Grange facilities. During the two years of study, four upstream migrating adult *O. mykiss*, were detected passing the lower Tuolumne River weir (RM 24.5). Two of the four *O. mykiss* were adipose fin-clipped indicating hatchery origin. These individuals passed on January 29, 2016 and December 19, 2016, respectively (Sonke 2017). Based on size, the adipose fin clip, and few observations of ad-clipped *O. mykiss* in the Tuolumne River (only five ad-clipped *O. mykiss* (>30 cm) observed in eight years), these two individuals are believed to account for multiple passages of adipose fin-clipped *O. mykiss* observed at the tailrace weir during each monitoring season.

Because it was not possible to identify individual, un-clipped *O. mykiss* at the tailrace and main channel weirs, it is not known whether either of the un-clipped *O. mykiss* observed at the lower Tuolumne River weir approached the La Grange facilities. Based on these observations, at least one out of three potential steelhead were observed in the vicinity of the La Grange facilities during the 2015/2016 monitoring period. The only potential steelhead observed during the 2016/2017 monitoring period was also observed in the vicinity of the La Grange facilities.

Positive identification of the remaining *O. mykiss* that could be potential steelhead approaching the La Grange facilities was not possible due to the presence of large "resident" *O. mykiss* residing in the tailrace channel. Due to the number of "resident" *O. mykiss* passages, it was not possible to calculate the persistent upstream migration of steelhead (i.e., as defined in the RSP, number of individual *O. mykiss* remaining upstream of the weir divided by the total count of *O. mykiss* observed passing the weir at RM 24.5). Given that no *O. mykiss* remained above the main channel or tailrace weirs and no *O. mykiss* carcasses were recovered to evaluate pre-spawn mortality (note unlike Chinook salmon, *O. mykiss* spawn multiple times), it is expected that all fish moved downstream to spawn and the La Grange facilities did not impact potential *O. mykiss* production.

7.0 STUDY VARIANCES AND MODIFICATIONS

This study was conducted consistent with the FERC-approved study plan. A single variance occurred, as the 2016/2017 monitoring period ended earlier than planned. The monitoring season was scheduled to continue through mid-April 2017; however, monitoring was suspended and all equipment removed from the river on January 2, 2017 due to the onset of flood control releases from Don Pedro Reservoir.

8.0 REFERENCES

Becker, C., J. Guignard, and A. Fuller. 2016. Fall Migration Monitoring at the Tuolumne River Weir 2015 Annual Report. Submitted to Turlock and Modesto Irrigation Districts. March 2016.

Boggs, C.T., M.L. Keefer, C.A. Peery, L.C. Stuehrenberg, and B.J. Burke. 2005. Fallback, Reascension and Adjusted Fishway Escapement for Adult Chinook Salmon and Steelhead at Columbia and Snake River Dams, 1996-2003. Idaho Cooperative Fish and Wildlife Research Unit. Technical Report 2005-6.

Buttars, B. 2013. Constant Fractional Marking/Tagging Program for Central Valley Fall Chinook Salmon, 2013 Marking Season. Pacific States Marine Fisheries Commission.

California Department of Fish and Wildlife (CDFW). 2014. Comments on La Grange Hydroelectric Project Federal Energy Regulatory Commission Project No. 14581 Tuolumne River [comments submitted on the TID/MID La Grange Hydroelectric Project Preliminary Study Plan (PSP)].

______. 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 Hatchery Scientific Review Group (California HSRG). 2012. California Hatchery Review Report. Prepared for the US Fish and Wildlife Service and Pacific States Marine Fisheries Commission. June 2012. 100 pgs.

Killiam, D. and M. Johnson. 2008. The 2007 Mill Creek video station steelhead and spring-run Chinook salmon counts. California Department of Fish and Game, SRSSAP Tech. Report No. 08-1.

Kormos, B.M., M. Palmer-Zwahlen, and A. Low. 2012. Recovery of coded-wire tags from Chinook salmon in California's Central Valley escapement and ocean harvest in 2010. Santa Rosa (CA): California Department of Fish and Game, Fisheries Branch Administrative Report 2012-02.

Murphey, G. 2017. Personal communication with Jason Guignard of FISHBIO. Environmental Scientist, CDFW. January 2017.

O'Brien, J. 2008. 2008 Tuolumne River Fall Chinook Salmon Escapement Survey (Draft). California Department of Fish and Game. La Grange, CA.

Okland, F., J. Erkinaro, K. Moen, E. Niemela, P. Fiske, R.S. McKinley, and E.B. Thorstad. 2001. Return migration of Atlantic Salmon in the Rifer Tana: Phases of Migratory Behaviour. Journal of Fish Biology 59: 862-874

Palmer-Zwahlen, M. and M. Kormos. 2013. Recovery of coded-wire tags from Chinook salmon in California's Central Valley escapement and ocean harvest in 2011. Santa Rosa (CA): California Department of Fish and Game, Fisheries Branch Administrative Report 2013-02.

______. 2015. Recovery of coded-wire tags from Chinook salmon in California's Central Valley Escapement, Inland Harvest, and Ocean Harvest in 2012. Santa Rosa (CA): California Department of Fish and Wildlife, Fisheries Branch Administrative Report 2015-4.

Regional Mark Processing Center. 2017. RMIS database accessible at http://www.rmpc.org

Sonke, C. 2017. Fall Migration Monitoring at the Tuolumne River Weir 2016 Annual Report. Submitted to Turlock and Modesto Irrigation Districts. March 2017.

Stillwater Sciences. 2010. March and August 2010 population size estimates of *Oncorhynchus mykiss* in the Lower Tuolumne River. Prepared for the Turlock Irrigation District and the Modesto Irrigation District by Stillwater Sciences, Berkeley, CA. November 2010.

______. 2012. September 2011 population size estimates of *Oncorhynchus mykiss* in the Lower Tuolumne River. Draft. Prepared by Stillwater Sciences, Berkeley, California for the Turlock Irrigation District and the Modesto Irrigation Districts, California. January 2012.

Turlock Irrigation District and Modesto Irrigation District (TID/MID). 2017a. Fish Presence and Stranding Assessment Technical Memorandum. Prepared by FISHBIO. September 2017.

______. 2017b. Flow Records for Five Discharge Structures at the La Grange Project Technical Memorandum. Prepared by HDR, Inc. September 2017.

Zimmerman, C.E., G.W. Edwards, and K. Perry. 2008. Maternal origin and migratory history of *Oncorhynchus mykiss* captured in rivers of the Central Valley, California. March 2008.

LA GRANGE PROJECT FISH BARRIER ASSESSMENT
FINAL REPORT

ATTACHMENT A

WEIR FISH PASSAGE DATA FOR
SEPTEMBER 23, 2015 THROUGH APRIL 14, 2016

Table A-1. Tailrace channel weir Chinook salmon passage information, 2015/2016 monitoring season.

Fish ID	Est. Length (cm)	Sex	Ad-Clip	Initial Passage	Final Passage	Passage Events	
						No. Up	No. Down
M1	60-75	Male	No	9/23/15 7:48	10/27/15 15:42	42	-42
F1	60-70	Female	No	10/21/15 22:08	10/29/15 9:33	15	-17
F3	50-70	Female	Yes	10/25/15 21:32	10/27/15 18:45	11	-11
F2	50-65	Female	No	10/25/15 22:10	10/29/15 16:30	4	-4
F1 or F2	60-70	Female	No	10/27/15 1:40	10/27/15 2:37	1	-2
F4	45-60	Female	No	10/27/15 10:40	10/28/15 10:58	2	-3
M2	60-80	Male	No	10/28/15 2:43	11/9/15 22:59	40	-42
F5	60-80	Female	Yes	10/28/15 7:34	11/2/15 18:35	11	-11
F6	60-80	Female	No	10/29/15 20:19	11/13/15 22:55	33	-31
F7	50-65	Female	No	11/1/15 0:40	11/3/15 17:31	3	-3
F8	70-80	Female	No	11/1/15 1:36	11/14/15 4:46	8	-6
M3	55-70	Male	No	11/2/15 2:21	11/11/15 14:31	15	-17
M4	60-80	Male	Yes	11/3/15 12:52	11/13/15 11:05	10	-10
F10	50-60	Female	No	11/8/15 3:46	11/9/15 0:00	2	-2
F9	60-70	Female	Yes	11/8/15 3:46	11/12/15 18:46	3	-4
M5	55-70	Male	No	11/8/15 5:06	11/9/15 15:29	16	-16
M6	70-80	Male	No	11/8/15 19:10	11/14/15 11:39	5	-5
F11	80	Female	No	11/8/15 19:36	11/8/15 22:42	1	-1
M7	80-100	Male	No	11/8/15 19:55	11/12/15 6:50	3	-3
M8	55-60	Male	No	11/9/15 12:53	11/15/15 17:20	2	-2
M9	60-80	Male	No	11/9/15 16:52	11/10/15 23:14	5	-5
M10	90-100	Male	Yes	11/10/15 7:53	11/14/15 4:05	3	-3
M11	50-70	Male	No	11/11/15 1:40	11/17/15 17:50	19	-19
M12	50-60	Male	No	11/11/15 3:19	11/21/15 8:52	26	-26
M13	80	Male	Yes	11/11/15 10:54	11/11/15 12:50	1	-1
F12	70-80	Female	Yes	11/12/15 18:17	11/17/15 1:41	4	-4
M14	70-85	Male	No	11/14/15 3:43	11/20/15 13:23	13	-13
F13	80	Female	No	11/14/15 6:32	11/15/15 0:15	2	-1
M15	60-70	Male	Yes	11/14/15 6:55	11/20/15 9:26	16	-17
M17	55-70	Male	No	11/14/15 8:18	11/20/15 1:16	17	-17
M16	60-70	Male	No	11/14/15 23:13	11/20/15 15:49	10	-11
F14	70-80	Female	No	11/15/15 2:10	11/19/15 21:54	6	-6
F15	60-70	Female	No	11/15/15 2:41	11/16/15 2:53	2	-2
M20	70-90	Male	No	11/15/15 6:23	11/28/15 9:01	28	-28
M18	70-75	Male	No	11/15/15 10:11	11/15/15 21:56	2	-2
M19	60-75	Male	No	11/15/15 11:19	11/23/15 8:17	24	-22
M21	50-60	Male	No	11/16/15 1:01	11/21/15 13:18	4	-4
F16	50-60	Female	No	11/16/15 13:55	11/26/15 23:33	8	-8
M23	50-70	Male	Yes	11/16/15 16:25	11/26/15 10:31	17	-14
M22	70-80	Male	Yes	11/16/15 19:19	11/20/15 22:22	5	-6
F17	60-70	Female	No	11/16/15 22:16	11/21/15 3:44	4	-4
M24	50-70	Male	No	11/18/15 6:22	11/26/15 16:41	14	-14
M25	50-60	Male	No	11/20/15 6:39	11/24/15 10:51	5	-5
M26	60-70	Male	Yes	11/22/15 23:47	11/26/15 14:55	4	-4
M27	60-80	Male	No	11/23/15 18:01	11/26/15 17:21	5	-5
M28	80	Male	No	11/24/15 2:54	11/30/15 14:14	9	-9
M29	120	Male	No	11/24/15 3:42	11/24/15 5:37	1	-1
M30	50-70	Male	No	11/24/15 8:14	11/30/15 20:01	27	-27

Fish ID	Est. Length (cm)	Sex	Ad-Clip	Initial Passage	Final Passage	Passage Events	
						No. Up	No. Down
M32	50-60	Male	No	11/26/15 15:45	11/29/15 19:41	5	-5
M31	70-85	Male	No	11/26/15 17:08	12/4/15 4:58	22	-22
F18	70-80	Female	Yes	11/26/15 20:39	11/27/15 6:05	3	-3
F19	60	Female	Yes	11/27/15 4:57	11/29/15 15:57	3	-3
M33	60-90	Male	No	11/27/15 6:12	12/7/15 22:45	54	-54
M34	60-80	Male	No	11/27/15 6:37	12/2/15 12:38	12	-12
F20	50-60	Female	Yes	11/27/15 12:58	11/29/15 14:04	4	-4
F21	70-80	Female	No	11/29/15 3:27	12/8/15 6:29	7	-7
M35	55-70	Male	Yes	11/29/15 14:04	12/13/15 16:42	10	-10
M36	60-70	Male	Yes	11/29/15 14:05	12/2/15 20:40	6	-6
F22	40-45	Female	No	11/30/15 20:23	11/30/15 21:07	2	-2
F23	60-75	Female	No	12/1/15 4:58	12/8/15 14:23	7	-7
M37	50-65	Male	No	12/1/15 7:11	12/6/15 15:32	23	-22
M38	55-70	Male	No	12/1/15 9:56	12/9/15 8:18	39	-41
M39	80-85	Male	Yes	12/1/15 14:34	12/8/15 12:26	8	-7
F24	60-70	Female	Yes	12/3/15 0:27	12/3/15 2:54	1	-1
M41	70-80	Male	No	12/3/15 4:58	12/7/15 7:03	13	-13
M42	55-65	Male	Yes	12/3/15 15:22	12/6/15 11:30	9	-9
M44	55-75	Male	No	12/4/15 2:04	12/21/15 13:46	42	-43
M43	90-100	Male	No	12/4/15 3:56	12/4/15 5:49	2	-2
M45	50-60	Male	No	12/5/15 8:09	12/12/15 11:55	8	-8
M46	60-65	Male	Yes	12/6/15 10:55	12/10/15 0:35	14	-14
M40	85-100	Male	Yes	12/8/15 13:46	12/10/15 1:16	12	-13
M47	50-60	Male	Yes	12/11/15 11:37	12/18/15 18:12	13	-14
F25	60-70	Female	Yes	12/11/15 16:26	12/12/15 12:41	7	-7
F26	50-70	Female	No	12/12/15 13:14	12/15/15 23:58	9	-9
M48	50-70	Male	No	12/12/15 13:47	12/22/15 19:56	35	-34
M49	50-70	Male	No	12/12/15 14:01	12/22/15 21:29	34	-34
M50	70-90	Male	Yes	12/13/15 9:26	12/18/15 2:39	5	-5
M51	60-90	Male	No	12/13/15 23:01	12/22/15 11:27	25	-24
M52	70-90	Male	No	12/14/15 14:14	12/19/15 14:57	13	-13
M53	50-70	Male	No	12/16/15 13:57	12/22/15 18:37	13	-13
M54	50-60	Male	No	12/18/15 8:56	12/22/15 18:37	34	-34
M55	60-70	Male	Yes	12/18/15 9:02	12/22/15 14:34	22	-22
M56	50-60	Male	No	12/22/15 11:11	12/22/15 15:05	3	-3
M57	50-60	Male	No	12/22/15 15:17	12/22/15 16:21	5	-5
M58	60	Male	No	12/22/15 15:47	12/22/15 20:37	4	-4
M59	70	Male	Yes	12/22/15 18:39	12/22/15 20:51	2	-2
M60	50-65	Male	Yes	12/22/15 18:45	12/24/15 22:09	14	14
M61	40-50	Male	No	12/23/15 8:01	12/24/15 15:24	2	2
M62	50-70	Male	No	12/24/15 17:08	1/4/16 16:51	10	-10
M63	50-70	Male	No	12/25/15 0:17	12/27/15 14:28	17	-17
F27	65	Female	No	12/25/15 4:01	--[1]	1	0
F28	70	Female	No	12/25/15 15:34	12/25/15 16:00	1	-1
F29	50-70	Female	No	12/28/15 5:06	1/3/16 8:14	16	-17
F30	70	Female	Yes	12/31/15 22:56	1/1/16 11:52	1	-1
M64	60-80	Male	No	1/7/16 0:54	1/15/16 17:05	6	-6
M65	50	Male	Yes	1/7/16 13:06	1/7/16 14:21	1	-1
M66	60-80	Male	No	1/19/16 21:45	1/25/16 11:36	3	-3
F31	60-70	Female	Yes	1/20/16 23:48	1/26/16 14:28	21	-20

Fish ID	Est. Length (cm)	Sex	Ad-Clip	Initial Passage	Final Passage	Passage Events	
						No. Up	No. Down
M67	50-60	Male	No	1/21/16 13:42	1/21/16 14:04	2	-2
M68	60-70	Male	No	1/22/16 4:20	1/22/16 5:36	1	-1
M69	60	Male	No	2/4/16 11:58	2/4/16 13:00	1	-1
M70	60-75	Male	No	2/8/16 3:31	2/9/16 8:08	3	-3
M71	50-55	Male	Yes	2/10/16 7:02	2/13/16 14:43	2	-2
M72	70	Male	No	2/13/16 5:06	2/13/16 11:40	2	-2
M73	50-70	Male	No	2/13/16 8:49	2/15/16 13:22	2	-2
M74	110	Male	No	2/14/16 15:27	2/14/16 16:15	1	-1
UNID	50-80	N/A	N/A	10/28/15 0:00	12/24/15 0:00	10	-25

N/A indicates data is not available.

[1] No downstream passage, unspawned Chinook carcass was recovered in the sluice gate channel on 12/25/15.

Table A-2. Main channel weir Chinook salmon passage information for the 2015/2016 monitoring season.

Fish ID	Est. Length (cm)	Sex	Ad-Clip	Initial Passage	Final Passage	Passage Events	
						No. Up	No. Down
MC-F1	60-70	Female	No	11/3/15 19:27	11/14/15 20:37	20	-20
MC-M1	55-70	Male	No	11/10/15 9:55	11/16/15 13:08	26	-27
MC-F2	55-70	Female	Yes	11/13/15 18:47	11/16/15 12:52	7	-7
MC-M2	50-70	Male	No	11/14/15 20:36	11/20/15 12:21	71	-73
MC-F3	50-70	Female	No	11/15/15 1:51	11/21/15 17:53	107	-111
MC-F4	55-70	Female	No	11/15/15 12:29	11/18/15 7:36	5	-5
MC-M3	50-70	Male	No	11/15/15 12:34	11/23/15 23:37	31	-32
MC-M4	60-70	Male	No	11/16/15 23:05	11/18/15 13:46	33	-33
MC-M5	60-70	Male	No	11/24/15 3:07	12/14/15 14:24	48	-48
MC-M6	60	Male	Yes	11/27/15 19:32	11/28/15 0:22	1	-1
MC-M7	60	Male	No	11/28/15 19:39	12/12/15 16:56	54	-54
MC-M8	60	Male	No	12/11/15 8:24	12/23/15 14:15	58	-60
UNID	N/A	N/A	N/A	11/8/15 0:00	11/15/15 0:00	1	-2

N/A indicates data is not available.

Table A-3. Tailrace channel weir adult (>30 cm) *O. mykiss* passage information, 2015/2016 monitoring season.

Date	Time	Species[1]	Est. Length (cm)	Sex	Ad-Clip	Passage Direction	Observational Certainty
10/6/15	14:07:18	RBT	40	Unknown	No	Down	Low
10/7/15	12:44:46	RBT	50	Female	No	Down	High
10/24/15	9:13:51	RBT	30	Unknown	No	Up	Medium
10/24/15	16:22:49	RBT	30	Unknown	No	Down	High
10/29/15	14:47:06	RBT	40	Unknown	No	Down	High
10/31/15	18:54:05	RBT	35	Unknown	Unknown	Down	Medium
11/1/15	1:04:53	RBT	40	Unknown	Unknown	Up	Low
11/1/15	1:13:48	RBT	40	Unknown	Unknown	Down	Low
11/1/15	1:15:32	RBT	30	Unknown	No	Up	Medium
11/1/15	19:32:12	RBT	30	Unknown	Unknown	Down	Low
11/2/15	6:16:13	RBT	30	Unknown	Unknown	Up	Medium
11/2/15	6:19:11	RBT	30	Unknown	Unknown	Up	Low
11/2/15	6:21:39	RBT	30	Unknown	Unknown	Up	Low
11/2/15	17:10:56	RBT	30	Unknown	Unknown	Down	Low
11/2/15	17:32:49	RBT	30	Unknown	Unknown	Down	Medium

Date	Time	Species[1]	Est. Length (cm)	Sex	Ad-Clip	Passage Direction	Observational Certainty
11/2/15	17:50:32	RBT	30	Unknown	Unknown	Down	Low
11/2/15	17:57:41	RBT	30	Unknown	Unknown	Down	Low
11/4/15	17:57:27	RBT	30	Unknown	Unknown	Down	Low
11/6/15	5:03:48	RBT	30	Unknown	No	Up	Low
11/7/15	4:41:53	RBT	30	Unknown	Unknown	Up	Medium
11/7/15	23:01:36	RBT	40	Unknown	No	Down	Low
11/8/15	5:31:46	RBT	35	Unknown	Unknown	Up	Low
11/8/15	5:54:08	RBT	30	Unknown	Unknown	Up	Low
11/8/15	5:54:20	RBT	30	Unknown	Unknown	Up	Medium
11/8/15	5:57:06	RBT	45	Unknown	No	Up	Low
11/8/15	6:00:52	RBT	45	Female	No	Down	High
11/8/15	12:45:53	RBT	40	Male	No	Up	High
11/8/15	15:43:03	RBT	35	Unknown	No	Up	High
11/8/15	17:43:48	RBT	30	Unknown	Unknown	Up	Medium
11/9/15	6:05:02	RBT	30	Unknown	Unknown	Up	Medium
11/9/15	8:08:40	RBT	35	Unknown	Unknown	Up	High
11/9/15	16:36:11	RBT	35	Unknown	Unknown	Down	Low
11/9/15	17:28:47	RBT	35	Unknown	Unknown	Down	Low
11/9/15	17:44:54	RBT	45	Unknown	Unknown	Down	Low
11/10/15	3:38:39	RBT	35	Unknown	Unknown	Down	Low
11/10/15	6:00:39	RBT	35	Unknown	Unknown	Up	Medium
11/10/15	6:13:15	RBT	30	Unknown	Unknown	Up	Medium
11/10/15	6:25:23	RBT	35	Unknown	No	Up	High
11/10/15	17:02:33	RBT	30	Unknown	Unknown	Down	Low
11/10/15	17:24:21	RBT	35	Unknown	Unknown	Down	Low
11/11/15	12:47:08	RBT	50	Unknown	No	Up	High
11/13/15	5:58:26	RBT	30	Unknown	Unknown	Up	Low
11/13/15	18:10:44	RBT	45	Female	No	Down	High
11/13/15	20:20:44	RBT	45	Unknown	Unknown	Up	Low
11/15/15	5:04:14	RBT	30	Unknown	Unknown	Up	Low
11/15/15	16:31:57	RBT	45	Unknown	No	Down	Medium
11/16/15	3:32:12	RBT	30	Unknown	Unknown	Up	Medium
11/16/15	18:20:39	RBT	30	Unknown	Unknown	Down	Medium
11/16/15	18:34:50	RBT	40	Unknown	No	Up	Low
11/16/15	18:44:09	RBT	40	Unknown	No	Down	Medium
11/17/15	2:53:10	RBT	35	Unknown	Unknown	Up	Low
11/17/15	3:47:44	RBT	30	Unknown	Unknown	Up	Medium
11/17/15	3:48:04	RBT	30	Unknown	Unknown	Up	Low
11/17/15	8:40:17	RBT	30	Unknown	No	Up	Medium
11/17/15	17:40:03	RBT	35	Unknown	Unknown	Down	Low
11/20/15	16:29:04	RBT	40	Unknown	No	Up	High
11/21/15	6:02:55	RBT	30	Unknown	Unknown	Up	Medium
11/21/15	12:50:41	RBT	30	Unknown	No	Down	High
11/27/15	21:50:14	RBT	50	Unknown	Unknown	Down	Low
11/27/15	21:53:31	RBT	50	Unknown	Unknown	Up	Low
12/3/15	4:56:02	RBT	30	Unknown	Unknown	Up	Low
12/4/15	12:33:12	RBT	40	Unknown	No	Up	High
12/4/15	13:03:31	RBT	50	Unknown	Unknown	Down	High
12/5/15	14:19:10	RBT	40	Unknown	No	Up	High
12/5/15	14:44:44	RBT	40	Unknown	No	Down	High
12/5/15	16:30:09	RBT	30	Unknown	Unknown	Down	Medium

Date	Time	Species[1]	Est. Length (cm)	Sex	Ad-Clip	Passage Direction	Observational Certainty
12/5/15	16:32:38	RBT	30	Unknown	Unknown	Up	Low
12/5/15	16:35:35	RBT	30	Unknown	Unknown	Down	Low
12/7/15	6:46:12	RBT	40	Unknown	Unknown	Up	Medium
12/7/15	20:54:18	RBT	30	Unknown	Unknown	Up	Low
12/12/15	7:55:11	RBT	35	Unknown	No	Down	Medium
12/12/15	8:29:54	RBT	35	Unknown	No	Up	High
12/12/15	16:15:11	RBT	50	Unknown	No	Down	High
12/14/15	8:14:53	RBT	40	Unknown	No	Up	High
12/15/15	5:35:02	RBT	40	Unknown	Unknown	Down	Low
12/19/15	3:27:58	RBT	40	Unknown	No	Up	Medium
12/20/15	23:55:30	RBT	40	Unknown	Unknown	Up	Low
12/22/15	15:07:28	RBT	35	Unknown	No	Up	High
12/22/15	16:19:00	RBT	40	Unknown	No	Up	Low
12/22/15	20:14:11	RBT	40	Unknown	No	Down	Low
12/22/15	20:17:51	RBT	40	Unknown	Unknown	Up	Low
12/22/15	20:34:54	RBT	40	Unknown	Unknown	Down	Low
12/22/15	20:42:49	RBT	40	Unknown	No	Up	Low
12/25/15	19:52:36	RBT	40	Unknown	No	Down	High
12/26/15	0:40:46	RBT	45	Unknown	No	Down	Medium
12/26/15	2:09:00	RBT	50	Unknown	Unknown	Down	Low
12/26/15	2:10:20	RBT	50	Unknown	Unknown	Up	Low
12/26/15	2:10:23	RBT	50	Unknown	Unknown	Up	Low
12/26/15	2:16:48	RBT	50	Unknown	Unknown	Down	Low
12/26/15	6:57:40	RBT	50	Unknown	Unknown	Up	Low
12/27/15	18:50:55	RBT	50	Female	Unknown	Down	Medium
12/28/15	4:33:55	RBT	40	Unknown	Unknown	Up	Low
12/28/15	13:45:04	RBT	50	Unknown	No	Down	Low
12/30/15	15:48:23	RBT	50	Unknown	No	Down	Medium
12/31/15	1:52:41	RBT	50	Unknown	No	Up	Medium
1/9/16	14:05:35	RBT	50	Unknown	No	Down	Low
1/11/16	8:09:57	RBT	40	Male	No	Down	Low
1/11/16	8:09:57	RBT	40	Female	No	Down	High
1/11/16	10:55:26	RBT	40	Male	No	Up	High
1/11/16	14:33:09	RBT	50	Unknown	No	Down	Medium
1/11/16	14:33:09	RBT	40	Unknown	No	Down	Low
1/11/16	14:57:14	RBT	50	Unknown	No	Up	Low
1/11/16	14:57:14	RBT	40	Unknown	No	Up	Low
1/12/16	7:55:07	RBT	40	Unknown	No	Down	Low
1/12/16	7:55:07	RBT	50	Female	No	Down	Medium
1/12/16	8:38:36	RBT	40	Unknown	No	Up	Medium
1/12/16	8:38:36	RBT	50	Female	No	Up	High
1/12/16	9:13:40	RBT	40	Male	No	Down	High
1/12/16	9:13:40	RBT	50	Female	No	Down	High
1/12/16	9:45:14	RBT	30	Unknown	No	Up	High
1/12/16	10:49:48	RBT	40	Male	No	Up	Medium
1/12/16	13:47:34	RBT	50	Unknown	No	Down	Low
1/16/16	13:33:48	RBT	50	Female	No	Up	High
1/16/16	23:43:53	RBT	50	Unknown	Unknown	Down	Low
1/17/16	13:51:33	RBT	40	Unknown	No	Up	Medium
1/18/16	9:29:22	RBT	30	Unknown	No	Up	High
1/20/16	12:38:53	RBT	45	Unknown	No	Down	Medium

Date	Time	Species[1]	Est. Length (cm)	Sex	Ad-Clip	Passage Direction	Observational Certainty
1/21/16	10:49:13	RBT	40	Unknown	No	Down	Medium
1/21/16	15:48:45	RBT	40	Unknown	No	Up	High
1/21/16	16:12:57	RBT	40	Unknown	No	Down	High
1/22/16	2:49:45	RBT	40	Unknown	Unknown	Up	Medium
1/22/16	11:30:58	RBT	40	Female	No	Down	High
1/22/16	23:15:09	RBT	40	Unknown	Unknown	Up	Low
1/23/16	15:58:34	RBT	45	Unknown	No	Down	High
2/19/16	3:43:06	RBT	50	Unknown	Yes	Down	Medium
2/19/16	21:09:23	RBT	40	Female	No	Down	High
2/20/16	7:14:15	RBT	35	Unknown	No	Down	High
2/23/16	20:38:12	RBT	40	Unknown	No	Down	High
2/24/16	6:36:55	RBT	30	Unknown	No	Down	Medium
2/24/16	22:09:59	RBT	35	Unknown	Unknown	Up	Medium
2/24/16	23:37:38	RBT	50	Unknown	Yes	Up	Medium
2/25/16	0:03:40	RBT	35	Unknown	Unknown	Down	High
2/25/16	0:03:40	RBT	40	Unknown	Unknown	Down	High
2/25/16	0:20:42	RBT	30	Unknown	Yes	Down	Medium
2/25/16	5:17:24	RBT	30	Unknown	No	Down	Medium
2/25/16	6:27:40	RBT	40	Unknown	Unknown	Down	Medium
2/25/16	6:27:40	RBT	30	Unknown	Unknown	Down	Medium
2/26/16	17:36:09	RBT	35	Unknown	No	Down	High
3/3/16	9:21:08	RBT	30	Unknown	No	Down	Medium
3/29/16	10:00:10	RBT	50	Unknown	Unknown	Up	Medium
3/29/16	10:15:21	RBT	50	Unknown	Unknown	Down	Medium

[1] RBT = Rainbow trout.

LA GRANGE PROJECT FISH BARRIER ASSESSMENT
FINAL REPORT

ATTACHMENT B

WEIR FISH PASSAGE DATA FOR
SEPTEMBER 20, 2016 THROUGH JANUARY 1, 2017

Table B-1. Tailrace channel weir Chinook salmon passage information, 2016/2017 monitoring season.

Data available upon request.

Table B-2. Main channel weir Chinook salmon passage information for the 2016/2017 monitoring season.

Data available upon request.

Table B-3. Tailrace channel weir adult (>30 cm) *O. mykiss* passage information, 2015/2016 monitoring season.

Date	Time	Species[1]	Est. Length (cm)	Sex	Ad-Clip	Passage Direction	Observational Certainty
10/1/16	19:23:46	RBT	30	Unknown	Unknown	Down	Low
11/5/16	1:27:10	RBT	40	Unknown	Unknown	Down	Low
11/5/16	23:07:25	RBT	35	Unknown	Unknown	Down	Low
11/6/16	1:32:26	RBT	40	Unknown	Unknown	Down	Low
11/6/16	17:06:03	RBT	30	Unknown	Unknown	Down	Low
11/6/16	17:22:04	RBT	30	Unknown	Unknown	Down	Medium
11/6/16	18:10:27	RBT	35	Unknown	Unknown	Down	Low
11/6/16	21:01:58	RBT	30	Unknown	Unknown	Down	Low
11/6/16	21:02:31	RBT	30	Unknown	Unknown	Up	Low
11/6/16	21:26:50	RBT	30	Unknown	Unknown	Down	Low
11/6/16	21:26:57	RBT	30	Unknown	Unknown	Up	Low
11/6/16	21:58:10	RBT	30	Unknown	Unknown	Down	Low
11/6/16	23:34:06	RBT	40	Unknown	Unknown	Up	Low
11/7/16	3:32:58	RBT	30	Unknown	Unknown	Down	Low
11/7/16	6:13:01	RBT	30	Unknown	Unknown	Up	Low
11/7/16	14:33:41	RBT	45	Unknown	No	Up	Medium
11/7/16	16:29:56	RBT	30	Unknown	Unknown	Down	High
11/8/16	2:28:45	RBT	30	Unknown	Unknown	Up	Low
11/9/16	0:31:44	RBT	50	Unknown	Unknown	Up	Low
11/10/16	16:50:29	RBT	30	Unknown	Unknown	Up	Medium
11/12/16	17:26:19	RBT	30	Unknown	Unknown	Down	Low
11/12/16	22:11:40	RBT	35	Unknown	Unknown	Up	Medium
11/14/16	17:29:07	RBT	30	Unknown	Unknown	Down	Low
11/14/16	17:52:14	RBT	30	Unknown	Unknown	Down	Low
11/16/16	6:23:06	RBT	30	Unknown	Unknown	Up	Low
11/16/16	17:23:00	RBT	30	Unknown	Unknown	Down	Low
11/17/16	16:02:24	RBT	30	Unknown	Unknown	Up	High
11/17/16	17:13:53	RBT	30	Unknown	Unknown	Down	Medium
11/18/16	15:14:11	RBT	30	Unknown	Unknown	Up	High
11/18/16	20:46:56	RBT	30	Unknown	Unknown	Down	Low
11/19/16	15:06:05	RBT	30	Unknown	Unknown	Down	High
11/19/16	17:01:53	RBT	30	Unknown	Unknown	Down	Low
11/19/16	21:53:13	RBT	30	Unknown	Unknown	Down	Low
11/21/16	6:12:46	RBT	30	Unknown	Unknown	Up	Low
11/23/16	15:28:52	RBT	30	Unknown	Unknown	Down	Low
11/24/16	17:25:59	RBT	30	Unknown	Unknown	Down	Low
11/24/16	17:29:06	RBT	30	Unknown	Unknown	Down	Low
11/24/16	17:43:34	RBT	30	Unknown	Unknown	Down	Low
11/25/16	17:42:34	RBT	30	Unknown	Unknown	Down	Low
11/25/16	23:12:57	RBT	30	Unknown	Unknown	Up	Low

Date	Time	Species[1]	Est. Length (cm)	Sex	Ad-Clip	Passage Direction	Observational Certainty
11/26/16	16:30:44	RBT	30	Unknown	Unknown	Down	Low
11/26/16	17:03:23	RBT	40	Unknown	Unknown	Down	Low
11/28/16	17:32:04	RBT	30	Unknown	Unknown	Down	Low
11/29/16	9:32:14	RBT	30	Unknown	No	Up	High
11/29/16	16:06:32	RBT	30	Unknown	No	Down	High
11/29/16	17:33:43	RBT	30	Unknown	Unknown	Down	Low
11/30/16	8:24:29	RBT	30	Unknown	No	Up	High
12/1/16	7:51:28	RBT	30	Unknown	No	Up	High
12/1/16	16:50:40	RBT	40	Unknown	Unknown	Down	Low
12/2/16	8:35:26	RBT	35	Unknown	No	Up	High
12/2/16	15:10:19	RBT	40	Unknown	No	Down	High
12/3/16	6:33:21	RBT	30	Unknown	Unknown	Up	Low
12/3/16	14:44:22	RBT	30	Unknown	No	Down	High
12/3/16	17:00:28	RBT	30	Unknown	Unknown	Down	Low
12/4/16	14:08:42	RBT	30	Unknown	No	Down	High
12/6/16	6:31:00	RBT	30	Unknown	Unknown	Up	Low
12/6/16	15:25:18	RBT	35	Unknown	No	Down	High
12/7/16	8:56:22	RBT	35	Unknown	No	Up	High
12/7/16	14:56:18	RBT	35	Unknown	No	Down	High
12/10/16	15:18:40	RBT	30	Unknown	No	Down	High
12/11/16	8:14:45	RBT	40	Unknown	Unknown	Up	High
12/12/16	0:55:53	RBT	35	Unknown	Unknown	Down	Medium
12/12/16	3:33:12	RBT	30	Unknown	Unknown	Down	High
12/12/16	7:12:03	RBT	40	Unknown	Unknown	Down	Medium
12/12/16	9:05:41	RBT	30	Unknown	No	Down	High
12/13/16	16:42:06	RBT	30	Unknown	No	Down	Low
12/14/16	16:41:43	RBT	35	Unknown	Unknown	Down	Low
12/15/16	6:56:46	RBT	30	Unknown	Unknown	Up	Medium
12/15/16	15:53:52	RBT	30	Unknown	Unknown	Down	Medium
12/16/16	16:59:16	RBT	30	Unknown	Unknown	Down	Medium
12/16/16	17:00:53	RBT	30	Unknown	Unknown	Down	Medium
12/16/16	20:49:43	RBT	40	Unknown	Unknown	Up	Medium
12/18/16	2:23:40	RBT	30	Unknown	Unknown	Up	Medium
12/18/16	8:00:16	RBT	30	Unknown	No	Up	High
12/18/16	15:29:28	RBT	30	Unknown	No	Up	High
12/18/16	15:56:54	RBT	30	Unknown	No	Down	High
12/18/16	18:57:02	RBT	40	Unknown	Unknown	Down	High
12/19/16	7:41:15	RBT	30	Unknown	Unknown	Down	High
12/20/16	13:38:05	RBT	30	Unknown	No	Down	Medium
12/20/16	16:05:08	RBT	30	Unknown	No	Down	Medium
12/22/16	22:44:56	RBT	30	Unknown	No	Up	Medium
12/24/16	1:26:15	RBT	45	Unknown	Unknown	Down	Low
12/24/16	1:32:27	RBT	50	Unknown	Unknown	Up	Low
12/24/16	1:34:18	RBT	50	Unknown	Yes	Down	Low
12/24/16	1:49:55	RBT	50	Unknown	Yes	Up	Medium
12/24/16	1:51:38	RBT	40	Unknown	No	Down	Medium
12/24/16	3:50:01	RBT	50	Unknown	Unknown	Down	Low
12/24/16	11:17:51	RBT	45	Male	No	Up	High
12/24/16	20:33:16	RBT	50	Unknown	No	Down	Low
12/24/16	20:49:49	RBT	50	Unknown	Unknown	Down	Low
12/24/16	21:16:50	RBT	45	Unknown	Yes	Down	High

Date	Time	Species[1]	Est. Length (cm)	Sex	Ad-Clip	Passage Direction	Observational Certainty
12/24/16	23:29:14	RBT	40	Unknown	Yes	Up	High
12/24/16	23:53:58	RBT	40	Unknown	Unknown	Up	Low
12/25/16	2:21:27	RBT	40	Unknown	Unknown	Up	Low
12/25/16	2:21:52	RBT	50	Unknown	No	Down	Medium
12/25/16	2:21:55	RBT	50	Unknown	Unknown	Down	Medium
12/25/16	2:23:53	RBT	50	Unknown	No	Up	Medium
12/25/16	12:23:28	RBT	30	Unknown	No	Up	High
12/25/16	13:42:00	RBT	40	Unknown	No	Down	Medium
12/25/16	13:42:47	RBT	40	Unknown	No	Up	Medium
12/25/16	14:48:27	RBT	40	Unknown	No	Down	Medium
12/25/16	14:54:20	RBT	45	Unknown	No	Down	Medium
12/25/16	15:00:58	RBT	50	Unknown	No	Down	Medium
12/25/16	21:23:22	RBT	40	Unknown	No	Down	Medium
12/25/16	21:28:26	RBT	50	Unknown	Yes	Down	Medium
12/26/16	4:00:08	RBT	40	Unknown	Unknown	Down	Low
12/26/16	4:17:30	RBT	30	Unknown	Unknown	Up	Low
12/26/16	4:26:02	RBT	30	Unknown	Unknown	Down	Low
12/26/16	4:45:52	RBT	30	Unknown	Unknown	Up	Low
12/26/16	7:26:52	RBT	40	Unknown	Unknown	Up	Low
12/26/16	22:49:20	RBT	45	Unknown	Unknown	Down	Low
12/27/16	8:25:52	RBT	50	Unknown	Yes	Up	Medium
12/27/16	8:32:19	RBT	35	Unknown	No	Up	High
12/27/16	17:43:32	RBT	40	Unknown	Unknown	Down	Low
12/30/16	1:52:52	RBT	50	Unknown	Unknown	Down	Low
12/31/16	0:29:31	RBT	50	Unknown	Unknown	Up	Low
12/31/16	1:03:26	RBT	50	Unknown	Unknown	Down	Low
12/31/16	7:08:01	RBT	45	Unknown	No	Up	Medium
12/31/16	7:17:00	RBT	45	Unknown	No	Down	Medium
12/31/16	7:56:26	RBT	50	Unknown	No	Down	High
12/31/16	14:02:22	RBT	40	Unknown	Yes	Down	Medium
12/31/16	14:03:17	RBT	40	Unknown	Yes	Up	Medium
12/31/16	14:06:32	RBT	40	Male	No	Down	High
12/31/16	17:42:05	RBT	40	Unknown	Unknown	Down	Low
12/31/16	22:16:23	RBT	40	Unknown	No	Up	High

[1] RBT = Rainbow trout.