

McCloud River Winter Run Chinook Salmon Reintroduction, Implementation, and Monitoring: Report on Field Operations in 2024 & 2025



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Cover photo: Crew member removing a dead egg from a remote site incubator at AhDiNa campground

This report covers the third year of winter-run chinook salmon reintroduction in the McCloud River, and the first and second year of Pacific States Marine Fisheries Commissions involvement in the project. The work described in this annualized report is funded by Assembly bill 211 Section 2a's general fund for protecting salmon. In addition to Section 3a's California Emergency Relief fund for improving drought resiliency on state owned land. Actions and efforts described in this report were fulfilled through a collaborative effort with California Department of Fish and Wildlife (CDFW), Pacific States Marine Fisheries Commission (PSMFC), University of California Davis (UCD), Center for Watershed Science (CWS), the Winnemem Wintu Tribe (WWT), University of California Santa Cruz (UCSC), National Oceanic and Atmospheric Administration (NOAA), and the U.S. Fish and Wildlife Service (USFWS). The funding source is derived from a CDFW contract: McCloud River Winter Run Chinook Salmon Reintroduction Implementation and Monitoring (Grant Agreement Number – Q2396062) with PSMFC.

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SUMMARY

The McCloud winter-run Chinook salmon (*Oncorhynchus tshawytscha*) (WRCS) reintroduction project is structured as a two-phase design. Phase One involved rearing WRCS eggs in a Remote Site Incubator (RSI) at the AhDiNa Campground near McCloud, California. Eggs were delivered via helicopter from Livingston Stone National Fish Hatchery (LSNFH) and promptly placed into the RSI. Two different incubation methods were used to hatch WRCS and rear juveniles until they were sufficiently developed for release into the McCloud River. In 2024, Heath trays were utilized; in 2025, the program transitioned to Hatchery Partner Boxes (HPBs).

Phase Two focused on a cooperative effort between Pacific States Marine Fisheries Commission (PSMFC) staff and the Winnemem Wintu Tribe (WWT) personnel to trap out-migrating WRCS 20.65 miles downstream from the hatching and fry release site on the McCloud River. Captured fish were transported to the Sacramento River below Keswick Dam, near Redding, to complete their anadromous lifecycle. Two trapping systems were implemented on the lower McCloud River: a Rotary Screw Trap (RST) and an Incline Plane Trap (informally termed the “FrySCOOPER”), which incorporated a V-shaped row of steel weir panels to funnel juvenile Chinook salmon into the trap. Both traps were operated and maintained seven days per week. PSMFC staff also coordinated with, and transported fish collected at the Juvenile Salmon Collection System (JSCS), an in-lake trap operated by the California Department of Water Resources (DWR).

In the first year of operation, 2024, WRCS eggs and alevins were held in the RSI from July 12 through September 26. Egg deliveries occurred on July 12, July 26, and August 16 of 2024. The PSMFC-managed RSI received 20,100 eggs, and an additional 42,188 eggs were placed in a “Nur Nature Base” system operated by the University of California, Davis (UCD) and WWT at the same campground. After approximately six weeks, the fry hatched and was ready for release. Releases occurred at night over three dates: August 26, September 19, and September 26. These events resulted in the release of 19,298 fry into the McCloud River from the PSMFC RSI. A total of 4,617 WRCS were captured in the traps, transported to the boat ramp, and released into the Sacramento River. Traps were maintained and operational daily from August 27 through November 19 of 2024.

In the second year of operation, 2025, WRCS eggs were delivered on August 16 and August 23. The PSMFC HPBs held 10,000 eggs total, with 5,000 eggs per box. An additional

83,000 eggs were placed in the “Nur Nature Base” system, monitored by UCD and WWT at the same campground. WRCS fry were released over five dates between October 2 and October 17, resulting in 9,246 fry released into the McCloud River from the HPBs. The PSMFC in-river trapping effort captured and transported 9,570 WRCS beyond anadromous barriers. Overall, monitoring efforts were designed to provide objective evidence regarding the McCloud River system’s capacity to support egg incubation and juvenile rearing of Chinook salmon, as well as the feasibility of trapping and successfully transporting out-migrating juveniles. These efforts contribute to evaluating the river’s potential to enhance juvenile recruitment within the broader Upper Sacramento River WRCS population.

INTRODUCTION

The Sacramento River is the largest river in California; its watershed occupies 17% of the state’s total land area (Golet 2003). These waters are home to 125 different fish species, found across various locations and seasons (Wang 1986). This includes four distinct Evolutionarily Significant Units (ESUs) or runs of Chinook salmon: Winter, Spring, Fall, and Late Fall, classified by the timing of their freshwater migration upriver. The Sacramento River is home to the only winter-run Chinook salmon (WRCS) population in the world (US NMFS, 2019). Chinook salmon rarely migrate further south than the Central Valley Watershed and its tributaries because they depend on cold, oxygenated freshwater for reproduction. Though adult chinook salmon can withstand warmer water conditions than juveniles, water temperatures exceeding 56 to 59° Fahrenheit between arrival and spawning can have a direct impact on offspring size, number, and overall fertility of eggs (Windell et al, 2017).

The upper reaches of the Sacramento River is home to the first National Fish Hatchery: Baird Station. It was constructed in 1872 on the McCloud River to bring east coast fish to California to help support a growing population (NOAA 2021). In return, hundreds of millions of Chinook salmon eggs were sent to the east coast to stock rivers and streams throughout the United States and around the world. It was operated by the U.S. Fish Commission and chief Conchoolooloo of the McCloud Wintu tribe. The Winnimem Wintu tribe referred to the salmon

as “Nur”. In July of 1881, egg collection on 6,000 WRCS could occur in a single day. In 1878, 200,000 spring-run Chinook salmon were processed from August 27th to October 5th, the McCloud River was saturated with spawning salmon (Yoshiyama 2001). Baird Station was abandoned in 1937 due to the construction of Shasta Dam and now lies as a submerged relic beneath Shasta Lake. Shasta Dam underwent construction for seven years from 1938 until its completion in 1945, standing 602 feet above the outflow of the Sacramento River (USBR 2022).

Under the Central Valley Project, every major waterway (American River, Feather River, Mokelumne River) feeding the Central California drainage were dammed. This resulted in an estimated 1,057 miles (or 48%) of viable Chinook salmon habitat in the Central Valley watershed being unreachable (Yoshiyama 2001) (Figure 1). This action prevented WRCS from reaching their historical spawning grounds in the Southern Cascade Mountains in the headwaters of the Sacramento, McCloud, and Pit rivers (NMFS 2021). Salmon populations that once drove up into cold, oxygenated headwaters, are now forced to spawn in a less suitable habitat on the valley floor. Following this wave of watershed manipulation, Chinook salmon populations on the Sacramento River have declined precipitously, by more than 75 percent since the 1950’s (Yoshiyama et al. 1998). Monitoring Central Valley Chinook salmon runs began in the mid 1900’s following years of declining population sizes and the construction of Shasta Dam.

WRCS escapement estimates began being produced by CDFW in 1969, in just over 20 years, population sizes plummeted from 53,000 adults to just 144 in 1991 (Azat 2024). This rapid decline landed WRCS on the list of threatened species in 1989. It was apparent that water temperatures on the valley floor were exceeding the survivability threshold for eggs and juveniles. In 1992, the Bureau of Reclamation was required to build a “Temperature Control Device” that would allow them to control the depth of which they pulled water from Lake Shasta. This gave the USBR the ability to manipulate the water temperatures of the upper Sacramento River (CDFW 2018). Despite these changes by the USBR, populations to this day have dwindled and even in the best return years are a fraction of the run size in the early 1900’s. This has led to the species being listed as an Endangered species in 1994 and then reaffirmed in 2005 and 2016 (Endangered and Threatened Species, 2016).

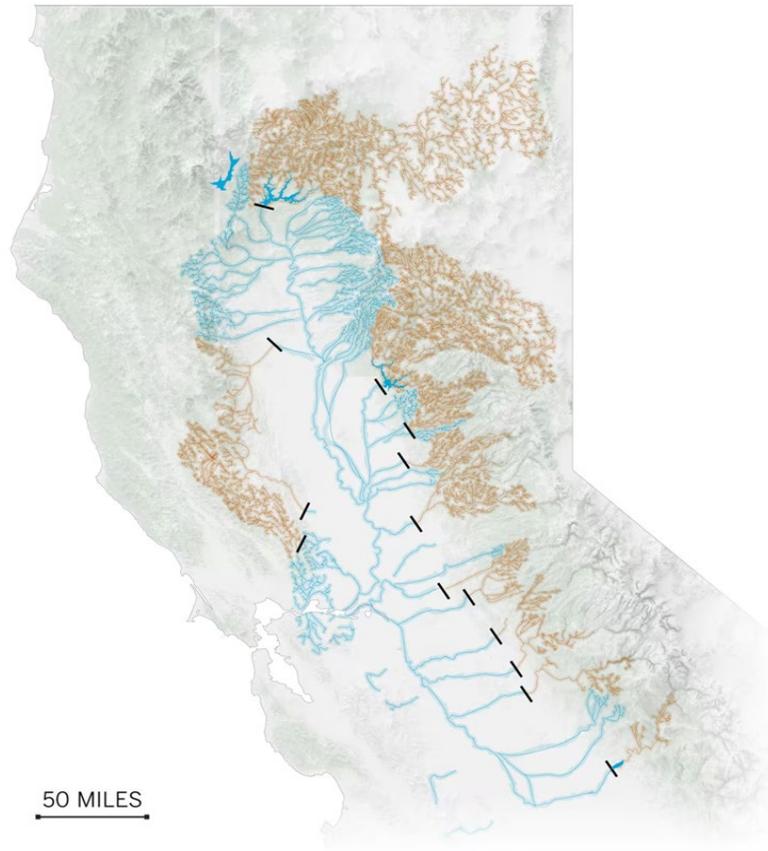


Figure 1. Damming across the Central Valley watershed, brown coloration represents historical salmon habitat that is now unreachable, black lines represent constructed dams, and blue lines represent rivers accessible to anadromous salmon populations. (Outdoor Project 2016).

WRCS are faced with tremendous adversity in both their upstream and downstream journeys. Historically, WRCS were the first run in the river each season and before the implementation of the “Temperature Control Device”, endured the warmest seasonal river temperatures at its most vulnerable stage (eggs). WRCS returning adults begin their journey into a brackish water system in the San Francisco Bay around December. The modern peak spawn time for adult WRCS is between May and August in the upper reaches of the Sacramento River (CDFW 2018). Typically, WRCS average a 90-day incubation from once eggs are laid till alevins emerge, usually late August to late November. Alevins are also called sac fry due to a ventrally attached yolk sac derived from the egg they once resided in. At this stage of life, fish are very limited in mobility, they do not feed and rely on the nourishment from the yolk sac to give them a better chance of survival before they emerge from the gravel (NPS 2019). Alevins slowly absorb their yolk sac for roughly another month, once the yolk sac is fully absorbed, it’s crucial fish are released into the river as they must begin feeding. Juvenile chinook does not possess

many defensible mechanisms other than their ability to swim away in a burst of speed, this greatly impacts their susceptibility to predation (Taylor and McPhail 1985).

In 2014 and 2015, Temperature Dependent Mortality (TDM) accounted for approximately 95% of the WRCS egg population, when water temperatures exceeded the 56°F threshold (CDFW 2018). The “Temperature Control Device” aids in the ability to supply cool water to the Upper Sacramento River despite hot summer temperatures in Northern California. However, in extreme drought events when Shasta Lake water levels drop, the ability to pull cold water from a greater depth in the lake is hindered. Other runs are not abstained from these issues, WRCS, due to the run and emergence time were just the first to be hit to this degree.

This predicament forged a whole new way of thinking: if the colder water cannot be brought to the fish, how can the fish be brought to colder water. In 2014, the USBR completed a survey of aerial imagery to identify habitat type, water temperature, and flows to quantify areas that meet the reproductive suitability index for Chinook salmon above Shasta and Keswick Dams (created by Batelle's Pacific Northwest National Laboratory Marine Sciences Lab in 2010). They found that the Upper Sacramento and McCloud Rivers could support a population of 2,163 spawning females (USBR 2014). There are a variety of factors that can impact watersheds viability for WRCS reproduction, starting with turbidity.

The McCloud River is known for its glacial hue, largely a result of the glacial fed mud creek tributary. This turbidity can be both advantageous and disadvantageous to juvenile chinook populations. NTU levels ranging from 10-80+ NTU's (Nephelometric Turbidity Units) can have a deleterious effect on juvenile chinook populations (Gregory 1992). In some years, NTU levels above 70 on the McCloud River are common. In addition to turbidity and water temperature, another vital factor to juvenile salmonid survival is dissolved oxygen levels. Dissolved oxygen readings are typically taken from a portion of the water column. This is helpful when pertaining to emerging fry, but for alevins or eggs still in the gravel this can be misleading. Typically, chinook eggs sit in the top 4 inches of gravel, at this depth dissolved oxygen levels are believed to be 3 mg/L (Milligrams per Liter) lower than the dissolved oxygen level in the overlying water column (ODEQ 1995). The average embryo in the soil will begin to show symptoms of oxygen deprivation distress at levels lower than 6.5 mg/L in the gravel. Levels lower than 5 mg/L have proven to have a great impact on the rate of embryonic development, hatch timing, and overall survival of chinook salmon (Bjornn & Reiser 1991).

While they do require different spawning conditions three different species of salmonid already spawn on the McCloud River: Kokanee (landlocked Sockeye salmon) (*Oncorhynchus nerka*), Brown Trout (*Salmo Trutta*), and Rainbow Trout (*Oncorhynchus mykiss*). All three species share similar life cycles, they feed in the lake Shasta ecosystem, supporting accelerated growth rates with greater and more consistent access to food than that found in the river. They also utilize the McCloud River system when it comes time to spawn. Browns spawn from April to June, rainbows spawn anywhere from April to October, and Kokanee spawn between September and November. They travel up the river system looking for ideal substrate, colder water temperatures, and higher dissolved oxygen levels (Hayes 1987).

In 2022, a pilot project began on the McCloud River, planting 80,000 WRCS eggs just below McCloud Reservoir. The project closely monitored egg survival and trapped out-migrating fry to better understand migration patterns. This study aimed to assess the effectiveness of rearing juvenile Chinook on the McCloud River and to determine if water conditions could still support WRCS after an 80-year absence. Since then, similar projects have started on the Feather River, Yuba River, and American River to explore volitional passage to former anadromous barriers. The 2024 and 2025 McCloud Reintroduction Project aimed at and continued to build momentum, improving and expanding the WRCS reintroduction efforts that began in 2022 and 2023.

METHODS

Remote Site Incubation

The incubation site is located 22 miles upstream from Lake Shasta at AhDiNa Campground, on the McCloud River. Two different incubation styles were implemented on site by PSMFC crews over the two field seasons. The first Remote Site Incubator (RSI) was the PSMFC operated Heath Tray system, a common practice used at most California Fish hatcheries (Figure 2). The Heath Trays utilize a gravity fed water supply line to circulate freshwater in the RSI. In the second year, the heath trays were swapped for two HPB's (Figure 3). This change opened the door to implementing a more hands-off approach to rearing juvenile chinook as these boxes lay staked into the riverbed and don't rely on pipes to supply fresh oxygenated water to the eggs. This eliminated the need to check eggs and flows daily. These RSIs were installed 7-10 days before the egg delivery date to ensure the fostering of a safe and secure environment well before the housed any eggs. Due to the remote nature of the incubation site, eggs were flown in

with a helicopter before being dispersed into the respective RSI. These eggs originated from Livingston Stone National fish Hatchery. Throughout the two years of operation on the McCloud River, two separate rearing strategies were used: HPB's and Heath Trays. It is important to note that egg-to-fry survival was calculated by subtracting the number of eggs and alevins removed from the HPB from the total number of eggs placed in the incubator, then dividing the remaining eggs and alevins by the number of eggs initially delivered to the system.



Figure 2. Heath tray system used to hold eggs up at AhDiNa Campground in the 2024 season operated by PSMFC

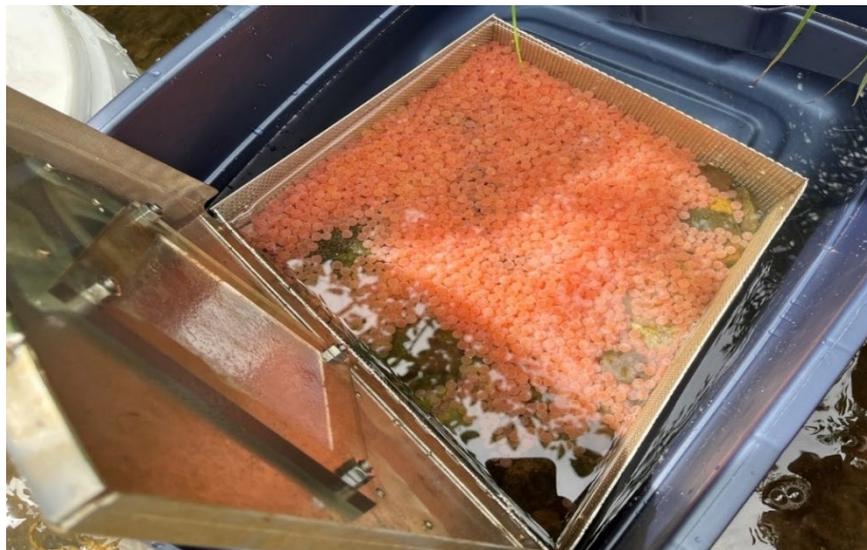


Figure 3. WRCS eggs settled into a HPB before being secured to the riverbed.

In the first year of operation a PSMFC crew was required to camp out at AhDiNa campground to perform twice daily checks seven days per week. From July 12th through

September 26th the crew occupied the campground. This was done to protect eggs from predation, remove dead eggs to prevent the spread of harmful ectoparasites or bacteria, and ensure proper water and oxygen flow were being supplied to the eggs (Figure 4). Water lines were checked to ensure that proper water circulation flowed through the Heath trays. Heath trays are an incredibly water efficient RSI, they can rear up to 80,000 eggs on just five GPM (Gallons Per Minute). Approximately five gallons of water per minute were circulated through each stack. Each stack holds eight incubation trays, and each tray holds five to 10 thousand eggs. Each tray of eggs was checked once daily to remove any dead or dying eggs from the collective group and recorded. The first batch of eggs was received on July 12th with additional deliveries on July 26th and August 16th. Between the three deliveries, a total of 20,100 WRCS eggs resided in the PSMFC-maintained heath trays. Additionally, 42,188 eggs were delivered to the “Nur Nature Base” system operated by UCD and WWT, at the same campground.



Figure 4. One dead egg latching onto and jeopardizing the health and safety of three live eggs



Figure 5. Circular tank, holding the remaining Chinook, with a belt feeder

Approximately 10–14 days after the eggs arrived at AhDiNa, the first alevins began to hatch. Following hatch, alevins were held for approximately one month until they were “buttoned up,” a term describing juvenile Chinook salmon that have fully absorbed their yolk sac. At this stage, fry becomes mobile and begin actively searching for food. Fry were released from AhDiNa Campground on August 26, 2024, and September 26, 2024, to begin their downstream migration in the McCloud River. Two release strategies were implemented. The first release occurred on the night of August 26, immediately after the fry buttoned up, with 7,297 WRCS released directly from the campground. The second release was postponed due to the relocation of the Incline Plane Trap (IPT) farther downstream. During this period, the fry was transferred into a circular holding tank and maintained for 16 days until the trap was operational. An automatic belt feeder was installed above the tank to provide a consistent daily food ration (Figure 5). However, on one occasion, wildlife damaged the feeder and dislodged the standpipe in the tank, resulting in the premature release of 2,898 fish. Following this incident, all feeding was conducted manually until the remaining 9,103 fish were released on September 26.

The 2025 field season brought about the installation of HPB’s that would go on to replace the heath trays. Due to the less invasive nature of this rearing method, PSMFC crews were not obligated to be on site. These boxes were checked once per week as opposed to twice daily with the heath trays. The same suitability index created by Batelle’s Lab was used to identify an optimal site for the HPB’s. This box was meant to imitate a collection of eggs deposited into a

red. Depth and flow were the two main factors that contributed to our site selection. The HPB is comprised of a pentagon shaped outer shell with vents on both sides to allow for flow to enter the box while keeping larger predators out. Inside the shell is a smaller detachable compartment made of perforated metal to supply eggs with copious amounts of oxygenated water whilst keeping predators at bay. They are then staked into the ground using railroad stakes with the point of the pentagon oriented into the direct flow. The external shell contains a viewing window, that we utilized to check on the eggs without removing the internal carriage.

A two to five-inch layer of rock was placed at the bottom of each box to simulate natural substrate conditions and prevent eggs from being displaced by water flow. Approximately 5,000 eggs were deposited into each box, for a total of 10,000 eggs under PSMFC supervision. These deliveries occurred on August 16 and August 23. An additional 83,000 eggs were allocated to the “Nur Nature Base” system. Dead eggs and alevins were removed weekly and buried on land to prevent predators from associating the site with a consistent food source. Developmental progress was monitored throughout the incubation period. Beginning on October 2, the first of five fry releases was conducted, with release events occurring between 11:00 a.m. and 2:00 p.m. (Figure 6). Increasing the number of release events helped ensure that underdeveloped fry was not released prematurely. Fish were counted in groups of five prior to being released directly into the river. Staggered releases allowed faster-growing individuals to be released at the appropriate developmental stage without forcing the premature release of slower-growing fry. The final release took place on October 17. All equipment was removed that day, and operations transitioned fully to the trapping phase of the project.

Trap Operation

While fry developed at AhDiNa Campground, two trapping systems were installed 20.7 miles downstream on the lower McCloud River. These systems included a Rotary Screw Trap (RST) and an Incline Plane Trap (IPT), informally referred to as the “FrySCOOPER”. The IPT incorporated a 160-foot-long, V-shaped row of perforated steel weir panels designed to funnel downstream-migrating juvenile Chinook salmon into the trap. Both traps were operated and maintained seven days per week. Depending on debris load, the perforations in the weir panels were susceptible to clogging, which could restrict water flow and cause water levels to rise upstream of the structure. To prevent overtopping and potential fish bypass, the panels were

scrubbed twice daily. If left unattended, elevated water levels overtopped the weir, allowing fish to bypass the trap and potentially compromise fish safety within the trap's live well.

The end of the trapping season was largely dictated by late-season weather conditions. Typical trapping flows ranged between 300 and 500 cubic feet per second (CFS). Flows exceeding 550 CFS could overtop the weir, resulting in fish passage and reduced trap effectiveness. During major storm events, flows on the McCloud River exceeded 12,000 CFS, making trap operation unsafe and infeasible. PSMFC staff and the Winnemem Wintu Tribe (WWT) worked seven days per week to ensure that both the weir and traps were cleared of debris and that fish were not confined in the live wells for extended periods, thereby minimizing stress and risk to their safety. After servicing one trap, crews then traveled approximately 1.5 miles to inspect, clean, and process fish at the second trap. When vegetative debris accumulated on the weir panels, water flow through the perforations decreased, resulting in increased velocities within the Incline Plane Trap (IPT). To mitigate elevated velocities within the trap, several adaptive management strategies were implemented throughout the field seasons. For example, willow branches were placed inside the trap to create hydraulic refugia, reducing flow velocity and providing cover from predation (Figure 6).



Figure 6. The use of sandbar willow to mitigate high velocities and predation in the IPT during the 2024 season.

Table 1. This table represents the species codes associated with the common names of fish found in the McCloud in-river traps.

Species Code	Common Name
BLUEGI	Bluegill
BROTRO	Brown Trout
LARBAS	Largemouth Bass
RAITRO	Rainbow Trout
RIFSCU	Riffle Sculpin
RIVLAM	River Lamprey
SACPIK	Sacramento Pikeminnow
SACSUC	Sacramento Sucker
SMABAS	Smallmouth Bass
SOCSAL	Sockeye Salmon (Kokanee)
SPOBAS	Spotted Bass

In a typical trap check of the IPT, the weir was cleared of debris first, alleviating flow in the trap by clearing the perforated panels and allowing water to bypass the trap instead of being funneled into the trap itself. This can prevent injury and mortality of trapped fish, as well as keeping extraction safer and easier crews. Following the cleaning of the weir, both target and non-target species are identified and extracted from the trap. Any non-target species were tallied and measured before being released behind the trap. Only 15 individuals of a single species were measured, after those additional individuals were tallied. Species were assigned a six-digit code (Table 1).

Any bass species were set aside in an in-river live well and members of the WWT performed gastric lavages to assess bass species predation rate on juvenile chinook. Chinook were counted and placed into perforated buckets and submerged in the river until the crew was ready to further process and eventually transport them. Aside from identifying and extracting both target and non-target fish species from each trap, a set of river characteristics were also taken. Among these were flow (FPS), turbidity levels (NTU- Nephelometric Turbidity), water and air temperature (degrees Fahrenheit), weather conditions, and depth the trap was fished at (feet). Each variable impacts the crew's ability to perform a trap check as well as influence the health and safety of captured fish species.

Once the traps were installed, efficiency trials were conducted by a NOAA crew to evaluate trap capture efficiency. Whenever modifications were made to the trap configuration, additional trials were performed to reassess performance. During these trials, a known number of fry were released at night and marked with identifiable markers, such as Bismarck Brown (BB) dye and/or an upper caudal (UC) fin clip. These marks allowed crews to distinguish efficiency trial fish from naturally out-migrating fry originating at the incubation site. Trap efficiency was calculated by dividing the number of marked fish recaptured by the total number of marked fish released, yielding an estimate of capture efficiency for the given configuration. Studies have shown that fry released at night may experience 25–30% higher survival rates compared to daytime releases (Grant County Public Utility District, 2019).



Figure 7. A WRCS being photographed in the fish viewer, each box represents 5 mm.

Both day and night release strategies were implemented on the McCloud River during each season. Efficiency testing served as an important tool for evaluating trap performance, as low catch numbers do not necessarily indicate low out-migration. These trials also helped identify necessary repairs or performance issues that might otherwise go unnoticed. Captured Chinook salmon were set aside for further processing, counted, and placed in an in-river live car while crews completed trap maintenance. By group consensus, project partners prioritized minimizing fish handling to reduce stress on WRCS. To support this effort, the University of California, Davis (UCD) research team developed a non-invasive measuring device known as the

“Fish Viewer” (Figure 7). Co-managers agreed that McCloud crews would process every other fish, up to a maximum of 15 WRCS per day, to further limit handling.

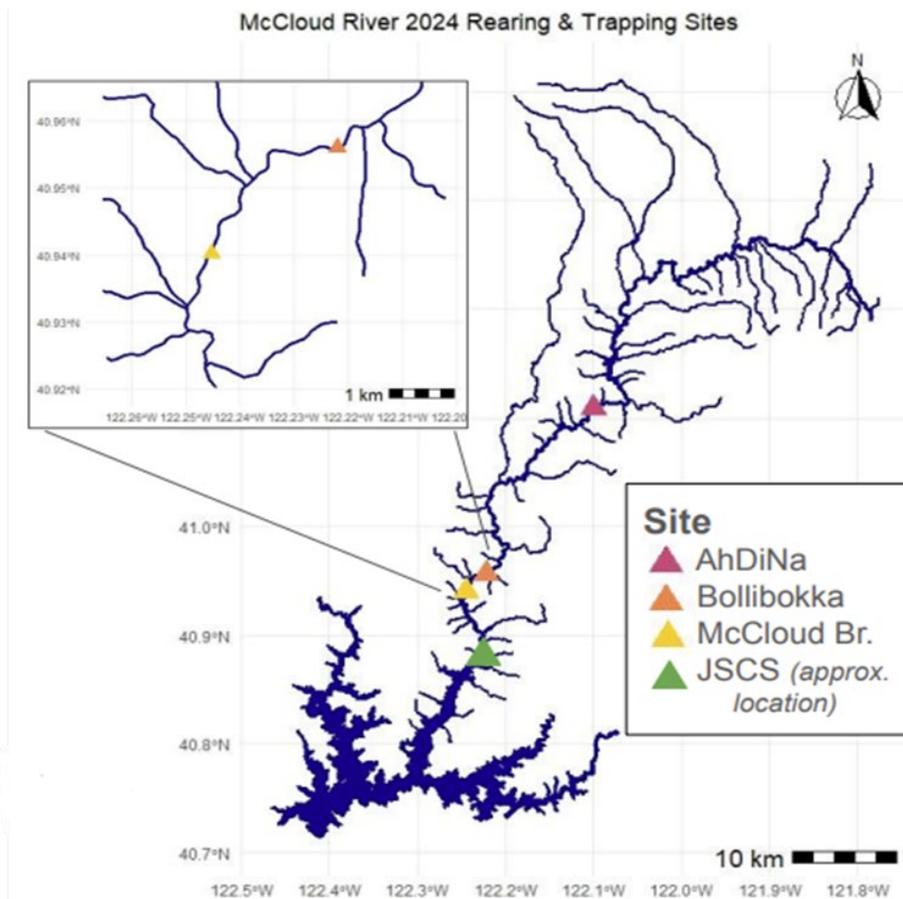


Figure 8. A map displaying the location of the three different traps used on the McCloud River arm in relation to the rearing site.

During the 2024 season, traps were initially installed on August 27 at Bollibokka’s property, a new location compared to previous years. Relocating the trap farther upstream allowed for earlier installation. In contrast, the former site at the McCloud Bridge is often unusable depending on water year conditions, as installation requires lake levels to drop sufficiently to accommodate equipment setup. From August 27 through September 12, flows at the new site were deemed unsuitable for operation of the Incline Plane Trap (“FrySCOOPER”), as the structure was consistently submerged. In response, crews experimented with deploying a Rotary Screw Trap (RST) positioned between the weir panels; however, this configuration proved unsuccessful in capturing out-migrating WRCS. A decision was subsequently made to relocate the FrySCOOPER downstream to the previous McCloud Bridge site. There, the trap was maintained and fully operational from September 21 through November 19. Throughout the season, PSMFC crews conducted daily check-ins at, and transported fish from, the Juvenile

Salmon Collection System (JSCS), an in-lake trap located approximately two miles downstream and operated by the California Department of Water Resources (DWR) (Figure 8).

Throughout the season several strategies were employed to prevent high velocities from compromising the IPT ability to fish or cause harm to entrapped fish. Observed velocities ranged from 0.8 to 5.5 feet per second (ft/s). Juvenile salmon approximately 50 mm in length have a sustained swimming speed of about 1.2 ft/s (Fangue et al, 2021). Prolonged exposure to velocities exceeding sustained swimming speeds can result in fatigue, injury, or mortality in juvenile WRCS. One strategy was the WWT deploying an evening crew that was able to ensure that debris was cleaned off the weir multiple times a day. While the PSMFC crew cleaned panels first thing in the morning. This allowed more water to pass through the weir panels and reduce the sweeping velocity that was carrying water across the panels and into the trap. Other strategies included placing cinderblock stacks inside the trap in a grid-like pattern to break up flow, cutting willow branches to add refuge, and even removing select panels from the weir, allowing water to pass unobstructed. These strategies were effective, but heavily reliant on adaptive management as the river conditions changed.

The RST did not endure these same adversities that the IPT did. We fished this trap from August 27th through November 19th. The RST traps fish within two to three feet of the surface of the water and did not have the same weir funneling a vast majority of the river into it. During September and October, fall leaf litter began to accumulate in the water column. We installed a debris boom, and the WWT diverged into an evening crew so that the trap could be cleaned constantly. Fish were extracted from the trap daily, identified, and sorted according to species.

During the 2025 season, the Rotary Screw Trap (RST) was installed earlier to capture older out-migrating WRCS. Two RSTs were installed on March 24 and officially began fishing on March 25. One trap was removed on August 27 due to declining flows and receding lake levels, which allowed only a single trap to fish the thalweg at a time. The remaining trap continued operating until December 17, marking the end of the trapping season. The Incline Plane Trap (IPT) could not be installed until lake levels dropped sufficiently to allow safe placement of the weir panels and trap. This year, the IPT was installed at the former site downstream of McCloud Bridge. To improve trap maintenance and monitoring, a PSMFC crew camped at McCloud Bridge Campground from August 24 through October 31. This arrangement enabled an additional daily trap check and enhanced oversight of trap conditions and fish

presence. Installation of the trap began on August 19, with operations commencing on August 24. The trap remained operational until a forecasted spike in flows on November 4. Between the 2024 and 2025 seasons, modifications were made to the trap to enhance efficiency and overall effectiveness in future operations.

Modifications added to the IPT included: a rubber skirt at the bottom of weir panels, weir panel spacing, and adjustments to the live well. A rubber skirt was added to the bottoms of weir panels to allow them to sit tightly on the rocky riverbed removing gaps between bottoms of the panel and the riverbed. A fixed panel linked the weir to the trap itself, as compared to the seine nets last year. The weir panel perforations changed from 30 percent to 60 percent open space to allow for more water to pass through. A plethora of velocity breaks were added inside the trap that allowed the trap to adjust to varying river conditions. A tri-chambered live well was installed with varying gaps to filter out fish by size and offer safe refuge for smaller fry. The transition from the first live well to the second was separated by strips of aluminum cut angle with 1-inch gaps. The transition from the second live well into the third was sectioned off by half inch gaps in between conduit bars. Despite the adjustments to the trap in the off-season, changes still needed to be made in the mid-season.



Figure 9. A display of the louvers' ability to break up flow entering the trap.

In response to this, crews constantly adjusted the level of weir maintenance. During high flows the panels were only cleaned once in the morning to allow time for debris to build up, thus plugging up those perforations that led to fish impingement. Additionally, a third of the panels

had to be raided upwards in the water column and rested on 6” tall cinderblocks to allow for water to pass under the trap without compromising the trap’s efficiency. Daily adjustments to the louvers at the mouth of the trap significantly reduced water velocity within the trap (Figure 9). These adjustments, combined with a primary trap check at 8:00 AM and a secondary check at 5:00 PM, ensured that fish were not held in the trap for extended periods.

Transportation Methods



Figure 10. Fish held in a cooler acclimating until they are ready for release.

After processing the WRCS captured in the traps, fish were placed into Engel coolers in preparation for transport (Figure 10). The coolers were equipped with bubblers to maintain oxygenated water and were submerged in the river for approximately one hour prior to adding fish to stabilize both the external and internal temperatures of the containers. While the fish remained safely in a live pen in the river, the trap was cleaned and necessary modifications were completed. Water temperature was recorded before transport and again upon arrival at the release site.

The PSMFC crew coordinated daily with the Juvenile Salmon Collection System (JSCS) crew to collect fish captured in the downstream trap, which were transported together with fish captured at the McCloud River traps. The Engel coolers used were rated for safely holding up to 400 two-inch minnows for two hours; however, to account for the cold-water requirements and high dissolved oxygen needs of WRCS, cooler loads were conservatively limited to 250 fish per container. Fish were transported by vehicle for approximately one hour to the Posse Grounds Boat Ramp in Redding, California. Upon arrival, the water temperature of the Sacramento River was checked to ensure proper acclimation, following the standard guideline of no more than a

3.6°F change per hour (Poletto, 2017). Transit mortality was recorded at the release site. Once the water temperature in the transport cooler and release site was within two degrees Fahrenheit of each other, fish were released near cover into the Sacramento River. Released fish were briefly observed to monitor for injury or additional mortality.

RESULTS

Remote Site Incubation

The PSMFC crew was originally scheduled to rear 40,000 WRCS eggs at AhDiNa Campground for the 2024 season. However, due to a poor return of adult WRCS, half of the egg allotment was reallocated to prioritize releases into the Sacramento River rather than the McCloud River. PSMFC staff were responsible for rearing 20,100 eggs. During rearing, a delay in transferring fish from trays to a circular holding tank resulted in the loss of 135 Chinook salmon due to emaciation; their yolk sacs were fully absorbed, and they required feeding. In total, 638 eggs and alevins died prior to release, representing a total mortality rate of 3.17% for the 2024 season. For comparison, typical hatchery mortality rates range from 4% to 10% from egg to buttoned-up alevin (Gallinat, 2024).

Throughout the crew's 12-week occupation at AhDiNa, water temperatures fluctuated from 32°F degrees to 58°F. The average temperature at the rearing site was 52.13°F with a median of 51.62°F. The Diurnal temperature cycles on the McCloud River swing on average 5.1°F throughout the day during our sampling period. Throughout our 12-week egg incubation and juvenile rearing period, flows were consistently between 300-400 CFS. Dissolved oxygen levels at the incubation site swung between 10.02 and 25.75 mg/L. The average dissolved oxygen level at AhDiNa campground was 11.12mg/L Crews also recorded daily turbidity levels (NTU) in the McCloud River. From July through August, while eggs were in the water the turbidity conditions at AhDiNa campground ranged from 2.1-12.9 NTU's.

During the 2025 season, a more hands-off approach was implemented, with the trap checked weekly rather than daily. The PSMFC crew maintained two HPBs containing a total of 10,000 WRCS eggs. Small predators, such as rainbow trout and riffle sculpin, were occasionally found within the external shell of the boxes but were not present inside the internal carriage with

the eggs. A total of 96 egg and alevin mortalities were removed to prevent the spread of disease and bacteria, resulting in a mortality rate of 0.96% from eyed egg to buttoned-up fry.

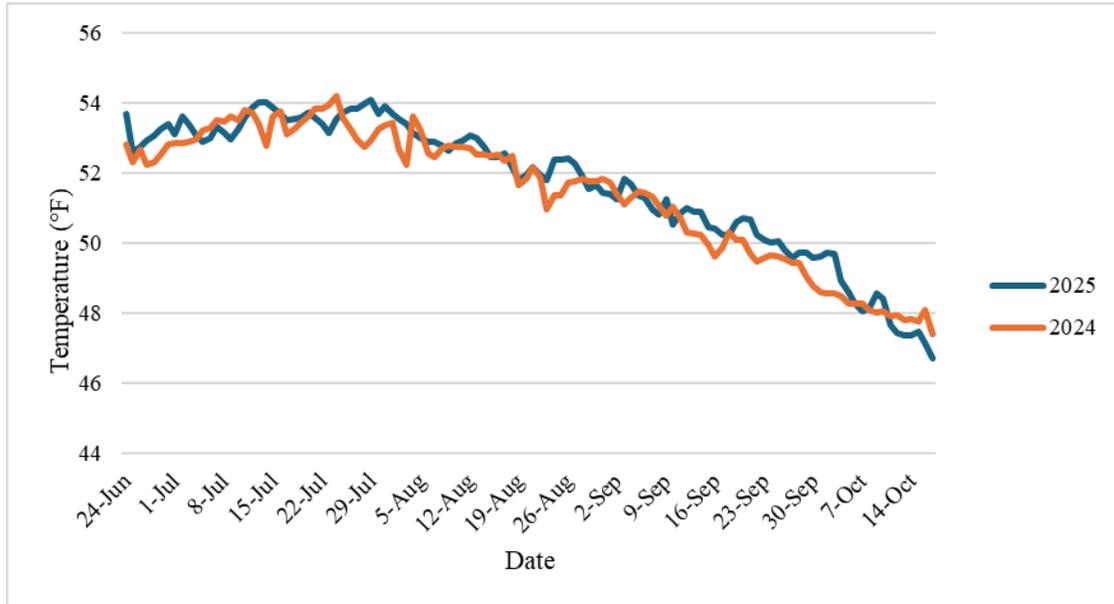


Figure 11. Analysis between water temperatures (°F) at the same incubation site during the 2024 and 2025 season.

Table 2. McCloud egg mortality over the four years of operation.

Years	Eggs Delivered	Count of Dead Eggs	Egg Mortality Rate
2022	40,000	4,710	11.78%
2023	40,000	15,200	38.00%
2024	20,100	638	3.17%
2025	10,000	96	0.96%

This 2025 season reflected the highest egg-to-fry survival observed over the four years that WRCS eggs have been transported to the McCloud River (Table 2). The water parameters remained much more consistent as the HPBs were staked into the riverbed. The river supplies much more consistent dissolved oxygen levels and water temperatures. The water conditions in the Heath Trays were much more variable, as they were heavily affected by changes in weather and temperatures. Throughout the incubation period water temperatures in the hatch partner boxes ranged from 46.69 °F to 54.07°F (Figure 11). With the warmest water temperatures at the incubation site in late July and the coldest in early October. Water temperatures in 2024 and 2025 were consistent, diverging plus or minus two degrees from each other (Figure 11). Flows (CFS) at the incubation site fluctuated minutely compared to the flows down river at the trapping site. Due to the rearing sites proximity to the McCloud Reservoir dam, flows were controlled between

300-400 CFS. Turbidity ranged between 1.21 and 2.4 NTU's throughout the incubation period. Mid-August offered the highest turbidity before clearing up into October. Despite the challenges of rearing and trapping juvenile salmonids, the PSMFC crew achieved the lowest egg-to-fry mortality rate in a four-year span that is the McCloud project at 0.96%.

Trapping

River conditions on the McCloud River varied throughout the 2024 trapping season, with flows ranging from 330 to 1,650 cubic feet per second (CFS) (Figure 12). Flow through the Incline Plane Trap (IPT) was carefully managed to avoid velocities exceeding the sustained swimming capacity of juvenile Chinook salmon (1.2 ft/s), as higher flows could result in mortality. Over the course of the season, 339 Chinook were recorded as dead, with three days accounting for 48.6% of total mortality, likely due to elevated velocities. Initially, the trap site located just north of the McCloud Bridge experienced operational challenges. Despite the release of 7,297 WRCS from AhDiNa on August 26, the IPT captured only three live fish and 60 dead. In response, the PSMFC crew replaced the Rotary Screw Trap (RST) with the IPT to evaluate its capture efficiency. During an efficiency trial, the RST failed to capture any of 99 marked fish, resulting in a 0% capture efficiency rate. Following these results, the IPT and associated weir were relocated downstream, closer to the lake arm, to improve trap performance and fish safety.

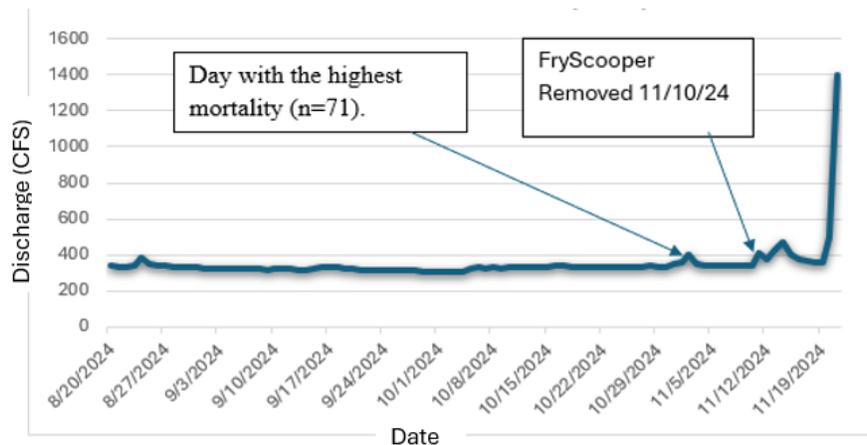


Figure 12. Flow (cubic feet per second) on the McCloud River System above Lake Shasta from August 20th through November 20th, 2024 (CDEC, 2024).

Table 3. Efficiency trial results from the RST and IPT throughout the 2024 season. The orange rows represent an efficiency trial performed when 30 feet of weir panels were removed to alleviate velocity in the FrySCOOPER.

Date	Trap Type	Individuals Released	Individuals Caught	Percentage	Type of Mark
September 10th 2024	RST	98	0	0%	BB/UC
September 25th 2024	Fry Scooper	200	45	22.50%	BB/UC
October 24th 2024	Fry Scooper	400	301	75.25%	BB/UC
November 5th 2024	RST	202	7	3.47%	BB Only
November 5th 2024	Fry Scooper	202	139	68.81%	BB Only
November 5th 2024	Fry Scooper	104	67	64.42%	BB/UC

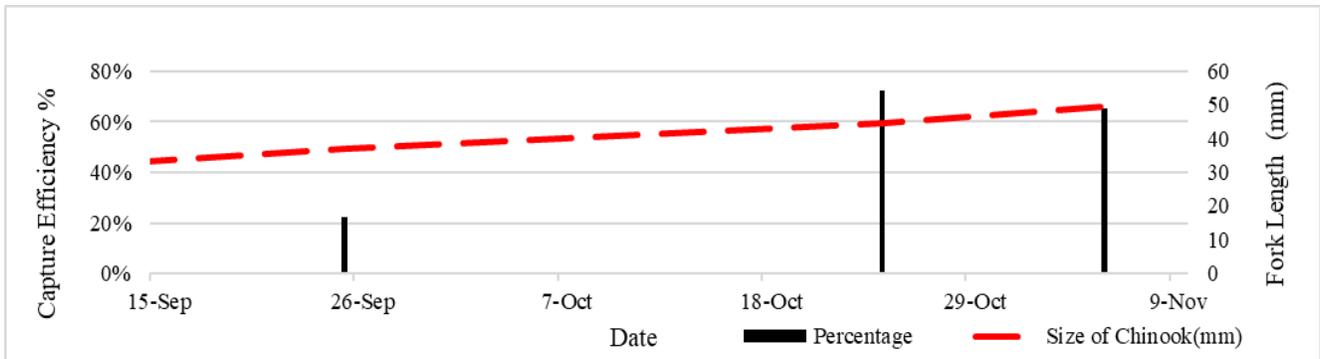


Figure 13. The FrySCOOPERS capture efficiency throughout the trapping season with the blue bars representing capture efficiency. In relation to the orange line tracking size of chinook used in efficiency trial.

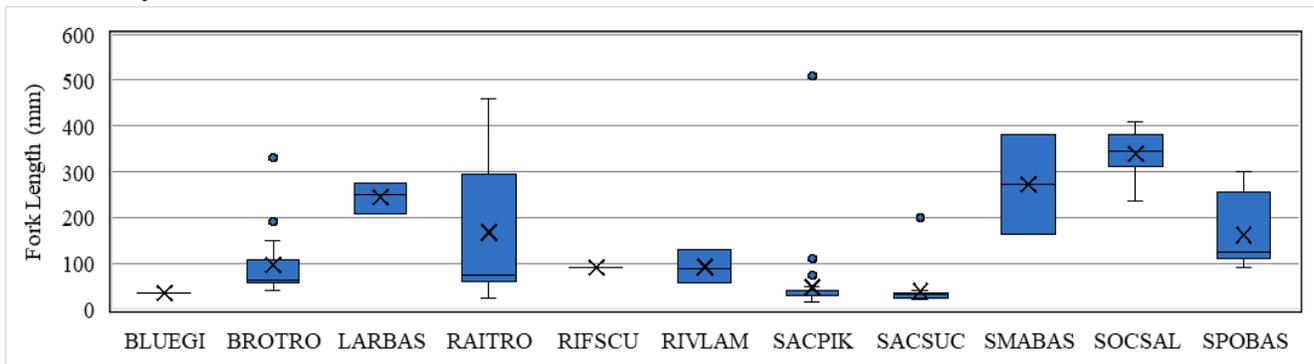


Figure 14. Bycatch species recovered from in-river traps (RST & IPT). The dots are representative of an outlier, that is a data point outside the interquartile range and represents data that’s found outside the typical distribution or 1.5 times the upper quartile, the solid black line represents the median while the “X” represents the mean.

Three separate efficiency trials ensued following the relocation of the IPT downstream. Efficiency trials ranged from 22.50% all the way up to 75% (Table 3). Efficiency trial fish were found in the trap for up to three days following the release. As the season progressed, the average

size of the WRCS being captured trended in an increasing direction. This was reflected in the fish used for trap efficiencies as well, fish used in efficiency trials ranged from 31.8 mm to as high as 49.5 mm by the end of the trapping season (Figure 13). Another key factor that can impact trap efficiency is predation in the reach of river where your trap is located.

Three species of bass are present in the lower McCloud River: spotted bass (*Micropterus punctulatus*), largemouth bass (*Micropterus salmoides*), and smallmouth bass (*Micropterus dolomieu*). The WWT conducted gut content analyses on 21 captured bass to assess predation on Chinook salmon fry. Chinook fry was detected in 14.2% of stomachs, and only in spotted bass. Only three spotted bass were captured after October 28, when daily river temperatures dropped to nearly 43°F. Spotted bass are believed to have a thermal survivability threshold of approximately 6°C (42.8°F) (Cherry et al, 1977). This data suggests that spotted bass, a primary predator of WRCS fry in the McCloud River, begins to leave the system as early as mid-October. This interpretation is supported by efficiency trials conducted in mid-to-late October, which demonstrated capture rates as high as 75%, indicating that predation had a minimal effect on out-migrating Chinook during this period.

Between the RST and IPT, a total of 11 different bycatch species represented by a 6 letter species code (Table 3), were captured in addition to our target species (Figure 14). Rainbow trout made up most of the catch representing 39.2% of our overall bycatch. The average rainbow trout that was caught was roughly 167 mm (Figure 14). Brown trout were also caught throughout the season though much less frequently as they made up just 7.7% of our non-target catch. Most of the trout were either young of the year or adults utilizing the McCloud River to spawn as represented by fork lengths distribution below.

The Incline Plane Trap (IPT) operated from August 27 through November 11, although it was not fully effective until its complete relocation on September 21. Over the season, the IPT captured a total of 4,123 Chinook, representing 89.3% of the total WRCS catch in 2024. It is important to note that both Heath tray releases occurred when trap efficiency was low, 0% and 22.5%, respectively, resulting in the two lowest capture efficiencies of the season. These releases accounted for 20,000 of the 62,000 fish reared at AhDiNa Campground, contributing to low recovery percentages for fish out-migrating earlier in the trapping season. The IPT demonstrated strong efficiency in capturing Chinook; however, modifications were necessary to ensure the safe recapture of WRCS. High in-trap water velocities were a persistent challenge throughout the

season. Inputting Sandbar willows in the trapped helped address these issues; even with water velocities reaching 2.9 FPS, juvenile fish swimming velocity was only 1.14 FPS when using sandbar willow (Fangue et al. 2021). Additional modifications with metal plates that formed a channel system, and a grid pattern made of cinderblocks, helped reduce flow inside the trap to safer levels for the fish ($n < 0.5$ FPS). However, even with all these adjustments, 99.4% of total Chinook mortality (337 of 339 fish) from in-river traps occurred in the IPT.

The RST fished from August 27th through November 19th. The RST demonstrated the ability to remain operable in high flow conditions. With that reason alone it was able to fish for a total of 84 days this trapping season, compared to the IPT only fishing 68 days. In totality, the RST captured 494 WRCS which represents 10.7% of our total chinook catch for the 2024 season despite operating 16 more days than the IPT. Despite seasonal high debris load and strong flow conditions, the RST only resulted in two chinook mortalities throughout the season.

The 2024 season produced the highest capture efficiency of any trap on the McCloud River (72%) over the four years of trapping efforts. However, the trapping season was cut short by an early atmospheric river in November, which dropped 12 inches of rain in a three-day period. This caused the McCloud River to swell to 4,800 CFS, which is 12 times the flow levels observed throughout the season. All gear was removed before the storm arrived, effectively ending the trapping season. We expanded on our trapping success in the following season, maintaining an average trap efficiency of 56% throughout the four-month trapping window.

Traps were operated on the McCloud River from August 25 through December 15. During this period, flows fluctuated between 277 and 1,441 cubic feet per second (CFS) (Figure 16). Flows exceeding 450 CFS could overtop the weir, allowing water to bypass the Incline Plane Trap (IPT) and reduce trap efficiency. High flows also exceeded the sustainable swimming speed of juvenile WRCS (1.2 ft/s), placing fish safety at risk. A total of 458 WRCS mortalities were recorded, representing a mortality rate of 4.79% for all individuals encountered. Unlike the previous year, only a small proportion (20%) of mortality occurred inside the trap. Improvements to the live well system and the addition of adjustable louvers enhanced the safety of captured fish. Most of the mortality occurred on the weir panels, where oversized perforations created suction that pinned fish against the panels. Over the season, 348 Chinook, approximately 76% of total mortality, were recovered in this manner. The remaining 4% of mortalities were attributed

to transport, with most of these fish having sustained injuries either during handling by crew members or from river conditions.

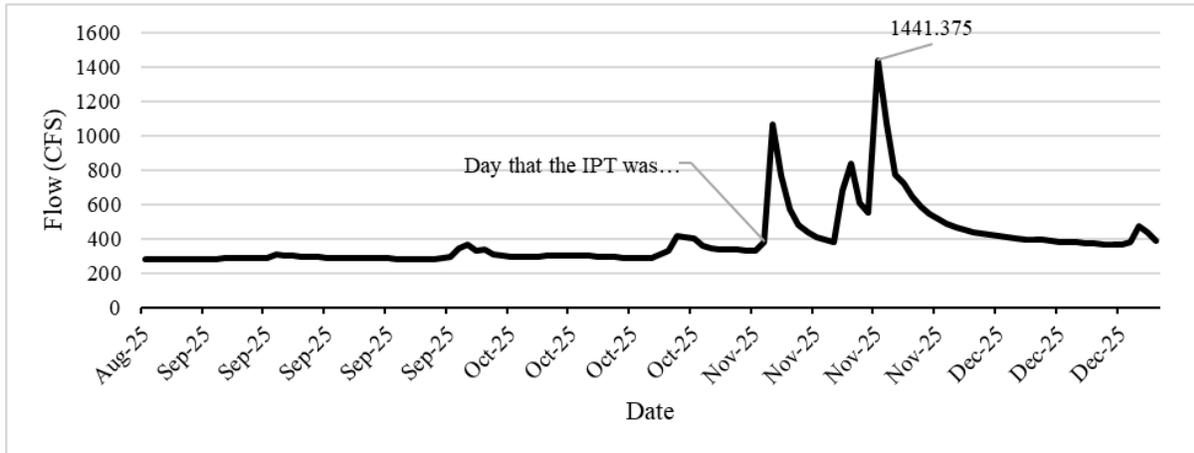


Figure 15. Daily average flow in CFS on the McCloud River during the 2025 trapping season from August 25th through December 17th (CDEC gage MSS).

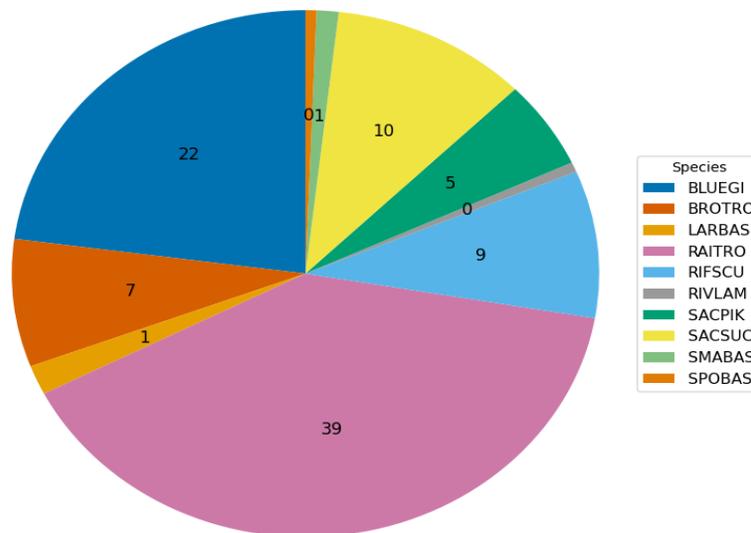


Figure 16. Represents the various number of non-target fish caught in traps on the McCloud River in the 2024 trapping season.

We identified eleven different species of fish in the RST and IPT (Figure 15). Sacramento Pikeminnow was the most common and represented 47% of our non-target species catch (Figure 16). Due to the required relocation of the IPT during the 2024 season, we were able to get the IPT fishing almost a month earlier than the prior year. This led to a significant shift in bycatch representation. Pikeminnow last year represented just 22.5% of our bycatch representation. Sacramento Suckers increased from 10.6% in 2024 to 34% in 2025 (Figure 17). The average

pikeminnow’s fork length measured out to just 16mm, leading to the belief that these are freshly hatched fry out-migrating the system, that for the most part we missed in the prior year.

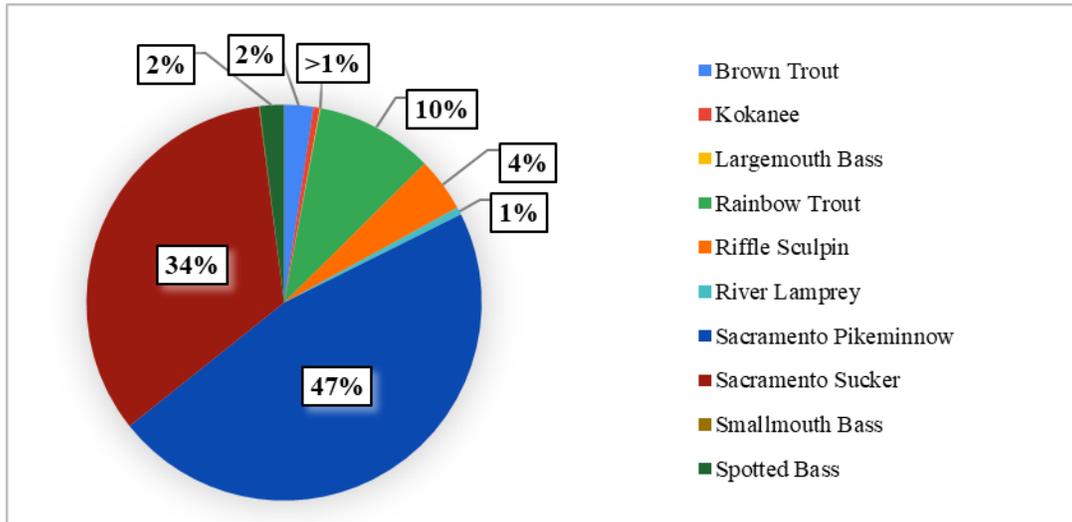


Figure 17. Distribution of bycatch (or non-target) species on the McCloud River during the 2025 trapping season

Table 3. Capture efficiency trials run on the IPT throughout the 2025 season. Mark types are comprised of two marking methods: Bismark Brown Dye (BB) and Upper Caudal Clip (UC).

Date	Trap Type	Released	Caught	Percentage	Type of Mark	Release Timing
9/4/2025	IPT	244	102	42%	BB/UC	Day
9/18/2025	IPT	98	59	60%	UC	Night
10/1/2025	IPT	486	310	64%	UC/BB	Night
10/15/2025	IPT	499	322	65%	UC	Night
10/22/2025	IPT	431	224	52%	UC	Night

Pulses in flow necessitated adaptive trap management and changes to daily maintenance, which led to variation in trap efficiency for capturing out-migrating WRCS. Five separate efficiency trials were operated to assess the IPT’s current state. The IPT’s efficiency ranged from 42% to 65% for the duration of the trapping season (Table 3). The final two efficiency trials had water flowing over top the weir panels when crews reached the trap in the morning, due to higher flows. This was also reflected in the catch from the JSCS located downstream, they recovered more of our marked efficiency fish when trials were performed while water breached our weir. The first efficiency trial sported the lowest efficiency results. We attributed this to what we believed to be higher predation with efficiency fish released in the middle of the day, versus releasing efficiency trial fish after sundown.

Predation within the trap was greatly reduced by the tri-chambered live well offering refuge to juvenile WRC in the trap. Any bass out of the three local species (Spotted/Largemouth /and Smallmouth) that was found in the trap had its stomach searched to further understand the species predation rate on juvenile chinook. Out of the 44 bass that were operated on, only 9.1% (n=4/44) had WRCS in their stomachs. This is a sign of improvement from the 14.2% of bass in 2024 that were confirmed to have predated on chinook. Supporting the notion that the improvements to the trap positively affected predation rates within the trap. Once again spotted bass (Figure 19), though they had a greater presence in the river, were the sole perpetrators out of the three bass species found locally to predate on WRCS according to our gastric lavages.



Figure 18. This picture represents a spotted bass that was pulled out of the IPT during the 2025 season.

The Incline Plane Trap (IPT) was operated from August 24 through November 4, totaling 82 fishing days. The trap remained deployed at a single, consistent location throughout the 2025 field season. During this period, the FrySCOOPER captured 8,412 WRCS, representing 87.8% of the total seasonal catch. The IPT achieved an overall average capture efficiency of 56.6%. Notably, capture efficiency increased from 64 to 65% during the AhDiNa fry release period, corresponding with a marked increase in WRCS catch. Daily catch trends exhibited a pulsed distribution pattern, characterized by episodic spikes followed by periods of low activity (Figure 18). These spikes likely reflect synchronized downstream migration events involving large

cohorts of fish. Catch variability was strongly influenced by HPB-scheduled releases, in combination with environmental cues that initiate downstream migration behavior of fish.

An adjustment was made to the perforated metal panels that made up the weir. Instead of using 30% open space perforations, as in 2024, 60% open space perforations doubled the amount of water passed through the panels, reducing the volume of water being funneled into the trap and leading to mortality. Under high flow and a fully constructed weir blocking the water way, the perforations were too large and small fry were pinned via the suction of water pushing through the perforations. Flows greater than 325 CFS caused small fish to become pinned to the panels, preventing escape and leading to mortality. To combat this panels were plugged up with debris to prevent fish impingement.

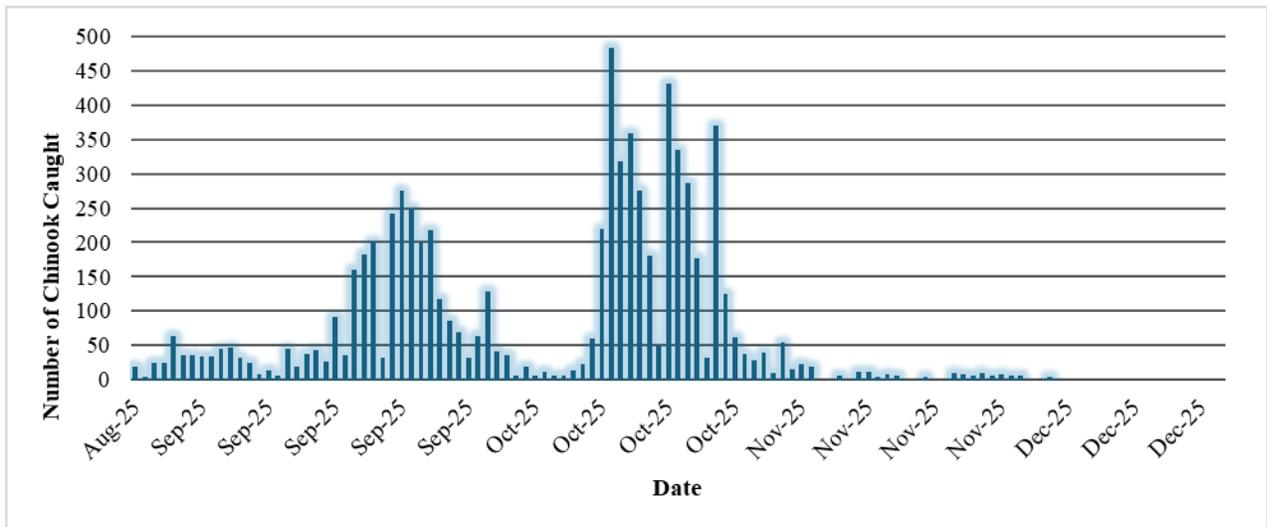


Figure 19. Daily WRCS catch totals throughout the 2025 trapping season.

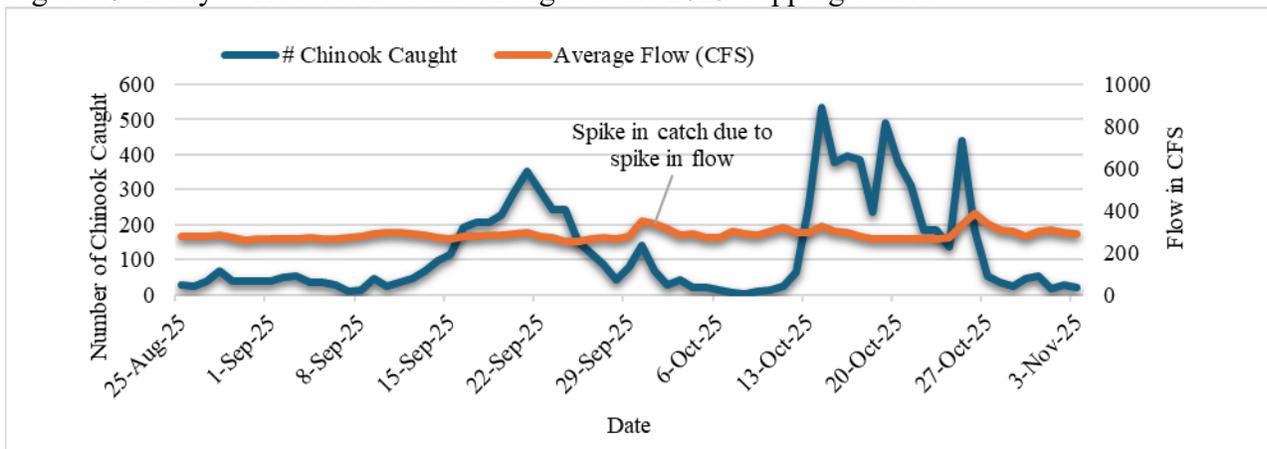


Figure 20. Discharge (measured in CFS) influences WRCS migration patterns. The blue line represents the daily number of Chinook caught, while the orange line shows the average flow in CFS.

Temporal analysis indicated that less than 1% of the total WRCS catch occurred during evening trap checks, suggesting minimal diurnal Chinook activity. The remaining catch occurred during overnight periods, supporting evidence of predominantly nocturnal migratory behavior. River discharge also influenced daily Chinook catch rates. Increased flow events appeared to mobilize smaller individuals holding upstream, effectively flushing them downstream and increasing trap capture (Figure 20). Overall, the IPT functioned effectively in directing fish into the trap. However, it accounted for 97% of total fish mortality between the two traps operating on the river during the 2025 season.

The RST operated from March 25th through December 17th for a total of 187 days. During periods of elevated flow, the trap was tethered to shore and redeployed once conditions stabilized. When water levels were high, two traps fished in tandem; however, as flows receded, the second trap was left in a low-flow pool and removed from operation. This allowed us to fish the trap deeper into the trapping season. Despite fishing for 105 more days than the FrySCOOPER, the RST was responsible for ~12.2% of total WRCS catch over the 2025 season. The RST only experienced five chinook mortalities throughout the season, and all were a result from processing mortality (injured or killed netting them out of the trap).

Out of the 4,617 WRCS trapped in the 2024 season, 600 fish were processed in the fish viewer, and size in millimeters (mm) was determined. WRCS caught in the RST and IPT this year varied from 20.96 – 71.68 mm in length (Figure 21). The average individual WRCS caught this year was 35.96 mm. The differentiation between the three years of trapping on the McCloud River (2022-2024), shows a broader size distribution in this year's data set compared to previous years (Figure 22). This is represented by the standard deviation taken from all three data sets, in 2022 it was 6.23, 2023 was 6.52, and lastly 2024 was 7.44. This higher standard deviation resembles the degree of variation between sampled individuals. During the 2025 trapping season, PSMFC-operated in-river traps captured a total of 9,570 WRCS. Of these, 604 individuals were processed using the fish viewer to obtain a representative sample of fork lengths throughout the duration of the trapping season. This dataset is representative of fish captured in both the IPT and RST during the season. Fork lengths ranged from 26 to 70.3 mm (Figure 23). As observed in previous years, the general trend of fish increasing in size as the season progressed held true. The decline in fish size observed from October 2 through October 20 is largely attributed to the release of freshly "buttoned-up" fry from the HPBs. This resulted in an

influx of individuals that were developmentally behind their cohorts that had been feeding in the river for a longer period. Overall, this year’s catch trended smaller in average fork length compared to previous years.

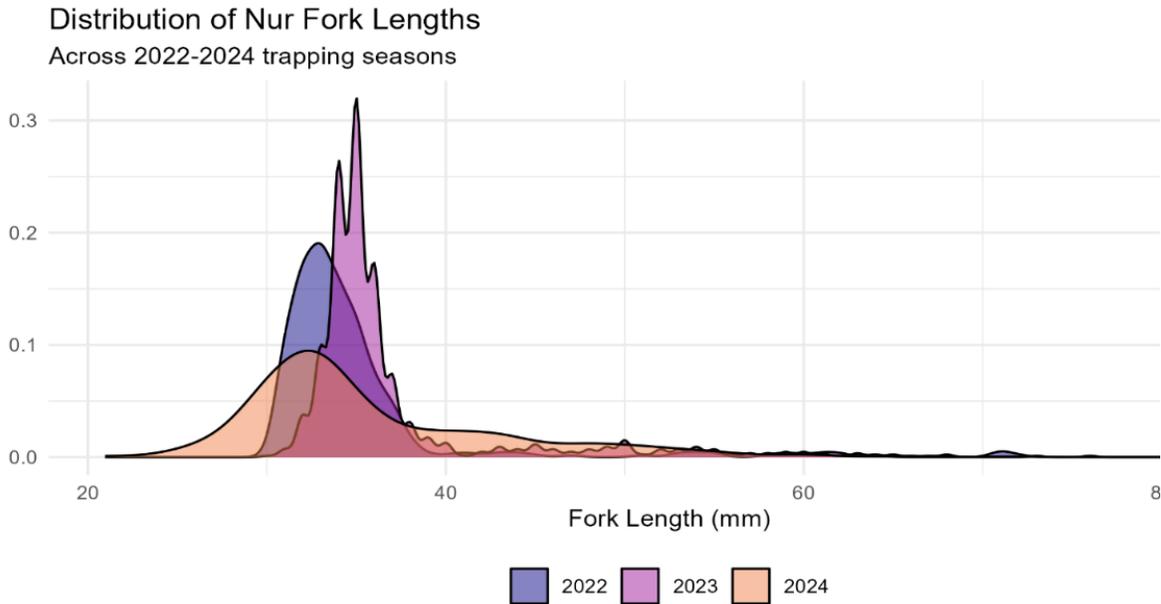


Figure 21. Weekly size distribution of chinook salmon caught in traps as the trapping season progressed contrasted with years 2022-2024.

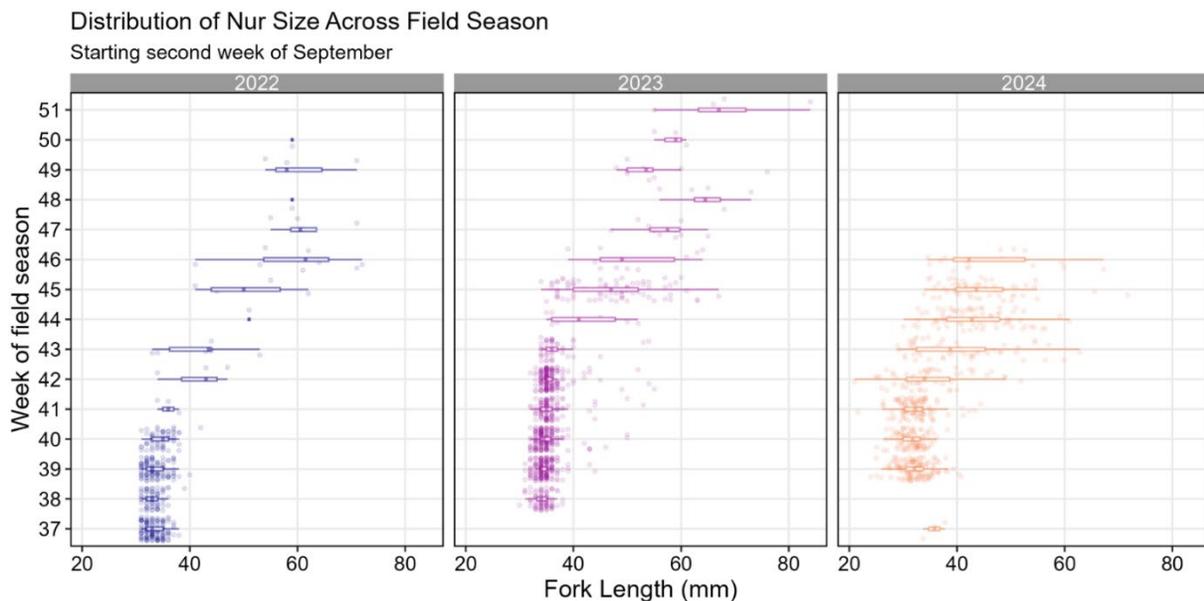


Figure 22. Distribution of WRCS or “Nur” fork lengths acrossed trapping seasons from the UCD Center for Watershed Sciences.

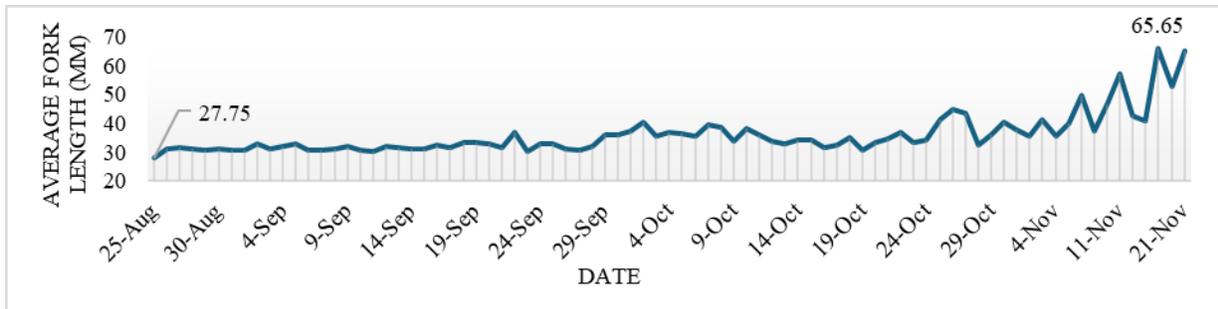


Figure 23. The average fork length for WRCS was measured in the fish viewer during the 2025 season.

Transport and Release

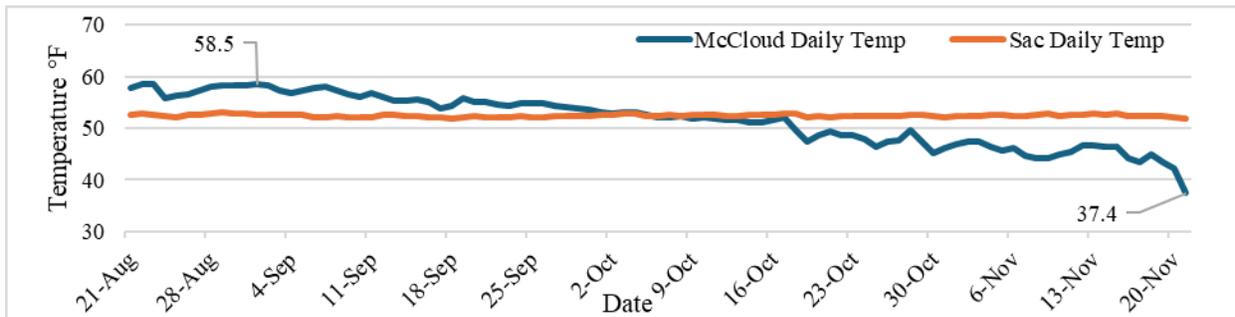


Figure 24. 2024 Daily average water temperature of the McCloud River above Lake Shasta and at the mainstem Sacramento River (SAC gauge) (CDEC, 2024).

Fish were transported from McCloud Bridge Campground to the Posse Grounds boat ramp in Redding, California throughout the 2024 trapping season. During this period, the PSMFC crew transported a total of 4,617 Chinook salmon. Of these, 10 individuals did not survive transport, including one fish originating from the in-lake trap (JSCS). This corresponds to an overall transport survival rate of 99.8% for the 2024 season. One transported individual was a 140 mm yearling Chinook salmon, which was successfully delivered to the release site. For most of the trapping season, water temperatures at the McCloud River trapping site and the Sacramento River release site remained within several degrees of one another. However, in November, McCloud River temperatures declined while Sacramento River temperatures at the release location remained relatively stable. Despite the increasing temperature differential and implementation of extended acclimation periods, only one Chinook salmon mortality occurred during transport in November. Over the course of the season, McCloud River water temperatures ranged from a high of 58.6°F to a low of 37.4°F (Figure 24; CDWR 2024). This represents a substantially greater seasonal temperature fluctuation compared to conditions observed in the Sacramento River at the release site.

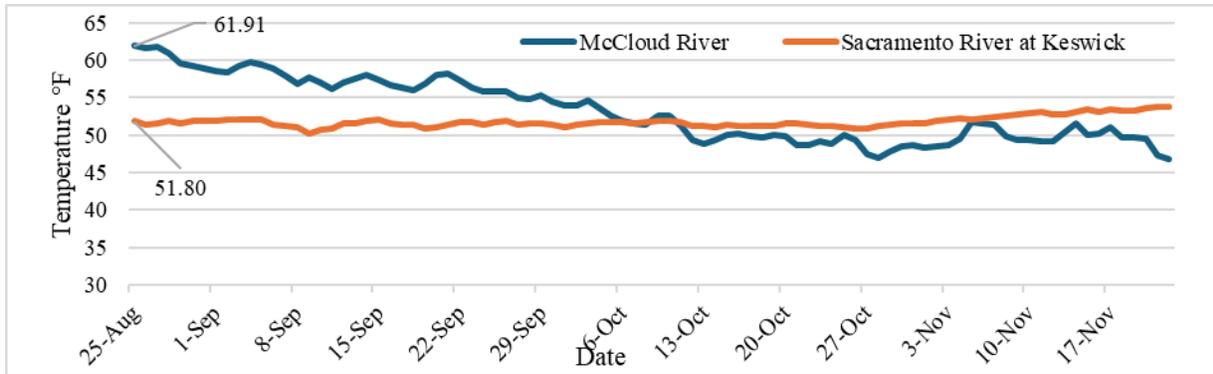


Figure 25. A comparison between water temperatures in Fahrenheit at the trapping site on the McCloud River versus the release point on the Sacramento River in Redding. The blue trendline signifies the water temperatures on the McCloud River while the orange line represents the temperatures at the release point in the Sacramento River (SAC Gage) (CDEC, 2025).

In the 2025 season, a total of 10,349 WRCS were transported from McCloud

Campground to Posse ground Boat Ramp in Redding. This comprised of 771 fish from the DWR operated JSCS and 9,578 from the PSMFC and WWT operated IPT and RST. Out of the 10,349 fish transported eight did not survive the journey for a transit mortality rate of 0.07%. Most of these transit mortalities were a result from injuries sustained before or during processing. The greatest deviation in water temperatures between capture and release points was just over ten degrees in late August. This required the greatest acclimation time, sometimes over two hours. Water temperatures at the trapping site swung from 62 degrees to 46 degrees Fahrenheit (Figure 25). Early into the season trapping conditions were a mixture of water from Shasta Lake and water from the McCloud River. McCloud River water temperatures at the trap site are warm early into the trapping season due to the receding of the lake arm. Water temperatures at the incubation site were close to 51 degrees Fahrenheit in late August, but as the lake levels recede the water temperatures at the trap site cool down. Like the 2024 season, McCloud River temperatures became colder than the Upper Sacramento River in early October. In the 2025 season, a warmer fall combined with less precipitation resulted in water temperatures remaining stagnant through the end of the trapping season.

DISCUSSION

The McCloud River Winter Run Chinook Salmon Reintroduction, Implementation, and Monitoring project seeks to evaluate the system's capacity to support and sustain a reintroduced WRCS population through comprehensive research and data collection. The PSMFC crews collected field data and observations to obtain objective evidence to best aid a struggling fish population. The co-managers can utilize this data to dictate the direction of WRCS conservation.

This project was made possible in large part by CDFW who supplied the funding for the data collection.

Heath trays offered much more hands-on monitoring effort, which proved a necessity for a project trying to gain a better understanding of the suitability conditions for WRCS in the McCloud River. Eggs were checked daily and with that water parameters were logged daily. This data gave a baseline for comparing the differences between the habitat juvenile WRCS have access to currently (below the dam) and their historical habitat. Some of these metrics can be recorded with Onset® HOB0 loggers but physically observing the eggs in real time gave more opportunity for descriptive quantitative data. A major limitation of Heath Trays was their sensitivity to water flow. Any loss of irrigation pressure could compromise the entire stack, potentially resulting in complete loss. The labor from installation and extraction of Heath Trays was greater and required several days of work.

HPB's are considered to have a higher survival rate and offer a much more hands-off approach to rearing WRCS. This could be a benefit in reallocating the personnel down river to aid in a more intensive trap maintenance regiment. HPB's could be installed and removed within a day, while staked into the riverbed, the RSIs went undisturbed by predators or members of the public. Due to the fragility of the eggs inside HPB's handling was limited. In 2024, eggs were checked daily, and any egg mortality was removed from the system. In 2025, eggs were checked once weekly, and sometimes once every two weeks. Therefore, there is a possibility that egg mortality in the HPB's could deteriorate before the next check, thus it would not have been counted. It's also difficult to determine whether the reported number of eggs delivered was accurate, as the sum of dead eggs and released fry did not equal the delivery total. This makes it difficult to deduce which method is more effective. The small cobble layer inside the HPB mimics that of a natural redd allowing eggs to settle. Over handling this compartment could crush eggs, so dead eggs or alevins may have deteriorated by the time the next check came. In the future, having a better method for tracking egg counts and live fry could greatly improve the understanding of survival.

Since the project's inception, an environment has been established to foster the development of innovative tools to advance salmon conservation and reintroduction. Various methods of remote site incubation have been tested, providing tangible evidence of their efficacy and performance on the McCloud system. While the IPT has been used in previous monitoring

efforts, this one was specifically designed for the McCloud River and performed exceptionally well in areas where IPTs on other rivers have faced challenges, such as high debris load. In the 2025 season, the IPT produced consistent trap efficiency results. Throughout the season the average trap efficiency expanded the window of success shown in the 2024 season. A major benefit of the partnership with WWT is the incorporation of Traditional Ecological Knowledge (TEK) into the trap configuration. Rather than designing refugia for fish within the IPT, the approach leveraged natural habitat used by fish within the river system. Numerous new projects aimed at increasing rearing habitat for juvenile WRCS have focused on planting willows along riverbanks to combat erosion and provide critical habitat for the species. In addition, UCD has developed a hands-off fish measuring device in hopes to decrease fish stress through processing. All contributing agencies push the group to reject complacency and continue to find new ways of thinking about salmon reintroduction.

The final efficiency trial was held with 30 feet of river unobstructed with a minimal effect on overall capture. Furthermore, fish released further upriver proved to have a higher capture efficiency than fish released just upstream from the trap. Out-migrating Chinook tend to select a migratory corridor when moving down stream before holding in cover for the day (Rosario et al 2013). Juvenile Chinook are not equally distributed in a watershed while they out-migrate but instead select for these migratory corridors where they can out-migrate the system impinged. There were also several other culminating factors that boosted capture efficiencies, such as increasing fish size, outmigration of predator species in the McCloud River system, and increased turbidity. More studies on predation, residency, holding patterns, and survival rates could greatly improve the understanding of how to raise WRCS above Shasta Dam. There were 93,000 eggs delivered to AhDiNa Campground in the 2025 season, but roughly 76,000 fish never made it to the trapping site downstream. The McCloud River system, also, offers a steady supply of invertebrates, prey that many juvenile salmonids seek out, so more studies on invertebrate populations could also be beneficial.

In addition to larger, tangible debris within the McCloud River system, there are heavy amounts of microscopic, suspended debris throughout the water column. This generates the glacial hue that the McCloud River is known for. Most Piscivorous fish, bird, and mammal species are reliant on visuals to detect prey. This has an impact on the physiology and behavior of juvenile chinook. More fish tend to be more dispersed in the water column instead of

displaying cover seeking tactics which promotes an overall quicker migration rate (Gregory 1998). This is suspected to have aided fish in the McCloud River system, more specifically the second release group (released September 26th).

Upstream of AhDiNa campground sits Lake McCloud. Despite obtaining optimal water conditions (high dissolved oxygen levels and cold water) for juvenile WRCS rearing, the Lake McCloud dam does play a pivotal role in the future of WRCS reintroductions to the McCloud River system. The hydroelectric dam was built in 1965 and since then few adaptations have been made to improve both its operation and efficiency, as well as improve the water quality that is released into the lower McCloud River. The dam does not utilize a Temperature Control Device (TCD). Water is pulled from the upper half of the water column. Despite having access to much colder water at greater depths in the lake. Colder water is also synonymous with higher dissolved oxygen levels. Both key factors in the Chinook Salmon reproductive suitability index. Inputting a TCD could create an even greater success for a reintroduced WRCS population and bolster overall salmonid populations in the McCloud River.

A true representation of the adult fish cannot be produced by trap results due to their ability to swim freely in and out of the trap. Both trout and bass species were observed doing this behavior while smaller fish were trapped inside due to high velocities pushing them back into the back of the FrySCOOPER. This most likely led to an unknown number of predatory events as both species are known to predate upon juvenile chinook. Most trout caught in the IPT were categorized into two groups: young of the year, or adults running up the river to spawn. Most adult trout caught in the trap could be categorized as pre-spawn or post-spawn individuals during the trapping season. Despite only 9% of captured bass having confirmed WRCS in their stomach, there was likely more predation taking place out in front of the trap. There were schools of up to 330 bass observed directly in front of the trap. To alleviate this predation pressure, panels were raised ~7" off the bottom of the river to allow for passage beyond the IPT. In the future, more studies could help to understand how weir impacts predation. Other monitoring efforts depending on the objective, use RSTs, which better manage debris load, high velocities, and predation. However, RSTs host on average a three to five percent capture efficiency. The project's objective is less focused on monitoring and more focused on capture, and for this reason, RSTs were not as effective.

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ABBREVIATIONS

(BB) Bismark Brown dye
(CDEC) California Data Exchange Center
(CDFW) California Department of Fish and Wildlife
(CFS) Cubic Feet per Second
(CWS) Center for Watershed Science
(DWR) Department of Water Resources
(ESU) Evolutionary Significant Units
(FPS) Feet Per Second
(GPM) Gallons Per Minute
(HPB) Hatch Partner Box
(IPT) Incline Plane Trap
(JSCS) Juvenile Salmon Collection System

(LSNFH) Livingston Stone National Fish Hatchery
(mm) Millimeters
(NMFS) National Marine Fisheries Service
(NOAA) National Oceanic Atmospheric Administration
(NPS) National Park Service
(NTU) Nephelometric Turbidity Units
(PSMFC) Pacific States Marine Fisheries Commission
(RSI) Remote Site Incubator
(TEK) Traditional Ecological Knowledge
(UC) Upper Caudal clip
(UCD) University of California Davis
(UCSC) University of Santa Cruz
(USBR) United States Bureau of Reclamation
(USFWS) United States Fish and Wildlife Service
(WRCS) Winter Run Chinook Salmon
(WWT) Winnimem Wintu Tribe

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