2022-23 Annual Report for the Alameda Creek Fish Ladder Operations and Water Stewardship (FLOWS) Monitoring Program

Submitted to

National Marine Fisheries Service North-Central Coast Office, Attention: San Francisco Bay Branch Supervisor, 777 Sonoma Avenue, Room 325, Santa Rosa, California, 95404-6528.

Submitted by

Alameda County Water District
Alameda County Flood Control and Water Conservation District

November 9, 2023

1. EXECUTIVE SUMMARY

The Alameda County Water District (ACWD) and the Alameda County Flood Control and Water Conservation District (ACFCD) have undertaken the Joint Lower Alameda Creek Fish Passage Improvements Project (Project) to reestablish passage of federally threatened Central California Coast Distinct Population Segment steelhead (*Oncorhynchus mykiss* or *O. mykiss*) at ACWD's Rubber Dams 1 and 3 (RD1 and RD3) and the BART Weir (Drop Structure) on Alameda Creek. This Project allows fish to access miles of spawning habitat upstream of these previously inaccessible barriers. To permit this Project, ACWD and ACFCD (hereinafter Districts will be used for simplicity) received a Biological Opinion (BiOp) from the National Marine Fisheries Service (NMFS) dated 5 October 2017 (NMFS No. SWR-2013-9696) describing their analysis of the effects of the construction and operation of the Project on steelhead. The BiOp sets forth several requirements (Section 2.9.4) including the following requirements for the annual report:

> "a. By November 1 of each year, ACWD and/or ACFCD shall provide an annual written report to NMFS regarding the following items from the previous season (season indicated in parenthesis below):
>
> (1) Fishway and fish screen monitoring and inspections (October 1 through September 30);
> (2) Streamflow monitoring and bypass flows (October 1 through September 30);
> (3) Results of biological monitoring and adaptive management actions (July 1 through June 30)."

This document is the annual report for the reporting period 1 October 2022 – 30 September 2023, to be submitted to NMFS. ACWD has confirmed with NMFS that an electronic submittal is permitted, and that submittal of this year's annual report is permitted to be submitted on 9 November 2023. In the event that the annual report contains requirements that conflict with the BiOp, the BiOp requirements shall govern.

In this inaugural year of BiOp implementation and reporting, the Districts have included additional required elements of the BiOp which are otherwise considered separate tasks. These elements include a detailed report on fish ladder start-up testing (Chapter 4), an annual monitoring and maintenance plan (Chapter 5), and a discussion on adaptive management (Chapter 6) which includes key takeaways and findings from the start-up testing and annual monitoring and maintenance. Chapter 6 also includes recommendations for the upcoming migration year. In subsequent years, these elements will be removed from the annual report and maintained as separate, living documents.

This first migration year yielded great successes including documentation of migration and use of the fish passage facilities by steelhead, Chinook salmon, and Pacific Lamprey. These findings are supported by data from the monitoring equipment, regular monitoring of the fish ladders and project area by ACWD staff, and field observations and photography provided by many volunteers throughout the Alameda Creek watershed.

The reporting period included several extraordinary events, such as the largest instantaneous streamflow in lower Alameda Creek since the US Army Corps constructed the flood control channel, followed by a series of successive atmospheric river storm events resulting in sustained high flows in Alameda Creek for several weeks. These historic and sustained high flows created many challenges during the first year of operations. Most notably, mobilized debris and sediment damaged the upstream rubber dam (RD3) rendering the RD3 Fish Ladder inoperable. Water intrusion from storm events also caused electrical problems at the RD1 Fish Ladder, such as the failure of automated controls of the auxiliary bypass, which hindered optimized operations throughout most of the reporting period. Nonetheless, ACWD was able to provide fishway flows supporting migratory conditions for all days of the migration season.

This annual report provides extensive detail on the start-up testing, operation, and monitoring of this new fisheries program. Some highlights of the findings and contents of the 2023 Annual report include:

Start-up testing

> ACWD tested and confirmed the proper operation, within the normal range of criteria, of all critical elements of the facility including head drop measurements between fish ladder pools, depth-to-fall ratios within the juvenile spillway at high and low flows, velocities within the RD1 Fish Ladder, the RD1 plate fish screen cleaning and debris removal systems, and no significant debris accumulation or obstructions of fish ladders.
>
> Start-up testing of the monitoring equipment found that the ARIS SONAR imaging system produced a range of image quality, and a large salmon carcass could be detected by both echogram and SONAR. Of 11 trials, ~91% of objects could be accurately identified with size measurements ranging from 47% smaller to 18% larger than actual (averaging 9.3% smaller than known). The Passive Integrated Transducer (PIT) tag system test successfully detected all 50 test tags with at least one of the antennae, suggesting an overall probability of detecting a tagged steelhead at 98%.

Operations

> Monitoring of the physical condition and operation of the facilities included daily monitoring by staff of all facilities and components as well as the extensive use of Supervisory Control and Data Acquisition (SCADA) systems which provides for continuous monitoring and automation of the facilities, confirming that operations remained within both engineering and biological specifications.
>
> ACWD met or exceeded RD1 fish ladder bypass flow targets on all but two summer days when downstream flows were below target by 1 and 2 cfs respectively. An assessment of conditions found targets could not be met due to sustained low flow at the Niles gauge and natural streamflow losses further downstream. The upstream conditions appear to have been exacerbated by fluctuating discharges from Quarries in the watershed. Operationally, however, ACWD was in full compliance with BiOp requirements as it bypassed 100% of flows reaching the BART Weir Complex.

Biological Monitoring

Monitoring of fish and predation included visual observation by District staff and volunteers to the use of sophisticated technology including PIT tags and an ARIS SONAR sonographic imaging system. Migratory target species observed included *O. mykiss* (3), Chinook salmon (25), and Pacific lamprey (7) during periods that matched their anticipated immigration and emigration schedules. At least 2 adult Chinook salmon and 1 Pacific lamprey were definitively identified by the ARIS camera and 1 PIT tag, implanted in a juvenile O. mykiss in the upper watershed, was detected by the antennae array.

Potential salmonid and lamprey predators observed included avian (bald eagle, heron, egret, osprey, cormorants, etc.), mammal (otters, raccoons, etc.), and fish (e.g., largemouth bass, etc.) species. The most common potential predators were avian (114), followed by mammals (12) and fish (7). While predator observations coincided with the sightings of migratory species, they persisted beyond the period of the last observed migratory species. Most predators were observed in RD1.

Overall, this first migration year demonstrated many successes and invaluable operational and biological monitoring experience for ACWD staff. Several tasks have been identified to further improve operations and biological monitoring in the upcoming migration year, including but not limited to the refinement of the safe entry plan to allow for the frequent, safe, and efficient performance of routine maintenance activities for the ARIS sonar camera to help clear the lens from silt accumulation; improvements in gathering and analyzing monitoring data and overall data management; protocol development for predator and milling surveys; and installation of additional water quality and contingency biological monitoring tools to gather more information (adaptive management recommendations are provided in detail in Chapter 6.) Finally, this Project was a remarkable success due to effective collaboration and communication among the Operations Working Group and other Alameda Creek watershed stakeholders.

Table Of Contents

2. INTRODUCTION

Alameda County Water District (ACWD) and the Alameda County Flood Control and Water Conservation District (ACFCD) (hereinafter referred to as "Districts") have undertaken the Lower Alameda Creek Fish Passage Improvement Project (Project) to provide Central California Coast (CCC) steelhead (*Oncorhynchus mykiss* or *O. mykiss*) and other native fish species unimpeded passage through the Alameda Creek Flood Control Channel (Flood Control Channel) while maintaining flood protection capacity and the ability to divert water from Alameda Creek. Facilitating successful upstream (immigration) or downstream (emigration) fish passage at an in-river impediment is a dynamic integration of fish behavior, physiology, and biomechanics with hydraulic analysis, hydrologic study, and engineering. Installing a fish passage structure does not constitute providing satisfactory fish passage unless all the above components are adequately factored into the design and operation. Successful passage must also consider the dynamic conditions, including hydrologic and other physical, biological, temporal, and spatial variability, occurring within a watershed, the passage facility, and a healthy fish population.

The Districts received a biological opinion (BiOp) from the National Marine Fisheries Service (NMFS; 5 October 2017; NMFS No. SWR-2013-9696) describing their effects analysis of the Alameda Creek fish ladder construction and operations for CCC steelhead. ACWD seeks to enhance fish passage and support CCC steelhead restoration on Alameda Creek while maintaining water supply goals, which depend on maintaining water diversions from Alameda Creek. On an ongoing basis, ACWD operates, monitors, and adaptively manages its water supply facilities along Alameda Creek in accordance with the NMFS BiOp and coordinates program activities with other watershed stakeholders. More specifically, Districts' goals are to:

1) provide adequate conditions for downstream migrating (emigrating) steelhead smolts;
2) provide optimal kelt emigration conditions and improve fish passage for other native fish such as Pacific lamprey and Chinook salmon; and
3) improve physical and biological components, such as water quality, that will benefit steelhead, Chinook, lamprey, and other native fishes, and negatively impact non-native fishes.

ACWD has developed the Fish Ladder Operations and Water Stewardship (FLOWS) program. The Alameda Creek FLOWS Program is a new, voluntary, environmental resources management program implemented by ACWD staff which will function in perpetuity to support the successful restoration of the federally threatened CCC steelhead in Alameda Creek while maintaining groundwater recharge activities essential to ACWD's water supply. The program provides the ongoing continuity and coordination needed to manage ACWD's environmental responsibilities and water supply, including regulatory compliance elements (required by the NMFS BiOp), interagency coordination, water supply planning, groundwater recharge operations, and community engagement and outreach. Development and implementation of the program is one of the major strategic initiatives identified in ACWD's Strategic Plan adopted March 8th, 2018. The FLOWS program includes tasks such as authoring regulatory reports, while providing subject-matter expertise and coordination support to other groups responsible for directly carrying out other functions such as groundwater recharge operations and public outreach. The FLOWS program goal is as follows:

> "ACWD seeks to enhance fish passage on Alameda Creek while maintaining water supply goals. On an ongoing basis, ACWD will operate, monitor, and adaptively manage its creek facilities in accordance with the National Marine Fisheries Service biological opinion and coordinate program activities with other watershed stakeholders."

To support the FLOWS Program, and in response to the BiOp, ACWD has committed, in a coordinated effort with ACFCD, to develop and implement a Monitoring and Adaptive Management Plan (MAMP) to ensure that bypass flows and operation of ACWD facilities in the Flood Control Channel meet project objectives related to fish passage through the channel. The adaptive management program has established management objectives and utilizes the results of the monitoring program to measure the effectiveness of ACWD's operations with respect to fish passage. Ongoing monitoring and learning through this program is meant to be used to recognize differences in the consequences of various actions, which will in turn offer the opportunity to evaluate management strategies. By comparing different actions, ACWD will be able to refine its operations and choose the best action to meet water supply goals and passage for anadromous fish.

The Districts prepared and submitted the draft Monitoring and Adaptive Management Plan to NMFS, and MAMP implementation was initiated in November 2022. The purpose of this document is to provide a report to NMFS on the MAMP and associated 7-Day Pulse Releases Framework. Specifically, this document provides annual information on reasonable and prudent measures identified by NMFS to minimize the take of CCC steelhead associated with the project that were identified in the MAMP:

1. Monitor operation of Project facilities in the Alameda Creek Flood Control Channel to ensure the fish screens and fishways are functioning properly;
2. Monitor operation of Project facilities in the Alameda Creek Flood Control Channel to ensure bypass flow requirements are fully achieved;
3. Prepare and submit annual reports to NMFS regarding operation of Project facilities, fish bypass flows, biological monitoring, and adaptive management actions.

Most of the fish passage facility construction and commissioning activities were completed by November of 2022 and the passage program was initiated on 1 January 2023. The FLOWS Program undertook a start-up test of the Project facilities in November and December of 2022 to initiate the adaptive management process identified in the BiOp (Figure 2-1).

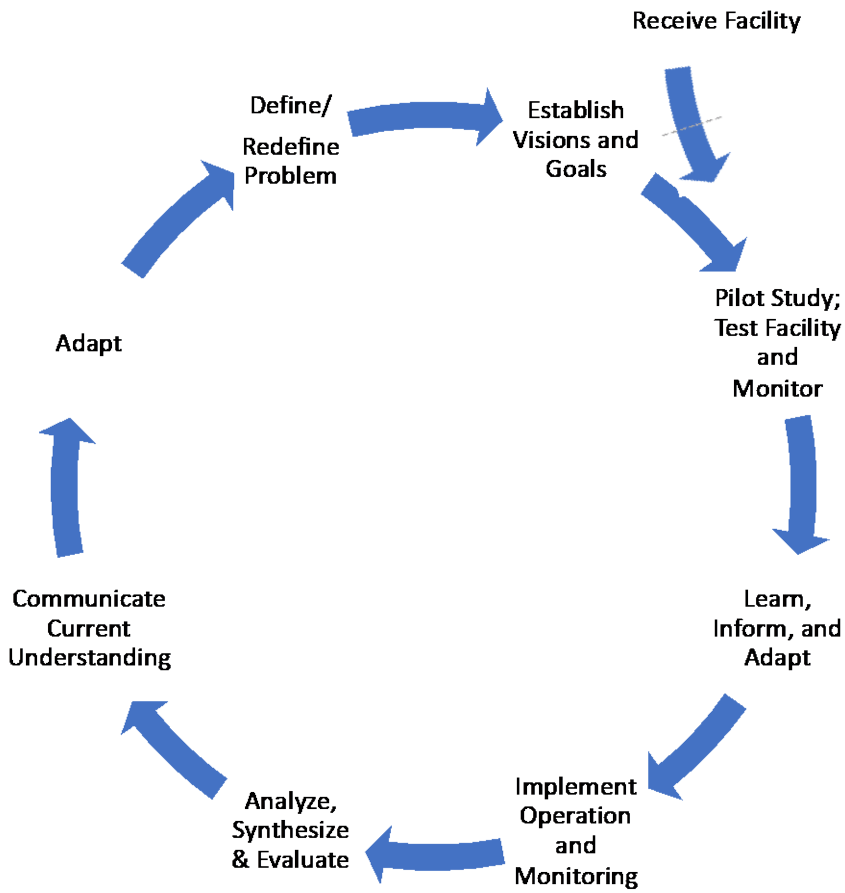


Figure 2-1: Adaptive Management Cycle, revised from the Draft MAMP (2022). Each step of the AM cycle contributes to the continual reduction of uncertainty around management actions, which ultimately leads to better-informed decision-making.

This annual report marks the first year of the MAMP operations, maintenance, and monitoring of the Project facilities and encompasses the period of 1 September 2022 through 30 August 2023, including a December 2022 start-up testing of the fish passage facility that spans the passage barriers of ACWD's Rubber Dam No. 1 (RD1) and ACFCWCD's BART Weir Drop Structure. This annual report provides a description of the Project Action Area and a summary of results of the 2022 start up testing of the fish passage facility at RD1, results of the 2023 Operations and Maintenance Program for the Flood Channel and associated passage facilities, environmental (physical) conditions for the 2023 monitoring year, and results of qualitative and quantitative biological monitoring during the first monitoring year. Its purpose is to communicate information that directly improves our current understanding of the Project and inform the adaptive management process.

3. PROJECT ACTION AREA – ALAMEDA CREEK FLOOD CONTROL CHANNEL

The Flood Control Channel is a highly engineered section of the Alameda Creek Watershed, including two fish passage facilities and several fish screening operations with the primary goal of successful passage (immigration to and emigration from the Alameda Creek Watershed) of listed CCC steelhead while facilitating water diversion and flood protection (BiOp 2017).

“Action Area” means all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action (50 CFR 402.02). The approximately 11.3-mile (18,200 meters) Action Area for this project consists of the Alameda Creek Flood Control Channel from the upstream end of the Rubber Dam No. 3 (RD3) impoundment near Mission Boulevard (see Reach V description below) to the mouth of Alameda Creek at San Francisco Bay (Figure 3-1). This area contains all ACWD’s facilities within the Flood Control Channel and reaches where streamflow is affected by ACWD‘s water diversions, including the Project’s new fish ladders and fish screens, as described below.

3.1. ACTION AREA REGIONS

In regulated streams, environmental conditions (e.g., flow) and salmonid characteristics (e.g., size) have a strong influence on observed mortality and this can vary substantially between stream reaches (Zeug et al. 2019). Therefore, to facilitate planning, coordination, and monitoring of passage management associated with the MAMP and Pulse Program, the Action Area is divided into five (5) reaches:

Reach I – The approximately 15,400 meters (9.6 miles) stretch from Estuary mouth (37°35'38.69"N; 122° 8'47.12"W) to pool at the bottom of Larinier Fishway (37°34'5.93"N; 121°59'20.97"W).

Reach II – The approximately 208 meters (0.13 miles) from the bottom pool of the Larinier Fishway to the upstream fish ladder exit within the Rubber Dam 1 (RD1) impoundment (37°34'10.27"N; 121°59'17.03"W).

Reach III – The approximately 1,588 meter (~1 mile) RD1 impoundment from RD1 (37°34'9.29"N; 121°59'17.47"W) to the base of RD3 (37°34'22.29"N; 121°58'18.95"W).

Reach IV – The approximately 75.3 meter long (0.05 mile) RD3 Fish Ladder, from the downstream entrance pool (37°34'23.58"N; 121°58'20.05"W) just downstream of RD3, to the upstream fish ladder exit (37°34'24.28"N; 121°58'19.22"W) within the RD3 Impoundment.

Reach V – The RD3 Impoundment, from RD3 (37°34'22.47"N; 121°58'18.88"W) approximately 1135 meters (0.7 miles) to the upstream extent of RD3 (37°34'50.12"N 121°57'53.81"W); somewhere between the Old Canyon Rd Bridge (37°34'42.08"N 121°58'7.04"W) and the USGS Niles Stream Gage (37°35'14" N; 121°57'35" W) referenced to North American Datum of 1927, in NW 1/4 sec.15, T.4 S., R.1 W., Alameda County, CA, Hydrologic Unit 18050004, Mt. Diablo meridian, on right bank, 0.3 mi downstream from the railroad bridge, 1.2 mi northeast of Niles, and 8.3 mi downstream from James H. Turner Dam on San Antonio Creek).

3.2. ACTION AREA KEY FEATURES

Specific features and facilities within the action area called out in the BiOp and meaningful to passage planning are listed below and marked in Figure 3-1:

1. USGS Stream Gage Station 11179100 at Sequoia Road Bridge (Sequoia Gage)
2. Larinier Fishway within the foundation of RD2

3. RD1-BART Weir Complex, vertical slot fish ladder, transition pool, vortex pool and chute fish ladder, guide wall, and plunge pool
4. Shinn Fish Screens
5. Kaiser Fish Screens
6. RD3
7. Mission Fish Screens / Alameda Creek Pipeline
8. RD1 Impoundment
9. RD3 Impoundment
10. Upstream extent of RD3 Impoundment inundation (at full 13 ft elevation)
11. Bunting Fish Screens
12. RD3 Fish Ladder
13. USGS Stream Gage Station 111790000 in Niles Canyon (Niles Gage)

These features are more fully described below:

1. USGS Stream Gage Station 11179100 at Sequoia Road Bridge (Sequoia Gage) (37°33'59.54"N; 122° 0'5.28"W). To implement bypass stream flows, the total stream flow through the Flood Control Channel is measured as an average daily flow downstream of the RD1/Drop Structure at the Sequoia Gage. This stream gage is used to document flows in the Flood Control Channel and for compliance with bypass requirements. Bypass stream flow amounts are based on Alameda Creek flow upstream of ACWD's facilities and measured upstream of Mission Boulevard in the Niles Canyon at USGS Station 111790000 (Niles Gage). ACWD ensures their operations are compliant with the Project's Alameda Creek streamflow bypass requirements by monitoring streamflow at the Sequoia Gage (downstream of Larinier Fishway within the foundation of RD2) and the Niles Gage (upstream of RD3). Water quality data collected at the Niles Gage (currently water temperature, turbidity, and suspended sediment) are monitored. Auxiliary flow in the RD1 Fish Ladder facility is measured using a flow meter, and a stage-discharge is used to measure flow through the vertical slot fishway pools of the RD1 Fish Ladder.

2. Larinier Fishway within the foundation of RD2 (37°34'5.93"N; 121°59'20.97"W) is a baffle fishway constructed at the site of the former RD2 in 2019. This is a passive passage facility designed to provide low-flow passage over the former RD2 foundation. The foundation is passable at higher flow rates.

3. RD1-BART Weir Complex, vertical slot fish ladder, transition pool, vortex pool and chute fish ladder, guide wall, and plunge pool (37°34'7.17"N; 121°59'20.62"W) & (37°34'7.82"N; 121°59'18.52"W). The RD1-BART Weir Complex is located in the Flood Control Channel, approximately 10 miles upstream from the creek entrance to San Francisco Bay. The weir is a 15' flood control drop structure that was completed as part of the flood control channel in 1972; ACWD's RD1 was constructed just upstream (37°34'9.01"N; 121°59'16.87"W). Both structures are fish barriers and require ladders to pass steelhead upstream. The channel at the RD1-BART Weir Complex (Complex) is bordered by 20-25 ft high levees with steep rock riprap and/or concrete faces. When fully inflated, RD1 operates to approximately 13 feet in height. The dam sits on a reinforced concrete slab foundation about 210 feet across between the toes of the channel banks (fully inflated top width is longer) and 35 feet wide. The dam impounds water for ACWD's Shinn and Kaiser ponds diversion intakes and provides in-channel groundwater recharge. The existing dam is raised and lowered by filling and draining with water from the adjacent Shinn Pond.

The Complex has been modified to provide fish passage with a vertical slot fish ladder, transition pool, vortex pool and chute fish ladder, guide wall, and plunge pool, meant to enable steelhead and Chinook salmon to move past the Complex. The fishway was installed along the rip-rap bank and concrete wall of the north levee. The fishway includes modifications to the Drop Structure and other channel hardscapes. The upper segment of the fishway (the RD1 Fish Ladder) is a vertical slot ladder design, including an auxiliary flow screen and associated piping. The RD1 Fish Ladder includes a sluicing pipe system to help remove sediment buildup within the RD1 Fish Ladder exit channel. The sluice piping is adjacent to the fishway and discharges near the entrance to the lower fish ladder segment. The screened auxiliary discharge is in the middle fishway segment to enhance attraction flow. Trash racks on the upper segment exit channel prevent larger debris from entering the RD1 Fish Ladder. A control cabinet installed on the channel's upper embankment houses automation equipment for facility monitoring and control.

Modifications to the existing Drop Structure concrete apron were made to construct the middle fishway segment, concrete transition pool, and lower fish ladder segment downstream of the transition pool. The lower fish ladder segment construction required modifications to rock riprap on the embankment and within the channel. The lower fish ladder is a vortex pool and chute ladder design. A guidewall was constructed across the channel to guide fish to the lower fish ladder segment entrance. Downstream of the guidewall, an existing scour pool was enhanced and must be maintained as the interface between the lower fish ladder segment and the downstream earthen channel. The rubber dam's foundation and the downstream grouted rock were modified to include a stream-wide plunge pool, about 2.5 feet deep, immediately downstream of the rubber dam. Additionally, renovation to the RD1 control building was made to accommodate new RD1 Fish Ladder control equipment and controls used to inflate/deflate the RD1 bladder. The new permanent facilities associated with the Complex's fishway have a footprint of about 0.9 acres within the channel and along the rock rip-rap embankment.

Steelhead have been observed unsuccessfully attempting to swim up the Drop Structure concrete sloping face, which is too steep and shallow for steelhead to traverse. To prevent steelhead from attempting to swim up the structure's apron, a 2-foot-tall by 2-foot-wide concrete sill was built along the downstream edge of the apron. The sill spans the entire channel from the transition pool to the south bank. Riprap was rebuilt downstream of the concrete apron to raise the sill height. This provides any stray fish swimming up the riprap apron a means of swimming over the sill and onto the backwatered apron. Fish will then move laterally towards the transition pool and vertical slot fish ladder entrance. To accommodate fish migrating along the south bank, a 0.5-foot-deep notch was placed in the sill near the south side of the Flood Control Channel to attract and guide fish toward the upstream end of the sill and enable them to move laterally towards the vertical slot fish ladder entrance.

4. Shinn Fish Screens (37°34'12.01"N; 121°59'14.91"W). The Shinn Screens are a positive barrier, retractable, self-cleaning, cylindrical fish screen made from wedge wire by Intake Screens, Inc (ISI). The District has a standardized ISI design for all fish screen locations, varying only in size. The Shinn Fish screens include a total of 6 cylindrical screens providing a combined 230 cfs of diversion capacity from the north levee of the RD1 impoundment to Shinn Pond. Four additional screens are planned for future construction, which would bring the combined diversion rated capacity of 425 cfs. The Shinn Fish Screens occupy an area approximately 300 feet long by 75 feet wide along the levee of the flood channel; a track-mounted configuration with winches that raise the screens out of the water when not in use, most often during high-streamflow events. Flow is controlled by slide gates mounted under the screens with stems that extend to allow for gate control from the top of the bank. The screens are cleaned by rotating against stationary internal and external brushes. The screens prevent the entrainment and impingement of steelhead as water from Alameda Creek is diverted through pipelines in the levee to off-channel recharge basins. The fish screens are designed to provide a maximum approach velocity of 0.33 cfs which allow the smallest life stages of steelhead to freely swim away from the face of the screen (i.e., avoid impingement). The screen mesh has openings no larger than 1.75 mm (~0.07 in) which prevent the entrainment of all life stages of steelhead into the diversion system. Screen facility designed to operate effectively in an environment with minimal-to-no sweeping flow and in an environment that is affected by intermittent periods of high flow events with heavy debris loads. The cylindrical screens include self-cleaning brush systems and can easily be removed from the channel for inspection or repair without special equipment.

5. Kaiser Fish Screens (37°34'17.67"N; 121°58'50.24"W), using the same ISI design as Shinn, The Kaiser Fish screens include a total of two cylindrical screens providing a combined 50 cfs of diversion capacity from the south levee of the RD1 impoundment to Kaiser Pond.

6. RD3 (37°34'22.44"N; 121°58'18.79"W) - When the rubber dams are inflated, they create large, upstream ponds that allow water to flow by gravity through diversion pipelines into off-channel recharge ponds. Except during periods of high flow (about 1,000 cfs) or when maintenance is required, rubber dams are maintained in the "up" or "raised" position, and, thus, can be used to divert the natural flow of Alameda Creek and water released from upstream State Water Project (SWP) facilities. When inflated, RD1 and RD3 physically block steelhead migration.

7. Mission Fish Screens / Alameda Creek Pipeline (37°34'27.46"N; 121°58'15.48"W), using the same ISI design as Shinn, The Mission Screens include a total of four cylindrical screens providing a combined 150 cfs of diversion capacity from the north levee of the RD1 impoundment to Shinn Pond, via the Alameda Creek Pipeline.

8. RD 1 Impoundment (37°34'15.07"N; 121°59'9.93"W) created by RD1 when partially or fully inflated. When the rubber dams are inflated, they create large, upstream ponds that allow water to flow by gravity through diversion pipelines into off-channel recharge ponds. Except during periods of high flow (about 1,000 cfs) or when maintenance is required, rubber dams are maintained in the "up" or "raised" position, and, thus, can be used to divert the natural flow of Alameda Creek and water released from upstream State Water Project (SWP) facilities. When inflated, RD1 and RD3 physically block steelhead migration. This large pond of slow-moving water provides poor habitat conditions for steelhead due to low water velocities, lack of riffle habitat, thermal warming, high summer temperatures, and substrate with a large silt component.

9. RD 3 Impoundment (37°34'24.96"N; 121°58'15.30"W) is caused when RD3 is partially or fully inflated. When the rubber dams are inflated, they create large ponds that allow water to flow by gravity through diversion pipelines into off-channel recharge ponds. Except during periods of high flow (about 1,000 cfs) or when maintenance is required, rubber dams are maintained in the "up" or "raised" position, and, thus, can be used to divert the natural flow of Alameda Creek and water released from upstream State Water Project (SWP) facilities. When inflated, RD1 and RD3 physically block steelhead migration. This large pond of slow-moving water provides poor habitat conditions for steelhead due to low water velocities, lack of riffle habitat, thermal warming, high summer temperatures, and substrate with a large silt component.

10. Upstream extent of RD 3 Impoundment inundation (at full 13 ft elevation) is about 37°34'50.12"N 121°57'53.81"W, upstream of the Old Canyon Road Bridge within the Niles Canyon Staging Area.

11. Bunting Fish Screens (37°34'21.63"N; 121°58'17.24"W), using the same ISI design as Shinn, the Bunting Screens include a total of two cylindrical screens providing a combined 28 cfs of diversion capacity from the south levee of the RD3 impoundment to Bunting Pond.

12. RD3 Fish Ladder (37°34'23.77"N; 121°58'20.20"W) is designed to convey up- and downstream migrating steelhead and Chinook Salmon when RD3 is inflated, and the impoundment is partially full or filled to capacity. The fish ladder entrance pool is located immediately downstream of RD3 and is connected to a plunge pool at the base of RD3 so that fish migrating upstream through the center or southern portion of the channel can find the entrance after encountering the dam. The entrance is an automated wing gate that controls the water surface elevation within the entrance pool. The fish ladder is a vertical slot design.

Because RD3 does not have to overcome as much elevation as RD1, the fish ladder is much shorter. The RD3 plunge pool is backwatered to the impoundment caused by RD1.

13. USGS Stream Gage Station 111790000 in Niles Canyon (Niles Gage) bypass - stream flow amounts are based on the flow in Alameda Creek upstream of ACWD's facilities and measured upstream of Mission Boulevard at the Niles Gage (37°35'14" N; 121°57'35" W).

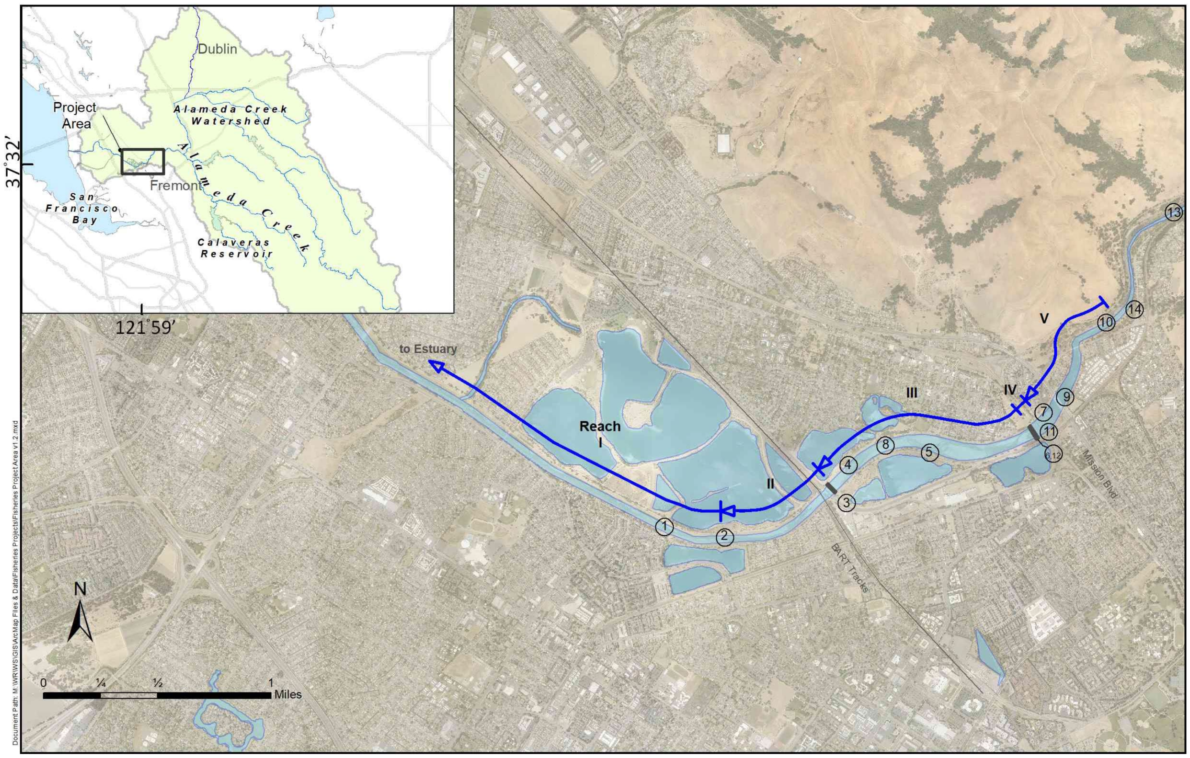


Figure 3-1: Alameda Creek Flood Control Channel Project Area including associated Alameda Creek Water District facilities

Reach I *– The ~15,400 meters (9.6 miles) stretch from Estuary mouth (37°35'38.69"N; 122° 8'47.12"W) to pool at bottom of Larinier Fishway (37°34'5.93"N; 121°59'20.97"W).*
Reach II *– The ~208 meters (0.13 miles) from the bottom pool of the Larinier Fishway to the upstream fish ladder exit within RD1 impoundment (37°34'10.27"N; 121°59'17.03"W).*
Reach III *- The ~1,588 meter (~1 mile) RD1 impoundment from RD1 (37°34'9.29"N; 121°59'17.47"W) to the base of RD3 (37°34'22.29"N; 121°58'18.95"W).*
Reach IV *- The ~75.3 meter (0.05 mile) RD3 Fish Ladder, from the downstream exit pool (37°34'23.58"N; 121°58'20.05"W) just downstream of RD3, to the upstream fish ladder entrance (37°34'24.28"N; 121°58'19.22"W) within RD3 Impoundment.*
Reach V *– The RD3 Impoundment, from RD3 (37°34'22.47"N; 121°58'18.88"W) approximately 1135 meters (0.7 miles) to the upstream extent of RD3 (37°34'50.12"N 121°57'53.81"W); between Old Canyon Rd Bridge (37°34'42.08"N 121°58'7.04"W) and Niles Gage (37°35'14" N; 121°57'35" W) referenced to North American Datum of 1927, in NW 1/4 sec.15, T.4 S., R.1 W., Alameda County, CA, Hydrologic Unit 18050004, Mt. Diablo meridian, on right bank, 0.3 mi downstream from railroad bridge, 1.2 mi northeast of Niles, and 8.3 mi downstream from James H. Turner Dam on San Antonio Creek).*
1. *Sequoia Gage (37°33'59.54"N; 122° 0'5.28"W;*
2. *The Larinier Fishway (37°34'7.17"N; 121°59'20.62"W);*
3. *RD1/Drop Structure (37°34'7.82"N; 121°59'18.52"W);*
4. *Shinn Fish Screens (37°34'12.01"N; 121°59'14.91"W);*
5. *Kaiser Fish Screens (37°34'17.67"N; 121°58'50.24"W);*
6. *RD3 (37°34'22.44"N; 121°58'18.79"W);*
7. *Mission Fish Screens / Alameda Creek Pipeline (37°34'27.46"N; 121°58'15.48"W) intake positive barrier fish*

screens;
8. *RD 1 Impoundment (37°34'15.07"N; 121°59'9.93"W);*
9. *RD 3 Impoundment (37°34'24.96"N; 121°58'15.30"W);*
10. *Upstream extent of RD 3 Impoundment inundation (at full 13 ft elevation) appears to be about 37°34'50.12"N 121°57'53.81"; Area.*
11. *Bunting Fish Screens – positive fish screens for the 28 cfs-capacity diversion for the Bunting Pond. Located in RD3 Impoundment (37°34'21.63"N; 121°58'17.24"W). intake positive barrier fish screen;*
12. *The RD3 Fish Ladder (37°34'23.77"N; 121°58'20.20"W);*
13. *USGS Station 111790000 (i.e., Niles Gage) bypass - stream flow amounts based on creek flow upstream of ACWD's facilities and measured upstream of Mission Boulevard at Niles Gage (37°35'14" N; 121°57'35" W);*
14. *Water quality monitoring station (ACWQMS).*

4. 2022 START-UP TESTING

4.1. 2022 TESTING PURPOSE AND OBJECTIVES

To confirm the RD1 Fish Ladder conforms to the specified design criteria and general BiOp requirements, several measurements and observations were identified that should be made both at the time of commissioning and at regular intervals afterward. A testing process was developed to support ACWD's ability to identify proper facility operational criteria are met and to mitigate potential facility and monitoring deficiencies before the operations deadline of 1 January 2023. This "test run" was also meant to support a complete test of the system delivered by the contractor before the construction project acceptance by ACWD Engineering. Finally, start-up testing allows Districts to exercise the general methodologies identified in the MAMP required by the BiOp and to provide necessary updates in an adaptive Management Framework as we enter the first monitoring season (WRA 2022). The following sections presents descriptions of the start-up testing objectives and methodologies, with results summarized at the end of this chapter.

Start-Up Testing Objectives

The following are the start-up testing objectives:

1. Gain operational familiarity with system controls, operations, and safety protocols.
2. Confirm passage conditions can be met at various flow rates, including during:
    a. use of each exit gate (1-5)
    b. use of juvenile spillway and low flow gate
    c. various operational settings using the auxiliary bypass
3. Confirm operation of the Biomark PIT tag antennae including:
    a. Lower antennae (2), testing at normal flow levels
    b. Upper antennae (2), testing at high flow levels (dependent if there are high enough flows)
    c. Data recording, storage, and access
    d. Confirm ARIS sonar camera operation including:
        i. Gain familiarity with sonar camera operation, PTZ features
        ii. Practice file storage, uploading, and hard drive swap-out processes
        iii. Test processes for safely flushing out accumulated sediment from the camera lens
4. Confirm operational and bypass data is being recorded for reporting purposes
5. Refine water controller daily checklist and observations form(s)
6. Review fish ladder start-up and shut-down processes and inspection protocols
7. Develop safety walk-through and training with staff
8. Refine fish and predator monitoring procedures
9. Refine and practice fish stranding procedures and protocols
10. Confirm Shinn Fish Screen operations by diverting water from RD1 impoundment into Shinn Pond to support ladder start-up testing if lower RD1 impoundment levels are needed

4.2. START-UP TESTING FLOW SCHEDULE

ACWD began operational testing of the new RD1 Fish Ladder and biological monitoring equipment located at the RD1 / BART Weir Complex on 28 November 2022 (Figure 4-1). Additional testing days were scheduled for 30 November 2022 and 2, 12, 15, and 20 December 2022 with the intention to complete testing and initiate full-time, automated operations during the last week of December 2022. However, until testing was completed and both ladders could be confirmed operational within specifications, they could not be left in operation without staff onsite. Therefore, the ladders remained unavailable for fish passage outside of scheduled active testing periods.

		Fish Ladder Tests & Data Collection							
		A 11/30/22	B 12/2/22	C 12/9/22	D 12/12/22	E 12/15/22	F 12/20/22	G 12/21/22	H 12/26/22
Data Type	Mechanical/ Programming	X	X	X	X	X	X	X	X
	Physical	X	X	X	X		X		
	Biological	X	X	X	X	X	X	X	X

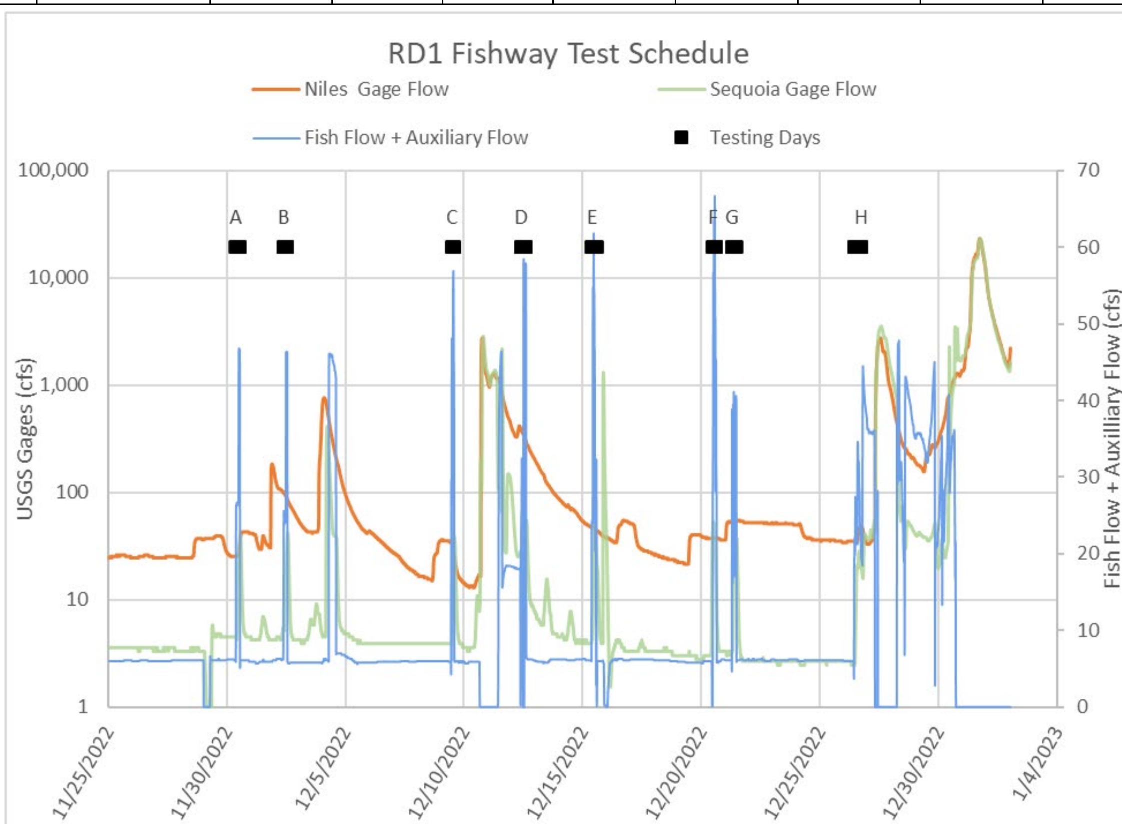


Figure 4-1. Alameda Creek Flood Channel Flows before, during and immediately after the start-up test, including flow diverted into the RD1 Fish Ladder.

4.3. GENERAL TEST FLOW CONDITIONS AND FUTURE SCENARIOS

Alameda Creek at Niles Canyon was dry as of 24 October 2022. There are multiple quarry operators within the Sunol Valley, upstream of the confluence of Alameda Creek and Arroyo de la Laguna, located along Calaveras Road and adjacent to Alameda Creek that will periodically discharge water from their quarry pits into Alameda Creek. These quarry discharge operations affect the flows recorded at Niles Gauge. When the Sunol quarries were not discharging water, there was no surface flow at the Sequoia Road Bridge Gauge (Figure 3-1). Even with quarry discharges, and Niles Gauge reporting about 20 cfs, streamflow was discontinuous within the Army Corps channelized reach of Alameda Creek. In advance of the start-up testing, ACWD delivered additional water, imported via the Vallecitos Channel, to support the start-up testing. Beginning on 1 November 2022, ACWD imported up to 20 cfs through Vallecitos Channel to build storage in the RD3 impoundment, which subsequently could be released into the RD1 impoundment once the RD1 facility was transferred from Engineering to the Water Supply section to begin the operational start-up testing. Once RD1 was inflated, ACWD could build the RD1 impoundment while also adjusting bypasses through the RD1 fish ladder to achieve approximately 5 cfs at Sequoia; a downstream flow rate less than what was observed with quarry discharges at that time. While numerous environmental triggers can initiate salmonid immigration, flow is one of the primary factors. On 8 November 2022 flows below RD1 increased to above 50 before that day's rain event and peaked at ~1230 cfs in a couple of hours that same day articulating the first major flow of the salmon migration season.

4.3.1. General Background on Compliance Condition Parameters

Hydraulic Parameters

ACWD is responsible for hydraulic monitoring and operation of the vertical slot fish ladders (RD1 and RD3) and ACWD and ACFCD have shared responsibilities for environmental regulatory monitoring, and reporting (for RD1/Drop Structure Fish Ladder). Water levels at several specific points in and around the fish ladders (upstream, downstream, specific pools, etc.) were measured. Within the pool-type passes, measurements included water levels and head differences for each pool and at the entrance to the fish ladder. These measurements are taken for several combinations of upstream and downstream water levels. A goal of this start-up testing was to verify that both the flow pattern and the level of turbulence at various points in the fish ladder remained compatible with the specific demands of juvenile and adult CCC steelhead, such as plunging or streaming flows at each cross-wall between pools, and presence of large recirculation areas in the pools.

Mechanical Parameters

In both baffle and pool-type fish passes, the various regulatory facilities for controlling the discharge or the head differences between the pools, and at the downstream entrance (i.e., automatic gates) should be monitored. The MAMP provides general information about mechanical function of the passage facility. Below are some specific examples of such mechanical parameter.

4.3.2. Pass Obstructions and Blockages

Particular attention should be paid to any obstructions caused by drifting debris. These may hinder fish passage in certain critical areas (communication between pools, the water intake of the fish ladder, etc.), or else they may reduce the attraction of the fish ladder (screen clogging for filtering the injection of auxiliary water). Either might occur without necessarily showing any obvious disturbance to the flow. In this regard, submerged orifices must be checked regularly and carefully.

4.3.3. Operations and Maintenance Procedures

A plan for operations and maintenance (O&M) procedures should be included (i.e., preventative and corrective maintenance procedures, inspections and reporting requirements, maintenance logs, etc.), particularly with respect to debris, screen cleaning, and sedimentation issues.

All passage facilities (both juvenile emigration and adult immigration/emigration) were designed to function properly through the full range of hydraulic conditions expected to occur at RD1 during fish migration periods and account for debris and sedimentation conditions which may occur.

Within the O&M plan, provide for periodic inspections and corrective action should the passage conditions become impaired because a structure is damaged or inoperable. At a minimum, operation and maintenance items should include:

- Specifying what entity is responsible for the daily operation and maintenance of the passage structure.
- Performing annual, seasonal, and/or daily operating activities necessary to ensure proper function of the structure.
- Checking the passage structure at regular intervals to ensure it is operating within design criteria.
- Cleaning trash racks and debris collectors and remove debris accumulations regularly.
- Adjusting gates, orifices, valves, or other control devices as needed to regulate flow and maintain passage structure within operating criteria.
- Periodically checking staff gauges or other flow metering devices for accuracy.
- Annually inspecting the passage structures for structural integrity and disrepair.
- Inspecting gate(s) and valve seals for damage.
- Replacing worn or broken stoplogs, baffles, fins, or other structural components.
- Removing sediment accumulations from within the passage structure, where applicable.

4.4. 2022 START-UP TEST METHODS

4.4.1. Operations and Maintenance Procedures

The start-up testing provided ACWD staff with their first experiences operating the new RD1 fish ladder facility and the upgraded RD1 facility. Tasks included reviewing Standard Operating Procedures (SOPs) and gaining familiarity with the human-machine interface (HMI) displays and settings on the supervisory control and data acquisition (SCADA) system which controls facility operations. For example, for the RD1 Fish Ladder, operators were able to cycle the slide gates for the exit gates, juvenile spillway, and low-flow gate. Staff also tested the operations of the sluice valve, the auxiliary bypass valves, and entrance gates. Staff tested fish ladder operations in both the manual and automatic settings and could compare the programming logic of operations under certain automatic settings. During start-up testing, Water Supply staff studied ladder dynamics and flow patterns to better understand how the ladder operates and how and where daily maintenance procedures could be conducted.

4.4.2. Debris Management and Removal

Start-up testing provided ACWD staff with an opportunity to gauge the throw distance of the trash rake and begin estimating the volume of debris accumulation on the ladder deck grating for the purposes of understanding frequency of debris removal operations. During start-up testing, the trash crane was not installed or operational, so staff could not gain operational familiarity with that equipment during the start-up testing.

4.4.3. Debris and Screen Fouling

During start-up testing, ACWD monitored the fish ladder for debris buildup and operated the cleaning and debris removal systems as needed, discussed below. The auxiliary pipeline in the RD1 Fish Ladder has a flat plate fish screen at the pipe inlet with a cleaning system that runs automatically on a set time interval, or manually, preventing high head loss and excessive approach velocities through the fish screen. The trash rack at the entrance to the RD1 Fish Ladder exit channel has a high head loss alarm that informs operators if debris is obstructing flow into the exit channel. The trash rack has a cleaning system (trash rake; refer to photos in Figure 4-2) that operates automatically on a set time interval, or manually, to clear woody debris from the face of the trash rack and prevent high head loss. The flat plate fish screen cleaning system, and trash rake, were tested and operable during the start-up testing period.

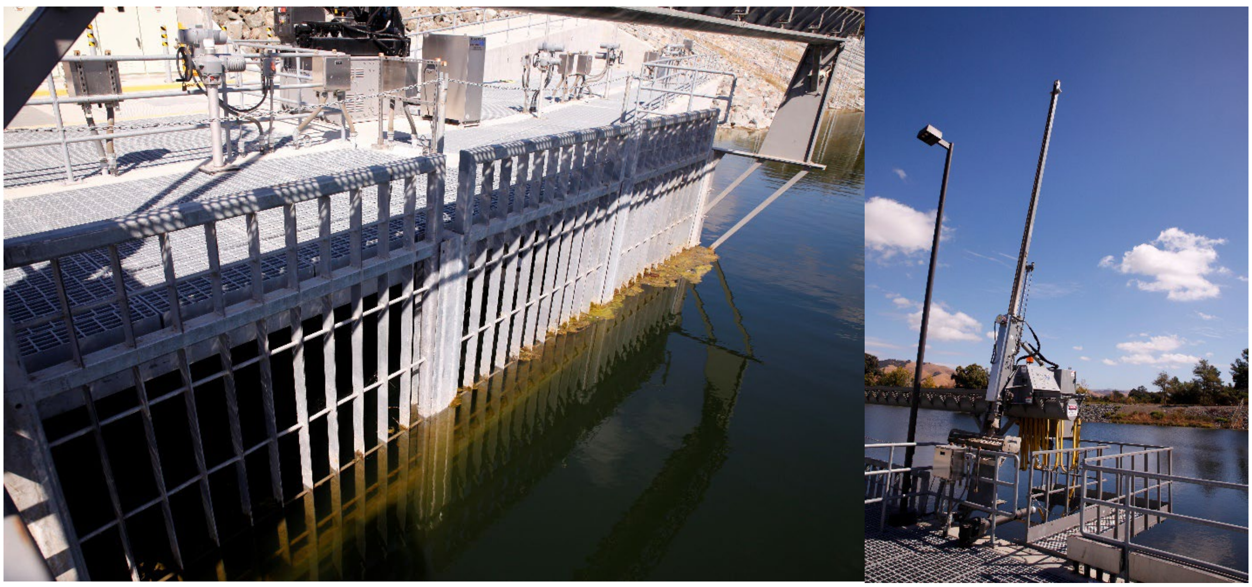


Figure 4-2: The RD1 Fish Ladder exit channel is screened from debris by the trash rack (left). The rack is cleaned by the trash rake, that operates automatically or manually to scrape debris off the rack (right).

4.4.4. Fish Screen Criteria

The start-up testing did not include any specific, new operations of fish screens at the ACWD diversions along Alameda Creek. However, the vertical plate fish screen on the RD1 Fish Ladder Auxiliary Bypass Pipeline intake from the fish ladder forebay was operational. Data collected at the vertical plate fish screen included water velocity measurements to help inform general operational and maintenance procedures.

In addition to the velocity data, data on operational aspects of the RD1 Fish Ladder vertical plate fish screen was collected to determine whether it is operating within criteria. For example, the cleaning system designed to remove debris was examined to determine whether it adequately prevented debris from creating flow issues, including reduced capacity. When debris accumulates on a screen it effectively reduces the cross-section area. This may, in turn, result in "hot spots" of high approach velocity, increasing the risk of impinging small fishes. Additional data will be collected during each future evaluation, including screen and seal conditions, screen submergence levels, cleaning system operation, diversion flow conditions, and observations of debris on or around the screen that might cause predator posting.

During the start-up testing, ACWD staff operated the Shinn Fish Screens to divert water from the RD1 impoundment into Shinn Pond. During these diversion operations, staff monitored operations to confirm if diversions through the Shinn Screens could be maintained within the approach velocity design criteria of 0.33 ft/s and that all adequate data is being recorded in the SCADA system.

4.4.5. Hydrology

There are two stream gages in lower Alameda Creek that the Districts uses for BiOp compliance, shown in Figure 3-1:

- US Geologic Survey (USGS) Station 11179000 (Niles Gage). This gauge is approximately 2 miles upstream of RD3 and measures discharge (flow), gauge height (water depth), and water temperature.
- USGS Station 11179100 (Sequoia Gage). This gauge is 0.5 miles downstream of RD1 and measures discharge (flow) and gauge height (water depth).

Time series graphs of streamflow at these two gages provide basic information on seasonal passage conditions. The BiOp sets minimum flow requirements downstream of the diversions to enhance fish passage conditions in the channel. The downstream flow requirement is based on incoming flows at Niles gauge with consideration for SFPUC releases; there is no expectation of water release from storage by ACWD to meet downstream flows. Compliance with minimum flows is measured at the Sequoia Bridge gauge. The BiOp calls these “Bypass Flows,” and they are provided in Appendix A. During start-up testing, ACWD evaluated the ability to meet these flow requirements through the programming in their water system controls.

Hydrologic Connectivity

Hydrologic connectivity in the flood control channel was examined by using flow models, past monitoring, and experience to analyze at what flow threshold the channel was expected to become disconnected in Reach 1 (see Figure 3-1). When this threshold was reached, regular surveys of Reach 1 were conducted to approximate the downstream extent of passage disruption. This included searching the flood control channel for blockages (e.g., depths shallower than NOAA passage requirements) and identifying what may be causing the disconnection, such as sediment build up and debris caused by vandalism/poaching.

Water Quality Throughout Project Footprint

Water quality, including temperature and dissolved oxygen, is an important factor in the viability of a waterbody to support steelhead, Chinook salmon and Pacific lamprey and other aquatic species. Water temperature and dissolved oxygen can create passage barriers or indirectly reduce fish health, including reduced overall survival during passage. Tracking water quality patterns can help correlate observations of fish and when they are potentially present.

Temperature and Dissolved Oxygen

During start-up testing turbidity was measured in the RD1 Fish Ladder, and dissolved oxygen and temperature measurements were collected in the RD1 Fish Ladder and RD1 Forebay. Refer to Section 4.6.2 for results.

4.5. TEST FLOW MONITORING

4.5.1. Physical Monitoring

Hydrology Objectives

Hydraulic Parameters
ACWD collected fish ladder hydraulic parameter measurements on multiple days from 30 November through 29 December 2022. The measurements included head drop between fish ladder pools and velocity measurements at vertical slots between fish ladder pools.

Head Drop Measurements
Head drop measurements between exit pools were collected across a range of flow conditions passable for fish (approximately 24 to 45 cfs). The juvenile spillway was tested to simulate high-flow out-migration conditions and the low-flow gate was tested to simulate low-flow out-migration conditions. Below is a summary list of fish ladder exit gate settings and flow conditions tested. For two flow conditions tested on 30 November 2022, the exit gates were not operated in automatic mode to be within the one-foot head drop passable criteria (between exit channel and exit pool), are not representative of expected future fish ladder operation, and are not included in this report. All other tests were conducted with exit gates in automatic mode, representative of normal expected conditions for various migratory season and off-season operations:

- Exit Gate 5 at 25 cfs
- Exit Gate 4 at 24 and 34 cfs
- Exit Gate 3 at 44 cfs
- Exit Gate 2 at 34 cfs
- Exit Gate 1 at 45 cfs
- Juvenile Spillway at average of 60 cfs
- Low Flow Gate at 8 cfs

Depth-to-Fall Ratios
The juvenile spillway and low flow gate were tested, and depth-to-fall ratios were calculated from measurements collected during testing.

Velocity Measurements
Velocity measurements were collected on 2 December 2022 while the RD1 Fish Ladder flow was 45 cfs, which is the high end of the expected passable flow rate (Figure 4-1). Velocity was measured as close to the axial center of each vertical slot in the fish ladder, though the placement of the measurement device was not consistent, with most measurements within about 6 to 10-inches of the axial center and one confirmed measurement taken in the center of a vertical slot. Multiple measurements were collected using a HACH FH950 portable velocity meter to obtain an average velocity for each measurement point.

4.5.2. Passage Facilities

Passage Obstruction and Blockage

ACWD staff inspected the trash rack and any submerged openings, such as the slide gates at exit gates or juvenile spillways and the vertical slots between fish ladder pools, prior to each day of start-up testing. Similarly, staff monitored these components periodically during the testing period in between testing days. After the fish ladder testing was completed each day, staff conducted a final inspection of these components to confirm there were no blockages or obstructions.

RD1 Fish Ladder
During start-up testing, the RD1 Fish Ladder was kept free of debris and obstructions by frequent use of the trash rake to periodically clean the trash rack and by daily observations by ACWD to check for obstructions in the vertical slot openings in the fish ladder. The trash rake has an automated cleaning process on a set time interval which keeps the trash rack free of debris and fouling. The rake can be set to operate automatically at a pre-determined interval, and it was set to clean the trash rack at least once every six hours.

The RD1 Fish Ladder auxiliary pipeline flat plate fish screen has a cleaning system that operates automatically on a set time interval, or manually, which keeps the screen free of debris and fouling. The cleaning system was programmed to operate automatically at a pre-determined interval, and it was set to clean the trash rack periodically during the testing period.

4.5.3. Qualitative Biological Observations

Visual Inspection/Observations – Fish Milling, Predators, and Other (Poaching, Vandalism, Etc.)

Pacific salmonids can experience high mortality rates during emigration to and from the sea (Michel 2015; Singer 2013). Various anthropogenic stressors can further complicate mortality or modify future success by altering migration speed or creating behavioral changes that increase or decrease susceptibility to predation. Such stressors include habitat alterations and the introduction of non-native predators (Sabal 2016). This is further complicated by fishing pressure when anglers optimize catch where delays in or concentrations of migratory fish increase angling susceptibility (Jaeger 2005). High predation pressure in areas below dams where fish aggregate has been reported by several authors, especially for juvenile salmonids during downstream movements along North American rivers but has also been observed for immigrating adult salmonids. There are different groups of relevant predators in these environments, including birds (Ruggerone 1986), mammals (Gowans et al. 2003), reptiles, and fish (Petersen et al. 1994; Schilt 2007). Installing facilities such as fish ladders that allow fish runs to pass upstream of impoundments has been considered a positive strategy for reducing downstream fish density, thus mitigating predation mortality and increasing access to unavailable habitat. However, intensified predation and injuries can occur in and around a ladder if high fish concentrations are observed. Thus, potential intensified predation should be assessed early in facility operation to reduce the possibility of it becoming a predation hotspot.

During this observational study, we assumed only upstream migratory fish (and associated predators/anglers) would be active. Therefore, during daylight hours, crews performed surveys looking for signs of predators and adult fish along the stream bank, where possible.

Surveys were performed before maintenance work to avoid potential predator and prey activity disturbance. Staff slowly approached any sites of potential fish concentration or migration delay from the streamside. Crews used binoculars to observe for direct signs of fish milling around ladder entrances and exits and within bays; predator activity, including herons, egrets, mergansers, osprey, otters, etc. Using polarized glasses, crews looked for indications of fish, including schooling by either small fish or potentially large predator-sized fish, near or around opening and exits as well as riffles immediately downstream of RD1. Crews also looked for indications of predation, such as attack or feeding rings, along the water surface. Crews searched for signs of predation including scat, fish scales, or other indications of recent predation activity at or near the screens, including rip-rap banks or perching areas on screening infrastructure.

Piscivorous species were defined as those that have been documented in the literature consuming juvenile salmonids within the California streams that support O. mykiss and Chinook Salmon (Cavallo 2013; Grossman 2016; Michel 2018) or adult salmonids, such as river otters and bald eagles (Ben-David, M., Hanley, T.A. and Schell, D.M., 1998) To investigate potential piscivorous fish activity, regular visual observations were made within the Project footprint. To estimate piscivorous fish activity within the passage facility, we followed two survey methods. In the vicinity of the ladder, visual counts were conducted in the diffusion pools (ladder entrance) and above the water intake (exit). These counts were based on visual fish detection performed by staff trained to visually identify and record species. Each observation was performed weekly for approximately 10 min in the morning during the test flow. To quantify the numerical importance of piscivorous species near the entrance and exit of the ladder and along the longitudinal gradient of the project footprint, the fractions of the total piscivorous recorded in relation to the total number of individuals and species at each site were calculated. To investigate the contribution of the larger species (and therefore more predatory capacity per individual), the proportion of the piscivorous species with a maximum length above >175 mm FL was also examined (Murphy 2021).

Ladder use by piscivorous fish species was evaluated by the frequency at which those species were identified in the structure during the survey. Finally, the presence of other predators (including birds, and mammals) in the vicinity of the fish ladders was evaluated in a preliminary and qualitative manner. The animals were recorded, photographed, and identified (Agostinho et al. 2012). See fish milling and predator survey methods above.

Other – Poaching, Vandalism, Etc.

Surveys of direct or indirect poaching observations (e.g., anglers, nets or fishing paraphernalia) and vandalism (e.g., channel debris or ladder damage) were also made during surveys performed above.

Stranding Surveys

In the BiOp (section 2.9), NMFS determined that incidental take was reasonably certain to occur in association with operation of ACWD's facilities in the Alameda Creek Flood Control Channel. ACWD's operation of two inflatable rubber dams and the associated water intakes will divert the streamflow of Alameda Creek and adversely affect a small number of steelhead adults, kelts, and smolts migrating through the Flood Control Channel. Reductions in streamflow by ACWD's diversion operations will decrease water depths over riffles and diminish the size of holding pools in the channel downstream of RD1/Drop Structure. Reduced water depths during some time periods are anticipated to make the migration of adult, smolt, and kelt steelhead over these riffles incrementally more challenging and increase migration time through the Alameda Creek Flood Control Channel. Inflation of the rubber dams and the associated filling of the impoundments may strand a small number of migrating steelhead on gravel bars, in isolated side channels/pools in the Alameda Creek Flood Control Channel, or within the recessed plunge pool on the downstream side of RD1. However, NMFS indicated take would be difficult to quantify and therefore reasonable and prudent measures are necessary to minimize CCC steelhead. Therefore, as part of ACWD's monitoring of facilities operations, ACWD concluded it important to determine when such stranding events may occur, estimate the population effect of such events for target species and, if warranted, determine potential mediation or mitigation of these impacts.

In this initial test flow, stranding surveys were performed to develop a framework for predicting adult and juvenile Chinook Salmon and steelhead stranding events from available spatial and hydro-modeling data within the project footprint and determining the potential for stranding episodes to salmonids as they relate to federal and state management plans.

These data are, if found warranted, meant to develop a draft decision tree process for determining appropriate actions to identify, reduce and/or mitigate for population impacts to Alameda Creek salmonids and other native fishes (e.g., Pacific lamprey).

For initial surveys, it was assumed there would be periods of ~4 to 24 hrs when stream flows would drop while RD1 was inflating. RD1 typically inflates when streamflows drop to <700 cfs. During these infrequent dam inflation periods, it was assumed there might be slight disruptions to fish passage opportunities and potential for stranding due to changing stage elevations as the forebay filled to capacity. In the BiOp, it was assumed RD1 inflation and subsequent impoundment filling would result in downstream streamflow reductions at rates generally ranging 0.01 to 0.75 feet/hour and ~85% of the time, the water surface elevation drop rate would be <0.5 feet/hour during RD1 filling. If the water surface elevation drops too quickly in the channel downstream, stranding on gravel bars, in isolated side channels or pools, or within the recessed plunge pool on the downstream side of RD1 might occur. Furthermore, during early testing of the fish facilities, flow reductions might occur within the passage facilities during adult immigration. Therefore, if a flow reduction occurred in which flows approach a level predicted by modeling (or expert opinion) to initiate stranding, or if additional stranding areas were identified during site visits, a stranding survey was conducted, including main channel, fishways, spill basins and riprap fields. Areas isolated from the main channel were marked by GPS and total area visually estimated or a polygon recorded around the stranding pool and average depth estimated. A visual estimation of fish species and numbers was made.

Stakeholder Activities

Stakeholder participation was a vital component of the start-up testing. Given the close involvement of EBRPD fisheries biologist staff, ACWD enlisted the support of EBRPD fisheries biologists to support start-up testing. NMFS and CDFW were also invited to the start-up testing, however, NMFS was unable to attend. Not only were EBRPD staff able to provide valuable assistance in the testing for biological monitoring equipment and physical/hydrologic parameters, but their participation in the start-up testing also gave EBRDP staff greater understanding into the fish ladder operations and monitoring.

The initiation of fish ladder bypass flows, coinciding with the arrival of in-migrant Chinook, generated great interest from the wider public, including volunteer observers with the Alameda Creek Alliance (ACA) and hobbyist nature photographers along the Alameda Creek trails. For example, ACWD received photos from Dan Sarka of staff performing start-up testing. The input from online social media fora such as the ACA observer Signal channel and Facebook posts provided ACWD with near real-time updates on fish observations and flow conditions in portions of Alameda Creek.

4.5.4. Quantitative Biological Monitoring

Hydroacoustic Imaging – ARIS

To aid in biological monitoring activities, the RD1 fish ladder includes a high frequency Adaptive Resolution Imaging Sonar (ARIS) camera installed within the middle fish ladder pool immediately downstream of the box culvert. The ARIS Explorer 3000 SONAR (Sound Navigation and Ranging) imaging camera is located within the middle fish ladder for the purposes of identifying species, size, direction, and timing of fish passage within the RD1 fish ladder. The camera is meant to collect representative images of fish moving through the middle fish ladder (approximately 100 feet upstream of the PIT tag reader). The sonar camera can record the outline and movement patterns of fish, allowing for approximate identification of large fish types, even under turbid conditions. However, the sonar camera is unlikely to distinguish between: fish gender, tagged vs untagged fish (i.e., fin clipped or not fin clipped), and may also not be able to distinguish between small fish (such as young salmonids) and debris. Cost-effective approaches are being identified due to the high costs of data storage and interpretation.

Theoretically, a target’s range and position in the water column have considerable impact as to whether it is located within the sonar beam. Fish carcasses have been used to provide immobile targets of known location and therefore a more stable platform with which surveys can be conducted for a matter of minutes,

Figure 4-3: Testing of the ARIS sonar camera using market fish. (1) Float used to keep fish oriented and off channel bottom; (2) Stadia rod used to take water depths and hold weight and can in place; (3) 83.21 cm Atlantic Salmon (4) 38.10 cm Striped Bass; (5) 5.08 cm 8-ounce weight. The reference aluminum can is not shown.

rather than seconds to test equipment (Parsons et al. 2014). Two whole fish carcasses (1 *Salmo salar* and 1 *Morone saxatilis*) were purchased from a local fish market to represent large salmon and smaller teleosts expected to be observed in the passage facility. The two specimens were put on ice before transport to the facility. Crews suspended carcasses at depths of 0.25 – 1 m (~0.8-3.3 ft; surface to water column bottom) from plastic floats (one at head and one at tail), using monofilament fishing line. To remove air from body cavities that would have previously been filled by water or mucus before the fish was removed from the water, each was flushed with river water, lowered, tail first into the water and bubbles allowed to escape. Each fish was then brushed down and briefly dragged through the water. Fish were drifted in the water column at 3 depths (0.25 -1 m water depth) while being imaged using the ARIS system at ranges between 0.25 and 2 m from the camera. Imaging of the floats alone was also conducted at ranges of up to 1 m to ensure that these did not contribute to the sonar images of the fish carcasses.

The major goals for the test run of the hydroacoustic imaging were to:

- Determine the best camera angle to capture immigrating fish;
- Determine if objects of various sizes and material could be identified and size estimated;
- Test camera orientation around the bay to identify specific bay features including ladder, corners and bay entrance to fish;
- Determine blind spots.

Videos were recorded to a flash drive and transported to ACWD facilities for backup and storage.

PIT Tag Detection – Antenna Array

There are four Passive Integrated Transponder (PIT) antennas installed in the fish ladder to capture detections of any PIT-tagged steelhead (or other species) utilizing the fish ladder. Two antennas are vertical slot, pass-through antennas that operate at low flows, and each of these antennas has an overflow antenna above that operates at high flows, typically greater than 75 cfs. The purpose of this study was to estimate the detection efficiency of these PIT antennas.

Efficiency tests were conducted at the Alameda Creek Fish Ladder during low flows on 30 November 2022, so only the two vertical slot, pass-through antennas were underwater and tested for detection efficiency. The upstream antenna closer to the release point is Antenna 4 and the downstream antenna farther from the release point is Antenna 2. West Fork Environmental, a company that specializes in PIT tag technology, provided float apparatuses designed to hold and orient PIT tags perpendicular to antennas for use in efficiency tests (Figure 4-4*).*

Figure 4-4: Customized float apparatus from West Fork Environmental to hold test PIT tags.

$\hat{p}\ =$

Fifty test tags (Biomark APT12) were implanted into float apparatuses and released across ten release groups, where the first five release groups were spaced 10 min apart and the latter five release groups were spaced 5-7 min apart.

Figure 4-5: Example of two tags floating through a ladder bay. Flow is moving from bottom of photo up. Note this bay does not have an antenna and the image is for illustration purposes only.

Data Analysis

Detection data were offloaded from each Biomark PIT antenna and incorporated into the Peterson/Lincoln single mark-recapture model (include citation) to estimate detection probability at each antenna using:

$$p_1 = \frac{m}{n_2} \qquad (1)$$

and

$$p_2 = \frac{m}{n_1} \qquad (2)$$

Where $n_1 = number\ of\ PIT\ tags\ detected\ at\ the\ first\ antenna;$
$n_2 = number\ of\ PIT\ tags\ detected\ at\ the\ second\ antenna;$
$m = number\ of\ PIT\ tags\ detected\ at\ both\ antennas.$

Overall detection probability was then estimated using:

$$\hat{p}\ =\ \frac{n_1 n_2 - (n_1 - m)(n_2 - m)}{n_1 n_2} \qquad (3)$$

Travel time through the fish ladder was estimated for individual tags. The first detection recorded at each antenna was used to calculate the number of seconds from release to Antenna 4, and from Antenna 4 to Antenna 2. Duplicate detections were retained to observe differences in number of detections per unique tags and to understand the total number of detections recorded during this study. All calculations were performed using R (version 4.2.2) in RStudio 2022.12.0 Build 353.

4.6. 2022 START-UP TEST RESULTS

4.6.1. Operations and Maintenance Procedures

Debris and Fouling

While staff monitored the trash rake, slide gates, and vertical slots for any signs of debris or obstructions during the testing operations, no significant debris or obstructions were observed. Staff also monitored the condition of the Auxiliary Bypass vertical plate fish screen, and likewise no fouling was observed during the start-up testing. As noted above, the natural runoff during the start-up testing period was minimal, and natural flows had to be supplemented with imported water supplies delivered via Vallecitos Channel to support adequate bypass flows. As a result, debris accumulation during the five weeks of start-up testing was minimal, with the accumulated debris volume at the trash rake totaling less than would have filled a 20-gallon refuse container.

Debris Management and Removal

While there was no debris of significant size to cause obstructions, the trash rake operated to run cleaning cycles at preset intervals. There were minor debris items, such as twigs, branches, bottles, and foam pieces that were collected on the grating due to trash rake operation. Such debris was collected on a weekly or biweekly basis, as necessary, by operators who placed the debris into garbage bags and hauled it offsite.

Fish Screen Criteria

The vertical plate fish screen within the RD1 Fish Ladder performed as expected during the start-up testing. ACWD staff observed the plate cleaning mechanism functioning properly without incident, and SCADA was adequately providing data of the operations.

ACWD staff reviewed data from the operation of the Shinn Fish Screens when diverting water from the RD1 impoundment into Shinn Pond during the start-up testing period. During some diversion operations, data indicated that, under certain settings, the Shinn Screens operations exceeded the approach velocity design criteria of 0.33 ft/s. ACWD staff were trained to monitor for excessive approach velocity and how to manually adjust diversion settings to maintain the approach velocity to not exceed design criteria. ACWD is developing additional testing protocols to confirm automated settings do not exceed the design criteria in all conditions.

4.6.2. Test Flow Monitoring

Hydrology

Head Drop Measurement Results
Head drop measurements between fish ladder pools were on average close to the one-foot head drop design criteria, except for relatively higher head drop between pools 12 and 11 with an average 1.29 ft.

Juvenile Spillway Test Results

Depth-to-fall ratios calculated during juvenile spillway testing met the fish ladder facility's Draft Basis of Design Report (BODR) minimum threshold of 0.25 ft/ft at juvenile spillway flowrates greater than approximately 18 cfs. The precise minimum flowrate that the juvenile spillway can be utilized will be further refined through additional operational experience, though it is not expected to be used at flow rates below 20 cfs unless additional exit gates are providing flow and additional water depth in the plunge pool (pool 10) below the juvenile spillway. Figure 17 below shows the juvenile spillway testing data collected on 12 December 2022.

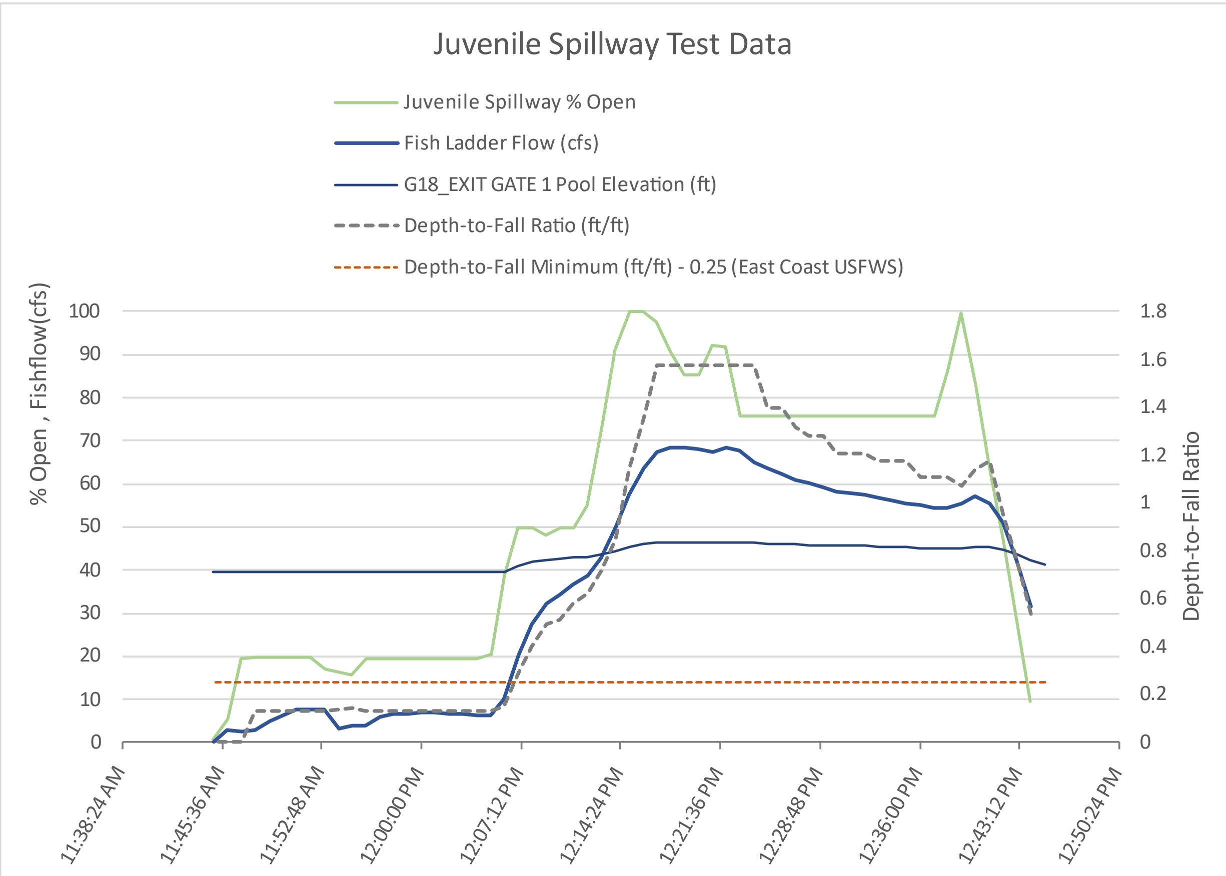


Figure 4-6: Juvenile spillway test data to evaluate depth-to-fall criteria. Minimum recommended depth-to-fall ratio is met when flow through Juvenile Spillway is approximately 18 cfs, as measured downstream in the fish ladder.

Water Surface Elevation Change in Ladder

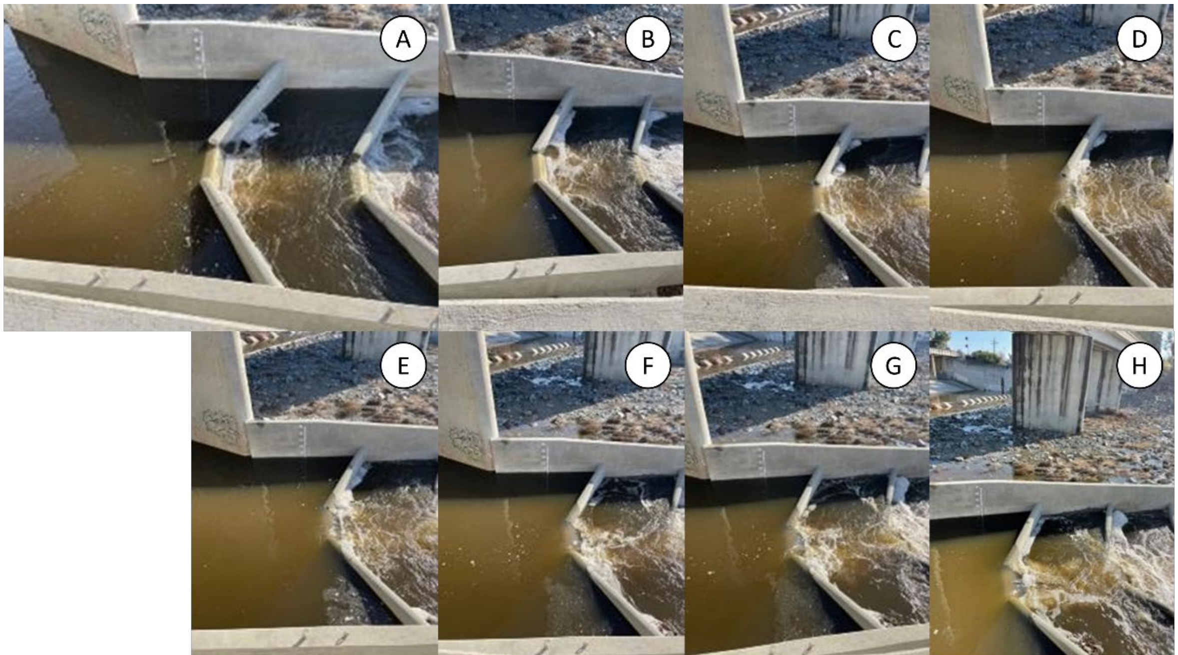
Figure 4-7: Location of photo documentation during test flows 15 December 2022. Red arrow indications where images were captured at the Rubber Dam 1 lower fish ladder. Note dragon's teeth in image.

This short study was meant to determine the relationship between water surface elevation (WSE) in the lower ladder and water released into the RD1 fish ladder when no water is released over RD1. The test was intended to confirm the theoretical relationship, used to establish automated operational programming.

Methods

During flows that ranged from 46.1 - 47.3 cfs (9:45-11:00am), an iPhone 10 was used to record photo images of the water surface as flows increased within the fish ladder during a flow test run 15 December 2022. Each image was taken to illustrate where a visible WSE change occurred during flow increase within the RD1 Fish ladder. Photos were recorded every 5-15 minutes while the ladder flow was maintained at approximately 22 cfs. The time of specific images were then matched with ladder and creek flows recorded for those times. WSE was estimated to the nearest 0.05 ft (0.6 in).

The weir notches begin to flow at about WSE of 35.5 ft (estimated from Figure 4-8A). Inundation of the dragon's teeth begins about WSE 36.0 ft (Figure 4-8C). The notches begin to overtop somewhere around WSE 36.2 ft (Figure 4-8D, E). As flows recede between WSE 37 ft and 36 ft, stranding potential is identified below RD1 (Figure 4-8F,G,H). This assisted ACWD in their understanding of ladder and channel function under a range of test flows. The R^2 between flow in the ladder and WSE was 0.78 (Figure 4-9). While this is a good fit, more measures are needed, and so it is recommended that expansion of monitoring of gauge measurements at flows outside of this range be completed.



A	B	C	D	E	F	G	H
9:46 am	10:20 am	10:27 am	10:29 am	10:32 am	10:39:03 am	10:39:06 am	11:00 am
35.5 ft	35.65 ft	36.05 ft	36.1 ft	36.25 ft	36.3 ft	36.4 ft	36.35 ft

Figure 4-8: Water surface elevation changes in the lower fish ladder during start-up testing on 15 December 2022. Time and WSE is recorded for each image in the table at bottom. Notes: C) 36 ft. is the beginning of dragon teeth inundation, F) water beginning to pool in sediment below the dragon teeth apron at 36.3 ft, and G) channel flowing to the south of the ladder above 36.3 ft.

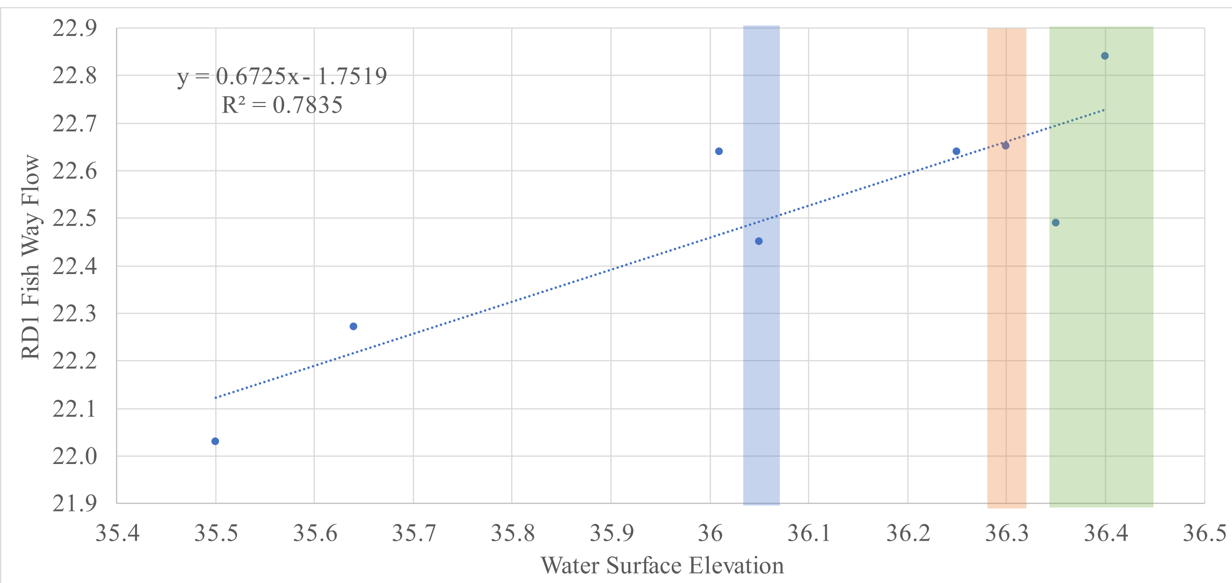


Figure 4-9: The relationship between water surface elevation measured at the lower fish ladder and mechanically estimated flow within the RD1 Fish Ladder during dry run tests of the fish facility at RD 1. Measurements were recorded by photo between 9:47 and 10:40 am, 15 December 2022. Flow measured at the Niles Gauge was 43 cfs. Flows measured at the Sequoia Gauge ranged from 4-15 cfs during the same period of time. The blue bar indicates when "dragon's teeth" first become wet. Orange bar indicates when water begins to flow in channel next to ladder. Green bar indicates when riprap below the dragon's teeth begins to inundate.

Low Flow Gate Test Results

Depth-to-fall ratios calculated during low-flow gate testing met the BODR minimum threshold of 0.25 ft/ft at flowrates greater than approximately 8 cfs. At flowrates lower than about 8 cfs it is expected that baffles could be installed in the vertical slots between Pools 20, 19, and 18, to increase the water depth in pool 20, and maintain the 1-foot head drop criteria between pools downstream of Pool 20. During out-migration season, the low flow gate is not expected to be used at flow rates below 8 cfs unless additional exit gates, mainly exit gate 5, provide flow and additional water depth in Pool 20 below the low flow gate. Figure 4-10 below shows the low flow gate testing data collected on 12 December 2022.

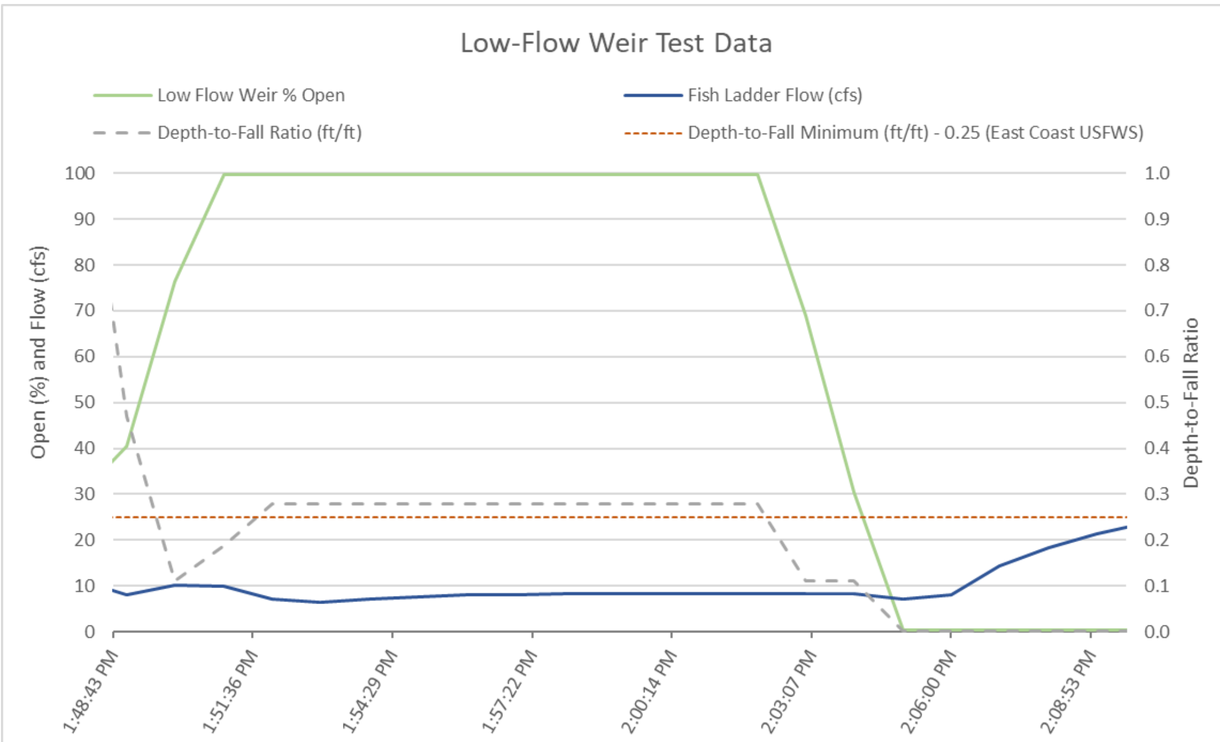


Figure 4-10: Low flow gate test data to evaluate depth-to-fall criteria. Minimum recommended depth-to-fall ratio is met when flow through the low flow gate is a minimum of approximately 8 cfs.

Velocity Measurements

Velocities measured at 45 cfs flow within the RD1 Fish Ladder, at vertical slots where the meter was positioned within about 6 to 10-inches upstream of the axial center averaged about 2.8 ft/sec. This average excludes one outlier where the velocity was likely too low due to incorrect meter positioning relative to flow in the vertical slot. The average velocity was notably higher (4.6 ft/sec) for the one measurement where the meter was managed to be positioned in the axial center of the vertical slot. This measurement, collected in the slot between pools no. one (#1) and two (#2), is expected to be representative of maximum velocity.

Water Quality

Water quality parameters presented here were measured using hand-held probes during the initial start-up of the RD1 fish ladder.

Turbidity measurements (shown in Table 4-1) indicate higher turbidity at higher fish ladder flow rates, as expected due to additional flushing of sediment through the fish ladder. During auxiliary pipeline testing the measured turbidity was similar to the preceding fish ladder flow test, with some minor variability.

Dissolved oxygen (DO) and temperature in the RD1 Forebay (shown in Table 4-1) were similar to levels measured in the RD1 Fish Ladder entrance pool.

Table 4-1: RD1 Fish Ladder Entrance Pool Turbidity, Temperature, and Dissolved Oxygen

Turbidity, inside RD1 Fish Ladder Entrance Pool			
Turbidity (NTU)	**Time, Date**	**Fish Ladder Flowrate (cfs)**	**Auxiliary Pipeline Flowrate (cfs)**
6.02	11:35, 30 November 2022	26	
6.07	11:35, 30 November 2022	26	
5.70	11:36, 30 November 2022	26	
5.34	11:37, 30 November 2022	26	
10.8	13:14, 30 November 2022	46	
11.3	13:15, 30 November 2022	46	
12.1	13:35, 30 November 2022		6
12.2	13:36, 30 November 2022		6
7.86	13:36, 30 November 2022		6

Dissolved Oxygen and Temperature, RD1 Forebay				
51.1 °F	761.2 mm HG	102.2 % saturation	11.38 mg/L DO	10:22pm 30 November 2022
49.8 °F	760.9 mm HG	105.0 % saturation	11.89 mg/L DO	10:35pm 30 November 2022
50.2 °F	759.8 mm HG	103.7 % saturation	11.66 mg/L DO	12:10pm 30 November 2022
49.8 °F	759.8 mm HG	104.8 % saturation	11.85 mg/L DO	12:13pm 30 November 2022
49.8 °F	759.7 mm HG	103.3 % saturation	11.69 mg/L DO	12:27pm 30 November 2022

4.6.3. Passage Facilities

Passage Obstruction and Blockage

RD3 Fish Ladder
At a minimum, ACWD staff monitored the RD3 Fish Ladder on a daily basis. While staff monitored the trash rake, slide gates, and vertical slots for any signs of debris or obstructions during the testing operations, no significant debris or obstructions were observed at RD3 Fish Ladder.

RD1 Fish Ladder
At a minimum, ACWD staff monitored passage conditions at the RD1 Fish Ladder daily. While staff monitored the trash rake, slide gates, and vertical slots for any signs of debris or obstructions during the testing operations, no significant debris or obstructions were observed at RD1 Fish Ladder. As noted above, the natural runoff during the start-up testing period was minimal, and flows had to be supplemented with imported water supplies delivered via Vallecitos Channel to support adequate bypass flows on testing days. As a result, debris observed during the start-up testing was minimal, with no impact to fish passage due to obstructions or blockages. Staff also monitored the condition of the Auxiliary Bypass vertical plate fish screen, and likewise no fouling, blockages, or “hot spots” observed during the start-up testing.

4.6.4. Qualitative Biological Observations

Visual Inspection/Observations – Fish Milling, Predators, and Other (Poaching, Vandalism, Etc.)

Between 1 December 2021 and 1 January 2023, 204 surveys were performed between the RD3 impoundment and bottom of the Bart Weir pool. Over this time, a total of 26 adult salmonids (most likely all Chinook Salmon) and 7 Chinook Salmon carcasses were verified by survey. Numerous observations were also made and documented by photos from local volunteers. Most observations were made in November and December of 2021 and 2022 (Figure 4-11). Fewer live salmon and carcasses were observed in 2022 than 2021. Observations of both also appeared to decrease when the ladder was operated during the test flow. While a total of 10 Chinook Salmon redds were identified in the riffle tail out below the Bart Weir pool in December of 2021, none were observed in 2022.

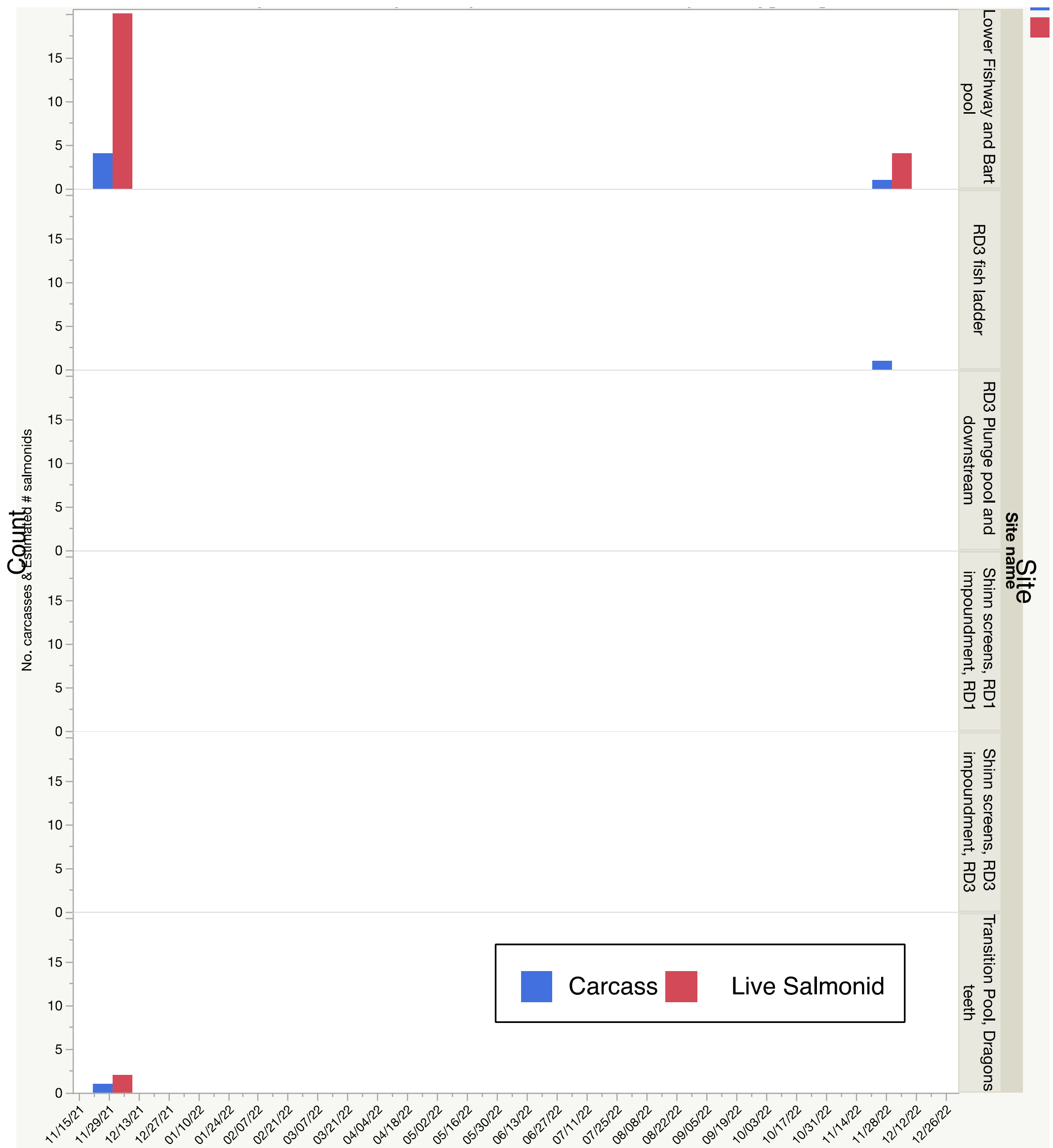


Figure 4-11: Live adult salmonid (presumed all adult Chinook Salmon) and carcass counts from visual surveys randomly performed between 1 December 2021 and 1 January 2023.

Over the same period, a total of 12 predator observations (animals thought to consume adult salmonids) were made during the surveys (Figure 4-12). These included river otters, raccoons, blue herons, eagles, and human anglers. During test flows, several observations of adult Chinook Salmon being consumed by otters and blue herons were made. Observers were unable to confirm whether these were actual predation observations or carcass scavenging. Figure 4-13 includes predator observations beyond the start-up testing

Figure 4-12: Adult salmon predator and angler counts from visual surveys randomly performed between 1 December 2021 and 1 March 2023 (blue = angler; green = avian; red = mammal).

period which is further discussed in Section 5.8.1.

4.6.5. Quantitative Biological Monitoring

Hydroacoustic Imaging – ARIS

Before the 30 November 2022 test, the ladder was relatively dry with sediment accumulation and subsequent terrestrial plant colonization within the camara bay (Figure 4-13; Image 1). By approximately 12 noon, 30 November, the ladder bay was inundated with water (Figure 4-13; Image 2) and the camera submerged. As flows came up, reference points were identified in the camera bay (Figure 4-13; Image 3) and then the camera was oriented to identify these features within the camera screen (Figure 4-13; Image 4).

Between ~10:00am and 12:50PM, a total of 8 trials with 5 test objects (e.g., fish carcasses, stadia rod, weight, aluminum can) were performed by either dragging objects in front of the camera or the camera was moved to focus on 2 fixed elements inside the ladder (e.g., metal access ladder; vegetation). Notes from each video trial were recorded on data sheets and video from the echogram and SONAR were also recorded to a hard drive located on site and then downloaded to a flash drive for later review.

The SONAR provided a range of image quality and could be detected by both echogram and SONAR, as is demonstrated by the large salmon carcass observations (Figure 4-14; Figure 4-15).

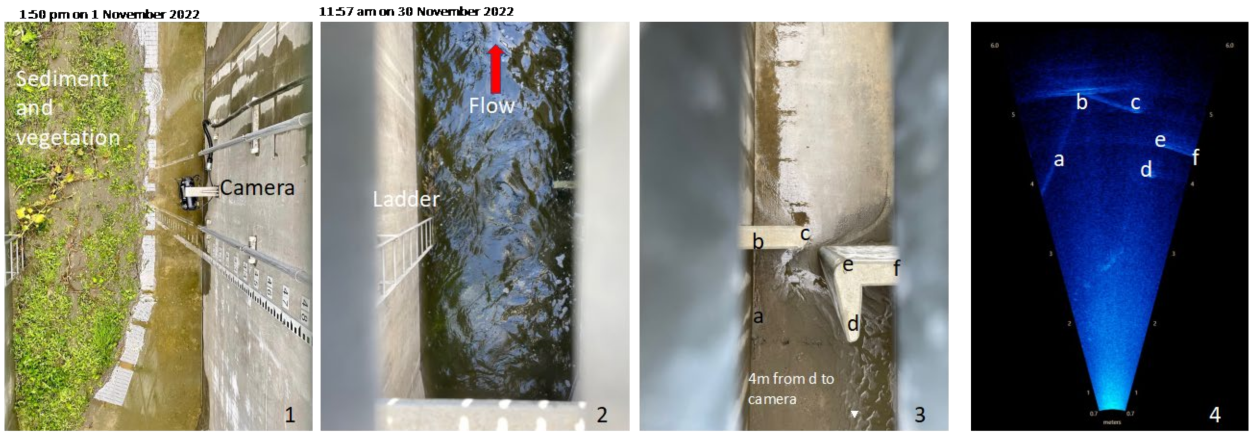


Figure 4-13: Image 1 demonstrates ARIS bay dry. Note sediment and moisture allow terrestrial vegetation colonization (taken 1 November 2022). SONAR camera is facing downstream. Camera mount is ~ 61 cm above concrete floor. Image 2 demonstrates the ARIS bay with passage flow; Camera and mount submerged. Water depth is ~65 cm. Image 3 shows demonstrates downstream opening to ARIS bay. Note corresponding letters in SONAR image (Image 4).

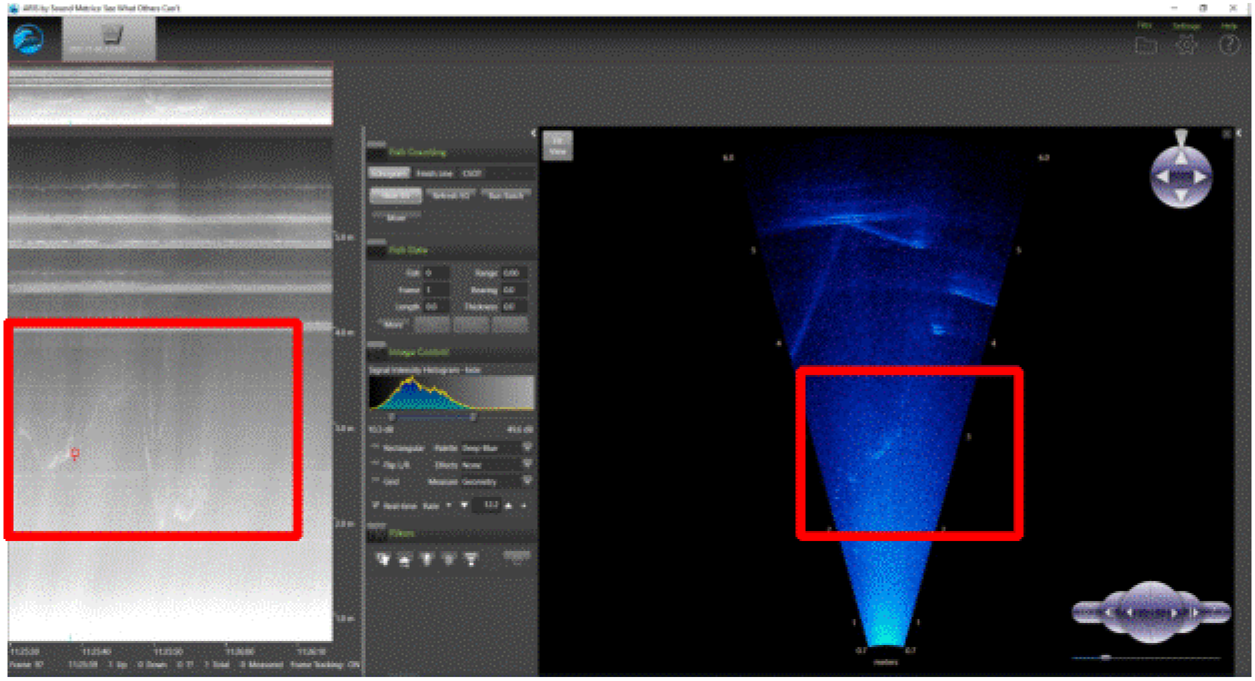


Figure 4-14. Example of echogram showing the movement of an object (Figure 4-11 salmon carcass) in left red box. Image of salmon carcass on right (red box). Time Start: 11:25; Time Stop: 11:26. Note the carcass was recorded approximately 3 m from the camera and identified on scales in both screens.

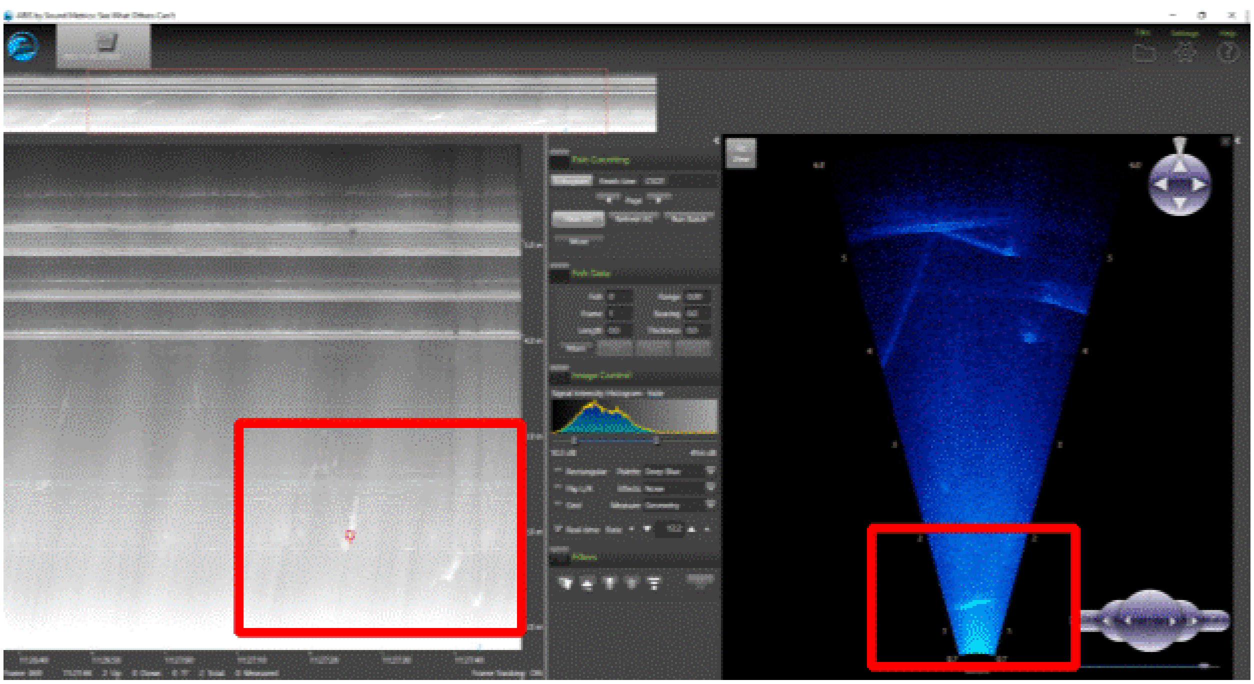


Figure 4-15. Echogram showing the movement of the salmon carcass (Figure 4-11) in left box. Image of the carcass on the right, a little more than 1 m from the camera. Time Start: 11:26 Time Stop: 11:27.

Objects with relatively small footprints that were mobile in the camera frame, such as the striped bass and stadia rod, often showed up better as a “shadow” on the back wall (see Figure 4-16; 1a) versus the hard ladder and rooted vegetation, which demonstrated as objects and shadows within the images (Figure 4-16; 2b,c,d).

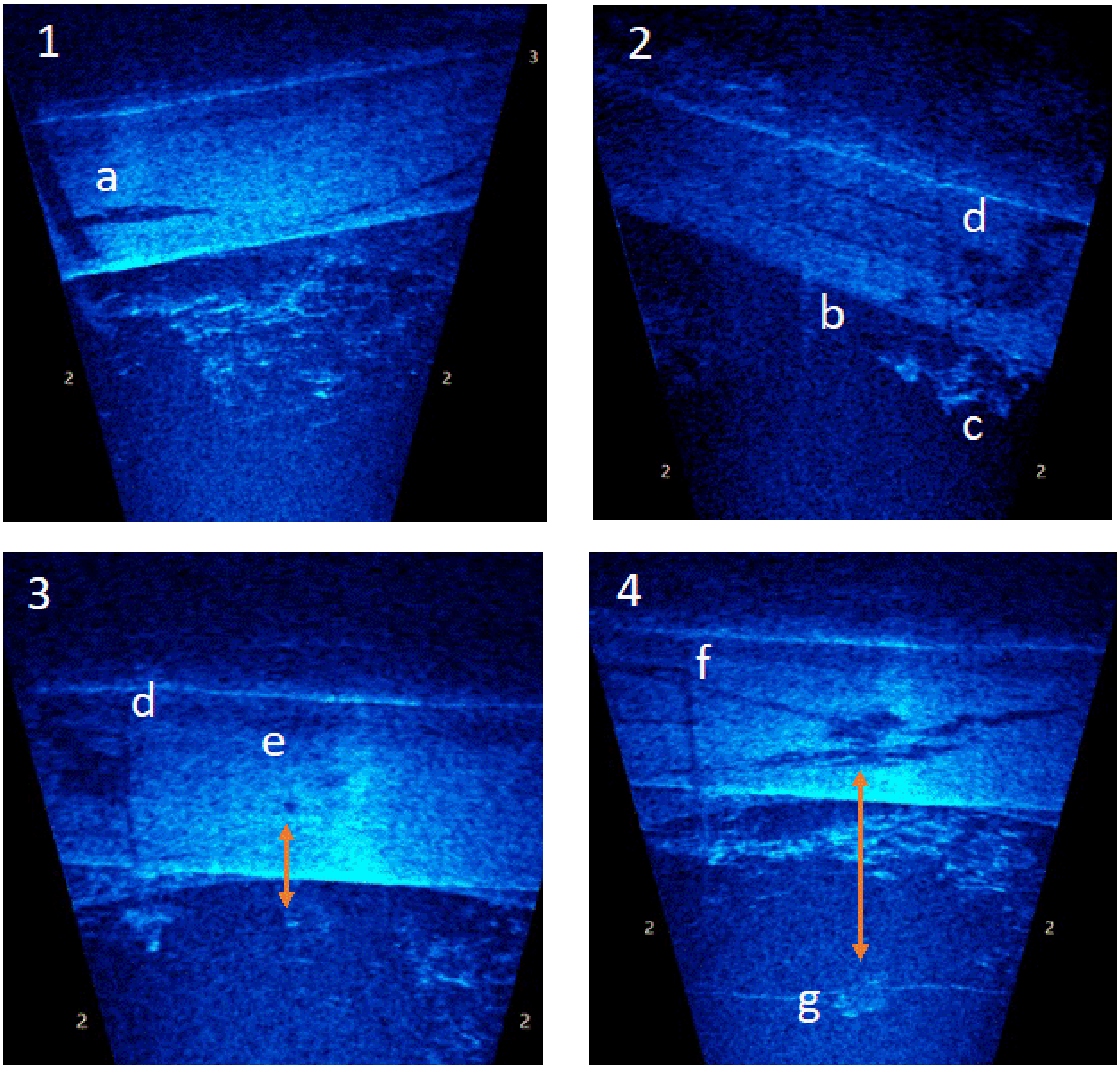


Figure 4-16: Image 1 demonstrates a 38.1 cm Striped Bass attached to stadia rod. The camera was panned to view directly across the bay (see Figure 4-13 as reference to items identified here). The bright midline is where the bay floor and south wall meet. The Striped Bass and rod are obscured by submerged vegetation and their shadows (a) are more clear than actual objects. Image 2 demonstrates a camera screenshot panned approximately 30 degrees more upstream. (b) is the access ladder (c) is a clump of vegetation and (d) is the shadow of the vegetation on the wall. Image 3 demonstrates where the camera was panned downstream approximately 15 degrees from Image 2. The access ladder (d) is a reference point; and the shadow (e) of a 5.08 cm-long weight and the actual weight (orange arrow) can be seen. Image 4 demonstrates the (f) access ladder and the (g) Striped Bass off the end of the stadia rod. The shadow of the rod and bass show up on the wall (orange arrow at g). Note that the vegetation clump depicted in 2c can also be seen at various angles throughout the other images.

Of the 11 trials, ~91% of objects (10) could be accurately identified in the video images (Table 4-2*).* The 1 unidentified object (Atlantic Salmon) was pulled directly across from the camera in the bay. Target sizes estimated from the screen with the ARIS program were anywhere from 47% smaller to 18% larger than known sizes taken before the trials (mean 9.3% smaller). In general, the size of the two tethered carcasses were estimated to be smaller than actual size while inanimate targets were estimated larger than known size.

Table 4-2: Results from SONAR camera trials run from 11:00am – 1:00pm 30 November 2023. Image items are described in Figure 4 6 and Figure 4 13.

Time Start	Time Stop	Transect	Camera angle/ view	Known Image	Known size (cm)	Object Observed Y/N	What you would be able to ID	Where?	Estimated size (cm)	Deviation
11:23	11:25	RL	Downstream	Tethered Alantic Salmon	83.21	Y	Large Fish	RL	70.4	85%
11:25	11:26	Center	Downstream	Tethered Alantic Salmon	83.21	Y	Large Fish	Center	73.4	88%
11:26	11:27	RR	Downstream	Tethered Alantic Salmon	83.21	Y	Large Fish	Center/RR	67.5	81%
11:30	11:32	RL	Across Fish Ladder	Tethered Alantic Salmon	83.21	Y	Fish?	Center	47.6	57%
11:32	11:33	Center	Across Fish Ladder	Tethered Alantic Salmon	83.21	N	No	N/A	N/A	N/A
11:33	11:36	RL	Across Fish Ladder	Tethered Alantic Salmon	83.21	Y	Large salmonid	RL	68.1	82%
12:04	12:05	RL	Slightly Upstream and Across	Access Ladder	42.40	Y	Ladder	RL	50.1	118%
12:36	12:37	RL	Slightly Upstream and Across	Access Ladder	42.40	Y	Ladder	RL	48.9	115%
12:42	12:44	RL	Slightly Downstream and Across	Striped Bass on Stada Rod	38.10	Y	Rod + Fish	RL	37.4	98%
12:46	12:47	RL	Across Fish Ladder	Triangular Fishing Weight	5.08	Y	Solid object dropped in ladder	RL	3.5	69%
12:51	12:52	RL	Across Fish Ladder	Aluminum Can on String	11.43	Y	Solid object on string	RL/ Center	13	114%
					Percent observ	90.9%		Mean		90.7% (SE 6'

PIT Tag Detection – Antenna Array

All 50 test tags were detected on at least one antenna and 39 tags were detected at both antennas (*m* = 39) (*Table 4-3*; Figure 4-17*).* Individually, Antenna 4 recorded 112 total detections comprising 43 unique tags (n_1), while Antenna 2 recorded 173 detections that represented 46 unique tags (n_2) (*Table 4-3*; Figure

4-17*).* The detection probabilities for Antenna 4 and Antenna 2 were similar (Antenna 4 (p_1) = 0.85; Antenna 2 (p_2) = 0.91), and the overall detection probability ($\hat{p}$) for both antennas is 0.98 (*Table 4-3).*

Table 4-3. Summary table of detections and detection probability at each antenna. The detection probability of either antenna is left blank, as it represents the same as the detection probability in the first two columns of Antenna 4 or Antenna 2.

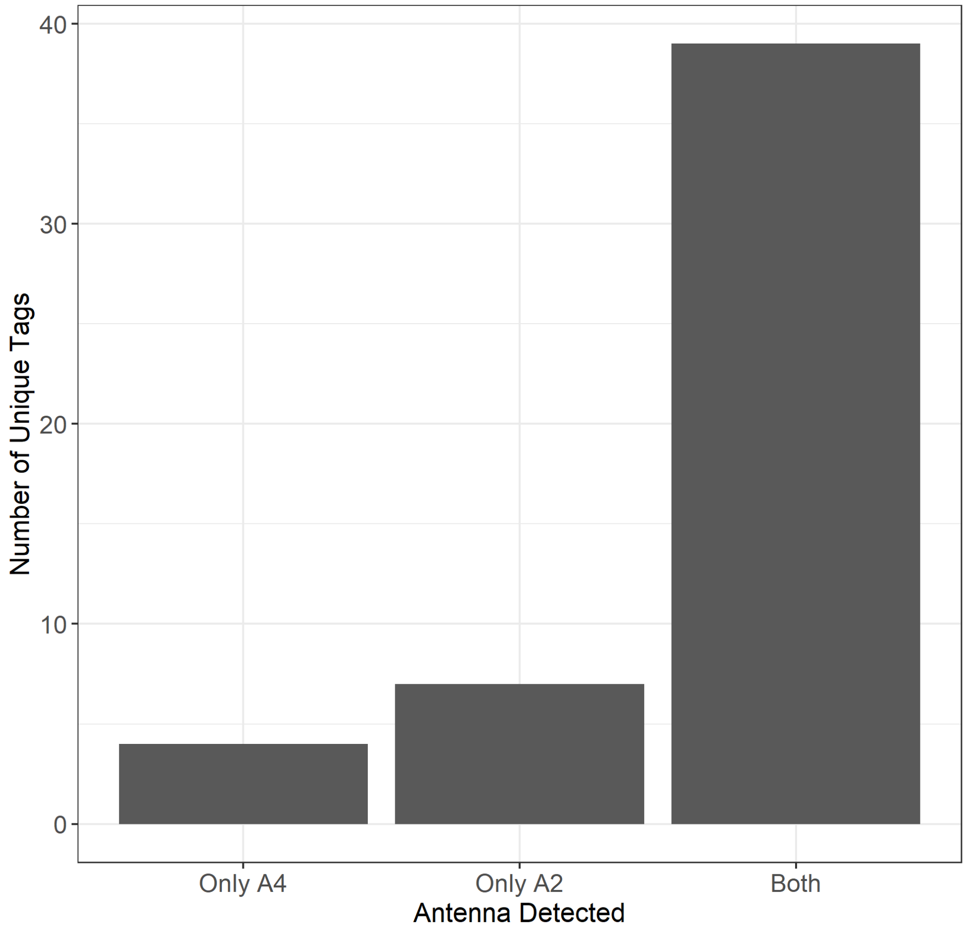


Figure 4-17: Number of unique tags detected by Antenna 4 (Only A4), Antenna 2 (Only A2), or both antennas (Both).

	Antenna 4	**Antenna 2**	**Either Antenna**	**Both Antennas**
Total number of detections	112	173	285	255
Number of tags detected	43	46	50	39
Detection probability	0.85	0.91	-	0.98

Release times recorded were not synchronized with internal clock settings of antennas, which resulted in release times that were suggested to occur after a detection was recorded. The time discrepancies were a few seconds up to 192 seconds – for this reason, the release times were discarded from the analysis and only travel times between Antenna 4 and Antenna 2 were calculated. For the 39 tags that were detected at both antennas, travel time ranged from 7 to 157 seconds with an average of 63 seconds (Figure 4-18). Increased travel times between antennas might suggest that tags are moving slower through the fish ladder and result in higher numbers of duplicate detections, but this pattern was not observed in this study (Figure 4-18). Tags with longer travel times did not consistently result in a greater number of detections; similarly, tags with shorter travel times did not consistently result in lower detection numbers (Figure 4-18).

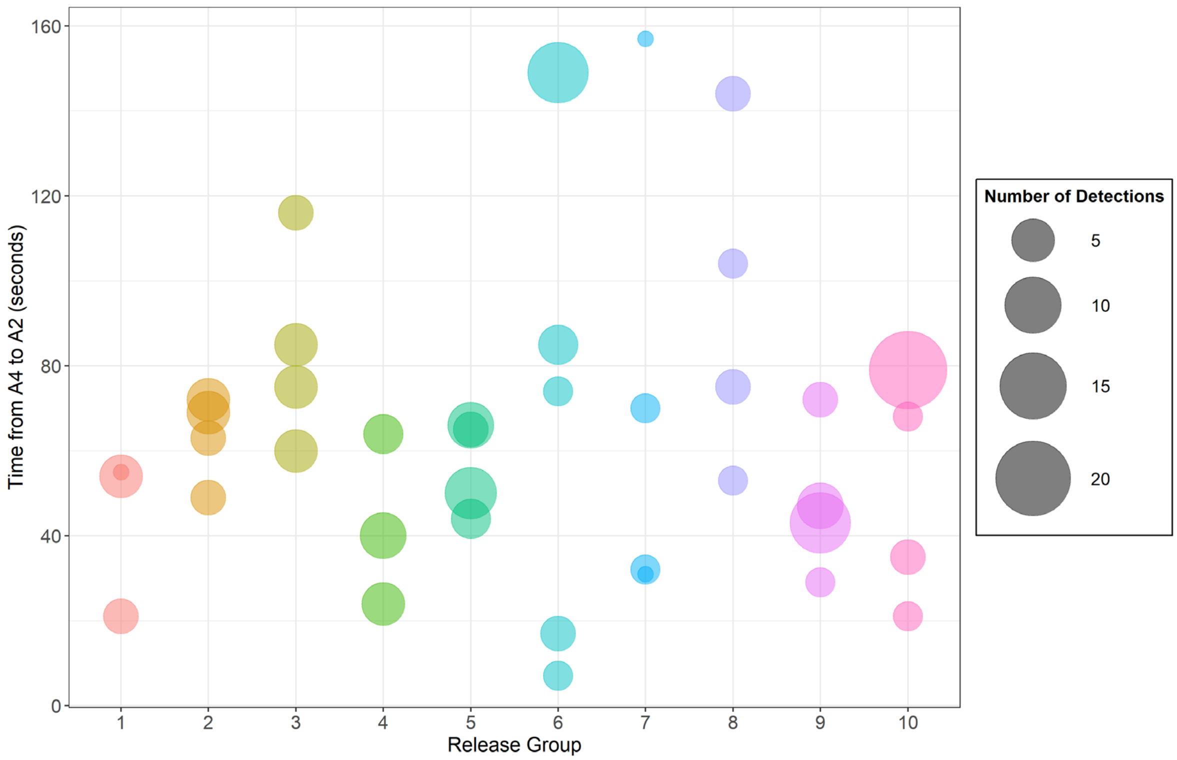


Figure 4-18: Travel time (seconds) between antennas for individual tags that were detected at both antennas (n = 39). The size of each point is scaled to represent the number of detections that were recorded for a given tag.

4.7. DISCUSSION OF START-UP TEST RESULTS

4.7.1. Physical Conditions

The start-up testing provided ACWD staff with their first experiences operating the new RD1 fish ladder facility and the upgraded RD1 facility. Tasks included reviewing SOPs and gaining familiarity with the HMI displays and settings on the SCADA system which controls facility operations. For example, for the RD1 Fish Ladder, operators were able to cycle the slide gates for the exit gates, juvenile spillway, and low-flow gate. Staff also tested the operations of the sluice valve, the auxiliary bypass valves, and entrance gates. Staff tested fish ladder operations in both the manual and automatic settings and could compare the programming logic of operations under certain automatic settings. Overall, ACWD staff studied ladder dynamics and flow patterns to better understand how the ladder operates and how and where daily maintenance procedures could be conducted. This led to improved daily datasheets and monitoring of fish passage equipment during operation of the fish ladders.

ACWD was able to confirm that passage conditions could be met at various flows passable for fish (about 24 to 45 cfs) at each exit gate (exit gates 1-5). However, it is noted that for two flow conditions tested on 30 November 2022, the exit gates were not operated in automatic mode to be within the one-foot head drop passable criteria (between exit channel and exit pool), are not representative of expected future fish ladder operation, and are not included in this report. All other tests were conducted with exit gates in automatic mode, representative of normal expected conditions for various migratory season and off-season operations. The passage conditions for the juvenile spillway and low flow gate were also tested and confirmed for normal expected conditions for various migratory and off-season operations. Refer to section 4.5.1 for result details.

ACWD also analyzed the relationship between the water surface elevation in the lower fish ladder and flow released into the RD1 fish ladder without flow over RD1. This theoretical relationship was used to establish automated operational programming. This helped ACWD's understanding of the ladder and channel function under a range of test flows. While the relationship between flow in the fish ladder and the water surface elevation was a good fit, it was recommended to have additional measurements of this especially when RD1 ladder flows are less than 22 cfs and greater than 23 cfs.

During the start-up testing, ACWD ran through processes for inspecting debris and the RD3 and RD1 trash rake, slide gates, and vertical slots to gain experience for daily monitoring. However, since the start-up testing was completed over a relatively short period of time and so only provided experience for environmental conditions during that period, it was recommended to do long-term monitoring and inspection of debris and the trash rack which would be included in the daily datasheets.

Head drop measurements between fish ladder pools were on average close to the one-foot head drop design criteria. These head drop measurements can be tested again to confirm they are within the design criteria. Also, the depth-to-fall ratios calculated during juvenile spillway testing met the fish ladder facility's Draft BODR minimum threshold of 0.25 ft/ft at juvenile spillway flowrates greater than approximately 18 cfs. The precise minimum flowrate that the juvenile spillway can be utilized will be further refined through additional operational experience, though it is not expected to be used at flow rates below 20 cfs unless additional exit gates are providing flow and additional water depth in the plunge pool (pool 10) below the juvenile spillway. The depth-to-fall ratios calculated during low-flow gate testing met the BODR minimum threshold of 0.25 ft/ft at flowrates greater than approximately 8 cfs. At flowrates lower than about 8 cfs it is expected that baffles could be installed in the vertical slots between Pools 20, 19, and 18, to increase the water depth in pool 20, and maintain the 1-foot head drop criteria between pools downstream of Pool 20. During out-migration season, the low flow gate is not expected to be used at flow rates below 8 cfs unless additional exit gates, mainly exit gate 5, provide flow and additional water depth in Pool 20 below the low flow gate. These scenarios can be tested for the next migration season.

The velocity measurements taken within the RD1 fish ladder at vertical slots where the velocity meter was positioned within about 6 to 10-inches upstream of the axial center resulted in an average of about 2.8 ft./sec. When the velocity meter was able to be positioned to the axial center of the vertical slot (positioned between pools #1 and #2), the average velocity was notably higher at about 4.6 ft./sec. Due to the variability of the velocity measurements, it is recommended that these tests be repeated.

Turbidity, DO, and temperature were also measured during the start-up testing at the RD1 fish ladder entrance pool (turbidity) and the RD1 forebay and fish ladder (DO and temperature) (refer to section 4.6.2 for data and details). As the start-up testing covered a relatively small time period and only a couple of locations, it was recommended to gather water quality data year-round throughout the project area. For example, temperature may surpass target species requirements during November and April-May, especially during dry and critically dry water years. During low flow periods, RD3 and RD1 may stratify when dams are fully inflated. Such stratification may provide benefits during such periods, and this should be studied more fully in the future.

4.7.2. Biological Monitoring Equipment

The ARIS sonar camera and PIT tag antennas were also tested during the start-up testing. For the ARIS sonar camera, in general, the size of the two tethered fish carcasses were estimated smaller than actual size while inanimate targets were estimated larger than known size.. The findings and recommendations for the ARIS sonar camera and PIT tag antennas are further described in the sections below.

ARIS Sonar Camera Function

A few of the key challenges associated with fish monitoring using imaging sonar included: (1) recognition of small fish forming dense aggregations; (2) species identification, which limits their use in species-specific studies; and (3) time-consuming massive data processing. It is important to note that similar issues were encountered by staff viewing DIDSON and ARIS footage from Upper Sacramento River Basin program, reporting little difficulty identifying larger adult salmon (Killam et al. 2018). However, for the smaller fish (e.g., 18 to 24-inch) common to Sacramento Basin, viewers often were unable to identify individual species. These included species such as steelhead, smaller salmon, Sacramento Pikeminnow (Ptychocheilus grandis), Hardhead (Mylopharodon conocephalus), Sacramento Sucker (Catostomus occidentalis) and even beavers and river otters were difficult to distinguish using just sonar footage. Therefore, advanced algorithms for sonar imagery processing and integrations with other sampling technologies are needed for future development (Wei et al. 2022). According to the Alaska Department of Fish and Wildlife, ARIS can be used to distinguish different sizes (lengths) of fish, but not different species of the same size. Even so, CFS was able to definitively identify adult Chinook Salmon and Pacific Lamprey under sub-ideal conditions. This sets the stage for continued fish passage monitoring program development at the RD1 fish passage facility. Overall, it is recommended that additional periodic testing of the ARIS sonar camera is recommended to confirm the findings of this initial test and further refine the understanding of this relatively new sonar camera system

Detection Accuracy
The RD1 ARIS sonar camera provided a range of image quality and objects could be detected by both echogram and SONAR, including a large adult salmon carcass. Of the 11 trials, ~91% of the 6 known objects used in the trials could be accurately identified in the video images.

Length Estimate Accuracy
Target sizes estimated from the computer screen with the ARIS program were anywhere from 47% smaller to 18% larger than known sizes taken before the trials (mean 9.3% smaller). In general, tethered carcasses were estimated smaller than actual size while inanimate targets were estimated larger than known size. These preliminary results compare with Helminen et al (2020), who found in an experiment where 69 known-sized adult Atlantic salmon (*Salmo salar*) directly released into the sonar field at ranges between 15 and 29 m from the camera. They found wide size ranges in estimates size with estimated generally smaller than actual sizes. Of all their human-generated measurements, 50% were classified as fair, 41% poor or very poor, and only 9% of the measurements classified as good or very good. Similarly, Cook et al. (2019), found accuracy and precision of imaging sonar to be poorer than a stereo-camera system when measuring static synthetic targets as highlighted by the +29.8 ± 12.0% overall accuracy of the imaging sonar compared with the -2.3% ± 2.8% overall accuracy of the stereo-camera during synthetic target size determinations. They found that imaging sonar accuracy was adversely affected by the angle at which the target presented to the beams. Whereby, the overall error on imaging sonar measurements of the synthetic targets was +29.8 ± 6.9% including the 0° orientation angle, or +13.3 ± 4.3% when the 0° orientation angle was excluded from analysis. Because the RD1 ARIS was sited in the middle of the chamber wall, angling the camara to detect fish entering the chamber from downstream orients the angle close to 0°, ACWD could expect fish

images to have relatively large errors and would need to take these into account over the monitoring season.

PIT Tag Antenna Function

Regarding the PIT tag antenna testing, detection efficiency for the two vertical slot, pass-through PIT antennas in the RD1 fish ladder was very good during low flow conditions. From this start-up testing, it is expected that the probability of detecting a tagged steelhead (or other species) at Antenna 4 to be 0.85, Antenna 2 to be 0.91, and overall probability at both antennas to be 0.98. While these results are promising, further detection efficiency tests should be conducted with conditions that inundate the two high flow antennas.

Detection Accuracy
Under study conditions (low flow), ACWD can expect the probability of detecting a tagged steelhead at Antenna 4 to be 0.85, Antenna 2 to be 0.91, and overall probability at both antennas to be 0.98. These results are similar to those reported in the literature (Gibbons and Andrews 2004), including a PIT system installed at a weir leading into a fish trap at Bonneville Dam, Columbia River for adult steelhead (98%; [McCutcheon et al. 1994]).

Time Between Antenna Detections
For the 39 test tags that were detected at both low-flow vertical slot pass-through antennas, travel time between antennas ranged from 7 to 157 sec (mean = 63 sec). Increased travel times between antennas might suggest that tags are moving slower through the fish ladder and result in higher numbers of duplicate detections, but this pattern was not observed in this study. Suggesting the antennae are performing well under these conditions.

Adaptive Management: Incorporating Biological Monitoring Test Results Into 2023 Monitoring Season

CFS used the test video file size by time recorded to determine how big a data storage unit was needed for the ARIS videos over the monitoring season. CFS then used this to confirm how long it would take to fill each hard drive and planned for data download accordingly. Results from the test study demonstrated that video images collected by the ARIS camera did not identify fish equally across the field of vision. From these observations, a field grid monitoring scheme was developed to pinpoint areas of poor image collection over the monitoring season.

While the PIT tag antenna results are promising for low flow detections, efficiency tests should be conducted at high flow conditions to determine detection efficiency for the two high flow antennas (1 and 3).

5. 2023 ANNUAL OPERATIONS, MONITORING, AND MAINTENANCE ACTIVITIES

5.1. GENERAL BACKGROUND ON COMPLIANCE CONDITIONS

5.1.1. Operations and Maintenance Procedures

Districts are drafting a plan for O&M procedures (i.e., preventive and corrective maintenance procedures, inspections and reporting requirements, maintenance logs, etc.), particularly with respect to debris, screen cleaning, and sedimentation issues. Experience and data gained from this report will support the development of the draft O&M Plan. The final detailed plan shall be based on the functional design unless design changes are agreed to by NMFS and with voluntary coordination with CDFW. All passage facilities (both juvenile emigration and adult immigration/emigration) will be operated as designed to function properly through the full range of hydraulic conditions expected at a particular project site during fish migration periods and will account for debris and sedimentation conditions that may occur.

Within the O&M plan, Districts will provide periodic inspections and corrective action should the passage conditions become impaired because a facility is damaged or inoperable. At a minimum, operation and maintenance items include:

- Specifying what entity is responsible for the daily operation and maintenance of the various elements or portions of the Districts' jointly managed RD1 fish ladder facility.
- Annual, seasonal, and/or daily operating activities necessary to ensure proper function of the facility.
- Check the passage facility at regular intervals to confirm it is operating within design criteria.
- Clean trash racks and debris collectors and remove debris accumulations regularly.
- Adjust gates, orifices, valves, or other control devices as needed to regulate flow and maintain passage structure within operating criteria.
- Periodically check staff gauges or other flow metering devices for accuracy.
- Annually inspect the passage structures for structural integrity and disrepair.
- Inspect gate(s) and valve seals for damage.
- Replace worn or broken stoplogs, baffles, fins, or other structural components.
- Remove sediment accumulations from within the passage structure, where applicable.

Additionally, to confirm if the minimum bypass flows are being maintained, ACWD will maintain an operations log with a date and time for each major operational event, such as raising the dams, lowering the dams, initiation and termination of diversions and transitions between flow schedule periods. A summary of the operations log and streamflow at compliance points (i.e., USGS gauges) shall be provided annually in compliance with the BiOp.

ACWD is responsible for hydraulic monitoring and operation of the fish ladders and ACWD and ACFCD have shared responsibilities for environmental regulatory monitoring, maintenance, and reporting for the RD1 upper vertical slot ladder and the lower pool and chute ladder. The Districts have entered into an agreement to delineate maintenance responsibilities for the RD1 upper vertical slot ladder and the lower pool and chute ladder.

5.1.2. Hydraulic Parameters

Water levels at several specific points in and around the fish ladder (upstream, downstream, specific pools, etc.) are measured and recorded. For example, within the RD1 Fish Ladder, water levels and head differences are monitored and recorded at the RD1 impoundment and at each pool immediately downstream of an exit gate, at the juvenile spillway, and at the entrance pool and transition pool located upstream and downstream, respectively, of the entrance gate. The ACWD SCADA system monitors and records these measurements, which vary depending on upstream and downstream water levels as well as gate position. It should be verified that both the flow pattern and the level of turbulence at various points in the fish ladder remain compatible with the specific demands of the various species, such as plunging or streaming flows at each cross-wall between pools, or the presence of large recirculation areas in the pools. If needed, metal baffles can be inserted into vertical slot openings between pools to create additional pool depth within the upper pools, and an auxiliary bypass can be operated to covey additional water from the forebay to Pool 1 of the RD1 Fish Ladder to ensure that hydraulic parameters within the fish ladder meet the requirements.

5.1.3. Mechanical Parameters

For vertical slot fish ladder facilities, the various flow regulatory components, such as slide gates at the exit gate openings or juvenile spillway openings at the upstream portion of the ladder, baffles which can be inserted into vertical slot openings between pools, auxiliary bypass valves within the auxiliary bypass pipeline, and the adjustable “saloon” style gates at the downstream entrance, are used for controlling the discharge or the head differences between the pools throughout the operable run of the fish ladder. ACWD Water Controllers monitor these components of the fish ladder each day of the year to confirm they are functioning properly when in use. When components are determined not to function properly, Water Controllers first determine if there are minor operational or SCADA settings that can be adjusted or reset to restore functionality. If components are broken or unresponsive to minor corrective measures, ACWD Water Supply staff will notify the ACWD Facilities Maintenance Division to request technical or mechanical support. If critical components need major repair, ACWD Water Supply staff will coordinate with ACWD Facilities Maintenance Staff or Engineering staff, as appropriate, to develop a contingency plan to temporarily support continued operational compliance while repairs are affected. All mechanical components, including valves, should be fully cycled (operated from fully closed to fully open, then back to fully closed) as part of an annual preventative maintenance program. ACWD Water Controllers will fully cycle each valve at least annually and inspect valve condition for any additional maintenance, such as lubrication or sealants. If needed, Water Controllers will request support from Facilities Maintenance Division staff for additional maintenance as needed. The MAMP provides general information about the mechanical function of the passage facility. Below are specific details related to the daily O&M logs for mechanical parameters for the Annual Report Period.

5.1.4. Passage Obstruction And Blockage

Particular attention is paid to any obstructions caused by drifting debris, which may hinder fish passage in certain critical areas (communication between pools, the water intake of the fish ladder, etc.), or may reduce the attraction of the fish ladder (screen clogging for filtering the injection of auxiliary water). Either might occur without necessarily showing any obvious disturbance to the flow. Water Controllers carefully and regularly check the fish ladder trash rack and submerged orifices, including vertical slots, exit and spillway gates, and are checked regularly and carefully daily. The MAMP provides general information about passage obstruction and blockages of the passage facilities. Below are specific details related to the daily O&M logs for passage obstruction and blockage parameters for the Annual Report Period.

5.2. FISH SCREENS

5.2.1. Fish Screening on Diversion Points

Screening diversions can serve multiple objectives such as fish protection and debris and sediment management (USDA 2013). ACWD operates a total of 12 cylindrical screens installed at four separate locations along Alameda Creek. The new Shinn Screened Diversion facility currently includes six cylindrical fish screens and occupies an area approximately 300 feet long by 75 feet wide along the levee of the flood channel. Project fish screen facilities were designed to include a track-mounted configuration with winches that raise and lower the screens for maintenance, avoid debris impact, and to store out of flow when not in use. Flow through the screens is controlled by slide gates mounted under the screens with stems that extend to allow for gate control from the top of the bank. The screens are cleaned by rotating against stationary internal and external brushes. The screens are meant to prevent steelhead and other fish entrainment and impingement as Alameda Creek water from is diverted through pipelines in the levee to off-channel recharge basins. The screens are designed to provide a maximum approach velocity of 0.33 ft/sec, allowing the smallest life stages of steelhead to freely swim away from the face of the screen (i.e., avoid impingement). The screen mesh <1.75 mm (~0.07 in) prevents entrainment of all life stages of steelhead into the diversion system. The screen facility is designed to operate effectively in an environment with minimal to no sweeping flow and in an environment that is affected by intermittent periods of high flow events with heavy debris loads. The screens include self-cleaning brush systems and can easily be removed from the channel for inspection or repair without special equipment. Photos of the fish screens are provided in Figure 5-1.

Figure 5-1: Single Shinn fish screen close-up (left), and the set of screens lined up on the northern bank of Alameda Creek (right).

5.2.2. Debris, Fouling

Debris Management and Removal

Each ACWD diversion is equipped with state-of-the-art cylindrical fish screens which include active debris management and anti-fouling processes. The screens include internal and external brushes that clean the entire circumference of the fish screen cylinder on a regular schedule. SCADA system monitors and records the cleaning intervals and displays an alarm to notify the Water Controller if the cleaning interval threshold is exceeded. On at least a daily basis, Water Controllers will monitor the cleaning operations daily to confirm optimal screening performance. If there is any question about performance, the Water Controller may close the diversion and retract the fish screen to physically inspect the screen for debris and cleaning.

Understanding Fish Screen Hydraulics

Flow velocity measured perpendicular to the screen surface is referred to as screen approach velocity (Va). This is the velocity a fish must swim against to avoid impinging on the screen mesh. Flow velocity measured parallel to the screen surface is referred to as screen sweeping velocity (Vs). This is the velocity that carries a fish swimming against the approach velocity away from the screen. Creating a strong sweeping flow is a highly desirable feature for transporting fish and debris away from the screen. In the absence of a strong sweeping flow, fish are more likely to swim against flow entering the screen until exhaustion impairs their ability to avoid impingement. The time it takes for a particle carried by sweeping flow to pass the length of the screen can be thought of as approximately the duration that a fish will be in danger of impingement. For small screens, this duration should be relatively short. Therefore, NOAA small screen criteria (applies to screen lengths <4 ft) allow screens to be set at any angle to the stream and bypass flow. Although not required under NOAA small screen criteria, establishing a strong sweeping flow across a small screen is recommended and will benefit fish protection and debris and sediment management.

Minimizing fish impingement risk also requires that the approach velocity (Va) to the screen is less than the fish's swimming ability for short periods referred to as the fish's sustained swimming speed (Castro-Santos 2005). Sustained swimming speed can vary widely between fish species and age class (body size). NOAA salmonid fry criteria for screens with active cleaning systems require a screen approach velocity of ≤ 0.4 ft/s for canals and ≤ 0.33 ft/s for rivers, streams, and lakes based on total area of screen fabric. For fingerling-sized salmonids and larger, an approach velocity ≤ 0.8 ft/s is allowed.

As part of the draft O&M plan, ACWD is developing an evaluation strategy using physical and biological field data to determine whether the fish screen sites comply with the intent of the fish protection criteria.

5.2.3. Fish Protection

NOAA criteria contain two levels of screen criteria, one for protecting juvenile salmonid fingerling size and larger fish, and a second level for protecting salmonid fry and larger fish. Fingerlings are defined as juvenile salmonids larger than 60 mm (2.4 in) and fry are juvenile salmonids less than 60 mm in length (NOAA 1997). The fingerling criteria allow for greater screen approach flow velocity, screen opening, and minimum screen porosity based on the larger fish size and greater swimming strength of an older juvenile. When NOAA criteria are required, the fingerling criteria can only be used when it can be shown fry are not present during diversion. This is often difficult to prove and therefore NOAA fry criteria are widely used for screening. In general, NOAA fry screen criteria will protect many fish species with body lengths greater than 25 to 50 mm (~1 to 2 inch). Excluding smaller bodied fish including eggs are not discussed herein but may be feasible with specially designed screens.

5.3. SAFETY PROGRAM

The Districts prioritize safety in the operation and maintenance of these fish passage facilities. With new facilities, new standard operating procedures must be developed to identify potential hazards and to mitigate those identified hazards associated with work tasks at the new facilities. During the reporting period, ACWD Project Engineering staff, responsible for the design, construction, and commissioning of the new facilities, released Shinn Screened Diversions and the RD1 fish ladder to ACFCD and ACWD (Water Supply and Facilities divisions) for their respective operation and maintenance responsibilities. ACWD Facilities staff and Water Supply staff worked closely with the ACWD Health and Safety Officer to conduct preliminary job hazard analyses of the anticipated O&M tasks at the new fish passage facilities. During that effort, ACWD identified several safety improvements that were recommended to provide either administrative or engineering controls to mitigate potential hazards.

Additionally, ACWD utilized a third-party contractor to conduct a safety evaluation of the new facilities, including the RD1 upgrades, the vertical slot fish ladder at RD1, and the Shinn Screened Diversions, to thoroughly review expected O&M activities at these facilities. The safety evaluation identified which activities required entry into permit-confined spaces and suggested several safety improvements to make work in and around the facilities safer for staff and contractors. ACWD's Health and Safety Officer has led a review of the safety evaluation and is considering recommendations for both administrative and engineering controls to ensure staff safety at these facilities.

As the Districts gain operational experience during the first year of operation of the new facilities, they are identifying new safety considerations associated with completion of O&M activities. For example, the new vertical slot fish ladders and the new pressure relief structure at RD1 both require routine operations or maintenance activities, however they are deemed confined spaces and require permits to allow entry.

To illustrate both the criticality and consequences of the Safety Program development during this first year of operations, consideration has also been given to routine maintenance of the sonar camera and associated equipment located within the RD1 Fish Ladder in Pool 10. While the sonar camera manufacturer documentation noted that the design of the camera includes ports to allow water to flow within the camera body and around the camera lens, and that, depending on the water quality conditions, routine maintenance may be required to perform periodic cleaning around the camera lens to remove accumulated silt deposits, the frequency of the cleaning would be determined through evaluation of image quality during actual use.

Starting in November 2022, ACWD Water Supply staff began discussions with the ACWD Health and Safety Office to prepare a safe entry procedure to access monitoring equipment within the RD1 Fish Ladder for routine maintenance. Preliminary safety evaluation determined that, upon certain conditions, Pool 10 could be classified as a Permit Confined Space, meaning access to the sonar camera required permit confined space entry procedures to be developed and approved before ACWD staff could access the camera. Ultimately, ACWD developed a safe entry protocol that would allow staff to safely access the sonar camera for maintenance, but the protocol was not completed and approved until May 2023. Adequate staff training and scheduling of the support team necessary for the safe entry subsequently resulted in the first safe entry into Pool 10 by ACWD staff in June 2023, after the conclusion of the out-migration period and several weeks after the sonar camera video quality had degraded to the point of no longer providing any useful imagery. More discussion of this issue is provided in Section 6.

Where appropriate, and in some cases as a contingency plan to compensate for the lack of safe entry protocols, ACWD staff utilized GoPro cameras to collect still images and/or video imagery to reduce crew exposure to confined spaces and/or need to access flowing water. This equipment also reduced the need to alter flow for fish passage facilities inspection.

5.4. DATA MANAGEMENT

Program data management is the collection, processing, analyzing, and communicating of program data to assist decision making. The purpose of data management in the FLOWS Program is to provide consistent and rapid access to accurate, validated data which can be used in decision making concerning successful steelhead and other target species passage within the flood control channel and associated ACWD facilities. The benefits of program data management includes but is not limited to:

- Enhanced communications by providing project team data access
- Facilitates rapid data retrieval and analysis
- Ensures data integrity and control – data security
- Maximize confidence and certainty associated with data
- Provides for data to be transitioned to clients/owners
- Complies with contract requirements
- Provide data of known quality for legal and technical defensibility

The FLOWS Program includes development of a Data Management Plan (DMP) to identify and document the Program's requirements and responsibilities for managing, using, and archiving environmental information related to the Program. Sufficient detail will be provided in the DMP to clearly define data types the FLOWS Program will generate and use; who is responsible for the various activities related to information management; how the FLOWS Program will manage its data; and when data exchanges will occur and between whom. The DMP only pertains to the management of the FLOWS Program's environmental information. Environmental information includes electronic or hard copy records obtained by the FLOWS Program that describes environmental processes or conditions; both physical and biological. Information generated by the FLOWS Program (e.g., analytical results from samples collected) and obtained from sources outside the of the FLOWS Program t (e.g., historical data) fall within the scope of the DMP. Certain types of information, such as personnel or financial records, are outside the scope of the DMP. Key DMP aspects include:

- Data stewardship
- Data policy, ownership, custodianship
- Database design and implementation
- Standardized datasheets
- Storage, backup and archiving
- Access and security
- Data management
- Data modeling
- Data acquisition
- Quality assurance and quality control
- Data sharing process

This first year of data collection supports the understanding of the type, quantity and quality of data to be collected under the FLOWS Program for us to develop a robust and adaptable DMP. It is expected that the DMP will be completed early in the FLOWS Program life cycle (assumed mid-2024) to confirm that the necessary and appropriate data management systems and personnel are in place before the FLOWS Program acquires large data quantities. The DMP will be reviewed and updated as necessary.

5.5. FISH SCREENS AND FISH LADDERS FUNCTION

5.5.1. Methods

Fish Ladder And Fish Screen Inspections

Physical Inspections

The Districts have been jointly developing an O&M manual for the fish passage facilities in the Flood Control Channel. When complete, this plan will be provided to NMFS and CDFW for approval. The plan is expected to be completed within one year of initial operation facilities operation. Until that time, the Districts used the following draft methods.

Routine inspection and maintenance work is contained within the Flood Control Channel and levees from Mission Boulevard downstream to the RD1/Drop Structure fish ladder. This included routine fish ladder and fish screen inspections performed at RD1 and the fish ladder, RD3 and fish ladder, and all water intakes operated within the Flood Control Channel to determine their condition and required maintenance.

The following components, where applicable, of each facility are inspected on a daily basis by ACWD Water Controllers: (1) upstream access and channels; (2) downstream access and channels; (3) culverts; (4) baffles/pools; (5) pool/chute structures; (6) entry and terminal pools; (7) weirs; (8) bypass channels; (9) gates; (10) debris racks; (11) control systems; (12) screen faces; and (13) screen cleaning systems.

Inspections were performed to confirm if sediment, debris, and/or algal growth impaired the functionality of the facilities. Inspections are also performed to determine if any components of the facility are loose, broken, missing, or present sharp edges that could injure fish and/or wildlife within the Project passage channels. For fish screens, inspections are performed to determine if screens are firmly attached and to ensure that no gaps, tears, rips, or holes are present. Activities include (where existing permitting allowed):

(1) Removal and disposal of sediment, trash, and woody debris from the fish ladders, plunge pools, and associated trash raking systems; typically using hand tools, small cranes and lifts, hoses and suction pumps, and similar small equipment;
(2) Inspection of moving parts and lubrication, painting, sealing, cleaning, and replacement of moveable parts;
(3) Inspection, repair, and/or replacement of instrumentation and monitoring devices including sensors and flow meters;
(4) Patching damaged concrete and grouted rock (generally following periods of high flow and damage from debris); and
(5) Periodic repair and replacement of rubber dams.

The fish ladders were designed to include grate openings in the fish ladder metal decking for inspection for obstructions at all vertical slot openings, a sluice pipe system for flushing sediment, and a trash rake and crane for debris removal. However, due to the sourcing and installation of some crane components, the crane for debris removal has not been fully installed, tested, and commissioned and, therefore, was not operational during the reporting period. Districts implemented several measures from the BiOp that were designed to avoid and minimize impacts to steelhead associated with maintenance including, where possible, scheduling maintenance activities during the period of June through October, isolation of maintenance work sites from the waters of Alameda Creek, and regular notification and coordination with agency staff.

Test Video Inspection of Fish Ladder Screens and Fish Ladder Function

Underwater video is a potentially safe alternative to physical access of fish passage facilities by staff and can reduce the need to lower water levels during critical passage periods to visually inspect facility operations. We enlisted a video camera system to test its performance for routine inspections of the RD1 fish ladder. The underwater video system consisted of two GoPro cameras in waterproof housings attached to a ~15 ft extendable pole with a camera mount (Figure 5-2).

Figure 5-2: GoPro stereo-camera system mount on adjustable ~15ft aluminum pole.

GoPro 10 cameras were used to record video images. For each sampling period, the stereo camera set-up was deployed at various locations within the facility to perform both routine maintenance inspections and as part of predator and milling surveys. This included access through grate openings in the fish ladder metal decking to look for organisms and debris within the ladder bays, along debris rack surfaces to search for blockage by debris and milling fish. Stereo cameras were deployed to facilitate estimates of fish length using the SeaGIS Program (Flynn and Chapra 2014). Cameras were equipped with Bluetooth wireless connections so the field of view and shutter can be monitored and activated remotely in real time via an iPhone application. The camera has a waterproof case, which allows it to be used for underwater applications. Video data were exported and backed up to cloud storage at the end of the day for later review.

The stereo-camera system was used to provide relatively accurate estimates of individual body lengths (Letessier et al. 2015) and thus provide information related to fish population structure. The customized software (www.seagis.com) was used to apply trigonometric principles and generate estimates of horizontal and vertical orientation, lengths of target fish (mm), 3-dimensional positioning (x, y, z coordinates) and angle to the optical axis. The use of GoPro Video cameras was tested for performing routine inspections of RD1 fish passage facility in April and August 2023.

5.5.2. Results of Fish Ladder Inspections

Physical Inspections

Between 28 November 2022 and the end of this reporting period on 31 August 2023, ACWD performed daily inspections of the fish ladder facilities and screened diversion facilities in Alameda Creek. As part of regular daily inspections, and along with routine operation of the facilities to maintain the minimum bypass flow, ACWD staff also maintained an operations log with date and time for each major operational event, such as raising the dams, lowering the dams, initiation and termination of diversions, transitions between flow schedule periods, and any major problems with the fish ladder facilities that might affect operational performance and compliance. A summary of the operations log and a report of the daily streamflow at compliance points (i.e., USGS gauges) are provided annually to CDFW as part of the Reporting Requirements and is included in Appendices B and A, respectively.

In this reporting period, the daily physical inspections of RD3 identified no significant issues to report, mostly given the very truncated operations of the RD3 fish ladder due to the RD3 bladder failure on 21 January

Figure 5-3: Sediment deposition at RD3 fish ladder. In clockwise order: A) entrance gate and river right side of buried RD3 dam apron; B) entrance gate buried in sediment; C) exit gate and trash rake; and D) dam apron with flow over top, buried in sediment.

2023. While it was operating, the RD3 fish ladder had no observable issues with mechanical components, gate valve operations, passage constraints, or debris accumulation. After the storm water receded, there was sediment and debris in the forebay area upstream of the exit gates and significant sediment deposited on river right, specifically on top of the deflated RD3 (Figure 5-3A,D), along the trash grate (Figure 5-3C), and in front of and within the entrance gate (Figure 5-3A,B). By the end of this reporting period, ACWD had applied for permits necessary to remove some sediment and repair the RD3 bladder, but ACWD had not received the required permits to perform the work.

At RD1, ACWD Water Controllers' daily inspections recorded electrical issues related to mechanical components, such as the control valves for the sluice pipe and the auxiliary bypass pipeline, in November and March. ACWD Water Controllers observed the sluice pipe control valve actuator was not operable on 15 December 2022. They reset the circuit breaker to solve the problem temporarily. Similarly, by 9 January 2023, the actuator for the auxiliary bypass control valve failed, rendering the auxiliary bypass inoperable through the remainder of the reporting period. Investigations into both issues by ACWD Engineering staff determined the cause was related to water intrusion into the electrical components. The actuator for the sluice valve was opened and dried out, which resolved the problem. The actuator for the auxiliary bypass needed to be replaced, and replacement parts had not arrived by the end of the reporting period. ACWD Engineering staff worked with our Facilities Maintenance staff and the construction contractor to improve electrical conduit waterproofing and drainage. The RD1 Fish Ladder entrance gate was observed to be inoperable on 13 March 2023; due to a disconnection of the southern gate panel from the actuator-driven gearing, the gate panel would swing freely and would not articulate. ACWD Water Controller staff used slings to affix the gate panel in the open position, and the entrance gate was not fully functional until after the migration season, when the construction contractor affected repairs on 5 July 2023.

During the reporting period, ACWD Water Controllers conducted physical inspections of the fish ladders to observe for any accumulation of sediment or debris that might inhibit fish passage. Silt and fines deposits were observed in Pool 10 at the start of project hand-off and occurred at some point prior to Start-up Testing (Figure 4-13, image 1). During the reporting period, ACWD Water Controllers periodically operated the sluice pipe to remove sediment deposits in the RD1 Fish Ladder forebay as a preventative measure. During brief periods of dewatering the RD1 Fish Ladder for testing or maintenance-related activities, water would drain from Pools 5 through 20. ACWD staff observed filamentous algae on the walls and floors in wetted portions of the ladder, but there was no significant accumulation of sediment within these vertical slot pools. A discussion of sediment downstream of the RD1 Fish Ladder entrance gate is provided below, in *Debris Management and Removal*.

Video Inspections

25 April 2023 Video Survey

The initial video survey test utilized two GoPro cameras mounted on an extension pole for observing potential fish and obstructions in the RD1 fish ladder (Figure 5-2). The test was performed to confirm the feasibility of accessing the RD1 fish ladder through available grate openings within the metal grates. The initial pole used was an extendable painting pole and made it difficult to control the camera and the angle of the GoPro cameras and led to some difficulty discerning footage. Also, areas of high turbulence were hard to read as many bubbles obstructed the field of view (Figure 5-6). These problems have been improved upon in more recent trials. During this site visit there were many areas in the corners of the ladder that were more visible and proved that the video could be used for spot checks (Figure 5-4, Figure 5-5, Figure 5-7). These spot checks could be used to check for fish or debris in the ladder. In the videos recorded on 25 April 2023 there was a total of 6 minutes and 21 seconds of footage collected (Table 5-1). No fish or obstructions were observed. The lack of observed obstructions implied nothing was impeding fish passage in the ladder. The following information summarizes the videos and shows examples of video quality collected.

Table 5-1. Observations from video recorded within the RD1 fish ladder, 25 April 2023.

Video	Date	Location	Time	Fish	Obstruction	Damage	Observations
1	25-Apr-23	Pool 1 downstream	0:23-01:20	NA	NA	NA	Bubbles obscured image
2	25-Apr-23	Pool 1 downstream	0:10-01:20	NA	NA	NA	Bubbles obscured image
3	25-Apr-23	Pool 1 downstream	0:22-01:41	No	No	No	Video readable/ less bubbles, no fish observed
4	25-Apr-23	Pool 8 downstream	0:19-01_41	No	No	No	Video readable/ less bubbles, no fish observed
5	25-Apr-23	Pool 8 upstream	0:18-01:21	No	No	No	Video readable/ less bubbles, no fish observed
6	25-Apr-23	Pool 10 downstream	0:25-01:49	No	No	No	Video readable/ less bubbles, no fish observed, ARIS visible in footage. ARIS clear of debris.
7	25-Apr-23	Pool 10 upstream of ARIS	0:22-01:00	No	No	No	Video readable/ less bubbles, no fish observed
8	25-Apr-23	Pool 17 downstream	0:15-01:13	No	No	No	Video readable/ less bubbles, no fish observed
9	25-Apr-23	Pool 20	0:12-01:29	No	No	No	Video readable/ less bubbles, no fish observed

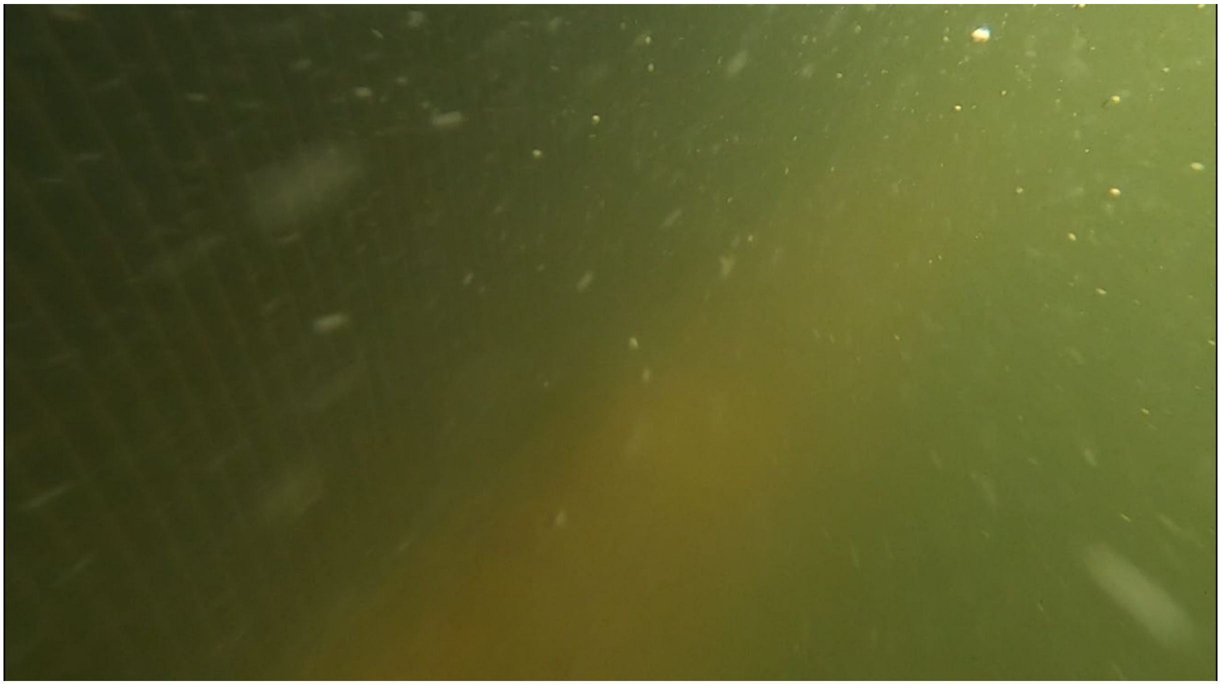


Figure 5-4. Wall and debris screen from Video 3; Ladder Pool 1. Note green hew of image but no indication of algal growth or other vegetation on the screens. 25 April 2023.

Figure 5-5. ARIS from Video 6; Ladder Pool 10. Example of no debris associated with the camera and unobscured view. 25 April 2023.

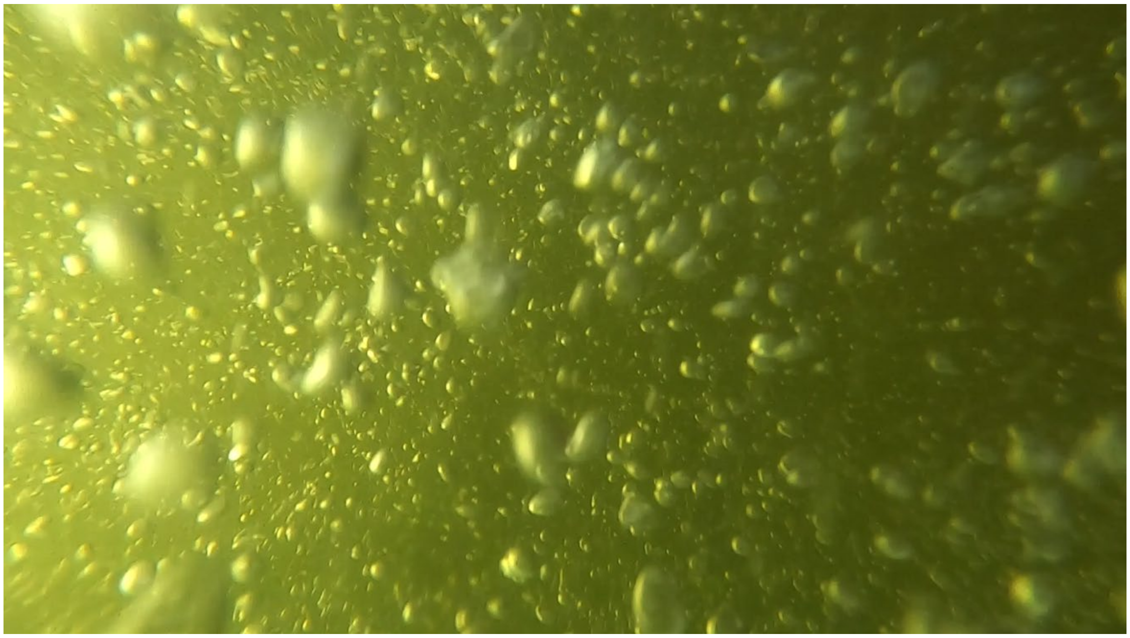


Figure 5-6. Video 2; High Turbulence/ Bubbles; Ladder Pool 1. 25 April 2023.

Figure 5-7. Visibility Example from Video 9; Ladder Pool 20. Note scale with "49" and "50" indicating height. 25 April 2023.

21 August 2023 Video Survey

During the second video survey, the cameras successfully recorded 4 videos (5 minutes - 48 seconds total; Table 5-2). The surveyor recorded video clips around the outside of the RD1 fish ladder operating structure upstream of RD1. Video clips were also recorded in the fish ladder pools right behind the fish ladder operating structure (Figures 26-29). In the recording we observed three (3) adult Largemouth Bass (Micropterus salmoides; Figure 5-8; Figure 5-9; Figure 5-10) and a juvenile Sacramento Pikeminnow (Ptychocheilus grandis) (Figure 5-12). The video also provided clear recordings of the substrate, fish ladder structure, and aquatic vegetation occurring in and outside of the fish ladder (e.g., Figure 5-11; Figure 5-12). No debris was detected obstructing the screens or the fish ladder bays. This suggests that fish passage was unobstructed within the ladder at the sites checked. Video quality demonstrates this procedure works well for observing potential predators, target species, and debris that may be obstructing ladder functionality both inside the ladder and outside the screens at the turbidity and light levels tested.

Table 5-2. Observations from video recorded within the RD1 fish ladder, 15 August 2023

Video	Date	Location	Time	Fish	Obstruction	Damage	Observations
1	21-Aug-23	In front of RD1 Debris Rack	0:48-2:04	Yes	NA	NA	1:44- 1:56 Sacramento Pikeminnow 73mm
2	21-Aug-23	Along RD1 observatio n deck face	0:13-0:50	NA	NA	NA	no fish seen. Large Cobble/ Boulder substrate visible.
3	21-Aug-23	In front of RD1 Debris Rack; upstream	0:37-1:45 and 2:00-3:27	Yes	No	No	1:25-1:38 Three large bass seen on inside of gate structure of fish ladder Bass 1- 292 mm Bass 3- unmeasurable; not in both cameras; similar size
4	21-Aug-23	Pool 20	0:59-1:27; 1:37-2:25	No	No	No	Camera placed in two fish ladder bays adjacent to the ladder operating facilities, no fish or debris observed

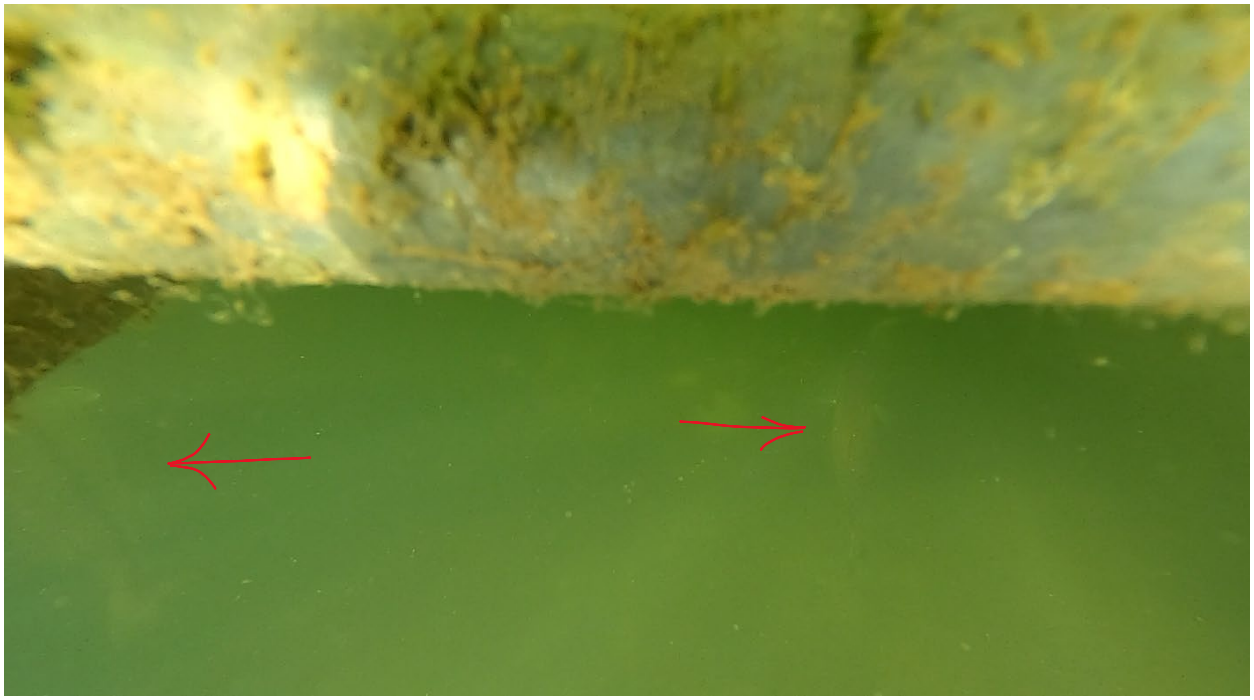


Figure 5-8. Largemouth Bass (red arrows) observed in front of the RD1 Fish Ladder Trash Rack from Video 3; 21 August 2023.

Figure 5-9. Largemouth Bass (red arrow) observed in front of the RD1 Fish Ladder Trash Rack. From Video 3, 21 August 2023.

Figure 5-10. Largemouth Bass (red arrows) observed in front of the RD1 Fish Ladder Trash Rack. From Video 3, 21 August 2023.

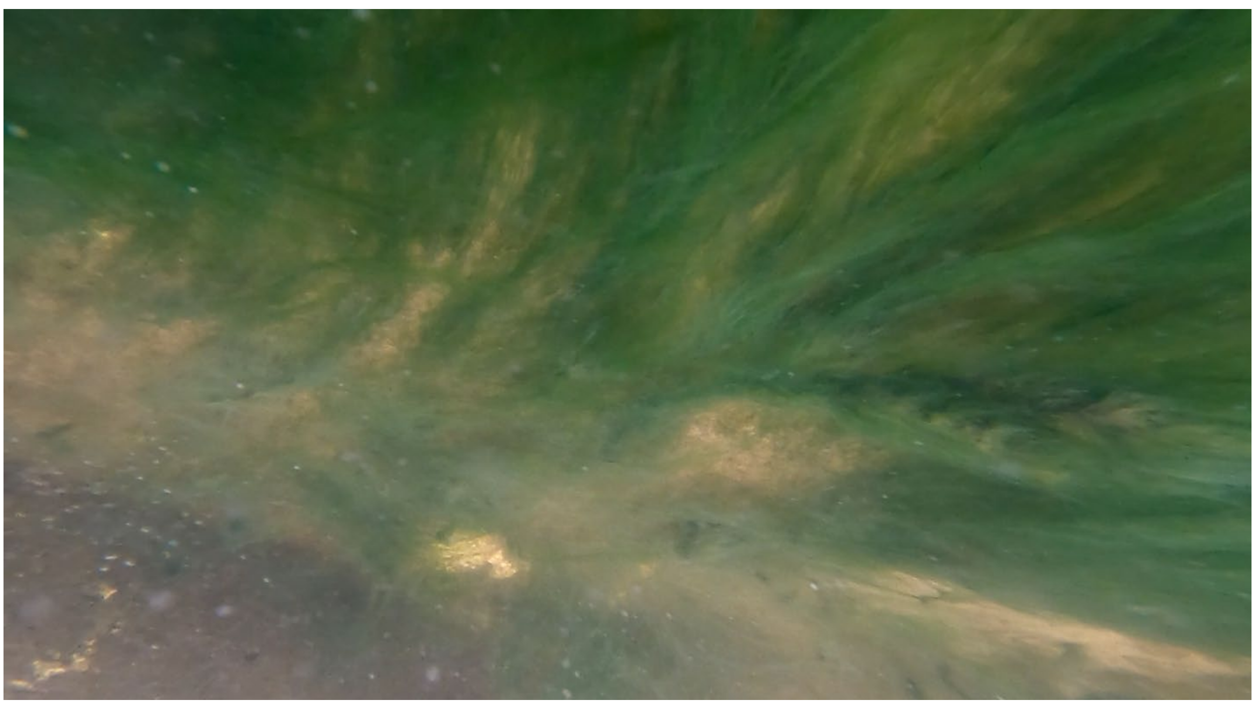


Figure 5-11. Filamentous algae observed in pool 20 from Video 4, 21 August 2023.

Figure 5-12. Juvenile Sacramento Pikeminnow from Video 1. Note possible bird scars and infection.

Debris Management and Removal

During the reporting period, ACWD Water Controllers would conduct daily inspections of the fish ladder facilities to observe for any debris or obstructions that could inhibit fish passage. As the high flow from storm runoff and upstream reservoir releases temporarily decreased in late January and early February, ACWD staff observed significant sediment deposits at RD3 and RD1. Reference Section 5.5.2. *Physical Inspections*

for discussion of the RD3 and portions of the RD1 Fish Ladder upstream of the entrance gate. Downstream of RD1 fish ladder entrance gate, ACWD staff observed sediment mounds emerging from the receding water in the lowest pool of the Lower RD1 Fish Passage Facility. Over the next several weeks, as water turbidity decreased and flows receded, the extent of the sediment deposits became more visible throughout the entire lower fish ladder and into the transition pool area. A subsequent analysis, described below, was required to determine if the sediment was creating a barrier for fish passage until it could be removed.

Sediment Analysis in Lower RD1 Fish Passage Facility
During system surveys in the early summer of 2023, it was determined that the above normal runoff in Alameda Creek deposited a relatively high volume of sediment (e.g., gravel, sand, silt) within the lower ladder of RD1 (see *Figure* 5-13). Unlike the upper portion of the RD1 fish ladder, which utilizes a vertical slot design, the lower ladder at RD1 uses a vortex pool and chute design. ACWD therefore set up a field survey of depths and velocities within the lower ladder to determine to what extent passage criteria were impacted by the sediment.

Figure 5-13. Demonstration of sediment deposited at the upstream extent of the RD1 lower ladder. Photo on the left was taken on 15 December 2022 and photo right was taken on 21 August 2023.

A total of 3 depth and velocity transects were performed to:

- Estimate flow through the lower ladder;
- Confirm if depth and velocities were potential impediments to adult passage at these flows.

Pool depth and spill height were also recorded in two pools to confirm if:

- Pool depth and jump heights were potential impediments to adult passage.

Finally, each pool was surveyed to confirm if:

- Sediment impaired function of weep holes in each pool for juvenile salmonid emigration.

Methods

Surveys were performed on 21 August 2023, between 10 am and 12 pm by staff from CFS.

Flow Transects

Depth and velocity transects were recorded with a Hach FH950 Handheld Flow Meter and USGS top-setting wading rod. Data were recorded every 0.5m across the channel with depth recorded at ~60% of depth.

Jump Heights

Within two pools, pool depth on the upstream and downstream side of the weir and the elevation of the notch above the water surface were measured by the topsetting rod.

Submerged Orifice Passage

To confirm if the submerged orifices were blocked by sediment, a crew member waded in each pool and felt by hand for each of the two holes in each pool. The topsetting rod was then used to determine the depth of sediment that accumulated above the orifice (hole burial depth).

Analysis

The following equation was used to estimate flow through the lower fish ladder:

$$Flow(D) = average\ width \times average\ depth \times average\ velocity$$

Recorded data were compared against passage requirements for adult steelhead. The general idea behind a minimum depth is that it should at least equal the full body of the fish. For road crossings, NOAA (2001) recommends a minimum depth of 1 ft for adult upstream passage. NOAA (2022) consider barriers as "*Weirs, aprons, hydraulic jumps, or other hydraulic features that produce depths of less than 10 inches, or flow velocity greater than 12 feet per second (ft/s) for more than 90% of the stream channel cross section*".

Maximum velocities are a product of fish size and swimming mode. Sustained swimming is associated with velocities that a fish can maintain for extended periods without fatigue. Water velocities below a fish's maximum sustained speed should be passable regardless of the distance covered. Therefore, this is often recommended in long culverts, fish pass pools, and at the approach to screens. Cruising (prolonged) speed is defined as the speed that can be maintained for periods of minutes without fatigue (Bell 1986, 1991). Burst (darting) speed allows the fish to reach top speeds but can only be maintained for a matter of seconds and is used to escape predation and/or for feeding. Ranges of sustained, prolonged, and burst speeds are shown in Table 5-3. The upper limit of burst swimming speeds is 6 seconds (Bell 1990; Powers and Orsborn 1985).

Table 5-3. Chinook salmon and steelhead swimming speed from Bell (1986). Fish speed is in feet per second (FPS).

Species	Sustained	Prolonged (~30 min)	Burst (< 6 s)
Steelhead	0-4.6	4.6-13.7	13.7-26.5
Chinook	0-3.4	3.4-10.8	10.8-22.4

According to Bell (1986) cruising speed is used during migration, sustained speed for passage through difficult areas, and darting speed for escape and feeding. Water velocities of 3.4 fps approach the upper sustained swimming ability of these adult salmonids.

Outside of the Chinook immigration period (after 1 February) the BiOp recommends a minimum of 0.6 ft water depth for steelhead immigration and 0.3 ft for juvenile salmonid emigration.

For practical application, jump pool requirements are generally specified based on a ratio of jump height to pool depth. For this application, we used 1.5 times jump height, or a minimum of 0.6 m (2 ft) depth (Robison et al. 1999).

Results

The three transects ranged from ~21.3 ft to 26.25 ft with a total of 21 depth and velocity measurements. Average and maximum depths and velocities for each of the transects are provided in Table 5-4.

Table 5-4. Mean Depth, Max Depth, and Measured Flow for flow transects at lower RD1 fish ladder on 21 August 2023.

Site Location	Mean Depth (ft)	Max Depth (ft)	Flow (cfs)
RD1 Lower Entrance Site 1	0.3	0.5	11.9
D1 Lower Entrance Site 2	0.4	0.9	9.7
RD1 Lower Exit Site 5	0.5	1.2	10.5

Estimated discharge at the lower ladder ranged from 9.7 cfs at the lower ladder entrance (Site 1) to 11.9 cfs at the lower entrance site 2 (mean = 10.7 cfs). At these flows, Site 1 did not meet minimum passage requirements for adult steelhead or Chinook salmon. For Site 2, ~30% of the channel transect met minimum depth requirements for steelhead and 0% for adult Chinook. For Site 3, ~30% of the channel met minimum passage requirements and ~14% of the channel met adult Chinook passage requirements (Figure 5-14). Velocities were met at all three locations for all life stages. Results from the pool depth to jump height are provided in Table 5-5.

Table 5-5. Jump Height and Pool Depth Results for Sites 3 and 4. Site located in the middle bays of the lower RD1 fish ladder.

Site Location	Jump Height (ft)	Pool Depth Downstream Side (ft)	Pool Depth Upstream Side (ft)	Downstream Pool Depth/ Jump Height
RD1 Lower Ladder Site 3	0.9	3.7	2.5	4.4x
RD1 Lower Ladder Site 4	1.1	3.9	2.0	3.7x

Jump heights and pool depths met adult passage requirements (Table 5-2). During the survey of submerged orifice sedimentation, only 1 orifice in the 5 total bays we had access to (10 total holes), was open (*Figure* 5-13 and Figure 5-14*).* The other 9 holes were under at least 1 ft of sediment.

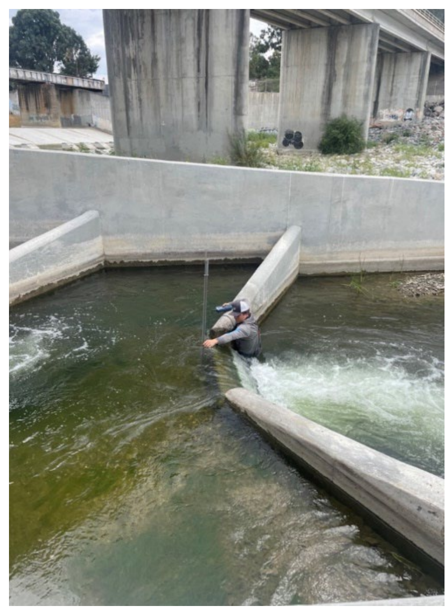


Figure 5-14: Site 4 in middle of lower fish ladder. Notice the large amounts of sediment on the downstream river left of the pool BHF is standing in. This sediment is blocking the weep holes which facilitate downstream juvenile migration.

5.5.3. Discussion

Results from this survey suggest some impediment for adult and juvenile salmonid passage at the lower RD1 fish ladder (Figure 5-15*).* In general, water depths at critical riffles identified at the entrance and exit of the lower ladder would expose backs, eyes and portions of gills of larger adult salmon for short distances. This may in turn, expose them to greater chances of predation and/or stress although these shallow riffles (~<15 ft) could be negotiated. Jump heights and pool depths within the sediment-filled ladder were well within adult salmon capabilities. However, when passing this style of ladder, fish have the choice of leaping or swimming over the weir or swimming through the orifice, and it is NMFS' experience that most salmonids prefer to swim through the orifice (NMFS 2022). Because the submerged orifices are generally full of sediment, juvenile and adult salmonids might be confused during low flows or be exposed to predation, especially by birds if they were forced to swim near the surface to negotiate the weirs.

Recommended maintenance activities would include flushing or removal of the sediment from the ladder entrance and exits and from the weir openings to improve passage conditions developed within the design criteria. The work appears to be possible with hand tools and/or high-pressure hoses, as recommended in the BiOp (NMFS 2017).

Figure 5-15: Site 5 Transect above lower fish ladder entrance.

5.6. PHYSICAL CONDITIONS

To assess the physical conditions of the Fish Passage Facility, ACWD employed several measurement systems, including recorded instantaneous water temperature and dissolved oxygen using an YSI Handheld Dissolved Oxygen Instrument (YSI® Prosopon Optical Dissolved Oxygen Meter). Instantaneous turbidity was measured in Nephelometric Turbidity Units (NTU) using a turbidity meter (Hach 2100Q Portable Turbidimeter). Samples were collected approximately 6 inches (15.25 cm) below the water surface during semi-regular intervals while flow increased within the ARIS (Adaptive Resolution Imaging Sonar) camera bay of the ladder using and within the reservoir surface adjacent to the ladder bay. Facility was further assessed for physical barriers to salmonid passage such as large head drops in the ladder, high-velocity flow, and sediment deposition or debris jams.

5.6.1. Temperature

Four Hobo MX2201 temperature sensors were installed in the Flood Control Channel in May 2022 upstream and downstream of the fish passage project area. Sensors were mounted within concrete cinder blocks to be shaded from the sun and be less conspicuous and prone to vandalism. Cinder blocks were secured with a 3/8-inch diameter steel cable to steel stakes driven into the channel bed (Figure 5-16).

Figure 5-16: A Hobo MX2201 temperature sensor secured using $3/8^{th}$-inch steel cable to steel stake, driven into channel bed.

Of the four sensors installed in May 2022 three were lost, presumably during the high flow events (peaked at >23,000 cfs) that started in December 2022; only partial data were collected from the three sensors that were lost. The one temperature sensor remaining from the May 2022 installation is in the Flood Control Channel near the Alvarado Blvd crossing (Figure 5-17, point *T-3*). Data were downloaded periodically as time allowed and when safe to access the Flood Control Channel. The District is in the process of scoping reinstallation of temperature sensors at select locations in the Alameda Creek Flood Control Channel (ACFCC), including near the bypass flows compliance point at Sequoia Bridge.

Five Hobo MX2201 temperature sensors were installed within the RD1 and RD3 fish ladders on 29 December 2022. The two sensors installed in the RD3 fish ladder were only installed for two days before the RD3 rubber dam was deflated due to high flows in the ACFCC. When the RD3 rubber ruptured on 21 January 2023, the temperature sensors in the RD3 fish ladder were rendered non-functional during 2023. These sensors in the RD3 fish ladder will be redeployed when the RD3 rubber dam is repaired and reinflated.

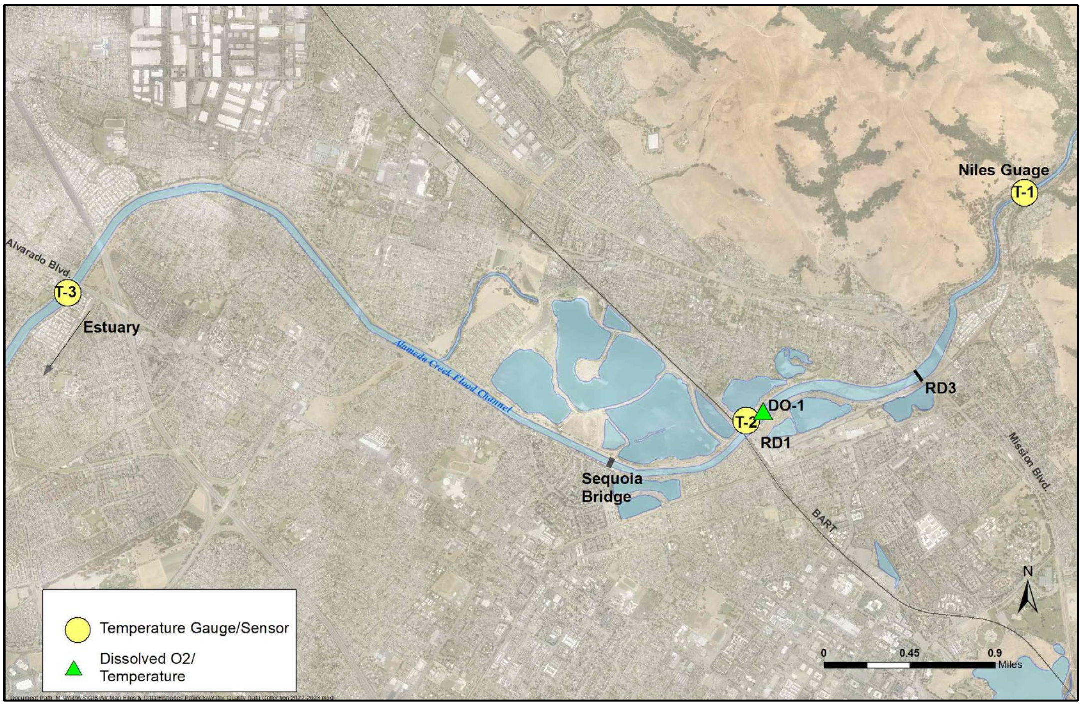


Figure 5-17: Map of temperature and dissolved oxygen sensors. (T-1) is the temperature sensor at USGS Niles Gauge (USGS 11179000); (T-2) is a set of sensors within the RD1 Fish Ladder, one near the entrance gate at the downstream end of the upper fish ladder, and the other is near the exit gates by the trash rack on the upstream end of the fish ladder; (T-3) is in the flood channel at Alvarado Blvd. bridge. The green triangle is the location of a dissolved oxygen and temperature sensor, located in the RD1 forebay, near the trash rack, approximately mid-water column.

Two out of three temperature sensors installed at the RD1 fishway remain, while the sensor deployed in the RD1 fish ladder transition pool was lost during winter 2023, likely due to woody debris becoming entangled with and breaking the deployment line during high flows in the Flood Control Channel.

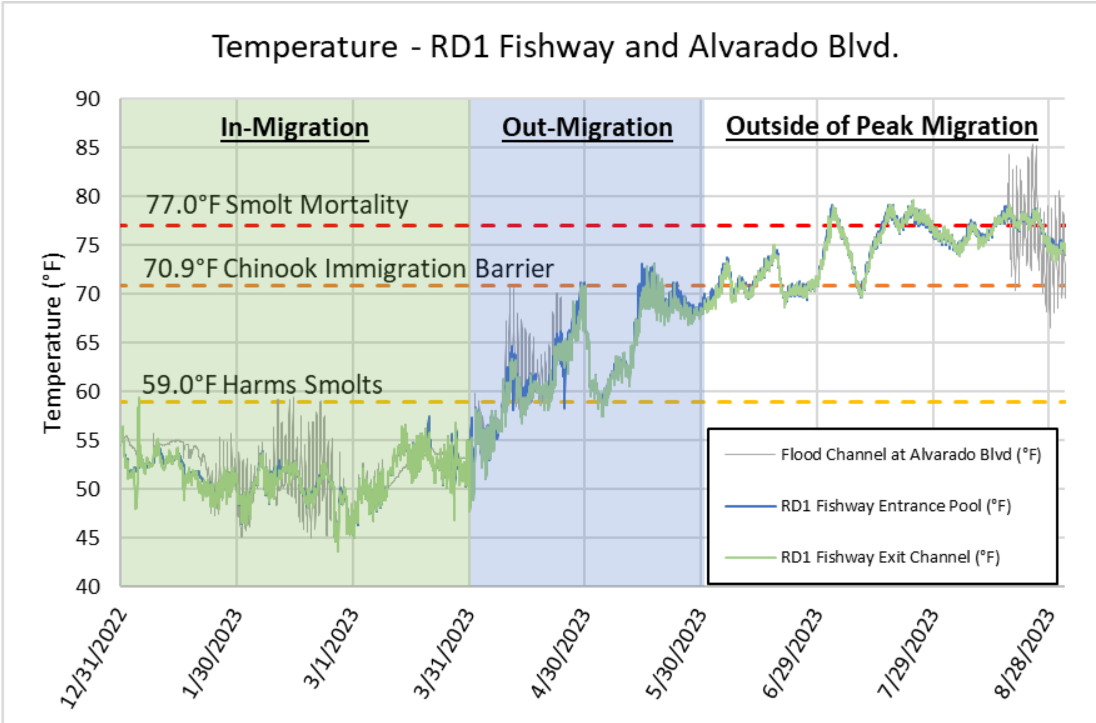


Figure 5-19:Temperature as measure at the upstream exit channel of the RD1 Fish Ladder (green), downstream entrance gate (blue) both located at point (B) in Figure 5-17, and far downstream Alvarado Blvd. Crossing (grey, points), located at point (C) in Figure 5-17. Known threshold temperatures for smolt damage and mortality (yellow and red) and Chinook passage impediment (orange) are marked as well. The temperature gage at Alvarado Blvd. failed from 4/23/23 to 8/17/23.

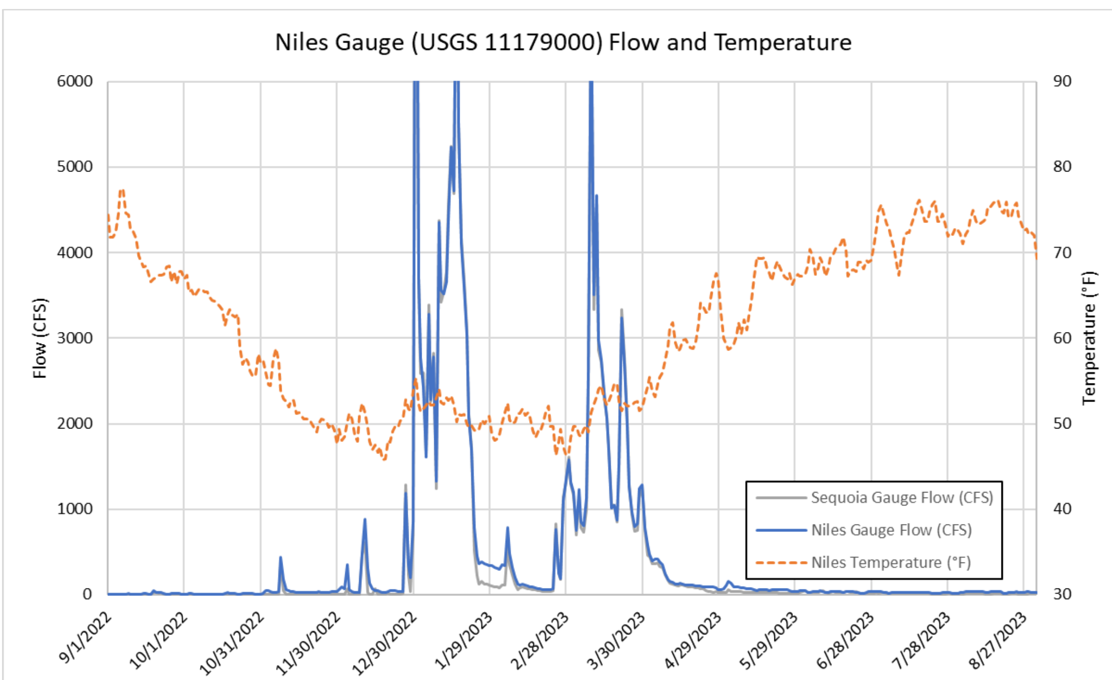


Figure 5-18: Average flow (cfs) at the Niles and Sequoia gauges and average surface water temperature (F) at the Niles gauge 1 September 2022 through 31 August 2023.

5.6.2. Dissolved Oxygen

Dissolved oxygen (DO) is considered an important measure of water quality as it is a direct indicator of an aquatic resource's ability to support aquatic life. A DO and temperature sensor (Hobo U26) was installed in the RD1 forebay in May 2023 after creek flows subsided and the likelihood of RD1 deflation due to high creek flows was lower. The sensor was suspended at approximately the middle of the water column, or about five feet below the water surface.

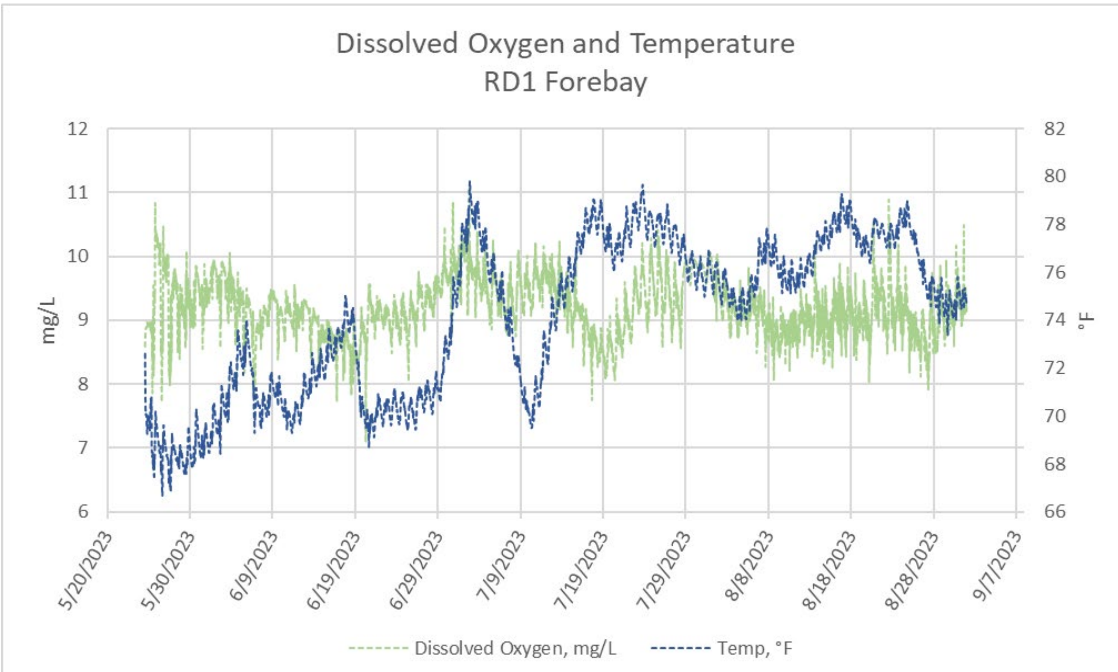


Figure 5-20: Dissolved oxygen had diurnal cycling, but otherwise remained relatively flat between 8-10 mg/L. Temperatures in the forebay rose over the measurement period of May-September.

5.6.3. Turbidity

In many cases, salmonids avoid turbid water, and migrating salmonids avoid waters with high silt loads or cease migration when such loads are unavoidable (Cordone and Kelley 1961; Sedell et al. 1990). Bell (1986) cited a study in which adult salmonids did not move in streams where the suspended sediment concentration exceeded 4,000 mg/L (as a result of a landslide). In the lower Columbia River, the upstream migration of salmon may be reduced when secchi disk readings are less than 0.6 m (Bjornn and Reiser 1991).

Daily turbidity was measured using a Hach 2100Q at the Alameda Creek Water Quality Monitoring Station (ACWQMS), located near the upstream end of the RD3 impoundment. Turbidity ranged from 0.8 to 2.6 NTU in June 2023 to 39.6 to 1000 NTU in March 2023 (Figure 5-21). Table 1 in the BiOp requires no stream diversions when turbidity is high year-round (January 1 – December 31); high turbidity is historically correlated to Niles gauge flows greater than 400 cfs. January 2023 was the wettest month with 4.2 inches of rain while October 2022, and June, July, August 2023 were the driest with no rain.

In laboratory experiments, 25-50 NTU caused a reduction in juvenile steelhead densities and complete avoidance at 167 NTU and higher (Sigler et al. 1984). Bell (1986) cited a study in which adult salmonids did not move in streams where the suspended sediment concentration exceeded 4,000 mg/L (12,000 NTU;

as a result of a landslide). Adult Chinook males showed an avoidance response to their home water in the presence of a seven-day exposure to ash suspension of 650 mg/l (1,950 NTU; Whitman et al. 1982).

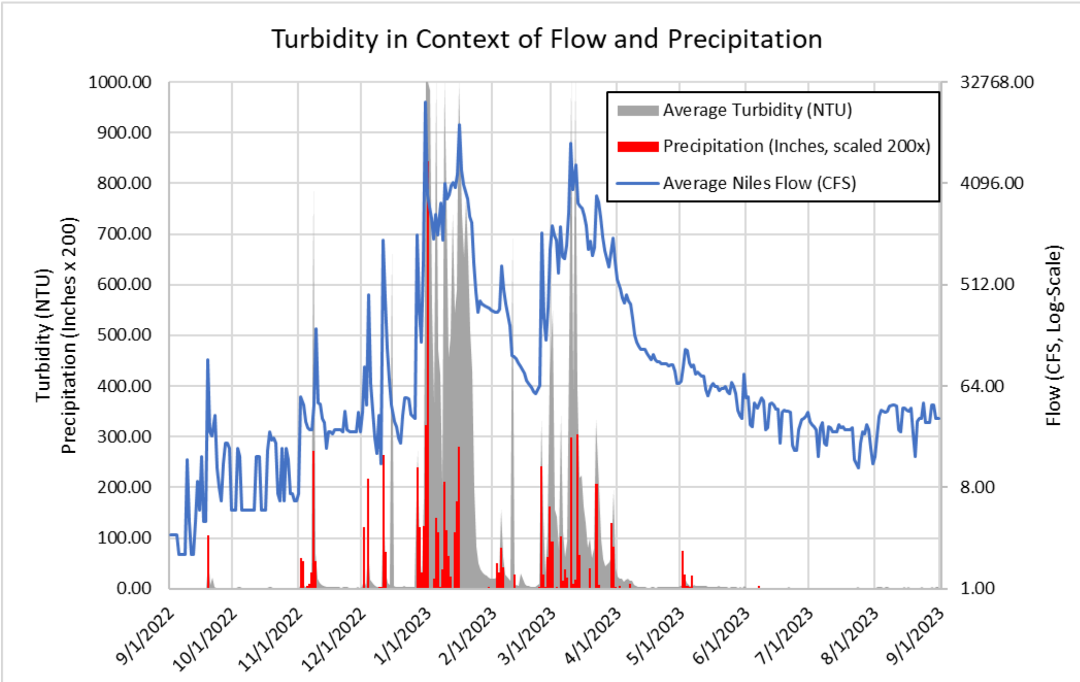


Figure 5-21: Daily average turbidity (NTU), precipitation (inches) and flow (cfs) at the Nile Canyon flow gauge, 1 September 2022 through 1 September 2023. Average turbidity (NTU; grey shaded area) plotted against precipitation (in. scaled x 200; red bars) and average Niles gauge flow (cfs, log-scale; blue line).

5.6.4. Barriers

Debris jams, critical riffles, infrastructure, and excessive water velocities may impede migrating fish. Given suitable conditions, salmon and steelhead can get past many obstacles that appear to be barriers (Bjornn and Reiser 1991). To meet this subject, ACWD staff, on a minimum daily basis, surveyed the river channel within Reaches II through V from the Alameda Creek Trail downstream of RD1 to the Niles Staging Area to look for and flag any obvious passage obstructions for immigrating and emigrating salmonids. Similarly, ACWD staff, on a minimum weekly basis, surveyed the river channel within Reaches I and II from the Alameda Creek Trail downstream of RD1 and Sequoia Gauge, to look for and flag any obvious passage obstructions for immigrating and emigrating salmonids. Staff recorded this information in logs and notified appropriate authorities if warranted.

5.7. STREAMFLOW AND BYPASS REQUIREMENTS

ACWD's bypass flow requirements included in the BiOp were based on the structural capability of the rubber dams, diversion requirements of ACWD, the needs of migratory fish, and were first captured in an agreement among NOAA, CDFW, and ACWD as outlined in the *Alameda Creek Steelhead Fisheries Restoration: Alameda County Water District Flow/Bypass Operations Meeting Summary*, January 27, 2011. The requirements are based on both time of year and the streamflow measured at the USGS Niles gauge (USGS Station No. 11179000).

The basics of the flow schedule, described in greater detail further on, defines three seasonal periods:

1. The anadromous salmonid *Immigration* period is from 1 January 1 through 31 March.

2. The salmonid *Emigration* period is 1 April through 31 May.
3. The *Outside of Peak Migration Periods for Steelhead* is 1 June through 31 December.

5.7.1. Water Year Type and Determination Method

ACWD's bypass flows for the peak period of juvenile and kelt steelhead outmigration (1 April through 31 May) are determined by water year type calculated on 1 April of each year (NMFS 2017). ACWD determines the water year type based on the cumulative precipitation measured at ACWD's Blending Facility in Fremont, California. The "normal/wet" water year classification is based on a 60% exceedance threshold (i.e., 60% of the outmigration seasons [April and May] are expected to be classified as "normal/wet") and the "dry/critical" water year classification is also based on the 60% exceedance threshold (i.e., 40% of the outmigration seasons are classified as "dry/critical"). To facilitate this, ACWD used the 137-year period of record at this location to define normal/wet and dry water year types. Results of this analysis indicate that if cumulative rainfall calculated from 1 October to 31 March is less than 15.3 inches, conditions are considered "dry," and if the cumulative rainfall is greater than 15.3 inches, conditions are classified as "normal/wet." Per the BiOp and vision and goals/objectives described in previous sections, Figure 5-22 provides a summary of the 7-day pulse release structured decision-making process (SDMP). SDMPs are further detailed in subsequent sections. As indicated in Figure 5-22, the 7-day pulse release flow process begins with the year-type determination (i.e., whether it is a dry or critical dry year) based on cumulative rainfall during the rain year at the end of each March. ACWD will update the OWG on cumulative rainfall once a month starting every January, and if the cumulative rainfall exceeds 15.3 inches (this is the threshold for year-type determination per the BiOp) before the end of each March then a year-type determination of "normal/wet" can be made. This determination will be aided by reviewing past years' and the most recent fall and early winter season's observed precipitation as well as looking at weather forecasts. If it is determined that the year is dry or critical dry and the Niles Gauge is less than 25 cfs, the 7-day pulse releases will be triggered in April and May. The 7-day pulse releases may be coordinated with any SFPUC releases, and the timing of the releases may be sequenced so that pulse events follow natural rain freshets.

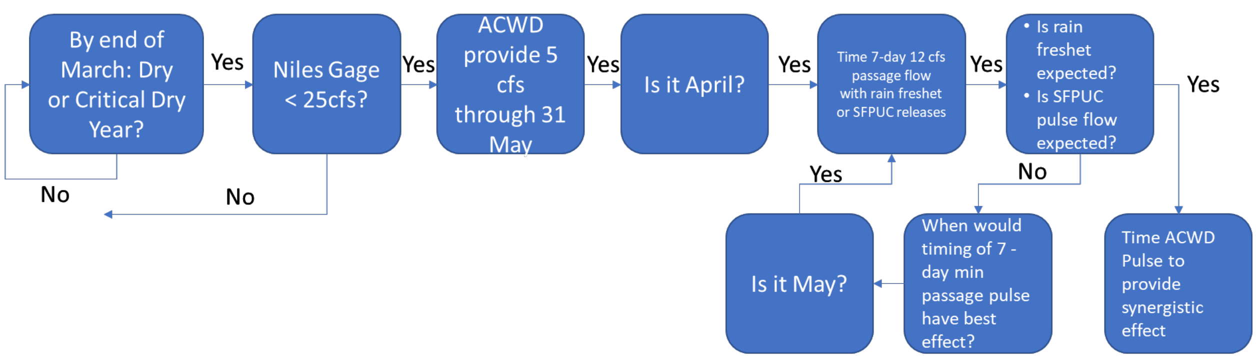


Figure 5-22: Pulse Flow Structured Decision-Making Process

Watershed precipitation and runoff for the 2022-23 monitoring period

January 2023 was the wettest month with 4.2 inches of rain while October 2022, and June, July, August 2023 were the driest with no rain. Niles gauge flows ranged from 1.1 cfs in September 2022 to 22,200 cfs in December 2022 (Figure 5 18). Sequoia flows ranged from 0.0 cfs (September 2022) to 22,500 cfs (December 2022).

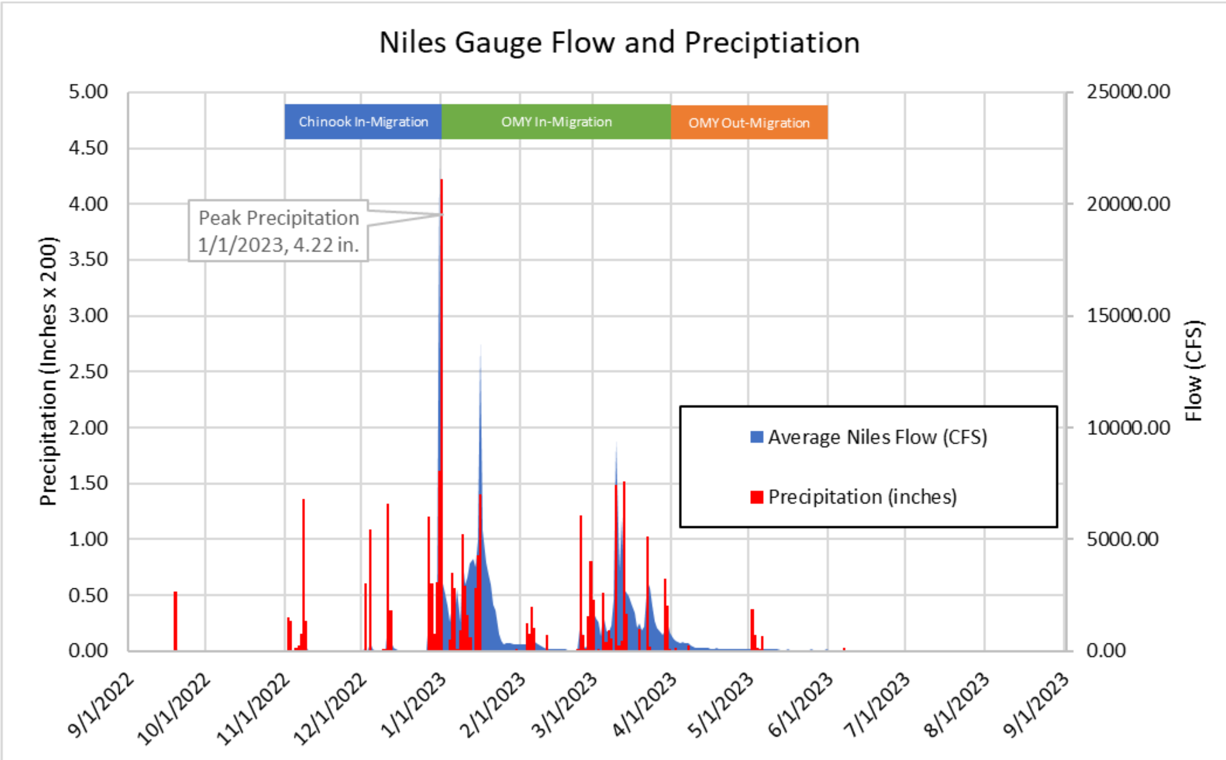


Figure 5-23. Estimated daily precipitation (inches; red bars) plotted against Niles gauge flows (cfs; blue region) from 1 September 2022 through 1 September 2023. Salmonid migration timing is plotted across the top in blue (Chinook salmon adult in-migration), green (O. mykiss adult in-migration), and orange (O. mykiss adult out-migration). Y-axes are scaled to match the dataset. OMY = O. mykiss.

Daily precipitation accumulation demonstrated the 15.3-inch threshold for normal/wet operations was reached in January 2023 (*Figure* 5-24*).* Based on the year determination criteria per the BiOp, this was a normal/wet year. Per the BiOp, for a normal/wet year, the minimum bypass flow at the ACFCD flood control drop structure for CCC steelhead out-migration (from April 1-May 31) requires 12 cfs plus net SFPUC releases that arrive at the Niles gauge for all daily average inflow volumes measured at the USGS Niles gauge. The normal/wet determination also eliminated the need to prepare for pulse releases in accordance with the 7-Day Pulse Framework[1].

[1] Development and use of a 7-Day Pulse Framework is a stipulation of the BiOp and is intended to provide improved out-migration for smolts during spring months of dry years. As this condition was not triggered in 2023, a planned schedule for pulse releases was not required.

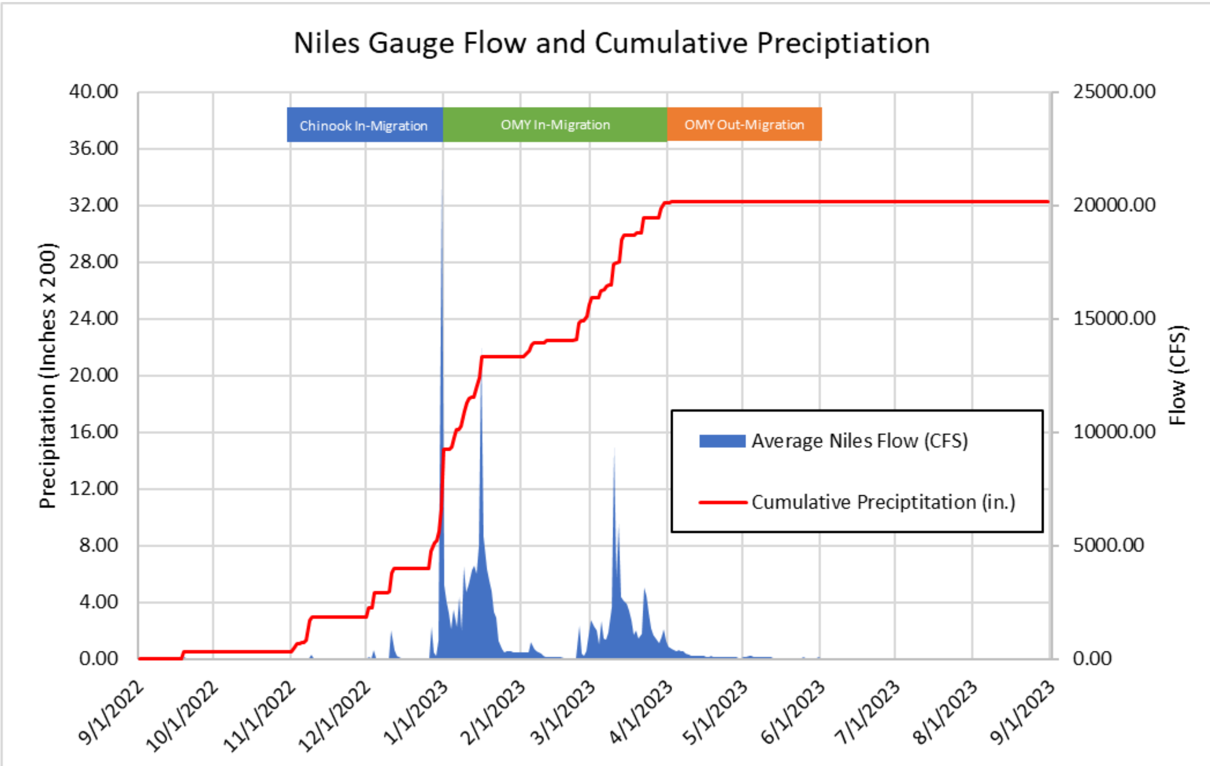


Figure 5-24. Cumulative Precipitation (inches) vs Flow recorded at Niles gauge (cfs). 1 September 2022 through 31 August 2023. Salmonid migration timing is plotted across the top in blue (Chinook salmon adult in-migration), green (O. mykiss adult in-migration), and orange (O. mykiss adult out-migration). Y-axes are scaled to match the dataset. OMY = O. mykiss.

5.7.2. RD1 Fish Ladder Bypass Flow

Bypass Requirements

Fish ladder bypass requirements for the RD1 Fish Ladder are determined in two additive parts: contributions from natural Niles Canyon in-flows, measured at the Niles USGS gauge (USGS gauge 11179000), and contributions from fisheries releases by SFPUC's live-stream operations in the Niles Canyon watershed.

Niles Bypass Component

Niles in-flow bypasses are determined using a set of local criteria.

1. The migration season, which is informed by time of year;
    a. Steelhead in-migration, 1 January 1 – 31 March 31
    b. Steelhead out-migration, 1 April 1 – 31 May 31
    c. Outside of peak migration, 1 June 1 – 31 Dec 31
2. The water year type – 60% of water years should be classified as normal/wet:
    a. Normal/wet year if cumulative precipitation 1 Oct – 31 Mar exceeds the 40th percentile of cumulative rainfall
    b. Dry if the cumulative precipitation 1 Oct – 31 Mar is below the 40th percentile

Dependent on the water year type and migration season, the bypass requirement is determined from the 24-hour average of Niles inflows at gauge 11179000 using discrete inflow tiers. A visual representation of this tier selection is presented in Figure 5-25[2].

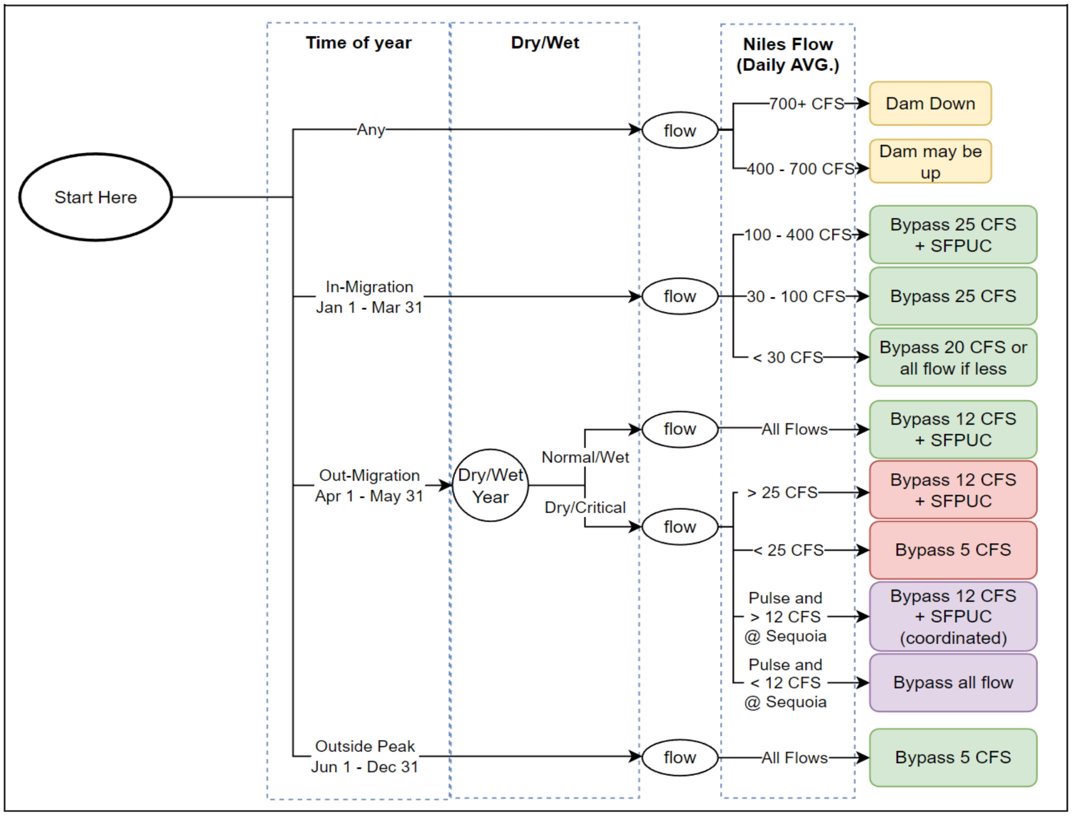


Figure 5-25: Bypass flows at the RD1 Fish Ladder are determined using time-of-year, cumulative precipitation, and contributions from SFPUC fisheries activities.

SFPUC Fisheries Releases Bypass Component

SFPUC performs fisheries releases out of Calaveras Dam and associated Alameda Creek Diversion Dam, which influence flows at the USGS Niles gauge. Any such flows that arrive at the RD1 fish ladder from these activities is included in the total bypass requirement for the RD1 fish ladder, depending on if the migration season and bypass tier requires it or not.

Bypass Calculation Periods

The bypass tier for the current operating day is determined from the previous 24-hour period of Niles canyon inflow. The RD1 facility is issued a bypass tier for the day, which operators will use to inform operations for the current 24-hour period. At the end of the period, the 24-hour average flow at the downstream Sequoia USGS gauge (USGS gauge 11179100) is used as the compliance point to determine if the bypass requirement was met or not.

2022-2023 Period Bypass Compliance Results

ACWD was in compliance with the BiOp 100% of days in the 2022-2023 compliance year. Bypass target flows were met or exceeded for all but 2 days, July 24th and August 1st when flows fell below target by ~1

[2] Figure was created by ACWD to simplify presentation of the bypass requirements set forth in the BiOp. For more detailed information please reference the BiOp (NMFS 2017)

and 2 cfs, respectively (Figure 5-26). These days are in the "outside of peak migration" period of bypass requirements when total flows are low in the creek. Refer to Appendix A to view compliance criteria and bypass operations for the year.

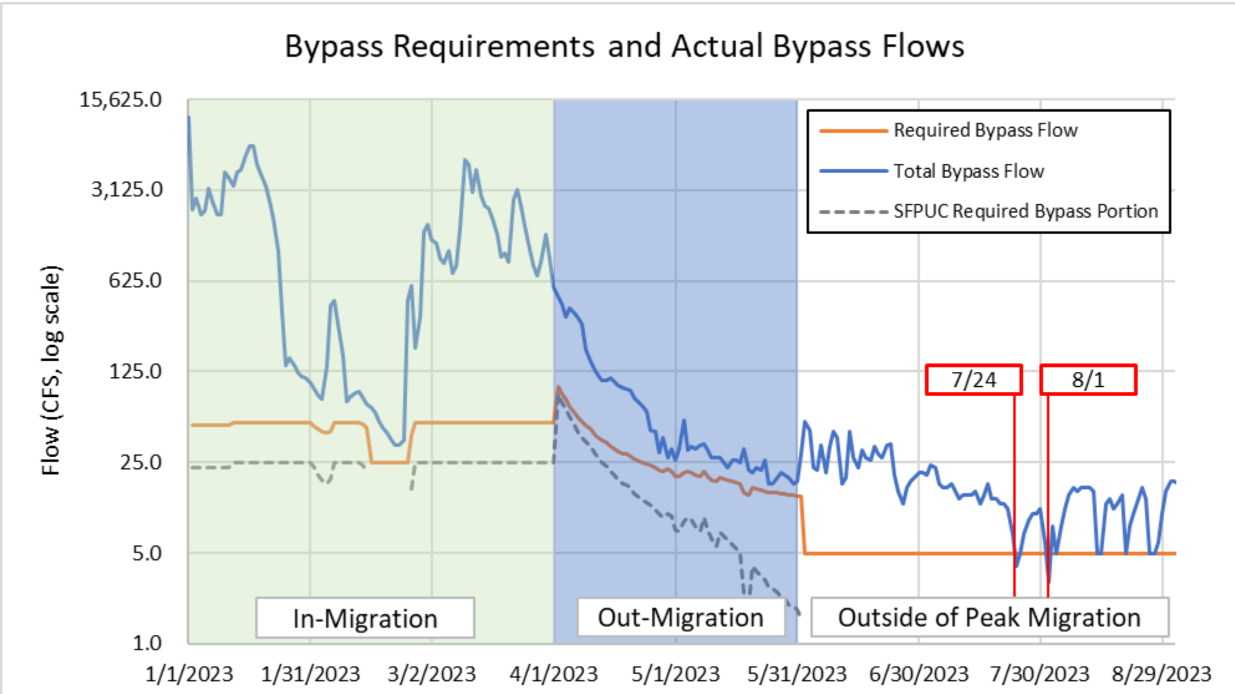


Figure 5-26: Flows in 2023 started off high due to many AR events; as such, bypass requirements were at their maximum for most of the start of the year (~48 cfs). At the start of the out-migration season, flows continued to be high due to Spring precipitation, and the SFPUC fisheries flow increased, leading to an increased requirement as of April 1. With no further precipitation, requirements and actual bypasses decreased through the out-migration, until the facility entered the outside of peak migration period, in which the bypass requirements are 5 cfs. Notice the two days, 24 July 2023 and 1 August 2023, where required bypass flows were not

An assessment of conditions on the two days that fell below target concluded that the low bypass flows were a result of several days of sustained low flow at Niles gauge, likely a result of fluctuating discharges at Quarries in the Sunol Valley (Figure 5-27). On these days, ACWD complied with BiOp requirements, specifically by not diverting water off-stream and bypassing all the flow reaching the BART Weir complex, however with only 12 cfs at Niles gauge and stream losses between Niles gauge and the Complex ranging between approximately 8 to 10 cfs, less than the target 5 cfs was available. ACWD's operations of the RD1 fish ladder attempted to mitigate by releasing additional water from storage to bolster downstream flows despite the BiOp specifically not requiring this to meet targets[3].

[3] "If less than 5 cfs arrives at [ACFCD] Drop Structure, all of the flow at [ACFCD] Drop Structure shall be bypassed. **No water will be released from storage to meet bypass flow requirements** (emphasis added)." (NMFS, 2017, pg. 21)

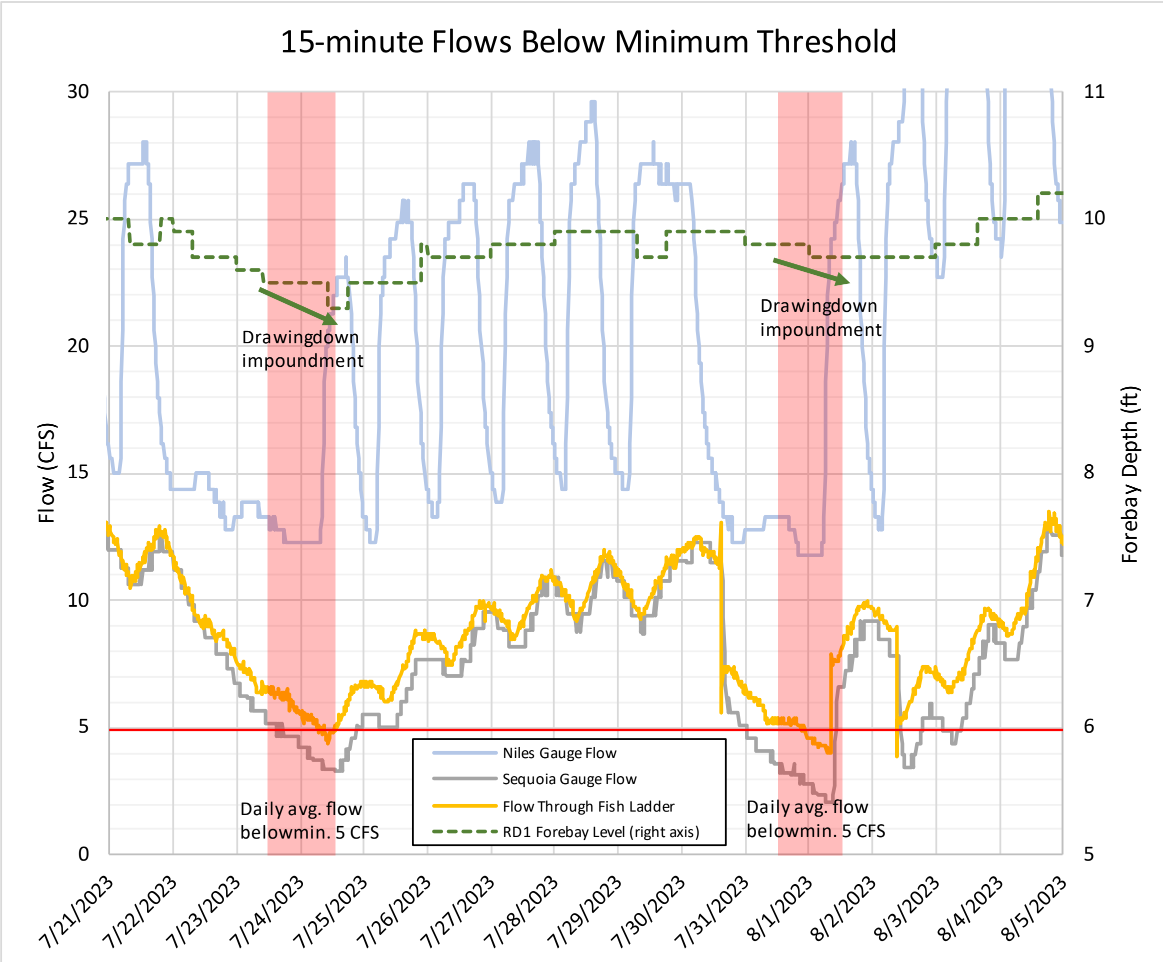


Figure 5-27: Highlighting the two days in which Summer bypass flows were below the target flow of 5 cfs due to prevailing low flows at the Niles gauge. Note that during both periods, the impoundment was dropping, and so there were no additions to storage at this time.

5.7.3. Stream Flows at Niles Gauge and at the Sequoia Road Bridge Gauge

The upstream and downstream gauges used for bypass flow compliance, Niles and Sequoia respectively, will differ in flows based on three main factors:

1. ACWD's capture of water for off-stream diversions.
2. Direct inflows between the gauges from small tributaries and urban stormwater drains.
3. Instream losses.

Direct inflows between the gauges typically only happen during storm events and often overlap with periods of deflated dams and no off-stream diversions, with little consequence for ACWD in meeting bypass flows requirements. Instream losses between gauges range from approximately 5 to 18 cfs and are more pronounced during depleted groundwater conditions or periods of drought and low stream flow. As observed during the summer of 2023, instream losses can be significant enough to reduce Alameda Creek flows to below the minimum bypass target of 5 cfs.

Flow in RD3 and RD1 Fish Ladders

Rubber Dam Overtopping

When RD3 is inflated, flows through the RD3 fish ladder generally range between 24 cfs and 45 cfs during the immigration season. If there is more than 45 cfs arriving at RD3 during the in-migration season, excess flows will overtop RD3. In the out-migration season, the RD3 juvenile spillway will provide up to approximately 150 cfs through the ladder. If there is more than 150 cfs arriving at RD3 in the out-migration season, excess flows will overtop RD3. The RD3 foundation was modified to include a plunge pool downstream of RD3, and if RD1 is inflated, the plunge pool will be backwatered by the impoundment caused by RD1.

During the reporting period, flow through the RD3 fish ladder ended when RD3 was deflated at the end of December 2022. As 2022 conditions were generally dry during the reporting period, there were only four storm events that required lowering RD3 due to high flows (8 November and 10, 15 and 27 December 2022). For those four events, immediately after reinflation, as flows were declining as the RD3 impoundment was filling, flows overtopped RD3. Additionally, there was one storm event on 4 December 2022 with flows that peaked around 415 cfs, when flows again overtopped RD3.

When RD1 is inflated, flows through the RD1 fish ladder generally range between 24 cfs and 45 cfs during the immigration season. Using the auxiliary bypass pipeline allows up to an additional 30 cfs to flow directly from the forebay to the entrance pool, thus providing for up to 75 cfs through the vertical slot fish ladder. If there is more than 75 cfs arriving at RD1 during the immigration season, excess flows will overtop RD1. In the emigration season, the RD1 juvenile spillway will provide up to approximately 150 cfs through the ladder. If there is more than 150 cfs arriving at RD1 in the out-migration season, excess flows will overtop RD1. The RD1 foundation was modified to include a plunge pool downstream of RD1.

During the reporting period, flow through the RD1 Fish Ladder was limited to 45 cfs during the in-migration season, due to the failure of the auxiliary bypass valve controls, described above. During immigration season, RD1 overtopped when flows arriving at RD1 were greater than 45 cfs and less than 1,200 cfs, which is when ACWD Water Controllers would deflate RD1. Reference the Compliance Report in Appendix A for daily estimates of overtopping. In general, RD1 was overtopping after reinflation of RD1 on 8 January 2023, between 23 January and 26 February 2023, and between 1 April and 23 April 2023. While the use of the auxiliary bypass would have helped reduce the percent of flow overtopping the dam, it should be noted that, even had the auxiliary bypass been functional in 2023, it would have only been able to prevent overtopping entirely for approximately seven days. Otherwise, the high flows due to storm flows and associated reservoir releases were too high for the auxiliary bypass to make a significant reduction in the volume of overtopping during this reporting period. The juvenile spillway was operational from 7 April 2023, through the rest of the emigration period, until 10 June 2023.

Low Flow Passage Conditions

While “low flow” has different meanings in other contexts, for RD1 fish ladder operations, low flow passage conditions during the out-migration season are understood to be flows through the fish ladder of less than 15 cfs; at this threshold the juvenile spillway is not used, and the low flow gate is operated instead. In this reporting period, required daily bypass targets fell below 15 cfs on 23 May 2023, and the low flow gate operation was prioritized over the use of the juvenile spillway. Off-season operations, from 1 June 2023 to the end of the reporting period, were low flow conditions which predominantly utilized the low flow gate to provide bypass flows through the ladder.

RD3 fish ladder operations under low flow conditions are less sophisticated than the RD1 fish ladder, as there is no low flow gate. Flows under 15 cfs simply pass through the appropriate exit gate, selected based

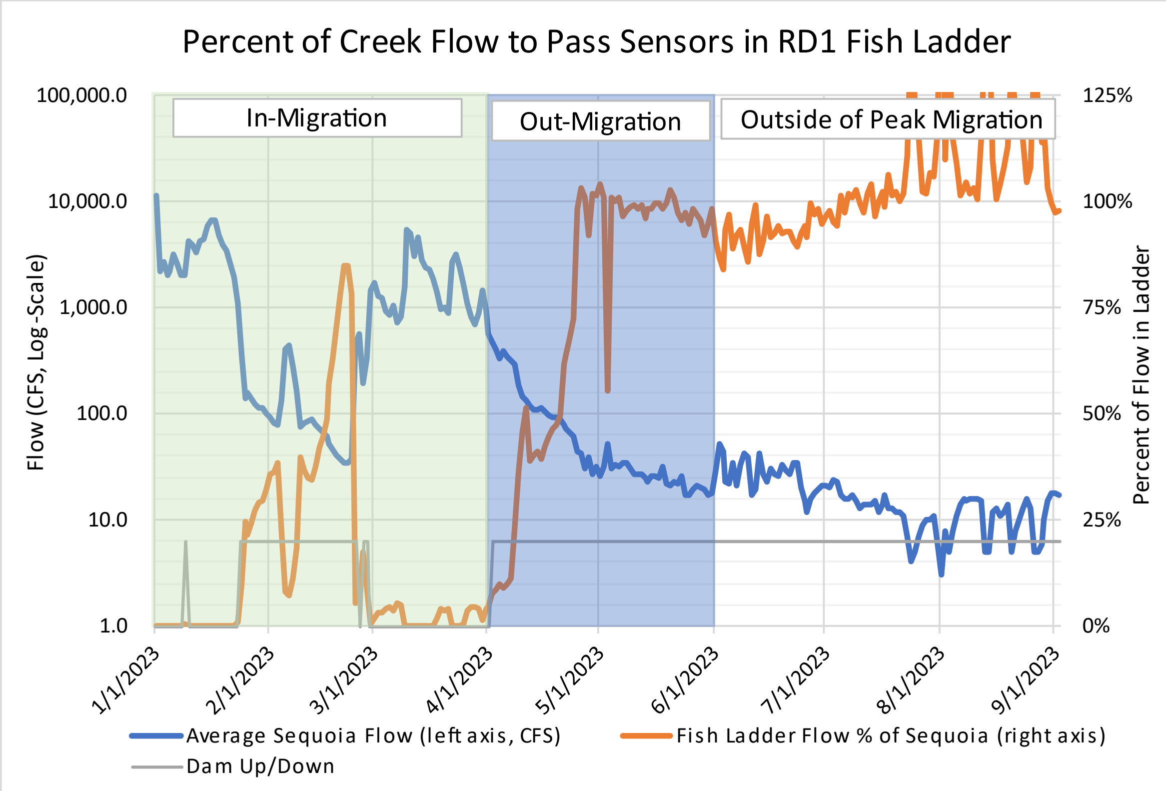


Figure 5-28: Fish ladder flow as a percentage of channel total as measured at Sequoia Gauge, 1 January 2023 through 1 September 2023. A larger portion of flow was exposed to RD 1 fish ladder monitoring sensors during out-migration than during in-migration. Period where fish ladder percentage is higher than 100% are indicative of percolation losses in the creek between the ladder and Sequoia gauge, particularly later in the year. The grey line indicates when the dam is inflated or deflated.

on the RD3 impoundment elevation. During 2023, RD3 fish ladder was not operational during low flow passage conditions.

The percentage of creek flow that passed through the RD1 fish ladder and associated sensors fluctuated substantially. Fish ladder flow was generally under 50% of all flow during the steelhead immigration due to the large flows from the extreme wet year. During emigration and the rest of the year, fish ladder flows accounted for nearly 100% of flow measured at Sequoia.

Certain events throughout the migration season had effects on fish passage or RD1 dam and fish ladder operations, or ability to measure certain criteria (Figure 5-29). In early spring, the rubber dam was inflated or deflated in response to expected flows in Niles gauge. Instantaneous flows in excess of 1,200 cfs required deflating the dam to prevent damage to the facility. Due to high sediment deposition in January, the RD3 dam bladder material ruptured, rendering the facility inoperable.

Towards the end of the season, the ARIS sonar camera was removed from the RD1 fish ladder for maintenance and cleaning.

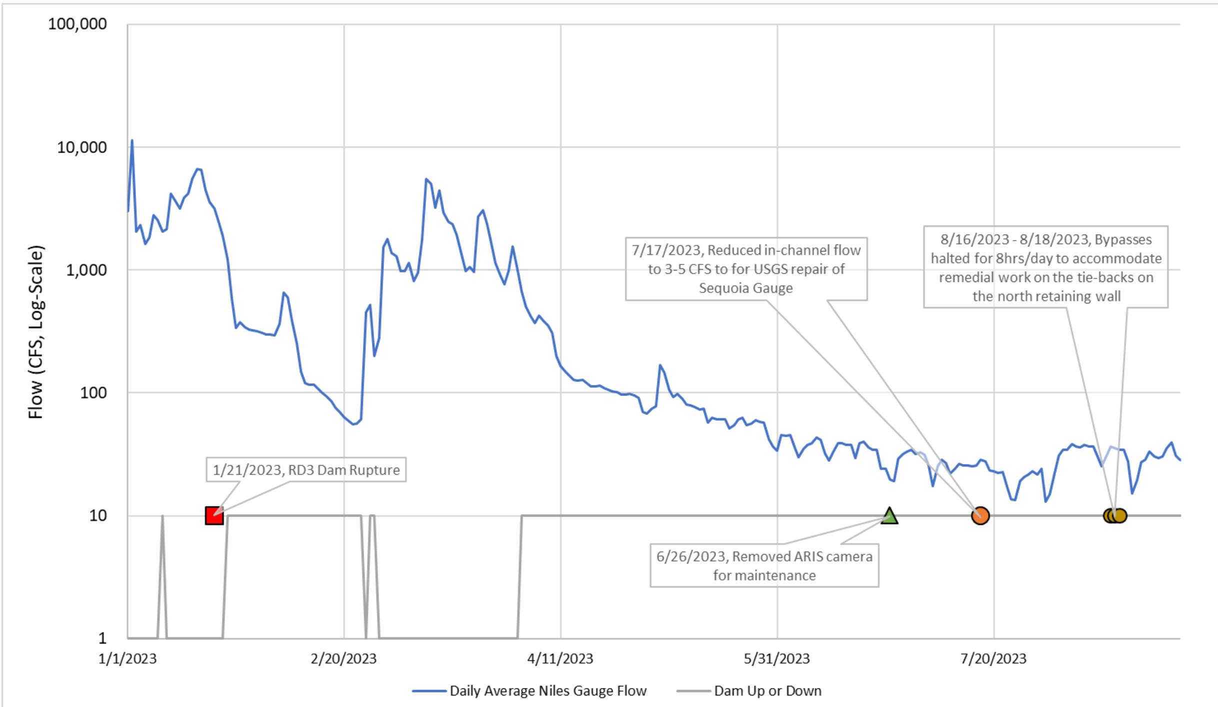


Figure 5-29: General observations of key events or triggers during the period 1 January 2023 through 31 August 2023.

5.8. BIOLOGICAL MONITORING

5.8.1. Qualitative Biological Observations

Predator/Milling Surveys

Surveys of migratory species and their potential predators at passage facilities can be used to assess the efficiency and effectiveness of the facilities while identifying potential design flaws or operational issues (Roscoe and Hinch 2010). Therefore, understanding target fish species behavior and those of their competitors and predators, is necessary to optimize passage facility function (Kynard 1993). Important fish behaviors are seasonal and daily timing of migration; near field orientation; swimming capability; schooling; and response to water quality (including chemicals), other species (competition and predation), and physical factors (e.g., illumination, sound, water depth, current velocity, and structure). By observing migratory species' behavior within the passage facility, researchers can gain insights into how these organisms interact with the infrastructure. For example, visual surveys may be used to monitor congregation areas designed to allow migratory species to rest. For instance, if high concentrations of target species are present in resting areas, it may indicate suitable habitat and effective passage design. Alternatively, if target species show signs of disorientation, circling, passage failure or fallback, or congregating (milling) in non-designated areas it could indicate a design flaw. Predator observations, including congregations, are also of interest as they may target migratory species as they attempt to pass the facilities (e.g., Sabal et al. 2016). Consistent visual surveys conducted over time can reveal seasonal and species-specific patterns in migratory fish and predator behavior (Cullinan et al. 2003). This information can be valuable for fine-tuning passage facilities operation of passage facilities to align with the needs of different species during their migrations. Therefore, we conducted surveys to document visual observations of predators, migratory species, and human activities in and around the fish passage facility to assess how these potential migratory stressors might influence passage success of target salmonids and lamprey.

Study area

The study area for predator/milling surveys includes a total of 8 sites, with 5 sites located near RD1 and 3 sites located near RD3 (Figure 3-1). The 5 sites associated with RD1 include “RD1 to Sequoia” (located upstream from RD1), “Shinn screens to RD1” (fish screens), “Lower Fishway and Bart Pool” (fishway and pool feature), “Plunge Pool and Fish Ladder” (plunge pool feature and fish passage ladder at RD1), and “Transition Pool and Dragon’s Teeth” (transitional pool and associated feature). The 3 sites associated with RD3 include “Shinn Screens to RD3” (fish screens), “RD3 impoundment” (RD3 bladder dam and surrounding area), “RD3 Fish Ladder, Plunge Pool and Downstream” (Fish ladder at RD3, plunge pool feature and downstream area).

Methods

CFS designed a protocol for ACWD to conduct daily field surveys at each site and implement a combination of visual techniques to quantify and document observations of potential predators, migratory species, human activities, and environmental conditions within the study area. Migratory species observations included steelhead trout and Chinook salmon (both live individuals and carcasses), and Pacific lamprey *Entosphenus tridentatus*. Predator observations included any bird, fish, or mammal capable of preying on identified migratory species.

Visual surveys were conducted to observe and document presence, signs (e.g., tracks, nests, or other presence indicators), and behaviors exhibited by both potential predators and migratory species in the study area. To enhance species identification and documentation, survey teams were equipped with cameras, field guides and binoculars. Visual surveys of migratory species congregating or becoming disoriented may indicate inefficiencies in the passage facility. During each survey, additional visual data were collected. This included the monitoring of fish angling activities, as well as the observation of any concurrent construction and ladder operations. These supplementary observations support a comprehensive overview of human activities within the study area, potentially affecting the local wildlife focusing on migration success of target fish species.

Abiotic data were recorded to characterize the environmental conditions during each survey. Abiotic parameters documented included air and water temperature (°F), cloud cover percentage, a description of weather conditions, date, time, and a measurement of water gauge height (ft) at the Niles Gauge inlet, RD1 facility, and Sequoia Gauge outlet (see Figure 3-1).

This comprehensive approach combined visual observations, data collection on fish and wildlife, human activities, and environmental conditions to provide a holistic view of the study area and its ecological dynamics.

Analysis

CFS compiled preliminary data summaries to assess general patterns of predator and migratory species observations and assess survey protocol efficiency.

Results

Compiled data spanned a period of three years, commencing in December 2021, and concluding in early September 2023 (Table 5-6). The number of surveys completed differs between sites, resulting in a combined total of 959 surveys conducted in the RD1 area and 736 surveys conducted in the RD3 area (Table 5-6). Survey regularity and consistency were lacking across sites in both 2021 and 2022. However, there was improvement in 2023, characterized by consistent, nearly daily observations being carried out at each site and these data, although inconsistent, offer a comparison of observations and animal behaviors before and after the ladder was operational.

Migratory target species observed included *O. mykiss* (3), Chinook salmon (25), and Pacific lamprey (7) during periods that matched their anticipated immigration and emigration schedules (*Figure* 5-30). A total of 1 *O. mykiss* (juvenile) and 25 live Chinook salmon (adults) were observed within the Project footprint over the monitoring period. Most target species utilizing the passage facility were observed in RD1, with a single salmon carcass and single adult Pacific lamprey identified in the RD3 footprint (Figure 5-30).

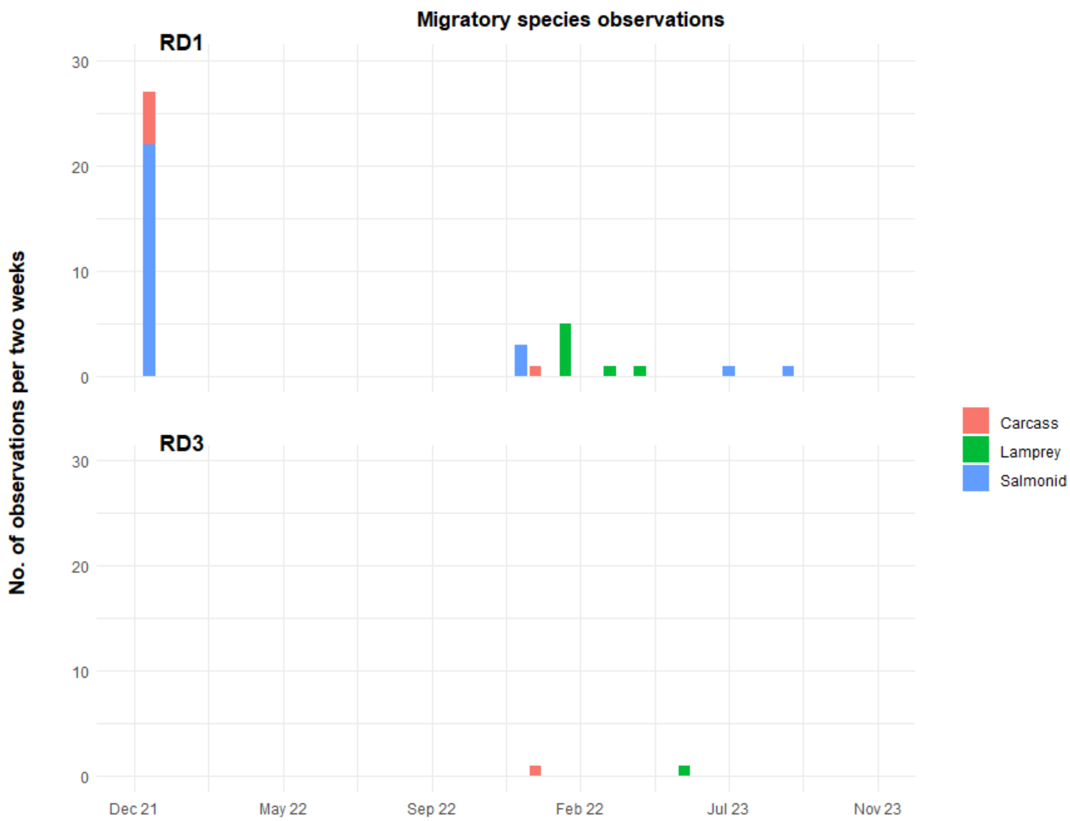


Figure 5-30. Timeline and biweekly aggregation of migratory species observations conducted in the RD1 and RD3 zones of the Alameda Creek passage facility from 1 December 2021 to 4 September 2023 (note: no surveys were performed between 1 January and 31 October 2022; See Table 5-6). The x-axis represents date and is organized into two-week intervals. The y-axis represents the cumulative count of migratory species observations made every two weeks. The upper and lower panels correspond to the RD1 and RD3 areas, respectively. Migratory species observations are categorized by live salmonid in blue, salmonid carcasses in red, and lamprey in green. Note: Carcasses are most likely all Chinook salmon.

Table 5-6. The weekly count of predator-milling surveys conducted at various site locations from November 2021 to early September 2023. These sites are categorized into impoundment RD1 and RD3 groups based on their proximity. This chart has a list of 8 specific locations within the Project area where these surveys were executed. Each square in the chart corresponds to a 7-day period aligned with the date at the top of each column. The presence of a blue square with a number inside signifies the week when surveys were carried out and indicates the quantity conducted within that week.

Alameda Creek Predator Milling Survey Summary

Year	Dam	Site	No. of surveys	Nov					Dec			
				1-Nov	8-Nov	15-Nov	22-Nov	29-Nov	6-Dec	13-Dec	20-Dec	27-Dec
2021	RD1	RD1 to Sequoia	1								1	
		Shinn screens, RD1 impoundment	0									
		Plunge pool and fish ladder	0									
		Lower Fishway and Bart pool	0									
		Transition Pool, Dragons teeth	0									
	RD3	RD3 fish ladder	0									
		RD3 Plunge pool and downstream	0									
		Shinn screens, RD3 impoundment	0									
2022	RD1	RD1 to Sequoia	9	1			1				4	3
		Shinn screens, RD1 impoundment	14						1	6	3	4
		Plunge pool and fish ladder	1						1			
		Lower Fishway and Bart pool	0									
		Transition Pool, Dragons teeth	1								1	
	RD3	RD3 fish ladder	15						1	6	3	5
		RD3 Plunge pool and downstream	0									
		Shinn screens, RD3 impoundment	15						1	6	3	5
2023	RD1	RD1 to Sequoia	3									
		Shinn screens, RD1 impoundment	235									
		Plunge pool and fish ladder	231									
		Lower Fishway and Bart pool	230									
		Transition Pool, Dragons teeth	234									
	RD3	RD3 fish ladder	230									
		RD3 Plunge pool and downstream	234									
		Shinn screens, RD3 impoundment	242									

Year	Dam	Site	Jan					Feb				Mar			
			3-Jan	10-Jan	17-Jan	24-Jan	31-Jan	7-Feb	14-Feb	21-Feb	28-Feb	7-Mar	14-Mar	21-Mar	28-Mar
2021	RD1	RD1 to Sequoia													
		Shinn screens, RD1 impoundment													
		Plunge pool and fish ladder													
		Lower Fishway and Bart pool													
		Transition Pool, Dragons teeth													
	RD3	RD3 fish ladder													
		RD3 Plunge pool and downstream													
		Shinn screens, RD3 impoundment													
2022	RD1	RD1 to Sequoia													
		Shinn screens, RD1 impoundment													
		Plunge pool and fish ladder													
		Lower Fishway and Bart pool													
		Transition Pool, Dragons teeth													
	RD3	RD3 fish ladder													
		RD3 Plunge pool and downstream													
		Shinn screens, RD3 impoundment													
2023	RD1	RD1 to Sequoia	2												
		Shinn screens, RD1 impoundment	3	6	4	6	3	7	7	7	7	7	7	6	7
		Plunge pool and fish ladder	3	6	7	6	3	7	7	7	7	7	7	8	7
		Lower Fishway and Bart pool	3	6	4	6	3	7	8	7	5	7	7	7	7
		Transition Pool, Dragons teeth	3	6	7	6	7	7	7	7	7	7	7	7	7
	RD3	RD3 fish ladder	3	6	7	6	3	7	7	7	7	7	7	7	7
		RD3 Plunge pool and downstream	3	6	7	6	7	7	7	7	7	7	7	7	7
		Shinn screens, RD3 impoundment	3	6	7	6	7	7	7	7	7	7	7	6	7

Year	Dam	Site	Apr				May					Jun			
			4-Apr	11-Apr	18-Apr	25-Apr	2-May	9-May	16-May	23-May	30-May	6-Jun	13-Jun	20-Jun	27-Jun
2021	RD1	RD1 to Sequoia													
		Shinn screens, RD1 impoundment													
		Plunge pool and fish ladder													
		Lower Fishway and Bart pool													
		Transition Pool, Dragons teeth													
	RD3	RD3 fish ladder													
		RD3 Plunge pool and downstream													
		Shinn screens, RD3 impoundment													
2022	RD1	RD1 to Sequoia													
		Shinn screens, RD1 impoundment													
		Plunge pool and fish ladder													
		Lower Fishway and Bart pool													
		Transition Pool, Dragons teeth													
	RD3	RD3 fish ladder													
		RD3 Plunge pool and downstream													
		Shinn screens, RD3 impoundment													
2023	RD1	RD1 to Sequoia													
		Shinn screens, RD1 impoundment	7	7	8	8	7	9	7	8	6	7	7	6	5
		Plunge pool and fish ladder	7	7	7	7	7	7	7	7	5	7	7	6	6
		Lower Fishway and Bart pool	7	7	7	7	7	7	7	7	5	7	7	7	7
		Transition Pool, Dragons teeth	7	7	7	7	7	7	7	7	5	7	7	6	6
	RD3	RD3 fish ladder	7	7	6	7	9	7	7	7	5	7	7	6	7
		RD3 Plunge pool and downstream	7	7	7	7	7	7	7	7	5	7	7	6	6
		Shinn screens, RD3 impoundment	7	7	8	8	7	7	9	8	6	7	7	6	5

Year	Dam	Site	Jul				Aug					Sep			
			4-Jul	11-Jul	18-Jul	25-Jul	1-Aug	8-Aug	15-Aug	22-Aug	29-Aug	5-Sep	12-Sep	19-Sep	26-Sep
2021	RD1	RD1 to Sequoia													
		Shinn screens, RD1 impoundment													
		Plunge pool and fish ladder													
		Lower Fishway and Bart pool													
		Transition Pool, Dragons teeth													
	RD3	RD3 fish ladder													
		RD3 Plunge pool and downstream													
		Shinn screens, RD3 impoundment													
2022	RD1	RD1 to Sequoia													
		Shinn screens, RD1 impoundment													
		Plunge pool and fish ladder													
		Lower Fishway and Bart pool													
		Transition Pool, Dragons teeth													
	RD3	RD3 fish ladder													
		RD3 Plunge pool and downstream													
		Shinn screens, RD3 impoundment													
2023	RD1	RD1 to Sequoia									1				
		Shinn screens, RD1 impoundment	8	9	7	8	7	6	7	7	7				
		Plunge pool and fish ladder	7	7	7	7	7	6	7	7	7				
		Lower Fishway and Bart pool	7	7	7	8	7	7	7	7	7				
		Transition Pool, Dragons teeth	7	7	7	7	7	7	6	7	7				
	RD3	RD3 fish ladder	7	7	6	7	7	6	7	7	6				
		RD3 Plunge pool and downstream	7	7	7	7	7	6	7	7	7				
		Shinn screens, RD3 impoundment	8	9	7	8	7	6	7	7	7				

Notably in 2021, when the passage facility was inactive, more than 20 adult Chinook salmon were observed below RD1. They were gathering, constructing redds, and actively spawning. This suggests that the fish would have utilized the ladder if it had been operational. Additionally, salmonid carcasses were noted during this period. Conversely, when the RD1 facility was activated during December 2022, no redds or carcasses were observed although at least 5 live adult Chinook were observed in the pool below the lower RD1 fish ladder, suggesting they passed.

Figure 5-31. Left: Adult male Chinook salmon carcass photographed in the upper Alameda Creek flood control channel 16 January 2022, underneath the Mission Blvd. Bridge. This is upstream of both the BART weir and RD3 and the RD3 fish ladder. Right: Adult Pacific lamprey observed during flow transects at the RD3 foundation while RD3 was deflated. May 2023. Photo Credit: T. Niesar.

Figure 5-32 shows a juvenile *O. mykiss* was observed at the RD1 passage facility on 17 August 2023; far outside the typical migration window. It seemed to be avoiding a school of largemouth bass milling around the fish ladder trash rack entrance.

Figure 5-32: 17 August 2023, a single juvenile O. mykiss observed in shallow waters of the northern alcove between the RD1 fish ladder outer wall, dam abutment and the rubber dam during routine surveys.

Potential salmonid and lamprey predators observed included a variety of avian (e.g., bald eagle, heron, egret, osprey, cormorants, etc.), mammal (e.g., otters, raccoons, etc.), and fish (e.g., largemouth bass, etc.) species (Figure 5-33). The most common potential predators were avian (114), followed by mammals (12) and fish (7). Predator observations seem to coincide with the sightings of migratory species, but they persisted beyond the period of the last observed migratory species. Most predators were observed in RD1. It is worth mentioning that the highest numbers of avian predators observed were described as congregations of cormorants near the facilities.

Although data has been effectively gathered regarding migratory and predator species, including their counts and locations, there is room for improvement through more consistent and detailed descriptions of these observations. For example, many predator observations include information about their type and count, but they lack specific identification or behavioral details. Apart from the lack of detailed explanations, the available tools, such as the camera and field guides, were not maximized to their full potential.

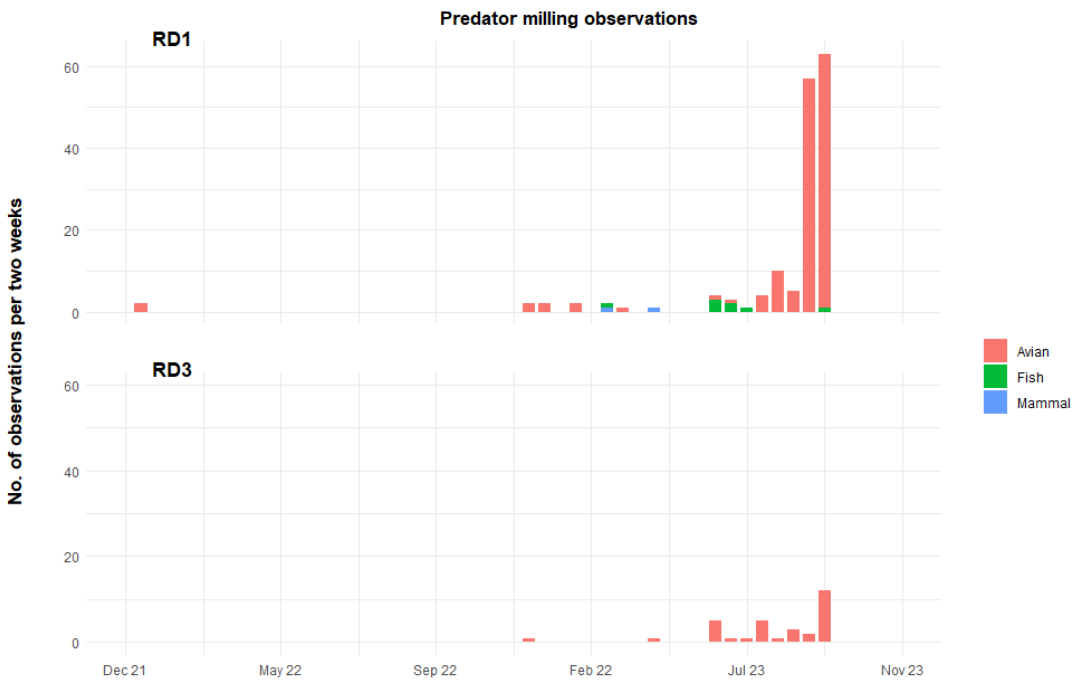


Figure 5-33. Timeline and biweekly aggregation of potential predator observations recorded in the RD1 and RD3 regions of the Project area from 20 December 2021 to 4 September 2023 (note: surveys were performed between 1 January and 31 October 2022; See Table 5-6). The x-axis represents date and is organized into two-week intervals. The y-axis represents the cumulative count of predator observations made every two weeks. The upper and lower panels correspond to RD1 and RD3, respectively. Predators are categorized into avian in red, fish in green, and mammal in blue groups, encompassing any species capable of preying on migratory species within and around the passage facility.

5.8.2. Stranding Surveys

Background

According to the draft MAMP for RD1 and RD3 Fish Passage Facilitates (WRA 2022), during fish ladder operation, observations of the biological response by fish may occur that are not as expected. In such cases, a “trigger” is described which would warrant additional investigation. The purpose of the investigation is to help determine the cause of the observation, and whether management of the fish ladder triggered the resulting observation including fish stranding (Table 5-4; Items 3,5,7). The purpose of these stranding surveys is to determine if steelhead have been isolated from the river mainstem channel or within the passage facility, as a result of rapid flow fluctuations associated with Project operations. Although not a Project focus, Chinook salmon and Pacific lamprey are also mentioned in the BiOp, due to their Species of Special Concern status.

Over the 1 January – 31 May 2023 period, it was observed that a total of 14 potential stranding events, which included 11 potential stranding in the rip rap area, and 3 potential events in the RD1 fish ladder when RD1 was re-inflated/fish ladder was turned off. Over this time, observations of fish exposed to low flow conditions were only observed within the RD1 fish ladder. This included observing several Lamprey on 8 January 2023 and at least 35 adult Pacific Lamprey on 27 February 2023 in the RD1 fish ladder as RD1 was deflated. The Pacific Lamprey observed on 8 January 2023 were able to move out of the RD1 fish ladder as the fish ladder was operated a couple of hours longer to allow their movement out of the fish ladder. The Pacific Lamprey observed on 27 February 2023 were able to move out of the ladder with the receding flows. Also, on 23 January 2023, several Pacific Lamprey were also observed on the BART weir as RD1 was inflating. At least two observational walk throughs were conducted during the potential stranding events in the rip rap area and no stranding was observed. There were also many instances that visual observations were conducted from the banks of Alameda Creek to observed if there were any indications of stranded fish as the flows receded. In every instance the RD1 fish ladder was dewatered, ACWD would walk the length of the ladder to confirm that there was no stranding of fish observed. Outside of the monitoring period there were a total of five events where five adult Chinook Salmon were observed and two O. mykiss (estimated > 15 in). No fish were exposed to water shallow enough to expose gills to air and each event was shorter than 5 minutes in duration.

Observations of adult Chinook salmon passage at RD1, corroborated by results of stranding surveys demonstrating adult Chinook salmon visually observed within the ladder between test flows and observations by stakeholders above RD1 (Figure 5-33; left). Similar observations were made for adult Pacific lamprey (Figure 5-33; right).

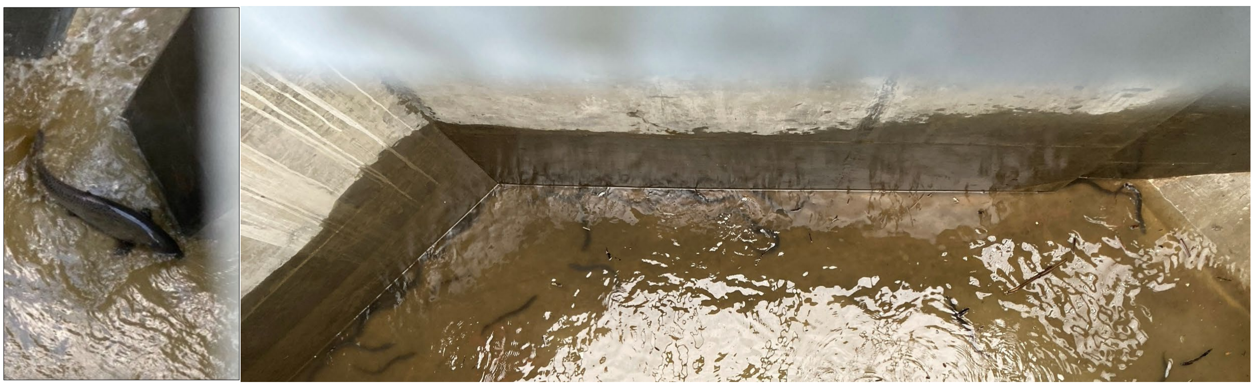


Figure 5-34. Examples of target fish observations during flow drawdown in the RD1 Fish Ladder. Left: Adult Chinook salmon observed in RD1 Fish Ladder during 12 December 2022 test flows. Right: Over 25 adult Pacific lamprey within the RD1 Fish Ladder during a 27 February 2023 drawdown.

On the morning of 23 June 2023, four images of two fish were recorded during RD1 fish ladder dewatering for inspection of the ARIS system. The images were recorded by camera through the metal grating over the ladder bay. According to ACWD Water Controller, David Kim, they appeared to be *O. mykiss*, with the larger fish estimated to be approximately 24 inches long and the smaller fish about 15 inches long. The Biomark antennas were operational however no tag detections were recorded. The ladder was fully dewatered five days later (28 June). Monitoring by a fisheries technician on site did not observe *O. mykiss* but did observe similar-sized fish exiting the downstream end of the ladder.

Figure 5-35 Two images of suspected O. mykiss in the RD1 ladder. The female (silvery) is visibly distressed by the dewatering but revived immediately when flows were promptly resumed after the fish were observed.

O. mykiss are not expected to be present in this region of the lower Alameda Creek watershed in late June as prevailing flow, water temperatures, and weather conditions are not typically suitable. However, since salmonid migration has only recently been reestablished, and with less than one year of observational data, few conclusions can be drawn about life history tactics. The purpose of this assessment is to use best science to identify the species of fish observed, their life stage, and a generalized theory as to why they were found in this otherwise unexpected part of the watershed at this time of year.

To provide an estimate of species, life stage, and possible sex for both fish, CFS used the characteristics described in Moyle et al. (2017) and outlined in Dagit et al. (2020) as well as secondary sexual characteristics identified in Merz and Merz (2004). In several images, an adipose fin can be seen on each fish suggesting each is a salmonid (note, smelt and catfish also have adipose fins but these clearly are neither). Only the tail and anal fin of the smaller fish can be clearly distinguished but suggests *O. mykiss*.

From estimates provided by ACWD Water Controller David Kim, visual inspection of the images and familiarity with the ladder features, CFS estimated that the:

- Smaller fish was between 15 – 17 inches total length
- Larger fish 18-24 inches total length

This suggests both fish are 2+ years old. The smaller fish demonstrates the steel color of a smolt or immigrating adult. The larger fish does not demonstrate coloration, but size indicates an adult. Sogard et al. (2009) used a cutoff of 4.72–5.12 inches to separate age-1 fish from older fish in June. Age-2 smolts are typically less than 15 inches (Hayes et al. 2011). This suggests these are both adult *O. mykiss*. While the larger fish is not as well defined, “guilt by association” and general physical stature suggest it is also an adult *O. mykiss*. The smaller fish has a small head and adipose fin-to-body length ratio suggesting this is a female. The larger fish has a relatively large head-to-body length ratio suggesting it is a male.

Stakeholder Involvement

The Alameda Creek Alliance (ACA) is a 2,000-member strong community watershed group, dedicated to protecting and restoring the natural ecosystems of the Alameda Creek watershed. ACA has been working to restore steelhead trout to the Alameda Creek watershed since 1997. Members of this community regularly patrol the watershed and make observations related to a variety of physical and biological incidences. During the monitoring period, ACWD upload these observations, including photo documentation from ACA, to a database. Where possible, fisheries and wildlife observations are translated to a count of individuals, identification of species and life stage.

On 3-4 December 2022, a small atmospheric river event produced Alameda Creek runoff volumes of up to 740 cfs (*Figure* 5-23*).* On 5 December, RD3 and RD1 were inflated, and the ladders were "closed" to in-migrant passage, as ACWD was still gathering field testing data at RD1 to confirm the ladder was functioning within design specifications. At the same time, ACWD provided ~6-8 cfs of bypass flows to maintain a continuous live stream downstream of RD1; this flow was conveyed in the RD1 Fish Ladder's auxiliary bypass pipeline (which takes water from the upstream exit channel via a screened pipe to release in the downstream entrance pool, located immediately upstream of the closed entrance gate). Additionally, approximately 30 Chinook salmon were observed attempting to ascend the BART weir by Alameda Creek Alliance volunteers. After peak flows receded, the salmon retreated to the pool downstream of the ladder where they were observed milling for the remainder of the week.

Figure 5-36. Chinook salmon attempting passage at the Bart Weir 5 December 2022. Photo Credit: D. Young.

Daily monitoring by ACWD staff revealed no evidence of stranding or carcasses, though at least one Chinook was observed being predated by river otters (Figure 5-37).

On 9 December 2022, Water Supply staff deflated RD3 to move that impoundment water to RD1 to support RD1 Fish Ladder testing. Before, during, and after RD1 Fish Ladder testing, staff surveyed for migratory fish with no observations.

On 12 December 2022 fish ladder testing resumed, during which time suitable flows for passage were provided for approximately six hours. The acoustic imaging ARIS (sonar) camera was not fully operational and therefore was unavailable for monitoring; however, staff at the camera station believe that at least one fish was observed swimming past the camera. ACWD staff observed at least three fish in the upper reaches of the ladder during the short periods of low flow in between flow tests, and staff observed one fish during shutdown and dewatering of the ladder at the end of the day; these fish were subsequently enticed to exit back down the ladder. These data points represent the first confirmation that adult salmonids had found the entrance to the ladder and ascended at least as far as the exit bay.

Figure 5-37: North American river otter (Lontra canadensis) eating Chinook salmon downstream of BART weir. Photo credit: Dan Sarka

On 13 and 14 December 2022, a notably smaller number of Chinook salmon were observed milling below the ladder. These fish appeared to be quite fresh as indicated by only slight color change and no spawning damage or apparent fungal infections. Monitoring revealed no indication of spawning behavior, as indicated by a lack of any nest or redd construction.

On 15 December 2022, between 2-5 Chinook were believed still present below the ladder. Another testing day commenced with a high ‘pulse flow’ of water through the ladder to entice fish to move. Extensive calibration work on the ARIS camera was conducted. While movement was detected on the camera, it could not be confirmed as a fish image. At

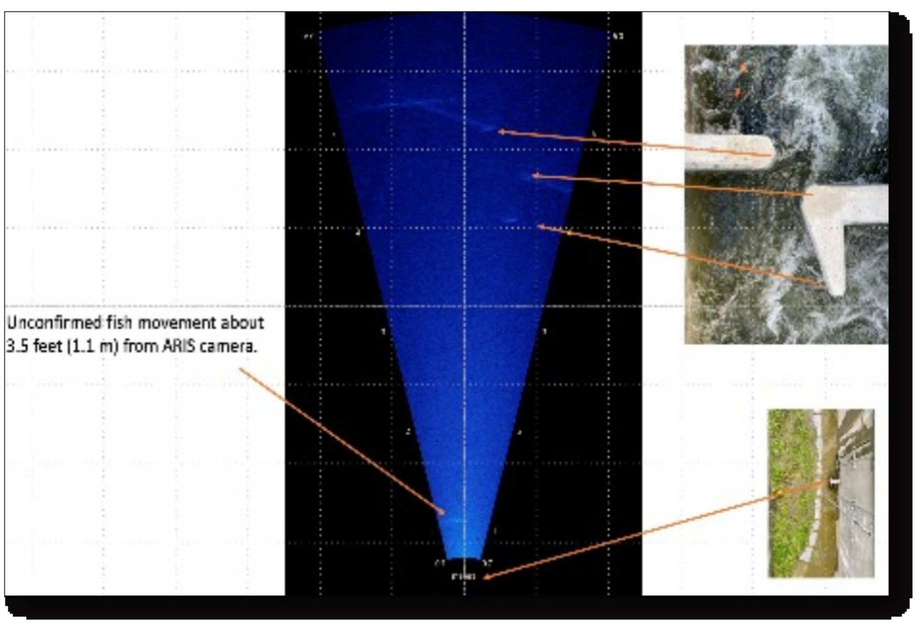


Figure 5-38: 15 December 2022. ARIS sonographic imaging demonstrating key features of the camera bay and a fish image recorded by the camera. Photo Credit: ACWD & CFS

day's end, dewatering once again revealed one adult female Chinook midway through the ladder. Staff pulsed flows downstream and successfully enticed her to exit downstream.

On 18 December 2022, Alameda Creek Alliance volunteers photographed several fish in Alameda Creek upstream of both of ACWD's rubber dams. The fish images on the video and still photos were verified as Chinook salmon by Program biologists. This marked the first proof that salmonids had ascended both new ladders and, for the first time in over 50 years, have volitional access to the Alameda Creek watershed.

On 19 December 2022, ACWD staff observed as many as 25 fish resembling Chinook, in both size and behavior, upstream of ACWD facilities and staging below a low flow barrier in lower Niles Canyon. Experts could not confirm with certainty that they were Chinook, however video footage of at least one confirmed adult Chinook passing the barrier was collected. It is important to note that large schools of adult carp (*Cyprinus* spp.) have also been observed in this area and can superficially appear as adult salmonids.

Figure 5-39: 18 December 2022 Chinook observed upstream. Photo credit: Dan Sarka

On 20 December 2022, staff monitored all upstream and downstream locations where they had observed Chinook during the previous days but did not see any activity.

Other stakeholder observations of anadromous fish passage include adult Pacific lamprey detected during passage facility maintenance on 1 April 2023 (Figure 5-40). These observations corroborate fish observations with the ARIS camera and strengthen our knowledge of lifestage timing for target organisms identified in the BiOp.

Figure 5-40. 1 April 2023, ACWD raised RD1 for maintenance with local lamprey retreating downstream to the BART bridge. Shortly after they began returning upstream to the pool at the drop structure. Photo credit: D. Sarka.

Discussion

These three qualitative monitoring efforts provide an excellent opportunity to strengthen passage data collected with the ARIS camera and PIT tag antenna with corroborative observations. Each has provided input to our ability to measure the success of this passage process, including confirmation of successful upstream passage of at least two native anadromous species, Chinook salmon and Pacific lamprey, during the first year of operation.

There were observations of at least two instances where target species were identified outside of their identified migratory period. The 2023 water year was atypical with above-average flow and cool temperatures. Therefore, while two adult and one juvenile O. mykiss were observed at the RD1 passage facility outside of their perspective migration windows, the abnormal water year could partly explain these late observations. Secondly, the damage to RD3 (deflated dam and inoperable ladder) possibly impeded immigration since the last significant flows in early April, which is still within the steelhead immigration window (BiOp 2017). Relying on the limited, observational data, the silvery color of the smaller adult, coupled with its robust physical appearance suggests that it was not far into the maturation process. Therefore, it could be either a large out-migrating smolt or a smaller in-migrating adult. Given that the three previous years had been significantly dry, the likelihood that the smaller fish resided in the watershed and emerged as a 2+ smolt is somewhat reduced. The male could be either an in-migrating adult or an out-migrating, post-spawned kelt. It is possible the two adult *O. mykiss* came up from the Bay and immigrated to the area of the BART Weir late in the adult migration season and were unable to negotiate the concrete sill of RD3 (Figure 5-41). Therefore, they staged in the vicinity of RD1 waiting for high flow conditions to arrive so that they could ascend the RD3 foundation. At the time of their discovery in June, they were found in the ladder where we speculate that temperatures and flow were more satisfactory for *O. mykiss*.

More than four anecdotal observations of predation on lamprey and Chinook were substantiated during the monitoring period. While predation can be a substantial threat to passage success (Sabal et al. 2016; Agostinho et al. 2012; Waples et al. 2008), it also plays a vital role in overall ecosystem processes and

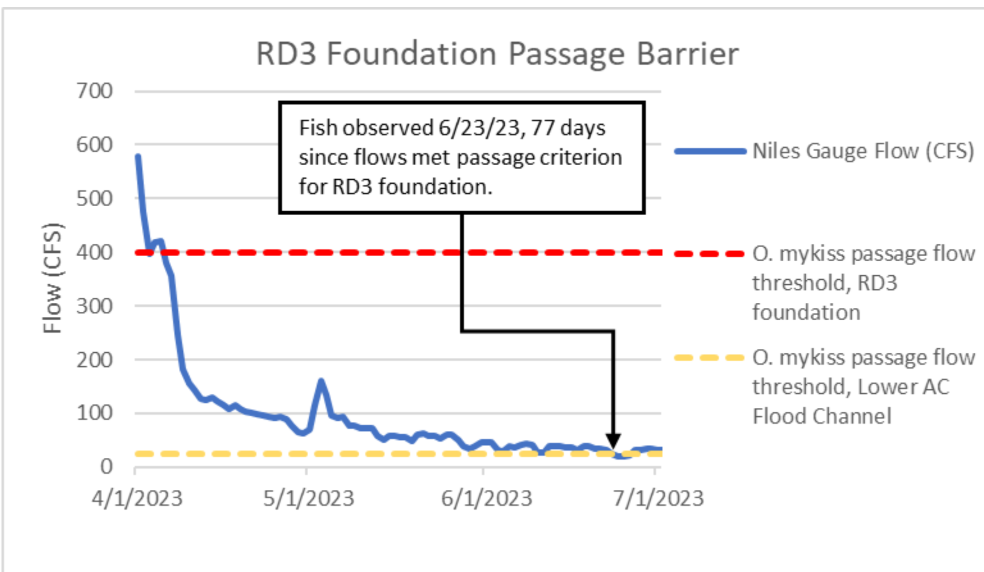


Figure 5-41: Niles gauge flow data (cfs). RD3 ruptured and has been out of service since January of 2023. The RD3 fish ladder is designed to provide passage with 25 cfs of flow (yellow broken: lower AC Flood Channel passage threshold). However the ladder is inoperable if RD3 is deflated. Staff assessment of the deflated RD3 and its foundation concluded that ~400 cfs (red broken: O. mykiss passage threshold at RD3 foundation) is needed to provide the minimum flow depth of 0.6 ft for adult O. mykiss passage; adult passage needed in the lower channel is only 25cfs. This chart reveals that conditions have been suitable for adults to in-migrate as far as the RD3 foundation for 77 days prior to the observation on June 23, but insufficient to ascend the RD3 foundation.

services and is often demonstrated as a measure of restoration success (Madin et al. 2012). While keeping this in mind, operation of the fish passage facilities should be operated so that, coupled with species invasions, it does not play a significant role in predation events within the project footprint. These observations provide some of the first observations of predation on salmonids in Alameda Creek.

5.8.3. Quantitative Biological Monitoring

ARIS Sonar

Sonar Data Collection

Sonar data were collected using ARIS Explorer 3000 Sonar (manufacturer Sound Metrics). This device was connected to a remote desktop at the RD1 facility (Figure 5-42). Data were collected from 21 December 2022 to 23 June 2023. The associated software ARIScope was set up to generate 15-minute files that were saved to an external hard drive. On a semi-regular basis, the external hard drives used to record data were swapped out for blank hard drives. Data collected on the external hard drives were then taken back to ACWD, uploaded to Microsoft SharePoint, and then sent to CFS to be stored on a master hard drive. The master hard drive was then used to distribute data to trained sonar readers.

ARIS Sonar Processing Methods

Trained sonar readers used ARISFish propriety software developed by Sound Metrics to process ARIS files. In this software there are multiple ways to process the sonar data. Given the relatively low-quality recording data collected this monitoring season, CFS chose to use the Echogram function in ARISFish to read the files and process the fish passage data as the echogram function is a more manual process than the other options available in ARISFish. An echogram is a visual representation of the ARIS image, compressed to a vertical line of pixels for each image frame. By default, the entire angular field of view (e.g., all sonar beams) is processed to form each frame line, so that fish swimming anywhere within the image may be observed in the echogram output. The y-axis of the echogram image thus contains all sonar returns over the selected range, while the x-axis represents time (frame number). Echogram function creates displays of “fish tracks” which represent the range location of the fish versus time as they swim across the beam (Figure 5-43). Readers marked “fish tracks” in the echogram and then used the sonar image to confirm fish presence vs debris floating through the ladder.

Figure 5-42: Computer station for the ARIS sonar camera

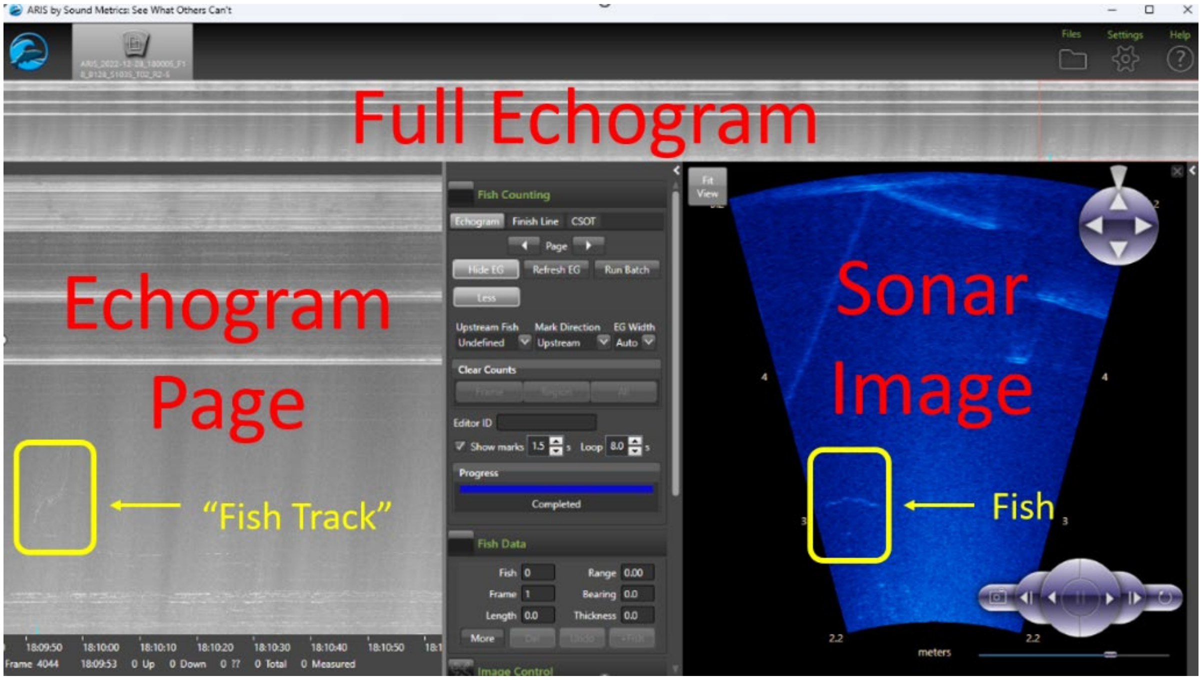


Figure 5-43: ARISFish Echogram Function. The sonar image on the right is a 2-D 'overhead' view of the fish ladder that the ARIS Explorer 3000 creates. The bar on the top is the full echogram for the file which is the visual representation of the ARIS sonar image over the frames captured in a recording. The box on the left is the echogram page which shows 2 minutes' worth of frames from the full echogram.

Fish tracks are first confirmed to be fish, rather than inanimate objects in the ladder or bubbles from turbulence, by reviewing the sonar image and are saved by marking the echogram. Measurement and movement data are recorded for all fish in the file. For measurement data, readers measured fish in the sonar image and assigned a confidence score to the measurement as a proxy for the quality of the image collected. For movement data, readers noted the direction a fish was predominately moving (i.e., up, down, across), how the fish was behaving in the ladder (i.e., running, milling, or backsliding), when and where on the sonar image that the fish came into the field of view, and when and where the fish left the field of view. Location data were generated by using the grid function in ARISFish that divided the sonar image into equivalent rectangles that were assigned a unique identifier (Figure 5-44). This step was added (not provided in the ARISFish software categories) to help understand how well the sonar was detecting fish throughout the field of view over time. Readers filled out a data tracker and recorded (a) the reviewer, (b) date reviewed, (c) time it took to review the file, (d) presence/absence of fish in the file, (e) if all the walls of the fish ladder were visible, and any pertinent notes on the file. After all fish were marked and measured, ARISFish autosaved six output files (.xml, .txt, .csv, .aris.fsettings, .egm.png, .eg.png.)

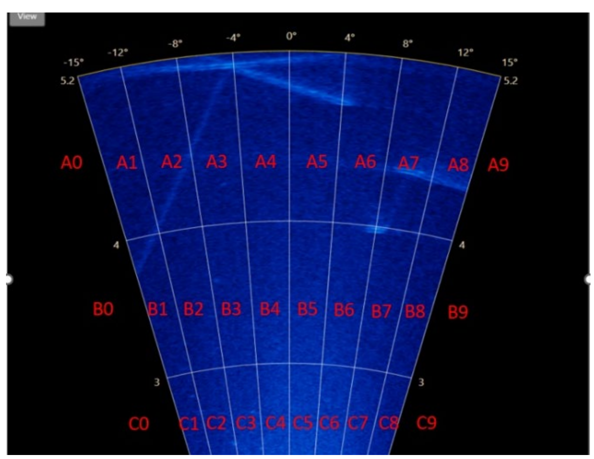


Figure 5-44: Grid Function in ARISFish. Used to keep track of where the sonar was able to detect fish within the field of view.

These files were transferred to Dropbox. The .csv files were compiled into an Excel file to produce summaries of the entire seasons fish passage data. This file was inspected for errors from the initial readers, anomalous data were inspected and corrected. High confidence scores, outlier lengths, and blank movement data were all corrected by this targeted approach. Manual ARIS data cleaning, quality assessments, and corrections were performed ad hoc, addressing anomalous data such as observations with the highest confidence score (5), data gaps such as missing time stamps or movement direction, and outlier fish lengths.

A QC protocol is in development to enhance ongoing precision and consistency monitoring among data readers. Currently, trained readers process all videos, of which 5-10% are randomly selected for a secondary assessment by a different reader. Additionally, it is a goal to conduct multiple blind reads using the same reader to assess consistency, especially with lower quality data. This dual-review approach, once analyzed, will enable the assessment of the percentage agreement in observations within and among readers, ultimately providing a standardized measure of reader precision. These data were used to determine the amount of error between readers for numbers of fish per file, as well as differences in movement and measurement data. The data was then analyzed using Excel and R coding software. Individual fish images were binned into possible taxonomic and age groups based on time of year identified in the MAMP (2022) and size frequencies identified in the literature (Table 5-7, Moyle 2002; Williams 2006).

Table 5-7. Criteria used to determine possible taxa and life stage assignments of ARIS data.

Taxon & Lifestage	Size Range (cm)	Timing
Juvenile salmonid	3 - 10	Year round
O. mykiss smolt	10 – 41	Year round
O. mykiss adult (in-migrant)	>= 41	1 Jan – 31 Mar
O. mykiss adult (out-migrant)	>= 41	1 Apr – 31 May
Chinook adult	45 – 60	1 Nov – 31 Dec

ARIS Sonar Results

ARIS Functionality

During the 2023 monitoring season the ARIS was deployed in the RD1 fish ladder for the entire season (1 January through 31 May 2023). While the unit was in the ladder for this period, a combination of environmental factors and protocol development needs, including safety requirements, interfered with the goal of collecting continuous data over the entire migration period. Water Year 2023 was extremely wet and allowed the fish ladder to operate for the entirety of the monitoring season; however, many days of video were not readable due to quality issues. Figure 5-45 demonstrates the trend of reviewable video collected over the monitoring season.

It is apparent that there were large gaps in readable quality video collected in January and March through May 2023 (Figure 5-45). These gaps in readable sonar came from a combination of the device not recording for long periods of time and low-quality videos (not able to be processed; Figure 5-45).

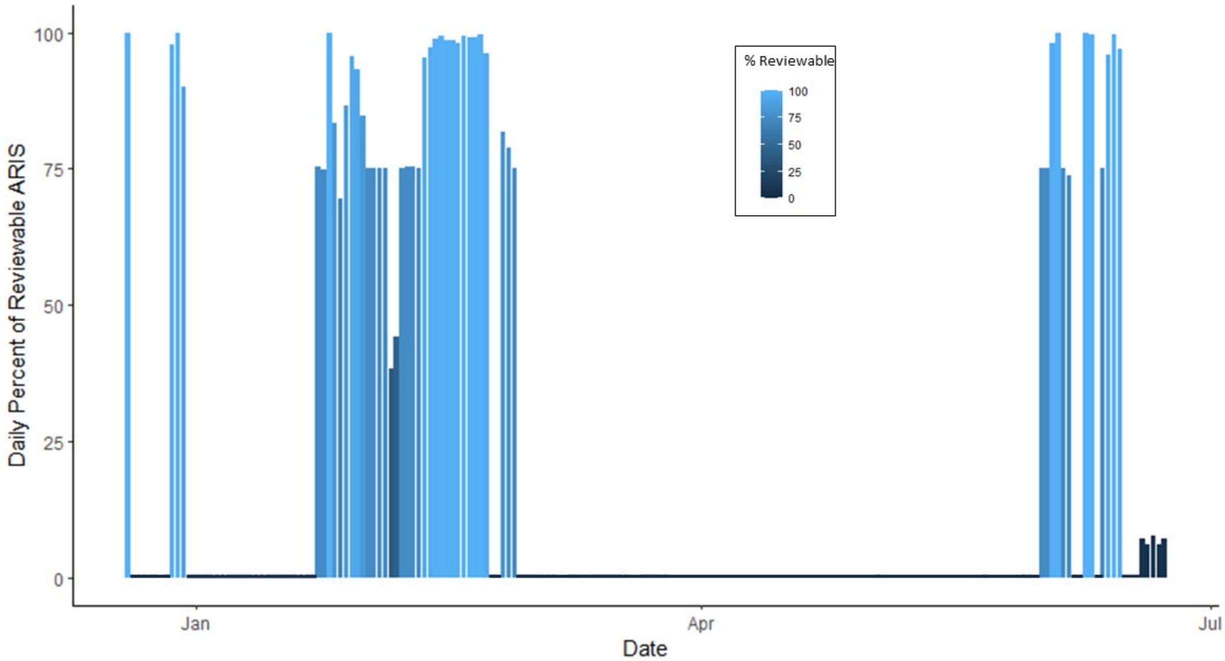


Figure 5-45. Daily percent of reviewable video collected each day during the period the sonar was operating (28 December 2022 through 23 June 2023).

The missing and poor-quality data were the result of environmental factors, as well as undeveloped system check and site access safety protocols. The wet water year and turbid flows caused silt to build up in the ARIS Explorer 3000. The season started with a high-quality image (Figure 5-46a), but the compounding effects of the silt build up resulted in image obstruction issues seen in Figure 5-46b and Figure 5-46c. Figure 5-47 shows that a majority of the season fell into the categories not reviewable (example in Figure 5-46c) or not recording. Of the 151 days in the monitoring season (1 January 2023 – 31 May 2023) 61 days (40%) were not readable and 52 (34%) were not recording. Lack of a developed system check and safety protocol also led to data not being collected for large periods of time during the monitoring season.

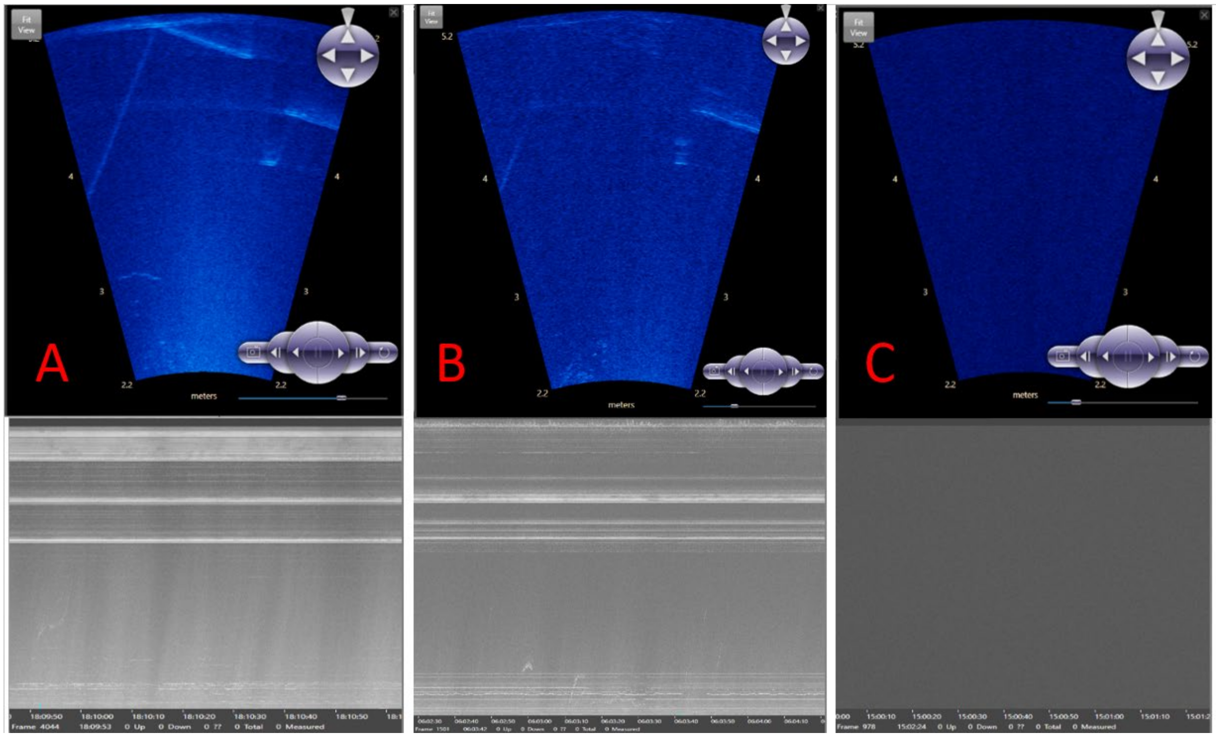


Figure 5-46: This figure shows sonar images categorized by quality of image and their associated echograms (A.) Fully Functional - High Quality Sonar Image and Echogram, all walls visible, high degree of confidence in detecting fish as they move through the field of view (B.) View Partially Obscured – Medium Quality Sonar Image and Echogram, wall furthest from ARIS sonar obscured, fish still able to be detected but with lower confidence. (C.) Not Functional – Lowest quality Image, all walls of fish ladder obscured, fish not able to be detected in either the sonar or echogram.

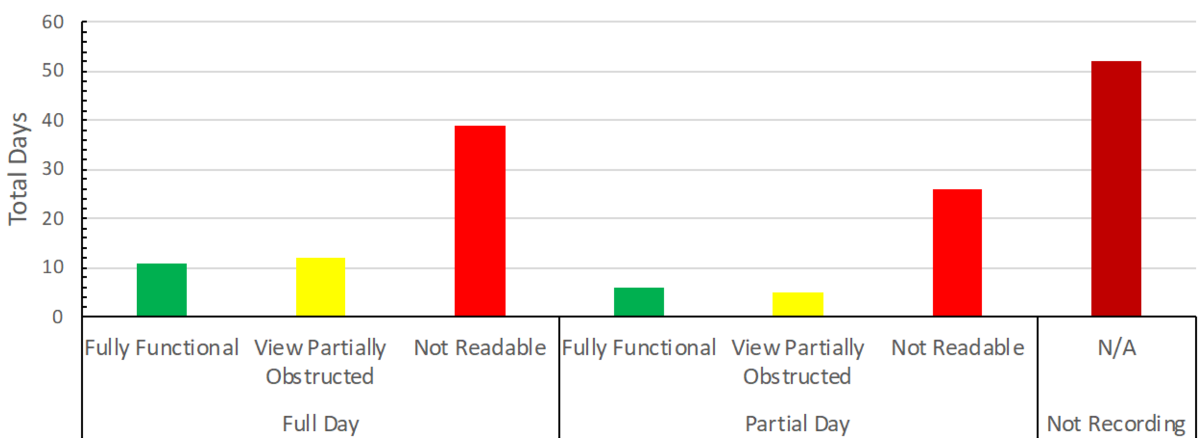


Figure 5-47. The status of ARIS recording and functionality for the 2023 monitoring period; 28 December 2022 through 23 June 2023. Note: The actual monitoring period is 1 January through 31 May.

Functionality and reliability were further divided into the categories “Fully Functional” and “View Partially Obscured” to get a sense of how well the sonar was operating through the periods that were reviewable. Only 11 full days (7% of total monitoring days) had high quality functioning video. A total of 34 days (23%) of the 151 had reviewable sonar data collected. Data collected in December and June was also reviewed and the number of fish observed in these periods are included in the subsequent analysis. Surprisingly, after continuous deterioration of sonar imagery, video quality improved again around 1 June 2023, which resulted in another 13 more Full or Partial days of usable recordings.

Table 5-8. Recorded number of days during the monitoring period (1 January through 31 May 2023) that SONAR collected data, grouped by data quality.

	Recording Count
Full Day	**62**
Fully Functional	11
View Partially Obstructed	12
Not Readable	39
Partial Day	**37**
Fully Functional	6
View Partially Obstructed	5
Not Readable	26
Not Recording	**52**
N/A	52
Grand Total	151

From these reviewable clips, 8,898 fish images of various quality were detected. Due to the constraints of the season, many of the sonar-detected fish images would appear and disappear in the field of view without clearly swimming out of the image. Tracking “entrance” and “exit” locations on the sonar grid (Figure 5-48) showed that the sonar was much more likely to detect fish in grids immediately adjacent to the ARIS sonar and that many fish disappeared out of the river right (RR) side of the ARIS image (B9, C9). This is a blind spot in the current deployment and adds to the difficulty of enumerating fish moving up or down the ladder. Additional inferences on how fish are behaviorally taking advantage of the different areas of the fish ladder may also be reflected in these data. However, this cannot be parsed out presently due to the lack of reliable fish detection in grids further away in the bay. For example, no detections were made in grids A5 and A6 during this season. These grids are at the entrance of the sonar bay where upstream migrating fish must pass up from the lower bay and into the sonar’s field of view. This demonstrates an area of functionality the program should aim to improve upon in the coming monitoring seasons.

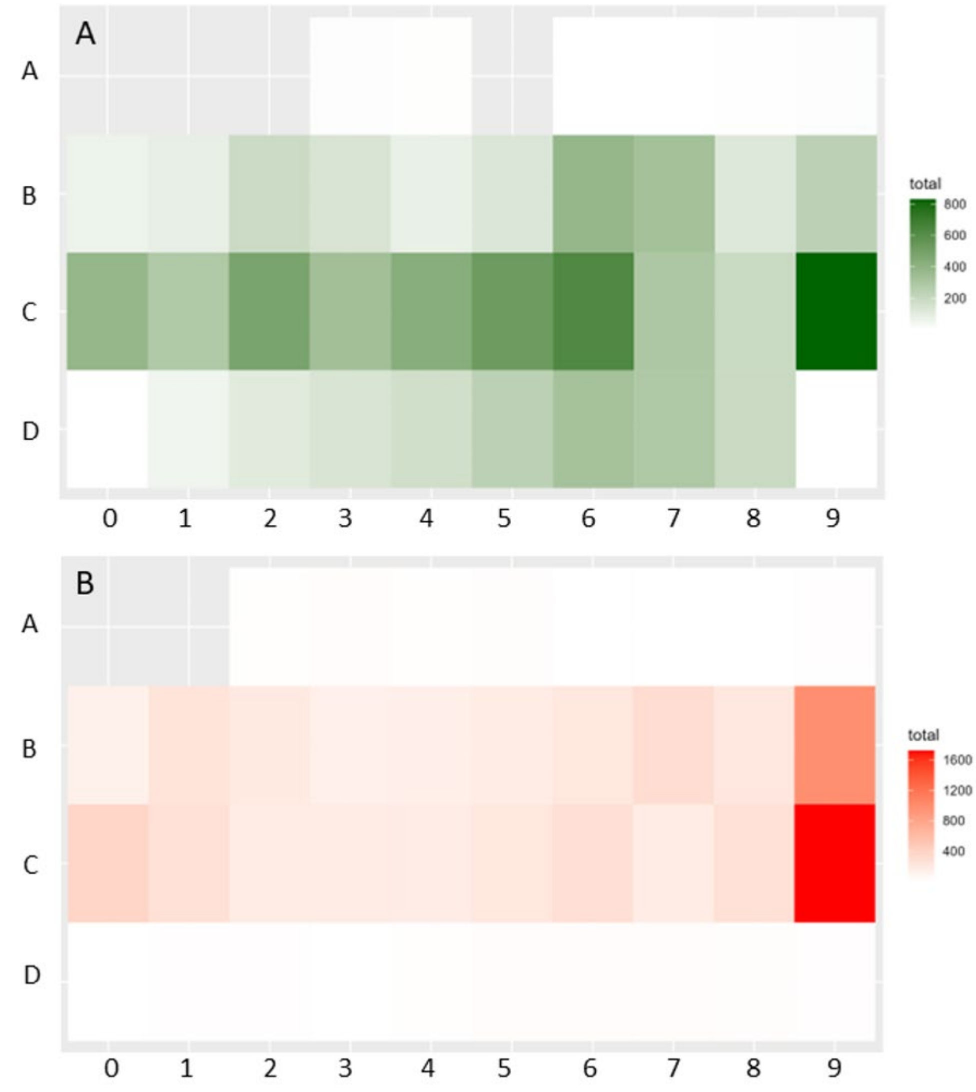


Figure 5-48: Heat maps showing entrance (A) and exit (B) locations of fish images on the sonar images. Note the difference in scales between the two maps showing that it was easier to detect fish entering the field of view across more grid spaces than exiting. Also note the decrease in detections and increase in blind spots further from the camera. The color scale intensity is related to the number of fish counted per grid.

Despite the combination of environmental conditions and data quality issues impeding the ability to continuous collect high-quality sonar images throughout the monitoring season, we were still able to record 8,898 fish images within the RD1 facility from 28 December 2022 to 23 June 2023. It is important to note that these are individual fish image detections and not necessarily 8,898 unique fish. Individual fish using the ladder bay once versus milling in the ladder (e.g., coming in and out of the sonar field of view numerous times) were difficult to differentiate as limitations in the sonar configuration and quality of the images collected caused numerous length measurements to be of low confidence. With more reliable length measurements individual fish seen multiple times in the ladder could be identified and total passage estimation could be possible. Of the 8,898 total fish image detections, 7,452 images met length and migration timing criteria for the various life stages of Central Valley Steelhead and Fall-Run Chinook salmon present in Alameda Creek and other regions of northern California (Williams 2006). Using the criteria in Table 5-7, a possible 164 juvenile salmonid images (mean length 8.3cm, SD 1.4), 7,119 *O. mykiss* smolt images (mean length 22.3cm, SD 6.7), 167 *O. mykiss* adult images (in-migrants, mean length 45.5cm, SD

4.3) and two Chinook adult images (mean length 51.1cm, SD 7.5) were recorded by the ARIS unit (Table 5-9). It is important to note that our test results demonstrated object sizes estimated on the ARIS screen were anywhere from 47% smaller to 18% larger than known sizes taken before the trials (mean 9.3% smaller). In general, the size of the two tethered carcasses were estimated to be smaller than actual size while inanimate targets were estimated larger than known size. This has ramifications for present and future classification results.

Table 5-9: The total fish identified by the ARIS camera binned into potential salmonid lifestages using estimated length and time seasons identified in the BiOp and MAMP.

Bin	Count	Min length (cm)	Median length (cm)	Max length (cm)	SD	Start Date	End Date
Juvenile salmonid	164	4	9	10	1.4	2022-12-28	2023-06-15
O. mykiss smolt	7,119	10	21	41	6.7	2022-12-28	2023-06-21
Chinook adult	2	46	51	56	7.5	2022-12-28	2022-12-30
O. mykiss adult (immigrant)	167	41	44	59	4.3	2023-01-24	2023-02-27

Several fish species and age classes on non-salmonids known to exist in this portion of the watershed fall within the size classes and timing we used for our image classifications. These include several native and non-native cyprinids (minnows), non-native lepomids (sunfish), and native Sacramento Sucker (*Catostomus occidentalis*) (e.g., Workgroup 2007; SFPUC 2009; this study). Figure 63 gives examples of fish detected in the ARISFish sonar image and conveys the difficulty of speciating fish given the quality of the recordings. Image 63a is the only example confidently identified to species – a Pacific lamprey; its unique morphology compared to typical finned fishes allow it to be easily differentiated with high quality recordings. These images are snapshots and species determinations can be more easily made by a trained reader with moving images that show swimming behavior and relative thickness.

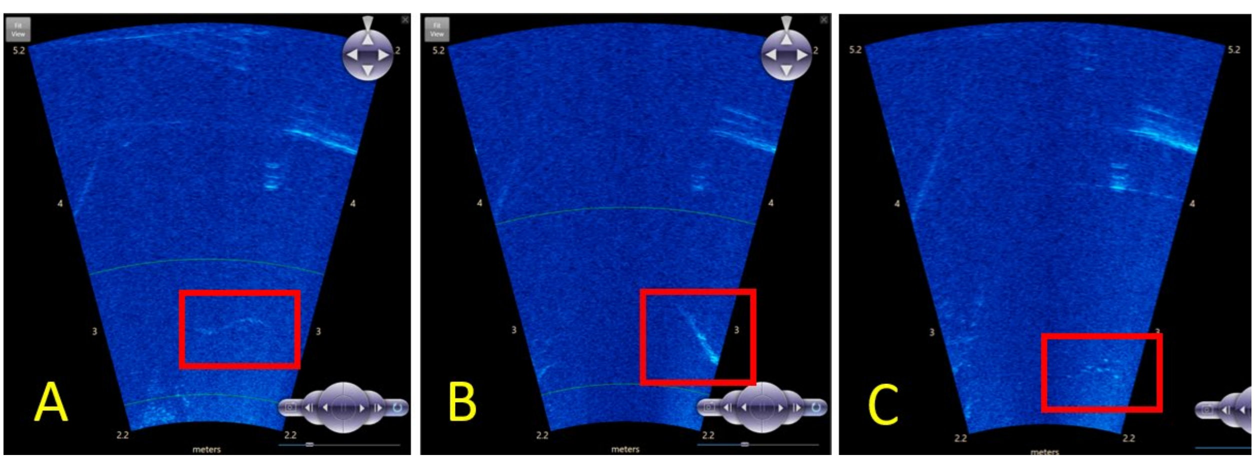


Figure 5-49: Sonar Images of various fish (A.) Lamprey, (B.) Large fish, (C.) School of small fish.

Fish were not detected from March through June of the monitoring season due to the lack of quality recordings (Figure 5-50); however, the data show that no fish images meeting the length and time of year criteria for the adult salmonid life stages were recorded in June (Figure 5-51). This is consistent with known migration timing of adult Fall-Run Chinook and Central Valley steelhead in other comparable Central Valley watersheds (Williams 2006). Even so, two adult *O. mykiss* were observed during a dewatering event at the RD1 Fish Ladder in Pool 10 near Exit Gate 1, upstream of both the ARIS camera and the box culvert, on 23 June 2023. This was a very wet and relatively cool water year. Deviations in "typical" *O. mykiss* behaviors were observed in several instances during the monitoring year and by other programs (e.g., R. Renn SFPUC pers. comm).

The week with the most individual recorded fish images was 12 June 2023 (n = 1,972); this week held the day (13 June 2023) with the highest number of individual fish images (n = 900). Other trend analyses on various life stages over the season would be difficult to perform due to the limited period of reliable recordings.

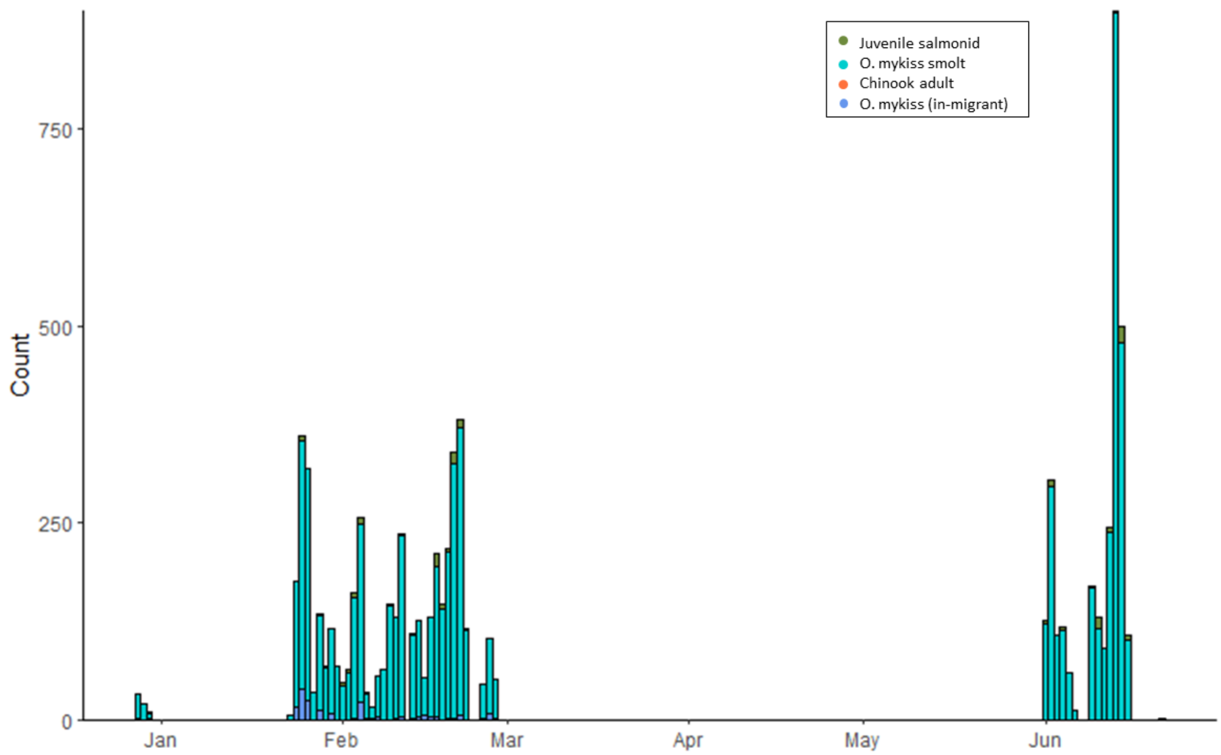


Figure 5-50: Daily detection counts with fish images binned into possible species and life stage based on size and time of year criteria.

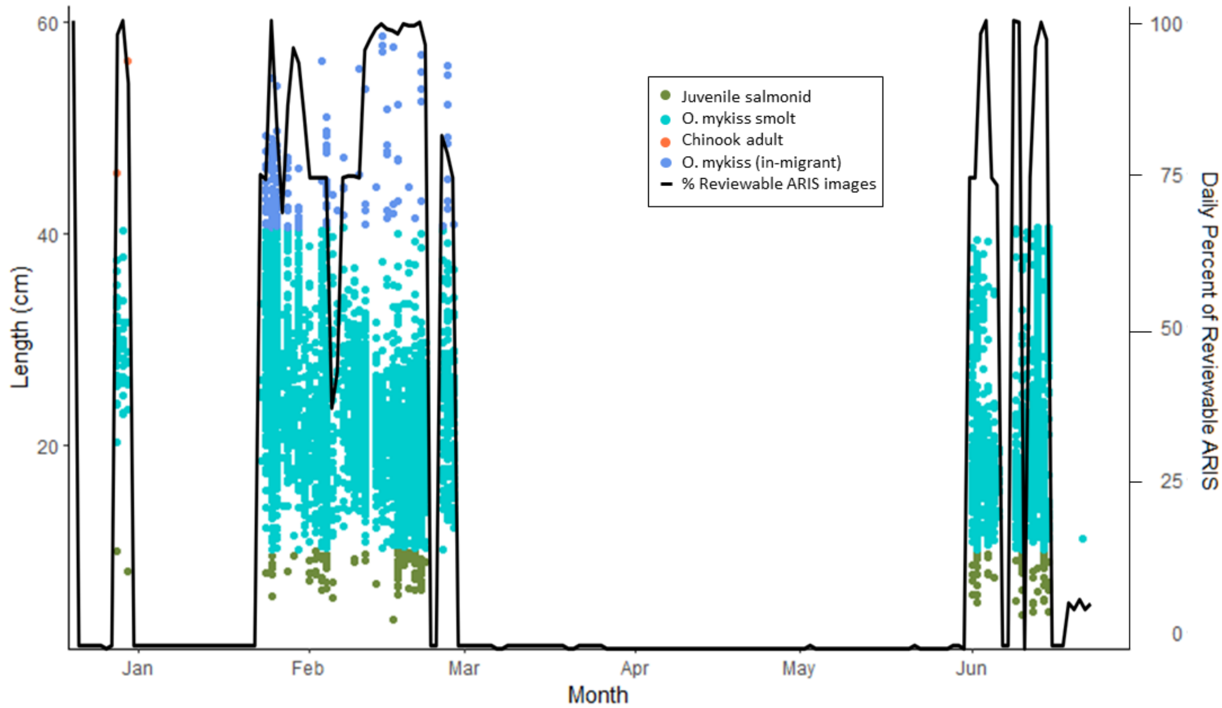


Figure 5-51: Individual length measurements with fish images binned into possible species and life stage based on size and time of year criteria (colored points). Black line indicates percentage of ARIS imagery that was reviewable each day. Note, these are counts of individual fish images, not estimated fish counts.

ARIS Maintenance

During the 2023 monitoring season the ARIS Explorer 3000 sonar unit was not able to be cleaned or maintained. The sonar unit is set up in a 15-20 ft deep fish ladder bay at the RD1 Fish Passage Facility and has many hazards associated with accessing the unit (e.g., considered confined space etc.). During the monitoring season ACWD was in the process of hiring a safety officer most of the season. Toward the end of the season the position was filled, and the safety officer was able to develop a protocol that would allow safe access to the ARIS Unit and Fish Ladder using lock-out tag-out procedures and confined space training. With the procedure developed, ACWD, CFS, and a contracted OSHA safety specialist were able to access the fish ladder and the ARIS Explorer 3000 sonar unit. During this procedure (23 June 2023), the sonar unit was extracted from the ladder. The ARIS sonar was then shipped to Sound Metrics for annual standard maintenance. Once serviced, the unit was returned for use in the 2023-2024 monitoring season. The inability to service the unit in-season affected the quality and functionality of the sonar data collected, especially since the abnormally wet water year had many high flow events. These high flow events carried high quantities of sediment and debris through the fish ladder (see Figure 5-46) that caused the ARIS Explorer 3000 to fill with silt impairing the image quality. The safety protocol developed during the 2023 monitoring season will help confirm quality sonar recording moving forward as it will allow technicians to perform routine maintenance and cleanings throughout the season.

ARIS 2024 Improvements

In the goals outlined for the 2023 monitoring season it was stated that the first several years of ARIS operation will involve troubleshooting collection and interpretation of sonar video to understand its capabilities, minimize unnecessary data interpretation, and optimize operation (Kajtaniak 2022). The 2022-2023 monitoring season should be considered a year of testing and adaptive management for ARIS sonar use with areas for improvement in sonar collection, processing, analysis, and maintenance moving forward. ACWD and CFS have taken steps to improve the collection of the sonar data through a series of testing, adjusting, and re-testing. CFS has developed a protocol for system checks that will provide an improved structure for downloading and storing data as well as improvements to data sharing processes that include a cloud backup of data at ACWD before hard drives are shipped to CFS. ACWD has developed safety protocols that will allow technicians to access the sonar unit for more routine maintenance. Sound Metrics (ARIS manufacturer) will continue to give expert guidance on system set-up and operation. Improvements in data storage, handling, and management made in 2023 should lead to more efficient data processing in future years.

One recommendation for the 2024 season is attaching a spreader lens to the ARIS Explorer 3000 sonar which will expand the field of view vertically; this should lead to more reliable fish detections over the relatively short distance that the ARIS Explorer 3000 is currently configured in. Testing the spreader lens and adjusting the angle that the ARIS sonar is pointing should greatly decrease the issue of fish appearing and disappearing within the sonar field of view. These actions should lead to improved relative quantity and quality of recordings collected.

The benefits of improved image quality and consistent operation of the sonar would be substantial to understanding how the fish ladder is being used by the fauna of Alameda Creek. The 2022 goals of the program included monitoring lamprey, steelhead, and salmon emigration and immigration. While these specific goals were not fully achieved this year, the infrastructure developed in 2023 should lead to improved sonar recordings. Improved images would allow for more reliable measurements of individual fish and could help determine total individuals moving up and down the ladder. These should be goals for the 2024 monitoring season. Individual species identifications could also be possible but should not be expected with ARIS operation alone at this time. Currently there are methods of processing the sonar data that could give species determinations, but they would require high quality images and would likely need to be paired with other fish population assessment methods (Jones 2021). Paired methods to verify fish could include tactical use of GoPro Cameras, a long-term video monitoring set-up, or periodic fish trapping at either end of the fish ladder. Another method of fish species determination is a tail-beat frequency analysis (Helminen 2021). This method utilizes the "fish tracks" that are captured by the echogram that are analogous to animal tracks being left in the snow. Species would be able to be determined by the pattern of movement over time. This method would involve the development of Artificial Intelligence (AI) technologies and paired lab studies to determine swimming rates of known species in the ACWD RD1 fish ladder project footprint. Like the other goals listed, this method would require high quality data collection and may take several years to develop for this project's specific needs.

Even in a low success data collection year there were 40+ days of reviewable footage clips that took 350+ hours to read and QC. Given the known goals of collecting high quality data consistently over the monitoring season it should be expected that in wet years there will be more reviewable footage collected. With this Project expectation, the need to automate processes is apparent for the longevity of monitoring fish passage at RD1. Investment in automating data processing could be significantly different depending on future Project goals. Detecting fish in the echogram would be relatively simple compared to developing a tail-beat frequency analysis. With this in mind, program goals for 2024 should be refined to reflect the level of investment desired.

PIT Tag Efficiency Test

Methods

There are four PIT antennas installed in the RD1 Fish Ladder to capture detections of any PIT-tagged steelhead utilizing the fish ladder (Figure 5-52). Two antennas are vertical slot, pass-through antennas that operate at low flows (Antennas 2 and 4, red arrow), and each of these antennas have an overflow antenna that operate at high flows (Antennas 1 and 3, yellow arrow).

To track continued efficacy of the antennas over the monitoring season, two types of efficiency tests were conducted in spring and summer of 2023. The first test was performed on 20 and 21 April 2023 by releasing three groups of thirty radishes, a semi-neutrally buoyant object, implanted with PIT tags upstream of the fish ladder in RD1 Reservoir. These tests were conducted at fish ladder flow rates between about 43-80 cfs. Discharge in Alameda Creek at the time of testing was near 100 cfs (USGS station 11179000 – Alameda C NR Niles CA). The second test consisted of swinging a test tag in front of the antennas on 20 randomly selected days between 01 May and 27 August 2023, during which discharge ranged from 12-150 cfs.

Detection data were offloaded from each Biomark PIT antenna and incorporated into the Peterson/Lincoln single mark-recapture model to estimate detection probability. Since the high flow antennas were not constantly operational, detection probabilities were only calculated for the two low flow antennas using:

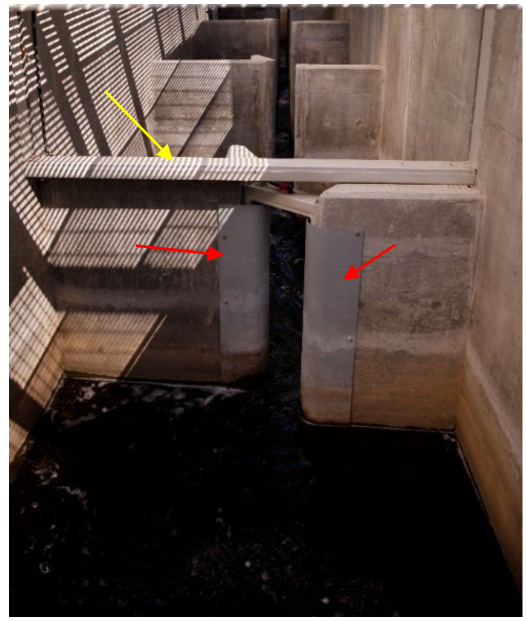


Figure 5-52: Pit tag antennas near the entrance gate of the upper RD1 Fish Ladder. Red arrow points to low flow vertical antenna; yellow arrow points to high flow horizontal antenna.

$$p_1 = \frac{m}{n_2} \tag{1}$$

and

$$p_2 = \frac{m}{n_1} \tag{2}$$

where

$n_1 = number\ of\ PIT\ tags\ detected\ at\ the\ first\ antenna;$

$n_2 = number\ of\ PIT\ tags\ detected\ at\ the\ second\ antenna;$

$m = number\ of\ PIT\ tags\ detected\ at\ both\ antennas.$

Overall detection probability was then estimated using:

$$\hat{p} = \frac{n_1 n_2 - (n_1 - m)(n_2 - m)}{n_1 n_2} \tag{3}$$

Travel time through the fish ladder was estimated for individual tags. The first detection recorded at each antenna was used to calculate the number of seconds from release to Antenna 4, and from Antenna 4 to Antenna 2. Duplicate detections were retained to observe differences in number of detections per unique tags and to understand the total number of detections recorded during this study. All calculations were performed using R (version 4.3.1) in RStudio 2023.06.2 Build 561.

PIT Tag Results

PIT Tagged Radishes

Out of 90 tagged radishes released, 67 were detected by at least one of the four PIT antennas (Table 5-10). High flow Antennas 1 and 3 performed poorly detecting only one and eight PIT tags, respectively. Their total number of detections were also low, where Antenna 1 only received one detection and Antenna 3 received fourteen detections. It is important to note that antennas 1 and 3 were not inundated during this experiment and therefore these low detections were expected. The fact that they still detected some tags under these conditions articulates their capabilities.

Antennas 2 and 4 detected 32 tags at both antennas (m = 32). Individually, Antenna 4 recorded 303 total detections comprising 47 unique tags (n_1), while Antenna 2 recorded 511 detections that represented 46 unique tags (n_2) (Table 5-10). The detection probabilities for Antenna 4 and Antenna 2 were similar (Antenna 4 (p_1) = 0.69; Antenna 2 (p_2) = 0.68), and the overall detection probability ($\hat{p}$) for both antennas was 0. 90.

Table 5-10: Summary table for detections of the PIT tagged radishes released in RD1 Reservoir.

Group	Time of release	# PIT tags detected	Antenna 1	Antenna 2	Antenna 3	Antenna 4
Group 1	9:26	28	0	272	1	173
Group 2	12:50	21	1	78	13	31
Group 3	14:45	18	0	161	0	99
Total	-	67	1	511	14	303

For the 47 tags that were detected at Antenna 4, the amount of time it took radishes to travel from the time of release to the time of detection ranged widely from 2.3 minutes to 17,136 minutes (11.9 days) (Figure 5-53). The immense spread of travel times is largely attributed to radishes from Group 3, which differed notably from the first two release groups by spending much longer to travel to Antenna 4 (Figure 5-53).

There were 32 tags detected at both Antenna 4 and Antenna 2, where travel times varied among the three release groups. Radishes in Group 3 still generally took longer than the other two groups, but Group 1 had a notably larger range of travel times than did those of Group 2 (Figure 5-54).

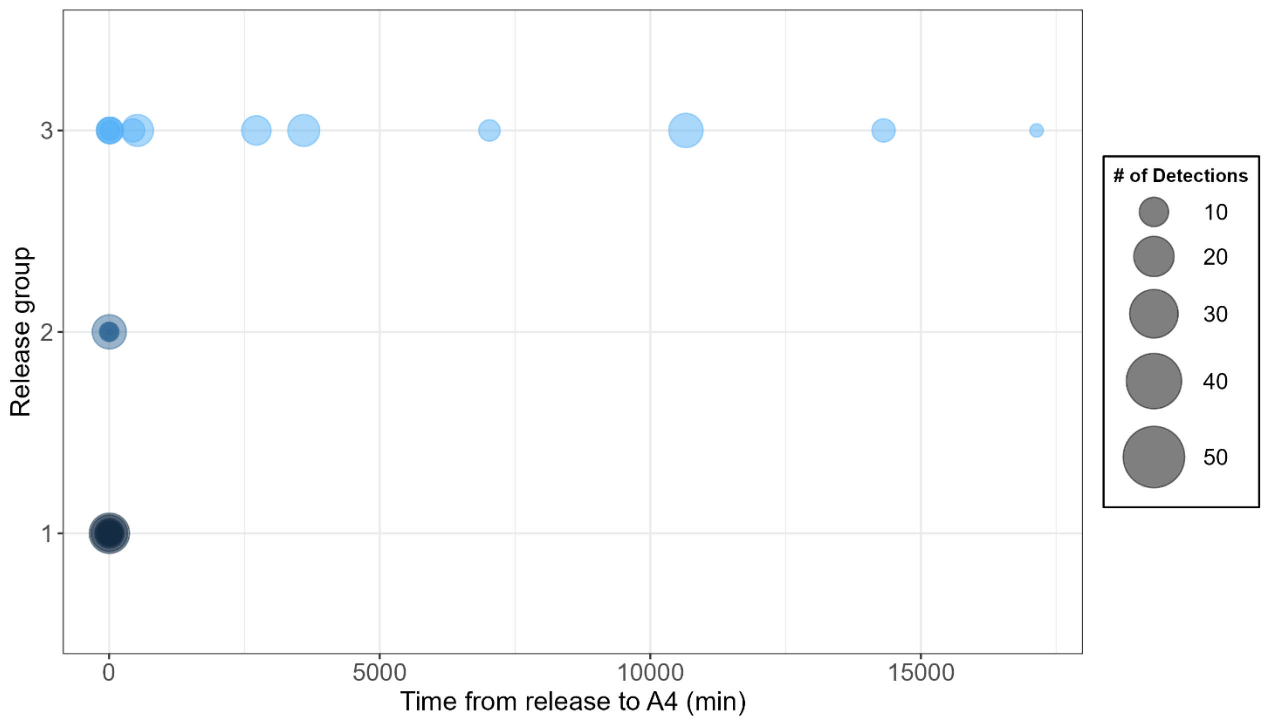


Figure 5-53: Travel time (minutes) from the time of release in RD1 Reservoir to the time of detection at Antenna 4. The size of each point is scaled to represent the number of detections that were recorded for a given tag within each group (n = 47).

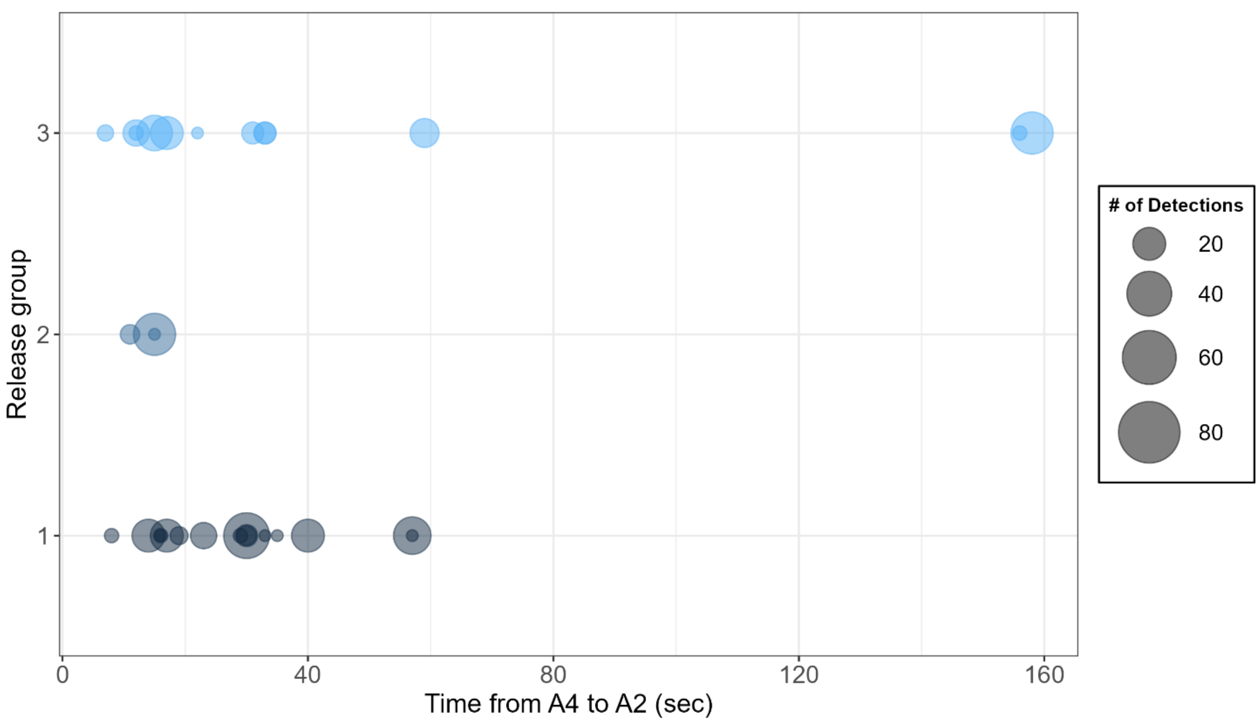


Figure 5-54. Travel time (seconds) from the time of detection at Antenna 4 to the time of detection at Antenna 2. The size of each point is scaled to represent the number of detections that were recorded for a given tag within each group (n = 32).

PIT Test Tags
Test tags were swung through the RD1 fish ladder on 20 randomly selected days between 01 May and 27 August 2023. For all 20 days, the test tag was successfully recorded by at least one PIT antenna (Figure 5-55). Antenna 1 recorded the fewest number of detections and was followed by Antenna 2, Antenna 3, and Antenna 4, each with 8, 108, 145, and 147 detections, respectively.

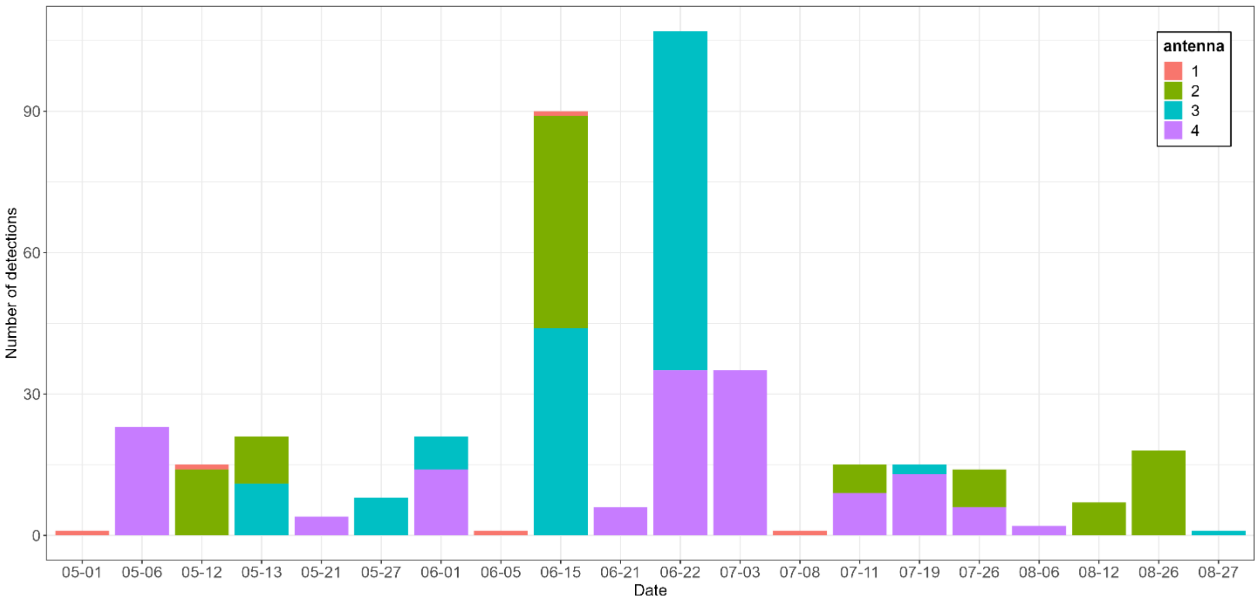


Figure 5-55. Number of detections by Antennas 1, 2, 3, or 4 on the twenty randomly selected test days.

Discussion

PIT Tagged Radishes
Detection efficiency for Antennas 2 and 4, the vertical slot, pass-through PIT antennas in the Alameda Creek RD1 Fish Ladder, decreased during tests on 20 April 2023 from first tests on 30 November 2022. From April's experiment during a discharge rate of 100 cfs, it is expected that the probability of detecting a tagged steelhead at Antenna 4 to be 0.69, Antenna 2 to be 0.68, and overall probability at both antennas to be 0. 90. Compare this to estimates from November's test where detection probabilities were 0.85 for Antenna 4, 0.91 for Antenna 2, and an overall probability at both antennas was 0.98. Discharge in Alameda Creek was lower during the November tests at 30 cfs, which may have contributed to the differences in detection efficiency. There is an optimal discharge rate that results in water depths and velocities that promotes antenna performance and improves detection efficiency. It is likely the discharge in November 2022 was near that optimal level for the low flow antennas while the test in April 2023 occurred during discharge that was less than optimal for the low flow antennas and barely operational for the high flow antennas. Detection efficiency tests should be conducted across a range of flow conditions to gain better estimates of detection probabilities throughout the steelhead migration period.

PIT Test Tags
Since test tags were detected by an antenna on all 20 days of testing, this result informs us that all antennas are functional when a tag is close enough for detection. There is a factor of human influence that is unknown for each test day (e.g., proximity of test tag to antenna, duration of test tag near antenna), so this test is primarily useful for confirmation that the antennas are functioning. Future detection efficiency tests should target efforts on utilizing objects implanted with PIT tags that behave more similarly to that of a migrating salmonid.

PIT Tag Detections in Salmonids

On 15 April 2023 at 11:45 am, a single tag was detected at the RD1 PIT tag antennas. This tag was implanted in a parr *O. mykiss* during an SFPUC electrofishing survey on 7 October 2022 in Alameda Creek ~1.25 miles downstream of the Calaveras Creek Confluence at river mile 24.27. The BART Weir is at river mile 9.7, suggesting this fish traveled a net 14.57 miles downstream over the 190 days. During the electrofishing survey, SFPUC measured this parr *O. mykiss* to have a 114 mm fork length. Because the tag only pinged one of the RD1 antennas, the swimming direction (upstream versus downstream) cannot be confirmed. However, based off of the initial capture date and time of recapture at RD1, it suggests smolt emigration through the fish ladder is promising.

6. DISCUSSION AND ADAPTIVE MANAGEMENT

6.1. START-UP TESTING RESULTS AND DISCUSSION

As described in Chapter 4, ACWD began operational testing of the new RD1 fish passage facility (fish ladder or fishway) and biological monitoring equipment located at the RD1 / BART Weir Complex on 28 November 2022. Additional testing days were scheduled for 30 November 2022 and 2, 12, 15, and 20 December 2022. ACWD was able to successfully start ladder operations by 1 January 2023.

6.1.1. Physical Conditions

The start-up testing provided ACWD staff with their first experiences operating the new RD1 fish ladder facility and the upgraded RD1 facility. Tasks included reviewing SOPs and gaining familiarity with the HMI displays and settings on the SCADA system which controls facility operations. For example, for the RD1 Fish Ladder, operators were able to cycle the slide gates for the exit gates, juvenile spillway, and low-flow gate. Staff also tested the operations of the sluice valve, the auxiliary bypass valves, and entrance gates. Staff tested fish ladder operations in both the manual and automatic settings and could compare the programming logic of operations under certain automatic settings. Overall, ACWD staff studied ladder dynamics and flow patterns to better understand how the ladder operates and how and where daily maintenance procedures could be conducted. This led to improved daily datasheets and monitoring of fish passage equipment during operation of the fish ladders.

ACWD was able to confirm that passage conditions could be met at various flows passable for fish (about 24 to 45 cfs) at each exit gate (exit gates 1-5). However, it is noted that for two flow conditions tested on 30 November 2022, the exit gates were not operated in automatic mode to be within the one-foot head drop passable criteria (between exit channel and exit pool), are not representative of expected future fish ladder operation, and are not included in this report. All other tests were conducted with exit gates in automatic mode, representative of normal expected conditions for various migratory season and off-season operations. The passage conditions for the juvenile spillway and low flow gate were also tested and confirmed for normal expected conditions for various migratory and off-season operations. Refer to section 4.5.1 for result details.

ACWD also analyzed the relationship between water surface elevation in the lower fish ladder and flow released into the RD1 fish ladder without flow over RD1. This theoretical relationship was used to establish automated operational programming. This helped ACWD's understanding of the ladder and channel function under a range of test flows. While the relationship between flow in the fish ladder and water surface elevation was a good fit, it was recommended to have additional measurements, especially under conditions where RD1 fish ladder flows are less than 22 cfs and greater than 23 cfs.

During the start-up testing, ACWD ran through processes for inspecting debris and the RD3 and RD1 trash rake, slide gates, and vertical slots to gain experience for daily monitoring. However, since the start-up testing was completed over a relatively short period of time and only provided experience for environmental conditions during that period, it was recommended ACWD continue long-term monitoring and inspection of debris accumulation rates at the trash rack, which would be included in observations recorded on daily datasheets.

Head drop measurements between fish ladder pools were on average close to the one-foot head drop design criteria. These head drop measurements can be tested again to confirm they are within the design criteria. Also, the depth-to-fall ratios calculated during juvenile spillway testing met the fish ladder facility's Draft BODR minimum threshold of 0.25 ft/ft at juvenile spillway flows greater than approximately 18 cfs. The precise minimum flow rate that the juvenile spillway can be utilized will be further refined through additional operational experience, though it is not expected to be used at flow rates below 20 cfs unless additional exit gates are providing flow and additional water depth in the plunge pool (Pool 10) below the juvenile spillway trough weir. The depth-to-fall ratios calculated during low-flow gate testing met the BODR minimum threshold of 0.25 ft/ft at flowrates greater than approximately 8 cfs. At flowrates lower than about 8 cfs, it is expected that baffles could be installed in the vertical slots between Pools 20, 19, and 18, to increase the water depth in pool 20, and maintain the 1-foot head drop criteria between pools downstream of Pool 20. During out-migration season, the low flow gate is not expected to be used at flow rates below 8 cfs unless additional exit gates, mainly exit gate 5, provide flow and additional water depth in Pool 20 below the low flow gate. These scenarios can be tested for the next migration season, depending on hydrologic conditions.

The velocity measurements taken within the RD1 fish ladder at vertical slots where the velocity meter was positioned within about 6 to 10-inches upstream of the axial center resulted in an average of about 2.8 ft./sec. When the velocity meter was able to be positioned to the axial center of the vertical slot (positioned between pools #1 and #2), the average velocity was notably higher at about 4.6 ft./sec. Due to the variability of the velocity measurements, it is recommended that these tests be repeated and velocity meter positioning criteria be further refined.

Turbidity, DO, and temperature were also measured during the start-up testing at the RD1 fish ladder entrance pool (turbidity) and the RD1 forebay and fish ladder (DO and temperature) (refer to section 4.6.2 for data and details). As the start-up testing covered a relatively small time period and only a couple of locations, it was recommended to gather water quality data year-round throughout the project area, as hydrologic conditions permit. For example, temperature may surpass target species requirements during November and April-May, especially during dry and critically dry water years. During low flow periods, RD3 and RD1 may stratify when dams are fully inflated. Such stratification may provide benefits during such periods, and this should be studied more fully in the future. DO collection within the channel will be dependent on having sufficient water to collect such data.

6.1.2. Biological Monitoring Equipment

The ARIS sonar camera and PIT tag antennas were also tested during the start-up testing. For the ARIS sonar camera, in general, the size of the two tethered fish carcasses were estimated smaller than actual size while inanimate targets were estimated larger than known size. Additional periodic testing of the ARIS sonar camera is recommended to confirm the findings of this initial test and further refine the understanding of this relatively new sonar camera system. Regarding the PTI tag antenna testing, detection efficiency for the two vertical slot, pass-through PIT antennas in the RD1 fish ladder was very good during low flow conditions. From this start-up testing, it is expected that the probability of detecting a tagged steelhead (or other species) at Antenna 4 to be 0.85, Antenna 2 to be 0.91, and overall probability at both antennas to be 0.98. While these results are promising, further detection efficiency tests should be conducted with conditions that inundate the two high flow antennas. The findings and recommendations for the ARIS sonar camera and PIT tag antennas are further described in the sections below.

ARIS Sonar Camera Function

A few of the key challenges associated with fish monitoring using imaging sonar included: (1) recognition of small fish forming dense aggregations; (2) species identification, which limits their use in species-specific studies; and (3) time-consuming massive data processing. It is important to note that similar issues were encountered by staff viewing DIDSON and ARIS footage from Upper Sacramento River Basin program, reporting little difficulty identifying larger adult salmon (Killam and Mache 2018). However, for the smaller fish (e.g., 18 to 24-inch) common to Sacramento Basin, viewers often were unable to identify individual species. These included species such as steelhead, smaller salmon, Sacramento Pikeminnow (Ptychocheilus grandis), Hardhead (Mylopharodon conocephalus), Sacramento Sucker (Catostomus occidentalis) and even beavers and river otters were difficult to distinguish using just sonar footage. Therefore, advanced algorithms for sonar imagery processing and integrations with other sampling technologies are needed for future development (Wei and Dan 2022). According to the Alaska Department of Fish and Wildlife, ARIS can be used to distinguish different sizes (lengths) of fish, but not different species of the same size. Even so, CFS was able to definitively identify adult Chinook Salmon and Pacific Lamprey under sub-ideal conditions. This sets the stage for continued fish passage monitoring program development at the RD1 fish passage facility.

Detection accuracy
The RD1 ARIS sonar camera provided a range of image quality and objects could be detected by both echogram and SONAR, including a large adult salmon carcass. Of the 11 trials, ~91% of the 6 known objects used in the trials could be accurately identified in the video images.

Length estimate accuracy
Target sizes estimated from the computer screen with the ARIS program were anywhere from 47% smaller to 18% larger than known sizes taken before the trials (mean 9.3% smaller). In general, tethered carcasses were estimated smaller than actual size while inanimate targets were estimated larger than known size. These preliminary results compare with Helminen et al (2020), who found in an experiment where 69 known-sized adult Atlantic salmon (Salmo salar) directly released into the sonar field at ranges between 15 and 29 m from the camera. They found wide size ranges in estimates size with estimated generally smaller than actual sizes. Of all their human-generated measurements, 50% were classified as fair, 41% poor or very poor, and only 9% of the measurements classified as good or very good. Similarly, Cook et al. (2019), found accuracy and precision of imaging sonar to be poorer than a stereo-camera system when measuring static synthetic targets as highlighted by the +29.8 ± 12.0% overall accuracy of the imaging sonar compared with the -2.3% ± 2.8% overall accuracy of the stereo-camera during synthetic target size determinations. They found that imaging sonar accuracy was adversely affected by the angle at which the target presented to the beams. Whereby, the overall error on imaging sonar measurements of the synthetic targets was +29.8 ± 6.9% including the 0° orientation angle, or +13.3 ± 4.3% when the 0° orientation angle was excluded from analysis. Because the RD1 ARIS was sited in the middle of the chamber wall, angling the camara to detect fish entering the chamber from downstream orients the angle close to 0°, ACWD could expect fish images to have relatively large errors and would need to take these into account over the monitoring season.

PIT Tag Antenna Function

Detection accuracy
Under study conditions (low flow), ACWD can expect the probability of detecting a tagged steelhead at Antenna 4 to be 0.85, Antenna 2 to be 0.91, and overall probability at both antennas to be 0.98. These results are similar to those reported in the literature (Gibbons and Andrews 2004), including a PIT system installed at a weir leading into a fish trap at Bonneville Dam, Columbia River for adult steelhead (98%; [McCutcheon et al. 1994]).

Time between antenna detections
For the 39 test tags that were detected at both low-flow vertical slot pass-through antennas, travel time between antennas ranged from 7 to 157 sec (mean = 63 sec). Increased travel times between antennas might suggest that tags are moving slower through the fish ladder and result in higher numbers of duplicate detections, but this pattern was not observed in this study. Suggesting the antennae are performing well under these conditions.

Adaptive Management: Incorporating Biological Monitoring Test Results Into 2023 Monitoring Season

CFS used the test video file size by time recorded to determine how big a data storage unit was needed for the ARIS videos over the monitoring season. CFS then used this to confirm how long it would take to fill each hard drive and planned for data download accordingly. Results from the test study demonstrated that video images collected by the ARIS camera did not identify fish equally across the field of vision. From these observations, a field grid monitoring scheme was developed to pinpoint areas of poor image collection over the monitoring season.

While the PIT tag antenna results are promising for low flow detections, efficiency tests should be conducted at high flow conditions to determine detection efficiency for the two high flow antennas (1 and 3).

6.1.3. Other Recommendations

Other recommended testing includes measuring water velocities in front of, and adjacent to, the screens using a flow meter and topsetting rod. This includes background velocities that provide a comparison to general channel conditions near the screens. The probe will be oriented into the current with the support assembly trailing downstream of flow to minimize interference from the vertical pole on velocity readings in the sample volume. The probe will be positioned as close to the screen surface as possible (~3 in). Velocities will be recorded at each sampling point along the screen for 15-30s and recorded on the datasheet. Water velocity measurements will be taken at the upstream side of each screen and at 3-5 evenly spaced points along the screen face of each screen. Distance from the screen and closest channel bed will be recorded along with velocity. In cases where depth/distance is <48 in, measurements were taken at one depth (0.6 x depth from the surface). In cases where depth/distance is >48 in, measurements will be taken at two depths (0.2 x depth from surface and 0.8 x depth from surface). All measurements will be taken with the axes of the probe oriented to measure water flowing parallel (sweep) and perpendicular (approach) to the screen surface. Average sweep and approach velocities will be calculated for each screen, and seasonal averages will be calculated at the end of all surveys. Relative turbulence in screen forebays was included as error bars on the velocity graph and represent the root-mean square (R MS) of the turbulent velocity fluctuations about the mean velocity. Sediment depth was estimated using the ADV support pole by feeling the start of resistance from the surface of the sediment layer and then forcing the support pole through the sediment to the concrete forebay floor.

It is also recommended to use underwater video to investigate screen seal condition and monitor debris buildup and fish presence. The video system consists of a digital camera (GoPro and waterproof case). The camera will be securely mounted on an extension pole and angled slightly downward to look for gaps between the screen and the bottom seal. The series of screens at each site will also be inspected, looking both upstream and downstream for signs of excessive debris or fish presence. Written observations will be made in the field when objects of interest are observed by camera (i.e., debris, gaps and fish). All videos will be later reviewed in detail, and images of interest digitally captured using appropriate software for archiving and reporting.

In addition to the velocity data and underwater videography, data on other aspects of the fish screen sites will be collected to determine whether they are operating within criteria. For example, systems designed to remove debris will be examined to determine whether they adequately prevent debris from creating flow issues including reduced capacity. When debris accumulates on a screen it effectively reduces the cross-section area. This may, in turn, result in "hot spots" of high approach velocity, impinging small fishes. Additional data will be collected during each evaluation including screen and seal conditions, screen submergence levels, cleaning system operation, diversion flow conditions, and observations of debris on or around the screen that might cause predator posting.

The start-up testing was an overall success and ACWD was able to successfully operate their facilities during this first migration season, with the exception of RD3 and the RD3 fish ladder due to storm damage. ACWD learned about and became familiar with this new, highly complex system during the start-up testing and was able to take lessons learned and use them as recommendations for additional testing and refinement of operations and procedures.

6.2. MONITORING YEAR - OPERATIONS AND MAINTENANCE AND RECOMMENDATIONS

Overall, ACWD met its goals of fish passage enhancement on Alameda Creek while maintaining its water supply goals. ACWD was able to operate, monitor, and adaptively manage its creek facilities in accordance with the NMFS BiOp and coordinate Program activities with other watershed stakeholders. Summarized below (refer to Chapter 5 for more detail) are what was completed during this monitoring year and recommendations going forward.

6.2.1. Physical Conditions

This past year was determined to be a “normal/wet” year. Refer to section 5.7.1 for details. ACWD will update the OWG on cumulative rainfall once a month starting every January, and if the cumulative rainfall exceeds 15.3 inches (this is the threshold for year-type determination per the BiOp) before the end of each March then a year-type determination of “normal/wet” can be made.

ACWD was in compliance with the BiOp 100% of days in the 2022-2023 compliance year. Bypass target flows were met or exceeded for all but 2 days, July 24th and August 1st when flows fell below target by ~1 and 2 cfs, respectively. These days are in the “outside of peak migration” period of bypass requirements when total flows are low in the creek. An assessment of conditions on the two days that fell below target concluded that the low bypass flows were a result of several days of sustained low flow at Niles gauge, likely a result of fluctuating discharges at Quarries in the Sunol Valley. On these days, ACWD complied with BiOp requirements, specifically by not diverting water off-stream and bypassing all the flow reaching the BART Weir complex, however with only 12 cfs at Niles gauge and stream losses between Niles gauge and the Complex ranging between approximately 8 to 10 cfs, less than the target 5 cfs was available. ACWD’s operations of the RD1 fish ladder attempted to mitigate by releasing additional water from storage to bolster downstream flows despite the BiOp specifically not requiring this to meet targets. Refer to Section 5.7.2 for details.

Due to the unprecedented weather that occurred during the compliance year, there was damage caused by storms to parts of the fish passage facilities. This included damage to RD3, which then rendered the RD3 fish ladder inoperable beginning on 21 January 2023 after a very large storm and there was significant sediment buildup. After the storm water receded, there was sediment and debris in the forebay area upstream of the exit gates and significant sediment deposited on river right, specifically on top of the deflated RD3, along the trash grate, and in front of and within the entrance gate. By the end of this reporting period, ACWD had applied for permits necessary to remove some sediment and repair the RD3 bladder, but ACWD had not received the required permits to perform the work.

The auxiliary bypass at the RD1 fish passage facilities were also damaged. At RD1, ACWD Water Controllers’ daily inspections recorded electrical issues related to mechanical components, such as the control valves for the sluice pipe and the auxiliary bypass pipeline, in November and March. ACWD Water Controllers observed the sluice pipe control valve actuator was not operable on 15 December 2022. They reset the circuit breaker to solve the problem temporarily. Similarly, by 9 January 2023, the actuator for the auxiliary bypass control valve failed, rendering the auxiliary bypass inoperable through the remainder of the reporting period. Investigations into both issues by ACWD Engineering staff determined the cause was related to water intrusion into the electrical components. The actuator for the sluice valve was opened and dried out, which resolved the problem. The actuator for the auxiliary bypass needed to be replaced, and replacement parts had not arrived by the end of the reporting period. ACWD Engineering staff worked with our Facilities Maintenance staff and the construction contractor to improve electrical conduit waterproofing and drainage. The RD1 Fish Ladder entrance gate was observed to be inoperable on 13 March 2023; due to a disconnection of the southern gate panel from the actuator-driven gearing, the gate panel would swing freely and would not articulate. ACWD Water Controller staff used slings to affix the gate panel in the open position, and the entrance gate was not fully functional until the construction contractor affected repairs on 5 July 2023, after the migration season.

There was also overtopping of RD1 (as described in Chapter 5). While the use of the auxiliary bypass would have helped reduce the percent of flow overtopping the dam, it should be noted that, even had the auxiliary bypass been functional in 2023, it would have only been able to prevent overtopping entirely for approximately seven days. Otherwise, the high flows due to storms and associated reservoir releases were too high for the auxiliary bypass to make a significant reduction in overtopping volume during this reporting period. The juvenile spillway was operational from 7 April 2023, through the rest of the outmigration period, until 10 June 2023.

During the reporting period, ACWD Water Controllers conducted physical inspections of the fish ladders to observe for any accumulation of sediment or debris that might inhibit fish passage. Silt and fines deposits were observed in Pool 10 at the start of project hand-off and occurred at some point prior to Start-up Testing (reference Image 1 of Figure 20 in Chapter 4). During the reporting period, ACWD Water Controllers periodically operated the sluice pipe to remove sediment deposits in the RD1 Fish Ladder forebay as a preventative measure. During brief periods of dewatering the RD1 Fish Ladder for testing or maintenance-related activities, water would drain from Pools 5 through 20. ACWD staff observed filamentous algae on the walls and floors in wetted portions of the ladder, but there was no significant sediment accumulation within these vertical slot pools. A discussion of sediment downstream of the RD1 Fish Ladder entrance gate is provided below in Chapter 5.

ACWD learned about and analyzed the low passage conditions at the Niles and Sequoia USGS gauges. The percent of creek flow that passed through the RD1 fish ladder and associated sensors fluctuated substantially. Fish ladder flow was generally under 50% of all flow during the steelhead in-migration due to the large flows from the extreme wet year. During out-migration and the rest of the year, fish ladder flows accounted for nearly 100% of flow measured at Sequoia. More data will be gathered in future migration seasons to further evaluate this year’s results.

6.2.2. Fish Passage Equipment

Water levels at several specific points in and around the fish ladder (upstream, downstream, specific pools, etc.) are measured and recorded. For example, within the RD1 Fish Ladder, water levels and head differences are monitored and recorded at the RD1 impoundment and at each pool immediately downstream of an exit gate, at the juvenile spillway, and at the entrance pool and transition pool located upstream and downstream, respectively, of the entrance gate. The ACWD SCADA system monitors and records these measurements, which vary depending on upstream and downstream water levels as well as gate position. It should be verified that both the flow pattern and the level of turbulence at various points in the fishway remain compatible with the specific demands of the various species, such as plunging or streaming flows at each cross-wall between pools, or the presence of large recirculation areas in the pools. If needed, metal baffles can be inserted into vertical slot openings between pools to create additional pool depth within the upper pools, and an auxiliary bypass can be operated to covey additional water from the forebay to Pool 1 of the RD1 Fish Ladder to ensure that hydraulic parameters within the fish ladder meet the requirements.

For vertical slot fish ladder facilities, the various flow regulatory components, such as slide gates at the exit gate openings or juvenile spillway openings at the upstream portion of the ladder, baffles which can be inserted into vertical slot openings between pools, auxiliary bypass valves within the auxiliary bypass pipeline, and the adjustable “saloon” style gates at the downstream entrance, are used for controlling the discharge or the head differences between the pools throughout the operable run of the fish ladder. ACWD Water Controllers monitor these components of the fish ladder each day of the year to confirm they are functioning properly when in use. When components are determined not to be functioning properly, Water Controllers first determine if there are minor operational or SCADA settings that can be adjusted or reset to restore functionality. If components are broken or unresponsive to minor corrective measures, ACWD Water Supply staff will notify the ACWD Facilities Maintenance Division to request technical or mechanical support. If critical components need major repair, ACWD Water Supply staff will coordinate with ACWD Facilities Maintenance Staff or Engineering staff, as appropriate, to develop a contingency plan to temporarily support continued operational compliance while repairs are affected. All mechanical components, including valves, should be fully cycled (operated from fully closed to fully open, then back to fully closed) as part of an annual preventative maintenance program. ACWD Water Controllers will fully cycle each valve at least annually and inspect valve condition for any additional maintenance, such as lubrication or sealants. If needed, Water Controllers will request support from Facilities Maintenance Division staff for additional maintenance as needed. The MAMP provides general information about the mechanical function of the passage facility. Below are specific details related to the daily O&M logs for mechanical parameters for the Annual Report Period.

Regarding fish screens, as part of the draft O&M plan, ACWD is developing an evaluation strategy using physical and biological field data to determine whether the fish screen sites comply with the intent of the fish protection criteria. For example, during the start-up testing, certain settings of the Shinn Fish Screens achieved approach velocities that exceeded 0.33 ft/s, which is a critical threshold above which small fish may be affected by diversion flows through the screens. ACWD instituted training to Water Controller staff to monitor and correct for these programming deficiencies. As a result, approach velocities only exceeded 0.33 ft/s on two occasions during the migration seasons. On 23 January 2023, the approach velocities on the screens exceeded the threshold for about 45 minutes upon startup of diversion operations, as the diversion gates were opening from a fully closed position. Similarly, upon startup of diversion operations on 3 April 2023, a second exceedance occurred for less than 15 minutes, as the diversion gates were opening from a fully closed position. These two incidents informed additional training of staff to minimize the number and duration of future occurrences.

Daily inspections of the fish ladder facilities, during the reporting period, were completed by ACWD Water Controllers to observe for any debris or obstructions that could inhibit fish passage. As the high flow from storm runoff and upstream reservoir releases temporarily decreased in late January and early February, ACWD staff observed significant sediment deposits at RD3 and RD1. Reference section 5.5.2. Physical Inspections for discussion of the RD3 and portions of the RD1 Fish Ladder upstream of the entrance gate. Downstream of RD1 fish ladder entrance gate, ACWD staff observed sediment mounds emerging from the receding water in the lowest pool of the Lower RD1 Fish Passage Facility. Over the next several weeks, as water turbidity decreased and flows receded, the extent of the sediment deposits became more visible throughout the entire lower fish ladder and into the transition pool area. A subsequent analysis, described below, was required to determine if the sediment was creating a barrier for fish passage until it could be removed.

During system surveys in the early summer of 2023, it was determined that the above normal runoff in Alameda Creek deposited a relatively high volume of sediment (e.g., gravel, sand, silt) within the lower ladder of RD1. Unlike the upper portion of the RD1 fish ladder, which uses a vertical slot design, the lower ladder at RD1 uses a vortex pool and chute design. ACWD therefore set up a field survey of depths and velocities within the lower ladder to determine to what extent passage criteria were impacted by the sediment.

Results from this survey suggest some impediment for adult and juvenile salmonid passage at the lower RD1 fish ladder. In general, water depths at critical riffles identified at the entrance and exit of the lower ladder would expose backs, eyes and portions of gills of larger adult salmon for short distances. This may in turn, expose them to greater chances of predation and/or stress although these shallow riffles (~<15 ft) could be negotiated. Jump heights and pool depths within the sediment-filled ladder were well within adult salmon and steelhead capabilities. However, when passing this style of ladder, fish have the choice of leaping or swimming over the weir or swimming through the orifice, and it is NMFS' experience that most salmonids prefer to swim through the orifice (NMFS 2022). Because the submerged orifices are generally full of sediment, juvenile and adult salmonids might be confused during low flows or be exposed to predation, especially by birds if they were forced to swim near the surface to negotiate the weirs. Recommended maintenance activities would include flushing or removal of the sediment from the ladder entrance and exits as well as from the weir openings to improve passage conditions developed within the design criteria. The work appears to be possible with hand tools and/or high-pressure hoses, as recommended in the BiOp (2017). It is also recommended to continue to monitor turbidity levels throughout the year to obtain a better understanding of turbidity trends in the Project area.

6.3. BIOLOGICAL MONITORING

During the first monitoring season (2022-2023), ACWD demonstrated successful installation of adult and juvenile steelhead migration monitoring facilities through the RD1/Drop Structure fishway; including a PIT tag antennae array and sonar camera. Through start-up testing and subsequent testing throughout the monitoring season, ACWD demonstrated that the facilities not only met general physical requirements for adult steelhead immigration and smolt and kelt emigration, but improved passage conditions for other native fish such as Pacific Lamprey and Chinook Salmon. ACWD also demonstrated that the PIT tag antennae could successfully detect tags under conditions smolts are expected to emigrate through at detection rates identified in the literature. Furthermore, ACWD demonstrated the ARIS sonar camera could detect fish moving past the camera and estimate size with errors similar to those within the literature.

With these tests complete, ACWD was able to document successful immigration of at least two adult Chinook Salmon and one Pacific Lamprey with the sonar camera. The camera also recorded numerous other fish images within the RD1 ladder, although their species and direction of movement could not be determined. Finally, a single PIT tag detection at the RD1 facility suggests juvenile *O. mykiss* emigration from the watershed during the first migration season.

6.3.1. Qualitative Biological Observations

Summary of Predator/Milling Surveys

As described in Chapter 5, ACWD developed and implemented milling and predator surveys for the flood control channel. Surveys performed prior to adder operation (2021-2022) documented adult Chinook Salmon immigrating to the RD1 in fall 2021 and 2022 and spawning activity in 2021 below the RD1 structure. Once passage criteria were met in November 2022, observations through these surveys documented adult Chinook Salmon immigrated through the facility. Surveyors also observed predation on adult Chinook Salmon in the RD1 basin by native mammal and bird species. As flows receded in the later spring period, these surveys also documented invasive fish species known to predate on juvenile salmonids milling near the debris rack of RD1. Finally, a single juvenile *O. mykiss* was observed at the RD1 fish passage facility in August 2023.

On the morning of 23 June 2023, two fish were recorded by still image (4 color photographs) during RD1 fish ladder dewatering for ARIS system inspection. The images were taken by camera through the metal grating over the ladder bay. According to an ACWD Water Controller they appeared to be *O. mykiss*, with the larger fish estimated to be approximately 24 in long and the smaller fish approximately 15 in long. The Biomark antennas were operational, however no tag detections were recorded. The ladder was fully dewatered five days later (28 June). A technician observed similar-sized fish exiting the downstream end of the ladder but could not identify species. *O. mykiss* are not expected to be present in this region of the lower Alameda Creek watershed in late June as prevailing flow, water temperatures, and weather conditions are not typically suitable. However, since salmonid migration has only recently been reestablished, and with less than one year of observational data recorded under unique water-year conditions, few conclusions can be drawn about life history tactics. The purpose of this assessment is to use the best science to identify the species of fish observed, their life stage, and a generalized theory as to why they were found in this otherwise unexpected part of the watershed at this time of year. While observations of these adult-sized *O. mykiss* in the RD1 ladder demonstrate their ability to access the ladder, they do not substantiate adult steelhead passage success at the time of this report. More data will be gathered in subsequent years to better understand why observations of target fish occur outside of the expected migration window.

Furthermore, predation should continue to be tracked as it plays a vital role in the overall ecosystem (as further detailed in section 5.8.2). The fish passage facilities should continue to be operated so that, coupled with species invasions, it does not play a significant role in predation events within the project footprint. These data provide some of the first observations of both salmonid and lamprey passage and predation in Alameda Creek. Observations of invasive predatory fish milling at the RD1 debris rack should be more fully evaluated to determine how much they overlap with the migration season. ACWD will continue to gather survey data and refine survey data gathering techniques to produce more detailed information.

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Although data have been effectively gathered regarding migratory and predator species, including their counts and locations, there is room for improvement through more consistent and detailed descriptions of these observations. For example, many predator observations include information about their type and count, but they lack specific identification or behavioral details. Observations of invasive predatory fish milling at the RD1 trash rack should be more fully evaluated to confirm how much they overlap with the migration season. Apart from the lack of detailed explanations, the available tools, such as the camera and field guides, were not maximized to their full potential.

Stranding Surveys

In the BiOp, (NMFS 2017), NMFS determined that incidental take of Central Valley steelhead is reasonably certain to occur in association with ACWD's facilities operations in the Alameda Creek Flood Control Channel. Take is expected to result from operation of the two inflatable rubber dams and associated water intake effects on steelhead passage and stranding. It was assumed that streamflow reductions will reduce water depths over riffles and diminish the size of holding pools in the channel downstream of the dams. Reduced water depths during fish migration are anticipated to make adult, smolt, and kelt steelhead passage over riffles incrementally more challenging and to increase migration time through the Flood Control Channel.

If water surface elevation drops too quickly, small numbers of steelhead (or other species) may also become stranded on gravel bars or in isolated side channels, pools, or within the recessed plunge pool downstream of RD1. According to the BiOp, RD1 will typically be inflated when average daily stream flows drop below 700 cfs. Filling of the RD1 impoundment will reduce water surface elevation downstream of RD1 at rates of 0.01-0.75 feet/hour and rates will be < 0.5 feet/hour approximately 85% of the time. Few steelhead are likely to be harmed or killed through stranding during RD1 impoundment filling because the smallest life stage expected in the action area (smolts, ~40-210 mm) are relatively strong swimmers and that are physically capable of avoiding stranding by volitionally moving downstream from RD 1. Smolts are anticipated to be actively out-migrating downstream in the vicinity of the channel thalweg, minimizing their susceptibility to stranding. In addition, Alameda Creek hydrology is very flashy and the anticipated drop of water levels in the Flood Control Channel under proposed Project operations is within the range of flow variability experienced by steelhead in many Central California streams.

It was assumed that monitoring of steelhead harmed by ACWD's operations is not feasible as the impact of water diversion operations is generally undetectable, except in the case of an adult stranding event. As a result, a surrogate measure of incidental take was used in the BiOp. Within the draft MAMP, ACWD determined several performance criteria related to Project operation that included potential for stranding of native fish.

To provide data to inform adaptive management, including potential future environmental compliance scenarios, ACWD used a combination of conditions called out in the BiOp as well as field observations during the 2022 test flow to identify potential stranding event triggers. The purpose of these stranding surveys was to determine if steelhead were isolated from the river main channel or within the passage facility, as a result of rapid flow fluctuations associated with Project operations. Although not a Project focus, Chinook Salmon and Pacific Lamprey are also mentioned in the BiOp, due to their Species of Concern Status.

As described above, the minimum bypass flow of 12 cfs plus the net SFPUC releases is expected to provide adequate water depths and velocities for out-migrating steelhead smolts. However, during periods when inflow to the Flood Control Channel drops below 25 cfs during the migration period, steelhead smolt passage may be poor at 5 cfs and delays may occur until required release and/or a precipitation event improves streamflow conditions. Smolts that partially pass downstream through the Flood Control Channel could become stranded in isolated pools and unable to complete their downstream migration. These smolts may become stressed, injured or killed when stranded under these critically low flow conditions (i.e., 5 cfs bypass) through predation, thermal stress, or desiccation.

Surveys were focus on riffles critical for passage, shallow, off-channel habitats prone to stranding, the fish ladders and roughened infrastructure in and around the rubber dam spillways. Specific areas of concern varied according to the particular trigger scenario (Table 6-1).

Table 6-1: ACWD flow operations stranding survey triggers and areas of concern

Flow Operations Triggering Event	Areas of Concern
When transition pool WSE drops below level of concrete sill (from approximately 37 – 36 ft)[4]	Newly exposed infrastructure including dragon's teeth, rip rap, concrete sill and adjacent structures
In-migration: RD1 inflation (transition below 800-1200 cfs) AND with resulting bypass flows below 100 cfs	Plunge pools below dams, newly exposed structures
Out-migration: RD1 inflation (transition below 800-1200 cfs) AND with resulting bypass flows below 150 cfs	Plunge pools below dams, newly exposed structures
Transition below 22 cfs	Pools throughout target area
Transition below 3-5 cfs	Stranding pools in active channel above Sequoia Road Bridge Gage to lake beds
Fish ladders taken offline	In ladders
Bladder dam raised or lowered, including emergency or computer error	Above and below dam, including plunge pools and sills

Over the 1 January – 31 May 2023 period, it was observed that a total of 14 potential stranding events, which included 11 potential stranding in the rip rap area, and 3 potential events in the RD1 fish ladder when RD1 was re-inflated/fish ladder was turned off. Over this time, observations of fish exposed to low flow conditions were only observed within the RD1 fish ladder. This included observing several Lamprey on 8 January 2023 and at least 35 adult Pacific Lamprey on 27 February 2023 in the RD1 fish ladder as RD1 was deflated. The Pacific Lamprey observed on 8 January 2023 were able to move out of the RD1 fish ladder as the fish ladder was operated a couple of hours longer to allow their movement out of the fish ladder. The Pacific Lamprey observed on 27 February 2023 were able to move out of the ladder with the receding flows. Also, on 23 January 2023, several Pacific Lamprey were also observed on the BART weir as RD1 was inflating. At least two observational walk throughs were conducted during the potential stranding events in the rip rap area and no stranding was observed. There were also many instances that visual observations were conducted from the banks of Alameda Creek to observed if there were any indications of stranded fish as the flows receded. In every instance the RD1 fish ladder was dewatered, ACWD would walk the length of the ladder to confirm that there was no stranding of fish observed. Outside of the monitoring period there were a total of five events where five adult Chinook Salmon were observed and two *O. mykiss* (estimated > 15 in). No fish were exposed to water shallow enough to expose gills to air and each event was shorter than 5 minutes in duration.

This has been a very exciting and eventful first year in operation and in observations. Described above were initial guidelines that ACWD staff used but ACWD recognizes there is a lot to improve on for potential stranding events. ACWD and CFS are also working with CDFW and NMFS on the draft CDFW Lake and Streambed Alteration Agreement (LSAA) for other aquatic organisms that should be considered during stranding surveys.

Stakeholder/Volunteer Involvement and Observations

ACWD participated in Alameda Creek Alliance observations made along the Flood Control Channel. This included posting images and video of organism sightings along with associated general location and time

[4] The weir notches begin to flow at about WSE of 35.5 ft. Inundation of the dragon's teeth begins about WSE 36.0 ft . The notches begin to overtop around WSE 36.2 ft. As flows recede between WSE 37 ft and 36 ft, stranding potential is identified below RD1.

the images were recorded. Photos were reviewed by biological staff to identify organism species and estimate counts, where possible.

Between 12 December 2022 and 19 July 2023, a total of 24 images with identifiable species were documented. Stakeholders/volunteers verified observations of over 57 individual fish of seven species including Chinook Salmon, Pacific Lamprey, Sacramento Pikeminnow and Sacramento Sucker in the Project footprint.

These images provided evidence of at least five adult Chinook Salmon within the pool below RD1 (Bart Weir) in December 2022, before the RD1 ladder was fully operational.

Photo documentation was helpful in demonstrating successful passage of both adult Chinook Salmon and Pacific Lamprey, with photos of at least two adult Chinook detected as high as the Niles Canyon gauge and one adult Lamprey above the RD3 dam.

Stakeholders/volunteers also identified over 11 images of confirmed predators of adult and juvenile salmonids over the monitoring year including 4 incidences of predation on adult Chinook Salmon and Pacific Lamprey. Evidence of adult salmon predation by more than one species was also detected. Chinook Salmon carcass images were recorded above RD1 and above RD3, further suggesting successful passage. It is important to note that 1 adult salmon carcass was identified under the Mission Blvd bridge on 19 January 2022, suggesting passage before RD1 facility completion.

At least one observation of a bald eagle with a stocked *O. mykiss* captured at Lago Los Osos was documented on 19 July 2023. Although not an actual predation event on a target species, it suggests the potential for natural predation on *O. mykiss* in the future.

Stakeholder partnerships, including participation through citizen volunteers, especially when trained, can be extremely beneficial to largescale fisheries management, including watershed restoration (Thomas and Burnett 2019). These results further support the success of the project under the first year of observation and enhance our understanding of benefits to reintroduction in the watershed.

Recommendation: ACWD will continue to work with watershed stakeholders/volunteers to build on these relationships and find areas for continued collaboration. It is recommended that a web portal be created for stakeholders/volunteers to be able to upload their photos and ACWD will provide training on the use of this web portal.

6.3.2. Quantitative Biological Monitoring

ARIS Sonar Camera

Refer to Section 5.8.3 for detailed analyses of the first of operation of the ARIS sonar camera. Operation of the ARIS system met some significant challenges, described below, with suggested recommendations for the next migration season. The missing and poor-quality data were the result of environmental factors, as well as undeveloped system check and site access safety protocols. Even so, ACWD proved its potential value including documentation of at least two immigrating adult Chinook Salmon in December 2022 and clear demonstration of at least one adult Pacific Lamprey in later winter of 2023.

Regular servicing of the ARIS unit is needed for the 2024 season to confirm high quality images are collected for the duration of the monitoring season. Protocols must be established for cleaning and maintenance, as well as real-time monitoring of image outputs. It is also recommended that for the 2024 season, a spreader lens be attached to the ARIS Explorer 3000 sonar which will expand the field of view vertically; this should lead to more reliable fish detections over the relatively short distance that the ARIS

Explorer 3000 is currently configured in. A spreader lens should be attached to the ARIS unit to expand the field of view vertically, Testing the spreader lens and adjusting the camera for the most effective orientation will increase detection efficiency.

Armed with the first year of monitoring experience, developing an automated workflow to process ARIS data should be started in the 2023-2024 monitoring season. This will significantly reduce processing time and will allow for the potential of more real-time fish passage monitoring. It is expected that full automation will take more than one monitoring season to complete and a combination of AI and trained personnel will be required until full automation is established.

Field tests should be carried out to validate fish species and size from the sonar unit. These tests should include a combination of GoPro surveys within the fish ladder. Measurements taken from the GoPros would be compared to those taken on the ARIS to establish size and species verifications. Secondly, additional carcass tests, like those performed in 2023, should be repeated.

The benefits of improved image quality and consistent operation of the sonar would be substantial to understanding how the fish ladder is being used by the fauna of Alameda Creek. The 2022 goals of the program included monitoring lamprey, steelhead, and salmon emigration and immigration. While these specific goals were not fully achieved this year, the infrastructure developed in 2023 should lead to improved sonar recordings. Improved images would allow for more reliable measurements of individual fish and could help determine total individuals moving up and down the ladder. These should be goals for the 2024 monitoring season. Individual species identifications could also be possible but should not be expected with ARIS operation alone at this time. Currently there are methods of processing the sonar data that could give species determinations, but they would require high quality images and would likely need to be paired with other fish population assessment methods (Jones 2021). Paired methods to verify fish could include tactical use of GoPro Cameras, a long-term video monitoring set-up, or periodic fish trapping at either end of the fish ladder. Another method of fish species determination is a tail-beat frequency analysis (Helminen 2021). This method utilizes the “fish tracks” that are captured by the echogram that are analogous to animal tracks being left in the snow. Species would be able to be determined by the pattern of movement over time. This method would involve the development of Artificial Intelligence (AI) technologies and paired lab studies to determine swimming rates of known species in the ACWD RD1 fish ladder project footprint. Like the other goals listed, this method would require high quality data collection and may take several years to develop for this project’s specific needs.

Even in a low success data collection year there were 40+ days of reviewable footage clips that took 350+ hours to read and QC. Given the known goals of collecting high quality data consistently over the monitoring season it should be expected that in wet years there will be more reviewable footage collected. With this Project expectation, the need to automate processes is apparent for the longevity of monitoring fish passage at RD1. Investment in automating data processing could be significantly different depending on future Project goals. Detecting fish in the echogram would be relatively simple compared to developing a tail-beat frequency analysis. With this in mind, Program goals for 2024 should be refined to reflect the level of investment desired.

PIT Tag Antennae

Refer to Section 5.8.3 for detailed analyses of the first operation of the PIT tag antennae. The PIT antennae worked well, though more efficiency testing should take place over a range of flows. ACWD currently has no data for the array at high flows so this should be a target for testing in 2024.

Additional inferences on how fish are behaviorally taking advantage of the different areas of the fish ladder may also be reflected in these data. However, this cannot be parsed out presently due to the lack of reliable fish detection in grids further away in the bay. For example, no detections were made in grids A5 and A6 during this season. These grids are at the entrance of the sonar bay where upstream migrating fish must pass up from the lower bay and into the sonar's field of view. This demonstrates an area of functionality the program should aim to improve upon in the coming monitoring seasons.

CFS has developed a protocol for system checks that will provide an improved structure for downloading and storing data as well as improvements to data sharing processes that include a cloud backup of data at ACWD before hard drives are shipped to CFS. ACWD has developed safety protocols that will allow technicians to access the sonar unit for more routine maintenance. Sound Metrics (ARIS manufacturer) will continue to give expert guidance on system set-up and operation. Improvements in data storage, handling, and management made in 2023 should lead to more efficient data processing in future years.

On 20 April 2023, ACWD and CFS conducted another calibration run of the PIT tag antennas using PIT tagged radishes. Detection efficiency for Antennas 2 and 4, the vertical slot, pass-through PIT antennas in the Alameda Creek RD1 Fish Ladder, decreased during tests on 20 April 2023 from first tests on 30 November 2022. From April's experiment during a discharge rate of 100 cfs, it is expected that the probability of detecting a tagged steelhead at Antenna 4 to be 0.69, Antenna 2 to be 0.68, and overall probability at both antennas to be 0. 90. Compare this to estimates from November's test where detection probabilities were 0.85 for Antenna 4, 0.91 for Antenna 2, and an overall probability at both antennas was 0.98. Discharge in Alameda Creek was lower during the November tests at 30 cfs, which may have contributed to the differences in detection efficiency. There is an optimal discharge rate that results in water depths and velocities that promotes antenna performance and improves detection efficiency. It is likely the discharge in November 2022 was near that optimal level for the low flow antennas while the test in April 2023 occurred during discharge that was less than optimal for the low flow antennas and barely operational for the high flow antennas. Detection efficiency tests should be conducted across a range of flow conditions to gain better estimates of detection probabilities throughout the steelhead migration period. Since test tags were detected by an antenna on all 20 days of testing, this result informs us that all antennas are functional when a tag is close enough for detection. There is a factor of human influence that is unknown for each test day (e.g., proximity of test tag to antenna, duration of test tag near antenna), so this test is primarily useful for confirmation that the antennas are functioning. Future detection efficiency tests should target efforts on utilizing objects implanted with PIT tags that behave more similarly to that of a migrating salmonid.

PIT Tag Detections In Salmonids

On 15 April 2023 at 11:45 am, a single tag was detected at the RD1 PIT tag antennas. This tag was implanted in a parr O. mykiss during an SFPUC electrofishing survey on 7 October 2022 in Alameda Creek ~1.25 miles downstream of the Calaveras Creek Confluence at river mile 24.27. The BART Weir is at river mile 9.7, suggesting this fish traveled a net 14.57 miles downstream over the 190 days. During the electrofishing survey, SFPUC measured this parr O. mykiss to have a 114 mm fork length. Because the tag only pinged one of the RD1 antennas, the swimming direction (upstream vs downstream) cannot be confirmed. However, based off of the initial capture date and time of recapture at RD1, it suggests smolt emigration through the fish ladder is promising.

Data Management Plan

As described in section 5.4, the DMP is in development and will incorporate lessons learned from this first migration year. The initial plan for the ARIS file data transfer was for ACWD staff to upload all data to SharePoint so CFS could download and process the files. The download time was onerous and impeded efficient workflow. The adjustment was made that after data was uploaded to SharePoint by ACWD, the physical hard drives were mailed to CFS for transfer to a master hard drive housed at their West

Sacramento lab. Original hard drives were sent back to ACWD. ACWD will continue with this workflow in 2023-2024 unless a better alternative is made available. Predator and milling datasheets were uploaded to Dropbox by ACWD and entered into a database by CFS staff. This worked well, though datasheets for one-off observations were not reliably included in this format. For the 2024 season, additional improvement and refinement will be made to standardize processing of predator and migratory species observations.

Collaboration

The Districts are very appreciative of the strong collaboration and communication amongst the Project's and watershed stakeholders/volunteers. On 10 January 2021, ACWD and ACFCD kicked off the FLOWS Program in preparation for the completion of the RD1 fish ladder construction and operation of the fish ladders. On 24 January 2023, ACWD met with the Operations Working Group (OWG) as described in the BiOp, which consisted of NMFS, CDFW, and ACFCD, for the framework for 7-day pulse releases. This was also an opportunity to kick-off the OWG coordination for other FLOWS Program related efforts and continue to foster collaboration and communication amongst stakeholders. The OWG has been meeting with other watershed stakeholders through the quarterly Alameda Creek Restoration Working Group and its Monitoring subcommittee. Soon after this initial meeting for the framework for the 7-day pulse releases, the Monitoring subcommittee began meeting monthly to provide more frequent opportunities for updates and coordination amongst watershed stakeholders.

On 3 March 28, ACWD met with the other OWG members to provide an update and overview of the framework for the 7-day pulse releases as well as updates on the fish ladder operations and water-year type determination for this past year. ACWD provided a FLOWS Program update to the OWG on 23 October 2023, which included an update on this first annual report as well as additional coordination for other tasks such as the permitting and processes related to stranding surveys.

ACWD has also collaborated with SFPUC to produce a Data Sharing Protocol (refer to Appendix C), which assists with the sharing of preliminary data and communication of updates within the watershed that may affect fish passage. This Data Sharing Protocol will also be refined and improved upon as ACWD and SFPUC gain more experience in fish passage monitoring. Additionally, ACWD appreciated being invited to assist SFPUC in their fall electrofishing surveys within upstream portions of the Alameda Creek Watershed. ACWD staff that were able to participate could benefit from building relationships with SFPUC staff and to gain a better understanding of the fish species being observed in that portion of the watershed.

EBRPD has been very collaborative throughout the FLOWS Program, Project, and preparation for operations. EBRPD coordinated very closely with ACWD and CDFW in responding to fish sightings within Alameda Creek. ACWD appreciated the expertise of EBRPD Fisheries Management staff in multiple trainings and field meetings with ACWD and CFS regarding stranding survey protocols and fish and predator observations. EBRPD Fisheries Management staff also provided invaluable assistance during the start-up testing of the biological monitoring equipment.

ACWD also appreciates the support and assistance from the other watershed stakeholders in the Alameda Creek Fisheries Restoration Workgroup. ACWD and CFS have provided monthly updates to the workgroup and their Monitoring Subcommittee to keep them informed of operational conditions. ACA has also been very collaborative and supportive of ACWD's fish ladder operational efforts and has provided volunteer's biological observations (as described in section 6.3.1).

CDFW and NMFS have been very supportive, collaborative, and communicative with the Districts and were also invited to the start-up testing of the RD1 fish passage facilities. NMFS was unable to attend but always expressed interest and tried to attend other fish ladder events.

6.3.3. Summary of Adaptive Management Recommendations

Below is a summary of conclusions and adaptive management activities to be implemented and/or proposed to be implemented in successive years. This includes review of any adaptive actions initiated, or maintenance performed to enhance function. ACWD and ACFCD will be incorporating this information compiled over this first migration year into the O&M plan.

1. The BiOp addresses improving understanding of watershed hydrology through the installation of new stream gauges as well as studies on stream losses through Sunol Valley. The SFPUC and USGS are currently in the process of installing a new gauge on Alameda Creek in the vicinity of their corp yard in Sunol, upstream of the confluence with Arroyo de la Laguna Creek. This will support further efforts to characterize Sunol Valley losses and improve the determination of net SFPUC releases reaching Niles Gauge for inclusion into ACWD's bypass flow calculation.
2. ACWD will aim to use the results from this first year of monitoring to refine observed trend summaries and to facilitate potential comparisons among future years.
3. Discussion of any anomalies observed in the year and what actions may have been taken.
    a. Damage from high flows
        i. The RD3 bladder ruptured during inflation which impaired the RD3 ladder and its ability to divert water. Anecdotal observations suggest this could have impaired adult salmonid immigration with observed adult *O. mykiss* in the RD1 ladder late in the season.
        ii. Sediment built up on RD3 while it was deflated; this sediment caused the dam to rupture. ACWD will aim to formulate a plan to clear sediment now and, in the future,
        iii. Similarly, sediment filled the lower fishway of RD1, reducing passage conditions for adult and juvenile salmonids. ACWD is working on a plan to move this sediment and regularly monitor for future build up.
4. There is a need to improve validation of fish species and size estimates from the data collected with the RD1 sonar unit. During 2024, ACWD will work to develop a range of techniques including the use of stereo video and still cameras to observe fish in and near the RD1 sonar unit.
5. This initial year of monitoring provided valuable insight into the capabilities of the ARIS camera. ACWD observed several "blind spots" in the sonar bay and will aim to spend time before the beginning of the 2024 season to determine if camera adjustments, including different angles, may reduce these blind spots and improve our ability to detect actual fish passage.
6. Where appropriate, and in some cases as a contingency plan to compensate for the lack of safe entry protocols, ACWD staff utilized GoPro cameras to collect still images and/or video imagery to reduce crew exposure to confined spaces and/or need to access flowing water. This equipment also reduced the need to alter flow for fish passage facilities inspection.
7. ACWD will continue to use surrogate fish, such as lures and decoys, to determine the camera's ability to detect fish of various sizes and determine schooling and direction of movement.
8. During 2023 monitoring season, the ARIS Explorer 3000 sonar unit could not be regularly cleaned and maintained in-season due to many hazards associated with getting to the sonar unit. The inability to service the unit in season affected the quality and functionality of the sonar data, especially since the abnormally wet year had many high flow events. These high flow events carried sediment and debris through the fish ladder, causing the sonar unit to fill with silt, impairing image quality. For 2024, ACWD will complete and implement safety protocols to help ensure quality sonar recording moving forward as it will allow technicians the ability to perform routine maintenance and cleanings throughout the season.
9. For the 2024 season, ACWD implement regular servicing and establish a protocol for confirming the ARIS sonar camera is recording and that the image quality meets minimum standards.
10. ACWD will complete data management protocols and improve processes for video data storage.
11. ACWD will work to improve the process for video review, including faster transfer of video to the video technicians and a more rapid turnaround of draft results.
12. Images and data recorded by watershed stakeholders were invaluable in 2023, validating RD1 and RD3 passage success for both Chinook Salmon and Pacific Lamprey. ACWD will work with watershed stakeholders to improve data collection protocol and standardized data recording and quality assurance to strengthen the qualitative surveys.

13. The predator and milling surveys performed by the ACWD team were also valuable. ACWD will continue to improve training and protocol development and expand the use of stereo camera surveys to better understand the potential of predatory fish in the ladders and performance of fish screens.
14. ACWD will work with resource agencies to review stranding instances documented during the volatile 2023 season to improve stranding monitoring protocol that enhance protection of target fish species and further the success of restoring steelhead, Chinook Salmon and Pacific Lamprey in the watershed.
15. ACWD will replace the lost temperature recording stations, will work to have them installed and operating before the start of the 2024 monitoring season, and will develop a protocol to help reduce future loss of equipment and the valuable data they provide. This will include siting installation locations that are appropriate for collecting representative water quality data.

7. ACKNOWLEDGEMENTS

The initiation of the FLOWS Program was a significant and labor-intensive undertaking which required collaboration, complex planning, and coordination. This first monitoring year was successful not only because of the dedicated efforts of staff from ACWD and ACFCD and their consultants, Cramer Fish Sciences and Chuck Hanson, respectively, but also because of the contributions of the individuals and organizations acknowledged here.

We express appreciation to ACWD's Project Engineering Division and their contractors for the installation of the fish passage facilities and monitoring equipment. Thank you very much to ACWD's Water Controllers who have taken on daily monitoring of environmental and O&M conditions. Thank you to ACWD's Facilities Maintenance Division and IT divisions for all the great coordination and assistance for the monitoring and O&M equipment needs.

Regarding assistance with the operation and maintenance of the monitoring equipment, we thank CFS's staff, which include Bret Fessenden, Jasmine Williamshen, and Thomas Avilla. Thank you to CFS staff, Bobbie Flores and Maeghan Wedgeworth, who greatly assisted ACWD in key technical aspects of the study regarding guidance and training for the milling, predator, and passage surveys and data management.

We also thank WRA, Inc. staff Nicholas Brinton-McBean, Carla Angulo, and Eliza Schlein, for their work in conducting weekly milling, predator, and passage surveys.

We are very appreciative of the Alameda Creek Restoration Working Group stakeholders and thank the Alameda Creek Alliance for their contribution of photo documentation of fish and wildlife in the Project area. We also acknowledge and thank SFPUC for the great collaborative coordination for biological monitoring and PIT tag communication. Thank you very much to CDFW and EBRPD staff, including Emily McKim, Joe Sullivan, and Edward Culver, for their support during the RD1 fish ladder start-up testing.

We thank the OWG, which includes NMFS, CDFW, and ACFCD for the ongoing support and great coordination and communication throughout this Project and FLOWS Program.

Finally, we thank and acknowledge those that assisted with putting together this first annual report, which includes staff from ACWD (Leonard Ash, Thomas Niesar, Russell Perry, and Jeremy Gekov), CFS (Joe Merz, Bobbie Flores, and Bret Fessenden), and Chuck Hanson.

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APPENDIX A
RD1 2023 Compliance Report

RD1 Bypass Compliance Report

Input Measuring Period (noon to noon)	Bypass Compliance Period (noon to noon)	Input Measuring Period End (at noon)	Bypass Compliance Period End (at noon)	Compliance Met (True/False)	Migration Season	Wet/Dry Season	Niles In-flow, CFS	SFPUC Required Bypass at RD1, CFS	Required Bypass Flow, CFS	Total Bypass Flow (fishway flow, auxiliary flow, overspill), CFS	Fishway Flow, CFS	Auxiliary Flow, CFS	Dam Up/Down	RD1 Dam Overspill, CFS	Excess Bypass, CFS
12/30/2022 - 12/31/2022	12/31/2022 - 01/01/2023	12/31/2022	1/1/2023	TRUE	Off Season	Dry	3,025.4	0.00	-	11,386.0	-	-	DOWN	-	11,386.0
12/31/2022 - 01/01/2023	01/01/2023 - 01/02/2023	1/1/2023	1/2/2023	TRUE	In-Migration	Dry	11,333.6	23.00	48.0	2,223.0	-	-	DOWN	-	2,175.0
01/01/2023 - 01/02/2023	01/02/2023 - 01/03/2023	1/2/2023	1/3/2023	TRUE	In-Migration	Dry	2,058.9	23.00	48.0	2,723.0	-	-	DOWN	-	2,675.0
01/02/2023 - 01/03/2023	01/03/2023 - 01/04/2023	1/3/2023	1/4/2023	TRUE	In-Migration	Dry	2,337.2	23.00	48.0	2,005.0	-	-	DOWN	-	1,957.0
01/03/2023 - 01/04/2023	01/04/2023 - 01/05/2023	1/4/2023	1/5/2023	TRUE	In-Migration	Dry	1,626.6	23.00	48.0	2,173.0	-	-	DOWN	-	2,125.0
01/04/2023 - 01/05/2023	01/05/2023 - 01/06/2023	1/5/2023	1/6/2023	TRUE	In-Migration	Dry	1,842.0	23.00	48.0	3,182.0	-	-	DOWN	-	3,134.0
01/05/2023 - 01/06/2023	01/06/2023 - 01/07/2023	1/6/2023	1/7/2023	TRUE	In-Migration	Dry	2,815.9	23.00	48.0	2,604.0	-	-	DOWN	-	2,556.0
01/06/2023 - 01/07/2023	01/07/2023 - 01/08/2023	1/7/2023	1/8/2023	TRUE	In-Migration	Dry	2,566.4	23.00	48.0	2,026.0	3.0	-	DOWN	-	1,978.0
01/07/2023 - 01/08/2023	01/08/2023 - 01/09/2023	1/8/2023	1/9/2023	TRUE	In-Migration	Dry	2,064.7	23.00	48.0	2,040.0	12.7	-	UP	2,027.3	1,992.0
01/08/2023 - 01/09/2023	01/09/2023 - 01/10/2023	1/9/2023	1/10/2023	TRUE	In-Migration	Dry	2,144.7	23.00	48.0	4,298.0	-	-	DOWN	-	4,250.0
01/09/2023 - 01/10/2023	01/10/2023 - 01/11/2023	1/10/2023	1/11/2023	TRUE	In-Migration	Dry	4,158.6	23.00	48.0	3,926.0	-	-	DOWN	-	3,878.0
01/10/2023 - 01/11/2023	01/11/2023 - 01/12/2023	1/11/2023	1/12/2023	TRUE	In-Migration	Wet	3,721.2	25.00	50.0	3,342.0	-	-	DOWN	-	3,292.0
01/11/2023 - 01/12/2023	01/12/2023 - 01/13/2023	1/12/2023	1/13/2023	TRUE	In-Migration	Wet	3,171.3	25.00	50.0	4,274.0	-	-	DOWN	-	4,224.0
01/12/2023 - 01/13/2023	01/13/2023 - 01/14/2023	1/13/2023	1/14/2023	TRUE	In-Migration	Wet	3,889.5	25.00	50.0	4,436.0	-	-	DOWN	-	4,386.0
01/13/2023 - 01/14/2023	01/14/2023 - 01/15/2023	1/14/2023	1/15/2023	TRUE	In-Migration	Wet	4,179.7	25.00	50.0	5,864.0	-	-	DOWN	-	5,814.0
01/14/2023 - 01/15/2023	01/15/2023 - 01/16/2023	1/15/2023	1/16/2023	TRUE	In-Migration	Wet	5,526.9	25.00	50.0	6,776.0	-	-	DOWN	-	6,726.0
01/15/2023 - 01/16/2023	01/16/2023 - 01/17/2023	1/16/2023	1/17/2023	TRUE	In-Migration	Wet	6,652.9	25.00	50.0	6,754.0	0.8	-	DOWN	-	6,704.0
01/16/2023 - 01/17/2023	01/17/2023 - 01/18/2023	1/17/2023	1/18/2023	TRUE	In-Migration	Wet	6,566.5	25.00	50.0	4,861.0	-	-	DOWN	-	4,811.0
01/17/2023 - 01/18/2023	01/18/2023 - 01/19/2023	1/18/2023	1/19/2023	TRUE	In-Migration	Wet	4,550.1	25.00	50.0	3,885.0	-	-	DOWN	-	3,835.0
01/18/2023 - 01/19/2023	01/19/2023 - 01/20/2023	1/19/2023	1/20/2023	TRUE	In-Migration	Wet	3,602.1	25.00	50.0	3,384.0	-	-	DOWN	-	3,334.0
01/19/2023 - 01/20/2023	01/20/2023 - 01/21/2023	1/20/2023	1/21/2023	TRUE	In-Migration	Wet	3,151.9	25.00	50.0	2,589.0	-	-	DOWN	-	2,539.0
01/20/2023 - 01/21/2023	01/21/2023 - 01/22/2023	1/21/2023	1/22/2023	TRUE	In-Migration	Wet	2,471.8	25.00	50.0	1,908.0	-	-	DOWN	-	1,858.0
01/21/2023 - 01/22/2023	01/22/2023 - 01/23/2023	1/22/2023	1/23/2023	TRUE	In-Migration	Wet	1,896.7	25.00	50.0	1,073.0	9.5	-	DOWN	-	1,023.0
01/22/2023 - 01/23/2023	01/23/2023 - 01/24/2023	1/23/2023	1/24/2023	TRUE	In-Migration	Wet	1,224.9	25.00	50.0	363.0	36.3	-	UP	326.7	313.0
01/23/2023 - 01/24/2023	01/24/2023 - 01/25/2023	1/24/2023	1/25/2023	TRUE	In-Migration	Wet	590.2	25.00	50.0	138.0	33.8	-	UP	104.2	88.0
01/24/2023 - 01/25/2023	01/25/2023 - 01/26/2023	1/25/2023	1/26/2023	TRUE	In-Migration	Wet	336.3	25.00	50.0	160.0	34.0	-	UP	126.0	110.0
01/25/2023 - 01/26/2023	01/26/2023 - 01/27/2023	1/26/2023	1/27/2023	TRUE	In-Migration	Wet	378.7	25.00	50.0	138.0	33.4	-	UP	104.6	88.0
01/26/2023 - 01/27/2023	01/27/2023 - 01/28/2023	1/27/2023	1/28/2023	TRUE	In-Migration	Wet	346.0	25.00	50.0	122.0	33.3	-	UP	88.7	72.0
01/27/2023 - 01/28/2023	01/28/2023 - 01/29/2023	1/28/2023	1/29/2023	TRUE	In-Migration	Wet	329.3	25.00	50.0	115.0	33.2	-	UP	81.8	65.0
01/28/2023 - 01/29/2023	01/29/2023 - 01/30/2023	1/29/2023	1/30/2023	TRUE	In-Migration	Wet	323.8	25.00	50.0	112.0	33.2	-	UP	78.8	62.0
01/29/2023 - 01/30/2023	01/30/2023 - 01/31/2023	1/30/2023	1/31/2023	TRUE	In-Migration	Wet	319.8	25.00	50.0	102.0	32.8	-	UP	69.2	52.0
01/30/2023 - 01/31/2023	01/31/2023 - 02/01/2023	1/31/2023	2/1/2023	TRUE	In-Migration	Wet	309.6	22.52	47.5	91.0	32.5	-	UP	58.5	43.5
01/31/2023 - 02/01/2023	02/01/2023 - 02/02/2023	2/1/2023	2/2/2023	TRUE	In-Migration	Wet	298.6	19.95	45.0	82.0	29.7	0.2	UP	52.1	37.0
02/01/2023 - 02/02/2023	02/02/2023 - 02/03/2023	2/2/2023	2/3/2023	TRUE	In-Migration	Wet	299.6	18.10	43.1	77.0	29.7	0.1	UP	47.2	33.9
02/02/2023 - 02/03/2023	02/03/2023 - 02/04/2023	2/3/2023	2/4/2023	TRUE	In-Migration	Wet	293.6	16.92	41.9	136.0	30.2	-	UP	105.8	94.1
02/03/2023 - 02/04/2023	02/04/2023 - 02/05/2023	2/4/2023	2/5/2023	TRUE	In-Migration	Wet	362.8	18.46	43.5	403.0	31.9	0.0	UP	371.0	359.5
02/04/2023 - 02/05/2023	02/05/2023 - 02/06/2023	2/5/2023	2/6/2023	TRUE	In-Migration	Wet	658.2	25.00	50.0	443.0	32.5	-	UP	410.5	393.0
02/05/2023 - 02/06/2023	02/06/2023 - 02/07/2023	2/6/2023	2/7/2023	TRUE	In-Migration	Wet	598.9	25.00	50.0	286.0	31.5	-	UP	254.5	236.0
02/06/2023 - 02/07/2023	02/07/2023 - 02/08/2023	2/7/2023	2/8/2023	TRUE	In-Migration	Wet	387.5	25.00	50.0	166.0	30.5	-	UP	135.5	116.0
02/07/2023 - 02/08/2023	02/08/2023 - 02/09/2023	2/8/2023	2/9/2023	TRUE	In-Migration	Wet	251.5	25.00	50.0	74.0	29.5	-	UP	44.5	24.0
02/08/2023 - 02/09/2023	02/09/2023 - 02/10/2023	2/9/2023	2/10/2023	TRUE	In-Migration	Wet	148.4	25.00	50.0	81.0	29.8	-	UP	51.2	31.0
02/09/2023 - 02/10/2023	02/10/2023 - 02/11/2023	2/10/2023	2/11/2023	TRUE	In-Migration	Wet	119.8	25.00	50.0	86.0	29.8	-	UP	56.2	36.0
02/10/2023 - 02/11/2023	02/11/2023 - 02/12/2023	2/11/2023	2/12/2023	TRUE	In-Migration	Wet	116.7	25.00	50.0	87.0	29.8	-	UP	57.2	37.0
02/11/2023 - 02/12/2023	02/12/2023 - 02/13/2023	2/12/2023	2/13/2023	TRUE	In-Migration	Wet	117.5	23.80	48.8	79.0	29.7	-	UP	49.3	30.2
02/12/2023 - 02/13/2023	02/13/2023 - 02/14/2023	2/13/2023	2/14/2023	TRUE	In-Migration	Wet	107.1	20.85	45.8	71.0	29.7	-	UP	41.3	25.2
02/13/2023 - 02/14/2023	02/14/2023 - 02/15/2023	2/14/2023	2/15/2023	TRUE	In-Migration	Wet	99.7	0.00	25.0	66.0	29.4	-	UP	36.6	41.0
02/14/2023 - 02/15/2023	02/15/2023 - 02/16/2023	2/15/2023	2/16/2023	TRUE	In-Migration	Wet	93.9	0.00	25.0	60.0	29.3	-	UP	30.7	35.0
02/15/2023 - 02/16/2023	02/16/2023 - 02/17/2023	2/16/2023	2/17/2023	TRUE	In-Migration	Wet	86.3	0.00	25.0	51.0	29.0	-	UP	22.0	26.0
02/16/2023 - 02/17/2023	02/17/2023 - 02/18/2023	2/17/2023	2/18/2023	TRUE	In-Migration	Wet	75.5	0.00	25.0	46.0	29.0	-	UP	17.0	21.0
02/17/2023 - 02/18/2023	02/18/2023 - 02/19/2023	2/18/2023	2/19/2023	TRUE	In-Migration	Wet	70.0	0.00	25.0	41.0	28.9	-	UP	12.1	16.0
02/18/2023 - 02/19/2023	02/19/2023 - 02/20/2023	2/19/2023	2/20/2023	TRUE	In-Migration	Wet	63.8	0.00	25.0	37.0	28.8	-	UP	8.2	12.0
02/19/2023 - 02/20/2023	02/20/2023 - 02/21/2023	2/20/2023	2/21/2023	TRUE	In-Migration	Wet	58.7	0.00	25.0	34.0	28.8	-	UP	5.2	9.0
02/20/2023 - 02/21/2023	02/21/2023 - 02/22/2023	2/21/2023	2/22/2023	TRUE	In-Migration	Wet	55.7	0.00	25.0	34.0	28.9	-	UP	5.1	9.0
02/21/2023 - 02/22/2023	02/22/2023 - 02/23/2023	2/22/2023	2/23/2023	TRUE	In-Migration	Wet	56.4	0.00	25.0	37.0	29.0	-	UP	8.0	12.0
02/22/2023 - 02/23/2023	02/23/2023 - 02/24/2023	2/23/2023	2/24/2023	TRUE	In-Migration	Wet	61.2	0.00	25.0	438.0	24.1	-	UP	413.9	413.0
02/23/2023 - 02/24/2023	02/24/2023 - 02/25/2023	2/24/2023	2/25/2023	TRUE	In-Migration	Wet	452.8	15.50	40.5	568.0	36.1	-	DOWN	-	527.5
02/24/2023 - 02/25/2023	02/25/2023 - 02/26/2023	2/25/2023	2/26/2023	TRUE	In-Migration	Wet	519.4	25.00	50.0	191.0	33.1	-	UP	157.9	141.0
02/25/2023 - 02/26/2023	02/26/2023 - 02/27/2023	2/26/2023	2/27/2023	TRUE	In-Migration	Wet	198.6	25.00	50.0	327.0	29.2	-	UP	297.8	277.0
02/26/2023 - 02/27/2023	02/27/2023 - 02/28/2023	2/27/2023	2/28/2023	TRUE	In-Migration	Wet	282.4	25.00	50.0	1,480.0	4.3	-	DOWN	-	1,430.0
02/27/2023 - 02/28/2023	02/28/2023 - 03/01/2023	2/28/2023	3/1/2023	TRUE	In-Migration	Wet	1,532.7	25.00	50.0	1,710.0	29.2	-	DOWN	-	1,660.0
02/28/2023 - 03/01/2023	03/01/2023 - 03/02/2023	3/1/2023	3/2/2023	TRUE	In-Migration	Wet	1,787.4	25.00	50.0	1,307.0	41.7	-	DOWN	-	1,257.0
03/01/2023 - 03/02/2023	03/02/2023 - 03/03/2023	3/2/2023	3/3/2023	TRUE	In-Migration	Wet	1,384.3	25.00	50.0	1,227.0	41.3	-	DOWN	-	1,177.0
03/02/2023 - 03/03/2023	03/03/2023 - 03/04/2023	3/3/2023	3/4/2023	TRUE	In-Migration	Wet	1,305.4	25.00	50.0	928.0	39.5	-	DOWN	-	878.0

RD1 Bypass Compliance Report

Input Measuring Period (noon to noon)	Bypass Compliance Period (noon to noon)	Input Measuring Period End (at noon)	Bypass Compliance Period End (at noon)	Compliance Met (True/False)	Migration Season	Wet/Dry Season	Niles In-flow, CFS	SFPUC Required Bypass at RD1, CFS	Required Bypass Flow, CFS	Total Bypass Flow (fishway flow, auxiliary flow, overspill), CFS	Fishway Flow, CFS	Auxiliary Flow, CFS	Dam Up/Down	RD1 Dam Overspill, CFS	Excess Bypass, CFS
03/03/2023 - 03/04/2023	03/04/2023 - 03/05/2023	3/4/2023	3/5/2023	TRUE	In-Migration	Wet	988.5	25.00	50.0	858.0	39.1	-	DOWN	-	808.0
03/04/2023 - 03/05/2023	03/05/2023 - 03/06/2023	3/5/2023	3/6/2023	TRUE	In-Migration	Wet	981.1	25.00	50.0	1,056.0	40.3	-	DOWN	-	1,006.0
03/05/2023 - 03/06/2023	03/06/2023 - 03/07/2023	3/6/2023	3/7/2023	TRUE	In-Migration	Wet	1,153.3	25.00	50.0	716.0	38.2	-	DOWN	-	666.0
03/06/2023 - 03/07/2023	03/07/2023 - 03/08/2023	3/7/2023	3/8/2023	TRUE	In-Migration	Wet	811.0	25.00	50.0	818.0	39.0	-	DOWN	-	768.0
03/07/2023 - 03/08/2023	03/08/2023 - 03/09/2023	3/8/2023	3/9/2023	TRUE	In-Migration	Wet	947.6	25.00	50.0	1,572.0	3.5	-	DOWN	-	1,522.0
03/08/2023 - 03/09/2023	03/09/2023 - 03/10/2023	3/9/2023	3/10/2023	TRUE	In-Migration	Wet	1,763.6	25.00	50.0	5,367.0	-	-	DOWN	-	5,317.0
03/09/2023 - 03/10/2023	03/10/2023 - 03/11/2023	3/10/2023	3/11/2023	TRUE	In-Migration	Wet	5,534.0	25.00	50.0	4,905.0	-	-	DOWN	-	4,855.0
03/10/2023 - 03/11/2023	03/11/2023 - 03/12/2023	3/11/2023	3/12/2023	TRUE	In-Migration	Wet	5,032.1	25.00	50.0	2,990.0	-	-	DOWN	-	2,940.0
03/11/2023 - 03/12/2023	03/12/2023 - 03/13/2023	3/12/2023	3/13/2023	TRUE	In-Migration	Wet	3,232.9	25.00	50.0	4,498.0	-	-	DOWN	-	4,448.0
03/12/2023 - 03/13/2023	03/13/2023 - 03/14/2023	3/13/2023	3/14/2023	TRUE	In-Migration	Wet	4,472.6	25.00	50.0	2,804.0	-	-	DOWN	-	2,754.0
03/13/2023 - 03/14/2023	03/14/2023 - 03/15/2023	3/14/2023	3/15/2023	TRUE	In-Migration	Wet	2,956.7	25.00	50.0	2,350.0	0.1	-	DOWN	-	2,300.0
03/14/2023 - 03/15/2023	03/15/2023 - 03/16/2023	3/15/2023	3/16/2023	TRUE	In-Migration	Wet	2,480.1	25.00	50.0	2,272.0	-	-	DOWN	-	2,222.0
03/15/2023 - 03/16/2023	03/16/2023 - 03/17/2023	3/16/2023	3/17/2023	TRUE	In-Migration	Wet	2,355.7	25.00	50.0	1,877.0	2.1	16.1	DOWN	-	1,827.0
03/16/2023 - 03/17/2023	03/17/2023 - 03/18/2023	3/17/2023	3/18/2023	TRUE	In-Migration	Wet	1,938.6	25.00	50.0	1,410.0	25.5	-	DOWN	-	1,360.0
03/17/2023 - 03/18/2023	03/18/2023 - 03/19/2023	3/18/2023	3/19/2023	TRUE	In-Migration	Wet	1,415.0	25.00	50.0	960.0	38.1	-	DOWN	-	910.0
03/18/2023 - 03/19/2023	03/19/2023 - 03/20/2023	3/19/2023	3/20/2023	TRUE	In-Migration	Wet	981.1	25.00	50.0	1,016.0	38.7	-	DOWN	-	966.0
03/19/2023 - 03/20/2023	03/20/2023 - 03/21/2023	3/20/2023	3/21/2023	TRUE	In-Migration	Wet	1,068.0	25.00	50.0	881.0	37.2	-	DOWN	-	831.0
03/20/2023 - 03/21/2023	03/21/2023 - 03/22/2023	3/21/2023	3/22/2023	TRUE	In-Migration	Wet	960.0	25.00	50.0	2,659.0	6.4	-	DOWN	-	2,609.0
03/21/2023 - 03/22/2023	03/22/2023 - 03/23/2023	3/22/2023	3/23/2023	TRUE	In-Migration	Wet	2,725.6	25.00	50.0	3,123.0	-	-	DOWN	-	3,073.0
03/22/2023 - 03/23/2023	03/23/2023 - 03/24/2023	3/23/2023	3/24/2023	TRUE	In-Migration	Wet	3,098.0	25.00	50.0	2,385.0	-	-	DOWN	-	2,335.0
03/23/2023 - 03/24/2023	03/24/2023 - 03/25/2023	3/24/2023	3/25/2023	TRUE	In-Migration	Wet	2,370.6	25.00	50.0	1,654.0	4.9	-	DOWN	-	1,604.0
03/24/2023 - 03/25/2023	03/25/2023 - 03/26/2023	3/25/2023	3/26/2023	TRUE	In-Migration	Wet	1,664.8	25.00	50.0	1,090.0	39.2	-	DOWN	-	1,040.0
03/25/2023 - 03/26/2023	03/26/2023 - 03/27/2023	3/26/2023	3/27/2023	TRUE	In-Migration	Wet	1,136.5	25.00	50.0	825.0	36.4	-	DOWN	-	775.0
03/26/2023 - 03/27/2023	03/27/2023 - 03/28/2023	3/27/2023	3/28/2023	TRUE	In-Migration	Wet	905.1	25.00	50.0	684.0	30.6	-	DOWN	-	634.0
03/27/2023 - 03/28/2023	03/28/2023 - 03/29/2023	3/28/2023	3/29/2023	TRUE	In-Migration	Wet	762.8	25.00	50.0	873.0	36.8	-	DOWN	-	823.0
03/28/2023 - 03/29/2023	03/29/2023 - 03/30/2023	3/29/2023	3/30/2023	TRUE	In-Migration	Wet	985.0	25.00	50.0	1,431.0	21.5	-	DOWN	-	1,381.0
03/29/2023 - 03/30/2023	03/30/2023 - 03/31/2023	3/30/2023	3/31/2023	TRUE	In-Migration	Wet	1,568.6	25.00	50.0	934.0	37.8	-	DOWN	-	884.0
03/30/2023 - 03/31/2023	03/31/2023 - 04/01/2023	3/31/2023	4/1/2023	TRUE	In-Migration	Wet	1,000.2	25.00	50.0	558.0	26.3	-	DOWN	-	508.0
03/31/2023 - 04/01/2023	04/01/2023 - 04/02/2023	4/1/2023	4/2/2023	TRUE	Out-Migration	Wet	670.9	84.58	96.6	474.0	35.3	-	UP	438.7	377.4
04/01/2023 - 04/02/2023	04/02/2023 - 04/03/2023	4/2/2023	4/3/2023	TRUE	Out-Migration	Wet	506.3	72.42	84.4	413.0	34.5	-	UP	378.5	328.6
04/02/2023 - 04/03/2023	04/03/2023 - 04/04/2023	4/3/2023	4/4/2023	TRUE	Out-Migration	Wet	421.4	64.71	76.7	332.0	33.1	-	UP	298.9	255.3
04/03/2023 - 04/04/2023	04/04/2023 - 04/05/2023	4/4/2023	4/5/2023	TRUE	Out-Migration	Wet	368.9	55.74	67.7	386.0	33.9	-	UP	352.1	318.3
04/04/2023 - 04/05/2023	04/05/2023 - 04/06/2023	4/5/2023	4/6/2023	TRUE	Out-Migration	Wet	429.5	48.55	60.5	349.0	34.0	-	UP	315.0	288.5
04/05/2023 - 04/06/2023	04/06/2023 - 04/07/2023	4/6/2023	4/7/2023	TRUE	Out-Migration	Wet	386.3	42.68	54.7	323.0	36.2	-	UP	286.8	268.3
04/06/2023 - 04/07/2023	04/07/2023 - 04/08/2023	4/7/2023	4/8/2023	TRUE	Out-Migration	Wet	352.1	39.11	51.1	290.0	67.0	-	UP	223.0	238.9
04/07/2023 - 04/08/2023	04/08/2023 - 04/09/2023	4/8/2023	4/9/2023	TRUE	Out-Migration	Wet	307.4	36.35	48.4	185.0	67.0	-	UP	118.0	136.6
04/08/2023 - 04/09/2023	04/09/2023 - 04/10/2023	4/9/2023	4/10/2023	TRUE	Out-Migration	Wet	200.2	32.84	44.8	148.0	67.3	-	UP	80.7	103.2
04/09/2023 - 04/10/2023	04/10/2023 - 04/11/2023	4/10/2023	4/11/2023	TRUE	Out-Migration	Wet	165.3	29.56	41.6	131.0	67.3	-	UP	63.7	89.4
04/10/2023 - 04/11/2023	04/11/2023 - 04/12/2023	4/11/2023	4/12/2023	TRUE	Out-Migration	Wet	149.2	26.86	38.9	118.0	46.1	-	UP	71.9	79.1
04/11/2023 - 04/12/2023	04/12/2023 - 04/13/2023	4/12/2023	4/13/2023	TRUE	Out-Migration	Wet	137.7	24.83	36.8	108.0	43.6	-	UP	64.4	71.2
04/12/2023 - 04/13/2023	04/13/2023 - 04/14/2023	4/13/2023	4/14/2023	TRUE	Out-Migration	Wet	127.8	23.20	35.2	107.0	43.8	-	UP	63.2	71.8
04/13/2023 - 04/14/2023	04/14/2023 - 04/15/2023	4/14/2023	4/15/2023	TRUE	Out-Migration	Wet	126.2	21.32	33.3	112.0	44.2	-	UP	67.8	78.7
04/14/2023 - 04/15/2023	04/15/2023 - 04/16/2023	4/15/2023	4/16/2023	TRUE	Out-Migration	Wet	128.8	19.78	31.8	104.0	44.0	-	UP	60.0	72.2
04/15/2023 - 04/16/2023	04/16/2023 - 04/17/2023	4/16/2023	4/17/2023	TRUE	Out-Migration	Wet	120.0	18.37	30.4	98.0	43.6	-	UP	54.4	67.6
04/16/2023 - 04/17/2023	04/17/2023 - 04/18/2023	4/17/2023	4/18/2023	TRUE	Out-Migration	Wet	113.6	17.07	29.1	93.0	43.4	-	UP	49.6	63.9
04/17/2023 - 04/18/2023	04/18/2023 - 04/19/2023	4/18/2023	4/19/2023	TRUE	Out-Migration	Wet	113.6	16.88	28.9	92.0	43.5	-	UP	48.5	63.1
04/18/2023 - 04/19/2023	04/19/2023 - 04/20/2023	4/19/2023	4/20/2023	TRUE	Out-Migration	Wet	114.6	15.81	27.8	90.0	44.5	-	UP	45.5	62.2
04/19/2023 - 04/20/2023	04/20/2023 - 04/21/2023	4/20/2023	4/21/2023	TRUE	Out-Migration	Wet	109.6	14.30	26.3	78.0	48.1	-	UP	29.9	51.7
04/20/2023 - 04/21/2023	04/21/2023 - 04/22/2023	4/21/2023	4/22/2023	TRUE	Out-Migration	Wet	105.6	13.45	25.4	72.0	46.0	-	UP	26.0	46.6
04/21/2023 - 04/22/2023	04/22/2023 - 04/23/2023	4/22/2023	4/23/2023	TRUE	Out-Migration	Wet	103.4	12.81	24.8	67.0	45.5	-	UP	21.5	42.2
04/22/2023 - 04/23/2023	04/23/2023 - 04/24/2023	4/23/2023	4/24/2023	TRUE	Out-Migration	Wet	101.0	12.14	24.1	62.0	44.9	-	UP	17.1	37.9
04/23/2023 - 04/24/2023	04/24/2023 - 04/25/2023	4/24/2023	4/25/2023	TRUE	Out-Migration	Wet	97.4	11.60	23.6	44.0	43.3	-	UP	0.7	20.4
04/24/2023 - 04/25/2023	04/25/2023 - 04/26/2023	4/25/2023	4/26/2023	TRUE	Out-Migration	Wet	96.6	10.81	22.8	43.0	44.3	-	UP	(1.3)	20.2
04/25/2023 - 04/26/2023	04/26/2023 - 04/27/2023	4/26/2023	4/27/2023	TRUE	Out-Migration	Wet	97.8	9.94	21.9	30.0	30.3	-	UP	(0.2)	8.1
04/26/2023 - 04/27/2023	04/27/2023 - 04/28/2023	4/27/2023	4/28/2023	TRUE	Out-Migration	Wet	95.4	9.44	21.4	39.0	35.8	-	UP	3.2	17.6
04/27/2023 - 04/28/2023	04/28/2023 - 04/29/2023	4/28/2023	4/29/2023	TRUE	Out-Migration	Wet	91.1	10.10	22.1	27.0	27.5	-	UP	(0.5)	4.9
04/28/2023 - 04/29/2023	04/29/2023 - 04/30/2023	4/29/2023	4/30/2023	TRUE	Out-Migration	Wet	70.6	9.53	21.5	32.0	32.5	-	UP	(0.5)	10.5
04/29/2023 - 04/30/2023	04/30/2023 - 05/01/2023	4/30/2023	5/1/2023	TRUE	Out-Migration	Wet	67.9	7.54	19.5	26.0	27.1	-	UP	(1.1)	6.5
04/30/2023 - 05/01/2023	05/01/2023 - 05/02/2023	5/1/2023	5/2/2023	TRUE	Out-Migration	Wet	74.0	7.41	19.4	32.0	32.3	-	UP	(0.3)	12.6
05/01/2023 - 05/02/2023	05/02/2023 - 05/03/2023	5/2/2023	5/3/2023	TRUE	Out-Migration	Wet	78.6	8.74	20.7	53.0	29.3	-	UP	23.7	32.3
05/02/2023 - 05/03/2023	05/03/2023 - 05/04/2023	5/3/2023	5/4/2023	TRUE	Out-Migration	Wet	167.6	9.42	21.4	31.0	31.3	-	UP	(0.3)	9.6
05/03/2023 - 05/04/2023	05/04/2023 - 05/05/2023	5/4/2023	5/5/2023	TRUE	Out-Migration	Wet	147.1	8.99	21.0	33.0	33.1	-	UP	(0.1)	12.0
05/04/2023 - 05/05/2023	05/05/2023 - 05/06/2023	5/5/2023	5/6/2023	TRUE	Out-Migration	Wet	106.7	8.11	20.1	32.0	32.3	-	UP	(0.3)	11.9

RD1 Bypass Compliance Report

Input Measuring Period (noon to noon)	Bypass Compliance Period (noon to noon)	Input Measuring Period End (at noon)	Bypass Compliance Period End (at noon)	Compliance Met (True/False)	Migration Season	Wet/Dry Season	Niles In-flow, CFS	SFPUC Required Bypass at RD1, CFS	Required Bypass Flow, CFS	Total Bypass Flow (fishway flow, auxiliary flow, overspill), CFS	Fishway Flow, CFS	Auxiliary Flow, CFS	Dam Up/Down	RD1 Dam Overspill, CFS	Excess Bypass, CFS
05/05/2023 - 05/06/2023	05/06/2023 - 05/07/2023	5/6/2023	5/7/2023	TRUE	Out-Migration	Wet	93.0	7.39	19.4	34.0	32.8	-	UP	1.2	14.6
05/06/2023 - 05/07/2023	05/07/2023 - 05/08/2023	5/7/2023	5/8/2023	TRUE	Out-Migration	Wet	98.4	9.33	21.3	35.0	34.2	-	UP	0.8	13.7
05/07/2023 - 05/08/2023	05/08/2023 - 05/09/2023	5/8/2023	5/9/2023	TRUE	Out-Migration	Wet	89.4	7.48	19.5	31.0	30.7	-	UP	0.3	11.5
05/08/2023 - 05/09/2023	05/09/2023 - 05/10/2023	5/9/2023	5/10/2023	TRUE	Out-Migration	Wet	80.4	6.43	18.4	27.0	26.8	-	UP	0.2	8.6
05/09/2023 - 05/10/2023	05/10/2023 - 05/11/2023	5/10/2023	5/11/2023	TRUE	Out-Migration	Wet	79.0	5.68	17.7	27.0	26.5	-	UP	0.5	9.3
05/10/2023 - 05/11/2023	05/11/2023 - 05/12/2023	5/11/2023	5/12/2023	TRUE	Out-Migration	Wet	76.7	7.18	19.2	27.0	26.8	-	UP	0.2	7.8
05/11/2023 - 05/12/2023	05/12/2023 - 05/13/2023	5/12/2023	5/13/2023	TRUE	Out-Migration	Wet	73.6	6.74	18.7	25.0	24.0	-	UP	1.0	6.3
05/12/2023 - 05/13/2023	05/13/2023 - 05/14/2023	5/13/2023	5/14/2023	TRUE	Out-Migration	Wet	74.4	6.31	18.3	23.0	22.6	-	UP	0.4	4.7
05/13/2023 - 05/14/2023	05/14/2023 - 05/15/2023	5/14/2023	5/15/2023	TRUE	Out-Migration	Wet	57.5	5.84	17.8	26.0	25.6	-	UP	0.4	8.2
05/14/2023 - 05/15/2023	05/15/2023 - 05/16/2023	5/15/2023	5/16/2023	TRUE	Out-Migration	Wet	63.2	5.35	17.4	26.0	25.9	-	UP	0.1	8.6
05/15/2023 - 05/16/2023	05/16/2023 - 05/17/2023	5/16/2023	5/17/2023	TRUE	Out-Migration	Wet	61.3	5.00	17.0	25.0	24.8	-	UP	0.2	8.0
05/16/2023 - 05/17/2023	05/17/2023 - 05/18/2023	5/17/2023	5/18/2023	TRUE	Out-Migration	Wet	61.1	2.49	14.5	32.0	31.5	-	UP	0.5	17.5
05/17/2023 - 05/18/2023	05/18/2023 - 05/19/2023	5/18/2023	5/19/2023	TRUE	Out-Migration	Wet	60.8	2.04	14.0	22.0	21.9	-	UP	0.1	8.0
05/18/2023 - 05/19/2023	05/19/2023 - 05/20/2023	5/19/2023	5/20/2023	TRUE	Out-Migration	Wet	51.7	3.93	15.9	21.0	21.5	-	UP	(0.5)	5.1
05/19/2023 - 05/20/2023	05/20/2023 - 05/21/2023	5/20/2023	5/21/2023	TRUE	Out-Migration	Wet	54.3	3.61	15.6	23.0	23.2	-	UP	(0.2)	7.4
05/20/2023 - 05/21/2023	05/21/2023 - 05/22/2023	5/21/2023	5/22/2023	TRUE	Out-Migration	Wet	61.0	3.33	15.3	22.0	21.4	-	UP	0.6	6.7
05/21/2023 - 05/22/2023	05/22/2023 - 05/23/2023	5/22/2023	5/23/2023	TRUE	Out-Migration	Wet	62.8	3.08	15.1	26.0	24.9	-	UP	1.1	10.9
05/22/2023 - 05/23/2023	05/23/2023 - 05/24/2023	5/23/2023	5/24/2023	TRUE	Out-Migration	Wet	54.7	2.70	14.7	17.0	16.5	-	UP	0.5	2.3
05/23/2023 - 05/24/2023	05/24/2023 - 05/25/2023	5/24/2023	5/25/2023	TRUE	Out-Migration	Wet	56.0	2.66	14.7	17.0	16.1	-	UP	0.9	2.3
05/24/2023 - 05/25/2023	05/25/2023 - 05/26/2023	5/25/2023	5/26/2023	TRUE	Out-Migration	Wet	60.4	2.52	14.5	19.0	18.6	-	UP	0.4	4.5
05/25/2023 - 05/26/2023	05/26/2023 - 05/27/2023	5/26/2023	5/27/2023	TRUE	Out-Migration	Wet	58.5	2.29	14.3	21.0	20.3	-	UP	0.7	6.7
05/26/2023 - 05/27/2023	05/27/2023 - 05/28/2023	5/27/2023	5/28/2023	TRUE	Out-Migration	Wet	57.7	2.22	14.2	20.0	19.1	-	UP	0.9	5.8
05/27/2023 - 05/28/2023	05/28/2023 - 05/29/2023	5/28/2023	5/29/2023	TRUE	Out-Migration	Wet	42.4	2.00	14.0	19.0	17.5	-	UP	1.5	5.0
05/28/2023 - 05/29/2023	05/29/2023 - 05/30/2023	5/29/2023	5/30/2023	TRUE	Out-Migration	Wet	36.6	1.96	14.0	17.0	16.1	-	UP	0.9	3.0
05/29/2023 - 05/30/2023	05/30/2023 - 05/31/2023	5/30/2023	5/31/2023	TRUE	Out-Migration	Wet	33.8	1.83	13.8	18.0	17.6	-	UP	0.4	4.2
05/30/2023 - 05/31/2023	05/31/2023 - 06/01/2023	5/31/2023	6/1/2023	TRUE	Out-Migration	Wet	45.4	1.58	13.6	29.0	26.3	-	UP	2.7	15.4
05/31/2023 - 06/01/2023	06/01/2023 - 06/02/2023	6/1/2023	6/2/2023	TRUE	Off Season	Wet	44.7	0.00	5.0	51.0	44.2	-	UP	6.8	46.0
06/01/2023 - 06/02/2023	06/02/2023 - 06/03/2023	6/2/2023	6/3/2023	TRUE	Off Season	Wet	45.4	0.00	5.0	44.0	36.9	-	UP	7.1	39.0
06/02/2023 - 06/03/2023	06/03/2023 - 06/04/2023	6/3/2023	6/4/2023	TRUE	Off Season	Wet	36.5	0.00	5.0	23.0	21.5	-	UP	1.5	18.0
06/03/2023 - 06/04/2023	06/04/2023 - 06/05/2023	6/4/2023	6/5/2023	TRUE	Off Season	Wet	29.9	0.00	5.0	22.0	21.3	-	UP	0.7	17.0
06/04/2023 - 06/05/2023	06/05/2023 - 06/06/2023	6/5/2023	6/6/2023	TRUE	Off Season	Wet	35.1	0.00	5.0	34.0	30.2	-	UP	3.8	29.0
06/05/2023 - 06/06/2023	06/06/2023 - 06/07/2023	6/6/2023	6/7/2023	TRUE	Off Season	Wet	37.7	0.00	5.0	21.0	19.3	-	UP	1.7	16.0
06/06/2023 - 06/07/2023	06/07/2023 - 06/08/2023	6/7/2023	6/8/2023	TRUE	Off Season	Wet	38.8	0.00	5.0	33.0	30.8	-	UP	2.2	28.0
06/07/2023 - 06/08/2023	06/08/2023 - 06/09/2023	6/8/2023	6/9/2023	TRUE	Off Season	Wet	43.4	0.00	5.0	43.0	38.4	-	UP	4.6	38.0
06/08/2023 - 06/09/2023	06/09/2023 - 06/10/2023	6/9/2023	6/10/2023	TRUE	Off Season	Wet	41.4	0.00	5.0	39.0	33.4	-	UP	5.6	34.0
06/09/2023 - 06/10/2023	06/10/2023 - 06/11/2023	6/10/2023	6/11/2023	TRUE	Off Season	Wet	32.5	0.00	5.0	17.0	16.1	-	UP	0.9	12.0
06/10/2023 - 06/11/2023	06/11/2023 - 06/12/2023	6/11/2023	6/12/2023	TRUE	Off Season	Wet	28.2	0.00	5.0	19.0	18.9	-	UP	0.1	14.0
06/11/2023 - 06/12/2023	06/12/2023 - 06/13/2023	6/12/2023	6/13/2023	TRUE	Off Season	Wet	34.0	0.00	5.0	43.0	37.6	-	UP	5.4	38.0
06/12/2023 - 06/13/2023	06/13/2023 - 06/14/2023	6/13/2023	6/14/2023	TRUE	Off Season	Wet	39.0	0.00	5.0	27.0	24.5	-	UP	2.5	22.0
06/13/2023 - 06/14/2023	06/14/2023 - 06/15/2023	6/14/2023	6/15/2023	TRUE	Off Season	Wet	38.9	0.00	5.0	23.0	22.2	-	UP	0.8	18.0
06/14/2023 - 06/15/2023	06/15/2023 - 06/16/2023	6/15/2023	6/16/2023	TRUE	Off Season	Wet	37.8	0.00	5.0	31.0	28.3	-	UP	2.7	26.0
06/15/2023 - 06/16/2023	06/16/2023 - 06/17/2023	6/16/2023	6/17/2023	TRUE	Off Season	Wet	37.5	0.00	5.0	27.0	24.9	-	UP	2.1	22.0
06/16/2023 - 06/17/2023	06/17/2023 - 06/18/2023	6/17/2023	6/18/2023	TRUE	Off Season	Wet	29.7	0.00	5.0	26.0	24.5	-	UP	1.5	21.0
06/17/2023 - 06/18/2023	06/18/2023 - 06/19/2023	6/18/2023	6/19/2023	TRUE	Off Season	Wet	38.7	0.00	5.0	33.0	30.5	-	UP	2.5	28.0
06/18/2023 - 06/19/2023	06/19/2023 - 06/20/2023	6/19/2023	6/20/2023	TRUE	Off Season	Wet	40.2	0.00	5.0	29.0	26.9	-	UP	2.1	24.0
06/19/2023 - 06/20/2023	06/20/2023 - 06/21/2023	6/20/2023	6/21/2023	TRUE	Off Season	Wet	35.9	0.00	5.0	27.0	25.0	-	UP	2.0	22.0
06/20/2023 - 06/21/2023	06/21/2023 - 06/22/2023	6/21/2023	6/22/2023	TRUE	Off Season	Wet	34.7	0.00	5.0	34.0	30.9	-	UP	3.1	29.0
06/21/2023 - 06/22/2023	06/22/2023 - 06/23/2023	6/22/2023	6/23/2023	TRUE	Off Season	Wet	34.5	0.00	5.0	35.0	31.3	-	UP	3.7	30.0
06/22/2023 - 06/23/2023	06/23/2023 - 06/24/2023	6/23/2023	6/24/2023	TRUE	Off Season	Wet	24.0	0.00	5.0	20.0	18.5	-	UP	1.5	15.0
06/23/2023 - 06/24/2023	06/24/2023 - 06/25/2023	6/24/2023	6/25/2023	TRUE	Off Season	Wet	24.2	0.00	5.0	15.0	14.1	-	UP	0.9	10.0
06/24/2023 - 06/25/2023	06/25/2023 - 06/26/2023	6/25/2023	6/26/2023	TRUE	Off Season	Wet	19.7	0.00	5.0	12.0	11.0	-	UP	1.0	7.0
06/25/2023 - 06/26/2023	06/26/2023 - 06/27/2023	6/26/2023	6/27/2023	TRUE	Off Season	Wet	19.3	0.00	5.0	16.0	15.9	-	UP	0.1	11.0
06/26/2023 - 06/27/2023	06/27/2023 - 06/28/2023	6/27/2023	6/28/2023	TRUE	Off Season	Wet	28.9	0.00	5.0	18.0	17.4	-	UP	0.6	13.0
06/27/2023 - 06/28/2023	06/28/2023 - 06/29/2023	6/28/2023	6/29/2023	TRUE	Off Season	Wet	32.0	0.00	5.0	19.0	18.7	-	UP	0.3	14.0
06/28/2023 - 06/29/2023	06/29/2023 - 06/30/2023	6/29/2023	6/30/2023	TRUE	Off Season	Wet	33.6	0.00	5.0	21.0	19.9	-	UP	1.1	16.0
06/29/2023 - 06/30/2023	06/30/2023 - 07/01/2023	6/30/2023	7/1/2023	TRUE	Off Season	Wet	34.2	0.00	5.0	21.0	20.3	-	UP	0.7	16.0
06/30/2023 - 07/01/2023	07/01/2023 - 07/02/2023	7/1/2023	7/2/2023	TRUE	Off Season	Wet	31.8	0.00	5.0	20.0	19.5	-	UP	0.5	15.0
07/01/2023 - 07/02/2023	07/02/2023 - 07/03/2023	7/2/2023	7/3/2023	TRUE	Off Season	Wet	32.9	0.00	5.0	24.0	22.8	-	UP	1.2	19.0
07/02/2023 - 07/03/2023	07/03/2023 - 07/04/2023	7/3/2023	7/4/2023	TRUE	Off Season	Wet	31.3	0.00	5.0	23.0	21.6	-	UP	1.4	18.0
07/03/2023 - 07/04/2023	07/04/2023 - 07/05/2023	7/4/2023	7/5/2023	TRUE	Off Season	Wet	25.9	0.00	5.0	17.0	17.3	-	UP	(0.3)	12.0
07/04/2023 - 07/05/2023	07/05/2023 - 07/06/2023	7/5/2023	7/6/2023	TRUE	Off Season	Wet	17.4	0.00	5.0	16.0	15.5	-	UP	0.5	11.0
07/05/2023 - 07/06/2023	07/06/2023 - 07/07/2023	7/6/2023	7/7/2023	TRUE	Off Season	Wet	25.3	0.00	5.0	16.0	16.3	-	UP	(0.3)	11.0
07/06/2023 - 07/07/2023	07/07/2023 - 07/08/2023	7/7/2023	7/8/2023	TRUE	Off Season	Wet	28.7	0.00	5.0	17.0	17.2	-	UP	(0.2)	12.0

RD1 Bypass Compliance Report

Input Measuring Period (noon to noon)	Bypass Compliance Period (noon to noon)	Input Measuring Period End (at noon)	Bypass Compliance Period End (at noon)	Compliance Met (True/False)	Migration Season	Wet/Dry Season	Niles In-flow, CFS	SFPUC Required Bypass at RD1, CFS	Required Bypass Flow, CFS	Total Bypass Flow (fishway flow, auxiliary flow, overspill), CFS	Fishway Flow, CFS	Auxiliary Flow, CFS	Dam Up/Down	RD1 Dam Overspill, CFS	Excess Bypass, CFS
07/07/2023 - 07/08/2023	07/08/2023 - 07/09/2023	7/8/2023	7/9/2023	TRUE	Off Season	Wet	26.9	0.00	5.0	15.0	15.4	-	UP	(0.4)	10.0
07/08/2023 - 07/09/2023	07/09/2023 - 07/10/2023	7/9/2023	7/10/2023	TRUE	Off Season	Wet	22.1	0.00	5.0	13.0	12.9	-	UP	0.1	8.0
07/09/2023 - 07/10/2023	07/10/2023 - 07/11/2023	7/10/2023	7/11/2023	TRUE	Off Season	Wet	24.2	0.00	5.0	14.0	13.6	-	UP	0.4	9.0
07/10/2023 - 07/11/2023	07/11/2023 - 07/12/2023	7/11/2023	7/12/2023	TRUE	Off Season	Wet	26.4	0.00	5.0	14.0	14.3	-	UP	(0.3)	9.0
07/11/2023 - 07/12/2023	07/12/2023 - 07/13/2023	7/12/2023	7/13/2023	TRUE	Off Season	Wet	25.7	0.00	5.0	14.0	14.6	-	UP	(0.6)	9.0
07/12/2023 - 07/13/2023	07/13/2023 - 07/14/2023	7/13/2023	7/14/2023	TRUE	Off Season	Wet	25.8	0.00	5.0	15.0	14.5	-	UP	0.5	10.0
07/13/2023 - 07/14/2023	07/14/2023 - 07/15/2023	7/14/2023	7/15/2023	TRUE	Off Season	Wet	25.3	0.00	5.0	12.0	12.0	-	UP	(0.0)	7.0
07/14/2023 - 07/15/2023	07/15/2023 - 07/16/2023	7/15/2023	7/16/2023	TRUE	Off Season	Wet	25.6	0.00	5.0	14.0	14.3	-	UP	(0.3)	9.0
07/15/2023 - 07/16/2023	07/16/2023 - 07/17/2023	7/16/2023	7/17/2023	TRUE	Off Season	Wet	28.5	0.00	5.0	17.0	16.8	-	UP	0.2	12.0
07/16/2023 - 07/17/2023	07/17/2023 - 07/18/2023	7/17/2023	7/18/2023	TRUE	Off Season	Wet	27.7	0.00	5.0	13.0	13.8	-	UP	(0.8)	8.0
07/17/2023 - 07/18/2023	07/18/2023 - 07/19/2023	7/18/2023	7/19/2023	TRUE	Off Season	Wet	23.5	0.00	5.0	13.0	13.2	-	UP	(0.2)	8.0
07/18/2023 - 07/19/2023	07/19/2023 - 07/20/2023	7/19/2023	7/20/2023	TRUE	Off Season	Wet	22.9	0.00	5.0	12.0	12.3	-	UP	(0.3)	7.0
07/19/2023 - 07/20/2023	07/20/2023 - 07/21/2023	7/20/2023	7/21/2023	TRUE	Off Season	Wet	22.3	0.00	5.0	12.0	12.0	-	UP	0.0	7.0
07/20/2023 - 07/21/2023	07/21/2023 - 07/22/2023	7/21/2023	7/22/2023	TRUE	Off Season	Wet	22.8	0.00	5.0	11.0	11.2	-	UP	(0.2)	6.0
07/21/2023 - 07/22/2023	07/22/2023 - 07/23/2023	7/22/2023	7/23/2023	TRUE	Off Season	Wet	17.5	0.00	5.0	7.0	7.7	-	UP	(0.7)	2.0
07/22/2023 - 07/23/2023	07/23/2023 - 07/24/2023	7/23/2023	7/24/2023	FALSE	Off Season	Wet	13.7	0.00	5.0	4.0	5.6	-	UP	(1.6)	-
07/23/2023 - 07/24/2023	07/24/2023 - 07/25/2023	7/24/2023	7/25/2023	TRUE	Off Season	Wet	13.5	0.00	5.0	5.0	6.2	-	UP	(1.2)	-
07/24/2023 - 07/25/2023	07/25/2023 - 07/26/2023	7/25/2023	7/26/2023	TRUE	Off Season	Wet	19.2	0.00	5.0	7.0	8.1	-	UP	(1.1)	2.0
07/25/2023 - 07/26/2023	07/26/2023 - 07/27/2023	7/26/2023	7/27/2023	TRUE	Off Season	Wet	20.7	0.00	5.0	9.0	9.2	-	UP	(0.2)	4.0
07/26/2023 - 07/27/2023	07/27/2023 - 07/28/2023	7/27/2023	7/28/2023	TRUE	Off Season	Wet	21.7	0.00	5.0	10.0	10.2	-	UP	(0.2)	5.0
07/27/2023 - 07/28/2023	07/28/2023 - 07/29/2023	7/28/2023	7/29/2023	TRUE	Off Season	Wet	22.9	0.00	5.0	10.0	10.7	-	UP	(0.7)	5.0
07/28/2023 - 07/29/2023	07/29/2023 - 07/30/2023	7/29/2023	7/30/2023	TRUE	Off Season	Wet	21.9	0.00	5.0	11.0	11.6	-	UP	(0.6)	6.0
07/29/2023 - 07/30/2023	07/30/2023 - 07/31/2023	7/30/2023	7/31/2023	TRUE	Off Season	Wet	24.0	0.00	5.0	6.0	7.0	-	UP	(1.0)	1.0
07/30/2023 - 07/31/2023	07/31/2023 - 08/01/2023	7/31/2023	8/1/2023	FALSE	Off Season	Wet	13.1	0.00	5.0	3.0	5.2	-	UP	(2.2)	-
07/31/2023 - 08/01/2023	08/01/2023 - 08/02/2023	8/1/2023	8/2/2023	TRUE	Off Season	Wet	15.1	0.00	5.0	8.0	8.8	-	UP	(0.8)	3.0
08/01/2023 - 08/02/2023	08/02/2023 - 08/03/2023	8/2/2023	8/3/2023	TRUE	Off Season	Wet	22.5	0.00	5.0	5.0	6.8	-	UP	(1.8)	-
08/02/2023 - 08/03/2023	08/03/2023 - 08/04/2023	8/3/2023	8/4/2023	TRUE	Off Season	Wet	30.7	0.00	5.0	8.0	9.2	-	UP	(1.2)	3.0
08/03/2023 - 08/04/2023	08/04/2023 - 08/05/2023	8/4/2023	8/5/2023	TRUE	Off Season	Wet	34.2	0.00	5.0	11.0	12.0	-	UP	(1.0)	6.0
08/04/2023 - 08/05/2023	08/05/2023 - 08/06/2023	8/5/2023	8/6/2023	TRUE	Off Season	Wet	34.5	0.00	5.0	14.0	14.2	-	UP	(0.2)	9.0
08/05/2023 - 08/06/2023	08/06/2023 - 08/07/2023	8/6/2023	8/7/2023	TRUE	Off Season	Wet	38.3	0.00	5.0	16.0	16.5	-	UP	(0.5)	11.0
08/06/2023 - 08/07/2023	08/07/2023 - 08/08/2023	8/7/2023	8/8/2023	TRUE	Off Season	Wet	36.8	0.00	5.0	15.0	15.7	-	UP	(0.7)	10.0
08/07/2023 - 08/08/2023	08/08/2023 - 08/09/2023	8/8/2023	8/9/2023	TRUE	Off Season	Wet	36.1	0.00	5.0	16.0	16.3	-	UP	(0.3)	11.0
08/08/2023 - 08/09/2023	08/09/2023 - 08/10/2023	8/9/2023	8/10/2023	TRUE	Off Season	Wet	38.0	0.00	5.0	16.0	16.5	-	UP	(0.5)	11.0
08/09/2023 - 08/10/2023	08/10/2023 - 08/11/2023	8/10/2023	8/11/2023	TRUE	Off Season	Wet	36.9	0.00	5.0	16.0	16.1	-	UP	(0.1)	11.0
08/10/2023 - 08/11/2023	08/11/2023 - 08/12/2023	8/11/2023	8/12/2023	TRUE	Off Season	Wet	36.4	0.00	5.0	15.0	17.2	-	UP	(2.2)	10.0
08/11/2023 - 08/12/2023	08/12/2023 - 08/13/2023	8/12/2023	8/13/2023	TRUE	Off Season	Wet	30.4	0.00	5.0	5.0	7.0	-	UP	(2.0)	-
08/12/2023 - 08/13/2023	08/13/2023 - 08/14/2023	8/13/2023	8/14/2023	TRUE	Off Season	Wet	25.3	0.00	5.0	5.0	7.3	-	UP	(2.3)	-
08/13/2023 - 08/14/2023	08/14/2023 - 08/15/2023	8/14/2023	8/15/2023	TRUE	Off Season	Wet	31.1	0.00	5.0	12.0	13.2	-	UP	(1.2)	7.0
08/14/2023 - 08/15/2023	08/15/2023 - 08/16/2023	8/15/2023	8/16/2023	TRUE	Off Season	Wet	36.5	0.00	5.0	13.0	13.1	-	UP	(0.1)	8.0
08/15/2023 - 08/16/2023	08/16/2023 - 08/17/2023	8/16/2023	8/17/2023	TRUE	Off Season	Wet	35.7	0.00	5.0	11.0	11.4	-	UP	(0.4)	6.0
08/16/2023 - 08/17/2023	08/17/2023 - 08/18/2023	8/17/2023	8/18/2023	TRUE	Off Season	Wet	34.7	0.00	5.0	12.0	13.0	-	UP	(1.0)	7.0
08/17/2023 - 08/18/2023	08/18/2023 - 08/19/2023	8/18/2023	8/19/2023	TRUE	Off Season	Wet	34.7	0.00	5.0	14.0	15.8	-	UP	(1.8)	9.0
08/18/2023 - 08/19/2023	08/19/2023 - 08/20/2023	8/19/2023	8/20/2023	TRUE	Off Season	Wet	27.8	0.00	5.0	5.0	6.6	-	UP	(1.6)	-
08/19/2023 - 08/20/2023	08/20/2023 - 08/21/2023	8/20/2023	8/21/2023	TRUE	Off Season	Wet	15.2	0.00	5.0	8.0	9.7	-	UP	(1.7)	3.0
08/20/2023 - 08/21/2023	08/21/2023 - 08/22/2023	8/21/2023	8/22/2023	TRUE	Off Season	Wet	19.5	0.00	5.0	10.0	12.0	-	UP	(2.0)	5.0
08/21/2023 - 08/22/2023	08/22/2023 - 08/23/2023	8/22/2023	8/23/2023	TRUE	Off Season	Wet	27.4	0.00	5.0	13.0	14.9	-	UP	(1.9)	8.0
08/22/2023 - 08/23/2023	08/23/2023 - 08/24/2023	8/23/2023	8/24/2023	TRUE	Off Season	Wet	28.4	0.00	5.0	16.0	16.7	-	UP	(0.7)	11.0
08/23/2023 - 08/24/2023	08/24/2023 - 08/25/2023	8/24/2023	8/25/2023	TRUE	Off Season	Wet	33.5	0.00	5.0	13.0	14.0	-	UP	(1.0)	8.0
08/24/2023 - 08/25/2023	08/25/2023 - 08/26/2023	8/25/2023	8/26/2023	TRUE	Off Season	Wet	30.5	0.00	5.0	5.0	6.7	-	UP	(1.7)	-
08/25/2023 - 08/26/2023	08/26/2023 - 08/27/2023	8/26/2023	8/27/2023	TRUE	Off Season	Wet	29.7	0.00	5.0	5.0	6.1	-	UP	(1.1)	-
08/26/2023 - 08/27/2023	08/27/2023 - 08/28/2023	8/27/2023	8/28/2023	TRUE	Off Season	Wet	30.5	0.00	5.0	6.0	6.8	-	UP	(0.8)	1.0
08/27/2023 - 08/28/2023	08/28/2023 - 08/29/2023	8/28/2023	8/29/2023	TRUE	Off Season	Wet	35.7	0.00	5.0	10.0	11.8	-	UP	(1.8)	5.0
08/28/2023 - 08/29/2023	08/29/2023 - 08/30/2023	8/29/2023	8/30/2023	TRUE	Off Season	Wet	39.4	0.00	5.0	15.0	15.5	-	UP	(0.5)	10.0
08/29/2023 - 08/30/2023	08/30/2023 - 08/31/2023	8/30/2023	8/31/2023	TRUE	Off Season	Wet	31.2	0.00	5.0	18.0	18.0	-	UP	0.0	13.0
08/30/2023 - 08/31/2023	08/31/2023 - 09/01/2023	8/31/2023	9/1/2023	TRUE	Off Season	Wet	28.7	0.00	5.0	18.0	17.5	-	UP	0.5	13.0
08/31/2023 - 09/01/2023	09/01/2023 - 09/02/2023	9/1/2023	9/2/2023	TRUE	Off Season	Wet	27.9	0.00	5.0	17.0	16.6	-	UP	0.4	12.0

APPENDIX B
2022-2023 Fisheries Operations Log

Operations Maintenance Log
Alameda Creek Fish Passage Program
2022-2023

Noon to Noon Period End Date	RD1 Up/Down	RD3 Up/Down	Diversion Occuring	Average Daily Diversion Flow (CFS)	RD1 Migration Setpoint	Active Gates	Events	Event Details
9/1/2023	Up	Down	Not Diverting	0.0	Off Season	Low Flow Splwy		
8/31/2023	Up	Down	Not Diverting	0.0	Off Season	Low Flow Splwy		
8/30/2023	Up	Down	Not Diverting	0.0	Off Season	Low Flow Splwy		
8/29/2023	Up	Down	Diverting	8.6	Off Season	Low Flow Splwy		
8/28/2023	Up	Down	Diverting	14.7	Off Season	Low Flow Splwy		
8/27/2023	Up	Down	Diverting	14.3	Off Season	Low Flow Splwy		
8/26/2023	Up	Down	Diverting	14.4	Off Season	Low Flow Splwy		
8/25/2023	Up	Down	Diverting	14.3	Off Season	Low Flow Splwy		
8/24/2023	Up	Down	Diverting	10.3	Off Season	Low Flow Splwy		
8/23/2023	Up	Down	Not Diverting	0.0	Off Season	Low Flow Splwy		
8/22/2023	Up	Down	Not Diverting	0.0	Off Season	Low Flow Splwy		
8/21/2023	Up	Down	Not Diverting	0.0	Off Season	Low Flow Splwy		
8/20/2023	Up	Down	Not Diverting	0.0	Off Season	Low Flow Splwy		
8/19/2023	Up	Down	Diverting	4.8	Off Season	Low Flow Splwy		
8/18/2023	Up	Down	Diverting	10.0	Off Season	Low Flow Splwy		
8/17/2023	Up	Down	Diverting	10.0	Off Season	Low Flow Splwy		
8/16/2023	Up	Down	Diverting	10.0	Off Season	Low Flow Splwy		
8/15/2023	Up	Down	Diverting	10.0	Off Season	Low Flow Splwy		
8/14/2023	Up	Down	Diverting	10.0	Off Season	Low Flow Splwy		
8/13/2023	Up	Down	Diverting	10.0	Off Season	Low Flow Splwy		
8/12/2023	Up	Down	Diverting	10.0	Off Season	Low Flow Splwy		
8/11/2023	Up	Down	Diverting	10.0	Off Season	Low Flow Splwy		
8/10/2023	Up	Down	Diverting	10.0	IN Migration	Low Flow Splwy		
8/9/2023	Up	Down	Diverting	10.0	Off Season	Low Flow Splwy		
8/8/2023	Up	Down	Diverting	10.0	Off Season	Low Flow Splwy		
8/7/2023	Up	Down	Diverting	10.0	Off Season	Low Flow Splwy		
8/6/2023	Up	Down	Diverting	10.0	Off Season	Low Flow Splwy		
8/5/2023	Up	Down	Diverting	10.0	Off Season	Low Flow Splwy		
8/4/2023	Up	Down	Diverting	10.0	Off Season	Low Flow Splwy		
8/3/2023	Up	Down	Diverting	10.0	Off Season	Low Flow Splwy		
8/2/2023	Up	Down	Diverting	6.1	Off Season	Low Flow Splwy		
8/1/2023	Up	Down	Not Diverting	0.0	Off Season	Low Flow Splwy		
7/31/2023	Up	Down	Not Diverting	0.0	Off Season	Low Flow Splwy		
7/30/2023	Up	Down	Not Diverting	0.0	Off Season	Low Flow Splwy		
7/29/2023	Up	Down	Not Diverting	0.0	Off Season	Low Flow Splwy		
7/28/2023	Up	Down	Not Diverting	0.0	Off Season	Low Flow Splwy		
7/27/2023	Up	Down	Not Diverting	0.0	Off Season	Low Flow Splwy		
7/26/2023	Up	Down	Not Diverting	0.0	Off Season	Low Flow Splwy		
7/25/2023	Up	Down	Not Diverting	0.0	Off Season	Low Flow Splwy		
7/24/2023	Up	Down	Not Diverting	0.0	Off Season	Low Flow Splwy		
7/23/2023	Up	Down	Not Diverting	0.0	Off Season	Low Flow Splwy		
7/22/2023	Up	Down	Not Diverting	0.0	Off Season	Low Flow Splwy		
7/21/2023	Up	Down	Diverting	0.2	Off Season	Low Flow Splwy		
7/20/2023	Up	Down	Not Diverting	0.0	Off Season	Low Flow Splwy		
7/19/2023	Up	Down	Not Diverting	0.0	Off Season	Low Flow Splwy		

Operations Maintenance Log
Alameda Creek Fish Passage Program
2022-2023

Noon to Noon Period End Date	RD1 Up/Down	RD3 Up/Down	Diversion Occuring	Average Daily Diversion Flow (CFS)	RD1 Migration Setpoint	Active Gates	Events	Event Details
7/18/2023	Up	Down	Not Diverting	0.0	Off Season	Low Flow Splwy		
7/17/2023	Up	Down	Not Diverting	0.0	Off Season	5, Low Flow Splwy		
7/16/2023	Up	Down	Not Diverting	0.0	Off Season	5		
7/15/2023	Up	Down	Not Diverting	0.0	Off Season	5		
7/14/2023	Up	Down	Not Diverting	0.0	Off Season	5, Low Flow Splwy		
7/13/2023	Up	Down	Not Diverting	0.0	Off Season	5		
7/12/2023	Up	Down	Not Diverting	0.0	Off Season	5		
7/11/2023	Up	Down	Not Diverting	0.0	Off Season	5		
7/10/2023	Up	Down	Not Diverting	0.0	Off Season	5		
7/9/2023	Up	Down	Not Diverting	0.0	Off Season	5		
7/8/2023	Up	Down	Not Diverting	0.0	Off Season	5		
7/7/2023	Up	Down	Not Diverting	0.0	Off Season	5		
7/6/2023	Up	Down	Not Diverting	0.0	Off Season	5		
7/5/2023	Up	Down	Not Diverting	0.0	Off Season	5		
7/4/2023	Up	Down	Not Diverting	0.0	Off Season	5		
7/3/2023	Up	Down	Not Diverting	0.0	Off Season	5		
7/2/2023	Up	Down	Not Diverting	0.0	Off Season	5		
7/1/2023	Up	Down	Not Diverting	0.0	Off Season	5		
6/30/2023	Up	Down	Not Diverting	0.0	Off Season	4, 5		
6/29/2023	Up	Down	Not Diverting	0.0	Off Season	4		
6/28/2023	Up	Down	Not Diverting	0.0	Off Season	4		
6/27/2023	Up	Down	Not Diverting	0.0	Off Season	4		
6/26/2023	Up	Down	Not Diverting	0.0	Off Season	4, 5		
6/25/2023	Up	Down	Not Diverting	0.0	Off Season	5		
6/24/2023	Up	Down	Not Diverting	0.0	Off Season	5		
6/23/2023	Up	Down	Not Diverting	0.0	Off Season	3, 4, 5		
6/22/2023	Up	Down	Not Diverting	0.0	Off Season	4, 5		
6/21/2023	Up	Down	Not Diverting	0.0	Off Season	5, Low Flow Splwy		
6/20/2023	Up	Down	Not Diverting	0.0	Off Season	5, Low Flow Splwy		
6/19/2023	Up	Down	Not Diverting	0.0	Off Season	5		
6/18/2023	Up	Down	Not Diverting	0.0	Off Season	5, Low Flow Splwy		
6/17/2023	Up	Down	Not Diverting	0.0	Off Season	5, Low Flow Splwy		
6/16/2023	Up	Down	Not Diverting	0.0	Off Season	5, Low Flow Splwy		
6/15/2023	Up	Down	Not Diverting	0.0	Off Season	5, Low Flow Splwy		
6/14/2023	Up	Down	Not Diverting	0.0	Off Season	5, Low Flow Splwy		
6/13/2023	Up	Down	Not Diverting	0.0	Off Season	3, 4, 5		
6/12/2023	Up	Down	Not Diverting	0.0	Off Season	4, Low Flow Splwy		
6/11/2023	Up	Down	Not Diverting	0.0	Off Season	Low Flow Splwy		
6/10/2023	Up	Down	Not Diverting	0.0	Off Season	3, 4, Low Flow Splwy		
6/9/2023	Up	Down	Not Diverting	0.0	Off Season	4, Juvenile Splwy		
6/8/2023	Up	Down	Not Diverting	0.0	Off Season	4, 5		
6/7/2023	Up	Down	Not Diverting	0.0	Off Season	5, Low Flow Splwy		
6/6/2023	Up	Down	Not Diverting	0.0	Off Season	4, Low Flow Splwy		
6/5/2023	Up	Down	Not Diverting	0.0	Off Season	4, 5		
6/4/2023	Up	Down	Not Diverting	0.0	Off Season	5		
6/3/2023	Up	Down	Not Diverting	0.0	Off Season	3, 4, 5		
6/2/2023	Up	Down	Not Diverting	0.0	Off Season	3, 4, Juvenile Splwy		
6/1/2023	Up	Down	Not Diverting	0.0	Off Season	4, 5, Low Flow Splwy, Juvenile Splwy		
5/31/2023	Up	Down	Diverting	8.6	Off Season	5, Low Flow Splwy		
5/30/2023	Up	Down	Diverting	13.3	Off Season	Low Flow Splwy		
5/29/2023	Up	Down	Diverting	11.8	Off Season	Low Flow Splwy		

Operations Maintenance Log
Alameda Creek Fish Passage Program
2022-2023

Noon to Noon Period End Date	RD1 Up/Down	RD3 Up/Down	Diversion Occuring	Average Daily Diversion Flow (CFS)	RD1 Migration Setpoint	Active Gates	Events	Event Details
5/28/2023	Up	Down	Diverting	16.5	Off Season	Low Flow Splwy		
5/27/2023	Up	Down	Diverting	26.1	Off Season	Low Flow Splwy		
5/26/2023	Up	Down	Diverting	31.7	Off Season	Low Flow Splwy		
5/25/2023	Up	Down	Diverting	36.2	Off Season	Low Flow Splwy		
5/24/2023	Up	Down	Diverting	35.1	Off Season	Low Flow Splwy		
5/23/2023	Up	Down	Diverting	29.4	Off Season	5, Low Flow Splwy		
5/22/2023	Up	Down	Diverting	30.1	Off Season	4, 5		
5/21/2023	Up	Down	Diverting	25.7	Off Season	3, 4		
5/20/2023	Up	Down	Diverting	19.0	Off Season	3		
5/19/2023	Up	Down	Diverting	19.0	Off Season	3		
5/18/2023	Up	Down	Diverting	30.3	Off Season	3		
5/17/2023	Up	Down	Diverting	35.9	Off Season	3, 4		
5/16/2023	Up	Down	Diverting	31.0	Off Season	4		
5/15/2023	Up	Down	Diverting	25.8	Off Season	4		
5/14/2023	Up	Down	Diverting	20.0	Off Season	4		
5/13/2023	Up	Down	Diverting	33.6	Off Season	4, Juvenile Splwy		
5/12/2023	Up	Down	Diverting	44.7	Off Season	4		
5/11/2023	Up	Down	Diverting	49.3	Off Season	4, 5		
5/10/2023	Up	Down	Diverting	52.4	Off Season	5		
5/9/2023	Up	Down	Diverting	54.7	Off Season	5		
5/8/2023	Up	Down	Diverting	51.3	Off Season	5		
5/7/2023	Up	Down	Diverting	53.8	Off Season	5		
5/6/2023	Up	Down	Diverting	56.2	Off Season	5		
5/5/2023	Up	Down	Diverting	62.9	Off Season	5		
5/4/2023	Up	Down	Diverting	96.8	Off Season	5		
5/3/2023	Up	Down	Diverting	107.6	Off Season	5		
5/2/2023	Up	Down	Diverting	47.1	Off Season	3, 4, 5		
5/1/2023	Up	Down	Diverting	30.1	Off Season	3		
4/30/2023	Up	Down	Diverting	47.4	Off Season	3		
4/29/2023	Up	Down	Diverting	54.4	Off Season	3, 4, 5		
4/28/2023	Up	Down	Diverting	59.6	Off Season	5		
4/27/2023	Up	Down	Diverting	29.6	Off Season	3, 4, 5		
4/26/2023	Up	Down	Diverting	72.8	Off Season	3, 4, 5, Juvenile Splwy		
4/25/2023	Up	Down	Diverting	45.1	Off Season	4, Juvenile Splwy		
4/24/2023	Up	Down	Diverting	39.0	Off Season	4, Juvenile Splwy		
4/23/2023	Up	Down	Diverting	28.3	Off Season	4, Juvenile Splwy		
4/22/2023	Up	Down	Diverting	26.5	Off Season	4, Juvenile Splwy		
4/21/2023	Up	Down	Diverting	23.5	Off Season	4, Juvenile Splwy		
4/20/2023	Up	Down	Diverting	16.7	Off Season	4, 5, Juvenile Splwy		
4/19/2023	Up	Down	Diverting	17.2	Off Season	4, Juvenile Splwy		
4/18/2023	Up	Down	Diverting	19.1	Off Season	4, Juvenile Splwy		
4/17/2023	Up	Down	Diverting	13.7	Off Season	4, Juvenile Splwy		
4/16/2023	Up	Down	Diverting	12.0	Off Season	4, Juvenile Splwy		
4/15/2023	Up	Down	Diverting	12.4	Off Season	4, Juvenile Splwy		
4/14/2023	Up	Down	Diverting	13.0	Off Season	4, Juvenile Splwy		
4/13/2023	Up	Down	Diverting	13.0	Off Season	4, Juvenile Splwy		
4/12/2023	Up	Down	Diverting	13.2	Off Season	4, Juvenile Splwy		
4/11/2023	Up	Down	Diverting	13.8	Off Season	4, Juvenile Splwy		
4/10/2023	Up	Down	Diverting	14.0	Off Season	4, Juvenile Splwy		
4/9/2023	Up	Down	Diverting	15.3	Off Season	4, Juvenile Splwy		
4/8/2023	Up	Down	Diverting	17.6	Off Season	4, Juvenile Splwy		
4/7/2023	Up	Down	Diverting	21.4	IN Migration	4, 5, Juvenile Splwy		
4/6/2023	Up	Down	Diverting	26.1	IN Migration	5		

Operations Maintenance Log
Alameda Creek Fish Passage Program
2022-2023

Noon to Noon Period End Date	RD1 Up/Down	RD3 Up/Down	Diversion Occuring	Average Daily Diversion Flow (CFS)	RD1 Migration Setpoint	Active Gates	Events	Event Details
4/5/2023	Up	Down	Diverting	29.0	IN Migration	5		
4/4/2023	Up	Down	Diverting	29.0	IN Migration	5		
4/3/2023	Up	Down	Diverting	16.1	IN Migration	5		
4/2/2023	Up	Down	Not Diverting	0.0	IN Migration	5		
4/1/2023	Down	Down	Not Diverting	0.0	IN Migration	1, 3, 5		
3/31/2023	Down	Down	Not Diverting	0.0	IN Migration	1		
3/30/2023	Down	Down	Not Diverting	0.0	IN Migration	1		
3/29/2023	Down	Down	Not Diverting	0.0	IN Migration	1, 2		
3/28/2023	Down	Down	Not Diverting	0.0	IN Migration	1		
3/27/2023	Down	Down	Not Diverting	0.0	IN Migration	1		
3/26/2023	Down	Down	Not Diverting	0.0	IN Migration	1		
3/25/2023	Down	Down	Not Diverting	0.0	IN Migration	1		
3/24/2023	Down	Down	Not Diverting	0.0	IN Migration			
3/23/2023	Down	Down	Not Diverting	0.0	IN Migration			
3/22/2023	Down	Down	Not Diverting	0.0	IN Migration			
3/21/2023	Down	Down	Not Diverting	0.0	IN Migration	1		
3/20/2023	Down	Down	Not Diverting	0.0	IN Migration	1		
3/19/2023	Down	Down	Not Diverting	0.0	IN Migration	1		
3/18/2023	Down	Down	Not Diverting	0.0	IN Migration	1, 2		
3/17/2023	Down	Down	Not Diverting	0.0	IN Migration	2		
3/16/2023	Down	Down	Not Diverting	0.0	IN Migration			
3/15/2023	Down	Down	Not Diverting	0.0	IN Migration			
3/14/2023	Down	Down	Not Diverting	0.0	IN Migration			
3/13/2023	Down	Down	Not Diverting	0.0	IN Migration			
3/12/2023	Down	Down	Not Diverting	0.0	IN Migration			
3/11/2023	Down	Down	Not Diverting	0.0	IN Migration			
3/10/2023	Down	Down	Not Diverting	0.0	IN Migration			
3/9/2023	Down	Down	Not Diverting	0.0	IN Migration			
3/8/2023	Down	Down	Not Diverting	0.0	IN Migration	1		
3/7/2023	Down	Down	Not Diverting	0.0	IN Migration	1		
3/6/2023	Down	Down	Not Diverting	0.0	IN Migration	1		
3/5/2023	Down	Down	Not Diverting	0.0	IN Migration	1		
3/4/2023	Down	Down	Not Diverting	0.0	IN Migration	1		
3/3/2023	Down	Down	Not Diverting	0.0	IN Migration	1		
3/2/2023	Down	Down	Not Diverting	0.0	IN Migration	1		
3/1/2023	Down	Down	Not Diverting	0.0	IN Migration	1, 2		
2/28/2023	Down	Down	Not Diverting	0.0	IN Migration	1, 2		
2/27/2023	Up	Down	Not Diverting	0.0	IN Migration	1, 4		
2/26/2023	Up	Down	Not Diverting	0.0	IN Migration	3, 4		
2/25/2023	Down	Down	Not Diverting	0.0	IN Migration	1, 2, 3		
2/24/2023	Up	Down	Diverting	4.5	IN Migration	1, 5		
2/23/2023	Up	Down	Diverting	15.8	IN Migration	5		
2/22/2023	Up	Down	Diverting	15.4	IN Migration	5		
2/21/2023	Up	Down	Diverting	15.5	IN Migration	5		
2/20/2023	Up	Down	Diverting	16.3	IN Migration	5		
2/19/2023	Up	Down	Diverting	17.3	IN Migration	5		
2/18/2023	Up	Down	Diverting	18.1	IN Migration	5		
2/17/2023	Up	Down	Diverting	18.8	IN Migration	5		
2/16/2023	Up	Down	Diverting	19.0	IN Migration	5		
2/15/2023	Up	Down	Diverting	19.8	IN Migration	5		
2/14/2023	Up	Down	Diverting	19.8	IN Migration	5		
2/13/2023	Up	Down	Diverting	20.2	IN Migration	5		
2/12/2023	Up	Down	Diverting	20.8	IN Migration	5		

Noon to Noon Period End Date	RD1 Up/Down	RD3 Up/Down	Diversion Occuring	Average Daily Diversion Flow (CFS)	RD1 Migration Setpoint	Active Gates	Events	Event Details
2/11/2023	Up	Down	Diverting	21.3	IN Migration	5		
2/10/2023	Up	Down	Diverting	22.0	IN Migration	5		
2/9/2023	Up	Down	Diverting	55.6	IN Migration	5		
2/8/2023	Up	Down	Diverting	78.5	IN Migration	5		
2/7/2023	Up	Down	Diverting	75.1	IN Migration	5		
2/6/2023	Up	Down	Diverting	111.0	IN Migration	5		
2/5/2023	Up	Down	Diverting	146.3	IN Migration	5		
2/4/2023	Up	Down	Diverting	214.7	IN Migration	5		
2/3/2023	Up	Down	Diverting	221.7	IN Migration	5		
2/2/2023	Up	Down	Diverting	221.0	IN Migration	5		
2/1/2023	Up	Down	Diverting	221.1	IN Migration	5		
1/31/2023	Up	Down	Diverting	221.3	IN Migration	5		
1/30/2023	Up	Down	Diverting	222.0	IN Migration	5		
1/29/2023	Up	Down	Diverting	222.0	IN Migration	5		
1/28/2023	Up	Down	Diverting	222.1	IN Migration	5		
1/27/2023	Up	Down	Diverting	222.1	IN Migration	5		
1/26/2023	Up	Down	Diverting	222.6	IN Migration	5		
1/25/2023	Up	Down	Diverting	222.1	IN Migration	5		
1/24/2023	Up	Down	Diverting	222.4	IN Migration	5		
1/23/2023	Down	Down	Diverting	175.2	IN Migration	3, 5		
1/22/2023	Down	Down	Not Diverting	0.0	IN Migration			
1/21/2023	Down	Down	Not Diverting	0.0	IN Migration			
1/20/2023	Down	Down	Not Diverting	0.0	IN Migration			
1/19/2023	Down	Down	Not Diverting	0.0	IN Migration			
1/18/2023	Down	Down	Not Diverting	0.0	IN Migration			
1/17/2023	Down	Down	Not Diverting	0.0	IN Migration			
1/16/2023	Down	Down	Not Diverting	0.0	IN Migration			
1/15/2023	Down	Down	Not Diverting	0.0	IN Migration			
1/14/2023	Down	Down	Not Diverting	0.0	IN Migration			
1/13/2023	Down	Down	Not Diverting	0.0	IN Migration			
1/12/2023	Down	Down	Not Diverting	0.0	IN Migration			
1/11/2023	Down	Down	Not Diverting	0.0	IN Migration			
1/10/2023	Down	Down	Not Diverting	0.0	IN Migration			
1/9/2023	Down	Down	Not Diverting	0.0	IN Migration			
1/8/2023	Down	Down	Diverting	40.5	IN Migration	1, 2, 4, 5		
1/7/2023	Down	Down	Not Diverting	0.0	IN Migration			
1/6/2023	Down	Down	Not Diverting	0.0	IN Migration			
1/5/2023	Down	Down	Not Diverting	0.0	IN Migration			
1/4/2023	Down	Down	Not Diverting	0.0	IN Migration			
1/3/2023	Down	Down	Not Diverting	0.0	IN Migration			
1/2/2023	Down	Down	Not Diverting	0.0	IN Migration			
1/1/2023	Down	Down	Not Diverting	0.0	IN Migration			
12/31/2022	Down	Down	Not Diverting	0.0	IN Migration			
12/30/2022	Up	Up	Diverting	218.5	IN Migration	3, 4, 5		
12/29/2022	Up	Up	Diverting	147.2	IN Migration	2, 3		
12/28/2022	Both	Both	Diverting	99.4	IN Migration	2, 3	Inflated RD1 and RD3 the morning of 12/28/22	
12/27/2022	Both	Both	Diverting	5.6	IN Migration	2	Deflated RD1 and RD3 in the afternoon	
12/26/2022	Up	Up	Diverting	77.4	IN Migration	2, 3, 4, 5, Low Flow Splwy		
12/25/2022	Up	Up	Diverting	13.0	Off Season			
12/24/2022	Up	Up	Diverting	11.8	Off Season			

Operations Maintenance Log
Alameda Creek Fish Passage Program
2022-2023

Noon to Noon Period End Date	RD1 Up/Down	RD3 Up/Down	Diversion Occuring	Average Daily Diversion Flow (CFS)	RD1 Migration Setpoint	Active Gates	Events	Event Details
12/23/2022	Up	Up	Diverting	14.3	Off Season			
12/22/2022	Up	Up	Diverting	7.2	Off Season			
12/21/2022	Up	Up	Diverting	7.5	Off Season	2		
12/20/2022	Up	Up	Diverting	7.7	Off Season	1, 2		
12/19/2022	Up	Up	Diverting	7.2	Off Season			
12/18/2022	Up	Up	Diverting	12.6	Off Season			
12/17/2022	Up	Up	Diverting	15.8	Off Season			
12/16/2022	Down	Up	Diverting	9.4	Off Season			
12/15/2022	Both	Up	Diverting	24.7	Off Season	4		
12/14/2022	Up	Up	Diverting	39.1	Off Season			
12/13/2022	Up	Up	Diverting	129.9	Off Season			
12/12/2022	Up	Up	Diverting	321.1	IN Migration	4, 5, Juvenile Splwy		
12/11/2022	Down	Down	Diverting	213.0	Off Season			
12/10/2022	Up	Down	Diverting	13.9	Off Season			
12/9/2022	Up	Up	Diverting	37.9	IN Migration	3, 4		
12/8/2022	Up	Up	Diverting	4.1	Off Season			
12/7/2022	Up	Up	Diverting	11.0	Off Season			
12/6/2022	Up	Up	Diverting	15.6	Off Season			
12/5/2022	Up	Up	Diverting	68.7	Off Season			
12/4/2022	Up	Up	Diverting	268.6	Off Season			
12/3/2022	Up	Up	Diverting	63.9	Off Season			
12/2/2022	Up	Up	Diverting	11.6	Off Season	2, 3		
12/1/2022	Up	Up	Diverting	64.0	Off Season			
11/30/2022	Up	Up	Diverting	41.1	Off Season	2, 3		
11/29/2022	Up	Up	Diverting	14.7	Off Season			
11/28/2022	Up	Up	Not Diverting	0.0	Off Season			
11/27/2022	Up	Up	Not Diverting	0.0	Off Season			
11/26/2022	Up	Up	Not Diverting	0.0	Off Season			
11/25/2022	Up	Up	Not Diverting	0.0	Off Season			
11/24/2022	Up	Up	Not Diverting	0.0	Off Season			
11/23/2022	Up	Up	Not Diverting	0.0	Off Season			
11/22/2022	Up	Up	Not Diverting	0.0	Off Season			
11/21/2022	Up	Up	Not Diverting	0.0	Off Season			
11/20/2022	Up	Up	Not Diverting	0.0	Off Season			
11/19/2022	Up	Up	Not Diverting	0.0	Off Season			
11/18/2022	Up	Up	Not Diverting	0.0	Off Season			
11/17/2022	Up	Up	Not Diverting	0.0	Off Season			
11/16/2022	Up	Up	Not Diverting	0.0	Off Season			
11/15/2022	Up	Up	Not Diverting	0.0	Off Season			
11/14/2022	Down	Up	Diverting	3.1	Off Season			
11/13/2022	Down	Up	Diverting	8.4	Off Season			
11/12/2022	Down	Up	Diverting	19.6	Off Season			
11/11/2022	Down	Up	Diverting	27.2	Off Season			
11/10/2022	Down	Up	Diverting	35.9	Off Season			
11/9/2022	Down	Up	Diverting	88.0	Off Season			
11/8/2022	Down	Up	Not Diverting	0.0	Off Season			
11/7/2022	Down	Up	Not Diverting	0.0	Off Season			
11/6/2022	Down	Up	Not Diverting	0.0	Off Season			
11/5/2022	Down	Up	Not Diverting	0.0	Off Season			
11/4/2022	Down	Up	Not Diverting	0.0	Off Season			
11/3/2022	Down	Up	Not Diverting	0.0	Off Season			
11/2/2022	Down	Up	Not Diverting	0.0	Off Season			
11/1/2022	Down	Down	Not Diverting	0.0	Off Season			

Operations Maintenance Log
Alameda Creek Fish Passage Program
2022-2023

Noon to Noon Period End Date	RD1 Up/Down	RD3 Up/Down	Diversion Occuring	Average Daily Diversion Flow (CFS)	RD1 Migration Setpoint	Active Gates	Events	Event Details
10/31/2022	Down	Down	Not Diverting	0.0	Off Season			
10/30/2022	Down	Down	Not Diverting	0.0	Off Season			
10/29/2022	Down	Down	Not Diverting	0.0	Off Season			
10/28/2022	Down	Down	Not Diverting	0.0	Off Season			
10/27/2022	Down	Down	Not Diverting	0.0	IN Migration			
10/26/2022	Down	Down	Not Diverting	0.0	Off Season			
10/25/2022	Down	Down	Not Diverting	0.0	Off Season			
10/24/2022	Down	Down	Not Diverting	0.0	Off Season			
10/23/2022	Down	Down	Not Diverting	0.0	Off Season			
10/22/2022	Down	Down	Not Diverting	0.0	Off Season			
10/21/2022	Down	Down	Not Diverting	0.0	Off Season			
10/20/2022	Down	Down	Not Diverting	0.0	Off Season			
10/19/2022	Down	Down	Not Diverting	0.0	Off Season			
10/18/2022	Down	Down	Not Diverting	0.0	Off Season			
10/17/2022	Down	Down	Not Diverting	0.0	Off Season			
10/16/2022	Down	Down	Not Diverting	0.0	Off Season			
10/15/2022	Down	Down	Not Diverting	0.0	Off Season			
10/14/2022	Down	Down	Not Diverting	0.0	Off Season			
10/13/2022	Down	Down	Not Diverting	0.0	Off Season			
10/12/2022	Down	Down	Not Diverting	0.0	Off Season			
10/11/2022	Down	Down	Not Diverting	0.0	Off Season			
10/10/2022	Down	Down	Not Diverting	0.0	Off Season			
10/9/2022	Down	Down	Not Diverting	0.0	Off Season			
10/8/2022	Down	Down	Not Diverting	0.0	Off Season			
10/7/2022	Down	Down	Not Diverting	0.0	Off Season			
10/6/2022	Down	Down	Not Diverting	0.0	Off Season			
10/5/2022	Down	Down	Not Diverting	0.0	Off Season			
10/4/2022	Down	Down	Not Diverting	0.0	Off Season			
10/3/2022	Down	Down	Not Diverting	0.0	Off Season			
10/2/2022	Down	Down	Not Diverting	0.0	Off Season			
10/1/2022	Down	Down	Not Diverting	0.0	Off Season			
9/30/2022	Down	Down	Not Diverting	0.0	Off Season			
9/29/2022	Down	Down	Not Diverting	0.0	Off Season			
9/28/2022	Down	Down	Not Diverting	0.0	Off Season			
9/27/2022	Down	Down	Not Diverting	0.0	Off Season			
9/26/2022	Down	Down	Not Diverting	0.0	Off Season			
9/25/2022	Down	Down	Not Diverting	0.0	Off Season			
9/24/2022	Down	Down	Not Diverting	0.0	Off Season			
9/23/2022	Down	Down	Not Diverting	0.0	Off Season			
9/22/2022	Down	Down	Not Diverting	0.0	Off Season			
9/21/2022	Down	Down	Not Diverting	0.0	Off Season			
9/20/2022	Down	Down	Not Diverting	0.0	Off Season			
9/19/2022	Down	Down	Not Diverting	0.0	Off Season			
9/18/2022	Down	Down	Not Diverting	0.0	Off Season			
9/17/2022	Down	Down	Not Diverting	0.0	Off Season			
9/16/2022	Down	Down	Not Diverting	0.0	Off Season			
9/15/2022	Down	Down	Not Diverting	0.0	Off Season			
9/14/2022	Down	Down	Not Diverting	0.0	Off Season			
9/13/2022	Down	Down	Not Diverting	0.0	Off Season			
9/12/2022	Down	Down	Not Diverting	0.0	Off Season			
9/11/2022	Down	Down	Not Diverting	0.0	Off Season			
9/10/2022	Down	Down	Not Diverting	0.0	Off Season			
9/9/2022	Down	Down	Not Diverting	0.0	Off Season			

Operations Maintenance Log
Alameda Creek Fish Passage Program
2022-2023

Noon to Noon Period End Date	RD1 Up/Down	RD3 Up/Down	Diversion Occuring	Average Daily Diversion Flow (CFS)	RD1 Migration Setpoint	Active Gates	Events	Event Details
9/8/2022	Down	Down	Not Diverting	0.0	Off Season			
9/7/2022	Down	Down	Not Diverting	0.0	Off Season			
9/6/2022	Down	Down	Not Diverting	0.0	Off Season			
9/5/2022	Down	Down	Not Diverting	0.0	Off Season			
9/4/2022	Down	Down	Not Diverting	0.0	Off Season			
9/3/2022	Down	Down	Not Diverting	0.0	Off Season			
9/2/2022	Down	Down	Not Diverting	0.0	Off Season			
9/1/2022	#N/A	#N/A	Not Diverting	0.0	Off Season			

APPENDIX C
Draft Final ACWD-SFPUC Fisheries Data Sharing Protocol

ACWD-SFPUC FISHERIES DATA SHARING PROTOCOL

DRAFT FINAL

Background and purpose:

The Alameda County Water District (ACWD) and the San Francisco Public Utilities Commission (SFPUC) (Agencies) are conducting fisheries restoration and monitoring projects in the Alameda Creek Watershed and have commitments to collect long-term data under their state and federal environmental regulatory permits, including their respective National Marine Fisheries Services biological opinions (BiOps) and, both have commitments to share detailed data with these state and federal agencies on an annual basis. These annual reports will take time to prepare as data sets may be large and require substantial quality assurance review prior to publication. ACWD is required to submit an annual report by November 1 of each year. The SFPUC is required to submit a report annually by July 31 of each year.

However, both Agencies acknowledge that the timely sharing of some basic, provisional data about the presence / non-presence of salmonids and lampreys with each other will be beneficial for their respective monitoring programs. Timely sharing of data will help facilitate Agencies' operations and inform monitoring efforts with the potential to be more successful in those efforts. As more is learned about the species of interest, such as migration patterns and travel times, this data sharing protocol can be adjusted if both SFPUC and ACWD agree to adjustments.

Overview of data collected by the Agencies:

San Francisco Public Utilities Commission

The SFPUC monitors spawning, rearing, and the movements of *Oncorhynchus mykiss (O. mykiss)*. The following data collection processes by ACWD at the BART Weir will provide meaningful information for the SFPUC:

- Passive integrated transponders (PIT) tag antenna detections
- Visual fish observations
- ARIS sonar camera data. *The camera data likely will not be monitored in real time and only available later, after substantial processing.*

<u>Alameda County Water District</u>

The ACWD monitors migration of steelhead, Pacific Lamprey, and other salmonids including fall run Chinook Salmon. The following data collection processes by the SFPUC will provide meaningful information for ACWD:

- Spawning surveys conducted between January 1 – April 30
- Out migrant fish trapping conducted between Feb 1 – May 31 (rotary screw trap and fyke net)
- PIT tag detections at antennas

Agreement to share data:

- To facilitate timely operations between Agencies and strive to communicate by email whenever salmonid or Pacific Lamprey presence is detected.
- SFPUC
    - Spawning surveys and out-migrant fish trapping - January 1st through May 31st
        - At minimum a monthly email will be sent to ACWD including *O. mykiss* spawning survey observations and a summary of *O. mykiss* and Pacific Lamprey collected during SFPUC's fish trapping surveys.
        - A weekly email will be sent to ACWD when ≥ 5 *O. mykiss* are captured per week during SFPUC's fish trapping surveys.

  - PIT tag antenna detections (approximately November through May 31st)
    - If out-migrating *O. mykiss* are detected at the SFPUC antennas, total fish numbers will be relayed to ACWD after antennas are downloaded (approximately every two to three weeks).
  - Brief indication of conditions for health and safety purposes, such as unexpected flow changes that could affect the safety of downstream staff. To facilitate data sharing, Agencies may develop forms that include key data / indicators.

- ACWD
  - PIT Tag Antenna Detections
    - ACWD will email the SFPUC unique PIT tag numbers detected at the BART Weir approximately every month.
  - Visual fish observations
    - ACWD will email the SFPUC when visual observations of in-migrating salmonids and/or Pacific Lamprey are detected within 24 hours. If fish numbers are high, weekly emails will suffice.
  - ARIS Camera Data
    - ACWD will email the SFPUC when in-migrating salmonids and/or Pacific Lamprey are detected within 1-2 days of processed identification.

Agencies will provide:

- SFPUC to provide ACWD:
  - Count of out-migrating smolts
  - SFPUC PIT tag number confirmations for detections on the BART Weir antenna will be given to ACWD upon request.

- ACWD to provide SFPUC:
  - Presence/non-presence of salmonids (visual or PIT tag reads)

  - Unique PIT tag numbers detected at the BART Weir antenna

- The contact at ACWD will be the Water Supply Supervisor, or their designated Water Resources Engineer; the contact at SFPUC will be the Biologist(s) leading the trapping and tag reading projects.

General guidelines for data sharing protocol:

- All data collected and transmitted is provisional.
- As more is learned about species travel time and migrations, notification and email times between ACWD and SFPUC can be adjusted as necessary.
- ACWD and the SFPUC will not use the other agencies shared data for any other purpose other than their own monitoring operations without the express written approval of the other agency. This includes, but is not limited to, white papers, journal publications, press releases, conference presentations, and its distribution in any form to NGOs, other local, state, or federal agencies, consultants, the media, or the public.
- At a later date, comprehensive scientific data will be shared with the Alameda Creek Fisheries Restoration Workgroup in the form of the annual reports required by state and federal resource agencies.
- This data sharing protocol can be revisited as conditions change.