# LA GRANGE HYDROELECTRIC PROJECT
# FERC NO. 14581

# UPDATED STUDY REPORT

# APPENDIX C

# LA GRANGE PROJECT FISH BARRIER ASSESSMENT PROGRESS REPORT

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## FERC NO. 14581

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

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## List of Attachments

## List of Acronyms and Abbreviations

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

# 1.0 INTRODUCTION

## 1.1 Background

The Turlock Irrigation District (TID) and Modesto Irrigation District (MID) (collectively, the Districts) 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 pool formed by the diversion dam. Under normal river flows, the pool formed by the diversion dam extends for approximately one mile upstream. When not in spill mode, the water level 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 pool storage is estimated to be less than 100 acre-feet of water.

The drainage area of the Tuolumne River upstream of LGDD is approximately 1,550 square miles. Tuolumne River flows upstream of LGDD are regulated by four reservoirs: Hetch Hetchy, Lake Eleanor, Lake Lloyd (known as Cherry Lake), 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). Inflow to the La Grange pool is the sum of releases from the Don Pedro Project, located 2.3 miles upstream, and very minor contributions from two small intermittent streams 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 slightly less than five megawatts. The La Grange Hydroelectric Project (La Grange Project or Project; FERC No. 14581) operates in a run-of-river mode. The LGDD provides no flood control benefits, and there are no recreation facilities associated with the Project or the La Grange pool.

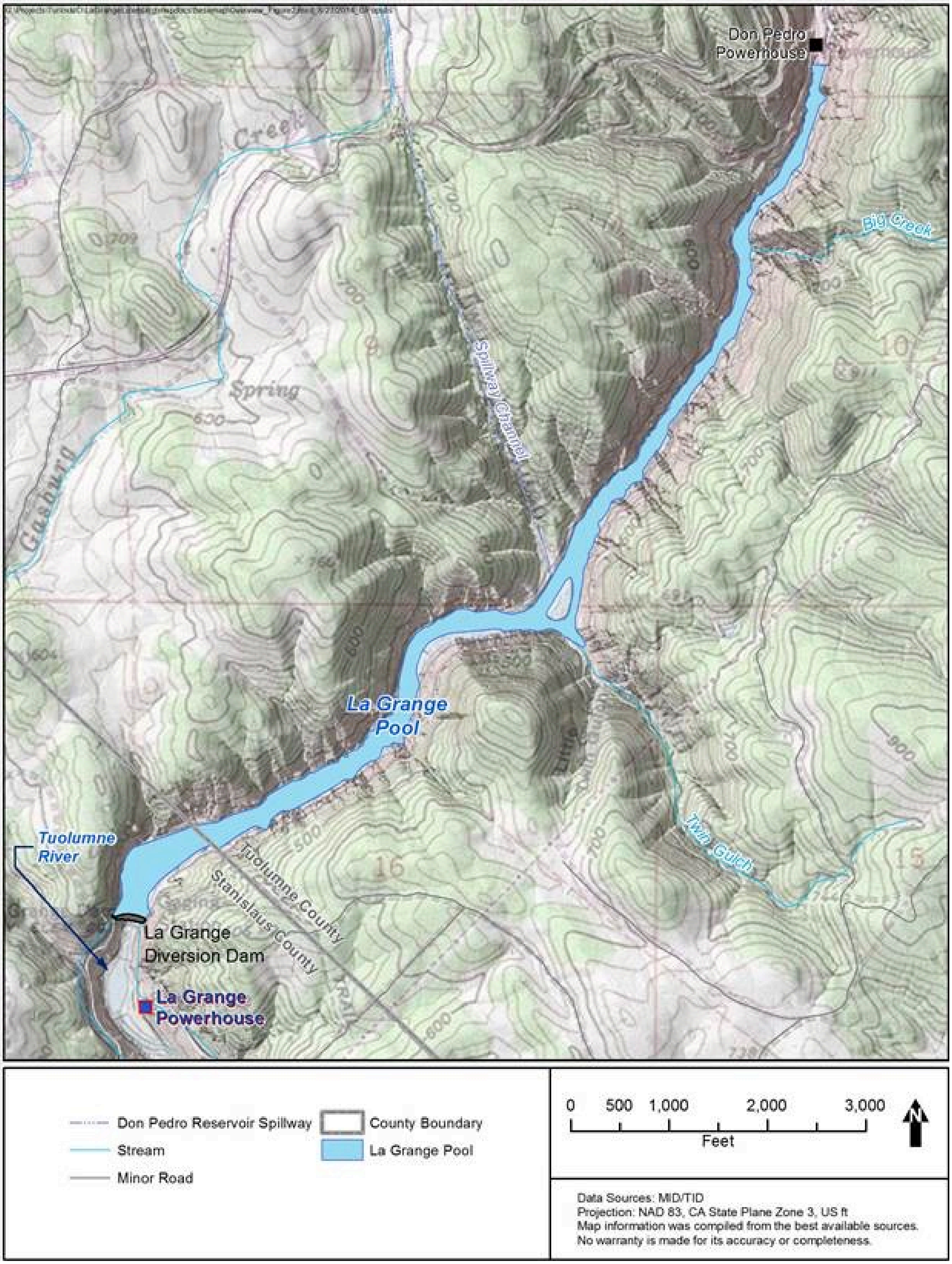


**Figure 1.1-1. La Grange Hydroelectric Project location map.**

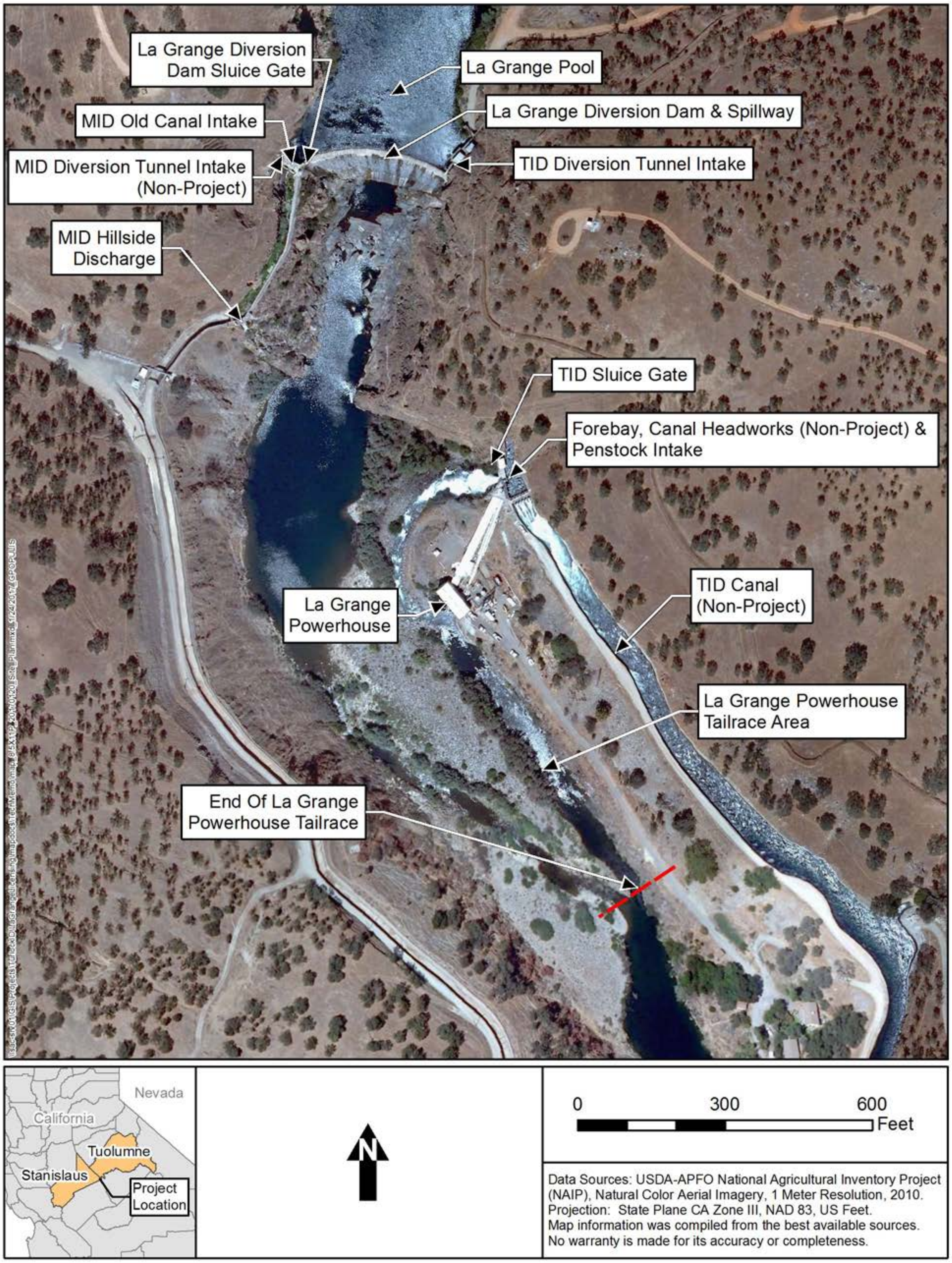


**Figure 1.1-2. La Grange Hydroelectric Project site plan.**

## 1.2 Licensing Process

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

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

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

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

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

In the SPD, FERC recommended that, as part of the Fish Passage Facilities Alternatives Assessment, the Districts evaluate the technical and biological feasibility of the movement of anadromous salmonids through La Grange and Don Pedro project reservoirs if the results from

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 pool. 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 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. 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. 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.

This progress 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 PAD, NMFS, CDFW, and the CGs 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 potential impact of LGDD and the La Grange powerhouse as barriers to the upstream migration of adult fall-run Chinook salmon and, if they occur, steelhead. 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 2017).

# 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 issues. 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 on September 11, 2015. After a brief testing period, weir operation and monitoring began on September 23, 2015 and continued through April 14, 2016. 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.

**Figure 4.1-1. Upstream view of main channel weir and passing chute.**

**Figure 4.1-2. Overhead view of tailrace channel weir and passing chute.**

## 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 (NTU), and water velocity 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. Boat surveys were conducted in both channels from LGDD to 0.3 miles downstream of the weir locations. Any spawning activity, live Chinook salmon (*Oncorhynchus tshawytscha*) or *Oncorhynchus mykiss* (*O. mykiss*), or carcasses observed upstream 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).

## 4.3 Video Review

A fisheries biologist or technician with prior video review experience reviewed digital video footage to determine passage events. Video review was limited to a group of five individuals in an attempt to ensure consistency through the review period. Video review consisted of viewing five-second motion detection clips from the overhead camera to determine fish presence, estimated length, and direction of passage. The underwater camera views were used for species identification, sex determination, and presence of an adipose fin. During periods when motion detection was ineffective, hourly 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. 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 separate fisheries biologist with extensive video review experience. Data selected for a second review included species identified as unknown, passages with a low observational certainty, and all recorded *O. mykiss* passages. Additionally, select hourly files were reviewed for passage events that were not captured by motion detection. Hourly files selected for second review were both hourly to evaluate video reviewer accuracy, and systematic to evaluate motion detection effectiveness (i.e. multiple upstream passages by an individual fish without subsequent downstream passages).

Raw data were summarized to determine daily upstream and downstream weir counts, the total numbers of individual fish moving through the weir (i.e., generating passage events), and the total number of fish exhibiting persistent upstream migration behavior (upstream counts minus downstream counts). The total number of fish exhibiting persistent upstream migration behavior was divided by total escapement determined at the lower weir (at RM 24.5) to estimate the extent to which the La Grange facilities are actually a barrier to upstream migration and spawning.

## 4.4 Lower Tuolumne River Weir

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

## 4.5 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 documented low levels of pre-spawn or partial-spawn mortality of fall-run Chinook in the Tuolumne River during surveys conducted in 1993, 1999, 2008, 2013, and 2014 (CDFW 2014). Of the years evaluated, the maximum annual occurrence of pre-spawn or partial-spawn mortality documented was five individuals (2013).

To evaluate the potential effect of LGDD and the La Grange powerhouse on the spawning of upstream migrants, 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.

# 5.0 RESULTS

This report summarizes all data collected during the 2015/2016 monitoring season. For the 2016/2017 migration season, sampling began on September 15, 2016 and is scheduled to continue through mid-April, 2017. Results of the 2016/2017 season will be provided in a final report after monitoring is completed and all data has been processed.

## 5.1 Weir Operations

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 2 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 came from the MID hillside discharge and was estimated to be approximately 25 cfs throughout the study period. 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 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 2015/2016 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 (hrs) |
|---|---|---|---|---|---|
| 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.

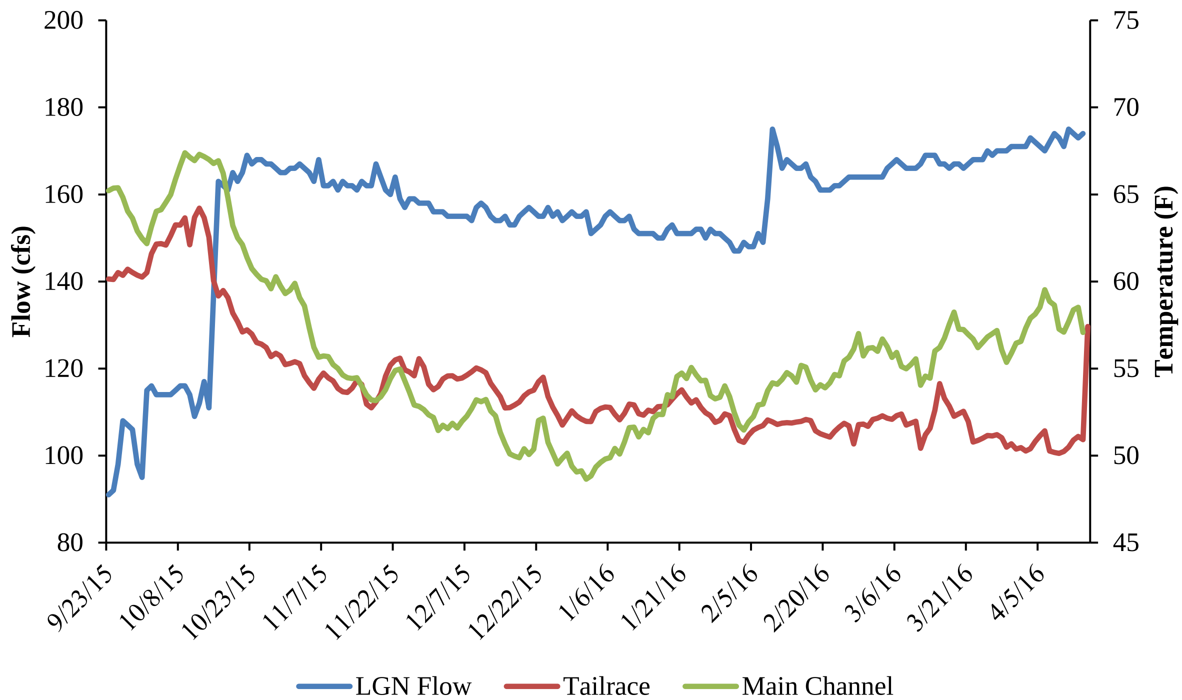


**Figure 5.1-1. Mean daily flow (cfs) at the USGS gage (LGN) and daily mean water temperatures at the tailrace channel weir and the main channel weir during the 2015/2016 monitoring season.**

## 5.2 Fish Passage

### 5.2.1 Chinook Salmon near La Grange Facilities

Based on data collected between September 23, 2015 and April 14, 2016, a total of 3,264 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 was observed September 23, 2015, and the last Chinook salmon 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 passages at the tailrace channel weir, and a total of 12 Chinook salmon accounting for the 935 passages at the main channel weir. Sex was determined for nearly all passages and consisted of 82 males and 35 females, with 28.2 percent (n=33) of the fish having a clipped adipose fin (ad-clipped). Based on morphological characteristics, it is likely that some individuals may have been detected at both weirs.

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). The mean time from initial passage through final passage was 119 hours (4.98 days), and ranged from 0.37 hours to 823.89 hours (34.33 days) at the tailrace weir. The mean time from initial passage through final passage was 183.87 hours (7.66 days), and ranged from 4.83 hours to 491.28 hours (20.47 days) at the main channel weir.

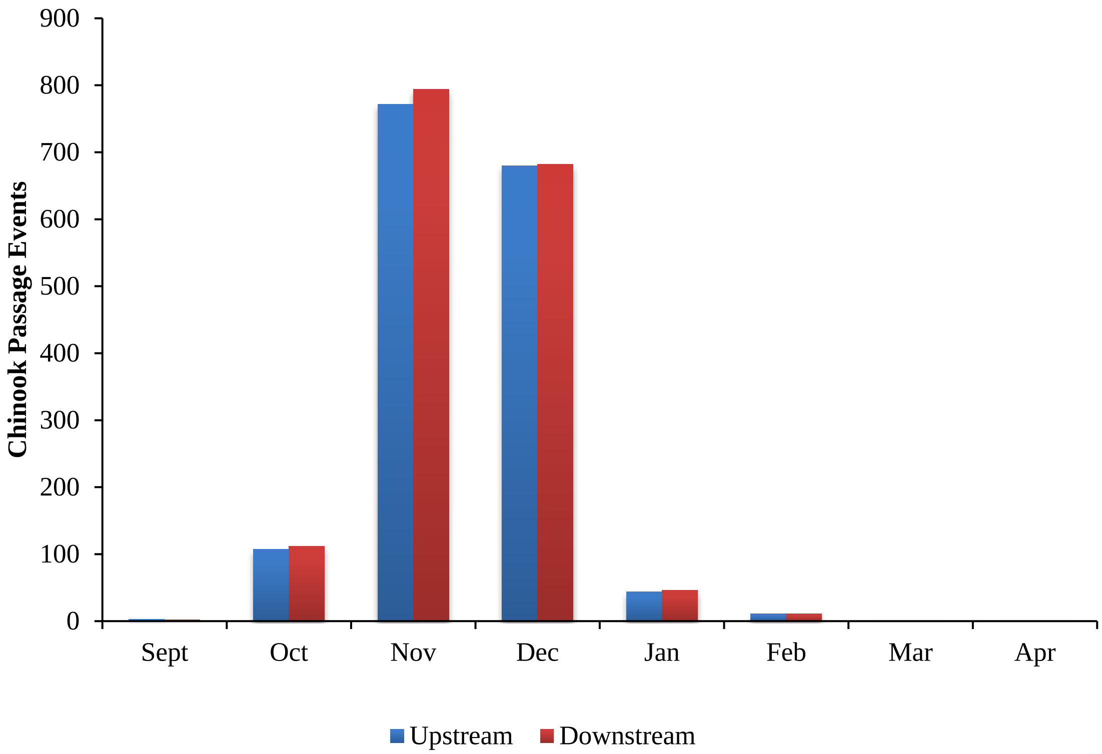


**Figure 5.2-1. Chinook passage events by month at the tailrace and main channel weirs.**

### 5.2.2 *O. mykiss* near La Grange Facilities

A total of 272 *O. mykiss* passage events (141 upstream, 131 downstream) were detected at the tailrace weir during the 2015/16 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 103 of these passages (45 upstream, 58 downstream) (Attachment A). Adult *O. mykiss* were first observed on October 6, 2015, and last observed on March 29, 2016 (Figure 5.2-2). 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 individual *O. mykiss* as there was much less variability in fish length, sex, and general morphological characteristics.

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.

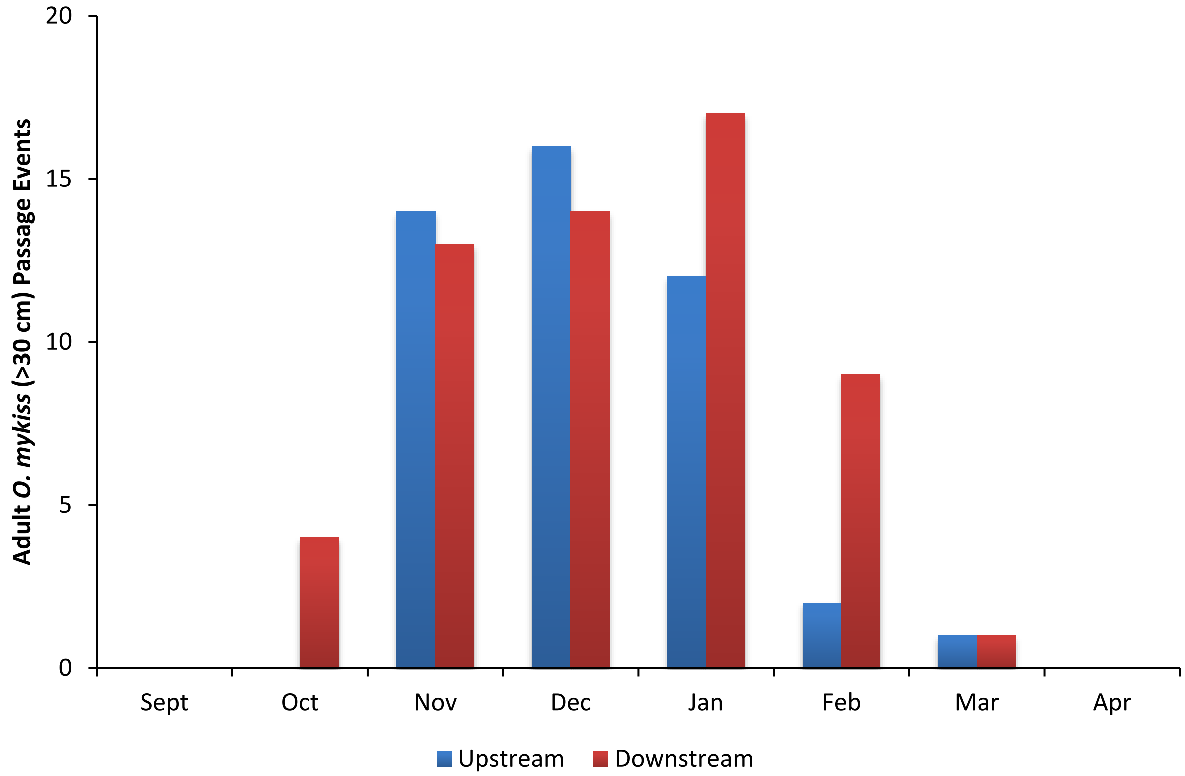


**Figure 5.2-2. Adult *O. mykiss* (>30 cm) passage events at the tailrace channel weir.**

### 5.2.3 Non-target Species near La Grange Facilities

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 5.2-1). Mammals observed included beaver (*Castor canadenis*) and river otter (*Lontra canadenis*).

**Table 5.2-1. 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 |

| Species | Location | Estimated Length Range (cm) | First Passage Date | Last Passage Date | Passage Events | |
|---|---|---|---|---|---|---|
| | | | | | # Up | # Down |
| 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 |

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 2012). This study provided the first formal documentation of these three species directly below La Grange powerhouse. On multiple occasions during the monitoring period, attempted predation events by striped bass were observed within the tailrace weir passing chute.

### 5.2.4 Passage at the Lower Tuolumne Weir

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 5.2-3). 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.

No *O. mykiss* were recorded passing the weir during the fall-run monitoring period, however three *O. mykiss* passages were recorded during the winter/spring period (January 1, 2016 to May 13, 2016) (Table 5.2-2).

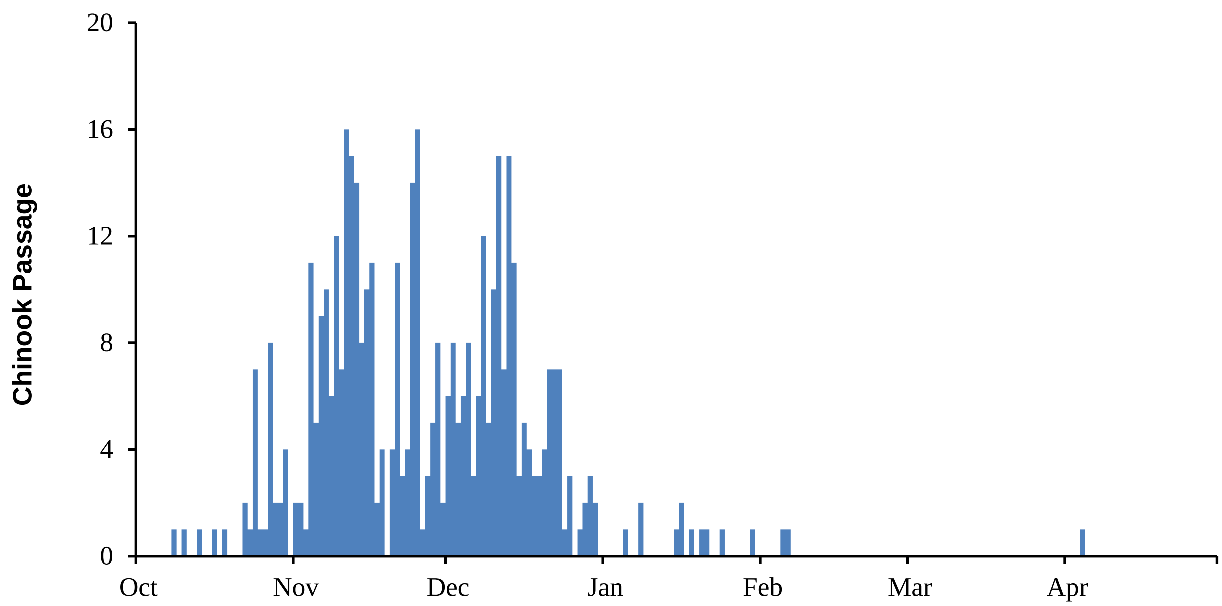


**Figure 5.2-3. Count of daily upstream Chinook salmon passages at the Tuolumne River weir (RM 24.5).**

**Table 5.2-2. Lower Tuolumne weir (RM 24.5) *O. mykiss* passage information for the 2015/2016 monitoring season.**

| Sample Date | Passage Time | Passage Direction | Estimated Length (cm) | Ad Clip |
|---|---|---|---|---|
| 1/27/16 | 14:37 | Up | 34 | UNK |
| 1/29/16 | 13:53 | Up | 42 | Y |
| 3/13/16 | 22:58 | Up | 40 | N |

## 5.3 Pre-spawn Mortality

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 2017). After evaluation for egg retention, this carcass was frozen and delivered to CDFW La Grange staff. This fish likely entered the sluice gate channel during a powerhouse outage event, and became stranded and de-watered when the powerhouse came back online. CDFW escapement surveys conducted in the Tuolumne River did not document any pre-spawn or partial spawn Chinook mortalities during the 2015 fall-run monitoring period (Gretchen Murphey, CDFW pers. comm., January 2017).

# 6.0 DISCUSSION AND FINDINGS

## 6.1 Chinook Salmon Passage

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). 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 in waiting of 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.

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 1-2 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).

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 don't return to downstream spawning habitat) to estimate the extent to which the La Grange facilities are actually a barrier to upstream migration and spawning. During the 2015/2016 monitoring season, only a single salmon met the criterion of exhibiting persistent upstream migration, a female that was likely stranded and dewatered in the sluice gate channel during an event when the powerhouse tripped offline. During the 2015/2016 monitoring period, 435 salmon moved upstream of the lower weir site (located at RM 24.5). Based on passages at the two monitoring locations, less than one percent of the total fall-run escapement exhibited persistent upstream migration as defined by the study criteria (1/435).

Considering that all but one of the Chinook salmon approaching the facilities moved downstream to spawn, and the relatively low rates of pre-spawn mortality observed in the lower Tuolumne River [4] (CDFW 2014, Gretchen Murphey, CDFW pers. comm., January 2017), it does not appear that the La Grange facilities affected Chinook production during the 2015/2016 study period.

[4] During the 2015 CDFW escapement surveys, CDFW did not observe any evidence of pre-spawn or partial spawn activity. A single pre-spawn mortality was observed in the sluice gate channel on December 25, 2015

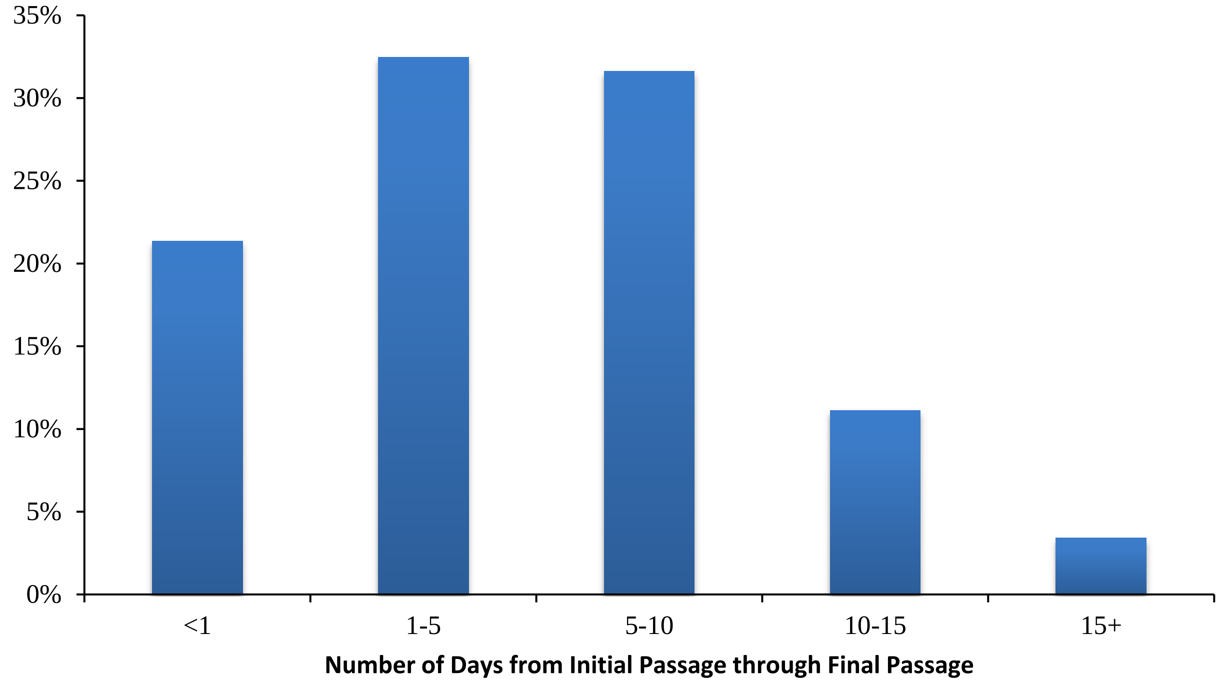


**Figure 6.1-1. Proportional distribution of the number of days from initial weir passage through final passage for individual salmon at the tailrace and main channel weirs during the 2015/2016 monitoring season.**

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 CWT's (Kormos et al. 2012, Palmer-Zwahlen and Kormos, 2013 and Palmer-Zwahlen and Kormos, 2015) found that hatchery-origin Chinook salmon comprised 49 percent, 73 perecent 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, suggesting 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. 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.

## 6.2 *O. mykiss* Passage

An objective of this study was to enumerate potential steelhead migrating upstream to the La Grange facilities. During the 2015/2016 monitoring season, three upstream migrating adult *O. mykiss*, were detected passing the Tuolumne River weir (RM 24.5). Due to the low number of upstream migrating *O. mykiss* observed at the downstream weir, the total of 103 adult (>30 cm) *O. mykiss* passages detected at the tailrace weir during the 2015/16 monitoring period, are primarily believed to represent movement of "resident" *O. mykiss* rearing in and around the La Grange powerhouse tailrace. Although it was not possible to identify individual *O. mykiss* passing the La Grange weirs, 83.5 percent (n=90) of the adult *O. mykiss* passage events occurred prior to the first *O. mykiss* detection at the lower weir site. Additionally, snorkel surveys (Stillwater 2010, Stillwater 2012) have regularly identified adult *O. mykiss* (30-50 cm) in the upper reaches of the lower Tuolumne River.

An ad-clipped *O. mykiss* was detected passing the Tuolumne River weir at RM 24.5 on January 29, 2016 (FISHBIO, unpublished). Based on size and the adipose fin clip, this is believed to be the same individual that accounted for multiple passages observed in the tailrace weir between February 19 and February 24, 2016. Since weir monitoring began at RM 24.5 in 2009, only four ad-clipped *O. mykiss* (>30 cm) have been detected. Given that ad-clipped *O. mykiss*, representing a hatchery-origin fish, are relatively rare in the Tuolumne River, it is likely that this single fish was detected at both monitoring locations.

## 7.0 STUDY VARIANCES AND MODIFICATIONS

This study was conducted consistent with the FERC-approved study plan. No variances or modifications occurred.

# 8.0 REFERENCES


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# LA GRANGE PROJECT FISH BARRIER ASSESSMENT
# PROGRESS REPORT

## ATTACHMENT A

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

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

| Fish ID | Est. Length | 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 |
| M32 | 50-60 | Male | No | 11/26/15 15:45 | 11/29/15 19:41 | 5 | -5 |

| Fish ID | Est. Length | Sex | Ad-clip | Initial passage | Final passage | Passage events No. Up | Passage events No. Down |
|---|---|---|---|---|---|---|---|
| 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 |
| 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 |

| Fish ID | Est. Length | Sex | Ad-clip | Initial passage | Final passage | Passage events | |
|---|---|---|---|---|---|---|---|
| | | | | | | No. Up | No. Down |
| 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 | 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 |
| 10/29/15 | 14:47:06 | RBT | 45 | 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 |
| 11/7/15 | 23:01:36 | RBT | 40 | Unknown | No | Down | Low |
| 11/8/15 | 5:31:46 | RBT | 35 | Unknown | Unknown | Up | Low |
| 11/8/15 | 5:57:06 | RBT | 50 | Unknown | No | Up | Low |
| 11/8/15 | 6:00:52 | RBT | 50 | 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 |
| 11/9/15 | 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 | 40 | Unknown | Unknown | Down | Low |
| 11/9/15 | 17:44:54 | RBT | 45 | Unknown | Unknown | Down | Low |
| 11/10/15 | 3:38:39 | RBT | 40 | Unknown | Unknown | Down | Low |

| Date | Time | Species | Est. Length (cm) | Sex | Ad-Clip | Passage Direction | Observational Certainty |
|---|---|---|---|---|---|---|---|
| 11/10/15 | 6:00:39 | RBT | 40 | Unknown | Unknown | Up | Medium |
| 11/10/15 | 6:25:23 | RBT | 40 | Unknown | No | Up | High |
| 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 | 18:10:44 | RBT | 45 | Female | No | Down | High |
| 11/13/15 | 20:20:44 | RBT | 45 | Unknown | Unknown | Up | Low |
| 11/15/15 | 16:31:57 | RBT | 50 | Unknown | No | 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 | 40 | Unknown | Unknown | Up | Low |
| 11/17/15 | 17:40:03 | RBT | 40 | Unknown | Unknown | Down | Low |
| 11/20/15 | 16:29:04 | RBT | 40 | Unknown | No | Up | 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 |
| 12/4/15 | 12:33:12 | RBT | 45 | Unknown | No | Up | High |
| 12/4/15 | 13:03:31 | RBT | 50 | Unknown | Unknown | Down | High |
| 12/5/15 | 14:19:10 | RBT | 45 | Unknown | No | Up | High |
| 12/5/15 | 14:44:44 | RBT | 45 | Unknown | No | Down | High |
| 12/7/15 | 6:46:12 | RBT | 40 | Unknown | Unknown | Up | Medium |
| 12/12/15 | 7:55:11 | RBT | 40 | Unknown | No | Down | Medium |
| 12/12/15 | 8:29:54 | RBT | 40 | 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 | 45 | 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 | 40 | Unknown | No | Up | High |
| 12/22/15 | 16:19:00 | RBT | 45 | 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 |
| 1/10/16 | 12:49:24 | RBT | 40 | Unknown | No | Up | Low |
| 1/11/16 | 8:09:57 | RBT | 50 | Male | No | Down | Low |
| 1/11/16 | 8:09:57 | RBT | 50 | Female | No | Down | High |
| 1/11/16 | 10:55:26 | RBT | 50 | Male | No | Up | High |
| 1/11/16 | 14:33:09 | RBT | 50 | Unknown | No | Down | Medium |
| 1/11/16 | 14:33:09 | RBT | 50 | Unknown | No | Down | Low |

| Date | Time | Species | Est. Length (cm) | Sex | Ad-Clip | Passage Direction | Observational Certainty |
|---|---|---|---|---|---|---|---|
| 1/11/16 | 14:57:14 | RBT | 50 | Unknown | No | Up | Low |
| 1/11/16 | 14:57:14 | RBT | 50 | Unknown | No | Up | Low |
| 1/12/16 | 7:55:07 | RBT | 50 | Unknown | No | Down | Low |
| 1/12/16 | 7:55:07 | RBT | 60 | Female | No | Down | Medium |
| 1/12/16 | 8:38:36 | RBT | 50 | Unknown | No | Up | Medium |
| 1/12/16 | 8:38:36 | RBT | 60 | Female | No | Up | High |
| 1/12/16 | 9:13:40 | RBT | 50 | Male | No | Down | High |
| 1/12/16 | 9:13:40 | RBT | 60 | Female | No | Down | High |
| 1/12/16 | 10:49:48 | RBT | 40 | Male | No | Up | Medium |
| 1/12/16 | 13:47:34 | RBT | 60 | Unknown | No | Down | Low |
| 1/16/16 | 13:33:48 | RBT | 50 | Female | No | Up | High |
| 1/16/16 | 23:43:53 | RBT | 60 | Unknown | Unknown | Down | Low |
| 1/17/16 | 13:51:33 | RBT | 50 | Unknown | No | Up | Medium |
| 1/20/16 | 12:38:53 | RBT | 50 | Unknown | No | Down | Medium |
| 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 | 50 | Female | No | Down | High |
| 1/22/16 | 23:15:09 | RBT | 50 | Unknown | Unknown | Up | Low |
| 1/22/16 | 23:16:30 | RBT | 40 | Unknown | Unknown | Down | Medium |
| 1/23/16 | 15:58:34 | RBT | 50 | 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 | 40 | Unknown | No | Down | High |
| 2/23/16 | 20:38:12 | RBT | 50 | Unknown | No | Down | High |
| 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 | 50 | Unknown | Unknown | Down | High |
| 2/25/16 | 0:03:40 | RBT | 50 | Unknown | Unknown | Down | High |
| 2/25/16 | 6:27:40 | RBT | 40 | Unknown | Unknown | Down | Medium |
| 2/25/16 | 6:27:40 | RBT | 40 | Unknown | Unknown | Down | Medium |
| 2/26/16 | 17:36:09 | RBT | 40 | Unknown | No | Down | High |
| 3/29/16 | 10:00:10 | RBT | 50 | Unknown | Unknown | Up | Medium |
| 3/29/16 | 10:15:21 | RBT | 50 | Unknown | Unknown | Down | Medium |