Juvenile Salmonid Collection System: Report on Field Operations 2024-2025

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Section 1. Introduction

1.1. Executive Summary

The Department of Water Resources (DWR) deployed and operated the Juvenile Salmonid Collection System or JSCS (fish trap, platform, docks, guidance nets, debris boom, and trap wrap) in the McCloud River Arm (McCloud Arm) of Shasta Reservoir between Pine Point and Ellery Creek from September 17, 2024, through January 19, 2025. The 2024-25 deployment of the JSCS is the third of four field seasons in the pilot study to recapture juvenile winter-run Chinook Salmon (Wintu name: *Nur)* reared upstream by project partners and to test new methods in juvenile capture.

The California Department of Fish and Wildlife (CDFW), NOAA National Marine Fisheries Service (NOAA Fisheries), and the Winnemem Wintu Tribe (WWT) reared 62,288 Nur eggs in remote site incubators (heath trays and nature-based Nur systems) at Ah-Di-Na Campground. CDFW and Pacific States Marine Fisheries Commission (PSMFC) released the first group of juveniles from heath trays into the McCloud River. To ensure their safety and well-being, the second group of Nur, initially housed in heath trays, was moved to a holding tank. The transfer was prompted by bear activity and concerns that issues with the in-river collection trap were leading to Nur mortality. The transfer allowed for necessary modifications to the trap to ensure safety of the Nur. The Winnemem Wintu Tribe designed the Nature-Based Nur system to allow juveniles to exit rearing tanks into rock pools, from which Nur volitionally enter the river without a discrete release. DWR targeted Nur for capture at the JSCS to assist with relocation in support of a pilot project by CDFW, NOAA Fisheries, and the Winnemem Wintu Tribe to assess the feasibility of a long-term reintroduction program. CDFW concurrently operated rotary screw traps and an inclined plane trap in the McCloud River above the JSCS. This dual effort aimed to capture as many Nur as possible that had been released from the Ah-Di-Na site. The JSCS was the most downstream point-of-capture and fished in head-of-reservoir conditions up to 1.25 mi downstream of the riverine-reservoir interface below CDFW's trapping efforts.

The 2024-25 field season provided an opportunity to evaluate JSCS efficacy under various field conditions including reservoir drawdown, reservoir filling, and winter storms. DWR conducted studies according to the Project Science Plan (2023) to evaluate the impact of the JSCS structure and deployment on catch, water temperatures, and water velocities using daily and weekly sampling methods to identify optimal conditions for trap operations. DWR monitored conditions at the JSCS site, including reservoir depth and structure position in the channel. DWR conducted weekly mark-and-recapture trap efficiency trials to evaluate capture probability and trap efficiency across changing reservoir conditions. DWR identified and enumerated all fish captured at the JSCS and transferred all salmon to CDFW/PSMFC/Winnemem Wintu Tribe for relocation and release into the Sacramento River downstream of Keswick Dam.

This season's study revealed constraints to JSCS operations: debris, severe weather events, and elevated water temperatures restricted operational periods. The temperature control panel ("trap wrap") and guidance nets effectively lowered temperatures directly upstream of the structure and within the fish trap and the JSCS operated in conditions up to 2,000 cubic feet per second (cfs). JSCS operation yielded data on capture numbers, resident fish assemblages, and initial efficiency rates. In total, the JSCS captured 40 Nur from Ah-Di-Na (river-reared fish, “Nur”) and 38 additional marked winter-run Chinook Salmon (efficiency fish). Overall capture efficiency was lower than anticipated: the average capture probability across the season was 1.5%, with a maximum recapture rate of 6% and a minimum recapture rate of 0%. The JSCS did not catch Nur after December 5, 2024, when water depth at the trap entrance exceeded 15 feet. Predation may have significantly impacted Nur survival and capture probability, and trap location and function likely contributed to low trap efficiencies.

Based on the findings from the 2024–25 season, the JSCS pilot study identified the following key conclusions regarding system performance, limitations, and recommended next steps:

- Performance Decline: The capture efficiency rate for winter-run Chinook Salmon at the JSCS fell sharply in 2024-25 to 1.5% (total catch 78 Nur), down from 22.5% (total catch 807 Nur) in 2023.
- Primary Cause of Low Efficiency: High reservoir levels (>40 ft) exceeded the system's optimal design range (<20 ft). This, combined with low water velocities and confirmed predation, significantly reduced efficacy.
- Operational Success: Despite capture challenges, the JSCS structure created a safe environment for collected salmonids by effectively moderating water temperatures without the use of a temperature curtain. Dissolved oxygen levels remained above safe thresholds and supplemental oxygen was not required.
- Planned Improvements: DWR will implement targeted modifications, including system reconfiguration for deployment in shallower water at the riverine-reservoir interface; trap covers; improved debris management; and redesigned fish trap components to boost future performance.
- Core Recommendation: Future JSCS operations must prioritize placement within the riverine-reservoir interface. This location offers shallower depths, higher water velocities, and reduced predator presence, all of which are necessary for successful Nur capture. This is consistent with recommendations from Chief Sisk and the Winnemem Wintu Tribe.

1.2. Study Area and Setting

The McCloud River (Wintu name: *Winnemem Waywaket*) drains a 427-square mile area across the lower Cascade Range and Mount Shasta before flowing into Shasta Reservoir (USGS 2023a). Mean annual precipitation in the McCloud River watershed exceeds 70 inches, with 80 percent falling as rain and the remainder as snow (USBR, 2016). The river runs 59 miles from its spring-fed stream headwaters, past the lava flows of Mount Shasta, and through steep canyons and mixed conifer forest until it meets the McCloud Arm of Shasta Reservoir. The complex topography of the McCloud River supports dozens of microhabitats and rich biodiversity; the river is known for an excellent trout fishery with cold water temperatures and good water quality. Historically, the McCloud River supported robust populations of all four runs (spring, fall, late-fall, and winter) of Sacramento River Chinook Salmon as well as Bull Trout and steelhead, but dam construction in the watershed resulted in the extirpation of anadromous species from the river (Moyle, Lusardi, & Samuel 2017). Early developments on the McCloud River included timber harvest, mining, and recreational development by wealthy settlers for fishing. Most of the land along the McCloud River is privately owned and used predominantly for timber harvest and hydropower. Shasta Reservoir is owned and operated by the United States Bureau of Reclamation (USBR), and adjacent land is managed by the United States Forest Service (USFS). A California State Wild & Scenic River designation protects the lower McCloud River from further development.

The McCloud River is dammed in two locations: first by Lakin Dam, initially constructed by the McCloud River Lumber Company for mill operations and water supply and currently owned by the USFS; and then by McCloud Dam, built in the 1960’s for private hydropower by PG&E. The McCloud Dam forms Lake McCloud and diverts up to 80% of the McCloud River flow into the Pit River for hydropower generation (USGS 2020). Below the dam, the reduced flow of the McCloud River continues for 23 miles until it reaches Shasta Reservoir. Hydropower operations negatively impact the temperature and turbidity conditions in the lower McCloud River, and erosion and timber management practices contribute to sediment events throughout the wet season (USBR 2016). The McCloud River flows into the McCloud Arm of Shasta Reservoir, which submerges roughly the last 14.5 miles of the historic river channel, riparian zone, and adjoining land.

Figure 1.2-1. McCloud River watershed with key project locations.

1.3. Treaty Rights and Land Tenure on the Winnemem Waywaket

The McCloud River (Winnemem Waywaket) watershed encompasses the traditional territory of the Winnemem Wintu Tribe, whose name translates to "middle waters people." The Winnemem Wintu have lived along the McCloud River since time immemorial and trace their origin as a people to their relationship with Nur who provided humans with a voice during creation. The California Genocide and the Gold Rush brought cultural devastation and ecological degradation to the Winnemem Waywaket: mining and logging practices choked streams with sediment and pollution while settlers targeted Winnemem communities and means of subsistence for annihilation (Madley 2019; WWT 2011; WWT 2019). The Reading Rancho Treaty of Peace and Friendship, also known as the Cottonwood Treaty, formally reserved a large area along the McCloud River for the Winnemem Wintu in 1851. Congress failed to ratify the treaty and sealed it to secrecy, leaving the Winnemem Wintu without federally recognized treaty rights to land or fish (Anderson, Ellison, and Heizer 1978).

Operations at Baird Station, the first national fish hatchery, relied heavily on Winnemem Wintu labor and ecological knowledge (Yoshiyama and Fisher 2001). Livingston Stone, the director of Baird Station, wrote in 1873 that "the presence of the [Wintu] is the great protection of the supply of Sacramento salmon" (Smith 1995 p.129, see also Wolfe-Hazard 2019). However, the Winnemem Wintu received unequal treatment at the hatchery and protested the encroachment of hatchery operations upon their fishery. Without the permission of the Winnemem Wintu Tribe, Livingston Stone exported Chinook Salmon eggs from the McCloud River worldwide in an attempt to establish commercial salmon fisheries elsewhere. Although Stone's proposal of land for the Winnemem as a "piscine reservation" never materialized, many Winnemem Wintu secured legal title to land for homesteads along the McCloud River under Grover Cleveland's 1893 amendment to the Dawes Allotment Act (Sisk 2002). The Winnemem Wintu continued to live along the McCloud River and worked to protect salmon until the construction of Shasta Dam in the mid-1940's. Today, wild Chinook Salmon from the McCloud River survive in several New Zealand rivers.

1.4. Shasta Dam Impacts to the McCloud River

Shasta Dam, one of the initial developments of the Central Valley Project, sits just below the confluence of the Sacramento, Pit, and McCloud rivers and forms a reservoir which covers a surface area of over 29,000 acres and holds up to 4.5 million acre-feet of water. Upon its completion in 1945, Shasta Dam flooded over 250 Winnemem Wintu sacred places, ceremony sites, village locations, burial grounds, and allotments (Ngo 2009). Over 90% of the traditional land of the Winnemem Wintu lies below the reservoir line (Garrett 2010).

Although the 1941 Use of Indian Lands for the Central Valley Project Act promised compensation or the provision of like land for submerged allotments, the Winnemem Wintu did not consent to the transfer or inundation of their land, and recompensation never reached the Tribe. Ownership of the remaining allotments along the McCloud River was transferred to the USFS, who manages the land around Shasta Reservoir for recreation; many village sites and allotments were developed into public campgrounds.

Notably, DWR conducted JSCS efficiency trials at the McCloud Bridge Campground, which was developed on top of a ceremonial site at William Curl's allotment and orchard. In 1985, the Bureau of Indian Affairs failed to include the Winnemem Wintu in a comprehensive list of federally recognized tribes. Although this technical error did not go through the mechanisms for formal termination, it nonetheless resulted in the loss of federal recognition and associated rights and benefits. Despite state and federal attempts, federal recognition has not been restored to the Winnemem Wintu Tribe. Chief Caleen Sisk, leader of the Winnemem Wintu Tribe, explains that "the loss was more than 26 miles of river, our dance grounds, our way of life that had been known by older people in my tribe. But we also lost a lot of dignity that came with being run out of our homeland and with no place to go" (McLeod 2013).

Shasta Dam was constructed without fish passage, and its construction in the 1940's permanently blocked salmon access to the McCloud, Pit, and Upper Sacramento rivers. Statewide, over 95% of salmon habitat is blocked by dams, and above-dam river systems have lost more salmonid species to extirpation and extinction than any other habitat type in California (Moyle, Lusardi, & Samuel 2017). Lack of access to high-quality cold-water spawning and rearing habitat has especially impacted winter-run Chinook Salmon, which spawn and hatch during the warmest parts of the year (Yoshiyama, Fisher, & Moyle 1998). Shasta and Keswick dams restrict the population of winter-run Chinook Salmon to the warmer waters of the mainstem Sacramento River and egg survival generally depends on managed cold-water releases from Shasta Dam (NMFS 2014). Winter-run Chinook Salmon populations declined after dam construction and the species was declared federally endangered in 1994. Livingston Stone National Fish Hatchery was constructed below Shasta Dam in 1997 to supplement the population with hatchery production and prevent further species decline. Despite hatchery production, the population of winter-run Chinook Salmon continues to diminish, driven by lack of access to suitable habitat and cold water. Shasta Dam lost its cold-water pool during the 2012-2016 drought and without cold-water releases, temperature-dependent mortality among winter-run Chinook Salmon in the wild spiked to 77% of eggs in 2014 and 86% in 2015 (NOAA 2023). Although 2021 saw the best return of adults in fifteen years, juvenile survival reached record lows in 2022. Without restored access to suitable habitat upstream of Shasta Dam, the population of Sacramento River winter-run Chinook Salmon is unlikely to recover (Lindley et al 2004; NMFS 2014).

1.5. Urgent Actions to Recover the Winter-run Chinook Salmon Population

The decline of winter-run Chinook Salmon is of great concern to the Winnemem Wintu Tribe, who maintain important kinship relationships with the salmon. Chinook Salmon (Nur) are a cultural keystone species (Garibaldi and Turner 2004) in California, and their presence or absence deeply impacts lifeways in the McCloud River watershed. If there are no Nur, then the Winnemem Wintu Tribe cannot exist. The Winnemem Wintu Tribe has advocated for the reintroduction of Nur to the McCloud River for over two decades on the basis that ecological and cultural conditions have declined without the presence of Nur. In 2010, the Winnemem Wintu Tribe received word from New Zealand that a population of McCloud River Chinook Salmon survived in the Rakaia River and members of the Tribe travelled to meet their Nur relatives. In 2016, the Winnemem Wintu Tribe submitted a Salmon Restoration Plan to the U.S. Bureau of Reclamation (USBR) advocating for the reintroduction of the New Zealand salmon to the McCloud River and the construction of a swimway to provide voluntary fish passage around Shasta Dam. As warm water temperatures below Shasta and Keswick dams continue to drive species decline in the wild, it is of great importance to the Winnemem Wintu Tribe to restore winter-run Chinook Salmon access to the cold-water rearing habitat in the McCloud River.

The reintroduction of winter-run Chinook Salmon to the McCloud River is also a priority for NOAA Fisheries, who included reintroduction as a priority action in the Species in the Spotlight: Sacramento River Winter-run Chinook Salmon Report. The Steering Committee for the Shasta Dam Fish Passage Evaluation effort (USBR 2016) determined juvenile salmon survival through Shasta Reservoir to a juvenile collection system at or near the dam was likely to be low. Therefore, the juvenile collection portion of a reintroduction program was to focus on the riverine-reservoir interface in head-of-reservoir conditions (Clancey et al 2017). In 2017, USBR awarded DWR a contract for the design, construction, installation, and operation of juvenile fish collection devices in the lower McCloud River and the McCloud Arm of Shasta Reservoir; USBR support was halted in 2019 after the initial fabrication of JSCS components.

In 2022, NOAA Fisheries, CDFW, and the Winnemem Wintu Tribe undertook urgent actions to mitigate temperature-dependent mortality in the mainstem Sacramento River and placed 40,000 winter-run Chinook Salmon eggs from Livingston Stone National Fish Hatchery in remote-site incubators on the McCloud River at Ah Di Na. This marked the first time that Nur returned the McCloud River in almost 80 years and the beginning of the McCloud River Salmon Restoration Project, a collaborative, multi-agency pilot study to assess the feasibility of a long-term reintroduction program. During the 2022 field season, DWR modified and deployed three of the four main components of the JSCS structure (guidance net, debris boom, and temperature curtain) to support the pilot study by testing a novel style of trap for head-of-reservoir fish collection. In 2023, CDFW and the Winnemem Wintu Tribe placed 80,000 winter-run Chinook Salmon eggs in two types of remote site incubators for release at Ah Di Na. For 2023, DWR added the fourth component of the JSCS, the fish trap, to serve as the most downstream point of collection for outmigrating Nur.

1.6. Overview of Field Operations 2024-2025

DWR deployed the JSCS at three sites during the 2024-2025 field season:

- Site 1: downstream of Pine Point (fishing 41 days between September 17 – October 28, 2024).
- Site 2: upstream of Ellery Creek (fishing 36 days between October 31 – December 19, 2024).
- Site 3: return to downstream of Pine Point (fishing 18 days between January 2 – January 19, 2025).

The primary objectives of the 2024-25 JSCS field season were to:

- Collect juvenile salmon to support trap and haul reintroduction efforts
- Test trap function and performance across new site locations, reservoir conditions, and seasons

- Test the efficacy of temperature control panel ("trap wrap") at lowering water temperatures within the trap (replacement for the 2022-23 temperature curtain)
- Monitor water quality parameters (e.g. temperature, dissolved oxygen, velocity) in and around the fish trap to ensure safe trap conditions for fish
- Monitor velocities around the structure and test the ability of structure components to influence velocities through the trap
- Test performance of the trap in high-flow (>1,500 cfs) conditions
- Detect and monitor the thermocline
- Assess position of the structure in the channel during regular operations, dynamic events (e.g., storms), and across reservoir conditions (e.g., filling and drawdown)
- Monitor resident fish assemblages and assess pathogen and predation risks
- Gather data to inform optimal performance of the JSCS fish trap (e.g., identify velocity and depth parameters which correspond to high capture probability)

The 2024-25 JSCS field operations required multi-agency collaboration and strong communication with project partners before, during, and after the field season. The Winnemem Wintu Tribe, CDFW, NOAA Fisheries, PSMFC, and Livingston Stone National Fish Hatchery (LSNFH) all provided crucial knowledge, guidance, and time to support JSCS field operations.

1.7. Purpose and Approach of this Document

This report is intended to inform the reader about the context, objectives, methods, and results for DWR's operation of the JSCS in the McCloud Arm of Shasta Reservoir during the 2024-2025 field season. A comprehensive analysis between seasons will be provided in the Final Report of this pilot study (anticipated 2026). This report answers the research questions outlined in the JSCS Science Plan (DWR 2023).

This document proceeds in five sections. **Section 1:** Introduction – provides background information to explain the purpose and context of JSCS operations in the McCloud River during the 2024-2025 field season. **Section 2**: Study Planning – explains site selection process and other key logistics to support the undertaking. **Section 3**: Methods – provides a general account of data collection in the research areas of water quality, water temperature, velocity, meteorology, aerial imaging, fish capture, trap efficiency, predation, and pathology. **Section 4**: Results – organizes and presents data from the 2024-2025 JSCS field season. **Section 5:** Conclusions – synthesizes across results to interpret data and make key recommendations for future field seasons.

Note on units: Some data described in this report, such as velocity and depth, were collected in the United States customary system of measurement (e.g., feet or feet per second or cubic feet per second). Other data, such as fork length, were collected in the metric system of measurement (e.g., millimeters). Data is described in this report by the units in which it was collected to preserve the clarity and accuracy of findings.

1.8. Major Findings

Reservoir water levels decreased steadily by 16 feet during the first two months of JSCS operation and began increasing in November; water surface elevation (WSE) increased by 42.5 feet in the last two months of JSCS operations. Velocities consistently increased as depths decreased for the first two months of the season, then decreased following the first storm event in mid-November and remained low for the rest of the season. Water temperatures decreased steadily from early September, stabilized in mid-November, and then rose slightly in January. The thermocline was most pronounced at the beginning of fishing the trap, disappeared as mixing improved during drawdown, and reappeared under reservoir filling conditions. A total of 41.8 inches of rain fell during the JSCS field season, and winter storms posed a significant safety hazard and logistical challenge to normal trap operations. Debris management following storm events interrupted or delayed operations on two separate occasions; debris poses the largest threat to JSCS operations in winter/storm conditions.

The JSCS operated in flows up to 2,000 cfs with adjustments to panels and nets enabling operation in higher flow conditions. The trap wrap and guidance nets worked as intended and had a cooling effect on water upstream of the JSCS components and within the trap structure. After the peak heat of summer passed in mid-September, temperatures, DO levels, and velocities in the trap remained within safe ranges for Nur. At depths greater than 20 feet, structural adjustment to impermeable panels and nets did not significantly increase velocities through the trap notch. See Appendix A for details on JSCS structure and design.

The JSCS captured 40 Nur and 38 dual-marked efficiency fish for a total of 78 winter-run Chinook Salmon. The JSCS captured juvenile winter-run Chinook Salmon at the first two sites but not at the third; capture probability across all three sites averaged 1.5% (5.8% at Site 1, 0.9% at Site 2, and 0% at Site 3). Juvenile Spotted Bass (*Micropterus punctulatus*) had winter-run Chinook Salmon in their stomachs at a rate of 5.9% and no intact salmon carcasses were recovered from Rainbow Trout, Brown Trout, or adult Black Bass stomachs. The JSCS crews made visual observations of predation and feeding behavior in the vicinity of the structure: a school of over 200 adult brown and rainbow trout appeared within the zone of the guidance nets at Site 2 and observations of adult trout and feeding activity continued for the rest of the season, which suggests that predation of juvenile salmon could have been occurring. There were also visual observations of multiple species of waterfowl and other predatory or piscivorous birds (blue heron, green heron, great egret, common merganser, American coot, multiple species of ducks, multiple species of raptors) at all sites, with most being noticeably present in the vicinity of the JSCS from September through December. River otters were also spotted in addition to black bear tracks immediately surrounding the structure from September through October. There were no observations of predation from these bird and mammal species.

Winter-run Chinook Salmon catch peaked in October. The period that the JSCS was fishing at Site 1 (September 17 through October 28, 2024) accounts for 75% of total Nur catch and 95% of catch for all other species. The JSCS did not catch fish, Nur, or other species, when depths exceeded 15 feet at the trap entrance.

Section 2. Study Planning

2.1. Site Selection and Trap Location

The McCloud Arm of Shasta Reservoir was previously identified as a suitable location for Chinook Salmon capture, and the stretch between the McCloud Bridge and Hirz Bay was a logistically feasible area for deployment (USBR 2014; NMFS 2014). The goal was to select a location as close to the riverine-reservoir interface (**Figure 2.1-1**) as possible while minimizing the number of mid-season system movements and disturbance of culturally significant sites. DWR, DWR consultant – Environmental Science Associates (ESA), DWR contractor – Pacific Netting Products (PNP), and the Winnemem Wintu Tribe collaboratively selected and vetted locations for the 2024 JSCS deployment. Hydrology, water level forecasts, culturally sensitive areas, and anchoring requirements were factored into site selection.

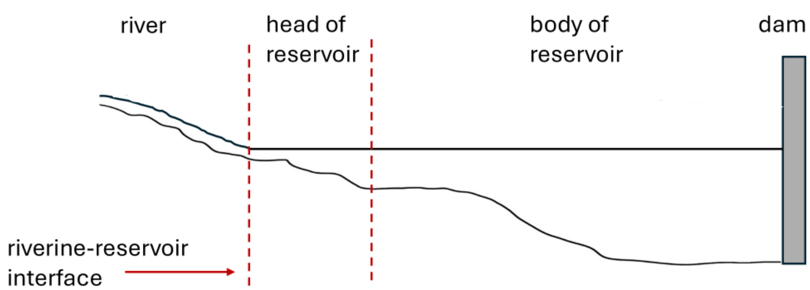


Figure 2.1-1. Anatomy of a reservoir as described in this report. The riverine-reservoir interface is the transitional zone where the river meets the reservoir. The head of the reservoir is the section of reservoir influenced by stream discharge directly downstream of the interface, which transitions to riverine during drawdown. The body of the reservoir is not influenced by stream discharge. The location of the riverine-reservoir interface changes with water surface elevation.

DWR initially proposed three areas suitable for fish collection (**Figure 2.1-2)**. The river-reservoir interface location was first estimated using forecasted monthly water levels provided by USBR and a bathymetric map of the McCloud River and Shasta Reservoir to identify a suitable area for proposed sites. Forecasted WSE from USBR were superimposed onto the bathymetric map to estimate water depths over time across the riverine-reservoir interface. Ideal locations sustain relatively shallow depths (ideally 20 feet or less) without becoming too shallow for operations (~6 feet). Based on these criteria, a section of the river ranging from approximately 1.5 to 2 miles downstream of the McCloud Bridge (Alternative B) was identified as suitable. Additional coordination with Pacific Gas and Electric Company (PG&E), which operates the McCloud Dam and controls the majority of the flow of water into the McCloud River upstream of the site, confirmed that discharge would remain constant at approximately 220 cfs for the majority of the season and PG&E would provide notice for any releases exceeding 300 cfs.

Once an optimal stretch of the river/reservoir was identified based on hydrologic criteria, specific sites were proposed within the designated suitable area to avoid culturally sensitive areas identified by the

Winnemem Wintu Tribe. DWR and the Winnemem Wintu Tribe accepted all of the proposed options for 2024.

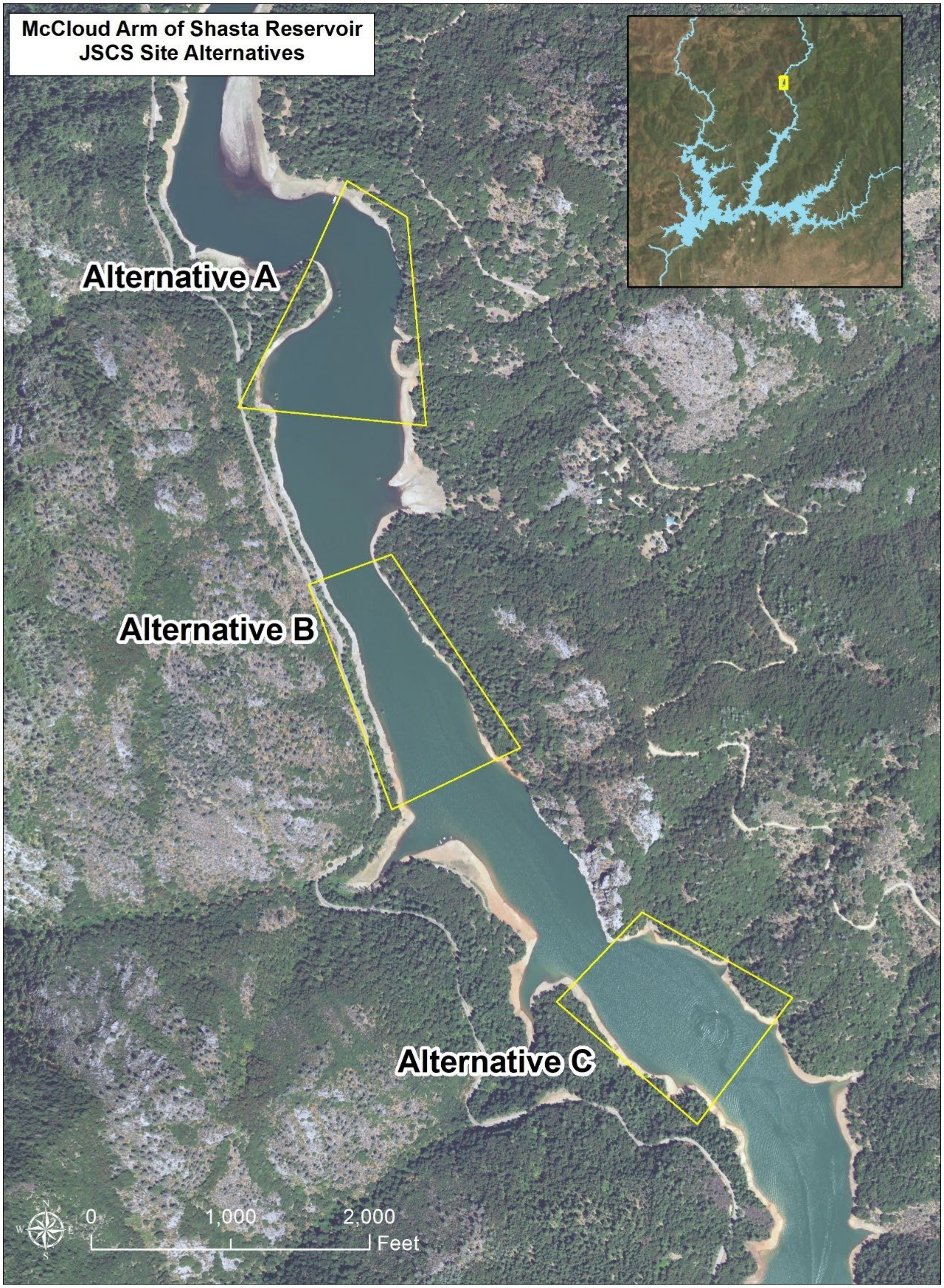


Figure 2.1-2. Three initial proposed areas for location of the JSCS during the 2024-25 field season.

2.2. Structural Configuration

The configuration of the system was like previous seasons with some minor changes based on lessons learned. The same trap, platform, debris boom, and guidance system were used from the prior season. However, unlike the prior seasons, no temperature curtain was used during the 2024-2025 season. Instead, 10 ft deep impermeable vinyl panels (the trap wrap) were wrapped along the sides and back of the trap platform—a cheaper and simpler alternative for water temperature control in the trap. However, after installation the vinyl wrapping at the back of the trap platform (the most downstream side) was raised out of the water to allow for greater water velocity within the trap. Another change from prior seasons was the use of fewer docks to prevent the system from bottoming out on the banks like it did in 2023. Six docks total (three on each side) were used during the 2024-2025 season compared to nine docks during the 2023 season. Another modification made to the system prior to the season was the addition of steel frames along the front of the docks to reduce billowing of the guidance nets in the top four feet of the water column. The guidance nets were also modified by removing the vinyl panels attached to the bottom so that the nets could more easily be adjusted throughout the season. The boat gates were modified slightly by creating a large pin closure mechanism to make opening and closing the gates easier. The manual hoist for lifting the fry box was replaced by a battery powered hoist to reduce noise and vibration while lifting the fry box. During the winter months, an additional debris guidance net was added to the system slightly upstream of the trap entrance to help trap additional debris that passed the primary debris boom. During deployment, the trap was strategically placed such that it was aligned with the thalweg to increase flow through the trap as much as possible.

2.3. Logistics and Study Organization

DWR planned logistics for transporting staff and materials to the site to ensure safe access to the site and minimize unnecessary travel. During mobilization and demobilization, DWR used the Hirz Bay Boat Ramp parking area as a staging area due to its large parking areas and multiple boat ramps. During normal field operations, DWR used the Ellery Creek campground as the meeting location each day. Staff drove a minimum of three vehicles to the site and kept them parked at the designated meeting location in case of an emergency. DWR primarily used state fleet trucks for transportation of staff and materials.

From the campgrounds, staff ferried to the site via a pontoon boat, which was anchored on shore overnight. An additional DWR jet boat was used occasionally and left at the Bridge Bay Marina as a backup. ESA used their jet boat for regular transport of staff and other field tasks. PNP used boats and barges to transport workers and materials to the site during mobilization, relocation, and demobilization. Staff used a houseboat throughout the season for equipment storage, shelter, and lab space.

During normal operations, the JSCS crew consisted of a field lead, at least one Winnemem Wintu Tribe cultural resource specialist, a lead fisheries biologist, a staff biologist, an engineer, and additional sub-weekly staff as needed. Daily field activities occurred from 8am until all tasks were completed, generally between 2pm and 4pm. From 2pm until 8am, security observed the site and ensured JSCS and public safety.

2.4. Permitting

For the 2024-25 JSCS field season, DWR applied for a new 5-year USFS Special Use Permit – receiving letters of permission to continue the project this season; amended a CDFW Scientific Collection Permit and California Endangered Species Act Memorandum of Understanding; maintained a Mitigated Negative Declaration CEQA; acquired a NOAA Fisheries 10(j) approval under the Endangered Species Act Section 10(a)1(A); and received Special Use Authorization for drone use in Shasta-Trinity National Forest. The geographic range of permitted operations is from McCloud Bridge to Dekkas Rock.

2.5. Training

Prior to the season, DWR staff took Wilderness First Aid and River Safety training courses with Sierra Rescue International. DWR staff also completed other internal safety training courses required by Department policy.

All DWR staff named as authorized individuals on the JSCS Scientific Collection Permit received up to 20 hours of training on best practices in juvenile fish handling and field fisheries methods prior to the start of the field season. Training included the provision of text materials (standard operating procedures; fish identification guides; reports summarizing other field projects) and opportunities for hands-on learning (shadowing the DWR Division of Integrated Science and Engineering field crew on the Yolo Bypass fyke and rotary screw traps; rotary screw trap and fish sampling training at the UC Davis rotary screw trap on Putah Creek; morphometric and fish handling training at the UC Davis Center for Aquatic Biology and Aquaculture). The lead fisheries biologists provided additional training in fish identification, proper handling, and sampling techniques on an as-needed basis in the field.

ESA trained DWR JSCS staff on proper data collection methods and the use of digital data forms. DWR also provided internal training on data quality assurance and quality control procedures. All DWR JSCS staff received additional training on proper calibration, use, and maintenance of water quality measurement equipment at the DWR water quality lab in West Sacramento. All JSCS staff participated in cross-training while operating the JSCS trap and other components.

Additionally, all DWR boat operators took a Motorboat Operators Training Course (MOTC) and obtained their California Boater Card. Due to departmental training capacity constraints, no new staff were able to receive MOTC training before the 2024-2025 season.

Section 3. Methods

3.1. Physical Setting and Project Area

The JSCS was deployed at three locations during the 2024-25 field season, both in the stretch of the McCloud Arm of the reservoir between Ellery Creek Campground and Pine Point Campground (**Figure 3.1-1**). Site 1 was located at coordinates 40.920962° N, -122.244949° W, approximately 1,400 feet upstream of Ellery Creek. Site 2 was located approximately 900 feet downstream of Site 1 at 40.918973° N, -122.242931° W, approximately 500 feet upstream of Ellery Creek. Site 3 was located at coordinates 40.921243° N, -122.245020° W, approximately 100 feet upstream of Site 1. Staff accessed the transport boat from the paved lower parking lot at the Ellery Creek Campground via a footpath across the exposed reservoir bed. All three JSCS Sites were characterized by steep banks with annual grasses and flowers, mixed conifer and oak forest, and close proximity to recreational amenities and cultural resources. Sites were selected based on the hydrology, water level forecasts, and consideration of sensitive cultural resources (see **Section 2.1** Site Selection and Trap Location). The JSCS was positioned in the center of the channel aligned with the thalweg with guidance nets in a "V" position.

3.2. Timeline of JSCS Operations 2024-2025

Table 3.2-1. *Timeline of JSCS Operations 2024-25*

Event	Date
Installation	9/3-16/2024
Fishing at Site 1	9/17-10/28/2024
Move (Not Fishing)	10/29-30/2024
Fishing at Site 2	10/31-11/20/2024
Storm (Not Fishing)	11/21-12/3/2024
Fishing at Site 2	12/4-19/2024
Move + Major Storm (Not Fishing)	12/20/2024-1/1/2025
Fishing at Site 3	1/2-19/2025
Demobilization	1/21-28/2025

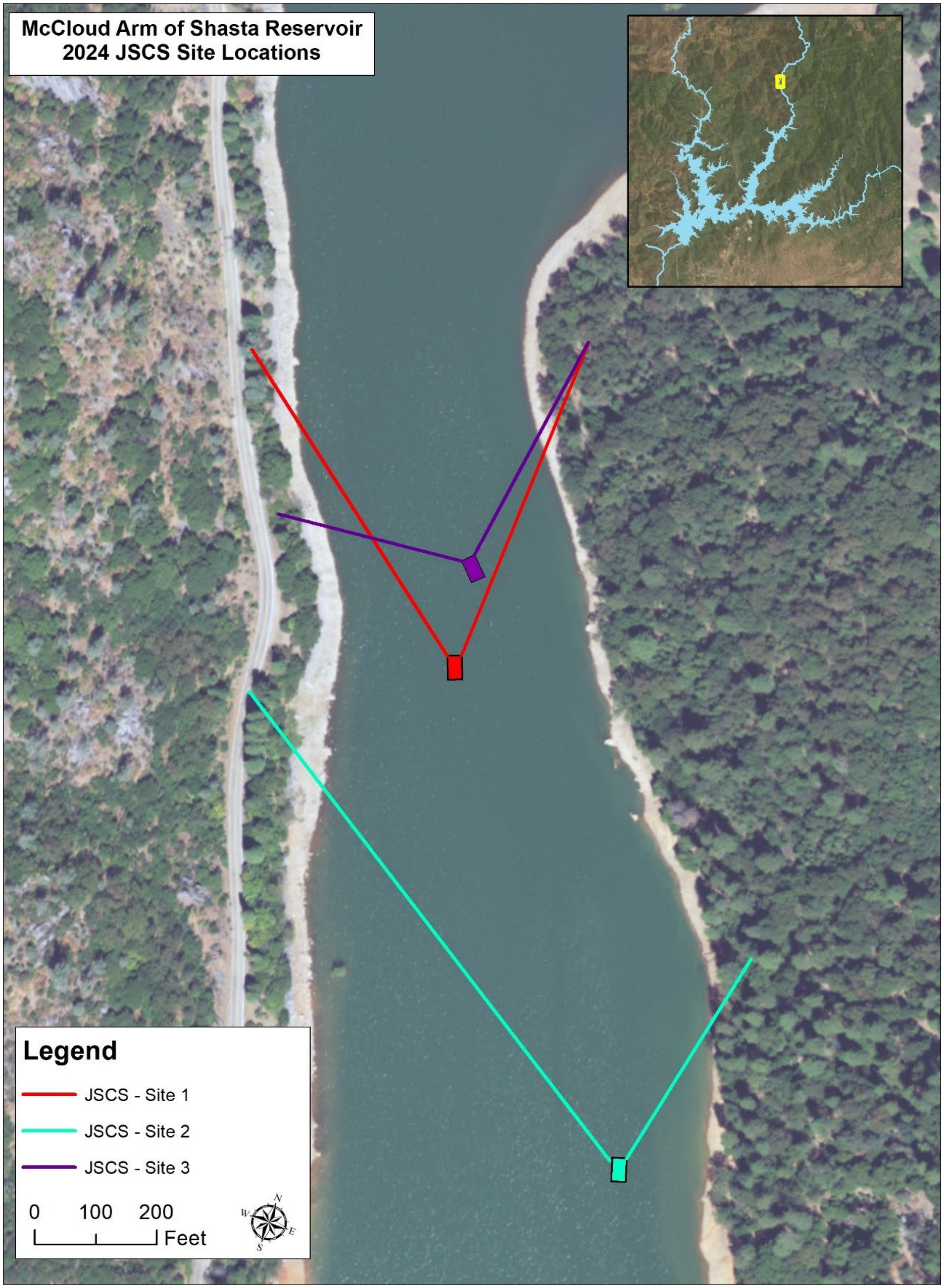


Figure 3.1-1. JSCS Sites during the 2024-25 field season.

3.3. Installation, Relocation, and Demobilization

JSCS installation started the week of September 3, 2024. During this first week of installation, PNP and their subcontractor staged equipment at the Hirz Bay Boat Ramp and configured anchoring systems for the site. During the second week, PNP brought the larger components of the system, along with more equipment and materials, to the staging area, and the contractors began assembling and transporting the system to Site 1 by towing via boat. The debris boom was installed first, followed by the main JSCS platform, docks, and nets. During this initial setup, DWR staff performed construction monitoring, the Winnemem Wintu Tribe performed cultural surveys, and ESA staff performed archaeological and bat surveys. Communication protocols were established, and radios were given to PSMFC to maintain contact for coordinating fish transfer. Satellite internet was installed for communications beyond the field. Trap operations at Site 1 began on September 17, 2024.

Once the first site became too shallow for operations (water depth approximately 7 feet), the JSCS was relocated to Site 2 downstream. The relocation process started on October 29, 2024. The contractors relocated the JSCS by releasing the guidance nets, fish trap platform, and debris boom from their anchoring systems and towing them downstream via boat. This process took approximately two days. Trap operations at the second site began on October 31, 2024. The JSCS was moved back upstream to Site 3 when water levels were approaching 30 feet. This second relocation process started on December 20 and only took a few days. However, a major storm event exceeding 10,000 cfs occurred immediately following this move. The depth at the trap increased from 29 feet prior to the move to 47 feet following this storm event. Due to the storm and subsequent heavy debris load, fishing did not resume until January 2.

The final day of trap operations was January 19 and demobilization started on January 21. Once trap operations were completed, each of the system components was detached from its anchoring system and transported downstream to Hirz Bay via boat. The demobilization process was finished by January 28.

3.4. Structural Operations

Prior to regular operations, DWR engineering staff checked system components to ensure that all trap elements were delivered and functioned properly. Daily structure inspections were performed following the DWR Shasta Juvenile Salmonid Collection System: Structure Inspection Standard Operating Procedures (DWR, 2024) to ensure that the various components of the system were functioning properly and to identify any changes from the previous day. The debris boom was inspected daily to check debris loads and ensure structural integrity. Guidance nets were inspected daily and remained functional throughout the season. However, minor tears in the nets were found throughout the season and reported to PNP, who fixed these tears during the season. The guidance nets also did not reach the bottom of the water column for a large portion of the winter season due to high water surface elevations and safety concerns during high flows. The guidance nets and impermeable panels were adjusted weekly (and sometimes daily) to remain taut as water levels decreased during the first half of the season and as water levels increased during the second half of the season. Docks along the guidance nets were inspected daily and did not have any issues. The trap platform was inspected daily and while the platform itself didn't have any major issues during the season, its shade canopy collapsed under the weight of accumulated snow when no staff were on board, and it was taken down for the remainder of the season.

The fish trap worked as intended with several minor issues. First, the electric winch for the chain hoist had issues starting during the first half of the season. A new battery powered hoist was ordered and worked well for the rest of the season. Second, leaf litter and debris accumulated overnight on Vexar screens used within the trap, which at times led to limiting the amount of flow going through the trap.

3.5. Environmental Data Collection Methods

Environmental data (hydrological, water quality, meteorological, water velocity, structure depth, orthomosaic aerial imagery) were collected with various instruments throughout the season. Depending on the parameter being collected, data were collected daily or continuously to evaluate the structure's effects on environmental conditions. Data was collected from both inside the trap and outside the surrounding structure.

The JSCS was deployed in the McCloud Arm of Shasta Reservoir, which is the reservoir inundated section of the McCloud River (Winnemem Waywaket). Inflow from this river is controlled by another reservoir upstream (McCloud Reservoir), operated by Pacific Gas and Electric (PG&E), which diverts water to the Pit River watershed to generate power. River inflow affects water temperature, water velocity, and other water-quality parameters at the head of reservoir where the JSCS was deployed. River flow and water temperature are measured at a gage a few miles upstream of the maximum reservoir extent operated by PG&E (CDEC Gage MSS, USGS 2023b); daily mean values of river temperature and flow were retrieved from the California Data Exchange Center.

DWR identified the following priority research questions in the 2024 JSCS Study Plan:

- What are the water temperatures around the trap?
- The water column is stratified at the beginning of deployment with regards to water temperature within and upstream of the trap; where upstream does the stratification begin horizontally (depth) and longitudinally (distance from McCloud Bridge); how does stratification change over the sampling season at each deployment site?
- How do temperature, dissolved oxygen, pH, conductivity, and turbidity vary over depth and time around the trap's major components: guidance net entrance upstream of the fish trap, guidance net downstream of the fish trap, and within the fish trap?
- What is the McCloud River inflow and water temperature during sampling?
- Is water temperature lower upstream of the guidance net and ¾ vinyl wrapped trap platform compared to downstream of the trap and ¾ vinyl wrapped trap platform?
- What are the water temperatures inside the trap?
- How do temperature, dissolved oxygen, and turbidity vary over time at the entrance to the trap?

- How do changes in water depth affect the velocity structure in and around the trap?
- How do flow patterns and velocities change as guidance net panels are manipulated?
- What are the range of flows in the river that are most conducive to JSCS operation (vs another type of in-river or in reservoir collection system)?
- How does the configuration change in relation to site conditions and over time?
- What is the likely debris loading as a function of season, wind, and other factors?

3.5a. Water Quality Around JSCS Structure

Water quality parameters at known depths were collected using an array of electronic sensors equipped with data storage. Onset sensor model MX2203 temperature loggers with a sampling frequency of 15 minutes were attached to an anchored buoy or from an anchored line hanging off the trap platform. Prior to deployment, the accuracy of the loggers was verified at five different set temperatures using a water bath and NIST thermometer following DWR standard operating procedure (DWR 2022). Vertical profiles of water quality were collected daily during fishing to understand variations in water temperature and other parameters using a YSI ProDSS. Profiles were taken in the morning between 8 – 11 AM at key locations on the JSCS structure at set depths; sensors were calibrated and verified daily for dissolved oxygen and temperature, and calibrated weekly for turbidity, pH, salinity and conductivity following DWR standard protocol (DWR 2024). A YSI EXO Sonde continuously sampled the same water quality parameters as the YSI ProDSS at a set depth of 3 feet below water surface (BWS) every 15 minutes; the sonde rested within a 4-inch diameter perforated PVC tube mounted approximately 3 feet toward river right from the trap entrance. The sonde was calibrated every 4-6 weeks following DWR standard protocol (DWR 2023), data were reviewed for accuracy, and out-of-water periods were removed from the final dataset.

The structure was modified this season to forgo the temperature curtain and instead install vinyl wrapping around the sides and back of the trap platform (trap wrap); however, at the back of the trap platform (the downstream end) the vinyl wrapping was raised out of the water to allow for greater water velocity within the trap. To test the effectiveness of the "trap wrap" and guidance net for temperature control, temperature loggers, set at the same depths as on the upstream buoys, were hung downstream of the guidance net from an anchored line off the river right, river left, and back center of the trap platform. Additionally, daily vertical profiles using the YSI ProDSS were taken at set depths upstream of the guidance net from the center of the middle docks on river right and left (Docks 6 and 10), at the mouth of the trap platform at river center, and 50 feet downstream of the guidance net at the back of the trap platform, river center. Monthly box plots comparing average temperature as depths at 1, 4, 9, 13, and 17 – 25 feet were created for each profile location as well as a time series plot of daily average temperature at each JSCS site. The range of top to bottom profile temperatures was plotted against the total depth at the upstream and downstream river center profile locations (Trap US and Trap DS). For the first period of deployment at Site 1, five buoys were deployed throughout the reservoir: one near the river inflow, three near the upstream mouth of the guidance net, and one further downstream at the expected location of Site 2; additionally, three lines were hung from the right, left, and center of the trap platform downstream of the guidance net. Due to varying water depths, some buoys had more sensors than others. A map with temperature array locations and JSCS sites is presented in Figure 3.5-1. Note the temperature sensor labeled 'Riverine' was lost by December 11, 2024, and the data could not be retrieved for analysis. Instead, data from the upstream USGS gage MSS was used to investigate the relationship between in-river water temperatures and water temperatures at the JSCS. Table 3.5-1 summarizes the buoys deployed during the JSCS deployment at Site 1. Longitudinal profiles of temperature buoy data were created to compare the average monthly surface and bottom water temperatures for each month of deployment.

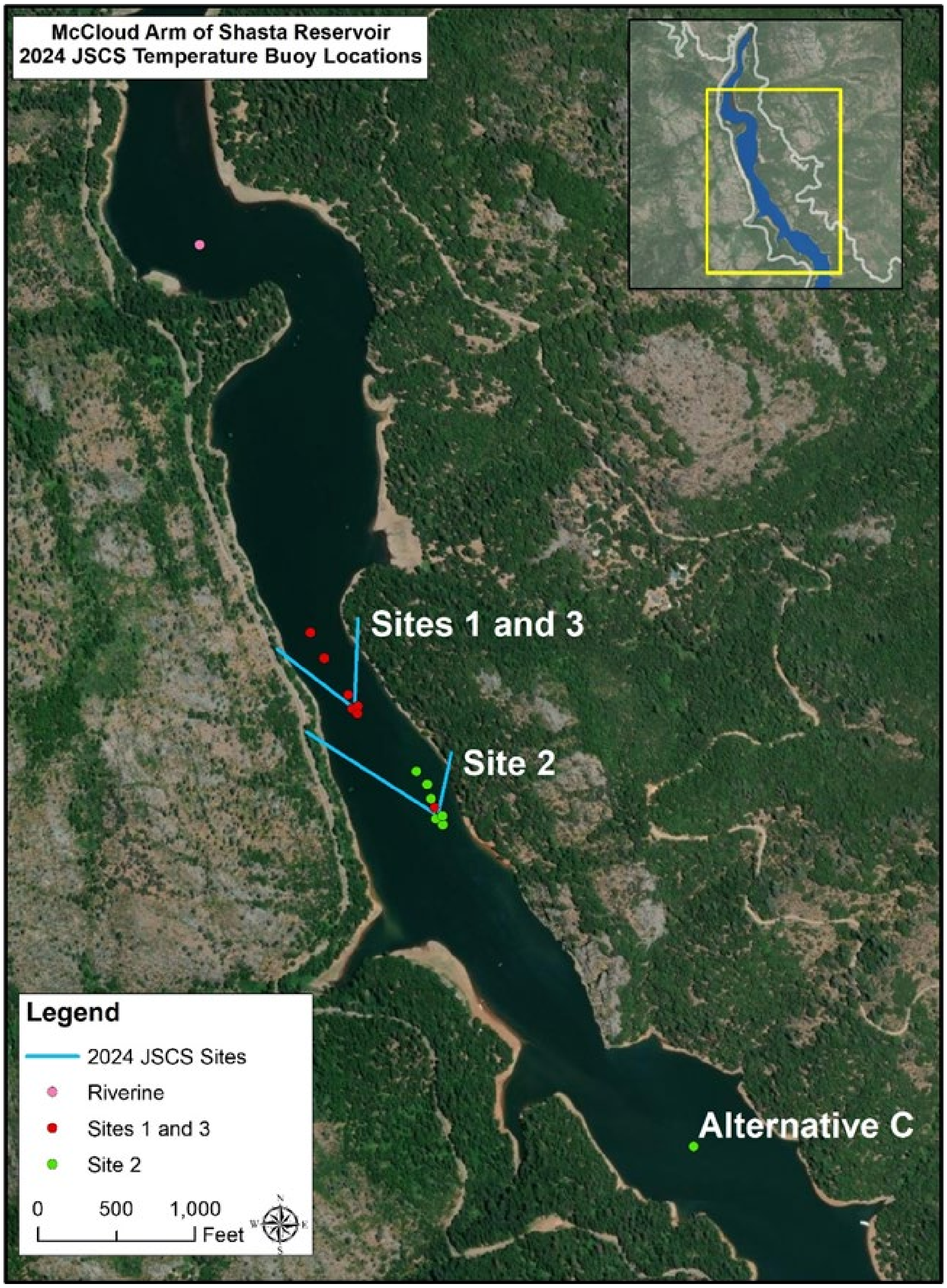


Figure 3.5-1. Map of the temperature buoy deployment locations for the 2024-25 JSCS season. Site 1 Deployment from September – November 2024; Site 2deployment from November – December 2024; Site 3 deployment January 2025; Alternative C (JSCS never deployed here).

Table 3.5-1. *Summary of temperature buoy deployment locations throughout the reservoir during JSCS deployment at Site 1 from September 13-October 29, 2024. The cells marked with "X" indicate the depths at which sensors were deployed. Sensors were deployed either relative to water surface (BWS, below water surface) or relative to reservoir bottom (HAB, height above bed).* ***S4****-4 feet BWS;* ***S7****-7 feet BWS;* ***S13****-13 feet BWS;* ***S23****-23 feet BWS;* ***B1****-1 feet HAB.*

Buoy #	Distance from McCloud Bridge (ft)	Description of location at Site 1	S4	S7	S13	S23	B1
1	4500	4,425 feet upstream of trap, river right (Riverine)					X
2	8600	325 feet upstream of trap entrance, river center	X	X	X		X
3	8700	225 feet upstream of trap entrance, river center	X	X	X		X
4	8900	25 feet upstream of trap entrance, river center	X	X	X		X
5	8950	25 feet downstream of trap off side of trap platform, river left	X	X	X		X
6	8950	25 feet downstream of trap off side of trap platform, river right	X	X	X		X
7	8975	50 feet downstream of trap off rear of trap platform, river center	X	X	X		X
8	10100	1,175 feet downstream of trap entrance at planned location of Site 2, river center	X	X	X	X	X

The JSCS at Site 2 was deployed 50 ft more upstream than planned, therefore 1 ft was added to the station label number for buoy #7 to avoid confusion. For the period of deployment at Site 2, five buoys were deployed throughout the reservoir: one riverine, the same buoy as in Table 3.5-1; three near the upstream mouth of the guidance net, and one further downstream at a planned but unused location (Site C) . Additionally, three lines were hung from the right, left, and center of the trap platform downstream of the guidance net. Due to varying water depths, some buoys had more sensors than others. **Table 3.5-2** summarizes the buoys deployed during the JSCS deployment at Site 2.

Table 3.5-2. *Summary of temperature buoy deployment locations throughout the reservoir during JSCS deployment at Site 2 between October 31, 2024 and December 19, 2024. Cells marked with "X" indicate the depths at which sensors were deployed. Sensors were deployed either relative to water surface (BWS, below water surface) or relative to reservoir bottom (HAB, height above bed).* ***S4****-4 feet BWS;* ***S7****-7 feet BWS;* ***S13****-13 feet BWS;* ***S23****-23 feet BWS;* ***B1****-1 feet HAB.*

Buoy #	Distance from McCloud Bridge (ft)	Description of location at Site 2	S4	S7	S13	S23	B1
1	4,500	5,550 feet upstream of trap entrance, river center					X
2	9,750	250 feet upstream of trap entrance, river center	X	X			X
3	9,850	150 feet upstream of trap entrance, river center	X	X			X
4	10,000	50 feet upstream of trap entrance, river center	X	X	X		X
5	10,075	25 feet downstream of trap entrance off trap platform, river left	X	X	X		X
6	10,075	25 feet downstream of trap entrance off trap platform, river right	X	X	X		X
7	10,101	50 feet downstream of trap entrance off trap platform, river center	X	X	X		X
8	12,000	1,950 feet downstream of trap at Site C, river center	X	X	X	X	X

Site 3 has the same geographic location as Site 1, but the time of year and environmental conditions were different. For the period of deployment at Site 3, no buoys were deployed throughout the reservoir due to unsafe conditions; only the three lines were hung from the right, left, and center rear sides of the trap platform downstream of the guidance net. Due to varying water depths, some buoys had more sensors than others. **Table 3.5-3** summarizes the buoys deployed during the JSCS deployment at Site 3.

Table 3.5-3. *Summary of temperature buoy deployment locations throughout the reservoir during JSCS deployment at Site 1 from before JSCS installation on January 2, 2025 until January 19, 2025. Cells marked with "X" indicate the depths at which sensors were deployed. Sensors were deployed either relative to water surface (BWS, below water surface) or relative to reservoir bottom (HAB, height above bed).* ***S4****-4 feet BWS;* ***S7****-7 feet BWS;* ***S13****-13 feet BWS;* ***S23****-23 feet BWS;* ***B1****-1 feet HAB.*

Buoy #	Distance from McCloud Bridge (ft)	Description of location	S4	S7	S13	S23	B1
1	8600	25 feet downstream of trap on river left side of trap platform at Site 1	X	X	X	X	X
2	8700	25 feet downstream of trap on river right side of trap platform at Site 1	X	X	X	X	X
3	8900	50 feet downstream of trap at center rear of trap platform at Site 1	X	X	X	X	X

To analyze the water temperatures along the reservoir, a longitudinal profile of water temperatures near surface (4 feet below water surface) and near bed (1 feet above bottom) was developed for all buoys for the dates shown in **Tables 3.5-1** to **3.5-3**. The mean water temperature during each month of deployment at the sensors closest to the surface and bottom of the riverbed for each buoy was plotted as a function of distance from McCloud Bridge. The purpose of this comparison is to analyze how the vertical variation in water temperature changes along the reservoir near the JSCS.

3.5b. Water Quality in JSCS Fish Trap

Water temperature at known depths of 1 foot below the surface and at the bottom of the trap was collected continuously using the same model temperature loggers attached to an anchored line. Additionally, each day prior to fishing the trap in the morning, water quality measurements including temperature, dissolved oxygen, turbidity, and salinity were sampled discretely at the same depths of 1 foot below the surface and at the bottom of the trap. Data was summarized by month to create box plots comparing the surface and bottom temperatures within the trap, and to plot a time-series for each month of the average temperature within the trap at every hour of the day.

3.5c. Velocity

During the 2024-25 JSCS deployment, hydraulic data were collected from various locations in proximity to the JSCS structure elements to understand spatial and temporal variations in hydraulics and evaluate the effects of the JSCS on environmental conditions and fish habitat. All velocity data were collected regularly over time to observe changes in environmental conditions and effects of structure operation. Velocity data were collected in accordance with the DWR Shasta Juvenile Salmonid Collection System: Structure Inspection Standard Operating Procedures (DWR, 2024).

The primary sources of data were the following:

1. Velocity transects using ADCP (acoustic Doppler current profiler, Sontek M9) mounted to a shallow-draft watercraft (rQPOD Modular Remote Survey Boat).
2. Point velocity measurements along the JSCS trap using a handheld ADV (acoustic Doppler velocimeter, Sontek FlowTracker 2).

The ADCP data were primarily collected in “transects” that involved starting at one position and ending at another to collect profiles of 3-D velocity data in either cross sections of the reservoir or along JSCS structure elements (e.g., along one wing of the guidance net). ADCP data were collected in cross-sectional transects prior to deployment of the JSCS at all five of the proposed locations of the JSCS. During deployment, ADCP transects were collected at three cross sections moving from upstream of the system to the trap inlet, along both guidance nets, and downstream of the system (total 6 locations, **Figure 3.5-2**). To ensure data quality, compass calibration of the ADCP was performed at the start of data collection, and pairs of transects were collected at each location and reviewed immediately after collection. When inconsistencies were present (e.g., total flow differed by more than 10% between the pair, poor GPS signal, etc.), a third transect was collected to determine which of the previous two was more accurate. ADCP data were collected at boat speeds less than the ambient water velocity when possible. ADCP data were collected approximately weekly.

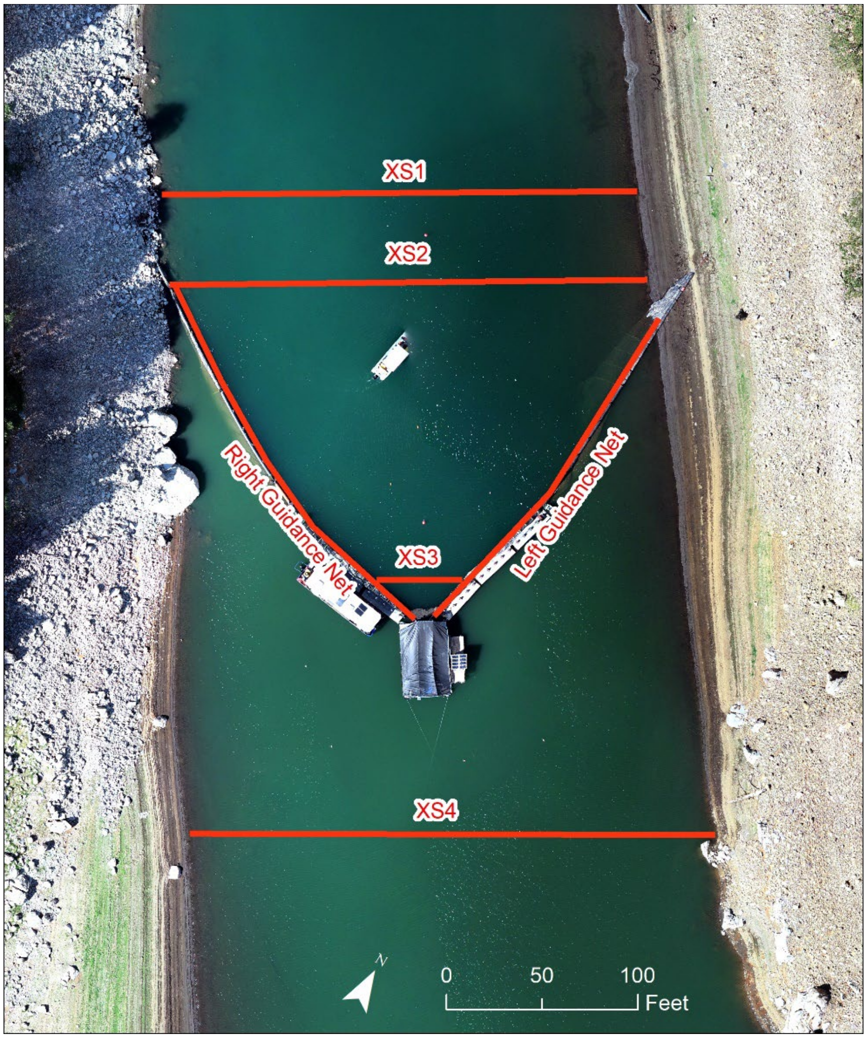


Figure 3.5-2. Aerial image of JSCS deployment at Site 1 on September 18, 2024, showing locations of ADCP-derived velocity data collection: parallel to the right and left wings of the guidance net (quantity 2) and along transects (XS1 – XS4) perpendicular to primary flow direction (quantity 4).

The ADV data were collected at discrete locations and depths to obtain point measurements of 3-D velocity to assess the velocity structure at the trap entrance and within the fry box. ADV data were collected at two depths (1 feet below water surface and 3 feet below water surface) at 2 horizontal positions along the trap (**Figure 3.5-3**). The two horizontal positions were downstream of the first fyke at the trap inlet and downstream of the second fyke inside the fry box. Generally, ADV data were collected daily in the morning prior to trap cleaning; during the start of leaf loading, additional data were collected after trap cleaning to evaluate effects of leaf loading on hydraulics. Each ADV measurement was collected for one minute and re-measured if instrument error exceeded acceptable thresholds. To facilitate comparison of velocities, velocity magnitude was calculated as the square root of the sum of each directional component (x, y, z) squared.

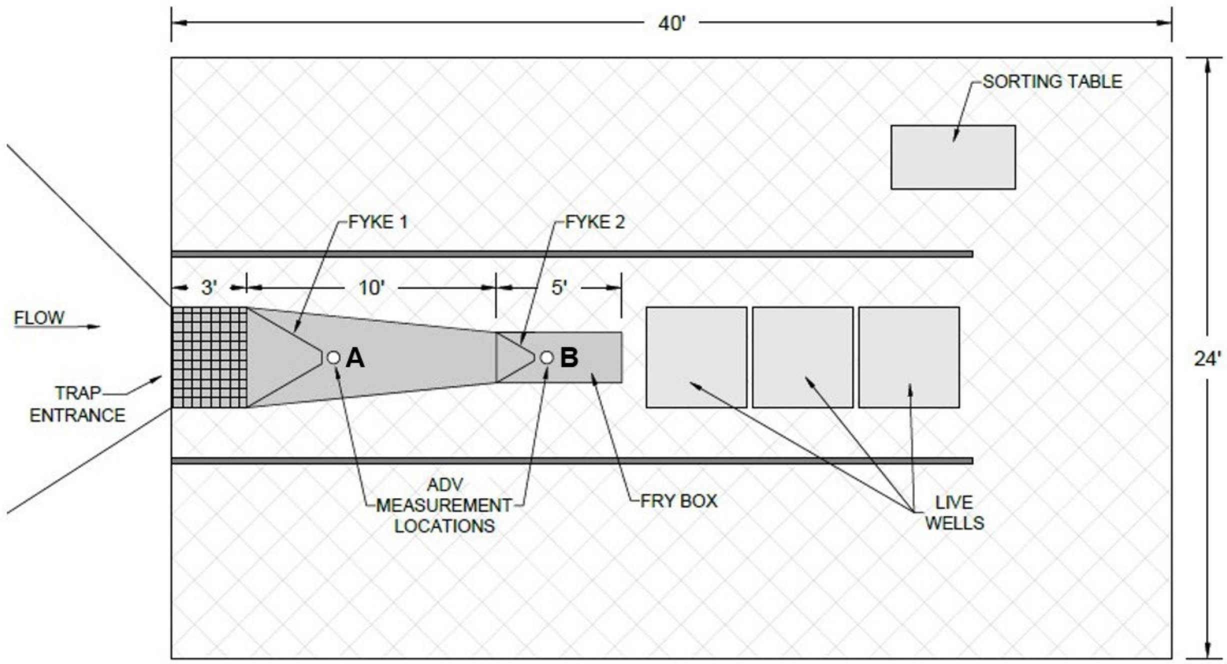


Figure 3.5-3. Schematic of the JSCS trap platform from construction plans showing locations of daily ADV-derived velocity data collection: A—downstream of trap entrance fyke (fyke 1) and B—downstream of fry box entrance fyke (fyke 2) within the fry box.

3.6. Meteorological Data Collection

Meteorological data was collected continuously by two stations: one installed on the right bank near Hirz Bay and one installed on the left bank upstream of Site 1. Meteorological data was collected every hour from September 11, 2024, until January 22, 2025. Specific meteorological variables that were measured include air temperature, rain, wind speed, wind direction, pressure, dew point, relative humidity, and solar radiation. Data from the weather stations were downloaded regularly throughout the season.

3.7. Drone and Aerial Data Collection

Georeferenced aerial imagery was collected weekly when conditions allowed and followed the DWR Shasta Juvenile Salmonid Collection System: Drone Operations Standard Operating Procedures (DWR, 2024). This imagery was obtained using a DJI Phantom 3 RTK drone and a Trimble R10 base station. For each flight, the drone was flown at an altitude of 300 feet and followed a predefined flight path (**Figure 3.7-1**). Images taken during the flights were stitched together using photogrammetry post-processing software and final orthomosaics were made for each weekly flight throughout the season.

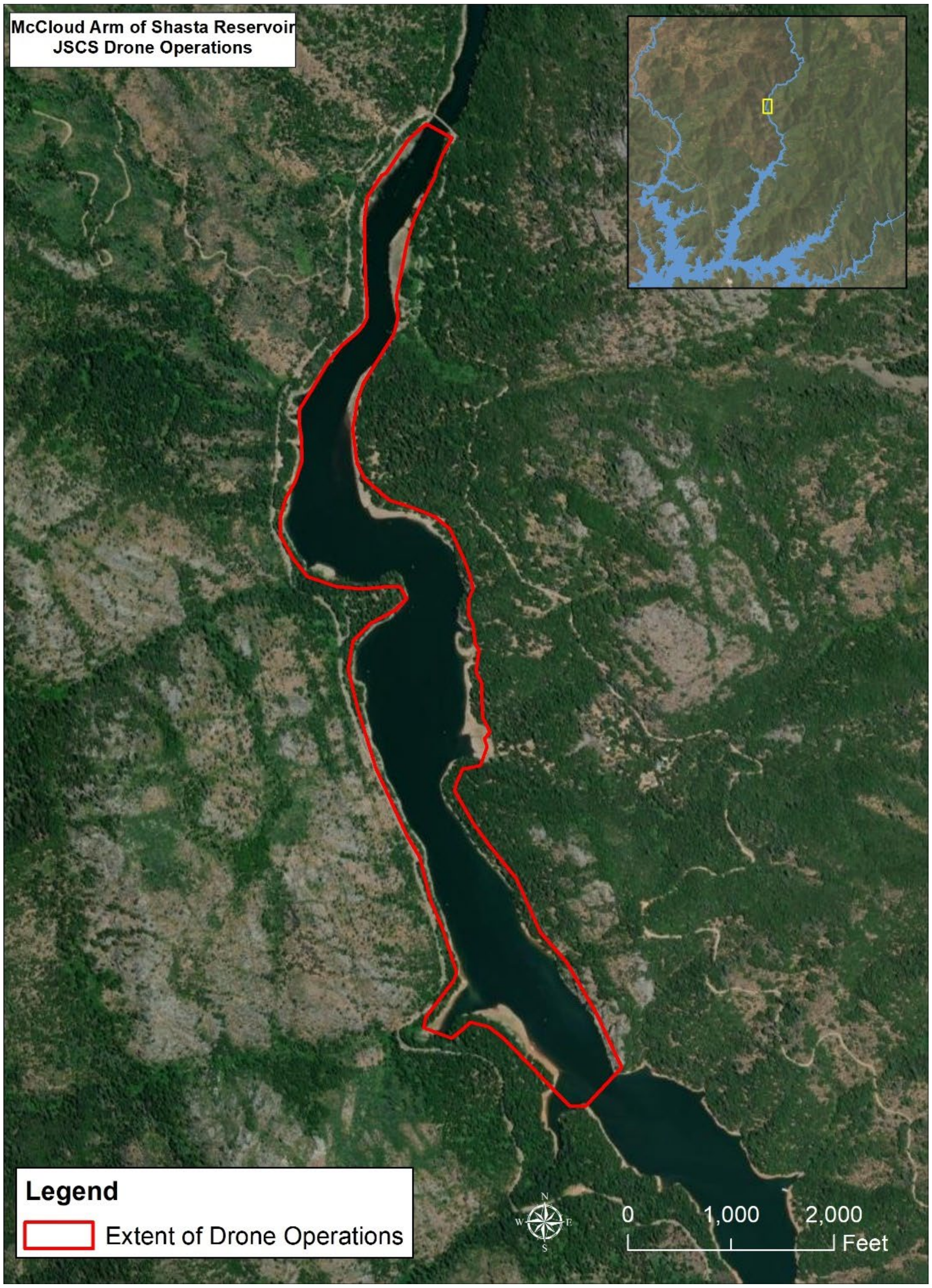


Figure 3.7-1. Regional Context and Project Area for JSCS Drone Surveys.

3.8. Fisheries Data Collection

The JSCS crew checked the fish trap daily, except when hazardous conditions prevented safe trap operation. The crew fished the trap overnight, closed the trap for sampling in the morning, and opened the trap again at the end of processing. All Nurcaptured at the JSCS were transported to the PSMFC crew and the Winnemem Wintu Tribe for relocation and release downstream under the authorization of

CDFW. Hook-and-line sampling provided data on predator assemblages and predation in the vicinity of the trap. Weekly mark-recapture trials (efficiency releases) provided data on capture probability. Changes from the previous field season included:

- Expansion of target predator species to include Spotted Bass, White Crappie, Bluegill Sunfish, Rainbow Trout, and Brown Trout
- Expansion of predator sampling methods to include hook-and-line sampling and gastric lavage
- No hook-and-line sampling to measure catch per unit effort
- Use of the “fish viewer” for morphometric sampling of Nur (collaboratively developed by the Winnemem Wintu Tribe and UC Davis)

DWR identified the following priority research questions in the JSCS Study Plan: Trap Collection and Predatory Fish (2024) and the JSCS Study Plan: Coordinated Trap Efficiency, Survival, and Capture Probability (2024):

- What is the outmigration timing of Nur in the McCloud River? When should JSCS be deployed to capture juveniles and yearlings (juveniles that overwintered in the river)?
- What is the composition (species, age class) of the resident fish assemblage in the vicinity of the JSCS? How does this change across timing, reservoir conditions, and siting locations?
- What physical (e.g., temperature) or biological (e.g., predation) factors play a role in trap efficiency and capture probability? What is the relationship between these factors?
- What are the positions and configurations trap (e.g., screen openings, fyke type, etc.) of the JSCS which allow for optimal capture probability? What reservoir conditions (e.g., depth, velocity, position in channel) allow for optimal capture probability?
- What are the diets of resident target predator species (e.g., Black Bass, Rainbow Trout, Brown Trout)? What is the frequency with which target predator species consume Nur in and around the JSCS trap?
- What pathogens are present among resident fish in the McCloud Arm of Shasts Reservoir? Do resident fish pose a pathogen risk to juvenile winter-run Chinook Salmon?
- What is the survival rate of juvenile Chinook salmon in the McCloud Arm of Shasta Reservoir and what is the relationship between physical and environmental variables and survival rate?

3.8a. Daily Trap Operations

Methods for daily trap sampling on the JSCS followed the DWR Shasta Juvenile Salmonid Collection System: Fish Sampling Standard Operating Procedures (2024). The trap was sampled at least once daily. All species caught in the trap were identified and enumerated during trap processing: Chinook Salmon were held for sampling and transport (**Figure 3.8-1**); target predator species were held for sampling (**Figure 3.8-2**); and non-target species were released downstream of the trap structure. Captured salmon were individually checked to confirm species, check health status, and identify marks (e.g., caudal clips, tag sutures, or dye) (**Figure 3.8-3**). Of the day’s catch, up to 15 efficiency fish (marked, hatchery-reared winter-run Chinook Salmon) and 10 Nur (unmarked, Ah Di Na-reared winter-run Chinook Salmon) were subsampled at the fish sampling station on the trap platform.

Figure 3.8-1. Chinook Salmon sampling paths for the JSCS field season 2024-25. When operated correctly, use of the fish viewer allowed water-to-water transfers instead of netting during measurement.

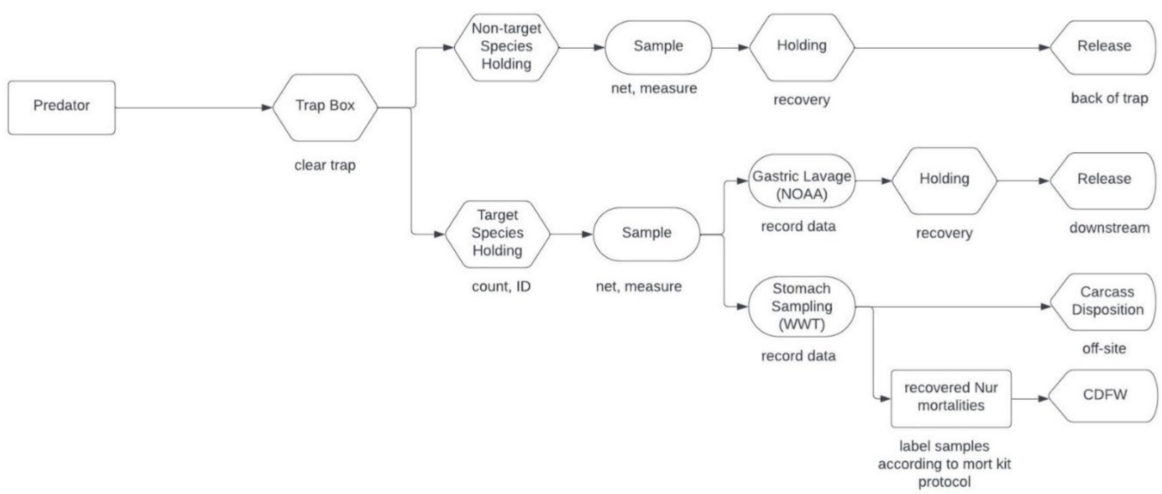


Figure 3.8-2. Predator species sampling paths for JSCS field season 2024-25.

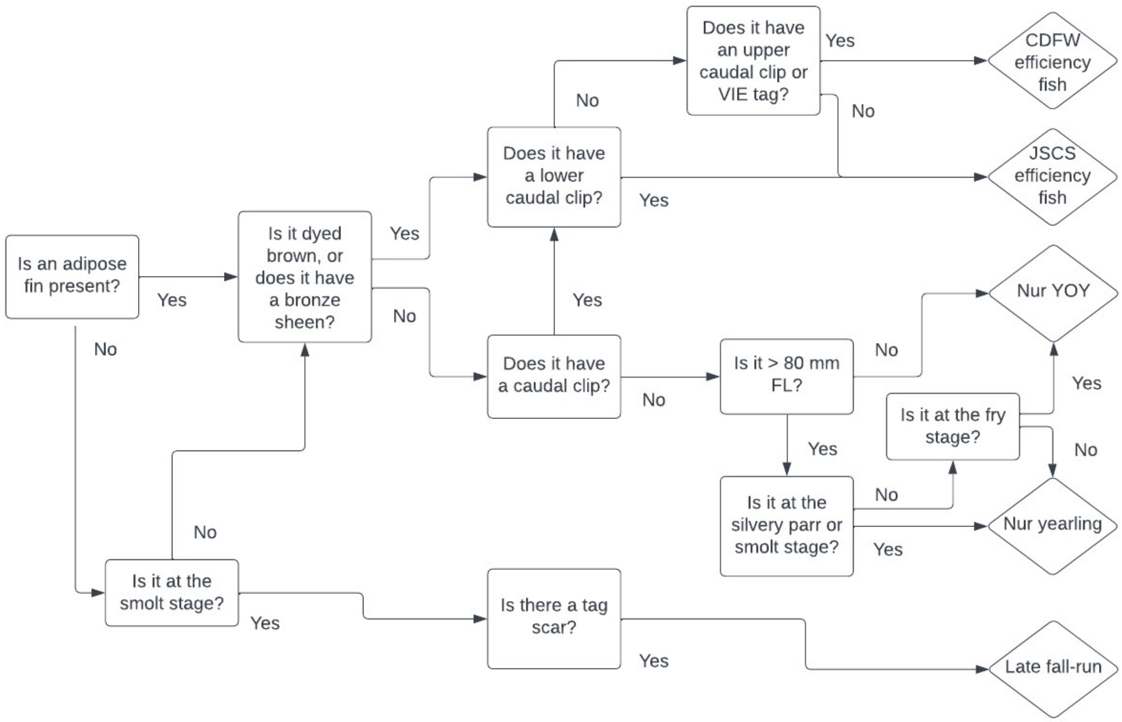


Figure 3.8-3. Juvenile Chinook Salmon identification key for Chinook Salmon present in McCloud River 2024-25.

The JSCS crew relied on the fish viewer to take morphometric measurements of Nur via camera and only used measuring boards to determine fork length when the fish viewer proved nonviable. The fish viewer is an experimental prototype developed to reduce handling stress and eliminate the need for out-of-water measurements, and the 2024-25 season served as field testing for the prototype. The JSCS crew did not take scale or tissue samples from salmon under the recommendation from the Winnemem Wintu Tribe to preserve fish health and maximize wildness.

All live salmon were placed in transport containers and driven to shore by boat for transfer and hand-off to PSMFC crews at 1:30 PM daily, after which PSMFC and the Winnemem Wintu Tribe transported the salmon for release into the Sacramento River below Keswick Dam. Any mortalities were stored in labeled sample bags according to the Mortality Kit protocol provided by NOAA and UC Davis and submitted to UC Davis and NOAA Fisheries.

3.8b. Trap Efficiency Trials

DWR conducted mark-recapture trap efficiency trials to assess capture probability of juvenile Chinook Salmon in the McCloud Arm of Shasta Reservoir according to the DWR Shasta Juvenile Salmonid Collection System: Efficiency Trials Standard Operating Procedure (2024) (**Table 4.6-1**). DWR planned for weekly trials, but adverse weather conditions (e.g., extreme heat events and severe winter storms) occasionally threatened the safety of staff or fish and prevented trial releases. Due to pathology concerns at Livingston Stone National Fish Hatchery, DWR did not conduct trial releases for two weeks in October. In total, DWR conducted nine trials across an 18-week field season.

In the 2023 field season, efficiency trial and trap sampling results indicated that predation between release and capture sites likely had an impact on juvenile Chinook Salmon survival during trials. In a change from previous seasons, for 2024-25 DWR divided efficiency trials into paired releases to assess the impact of predation upstream of the structure versus in immediate trap vicinity. DWR split efficiency trial releases into two groups: the “standard” release group and the “near” release group (**Table 3.8-1**). The “standard” release group typically contained 150 fish dual-marked with a lower caudal fin clip (LC) and Bismarck Brown-Y dye (BB) and released 0.5 kilometers upstream of the JSCS structure (**Figure 3.8-4**). The “near” release group contained between 50-150 fish marked only with BB and released 300 feet upstream of the JSCS structure. The trial size of the near release group was increased part way through the season to try and improve catch numbers from that group. All juvenile Chinook Salmon at Livingston Stone National Fish Hatchery received a coded wire tag (CWT) and adipose fin clip (AD) in January 2025, which provided the secondary mark for the final two trials of the season (**Table 3.8-1**). DWR typically conducted trials on Tuesdays and paired JSCS trials with upstream rotary screw trap (RST) and incline plane trap (IPT) trials when possible. Upstream trials used visual implant elastomer (VIE or a dual mark of BB paired with an upper caudal clip (UC) to differentiate fish.

Table 3.8-1. *Schedule of Efficiency Trial Releases and Marks*.

Date	Standard Release (number released, marking strategy)	Near Release (number released, marking strategy)	Total number of fish released
9/24/2024	N=149, BB+LC	N=50, BB	199
10/01/2024	N=149, BB+LC	N=49, BB	198
10/25/2024	N=150, BB+LC	N=50, BB	200
11/05/2024	N=150, BB+LC	N=150, BB	200
11/12/2024	N=150, BB+LC	N=150, BB	300
12/04/2024	N=150, BB+LC	N=150, BB	300
12/10/2024	N=150, BB+LC	N=150, BB	300
1/07/2025	N=150, AD+LC	N=150, AD	300
1/14/2025		N=150, AD+BB	150

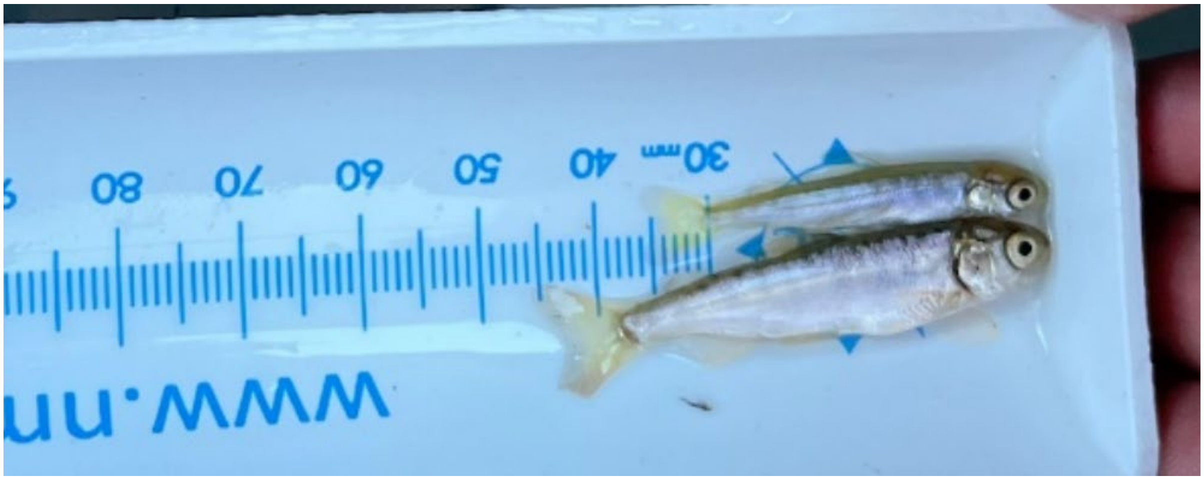


Figure 3.8-4. Unmarked Nur (above) with dual-marked efficiency fish (below) on measuring board.

Crews transported marked fish by truck from Livingston Stone National Fish Hatchery to the McCloud Bridge Campground. Crews conducted the releases at dusk, by boat when possible and by foot when boat passage proved infeasible. Release sites were established at a set distance from each trap site: 0.5 kilometers upstream and 300 feet upstream for standard and near release groups respectively (**Figure 3.8-5).** The JSCS recaptured most efficiency fish within 24 hours of release. It is assumed that fish not recaptured did not survive or passed downstream below the JSCS.

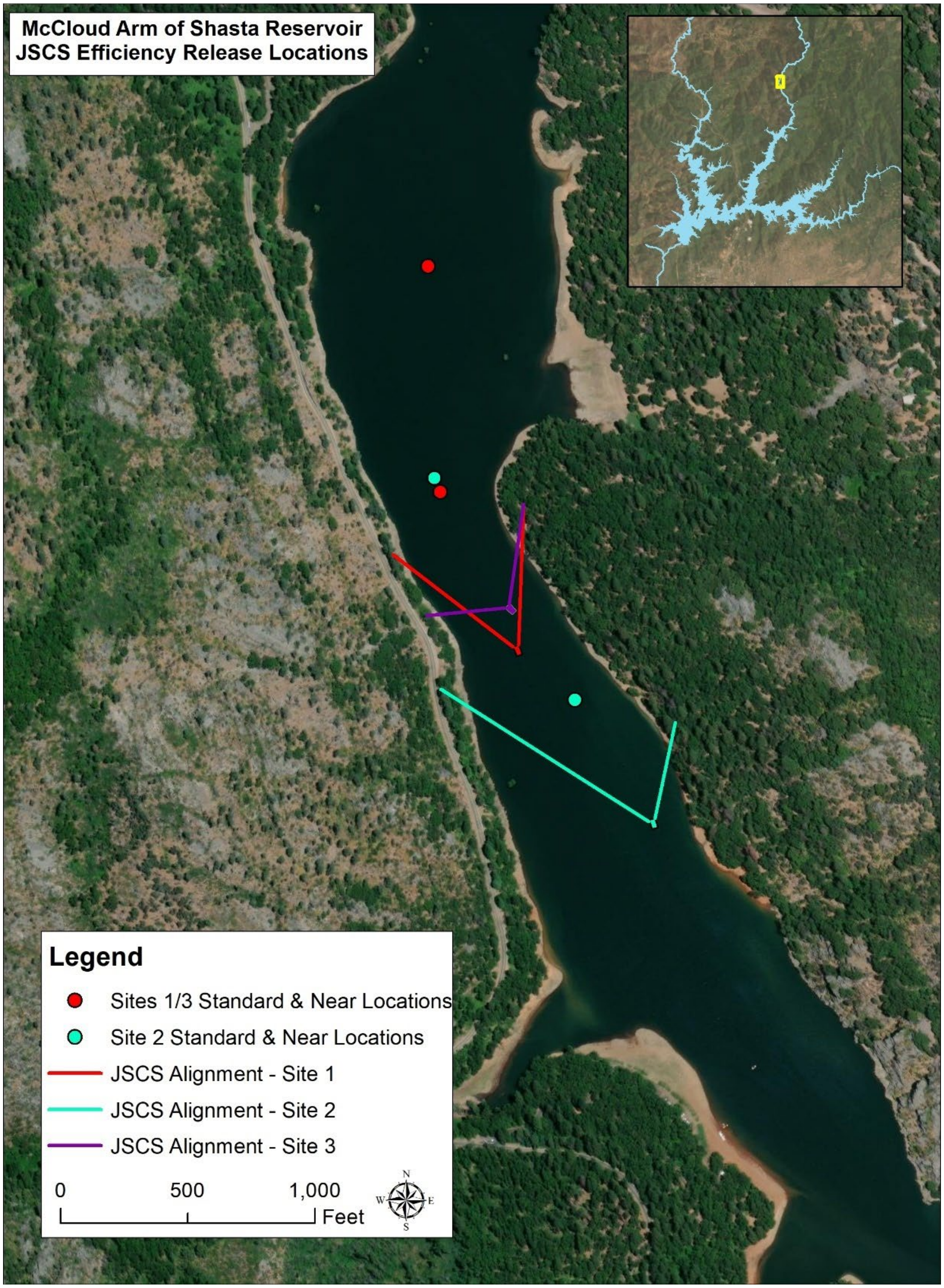


Figure 3.8-5. JSCS Efficiency Trial Release Locations.

3.8c. Predation

DWR transferred target predator species (Black Bass species and Sunfish species) to the custody of the Winnemem Wintu Tribe for lethal stomach sampling on a daily basis. Crews from University of Santa Cruz NOAA Southwest Fisheries Science Center sampled adult trout and bass species from the JSCS platforms by hook and line at weekly intervals between September and November to sample diets using non-lethal methods (**Table 3.8-2**).

Table 3.8-2. *Schedule of hook-and-line predator sampling days, locations, methods.*

Date	Sampling Location	Method
9/24/2024	JSCS Docks	Gastric Lavage
10/08/2024	JSCS Docks	Gastric Lavage
10/15/2024	JSCS Docks	Gastric Lavage
10/29/2024	JSCS Docks	Gastric Lavage
11/05/2024	JSCS Docks	Gastric Lavage

3.8d. Pathology

The United States Fish and Wildlife Service Cal-Nevada Anderson Fish Health Center tested the winter-run Chinook Salmon cohorts at Livingston Stone National Fish Hatchery and certified that all fish used in JSCS trap efficiency trials were free of disease and viral infection.

Protocol dictated that juvenile trout captured at the JSCS would be held for pathogen sampling by Cal-Nevada Anderson Fish Health Center to monitor pathology among resident salmonids. This sampling required that at least 10 trout be captured within one week and held live. The JSCS did not capture sufficient numbers of trout during any week of fishing during the 2024-25 season and was unable to complete this pathology testing.

JSCS crews photographically documented observations of clinical signs of disease among resident fish species caught in the JSCS fish trap and submitted these observations to Ken Nichols at the Cal-Nevada Anderson Fish Health Center.

3.8e. Traditional Ecological Knowledge

Protocols for salmon sampling differ significantly between Winnemem Wintu traditional ecological knowledge and western scientific fisheries methods. Winnemem Wintu traditional ecological knowledge centers relationships with salmon and the maintenance of multispecies kinship networks (McLeod 2001; Zedler and Stevens 2018; Woelfle-Hazard 2022) where western science typically prioritizes the collection of numeric data to quantify ecological phenomenon (Smith 1990; Scott 1998). This difference presents itself in divergent approaches to salmon handling: standard scientific methods in western fisheries sampling include netting the fish, anesthetizing it, taking morphometric measurements, taking scale or genetic samples, and conducting surgery to mark the fish or implant a tag. The Winnemem Wintu Tribe holds knowledge that this kind of handling decreases the wildness of Nur, causes stress to juveniles, and adversely affects the overall fitness of salmon. The Winnemem Wintu Tribe recommended that DWR adopt sampling methods which minimize fish handling and time out of water. Under this guidance, DWR used the fish viewer prototype developed collaboratively by the Winnemem Wintu Tribe and UC Davis Engineering to collect morphometric data for Nur without measuring boards or scales and did not take additional samples from Nur.

In the 2024-25 field season, DWR incorporated traditional methods through collaboration with Winnemem Wintu Tribe scientists and cultural resource specialists. These methods included using woven willow to replace plastic Vexar across the trap fykes for predator exclusions; minimizing Nur sampling and increasing sampling of invasive predators; and respecting and participating in ceremony.

Section 4. Results and Observations

4.1. Hydrology and Water Surface Elevation

After a particularly dry 2022, the winters of 2023 and 2024 had above-average precipitation that caused Shasta Reservoir to reach a water surface elevation (WSE) near its full capacity at 1067 feet (**Figure 4.1-1**) in May of those years. Comparison of WSE in 2022, 2023, and 2024-25 is shown visually in Figure 4.1-1. Project duration for the 2022 and 2023 field seasons is represented by blue shading while the additional project duration of the 2024-25 field season is represented by orange shading. The difference in WSE at the start of JSCS project operations between 2022 and 2023 was nearly 96.6 feet. The WSE was 23 feet greater at the start of operations in 2023 than in 2024-25. Over the JSCS deployment, reservoir WSE decreased approximately 10 feet in 2022 and 12 feet in 2023. In 2024-25, reservoir WSE decreased by 16 feet and then increased by 42.5 feet, resulting in a net overall increase of 26.5 feet.

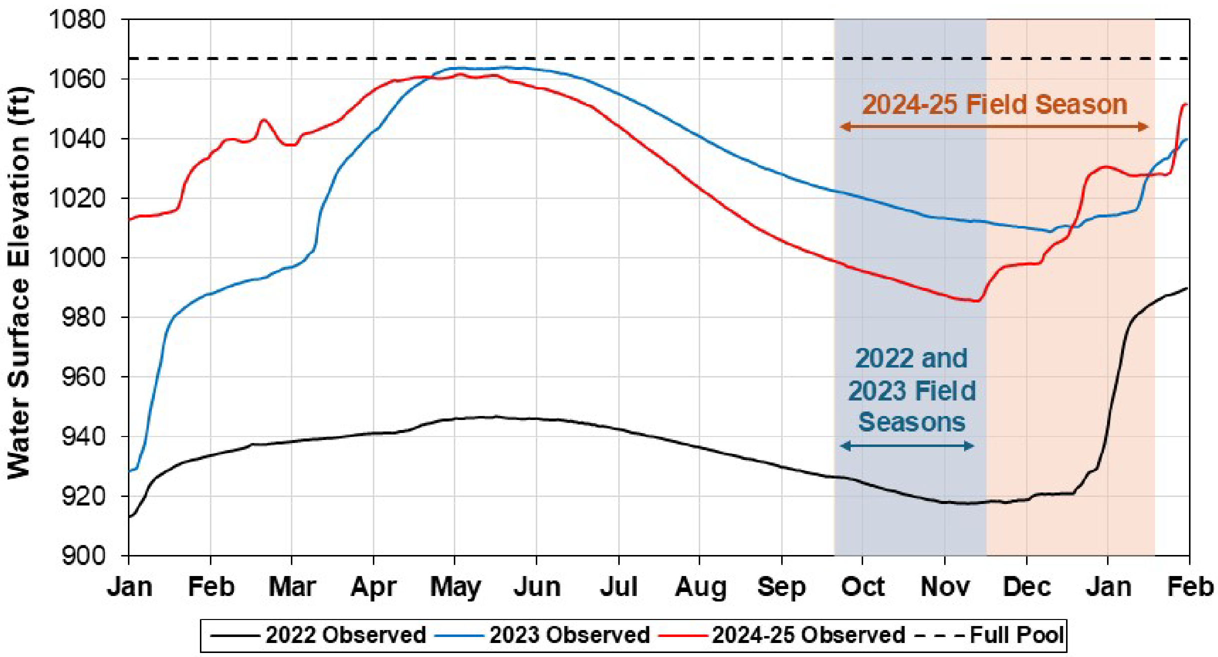


Figure 4.1-1. Comparison of Shasta Reservoir water surface elevations for the three field seasons with shaded season durations.

During the 2024-25 field season, WSE started at 1001.9 feet and then decreased by approximately 0.3 feet/day for the first two months, followed by rapid increases of 11 feet, 7 feet, and 25 feet following storm events. WSE reached a minimum value of 985.5 feet on November 19, 2024 and finished the season at 1027.9 feet. **Figure 4.1-2** shows the observed WSE of Shasta Reservoir over time and the August forecasts that were used to finalize plans for the 2024-25 field season. The observed WSE fell between the 50% and 90% forecasts for the first two months of the field season. However, the late fall storm events rapidly pushed the WSEs above the 90% forecast values prior to the start of winter. These rapid changes in water level highlight the unpredictable nature of the reservoir and uncertainty in forecasting reservoir WSEs during the rainy season.

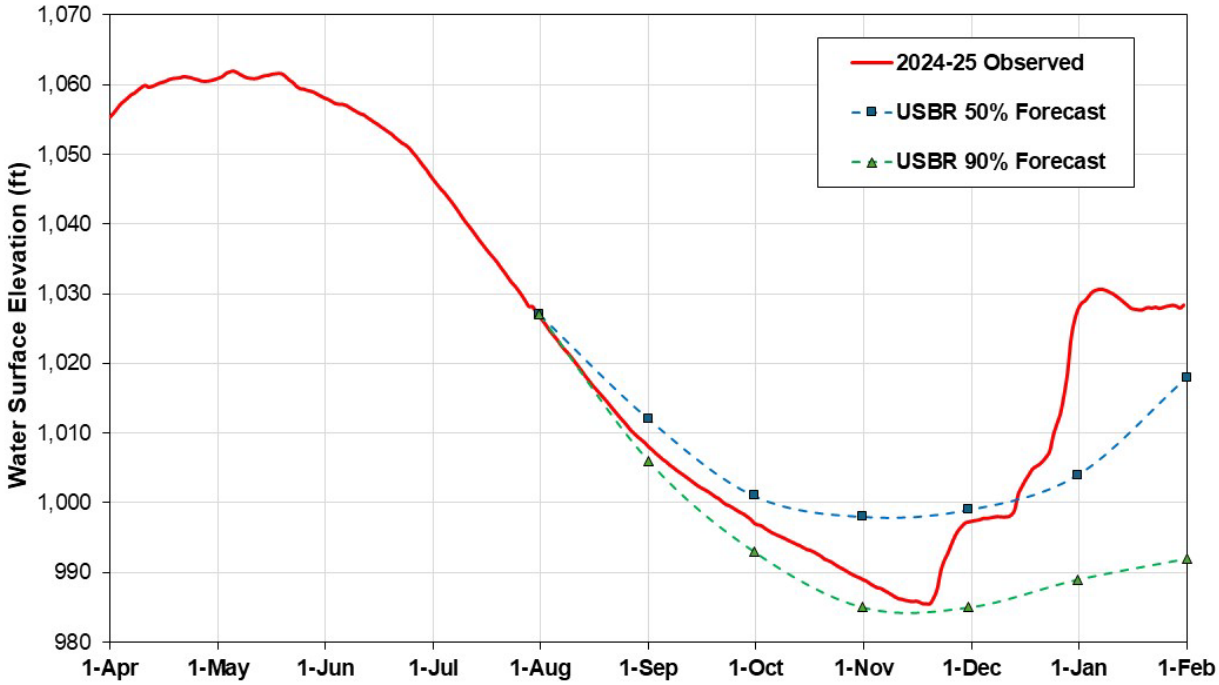


Figure 4.1-2. Comparison of observed Shasta Reservoir water surface elevations and USBR forecasts of WSEs over the duration of the field season.

Unlike the previous two field seasons, the 2024-25 field season included several high-flow events. **Figure 4.1-3** shows McCloud River inflow hydrographs for the three field seasons. In 2022, the average flow during the field season was 420 cfs with a maximum flow of 862 cfs. In 2023, average flow during the field season was 340 cfs with a maximum flow of 651 cfs. In 2024, average flow during the field season was 953 cfs with a maximum flow of 10,579 cfs. The higher flows resulted in logistical challenges that delayed or ceased operations for several days twice during the field season. **Figure 4.1-4** shows the precipitation hyetograph and flow hydrograph for the 2024-25 field season with periods of normal operations shaded in grey. The two large gaps in the middle of the season illustrate how significantly the winter storm events affected operations.

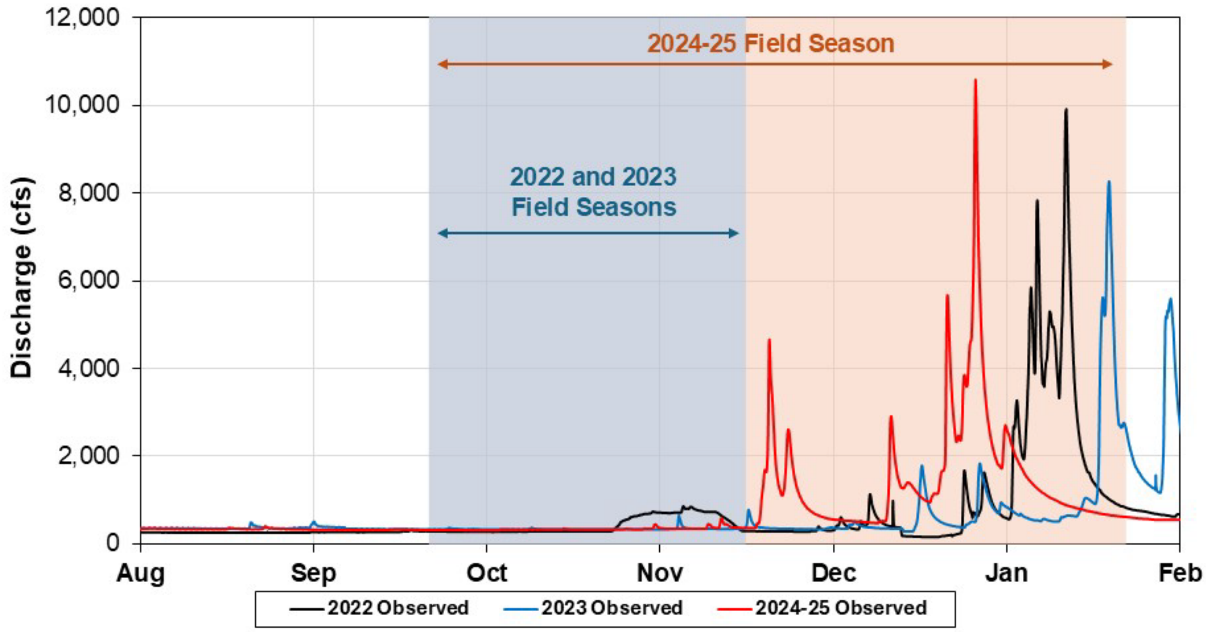


Figure 4.1-3. Comparison of McCloud River flow hydrographs for the three field seasons with shaded season durations.

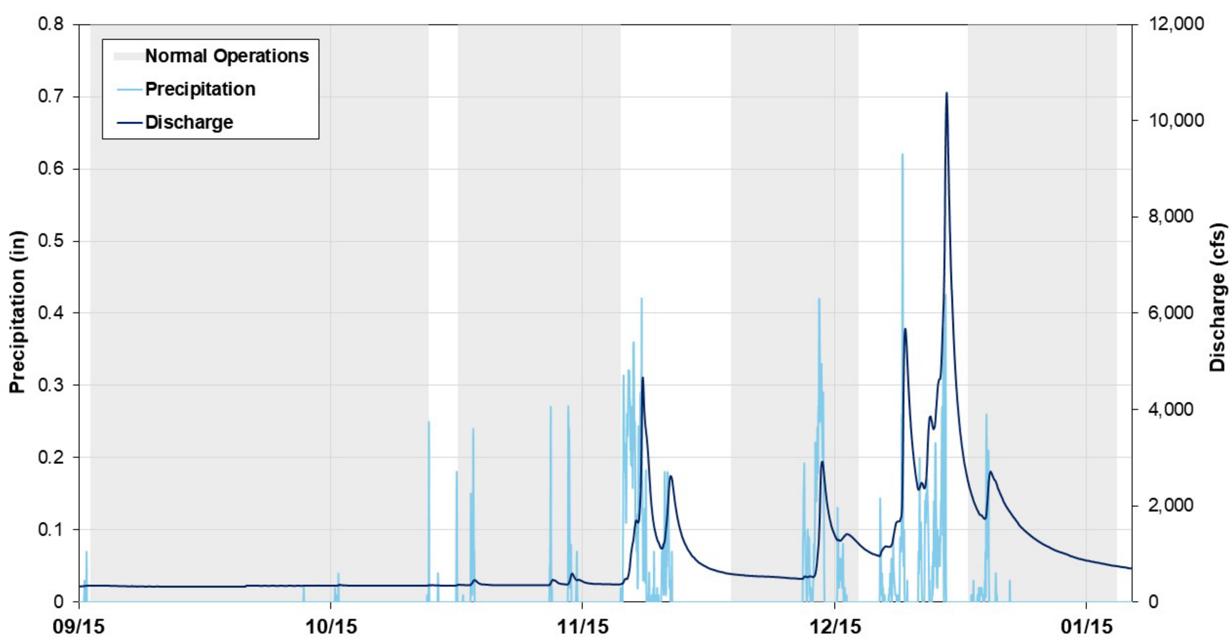


Figure 4.1-4. Flow hydrograph and precipitation data for the 2024-25 field season. Flow data is from the McCloud River CDEC gage (MSS) and precipitation data from the weather station adjacent to the JSCS.

4.2. Water Quality

Water quality is a quantification of the ability of a water source to meet the chemical, biological, and physical requirements of a specific water use (FJC 2025). Water temperature varies vertically and is a function of depth, time of year, and roughness. Dissolved oxygen (DO) is a physical measure of the amount of oxygen currently dissolved in the water. DO is impacted by chemical, physical, and biological properties. Cooler water can carry more DO than warmer water. Rapidly moving water typically has a higher DO content than stagnant water. Furthermore, deep lakes can be prone to thermal stratification, especially during warm summer months. Turbidity evaluates the "cloudiness" of the water and is affected by variety of factors, including small particles of suspended clays and silts, dissolved organic compounds, and algae, zooplankton, and other microorganisms. Turbidity can vary significantly based on the flow rate of the waterbody at the time of measurement. Specific conductivity and pH are also important in understanding how tidal influence and soil interactions affect water chemistry. In this case, depth is a proxy for location relative to the river-reservoir interface and the presence of JSCS structure elements in the water introduces roughness which is designed to improve the water quality parameters in the functional area for juvenile salmonids.

The data collected in 2024-25 show stratified conditions during deployment persist throughout the reservoir arm at deeper locations and that the presence of the JSCS structure affects the stratification. For instance, morning surface temperatures during September at the US trap entrance ranged from 22.4-12.5 ˚C with the median temperature at 13.4 ˚C, whereas the near bed temperatures at the same time only differed by 0.5 ˚C with a median of 12.6 ˚C. Further upstream in shallower riverine conditions, there was no stratification nor significant difference in water temperatures (R^2>0.8) between the MSS gauge and the traps deployed by CDFW during their operations (**Figure 4.2-1** and **Figure 4.2-2**). At the 2024-25 JSCS deployment sites, water temperature in the reservoir was stratified prior to guidance net installation. The guidance net, with impermeable panels installed over the net, along with the trap wrap reduced this stratification upstream of the trap entrance immediately upon installation and eliminated it by September 19, 2024 (**Figure 4.2-2;** see also **Section 4.3a**). Despite the elimination of stratification upstream of the guidance net, downstream of the trap platform remained stratified, which gave rise to stratified temperatures within the fry box at Site 1 during September and October operations (**Figure 4.2-4**). Considering that water depth in the fry box is only 5.6 feet, large top-bottom variations in temperature can indicate a limited volume for which any captured fry can find cool temperatures. However, the mean monthly water temperature within the fry box was always below 21.5 ˚C (figure 4.2-5), a critical threshold for juvenile salmonids (USEPA 1999, Fleisig & Labiosa 2022), and even during the warmer months cold water refugia was present within the fry box near the bed.

4.2a. River and Reservoir Temperatures

Data from the MSS Gage shows a decreasing trend in McCloud River temperature during the period of JSCS operations between September 17, 2024 and January 19, 2025 (**Figure 4.2-1 and Figure 4.2-5**). The river temperature at the start and end of operations was 12.4 °C and 5.3 °C, respectively, with an average temperature over the deployment of 8.5 °C.

Comparatively, water temperatures at the JSCS were 18.5 °C at the start of operations; reached a low of 4.8 °C on December 10, 2024; rose to 10.3 °C January 6, 2025; and decreased to 9.3 °C by the end of operations (Figure 4.2-1). The average daily water temperature over the deployment at the JSCS upstream entrance to the trap was 9.5 °C.

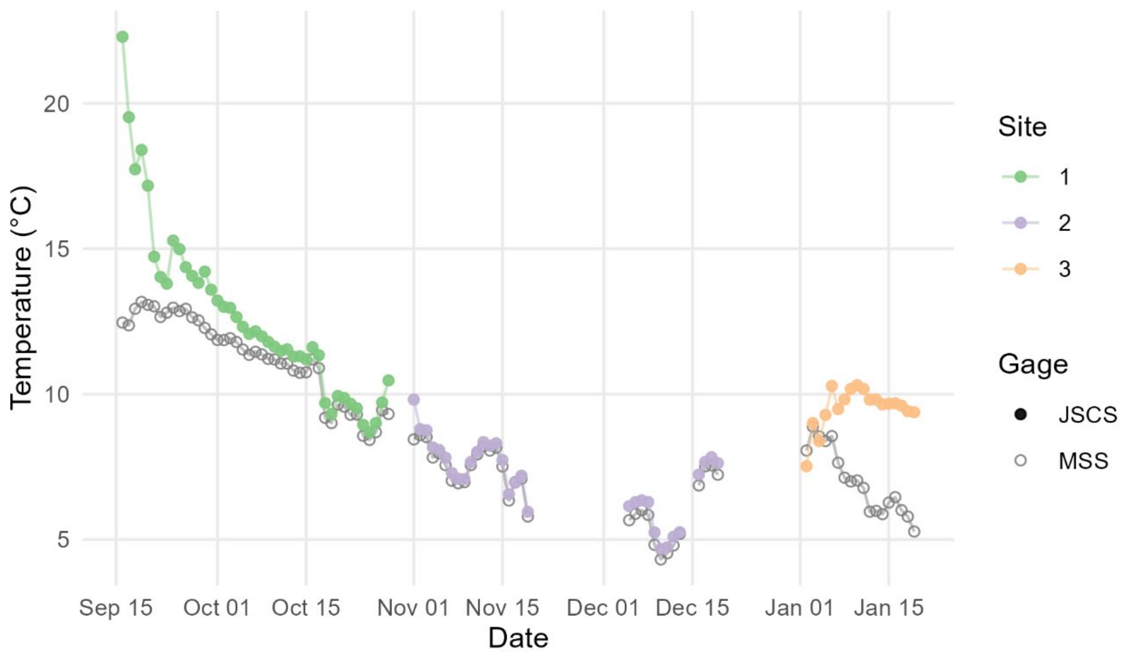


Figure 4.2-1. Daily time-series of mean water temperature at MSS gauge (Riverine) compared to the entrance of the JSCS Trap during fishing operations; the open dot is at the MSS gauge, and the solid dot is the at trap entrance of the JSCS at 3 ft deep for Sites 1, 2, and 3.

In addition to water temperature data in the vicinity of the JSCS, DWR collected water temperature data at the rotary screw trap (RST) at Bollibokka and at the incline plane trap (IPT) just below the McCloud Bridge. The RST was deployed 11,825 feet above the McCloud Bridge and the IPT was deployed 750 ft below the bridge. A short period of data was available to compare with water temperature collected at the MSS gage (**Figure 4.2-2**) from October 1, 2024, until November 13, 2024, for the IPT and until November 19, 2024, for the RST. These results show that the in-river trap data was comparable to McCloud River Above Shasta Lake (MSS) gage data during the sample period. Investigating the time series more closely (Figure 4.2-2), the in-river trap temperatures are essentially equal to MSS gage temperatures for both traps at temperatures above 7 ˚C. This comparison shows that the MSS gage is a reasonable surrogate for water temperatures within the river where CDFW deploys their traps, and this data can be used as a baseline for comparison to water temperatures at the JSCS which is located further downstream at the river-reservoir interface. JSCS water temperatures, however, differ significantly from temperatures at MSS Gage prior to October 15 and after January 1 (Figure 4.2-1), which demonstrates that the JSCS and IPT/RST operate in different temperature conditions.

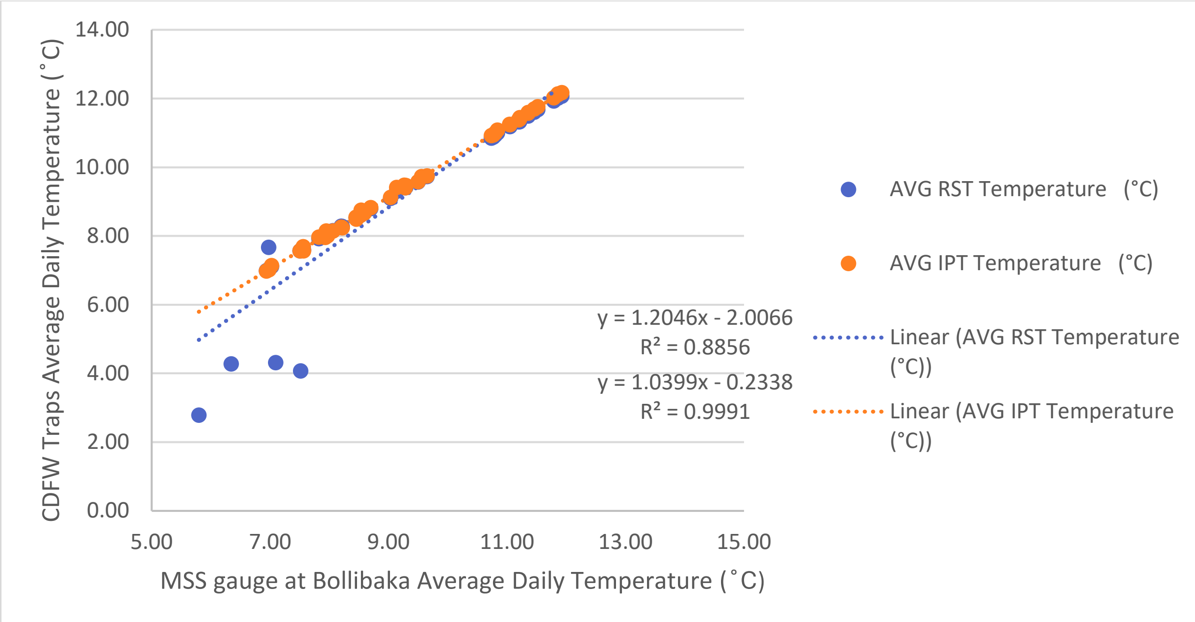


Figure 4.2-2. Best-fit line of continuous hourly water temperature data from CDFW traps compared to MSS gauge at Bollibokka during CDFW fishing operations. Sampling occurred 10/1/2024 to 11/19/2024, dashed line is best fit trend line.

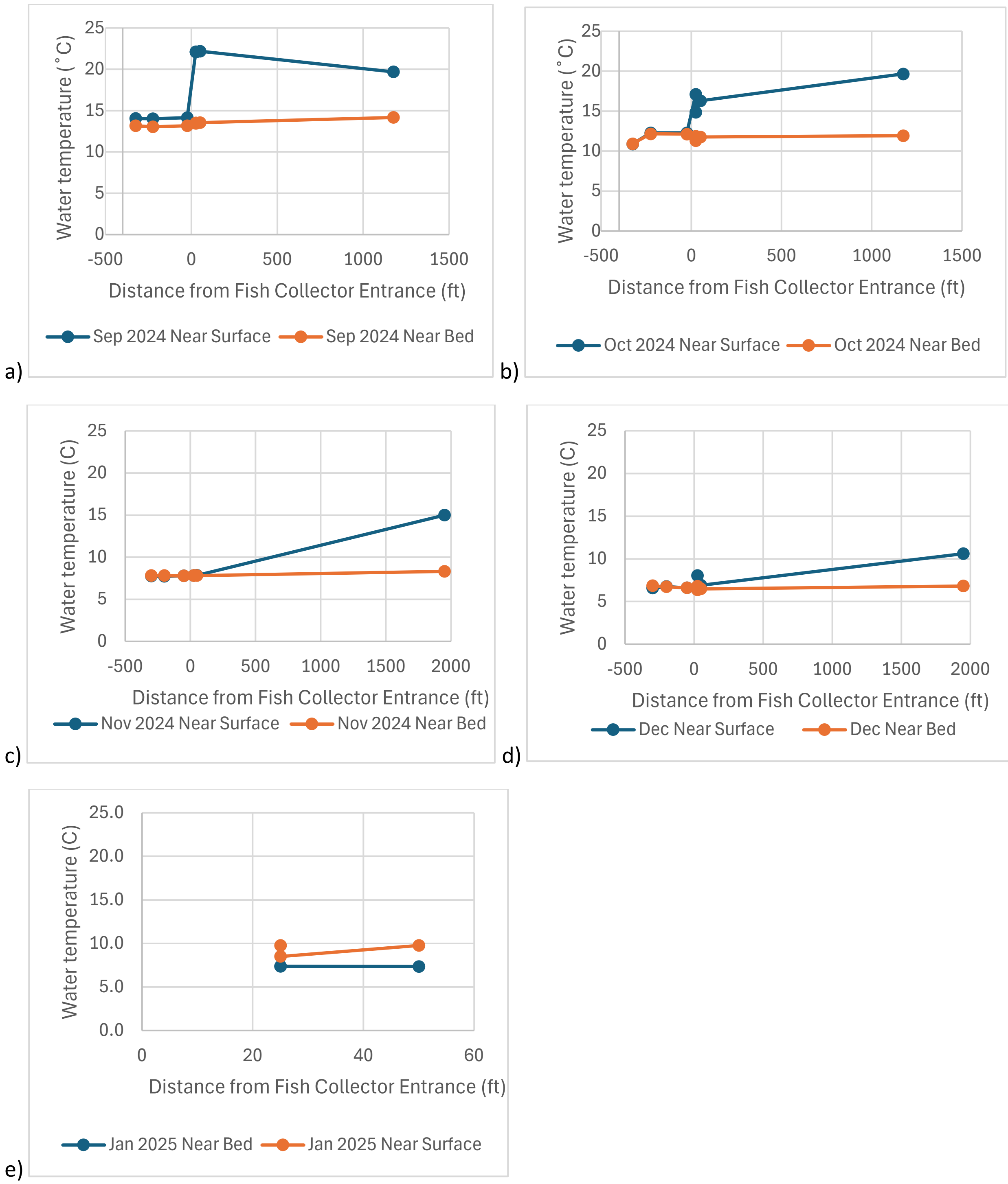
4.2b. Longitudinal Profiles

At Site 1 in early September, water temperatures were stratified. By September 19, six days after the guidance net and trap wrap were installed, the region upstream of the guidance net was well-mixed and trending towards the colder riverine temperatures at the MSS Gauge (Figure 4.2-1). Downstream of the trap platform, the reservoir remained stratified (**Figure 4.2-3a – b**).

At Site 2, conditions were also stratified prior to guidance net and trap platform installation on October 31, 2024. By November 1, 2024, conditions upstream of the guidance nets and trap platform were well-mixed and cold, with a November monthly average of 7.8 °C ± 0.8 SD (Figure 5.2-3-d). Water temperature remained stratified downstream of the JSCS trap platform at Site 2 and were strongly stratified at the planned Alternative Location C deployment site downstream **(Figure 4.2-4-c – d)**. However, the JSCS was never deployed at this downstream alternative.

Conditions at Site 3 remained weakly stratified downstream of the guidance net for the remaining 3 weeks of sampling **(Figure 4.2-e)**. Due to winter storms and heavy debris flow, no temperature buoys were deployed upstream of the guidance net during this time. The data collected from the temperature buoys shows a weak stratification (1.4 – 2.5 ˚C difference bed to surface) occurring downstream of the guidance net, and the YSI profiles show a 1.4 ˚C difference between bed and surface temperatures upstream of the guidance net. Stratification in January at Site 3 was detected down to at least 13 feet deep, with the colder water appearing at a depth between 13-23 feet deep (Figure 4.2-4). The JSCS trap was operating outside of normal parameters at this time, in waters deeper than the guidance net is long

(40 feet), and these conditions likely contributed to the reemergence of temperature stratification both upstream and downstream of the trap.



Figures 4.2-3a-4.2-3e. Longitudinal profiles of monthly mean water temperature from buoys located at varying distances from the trap entrance.

4.2c. Water Temperature Profiles Around the JSCS and Inside the Fry Box

Water temperature profiles taken at Site 1 show a decline in monthly water temperatures with depth and over time in September and October. During this time, the site also became shallower, beginning deployment at the depth of approximately 20 feet and ending at the depth of approximately 7 feet (Figure 4.2-5). Temperature profiles were very similar among the upstream locations across the entire channel from river right, center, to left (Dock 6C, Trap US, and Dock 10C, respectively), with the average monthly water temperature dropping from 13.3 ˚C to 10.5 ˚C during deployment at Site 1, river center (Trap Upstream (US)). Fifty feet downstream of the guidance net (Trap Downstream (DS)), the water was warmer than upstream (Trap US) by an average of 4.7 ˚C in September and 2.8 ˚C in October. Stratification was present downstream of the guidance net with water temperatures averaging 21.8 ˚C down to a depth of at least 4 feet in September, while cooler temperatures, similar to the upstream locations, occurred at depths of 13-25 feet. In October, the downstream location was shallower and less stratified, with surface water 1 foot deep at 17.2 ˚C in October, and cooler water, similar to upstream temperatures, occurred between 4 – 13 feet.

At Site 2 deployment began October 31, 2024, starting at a total depth of 13.5 feet that declined to 10.3 feet at the mouth of the trap (Trap US) by 11/20/24, when fishing and operations stopped due to an incoming storm. During this time water temperatures continued to be very similar ranging from 7 – 10 ˚C with an average of 8 ˚C across all depths and location both upstream and downstream of the guidance net. These results indicate that the JSCS at Site 2 was in riverine conditions rather than reservoir before the storm, since stratification was not detected, and water temperatures were always suitable for juvenile salmonids within the functional area of the guidance net; colder water was maintained at all the upstream locations of the JSCS across the channel.

Reservoir levels rose after the storm, and fishing began again at Site 2 on December 4, 2024, at a total depth of 20.9 feet; fishing ended due to another incoming storm on December 19, 2024, and during this time water levels rose to a depth of 29.7 feet (Figure 4.2-5). Water temperatures upstream and downstream of the trap during this time were variable but similar across all depths, with average temperatures ranging from 4 ˚C to 8 ˚C, with a 6 ˚C monthly average temperature for all depths across all locations. This pattern of variability can likely be attributed to storms and the rising reservoir; additionally, the record is poor for this time because sampling did not occur when fishing was not occurring due to stormy weather.

The JSCS was relocated back to the first deployment site, and after the storms passed, fishing began at Site 3 on January 2, 2025, deployed at a depth of 45.6 feet (Trap US), outside the ideal operational parameters of the trap since the guidance net only extends 40 ft deep.

For the first 7 days the reservoir continued to rise marginally to a depth of 47.5 feet, before steadily declining to 44.2 feet by the end of sampling on January 19, 2025 (Figure 4.2-5). During this final deployment period water temperatures were similar across all sites and depths, both upstream and downstream of the guidance net; weak stratification of warm water occurred at the surface down to the depth of at least 13 feet, with temperatures 1.4 ˚C warmer than water at the depth of (17-25) feet. During this time, the JSCS was at depths that exceeded the length of the guidance nets.

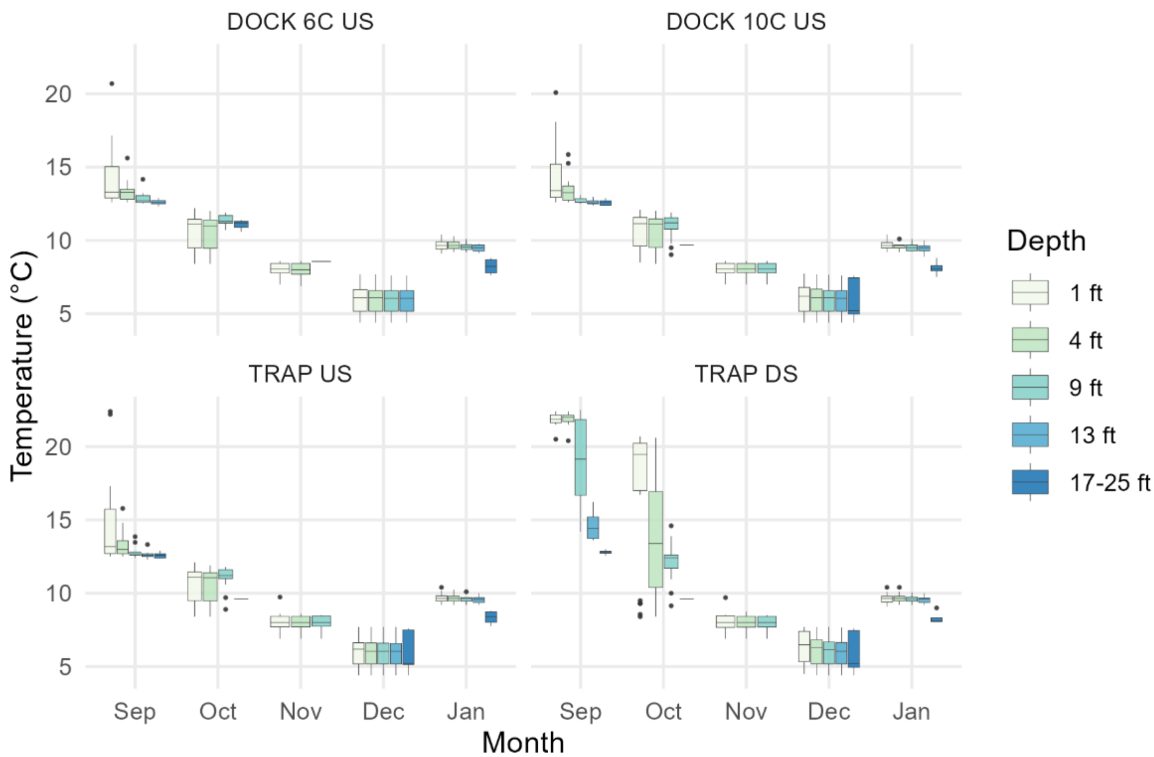
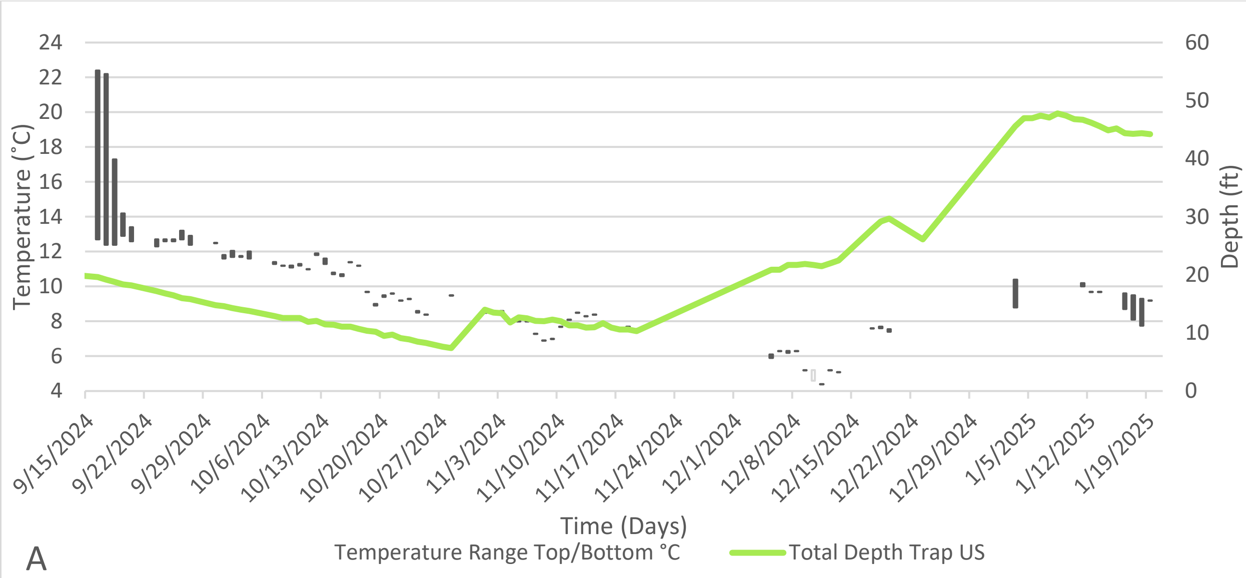
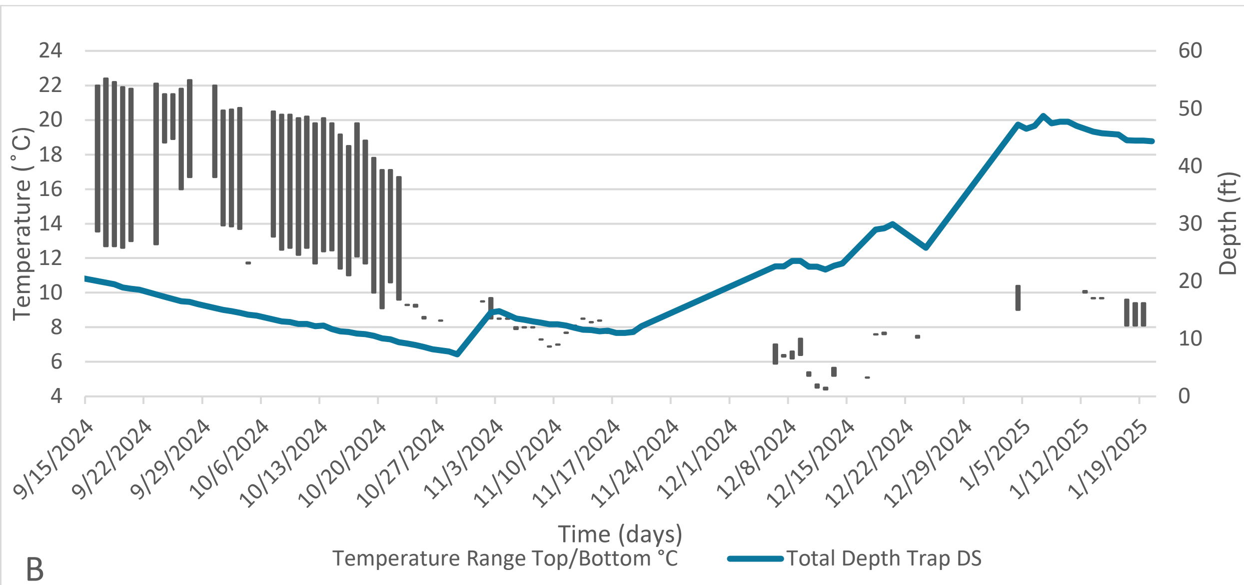


Figure 4.2-4. Box-plots of monthly water temperature profiles from key locations taken upstream (Dock 6C = River Right, Dock 10C =River Left, Trap US = Trap entrance, River Center) and downstream (Trap DS= Trap rear, river center) locations of the guidance net and JSCS trap platform.





Figures 4.2-5a-b. Time series of the temperature range (top and bottom) of YSI profiles taken daily at a) river center at the trap entrance upstream of the guidance net, and b) 50 ft downstream of the trap; total water depth at the location is shown on the 2nd Y-axis.

Water temperature data from loggers deployed in the fry box show stratification of the water column within the JSCS fish trap during September and October (Figure 4.2-6). Some points representing unusually warm temperatures in the figure, particularly during months with a move or a storm event, likely represent air temperatures collected when the loggers were removed from the fry box during trap closure periods. These data points can thus be considered outliers and do not represent water temperature conditions in the trap. Regardless, the average temperature within the fry box was never above 20.5 ˚C (Figure 4.2-7), indicating that conditions were safe for juvenile salmonids over the duration of the study. While surface temperatures were slightly higher than this threshold at some times in September, there was always colder water refugia available to fish lower within the fry box, and the hourly average temperature never reached 20 ˚C during operations.

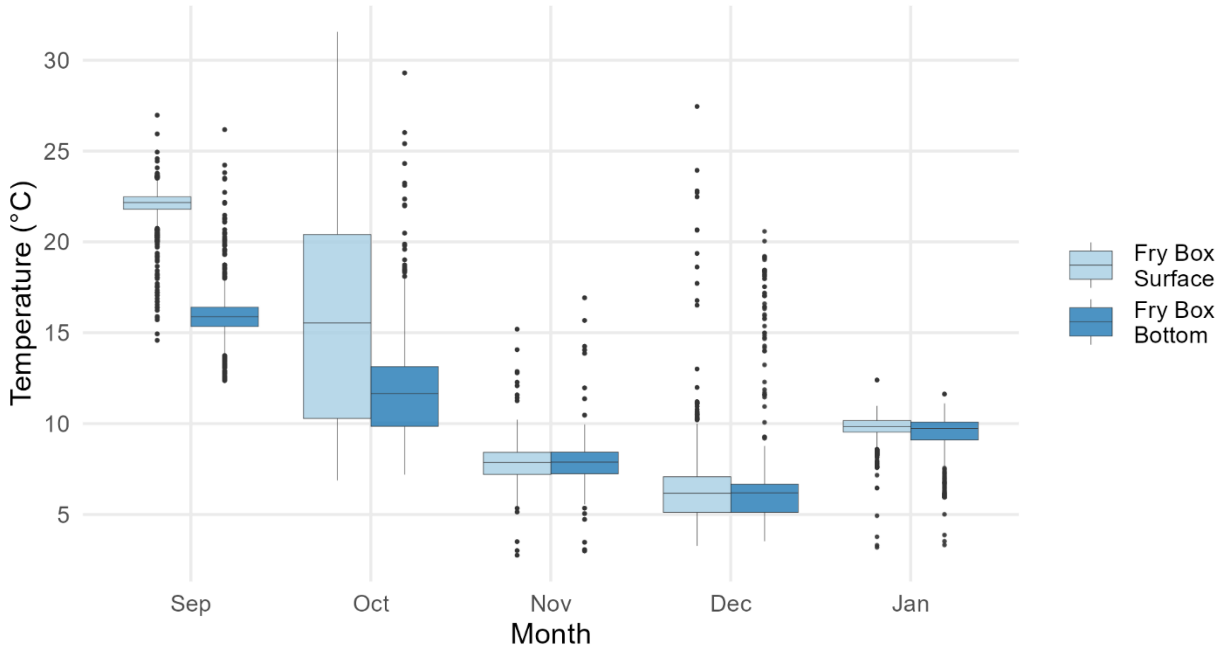


Figure 4.2-6. Box plots of continuous temperature data sampled every 15 minutes summarized by month collected at the surface and bottom of the fry box. Some warmer outliers likely represent air temperatures collected when the loggers were removed from the fry box during trap closure periods.

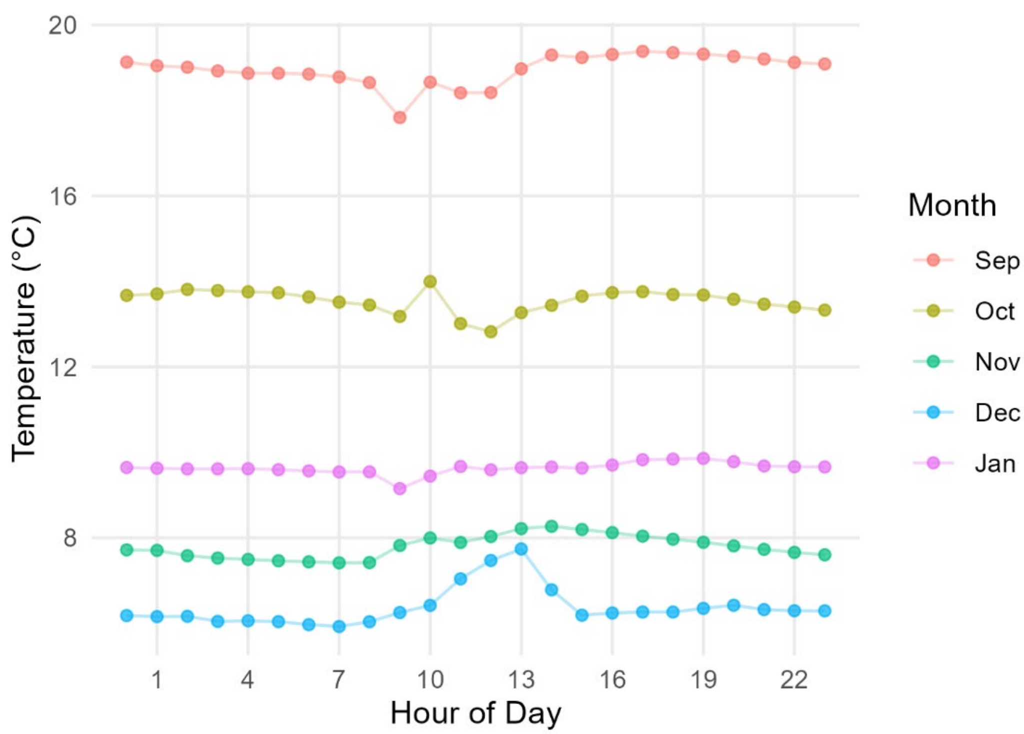


Figure 4.2-7. Time of day plot of average monthly water temperature each hour inside the fry box; temperatures were collected continuously from the surface (1 ft BWS) and bottom (0.1 ft HAB).

4.2d. Dissolved Oxygen and other Water Quality Parameters

Water quality profiles indicate a strong, negative correlation between water temperature and oxygen content, both dissolved oxygen (0.99) and percent oxygen saturation (0.71) (Figure 4.2-8), which is an expected, known relationship (USGS 2018). Oxygen enters river water through the atmosphere and groundwater, so although temperatures were cooler in deeper water, the saturation percentage was more varied, especially in September and October when the water temperature was stratified, but profiles exhibited an inverse relationship overall and implies warm water stratification influenced oxygen saturation (Figure 4.2-9b). A critical dissolved oxygen threshold for juvenile salmonids is 5.0 mg/l (Fleisig & Labiosa 2022), and conditions in the vicinity of the JSCS were always above this threshold, with the monthly average ranging from 7 to 12 mg/l dissolved oxygen concentration and 86 to 98% oxygen saturation over the duration of the study (Figure 4.2-9).

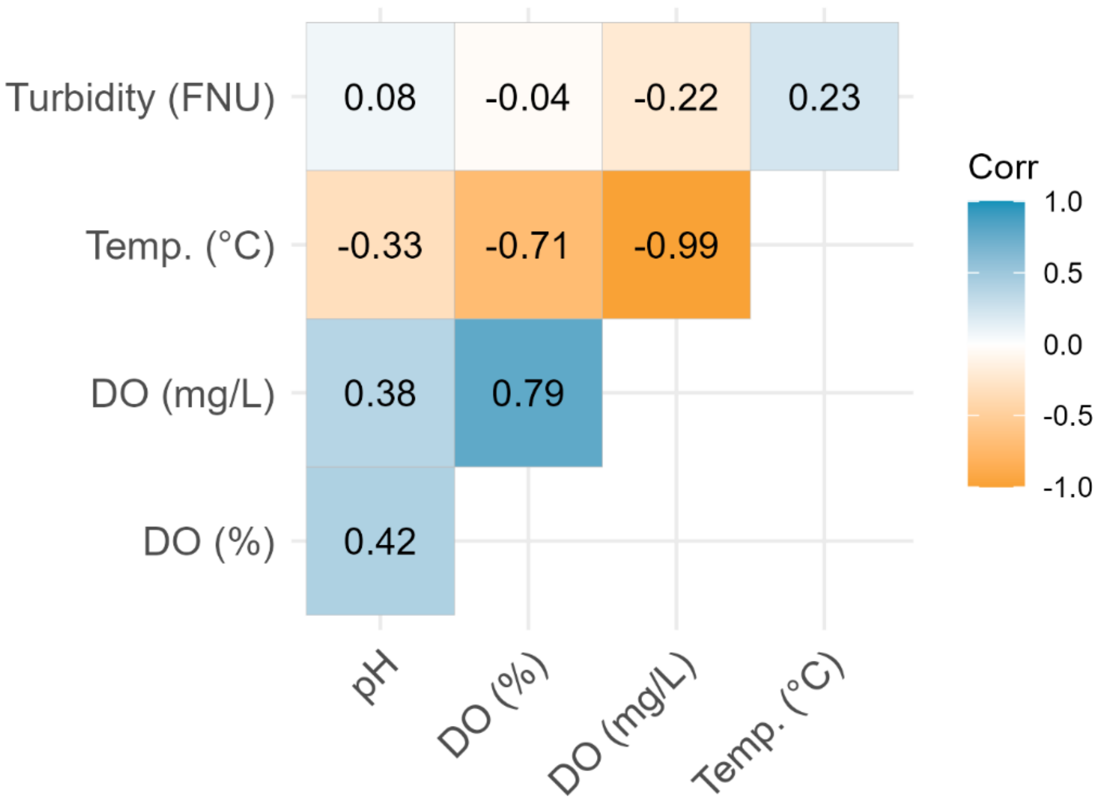
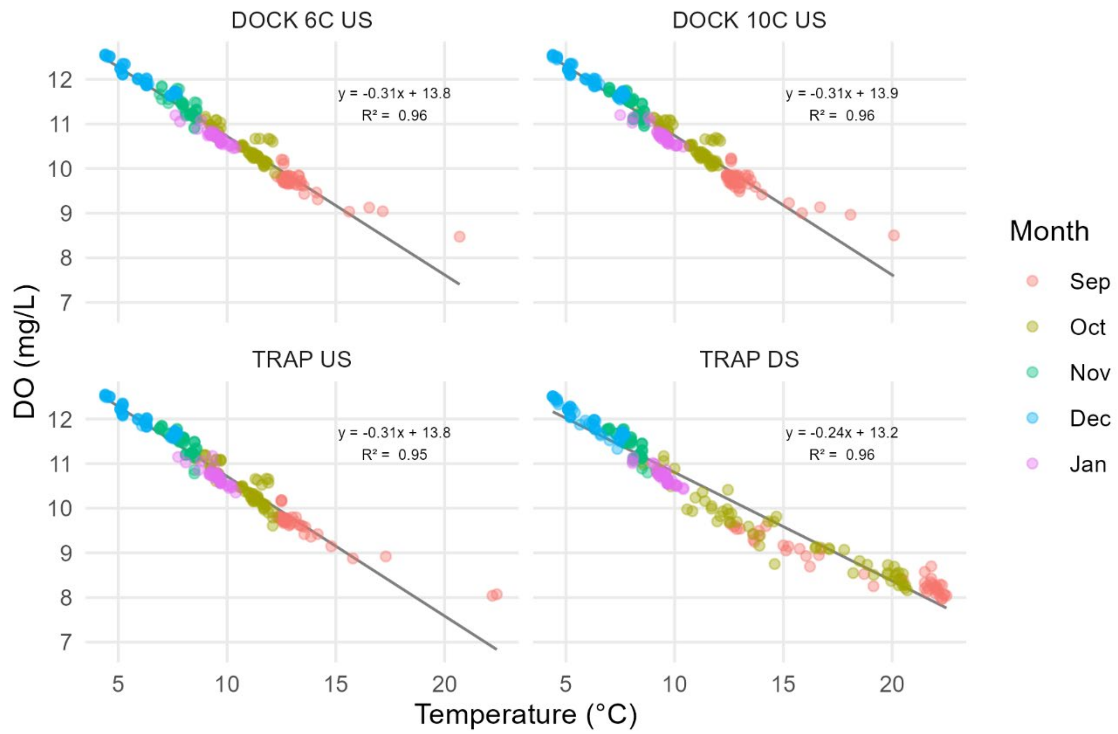
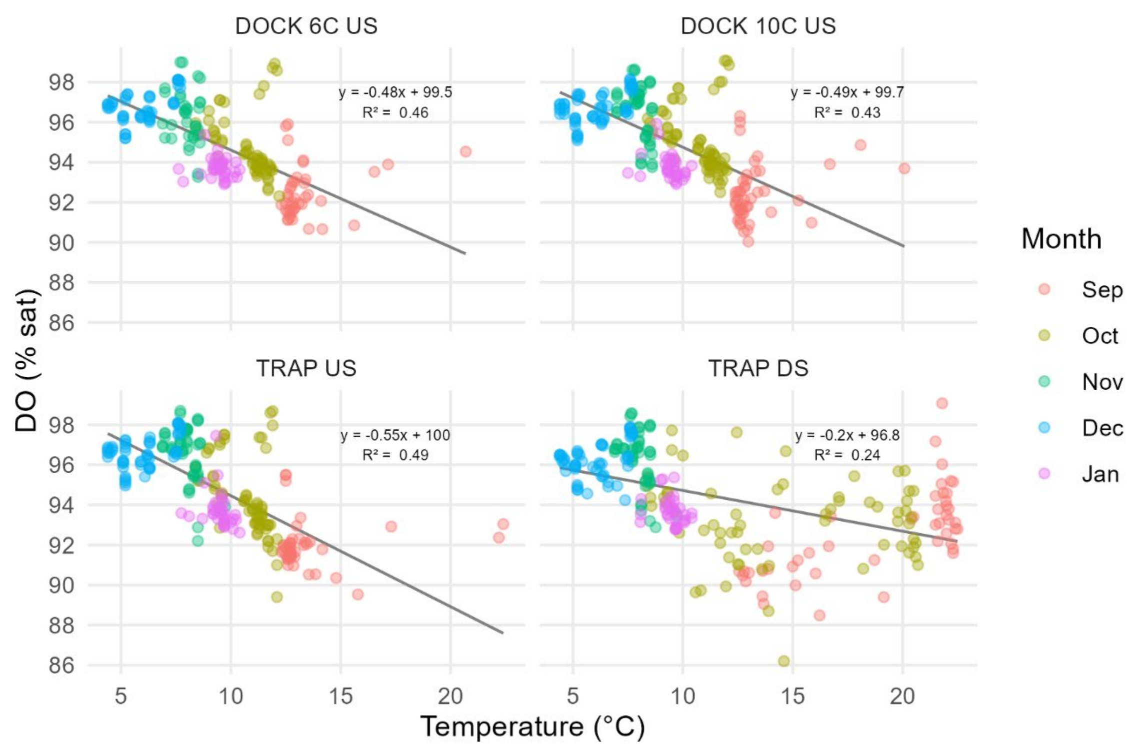


Figure 4.2-8. Correlation matrix comparing relationships between water quality parameters calculated from daily YSI profiles around the JSCS sampled between 8 – 11 AM.



a)



b)

Figure 4.2-9a – 4.2-9b. Best-fit trend analysis of water temperatures compared to a) dissolved oxygen and b) percent oxygen saturation calculated from YSI profiles taken daily between 8-11 AM during fishing operations.

Although no correlation was detected for turbidity or pH from the profiles, the average daily value is reported below as a time series, with no observable differences in patterns between upstream and downstream of the guidance net. Daily average turbidity ranged between 0 – 15 FNU for the duration of the study, and turbidity was relatively stable at <5 FNU while fishing at Sites 1 and 3; at Site 2 the turbidity spiked both up to >10 FNU and down to 0 (Figure 4.2-10). Negative FNU was observed during deployment at Site 2 and 3 occasionally from discrete measurements, which is atypical and indicates either a faulty calibration process, a faulty sensor, or a faulty standard. Daily average turbidity measure continuously at the trap entrance was never negative. It should be noted that other staff within DWR who use YSI meters were also experiencing faulty turbidity readings at this time from the same vendor, and recalibration was performed after negative values were recorded. Although a spike in discrete turbidity values did occur at Site 2, it is not likely biologically significant, since it was only one day measured in the morning, and continuously measured turbidity values for the entire day were always below 10 FNU daily on average; values below 10 FNU are considered safe for juvenile salmonids (EPA 2024).

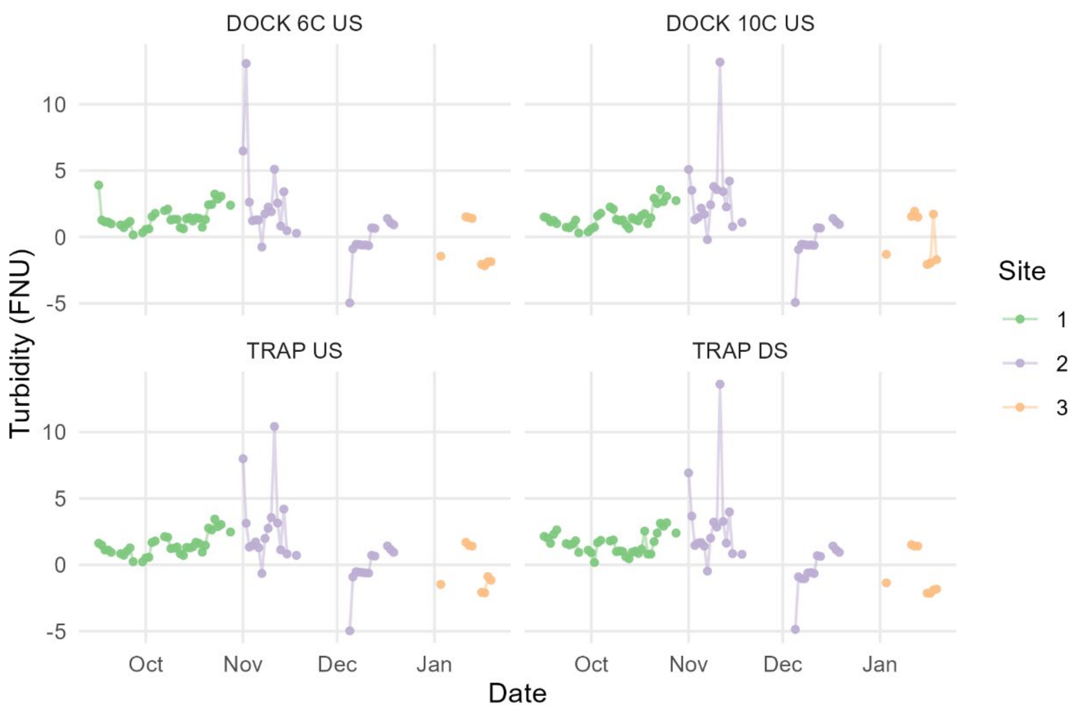


Figure 4.2-10. Time series of daily average turbidity (FNU) and JSCS site location calculated from profiles taken daily from 8-11 AM during fishing operations.

The pH of the water around the JSCS ranged from 7.0 - 8.8 over the duration of the study and was highly variable during September, October, November, and early December, while remaining between 7 - 7.6 in late December and January. Salmon populations are adversely impacted by both acute and chronic exposure to low pH. For salmon and many other aquatic organisms, pH levels of 7.0 to 8.0 are considered optimal to maintain a productive ecosystem; however, low pH below 7 is more detrimental and may have low-level chronic effects on salmon and habitat, whereas salmon can persist in waters up to 8.5 pH (Trasky 2008).

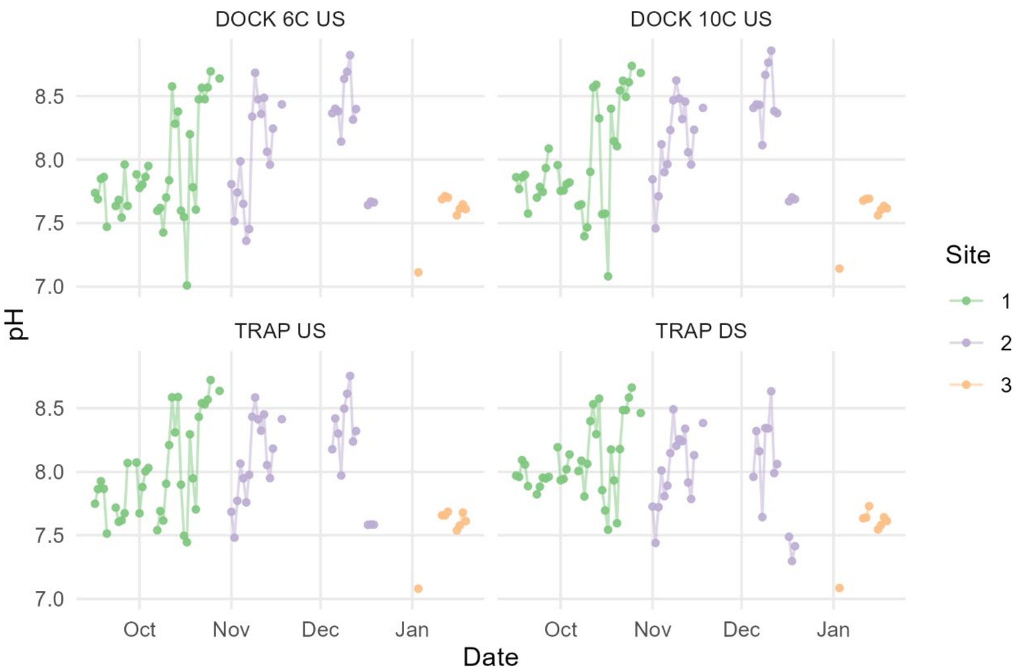


Figure 4.2-11. Time series of daily average pH and JSCS site location calculated from profiles taken daily from 8-11 AM during fishing operations.

Daily average specific conductivity measured from YSI profiles ranged from 105 – 130 µS/cm for the duration of the study. During deployment at Site 1, specific conductivity was slightly higher at the downstream sampling location compared to upstream of the guidance net, and this difference is likely attributed to net occlusion. Regardless, specific conductivity was well within normal operating conditions for freshwater streams in the United States (CWT 2004) and likely did not adversely affect salmon captured by the JSCS.

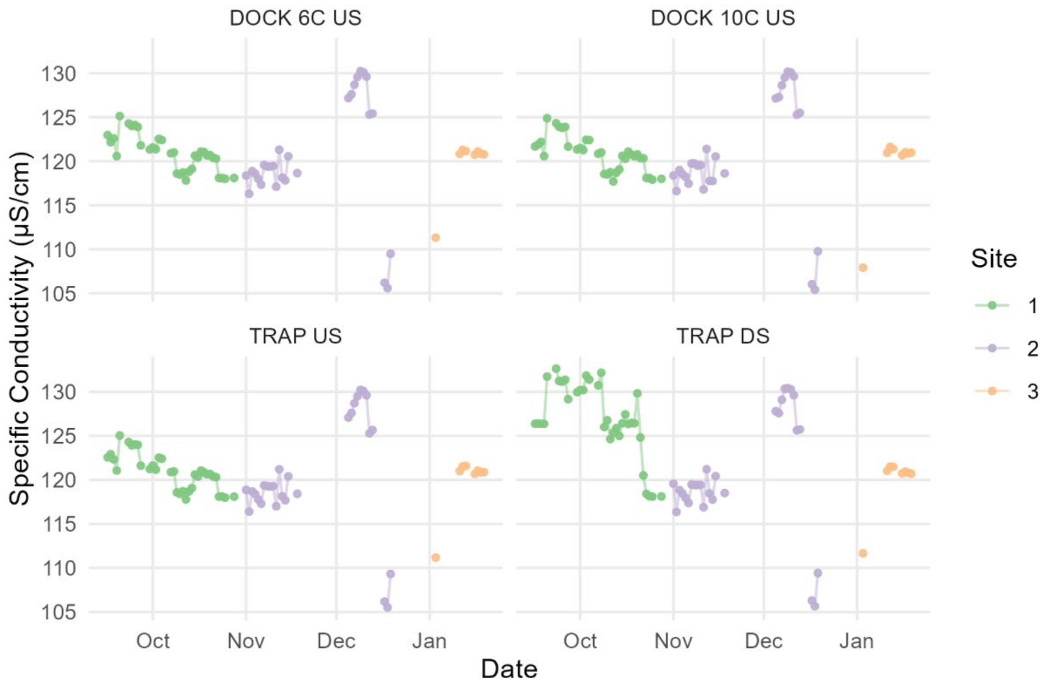


Figure 4.2-12. Time series of daily average specific conductivity (µS/cm) and JSCS site location calculated from profiles taken daily from 8-11 AM during fishing operations.

4.2e: Water Quality Results Discussion

The JSCS affects water temperatures in the reservoir. The guidance nets and trap wrap caused a cooling effect in the water column directly upstream of the structure and within the trap from near-surface to mid-depth. When the JSCS is installed in September, the structure supports cooler water temperatures in the fry box during the period of peak annual air temperatures in the region. These results indicate Site 1 was accurately chosen as the river-reservoir interface because after the JSCS installation, temperatures were suitable for Nur, and conditions became more riverine as fishing progressed. Additionally, the structure functioned well without the temperature curtain, maintaining adequate temperatures for juvenile salmon in the upstream area of the guidance net between the debris boom and the mouth of the trap. There was no observable difference between the river left, center and right upstream areas immediately upstream of the guidance net, and the main differences between the upstream sites can be attributed to the channel bottom. The guidance net and trap wrapped platform appeared to have the intended cross-channel effect immediately upon installation and cooler upstream conditions were maintained in the upstream area of the guidance net and mouth of the trap throughout the duration of deployment at Site 1. While surface temperatures were slightly higher than this threshold at some times in September, there was always colder water refugia available to fish lower within the fry box, and the hourly average temperature never reached 20 ˚C during operations. However, if deployment is delayed until October or if deployment targets shallow (<10 feet) conditions, the trap wrap would likely not be necessary.

At Site 2, Although storms occurred during this time that interrupted sampling, the JSCS appeared to be more within the riverine side of the reservoir interface due to the presence of cool, well mixed water at similar temperatures across all depths on both sides of the guidance net. At Site 3, the weak stratification detected at all locations of the YSI profiles can be attributed to the depth of the water and indicates the JSCS was deployed in reservoir conditions. The guidance net and trap wrapped platform did not function as a cross-channel temperature barrier and appeared to have no effect on the channel conditions within the functional area of the JSCS.

Regarding the other measured water quality parameters besides temperature, there was an expected negative correlation between DO and temperature, and DO conditions were always within an acceptable range for juvenile salmonids. Turbidity and specific conductivity ranges were mostly safe for fish except for a few turbidity spikes that can be attributed to storms. The pH conditions were mostly safe for salmonids during the study, except for a few days at the end of fishing at Sites 1 and 2. In general, pH increased over time at each site and may be attributed to biological interactions from the guidance net, which became increasingly fouled over deployment, and can affect water exchange due to net occlusion. Future deployments can use the data and analysis here to improve the JSCS design.

4.3. Velocity

Velocity data presented in this section show the evolution of velocity structure over time and the response of the environment to the presence of JSCS components. Over the course of the first deployment at Site 1, velocities gradually increased as water levels decreased. Velocity data at Site 2 exhibited a similar pattern until the mid-November storm event, which produced significantly higher velocities. After this storm event, velocities remained low for the remainder of time at Site 2 and after relocating to Site 3 due to the deep reservoir conditions created by winter storm events.

4.3a. Cross-sectional Velocity (ADCP)

ADCP-derived velocity data were successfully collected on 15 separate days during the 2024 deployment (**Table 4.3-1**). Data were collected once at five locations before deployment at Site 1, on seven separate days (approximately weekly) during deployment at Site 1, on six separate days (approximately weekly) during deployment at Site 2, and on two separate days during the deployment at Site 3. While 3-dimensional velocity data were collected, this analysis focuses on one dimension of velocity, the along-channel (streamwise) component. Streamwise velocity data are visualized using contour plots with similar colorbar scales between figures for easy comparison. Axis scales vary based on the depth and length of the given cross-section to effectively visualize the results. Cross-sectional plots are facing downstream, with the left bank displayed on the left and the right bank displayed on the right.

ADCP measurements taken at the cross-section upstream of the JSCS (XS1) and immediately upstream of the trap entrance (XS3) are presented in Table 4.3-1 and cross-sections illustrating velocity structure are only shown from XS1 to focus on salient results and simplify comparisons across the deployment. It should be noted that measurements of XS3 either did not occur or had poor data quality on several occasions.

Table 4.3-1. *Dates, conditions, and water depths at the trap for ADCP data are shown in Figures 4.3-1 through 4.3-17, comparing velocity transects upstream of the JSCS trap platform over time.*

Date	Condition	Water Depth at Trap (ft)	Average Cross-Sectional Velocity at XS1 (ft/s)	Average Cross-Sectional Velocity at XS3 (ft/s)	Total Discharge at MSS gage (cfs)
7/25/24	Baseline conditions prior to deployment at Site 1	n/a	0.02	n/a	350
9/19/24	3 days after JSCS installation at Site 1	18.7	0.08	0.10	326
9/26/24	10 days after JSCS installation at Site 1	16	0.12	0.14	314
10/4/24	18 days after JSCS installation at Site 1	14	0.16	0.13	310
10/9/24	23 days after JSCS installation at Site 1	12.7	0.16	0.15	330
10/17/24	31 days after JSCS installation at Site 1	10.7	0.17	0.18	339
10/23/24	37 days after JSCS installation at Site 1	8.9	0.31	0.26	330
10/30/24	During JSCS installation at Site 2	7.4	0.45	n/a	334
10/31/24	1 day after JSCS installation at Site 2	14.3	0.25	n/a	347
11/7/24	8 days after JSCS installation at Site 2	12.9	0.25	0.30	343
11/15/24	16 days after JSCS installation at Site 2	11.2	0.40	0.43	401
11/23/24	24 days after JSCS installation at Site 2	17.4	1.20	n/a	2,314
12/5/24	37 days after JSCS installation at Site 2	21.9	0.14	0.14	537
12/17/24	49 days after JSCS installation at Site 2	28.5	0.28	n/a	1,402
12/31/24	During JSCS reinstallation at Site 1	47.2	0.28	n/a	3,045
1/14/24	14 days after JSCS reinstallation at Site 1	45.2	0.02	n/a	891

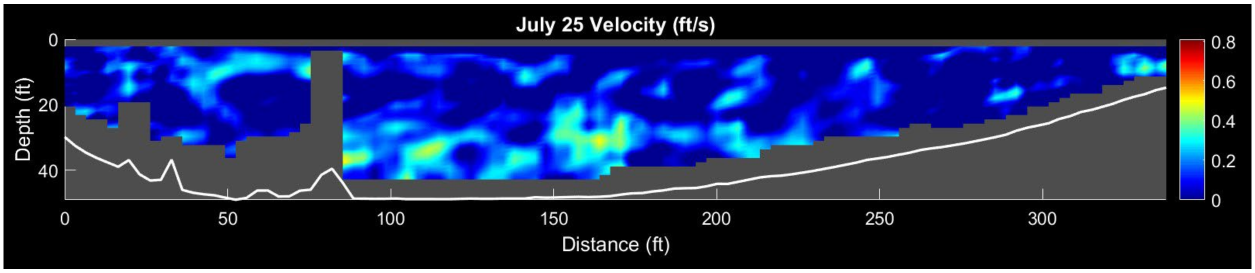


Figure 4.3-1. Velocity contour plots collected during the baseline survey before JSCS deployment on July 25, 2024. Velocity at a transect at the planned location for Site 1, having a maximum depth of ~45 feet.

Velocity data collected before JSCS installation on July 25, 2024, provides an illustration of velocity conditions at a high WSE (**Figure 4.3-1**). The location is at the planned Site 1 for the JSCS, but the water depth was 45 feet, approximately 25 feet deeper than at the start of JSCS operations on September 16, 2024. The velocity structure has some missing data due to ADCP beam interference, but this data is not necessary as the reservoir had very-low velocities, with an average velocity for the entire cross-section of 0.02 ft/s at a total discharge of 350 cfs. The plot also illustrates noisy data, which is consistently the result of ADCP surveys in deep, slow-moving water.

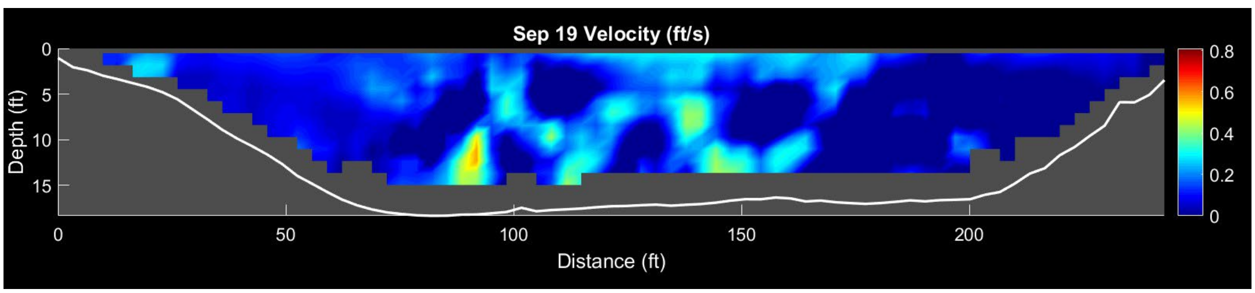


Figure 4.3-2. Velocity contour plots collected during JSCS operations at Site 1 on September 19, 2024.

Velocity data collected 3 days after JSCS installation at Site 1 on September 19, 2024, show somewhat mixed conditions with some noisy velocity data (**Figure 4.3-2**). On this date, all six docks had impermeable panels deployed, water depth was 18.7 ft immediately upstream of the trap entrance, average velocity upstream of the system at XS1 was 0.08 ft/s, average velocity upstream of the trap at XS3 was 0.10 ft/s, and total discharge was 326 cfs. At this point, the trap was still experiencing reservoir conditions with deep, slow-moving water. However, the velocity increased slightly from the baseline conditions in July.

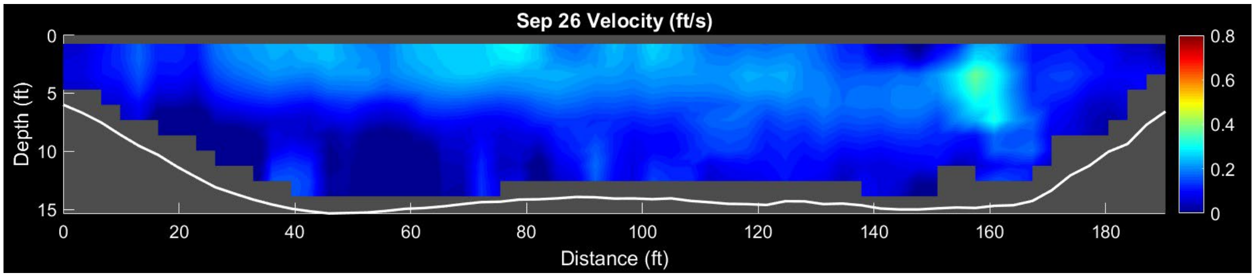


Figure 4.3-3. Velocity contour plots collected during JSCS operations at Site 1 on September 26, 2024.

Velocity data collected 10 days after JSCS installation at Site 1 on September 26, 2024, exhibit well-mixed conditions with an increase in velocity magnitude compared to the prior week (**Figure 4.3-3**). On this date, all six docks had impermeable panels deployed, water depth was 16 feet immediately upstream of the trap entrance, average velocity upstream of the system at XS1 was 0.12 ft/s, average velocity upstream of the trap at XS3 was 0.14 ft/s, and total discharge was 314 cfs.

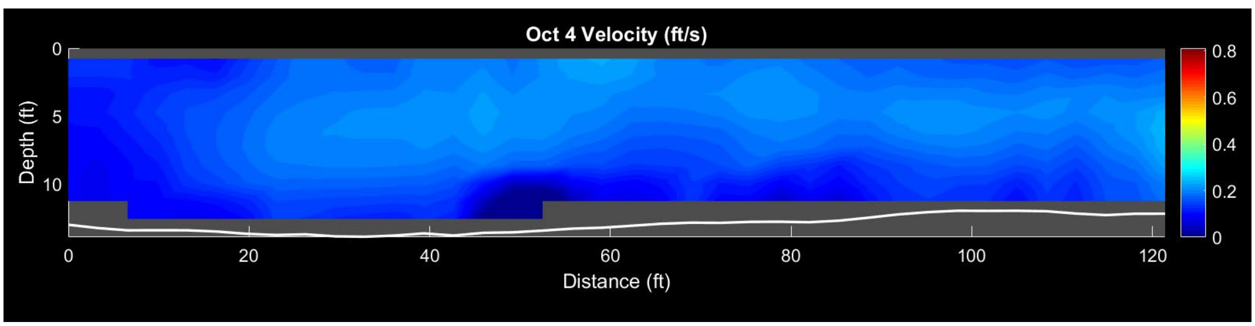


Figure 4.3-4. Velocity contour plots collected during JSCS operations at Site 1 on October 4, 2024.

Velocity data collected 18 days after JSCS installation at Site 1 on October 4, 2024, exhibit well-mixed conditions with an increased velocity magnitude compared to the prior week (**Figure 4.3-4**). On this date, all six docks had impermeable panels deployed, water depth was 14 feet immediately upstream of the trap entrance, average velocity upstream of the system at XS1 was 0.16 ft/s, average velocity upstream of the trap at XS3 was 0.13 ft/s, and total discharge was 310 cfs. It should be noted that this transect is shorter than the others and doe not include the banks, however it was still taken at the same location.

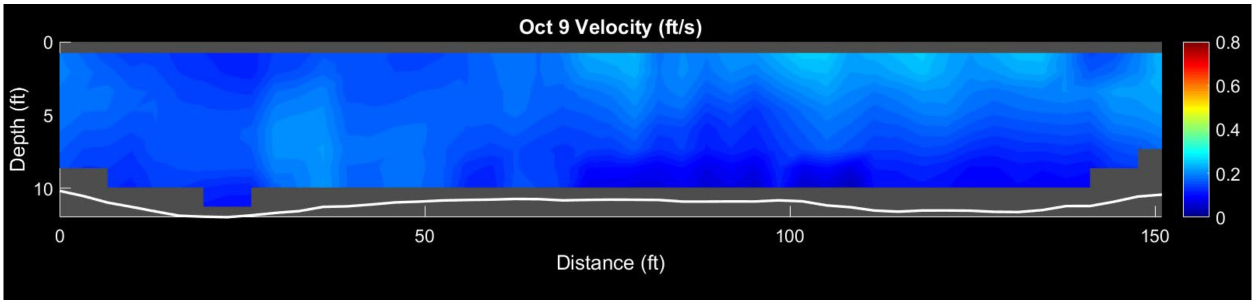


Figure 4.3-5. Velocity contour plots collected during JSCS operations at Site 1 on October 9, 2024.

Velocity data collected 23 days after JSCS installation at Site 1 on October 9, 2024, exhibit well-mixed conditions with a similar velocity magnitude compared to the prior week (**Figure 4.3-5**). On this date, all six docks had impermeable panels deployed, water depth was 12.7 feet immediately upstream of the trap entrance, average velocity upstream of the system at XS1 was 0.16 ft/s, average velocity upstream of the trap at XS3 was 0.15 ft/s, and total discharge was 330 cfs. It should be noted that the ADCP cross-section on this date was slightly narrower than other cross-sections. This may have affected the average cross-sectional velocity calculation and distribution of values, but the cross-section showed the same velocity structure and magnitude as the previous and subsequent weeks.

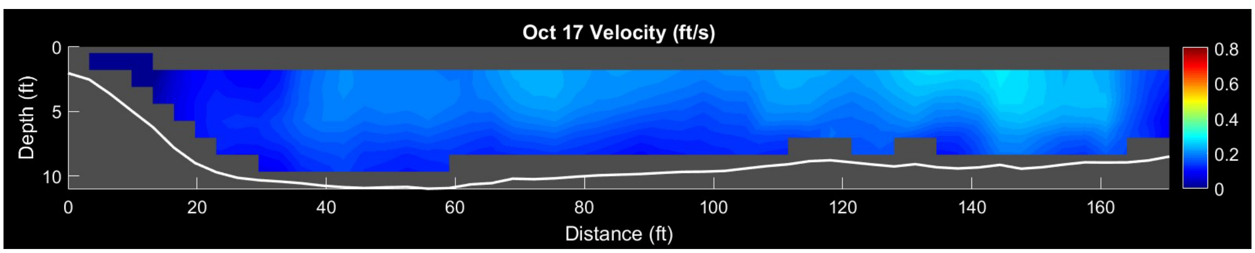


Figure 4.3-6. Velocity contour plots collected during JSCS operations at Site 1 on October 17, 2024.

Velocity data collected 31 days after JSCS installation at Site 1 on October 17, 2024, exhibit well-mixed conditions with a similar velocity magnitude compared to the prior week (**Figure 4.3-6**). On this date, all six docks had impermeable panels deployed, water depth was 10.7 feet immediately upstream of the trap entrance, average velocity upstream of the system at XS1 was 0.17 ft/s, average velocity upstream of the trap at XS3 was 0.18 ft/s, and total discharge was 339 cfs.

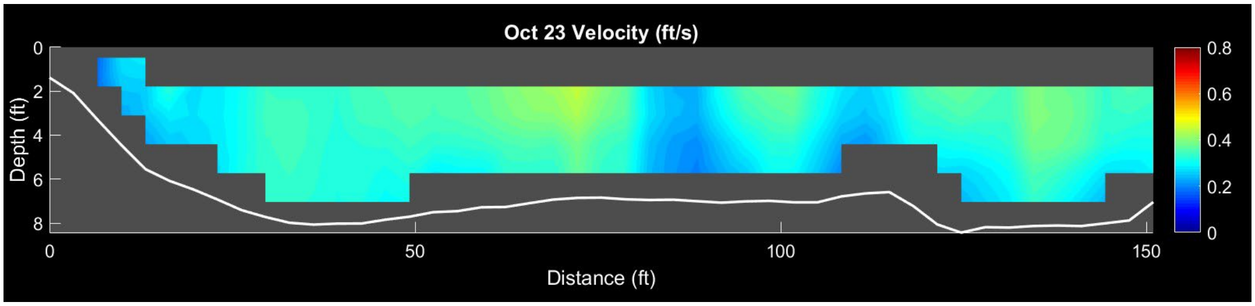


Figure 4.3-7. Velocity contour plots collected during JSCS operations at Site 1 on October 23, 2024.

Velocity data collected 37 days after JSCS installation at Site 1 on October 23, 2024, exhibit well-mixed conditions with a higher velocity magnitude than the prior week (**Figure 4.3-7**). On this date, all six docks had impermeable panels deployed, water depth was 8.9 feet immediately upstream of the trap entrance, average velocity upstream of the system at XS1 was 0.31 ft/s, average velocity upstream of the trap at XS3 was 0.26 ft/s, and total discharge was 330 cfs. By this date, Site 1 was beginning to experience river-like conditions with lower depths and higher velocities.

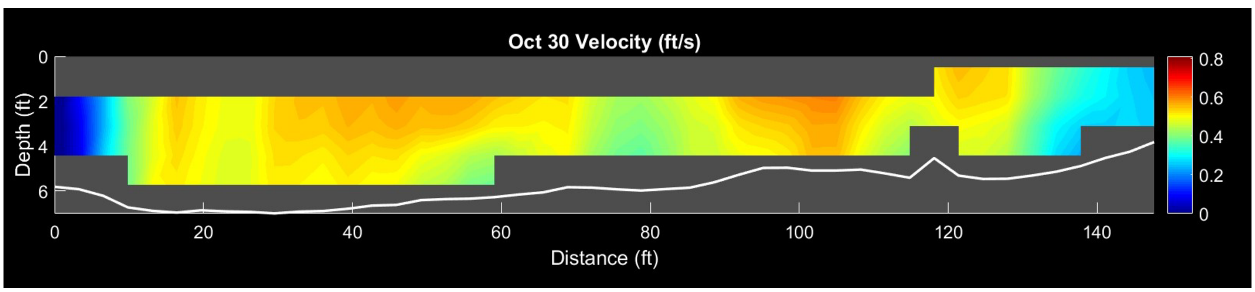


Figure 4.3-8. Velocity contour plots collected during JSCS operations at Site 1 on October 30, 2024.

Velocity data collected during the JSCS move from Site 1 to Site 2 on October 30, 2024, exhibit well-mixed conditions with a higher velocity magnitude compared to the prior week (**Figure 4.3-8**). On this date, the system was being moved downstream, water depth was 7.4 feet where the trap had been at Site 1, average velocity upstream of the system at XS1 was 0.45 ft/s, and total discharge was 334 cfs. By this date, the river/reservoir interface was approaching Site 1. However, the trap was moved during this week due to the low depth.

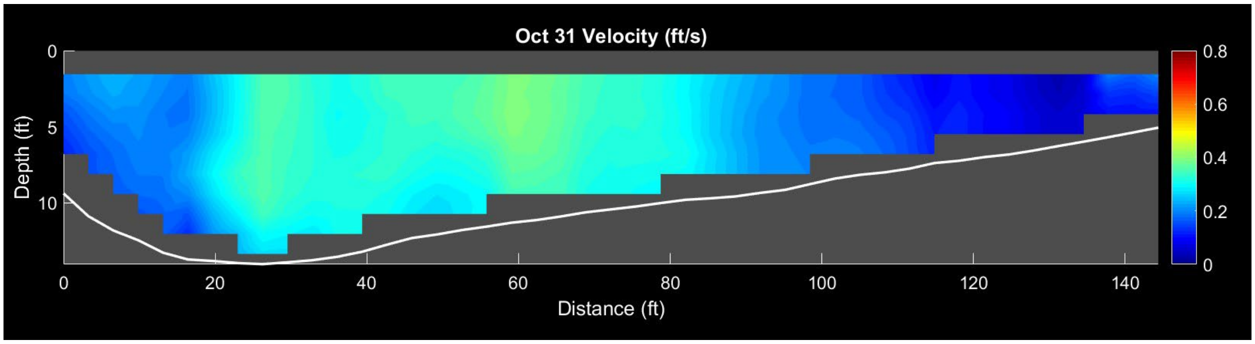


Figure 4.3-9. Velocity contour plots collected during JSCS operations at Site 2 on October 31, 2024.

Velocity data collected 1 day after JSCS installation at Site 2 on October 31, 2024, exhibit well-mixed conditions with a lower velocity magnitude compared to the prior day (**Figure 4.3-9**). On this date, impermeable panels had not yet been deployed, water depth was 14.3 feet immediately upstream of the trap entrance, average velocity upstream of the system at XS1 was 0.25 ft/s, and total discharge was 347 cfs.

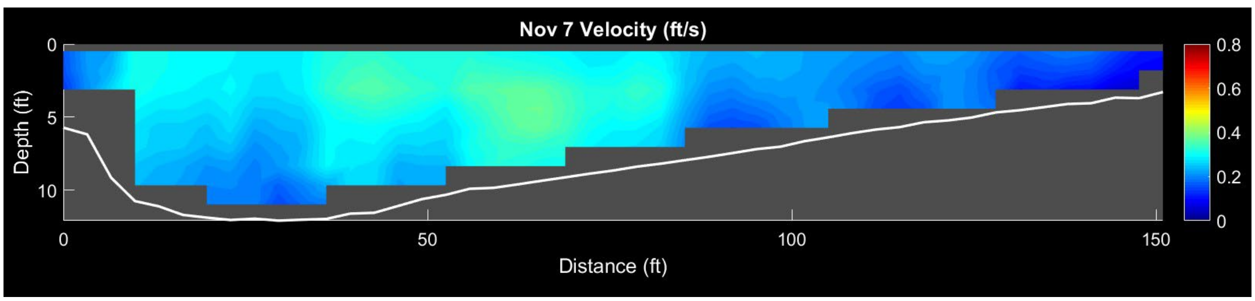


Figure 4.3-10. Velocity contour plots collected during JSCS operations at Site 2 on November 7, 2024.

Velocity data collected 8 days after JSCS installation at Site 2 on November 7, 2024, exhibit well-mixed conditions with a similar velocity magnitude compared to the prior week (**Figure 4.3-10**). On this date, all six docks had impermeable panels deployed, water depth was 12.9 feet immediately upstream of the trap entrance, average velocity upstream of the system at XS1 was 0.25 ft/s, average velocity upstream of the trap at XS3 was 0.30 ft/s, and total discharge was 343 cfs.

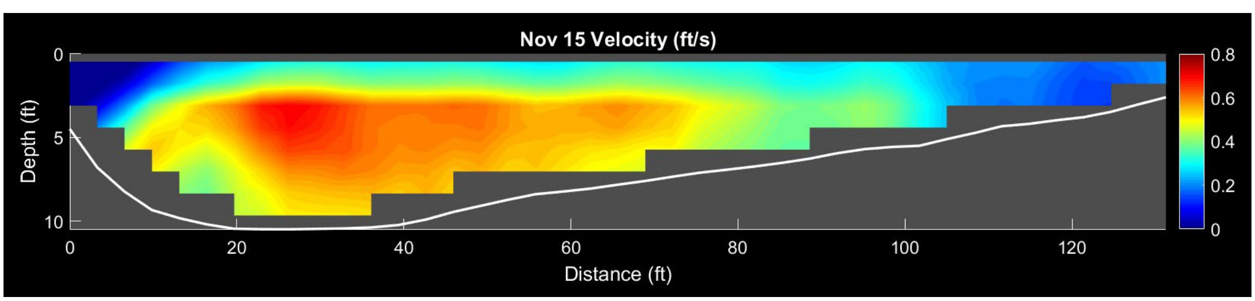


Figure 4.3-11. Velocity contour plots collected during JSCS operations at Site 2 on November 15, 2024.

Velocity data collected 16 days after JSCS installation at Site 2 on November 7, 2024, exhibit well-mixed conditions with a higher velocity magnitude than the prior week (**Figure 4.3-11**). On this date, all six docks had impermeable panels deployed, water depth was 11.2 feet immediately upstream of the trap entrance, average velocity upstream of the system at XS1 was 0.40 ft/s, average velocity upstream of the trap at XS3 was 0.43 ft/s, and total discharge was 401 cfs. By this date, Site 2 was beginning to experience river-like conditions with lower depths and higher velocities.

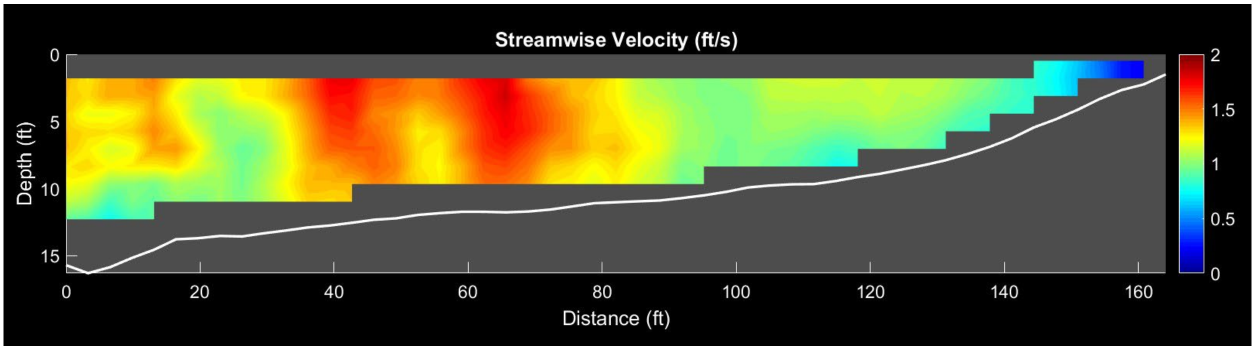


Figure 4.3-12. Velocity contour plots collected during JSCS operations at Site 2 on November 23, 2024.

Velocity data was collected following the first major storm event of the season on November 23, 2024, 24 days after JSCS installation at Site 2. During this period following the storm event, the trap was not in operation due to safety concerns. Velocity data exhibit well-mixed conditions with significantly higher velocity magnitude than the prior week (**Figure 4.3-12**). On this date, impermeable panels were not deployed, guidance nets were pulled out of the water, water depth was 17.4 feet immediately upstream of the trap entrance, average velocity upstream of the system at XS1 was 1.20 ft/s, and total discharge was 2,314 cfs. Water was visibly moving on this date, and Site 2 was experiencing riverine conditions. Note that the scale differs from the other plots due to much higher velocities on this date.

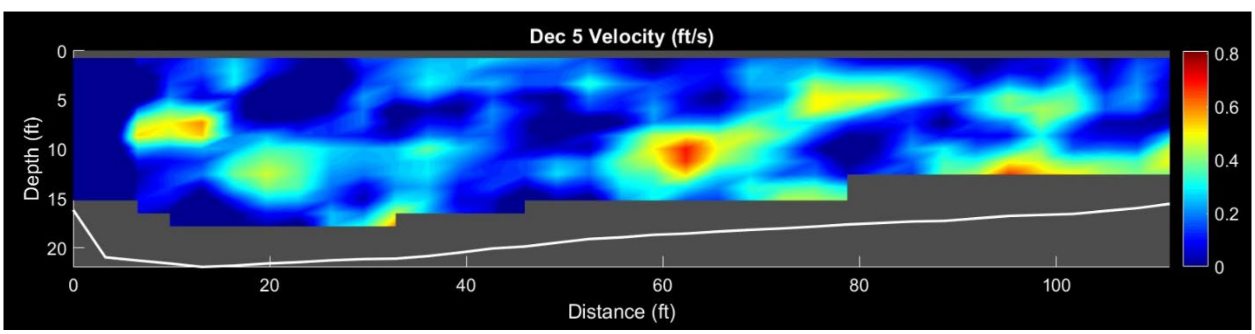


Figure 4.3-13. Velocity contour plots collected during JSCS operations at Site 2 on December 5, 2024.

Velocity data collected 37 days after JSCS installation at Site 2 on December 5, 2024, exhibit much lower magnitudes compared to the prior week (**Figure 4.3-13**). On this date, impermeable panels were being deployed, water depth was 21.9 feet immediately upstream of the trap entrance, average velocity upstream of the system at XS1 was 0.14 ft/s, average velocity upstream of the trap at XS3 was 0.14 ft/s, and total discharge was 537 cfs. On this date, Site 2 was experiencing reservoir conditions with higher depths and lower velocities.

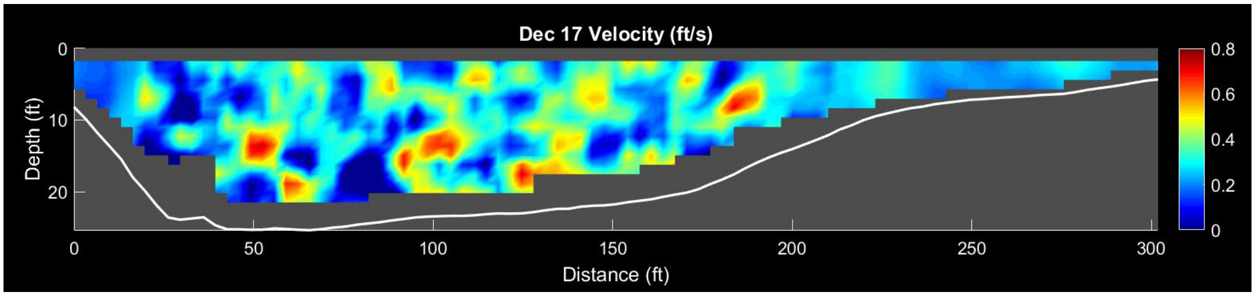


Figure 4.3-14. Velocity contour plots collected during JSCS operations at Site 2 on December 17, 2024.

Velocity data collected 49 days after JSCS installation at Site 2 on December 17, 2024, exhibit higher magnitudes than the prior week (**Figure 4.3-14**). On this date, impermeable panels were not deployed, water depth was 28.5 feet immediately upstream of the trap entrance, average velocity upstream of the system at XS1 was 0.28 ft/s, and total discharge was 1,402 cfs. Despite the increased depth, velocity was higher than the previous week as data was collected on the receding limb of a 3,000 cfs storm hydrograph. On this date, Site 2 was experiencing reservoir conditions with high depths and low velocities.

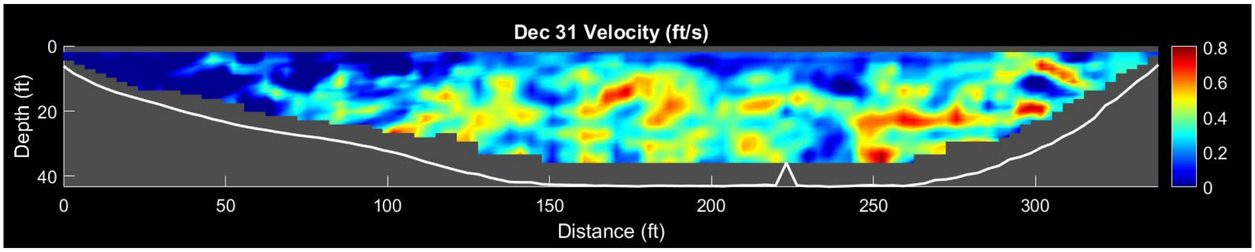


Figure 4.3-15. Velocity contour plots collected during JSCS operations at Site 3 on December 31, 2024.

Velocity data collected during JSCS reinstallation at Site 3 on December 31, 2024, exhibit similar magnitudes and structure compared to the prior week (**Figure 4.3-15**). On this date, impermeable panels were not deployed, water depth was 47.2 feet immediately upstream of the trap entrance, average velocity upstream of the system at XS1 was 0.28 ft/s, and total discharge was 3,045 cfs. On this date, Site 3 was starting to experience reservoir conditions with very high depths and low velocities.

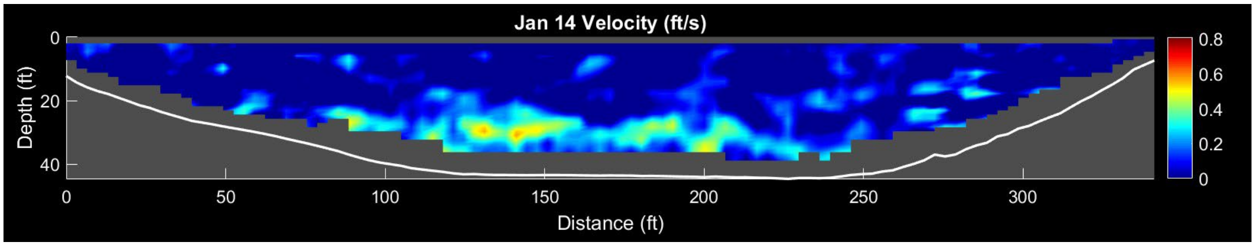


Figure 4.3-16. Velocity contour plots collected during JSCS operations at Site 3 on January 14, 2025.

Velocity data collected 14 days after JSCS reinstallation at Site 3 on January 14, 2025, exhibit lower magnitudes than the prior week (**Figure 4.3-16**). On this date, impermeable panels were not deployed, water depth was 45.2 feet immediately upstream of the trap entrance, average velocity upstream of the system at XS1 was 0.02 ft/s, and total discharge was 891 cfs. On this date, Site 3 was experiencing reservoir conditions with very high depths and very low velocities.

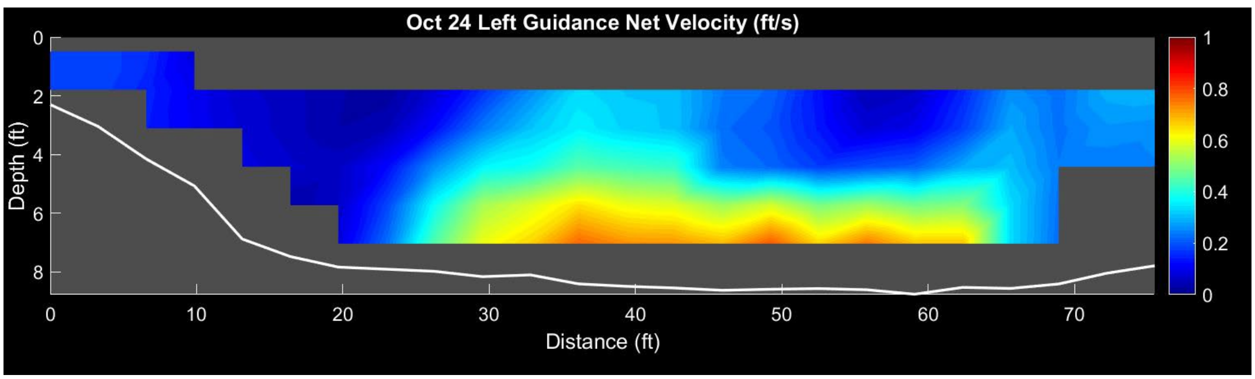


Figure 4.3-17. Velocity contour plots collected during JSCS operations along the left guidance net at Site 1 on October 24, 2024.

An additional cross-section was measured along the upstream side of the left guidance net on October 24, 2024, to verify visual observations of water upwelling downstream of the left guidance net. Velocity data illustrate a clear pattern of water flowing underneath the guidance net at up to 1 ft/s (**Fig 4.3-17**). The guidance nets and impermeable panels were raised and inspected prior to the October 30 move and no tears were identified. Additionally, the highest velocities during this period were slightly to the left of the trap location. This suggests that the location of the trap was slightly off from the thalweg and high velocities at the bottom of the left guidance net created enough pressure to raise the chains of the guidance nets off of the channel bed.

Overall, average cross-sectional velocity values at XS1 gradually increased from approximately 0.08 ft/s to 0.17 ft/s over the first five weeks at Site 1 and increased to an average value of approximately 0.45 ft/s in the final week at Site 1. Average velocity values at Site 2 were 0.25 ft/s for the first two weeks before increasing to 0.40 ft/s in the third week and 1.20 ft/s in the fourth week following the first major storm event. Following this storm, velocities decreased to 0.14 ft/s and 0.28 ft/s in the following two weeks at Site 2. Following the move to Site 3, average velocities were 0.28 ft/s during the first week before falling to 0.02 ft/s in the final week of operations (**Figure 4.3-18)**. Before the first storm event in mid-November, flows remained fairly constant and velocities followed a more consistent pattern of increasing with decreasing depth. These results before the first storm event are consistent with results from 2023. Velocities increased immediately following the three major storm events that happened during the season. However, these large storm events also substantially increased the reservoir WSE, leading to higher depths and lower velocities following the events.

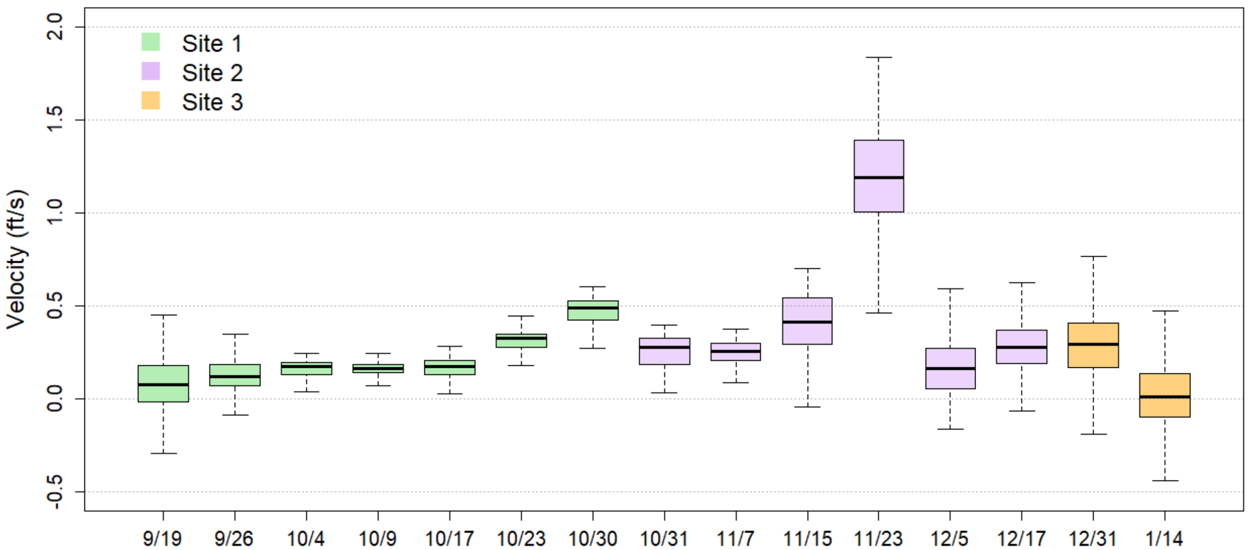


Figure 4.3-18. Boxplots illustrating ADCP cross-sectional velocity distributions over the course of the season. Each boxplot represents the distribution of velocity values from XS1 located upstream of the trap.

4.3b. Point Velocity (ADV)

ADV-derived velocity data were collected approximately daily at locations in the trap and the fry box (Figure 3.5-3). Velocity was observed at 2 depths—1 foot and 3 feet below the water surface at both locations. Three-dimensional velocity data at each location and depth were collected, and a resulting magnitude was calculated based on the 3-dimensional data. Velocity data are presented in a time series with identical y-axis limits for ease of comparison.

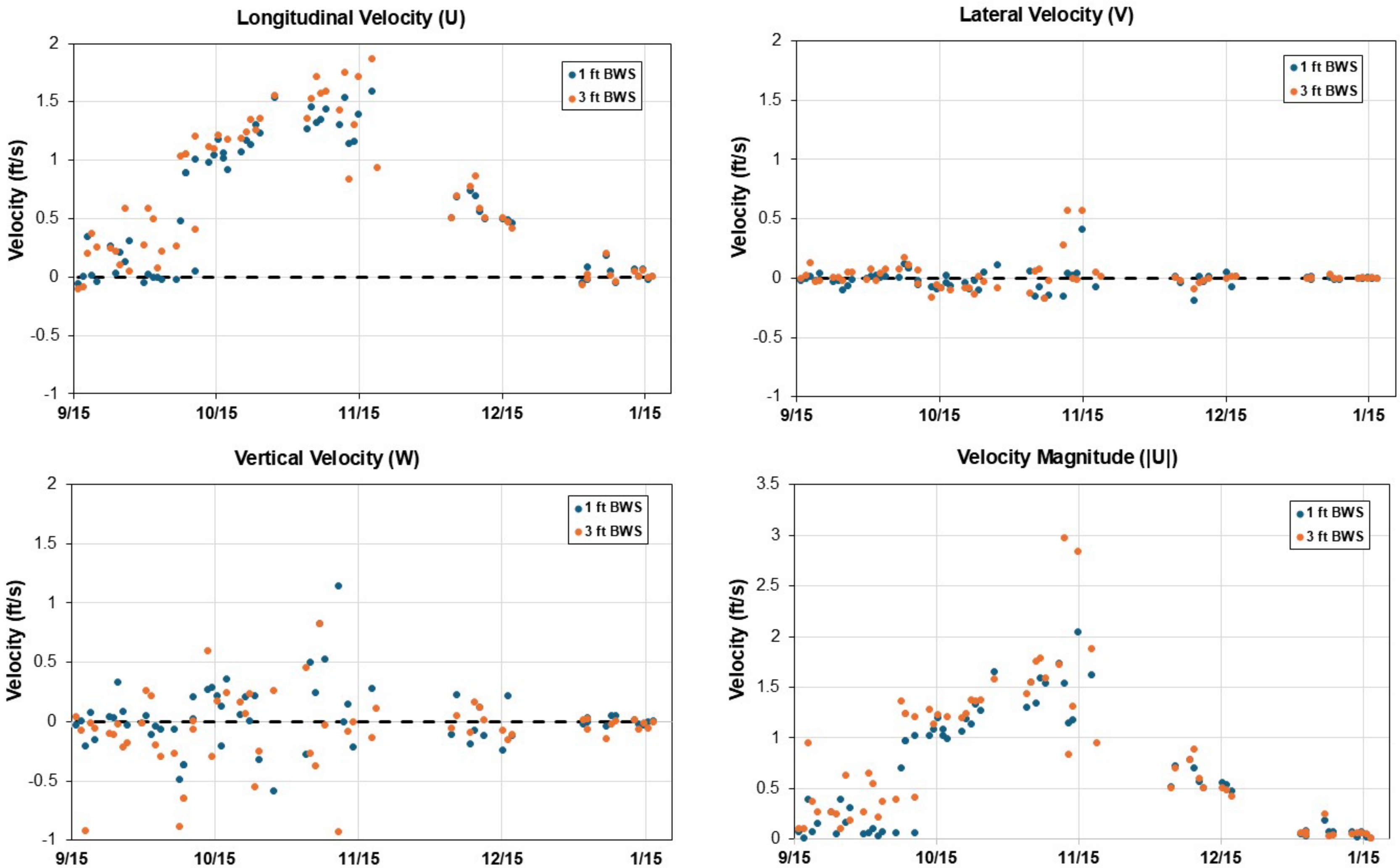


Figure 4.3-19. Time series of velocity components measured with an ADV downstream of the trap entrance fyke (location A in Figure 3.5-3) at two depths (1 feet and 3 feet below water surface, BWS). Velocity components U, V, W are measured by the ADV and velocity magnitude |U| is calculated.

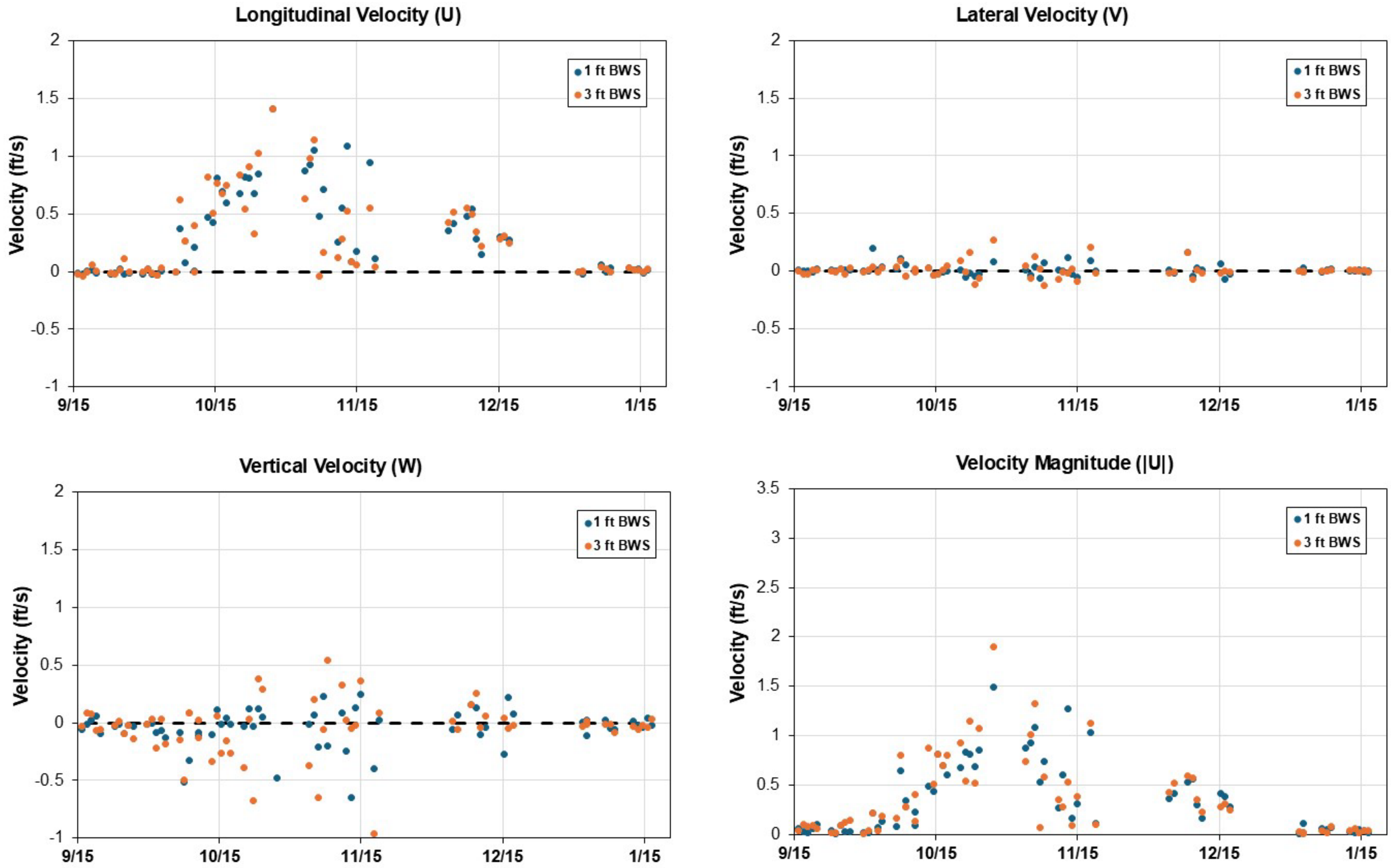


Figure 4.3-20. Time series of velocity components measured with an ADV downstream of the fry box entrance fyke (location B in Figure 3.5-3) at two depths (1 feet and 3 feet below water surface, BWS). Velocity components U, V, W are measured by the ADV and velocity magnitude |U| is calculated.

As seen in **Figure 4.3-19**, velocity components and magnitudes just downstream of the trap entrance fyke (location A in Figure 3.5-3) vary over time. Comparing the 1-foot and 3-feet depths, there is generally good agreement, indicating relatively uniform velocity over depth. Generally, most of the flow is in the along-channel (longitudinal, U) velocity component, except for several days, the vertical component (W) was elevated. During the initial period of operation at Site 1 and the first half of operations at Site 2, the velocity magnitude steadily increased to a peak value of 3.0 ft/s on November 12, 2024. After the first major storm event in mid-November, velocity magnitude was low and remained between 0.5 ft/s and 1 ft/s. Following relocation to Site 3, velocity magnitude dropped to less than 0.25 ft/s for the remainder of the season.

Contrasting these data with those just downstream of the fry box fyke within the fry box (location B in Figure 3.5-3), the velocities are much lower with less variability **(Figure 4.3-20)**. Comparing data from the 1-foot and 3-feet depths, there is generally good agreement, indicating relatively uniform velocity over depth. Generally, most of the flow is in the along-channel (longitudinal, U) velocity component, except for several days in October and November when the vertical component (W) was elevated. During the initial period of operation at Site 1 and the first half of operations at Site 2, the velocity magnitude slightly increased to a peak value of 1.9 ft/s on October 28, 2024. After the first major storm event in mid-November, velocity magnitude was low and remained between 0.15 ft/s and 0.6 ft/s. Following relocation to Site 3, velocity magnitude dropped to less than 0.1 ft/s for the remainder of the season.

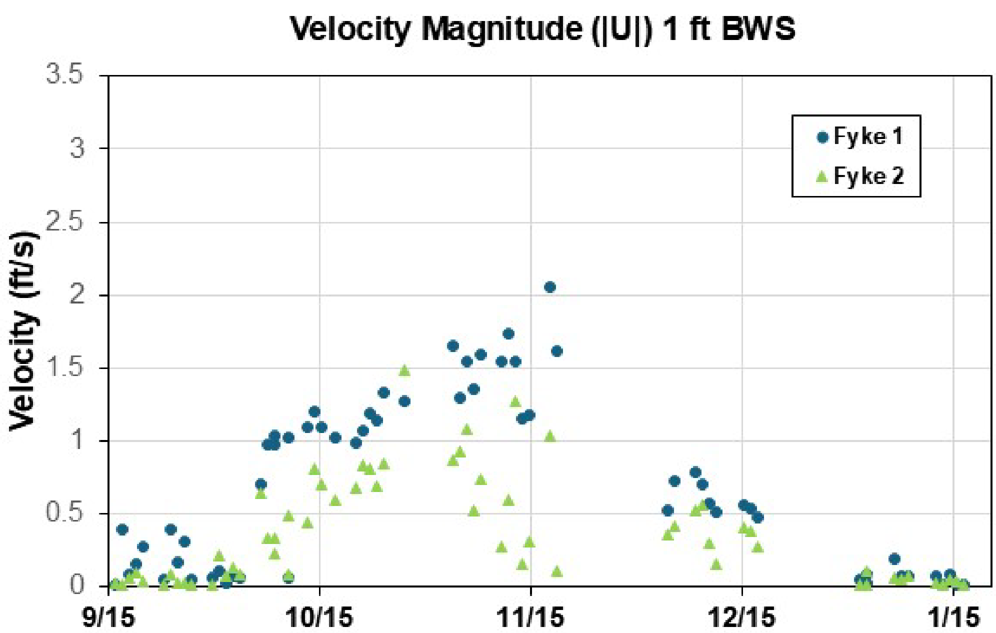


Figure 4.3-21. Time series of velocity magnitude measured with an ADV at two locations—downstream of trap entrance fyke (Fyke 1, location A in Figure 3.5-3) and downstream of fry box fyke (Fyke 2, location B in Figure 3.5-3) at a depth of 1 feet below water surface, BWS.

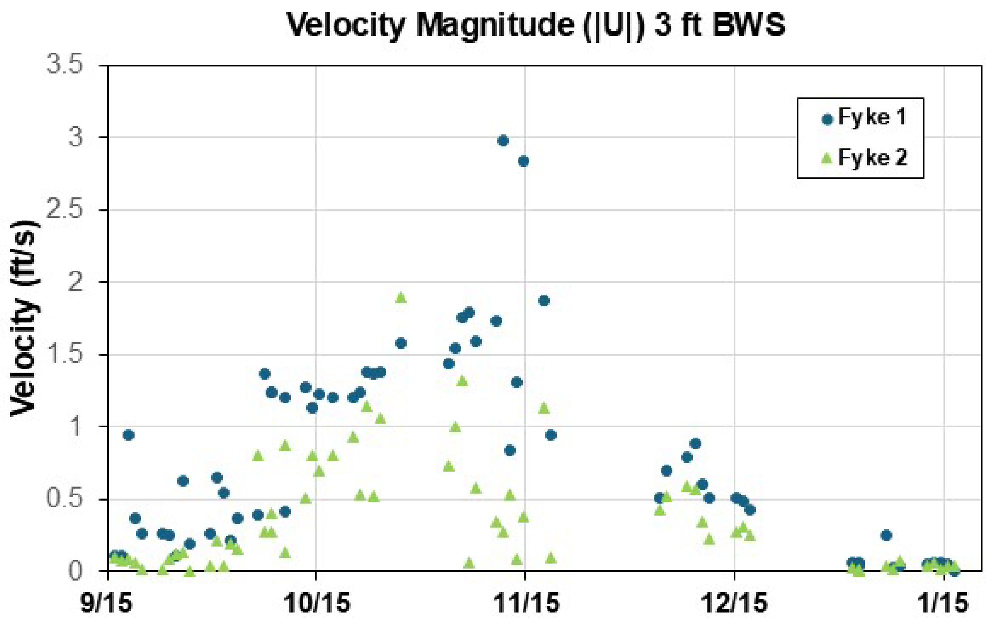


Figure 4.3-22. Time series of velocity magnitude measured with an ADV at two locations—downstream of trap entrance fyke (Fyke 1, location A in Figure 3.5-3) and downstream of fry box fyke (Fyke 2, location B in Figure 3.5-3) at a depth of 3 feet below water surface, BWS.

A direct comparison of velocity magnitude between these two locations at depths of 1 feet BWS and 3 feet BWS is presented in **Figure 4.3-21** and **Figure 4.3-22**. These comparisons show how velocity is diffused between the trap entrance and the Fry Box. Even at the highest velocity magnitudes of 2-3 ft/s, the velocity magnitude inside the fry box was two to three times lower, with the exception of October 28. The diffusion of velocity indicates that the trap platform design was adequate for reducing velocities within the fry box during periods of high-inlet velocity conditions.

4.3c. Summary of Velocity Data

Velocity data collectively illustrate that velocity in and upstream of the system steadily increased as depths decreased over the first two months of the season while flows remained consistently low. Following major storm events, velocities initially increased before decreasing due to increased reservoir levels. Later in the season, the reservoir became very deep, and velocities decreased substantially, even at higher inflows. Compared to the 2023 field season, velocities were slightly lower at similar depths. This may be because the channel was slightly wider with a greater cross-sectional flow area during the 2024-25 field season. Impermeable panels slightly increased velocity approaching the trap. However, during the last few weeks at Site 1, velocities decreased approaching the trap. This was likely due to flow going underneath the left guidance net and the trap being slightly offset from the thalweg at Site 1. The fykes within the trap created the desired hydraulic effects of increased velocity at the entrance of the trap and slightly lower velocities at the fry box entrance.

4.4. Meteorological Data

Several observations were made from the meteorological data. Air temperature ranged from 1.2°C (34.1 °F) to 36.8 °C (98.3 °F) with an average temperature of 12.9°C (55.3 °F). Air pressure remained fairly constant over the season, ranging from 28.6 to 29.4 inHg. Wind speeds were variable during the season, with maximum sustained winds of 24 mph and maximum wind gusts of 57 mph. Wind direction was also highly variable but frequently oriented approximately 350° from true north. A total of 41.8 inches of rain fell during the season. Of that 41.8 inches, 0 inches fell in September, 0.8 inches fell in October, 18.5 inches fell in November, 20.7 inches fell in December, and 1.8 inches fell in January.

4.5. Drone and Aerial Imagery

A total of 10 drone flights were conducted throughout the season. Imagery from these flights show the decrease and increase in WSE over time and how the JSCS shifted as a result (**Figure 4.5-1 and Figure 4.5-2**). At Site 1, the JSCS configuration shifted after the initial deployment but did not shift much over time before the first move (**Figure 4.5-3)**. The JSCS did not noticeably shift at Site 2 as the load on the system remained very low while it was located there. At Site 3, following the second move, the JSCS also did not change significantly due to very low loads on the system.

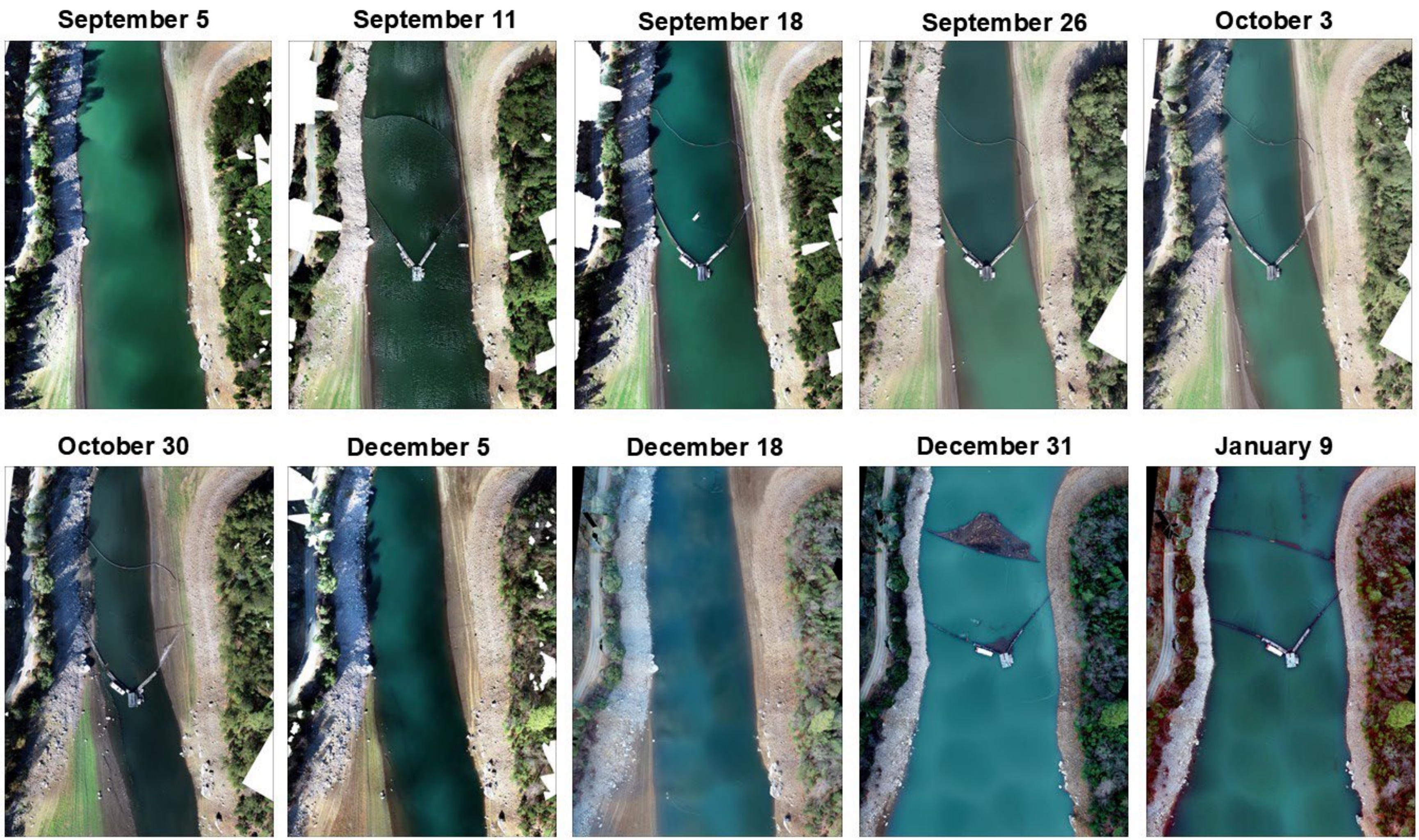


Figure 4.5-1. Aerial imagery of JSCS location within McCloud Arm at Sites 1 and 3 from September 5, 2024 – January 9, 2025.

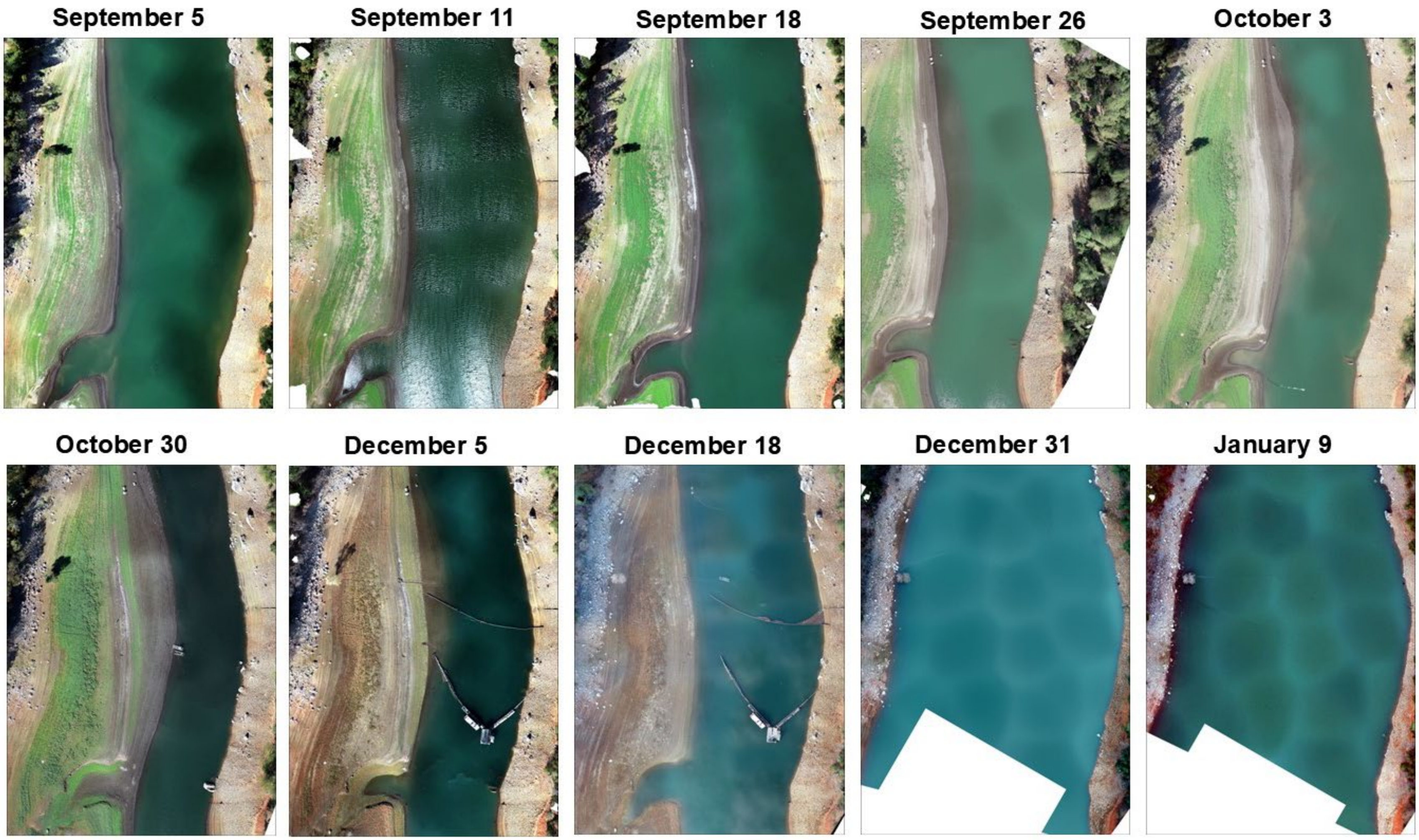


Figure 4.5-2. Aerial imagery of JSCS location within McCloud Arm at Site 2 from September 5, 2024 – January 9, 2025.

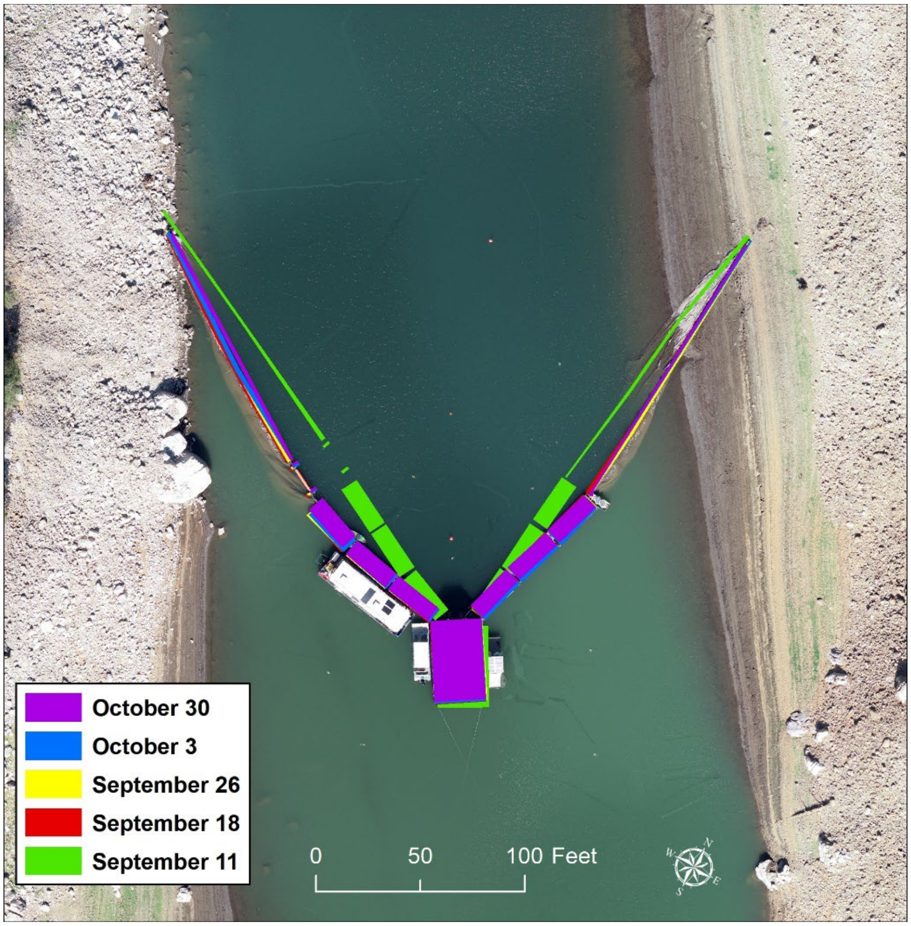


Figure 4.5-3. Configuration of JSCS platform and docks over time at Site 1. Background imagery is from September 26, 2024.

4.6. Fish Sampling

Different project partners (DWR, PSMFC, Winnemem Wintu Tribe) operated a total of three traps across a total of five locations to capture and relocate outmigrating Nur on the McCloud River for the 2024-25 field season. PSMFC and the Winnemem Wintu Tribe operated two traps across two locations between August 27 and November 19, 2024: an IPT and an RST were deployed first at Bollibokka and subsequently moved to a location downstream of the McCloud Bridge. DWR and the Winnemem Wintu Tribe operated the JSCS fish trap at three sites between Ellery Creek and Pine Point campgrounds from September 17, 2024, through January 19, 2025 (**Table 4.6-1**). DWR checked the JSCS trap at least once daily and conducted mark-recapture trap efficiency trials weekly. Project partners conducted gastric lavage sampling to assess adult predator diets five times between September and November 2025; the Winnemem Wintu Tribe sampled diets of target predators (primarily juvenile Spotted Bass) captured in the trap daily.

Table 4.6-1. *JSCS Windows of Operation at Sites 1, 2, and 3 2024-25 (noting that Site 3 is Site 1 in January 2025 as described in sections 4.1-4.5).*

Site	Dates Fishing	Days Fishing
1	9/17-10/28/2024	41
2	10/31-11/20/2024, 12/4-12/19/2024	36
3	1/2-1/19/2025	18

Severe weather events disrupted fish sampling and trap operations: storms at the end of November and in mid- and late-December repeatedly pushed daily flows in the McCloud River above 2,000 cfs (**Figure 4.6-1**). During storm events which threatened crew safety and structural integrity, DWR pulled up the nets and closed the JSCS trap to fishing. DWR fished the trap in flows in excess of 2,000 cfs at the end of the season in January to test trap performance in winter storm conditions. Compared to the 2023 season, the JSCS was moved more frequently, fished for additional months, and fished over a wider range of weather and reservoir conditions in the 2024-25 season.

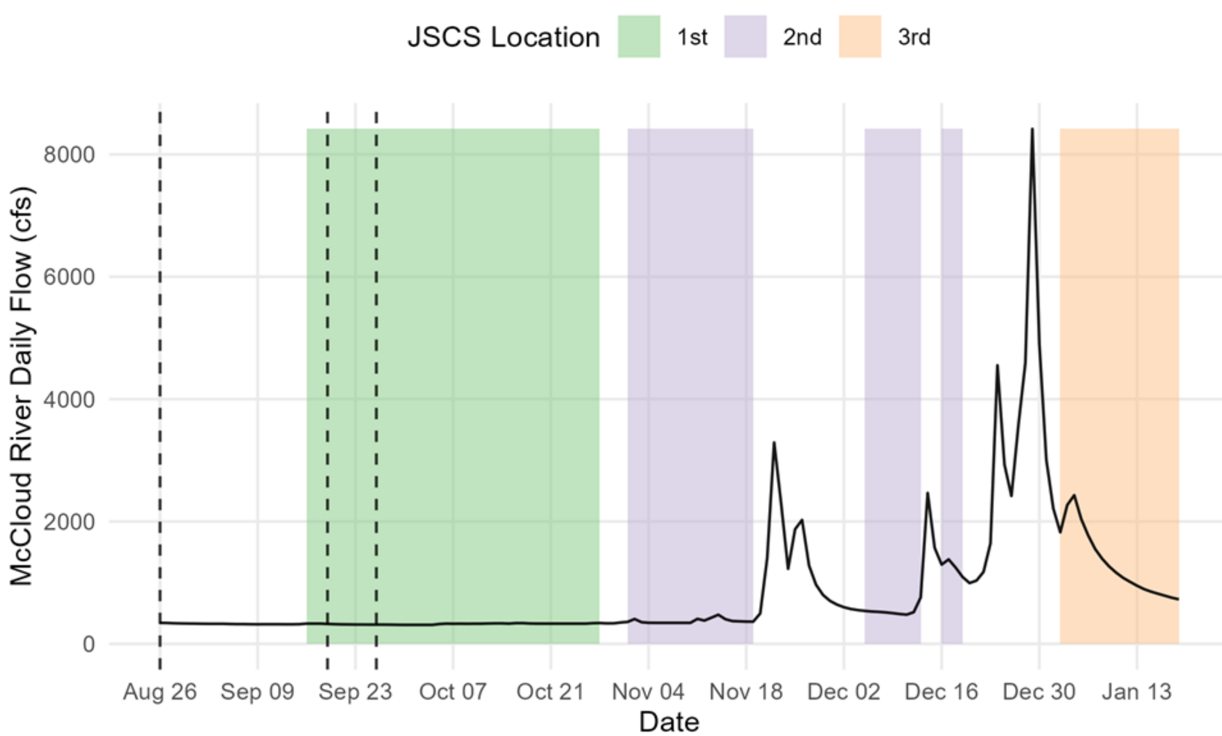


Figure 4.6-1. McCloud River daily flow in the 2024-25 trapping season. The solid line is the daily flow. Vertical dashed lines show the dates of heath tray releases. Shaded regions show when the JSCS was operated.

The trap catch analysis includes water temperature in the middle of the fry box, water velocity through the trap, and water depth at the trap notch. Several velocity measurements were taken throughout the entrance fyke and fry box (see **Section 3.5**: Velocity for details). For this analysis, those values were averaged into a single daily velocity value. Several potential covariates were confounded. Velocity is correlated with water depth at the trap and the number of panels deployed. Thus, we use velocity here as a proxy measure for changes to the JSCS structure. Water temperature was not correlated with velocity, depth, or panels deployed. However, water temperature *was* correlated with day of year and, thus, temperature effects on catch can't be teased apart from non-temperature based seasonal effects.

This section focuses specifically on JSCS catch during the 2024-2025 field season and comparative analysis to other trapping seasons and other traps will be reserved for the Final Report of this pilot study.

4.6a. Trap Catch

In total, the JSCS captured 1,308 fish representing 17 different species at larval, juvenile, and sub-adult life stages (**Table 4.6-2**). The JSCS operated at or downstream of the riverine-reservoir interface and fished in transitional river-like and reservoir conditions for the entirety of the season.

Non-native fish species represent the vast majority of fish captured, and Bluegill Sunfish alone represent 76% of the catch (**Table 4.6-2**). The JSCS captured 164 Bluegill Sunfish on September 19; 688 Bluegill Sunfish on September 20; and 72 Bluegill Sunfish on September 21, 2024. All of these fish were at the juvenile life stage and were generally <30 mm fork length. This spike in catch corresponds to the first rain event of the season and significantly exceeded catch for the rest of the season: the pulse flushed juvenile Bluegill rearing upstream of the site into the JSCS. Spotted Bass were the second most common species captured at the JSCS and were most abundant in September (**Figure 4.6-2**). Altogether, bass and sunfish species comprise 91.6% of the total JSCS catch for the 2024-25 field season (**Table 4.6-2**). JSCS catch is characterized by a pronounced early peak in bass and sunfish, although capture of both species groups was consistent in small numbers for the duration of the field season.

The catch of native species included Sacramento Pikeminnow, Riffle Sculpin, and Rainbow Trout, which represent a combined 1% of JSCS trap catch. Catch of Sacramento Pikeminnow exhibits a clear peak in January, with most of the catch occurring from January 4-18, 2025 (**Figure 4.6-2**).

Table 4.6-2. 2024-25 JSCS Trap Catch by Species

Species	Total Catch
Chinook Salmon (*Oncorhynchus tshawytscha*)	**80**
Nur (Winter-run Chinook Salmon)	40
Marked Winter-run Chinook Salmon	
JSCS trial recaps	32
Upstream trial recaps	6
Late Fall-run Chinook	2
Non-native Fish Species	**1,212**
Spotted Bass (*Micropterus punctulatus*)	111
Largemouth Bass (*Micropterus salmoides*)	2
Smallmouth Bass (*Micropterus dolomieu*)	2
Micropterus spp.	11
Bluegill Sunfish (*Lepomis macrochirus*)	1056

Pumpkinseed Sunfish (*Lepomis gibbosus*)	1
Green Sunfish (*Lepomis cyanellus*)	4
Centrarchidae spp.	11
Threadfin Shad (*Dorosoma petenense*)	10
Brown Bullhead (*Ameiurus nebulosus*)	1
White Catfish (*Ameiurus catus*)	2
Native Fish Species	**15**
Sacramento Pikeminnow (*Ptychocheilus grandis*)	12
Rainbow Trout (*Oncorhynchus mykiss*)	2
Riffle Sculpin (*Cottus gulosus*)	1

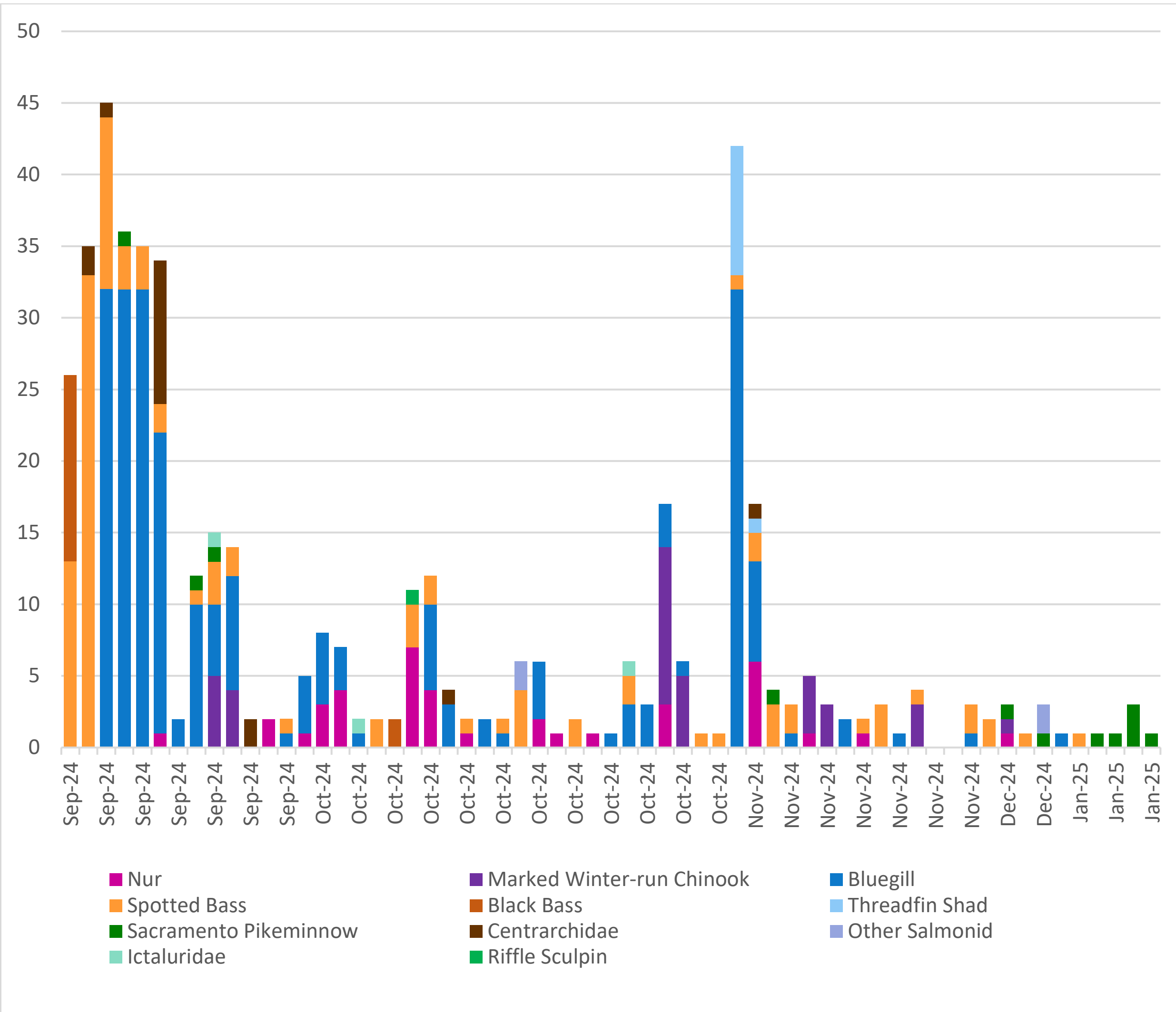


Figure 4.6-2. 2024-2025 JSCS Daily Trap Catch by Species. Actual catch of Bluegill Sunfish was 174 on September 19; 688 on September 20; and 72 on September 11. Catch was truncated at 32 Bluegill Sunfish on these days to remove outliers and preserve visibility in this figure.

The distribution and quantity of catch varied by site. Because different sites represent different bathymetry and reservoir conditions, we understand that site is confounded with factors including depth, temperature, velocity, and seasonality. Daily average catch of Chinook Salmon (including both marked fish and Nur) was similar between Site 1 and Site 2 but dropped off sharply at Site 3. Non-native fish catch was highest at Site 1 (including the juvenile Bluegill Sunfish outmigration event in mid-September), declined at Site 2, and decreased sharply at Site 3. Catch of native fish species, however, was greatest at Site 3 (**Table 4.6-3**).

Table 4.6-3. *2024-25 JSCS Trap Catch by Site and Species Class. Marked and recaptured fish are included under Chinook Salmon.*

	Site 1		**Site 2**		**Site 3**	
	Total Catch	Average Daily Catch	Total Catch	Average Daily Catch	Total Catch	Average Daily Catch
Winter-run Chinook Salmon	40	0.975	38	1.02	0	0.00
Native Fishes	4	0.10	5	0.14	6	0.33
Non-Native Fishes	1157	28.22	53	1.47	2	0.11

The JSCS crew recorded visual observations of a large school of adult brown and rainbow trout (N>200) near the trap at Site 2: the school formed directly in front of the trap entrance between the guidance nets. Adult trout remained present in large numbers consistently at Site 2 and Site 3. JSCS crews made visual observations of feeding behavior, and it is assumed that predation influenced trap catch at Sites 2 and 3. No adult fish were captured in the JSCS trap and these fish are not represented in JSCS catch data.

4.6b. Nur Catch

JSCS capture of juvenile salmonids remained consistently low throughout the 2024-25 field season, totaling 78 winter-run Chinook Salmon (40 Nur and 38 marked winter-run Chinook Salmon) (**Table 4.6-2**). In comparison, the JSCS captured 843 winter-run Chinook Salmon (489 Nur and 349 marked winter-run Chinook Salmon) during the 2023 field season. The JSCS most frequently captured only one or two Nur at a time and did not capture more than 7 Nur in one day at any point during the 2024-25 field season (**Figure 4.6-3).** No Nur were injured or killed by trap structure and fishing operations; one mortality occurred incidental to the use of the fish viewer in morphometric measurement.

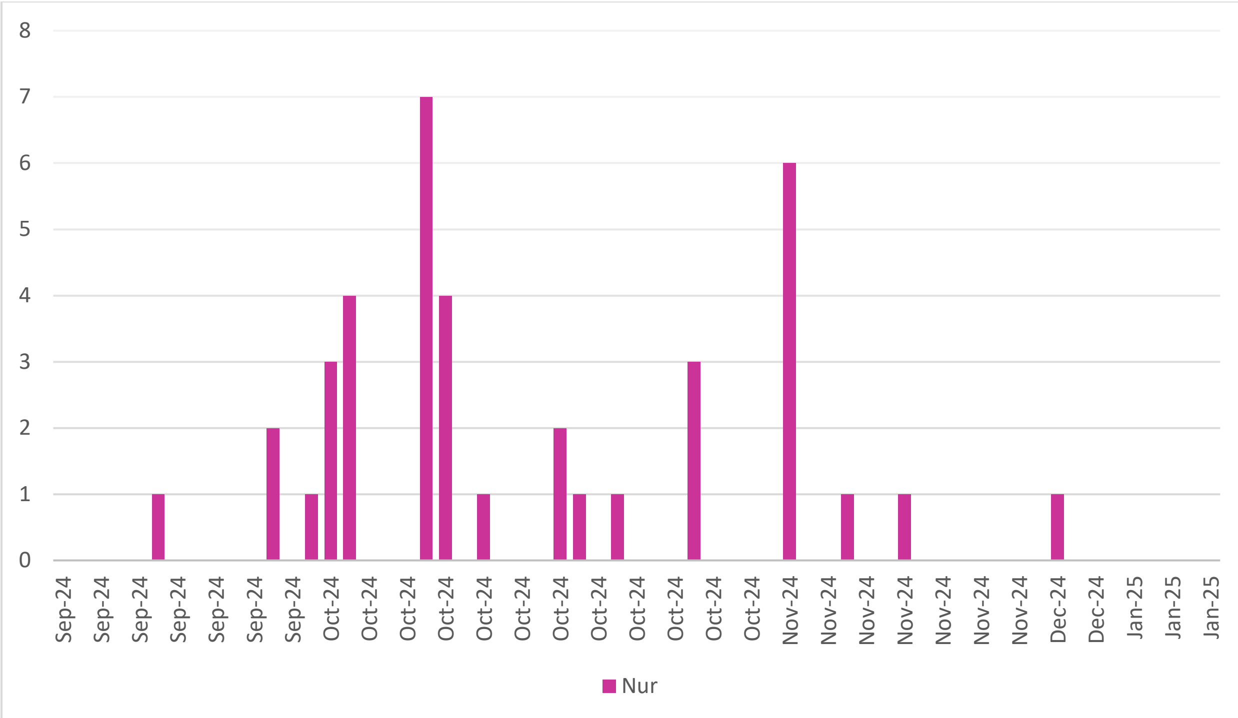


Figure 4.6-3. JSCS Trap Daily Nur Catch 2024-25.

The period that the JSCS was fishing at Site 1, September 17 through October 28, 2024, accounts for 75% of the total Nur catch for the season (**Figure 4.6-4**). The JSCS captured 27 Nur in October alone (**Table 4.6-4**).

The JSCS continued to capture Nur with some regularity during the month of November at Site 2 but catch declined to a single Nur in December. The JSCS captured zero Nur at Site 3 in January (**Table 4.6-4**).

The JSCS caught the only Nur yearling (180 mm FL) of the season on December 5, 2024.

Table 4.6-4. *2024-25 JSCS Trap Catch of Salmonids*

	September	October	November	December	January
Nur	3	27	8	1	0
Marked Winter-run Chinook	9	16	10	1	0
Marked Late Fall-run Chinook	0	2	0	0	0
Rainbow Trout	0	0	0	2	0

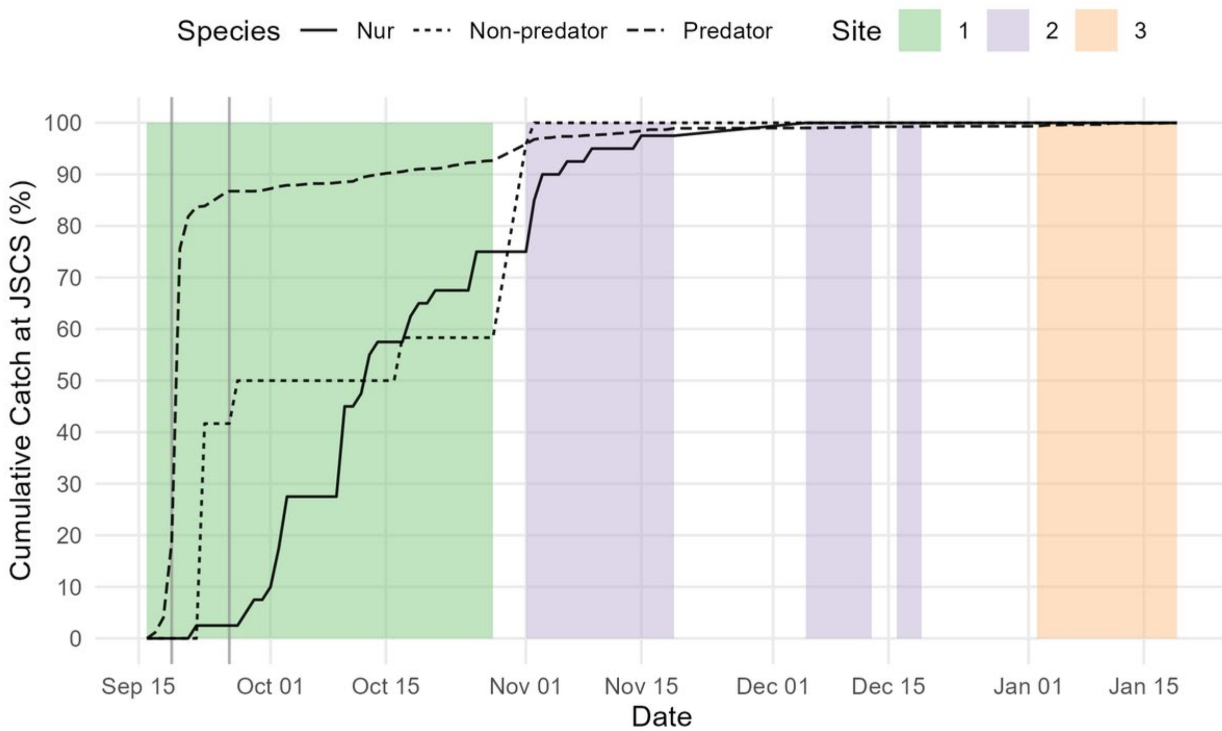


Figure 4.6-4. Cumulative catch at the JSCS for three species groups. The solid line is the cumulative catch. Shaded regions show when the trap was operated. The predator group includes piscivorous native fishes; the non-predator site includes non-piscivorous non-native fishes.

PSMFC and the Winnemem Wintu Tribe captured a combined total of 4,581 winter-run Chinook Salmon across the IPT and RST at both locations. The IPT and RST captured 2,541 winter-run Chinook Salmon in October, representing 55.4% of total upstream catch.

4.6c. Size and Age Class

The JSCS crew measured 240 fish representing five species (winter-run Chinook Salmon, Spotted Bass, Bluegill Sunfish, Sacramento Pikeminnow, and Threadfin Shad) during the 2024-25 field season. Other species were not captured or measured in quantities sufficient for statistical analysis. The JSCS crews used the fish viewer to sample Nur and used measuring boards to sample all other species (as well as Nur when the fish viewer was inoperable). Morphometric results from the fish viewer are still under processing at UC Davis at the time of writing this report (anticipated spring 2025); this section includes analysis of data from measuring boards only.

The JSCS captured fish across larval, fry, juvenile, and sub-adult life stages. The average fork length (FL) of Nur caught in the JSCS in the 2024-25 field season was 46.89 millimeters (mm) (**Figure 4.6-5**). Nur caught at Site 1 were typically fry (newly hatched), with an average fork length of 43.7 mm. Nur caught at Site 2 were typically parr (more developed with defined parr marks), but the average fork length was 42.2 mm, smaller than fish captured earlier in the season. One Nur at the yearling life stage (180 mm FL) was captured at Site 2. In contrast, winter-run Chinook Salmon from LSNFH ("efficiency fish") steadily increased in size across the season. Efficiency fish averaged 39.6 mm at Site 1; 55.6 mm at Site 2; and 74.2 mm at Site 3 (**Figure 4.6-6**).

Bluegill Sunfish were the most abundant species caught at the JSCS in the 2024-25 field season, and were primarily captured at juvenile, fry, and larval life stages. The average fork length among Bluegill Sunfish (excluding larval fish) was 30 mm FL. Spotted Bass were the second most abundant species caught at the JSCS and exhibited the widest distribution of life stages. Spotted Bass were captured at juvenile and sub-adult life stages, with fork lengths ranging from 49 mm to 232 mm and averaging 110 mm. Sacramento Pikeminnow and Threadfin Shad were captured at fry life stages, averaging 31 mm and 36 mm FL, respectively (Figure 4.6-5). This size distribution of catch demonstrates that the JSCS reliably captures fish across fry, juvenile, and sub-adult life stages; effectively targets juvenile fishes; and excludes resident adult fishes.

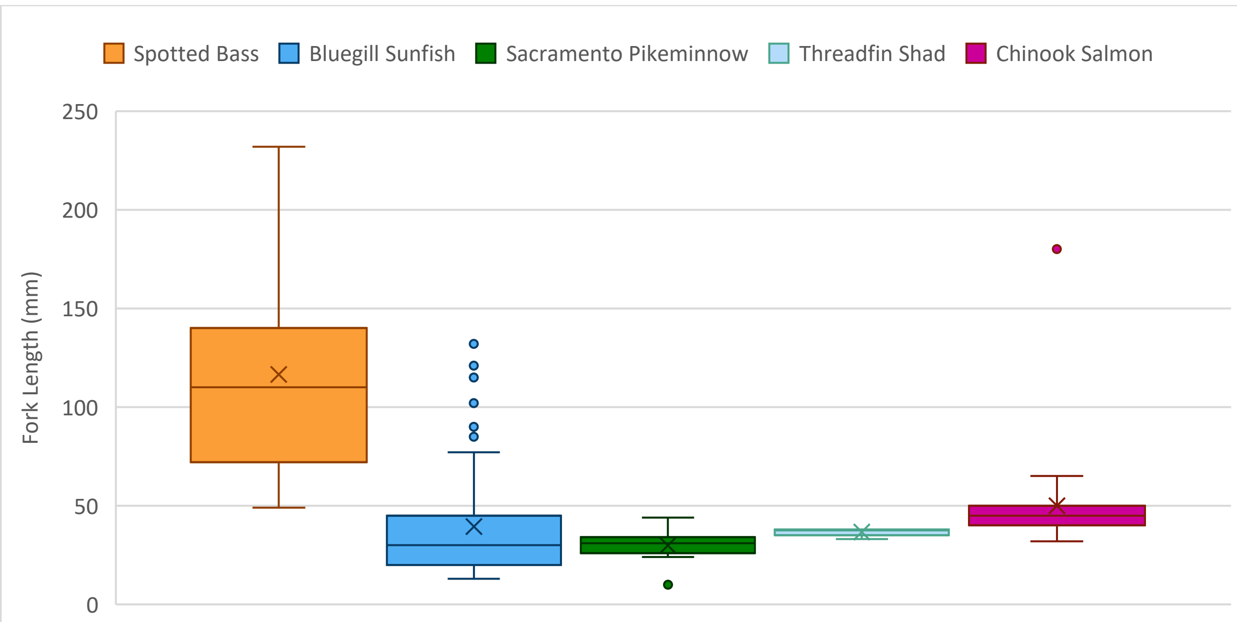


Figure 4.6-5. JSCS Catch 2024-25 Fork Length by Species. Note that JSCS crew did not measure fish at larval life stages or under <20mm FL; fish at larval life stages are excluded from this analysis**.**

4.6d. Trap Efficiency and Capture Probability

The JSCS conducted nine mark-release-recapture trap efficiency trials over the 2024-25 field season. The JSCS exhibited consistently low trap efficiency, with an average total trap efficiency of 1.54%. Four of nine trials yielded no recaptures, and only three of nine trials met the minimum threshold of recapturing seven marked fish. The maximum trap efficiency of any trial was 6% (**Table 4.6-5**).

Recapture rates among the “Near” release groups were significantly higher than recapture of the “Standard” release group on the September 24th and October 25th trials, indicating that predation and survival in the reservoir stretch upstream of the trap may be impacting recapture rates (**Table 4.6-5**). However, trap efficiencies were consistently too low to draw clear conclusions.

Table 4.6-5. *JSCS Efficiency Trial Results 2024-25. This table does not include recaptures from trials conducted at other traps upstream. S is "Standard Release" (0.5 km); N is "Near Release" (300 feet).*

Date	Release Groups and Marks	Recaptures by Release Group	Efficiency By Release Group	Total Efficiency
9/24/2024	S=149, BB+LC	2	1.3%	4.52%
	N=50, BB	7	14%	
10/01/2024	S=149, BB+LC	0	0%	0.00%
	N=49, BB	0	0%	
10/25/2024	S=150, BB+LC	3	2%	6.00%
	N=50, BB	9	18%	
11/05/2024	S=150, BB+LC	6	4%	2.33%
	N=150, BB	1	0.06%	
11/12/2024	S=150, BB+LC	3	2%	1.00%
	N=150, BB	0	0%	
12/05/2024	S=150, BB+LC	0	0%	0.03%
	N=150, BB	1	0.06%	
12/10/2024	S=150, BB+LC	0	0%	0.00%
	N=150, BB	0	0%	
1/07/2025	S=150, AD+LC	0	0%	0.00%
	N=150, AD+BB	0	0%	
1/14/2025	N=150, AD+BB	0	0%	0.00%

The fork length of winter-run Chinook Salmon used in trap efficiency trials consistently increased over the season (**Figure 4.6-6**). Marked fish used in trials were on average larger than the Nur captured at the JSCS (**Figure 4.6-5**). Release crews observed bass and trout feeding behavior during releases and observed released fish swimming upstream or towards the shallows.

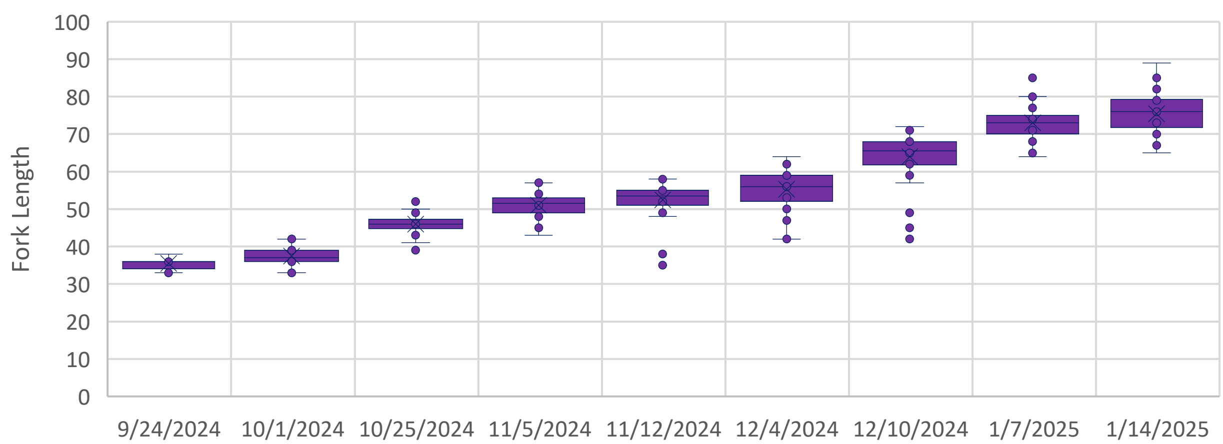


Figure 4.6-6. Fork length of marked winter-run Chinook Salmon used in JSCS trap efficiency trials. All marked winter-run Chinook Salmon originated from Livingston Stone National Fish Hatchery.

Trap efficiencies were highest at Site 1, declined at Site 2, and fell to zero at Site 3 (**Table 4.6-5**). Trap efficiencies were highest when velocities were between 0.25-1.5 ft/s and depths were shallower than 17 feet. Trap efficiencies were 0% when depths exceeded 20 feet (**Figure 4.6-7**).

Table 4.6-6: *Trap Efficiency Release and Recapture Totals by Site*

Site	Total Released	Total Recaptured	Total Recap Rate
Site 1	597	21	3.52%
Site 2	1199	11	0.92%
Site 3	450	0	0.00%

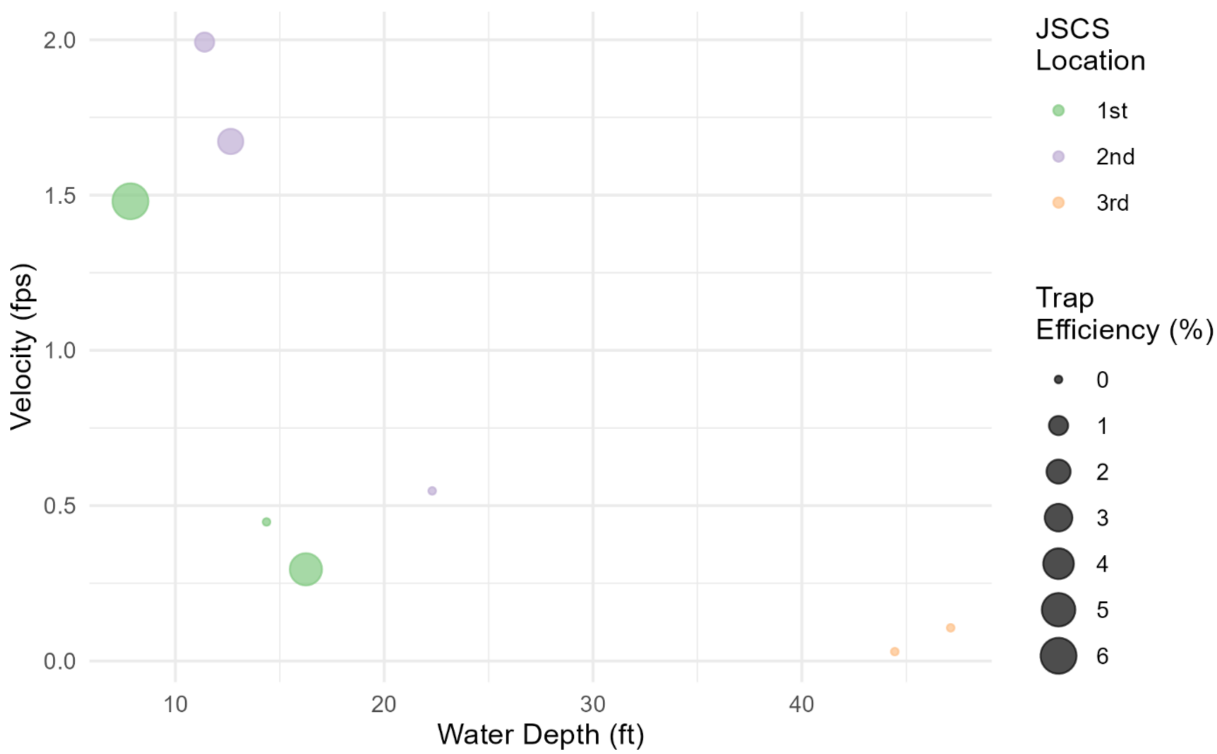


Figure 4.6-7. The relationship between average water velocity and water depth at the JSCS trap in two trapping seasons. Symbol size indicates the trap efficiency over 3-day period after release (summed across near and standard release distances in 2024-25). Average temperature and depth include the release date and the subsequent three days. Note, there is no data point for the December 4 release date because of missing water depth measurements.

NOAA Fisheries and USGS conducted releases of PIT- and JSAT-tagged yearling late fall-run Chinook Salmon upstream of the JSCS and monitored their movement in the McCloud Arm of Shasta Reservoir. Acoustic telemetry data revealed that yearling Chinook Salmon survived to reach the JSCS, evaded capture, and continued downstream. Detections indicated that a significant portion of yearlings held upstream of the JSCS and outmigrated later during winter pulse flows. The JSCS captured only two of the 186 yearlings that were detected at the trap (**Figure 4.6-8**, Michel 2025). Detections of yearling Chinook Salmon downstream of the JSCS peaked during the first winter storm event in late November, when the

JSCS suspended fishing (**Figure 4.6-9,** Kock 2025). Taken altogether, these data indicate that the JSCS does not effectively block the downstream movement of yearling Chinook Salmon.

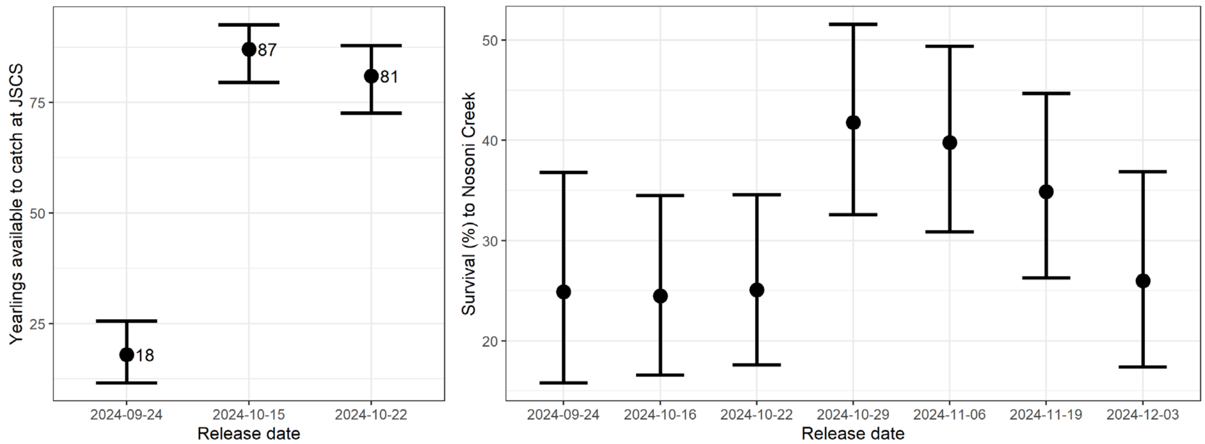


Figure 4.6-8. Number of yearling late fall-run Chinook Salmon that reached the JSCS (left) and percent survival of yearlings as determined by detection at Nosoni Creek downstream of the JSCS (right). Preliminary data from Cyril Michel, subject to revision.

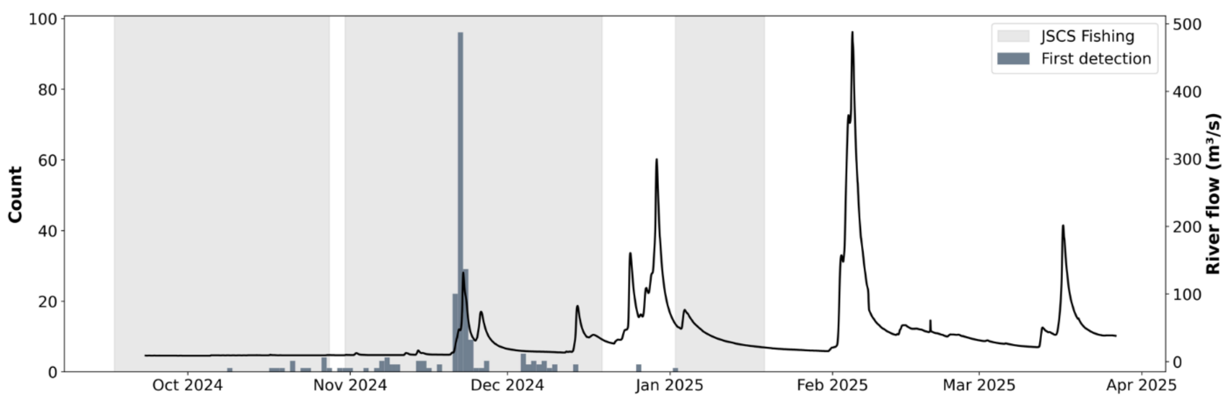


Figure 4.6-9. Detection count of yearling late fall-run Chinook Salmon at array five miles downstream of JSCS. Preliminary data from Toby Kock, subject to revision.

4.6e. Correlation Between Catch and Other Factors

Analysis of the relationship between catch, velocity, and depth revealed that the JSCS captured the most Nur when water depths at the trap entrance were shallower than 15 ft and velocities through the trap were 0.25-1.5 ft/s (**Figure 4.6-8**). Catch of predators is also correlated with shallower depths (**Figure 4.6-13**). Depth is a stronger indicator of catch than velocity, although depth and velocity have a negative correlation: as the reservoir deepened, water velocities through the trap decreased (**Figure 4.6-10**).

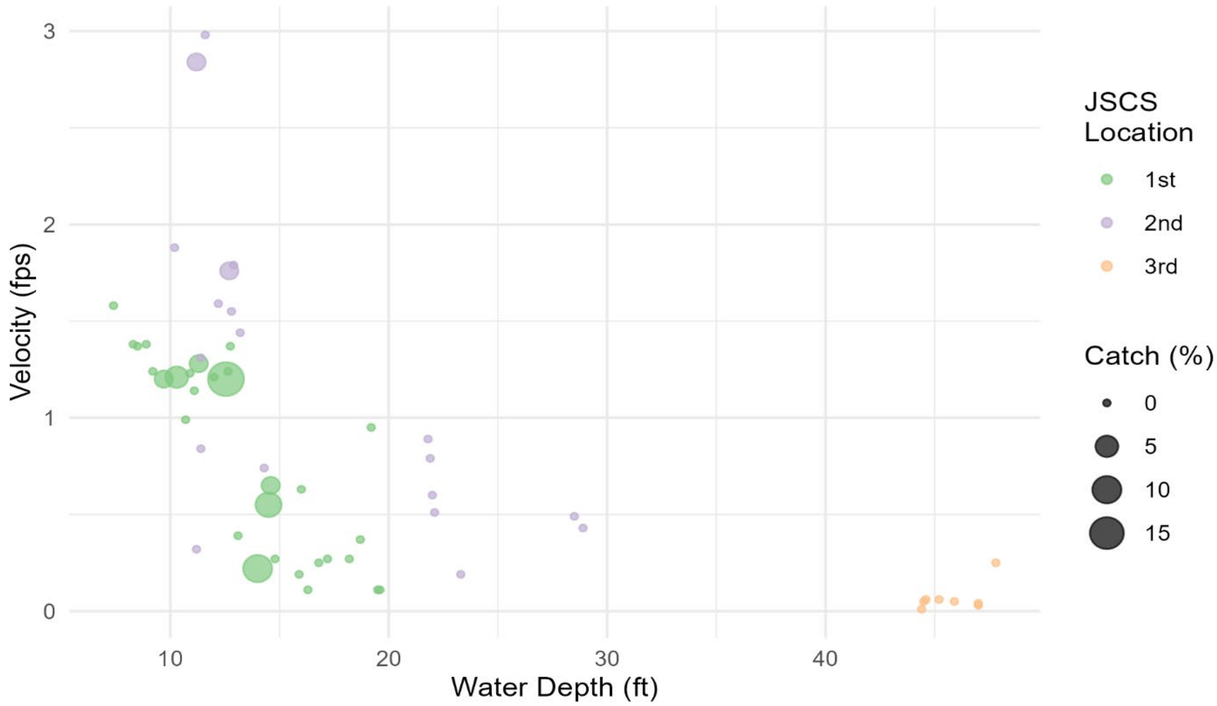


Figure 4.6-10. Relationship between Nur catch, average daily water velocity, and water depth at the JSCS trap. Symbol size indicates the percentage of Nur catch on that date.

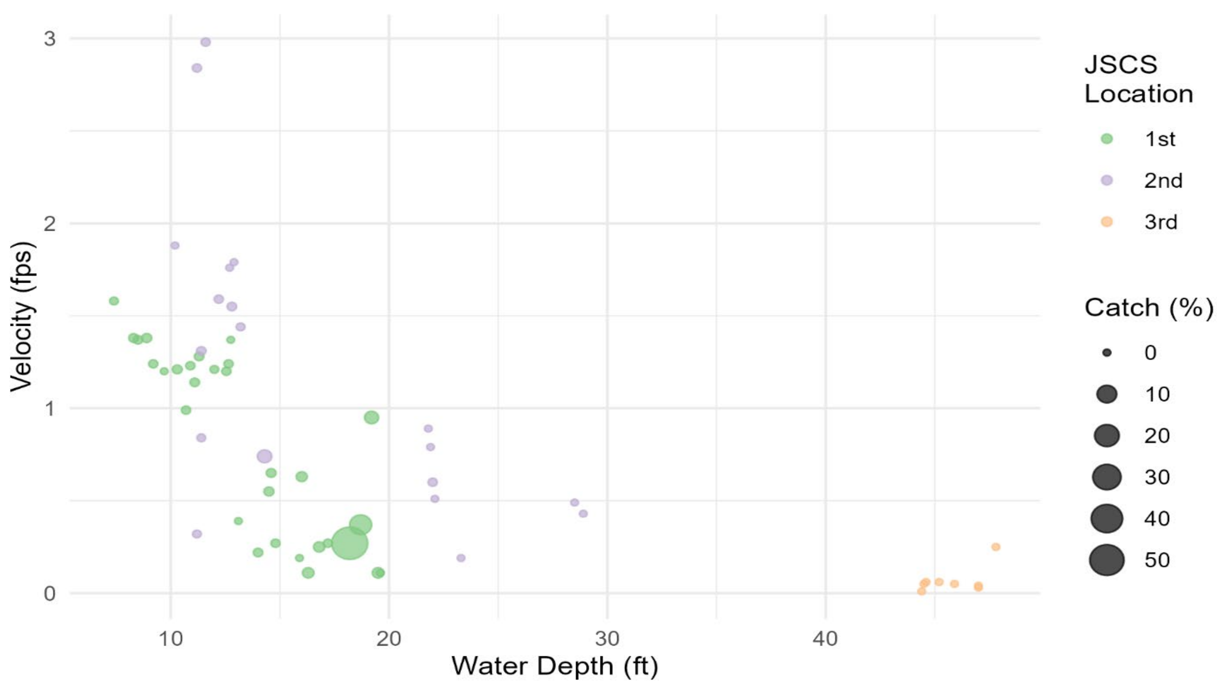


Figure 4.6-11. Relationship between Predator catch, average daily water velocity, and water depth at the JSCS trap. Symbol size indicates the percentage of predators caught on that date. In this figure, three consecutive days (September 19-21) of Bluegill Sunfish catch (150, 682, 72) accounted for 71% of all catch (across all groups) throughout the season.

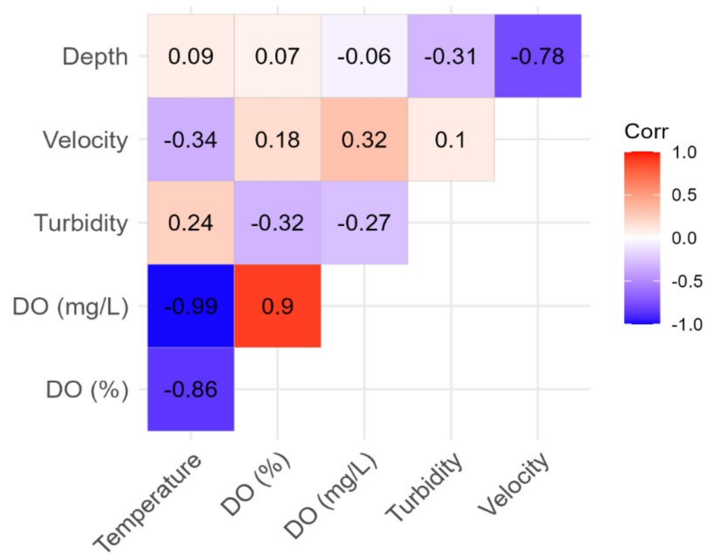


Figure 4.6-12. Spearman correlation coefficient matrix for six environmental variables collected at the JSCS trap.

4.6f. Predation and Stomach Sampling

The JSCS captured seven species classified as predators totaling 1,200 fish (**Table 4.6-8**). Spotted Bass are of particular concern to the Winnemem Wintu Tribe and are known to be piscivorous at all life stages (**Figure 4.6-11**). The Winnemem Wintu Tribe lethally sampled the stomachs of Spotted Bass captured at the JSCS to assess the presence or absence of Nur.

Table 4.6-7. *Total JSCS Catch of Predator Species 2024-25*

Predator Species	Total Trap Catch
Spotted Bass	111
Black Bass spp.	15
Bluegill Sunfish	1,056
Catfish spp.	3
Sacramento Pikeminnow	12
Rainbow Trout	2
Riffle Sculpin	1

Figure 4.6-13. Spotted Bass sampled by the Winnemem Wintu Tribe revealing juvenile Bluegill Sunfish in the stomach.

In addition to stomach sampling performed by the Winnemem Wintu Tribe on bass caught in the JSCS Trap, UC Santa Cruz NOAA Southwest Fisheries Science Center performed non-lethal stomach sampling on predators (Spotted Bass, Brown Trout, and Rainbow Trout) caught by hook and line in the vicinity of the JSCS structure. The combination of methods allowed the JSCS to sample the stomachs of predator species across size classes and life stages. At Site 1, predators sampled from the trap by the Tribe averaged 129.4 mm FL, while predators sampled by hook and line averaged 337.8 mm FL. At Site 2, predators sampled from the trap by the Tribe averaged 87.94 mm FL while predators sampled by hook and line averaged 347.8 mm FL (**Figure 4.6-12**). The size of predators caught in the trap (juvenile bass) decreased between sites, but the size of predators caught by hook and line was not significantly different.

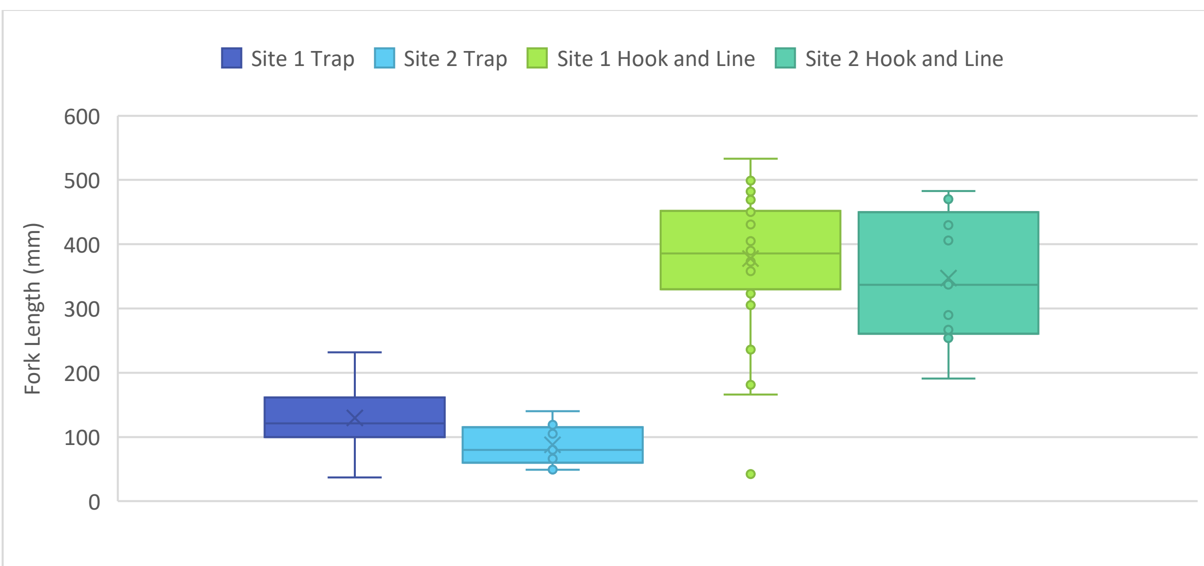


Figure 4.6-14. Fork lengths of sampled predator fishes by site and catch method.

Of the 74 Spotted Bass sampled at Site 1, nine had juvenile fish in their stomachs, including five Nur (**Table 4.6-9**). Of the 27 Spotted Bass sampled at Site 2, only one had a juvenile fish in its stomach. In total, six of 101 Spotted Bass sampled had intact Chinook Salmon carcasses in their stomach (5.9%). Only one Spotted Bass was sampled at Site 3 and its stomach was empty. For comparison, 32 of 299 (10.1%) Spotted Bass sampled during the 2023 field season had stomach contents including intact Chinook Salmon carcasses, representing a predation rate nearly double that of the 2024-25 field season.

None of the 42 trout sampled with hook and line and gastric lavage had intact juvenile fish in their stomachs; six trout at Site 1 contained insects or invertebrates and two contained plant matter. DNA analysis of these samples revealed trace amounts of Chinook Salmon DNA in 12 adult Rainbow Trout diets and 1 Spotted Bass diet, indicating that these fish may have consumed Chinook Salmon. All other diets had mean relative Chinook Salmon DNA concentrations of zero, indicating that the remaining 29 adult trout had *not* consumed salmon (Michel 2025).

Table 4.6-8. *Number of predators sampled for stomach contents by species, method, and site. Contents refers to the number of fish with visually identifiable stomach contents present in diet sample.*

Site 1				
	Trap		H&L	
	Count	Contents	Count	Contents
Spotted Bass	74	11	6	1
Rainbow Trout	0	0	29	8
Brown Trout	0	0	4	0
Other	5	0	0	0
Total	**79**	**11**	**39**	**0**
Site 2				
	Trap		H&L	
	Count	Contents	Count	Contents
Spotted Bass	27	1	0	0
Rainbow Trout	0	0	4	0
Brown Trout	0	0	5	0
Total	**27**	**1**	**9**	**0**
Site 3				
	Trap		H&L	
	Count	Contents	Count	Contents
Spotted Bass	1	0	0	0
Rainbow Trout	0	0	1	0
Total	**1**	**0**	**1**	**0**

Table 4.6-9. *Stomach contents by species and site.*

Site 1		
Predator Species	**Stomach Contents ID**	**Count**
Rainbow Trout	Green Midge	4
	Plant Matter	2
	Invertebrates	2
	Chinook Salmon DNA	12
Spotted Bass	Invertebrates	1
	Chinook Salmon	5
	Bluegill Sunfish	4
	Unknown	2
	Chinook Salmon DNA	1
Site 2		
Predator Species	**Stomach Contents ID**	**Count**
Spotted Bass	Bluegill Sunfish	1

4.6g. Disease

JSCS crews made visual observations of clinical signs of disease among resident fish species in the McCloud Arm of Shasta Reservoir throughout the season. One parasitic horsehair worm was also captured inside the trap box, although there were no signs of disease caused by this parasite on captured fish at the time of capture. Clinical signs of disease typically included lesions, fungus, and discoloration accompanied by lethargy and abnormal swimming behavior (**Figure 4.6-13**). Spotted Bass exhibited the highest rate of disease, with 28 individuals out of 111 from the trap showing clinical signs, or 25.2% of bass captured (**Table 4.6-11**). Sunfish species (Bluegill Sunfish and Green Sunfish) also exhibited clinical signs, although crews observed only four sunfish with clinical signs out of 1,072 individuals, representing 0.3% of sunfish captured. Crews did not observe clinical signs of disease among other species captured in the JSCS trap. However, trout in the vicinity of the guidance nets showed signs of spawning stress and associated fungal infection.

Table 4.6-10. *Number of fish captured with clinical signs of disease.*

Species	October	Rest of Season	Total Count
Sunfish spp.	3	1	4
Spotted bass	19	5	28

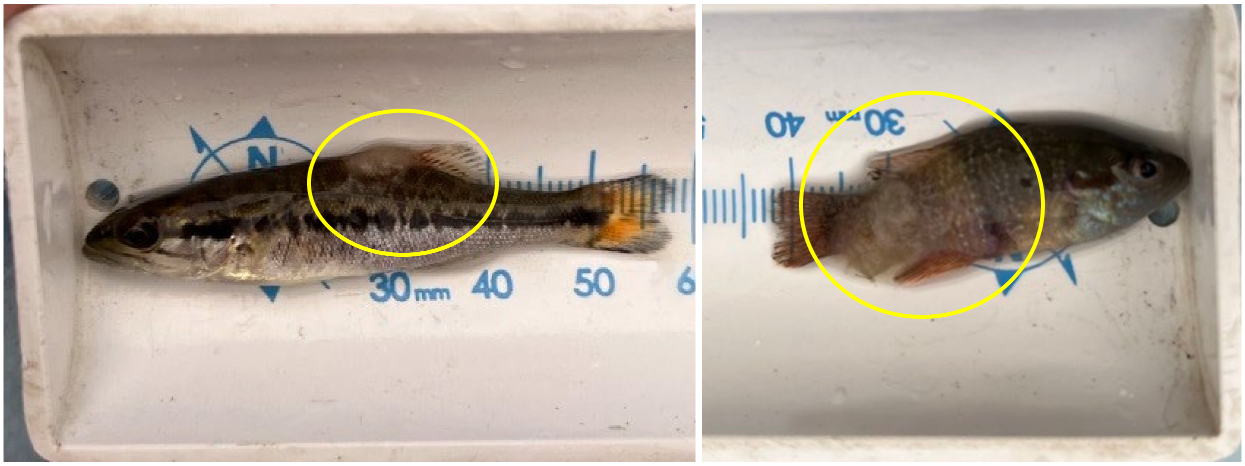


Figure 4.6-15. Clinical signs of disease in Spotted Bass (left) and Bluegill Sunfish (right) among resident fish captured in the JSCS 2024-25.

Disease observations were most prevalent in October, accounting for 22 out of 32 total (68.8%) during the 2024-25 field season (**Table 4.6-11**, **Figure 4.6-19**). This is confounded with factors including temperature (which was relatively warm but consistently dropping) and catch (which was highest) during October. No observations of disease were made after the end of November. Catch across all species groups remained low after November; lack of observation does not indicate lack of disease presence among resident fishes.

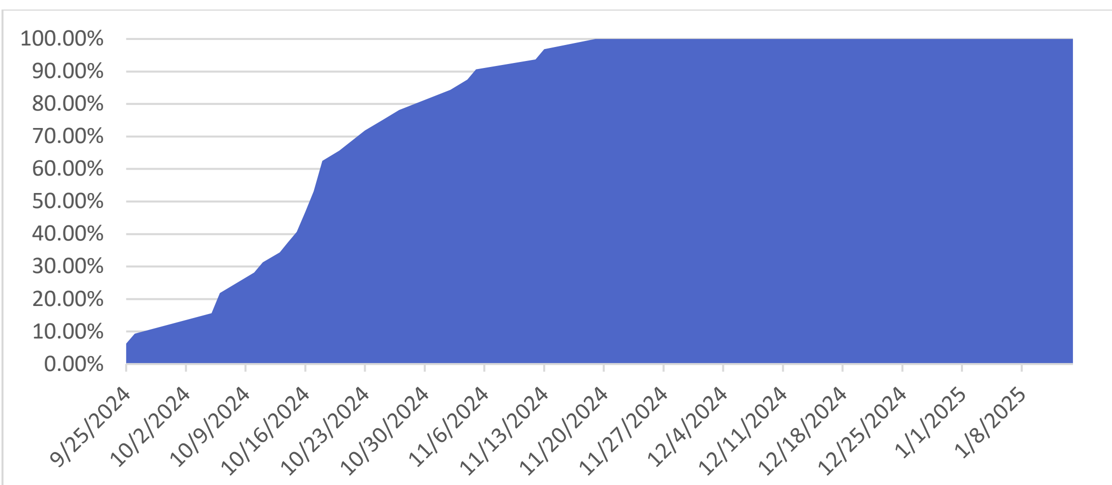


Figure 4.6-16. Cumulative Observations of Fish Disease at the JSCS Trap 2024-25.

4.6h. Fish Results Discussion

Catch of juvenile winter-run Chinook Salmon at the JSCS declined in 2024-25 compared to 2023. Upstream catch at the IPT and RST also declined (largely a function of low IPT performance at an unsuitable site in the beginning of the 2024 field season), and total winter-run Chinook Salmon capture across all gear types (IPT, RST, JSCS) in the McCloud River fell from 8,824 juveniles out of ~80,000 eggs deployed in 2023 (11%) to 4,659 juveniles out of ~62,000 eggs deployed in 2024 (7.5%).

When upstream rearing strategies include both heath trays and Nur Nature Base methods, the window for Nur outmigration extends from mid-September through November. In 2024-25, catch peaked in October for the JSCS, IPT, and RST. Peaks in daily trap catch followed releases from the heath trays. Although the JSCS caught only one Nur in December 2024 and none in January 2025, zero percent trap efficiencies make it difficult to accurately monitor the tail end of outmigration. The timing of juvenile outmigration may shift with changes to upstream rearing strategies (e.g., rearing in only Nur Nature Base systems).

In addition to Chinook Salmon, the JSCS captures resident fishes across juvenile life stages. Resident fish catch is primarily composed of non-native, warmwater fishes (e.g., Spotted Bass, Bluegill Sunfish, White Crappie), which peaked in October and comprised the majority of catch in the 2024-25 season. The presence of native fishes (e.g., Sacramento Pikeminnow, Riffle Sculpin, Rainbow Trout) increased as water temperatures dropped and the reservoir entered filling conditions in the winter. Trout migration began in November and ran through December, as evidenced by the movement of trout upstream of the JSCS. Clinical signs of disease were present among resident fishes (Spotted Bass and Bluegill Sunfish) but were not observed with the frequency necessary for pathology testing to verify visual observations.

Poor trap efficiency results across the 2024-25 season make it difficult to assess the specific effects of given factors or structural adjustments on capture probability with any degree of certainty. Out-migrant collection efficiency is commonly cited as a significant complication to effective trap and haul operations across watersheds (Moyle and Lusardi 2017), so difficulties achieving high trap efficiency at the JSCS are to be expected as part of a pilot study testing new gear types. In a review of existing trap and haul operations, Kock et al (2020) found that Chinook Salmon have the lowest collection efficiencies among all species targeted in juvenile capture operations. Looking across both the 2024-25 and the 2023 seasons, trap efficiency clearly corresponds with depth. In 2023, trap efficiency peaked (>40%) when the JSCS fished in depths of 10-12 feet. In 2024-25, the JSCS did not recapture efficiency trial fish at all when fishing in depths >15 feet. Depth at the JSCS trap entrance is correlated with water velocities through the trap and is an approximate reference for distance from the riverine-reservoir interface: greater depths typically mean that the JSCS is fishing in reservoir conditions and shallower depths indicate closer proximity to the river. JSCS operations in shallower depths closer to the riverine-reservoir interface are associated with the highest Chinook Salmon collection efficiencies.

The most plausible explanations for low rates of capture and low trap efficiency include fish behavior (fish holding upstream or otherwise not following downstream cues); poor trap function (gaps in nets, too deep to function properly); and predation (predator feeding activity leading to low survival). First, the Winnemem Wintu Tribe tells us that Nur prefer areas with habitat complexity and hold in cold water for longer rearing periods, and that Nur may avoid warmer water with low flows (i.e., reservoir conditions). Visual observations of fish behavior during efficiency trial releases in the reservoir support this hypothesis, with released fish scattering upstream and towards the shallows and not following flow cues downstream. Second, flow beneath and around the guidance nets may have affected trap function by providing unintended routes for fish passage around the structure, as demonstrated by the ability of late fall-run yearlings to pass downstream. Velocity data shows a gap under the guidance nets on river right at Site 1, and reservoir depths exceeded guidance net length at Sites 2 and 3. Trap performance at

Sites 2 and 3 was poor, and the JSCS structure may not have effectively blocked fish passage downstream at these locations. Cyril Michel conducted a migration study with PIT- and acoustic-tagged late fall-run Chinook Salmon which will provide clarity about JSCS capture and bypass when data becomes available in late spring. Lastly, predation has a significant impact on capture probability and juvenile survival. The majority of fish captured in the JSCS in 2024-25 were non-native piscivorous species (e.g., Bluegill Sunfish and Spotted Bass), primarily at juvenile life stages. Stomach sampling results from fish captured in the JSCS indicate that juvenile Spotted Bass pose the primary predation risk to Nur. The arrival of a large school of adult Brown Trout and Rainbow Trout directly in front of the trap entrance at the beginning of November coincides with the decline of trap efficiency to zero. Although predation by Brown Trout is known to significantly impact juvenile salmon populations (Alvarez & Ward 2019), preliminary stomach sampling results from adult trout at the JSCS do not show a rate of predation that fully explains low capture efficiency. When it becomes available in late spring, additional data from DNA analysis of gastric lavage samples may provide additional information about predation near the JSCS trap. However, studies assessing predation outside of the JSCS trap itself are beyond the scope of this pilot project.

The relationship between trap efficiency and juvenile production remains unknown for the 2024-25 field season. In order to assess McCloud River juvenile production and survival, a given number (>7) individuals from upstream trap efficiency trials must bypass the IPT and RST and be recaptured at the JSCS. The JSCS only captured four individuals from upstream trials, leaving this question in need of additional investigation.

4.7. Operational Issues

Unforeseen operational issues posed minor and significant challenges to the safe and successful completion of the 2024-2025 field season. Minor issues faced during the season included: difficulty opening the boat gates, difficulty moving the house boat in shallow water, power issues with the electric winch for gantry crane, temperature buoys moving downstream due to rapid increases in water levels, instrumentation errors after getting wet, and minor tears in the guidance nets and impermeable panels. PNP and DWR engineering staff were able to fix many of these minor issues throughout the season. Specifically, the small guidance net hole identified by staff was patched and a larger tear in one of the impermeable panels was patched with net. More serious issues faced during the season included winter storms, debris, and fire. Each of these challenges is discussed in the following sections.

4.7a. Storms and Winter Flows

Winter storms and associated high flows presented a significant challenge during the field season. Three storm events of 3,000 cfs or greater were experienced during the winter months of 2024-25. **Figure 4.7-1** shows the hydrograph of McCloud River inflows and Shasta Reservoir water surface elevations for November 1, 2024 – February 1, 2025. Storms were anticipated 5 days in advance using McCloud River forecasts produced by the California Nevada River Forecast Center. This allowed for some level of planning in advance of each event. Specifically, a simple hydraulic analysis was conducted prior to each storm event to estimate predicted flow area and corresponding average cross-sectional velocity based on the forecasted inflows. If these velocities were deemed unsafe due to increased load on the system, recommendations were made to raise the impermeable panels and guidance nets out of the water and cease normal operations while velocities remained high. A summary of these findings and recommendations was documented prior to each storm event and shared with management to inform decisions.

Operations were temporarily ceased before and during the first storm event due to the uncertainty regarding load on the system and safety for staff. The third storm event, which produced back-to-back peak flows of 5,673 cfs and 10,579 cfs, occurred during the relocation of the JSCS from Site 2 to Site 3. This delayed the resumption of operations by several days.

A significant unforeseen consequence of these storm events was that each increased the reservoir's WSE substantially. The first storm event increased the WSE of Shasta Reservoir by 11 feet over 10 days. The second storm event increased the WSE of Shasta Reservoir by 7 feet over 8 days. The third pair of storm events increased the WSE of Shasta Reservoir by 25 feet over 16 days. These rapid water level increases were unexpected and very challenging to prepare for. This also resulted in very deep and slow-moving water, which is not an ideal condition for the JSCS. Because the JSCS takes time and resources to move, relocating the system to shallower water was not feasible after each storm event. A thorough hydraulic modeling analysis is recommended for the 2025-26 season to better understand the range of possible conditions the JSCS could be exposed to during the winter months to avoid similar issues.

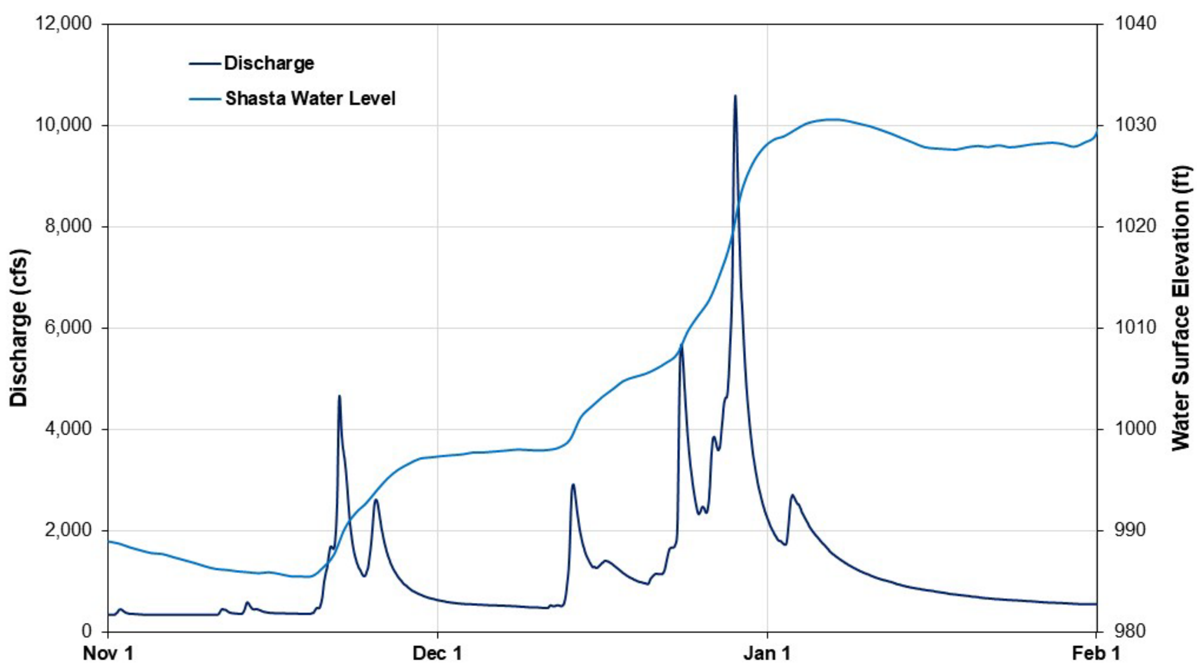


Figure 4.7-1. Winter storm hydrographs and associated WSEs of Shasta Reservoir during the 2024-25 field season.

4.7b. Debris

Debris management was a major challenge during the 2024-25 field season. From the start of the season until November 21, debris loading consisted of mostly small leaf litter and twigs. The debris rack at the trap entrance blocked medium sized debris and the Vexar on the fykes within the trap further blocked smaller debris. Debris was cleaned daily from inside and in front of the trap to minimize accumulation.

Following the November 21 storm event (peak of 4,660 cfs), 800 ft^2 of debris accumulated along the docks (**Figure 4.7-2**). This debris consisted of a thick layer of medium-sized debris and large logs/trees. Clearing debris from this storm event took several staff five days to fully remove enough debris to resume fishing the trap safely. A storm event on December 14 (peak of 2,910 cfs) yielded 1,800 ft^2 of debris accumulation and almost all this debris was contained by the debris boom (**Figure 4.7-3**). Fishing operations continued as planned following this storm due to the limited amount of debris accumulation on the system. Back-to-back storm events on December 24 and December 29 produced peak flows of 5,673 cfs and 10,579 cfs, respectively. This resulted in 19,125 ft^2 of debris accumulation, of which 17,075 ft^2 was on the debris boom and 2,050 ft^2 was in front of the trap (**Figure 4.7-4**; **Figure 4.7-5**). The cleaning effort following this period took several staff seven days to fully clear the portion of debris in front of the trap. Accumulated debris upstream of the debris boom drifted upstream in subsequent days, likely due to wind-driven surface velocities. A local debris management expert from USFS confirmed that this phenomenon occurs regularly across Shasta Reservoir following large storm events.

Overall, debris loading was a significant obstacle that limited the operation of the JSCS during the winter months of the 2024-25 field season. In its current configuration, the JSCS does not handle large amounts of debris following large storm events. Adjustments to the system will likely be needed to adequately collect or pass large amounts of debris during periods following large storm events.

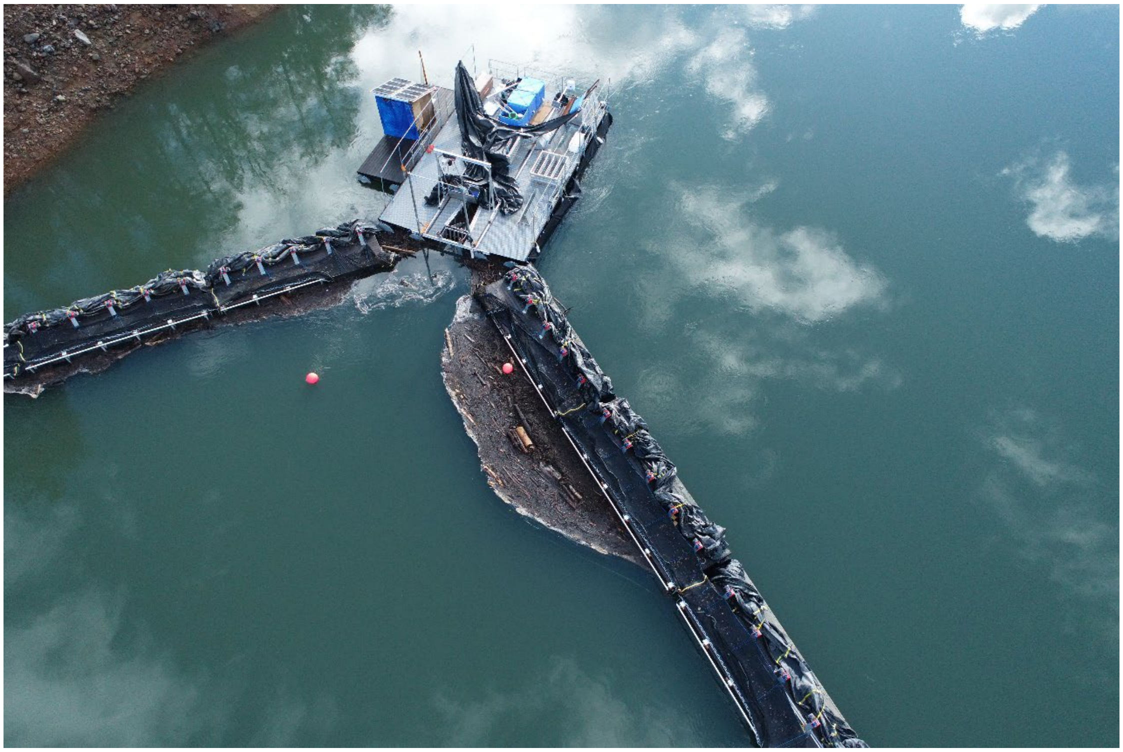


Figure 4.7-2. Oblique image of debris accumulation following the November 21 storm event.

Figure 4.7-3. Aerial image of debris accumulation upstream of the debris boom following the December 14 storm event.

Figure 4.7-4. Oblique image of debris accumulation following the December 25-29 storm events.

Figure 4.7-5. Close-up aerial image of debris accumulation upstream of the debris boom following the December 25-29 storm events.

4.7c. Fire

On October 9, 2024, the Shoe Fire initiated approximately 8 miles east of the JSCS (**Figure 4.7-6**). This fire grew to several thousand acres within the first few days of burning and gradually spread for the following month until being completely contained on November 9, 2024. In total, the fire burned an area of 5,124 acres over the course of a month during the field season. While the fire did not stop field operations, it did have several impacts on operations. First, air quality worsened at times during the fire and staff wore N-95 masks during these time periods for safety. Schedules for some field days had to be shortened or adjusted to avoid localized poor air quality events. Second, a temporary flight restriction was issued to prevent interference with aerial firefighting efforts. Because of this, drone operations ceased for several weeks until the flight restriction was lifted. Third, hundreds of firefighting personnel were deployed to the region to slow the spread of the fire. The only access route to the fire was via Gilman and Fenders Ferry Roads and staging areas were set up in most of the campgrounds along these routes. This led to increased traffic on Gilman Road for the transport of fire fighters vehicles and equipment.

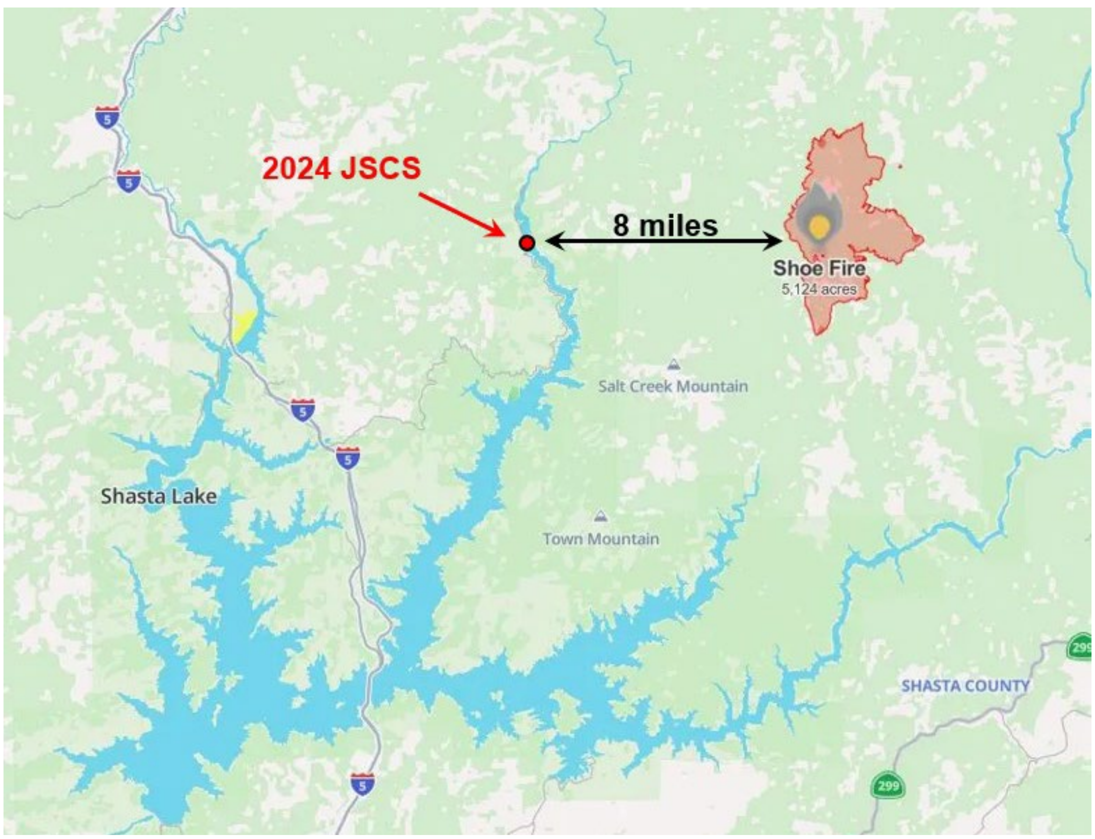


Figure 4.7-6. Map of the Shoe Fire and its proximity to the JSCS.

Section 5. Conclusions and Recommendations

The 2024-25 JSCS field season tested trap performance at three new sites, across reservoir drawdown and filling conditions, in storm events and high flow conditions, and for a significantly longer period than previous field seasons (extending from November through January). Data collected during the 2024-25 season shows that the JSCS works to catch juvenile fishes in head-of-reservoir conditions in the McCloud Arm of Shasta Reservoir but that capture probability of winter-run Chinook Salmon decreased in 2024-25 compared to 2023. **The 2023 field season averaged 22.5% capture probability** (807 winter-run Chinook Salmon captured), and **average capture probability for the 2024-25 field season fell to 1.5%** (78 winter-run Chinook Salmon captured). Declines in trap efficiency may be attributed to the three following causes: trap function and location; juvenile behavior and survival in the reservoir; and predation.

JSCS mobilization begins in September after Labor Day, which coincides with peak annual regional air temperatures. All JSCS field seasons (2022, 2023, 2024-25) exhibit high water temperatures (>22°C) in the reservoir during initial deployment. **Water temperatures around the structure typically remain near or above unsafe thresholds** for salmonids in the top one foot of the water column during this period. Upon deployment, however, data shows that the trap wrap and impermeable panels over the guidance nets quickly and consistently reduced water temperatures upstream of the structure, and the depth of the frybox offers additional thermal refuge (<20°C) at three feet below water surface. The success of the temperature curtain in the 2023 field season in addition to strong performance of the trap wrap in 2024-25 confirms that **the JSCS structure effectively moderates water temperatures for safe salmon trapping and handling.** Additionally, dissolved oxygen within the trap always exceeded the critical threshold for juvenile salmon (>5.0 mg/l), indicating that supplemental oxygenation within the fry box from oxygen gas canisters or air bubblers is not required.

High flows pose a risk to JSCS trap operations as the season moves towards winter. **The JSCS caught juvenile fish in flows exceeding 2,000 cfs,** but the debris and severe weather conditions associated with high flows disrupted JSCS operations three separate times during the 2024-25 field season. These seasonal storm events coincided with reservoir operations shifting from drawdown to filling, meaning that the water surface elevation increases significantly and unpredictably. The JSCS was designed to fish in <40 feet of water, with a range between 7 feet and 20 feet targeted for fishing during September and October. Flows from fall and winter storms increased depths at head-of-reservoir conditions to above 28 feet by mid-December and although the JSCS moved to a shallower site in January, depths at the trap entrance remained more than 40 feet for the rest of the season. Nur catch peaked in October (67% of catch) and dropped to very low levels in December (a single yearling); the JSCS caught no Nur in January.

Subsequent JSCS operations should focus on deployment between the end of September and the end of November to maximize catch while ensuring safe and efficient operations. While the JSCS can handle significantly greater flows than in-river collection gear, extending the head-of-reservoir fishing season into winter did not yield sustained catch of juvenile winter-run Chinook Salmon.

Water Temperatures, Depth, and Velocity

Data from the 2022 (testing) and 2023 (fishing) field seasons indicated that while effective, the temperature curtain component of the JSCS structure was generally redundant since the guidance nets had a similar cooling effect on upstream temperatures. In 2024-25, DWR replaced the temperature curtain with a smaller “trap wrap” affixed to the trap platform itself. **The trap wrap**, in combination with the guidance nets, **performed adequately to reduce temperatures upstream of the trap**. These structure components had a cooling effect on upstream water temperatures and the cooling effect was even across the channel. With three years of data supporting the efficacy of JSCS temperature moderation, the complexity of temperature monitoring arrays may be simplified for subsequent field deployments to focus research efforts on other questions.

Depth is closely correlated with velocity. The JSCS fished a larger (deeper) cross-sectional area during the 2024-25 field season compared to 2023; velocity diffused over this area produced lower velocities through the JSCS trap. Even in high-flow conditions and with all velocity control measures in place, velocities through the trap entrance remained low, **with velocities at the trap averaging 0.7 ft/s and <1 ft/s during 65.7% of trap operations.** The crew made visual observations of juvenile salmonids exiting the trap during low velocity (<0.5 ft/s) conditions, and low velocities at the trap may contribute to this season’s decrease in capture probability. Subsequent JSCS deployment should target operations within the riverine-reservoir interface, where velocities are higher and conditions closer to those of the McCloud River.

Catch and Capture Probability

The JSCS effectively captures juvenile fishes in head-of-reservoir conditions: the JSCS caught a total of 2,976 juvenile fishes representing over 19 species over two seasons of field operations. The JSCS captured a total of 831 winter-run Chinook Salmon in 2023 and 78 winter-run Chinook Salmon in 2024-25. Capture probabilities for these seasons averaged 22.5% and 1.5% respectively, and trap efficiencies across both seasons ranged from 51.5% to 0%. **Catch of juvenile salmon declines when the JSCS operates further from the riverine-reservoir interface and the McCloud River hydrotone**; low trap efficiencies correspond with greater depths and prevalent reservoir conditions. Reservoir conditions present different flow, temperature, and habitat conditions than the river, and a different assemblage of resident fish and predators. Trap and haul methods targeting reservoir collection are typically characterized by difficulty maintaining efficient juvenile capture and uneven catch across seasons, and the JSCS is not exempt from this pattern.

Low trap efficiency and capture probability at the JSCS may be attributed to some combination of trap function and location, juvenile behavior and survival in the reservoir, and predation.

Juvenile salmon behavior around the JSCS structure and reservoir conditions may also contribute to low rates of capture and recapture. The Winnemem Wintu Tribe believes that Nur are holding in the McCloud River upstream of the JSCS, which is supported by acoustic telemetry data. With low velocities in the reservoir, juvenile salmon lack clear flow cues to follow downstream into the trap. Crews conducting mark-recapture trials reported juvenile fish swam downstream when released into a riffle in

2023 but scattered upstream and towards the shallows when released into the reservoir pool in 2024-25 trials. High turbidity makes snorkel or video monitoring of juvenile salmon upstream of the JSCS unreliable, leaving open the question: where are winter-run Chinook Salmon going if not into traps?

Gaps and small tears in the guidance nets and panels provide one possible answer: flow cues and passage opportunities caused by net failures would direct fish beneath the trap instead of inside it. Acoustic telemetry data confirms that yearling Chinook Salmon passed downstream of the JSCS structure. While there were only two documented tears in 2024-25, tears are difficult to safely monitor or repair during deployment without the assistance of a qualified diver. Juvenile salmon typically prefer outmigration pathways in the top of the water column and the JSCS was accordingly designed to fish the top 20 feet of the water column. In conditions exceeding 40 feet, however, the guidance nets do not reach the bottom of the bed and fish may follow flow under the nets. Deployment in sites further downstream of the riverine-reservoir interface thus contributes to low capture probability. **Location and siting decisions in subsequent seasons should prioritize fishing in upstream locations and at shallower depths** and should ensure that the trap sits in the thalweg so that flow cues guide juveniles into the trap entrance.

Predation offers another partial answer to this question: the presence of winter-run Chinook Salmon carcasses in predator stomachs during both 2023 and 2024-25 sampling confirms that predation significantly impacts the survival and capture probability of juvenile winter-run Chinook Salmon in the JSCS. Typically, a mark-recapture study for trap efficiency assumes 100% survival between release and recapture. In 2023, 10.1% of juvenile Spotted Bass collected at the JSCS had predated juvenile salmon; in 2024-25 the rate of predation of salmon among Spotted Bass was 5.9%. Marked salmon used in mark-recapture trials were found in bass stomachs in both seasons, which confirms that predation impacts trap efficiency. Efforts to use hook-and-line sampling on the structure to study predator diets improved predation monitoring in 2024, but the sampling was relatively limited and may not be representative of actual predation dynamics. Additionally, tissues in stomach contents may degrade within eight to twenty-four hours after consumption and it is difficult to recognize contents through gastric lavage or DNA analysis after that window.

Predation and predator load shift across different hydrotones and reservoir conditions. Crews observed large schools of juvenile Spotted Bass in the shallows of the reservoir while adult Rainbow Trout, Brown Trout, and Sacramento Pikeminnow were observed schooling in deeper reservoir pools. Diet sampling results indicate that juvenile Spotted Bass are the primary predator threat to juvenile Chinook Salmon in head of reservoir conditions. **Crews observed predator feeding activity at all sites across both seasons of fishing**, although monitoring of predation which occurs beyond the trap structure is outside the scope of this pilot study. The impact of predation on juvenile salmon in the McCloud River and the McCloud Arm of Shasta Reservoir deserves further study and specific attention in the greater effort to reintroduce Nur above Shasta Dam.

Location and Deployment Strategy

To date, DWR has deployed the JSCS fish trap at six sites between the McCloud Bridge and Dekkas Rock. The 2023 field operations spanned two sites (Site 1 upstream of Kabyai Creek, Site 2 upstream of Pine Point; one move), and the 2024-25 field operations spanned three sites and two moves (Site 1 downstream of Pine Point, Site 2 upstream of Ellery Creek, and Site 3 slightly upstream of Site 1; two moves). The 2022 JSCS operations occurred just downstream from Dekkas Rock but did not include a fish trap or a site move. These sites span a variety of seasonal reservoir conditions, depths, and proximities to the riverine-reservoir interface. Sites in the 2024-25 field season were downstream of both 2023 locations, and at or downstream of the riverine-reservoir interface. **Shallower sites closest to or at the riverine-reservoir interface have yielded the highest trap efficiencies and greatest rates of capture.**

DWR designed the JSCS to move over the course of the season to adjust position and respond to dynamic reservoir water surface elevations. Over the field seasons, however, moving the JSCS between sites has proven to be an expensive and difficult process that requires a week-long break in trap operations per relocation. The JSCS is not a nimble structure and requires specialized expertise and equipment to deploy and relocate. **Future deployments should take every measure to minimize moves between sites** and consider what adjustments can be made to the JSCS structure components to improve flexibility at a single site (e.g., install winches or longer cables; modularity). Efforts should also be made to improve flexibility and ease of operation, allowing staff to easily make adjustments or move the structural components.

Taking the 2023 and 2024-25 field seasons into account, the JSCS has not exceeded average annual trap efficiencies of 25% under current deployment strategies. **The JSCS fails to effectively capture juvenile salmon when deployed in reservoir conditions with depths exceeding 15 feet at the trap entrance.** The JSCS displayed the highest trap efficiency (34.5%) at Site 1, 2023, located <0.25mi downstream of the riverine-reservoir interface, where depths ranged from 7-18 feet and the trap fished. **The further downstream into reservoir conditions the JSCS moves, the lower the capture probability for juvenile salmon**. Given passage and survival estimate from Shasta Reservoir studies, the Volitional Passage Technical Advisory Group classifies conditions in Shasta Reservoir (temperatures, predation, lack of habitat) as a passage barrier. Even with tweaks to trap structure, continuing to fish the JSCS in reservoir conditions is unlikely to yield higher catch or trap efficiency. Improving the capture probability of winter-run Chinook Salmon at the JSCS requires that we rethink our approach: **the JSCS should be reconfigured for fishing at the riverine-reservoir interface instead of downstream in head-of-reservoir conditions**. Fishing at the riverine-reservoir interface should increase velocities through the trap, decrease water temperatures at the trap, decrease warmwater predator interactions, and improve refuge and habitat availability in the vicinity of the JSCS. This shift in deployment strategy will require the modification of existing structure components (including guidance nets, debris boom, fish trap box, trap platform, pontoons, docks, and panels) into a shallower, nimbler, more versatile version of the JSCS.

Key Conclusions and Recommendations

Based on the findings from the 2024–25 season, the JSCS pilot study identified the following key conclusions regarding system performance, limitations, and recommended next steps:

- Performance Decline: The capture efficiency rate for Nur at the JSCS fell sharply in 2024-25 to 1.5% (total catch 78 Nur), down from 22.5% (total catch 807 Nur) in 2023.

- Primary Cause of Low Efficiency: High reservoir levels (>40 ft) exceeded the system's optimal design range (<20 ft). This, combined with low water velocities and confirmed predation, significantly reduced efficacy.
- Operational Success: Despite capture challenges, the JSCS structure created a safe environment for collected salmonids by effectively moderating water temperatures without the use of a temperature curtain. Dissolved oxygen levels remained above safe thresholds and supplemental oxygen was not required.
- Planned Improvements: DWR will implement targeted modifications, including system reconfiguration for deployment in shallower water at the riverine-reservoir interface; trap covers; improved debris management; and redesigned fish trap components to boost future performance.
- Core Recommendation: Future JSCS operations must prioritize placement within the riverine-reservoir interface. This location offers shallower depths, higher water velocities, and reduced predator presence, all of which are necessary for successful salmon capture.

Recommendations for the final year of the JSCS pilot study to improve capture probability, trap function, and research methods:

- Install a camera in the trap entrance and frybox fyke to monitor entrance points for predation and exit.
- Fabricate cover for the frybox.
- Modify the trap to allow for more convenient operation, debris cleaning, and fish crowding.
- Improve debris management and structural configuration to easily pass or clear debris.
- Fabricate narrower fykes. Include willow, natural, and traditional materials in fabrication when feasible.
- Conduct trap efficiency trials in paired releases with upstream traps to maximize data on survival and production.
- Revise existing wildlife observation sheets to include more details such as wildlife interactions and wildlife present (including potential terrestrial and aquatic predators). Implement these observations and tracking on a daily basis.
- Adjust efficiency trial methods and timing to maximize data collection and reduce impacts to endangered fish stocks.
- Continue to conduct opportunistic hook and line sampling and the partnership with the UC Santa Cruz NOAA Southwest Fisheries Science Center team for their hook and line fish stomach content sampling study on and around the system.
- Reduce the number and complexity of temperature buoys to eliminate the need for a boat to retrieve buoys upstream of the trap and improve operational efficiency.
- Reconfigure the JSCS, including significant changes to the structural components, to target deployment at the riverine-reservoir interface. Replace nets with louvers.

Section 6. Acknowledgements

The JSCS would not be possible without the significant contributions of collaborators, project partners, and co-researchers.

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APPENDIX A. JSCS STRUCTURE AND DESIGN

This appendix is meant to provide additional information on the structural components of the JSCS and overall design. The primary system components deployed during the 2024-25 field season were a debris boom, guidance nets, impermeable panels, and a trap (**Figure A-1**). The debris boom was deployed approximately 300 feet upstream of the trap and sheared at an angle to push debris to the left bank. Guidance nets and impermeable panels were deployed from the three docks on each side of the trap platform following guidance from the DWR Shasta Juvenile Salmonid Collection System: Structure Inspection Standard Operating Procedures (DWR, 2024). The same trap platform and trap used during the 2023 field season were used again during the 2024-25 season. The trap itself was not modified prior to the 2024-25 season. Details regarding the trap design are shown in **Figure A-2** and **Figure A-3**.

Other components of the system include a gate to allow for boat passage, clump weights to provide anchoring strength, in-water anchors to keep the trap from shifting, a solar shed for powering various field equipment, temperature buoys for monitoring temperature profiles, and a houseboat for storing field equipment (**Figure A-4**).

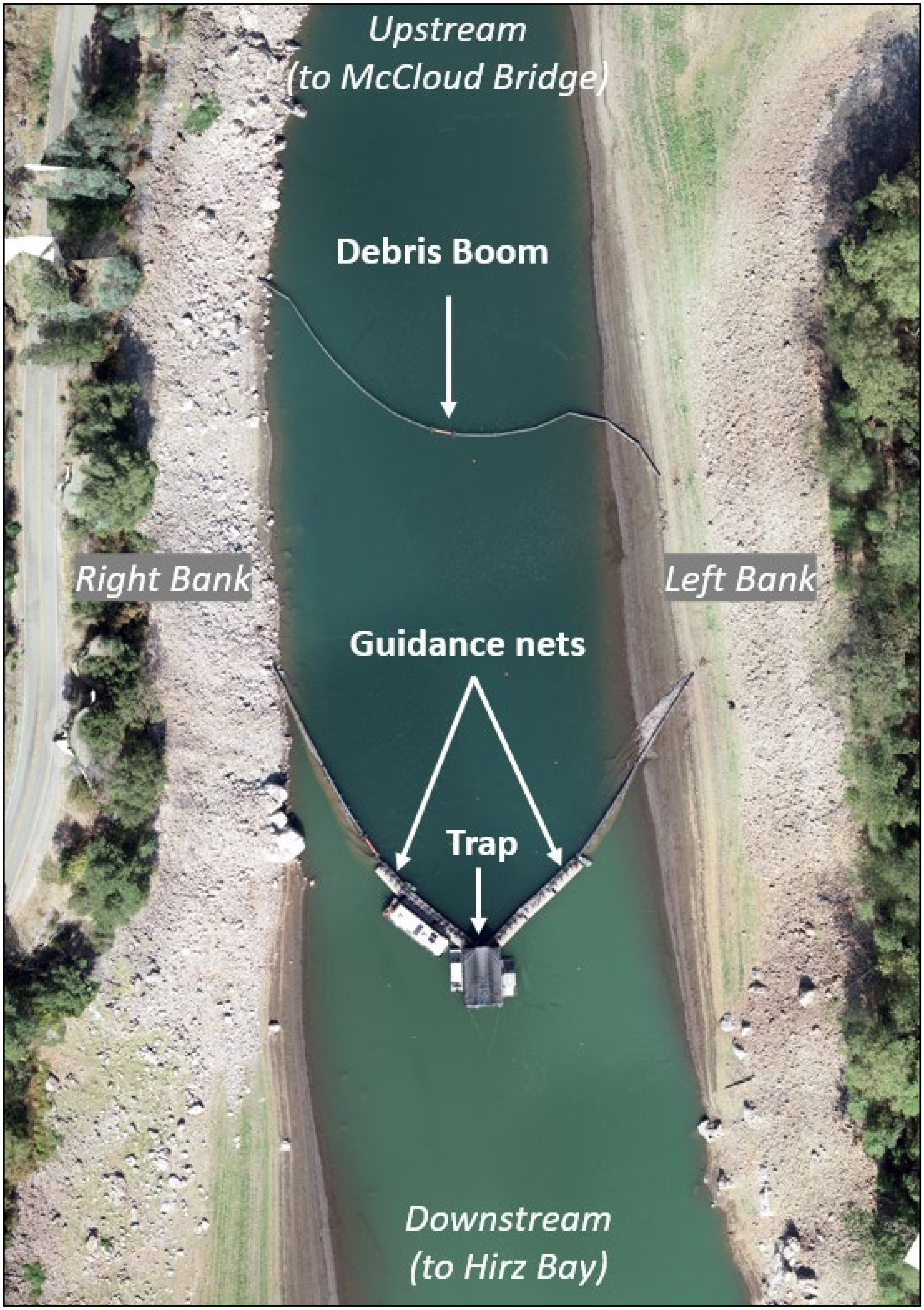


Figure A-1. Aerial imagery showing configuration of JSCS and main system components.

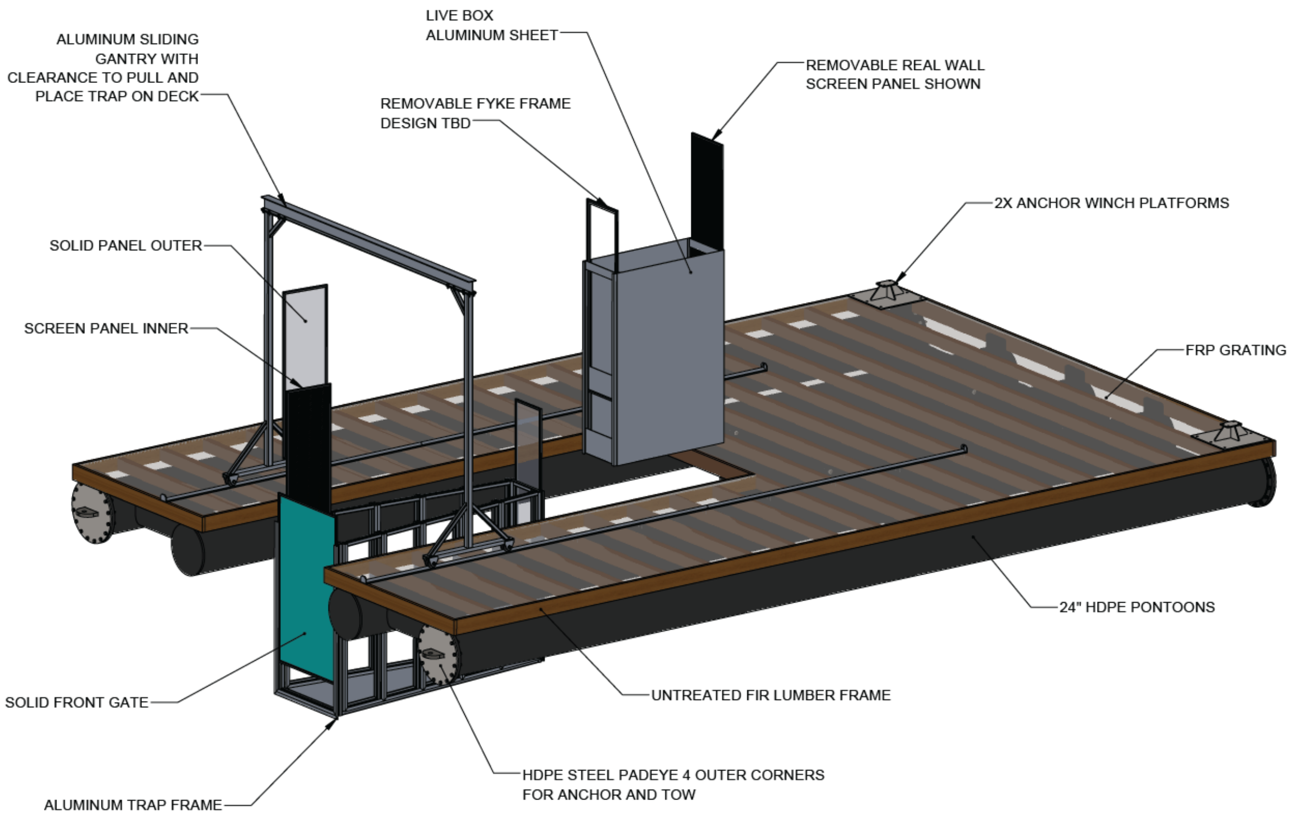
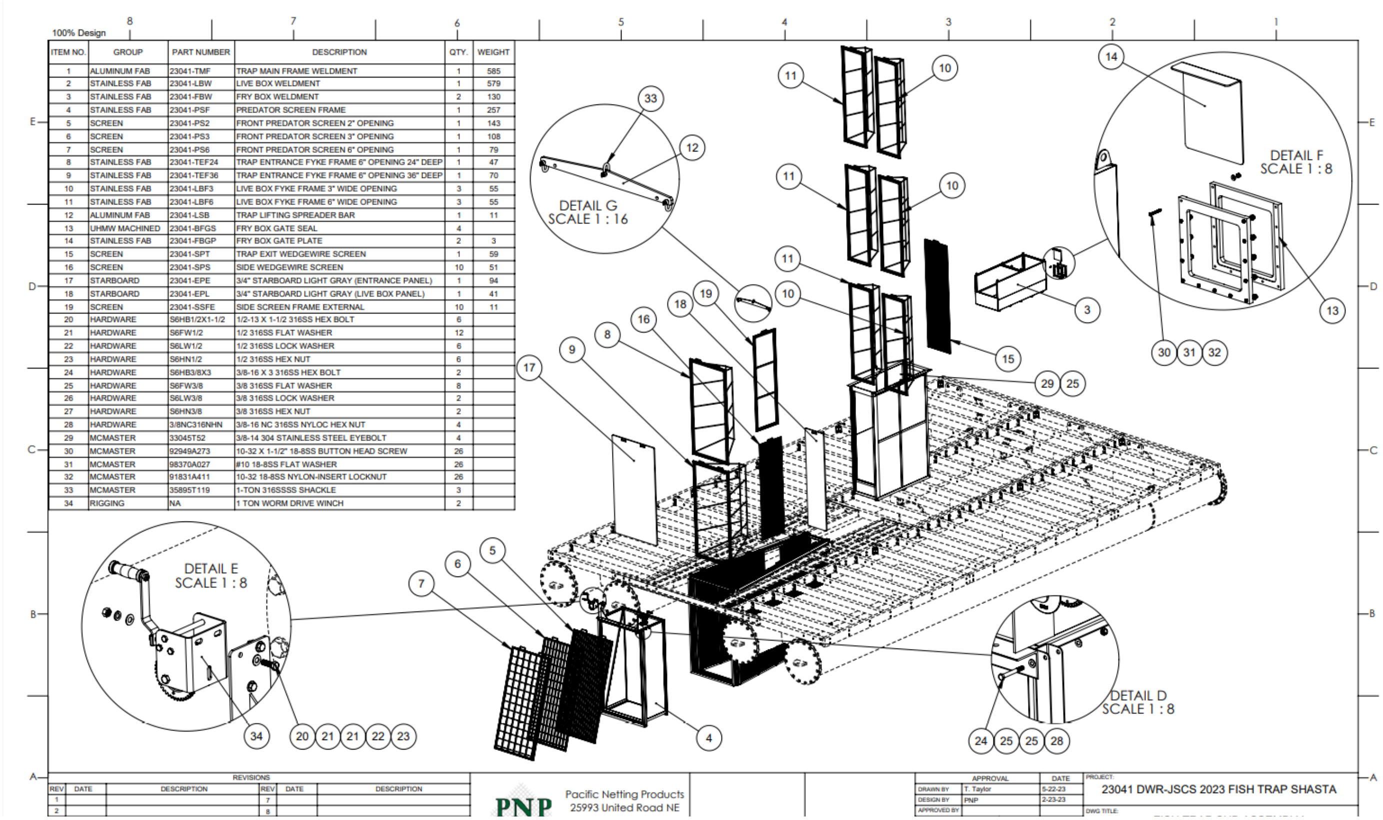


Figure A-2. Simplified diagram of trap components.



ITEM NO.	GROUP	PART NUMBER	DESCRIPTION	QTY.	WEIGHT
1	ALUMINUM FAB	23041-TMF	TRAP MAIN FRAME WELDMENT	1	585
2	STAINLESS FAB	23041-LBW	LIVE BOX WELDMENT	1	579
3	STAINLESS FAB	23041-FBW	FRY BOX WELDMENT	2	130
4	STAINLESS FAB	23041-PSF	PREDATOR SCREEN FRAME	1	257
5	SCREEN	23041-PS2	FRONT PREDATOR SCREEN 2" OPENING	1	143
6	SCREEN	23041-PS3	FRONT PREDATOR SCREEN 3" OPENING	1	108
7	SCREEN	23041-PS6	FRONT PREDATOR SCREEN 6" OPENING	1	79
8	STAINLESS FAB	23041-TEF24	TRAP ENTRANCE FYKE FRAME 6" OPENING 24" DEEP	1	47
9	STAINLESS FAB	23041-TEF36	TRAP ENTRANCE FYKE FRAME 6" OPENING 36" DEEP	1	70
10	STAINLESS FAB	23041-LBF3	LIVE BOX FYKE FRAME 3" WIDE OPENING	3	55
11	STAINLESS FAB	23041-LBF6	LIVE BOX FYKE FRAME 6" WIDE OPENING	3	55
12	ALUMINUM FAB	23041-LSB	TRAP LIFTING SPREADER BAR	1	11
13	UHMW MACHINED	23041-BFGS	FRY BOX GATE SEAL	4	
14	STAINLESS FAB	23041-FBGP	FRY BOX GATE PLATE	2	3
15	SCREEN	23041-SPT	TRAP EXIT WEDGEWIRE SCREEN	1	59
16	SCREEN	23041-SPS	SIDE WEDGEWIRE SCREEN	10	51
17	STARBOARD	23041-EPE	3/4" STARBOARD LIGHT GRAY (ENTRANCE PANEL)	1	94
18	STARBOARD	23041-EPL	3/4" STARBOARD LIGHT GRAY (LIVE BOX PANEL)	1	41
19	SCREEN	23041-SSFE	SIDE SCREEN FRAME EXTERNAL	10	11
20	HARDWARE	S6HB1/2X1-1/2	1/2-13 X 1-1/2 316SS HEX BOLT	6	
21	HARDWARE	S6FW1/2	1/2 316SS FLAT WASHER	12	
22	HARDWARE	S6LW1/2	1/2 316SS LOCK WASHER	6	
23	HARDWARE	S6HN1/2	1/2 316SS HEX NUT	6	
24	HARDWARE	S6HB3/8X3	3/8-16 X 3 316SS HEX BOLT	2	
25	HARDWARE	S6FW3/8	3/8 316SS FLAT WASHER	8	
26	HARDWARE	S6LW3/8	3/8 316SS LOCK WASHER	2	
27	HARDWARE	S6HN3/8	3/8 316SS HEX NUT	2	
28	HARDWARE	3/8NC316NHN	3/8-16 NC 316SS NYLOC HEX NUT	4	
29	MCMASTER	33045T52	3/8-14 304 STAINLESS STEEL EYEBOLT	4	
30	MCMASTER	92949A273	10-32 X 1-1/2" 18-8SS BUTTON HEAD SCREW	26	
31	MCMASTER	98370A027	#10 18-8SS FLAT WASHER	26	
32	MCMASTER	91831A411	10-32 18-8SS NYLON-INSERT LOCKNUT	26	
33	MCMASTER	35895T119	1-TON 316SSSS SHACKLE	3	
34	RIGGING	NA	1 TON WORM DRIVE WINCH	2	

Figure A-3. Detailed trap design with all components included.

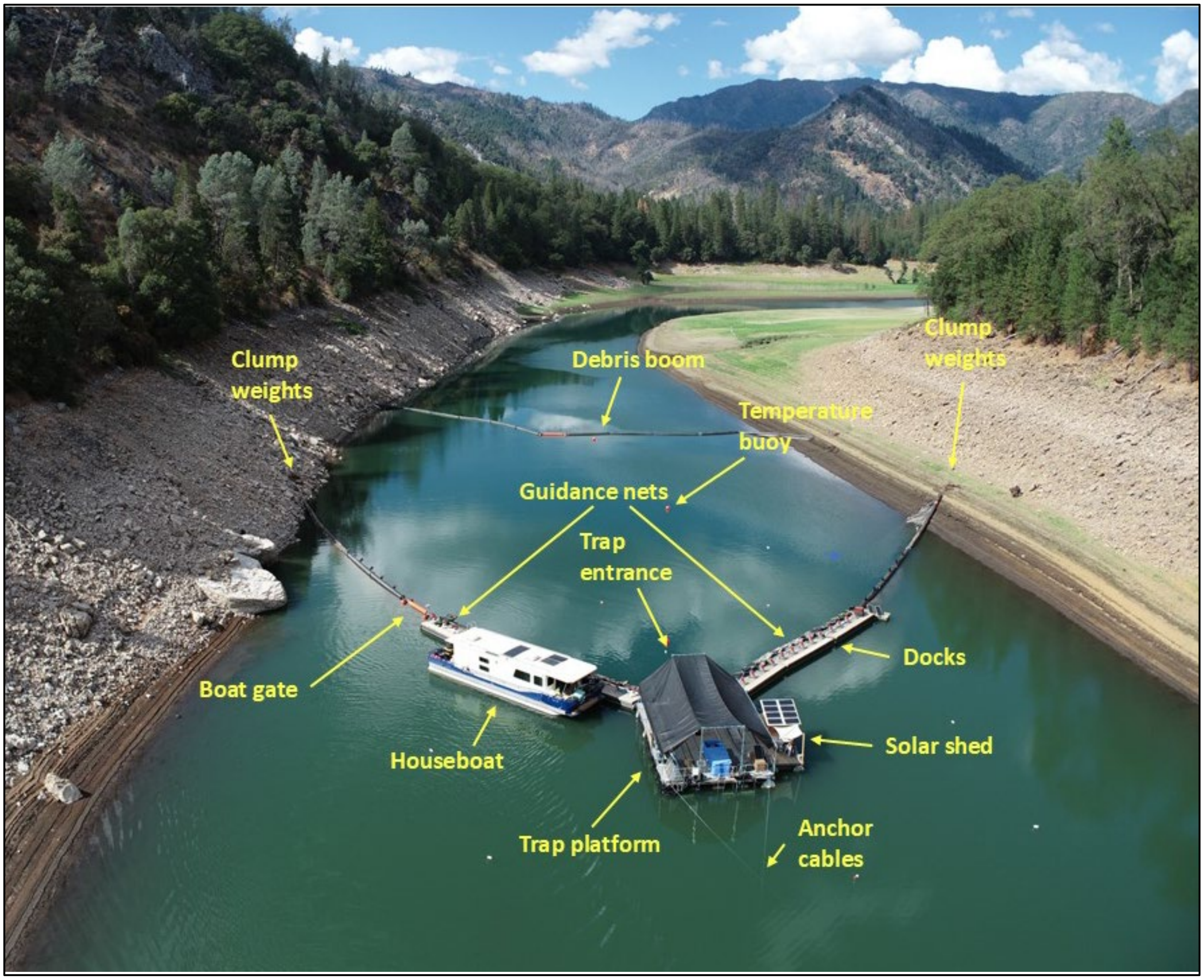


Figure A-4. Oblique aerial imagery showing configuration of JSCS and various system components.