Final

DOWNSTREAM JUVENILE FISH PASSAGE MONITORING VIA ROTARY SCREW TRAPS

Annual Report

Prepared for

US Army Corps of Engineers

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Acronyms and Abbreviations

AICc	Akaike Information Criterion
AQI	Air Quality Index
BBY	Bismarck brown dye
Big Cliff	Big Cliff Dam
BiOp	Willamette Project Biological Opinion
BPA	Bonneville Power Administration
BY	Brood Year
CI	Confidence Interval
cfs	cubic feet per second
CFS/Cramer	Cramer Fish Sciences
Cougar Dam HOR	Cougar Dam Head of Reservoir
Dexter	Dexter Dam Tailrace
EAS	Environmental Assessment Services, LLC
ESA	Endangered Species Act
Fall Creek HOR	Fall Creek Head of Reservoir
Fall Creek TR	Fall Creek Dam Tailrace
Foster HOR	Foster Dam Head of Reservoir – South Santiam River
Green Peter TR	Green Peter Tailrace – Middle Santiam River
HOR	Head of Reservoir
Lookout Dam HOR	Lookout Dam Head of Reservoir
Lookout Dam TR	Lookout Dam Tailrace
NMFS	National Marine Fisheries Service
NOR	Natural Origin
ODFW	Oregon Department of Fish and Wildlife
PH	Powerhouse
PIT	Passive Integrated Transponder
PNNL	Pacific Northwest National Laboratory
PTAGIS	PIT Tag Information System
RO	Regulating Outlet
ROR	Run of River
RPA	Reasonable and Prudent Alternative
RST	Rotary screw traps
TE	Trapping Efficiency
US	United States
USACE	US Army Corps of Engineers
USGS	US Geological Survey
UWR	Upper Willamette River
VIE	Visible Implant Elastomer
WVP	Willamette Valley Project

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1 Rotary Screw Trap Program Annual Report

1.1 Introduction

The US Army Corps of Engineers (USACE) operates 13 dams in the largest five Willamette River tributaries for flood risk management, irrigation, recreation, and hydropower. Major habitat blockages of Upper Willamette River Chinook salmon and winter steelhead resulted from dam construction circa 1952 from Big Cliff and Detroit Dams on the North Santiam River, Cougar Dam on the McKenzie River, Hills Creek Dam and Dexter/Lookout Point Dam on the Middle Fork Willamette River, and circa 1967 from Green Peter Dam on the Middle Santiam River (NMFS 2008a). High-head, flood risk management dams in Oregon's Willamette River basin are operated differently than the run of river (ROR) projects on the Columbia and Snake Rivers. Willamette basin dams are in tributaries rather than on the mainstem, and many have no upstream or downstream fish passage facilities (Myers et al. 2006; NMFS 2008b). The National Marine Fisheries Service (NMFS) worked with the USACE, the US Bureau of Reclamation, and the Bonneville Power Administration (BPA) to evaluate the impact of the Willamette Valley Project (WVP) on the Endangered Species Act (ESA) listed salmon and trout by developing the 2008 Willamette Project Biological Opinion (BiOp; NMFS 2008b). In the BiOp, NMFS identified a Reasonable and Prudent Alternative (RPA) that set forth specific actions in which the Action Agencies could implement to satisfy their legal obligations under the ESA to "…avoid the likelihood of jeopardizing the continued existence of the ESA-listed species or the destruction or adverse modification of their designated critical habitat" (NMFS 2008b).

In 2018, the Action Agencies reinitiated ESA consultation with NMFS on the effects of the WVP to ESA-listed species and their critical habitat. In 2020, the USACE, BPA, and NMFS identified and agreed to implement a suite of interim measures, in addition to the measures in the RPA, to benefit ESA-listed salmonids in the Willamette until the reinitiated consultation is completed. Broadly, the interim measures were intended to improve water quality and downstream passage of juvenile salmonids.

In September 2021, the US District Court for the District of Oregon issued an Interim Injunction Order directing the USACE to implement certain interim injunctive measures to improve fish passage and water quality at several WVP dam sites to benefit Upper Willamette River Spring Chinook salmon and winter steelhead. These interim injunctive measures replaced some of the prior interim measures and continued others. This study, in conjunction with other efforts, evaluated the biological effects of these measures that were implemented starting in fall 2021 on downstream passage of emigrating juvenile Chinook salmon (e.g., timing, size at migration, and natural production) and compared them to similar sampling that occurred prior to their implementation.

Rotary screw traps (RSTs) were used in accordance to established methods (Keefer et al. 2012, 2013; Romer et al. 2013–2016) to aid and understand the effects of downstream fish passage through the reservoirs and dams in rivers upstream of Detroit, Green Peter, Foster, Cougar, Fall Creek, Lookout Point, and Hills Creek reservoirs, and in the tailraces of Big Cliff, Green Peter, Cougar, Fall Creek, Dexter, Lookout and Hills Creek Dams.

These traps were used to carry out the objectives of the project, which include the collection of length and weight data of natural-origin (NOR) juvenile salmonids passing through WVP reservoirs, migration timing, evaluating juvenile salmonids for presence of injuries, gathering information on relative abundance of incidental fish species, assessing post-collection mortality, and to provide data to compare to previously collected information from RSTs operating prior to the commencement of the injunction measures described above. At sites where trapping efficiency (TE) trials provided sufficiently robust results, an objective of the RSTs was to estimate the abundance of out-migrating juvenile salmonids.

Previous RST sampling was conducted by Cramer Fish Sciences (CFS) at certain sites through November 2021 to meet interim injunctive measure requirements (CFS 2023a) and the USACE at Fall Creek Tailrace through winter 2022. For information regarding these sampling efforts, please refer to their associated reports.

RST sampling was conducted by Environmental Assessment Services, LLC (EAS) for the USACE under EAS base contract W9127N19D0007 at the following locations: Big Cliff Dam Tailrace, Green Peter Dam Tailrace, Foster Head of Reservoir – South Santiam, Cougar Dam Tailrace, Cougar Head of Reservoir, Fall Creek Dam Tailrace, Fall Creek Head of Reservoir, Dexter Dam Tailrace, Lookout Dam Tailrace, Lookout Point Head of Reservoir, and Hills Creek Dam Tailrace in 2023. Additionally, EAS performed RST sampling in 2023 for CFS under contract W9127N19D0009 at the following sites: Breitenbush River, Detroit Head of Reservoir – North Santiam River, Big Cliff Dam Tailrace, Green Peter Head of Reservoir – Middle Santiam River, Green Peter Dam Tailrace, Cougar Dam Tailrace, Fall Creek Dam Tailrace, Dexter Dam Tailrace, Lookout Dam Tailrace, Lookout Point Head of Reservoir, Hills Creek Dam Tailrace, and Hills Creek Head of Reservoir. Results for sampling at these sites can be found in the associated reports (EAS 2024 and EAS 2024a).

This report was written by EAS for CFS under contract W9127N19D0009-W9127N23F0009. Sampling of all RSTs from January 1, 2024, through December 31, 2024, was performed by EAS as a sub-contractor for CFS under contract W9127N19D0009.

This report contains a compiled summary and analysis of the field study implemented by EAS for RST sampling efforts from January 1, 2024, through December 31, 2024, at the following sites: Breitenbush River, Detroit Head of Reservoir – North Santiam River, Big Cliff Dam Tailrace, Green Peter Head of Reservoir – Middle Santiam River, Green Peter Dam Tailrace, Foster Dam Head of Reservoir- South Santiam River, Cougar Head of Reservoir, Cougar Dam Tailrace, Fall Creek Head of Reservoir, Fall Creek Dam Tailrace, Hills Creek Head of Reservoir – Middle Fork Willamette, Hills Creek Dam Tailrace, Lookout Point Head of Reservoir – Middle Fork Willamette, Lookout Dam Tailrace, and Dexter Dam Tailrace.

1.2 Methods

1.2.1 Rotary Screw Traps and Sampling Sites

An RST consists of a cone with interior baffles that use the flow of the water to rotate the cone and funnel fish to a live well supported on a pontoon system. RSTs are commonly built in two sizes determined by the size of the cone's upriver opening diameter, either a 5-foot or 8-foot opening. Traps are connected to a highline cable that spans the river or river section that is being sampled and is anchored to a fixed point on either side. A block is set on the highline for the dropper to the trap to attach. A loop line running through two blocks at either anchor point is then connected to the highline block to allow for trap position adjustments along the highline. Perpendicular adjustments are achieved by changing the length of the dropper line(s) to the trap. A labelled image of an RST is provided in Appendix H: Images of Traps Sampling in Various Conditions.

Traps are predominantly set in the river thalweg or in positions likely to capture juvenile fish as they travel downstream through the sampling area. However, during times of heavy debris or high flow rates near the operational limits of the RSTs, they are positioned outside of the thalweg to prevent the trap from clogging between checks, getting damaged, and avoiding fish mortality. Traps were accessed either by wading, with inflatable kayaks, or by being pulled nearshore with the highline. The RSTs used for sampling were manufactured by E.G. Solutions. EAS used a combination of RSTs provided by USACE and procured additional RSTs as necessary to perform sampling tasks. EAS staff made minor repairs throughout the season to ensure that traps sampled efficiently and safely.

Under this contract, RSTs were operated at 15 locations in the southern Willamette River watershed: Breitenbush River, Detroit Head of Reservoir – North Santiam River, Big Cliff Dam Tailrace, Green Peter Head of Reservoir – Middle Santiam River, Green Peter Dam Tailrace, Foster Dam Head of Reservoir-South Santiam River, Cougar Dam Head of Reservoir, Cougar Dam Tailrace, Fall Creek Head of Reservoir, Fall Creek Dam Tailrace, Hills Creek Head of Reservoir – Middle Fork Willamette, Hills Creek Dam Tailrace, Lookout Point Head of Reservoir – Middle Fork Willamette, Lookout Dam Tailrace, and Dexter Dam Tailrace. Trap deployment locations at each of these sites were placed as close to historical sampling locations as possible. For sites where environmental conditions no longer allowed for a trap to sample in a historic location, an alternative site was selected in an area that allowed for safe sampling while maximizing the trap's capture efficiency. For locations of traps for sampling before and after 2021, refer to Appendix A: Locations of Rotary Screw Traps.

Below is the list of sites where traps were operated:

- A 5-foot RST operated in the Breitenbush River approximately 100 meters downstream of the first bridge. Trap operation began on February 1, 2024, and continued through November 30, 2024.
- A 5-foot RST operated at the Detroit Head of Reservoir – North Santiam River below the Cooper's Ridge Road bridge from February 1, 2024, through November 30, 2024.
- An 8-foot RST operated in the Big Cliff Dam Tailrace from January 1, 2024, through December 31, 2024.
- A 5-foot RST operated at the Green Peter Head of Reservoir – Middle Santiam River site approximately 200 meters downstream from the US Geological Survey (USGS) gaging station, from February 1, 2024, through November 30, 2024.
- An 8-foot RST operated in the Green Peter Dam Tailrace – Middle Santiam River from January 1, 2024, through December 31, 2024.
- A 5-foot RST operated at the Foster Dam Head of Reservoir – South Santiam River site from February 1, 2024, through November 30, 2024.
- A 5-foot RST operated at the Cougar Head of Reservoir site – South Fork McKenzie River, from February 1, 2024, to November 30, 2024.
- Two 8-foot RSTs in the Powerhouse (PH) channel and one 5-foot RST in the Regulating Outlet (RO) channel operated in the Cougar Dam Tailrace, from January 1, 2024, through December 31, 2024.
- An 8-foot RST operated at the Fall Creek Head of Reservoir site approximately 250 meters downstream from Dolly Varden Campground from January 1, 2024, to June 30, 2024.
- An 8-foot RST operated in the Fall Creek Dam Tailrace RO channel from January 1, 2024, through July 15, 2024, then again from October 1, 2024, through December 31, 2024.
- A 5-foot RST operated at the Hills Creek Head of Reservoir site in the Middle Fork Willamette River above Hills Creek Reservoir below the USGS gaging station, from February 1, 2024, through June 30, 2024.
- An 8-foot RST in the PH channel and a 5-foot RST in the RO channel operate in the Hills Creek Dam Tailrace from January 1, 2024, through June 30, 2024, then from September 15, 2024, through December 31, 2024.
- A 5-foot RST operated at the Lookout Head of Reservoir – Middle Fork Willamette River site at the US Forest Service Seed Farm, from January 1, 2024, through December 31, 2024.
- Three 8-foot RSTs (two in the PH channel and one in the Spill channel) operated below the Lookout Dam Tailrace from January 1, 2024, through December 31, 2024.
- A 5-foot RST operated in the Dexter Dam Tailrace from January 1, 2024, through December 31, 2024.

Maps showing trap deployment locations for each site are provided in Appendix A: Locations of Rotary Screw Traps. Sampling at various sites had to be stopped for short periods of time due to damage and environmental conditions, such as unsafe river discharge and increased flow levels, localized forest fires, severe ice storms, and incidents involving crew safety. A summary table of these outages by site is provided in Appendix B: Sampling Outages by Site. Information on trap installation and sampling periods by site is provided in Table 1.

Table 1. Rotary screw trap locations, installation dates, and sampling periods.

Site	Trap Installation	Reporting Period
Breitenbush River	01/25/2024	02/01/2024–11/30/2024
Detroit Head of Reservoir – North Santiam	01/31/2023	02/01/2024–11/30/2024
Big Cliff Dam Tailrace	05/23/2021*,‡	01/01/2024–12/31/2024
Green Peter Head of Reservoir – Middle Santiam	04/05/2023**	02/01/2024–11/30/2024
Green Peter Dam Tailrace – Middle Santiam	03/14/2023*,†	01/01/2024–12-31/2024
Foster Dam Head of Reservoir – South Santiam	01/24/2024*	02/01/2024–11/30/2024
Cougar Head of Reservoir	01/23/2024*	02/01/2024–11/30/2024
Cougar Dam Tailrace	03/24/2021*,‡	01/01/2024–12/31/2024
Fall Creek Head of Reservoir	01/01/2024	01/01/2024–06/30/2024
Fall Creek Dam Tailrace	03/15/2022*	01/01/2024–07/15/2024 10/01/2024–12/31/2024
Hills Creek Head of Reservoir – Middle Fork Willamette	01/24/2023*	02/01/2024–06/30/2024
Hills Creek Dam Tailrace	09/15/2022*	01/01/2024–06/30/2024 09/15/2024–12/31/2024
Lookout Point Head of Reservoir – Middle Fork Willamette	03/06/2022*	01/01/2024–12/31/2024
Lookout Point Dam Tailrace	03/15/2021*,‡	01/01/2024–12/31/2024
Dexter Dam Tailrace	03/03/2022*	01/01/2024–12/31/2024

* Previously monitored by EAS for the USACE under contract W9127N19D0007.
** Initiation of sampling delayed following contract award in March 2023 and permits approval.
† Initiation of sampling was delayed until a new anchor system could be installed.
‡ Previously monitored by CFS for the USACE

1.2.2 Data Collection

1.2.2.1 Fish Collection, Trap, and Environmental Metrics

RSTs were typically checked once per day unless conditions necessitated additional checks for fish or trap safety. In extreme circumstances, such as ice storms which resulted in an Oregon State of Emergency, enforcing road closures, and making travel unsafe, it was not possible to monitor and sample the RST daily. For a detailed list on RST sampling throughout the year, please see Appendix B: Sampling Outages by Site. Upon arrival at a trap site, crews collected data on cone rotation speed (time for three full cone rotations), rotation count from last check to current check, water temperature at trap, and time of fish collection. Additional environmental data was collected from HOBO temperature loggers, which were located in trap live wells, USGS gages, and USACE dam operations; data included inflow, outflow by route, water temperature, and dissolved oxygen concentration where available. Target fish species were removed from traps and transported to a safe work-up location. Non-target fish species were identified at the time of capture, enumerated, assigned a condition code (unharmed, injured, or dead), and released back into the river. Target fish were then anesthetized using a prepared Tricaine methanesulfonate solution (Syndel USA Tricaine-S) that was buffered with sodium bicarbonate (Aldon Corporation Sodium Bicarbonate) to neutralize the pH. Furthermore, these fish were anesthetized in small groups in aerated anesthetic baths made from the prepared Tricaine solution and river water. Aerated recovery tanks were set up with river water and stress coat (API Stress Coat) to allow for fish recuperation after handling. Additionally, water temperature of the anesthetic bath and recovery tanks were monitored and fully replaced if the surrounding water temperature increased 2°C. At sites located in the Santiam basin, all unmarked juvenile *Oncorhynchus mykiss* (*O. mykiss*) were treated and reported as winter steelhead.

1.2.2.2 Biological Data and Tagging

Biological data was collected for each target fish captured. At all sites, juvenile Chinook salmon that did not display any clip, tag, or dye and were presumed to be of NOR were considered target fish. Additionally, at sites in the Santiam River Basin, winter steelhead that did not display any clip, tag, or dye and were presumed to be of NOR, were considered target fish. Winter steelhead have not been out-planted above Detroit or Green Peter Reservoirs in the recent era, but sampling of *O. mykiss* is required by the injunction order. Therefore, all juvenile *O. mykiss* captured that did not display any clip, tag, or dye and were presumed to be NOR were treated as targets, as it is not possible to accurately distinguish between resident rainbow trout and anadromous steelhead trout. Hatchery rainbow trout are present at many sites and are identified by the presence of an adipose clip. Hatchery rainbow trout of harvestable size are not anaesthetized as they are considered food fish and may be harvested for consumption.

Table 2 lists all sites and the target species at each site. Data collected included species, fork length to the nearest millimeter, weight to the nearest 0.1-gram, fish condition, injuries, lifestage, and assessment for the presence of tags or other marks. Lifestage in the field was delineated as fry, parr, smolt, or adult based on morphological characteristics. In general, fry were sub-yearling fish under 50 mm fork length, parr were fish larger than 50 mm that displayed parr marks, and smolt were fish that had become silvery in appearance. This is a subjective delineation dependent on environmental conditions and life history with some overlap in lengths. A list of injury codes used for assessments is provided in Table 3. In addition to the injury codes listed, EAS also enumerated the number of adult gravid female copepods (*Salmincola californeinsis*) by attachment location (branchial cavity or fins) and assigned a value to the level of gas bubble disease observed in fish (1 to 4). Additionally, standard biological metrics were recorded from all marked Chinook captured in RSTs. These fish were then identified as those used by the *Bulk Mark Release and Reservoir Distribution Study Annual Report* (CFS 2024) or from other Willamette Valley projects.

Scales were collected from fish larger than 50 mm in fork length, and fin clips for future DNA analysis were collected from fish larger than 45 mm in fork length. Scales and fin clips were collected from nearly all fish meeting these criteria unless they were too damaged or decomposed to provide viable samples. Aged fish were then delineated as yearlings or sub-yearlings and assigned an appropriate brood year (BY) category based on the age class determined from scales and time of capture. Fish were reported as sub-yearling or yearling along with the BY they were assigned. In some cases, small sub-yearling fish are referred to as fry and large yearlings as smolt. All fish with a fork length of 65 mm or larger, not being placed in a 24-hour-hold study, were Passive Integrated Transponder (PIT) tagged (APT12 or Mini HPT8 models) and released. All PIT tag data was uploaded into PTAGIS. Appendix C: PIT Tags and VIE Tagging contains information on PIT tags and tag files. In total, EAS monitors nine sites where target species have the potential to be recaptured at another RST site further downstream. Therefore, fish that were non-sac-fry, smaller than 65 mm, and larger than 35 mm were marked with visible implant elastomer (VIE). Photos of target species encountered, and injuries were collected throughout the sampling periods and are provided in Appendix F: Example of Injury Photos.

Table 2. Summary of data collected at each RST site.

Rotary Screw Trap Sampling Site	Trap Efficiency Trials	Target Species	Biological and Injury Data	Scale and DNA Samples	24-hour Holds (post collection)	PIT Tagging (>65 mm)	Elastomer Tagging (<65 mm)
Breitenbush River	Yes, Run of River Fish, Hatchery Fish	Spring Chinook and *O. mykiss*	Yes, weight (nearest 0.1 g), F.L. (mm), Injuries	Yes	No	Yes	Yes
Detroit Head of Reservoir – North Santiam	Yes, Run of River Fish, Hatchery Fish	Spring Chinook and *O. mykiss*	Yes, weight (nearest 0.1 g), F.L. (mm), Injuries	Yes	No	Yes	Yes
Big Cliff Dam Tailrace	Yes, Hatchery Fish	Spring Chinook and *O. mykiss*	Yes, weight (nearest 0.1 g), F.L. (mm), Injuries	Yes	Yes	Yes, on fish not included in 24-hour holds	No
Green Peter Head of Reservoir – Middle Santiam	Yes, Run of River Fish, Hatchery Fish	Spring Chinook and *O. mykiss*	Yes, weight (nearest 0.1 g), F.L. (mm), Injuries	Yes	No	Yes	Yes
Green Peter Dam Tailrace	Yes, Hatchery Fish	Spring Chinook and *O. mykiss*	Yes, weight (nearest 0.1 g), F.L. (mm), Injuries	Yes	Yes	Yes, on fish not included in 24-hour holds	No
Cougar Head of Reservoir	Yes, Run of River Fish, Hatchery Fish	Spring Chinook	Yes, weight (nearest 0.1 g), F.L. (mm), Injuries	Yes	Yes	Yes, on fish not included in 24-hour holds	Yes
Cougar Dam Tailrace	Yes, Run of River Fish, Hatchery Fish	Spring Chinook	Yes, weight (nearest 0.1 g), F.L. (mm), Injuries	Yes	Yes	Yes, on fish not included in 24-hour holds	No
Fall Creek Head of Reservoir	Yes, Hatchery Fish	Spring Chinook	Yes, weight (nearest 0.1 g), F.L. (mm), Injuries	Yes	Yes	Yes	Yes
Fall Creek Dam Tailrace	Yes, Hatchery Fish	Spring Chinook	Yes, weight (nearest 0.1 g), F.L. (mm), Injuries	Yes	Yes	Yes	No
Hills Creek Head of Reservoir – Middle Fork Willamette	Yes, Run of River Fish, Hatchery Fish	Spring Chinook	Yes, weight (nearest 0.1 g), F.L. (mm), Injuries	Yes	No	Yes	Yes
Hills Creek Dam Tailrace	Yes, Run of River Fish, Hatchery Fish	Spring Chinook	Yes, weight (nearest 0.1 g), F.L. (mm), Injuries	Yes	Yes	Yes, on fish not included in 24-hour holds	Yes, on fish not included in 24-hr holds

Rotary Screw Trap Sampling Site	Trap Efficiency Trials	Target Species	Biological and Injury Data	Scale and DNA Samples	24-hour Holds (post collection)	PIT Tagging (>65 mm)	Elastomer Tagging (<65 mm)
Lookout Point Head of Reservoir	Yes, Hatchery Fish	Spring Chinook	Yes, weight (nearest 0.1 g), F.L. (mm), Injuries	Yes	No	Yes	Yes
Lookout Dam Tailrace	Yes, Hatchery Fish	Spring Chinook	Yes, weight (nearest 0.1 g), F.L. (mm), Injuries	Yes	Yes	Yes, on fish not included in 24-hour holds	Yes, on fish not included in 24-hr holds
Dexter Dam Tailrace	Yes, Hatchery Fish	Spring Chinook	Yes, weight (nearest 0.1 g), F.L. (mm), Injuries	Yes	Yes	Yes, on fish not included in 24-hour holds	No

Table 3. List of injury codes and abbreviations for injury assessments.

Description of Injury/Condition	Injury Code
Live fish with no external injuries	NXI
Mortality with no external injuries	MUNK
Descaling < 20%	DS<2
Descaling > 20%	DS>2
Bloated	BLO
Bloody eye (hemorrhage)	EYB
Bleeding from vent	BVT
Fin blood vessels broken	FVB
Gas Bubble Disease (fin ray/eye inclusions)	GBD
Pop eye (eye popping out of head)	POP
Head injury	HIN
Opercle Damage	OPD
Body injury (tears, scrapes, mechanical damage)	TEA
Bruising (any part of body)	BRU
Hole behind pectoral fin	HBP
Head only	HO
Body only	BO
Head barely connected	HBO
Fin damage	FID
Predation marks (vertical claw or teeth marks)	PRD
Copepods (on gills or fins)	COP
BKD (distended abdomen)	BKD
Fungus	FUN

1.2.3 Trapping Efficiency Trials and Approach

1.2.3.1 Approach

Hatchery reared Chinook salmon were utilized for TE trials because catch of ROR fish was frequently insufficient to perform effective trials. However, due to finite hatchery fish availability and inconsistent catch of ROR fish for TE trials, EAS attempted to use a flow-based TE model approach to evaluate the efficiency of each trap at the start of this project in late 2021. EAS chose this approach because water flow has been shown to be a dominant factor affecting TE in multiple RST out-migrating juvenile salmonid studies (Cheng and Gallinat 2004; Dambacher 1991; Rayton and Wagner 2006; Volkhardt et al. 2007; Voss and Poytress 2020).

Additionally, EAS anticipated it would take a substantial amount of time to perform enough TE trials to model a single variable, so EAS initially focused on flow. As a rule of thumb, sample sizes of approximately 30 are needed to provide enough information to make a statistically sound conclusion to model a single variable. In regression analysis with one independent variable, having an adequate sample size is crucial to ensure the reliability and generalizability of the results. This sample size is recommended for several reasons such as having enough statistical power, meeting normality assumptions, having robustness against outliers, reduction in standard error, and applicability to larger populations from the samples. This is well documented in statistical literature. For example, Montgomery et al. (2012) emphasizes the importance of sample size in ensuring the validity of regression results. When additional variables are included in the regression model, it is generally recommended to have more samples to maintain statistical power and reliability. A general rule of thumb is that at least 10 more samples per additional variable helps to account for the increased complexity of the model and the potential for overfitting. This ensures that there are an adequate number of observations for each predictor variable, which improves the stability and generalizability of the regression results (Cohen et al. 2003; Hair et al. 2019).

In addition to flow, we collect data on other variables with the intent to use them to improve TE estimates. EAS has investigated alternative variables such as brood year, lifestage, size, trap cone revolutions, and the volume flow across the submerged portion of an RST cone at select sites. Through 2023 EAS focused on obtaining enough TE trials to determine associations or lack thereof with potential environmental and biological covariates. In 2024 it was determined that a sufficient number of TE trials had occurred to begin relating TE to flow conditions at the different sampling sites. To accomplish this, an analysis was conducted that investigated the relationship between discharge (or gage height when necessary) and trap cone revolutions to TE at each site individually (see EAS 2024c and Appendix E: Trap Efficiency Plots). Results from the analysis suggested a good fit for discharge to TE at some sampling sites but not all. Median fork length has been incorporated as an additional covariate in an updated analysis to refine the relationship between TE and environmental and biological factors. Some sites were determined to not be appropriate for a TE analysis due to operations or unusually low trap efficiency estimates. As more data is collected from additional TE trials EAS plans to investigate the relationship between TE and model covariates in more depth. Specifically, future analysis will incorporate the proportion of discharge sampled, as this covariate has been found to have a strong relationship with TE in large streams (Voss and Poytress 2020). A full description of analysis methods, results, and future modelling plans is available in Appendix E: Trap Efficiency Plots.

EAS conducted multiple trials with marked hatchery fish across a range of flows to capture the variability environmental conditions occurring throughout the sampling period. When enough ROR fish were available, captured fish were uniquely marked and released upstream of the trap. EAS also tracked trials based on size of hatchery fish used. This allowed EAS to further evaluate the differences in capture efficiency by flow, fish size, and origin. With this approach, EAS hypothesized we would be able to use historical data to supplement efficiency calculations and continue to add to data in subsequent years as more trials are performed at locations where trap locations and channel conditions did not change between the time in which the historical data was collected and current conditions.

It is important to note that RSTs are designed to capture fish actively out-migrating and generally do not capture fish that are moving upstream or rearing near sampling sites. Additionally, environmental variables such as ice storms and forest fires, biological variables related to poor water quality, decreased fish health, increased sedimentation, rapidly changing Dam operations, predators entering traps and consuming fish from trials, and other unplanned factors have subsequently led to some TE trials being unsuccessful. Many sites experience a wide range of flows throughout sampling and the performance of the RST varies widely across these ranges. During this reporting period, flow rates at some sites decreased to the point where the trap would barely spin, allowing fish to potentially avoid capture. Trials performed at these low flow rates often do not yield enough recaptures to be considered successful but provide information on the lower range of flows in which traps are effectively sampled. Furthermore, it is assumed that all fish released for

TE trials migrate downstream past the trapping site within a one-week period. Additional assumptions are provided in the subsequent TE trial sections.

1.2.3.2 Trapping Efficiency Trials

Hatchery Fish. TE was performed at all sites during 2024 using large quantities of hatchery reared Chinook salmon. To utilize TE from hatchery fish to calculate ROR passage, EAS must assume that hatchery fish and ROR fish have the same probability of being captured in an RST. When possible, EAS performed ROR fish trials to further interrogate this assumption. All hatchery fish utilized in TE trials were adipose clipped at minimum. Additional fin clips and Bismarck brown dye (BBY) were utilized at sites to differentiate fish by release location and route. Fifty fish from each trial had their fork length measured to the nearest millimeter, weighed to nearest 0.1 gram, and had injury assessments performed prior to release. Hatchery fish were collected from ODFW hatcheries in the basin. Water temperature and dissolved oxygen levels were continuously monitored during fish transportation and corrected as necessary. Upon arrival at the release site, river water was slowly mixed into transport and marking tanks to acclimate fish to the site conditions before work-up and final release. Fish were then anesthetized and marked in small batches and placed into a large tank of river water treated with stress coat to fully recover. Once recovered, fish were released in small groups across the channel being tested to discourage schooling behavior. Fish were released approximately 500 meters above the trap, or as far upstream as possible at below-dam sites if the distance from the trap to the release site was less than 500 meters. Marked fish recaptured within one week of release were considered as recaptured fish regarding the trap's efficiency. Those captured outside of the one-week period were not included in the efficiency calculation. Additionally, some fish recaptured during trapping efficiency trials were given an additional fin clip and held in the livewell overnight to provide insight into livewell retention of RST captured fish. Fish numbers placed into the livewell and then found still in the livewell upon check the next day were recorded. More data will be collected for livewell retention studies in the future and a summary of the data collected in 2024 can be found in Appendix K: 2024 Livewell Retention Study.

Run of River Fish. ROR fish were captured, differentially marked, and released upstream of the trapping sites to assess the capture efficiency of the trap. These ROR trials only occurred at locations when sufficient numbers of NOR fish were captured to allow for trials to be performed. In 2024, ROR trials were utilized at the Breitenbush River, Detroit Head of Reservoir – North Santiam River, Green Peter Head of Reservoir – Middle Santiam River, Foster Dam Head of Reservoir – South Santiam River, and Cougar Dam Powerhouse sites to supplement the hatchery fish trials and allow us to compare between hatchery and ROR capture efficiencies. Additionally, small trials of dead NOR fish were performed at Cougar Dam, Green Peter Dam Tailrace, and Hills Creek Dam Tailrace. These fish were encountered dead in the RST, differentially marked, and released upstream of the trapping sites to assess dead fish TE. At the Cougar Dam site, ROR TE trials were performed when sufficient numbers of NOR fish were being collected weekly to allow for enough fish to be released so that at least five recaptures would occur. For fish used in trials, data was collected on captured fish as normal, fish were then tagged and marked with a caudal clip that alternated weekly between the lower or upper lobe and then were released approximately 500 meters upstream of the trap. Releases occurred on the same day fish were originally collected from the RST. Marked fish recaptured within one week of release were considered as recaptured fish regarding the trap's efficiency. Those recaptured outside of the one-week period were not included in the efficiency calculation. A summary of TE trials performed at each site are provided in subsequent results and discussion sections.

1.2.4 24-Hour Post-Capture Holding Trials

At Big Cliff Dam Tailrace, Green Peter Dam Tailrace, Cougar Dam Tailrace, Fall Creek Dam Tailrace, Dexter Dam Tailrace, Lookout Dam Tailrace, and Hills Creek Dam Tailrace, the first 60 NOR juvenile Chinook salmon (or *O. mykiss* where applicable) were held for 24 hours to assess post-capture or delayed mortality. Biological data was collected on captured fish per normal protocol as described in the Biological Data and Tagging subsection. Fish placed in the hold trial were not PIT tagged or VIE marked to not bias the delayed mortality study. After work-up and recovery, the first 60 ROR fish captured each week were placed into a holding tank. Where applicable, fish passing through a RO or spill route were prioritized for hold. At most sites, hold tanks were created using perforated buckets that were attached to the traps so that fish could be held in low densities (less than 0.22 kg of fish per 3.8 L of water) in the river. At Cougar

Dam, two large holding tanks were set up with constant water inflow from the river. Fish were held within these tanks in perforated buckets to allow for fish sorting by size and route. After the 24-hour holding period, live fish were enumerated and released at their capture site. Mortalities were enumerated and processed for injury/biological data again. It is important to note that a control was not included in the hold trials. Other groups that have performed similar studies in the Willamette basin observed high mortality rates of wild juvenile Chinook salmon after being captured (Herron et al. 2018). Mortality rates from this study reflect the combined effects of previous fish health conditions at the time of passage, passage effects, handling, and holding at the trap site.

1.2.5 Data Analysis

1.2.5.1 Passage Estimates

Catch Evaluations. Where possible, daily catch rates were standardized to 24-hour sampling intervals based on trap start and stop times (time between trap checks). At Cougar Dam PH, Cougar Dam RO, and Hills Creek Dam PH, raw daily catch numbers were used. At those three locations, operations frequently cycled within 24 hours (i.e., the RO cycles regularly during a fish passage operation, but the trap samples the entirety of the operation between checks) and resulted in discrete flow time windows the traps sampled between checks. Due to RST operations in these situations, standardization of catch was not necessary, and an alternative equation was used. Refer to equations detailed below.

Operations cycled at other sites, such as Big Cliff, but those traps were in the tailrace and experienced continuous flow, allowing EAS to standardize catch to 24-hour periods. Across all sites for this reporting period, RSTs were fished a total of 5,992 start/stop times with an average duration of 24.17 hours between checks (standard deviation of 6.0 hours). Trap sampling time between checks ranged from 1.0 to 146.7 hours. In almost all instances (>99%) traps were fished overnight, but due to logistics, trap checks occurred at various times the following day. This resulted in sampling duration that included overnight effort ranging from approximately 15 to 34 hours. In a few instances (n=13) traps were not fished overnight, typically during high flows due to safety concerns, or debris clogging issues classified as weather event checks and subsequently excluded from analysis. Furthermore, an ice storm in January prevented crews from being able to access trap sites and resulted in traps sampling between 40 and 146 hours between checks. Additionally, data was excluded (<3%) from further analysis if a trap was not functioning upon arrival, typically due to debris clogging or cones grounding out and stopping. Adjusted daily catch was calculated with the following equation:

$$c_{adj} = c^*\{(T_e - T_s)/24\}$$

where:

c_{adj} = Daily catch adjusted to 24 hours
c = number of fish captured between traps start and stop
T_s = Daily trap start time
T_e = Trap check time the following day.

Weekly standardized catch was calculated from the standardized daily catch rates.

$$c_w = \sum c_{adj} *(7/D_f)$$

or

$$c_w = \sum c *(7/D_f)$$

where:

c_w = Adjusted weekly catch
$\sum c_{adj}$ = Weekly sum of adjusted daily catch
$\sum c$ = Weekly sum of raw catch at locations that had discrete flows
D_f = Days fished in a week.

1.2.5.2 Abundance Estimates of Out-Migrating Target Species

Building on the previous work in the area conducted by Keefer et al. (2013), Romer et al. (2012–2017), and CFS (2023), we calculated trap capture efficiency by marking hatchery Chinook salmon for each TE trial. Fish were released upstream ~500 m from the trap, or as far upstream as possible at the below-dam sites. Fish for TE releases were uniquely marked for each trial individually or in combination with PIT tags, fin clips (adipose, vent right or left, and caudal upper or lower), and BBY staining. Unique marking was especially important for sites (e.g., Hills Creek RO) where captured fish could have traveled from two routes to the trap or when second trials occurred within the recapture window of a week. Recaptured fish were recorded, and weekly abundance estimates made based on the hatchery TE trials for each trap. Weekly abundance estimates for outmigration were calculated by using equations modified from Romer et al. (2016).

$$N_{mf} = c_w / e_{mf}$$
and
$$e_m = r/m$$

where:

- N_{mf} = weekly estimated out-migrants, based on flow levels (low, medium, and high) where possible.
- C_w = adjusted weekly catch
- e_m = average measured trap efficiency, based on flow levels (low, medium, and high) where possible
- r = number of recaptured marked fish
- m = number of marked fish released.

Determining trap efficacy is problematic and likely a large source of error with RST research in this area, especially at sites with wide and/or deep flow channels (e.g., below Lookout Dam). Ideally, ROR TE trials would be conducted weekly, but previous work in the area has shown that releasing enough RST captured fish to obtain the minimum of five recaptures to calculate TE is problematic at most locations. Unfortunately, it is unrealistic to perform weekly trials at sites with hatchery fish as there are not enough fish available for this purpose.

Hatchery TE trials (except when trap was non-functional) were pooled to calculate an average TE and 95% confidence intervals (CI) based on the standard deviation.

CIs were calculated at alpha 0.05 level based on the TE trials for each flow range (when possible).

$$N_{95} = c_w / e_{95}$$
and
$$e_{95} = e_m\ (\alpha * s * n)$$

where:

- N_{95} = estimated 95% weekly CI for out-migrants
- C_w = adjusted weekly catch
- e_{95} = upper and lower 95% TE CI
- α = 0.05 level of significance
- s = standard deviation of trap efficiency trials for a given site/route
- n = number of trap efficiency trials for a given site/route

Weekly passage was not estimated for the corresponding project week if the trap was out of operation for five consecutive days due to any of the following conditions: low flow preventing the trap from spinning, cone raised due to dangerously high flows or debris volume, access blocked due to weather or wildfire, or a requested non-sampling period. Table H-1 in Appendix H: Images of Traps Sampling in Various Conditions, details sampling constraints due to high flows and other factors. If TE criteria were not met (i.e., five TE fish recaptures per release) for a particular site, those trials were not used for any calculations.

Furthermore, in some instances (e.g., Lookout Tailrace) TE is so low that most trials are not successful even with releases as high as 4,000 fish. At the Lookout Dam Tailrace, the PH traps were sampled in their historic locations until September 5, 2023, when they were moved to sample side by side in order to alleviate crew safety concerns. It was anticipated that this reconfiguration of the traps would provide similar or improved results in regard to capture efficiency. Lookout PH had multiple TE releases of 4,000 fish, yet few of those TEs were found to be successful (both pre and post PH trap reconfiguration).

1.2.5.3 Brood Year

A subset of scales collected from juvenile Chinook salmon (and *O. mykiss* in Santiam basin sites) were mounted and read to determine the age of collected fish. Scales were read for at least 10% of the total catch for each site. Scale readers were provided with samples labelled with a unique identification number, location of capture, and date of capture. Fish length and weight were not included to not bias the reader. Scale readers would classify samples as either yearlings or sub-yearlings. Each sample was read by two individuals, independently. For samples with conflicting age classifications based on independent scale reads, a third read was performed by another reader. Additionally, a random subset of samples was read a third time to confirm age classifications. Fish age classes were then correlated back to individual fish using the unique identification number and used to determine BY for size class of fish throughout the year. BY determinations were made by considering all information gathered for the fish, including length, date of capture, and age classification.

When aged samples for subsets of total catch show clear size delineations by BY, size metrics will be reported by BY. In some instances, such as Big Cliff Dam out-migrants, significant overlap in size ranges between multiple BYs of fish are observed. Without being able to age every fish captured and verify age, it is not appropriate to report summary metrics for size by BY. In these instances, we will report size metrics for the overlapping BYs together to provide information on the fish out-migrating during that time period as a whole.

1.2.5.4 Trapping Injuries

To provide additional insight for injuries associated with handling and capture in a RST, injury data was collected on hatchery fish being released for TE trials before release and after capture. Injury rates by type pre and post capture were then compared to determine a rate of injury occurrence attributable to trap capture. This data was compiled for each below dam site for hatchery fish captured since 2021. This data is available in Appendix D: Additional Injury Information.

Through ongoing data collection and monitoring, EAS has found that NOR Chinook and *O. mykiss* typically illustrate signs of injury that are associated with dam passage and RST capture. Similar yet distinct observations show that fish utilized in TE trials present injuries associated with hatchery rearing and RST capture, while bulk marked released fish exhibit injuries related to hatchery rearing, dam passage, and RST capture.

1.3 Results

1.3.1 Breitenbush River

A single 5-foot RST was deployed in the Breitenbush River above Detroit Reservoir on February 1, 2024, and continued sampling until November 30, 2024.

Sampling outages resulting from high flows, excessive debris, severe weather, localized flood evacuations, and additional issues are listed in Appendix B: Sampling Outages by Site. Non-sampling periods illustrated in the figures below are further detailed in Appendix B: Sampling Outages by Site. It is important to note that previous sampling efforts in the Breitenbush River occurred at a sampling site downstream of the current location (see Appendix A: Locations of Rotary Screw Traps). Due to damage from the 2020 wildfires, resulting in the surrounding area being compromised, EAS was unable to utilize the previous, historic sampling location. The RST sampling location was relocated upstream to a new location approximately 200 meters downstream from the first bridge for sampling beginning in 2023.

1.3.1.1 Trapping Efficiency Trials

A total of 11 TE trials occurred at the Breitenbush River in 2024 using hatchery reared Chinook salmon. Collectively, 19 TE trials have occurred at this site since June 2023. A summary of the fish release numbers, recaptures, and flow level for each trial is provided in Table 4.

TEs ranged from 0.9% to 20.3%, with a pooled average of 6.3% (95% CI ± 2.7%, n=19) across all successful trials with five or more recaptures. Trap efficiency analysis identified the full model—incorporating weekly average discharge, average trap revolutions per hour, mean fork length, and interactions among these covariates—as having the highest pseudo R^2 (0.84, n=17), indicating a strong fit to the data. However, this model had the second-highest AICc score, suggesting that while the additional covariates and interactions improved the fit, the improvement may not justify the added complexity compared to simpler models. Regardless, these findings suggest that environmental conditions and fish size influence trap efficiency at this site. Detailed methods and full results of the trap efficiency modeling are provided in Appendix E: Trap Efficiency Plots.

Table 4. Summary table of marked hatchery Chinook salmon releases at the Breitenbush River RST site for trapping efficiency.

Release Location	Date of Release	cfs at Release	Number of Fish Released	Number of Fish Recaptured	Percent Efficiency
Breitenbush River	06/21/2023	231	749	53	7.1%
Breitenbush River	07/06/2023	173	763	25	3.3%
Breitenbush River	08/02/2023	133	791	12	1.5%
Breitenbush River	09/20/2023	114	756	7	0.9%
Breitenbush River	10/05/2023	131	789	18	2.3%
Breitenbush River	10/25/2023	289	750	51	6.8%
Breitenbush River	11/10/2023	578	750	152	20.3%
Breitenbush River	11/21/2023	405	900	55	6.1%
Breitenbush River	02/07/2024	730	750	15	2.0%
Breitenbush River	02/21/2024	715	750	134	17.9%
Breitenbush River	03/06/2024	540	748	78	10.4%
Breitenbush River	03/25/2024	822	243	11	4.5%
Breitenbush River	05/15/2024	819	692	9	1.3%
Breitenbush River	06/25/2024	297	752	45	6.0%
Breitenbush River	07/16/2024	188	764	18	2.4%
Breitenbush River	08/02/2024	151	684	16	2.3%
Breitenbush River	09/10/2024	122	774	11	1.4%

Release Location	Date of Release	cfs at Release	Number of Fish Released	Number of Fish Recaptured	Percent Efficiency
Breitenbush River	10/30/2024	163	786	29	3.7%
Breitenbush River	11/26/2024	750	718	120	16.7%

1.3.1.2 Run of River Trapping Efficiency Trials

Releases for ROR TE trials were pooled by month. A total of 2,382 Chinook salmon and 40 *O. mykiss* were released for ROR TE trials in 2024 (Table 5). Since September 2023, 2,525 Chinook have been released during seven ROR TE trials. TEs for ROR trials ranged from 0.0% to 12.8%, however sample sizes were highly variable ranging from 2 to 1,139 (Table 5). To account for sample size variability, monthly calculations were weighted based on sample size and then summed yielding an estimated TE for ROR trials of 4.8%. We found TE using ROR Chinook at Breitenbush River was 1.5% lower than TE using hatchery reared Chinook, however more ROR TE trials are necessary to increase the overall sample size.

Table 5. Summary table of run of river releases at the Breitenbush River site for trapping efficiency.

Release Location	Date of Release	Number of Fish Released	Number of Fish Recaptured	Percent Efficiency
Breitenbush River	September 2023	141	13	9.2%
Breitenbush River	October 2023	2	0	0.0%
Breitenbush River	February 2024	450	9	2.0%
Breitenbush River	March 2024	1,139	66	5.8%
Breitenbush River	April 2024	663	19	2.9%
Breitenbush River	October 2024	52	4	7.7%
Breitenbush River	November 2024	78	10	12.8%

1.3.1.3 Target Catch, Passage Estimates and Passage Timing

A total of 3,329 juvenile Chinook salmon and 512 juvenile *O.* mykiss were captured at this site in 2024. It is assumed that *O. mykiss* captured at this site are primarily composed of resident rainbow trout since steelhead are not transported to spawn above Detroit Reservoir. However, due to the difficulty in distinguishing between resident trout and anadromous steelhead, all unmarked *O. mykiss* were treated as target fish and reported as such.

Spring capture consisted of 3,109 juvenile Chinook salmon (93.4% of total Chinook catch for 2024) (Figure 1). Juvenile Chinook salmon catch in the spring consisted of two brood years: BY 2022 yearlings (n=29, 0.9% of total spring catch) and BY 2023 sub-yearlings (n=3,080, 99.1% of total spring catch) (Figure 2). The first BY 2023 Chinook salmon was captured on February 2, 2024, on the second day of sampling. Capture of juvenile Chinook continued throughout the sampling period. Peak spring capture of Chinook occurred in March (n=1530, 49.2% of spring catch).

A total of 220 juvenile Chinook (6.6% of total catch) were captured at this site in the fall. Juvenile Chinook salmon catch in the fall also consisted of fish from BY 2022 (n=4, 1.8% of fall catch) and BY 2023 (n=216, 98.2% of fall catch). Chinook catch occurred throughout the fall monitoring period with peak capture occurring in October (n=83, 37.7% of fall catch).

Peak passage for monitoring in 2024 occurred in March (n=1,530, 46.0% of total Chinook catch) which is consistent with observations from previous sampling efforts in which peak catch occurred in March and April (Romer et al. 2016, Figure 1). Using pooled averages of hatchery Chinook TEs, we estimate that 57,064 (95% CI: 39,986 to 99,608) juvenile Chinook salmon passed the trapping site during sampling in 2024 (Figure 1). This estimate is also similar to those created in 2016 by Romer et al. in which they reported 55,951 (95% CI ± 10,457) Chinook migrated into Detroit Reservoir from the Breitenbush River during their monitoring efforts. Monitoring efforts in 2016 were not performed after June 19th due to low flows but it was suspected that relatively few fish migrated past the site from July through December which is consistent with our observations and those from nearby locations such as the North Santiam above Detroit Reservoir.

Spring capture of *O. mykiss* consisted of 56 individuals (10.9% of total *O. mykiss* catch) with peak capture occurring in June (n=25, 44.6% of spring catch) (Figure 3). The *O. mykiss* captured at this site in the spring consisted of juveniles from three brood years: BY 2022, BY 2023, and BY 2024 (Figure 4). BY 2023 *O. mykiss* comprised the majority of the catch, with fish being captured throughout the monitoring period (n=48, 85.7% of spring catch). A single BY 2022 fish was captured on February 19, 2024, and the first BY 2024 fish was captured on June 8, 2024.

Fall capture of *O. mykiss* consisted of 456 individuals (89.1% of total *O. mykiss* catch) with peak capture occurring in July (n=382, 83.8% of fall catch). Fall capture comprised three brood years of fish: BY 2022 (n=2, 0.4% of fall catch), BY 2023 (n=34, 7.5% of total catch), and BY 2024 (n=420, 92.1% of total catch). Peak capture timing of *O. mykiss* occurred in July (n=382, 74.6% of total *O. mykiss* catch) and is similar to previous observations in timing of peak capture from sampling in 2023 (EAS 2024). The observed range of sizes within BYs suggests that there may be populations of *O. mykiss* that spawn in the Breitenbush River at different times throughout the year. A summary of fork lengths and weights for captured Chinook salmon and *O. mykiss* at this site is provided in Table 6.

Table 6. Summary of fork length and weight observed on juvenile Chinook salmon and *O. mykiss* at the Breitenbush River RST site by brood year.

Species	Date Range	BY	Number of Fish	Average F.L. (mm)	Min. F.L. (mm)	Max F.L. (mm)	Median F.L. (mm)	Average Weight (g)	Min. Weight (g)	Max Weight (g)	Median Weight (g)
Chinook	2/1/24–6/30/24	23	3,080	36.4	29	69	36	N/A	N/A	N/A	N/A
Chinook	2/1/24–6/30/24	22	29	96.7	81	147	95	13.9	5.6	105	9.5
Chinook	7/1/24–11/30/24	23	216	92.0	48	113	93	8.7	2.5	17.3	8.4
Chinook	7/1/24–11/30/24	22	4	116.8	95	140	116	17.6	9	257	17.9
O. mykiss	2/1/24–6/30/24	24	8	28.9	26	31	29	N/A	N/A	N/A	N/A
O. mykiss	2/1/24–6/30/24	23	47	101.3	33	193	90	16.6	<1	67.4	8.7
O. mykiss	2/1/24–6/30/24	22	1	270	270	270	N/A	183.0	183.0	183.0	N/A
O. mykiss	7/1/24–11/30/24	24	420	31.1	20	104	28	N/A	N/A	N/A	N/A
O. mykiss	7/1/24–11/30/24	23	34	132.6	96	165	132.5	26.1	11.1	47.9	25.8
O. mykiss	7/1/24–11/30/24	22	2	223.5	211	236	N/A	113.4	105.9	120.9	N/A

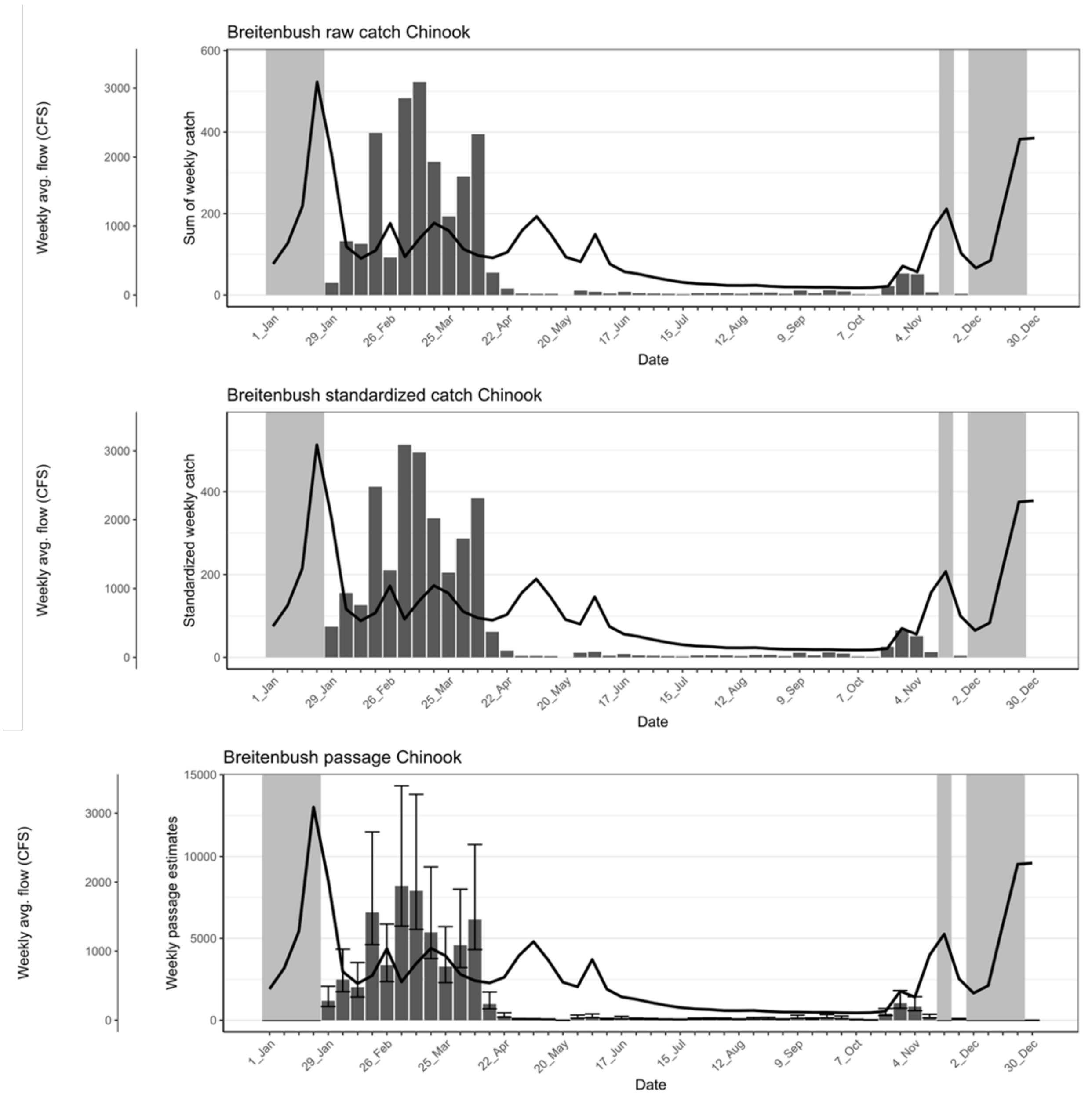

Figure 1. Raw catch (top panel), standardized catch (middle panel), and weekly passage estimates (bottom panel) of NOR juvenile Chinook at the Breitenbush River RST site overlayed with flow (black line) and non-sampling weeks shaded out (gray).

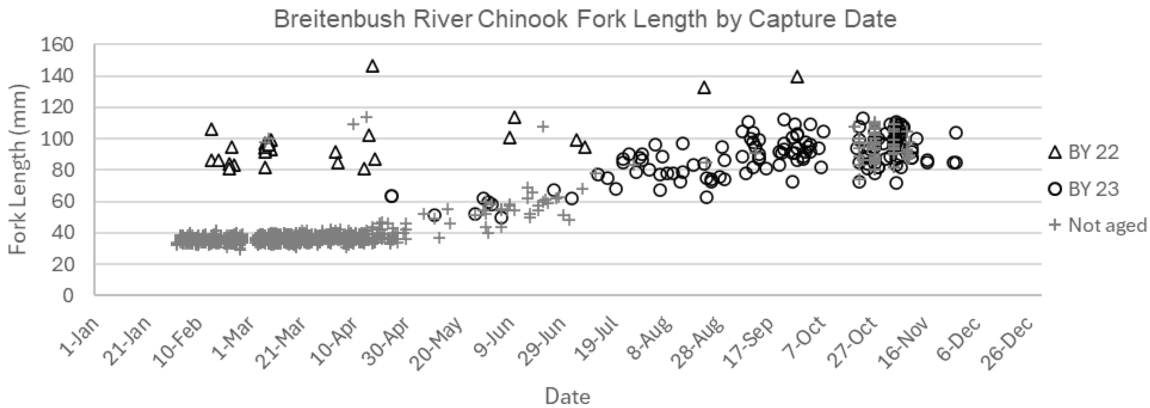

Figure 2. Length-frequency analysis for juvenile Chinook salmon at the Breitenbush River RST site.

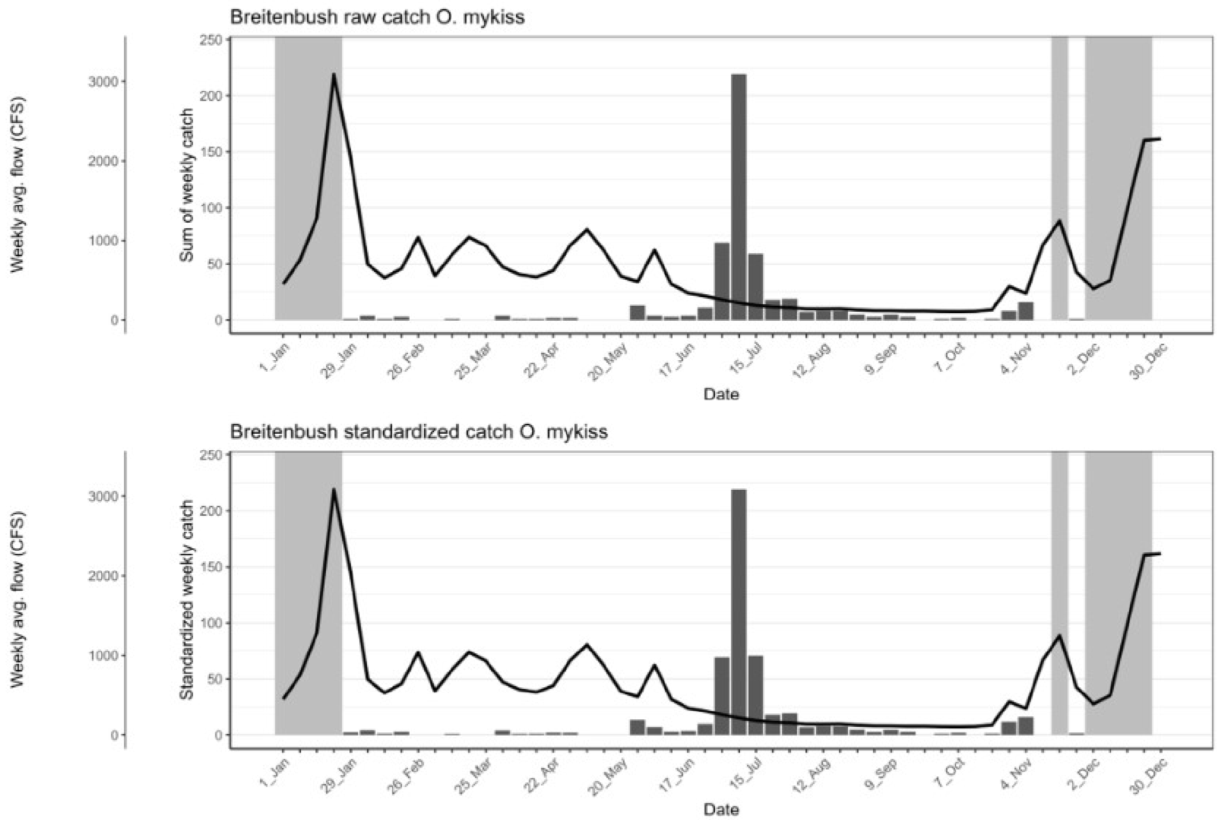

Figure 3. Raw catch (top panel) and weekly standardized catch (bottom panel) of juvenile *O. mykiss* overlayed with flow (black line) and non-sampling weeks shaded out (gray) at the Breitenbush River RST site.

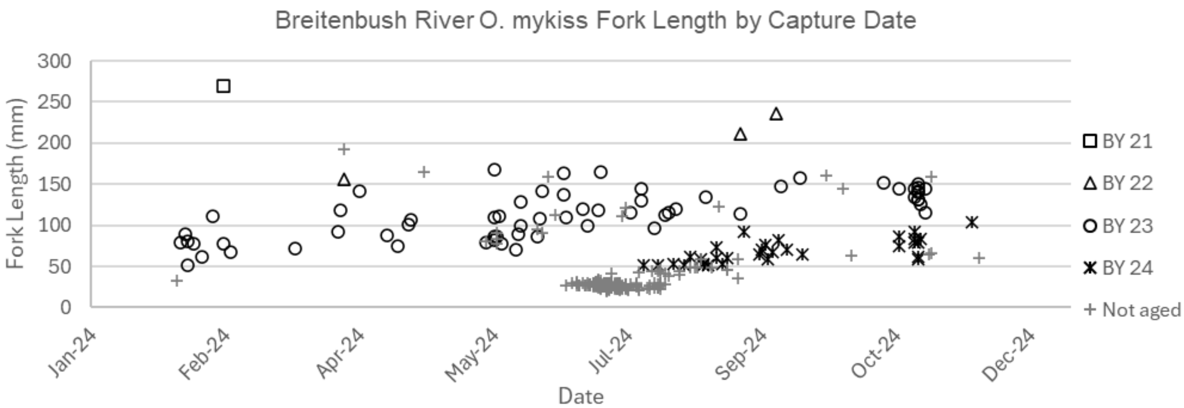

Figure 4. Length-frequency analysis by brood year for juvenile *O. mykiss* at the Breitenbush River RST site.

1.3.1.4 Injury Data

A total of 393 juvenile Chinook salmon (11.8% of total Chinook salmon catch) and 95 juvenile *O. mykiss* (18.6% of total *O. mykiss* catch) displayed at least one of the injury code conditions listed in Table 3. The most predominant injuries encountered on Chinook salmon observed at this site include fin damage and descaling less than 20% (Table 7). Descaling and fin damage injuries were likely incurred upon capture in the RST due to debris or contact with various surfaces of the trap. Most of the Chinook salmon encountered at the Breitenbush River RST were evidenced to have no external injuries (88.2%) (Table 7). Furthermore, TE hatchery Chinook were observed with higher percentages of descaling greater than and less than 20%, fin damage, and fungus when compared to NOR Chinook (Table 7). These injuries are associated with being reared in the hatchery and can be observed at all sites that EAS monitors.

Data collected on the injury rates of TE hatchery fish illustrated that both the percentage of fish with injuries and the average number of injuries per fish generally increased from pre-release to recaptured observations. Similar to NOR Chinook salmon, TE hatchery fish injuries were predominantly comprised of descaling less than 20% and fin damage (Table 7). Detailed findings on injury type are further presented in Appendix D: Additional Injury Information.

For the *O. mykiss* that had injuries present, the most predominant injuries include descaling less than 20% and fin damage (Table 7). Like the Chinook salmon encountered, these *O. mykiss* injuries were likely incurred upon capture due to the trap itself. Copepod presence on both Chinook salmon and *O. mykiss* was only observed on fish with fork lengths greater than 60 mm (Figure 5 and Figure 6). However, infection rate did not increase with the size of fish, as has been seen in many below dam sites within this report and in earlier reports completed by EAS. Copepod infection levels were found to be greater in reservoirs and therefore observed more frequently in below dam monitoring sites (Monzyk et al. 2015). Table 7 provides a summary of injuries observed on both Chinook salmon and *O. mykiss* at the Breitenbush River site. Additional information regarding injuries by size and average injuries per fish is available in Appendix D: Additional Injury Information.

Table 7. Summary of injuries observed on NOR and TE hatchery Chinook salmon, in addition to *O. mykiss* at the Breitenbush River RST site.

Injury Code	Chinook Injuries (NOR) (n=3,329)	Trapping Efficiency Hatchery Chinook (n=489)	*O. mykiss* Injuries (NOR) (n=512)
NXI (no external injury)	88.2%	3.3%	81.4%
MUNK	0.1%	0.0%	0.0%
DS<2	7.4%	80.2%	13.1%
DS>2	1.2%	9.8%	1.0%
BLO	0.1%	0.0%	0.4%
EYB	0.5%	0.4%	0.0%
BVT	0.1%	0.0%	0.0%
FVB	0.6%	0.8%	0.2%
GBD	0.0%	0.0%	0.0%
POP	1.1%	0.4%	0.2%
HIN	1.2%	1.0%	0.2%
OPD	1.5%	6.5%	1.0%
TEA	1.2%	0.4%	0.6%
BRU	1.4%	0.8%	1.4%
HBP	0.1%	0.0%	0.0%
HO	0.0%	0.0%	0.0%
BO	0.1%	0.0%	0.0%
HBO	0.0%	0.0%	0.0%
FID	5.0%	90.2%	12.1%
PRD	0.1%	0.0%	0.2%
COP	1.4%	0.0%	1.0%
BKD	0.0%	0.0%	0.0%
FUN	0.3%	15.3%	2.0%

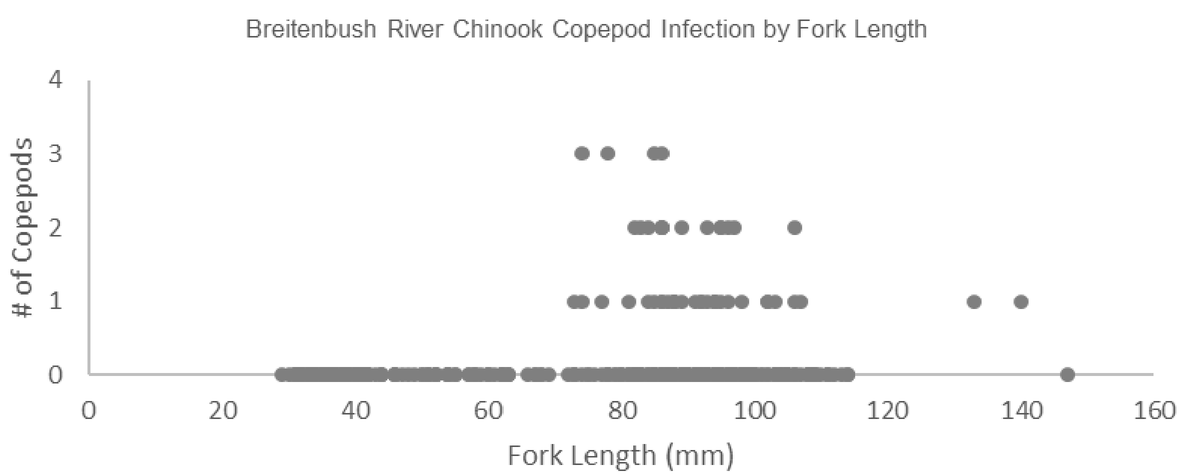

Figure 5. Copepod prevalence vs fork length on juvenile Chinook salmon captured at the Breitenbush River RST site.

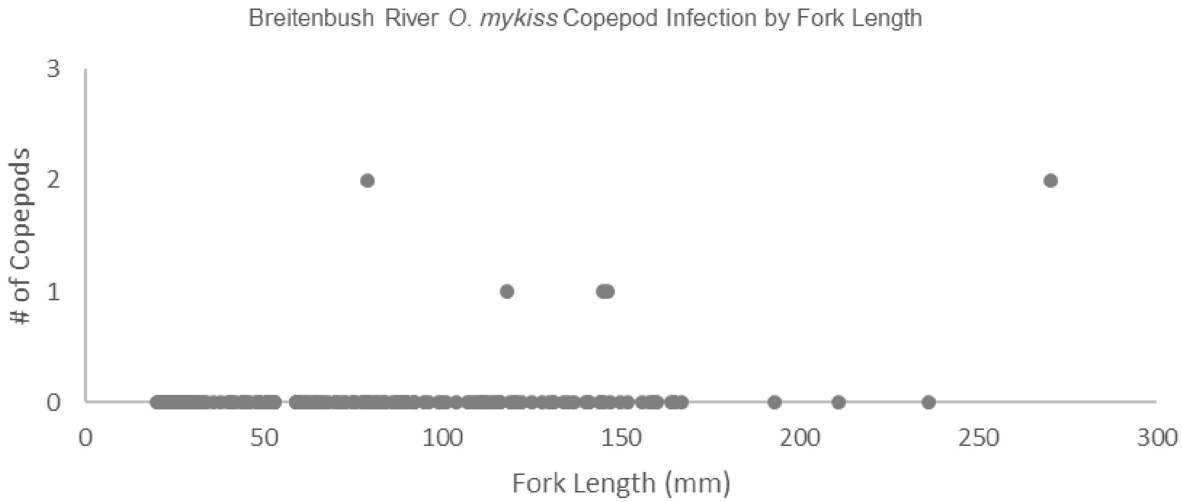

Figure 6. Copepod prevalence vs fork length on juvenile *O. mykiss* captured at the Breitenbush River RST site.

1.3.1.5 PIT Tagged and VIE Marked Fish

A total of 244 juvenile Chinook salmon and 95 juvenile *O. mykiss* were PIT tagged and released at the Breitenbush River site in 2024. Additionally, a total of 2,363 Chinook salmon and 39 *O. mykiss* were VIE marked at the Breitenbush site. Some fish were not tagged, as they were still sac-fry or too small to safely mark. None of the VIE marked fish have been detected at downstream sites. There were 5 PIT tagged Chinook and 1 PIT tagged *O. mykiss* recaptured at Big Cliff Dam Tailrace during this reporting period. The average travel time was 175.2 days (range 28 to 233 days). 1 PIT tagged Chinook was encountered at the TWX estuary array. The travel time was 46 days. A summary of downstream PIT tag detections is provided in Table 8 and a summary of VIE marked fish is provided in Table 9. More information regarding PIT tags at the RST and other sites is provided in Appendix C: PIT Tags and VIE Tagging.

Table 8. Summary of PIT tagged fish downstream redetections for the Breitenbush River RST site.

Species	PIT Tag #	Mark Date	Redetection Date	Recap Site	Travel Time (days)
Chinook	3DD.003BEE0FF3	06/21/2023	01/01/2024	Big Cliff Dam	194
Chinook	3DD.003BD397FF	10/06/2023	04/17/2024	Big Cliff Dam	194
Chinook	3DD.003BD397FC	10/06/2023	04/23/2024	Big Cliff Dam	200
O. mykiss	3DD.003E5283EC	04/04/2024	05/02/2024	Big Cliff Dam	28
Chinook	3DD.003BEE1AB2	09/13/2023	05/03/2024	Big Cliff Dam	233
Chinook	3DD.003BEE1373	10/18/2023	05/07/2024	Big Cliff Dam	202
Chinook	3DD.003E55A58E	03/25/2024	05/10/2024	TWX – Estuary Towed Array (Exp.)	46

Table 9. Summary table of VIE marked Chinook salmon at the Breitenbush River RST site.

Date Tagged	Species	Tag Location	VIE Color	# Tagged	# Recaptured
02/01/2024–02/15/2024	Chinook	Head	Yellow	126	0
02/01/2024–02/15/2024	*O. mykiss*	Head	Yellow	2	0
02/16/2024–02/29/2024	Chinook	Head	Yellow	322	0
02/16/2024–02/29/2024	*O. mykiss*	Head	Yellow	0	0
03/01/2024–03/15/2024	Chinook	Head	Red	670	0
03/01/2024–03/15/2024	*O. mykiss*	Head	Red	0	0
03/16/2024–03/31/2024	Chinook	Head	Red	541	0
03/16/2024–03/31/2024	*O. mykiss*	Head	Red	0	0
04/01/2024–04/15/2024	Chinook	Head	Blue	633	0
04/01/2024–04/15/2024	*O. mykiss*	Head	Blue	0	0
04/16/2024–04/30/2024	Chinook	Head	Blue	35	0
04/16/2024–04/30/2024	*O. mykiss*	Head	Blue	0	0
05/01/2024–05/15/2024	Chinook	Head	Orange	3	0
05/01/2024–05/15/2024	*O. mykiss*	Head	Orange	0	0
05/16/2024–05/31/2024	Chinook	Head	Orange	9	0
05/16/2024–05/31/2024	*O. mykiss*	Head	Orange	0	0
06/01/2024–06/15/2024	Chinook	Head	Pink	12	0
06/01/2024–06/15/2024	*O. mykiss*	Head	Pink	1	0
06/16/2024–06/30/2024	Chinook	Head	Pink	9	0
06/16/2024–06/30/2024	*O. mykiss*	Head	Pink	0	0
07/01/2024–07/15/2024	Chinook	Head	Green x2	2	0
07/01/2024–07/15/2024	*O. mykiss*	Head	Green x2	1	0
07/16/2024–07/31/2024	Chinook	Head	Green x2	0	0
07/16/2024–07/31/2024	*O. mykiss*	Head	Green x2	7	0
08/01/2024–08/15/2024	Chinook	Head	Yellow x2	0	0
08/01/2024–08/15/2024	*O. mykiss*	Head	Yellow x2	12	0
08/16/2024–08/31/2024	Chinook	Head	Yellow x2	1	0
08/16/2024–08/31/2024	*O. mykiss*	Head	Yellow x2	11	0
09/01/2024–09/15/2024	Chinook	Head	Red x2	0	0
09/01/2024–09/15/2024	*O. mykiss*	Head	Red x2	2	0
09/16/2024–09/30/2024	Chinook	Head	Red x2	0	0
09/16/2024–09/30/2024	*O. mykiss*	Head	Red x2	0	0
10/01/2024–10/15/2024	Chinook	Head	Blue x2	0	0
10/01/2024–0/15/2024	*O. mykiss*	Head	Blue x2	1	0
10/16/2024–10/31/2024	Chinook	Head	Blue x2	0	0
10/16/2024–10/31/2024	*O. mykiss*	Head	Blue x2	0	0
11/01/2024–11/15/2024	Chinook	Head	Orange x2	0	0
11/01/2024–11/15/2024	*O. mykiss*	Head	Orange x2	2	0
11/16/2024–11/30/2024	Chinook	Head	Orange x2	0	0
11/16/2024–11/30/2024	*O. mykiss*	Head	Orange x2	0	0

1.3.1.6 Willamette Valley Projects Encounters

There were 6 adipose clipped and PIT tagged Chinook encountered at this site in 2024. These fish were all released by the CFS Bulk Mark Release project and used for TE trials. For more information regarding bulk mark releases and detections of associated fish, refer to the *Bulk Mark Release and Reservoir Distribution Study Annual Report* (CFS 2024).

1.3.1.7 Non-Target Capture Data

A total of 45 non-target fish were captured in addition to NOR juvenile Chinook salmon and *O. mykiss* at the Breitenbush River site in 2024. The most frequently caught non-target species were sculpin and adipose clipped *O. mykiss*. A summary of non-target species is provided in Table 10.

Table 10. Summary of non-target fish capture at the Breitenbush River RST site in 2024.

Species	Season Total	Season Total Mortality (subset of total)
Juvenile Chinook (clipped)	6	0
Cutthroat Trout	2	0
Kokanee	2	0
Mountain Whitefish	1	0
O. mykiss (clipped)	10	0
Sculpin	23	6
Unknown*	1	1
Totals	**45**	**7**

*Species denoted as “unknown” were too small and/or too decomposed to identify.

1.3.2 Detroit Head of Reservoir – North Santiam River

A single 5-foot RST was deployed in the North Santiam River above Detroit Reservoir on February 1, 2024, and continued sampling until November 30, 2024.

Sampling outages resulting from high flows, excessive debris, severe weather, localized flood evacuations, and additional issues are listed in Appendix B: Sampling Outages by Site. Non-sampling periods illustrated in the figures below are further detailed in Appendix B: Sampling Outages by Site.

Additionally, the RST did not sample from November 17, 2024, to November 22, 2024, due to increased flows, which lead to a further accumulation of debris resulting in potentially unsafe capture of fish.

1.3.2.1 Trapping Efficiency Trials

A total of 11 TE trials occurred at the Detroit Head of Reservoir – North Santiam site in 2024 using hatchery reared Spring Chinook salmon. Collectively, 20 TE trials have occurred at this site since June 2023. A summary of the fish release numbers, recaptures, and flow level for each trial is provided in Table 11.

TEs ranged from 1.1% to 16.0% with a pooled average of 6.7% (95% CI ± 2.0%, n=20) of all successful trials with five or more recaptures. Trap efficiency analysis identified the model incorporating weekly discharge and the interaction between weekly discharge and mean fork length as having the highest pseudo R^2 (0.67, n=18), indicating a good fit to the data. This model also had the lowest AICc score suggesting that the simplistic model was a strong fit and that discharge and fork length influence trap efficiency at this site. Detailed methods and full results of the trap efficiency modeling are provided in Appendix E: Trap Efficiency Plots.

Table 11. Summary table of marked hatchery Chinook salmon releases at the Detroit Head of Reservoir – North Santiam River RST site for trapping efficiency.

Release Location	Date of Release	cfs at Release	Number of Fish Released	Number of Fish Recaptured	Percent Efficiency
Detroit Head of Reservoir – North Santiam River	06/06/2023	833	539	28	5.2%
Detroit Head of Reservoir – North Santiam River	06/20/2023	629	750	61	8.1%
Detroit Head of Reservoir – North Santiam River	07/06/2023	512	750	13	1.7%
Detroit Head of Reservoir – North Santiam River	08/02/2023	422	750	19	2.5%
Detroit Head of Reservoir – North Santiam River	09/06/2023	379	700	19	2.7%
Detroit Head of Reservoir – North Santiam River	10/05/2023	370	750	24	3.2%
Detroit Head of Reservoir – North Santiam River	10/25/2023	539	757	72	9.5%
Detroit Head of Reservoir – North Santiam River	11/10/2023	820	813	91	11.2%
Detroit Head of Reservoir – North Santiam River	11/21/2023	601	1,014	111	10.9%
Detroit Head of Reservoir – North Santiam River	02/07/2024	1,270	749	8	1.1%
Detroit Head of Reservoir – North Santiam River	02/21/2024	1,020	749	117	15.6%
Detroit Head of Reservoir – North Santiam River	03/06/2024	923	751	85	11.2%

Release Location	Date of Release	cfs at Release	Number of Fish Released	Number of Fish Recaptured	Percent Efficiency
Detroit Head of Reservoir – North Santiam River	05/15/2024	1,400	749	39	5.2%
Detroit Head of Reservoir – North Santiam River	06/06/2024	1,200	450	13	2.9%
Detroit Head of Reservoir – North Santiam River	06/18/2024	786	836	32	3.8%
Detroit Head of Reservoir – North Santiam River	07/19/2024	492	843	40	4.7%
Detroit Head of Reservoir – North Santiam River	08/02/2024	470	749	30	4.0%
Detroit Head of Reservoir – North Santiam River	09/05/2024	401	733	21	2.9%
Detroit Head of Reservoir – North Santiam River	10/30/2024	193	786	79	10.1%
Detroit Head of Reservoir – North Santiam River	11/15/2024	998	686	110	16.0%

* Trapping efficiency release performed by CFS

1.3.2.2 Run of River Trapping Efficiency Trials

Releases for ROR TE trials were pooled by month. A total of 15,121 juvenile Chinook salmon were released for ROR TE trials 2024 (Table 12). Since October 2023, 15,480 Chinook have been released during eight ROR TE trials at the Detroit HOR site. TEs for ROR trials ranged from 1.5% to 6.4% with sample sizes ranging from 58 to 9,059 (Table 12). To account for sample size variability, monthly calculations were weighted based on sample size and then summed yielding an estimated TE for ROR trials of 3.1%. Compared to the TE value using hatchery reared fish, TE using ROR fish was approximately 3.6% lower.

Table 12. Summary table of run of river releases at the Detroit Head of Reservoir RST site for trapping efficiency.

Release Location	Date of Release	Number of Fish Released	Number of Fish Recaptured	Percent Efficiency
Detroit Head of Reservoir – North Santiam River	October 2023	157	6	3.8%
Detroit Head of Reservoir – North Santiam River	November 2023	202	12	5.9%
Detroit Head of Reservoir – North Santiam River	February 2024	392	6	1.5%
Detroit Head of Reservoir – North Santiam River	March 2024	4,652	114	2.5%
Detroit Head of Reservoir – North Santiam River	April 2024	9,059	293	3.2%
Detroit Head of Reservoir – North Santiam River	May 2024	680	15	2.2%
Detroit Head of Reservoir – North Santiam River	October 2024	58	2	3.4%
Detroit Head of Reservoir – North Santiam River	November 2024	280	18	6.4%

1.3.2.3 Target Catch, Passage Estimates and Passage Timing

The trap captured a total of 27,536 juvenile Chinook and 305 juvenile *O. mykiss* during sampling in 2024. It is assumed that *O. mykiss* captured at this site are primarily composed of resident rainbow trout since steelhead are not transported to spawn above Detroit Reservoir. However, due to the difficulty in distinguishing between resident trout and anadromous steelhead, all unmarked *O. mykiss* were treated as target fish and reported as such.

A total of 26,858 juvenile Chinook salmon (97.5% of total Chinook catch) were captured during spring sampling in 2024 (Figure 7). Peak capture of juvenile Chinook salmon entering Detroit Reservoir in the spring occurred during April (n=13,805, 51.4% of total spring Chinook salmon catch). Chinook salmon catch from the initiation of sampling through June 30, 2023, was composed almost entirely of BY 2023 juveniles (n=26,809, 99.8% of total spring catch) (Figure 8). BY 2022 Chinook salmon were captured throughout the spring sampling period.

A total of 678 juvenile Chinook (2.5% of total Chinook catch) were captured during the fall monitoring period. Peak capture of Chinook in the fall occurred in November when 348 individuals were collected (51.3% of fall catch). Fall catch of Chinook consisted entirely of BY 2023 fish with individuals being encountered throughout the period.

The first BY 2023 sub-yearling Chinook captured at the trap occurred on the first day of sampling and the median migration date was April 13, 2024. Previous monitoring efforts observed median migration dates in May with the earliest median date of migration being April 20th (Romer et al. 2016). Peak passage of juvenile Chinook occurred in April (n=13,805, 50.1% of total Chinook catch). Sampling in 2023 was not initiated until April 21st and the resulting data showed peak capture occurring in late May. Data from 2024 shows a similar trend for capture of Chinook over same time period. Using a pooled average of the hatchery fish TEs, we estimate that 416,042 (95% CI: 318,780 to 598,710) juvenile Chinook salmon passed the trapping site in 2024 (Figure 7).

Chinook catch in the spring of 2024 was much higher than catch observed during previous efforts (Romer et al. 2016) and likely is a result of the increased number of adult outplants that occurred in 2023 as most of the Chinook captured were BY 2023 sub-yearlings. Similar observations were made during previous sampling, where increased catch of juvenile Chinook at this site appeared to be related to the number of adult females transported upstream of the reservoir (Romer 2016 et al. Table B-1). Adult Chinook out-planting numbers for 2010 through 2023 are provided in Appendix I: Adult Chinook Out-planting Above Willamette Valley Projects, Table I-1.

A total of 63 juvenile *O. mykiss* (20.7% of total *O. mykiss* catch) were captured at this site in the spring of 2024 (and Figure 9). Peak capture of juvenile *O. mykiss* in the spring monitoring period occurred in June (n=24, 38.1% of total spring *O. mykiss* catch) (Figure 9). *O. mykiss* catch in the spring consisted of four brood years: BY 2021, 2022, 2023, and 2024 (Figure 10). BY 2023 was the dominant age class captured at the site, with 40 individuals (63.5% of spring capture). A total of 1 BY 2021, 12 BY 2022, and 10 BY 2024 *O. mykiss* were also captured during this time.

Fall capture of *O. mykiss* consisted of 242 fish (79.3% of total catch) from two brood years: BY 2023 (n=4, 1.7% of fall catch) and BY 2024 (n=238, 98.3% of fall catch). A summary of fork length and weight data for Chinook salmon and *O. mykiss* captured at this site through the spring of 2024 is provided in Table 13

Table 13. Summary of fork length and weight observed on juvenile Chinook salmon and *O. mykiss* of NOR at the Detroit Head of Reservoir RST site by brood year.

Species	Date Range	BY	Number of Fish	Average F.L. (mm)	Min. F.L. (mm)	Max F.L. (mm)	Median F.L. (mm)	Average Weight (g)	Min. Weight (g)	Max Weight (g)	Median Weight (g)
Chinook	2/1/24–6/30/24	22	49	86.6	69	107	86	7.1	3.4	11.9	7.1
Chinook	2/1/24–6/30/24	23	26,809	36.6	28	72	36	N/A	N/A	N/A	N/A
Chinook	7/1/24–11/30/24	23	678	85.4	29	117	89	7.5	1.0	16.8	7.6
O. mykiss	2/1/24–6/30/24	21	1	315	315	315	N/A	309.1	309.1	309.1	N/A
O. mykiss	2/1/24–6/30/24	22	12	170.3	142	197	170	52.2	29.4	79.6	53.5
O. mykiss	2/1/24–6/30/24	23	40	72.8	34	115	74	5.9	<1	16.1	5.5
O. mykiss	2/1/24–6/30/24	24	10	30.1	22	39	28.5	N/A	N/A	N/A	N/A
O. mykiss	7/1/24–11/30/24	23	4	136.0	114	155	137.5	28.2	16.7	35.9	30.2
O. mykiss	7/1/24–11/30/24	24	238	34.7	17	82	28	N/A	N/A	N/A	N/A

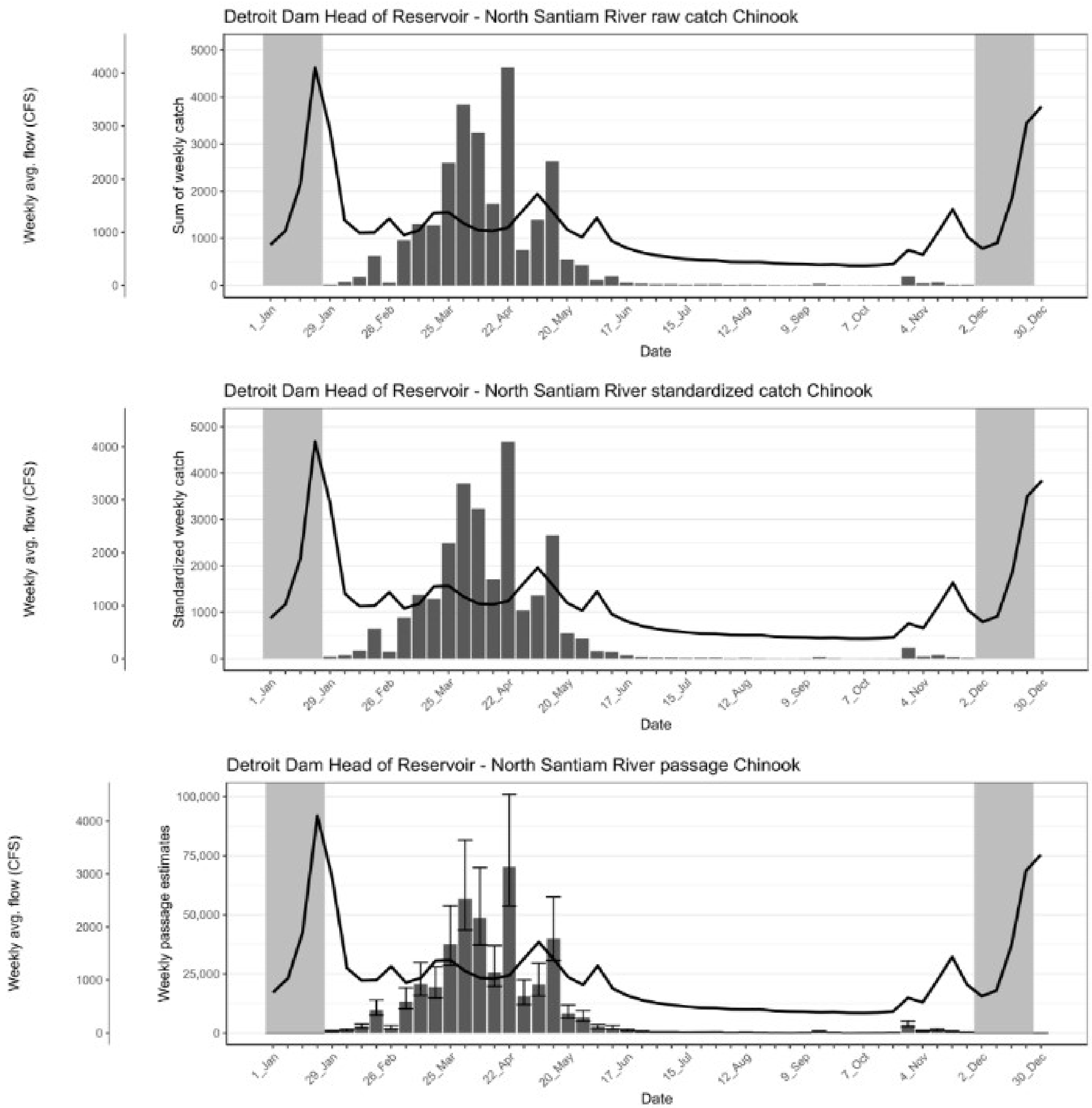

Figure 7. Raw catch (top panel), standardized catch (middle panel), and weekly passage estimates (bottom panel) of NOR juvenile Chinook at the Detroit Head of Reservoir- North Santiam River RST site with stream flow (black line) and non-sampling weeks shaded out (gray).

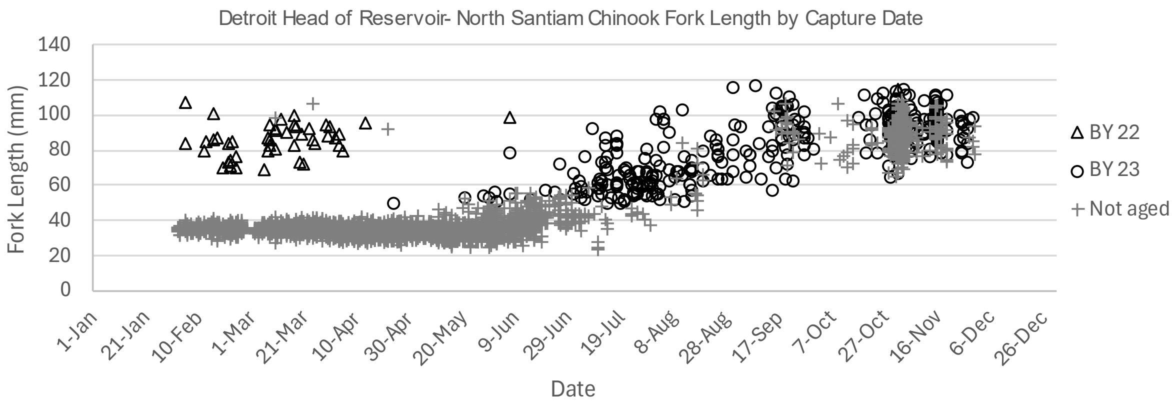

Figure 8. Length-frequency of juvenile Chinook salmon by brood year at the Detroit Head of Reservoir – North Santiam site.

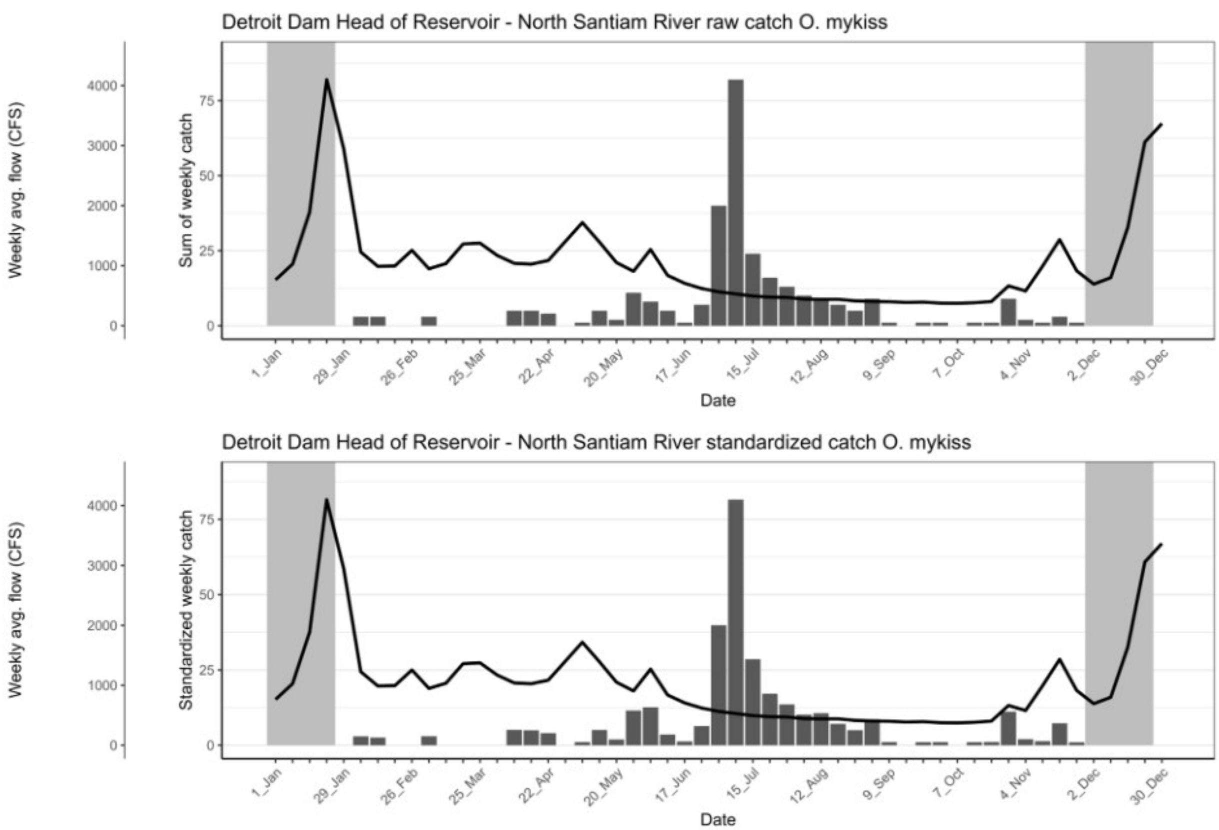

Figure 9. Shows raw catch (top panel) and weekly standardized catch (bottom panel) of juvenile *O. mykiss* overlayed with flow (black line) and non-sampling weeks shaded out (gray) at the Detroit Head of Reservoir – North Santiam site.

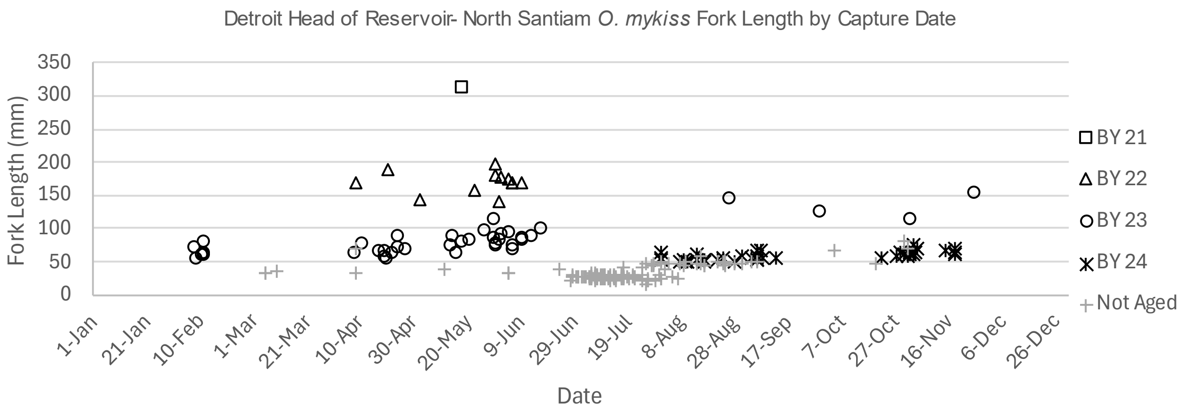

Figure 10. Length-frequency of juvenile *O. mykiss* by brood year at the Detroit Head of Reservoir – North Santiam River site.

1.3.2.4 Injury Data

A total of 1,571 juvenile Chinook salmon (5.7% of total Chinook salmon catch) and 56 *O. mykiss* (18.4% of total *O. mykiss* catch) displayed at least one of the injury code conditions listed in Table 3. The most frequently observed injuries in Chinook salmon at this site were descaling less than 20% and fin damage. The most frequently observed injuries in *O. mykiss* at this site were descaling less than and greater than 20% and fin damage (Table 14). Observed injuries were likely incurred upon capture in the RST due to debris or contact with various surfaces in the trap. A significant portion of the Chinook salmon target catch (94.3%) at this site were evidenced to have no external injuries (Table 14). Comparatively, the bulk marked released Chinook salmon illustrated similar trends to the NOR Chinook salmon, being predominantly unharmed, with the most frequent injuries recorded being descaling less than 20% and fin damage (Table 14). TE hatchery reared Chinook salmon were found to have higher occurrences of descaling greater than and less than 20%, head injuries, operculum damage, fin damage, and fungus when compared to both bulk marked released and NOR Chinook (Table 14).

Data collected on the injury rates of TE hatchery fish illustrated that both the percentage of fish with injuries and the average number of injuries per fish generally increased from pre-release to recaptured observations. Detailed findings on injury type are further presented in Appendix D: Additional Injury Information.

There were 438 Chinook salmon mortalities (1.6% of Chinook salmon catch) likely resulting from high debris in the trap, increased flows, and smaller body sizes this time of year. Copepods were only observed on Chinook salmon and *O. mykiss* with fork lengths greater than 50mm Copepod presence results did not show a strong association with increased sizes of fish, as has more recently been observed below dams (Figure 11 and Figure 12). Additional information regarding injuries by size and average injuries per fish is available in Appendix D: Additional Injury Information.

Table 14. Summary of injuries observed on NOR, bulk marked, and TE hatchery Chinook salmon, in addition to *O. mykiss* at the at the Detroit Head of Reservoir – North Santiam River RST site.

Injury Code	Chinook Injuries (NOR) (n=27,536)	Bulk Marked Released Chinook (n=16)	Trapping Efficiency Hatchery Chinook (n=562)	*O. mykiss* Injuries (NOR) (n=305)
NXI (no external injury)	94.3%	68.8%	13.2%	81.6%
MUNK	0.0%	0.0%	0.0%	0.3%
DS<2	2.5%	25.0%	70.1%	10.2%
DS>2	0.9%	0.0%	9.8%	2.3%
BLO	0.0%	0.0%	1.1%	0.0%
EYB	0.4%	0.0%	0.4%	0.7%
BVT	0.1%	0.0%	0.0%	0.0%
FVB	0.4%	0.0%	0.0%	0.3%
GBD	0.0%	0.0%	0.0%	0.0%
POP	0.8%	0.0%	0.2%	0.3%
HIN	1.0%	0.0%	1.4%	2.0%
OPD	0.8%	0.0%	3.2%	2.0%
TEA	1.0%	0.0%	0.2%	1.0%
BRU	1.0%	0.0%	1.8%	0.7%
HBP	0.0%	0.0%	0.0%	0.0%
HO	0.0%	0.0%	0.0%	0.0%
BO	0.2%	0.0%	0.0%	0.0%
HBO	0.0%	0.0%	0.0%	0.0%
FID	2.3%	25.0%	85.1%	10.2%
PRD	0.0%	0.0%	0.0%	0.0%
COP	0.3%	0.0%	0.4%	1.3%
BKD	0.0%	0.0%	0.0%	0.0%
FUN	0.0%	0.0%	10.5%	1.0%

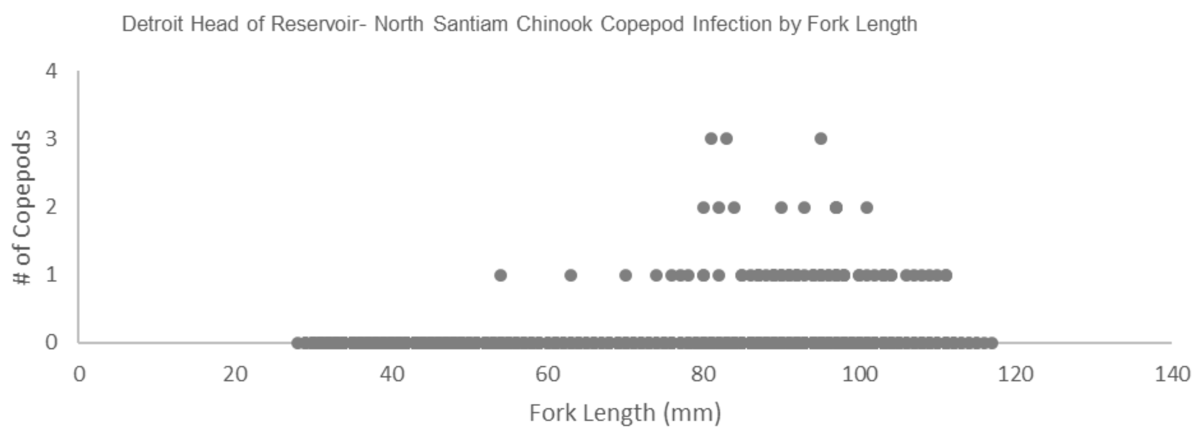

Figure 11. Copepod prevalence vs fork length on juvenile Chinook salmon captured at Detroit Head of Reservoir RST site.

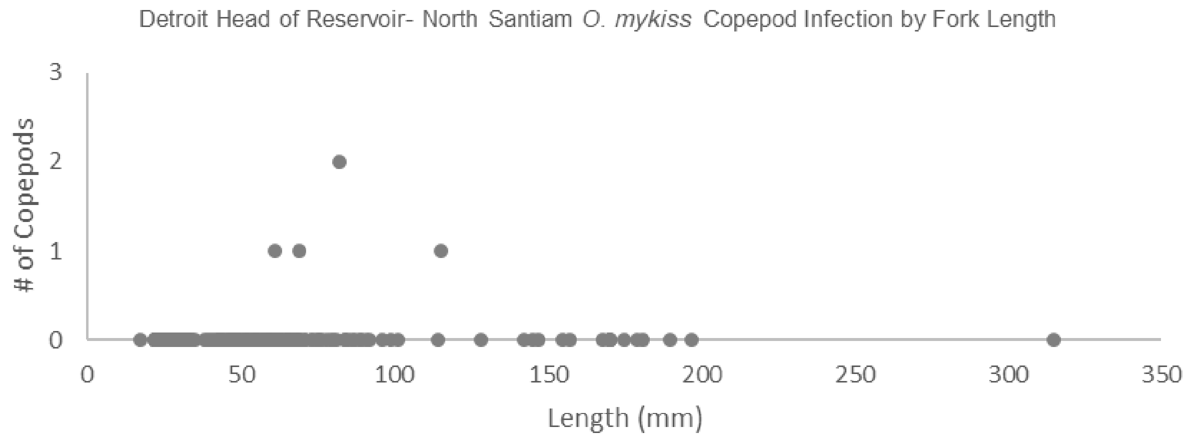

Figure 12. Copepod prevalence vs fork length on juvenile *O. mykiss* captured at Detroit Head of Reservoir RST site.

1.3.2.5 PIT Tagged/VIE Marked Fish and Downstream Detections

A total of 572 Chinook salmon and 58 *O. mykiss* were PIT tagged at this site in 2024. A total of 20,391 Chinook salmon and 66 *O. mykiss* were VIE marked. Additionally, another 1,691 Chinook salmon fry were marked with BBY staining and used for ROR TE trials. Some fish were not marked, as they were still sac-fry or too small to safely mark. 1 VIE marked fish was detected at the Big Cliff Dam Tailrace RST. This fish was tagged by EAS in May of 2024 and was recaptured in December of 2024. 2 PIT tagged Chinook were recaptured downstream at Big Cliff Dam Tailrace in 2024. The average travel time was 128 days. 2 PIT tagged Chinook were observed downstream at the Columbia River Estuary in 2024. The average travel time was 229 days. A summary of downstream PIT tag detections is provided in Table 15, and Table 16 provides a summary of VIE marked fish for the reporting period. More information regarding PIT tags at the RST and other sites is provided in Appendix C: PIT Tags and VIE Tagging.

Table 15. Summary of PIT tagged juvenile Chinook downstream redetections for the Detroit Dam Head of Reservoir site.

PIT Tag #	Mark Date	Redetection Date	Recap Site	Travel Time (Days)
3DD.003BEE1AA8	09/06/2023	05/02/2024	PD5 – Columbia River Estuary rkm 62	239
3DD.003BEE11EF	11/05/2023	05/06/2024	Big Cliff Dam RST	183
3DD.003BD22603	11/02/2023	06/08/2024	PD8 – Columbia River Estuary rkm 82	219
3DD.003E5281B1	10/13/2024	12/25/2024	Big Cliff Dam RST	74

Table 16. Summary table of VIE marked fish at the Detroit Head of Reservoir – North Santiam RST site.

Date Tagged	Species	Tag Location	VIE Color	# Tagged	# Recaptured
02/01/2024–02/15/2024	Chinook	Right Dorsal	Yellow	78	0
02/01/2024–02/15/2024	*O. mykiss*	Right Dorsal	Yellow	4	0
02/16/2024–02/29/2024	Chinook	Right Dorsal	Yellow	415	0
02/16/2024–02/29/2024	*O. mykiss*	Right Dorsal	Yellow	0	0
03/01/2024–03/15/2024	Chinook	Right Dorsal	Red	1,439	0
03/01/2024–03/15/2024	*O. mykiss*	Right Dorsal	Red	1	0
03/16/2024–03/31/2024	Chinook	Right Dorsal	Red	3,334	0
03/16/2024–03/31/2024	*O. mykiss*	Right Dorsal	Red	0	0
04/01/2024–04/15/2024	Chinook	Right Dorsal	Blue	5,379	0
04/01/2024–04/15/2024	*O. mykiss*	Right Dorsal	Blue	1	0
04/16/2024–04/30/2024	Chinook	Right Dorsal	Blue	4,527	0
04/16/2024–04/30/2024	*O. mykiss*	Right Dorsal	Blue	3	0
05/01/2024–05/15/2024	Chinook	Right Dorsal	Orange	3,112	**1**
05/01/2024–05/15/2024	*O. mykiss*	Right Dorsal	Orange	0	0
05/16/2024–05/31/2024	Chinook	Right Dorsal	Orange	1,533	0
05/16/2024–05/31/2024	*O. mykiss*	Right Dorsal	Orange	1	0
06/01/2024–06/15/2024	Chinook	Right Dorsal	Pink	333	0
06/01/2024–06/15/2024	*O. mykiss*	Right Dorsal	Pink	0	0
06/16/2024–06/30/2024	Chinook	Right Dorsal	Pink	139	0
06/16/2024–06/30/2024	*O. mykiss*	Right Dorsal	Pink	1	0
07/01/2024–07/15/2024	Chinook	Right Dorsal	Green x2	41	0
07/01/2024–07/15/2024	*O. mykiss*	Right Dorsal	Green x2	0	0
07/16/2024–07/31/2024	Chinook	Right Dorsal	Green x2	35	0
07/16/2024–07/31/2024	*O. mykiss*	Right Dorsal	Green x2	6	0
08/01/2024–08/15/2024	Chinook	Right Dorsal	Yellow x2	13	0
08/01/2024–08/15/2024	*O. mykiss*	Right Dorsal	Yellow x2	16	0
08/16/2024–08/31/2024	Chinook	Right Dorsal	Yellow x2	9	0
08/16/2024–08/31/2024	*O. mykiss*	Right Dorsal	Yellow x2	17	0
09/01/2024–09/15/2024	Chinook	Right Dorsal	Red x2	2	0
09/01/2024–09/15/2024	*O. mykiss*	Right Dorsal	Red x2	8	0
09/16/2024–09/30/2024	Chinook	Right Dorsal	Red x2	2	0
09/16/2024–09/30/2024	*O. mykiss*	Right Dorsal	Red x2	0	0
10/01/2024–10/15/2024	Chinook	Right Dorsal	Blue x2	0	0
10/01/2024–10/15/2024	*O. mykiss*	Right Dorsal	Blue x2	0	0
10/16/2024–10/31/2024	Chinook	Right Dorsal	Blue x2	0	0
10/16/2024–10/31/2024	*O. mykiss*	Right Dorsal	Blue x2	4	0
11/01/2024–11/15/2024	Chinook	Right Dorsal	Orange x2	0	0
11/01/2024–11/15/2024	*O. mykiss*	Right Dorsal	Orange x2	3	0
11/16/2024–11/30/2024	Chinook	Right Dorsal	Orange x2	0	0
11/16/2024–11/30/2024	*O. mykiss*	Right Dorsal	Orange x2	1	0

1.3.2.6 Willamette Valley Projects Encounters

There were 16 adipose clipped and PIT tagged Chinook encountered at this site in 2024. These fish were all released by the CFS Bulk Mark Release project. 14 of these fish were recaptured fish from TE trials. For more information regarding bulk mark releases and detections of associated fish, refer to the *Bulk Mark Release and Reservoir Distribution Study Annual Report* (CFS 2024).

1.3.2.7 Non-Target Capture Data

A total of 458 non-target fish were captured in addition to NOR juvenile Chinook salmon and *O. mykiss* at the Detroit Head of Reservoir RST in 2024. The most commonly captured non-target species were adipose clipped *O. mykiss* and wild Kokanee. A summary of species and numbers of fish caught is provided in Table 17.

Table 17. Summary of non-target fish capture at the Detroit Head of Reservoir – North Santiam RST site in 2024.

Species	Season Total	Season Total Mortality (subset of total)
Juvenile Chinook (clipped)	53	0
Cutthroat Trout	8	0
Dace	10	0
Kokanee	109	17
Largescale Sucker	1	0
Mountain Whitefish	20	8
O. mykiss (clipped)	155	7
Sculpin	26	8
Unknown*	76	76
Totals	**458**	**116**

*Species denoted as “unknown” were too small and/or too decomposed to identify.

1.3.3 Big Cliff Dam Tailrace

A single 8-foot RST continued monitoring activities at Big Cliff Dam and sampled from January 1, 2024, through December 31, 2024.

Sampling outages resulting from high flows, excessive debris, severe weather, localized flood evacuations, and additional issues are listed in Appendix B: Sampling Outages by Site. Non-sampling periods illustrated in the figures below are further detailed in Appendix B: Sampling Outages by Site.

Additionally, the trap did not sample from January 17, 2024, to February 8, 2024, due to high flows from flood evacuations that created unsafe sampling conditions for both captured fish and crew.

1.3.3.1 Trapping Efficiency Trials

A total of 14 TE trials occurred at the Big Cliff Dam Tailrace in 2024 using hatchery reared juvenile Chinook salmon. Collectively, 42 TE trials have occurred at this site since December 2021. A summary of the fish release numbers, recaptures, and flow level for each trial is provided in Table 18.

TEs ranged from 1.2% to 20.7% with a pooled average of 7.1% (95%CI ± 1.5%, n=38) of all successful trials with five or more recaptures. Two of the trials did not recapture enough fish to be used in the passage estimate calculation. Trap efficiency analysis identified the model incorporating weekly discharge and the interaction between weekly discharge and fish length had the highest pseudo R^2 (0.50, n=38). This model also had the fourth-lowest AICc of all models. However, the three models with lower AICc scores also had similar pseudo R^2 values (0.46–0.47). All models included discharge or fish length as covariates, suggesting that they may both be influencing trap efficiency at this site. Detailed methods and full results of the trap efficiency modeling are provided in Appendix E: Trap Efficiency Plots.

Table 18. Summary table of marked hatchery Chinook salmon releases at Big Cliff Dam for trapping efficiency.

Release Location	Date of Release	cfs at Release	Number of Fish Released	Number of Fish Recaptured	Percent Efficiency
Big Cliff Dam Tailrace*	12/22/2021	3,080	997	39	3.9%
Big Cliff Dam Tailrace*	05/25/2022	3,050	995	21	2.1%
Big Cliff Dam Tailrace*	08/09/2022	1,060	1000	92	9.2%
Big Cliff Dam Tailrace*	09/30/2022	1,590	995	48	4.8%
Big Cliff Dam Tailrace*	10/13/2022	2,820	500	15	3.0%
Big Cliff Dam Tailrace*	10/24/2022	5,520	535	25	4.7%
Big Cliff Dam Tailrace*	11/02/2022	5,450	949	40	4.2%
Big Cliff Dam Tailrace*	11/16/2022	2,790	509	15	2.9%
Big Cliff Dam Tailrace*	12/14/2022	1,380	502	60	12.0%
Big Cliff Dam Tailrace*	12/19/2022	1,330	1010	92	9.1%
Big Cliff Dam Tailrace*	12/21/2022	1,350	1014	33	3.3%
Big Cliff Dam Tailrace*	12/27/2022	1,520	704	47	6.7%
Big Cliff Dam Tailrace*	12/29/2022	1,480	452	22	4.9%
Big Cliff Dam Tailrace*	01/25/2023	1,330	500	56	11.2%
Big Cliff Dam Tailrace*	02/17/2023	1,470	499	38	7.6%
Big Cliff Dam Tailrace**	03/07/2023	1,080	2,968	61	2.1%
Big Cliff Dam Tailrace*	03/10/2023	1,180	541	112	20.7%
Big Cliff Dam Tailrace*	04/28/2023	1,310	498	34	6.8%
Big Cliff Dam Tailrace*	05/23/2023	2,440	500	6	1.2%
Big Cliff Dam Tailrace*	06/21/2023	2,740	500	8	1.6%
Big Cliff Dam Tailrace*	07/05/2023	1,580	500	33	6.6%
Big Cliff Dam Tailrace*	08/03/2023	1,080	474	42	8.9%
Big Cliff Dam Tailrace*	09/19/2023	1,580	424	64	15.1%
Big Cliff Dam Tailrace*	10/06/2023	1,590	500	56	11.2%
Big Cliff Dam Tailrace	10/25/2023	1,730	633	99	15.6%
Big Cliff Dam Tailrace	11/16/2023	4,050	527	0	0.0%
Big Cliff Dam Tailrace	11/21/2023	3,450	500	30	6.0%
Big Cliff Dam Tailrace	12/28/2023	1,990	550	56	10.2%
Big Cliff Dam Tailrace	02/14/2024	1,550	500	16	3.2%
Big Cliff Dam Tailrace	02/21/2024	1,060	464	52	11.2%
Big Cliff Dam Tailrace	03/06/2024	1,810	556	18	3.2%
Big Cliff Dam Tailrace**	03/07/2024	1,820	1,959	1	0.05%
Big Cliff Dam Tailrace	03/12/2024	1,780	550	18	3.3%
Big Cliff Dam Tailrace	05/07/2024	3,310	493	1	0.2%
Big Cliff Dam Tailrace	06/18/2024	1,440	499	18	3.6%
Big Cliff Dam Tailrace	07/26/2024	1,300	497	23	4.6%
Big Cliff Dam Tailrace	08/16/2024	1,080	500	48	9.6%
Big Cliff Dam Tailrace	09/05/2024	1,640	500	31	6.2%
Big Cliff Dam Tailrace	09/11/2024	1,610	1,054	80	7.6%
Big Cliff Dam Tailrace	10/30/2024	2,230	500	24	4.8%
Big Cliff Dam Tailrace	11/15/2024	4,600	500	17	3.4%
Big Cliff Dam Tailrace	12/03/2024	1,300	500	89	17.8%

*Release performed by EAS for the USACE under contract W9127N19D0007.
**Release performed by ODFW.

1.3.3.2 Run of River Trapping Efficiency Trials

No TE trials using ROR fish were performed at Big Cliff Dam tailrace in 2024. The first 60 wild fish caught per week are prioritized for the 24-hour hold mortality study and are not tagged. Thus, sufficient numbers of natural-origin fish to perform trials were not available during sampling in 2024.

1.3.3.3 Target Catch, Passage Estimates and Passage Timing

The trap captured 1,472 juvenile Chinook salmon and 122 juvenile *O. mykiss* during the reporting period. It is assumed that *O. mykiss* captured at this site are primarily composed of resident rainbow trout since steelhead are not transported to spawn above Detroit Reservoir. However, due to the difficulty in distinguishing between resident trout and anadromous steelhead, all unmarked *O. mykiss* were treated as target fish and reported as such.

A total of 937 juvenile Chinook (63.7% of total Chinook catch) were encountered during the spring of 2024. Peak capture of juvenile Chinook salmon exiting Big Cliff Dam in the spring occurred in April (n=555, 59.2% of spring capture) (Figure 13). Chinook salmon catch in the spring consisted of three brood year classes: BY 2021, BY 2022, and BY 2023 (Figure 16). There were 42 BY 2023 (4.5% of total spring catch) Chinook salmon captured during the spring sampling period at this site. The first BY 2023 sub-yearling Chinook salmon was captured on February 18, 2024. The spring migration timing of sub-yearling Chinook salmon through Big Cliff Dam is similar to observations from previous years (Romer et al. 2016). Scale age analysis from this period shows a significant amount of overlap in size between fish from BYs 2021 and 2022 (Figure 16). This overlap in size of Chinook salmon is similar to what was observed during RST sampling in 2022 and 2023 (EAS 2023) and from scale samples collected from Chinook salmon in the forebay of Detroit Reservoir by Monzyk and Romer (2015). Due to this overlap, we cannot reliably assign a BY category to fish where scales were not aged and size metrics for the two brood years will be reported together.

A total of 535 juvenile Chinook (36.3% of total Chinook capture) were collected in the fall monitoring period. Peak capture of juvenile Chinook in the fall occurred in July (n=250, 46.7% of fall catch). This timing is consistent with observations from previous monitoring by CFS (2021) and EAS (2022). Chinook catch in the fall was comprised of BY 2022 and 2023 fish. Similar to past years, a significant overlap in size between the two brood years was observed. Size metrics reported below are for both brood years combined. Using pooled averages of hatchery Chinook TEs, we estimate that 21,762 (95% CI: 18,008 to 27,496) juvenile Chinook salmon passed the trapping site during RST sampling in 2024 (Figure 13).

O. mykiss capture in the RST below Big Cliff Dam in the spring consisted of 74 individuals (60.7% of total catch) from four brood years: BY 2021, BY 2022, BY 2023, and BY 2024 (Figure 17). The first BY 2024 fish was captured on May 24, 2024. A majority of the O. *mykiss* captured in the spring occurred during May and June (n=59, 79.7% of total spring capture) (Figure 15). A single BY 2021 *O. mykiss* was captured on January 1, 2024.

Fall capture of *O. mykiss* was comprised of 48 fish with peak capture occurring in July (n=26, 54.2% of fall capture). Fish captured in the fall were comprised of four brood years: 2021, 2022, 2023, and 2024. The most prevalent brood year encountered in the fall was BY 2024 (n=43, 89.6% of total catch). Information on fork lengths and weights of each BY captured for Chinook salmon and *O. mykiss* at Big Cliff Dam is provided in Table 19.

Peak capture of Chinook salmon and *O. mykiss* at Big Cliff Dam coincided with spill operations at Detroit Dam that began in April and continued into June (Figure 14). Downstream movement of active tagged fish in Big Cliff Reservoir suggests that fish typically take about a day (mean: 1.11 days, range: 0.14–45.59 days) to navigate from the Detroit Dam Tailrace to the forebay of Big Cliff Dam (Beeman et al. 2015, Table 1-12). Assuming these migration rates for fish to reach the forebay of Big Cliff Dam from the Detroit Dam Tailrace, it is reasonable to accept that the increase in catch at Big Cliff Dam Tailrace in the spring is associated with Detroit Dam surface spill operations. Additionally, increases in catch were also observed during spill operations at Detroit that occurred in the fall period. Results from studies by CFS in 2021 (Cramer 2023) also observed increased catch associated with spill operations. However, this fall capture during spill in November also coincided with increased powerhouse outflows and a large rain event which may have also influenced fish movement. Figures displaying weekly raw catch for sampling at the Big Cliff Dam RST site for sampling from 2021 through 2023 and numbers of adult Chinook out plants above Detroit Reservoir for 2010 through 2023 are available in Appendix I: Adult Chinook Out-planting Above Willamette Valley Projects.

Table 19. Summary of fork length and weight observed on juvenile Chinook salmon and *O. mykiss* of NOR at the Big Cliff Dam RST site by brood year.

Species	Date Range	BY	Number of Fish	Average F.L. (mm)	Min. F.L. (mm)	Max F.L. (mm)	Median F.L. (mm)	Average Weight (g)	Min. Weight (g)	Max Weight (g)	Median Weight (g)
Chinook	1/1/2024–6/30/2024	21 and 22	895	144.8	80	231	142	32.7	6.8	186.0	28.7
Chinook	1/1/2024–6/30/2024	23	42	98.4	35	121	107	14.5	7.2	20.1	14.8
Chinook	7/1/2024–12/31/2024	22 and 23	535	139.2	47	260	132	33.2	1.4	209.8	26.4
O. mykiss	1/1/2024–6/30/2024	21	1	275	275	275	N/A	247.1	247.1	247.1	N/A
O. mykiss	1/1/2024–6/30/2024	22	39	199.4	154	260	195	73.1	30.0	181.0	64.6
O. mykiss	1/1/2024–6/30/2024	23	8	78.8	34	124	79	8.0	<1	18.3	6.1
O. mykiss	1/1/2024–6/30/2024	24	26	30.4	25	39	29	N/A	N/A	N/A	N/A
O. mykiss	7/1/2024–12/31/2024	21	1	285	285	285	N/A	195.0	195.0	195.0	N/A
O. mykiss	7/1/2024–12/31/2024	22	2	213.5	195	232	N/A	90.3	72.6	108.0	N/A
O. mykiss	7/1/2024–12/31/2024	23	2	133	122	144	N/A	27.8	24.6	30.9	N/A
O. mykiss	7/1/2024–12/31/2024	24	43	53.1	25	105	51	2.9	<1	15.0	2.1

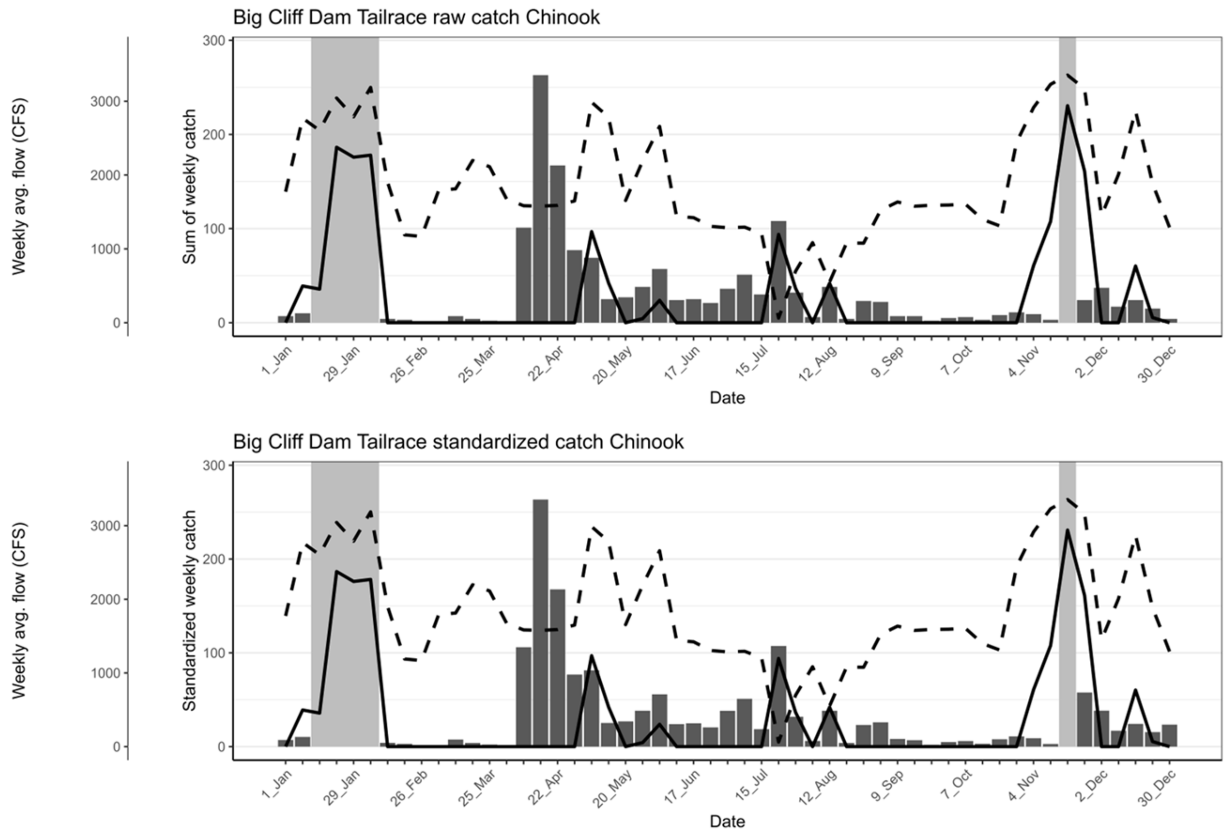

Figure 13. Raw catch (top panel) and weekly standardized catch (bottom panel) of NOR juvenile Chinook salmon at Big Cliff Dam with Big Cliff Dam operations with spill (black line), Powerhouse (black dash line) and non-sampling weeks shaded out (gray).

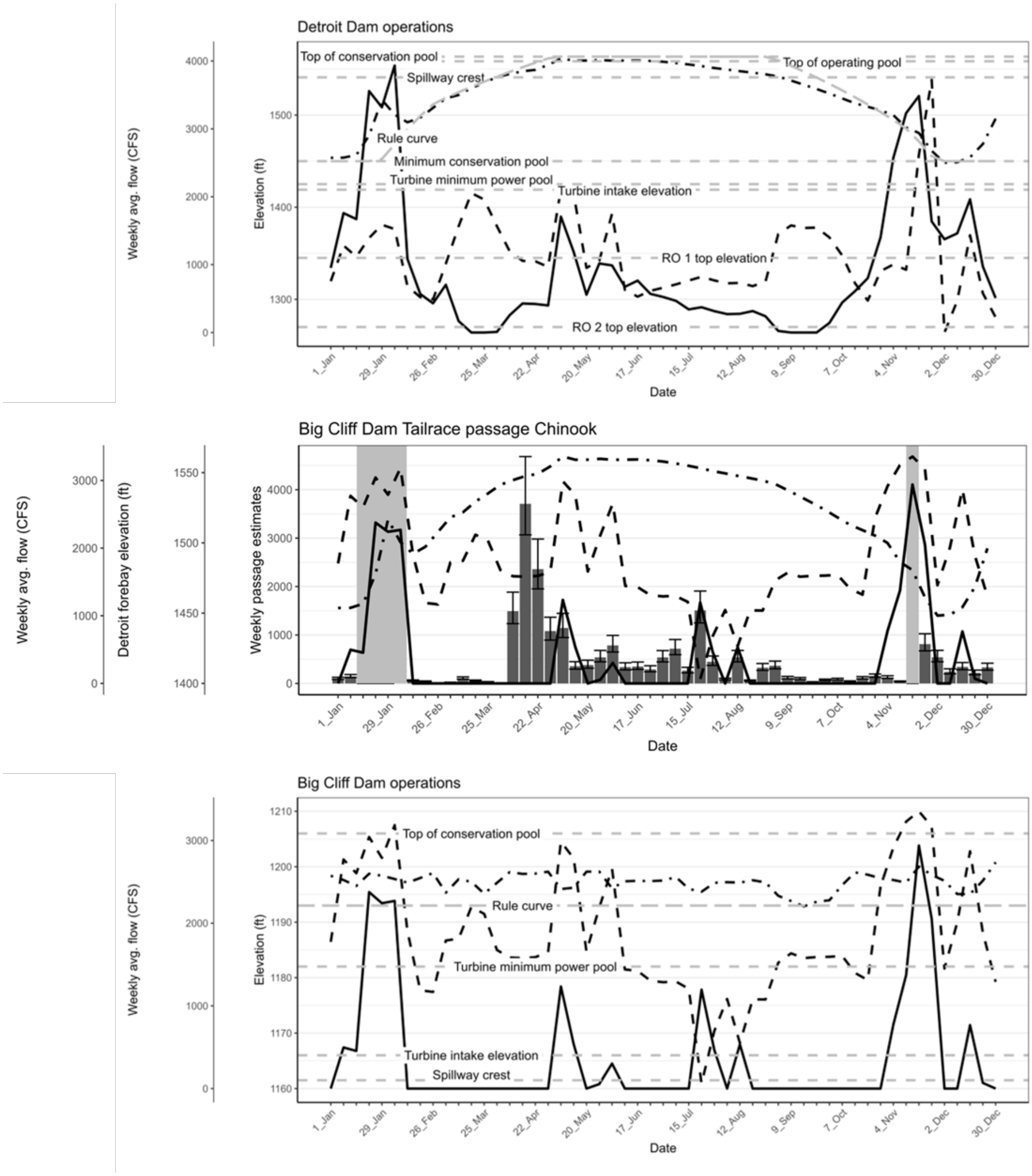

Figure 14. Detroit Dam (top panel) and Big Cliff Dam (bottom panel) operations with forebay elevation (black dot dash line), spill/RO outflow (black line) and powerhouse outflow (black dash line). Passage estimates with 95% confidence for juvenile Chinook salmon at Big Cliff Dam (middle panel) with spill at Big Cliff Dam (black line), Powerhouse outflow from Big Cliff Dam (black dash line), Detroit forebay elevation (black dot dash line), and non-sampling weeks shaded out (gray).

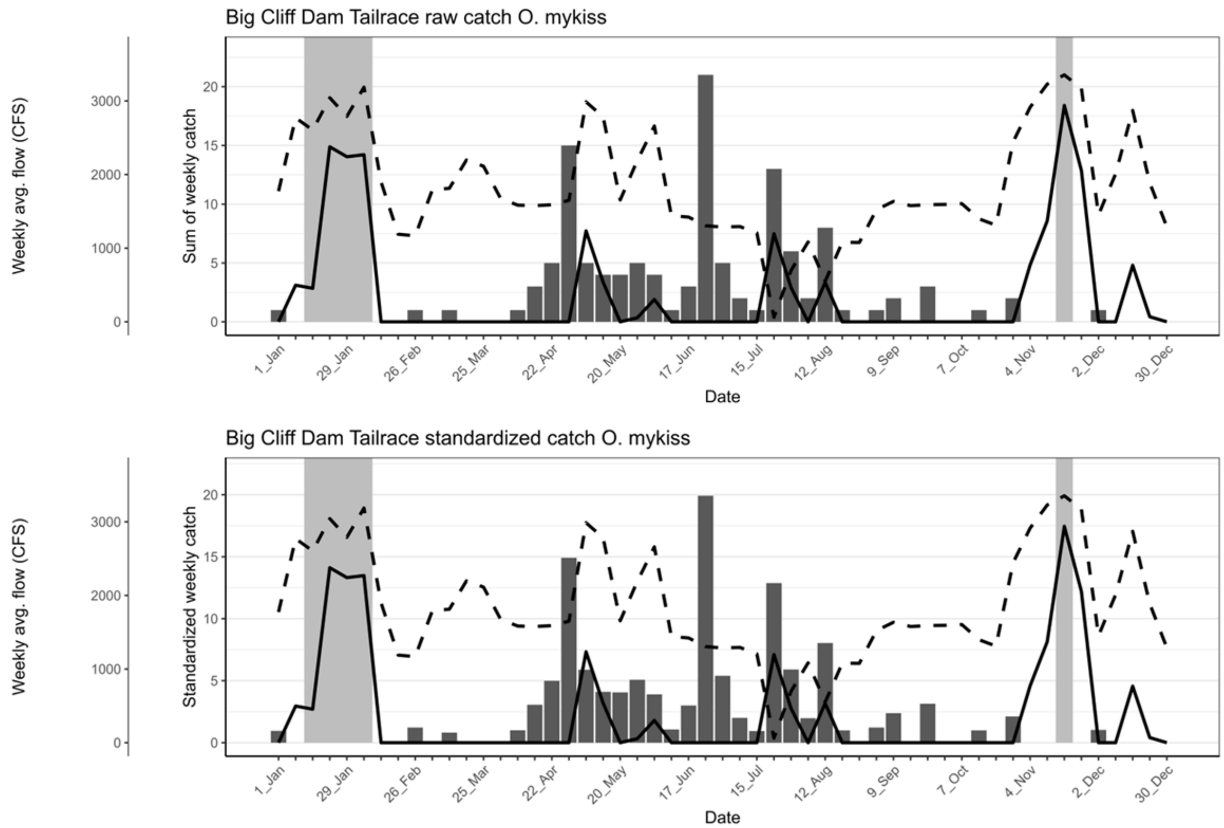

Figure 15. Raw catch (top panel) and weekly standardized catch (bottom panel) of NOR juvenile *O. mykiss* at Big Cliff Dam with Big Cliff Dam operations with spill (black line), Powerhouse (black dash line) and non-sampling weeks shaded out (gray).

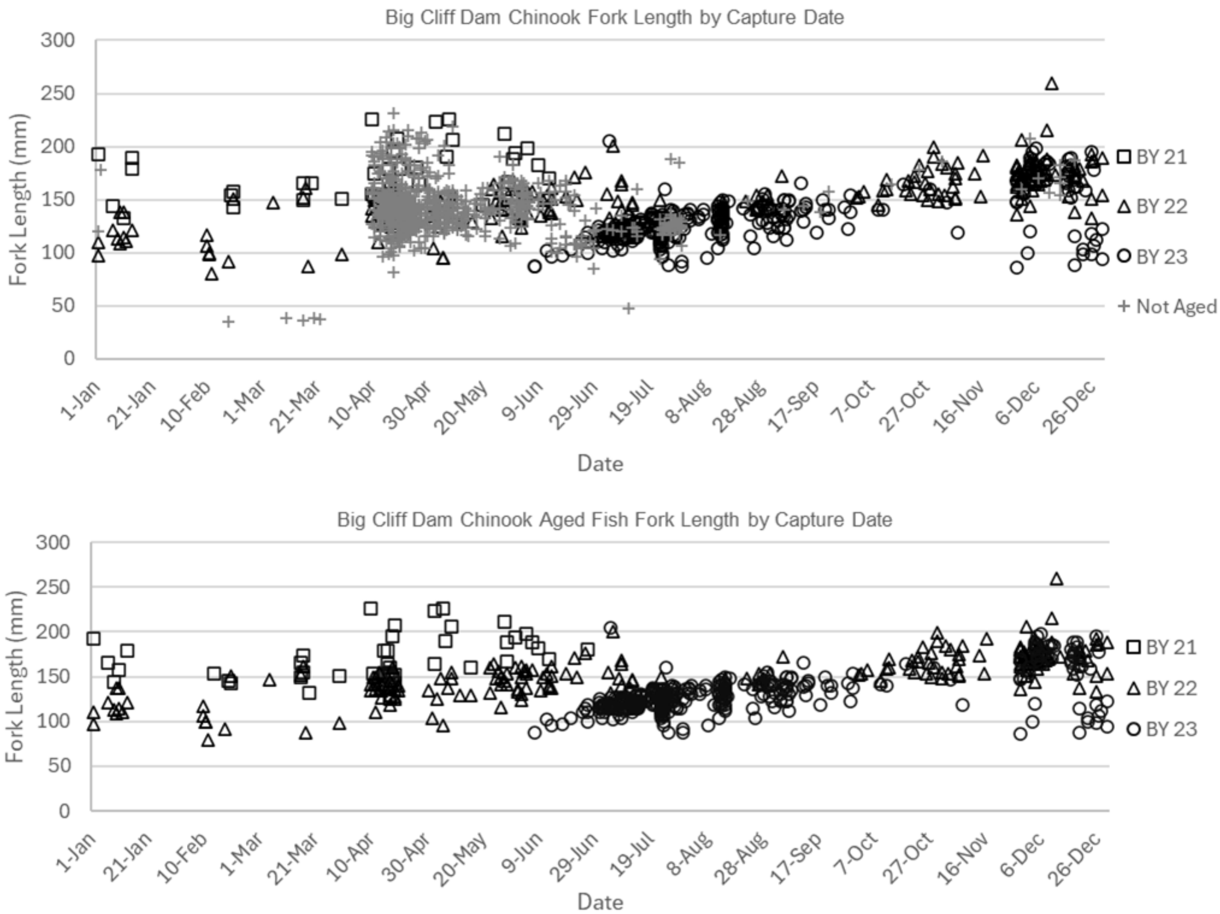

Figure 16. Length-frequency of juvenile Chinook salmon at the Big Cliff Dam Tailrace site. Top panel shows all fish and bottom panel shows only the aged fish.

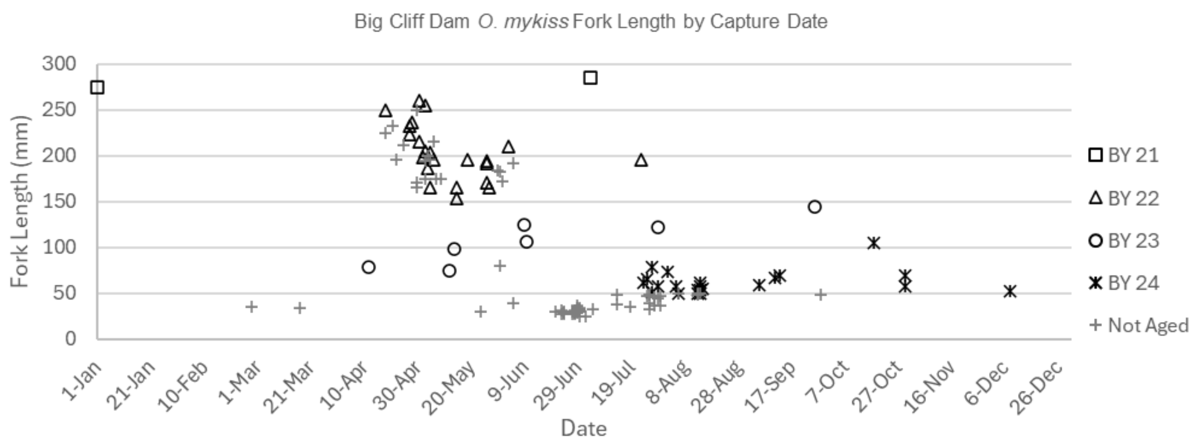

Figure 17. Length-frequency of juvenile *O. mykiss* at the Big Cliff Dam Tailrace site.

1.3.3.4 Injury Data

A total of 1,465 juvenile Chinook salmon (99.5% of total Chinook salmon catch) and 68 juvenile *O. mykiss* (55.7% of total *O. mykiss* catch) displayed at least one of the injury code conditions, other than copepods, listed in Table 3. During RST monitoring and data collection, 200 Chinook salmon (13.6%) and 16 *O. mykiss* (13.1%) were observed dead. To provide insight on injuries associated with capture in the RST, injury data was collected from bulk marked released and TE Chinook salmon. The most common injuries associated with RST capture in NOR Chinook and *O. mykiss* include descaling less than 20% and fin damage (Table 20). Additionally, 5.7% of the total Chinook salmon catch and 4.1% of the total *O. mykiss* catch displayed evidence of gas bubble disease. However, it is likely that observations of gas bubble disease are higher for RST captured fish than those that are not captured in a RST, as these fish are often captured and held in areas of higher dissolved gas.

Increases in the proportion of fish displaying injury often coincided with spill operations at Big Cliff Dam. Figure 18 illustrates that as tailrace flows increase, so does bodily injury, specifically, descaling less than 20%. Copepod presence on captured Chinook salmon and *O. mykiss* illustrates a positive correlation with the size of fish, similar to observations made by previous studies (CFS 2023a; Monzyk et al. 2015) (Figure 19). This is likely a correlation between time spent rearing in the reservoir, rather than the size of the fish. Monzyk et al. also noted that *O. mykiss* were infected with copepods at a much lower rate than Chinook salmon, a trend also observed in *O. mykiss* captured at the Big Cliff Dam site (Figure 20).

Furthermore, of the 117 bulk marked released Chinook salmon captured, the predominant injuries observed were descaling less than 20%, fin damage, and the presence of copepods (Table 20). Similar injuries were observed in the TE hatchery Chinook salmon. The predominant injuries observed in TE Chinook were descaling less than 20% and fin damage (Table 20). Further assessment and increased sample sizes will be utilized to yield more informed discussions.

Data collected on the injury rates of TE hatchery fish illustrated that both the percentage of fish with injuries and the average number of injuries per fish generally increased from pre-release to recaptured observations. Detailed findings on injury type are further presented in Appendix D: Additional Injury Information.

Preliminary findings illustrated that smaller Chinook salmon (<60 mm) were less likely to encounter injury during dam passage and subsequent RST capture; however, there were few fish <60 mm captured in 2024 (n=6), and a larger sample size is needed to further evaluate the interaction of size and injury. Descaling less than 20%, descaling greater than 20%, bruising, fin damage, and the presence of copepods were found to significantly increase as fish grew in size (Appendix D, Table D-1). Additional information regarding injuries by size and average injuries per fish by size is available in Appendix D: Additional Injury Information.

Table 20. Summary of injuries observed on NOR, bulk marked, and TE hatchery Chinook salmon, in addition to *O. mykiss* at the Big Cliff Dam RST site.

Injury Code	Chinook Injuries (NOR) (n=1,472)	Bulk Marked Released Chinook (n=117)	Trapping Efficiency Hatchery Chinook (n=436)	*O. mykiss* Injuries (NOR) (n=122)
NXI (no external injury)	0.5%	0.0%	3.2%	44.3%
MUNK	0.0%	0.0%	0.0%	0.0%
DS<2	72.2%	76.1%	71.6%	33.6%
DS>2	25.0%	21.4%	21.8%	18.0%
BLO	2.2%	3.4%	0.0%	1.6%
EYB	8.6%	9.4%	2.8%	10.7%
BVT	5.7%	2.6%	0.2%	3.3%
FVB	11.3%	8.5%	0.5%	6.6%
GBD	5.7%	4.3%	3.2%	4.1%
POP	2.3%	1.7%	0.5%	3.3%
HIN	10.2%	4.3%	2.1%	9.0%
OPD	17.6%	12.8%	9.6%	12.3%
TEA	4.7%	2.6%	0.0%	4.9%
BRU	13.7%	12.8%	2.1%	13.1%
HBP	1.6%	2.6%	0.0%	0.0%
HO	0.0%	0.0%	0.0%	0.0%
BO	1.5%	0.9%	0.0%	0.8%
HBO	0.3%	0.0%	0.0%	0.8%
FID	82.9%	86.3%	95.6%	46.7%
PRD	0.1%	0.0%	0.0%	0.0%
COP	82.7%	65.0%	0.0%	25.4%
BKD	0.0%	0.0%	0.0%	0.0%
FUN	4.2%	5.1%	1.4%	0.8%

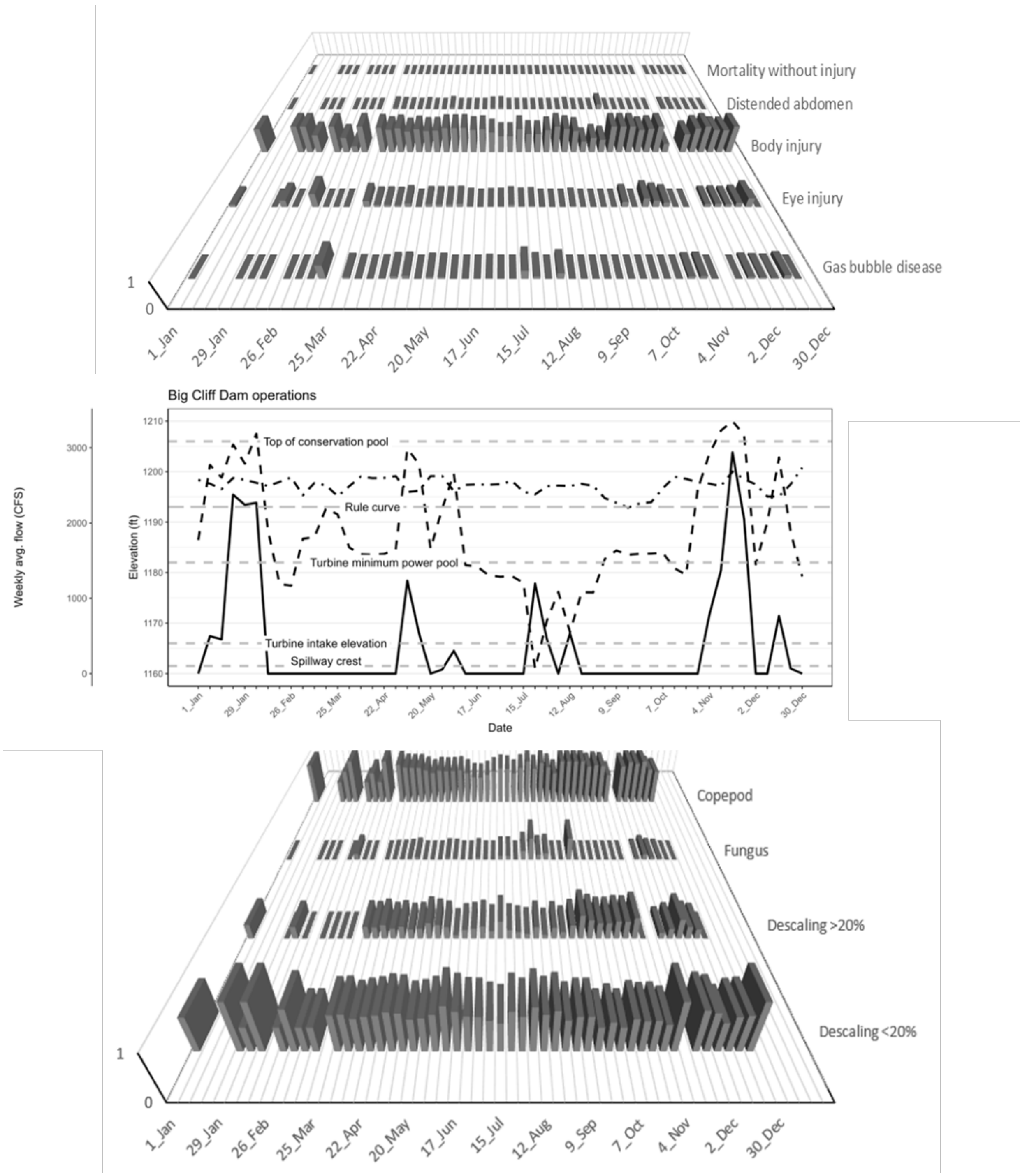

Figure 18. Injury rate of captured Chinook salmon below Big Cliff Dam displaying proportion of fish with injuries by type (top panel) and descaling injuries and copepod presence (bottom panel). The middle panel shows Big Cliff Dam operations with forebay elevation (black dot dash line), spill (black line) and Powerhouse flow (black dash line) at Big Cliff Dam.

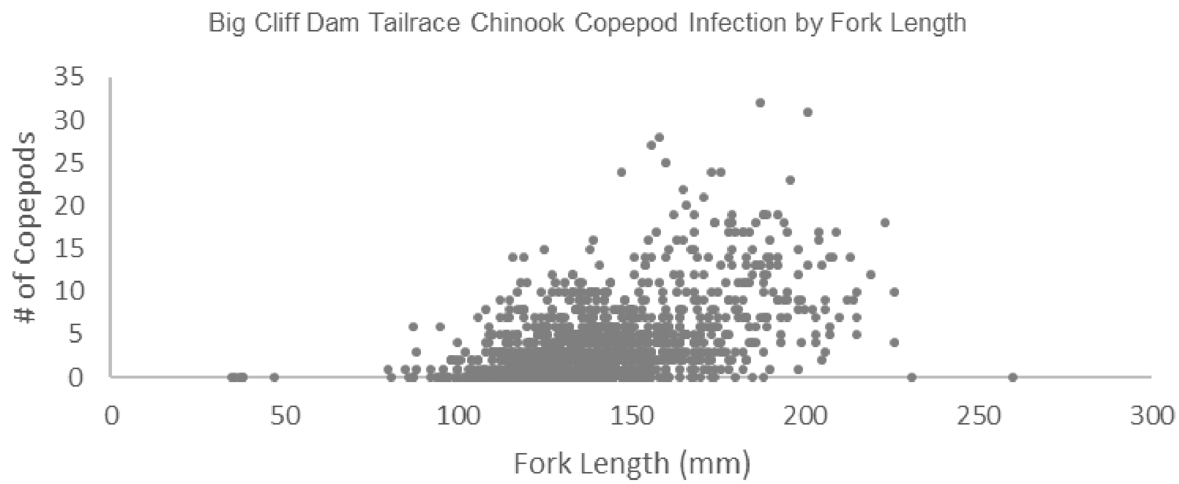

Figure 19. Copepod prevalence vs fork length on juvenile Chinook salmon captured at Big Cliff Dam Tailrace.

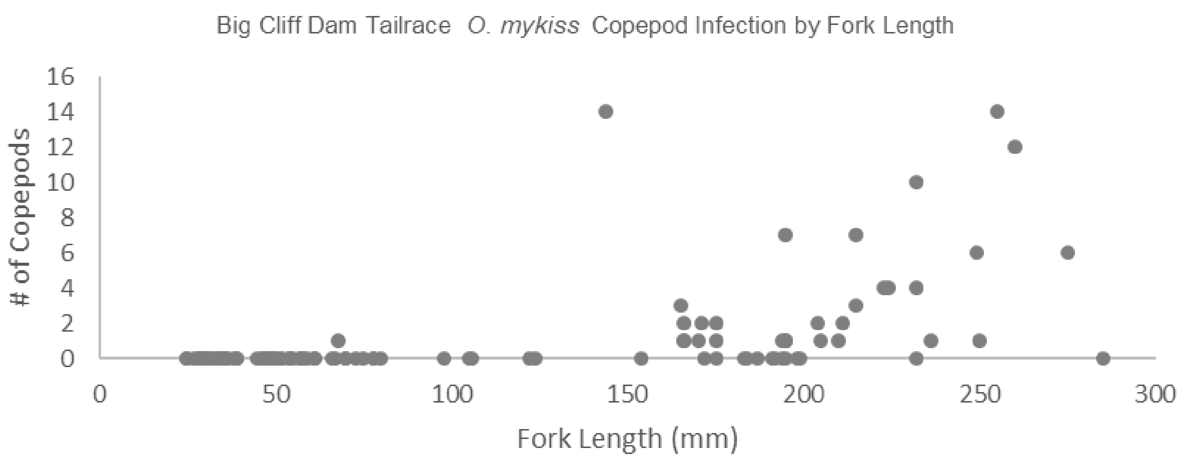

Figure 20. Copepod prevalence vs fork length on juvenile *O. mykiss* captured at Big Cliff Dam Tailrace.

1.3.3.5 24-Hour Hold Trials

24-hour hold trials were performed on NOR juvenile Chinook salmon and *O. mykiss* captured at the Big Cliff Dam Tailrace to assess delayed mortality resulting from dam passage. A total of 959 fish, 875 Chinook salmon and 84 *O. mykiss*, were held in 2024 (Table 21). A total of 144 fish died during hold (15.0%), 135 of the 875 Chinook salmon (15.4%) and 9 of the 84 *O. mykiss* (10.7%). Mortality rates across the two-week periods in which fish were held ranged from 0 to 33.6%.

Table 21. Summary of 24-hour hold trials for fish captured in the RST at the Big Cliff Dam Tailrace site.

Hold Period	Species	Number of Fish Held	Mortalities	% Survived
01/01–15/2024	Chinook	10	2	80.0%
01/01–15/2024	*O. mykiss*	1	0	100.0%
01/16–31/2024	Chinook	0	0	--
01/16–31/2024	*O. mykiss*	0	0	--
02/01–15/2024	Chinook	6	1	83.3%
02/01–15/2024	*O. mykiss*	0	0	--
02/16–29/2024	Chinook	5	0	100.0%
02/16–29/2024	*O. mykiss*	1	0	100.0%
03/01–15/2024	Chinook	1	0	100.0%
03/01–15/2024	*O. mykiss*	0	0	--
03/16–31/2024	Chinook	12	2	83.3%
03/16–31/2024	*O. mykiss*	1	0	100.0%
04/01–15/2024	Chinook	56	11	80.4%
04/01–15/2024	*O. mykiss*	0	0	--
04/16–30/2024	Chinook	91	17	81.3%
04/16–30/2024	*O. mykiss*	3	0	100.0%
05/01–15/2024	Chinook	80	10	87.5%
05/01–15/2024	*O. mykiss*	13	2	84.6%
05/16–31/2024	Chinook	56	5	91.1%
05/16–31/2024	*O. mykiss*	6	2	66.7%
06/01–15/2024	Chinook	80	8	90.0%
06/01–15/2024	*O. mykiss*	5	1	80.0%
06/16–30/2024	Chinook	45	3	93.3%
06/16–30/2024	*O. mykiss*	22	0	100.0%
07/01–15/2024	Chinook	81	9	88.9%
07/01–15/2024	*O. mykiss*	5	1	80.0%
07/16–31/2024	Chinook	110	37	66.4%
07/16–31/2024	*O. mykiss*	8	1	87.5%
08/01–15/2024	Chinook	48	6	87.5%
08/01–15/2024	*O. mykiss*	11	1	90.9%
08/16–31/2024	Chinook	25	2	92.0%
08/16–31/2024	*O. mykiss*	0	0	--
09/01–15/2024	Chinook	32	3	90.6%
09/01–15/2024	*O. mykiss*	3	1	66.7%
09/16–30/2024	Chinook	11	0	100.0%
09/16–30/2024	*O. mykiss*	2	0	100.0%
10/01–15/2024	Chinook	6	1	83.3%
10/01–15/2024	*O. mykiss*	0	0	--
10/16–31/2024	Chinook	13	1	92.3%
10/16–31/2024	*O. mykiss*	2	0	100.0%
11/01–15/2024	Chinook	11	2	81.8%
11/01–15/2024	*O. mykiss*	0	0	--
11/16–30/2024	Chinook	17	2	88.2%
11/16–30/2024	*O. mykiss*	0	0	--

Hold Period	Species	Number of Fish Held	Mortalities	% Survived
12/01–15/2024	Chinook	56	11	80.4%
12/01–15/2024	*O. mykiss*	1	0	100.0%
12/16–31/2024	Chinook	23	2	91.3%
12/16–31/2024	*O. mykiss*	0	0	--

1.3.3.6 PIT Tagged Fish and Downstream Detections

A total of 340 fish were PIT tagged at the Big Cliff Dam site in 2024, 332 juvenile Chinook salmon and 8 juvenile *O. mykiss*. The first 60 target fish captured at this location every week are prioritized for the 24-hour hold study and are not tagged. 5 PIT tagged Chinook and 1 PIT tagged *O. mykiss* that were tagged at the Breitenbush River RST were recaptured at this site during monitoring in 2024. The average travel time was 175 days. 2 PIT tagged Chinook that were tagged at the Detroit Head of Reservoir RST were recaptured at this site in 2024. The average travel time was 128 days. 1 VIE marked Chinook that was tagged at the Detroit Head of Reservoir site in May of 2024 was recaptured at this site in December of 2024. The travel time was 205–235 days. 2 PIT tagged Chinook that were tagged at Big Cliff Dam Tailrace were detected downstream in the Columbia River. The average travel time was 9 days. Additionally, 2 PIT tagged Chinook were detected at the Hanford Islands during an avian colony survey. These are likely avian predation detections and travel time was not included in this report.

A summary of downstream PIT tag detections is provided in Table 22. More information regarding PIT tags at the RST and other sites is provided in Appendix C: PIT Tags and VIE Tagging.

Table 22. Summary of PIT tagged juvenile Chinook downstream redetections for the Big Cliff Dam Tailrace site.

PIT Tag #	Mark Date	Redetection Date	Recap Site	Travel Time (Days)
3DD.003BE9F161	5/4/2024	5/9/2024	PD7 – Columbia River Estuary rkm 70	5
3DD.003BE9FE5C	4/26/2024	5/10/2024	TWX – Estuary Towed Array (Exp.)	14
3DD.003BE9FBA2	4/20/2024	8/14/2024	HANIS – Hanford Islands (Avian Colony)	N/A
3DD.003BE9FE40	4/24/2024	8/14/2024	HANIS – Hanford Islands (Avian Colony)	N/A

1.3.3.7 Willamette Valley Projects Encounters

On March 7, 2024, ODFW released 110,250 BBY Chinook fry into Detroit Reservoir at the Mongold boat ramp and 1,959 Chinook fry at the base of Big Cliff Dam. One fish from the Big Cliff Dam tailrace release group was captured on March 9, 2024. No other fish from these release groups were detected in the RST.

A total of 118 adipose clipped and PIT tagged Chinook salmon from Cramer Fish Science's bulk mark releases were detected at the Big Cliff Dam RST in 2024. For more information regarding release groups, dates, and other redetections, refer to the *Bulk Mark Release and Reservoir Distribution Study Annual Report* (CFS 2024).

1.3.3.8 Non-Target Capture Data

A total of 1,167 non-target fish were captured in addition to NOR juvenile Chinook salmon and *O. mykiss* at the Big Cliff Dam RST site in 2024 (Table 23). The most common non-targets captured were clipped Chinook and bluegill.

Table 23. Summary of non-target fish capture at the Big Cliff Dam RST site in 2024.

Species	Season Total	Season Total Mortality (subset of total)
Bluegill	517	104
Brown Bullhead catfish	3	0
Juvenile Chinook (clipped)	275	31
Chinook (adult)	2	0
Coho	37	0
Cutthroat Trout	1	0
Kokanee	187	67
Kokanee (clipped)	36	6
Mountain Whitefish	1	0
O. mykiss (clipped)	9	2
Pumpkinseed	70	10
Sculpin	6	1
Unknown*	23	23
Totals	**1,167**	**244**

*Species denoted as “unknown” were too small and/or too decomposed to identify.

1.3.4 Green Peter Head of Reservoir – Middle Santiam River

A single 5-foot RST was deployed in the Middle Santiam River above Green Peter Reservoir on February 1, 2024, and continued sampling until November 30, 2024.

Sampling outages resulting from high flows, excessive debris, severe weather, localized flood evacuations, and additional issues are listed in Appendix B: Sampling Outages by Site. Non-sampling periods illustrated in the figures below are further detailed in Appendix B: Sampling Outages by Site.

Additionally, the trap did not sample from February 27, 2024, to March 4, 2024, due to an incoming storm which subsequently caused projected flows to drastically increase, creating uncertain road, weather, and flow conditions for both EAS crew and captured fish.

1.3.4.1 Trapping Efficiency Trials

A total of 15 TE trials occurred at the Green Peter Head of Reservoir – Middle Santiam RST site in 2024 site using hatchery reared Chinook salmon. Of these, 3 trials used dead fish and 12 used live fish. Collectively, 19 live fish TE trials and 5 dead fish trials have occurred at this site since June 2023. A summary of the fish release numbers, recaptures, and flow level for each trial is provided in Table 24.

TEs ranged from 0.0% to 3.5% with a pooled average of 1.8% (95%CI ± 1.7%, n=3) for all successful trials with five or more recaptures. Only one fish was captured in the trap between the two dead fish trials. Of the 13 live fish trials only three trials captured more than five fish to be used to calculate a passage estimate. On June 23, 2024, the flow at this site became too low (gage height <2 feet), resulting in the cone grounding out and ceasing to rotate. The trap resumed normal operation on November 11, 2024, when the gage height reached two feet. However, four TE trials were conducted during the low flow period and no fish were recaptured. Trap efficiency analysis identified the full model—incorporating weekly discharge, trap revolutions per hour, median fork length, and the interaction between the three covariates—as having the highest pseudo R^2 (0.99, n=16). However, these results likely reflect overfitting due to small sample sizes and limited variability in the response data, driven by the low trap efficiencies. In such cases, models may be capturing site-specific noise rather than generalizable patterns, emphasizing the need for cautious interpretation of model results. More successful TE trials across the range of flows and fish lengths are required for meaningful insight at this site. Detailed methods and full results of the trap efficiency modeling are provided in Appendix E: Trap Efficiency Plots.

The placement of the RST is constrained by the requirement that both the trap and its associated highline must be entirely situated on land owned by the Bureau of Land Management. The local landowner upstream of this land has declined permission for the placement of an RST and any associated equipment on their property. This restricts the sampling location to a single pool in a relatively wide and flat section of the river. The RST is located within the thalweg, the best overall sampling position for the RST across all seasons. However, it does not spin appropriately at low flows in the summer, an occurrence commonly evidenced when operating sampling machinery of this nature. Therefore, efficient sampling at this site can only occur during sufficient flow. Comparing flow rate against gage height, the trap stops spinning at and below a gage height of 2 ft. Based on current flow conditions and weekly gage height averages from 2023, the trap is expected to be non-functional from late June to early November (EAS 2024).

Table 24. Summary of trapping efficiency trials at the Green Peter Head of Reservoir – Middle Santiam River RST site.

Release Location	Date of Release	Gage Height at Release (ft)	Number of Fish Released	Number of Fish Recaptured	Percent Efficiency
Green Peter Head of Reservoir – Middle Santiam (dead fish)	06/07/2023	2	1,000	0	0.00%
Green Peter Head of Reservoir – Middle Santiam	06/07/2023	2	750	0	0.0%
Green Peter Head of Reservoir – Middle Santiam	07/28/2023	1	750	0	0.0%
Green Peter Head of Reservoir – Middle Santiam	08/30/2023	0.9	749	0	0.0%
Green Peter Head of Reservoir – Middle Santiam	09/27/2023	1.3	741	0	0.0%
Green Peter Head of Reservoir – Middle Santiam	10/11/2023	2.9	750	0	0.0%
Green Peter Head of Reservoir – Middle Santiam	10/31/2023	1.5	750	0	0.0%
Green Peter Head of Reservoir – Middle Santiam (dead fish)	10/31/2023	1.5	1,000	0	0.0%
Green Peter Head of Reservoir – Middle Santiam	11/15/2023	2.5	749	1	0.1%
Green Peter Head of Reservoir – Middle Santiam	02/08/2024	3.2	753	4	0.5%
Green Peter Head of Reservoir – Middle Santiam+	03/06/2024	3.1	2,500	26	1.00%
Green Peter Head of Reservoir – Middle Santiam	03/14/2024	3.43	800	4	0.5%
Green Peter Head of Reservoir – Middle Santiam	04/02/2024	3.35	754	2	0.3%
Green Peter Head of Reservoir – Middle Santiam (dead fish)	04/02/2024	3.35	1,002	1	0.1%
Green Peter Head of Reservoir – Middle Santiam+	04/12/2024	3.04	2,500	24	1.0%
Green Peter Head of Reservoir – Middle Santiam (dead fish)	04/19/2024	2.63	1,000	0	0.0%
Green Peter Head of Reservoir – Middle Santiam	05/15/2024	3.17	998	35	3.5%
Green Peter Head of Reservoir – Middle Santiam	06/05/2024	3.52	1,083	10	0.9%
Green Peter Head of Reservoir – Middle Santiam	07/09/2024	1.4	1001	0	0.0%
Green Peter Head of Reservoir – Middle Santiam	08/14/2024	1.0	1001	0	0.0%
Green Peter Head of Reservoir – Middle Santiam	09/10/2024	0.9	999	0	0.0%
Green Peter Head of Reservoir – Middle Santiam	10/09/2024	0.8	998	0	0.0%
Green Peter Head of Reservoir – Middle Santiam	11/05/2024	2.7	996	3	0.3%
Green Peter Head of Reservoir – Middle Santiam (dead fish)	11/12/2024	2.8	1,000	1	0.1%

+TE release performed by CFS

1.3.4.2 Run of River Trapping Efficiency Trials

Releases for ROR TE trials were pooled by month. A total of 511 juvenile Chinook salmon and zero *O. mykiss* were released between February 3, 2024, and March 25, 2024, after which ROR trials were discontinued due to low catch rates (Table 25). In total, 7 fish were recaptured from the 2024 trials with TEs ranging from 0.6-1.7%. To account for sample size variability, monthly calculations were weighted based on sample size and then summed yielding an estimated TE for ROR trials of 1.4%. This value is similar to TE using hatchery reared Chinook salmon (1.8%); however, the limited number of trials indicates that more data is needed to increase the overall sample size.

Table 25. Summary table of run of river releases at the Green Peter Head of Reservoir RST site for trapping efficiency.

Release Location	Date of Release	Number of Fish Released	Number of Fish Recaptured	Percent Efficiency
Green Peter Head of Reservoir	February 2024	349	6	1.7%
Green Peter Head of Reservoir	March 2024	162	1	0.6%

1.3.4.3 Target Catch, Passage Estimates, and Passage Timing

The trap captured 811 juvenile Chinook salmon and 26 juvenile *O. mykiss*. It is assumed that *O. mykiss* captured at this site are primarily composed of resident rainbow trout since steelhead are not transported to spawn above Green Peter Reservoir. However, due to the difficulty in distinguishing between resident trout and anadromous steelhead, all unmarked *O. mykiss* were treated as target fish and reported as such.

Juvenile Chinook salmon were only captured during the spring monitoring period. Peak capture of juvenile Chinook salmon occurred in February (n=600, 74.0% of total catch) (Figure 21). Chinook salmon catch was composed primarily of BY 2023 fish (n=806, 99.4 % of total Chinook catch) (Figure 23). Additionally, 5 BY 2022 yearlings were captured between February and March. The first BY 2023 sub-yearling Chinook captured at the trap occurred on the first day of sampling and catch continued until mid-May. Capture of Chinook fry on the first day of sampling and peak capture of fish occurring in February suggests that many Chinook salmon sub-yearlings likely passed the trapping site prior to the initiation of sampling. Figure 21 shows raw and standardized catch overlayed with flow at the Green Peter Head of Reservoir- Middle Santiam site.

Due to the relatively few successful trials (n=3) and range of flows encountered, we were unable to create a passage estimate for this location. Additional trials are planned for this site and will be needed to create estimates in the future.

A majority of juvenile *O. mykiss* captured at the Green Peter Head of Reservoir RST site occurred during the spring monitoring period (n=24, 92.3% of total capture). Peak capture of juvenile *O. mykiss* at the Green Peter Head of Reservoir – Middle Santiam site occurred in May (n=10, 38.5% of total catch) (Figure 22). *O. mykiss* capture in the spring consisted of fish from four brood years: BY 2021, BY 2022, BY 2023 and BY 2024 (Figure 24). Fall capture of *O. mykiss* occurred in November when 2 fish from BY 2024 were encountered. A summary of fork lengths and weights of captured Chinook salmon and *O. mykiss* by BY is provided in Table 26.

Table 26. Summary of fork length and weight observed on juvenile Chinook salmon and *O. mykiss* of NOR at the Green Peter Head of Reservoir RST site by brood year.

Species	Date Range	BY	Number of Fish	Average F.L. (mm)	Min. F.L. (mm)	Max F.L. (mm)	Median F.L. (mm)	Average Weight (g)	Min. Weight (g)	Max Weight (g)	Median Weight (g)
Chinook	2/1/24–6/30/24	22	5	91.6	81	104	92	8.7	5.8	10.9	8.9
Chinook	2/1/24–6/30/24	23	806	36.2	32	70	36	N/A	N/A	N/A	N/A
Chinook	7/1/24–11/30/24	N/A	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
O. mykiss	2/1/24–6/30/24	21	1	255	255	255	N/A	147.5	147.5	147.5	N/A
O. mykiss	2/1/24–6/30/24	22	3	174	139	215	168	53.3	27.5	88.8	43.6
O. mykiss	2/1/24–6/30/24	23	18	95.2	75	115	92	9.1	6.4	18.4	9.1
O. mykiss	2/1/24–6/30/24	24	2	23.5	20	27	N/A	N/A	N/A	N/A	N/A
O. mykiss	7/1/24–11/30/24	24	2	90.5	87	94	N/A	8.4	7.2	9.5	N/A

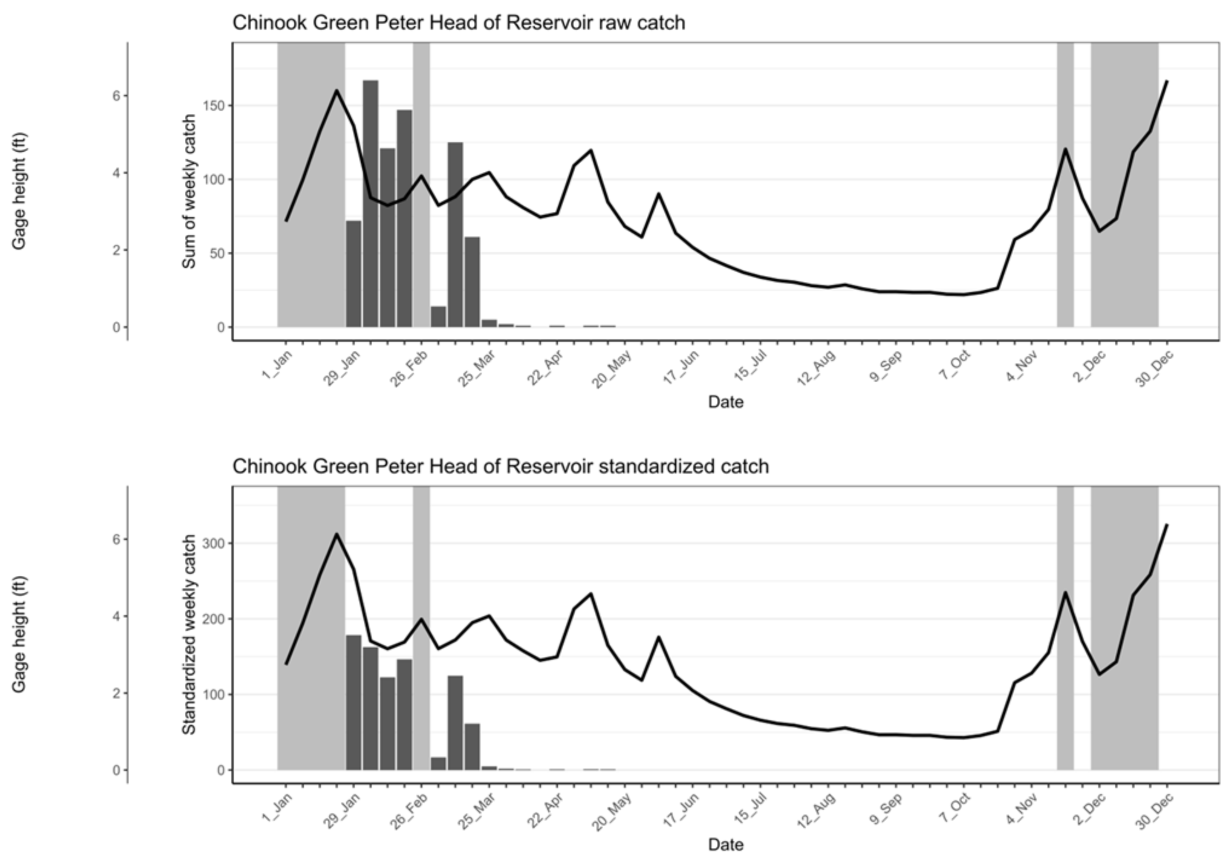

Figure 21. Raw catch (top panel) and weekly standardized catch (bottom panel) of NOR juvenile Chinook salmon at the Green Peter Head of Reservoir with stream gage height (black line) and non-sampling weeks shaded out (gray).

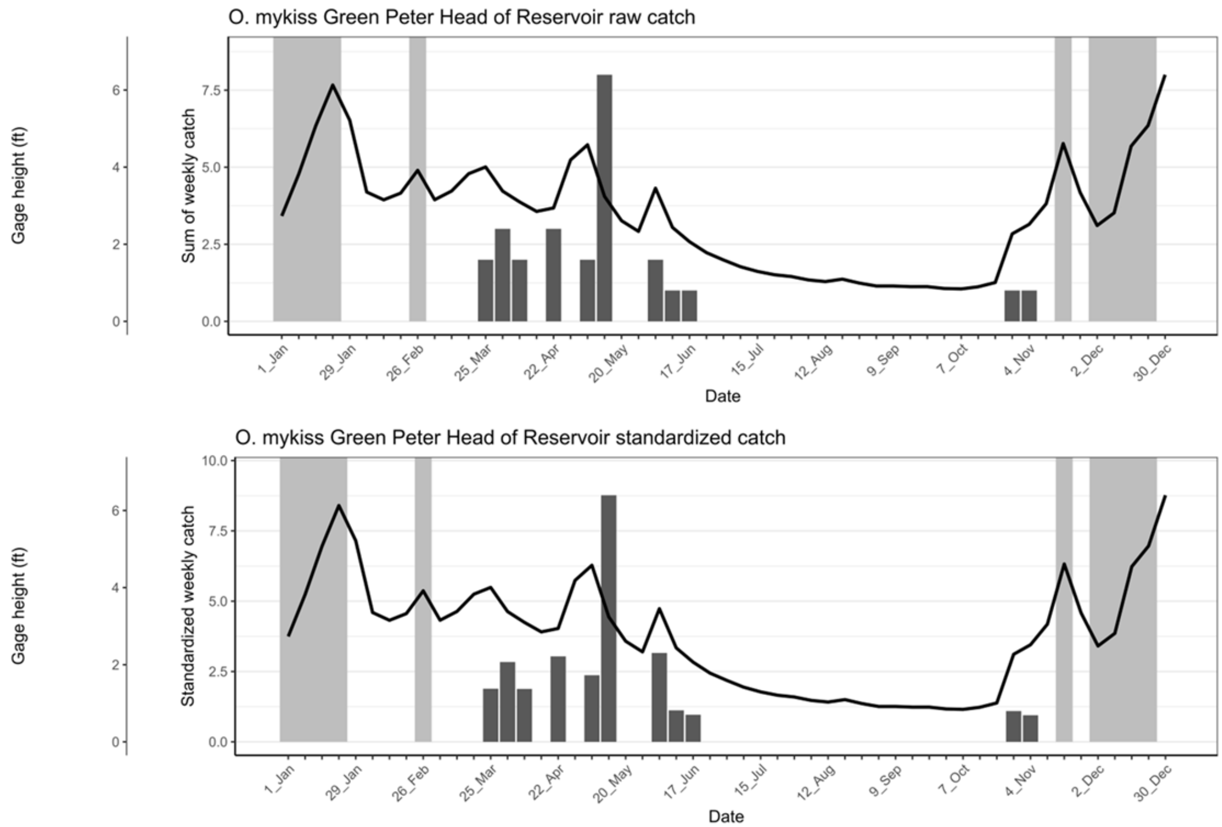

Figure 22. Raw catch (top panel) and weekly standardized catch (bottom panel) of NOR juvenile *O. mykiss* at Green Peter Head of Reservoir with stream gage height (black line) and non-sampling weeks shaded out (gray).

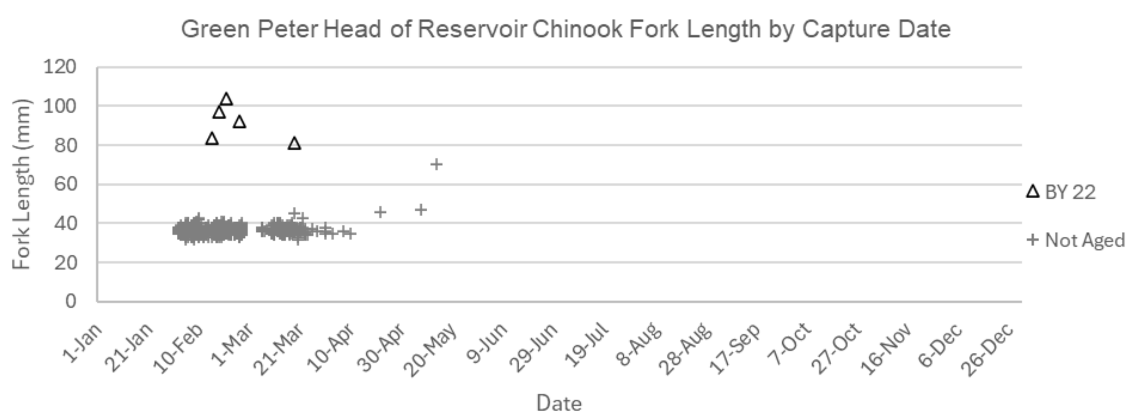

Figure 23. Length-frequency of juvenile Chinook salmon at the Green Peter Head of Reservoir site.

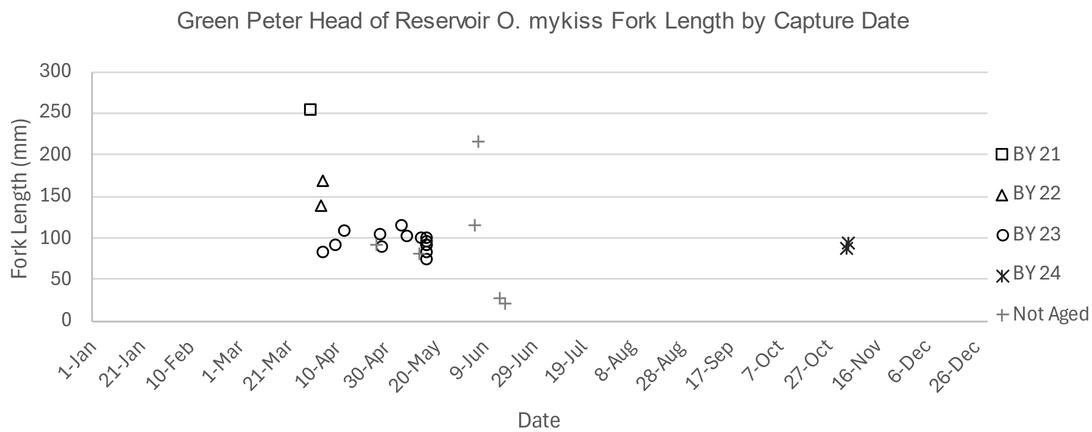

Figure 24. Length-frequency of juvenile *O. mykiss* at the Green Peter Head of Reservoir site.

1.3.4.4 Injury Data

A total of 55 juvenile Chinook salmon (6.8% of total Chinook salmon catch) displayed at least one of the injury code conditions listed in Table 3. Descaling less than 20%, bruising, head injury, operculum damage, and fin damage were the most common injuries seen in Chinook salmon at the Green Peter Head of Reservoir RST (Table 27). These injuries were likely incurred upon capture in the RST due to debris or contact with various surfaces in the trap. Bulk marked released Chinook at this site were observed having a higher percentage of descaling less than and greater than 20%, operculum damage, tears, and fin damage when compared to the NOR Chinook. It should be noted that bulk marked released Chinook at this site were assessed in relatively low numbers (n=3). TE hatchery Chinook salmon were found to have higher percentages of descaling less than 20%, bleeding from vent, and bruising as compared to both NOR and bulk marked released Chinook (Table 27).

Data collected on the injury rates of TE hatchery fish illustrated that the percentage of fish with external injuries decreased, while the average number of injuries per fish remained consistent from pre-release to recaptured observations of Chinook salmon at the Green Peter Head of Reservoir RST site. These findings are inconsistent with that of other sites. Generally speaking, an increase in external injuries is seen with recaptured Chinook salmon. The decrease in injury rates at the Green Peter Head of Reservoir site could be due to slower rotation speeds of the cone, resulting in less mechanical damage on captured fish. Additional observation of injury rates on recaptured fish will be needed to confirm these findings and elucidate potential variables influencing injuries on recaptured fish at this location. Detailed findings on injury type are further presented in Appendix D: Additional Injury Information.

A total of 17 *O. mykiss* (65.4% of total *O. mykiss* catch) displayed at least one of the injury codes detailed in Table 3. The most frequently observed injuries for *O. mykiss* were illustrated to be descaling less than 20%, fin damage, and the presence of copepods. Copepods were observed on 7.7% of the *O. mykiss* encountered. There were no copepods observed on Chinook salmon at this site (Figure 25 and Figure 26). The presence of copepods found on *O. mykiss* did not illustrate any relationship with size. Additional information regarding injuries by size and average injuries per fish is available in Appendix D: Additional Injury Information.

Table 27. Summary of injuries observed on NOR, bulk marked, and TE hatchery Chinook salmon, in addition to *O. mykiss* at the Green Peter Head of Reservoir – Middle Santiam River RST site.

Injury Code	Chinook Injuries (NOR) (n=811)	Bulk Marked Released Chinook (n=3)	Trapping Efficiency Hatchery Chinook (n=107)	*O. mykiss* Injuries (NOR) (n=26)
NXI (no external injury)	93.2%	0.0%	35.5%	34.6%
MUNK	0.0%	0.0%	0.0%	3.8%
DS<2	1.4%	33.3%	38.3%	42.3%
DS>2	0.5%	33.3%	3.7%	0.0%
BLO	0.0%	0.0%	0.0%	0.0%
EYB	0.4%	0.0%	0.0%	0.0%
BVT	0.1%	0.0%	0.0%	0.0%
FVB	0.7%	0.0%	2.8%	0.0%
GBD	0.0%	0.0%	0.0%	0.0%
POP	0.9%	0.0%	0.0%	0.0%
HIN	1.4%	0.0%	0.9%	0.0%
OPD	3.1%	66.7%	5.6%	0.0%
TEA	1.0%	66.7%	0.0%	0.0%
BRU	1.8%	0.0%	2.8%	0.0%
HBP	0.0%	0.0%	0.0%	0.0%
HO	0.0%	0.0%	0.0%	0.0%
BO	0.0%	0.0%	0.0%	0.0%
HBO	0.0%	0.0%	0.0%	0.0%
FID	1.2%	66.7%	50.5%	30.8%
PRD	0.0%	0.0%	0.0%	0.0%
COP	0.0%	0.0%	0.0%	7.7%
BKD	0.0%	0.0%	0.0%	0.0%
FUN	0.0%	0.0%	0.0%	0.0%

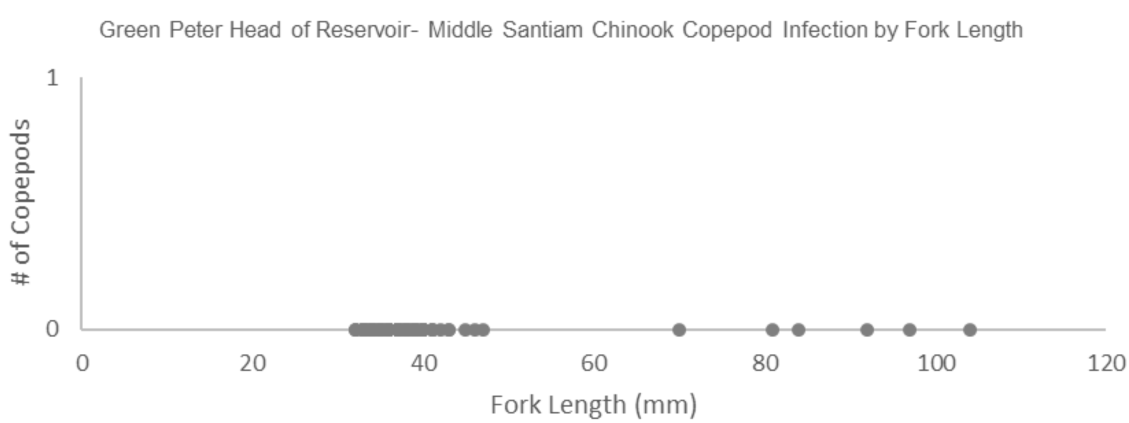

Figure 25. Copepod prevalence vs fork length on juvenile Chinook salmon captured at Green Peter Head of Reservoir.

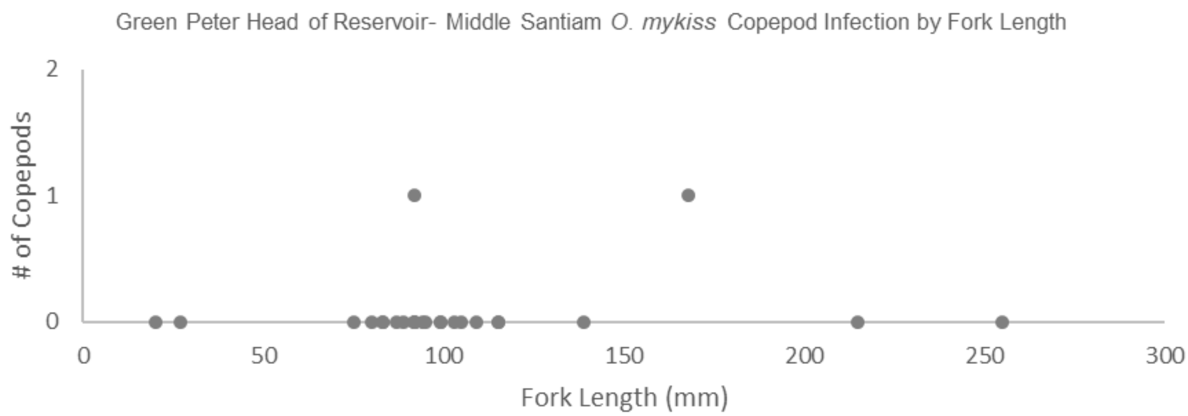

Figure 26. Copepod prevalence vs fork length on juvenile *O. mykiss* captured at Green Peter Head of Reservoir.

1.3.4.5 PIT Tagged/VIE Marked Fish and Downstream Detections

A total of 6 juvenile Chinook salmon and 23 juvenile *O. mykiss* were PIT tagged at the Green Peter Head of Reservoir – Middle Santiam site in 2024. 601 juvenile Chinook and zero *O. mykiss* were VIE marked. Some fish did not meet length requirements or were still sac-fry that were not able to be marked. No VIE or PIT tagged fish were redetected at downstream sites. Table 28 shows a summary of VIE marked fish with the tagging period and mark details.

Table 28. Summary table of VIE tagged fish at the Green Peter Head of Reservoir – Middle Santiam River RST site.

Date Tagged	Species	Tag Location	VIE Color	# Tagged	# Recaptured
02/01/2024–02/15/2024	Chinook	Right Dorsal	Yellow	177	0
02/01/2024–02/15/2024	*O. mykiss*	Right Dorsal	Yellow	0	0
02/16/2024–02/29/2024	Chinook	Right Dorsal	Yellow	239	0
02/16/2024–02/29/2024	*O. mykiss*	Right Dorsal	Yellow	0	0
03/01/2024–03/15/2024	Chinook	Right Dorsal	Red	91	0
03/01/2024–03/15/2024	*O. mykiss*	Right Dorsal	Red	0	0
03/16/2024–03/31/2024	Chinook	Right Dorsal	Red	89	0
03/16/2024–03/31/2024	*O. mykiss*	Right Dorsal	Red	0	0
04/01/2024–04/15/2024	Chinook	Right Dorsal	Blue	3	0
04/01/2024–04/15/2024	*O. mykiss*	Right Dorsal	Blue	0	0
04/16/2024–04/30/2024	Chinook	Right Dorsal	Blue	1	0
04/16/2024–04/30/2024	*O. mykiss*	Right Dorsal	Blue	0	0
05/01/2024–05/15/2024	Chinook	Right Dorsal	Orange	1	0
05/01/2024–05/15/2024	*O. mykiss*	Right Dorsal	Orange	0	0
05/16/2024–05/31/2024	Chinook	Right Dorsal	Orange	0	0
05/16/2024–05/31/2024	*O. mykiss*	Right Dorsal	Orange	0	0
06/01/2024–06/15/2024	Chinook	Right Dorsal	Pink	0	0
06/01/2024–06/15/2024	*O. mykiss*	Right Dorsal	Pink	0	0
06/16/2024–06/30/2024	Chinook	Right Dorsal	Pink	0	0
06/16/2024–06/30/2024	*O. mykiss*	Right Dorsal	Pink	0	0
07/01/2024–07/15/2024	Chinook	Right Dorsal	Green x2	0	0
07/01/2024–07/15/2024	*O. mykiss*	Right Dorsal	Green x2	0	0
07/16/2024–07/31/2024	Chinook	Right Dorsal	Green x2	0	0
07/16/2024–07/31/2024	*O. mykiss*	Right Dorsal	Green x2	0	0
08/01/2024–08/15/2024	Chinook	Right Dorsal	Yellow x2	0	0
08/01/2024–08/15/2024	*O. mykiss*	Right Dorsal	Yellow x2	0	0
08/16/2024–08/31/2024	Chinook	Right Dorsal	Yellow x2	0	0
08/16/2024–08/31/2024	*O. mykiss*	Right Dorsal	Yellow x2	0	0
09/01/2024–09/15/2024	Chinook	Right Dorsal	Red x2	0	0
09/01/2024–09/15/2024	*O. mykiss*	Right Dorsal	Red x2	0	0
09/16/2024–09/30/2024	Chinook	Right Dorsal	Red x2	0	0
09/16/2024–09/30/2024	*O. mykiss*	Right Dorsal	Red x2	0	0
10/01/2024–10/15/2024	Chinook	Right Dorsal	Blue x2	0	0
10/01/2024–10/15/2024	*O. mykiss*	Right Dorsal	Blue x2	0	0
10/16/2024–10/31/2024	Chinook	Right Dorsal	Blue x2	0	0
10/16/2024–10/31/2024	*O. mykiss*	Right Dorsal	Blue x2	0	0
11/01/2024–11/15/2024	Chinook	Right Dorsal	Orange x2	0	0
11/01/2024–11/15/2024	*O. mykiss*	Right Dorsal	Orange x2	0	0
11/16/2024–11/30/2024	Chinook	Right Dorsal	Orange x2	0	0
11/16/2024–11/30/2024	*O. mykiss*	Right Dorsal	Orange x2	0	0

1.3.4.6 Willamette Valley Projects Encounters

A total of 52 adipose clipped and PIT tagged Chinook salmon from Cramer Fish Science's bulk mark releases were detected at the Green Peter Head of Reservoir RST in 2024. 49 of these fish were considered recaptures for TE trials. For more information regarding release groups, dates, and other redetections, refer to the *Bulk Mark Release and Reservoir Distribution Study Annual Report* (CFS 2024).

1.3.4.7 Non-Target Capture Data

A total 53 non-target fish were captured in addition to NOR juvenile Chinook salmon and *O. mykiss* at the Green Peter Head of Reservoir site in 2024. The most commonly captured non-target species were dace and clipped Chinook. A summary of species and numbers of fish caught are provided in Table 29.

Table 29. Summary of non-target fish capture at the Green Peter Head of Reservoir – Middle Santiam River RST site in 2024.

Species	Season Total	Season Total Mortality (subset of total)
Juvenile Chinook (clipped)	4	0
Dace	44	3
Kokanee	1	0
Largescale Sucker	1	0
Mountain Whitefish	1	0
O. mykiss (clipped)	1	0
Unknown*	1	0
Totals	**53**	**3**

*Species denoted as "unknown" were too small and/or too decomposed to identify.

1.3.5 Green Peter Dam Tailrace – Middle Santiam River

A single 8-foot RST continued monitoring activities in the Green Peter Dam Tailrace and sampled from January 1, 2024, through December 31, 2024.

Sampling outages resulting from high flows, excessive debris, severe weather, localized flood evacuations, and additional issues are listed in Appendix B: Sampling Outages by Site. Non-sampling periods illustrated in the figures below are further detailed in Appendix B: Sampling Outages by Site.

The RST was raised to its non-sampling position from January 19, 2024, to February 9, 2024, and November 11, 2024, to November 22, 2024, due to high flows which subsequently caused safety concerns for both crew and fish as well as increasing overall debris loads. Additionally, the RST was raised to its non-sampling position from February 29, 2024, to March 4, 2024, as the USACE dam operator informed EAS that high flows, exceeding preset safety thresholds, were expected. Additionally, the RST was unable to sample from March 13, 2024 to March 14, 2024 and again from March 15, 2024 to March 19, 2024 due to large amounts of woody debris creating conditions in which the trap could not function during the initiation of spring nighttime surface spill operations that began on March 13, 2024.

In both calendar year 2022 and 2023, 800 adult Chinook salmon were released in tributaries above Green Peter Reservoir to spawn, 200 in Quartzville Creek, and 600 in the Middle Santiam River (CFS 2023b).

1.3.5.1 Trapping Efficiency Trials

A total of 17 TE trials occurred at the Green Peter Dam Tailrace in 2024 using hatchery reared Chinook salmon. Of these, 2 trials used dead fish and 15 used live fish. Collectively, 34 TE trials have occurred at this site since March, of 2022. 5 of these trials were dead fish releases. A summary of the fish release numbers, recaptures, and flow level for each trial is provided in Table 30.

For the live fish releases, TEs ranged from 0.0% to 2.8% with a pooled average of 1.5% (95%CI ± 0.4%, n=17) of all successful trials with five or more recaptures. Ten of the live fish trials did not recapture enough fish to be used in the passage estimate calculation. Dead fish releases were not included in the passage estimate. Trap efficiency analysis was not conducted for this site because many TE trials were conducted while flow was alternating between the powerhouse and regulating outlet routes. This made distinguishing the source of flow for the analysis unfeasible. Further investigation into operations at this site will be conducted to determine if a different analytical approach is possible.

Table 30. Summary table of marked hatchery Chinook salmon releases in the Green Peter Dam Tailrace for trapping efficiency.

Release Location	Date of Release	cfs at Release	Number of Fish Released	Number of Fish Recaptured	Percent Efficiency
Green Peter Dam Tailrace – Surface Spill*	03/29/2022	970	643	4	0.6%
Green Peter Dam Tailrace – Surface Spill*	04/30/2022	1,310	518	9	1.7%
Green Peter Dam Tailrace – Surface Spill*	05/11/2023	1,910	999	9	0.9%
Green Peter Dam Tailrace – Surface Spill (dead fish)*	05/11/2023	1,910	1,001	0	0.0%
Green Peter Dam Tailrace – PH*	05/25/2023	1,980	1,000	10	1.0%
Green Peter Dam Tailrace – PH	06/30/2023	2,000	1,000	9	0.9%
Green Peter Dam Tailrace – PH (dead fish)*	06/30/2023	50	1,000	10	1.0%
Green Peter Dam Tailrace – PH*	07/27/2023	49.4	1,009	13	1.3%
Green Peter Dam Tailrace – PH*	08/16/2023	3,905	1,008	7	0.7%
Green Peter Dam Tailrace – PH*	08/31/2023	34.6	1,000	8	0.8%
Green Peter Dam Tailrace – PH*	10/04/2023	3,060	1,005	0	0.0%
Green Peter Dam Tailrace – RO Spill*	11/01/2023	1,430	1,000	22	2.2%
Green Peter Dam Tailrace – RO Spill**	11/14/2023	1,300	1,000	7	0.7%
Green Peter Dam Tailrace – RO Spill*	11/29/2023	630	1,000	28	2.8%
Green Peter Dam Tailrace – RO Spill (dead fish)*	11/29/2023	630	3,999	11	0.3%
Green Peter Dam Tailrace*	12/08/2023	3,700	1,000	25	2.5%
Green Peter Dam Tailrace – RO Spill*	12/19/2023	50	1,000	3	0.3%
Green Peter Dam Tailrace – PH	01/09/2024	3,590	1,003	9	0.9%
Green Peter Dam Tailrace – RO Spill	02/16/2024	500	1,000	1	0.1%
Green Peter Dam Tailrace – PH	03/26/2024	2,120	1,014	1	0.1%
Green Peter Dam Tailrace – Surface Spill	03/26/2024	1,100	1,004	2	0.2%
Green Peter Dam Tailrace – Surface Spill (dead fish)	03/26/2024	1,100	3,000	0	0.0%
Green Peter Dam Tailrace – Surface Spill	04/18/2024	1,270	1,011	3	0.3%
Green Peter Dam Tailrace – Surface Spill (dead fish)	04/24/2024	1,270	3,000	2	0.1%
Green Peter Dam Tailrace – Surface Spill	04/24/2024	1,270	1,000	2	0.2%
Green Peter Dam Tailrace – PH	06/11/2024	1,890	1,000	3	0.3%
Green Peter Dam Tailrace – PH	06/18/2024	2,010	1,001	1	0.1%
Green Peter Dam Tailrace – PH	08/07/2024	2,009	1,000	12	1.2%
Green Peter Dam Tailrace – PH	08/21/2024	1,097	1,000	2	0.2%
Green Peter Dam Tailrace – PH	09/04/2024	2,070	999	0	0.0%
Green Peter Dam Tailrace – PH	10/01/2024	2,000	1,000	14	1.4%

Release Location	Date of Release	cfs at Release	Number of Fish Released	Number of Fish Recaptured	Percent Efficiency
Green Peter Dam Tailrace – RO Spill	10/30/2024	2,400	1,003	28	2.8%
Green Peter Dam Tailrace – RO Spill	11/01/2024	2,500	1,000	21	2.1%
Green Peter Dam Tailrace – RO Spill	12/11/2024	800	1,000	6	0.6%

*Release performed by EAS for the USACE under contract W9127N19D0007.

1.3.5.2 Run of River Trapping Efficiency Trials

No live TE trials using ROR fish were performed at Green Peter Dam in 2024. The first 60 wild fish caught per week are prioritized for the 24-hour hold mortality study. Sufficient numbers of NOR fish were not available to perform live ROR TE trials. During the deep drawdown period, we had sufficient numbers to run a dead fish ROR TE trial. A total of 106 dead Chinook were used for a ROR TE trial. These fish were encountered dead in the RST. They were differentially marked and released in the RO channel. There were zero ROR TE recaptures (Table 31).

Table 31. Summary table of run of river releases at the Green Peter Dam Tailrace RST site for trapping efficiency.

Release Location	Date of Release	Number of Fish Released	Number of Fish Recaptured	Percent Efficiency
Green Peter Dam Tailrace	November 2024	106	0	0.0%

1.3.5.3 Target Catch, Passage Estimates and Passage Timing

The trap captured 247 juvenile Chinook salmon and 10 juvenile *O. mykiss* at this site in 2024. *O. mykiss* captured at this location are likely progeny of resident trout, as winter steelhead are not transported above Green Peter Dam in recent years. However, all NOR juvenile *O. mykiss* at this site were treated as target fish.

The trap collected 128 juvenile Chinook salmon (51.8% of total Chinook catch) during sampling in the spring. Peak capture of juvenile Chinook salmon during this time occurred in June (n=47, 36.7% of spring catch) (Figure 27). Chinook salmon catch was composed primarily of BY 2023 sub-yearlings (n=77, 60.2% of spring catch) (Figure 29). The first BY 2023 sub-yearling Chinook was captured on January 4, 2024, and catch of these fish continued into June. BY 2022 yearlings were encountered from mid-January through early May.

Chinook catch in the fall was comprised of 119 fish (48.2% of total Chinook catch) from BYs 2022 and 2023. BY 2022 fish comprised a majority of catch in the fall (n=116, 97.5% of fall catch). Capture of Chinook in the fall occurred in October and November during deep drawdown and RO operations.

A total of 8 juvenile *O. mykiss* were collected during monitoring in the spring. Peak capture of juvenile *O. mykiss* occurred in April (n=5, 62.5% of spring catch) (Figure 28).The *O. mykiss* captured in the spring consisted entirely of BY 2023 fish and were only captured in April and May (Figure 30).

In total, 2 *O. mykiss* were captured during monitoring in the fall. Both individuals were BY 2023 fish and were encountered on the same day, November 8th. Descriptive statistics on fork length and size of fish captured at Green Peter Dam by BY is provided below in Table 32.

Periods of increased catch of both Chinook salmon and *O. mykiss* occurred in the spring and coincided with surface spill operations that occurred at Green Peter Dam in April, May, and June. Peak capture at Green Peter Dam in the spring coincided with a spill event that occurred in June. It also appears that capture of both species increased once spill operations switched from intermittent surface spill to continuous spill operations in both the April and June capture events. However, the trap had to be raised to non-sampling position from January 19, 2024, to February 9, 2024, due to high flows which subsequently caused safety concerns for both crew and fish and again from March 13, 2024 to March 19, 2024 due high debris loads which prevented the RST from operating. It is possible that juvenile Chinook passed through the sampling site during this time with the increased flows and short spill period that occurred. Capture of fish prior to the initiation of surface spill and after the extended spill operation in the spring suggests that Chinook arrive to the forebay of Green Peter Dam throughout the spring period.

Fall capture of Chinook occurred once RO operations began in October and catch increased as pool elevations dropped. Additionally, catch started as the forebay elevation dropped below an elevation of 900 feet and peaked as it approached and passed 800 feet. Unfortunately, a large rain event resulted in the need to increase outflows at Green Peter Dam above levels in which the RST could be safely operated resulting in a sampling outage from the 11th to the 22nd of November when the drawdown reached its lowest elevations. Trends in catch data suggest that many Chinook continued to pass through Green Peter Dam during this time. Using pooled averages of hatchery Chinook TEs, EAS estimates that 18,668 (95% CI: 14,924 to 24,921) juvenile Chinook salmon passed through Green Peter Dam Tailrace during sampling in 2024 (Figure 27).

Table 32. Summary of fork length and weight observed on juvenile Chinook salmon and *O. mykiss* of NOR at the Green Peter Dam Tailrace RST site by brood year.

Species	Date Range	BY	Number of Fish	Average F.L. (mm)	Min. F.L. (mm)	Max F.L. (mm)	Median F.L. (mm)	Average Weight (g)	Min. Weight (g)	Max Weight (g)	Median Weight (g)
Chinook	1/1/2024–6/30/2024	22	51	146.6	98	173	149	35.1	9.8	56.5	36.1
Chinook	1/1/2024–6/30/2024	23	77	105.3	36	141	107	15.3	1.9	27.3	14.6
Chinook	7/1/2024–12/31/2024	22	116	256.4	202	301	257.5	209.4	97.6	307.6	210.5
Chinook	7/1/2024–12/31/2024	23	3	128.0	103	159	122	26.9	20.0	49.0	11.7
O. mykiss	1/1/2024–6/30/2024	23	8	188.9	162	225	187.5	63.0	38.0	90.5	63.1
O. mykiss	7/1/2024–12/31/2024	23	2	140.5	134	147	N/A	28.5	24.2	32.8	N/A

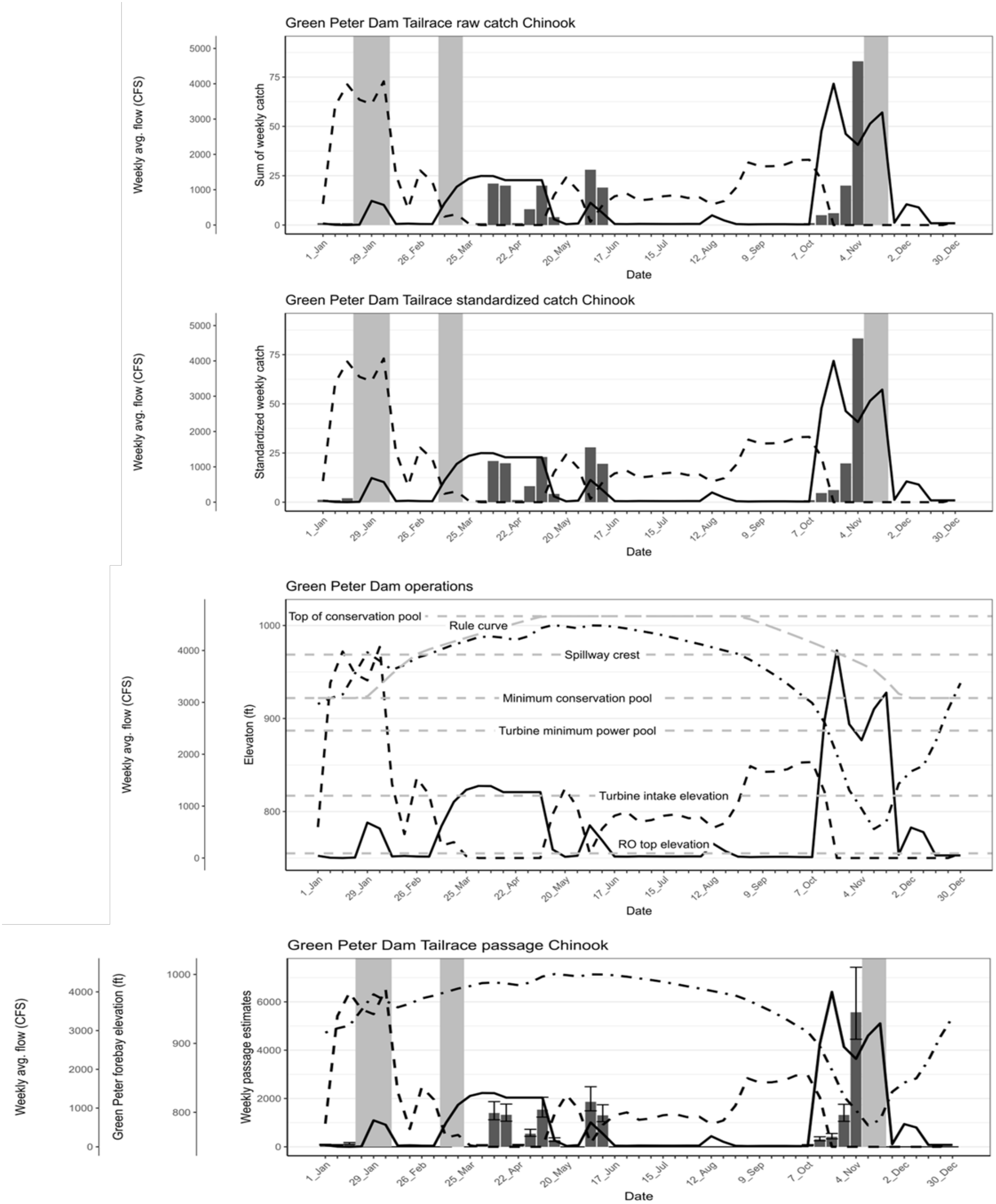

Figure 27. Raw catch (top panel), weekly standardized catch (second panel), and weekly passage estimates (bottom panel) of NOR juvenile Chinook salmon at Green Peter Dam Tailrace with spill/RO (black line), Powerhouse flow (black dash line), and non-sampling weeks shaded out (gray). The third panel displays Green Peter Dam operations and features of interest with spill/RO outflow (black line), Powerhouse outflow (black dash line), and forebay elevation (black dot dash line).

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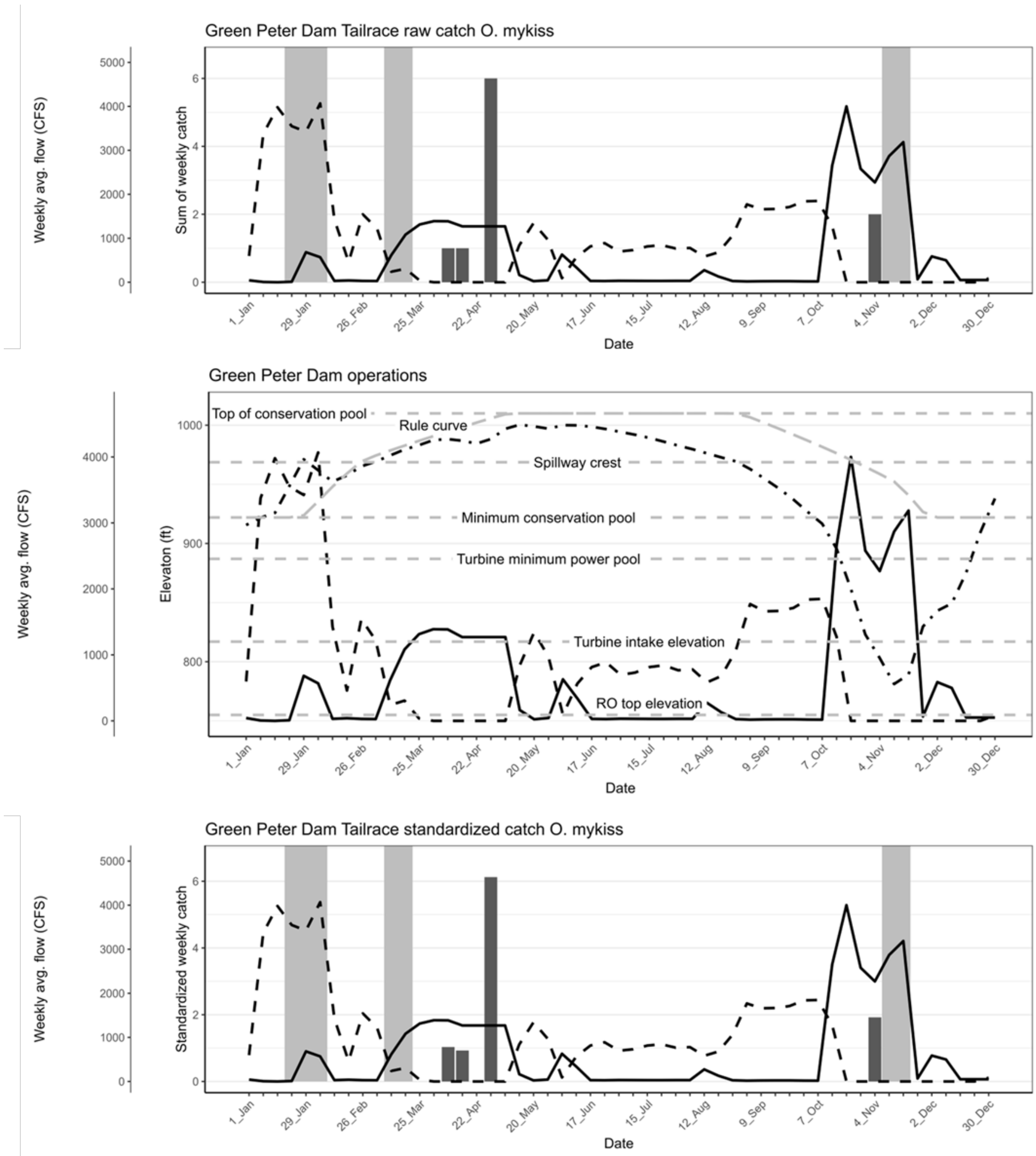

Figure 28. Raw catch (top panel) and weekly standardized catch (bottom panel) of NOR juvenile Chinook at Green Peter Dam Tailrace with spill (black line), Powerhouse (black dash line), and non-sampling weeks shaded out (gray). The middle panel displays Green Peter Dam operations and features of interest with spill/RO outflow (black line), Powerhouse outflow (black dash line), and forebay elevation (black dot dash line).

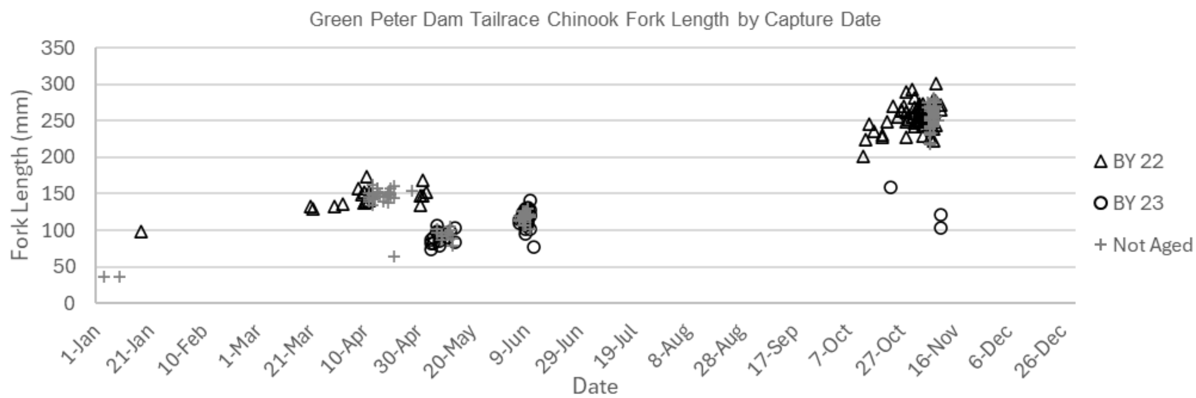

Figure 29. Age length-frequency for captured NOR Chinook salmon at the Green Peter Dam Tailrace site.

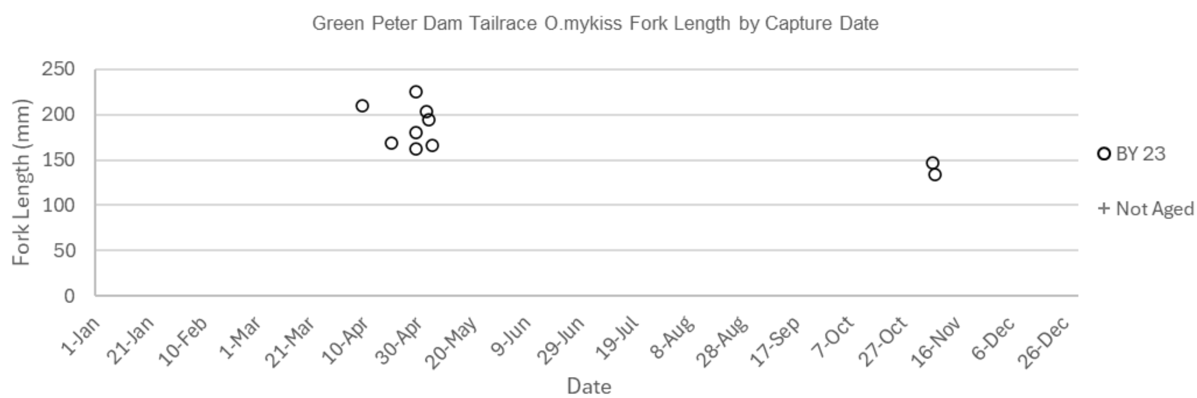

Figure 30. Age length-frequency for captured NOR *O. mykiss* at the Green Peter Dam Tailrace site.

1.3.5.4 Injury Data

A total of 244 juvenile Chinook salmon (98.8%) and 10 juvenile *O. mykiss* (100.0%) displayed at least one of the injury code conditions listed in Table 3. To provide insight on injuries associated with capture in a RST, injury data was collected from bulk marked released Chinook salmon and hatchery fish utilized for TE trials. Data from TE recaptures shows that the predominant injury seen in fish prior to TE releases were descaling less than 20%, descaling greater than 20%, and fin damage. Upon recapture of these TE fish, only descaling less than 20% and the presence of fungus were observed at higher rates, in addition to exhibiting similar rates of gas bubble disease, operculum damage and bruising (Appendix D: Additional Injury Information). For interpretation of results, it is important to note that this is a small sample size and observed trends should be considered preliminary until more data is available. The only category worth noting is fish in the >60 mm to <110 mm size range; there were not enough fish in the other two size ranges to compare between 2023 and 2024. In 2023, 79 NOR fish were collected. In 2024, a total of 42 NOR fish were collected. In 2023, injuries per fish (non NXI) was 2.7; in 2024, 2.5. In 2023, the total percent injured for NOR fish was 94.5%; in 2024, 95.3%.

The most common injuries observed on juvenile Chinook salmon and *O. mykiss* at this site include descaling less than and greater than 20%, fin damage, gas bubble disease, and the presence of copepods (Table 33). Figure 32 and Figure 33 illustrate that the presence of copepods in Chinook salmon potentially increases as does their size (albeit a weak relationship), while there is no discernable relationship between overall size of *O. mykiss* and the presence of copepods.

Chinook salmon that were bulk marked recaptures evidenced nominally higher rates of descaling less than 20%, bloating, bloody eye (hemorrhage), operculum damage, tears, and fin damage, as compared to NOR Chinook salmon caught at the Green Peter Dam RST site. The bulk marked Chinook salmon are hatchery reared fish that are subsequently released upstream of the dam and experience the same factors related to dam passage as the NOR Chinook. These fish display injuries related to dam passage and trap capture as well as injuries such as descaling and fin damage that are commonly observed in hatchery reared fish.

Figure 31 illustrates that increases in flow from RO and surface spill at Green Peter Dam directly affects overall bodily injury and gas bubble disease (Figure 31). Furthermore, it is evidenced that as RO or surface spill at Green Peter Dam Tailrace increases, so does descaling less than 20% in juvenile Chinook salmon (Figure 31). Relatively few fish were captured during periods in which the powerhouse operated at Green Peter Dam Tailrace in 2024 and thus, there is little information available to infer impacts of the powerhouse on passing Chinook at this location for 2024. It is likely that observations of gas bubble disease are higher for RST captured fish than those that are not captured in an RST as these fish are often caught and held in areas of higher dissolved gas. Surface spill periods are displayed in Table 34 and denoted in Figure 31.

Data collected on the injury rates of TE hatchery fish illustrated that both the percentage of fish with injuries and the average number of injuries per fish generally increased from pre-release to recaptured observations. Detailed findings on injury type are further presented in Appendix D: Additional Injury Information.

Similar to findings from Big Cliff Dam Tailrace, it was illustrated that juvenile Chinook salmon less than 60 mm incurred fewer injuries than those above 60 mm (Appendix D, Table D-2). All juvenile Chinook salmon greater than 110 mm were observed to have injuries.

During the time of trap check, 84 Chinook salmon (34.0% of total Chinook catch) were observed as deceased. A summary of injury type by species is included in Table 33. Additional information regarding injuries by size and average injuries per fish is available in Appendix D: Additional Injury Information.

Table 33. Summary of injuries observed on NOR, bulk marked, and TE hatchery Chinook salmon, in addition to *O. mykiss* at the Green Peter Dam RST site.

Injury Code	Chinook Injuries (NOR) (n=247)	Bulk Marked Released Chinook (n=178)	Trapping Efficiency Hatchery Chinook (n=105)	O. mykiss Injuries (NOR) (n=10)
NXI (no external injury)	1.2%	0.6%	1.0%	0.0%
MUNK	0.0%	0.0%	0.0%	0.0%
DS<2	64.0%	68.0%	88.6%	20.0%
DS>2	32.0%	30.3%	7.6%	80.0%
BLO	2.0%	3.4%	0.0%	0.0%
EYB	13.8%	14.0%	1.9%	20.0%
BVT	18.2%	10.7%	1.0%	10.0%
FVB	48.6%	22.5%	1.9%	20.0%
GBD	61.5%	37.6%	18.1%	50.0%
POP	1.6%	2.2%	0.0%	0.0%
HIN	14.6%	13.5%	1.0%	40.0%
OPD	16.2%	18.5%	13.3%	20.0%
TEA	3.2%	3.9%	0.0%	0.0%
BRU	23.1%	20.2%	3.8%	50.0%
HBP	0.8%	0.0%	0.0%	0.0%
HO	0.0%	0.0%	0.0%	0.0%
BO	0.0%	0.0%	0.0%	0.0%
HBO	0.0%	0.0%	0.0%	0.0%
FID	90.3%	93.3%	63.8%	100.0%
PRD	0.0%	0.0%	0.0%	0.0%
COP	43.3%	19.1%	0.0%	30.0%
BKD	0.0%	0.0%	0.0%	0.0%
FUN	5.7%	11.2%	6.7%	10.0%

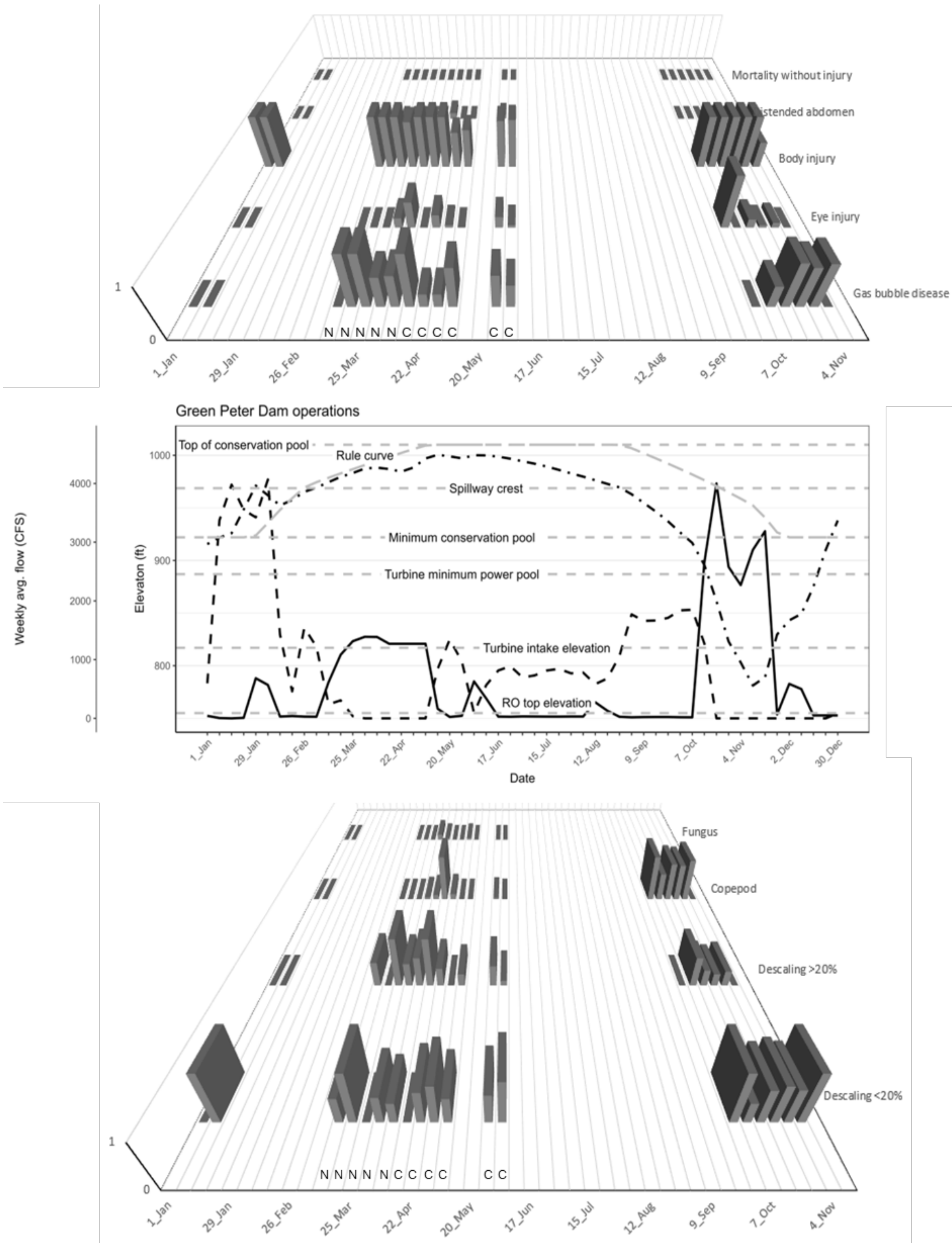

Figure 31. Injury rate of captured Chinook salmon below Green Peter Dam displaying proportion of fish with injuries by type (top panel) and descaling injuries and copepod presence (bottom panel). The middle panel shows Green Peter Dam operations and features of interest with spill/RO flow (black line), Powerhouse flow (black dash line), and forebay elevation (black dot dash line). Bars with a “C” denote weeks in which continuous surface spill occurred while those with “N” denote weeks when nighttime surface spill operations occurred.

Table 34. Summary of surface spill operations at the Green Peter Dam RST site for 2024.

Site	Dates	Description
Green Peter Dam Tailrace	03/13/2024–04/11/2024	Nighttime Surface Spill Operations
Green Peter Dam Tailrace	04/11/2024–05/13/2024	Continuous Surface Spill
Green Peter Dam Tailrace	06/07/2024–06/11/2024	Continuous Surface Spill

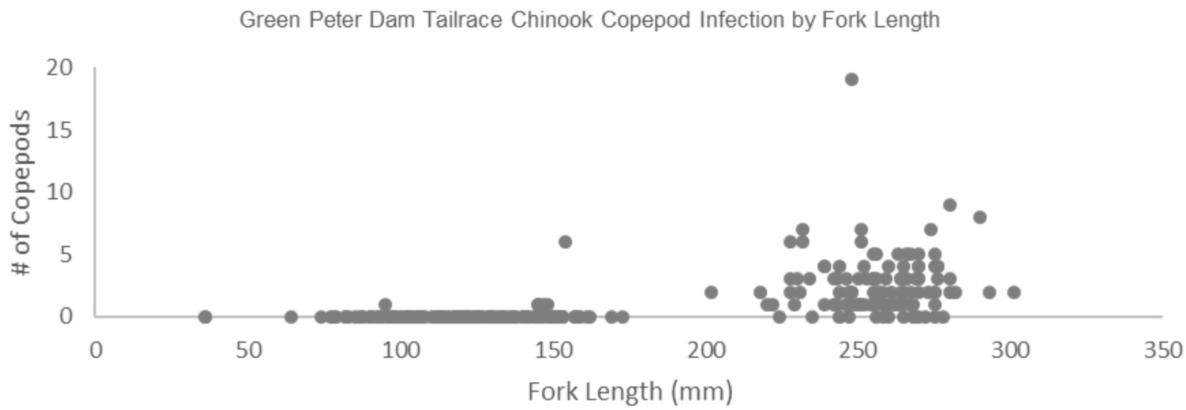

Figure 32. Copepod prevalence vs fork length on juvenile Chinook salmon captured at Green Peter Dam Tailrace.

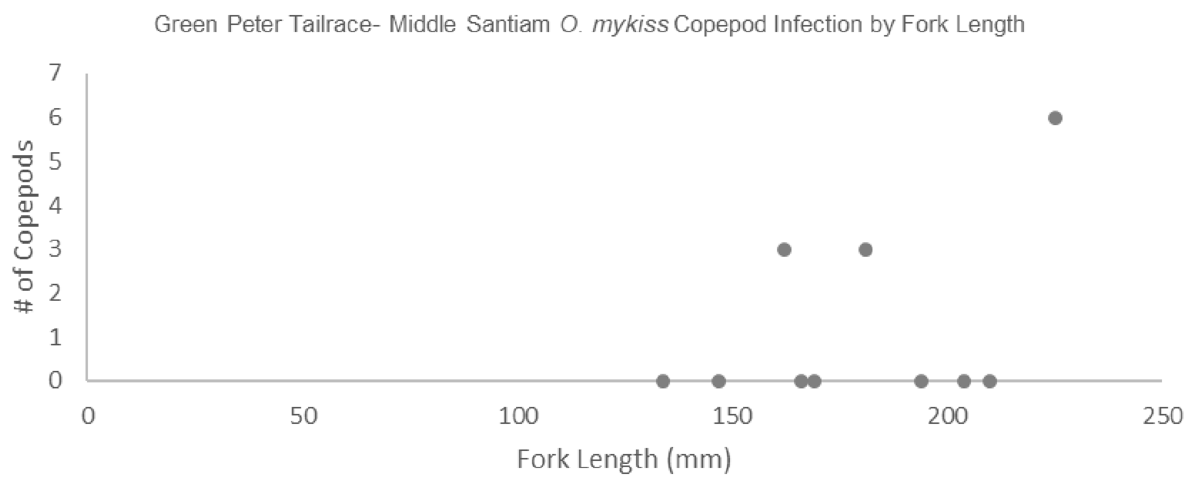

Figure 33. Copepod prevalence vs fork length on juvenile *O. mykiss* captured at Green Peter Dam Tailrace.

1.3.5.5 24-Hour Hold Trials

24-hour hold trials were performed on NOR juvenile Chinook salmon and *O. mykiss* captured in the Green Peter Dam Tailrace to assess delayed mortality resulting from dam passage. A total of 168 fish, 159 Chinook salmon and 9 *O. mykiss*, were held in 2024 (Table 35). A total of 56 fish died during hold (33.3%), 53 of the 159 Chinook salmon (33.3%) and 3 of the 9 *O. mykiss* (33.3%). Mortality rates across the two-week period in which fish were held ranged from 0 to 66.7%.

Table 35. Summary of 24-hour hold trials for fish captured in the RST at the Green Peter Dam Tailrace site.

Hold Period	Species	Number of Fish Held	Mortalities	% Survived
01/01–15/2024	Chinook	2	0	100.0%
01/01–15/2024	*O. mykiss*	0	0	
01/16–31/2024	Chinook	1	0	100.0%
01/16–31/2024	*O. mykiss*	0	0	--
02/01–15/2024	Chinook	0	0	--
02/01–15/2024	*O. mykiss*	0	0	--
02/16–29/2024	Chinook	0	0	--
02/16–29/2024	*O. mykiss*	0	0	--
03/01–15/2024	Chinook	0	0	--
03/01–15/2024	*O. mykiss*	0	0	--
03/16–31/2024	Chinook	2	0	100.0%
03/16–31/2024	*O. mykiss*	0	0	--
04/01–15/2024	Chinook	28	15	46.4%
04/01–15/2024	*O. mykiss*	1	0	100.0%
04/16–30/2024	Chinook	11	1	90.9%
04/16–30/2024	*O. mykiss*	4	1	75.0%
05/01–15/2024	Chinook	27	4	85.2%
05/01–15/2024	*O. mykiss*	3	2	33.3%
05/16–31/2024	Chinook	0	0	--
05/16–31/2024	*O. mykiss*	0	0	--
06/01–15/2024	Chinook	42	9	78.6%
06/01–15/2024	*O. mykiss*	0	0	--
06/16–30/2024	Chinook	0	0	--
06/16–30/2024	*O. mykiss*	0	0	--
07/01–15/2024	Chinook	0	0	--
07/01–15/2024	*O. mykiss*	0	0	--
07/16–31/2024	Chinook	0	0	--
07/16–31/2024	*O. mykiss*	0	0	--
08/01–15/2024	Chinook	0	0	--
08/01–15/2024	*O. mykiss*	0	0	--
08/16–31/2024	Chinook	0	0	--
08/16–31/2024	*O. mykiss*	0	0	--
09/01–15/2024	Chinook	0	0	--
09/01–15/2024	*O. mykiss*	0	0	--
09/16–30/2024	Chinook	0	0	--
09/16–30/2024	*O. mykiss*	0	0	--
10/01–15/2024	Chinook	2	0	100.0%
10/01–15/2024	*O. mykiss*	0	0	--
10/16–31/2024	Chinook	10	5	50.0%
10/16–31/2024	*O. mykiss*	0	0	--
11/01–15/2024	Chinook	34	19	44.1%
11/01–15/2024	*O. mykiss*	1	0	100.0%
11/16–30/2024	Chinook	0	0	--
11/16–30/2024	*O. mykiss*	0	0	--
12/01–15/2024	Chinook	0	0	--
12/01–15/2024	*O. mykiss*	0	0	--
12/16–31/2024	Chinook	0	0	--
12/16–31/2024	*O. mykiss*	0	0	--

1.3.5.6 PIT Tagged Fish and Downstream Detections

4 Chinook salmon were PIT tagged at the Green Peter Dam Tailrace site by EAS in 2024. The first 60 target fish captured at this location every week are prioritized for the 24-hour hold study and are not tagged. No PIT tagged or VIE marked fish were detected at the site from upstream release sites. A summary including tag numbers, observation date, and site is provided in Appendix C: PIT Tags and VIE Tagging.

1.3.5.7 Willamette Valley Projects Encounters

A total of 10 radio and PIT tagged Chinook salmon were captured in the Green Peter Dam Tailrace trap during the reporting period. These fish are a part of a PNNL/USACE dam passage study. Additionally, 177 adipose clipped and PIT tagged Chinook salmon were captured in 2024 that were associated with large bulk mark releases performed by CFS. For more information regarding release groups, dates, and other redetections, refer to the *Bulk Mark Release and Reservoir Distribution Study Annual Report* (CFS 2024).

1.3.5.8 Non-Target Capture Data

A total of 123,643 non-target fish were captured in addition to NOR juvenile Chinook salmon and *O. mykiss* in the Green Peter Dam Tailrace RST in 2024 (Table 36). The most common species captured were bluegill, clipped juvenile Chinook, and smallmouth bass. For information on non-target catch during sampling in 2023, refer to Images of Non-Target Species.

Table 36. Summary of non-target fish capture at the Green Peter Dam Tailrace site in 2024.

Species	Season Total	Season Total Mortality (subset of total)
Bluegill	123,244	35,949
Brown Bullhead Catfish	33	8
Juvenile Chinook (clipped)	246	82
Cutthroat Trout	1	1
Dace	7	0
Kokanee	17	6
Kokanee (clipped)	1	1
Largemouth Bass	4	0
Largescale Sucker	3	1
Mountain Whitefish	1	0
Northern Pikeminnow	2	0
O. mykiss (clipped)	19	2
O. mykiss (adult)	1	1
Pumpkinseed	1	0
Sculpin	3	1
Smallmouth Bass	47	20
Spotted Bass	10	5
Unknown*	3	3
Totals	**123,643**	**36,080**

*Species denoted as “unknown” were too small and/or too decomposed to identify.

1.3.6 Foster Dam Head of Reservoir – South Santiam River

A single 5-foot RST was deployed in the South Santiam River above Foster Reservoir on February 1, 2024, and continued sampling until November 30, 2024.

Sampling outages resulting from high flows, excessive debris, severe weather, localized flood evacuations, and additional issues are listed in Appendix B: Sampling Outages by Site. Non-sampling periods illustrated in the figures below are further detailed in Appendix B: Sampling Outages by Site.

Additionally, the RST was not sampled from July 13, 2024, to July 23, 2024, as the surrounding water temperatures were higher than the allowed sampling threshold.

1.3.6.1 Trapping Efficiency Trials

A total of 11 TE trials occurred in the South Santiam River above Foster Reservoir in 2024 using hatchery reared Chinook salmon. Collectively, 29 trials have occurred at this site since September 2022. A summary of fish release numbers, recaptures, and flow level for each trial conducted is provided in Table 37.

TEs ranged from 0.5% to 26.1% with a pooled average of 6.0% (95%CI +/- 2.9%, n=20) for all successful trials with five or more recaptures. Nine of the trials did not recapture enough fish to be used in the passage estimate calculation. Trap efficiency analysis identified the full log model—incorporating log transformed weekly discharge, trap revolutions per hour, median fish fork length, and an interaction between the covariates—as having the highest pseudo R^2 value (0.83, n=26). However, this model has a moderate AICc score, suggesting that while the additional covariates and interactions improved the fit, the improvement may not justify the added complexity compared to simpler models. Regardless, these findings suggest that environmental conditions and fish size influence trap efficiency at this site. Detailed methods and full results of the trap efficiency modeling are provided in Appendix E: Trap Efficiency Plots.

Past results have shown that low flows in the late spring and summer often result in low recapture numbers. In addition, sub-yearling fish are often recaptured in low numbers, possibly due to the long distance from the release site to the trap. It is also important to note that late spring/summer flows often result in the trap rotating slowly, allowing fish to easily avoid capture. As described in the methods section, it is assumed that fish migrate past the trap within one week of release. In low flow conditions, fish may hold in deep pools instead of actively migrating, resulting in failed TE trials.

Table 37. Summary table of marked hatchery Chinook salmon releases at the Foster Dam Head of Reservoir site for trapping efficiency.

Release Location	Date of Release	cfs at Release	Number of Fish Released	Number of Fish Recaptured	Percent Efficiency
Foster Dam Head of Reservoir – South Santiam*	09/29/2022	51	1,063	0	0.0%
Foster Dam Head of Reservoir – South Santiam*	10/25/2022	211	821	116	14.1%
Foster Dam Head of Reservoir – South Santiam*	11/01/2022	261	1,006	263	26.1%
Foster Dam Head of Reservoir – South Santiam*	11/09/2022	560	1,007	68	6.8%
Foster Dam Head of Reservoir – South Santiam*	11/15/2022	240	1,009	55	5.5%
Foster Dam Head of Reservoir – South Santiam*	11/22/2022	165	933	163	17.5%
Foster Dam Head of Reservoir – South Santiam*	02/27/2023	376	1,002	21	2.1%
Foster Dam Head of Reservoir – South Santiam*	03/09/2023	313	995	62	6.2%

Release Location	Date of Release	cfs at Release	Number of Fish Released	Number of Fish Recaptured	Percent Efficiency
Foster Dam Head of Reservoir – South Santiam*	03/15/2023	966	1,025	0	0.0%
Foster Dam Head of Reservoir – South Santiam*	05/11/2023	1,130	985	20	2.0%
Foster Dam Head of Reservoir – South Santiam*	06/02/2023	317	1,003	79	7.9%
Foster Dam Head of Reservoir – South Santiam*	06/29/2023	89	1,000	22	2.2%
Foster Dam Head of Reservoir – South Santiam*	07/27/2023	1,980	989	0	0.0%
Foster Dam Head of Reservoir – South Santiam*	08/31/2023	1,630	1,000	0	0.0%
Foster Dam Head of Reservoir – South Santiam*	09/27/2023	48.1	1,000	6	0.6%
Foster Dam Head of Reservoir – South Santiam*	10/10/2023	50.6	1,016	55	5.4%
Foster Dam Head of Reservoir – South Santiam*	11/14/2023	446	1,000	102	10.2%
Foster Dam Head of Reservoir – South Santiam*	11/22/2023	321	1,001	79	7.9%
Foster Dam Head of Reservoir – South Santiam	02/02/2024	1,290	1,005	46	4.6%
Foster Dam Head of Reservoir – South Santiam	03/19/2024	1,310	1,000	12	1.2%
Foster Dam Head of Reservoir – South Santiam	04/03/2024	923	1,003	16	1.6%
Foster Dam Head of Reservoir – South Santiam+	04/04/2024	774	1,909	28	1.5%
Foster Dam Head of Reservoir – South Santiam	05/15/2024	753	999	30	3.0%
Foster Dam Head of Reservoir – South Santiam	06/05/2024	1,160	1,000	5	0.5%
Foster Dam Head of Reservoir – South Santiam	08/13/2024	53.2	998	0	0.0%
Foster Dam Head of Reservoir – South Santiam	08/22/2024	50.6	999	0	0.0%
Foster Dam Head of Reservoir – South Santiam	09/18/2024	44.5	1,005	0	0.0%
Foster Dam Head of Reservoir – South Santiam	10/02/2024	36.6	1,000	0	0.0%
Foster Dam Head of Reservoir – South Santiam	11/08/2024	285	1,000	16	1.6%

*Release performed by EAS for the USACE under contract W9127N19D0007. +TE release performed by CFS

1.3.6.2 Run of River Trapping Efficiency Trials

Run of River trials were pooled by month. A total of 330 juvenile Chinook salmon and 1 *O. mykiss* were released in the fall of 2024. A total of 14 fish were recaptured between the months of October and November 2024. Additionally, 29 dead fish were re-run for a dead fish ROR TE trial. There were zero dead fish recaptures. Since February 2023, 469 fish have been released during nine ROR TE trials. TEs for ROR trials ranged from 0.0% to 9.5%, however samples sizes were highly variable ranging from 5 to 205.To account for sample size variability, monthly calculations were weighted based on sample size and then summed yielding an estimated TE for ROR trials of 3.2%. We found TE using ROR Chinook at Foster HOR was 2.8% lower than TE using hatchery reared Chinook, however more ROR TE trials are necessary to increase the overall sample size. A summary of ROR TE trials by month is provided in Table 38.

Table 38. Summary table of run of river releases at the Foster Dam HOR site for trapping efficiency.

Release Location	Date of Release	Number of Fish Released	Number of Fish Recaptured	Percent Efficiency
Foster Dam Head of Reservoir	February 2023	5	0	0%
Foster Dam Head of Reservoir	March 2023	17	0	0%
Foster Dam Head of Reservoir	April 2023	10	0	0%
Foster Dam Head of Reservoir	May 2023	19	0	0%
Foster Dam Head of Reservoir	June 2023	5	0	0%
Foster Dam Head of Reservoir	October 2023	62	1	1.6%
Foster Dam Head of Reservoir	November 2023	20	1	5.0%
Foster Dam Head of Reservoir	October 2024	126	12	9.52%
Foster Dam Head of Reservoir	November 2024	205	2	0.98%

1.3.6.3 Target Catch, Passage Estimates and Passage Timing

A total of 42 juvenile Chinook salmon and 738 juvenile *O. mykiss* were captured during monitoring in 2024. A total of 39 juvenile Chinook (92.9% of total Chinook catch) were captured at this site in the spring of 2024. Peak capture of juvenile Chinook salmon entering Foster Reservoir in the spring occurred during February (n=31, 79.5% of spring catch) (Figure 34). BY 2022 yearlings (n=3, 7.7% of spring catch) and BY 2023 sub-yearling (n=36, 92.3% of spring catch) Chinook salmon were captured at the trap during the spring monitoring period (Figure 36). The first BY 2023 sub-yearling Chinook was captured on February 7, 2024, and catch of Chinook continued through May. Previous studies by Romer (2015) captured the most sub-yearling Chinook salmon in January and February. They also noted that fry emergence in the South Santiam above Foster Reservoir in 2015 was earlier than other basins and that the fish they captured late in the spring were significantly larger than their counterparts in other areas. Past observations combined with our fry capture during the first week of sampling suggest that we may have missed Chinook salmon fry passing through the trap site prior to the initiation of sampling.

A total of 3 juvenile Chinook were encountered here during sampling in the fall. All captured Chinook were BY 2023 sub-yearlings. Chinook catch and timing in 2024 was similar to observations from monitoring in previous years. However, catch at this location has been highly variable when comparing to the number of adult females out planted the year before. For years 2013 through 2015, the RST at this location captured between 0.27 and 1.75 juvenile Chinook per adult female out planted (Romer et al. 2015, 2016, Hansen et al. 2017). In 2024, the RST captured 0.34 juvenile Chinook per adult female out planted. This variability could be caused by high, scouring flows in the South Santiam River during critical stages of egg incubation which limit juvenile production on years when these flows occur (Romer et al. 2016). For raw weekly Chinook capture at the Foster Dam Head of Reservoir- South Santiam RST site for sampling from 2022 and 2023 as well as adult Chinook out plants from 2010 to 2023, please refer to Appendix I: Adult Chinook Out-planting Above Willamette Valley Projects. Using pooled averages of hatchery Chinook TEs, we estimate that 735 (95% CI: 497 to 1,410) juvenile Chinook salmon passed the trapping site during monitoring in 2024 (Figure 34).

A total of 205 juvenile *O. mykiss* (27.8% of total *O. mykiss* catch) were captured during sampling in the spring of 2024. Peak capture of juvenile *O. mykiss* in the spring monitoring period occurred in June (n=160, 78.0% of spring catch) (Figure 35). *O. mykiss* catch in the spring comprised three brood years: BY 2022 (n=19, 9.3% of spring catch), BY 2023 (n=25, 12.2% of spring catch), and BY 2024 (n=159, 77.6% of spring catch) (Figure 37). BY 2022 fish were captured March through June and BY 2023 fish were captured throughout the entire period. The first BY 2024 *O. mykiss* was captured on June 6, 2024, and catch continued throughout the sampling period.

O. mykiss catch in the fall consisted of 535 fish (72.5% of total *O. mykiss* catch) from BY 2022, 2023, and 2024. BY 2024 sub-yearlings were the dominant age class captured in the fall (n=488, 91.2% of fall catch). Peak capture of fish occurred in November when 247 *O. mykiss* (46.2% of fall catch) were collected. The timing of BY 2024 fry is consistent with previous studies observed in the basin (Romer et al. 2010-2016). Sub-yearling fry passage timing and size of age 1- and 2-year-old *O. mykiss* closely resemble observations from catch in this basin by previous studies (Romer et al. 2012-2015). Information regarding length and weight for each BY is summarized in Table 39.

Table 39. Summary of fork length and weight observed on juvenile Chinook salmon and *O. mykiss* at the Foster Dam Head of Reservoir RST site by brood year.

Species	Date Range	BY	Number of Fish	Average F.L. (mm)	Min. F.L. (mm)	Max F.L. (mm)	Median F.L. (mm)	Average Weight (g)	Min. Weight (g)	Max Weight (g)	Median Weight (g)
Chinook	2/1/24–6/30/24	22	3	100.7	79	120	103	14.3	5.3	21.6	16.1
Chinook	2/1/24–6/30/24	23	36	40.3	35	86	38	N/A	N/A	N/A	N/A
Chinook	7/1/24–11/30/24	23	3	63.7	41	106	44	5.1	<1	13.3	1.0
O. mykiss	2/1/24–6/30/24	22	19	180.1	135	232	186	60.4	27.6	124.2	60.4
O. mykiss	2/1/24–6/30/24	23	25	97.3	71	132	98	11.3	4.3	25.8	10.2
O. mykiss	2/1/24–6/30/24	24	159	31.1	24	51	30	N/A	N/A	N/A	N/A
O. mykiss	7/1/24–11/30/24	22	1	195	195	195	N/A	82.5	82.5	82.5	N/A
O. mykiss	7/1/24–11/30/24	23	46	139.8	121	175	139	28.2	17.2	64.2	27
O. mykiss	7/1/24–11/30/24	24	488	92.9	22	128	65	9.3	<1	26.7	3.9

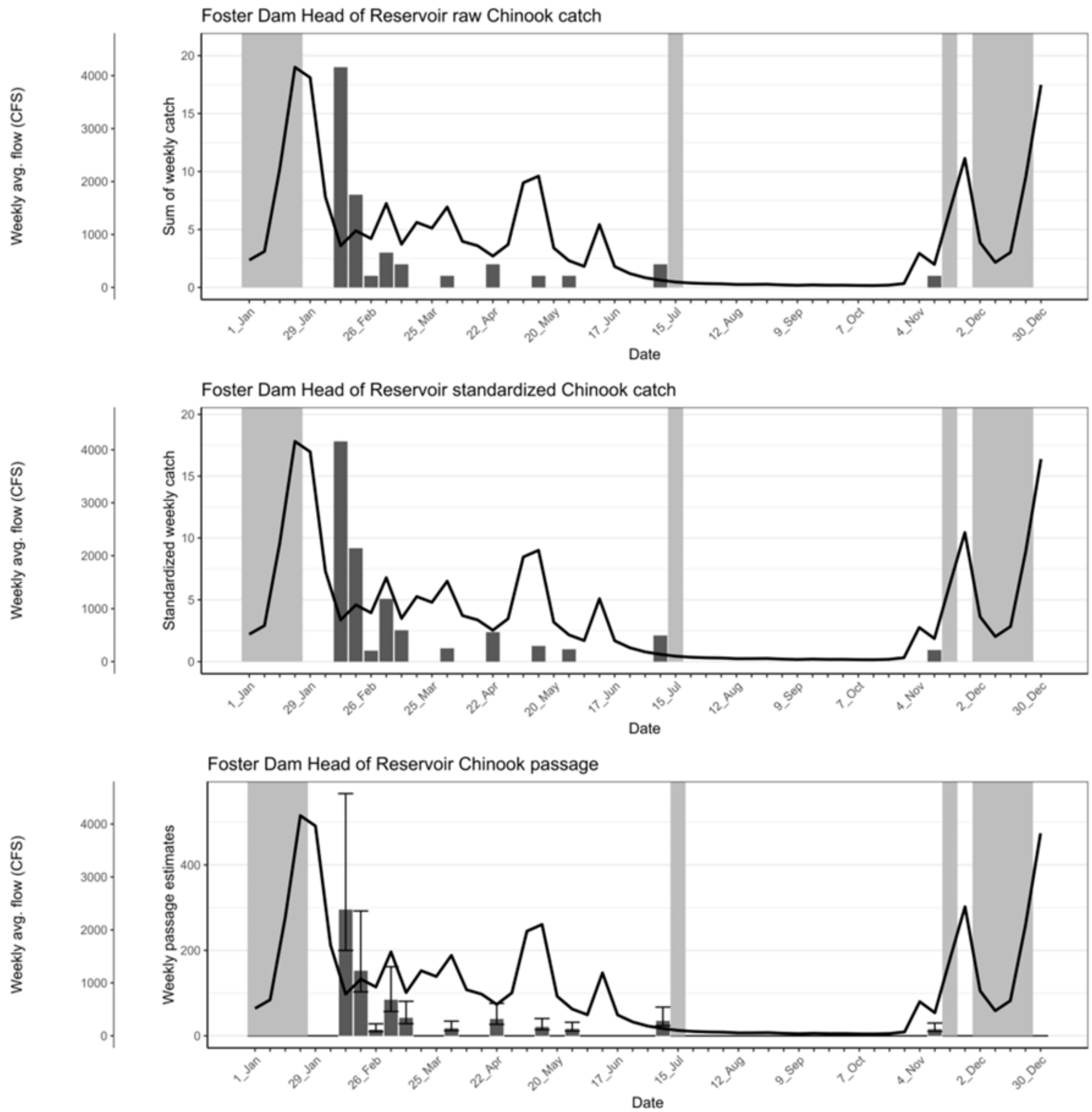

Figure 34. Raw catch (top panel), standardized catch (middle panel), and weekly passage estimates (bottom panel) overlayed with flow (black line) and non-sampling weeks shaded out (gray).

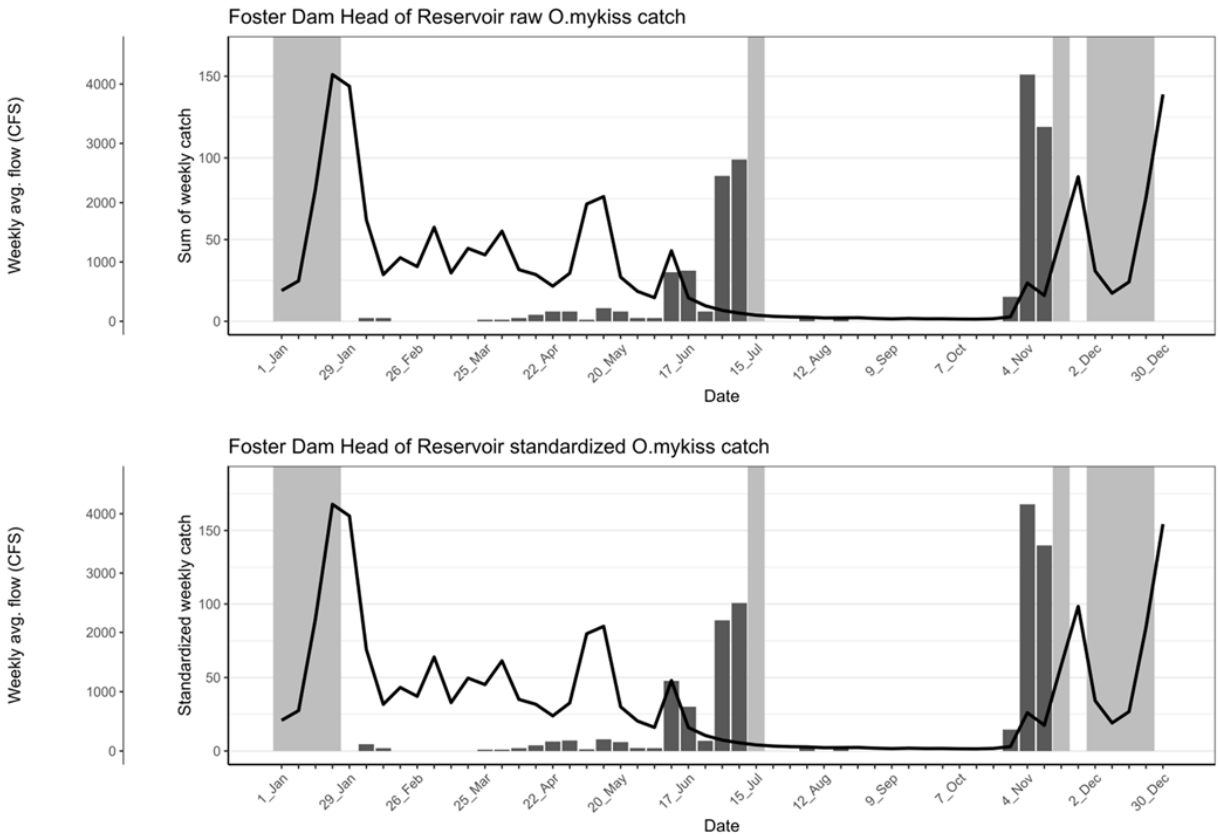

Figure 35. Shows raw (top panel) and weekly standardized (bottom panel) catch of juvenile *O. mykiss* overlayed with stream flow (black line) and non-sampling weeks shaded out (gray).

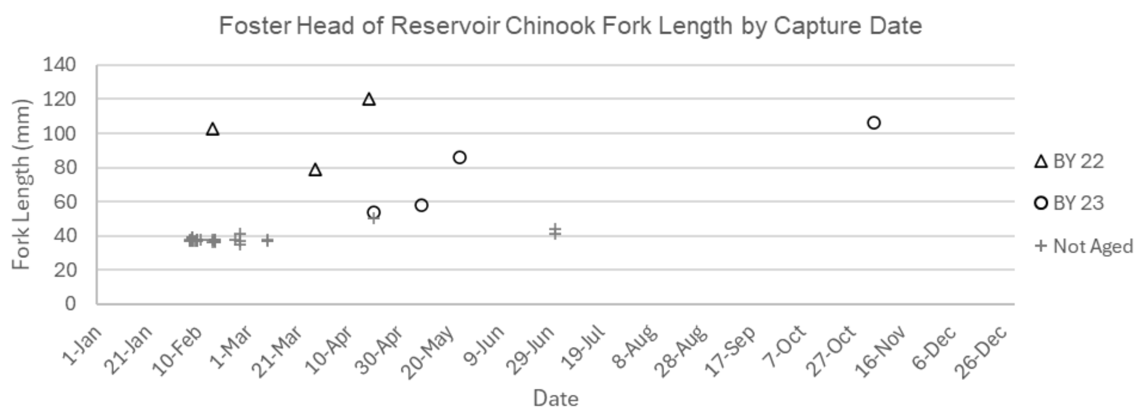

Figure 36. Length-frequency analysis for juvenile Chinook salmon at the Foster Dam Head of Reservoir site.

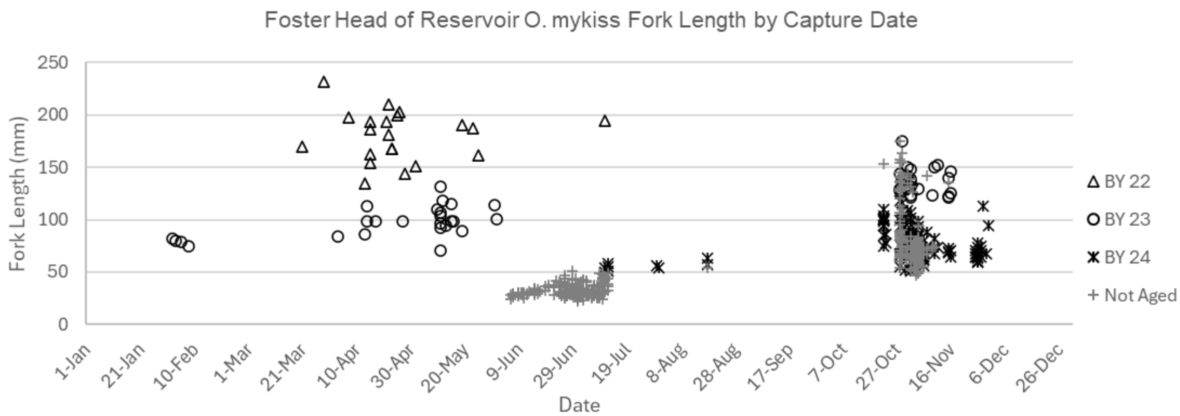

Figure 37. Shows length-frequency analysis by brood year for juvenile *O. mykiss* at the Foster Dam Head of Reservoir site.

1.3.6.4 Injury Data

A total of 8 juvenile Chinook salmon (19.0% of total Chinook salmon catch) and 270 juvenile *O. mykiss* (36.6% of total *O. mykiss* catch) displayed at least one of the injury code conditions listed in Table 3. The most common injury observed at this site for both Chinook salmon and *O. mykiss* was descaling less than 20%. These injuries were likely incurred upon capture in the RST due to debris or contact with various surfaces in the trap. Furthermore, 1 Chinook salmon (2.4%) and 15 *O. mykiss* (2.0%) were found dead at the time of trap check.

TE hatchery Chinook salmon were found to have higher percentages of almost all recordable injuries, including descaling greater than and less than 20%, eye bleeding (hemorrhage), operculum damage, and fin damage as compared to the NOR Chinook salmon from the Foster Dam Head of Reservoir RST site. Descaling greater than 20% and fin damage are common injuries observed within hatchery reared fish (Table 40).

The *O. mykiss* encountered at Foster Dam Head of Reservoir were found to have a higher copepod infection rate than their Chinook salmon counterparts (Figure 38 and Figure 39). Table 40 provides a summary of injuries observed on Chinook salmon and *O. mykiss* at the Foster Dam Head of Reservoir site.

Data collected on the injury rates of TE hatchery fish illustrated that both the percentage of fish with injuries and the average number of injuries per fish generally increased from pre-release to recaptured observations. Detailed findings on injury type are further presented in Appendix D: Additional Injury Information.

Table 40. Summary of injuries observed on NOR and TE hatchery Chinook salmon, in addition to *O. mykiss* at the Foster Dam Head of Reservoir RST site.

Injury Code	Chinook Injuries (NOR) (n=42)	Trapping Efficiency Hatchery Chinook (n=153)	*O. mykiss* Injuries (NOR) (n=738)
NXI (no external injury)	81.0%	0.0%	63.4%
MUNK	2.4%	0.0%	0.4%
DS<2	9.5%	97.4%	27.9%
DS>2	0.0%	2.0%	1.8%
BLO	0.0%	0.0%	0.0%
EYB	0.0%	3.3%	0.4%
BVT	0.0%	0.0%	0.1%
FVB	0.0%	1.3%	0.5%
GBD	0.0%	0.7%	0.0%
POP	0.0%	1.3%	0.0%
HIN	2.4%	0.7%	0.5%
OPD	2.4%	11.1%	2.6%
TEA	0.0%	1.3%	0.5%
BRU	2.4%	0.7%	1.8%
HBP	0.0%	0.0%	0.0%
HO	0.0%	0.0%	0.0%
BO	0.0%	0.0%	0.0%
HBO	0.0%	0.0%	0.0%
FID	0.0%	89.5%	20.7%
PRD	0.0%	0.0%	0.4%
COP	0.0%	0.0%	0.4%
BKD	0.0%	0.0%	0.0%
FUN	0.0%	0.0%	0.3%

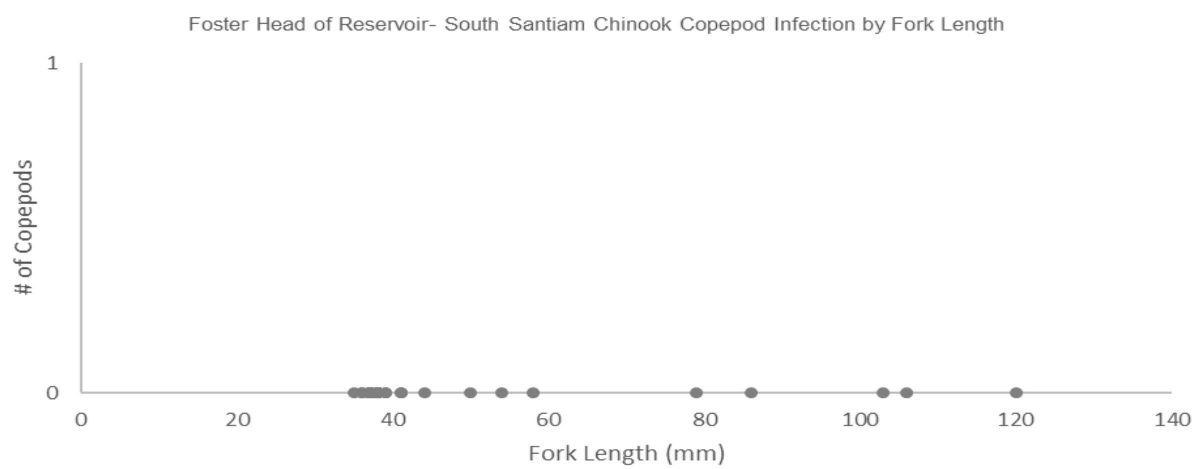

Figure 38. Copepod prevalence vs fork length on juvenile Chinook salmon captured at Foster Dam Head of Reservoir.

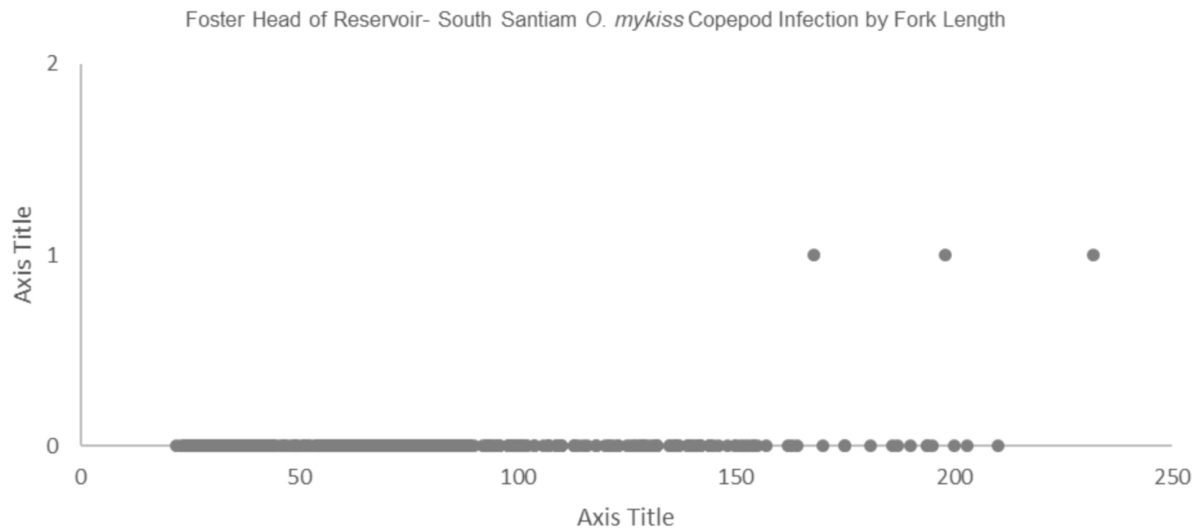

Figure 39. Copepod prevalence vs fork length on juvenile *O. mykiss* captured at Foster Dam Head of Reservoir.

1.3.6.5 PIT Tagged Fish and Downstream Detections

A total of 5 juvenile Chinook salmon and 399 juvenile *O. mykiss* were PIT tagged and released at the Foster Dam Head of Reservoir site during sampling in 2024. A total of 4 fish were detected at downstream sites, 2 Chinook salmon and 2 *O. mykiss.* Two PIT tagged fish were detected downstream in the Columbia River Estuary. The average travel time was 258 days. One *O. mykiss* was detected downstream at the Lebanon array. The travel time was 10 days. Additionally, one Chinook was detected at the Astoria Bridge from an Avian Colony survey. This is likely a predation detection and travel time was not included in this report. Table 41 shows a summary of the fish detected at downstream sites. Information regarding the redetections at the RST and other sites is provided in Appendix C: PIT Tags and VIE Tagging.

Table 41. Summary of PIT tagged fish downstream redetections for the Foster Dam Head of Reservoir site.

Species	PIT Tag #	Mark Date	Redetection Date	Recap Site	Travel Time (Days)
Chinook	3DD.003BD22B76	10/12/2023	04/25/2024	PD5 – Columbia River Estuary rkm 62	196
O. mykiss	3DD.003BD395E4	06/21/2023	05/06/2024	PD8 – Columbia River Estuary rkm 82	320
Chinook	3DD.003BD22B47	10/12/2023	09/17/2024	ASMEBR – Astoria-Megler Bridge (Avian Colony)	N/A
O. mykiss	3DD.003BE9EF92	10/31/2024	11/10/2024	LD2 – Lebanon Dam North Ladder	10

1.3.6.6 Willamette Valley Projects Encounters

There were 28 adipose clipped and PIT tagged Chinook encountered at this site in 2024. These fish were all released by the CFS Bulk Mark Release project and used for TE trials. For more information regarding release groups, dates, and other redetections, refer to the *Bulk Mark Release and Reservoir Distribution Study Annual Report* (CFS 2024).

1.3.6.7 Non-Target Capture Data

A total of 348 non-target fish were captured in addition to NOR juvenile Chinook salmon and *O. mykiss* at the Foster Dam Head of Reservoir site in 2024 (Table 42). The most encountered non-target species were dace and largescale suckers.

Table 42. Summary of non-target fish capture at the Foster Dam Head of Reservoir- South Santiam River site in 2024.

Species	Season Total	Season Total Mortality (subset of total)
Juvenile Chinook (clipped)	17	0
Cutthroat Trout	1	0
Dace	132	4
Lamprey	1	0
Largescale Sucker	132	12
Mountain Whitefish	15	0
Northern Pikeminnow	39	4
O. mykiss (clipped)	1	0
Sculpin	6	1
Unknown*	4	2
Totals	**348**	**23**

*Species denoted as “unknown” were too small and/or too decomposed to identify.

1.3.7 Cougar Dam Head of Reservoir

A single 5-foot RST was deployed in the South Fork McKenzie River above Cougar Reservoir on February 1, 2024, and continued sampling until November 30, 2024.

Sampling outages resulting from high flows, excessive debris, severe weather, localized flood evacuations, and additional issues are listed in Appendix B: Sampling Outages by Site. Non-sampling periods illustrated in the figures below are further detailed in Appendix B: Sampling Outages by Site.

Additionally, the RST did not sample from September 4, 2024, to September 11, 2024, because of low flow which resulted in unsafe operating conditions for fish, as well as excessive heat warnings in the surrounding areas.

1.3.7.1 Trapping Efficiency Trials

A total of 8 TE trials occurred at the Cougar Dam Head of Reservoir in site in 2024 using hatchery reared Chinook salmon. Collectively, 27 trials have occurred at this site since March 2022. A summary of the fish release numbers, recaptures, and discharge for each trial is provided in Table 43. Hatchery fish availability for TE trials in the McKenzie River basin in 2024 were limited due to shortfalls in BY 2023 Chinook made available by ODFW. Thus, TE trials did not occur to the extent that were originally planned for 2024.

TEs ranged from 1.4% to 10.2% with a pooled average of 4.6% (95%CI ± 0.8%, n=27) of all successful trials with five or more recaptures. Trap efficiency analysis revealed low pseudo R^2 values for all models with the full model—incorporating weekly average discharge, average trap revolutions per hour, mean fork length, and interactions among these covariates— having the highest value (pseudo R^2 = 0.45, n=25). However, this model had the second-highest AICc score, suggesting that while the additional covariates and interactions improved the fit, the improvement may not justify the added complexity compared to simpler models. Full results and methods for the flow modeling are in Appendix E: Trap Efficiency Plots.

Table 43. Summary table of marked hatchery Chinook salmon releases at the Cougar Dam Head of Reservoir site for trapping efficiency.

Release Location	Date of Release	cfs at Release	Number of Fish Released	Number of Fish Recaptured	Percent Efficiency
Cougar Head of Reservoir*	03/08/2022	774	806	40	5.00%
Cougar Head of Reservoir*	05/19/2022	1,385	498	23	4.60%
Cougar Head of Reservoir*	06/23/2022	711	486	7	1.40%
Cougar Head of Reservoir*	09/22/2022	225	551	56	10.20%
Cougar Head of Reservoir*	10/05/2022	207	608	47	7.70%
Cougar Head of Reservoir*	11/10/2022	340	704	33	4.70%
Cougar Head of Reservoir*	11/16/2022	259	719	28	3.90%
Cougar Head of Reservoir*	11/23/2022	292	752	48	6.40%
Cougar Head of Reservoir*	11/29/2022	295	620	48	7.70%
Cougar Head of Reservoir*	04/14/2023	482	506	10	2.00%
Cougar Head of Reservoir*	05/10/2023	950	508	7	1.40%
Cougar Head of Reservoir*	05/16/2023	1,140	497	23	4.60%
Cougar Head of Reservoir*	06/08/2023	1,670	510	23	4.50%
Cougar Head of Reservoir*	07/27/2023	486	758	27	3.60%
Cougar Head of Reservoir**	08/30/2023	211	5,151	127	2.50%
Cougar Head of Reservoir*	09/21/2023	194	745	41	5.50%
Cougar Head of Reservoir*	10/19/2023	211	750	42	5.60%
Cougar Head of Reservoir*	11/14/2023	343	756	21	2.80%
Cougar Head of Reservoir*	11/28/2023	266	760	67	8.80%
Cougar Head of Reservoir	02/06/2024	894	768	53	6.90%
Cougar Head of Reservoir	03/12/2024	720	756	26	3.40%
Cougar Head of Reservoir	04/01/2024	760	754	24	3.20%
Cougar Head of Reservoir	05/22/2024	859	760	41	5.40%
Cougar Head of Reservoir	06/12/2024	445	750	17	2.30%
Cougar Head of Reservoir	07/10/2024	256	749	20	2.50%
Cougar Head of Reservoir	10/08/2024	194	751	27	3.60%
Cougar Head of Reservoir	11/25/2024	807	749	33	4.40%

*Release performed by EAS for the USACE under contract W9127N19D0007.

1.3.7.2 Run of River Trapping Efficiency Trials

Releases for ROR TE trials were pooled by month. During 2024 sampling, a sufficient number of fish to perform ROR trials only occurred in April. In April, 83 fish were released but none were recovered. TEs for releases in 2023 ranged from 2.7% to 25%, however the highest TE resulted from a release of only 4 fish (Table 44). The sum of the weighted TEs is 1.9% and represents the overall ROR TE at this site. Given the limited number of releases and small number of recaptures, more data is required for any meaningful insight or a comparison with trials using hatchery-origin fish.

Table 44. Summary table of run of river releases at the Cougar Dam Head of Reservoir site for trapping efficiency.

Release Location	Date of Release	Number of Fish Released	Number of Fish Recaptured	Percent Efficiency
Cougar Dam Head of Reservoir	September 2023	71	2	2.7%
Cougar Dam Head of Reservoir	October 2023	4	1	25.0%
Cougar Dam Head of Reservoir	April 2024	83	0	0%

1.3.7.3 Target Catch, Passage Estimates and Passage Timing

The trap captured 278 juvenile Chinook salmon in 2024. Spring capture of juvenile Chinook consisted of 254 individuals (91.4% of total catch). Peak catch of juvenile Chinook salmon above Cougar Reservoir in the spring occurred in April (n=174, 68.5% of spring catch). This timing is consistent with data from previous studies (Romer et al. 2016). Figure 40 shows raw and standardized catch overlayed with flow at the Cougar Dam Head of Reservoir site. Spring catch consisted of two brood year classes: BY 2022 (n=28, 11.0% of spring catch) and BY 2023 (n=226, 89.0% of spring catch).

Fall capture of juvenile Chinook consisted of 24 individuals (8.6% of total catch), all from BY 2023. Peak capture of Chinook salmon in the fall period occurred in the latter half of October and early November (n=13, 54.2% of fall catch).

BY 2023 sub-yearling Chinook salmon were the dominant age class captured at this site throughout the year (Figure 41). The first BY 2023 Chinook salmon captured at the trap occurred on February 3, 2024, and catch of sub-yearlings continued through November. The first BY 2022 yearling was captured on February 2, 2024, and yearling catch continued into May. Since BY 2022 yearlings and 2023 sub-yearlings were captured so close to the initiation of sampling, it is likely that some early migrants were missed prior to sampling in 2024. Using pooled averages of hatchery Chinook TEs, EAS estimates that 7,165 (95% CI: 6,060 to 8,764) juvenile Chinook salmon passed the RST site during sampling in 2024 (Figure 40). A summary of fork length and weight data by BY is provided in Table 45.

Table 45. Summary of fork length and weight observed on juvenile Chinook salmon at the Cougar Dam Head of Reservoir RST site by brood year.

Species	Date Range	BY	Number of Fish	Average F.L. (mm)	Min. F.L. (mm)	Max F.L. (mm)	Median F.L. (mm)	Average Weight (g)	Min. Weight (g)	Max Weight (g)	Median Weight (g)
Chinook	2/1/2024–6/30/2024	22	28	79.6	51	95	82.5	5.8	1.8	9.1	5.85
Chinook	2/1/2024–6/30/2024	23	226	36.1	31	70	36	N/A	N/A	N/A	N/A
Chinook	7/1/2024–11/30/2024	23	24	85.1	59	106	92.5	7.1	2.3	14.2	8.1

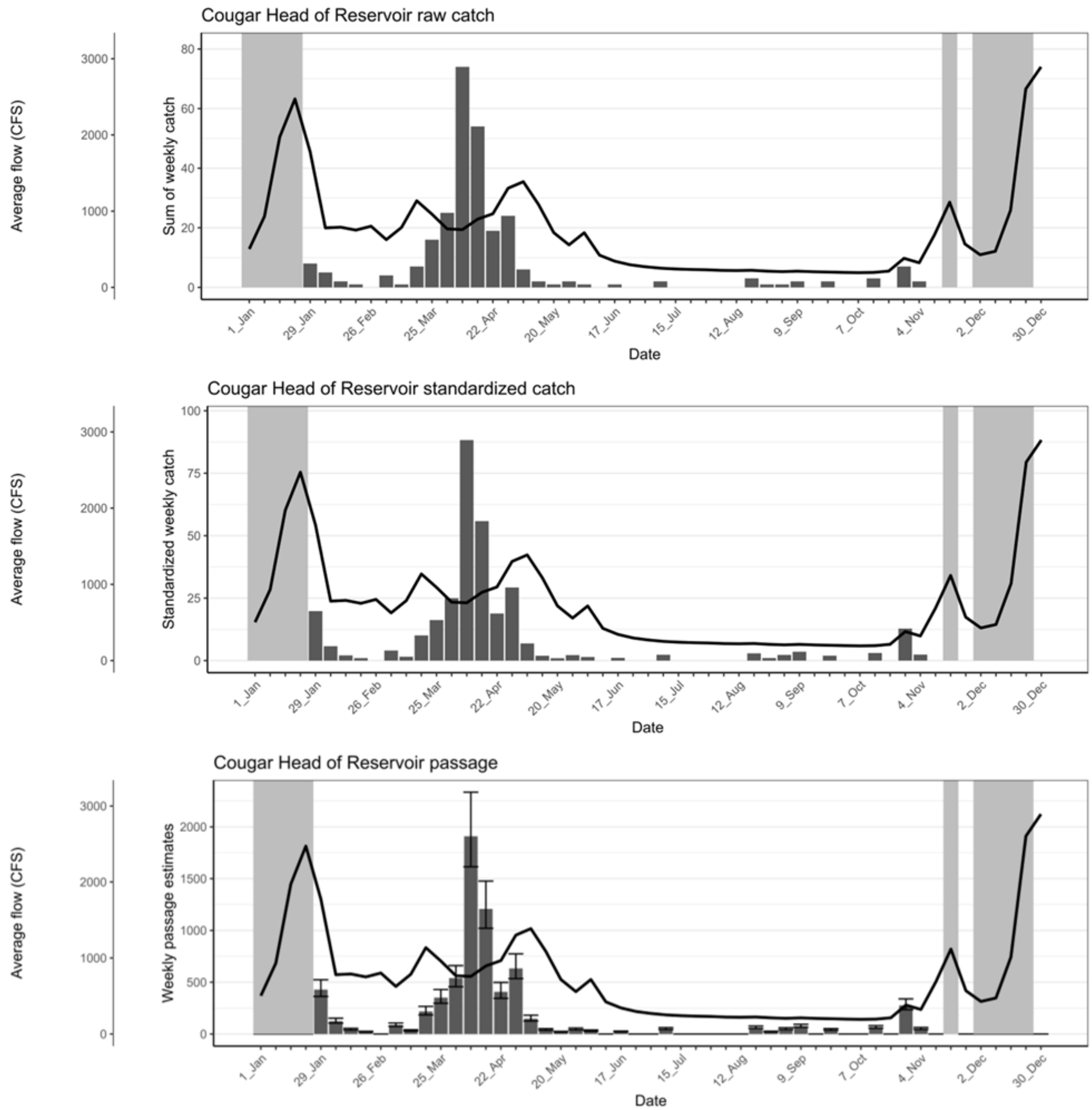

Figure 40. Raw catch (top panel), standardized catch (second panel), and weekly passage estimates (bottom panel) overlayed with stream flow (black line) for the Cougar Dam Head of Reservoir RST.

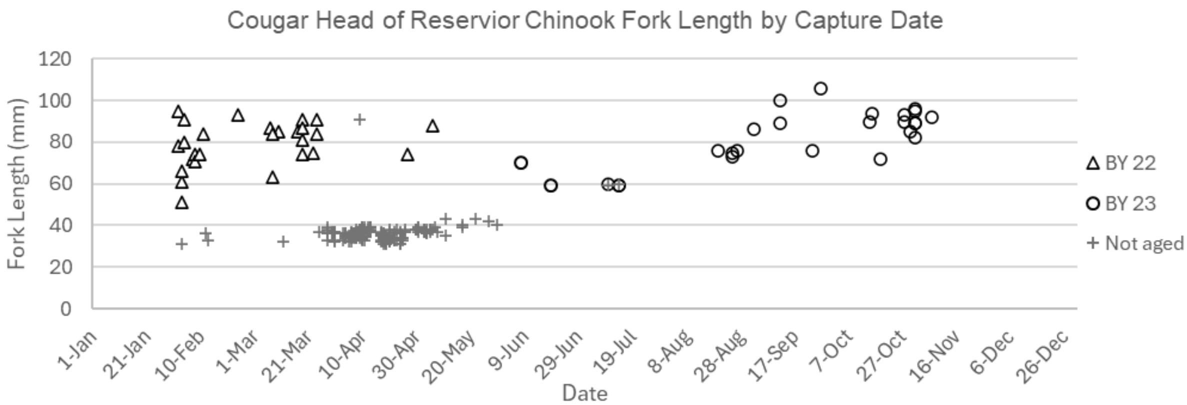

Figure 41. Length-frequency of juvenile Chinook salmon by Brood Year at the Cougar Dam Head of Reservoir site.

1.3.7.4 Injury Data

A total of 58 juvenile Chinook salmon (20.9% of total Chinook salmon catch) displayed at least one of the injury code conditions listed in Table 3. The most common injuries observed at this site include bruising and fin damage. These injuries were likely incurred upon capture in the RST due to debris or contact with various surfaces in the trap.

Copepod presence on captured Chinook salmon showed a weak positive association with the size of fish similar to observations made by previous studies (CFS 2022; Monzyk et al. 2015). However, this correlation is not as strong as those seen in other basins (Figure 42). Copepod presence on Chinook salmon was only observed in fish that had a fork length of at least 60 mm. Although both of these variables tend to increase in response to one another, their relationship is not strong. Additional information regarding injuries by size and average injuries per fish is available in Appendix D: Additional Injury Information.

There were 3 mortalities (1.1% of total Chinook salmon catch) likely resulting from high debris in the trap. These Chinook salmon were found dead at the time of trap check. TE hatchery Chinook salmon exhibited higher percentages of descaling less than and greater than 20%, operculum damage, fin damage, and fungus when compared to NOR fish. Additionally, no CFS bulk marked released Chinook salmon were found at this site by EAS personnel. A summary of injuries observed at the Cougar Dam Head of Reservoir site is provided in Table 46.

Data collected on the injury rates of TE hatchery fish illustrated that both the percentage of fish with injuries and the average number of injuries per fish generally decreased from pre-release to recaptured observations at the Cougar Head of Reservoir RST site. Detailed findings on injury type are further presented in Appendix D: Additional Injury Information.

Table 46. Summary of injuries observed on NOR and TE hatchery Chinook salmon at the Cougar Head of Reservoir RST site.

Injury Code	Chinook Injuries (NOR) (n=278)	Trapping Efficiency Hatchery Chinook (n=241)
NXI (no external injury)	79.1%	9.1%
MUNK	15.1%	0.0%
DS<2	0.0%	80.5%
DS>2	1.4%	5.8%
BLO	0.0%	0.0%
EYB	0.4%	0.0%
BVT	0.0%	0.0%
FVB	1.4%	0.0%
GBD	0.0%	0.0%
POP	0.4%	0.4%
HIN	1.8%	1.2%
OPD	1.1%	11.2%
TEA	1.1%	0.0%
BRU	3.2%	3.3%
HBP	0.0%	0.0%
HO	0.0%	0.0%
BO	0.0%	0.0%
HBO	0.0%	0.0%
FID	10.1%	82.6%
PRD	0.0%	0.0%
COP	2.9%	0.4%
BKD	0.0%	0.0%
FUN	0.0%	3.7%

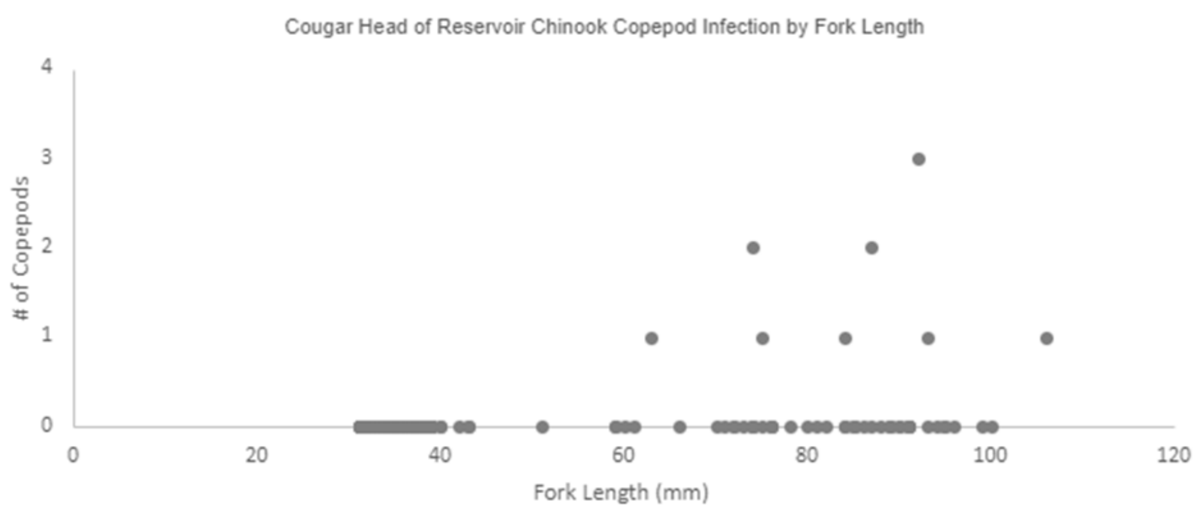

Figure 42. Copepod presence vs fork length on juvenile Chinook salmon captured at Cougar Dam Head of Reservoir.

1.3.7.5 PIT Tagged/VIE Marked Fish and Downstream Detections

A total of 46 NOR Chinook salmon were PIT tagged and 161 were VIE marked at Cougar Dam Head of Reservoir site in 2024. The rest of the captured fish were either sac-fry or did not meet minimum length requirements for tagging. No VIE marked fish have been detected downstream in 2024.

One Chinook salmon smolt was redetected at the Cougar Dam Tailrace PH trap. The travel time was 118 days. Two were redetected at the Cougar Dam Tailrace RO trap. The average travel time was 360 days. A summary of downstream PIT tag detections is provided in Table 47, and Table 48 provides a summary of VIE marked fish for the reporting period. See Appendix C: PIT Tags and VIE Tagging for information regarding tags encountered at the Cougar Dam Head of Reservoir site and VIE marked fish.

Table 47. Summary of redetections of juvenile PIT tagged Chinook at the Cougar Dam Head of Reservoir site.

PIT Tag #	Mark Date	Redetection Date	Recap Site	Travel Time (Days)
3DD.003BD224C5	11/04/2023	03/01/2024	Cougar Dam	118
3DD.003BD224ED	11/04/2023	10/28/2024	Cougar Dam	359
3DD.003BD224F7	11/05/2023	11/01/2024	Cougar Dam	362

Table 48. Summary of VIE marked Chinook salmon at the Cougar Dam Head of Reservoir site.

Date Tagged	Tag Location	VIE Color	# Tagged	# Recaptured
02/01/2024–02/15/2024	Right Dorsal	Yellow	4	0
02/16/2024–02/29/2024	Right Dorsal	Yellow	0	0
03/01/2024–03/15/2024	Right Dorsal	Red	1	0
03/16/2024–03/31/2024	Right Dorsal	Red	12	0
04/01/2024–04/15/2024	Right Dorsal	Blue	79	0
04/16/2024–04/30/2024	Right Dorsal	Blue	31	0
05/01/2024–05/15/2024	Right Dorsal	Orange	27	0
05/16/2024–05/31/2024	Right Dorsal	Orange	4	0
06/01/2024–06/15/2024	Right Dorsal	Pink	0	0
06/16/2024–06/30/2024	Right Dorsal	Pink	1	0
07/01/2024–07/15/2024	Right Dorsal	Green x2	2	0
07/16/2024–07/31/2024	Right Dorsal	Green x2	0	0
08/01/2024–08/15/2024	Right Dorsal	Yellow x2	0	0
08/16/2024–08/31/2024	Right Dorsal	Yellow x2	0	0
09/01/2024–09/15/2024	Right Dorsal	Red x2	0	0
09/16/2024–09/30/2024	Right Dorsal	Red x2	0	0
10/01/2024–10/15/2024	Right Dorsal	Blue x2	0	0
10/16/2024–10/31/2024	Right Dorsal	Blue x2	0	0
11/01/2024–11/15/2024	Right Dorsal	Orange x2	0	0
11/16/2024–11/30/2024	Right Dorsal	Orange x2	0	0

1.3.7.6 Willamette Valley Projects Encounters

No adipose clipped and PIT tagged Chinook salmon were captured in the Cougar Dam Head of Reservoir trap in 2024. For more information regarding release groups, dates, and other redetections, refer to the *Bulk Mark Release and Reservoir Distribution Study Annual Report* (CFS 2024).

1.3.7.7 Non-Target Capture Data

A total of 1,227 non-target fish were captured in addition to NOR juvenile Chinook salmon at the Cougar Dam Head of Reservoir RST site in 2024. The most captured non-target species were *O. mykiss*. The RST captured 9 bull trout that were reported to ODFW. All bull trout were measured and scanned for PIT tags. A juvenile brook trout was encountered this year and was reported to ODFW. Additional information on captured bull trout is provided in Appendix C: PIT Tags and VIE Tagging. A summary of species and numbers of fish caught are provided in Table 49.

Table 49. Summary of non-target species capture at the Cougar Dam Head of Reservoir RST site in 2024.

Species	Season Total	Season Total Mortality (subset of total)
Brook Trout	1	0
Bull Trout	9	0
Juvenile Chinook (clipped)	9	0
Cutthroat Trout	4	0
Dace	5	0
Lamprey	5	0
Mountain Whitefish	9	2
O. mykiss	1,173	8
Sculpin	12	1
Totals	**1,227**	**11**

1.3.8 Cougar Dam Tailrace

Two 8-foot RSTs in the PH channel and one 5-foot RST in the RO channel continued monitoring activities below Cougar Dam and sampled from January 1, 2024, through December 31, 2024.

Sampling outages resulting from high flows, excessive debris, severe weather, localized flood evacuations, and additional issues are listed in Appendix B: Sampling Outages by Site. Non-sampling periods illustrated in the figures below are further detailed in Appendix B: Sampling Outages by Site.

Additionally, the Cougar Dam PH channel traps did not sample from July 20, 2024, to August 1, 2024, because of severe debris build up. This debris clogged the throat of the RSTs and made it unsafe for fish passage and capture. These traps were raised once more from October 2, 2024, to October 15, 2024, due to low flows in the PH channel, which made the operation of the RST unsafe for fish capture.

1.3.8.1 Trapping Efficiency Trials

A total of 13 TE trials occurred below Cougar Dam in 2024 using hatchery reared Chinook salmon. Of these, seven occurred in the powerhouse (PH) channel and six in the RO channel. Collectively, 44 TE trials have occurred at this site (20 at the PH and 24 at the RO) since January 2022. A summary of fish release numbers, recaptures, and flow level for each trial is provided in Table 50. Hatchery fish availability for TE trials in the McKenzie River basin in 2024 were limited due to shortfalls in BY 2023 Chinook made available by ODFW. Thus, TE trials did not occur to the extent that were originally planned for 2024.

Trap efficiencies (TEs) ranged from 1.2% to 12.9% in the RO channel and 1.0% to 29.9% in the PH channel. The pooled averages for all successful trials with five or more recaptures were 6.0% (95% CI ± 1.6%, n=20) in the RO channel and 12.6% (95% CI ± 3.0%, n=20) in the PH channel. Four trials in the RO channel did not recapture enough fish to be included in passage estimates.

In the RO channel, all trap efficiency models yielded low pseudo R^2 values. The model incorporating log-transformed discharge, trap revolutions per hour, mean fork length, and their interactions had the highest pseudo R^2 (0.27, n=23) but also the highest AICc score, indicating that the added complexity may not be justified.

For the PH channel, the full model—including discharge, trap revolutions per hour, mean fork length, and their interactions—had the highest pseudo R^2 (0.47, n=20) but the second-highest AICc score, suggesting it is not a strong fit to the data. Full methods and results for trap efficiency modeling are provided in Appendix E: Trap Efficiency Plots.

Table 50. Summary table of marked hatchery Chinook salmon releases at Cougar Dam for trapping efficiency.

Release Location	Date of Release	cfs at Release	Number of Fish Released	Number of Fish Recaptured	Percent Efficiency
Cougar Dam Tailrace – PH*	01/19/2022	925	405	37	9.10%
Cougar Dam Tailrace – RO*	01/19/2022	1,000	410	26	6.30%
Cougar Dam Tailrace – PH*	04/20/2022	860	357	67	18.80%
Cougar Dam Tailrace – RO*	04/20/2022	400	378	16	4.20%
Cougar Dam Tailrace – RO*	05/15/2022	2,570	987	64	6.50%
Cougar Dam Tailrace – PH*	07/19/2022	310	495	148	29.90%
Cougar Dam Tailrace – PH*	08/11/2022	700	501	29	5.80%
Cougar Dam Tailrace – RO*	10/14/2022	890	442	49	11.10%
Cougar Dam Tailrace – RO*	11/22/2022	350	504	24	4.80%
Cougar Dam Tailrace – RO*	12/13/2022	430	506	42	8.30%
Cougar Dam Tailrace – RO*	12/15/2022	360	1015	56	5.50%
Cougar Dam Tailrace – RO*	12/20/2022	360	500	61	12.20%
Cougar Dam Tailrace – RO*	12/28/2022	900	443	14	3.20%
Cougar Dam Tailrace – PH*	01/12/2023	500	843	159	18.90%
Cougar Dam Tailrace – RO*	01/30/2023	500	509	6	1.20%
Cougar Dam Tailrace – PH*	03/23/2023	500	500	49	9.80%
Cougar Dam Tailrace – RO*	03/23/2023	810	511	3	0.60%
Cougar Dam Tailrace – PH*	03/30/2023	490	497	95	19.10%
Cougar Dam Tailrace – RO*	03/30/2023	800	491	31	6.30%
Cougar Dam Tailrace – PH*	04/18/2023	585	297	14	4.70%
Cougar Dam Tailrace – RO*	04/18/2023	800	501	2	0.40%
Cougar Dam Tailrace – PH*	05/10/2023	750	499	5	1.00%
Cougar Dam Tailrace – RO*	05/10/2023	600	499	0	0.00%
Cougar Dam Tailrace – PH*	06/06/2023	370	507	65	12.80%
Cougar Dam Tailrace – PH*	07/26/2023	370	510	63	12.40%
Cougar Dam Tailrace – PH*	09/21/2023	350	500	53	10.60%
Cougar Dam Tailrace – PH*	10/11/2023	2.7	500	83	16.60%
Cougar Dam Tailrace – RO*	10/11/2023	290	518	14	2.70%
Cougar Dam Tailrace – RO*	11/08/2023	1,100	508	43	8.50%
Cougar Dam Tailrace –RO*	11/30/2023	310	505	26	5.10%
Cougar Dam Tailrace – RO	12/18/2023	1,200	505	2	0.40%
Cougar Dam Tailrace – RO	01/11/2024	890	505	65	12.90%
Cougar Dam Tailrace – PH	01/30/2024	1,000	502	70	13.90%
Cougar Dam Tailrace – PH	02/07/2024	1,000	493	43	8.70%
Cougar Dam Tailrace – RO	02/07/2024	2,000	505	9	1.80%
Cougar Dam Tailrace – PH	03/11/2024	650	499	33	6.60%
Cougar Dam Tailrace – RO	03/12/2024	720	499	16	3.20%
Cougar Dam Tailrace – RO	04/01/2024	950	502	52	10.40%
Cougar Dam Tailrace – PH	04/04/2024	1,010	501	33	6.60%
Cougar Dam Tailrace – PH	05/22/2024	330	500	38	7.60%
Cougar Dam Tailrace – PH	06/12/2024	500	501	102	20.40%
Cougar Dam Tailrace – PH	07/10/2024	300	503	94	18.70%
Cougar Dam Tailrace – RO	10/08/2024	480	501	19	3.80%
Cougar Dam Tailrace – RO	11/15/2024	700	500	12	2.40%

*Release performed by EAS for the USACE under contract W9127N19D0007.

1.3.8.2 Run of River Trapping Efficiency Trials

Releases for ROR TE trials were pooled by month. A total of 78 Chinook salmon were released into the PH channel for ROR TE trials in February 2024 (Table 51). Of these, only 5 were recaptured in the trap for a TE of 6.4%. In total, 2,581 Chinook have been released into the RO channel and 84 have been released into the PH channel for ROR trials since April 2023. To account for sample size variability, monthly calculations were weighted based on sample size and then summed yielding an estimated TE for ROR trials of 4.8% and 6.0% for the RO and PH channels, respectively. These values were used to represent ROR TE for all corresponding RO and PH trials. No additional ROR TE releases were performed in 2024 due to low catch rates.

In addition to live fish trials, 45 dead Chinook were released into the PH channel in February 2024. These fish were found dead in the RST during trap checks and were used to conduct the trials. Fish were both upper and lower caudal clipped so as not to be confused with other dead fish found in the trap. Six of these fish were recaptured for a TE of 13.3%. However, the sample size is too small for meaningful insight from these trials. More dead fish trials will be necessary to increase the sample size and draw meaningful insight. No additional ROR TE releases were performed in 2024 due to low catch rates.

Table 51. Summary table of run of river releases at the Cougar Dam site for trapping efficiency.

Release Location	Date of Release	Number of Fish Released	Number of Fish Recaptured	Percent Efficiency
Regulating Outlet	April 2023	593	16	2.7%
Powerhouse	April 2023	6	0	0.0%
Regulating Outlet	October 2023	1,508	65	4.3%
Regulating Outlet	November 2023	480	43	9.0%
Powerhouse (dead)	February 2024	45	6	13.3%
Powerhouse	February 2024	78	5	6.4%

1.3.8.3 Target Catch, Passage Estimates and Passage Timing

A total of 1,208 juvenile Chinook salmon were captured at the Cougar Dam Tailrace in 2024. Of these, 323 Chinook salmon were captured in the PH traps (26.7% of total catch) (Figure 43) and 885 were captured in the RO trap (73.3% of total catch) (Figure 44).

A total of 1,131 Chinook were collected during sampling in the spring (93.6% of total catch), 305 Chinook salmon were captured in the PH traps (27.0% of spring catch) (Figure 43) and 826 in the RO trap (73.0% of spring catch) (Figure 44). Peak capture in the PH traps occurred in February (n=181, 59.3% of spring PH catch). Peak capture in the RO channel occurred in February and March (n=736, 89.1% of spring RO catch). Total catch for the spring of 2024 was similar to that of 2023 but lower than the observed catch for the spring of 2022 and 2021. Total spring catch in 2024 was within the range observed from sampling by ODFW from 2011 to 2016 (see Appendix I: Adult Chinook Out-planting Above Willamette Valley Projects and Romer et al. 2012–2016).

Chinook salmon catch in the spring comprised three brood years: BY 2021, BY 2022, and BY 2023 (Table 52 and Figure 45). Catch of yearling and older Chinook salmon below Cougar Dam during this period was significantly higher than had been observed in the past by previous monitoring efforts (Romer et al. 2016; CFS 2023a). This could be related to the number of adult Chinook out plants that occurred during 2021, 2022 and 2023. Sampling from 2015 (Romer et al. 2016) showed a majority of spring capture occurred in the powerhouse traps in contrast to observations from sampling through the spring of 2024. The first BY 2023 sub-yearling was captured on February 13, 2024, significantly earlier than what was observed in 2023 (EAS 2023). Catch of BY 2023 sub-yearlings continued through the end of the year. Scale age analysis shows a significant overlap in size between BYs 2021 and 2022 Chinook captured at this site in the spring of 2024. This overlap does not allow us to assign a BY to a captured Chinook salmon based on its fork length and thus, length and size statistics for BY 2021 and BY 2022 Chinook salmon in the spring will be reported for both BYs combined. BY 2021 and 2022 Chinook comprised a majority of the catch in RSTs below Cougar Dam during monitoring in the spring of 2024 (n=1,091, 96.5% of spring catch) and were encountered throughout the sampling period (Figure 45).

A total of 77 Chinook (6.4% of total catch) were captured at this site in the fall of 2024, 18 in the PH traps (23.4% of fall catch) and 59 in the RO trap (76.6% of fall catch). Peak capture of Chinook in the PH traps occurred in July (n=11, 61.1% of fall PH catch) whereas peak capture of Chinook in the RO trap occurred in October (n=43, 72.9% of fall RO catch). Fall catch comprised fish from BY 2022 (n=37, 48.1% of fall catch) and 2023 (n=40, 51.9% of fall catch). A summary of fork length and weight data by BY is provided in Table 52.

Similar to observations from past years, scale age analysis showed a significant overlap in the size of fish from both brood years (Figure 45). However, due to the relatively low number of fish encountered in the fall, it was possible to age all fish collected. Catch of Chinook at Cougar Dam in the fall of 2024 was significantly lower than has been observed in recent years (EAS 2023; CFS 2021). As mentioned above, this is likely related to the number of adults out-planted above Cougar Reservoir in 2023.

Peak capture of Chinook salmon below Cougar Dam during the spring of 2024 coincided with spring RO operations. Capture data shows significant increases in catch rate during spill operations in February and March and RO capture continued at a lower rate through the end of April. There was also an increase in Chinook salmon capture in the PH traps that occurred in June. Similar to past observations, peak capture of fish in the fall occurred once RO spill operations were initiated in October and peaked as the forebay elevation dropped below the elevation of 1,550 in the middle of October. We estimate that 14,777 (95% CI: 11,744 to 19,923) Chinook salmon passed through the RO and 2,629 (95% CI: 2,118 to 3,465) passed through the PH during sampling in 2024 (Figure 43 and Figure 44). Total passage at Cougar Dam during sampling efforts in 2024 is estimated to be 17,406 (95% CI: 13,862 to 23,388) juvenile Chinook salmon.

Table 52. Summary of fork length and weight observed on juvenile Chinook salmon of NOR at the Cougar Dam RST sites by brood year.

Species	Date Range	BY	Number of Fish	Average F.L. (mm)	Min. F.L. (mm)	Max F.L. (mm)	Median F.L. (mm)	Average Weight (g)	Min. Weight (g)	Max Weight (g)	Median Weight (g)
Chinook	1/1/24–6/30/24	21 and 22	1,091	116.2	57	207	118	18.1	2.9	80.3	16.5
Chinook	1/1/24–6/30/24	23	40	48.5	35	80	39.5	3.2	<1	6	1.0
Chinook	7/1/24–12/31/24	22	37	179.6	119	226	188	64.8	19.3	123.3	68.0
Chinook	7/1/24–12/31/24	23	40	118.0	79	160	119	19.2	5.3	42.0	18.7

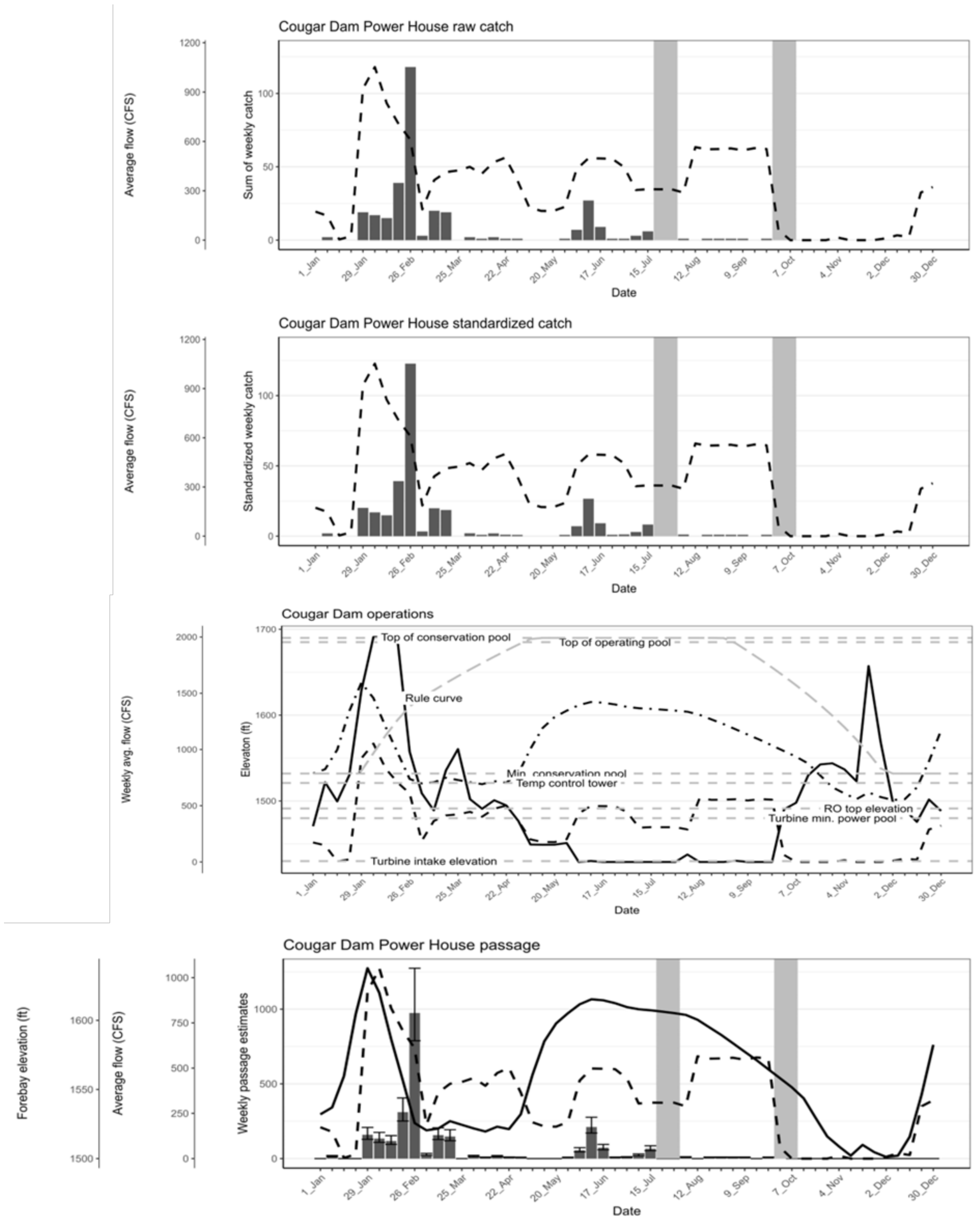

Figure 43. Raw catch (top panel), standardized catch (second panel), and weekly passage estimates (bottom panel) of NOR juvenile Chinook overlayed with Powerhouse outflow (black dash line), forebay elevation (black dot dash line), and non-sampling weeks shaded out (gray) for the Powerhouse traps at Cougar Dam. The third panel displays Cougar Dam operations and features of interest with forebay elevation (black dot dash line).

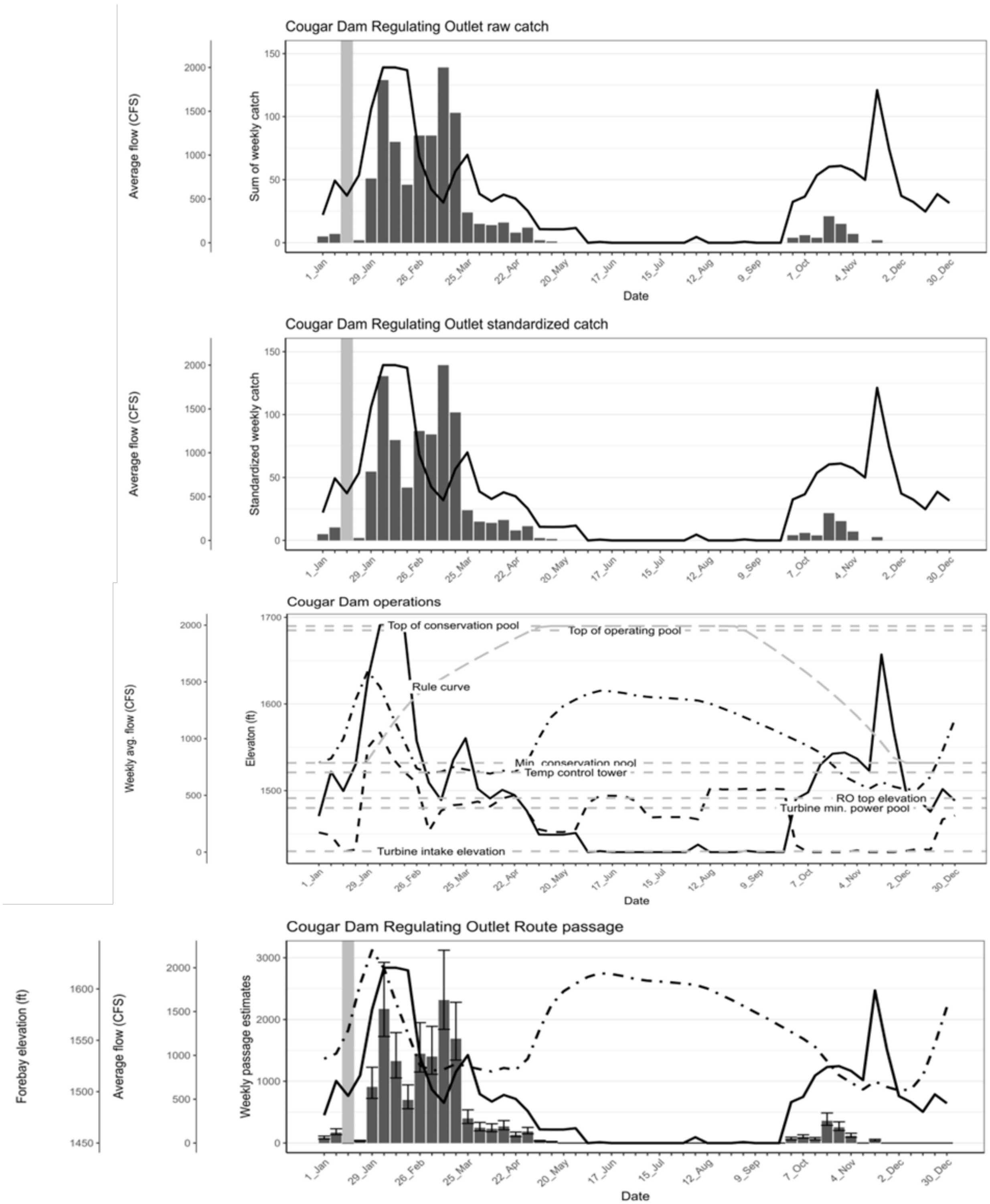

Figure 44. Raw catch (top panel), standardized catch (second panel), and weekly passage estimates (bottom panel) of NOR juvenile Chinook overlayed with Powerhouse outflow (black dash line), forebay elevation (black dot dash line), and non-sampling weeks shaded out (gray) for the RO trap at Cougar Dam. The third panel displays Cougar Dam operations and features of interest with forebay elevation (black dot dash line).

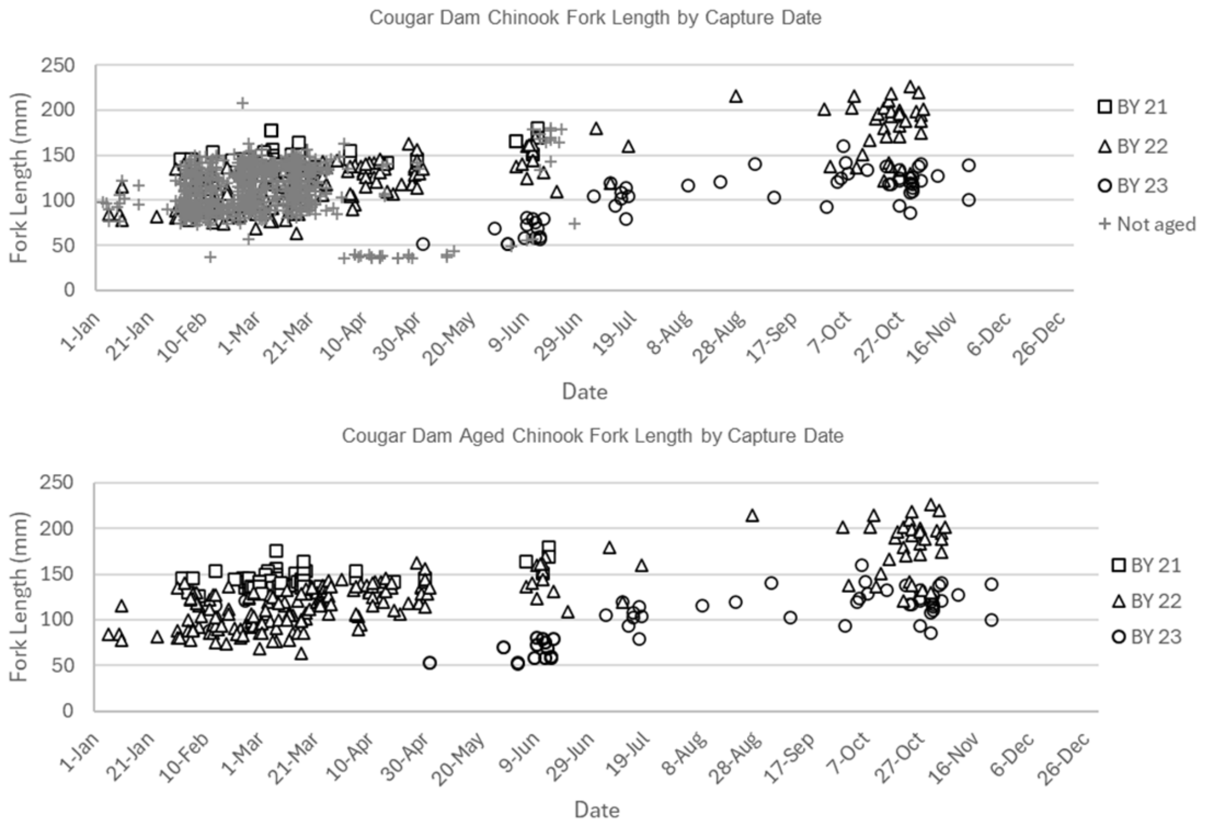

Figure 45. Length-frequency age analysis for juvenile Chinook salmon captured below Cougar Dam. The top panel shows all fish and bottom panel shows only the aged fish.

1.3.8.4 Injury Data

A total of 1,177 juvenile Chinook salmon (97.4% of total Chinook salmon catch), 869 captured in the RO trap (98.2% of total RO catch) and 308 captured in the PH traps (95.4% of total PH catch), displayed at least one of the injury code conditions listed in Table 3. The most predominant injuries observed among fish at the Cougar Dam RST site were descaling less than 20%, fin damage, and the presence of copepods. Furthermore, EAS crews observed that 178 Chinook salmon (14.7% of total Chinook salmon catch) were dead at the time the RST was checked, 34 in the Powerhouse traps (10.5% of Powerhouse capture) and 144 in the RO trap (16.3% of total RO capture).

To provide insight on injuries associated with capture in a RST, injury data was collected from both bulk mark released Chinook and hatchery fish utilized for TE trials at time of release and upon recapture. Injury rates by type, pre and post capture were then compared to elucidate a rate of injury occurrence attributable to trap capture. The most common injuries associated with trap capture include descaling less than 20% and fin damage while the most common injuries observed on captured NOR fish include descaling less than 20%, descaling greater than 20%, operculum damage, and fin damage (Appendix D: Additional Injury Information).

Similar to previous findings within this report, bulk mark recaptured Chinook salmon at both the PH and RO were evidenced to have a higher percentage of injuries as a whole, with fewer Chinook salmon exhibiting no external injuries (Table 53 and Table 54). The most predominant injuries observed on Chinook salmon that were bulk mark recaptured fish in both the PH and RO channels were descaling less than 20% and fin damage. TE hatchery Chinook exhibited similar injuries to both the NOR and bulk marked released Chinook. Percentages of fish that were observed with descaling less than and greater than 20% and fin damage remained consistent when comparing bulk marked and TE fish.

For fish captured in the PH traps, the most common injuries are descaling less than 20%, fin damage, and the presence of copepods, while the most common injuries for fish in the RO are descaling less than 20%, fin damage, the presence of copepods, and gas bubble disease. Injury rates generally increased with RO spill. It is likely that observations of gas bubble disease are higher for RST captured fish than those that are not captured in an RST as these fish are often captured and held in areas of higher dissolved gas.

Table 53 and Table 54 show injuries observed on Chinook salmon by route of passage. The proportion of fish displaying injuries by type over the sample period is shown in Figure 46. Furthermore, positive associations between spill at Cougar Dam Tailrace and bodily injury, specifically descaling greater than 20% in Chinook salmon are evident in Figure 46. Copepod presence on captured Chinook salmon (Figure 47) was evidenced to increase with the size of fish similar to observations made by previous studies (CFS 2023a; Monzyk et al. 2015). This is likely an association between time spent rearing in the reservoir rather than the size of the fish. Additional information regarding injuries by size and average injuries per fish is available in Appendix D: Additional Injury Information.

Data collected on the injury rates of TE hatchery fish illustrated that both the percentage of fish with injuries and the average number of injuries per fish generally decreased, or were relatively similar from pre-release to recaptured observations at the Cougar Dam PH RST site, while they increased at the Cougar Dam RO RST site. Detailed findings on injury type are further presented in Appendix D: Additional Injury Information.

As with other observations made in this report and in alignment with findings from both Big Cliff Dam Tailrace and Green Peter Dam Tailrace, Chinook salmon less than 60 mm were found to exhibit significantly fewer injuries than their larger counterparts ranging from 60 mm to 100 mm and greater than 100 mm (Appendix D, Table D-3 and Table D-4).

In the summer of 2023, construction was performed on the RO chute at Cougar Dam. Table D-5 in Appendix D shows injury data for RO captured NOR Chinook for the months of October through December 2021, 2022, and 2023. Initial observations do not show significant differences in injuries before and after construction occurred. However, the data is limited at this time and other variables need to be investigated to determine what impact the work may have on Chinook during passage.

Table 53. Summary of injuries observed on NOR, bulk marked, and TE hatchery Chinook salmon at the Cougar Dam Powerhouse RSTs.

Injury Code	Observed Chinook Injuries (NOR) (n=323)	Bulk Marked Released Chinook (n=89)	Trapping Efficiency Hatchery Chinook (n=413)
NXI (no external injury)	4.6%	1.1%	2.7%
MUNK	0.0%	0.0%	0.0%
DS<2	78.3%	76.4%	78.9%
DS>2	12.1%	20.2%	8.0%
BLO	1.2%	4.5%	1.0%
EYB	4.6%	2.2%	1.2%
BVT	2.8%	3.4%	0.2%
FVB	11.1%	12.4%	0.7%
GBD	3.7%	6.7%	1.7%
POP	1.9%	0.0%	0.5%
HIN	4.0%	1.1%	1.5%
OPD	14.6%	11.2%	5.6%
TEA	6.5%	4.5%	1.7%
BRU	8.4%	6.7%	1.0%
HBP	2.8%	4.5%	0.2%
HO	0.0%	0.0%	0.0%
BO	1.2%	0.0%	0.0%
HBO	0.3%	0.0%	0.0%
FID	63.2%	87.6%	83.5%
PRD	0.3%	0.0%	0.5%
COP	61.9%	73.0%	0.0%
BKD	0.0%	0.0%	0.0%
FUN	4.6%	7.9%	9.2%

Table 54. Summary of injuries observed on NOR, bulk marked, and TE hatchery Chinook salmon at the Cougar Dam RO RST.

Injury Code	Observed Chinook Injuries (NOR) (n=885)	Bulk Marked Released Chinook (n=528)	Trapping Efficiency Hatchery Chinook (n=173)
NXI (no external injury)	1.8%	0.0%	0.0%
MUNK	0.0%	0.0%	0.0%
DS<2	67.7%	76.7%	85.0%
DS>2	27.5%	23.1%	15.0%
BLO	2.3%	1.3%	4.0%
EYB	20.0%	13.8%	2.3%
BVT	4.0%	2.1%	0.0%
FVB	14.9%	8.1%	0.6%
GBD	47.5%	39.6%	9.8%
POP	3.4%	2.3%	3.5%
HIN	6.6%	3.8%	2.9%
OPD	20.5%	26.1%	9.2%
TEA	3.3%	3.4%	4.0%
BRU	10.2%	7.0%	0.0%
HBP	2.0%	0.2%	0.6%
HO	0.0%	0.0%	0.0%
BO	0.0%	0.0%	1.2%
HBO	0.0%	0.2%	0.0%
FID	79.8%	95.8%	100.0%
PRD	0.3%	0.6%	2.3%
COP	69.5%	33.3%	1.7%
BKD	0.0%	0.0%	0.0%
FUN	7.1%	13.4%	6.4%

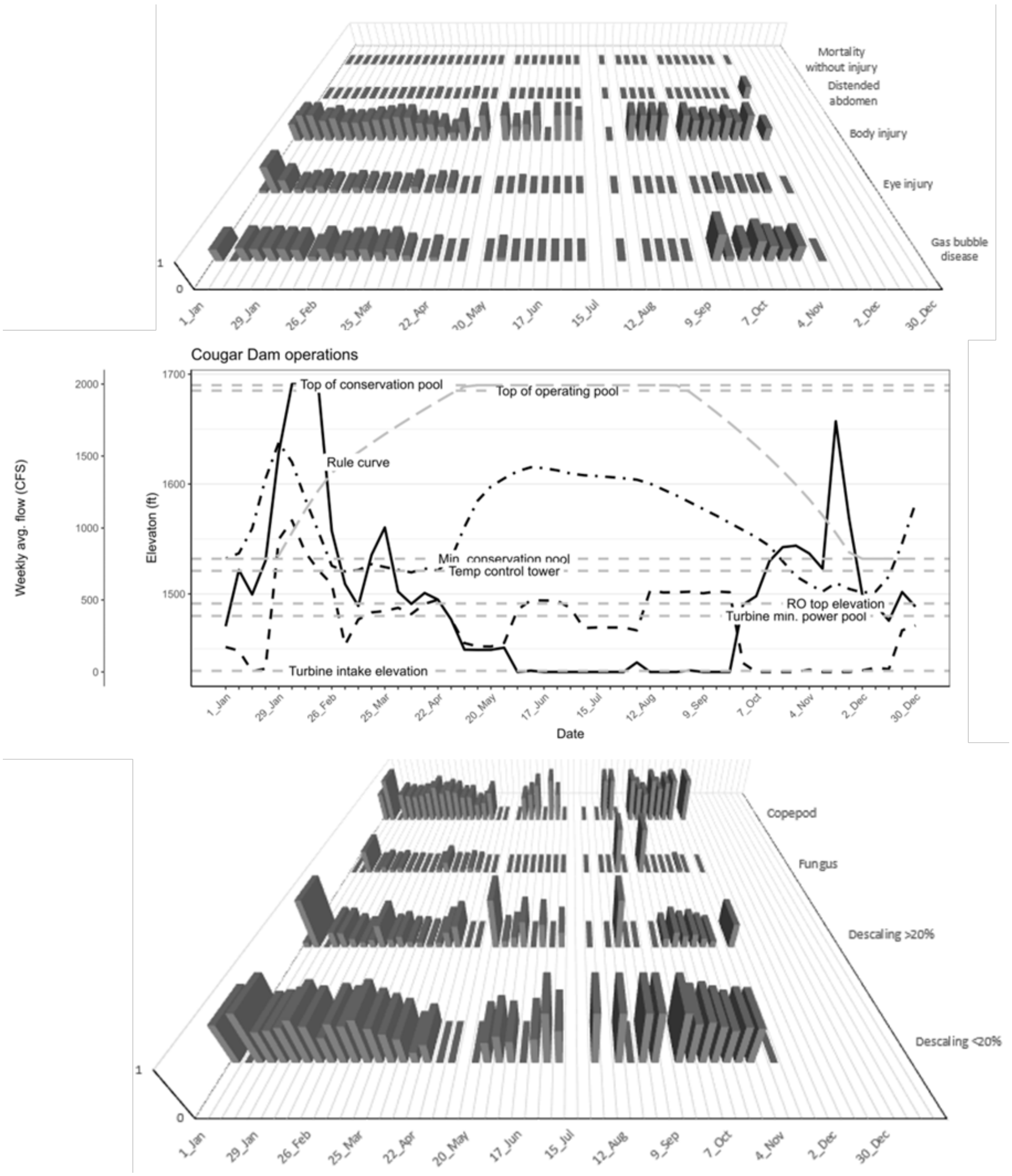

Figure 46. Proportion of captured juvenile Chinook salmon displaying injuries by type (top panel), operations data from Cougar Dam (middle panel) showing spill outflow (black line), Powerhouse outflow (black dash line), forebay elevation (black dot dash line), and proportion of captured juvenile Chinook displaying descaling and copepod injuries (bottom panel).

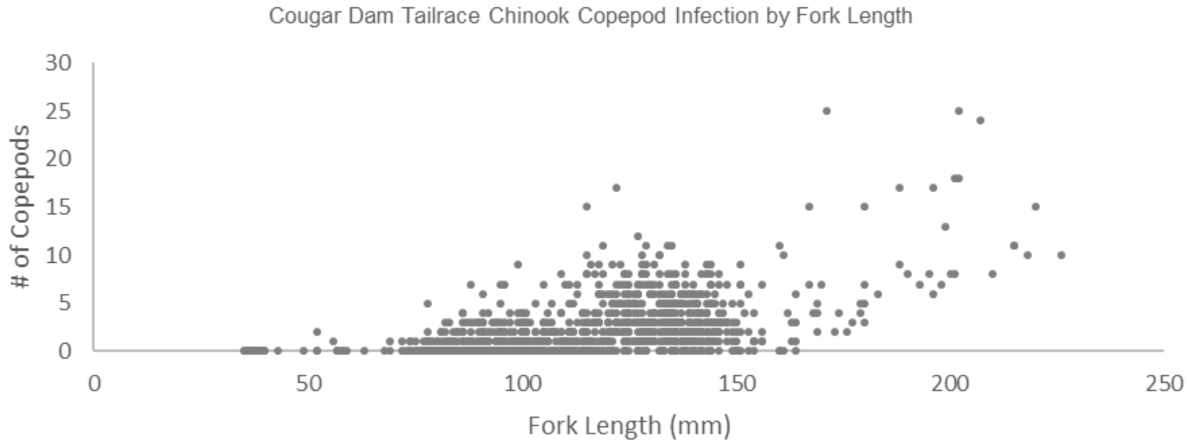

Figure 47. Copepod presence vs fork length on juvenile Chinook salmon captured at Cougar Dam.

1.3.8.5 24-Hour Hold Trials

24-hour hold trials were performed on NOR juvenile Chinook salmon captured at Cougar Dam to assess delayed mortality resulting from dam passage. A total of 700 fish, 521 from the RO and 179 from the PH, were held in 2024 (Table 55). A total of 39 fish died during hold (5.6%), 25 of the RO Chinook salmon (4.8%) and 14 of the PH Chinook salmon (7.8%). Mortality rates across the two-week periods in which fish were held ranged from 0.0% to 50.0%.

Table 55. Summary of 24-hour trials for Chinook salmon captured in the RSTs at the Powerhouse and Regulating Outlet.

Hold Period	Route	Number of Fish Held	Mortalities	% Survived
01/01–15/2024	PH	1	0	100.0%
01/01–15/2024	RO	9	0	100.0%
01/16–31/2024	PH	0	0	--
01/16–31/2024	RO	7	0	100.0%
02/01–15/2024	PH	31	0	100.0%
02/01–15/2024	RO	119	2	98.3%
02/16–29/2024	PH	72	3	95.8%
02/16–29/2024	RO	73	3	95.9%
03/01–15/2024	PH	3	0	100.0%
03/01–15/2024	RO	117	10	91.5%
03/16–31/2024	PH	9	0	100.0%
03/16–31/2024	RO	80	3	96.3%
04/01–15/2024	PH	3	0	100.0%
04/01–15/2024	RO	28	0	100.0%
04/16–30/2024	PH	2	0	100.0%
04/16–30/2024	RO	30	2	93.3%
05/01–15/2024	PH	1	0	100.0%
05/01–15/2024	RO	5	1	80.0%
05/16–31/2024	PH	1	0	100.0%
05/16–31/2024	RO	0	0	--
06/01–15/2024	PH	28	4	85.7%
06/01–15/2024	RO	0	0	--

Hold Period	Route	Number of Fish Held	Mortalities	% Survived
06/16–30/2024	PH	12	4	66.7%
06/16–30/2024	RO	0	0	--
07/01–15/2024	PH	6	0	100.0%
07/01–15/2024	RO	0	0	--
07/16–31/2024	PH	3	1	66.7%
07/16–31/2024	RO	0	0	--
08/01–15/2024	PH	1	0	100.0%
08/01–15/2024	RO	0	0	--
08/16–31/2024	PH	2	1	50.0%
08/16–31/2024	RO	0	0	--
09/01–15/2024	PH	2	0	100.0%
09/01–15/2024	RO	0	0	--
09/16–30/2024	PH	2	1	50.0%
09/16–30/2024	RO	0	0	--
10/01–15/2024	PH	0	0	--
10/01–15/2024	RO	6	0	100.0%
10/16–31/2024	PH	0	0	--
10/16–31/2024	RO	32	3	90.6%
11/01–15/2024	PH	0	0	--
11/01–15/2024	RO	14	1	92.9%
11/16–30/2024	PH	0	0	--
11/16–30/2024	RO	1	0	100.0%
12/01–15/2024	PH	0	0	--
12/01–15/2024	RO	0	0	--
12/16–31/2024	PH	0	0	--
12/16–31/2024	RO	0	0	--

1.3.8.6 PIT Tagged/VIE Marked Fish and Downstream Detections

A total of 349 NOR juvenile Chinook salmon were PIT tagged and released at the Cougar Dam traps in 2024. Three PIT tags were redetected downstream in the Columbia River Estuary. The average travel time was 133 days. Three Chinook salmon containing a PIT tag from Cougar the Head of Reservoir RST were captured in the Cougar Dam RSTs. The average travel time was 280 days. No VIE marked fish were encountered at this site during sampling in 2024. Table 56 shows a summary of the fish redetected at downstream sites. Information regarding PIT tags at the RST site is provided in Appendix C: PIT Tags and VIE Tagging.

Table 56. Summary of redetections PIT tagged juvenile Chinook at the Cougar Dam sites.

PIT Tag #	Mark Date	Redetection Date	Recap Site	Travel Time (Days)
3DD.003BEE1074	11/01/2023	040/1/2024	PD6 – Columbia River Estuary rkm 68	152
3DD.003BEE13F6	11/01/2023	4/5/2024	TWX – Estuary Towed Array (Exp.)	156
3DD.003BE9F60D	03/21/2024	5/26/2024	TWX – Estuary Towed Array (Exp.)	66

1.3.8.7 Willamette Valley Projects Encounters

A total of 619 adipose clipped and PIT tagged Chinook were captured at the Cougar Dam traps in 2024. These fish are a part of Cramer Fish Science's bulk mark release project. For information regarding bulk mark releases and detection data, refer to the *Bulk Marking and Reservoir Distribution Study Annual Report* (CFS 2024). One adult *O. mykiss* was encountered containing a PIT tag from a Chinook release by CFS. We believe this fish predated upon a juvenile Chinook. One bull trout was encountered containing a PIT tag. This fish had been tagged by EAS the month prior. Additionally, a Chinook was encountered containing a PIT tag from the ODFW South Fork McKenzie seining surveys.

1.3.8.8 Non-Target Capture Data

A total of 2,869 non-target fish were captured at the Cougar Dam RSTs in 2024.The most captured non-target species were dace, clipped Chinook, and sculpin. Three bull trout were encountered at this site and were reported to ODFW. All bull trout were measured and scanned for PIT tags. More information regarding captured bull trout is provided in Appendix C: PIT Tags and VIE Tagging. A summary of species and catch is provided below in Table 57.

Table 57. Summary of non-target fish capture for the Cougar Dam RSTs in 2024.

Species	Season Total	Season Total Mortality (subset of total)
Bluegill	4	2
Bull Trout	3	0
Juvenile Chinook (clipped)	827	74
Crappie	2	1
Cutthroat Trout	26	3
Dace	1,549	9
Lamprey	7	0
Largescale Sucker	2	0
Mountain Whitefish	41	2
Northern Pikeminnow	5	1
O. mykiss	140	5
Pacific Lamprey	1	0
Sculpin	199	1
Smallmouth Bass	52	10
Spotted Bass	7	5
Unknown*	4	0
Totals	**2,869**	**113**

*Species denoted as "unknown" were too small and/or too decomposed to identify.

1.3.9 Fall Creek Head of Reservoir

A single 8-foot RST was deployed at the Fall Creek Head of Reservoir site on January 1, 2024, and continued sampling until June 30, 2024.

Sampling outages resulting from high flows, excessive debris, severe weather, localized flood evacuations, and additional issues are listed in Appendix B: Sampling Outages by Site. Non-sampling periods illustrated in the figures below are further detailed in Appendix B: Sampling Outages by Site.

Additionally, the RST was not sampled from January 9, 2024, to January 22, 2024, due to the RST being submerged from high flows, excessive debris, and a large incoming winter storm. During this outage, the RST was storm sampled, but high debris continued to warrant the trap being raised. Furthermore, the RST was not sampled from May 3, 2024, to May 9, 2024, due to increased flows and high levels of debris.

1.3.9.1 Trapping Efficiency Trials

A total of 8 TE trials occurred at the Fall Creek Head of Reservoir site in 2024 using hatchery reared Chinook salmon. Collectively, 12 TE trials have occurred at this site since May 2023. A summary of the fish release numbers, recaptures, and flow level for each trial is provided in Table 58. Hatchery fish availability for TE trials in the Middle Fork Willamette River basin in 2024 were limited due to shortfalls in BY 2023 Chinook made available by ODFW.

TEs ranged from 0.5% to 18.1% with a pooled average of 8.9% (95%CI ± 3.5%, n=11) of all successful trials with five or more recaptures. One of the trials, performed on May 24, 2023, did not recapture enough fish to be used in the passage estimate calculation. The 2024 sampling season concluded on July 1 and the trap was removed. Trap efficiency analysis identified the full model—incorporating weekly average discharge, average trap revolutions per hour, mean fork length, and interactions among these covariates—as having the highest pseudo R^2 (0.88, n=12), suggesting a strong fit to the data. However, these results likely reflect overfitting due to the small sample size and limited variability in the response data, driven by the low trap efficiencies. In such cases, models may be capturing site-specific noise rather than generalizable patterns. Detailed methods and full results of the trap efficiency modeling are provided in Appendix E: Trap Efficiency Plots.

Table 58. Summary table of marked hatchery Chinook salmon releases at Fall Creek Head of Reservoir Site for trapping efficiency.

Release Location	Date of Release	Gage Height at Release (ft)	Number of Fish Released	Number of Fish Recaptured	Percent Efficiency
Fall Creek Head of Reservoir*	05/05/2023	3.8	756	15	2.00%
Fall Creek Head of Reservoir*	05/10/2023	3.8	750	23	3.10%
Fall Creek Head of Reservoir*	05/18/2023	3.5	511	7	1.40%
Fall Creek Head of Reservoir*	05/24/2023	3.3	760	4	0.50%
Fall Creek Head of Reservoir	01/02/2024	3.8	755	137	18.10%
Fall Creek Head of Reservoir	02/02/2024	4.1	751	51	6.80%
Fall Creek Head of Reservoir	03/05/2024	4.2	750	74	9.90%
Fall Creek Head of Reservoir	03/26/2024	3.9	998	99	9.90%
Fall Creek Head of Reservoir	04/15/2024	4.1	2,000	241	12.10%
Fall Creek Head of Reservoir	05/21/2024	3.5	749	24	3.20%
Fall Creek Head of Reservoir	05/29/2024	3.4	749	111	14.80%
Fall Creek Head of Reservoir	06/13/2024	3.4	750	120	16.00%

*Release performed by EAS for the USACE under contract W9127N19D0007.

1.3.9.2 Run of River Trapping Efficiency Trials

No ROR trials occurred in 2024 due to insufficient numbers of fish captured. Past ROR trials have resulted in small numbers of fish recaptured, likely due to the limited number of fish released. Large numbers of fish are required for release in order to get enough recaptures for meaningful insight. Additional trials will be attempted in the future. A summary of ROR TE trials by month is provided in Table 59.

Table 59. Summary table of run of river releases at the Fall Creek HOR site for trapping efficiency.

Release Location	Date of Release	Number of Fish Released	Number of Fish Recaptured	Percent Efficiency
Fall Creek Head of Reservoir	February 2023	3	0	0%
Fall Creek Head of Reservoir	March 2023	32	1	3.1%

1.3.9.3 Target Catch and Passage Timing

The trap at Fall Creek Head of Reservoir captured 7 juvenile Chinook salmon (Figure 48). Peak passage of Chinook salmon entering Fall Creek Reservoir occurred in February (n=4, 57.1% of total catch). Scale samples show that fish captured at this site consisted entirely of BY 2022 yearlings (Figure 49). Prior studies above Fall Creek Reservoir found that most fish migrated into the reservoir in December and through the early summer months. Our observations are consistent with past monitoring efforts. We estimate that 41 (95% CI: 29 to 68) Chinook salmon migrated past the sample site into Fall Creek Reservoir during sampling in the spring of 2024 (Figure 48). A summary of fork lengths and weight data is provided in Table 60.

In calendar year 2023, a total of 119 adult Chinook were out-planted above Fall Creek Reservoir. The Bedrock wildfire occurred in the drainage in July and was not fully contained until early October. Spawning surveys by ODFW and USACE staff, while limited, suggest that spawning success was very low for the out-planted adults. No sub-yearling Chinook were captured in the RST in 2024 further suggesting that few, if any, Chinook were able to successfully spawn in Fall Creek above Fall Creek Reservoir in 2023. However, the trap was unable to sample during high flows events in late January and it is possible that some fry may have passed the trapping site at that time. Fall capture data from the Fall Creek Dam RST did not observe any sub-yearling fish in 2024 further suggesting that out-planted adults in 2023 had poor spawning success.

Table 60. Summary of fork length and weight observed on juvenile Chinook salmon at the Fall Creek Head of Reservoir RST site by brood year.

Species	Date Range	BY	Number of Fish	Average F.L. (mm)	Min. F.L. (mm)	Max F.L. (mm)	Median F.L. (mm)	Average Weight (g)	Min. Weight (g)	Max Weight (g)	Median Weight (g)
Chinook	1/1/2024–6/30/2024	22	7	121.9	114	134	121	20.5	13.6	25.7	21.2

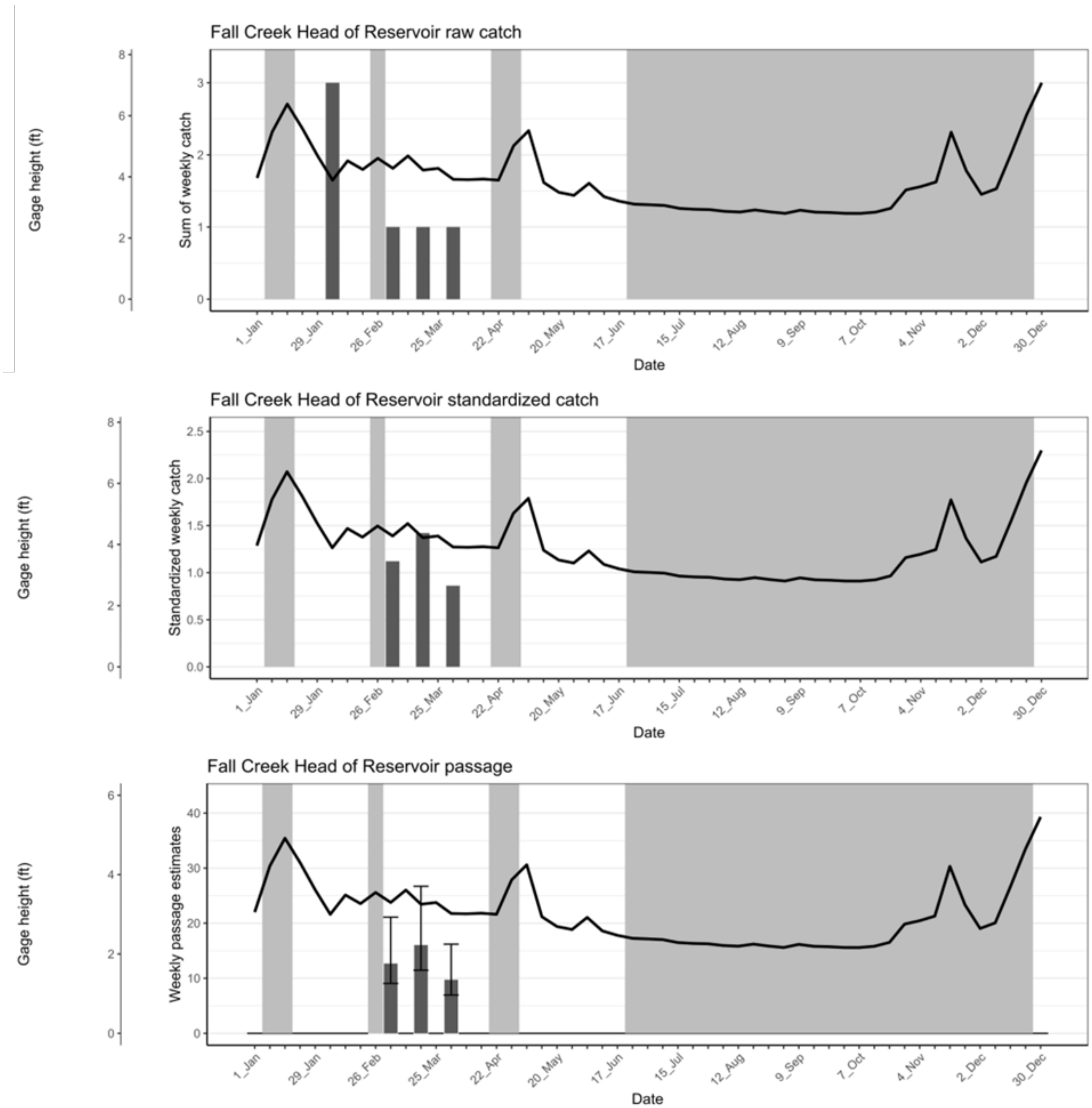

Figure 48. Raw catch (top panel), weekly standardized catch (middle panel), and weekly passage estimates (bottom panel) of NOR juvenile Chinook salmon at the Fall Creek Head of Reservoir site with stream flow (black line) and non-sampling weeks shaded out (gray).

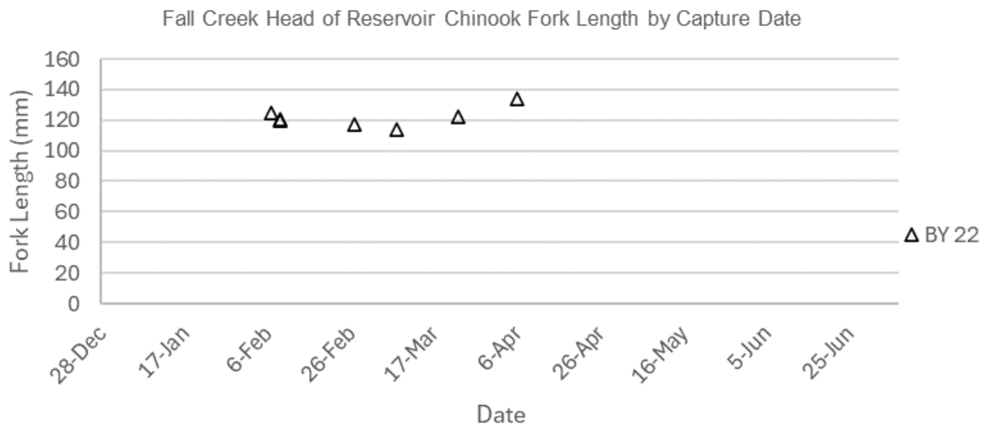

Figure 49. Length-Frequency of juvenile Chinook salmon at Fall Creek Head of Reservoir.

1.3.9.4 Injury Data

A total of 7 juvenile Chinook salmon (100% of total Chinook salmon capture) captured at the Fall Creek Head of Reservoir site displayed injuries at the time of capture. These injuries were likely the result of contact with debris or trap surfaces upon capture. The injuries encountered within these juvenile Chinook salmon were descaling greater than 20%, fin damage, and tears (Table 61). TE hatchery Chinook salmon captured at this site predominantly exhibited descaling less than and greater than 20%, operculum damage, bruising, fin damage, and fungus (Table 61).

No Chinook salmon were dead at the time of trap checks. No Chinook salmon were observed with copepods at the Fall Creek Head of Reservoir site in 2024. Additionally, no CFS bulk marked released Chinook salmon were found at this site by EAS personnel. Table 61 provides a summary of injuries at this site.

Data collected on the injury rates of TE hatchery fish illustrated that both the percentage of fish with injuries and the average number of injuries per fish generally increased from pre-release to recaptured observations. Detailed findings on injury type are further presented in Appendix D: Additional Injury Information.

Table 61. Summary of injuries observed on NOR and TE hatchery Chinook salmon at the Fall Creek Head of Reservoir RST site.

Injury Code	Chinook Injuries (NOR) (n=7)	Trapping Efficiency Hatchery Chinook (n=857)
NXI (no external injury)	0.0%	1.2%
MUNK	0.0%	0.0%
DS<2	0.0%	14.6%
DS>2	100.0%	81.2%
BLO	0.0%	0.0%
EYB	0.0%	0.6%
BVT	0.0%	0.0%
FVB	0.0%	0.1%
GBD	0.0%	0.0%
POP	0.0%	0.0%
HIN	0.0%	0.0%
OPD	0.0%	2.7%
TEA	14.3%	0.1%
BRU	0.0%	2.1%
HBP	0.0%	0.0%
HO	0.0%	0.0%
BO	0.0%	0.0%
HBO	0.0%	0.0%
FID	42.9%	92.4%
PRD	0.0%	0.0%
COP	0.0%	0.0%
BKD	0.0%	0.0%
FUN	0.0%	3.7%

1.3.9.5 PIT Tagged/VIE Marked Fish and Downstream Detections

A total of 7 NOR Chinook salmon were PIT tagged at the Fall Creek Head of Reservoir site in 2024. One PIT tagged Chinook was recaptured at the Fall Creek Dam Tailrace trap in 2024. The travel time was 8 days. No NOR Chinook salmon were VIE marked at the Fall Creek Head of Reservoir site in 2024. No VIE marked fish were redetected downstream at the Fall Creek Dam site. A summary of downstream PIT tag detections is provided in Table 62. Further information on tagged and VIE marked fish at this site is available in Appendix C: PIT Tags and VIE Tagging.

Table 62. Summary of PIT tagged Chinook downstream redetections for the Fall Creek Head of Reservoir site.

PIT Tag #	Mark Date	Redetection Date	Recap Site	Travel Time (Days)
3DD.003BE9F184	02/07/2024	02/15/2024	Fall Creek Dam Tailrace	8

1.3.9.6 Non-Target Capture Data

The Fall Creek Head of Reservoir trap captured 634 non-target fish in addition to NOR juvenile Chinook salmon in 2024. The most commonly captured non-target species were dace, *O. mykiss*, and lamprey. A summary of species and numbers of fish caught are provided in Table 63.

Table 63. Summary of non-target fish catch at the Fall Creek Head of Reservoir RST in 2024.

Species	Season Total	Season Total Mortality (subset of total)
Cutthroat Trout	76	1
Juvenile Chinook (clipped)	15	0
Dace	158	1
Largescale Sucker	2	0
Northern Pikeminnow	1	0
O. mykiss	201	1
O. mykiss (adult)	45	0
Pacific Lamprey	12	0
Sculpin	5	0
Lamprey	119	1
Totals	**634**	**4**

1.3.10 Fall Creek Dam Tailrace

A single 8-foot RST was deployed at the Fall Creek Dam Tailrace RO channel on January 1, 2024, and continued sampling until July 15, 2024. The RST did not sample from July 15, 2024, to September 30, 2024, but began sampling again from October 1, 2024, to December 31, 2024.

Sampling outages resulting from high flows, excessive debris, severe weather, localized flood evacuations, and additional issues are listed in Appendix B: Sampling Outages by Site. Non-sampling periods illustrated in the figures below are further detailed in Appendix B: Sampling Outages by Site.

Additionally, the RST was not sampled from January 1, 2024, to January 12, 2024, due to a sediment flush. The increased amount of sedimentation necessitated EAS to raise the cone due to the channel depth becoming too shallow to safely sample during this time. The trap was visited, and conditions checked daily to ensure a prompt return sampling once sediment loads decreased to safe levels.

1.3.10.1 Trapping Efficiency Trials

A total of five TE trials occurred at the Fall Creek Dam Tailrace in 2024 using hatchery reared juvenile Chinook salmon. Collectively,13 trials have occurred at this site since June 2022. A summary of the fish release numbers, recaptures, and flow level for each trial is provided in Table 64. Hatchery fish availability for TE trials in the Middle Fork Willamette River basin in 2024 were limited due to shortfalls in BY 2023 Chinook made available by ODFW. Thus, TE trials did not occur to the extent that were originally planned for 2024.

TEs ranged from 1.2% to 4.7% with a pooled average of 2.2% (95%CI ± 1.3%, n=5) of all successful trials with five or more recaptures. Eight of the trials did not recapture a sufficient number of fish to be used in the passage estimate calculation. Modeling results from the discharge and revolutions per hour analysis yielded a suite of models with high pseudo R^2 values, with a minimum of 0.832 for the model with discharge as a single variable. The full model with discharge, revolutions per hour, and their interaction had the highest pseudo R^2 of 0.99 (n=13). However, these results likely reflect overfitting due to the small sample size and limited variability in the response data, driven by the low trap efficiencies. In such cases, models may be capturing site-specific noise rather than generalizable patterns. Detailed methods and full results of the trap efficiency modeling are provided in Appendix E: Trap Efficiency Plots.

The five successful trials have occurred when flow was >950 cfs. TE trials performed during low flow did not yield any recaptures. This is likely due to the slow rotation speed of the trap and the subsequent flow levels allowing fish to easily avoid the trap.

Table 64. Summary table of marked hatchery Chinook salmon releases at Fall Creek Dam Tailrace for trapping efficiency.

Release Location	Date of Release	cfs at Release	Number of Fish Released	Number of Fish Recaptured	Percent Efficiency
Fall Creek Dam Regulating Outlet	06/08/2022	957	517	11	2.1%
Fall Creek Dam Regulating Outlet	06/30/2022	231	513	0	0.0%
Fall Creek Dam Regulating Outlet	07/13/2022	228	498	0	0.0%
Fall Creek Dam Regulating Outlet	05/11/2023	83	998	0	0.0%
Fall Creek Dam Regulating Outlet	06/28/2023	89	992	0	0.0%
Fall Creek Dam Regulating Outlet	07/11/2023	48	1,006	0	0.0%
Fall Creek Dam Regulating Outlet	10/03/2023	60	1,020	0	0.0%
Fall Creek Dam Regulating Outlet	10/17/2023	2,630	1,011	14	1.4%
Fall Creek Dam Regulating Outlet	01/22/2024	1,028	999	12	1.2%
Fall Creek Dam Regulating Outlet	02/13/2024	1,700	1,004	47	4.7%
Fall Creek Dam Regulating Outlet	03/05/2024	1,000	1,001	14	1.4%
Fall Creek Dam Regulating Outlet	03/26/2024	55	1,600	0	0.0%
Fall Creek Dam Regulating Outlet	04/08/2024	124	2,000	0	0.0%

1.3.10.2 Run of River Trapping Efficiency Trials

No TE trials using ROR fish were performed at Fall Creek Dam Tailrace in 2024. The first 60 wild fish caught per week are prioritized for the 24-hour hold mortality study and are not tagged. Sufficient numbers of NOR fish were not available to perform ROR TE trials.

1.3.10.3 Target Catch, Passage Estimates and Passage Timing

The trap in the RO channel below Fall Creek Dam captured 14 juvenile Chinook salmon during sampling in 2024. Capture of juvenile Chinook salmon occurred in February, March, and November (Figure 50). Peak capture occurred in February (n=6, 42.9% of total Chinook salmon capture). This timing is consistent with previous monitoring efforts observed where Chinook salmon sub-yearlings and yearlings often migrated out of Fall Creek Dam in January and February (Keefer et al. 2012). Chinook catch in the spring occurred during periods of increased RO flow associated with significant storm events necessitating the release of water to refill and then maintain reservoir elevations. Capture of fish in the fall occurred during the reservoir drawdown period when RO outflows were increased. Only BY 2022 yearlings were captured at this site during monitoring in 2024 (Figure 51). Similar to observations from previous studies, Chinook were not captured in the summer as the reservoir refilled. Previous studies indicated that passage is very low or zero during the summer when the reservoir elevation and thus water surface elevation over the fish horns is high (Keefer et al. 2012, Hansen et al. 2017). A summary of fork lengths and weights for Chinook salmon captured at Fall Creek Dam by BY is provided in Table 65. For raw weekly catch of Chinook at this site for sampling from 2022 and 2023, see Appendix I: Adult Chinook Out-planting Above Willamette Valley Projects. Due to the low number of successful TE trials at this site (n=5) and low numbers of collected fish, an estimate of passage at the Fall Creek Dam RST site is not available at this time. Additional successful trials are needed to provide accurate estimates in the future.

In calendar year 2023, a total of 119 adult Chinook were out-planted above Fall Creek Reservoir. The Bedrock wildfire occurred in the drainage in July and was not fully contained until early October. Spawning surveys by ODFW and USACE staff, while limited, suggest that spawning success was very low for the out-planted adults. No sub-yearling Chinook were captured in the RSTs above and below Fall Creek Reservoir during sampling in 2024, further suggesting that few, if any, Chinook were able to successfully spawn in Fall Creek above Fall Creek Reservoir in 2023. However, the trap was unable to sample the first two weeks in January due to high sediment loads flushing out of Fall Creek Dam Reservoir through the RO channel. It is possible that some Chinook fry passed the sampling site during that time. Fall sampling data further suggest that the success of out-planted adult Chinook above Fall Creek Reservoir in 2023 was poor.

Table 65. Summary of fork length and weight observed on juvenile Chinook salmon of NOR at the Fall Creek Dam RST site by brood year.

Species	Date Range	BY	Number of Fish	Average F.L. (mm)	Min. F.L. (mm)	Max F.L. (mm)	Median F.L. (mm)	Average Weight (g)	Min. Weight (g)	Max Weight (g)	Median Weight (g)
Chinook	1/1/2024–6/30/2024	22	9	129.6	112	146	130	26.1	15.5	24.7	26.5
Chinook	7/1/2024–12/31/2024	22	5	211.8	177	261	187	117.9	65.6	199.4	74.4

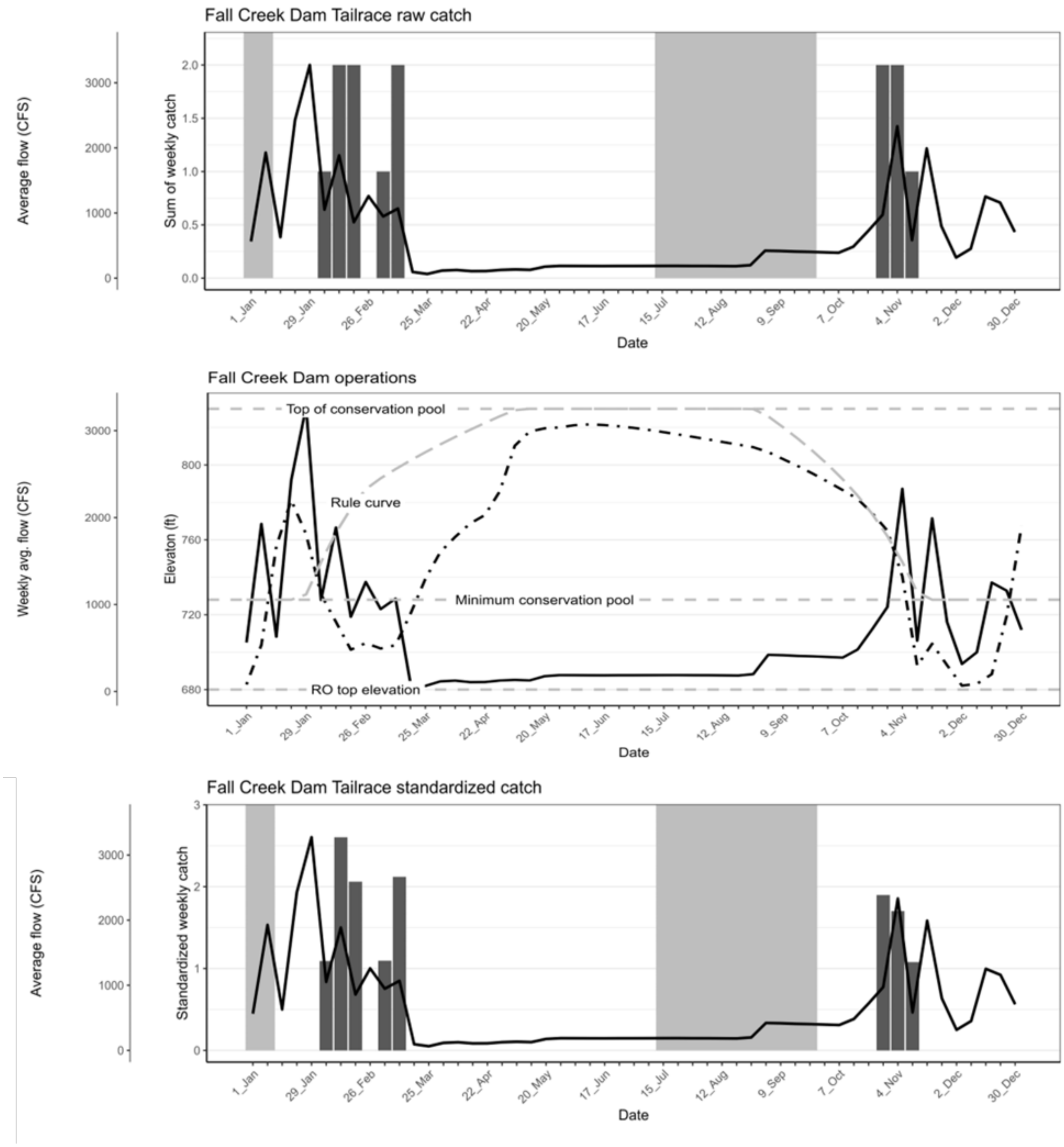

Figure 50. Raw catch (top panel) and weekly standardized catch (bottom panel) of NOR juvenile Chinook salmon at the Fall Creek Dam Tailrace site with RO outflow (black line) and non-sampling weeks shaded out (gray). Fall Creek Dam operations and features of interest (middle panel) with forebay elevation (black dot dash line) and outflow (black line)

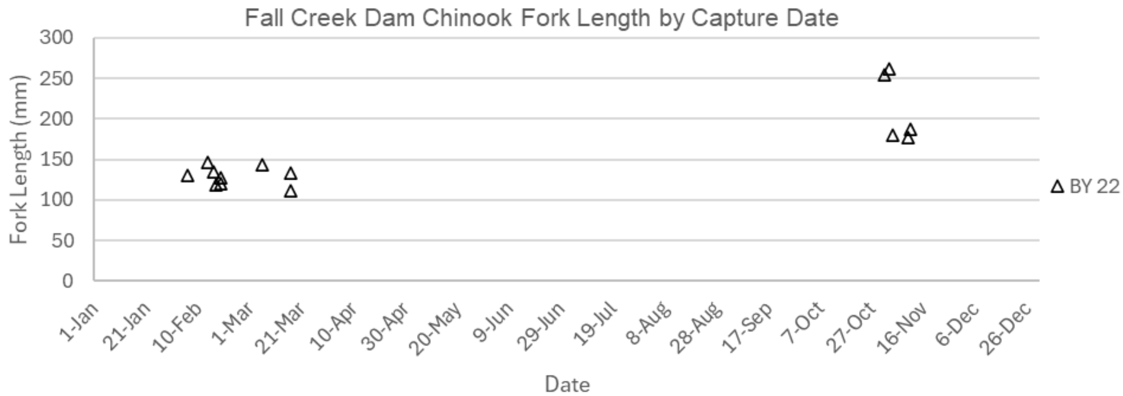

Figure 51. Length-frequency of juvenile Chinook salmon at the Fall Creek Dam Tailrace site.

1.3.10.4 Injury Data

In total, 14 juvenile Chinook salmon (100% of total Chinook salmon capture) captured at the Fall Creek Dam Tailrace site displayed injuries upon capture. The predominant injuries encountered within these juvenile Chinook salmon were descaling less than and greater than 20%, operculum damage, fin damage, and the presence of copepods (Table 66).

Comparatively, juvenile Chinook salmon that were of NOR and were encountered at the Fall Creek Dam Tailrace site exhibited lower percentages of descaling less than 20%and fin damage when assessed against the PIT tagged bulk marked released and TE hatchery Chinook salmon (Table 66). High percentages of descaling greater than 20% and fin damage were observed in captured TE hatchery fish. These findings are similar to many of those encountered when assessing hatchery raised fish among all sites. NOR Chinook salmon exhibited higher rates of operculum damage, tearing, bruising, the presence of copepods, and fungus when compared to bulk marked released and TE hatchery Chinook at this site.

No juvenile Chinook salmon that were encountered at the Fall Creek Dam Tailrace in the spring of 2024 had copepods present upon removal from the RST, as seen in Figure 52. A total of one Chinook salmon was dead at the time of trap check (11.1% of total Chinook salmon capture). A summary of injuries by type is shown in Table 66. Additional information regarding injuries by size and average injuries per fish is available in Appendix D: Additional Injury Information.

Data collected on the injury rates of TE hatchery fish illustrated that both the percentage of fish with injuries and the average number of injuries per fish generally increased from pre-release to recaptured observations. Detailed findings on injury type are further presented in Appendix D: Additional Injury Information.

Table 66. Summary of injuries observed on NOR, bulk marked, and TE hatchery Chinook salmon at the Fall Creek Dam Tailrace RST site.

Injury Code	Chinook Injuries (NOR) (n=14)	Bulk Marked Released Chinook (n=278)	Trapping Efficiency Hatchery Chinook (n=74)
NXI (no external injury)	0.0%	0.0%	0.0%
MUNK	0.0%	0.0%	0.0%
DS<2	78.6%	86.0%	86.5%
DS>2	21.4%	14.0%	13.5%
BLO	7.1%	0.7%	1.4%
EYB	7.1%	4.3%	2.7%
BVT	7.1%	4.0%	1.4%
FVB	7.1%	8.3%	0.0%
GBD	7.1%	4.0%	6.8%
POP	0.0%	0.4%	0.0%
HIN	0.0%	8.3%	4.1%
OPD	21.4%	5.8%	4.1%
TEA	14.3%	1.1%	0.0%
BRU	14.3%	7.2%	2.7%
HBP	0.0%	0.4%	0.0%
HO	0.0%	0.0%	0.0%
BO	0.0%	0.0%	0.0%
HBO	0.0%	0.0%	0.0%
FID	78.6%	99.3%	100.0%
PRD	0.0%	0.0%	0.0%
COP	35.7%	22.7%	0.0%
BKD	0.0%	0.0%	0.0%
FUN	14.3%	0.7%	1.4%

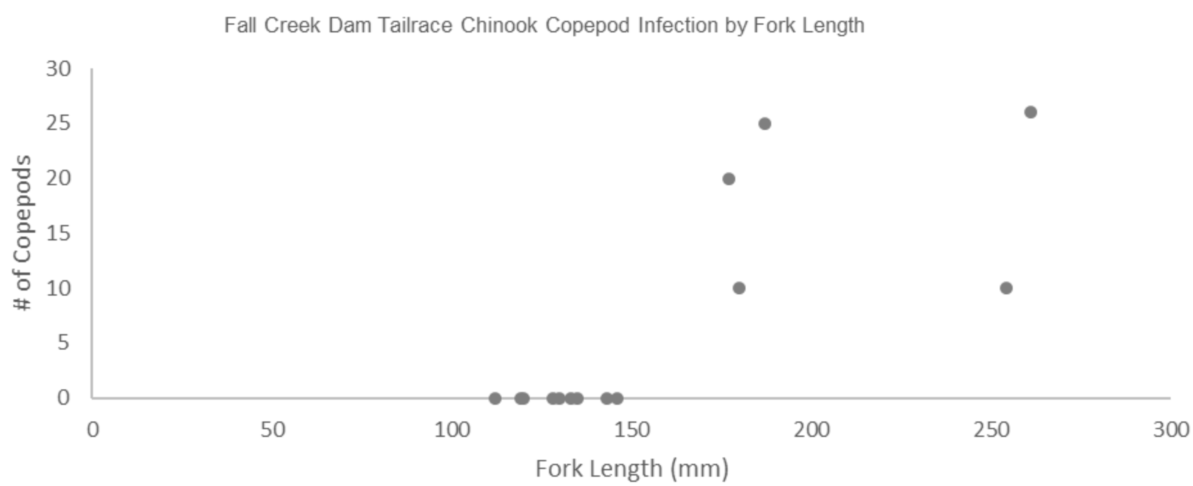

Figure 52. Copepod presence vs fork length on juvenile Chinook salmon captured at Fall Creek Dam Tailrace.

1.3.10.5 24-Hour Hold Trials

24-hour hold trials were performed on NOR juvenile Chinook salmon captured at Fall Creek Dam Tailrace to assess delayed mortality resulting from dam passage. A total of 10 Chinook salmon were held in 2024 (Table 67). A total of zero Chinook salmon died during hold (0.0%).

Table 67. Summary of 24-hour trials for fish captured in the RST at the Fall Creek Dam Tailrace site.

Hold Period	Species	Number of Fish Held	Mortalities	% Survived
01/01–15/2024	Chinook	0	0	--
01/16–31/2024	Chinook	0	0	--
02/01–15/2024	Chinook	2	0	100.0%
02/16–29/2024	Chinook	3	0	100.0%
03/01–15/2024	Chinook	1	0	100.0%
03/16–31/2024	Chinook	2	0	100.0%
04/01–15/2024	Chinook	0	0	--
04/16–30/2024	Chinook	0	0	--
05/01–15/2024	Chinook	0	0	--
05/16–31/2024	Chinook	0	0	--
06/01–15/2024	Chinook	0	0	--
06/16–30/2024	Chinook	0	0	--
07/01–15/2024	Chinook	0	0	--
11/01–15/2024	Chinook	2	0	100.0%
11/16–30/2024	Chinook	0	0	--
12/01–15/2024	Chinook	0	0	--
12/16–31/2024	Chinook	0	0	--

1.3.10.6 PIT Tagged/VIE Marked Fish and Downstream Detections

No fish were PIT tagged at the Fall Creek Dam Tailrace site in 2024 as all captured fish were placed into the 24-hour hold study. One PIT tagged fish from Fall Creek Head of Reservoir was recaptured at this site. The travel time for this fish was 8 days. No VIE marked Chinook salmon were detected at this site in 2024. Further information on tagged fish at this site is available in Appendix C: PIT Tags and VIE Tagging.

1.3.10.7 Willamette Valley Projects Encounters

A total of 278 adipose clipped and PIT tagged Chinook salmon were captured in the Fall Creek Dam RST in 2024 that were associated with large bulk mark releases performed by CFS. For more information regarding release groups, dates, and other redetections, refer to the *Bulk Mark Release and Reservoir Distribution Study Annual Report* (CFS 2024).

1.3.10.8 Non-Target Capture Data

The Fall Creek Dam Tailrace trap captured 11,107 non-target fish in addition to NOR juvenile Chinook salmon in 2024. The most captured non-target species were dace, brown bullhead, and largescale suckers. A summary of species and numbers of fish caught is provided in Table 68.

Table 68. Summary of non-target fish catch at the Fall Creek Dam Tailrace RST in 2024.

Species	Season Total	Season Total Mortality (subset of total)
Brown Bullhead catfish	2,676	2,525
Juvenile Chinook (clipped)	528	46
Cutthroat Trout	466	10
Dace	4,178	216
Lamprey	147	2
Largescale Sucker	2,425	240
Mosquitofish	30	3
Mountain Whitefish	19	4
Northern Pikeminnow	5	0
O. mykiss	473	25
O. mykiss (clipped)	55	12
Pacific Lamprey	69	0
Peamouth	4	4
Redside Shiner	10	0
Sculpin	21	3
Unknown*	1	1
Totals	**11,107**	**3,091**

*Species denoted as “unknown” were too small and/or too decomposed to identify.

1.3.11 Hills Creek Head of Reservoir – Middle Fork Willamette River

A single 5-foot RST was deployed in the Middle Fork Willamette River above Hills Creek Dam on February 1, 2024, and continued sampling until June 30, 2024.

Sampling outages resulting from high flows, excessive debris, severe weather, and additional issues are listed in Appendix B: Sampling Outages by Site. Non-sampling periods illustrated in the figures below are further detailed in Appendix B: Sampling Outages by Site.

In the calendar year 2022, a total of 468 adult spring Chinook salmon were out-planted above Hills Creek Dam. This consisted of 198 females, 250 males, and 14 jack Chinook salmon (USACE 2022). No adult Chinook were out-planted above Hills Creek Reservoir in 2023.

1.3.11.1 Trapping Efficiency Trials

A total of 7 TE trials occurred at the Hills Creek Head of Reservoir – Middle Fork Willamette River site in 2024 using hatchery reared Chinook salmon. Collectively, 9 trials have occurred at this site since May 2023. A summary of the fish release numbers, recaptures, and flow level for each trial is provided in Table 69. Hatchery fish availability for TE trials in the Middle Fork Willamette River basin in 2024 were limited due to shortfalls in BY 2023 Chinook made available by ODFW. Thus, TE trials did not occur to the extent that were originally planned for 2024.

TEs ranged from 0.1% to 8.5% with a pooled average of 2.6% (95% CI ± 1.8%, n=8) of all successful trials with five or more recaptures. One of the trials did not recapture enough fish to be used in the passage estimate calculation. The 2024 sampling season concluded on July 1 and the trap was removed. Trap efficiency analysis identified the full model—incorporating weekly average discharge, average trap revolutions per hour, mean fork length, and interactions among these covariates—as having the highest pseudo R^2 (0.87, n=9), suggesting a strong fit to the data. However, these results likely reflect overfitting due to the small sample size and limited variability in the response data, driven by the low trap efficiencies. In such cases, models may be capturing site-specific noise rather than generalizable patterns. Detailed methods and full results of the trap efficiency modeling are provided in Appendix E: Trap Efficiency Plots.

Table 69. Summary table of marked hatchery Chinook salmon releases at Hills Creek Head of Reservoir – Middle Fork Willamette River for trapping efficiency.

Release Location	Date of Release	Gage Height at Release (ft)	Number of Fish Released	Number of Fish Recaptured	Percent Efficiency
Hills Creek Head of Reservoir – Middle Fork Willamette River	05/18/2023	10.2	519	44	8.5%
Hills Creek Head of Reservoir – Middle Fork Willamette River	06/19/2023	8.9	760	6	0.8%
Hills Creek Head of Reservoir – Middle Fork Willamette River	02/15/2024	9.9	761	1	0.1%
Hills Creek Head of Reservoir – Middle Fork Willamette River	02/20/2024	10.05	749	18	2.4%
Hills Creek Head of Reservoir – Middle Fork Willamette River	03/20/2024	10.78	752	16	2.1%
Hills Creek Head of Reservoir – Middle Fork Willamette River	04/09/2024	9.5	2,001	9	0.4%
Hills Creek Head of Reservoir – Middle Fork Willamette River	05/01/2024	9.8	750	32	4.3%
Hills Creek Head of Reservoir – Middle Fork Willamette River	05/23/2024	9.6	749	11	1.5%
Hills Creek Head of Reservoir – Middle Fork Willamette River	06/20/2024	8.9	750	7	0.9%

1.3.11.2 Run of River Trapping Efficiency Trials

No TE trials using ROR fish were performed at Hills Creek Head of Reservoir in 2024. Sufficient numbers of NOR fish were not available to perform ROR TE trials.

1.3.11.3 Target Catch, Passage Estimates and Passage Timing

A total of 47 NOR juvenile Chinook salmon were captured in the RST above Hills Creek Dam during spring sampling 2024. Peak capture of juvenile Chinook salmon entering Hills Creek Reservoir occurred during February (n=26, 55.3% of total Chinook salmon catch) Figure 53). Scale age analysis showed that all the Chinook salmon captured were BY 2022 yearlings (Figure 54). The first Chinook salmon yearling was captured on February 4, 2024, on the first day of sampling (Figure 53 and Figure 54). Based on this observation, it is possible that some fish migrated into Hills Creek Reservoir prior to the initiation of sampling. However, previous sampling at this location found that peak migration of juvenile Chinook into Hills Creek Reservoir occurred in March (Hansen et al 2017), later in the spring than was observed in 2024. A summary of fork length and weight data by brood year for Chinook salmon captured at this site in 2024 is provided in Table 70. No adults were out-planted above Hills Creek Reservoir in 2023. For more information on adult out-planting above Hills Creek Reservoir, please refer to Appendix I: Adult Chinook Out-planting Above Willamette Valley Projects. Utilizing pooled averages of hatchery Chinook TE trials, EAS estimates that 2,134 (95% CI: 1,252 to 7,238) juvenile Chinook passed the sampling site during February to June 2024 monitoring period.

Table 70. Summary of fork length and weight observed on juvenile Chinook salmon of NOR at the Hills Creek Head of Reservoir RST site by brood year.

Species	Date Range	BY	Number of Fish	Average F.L. (mm)	Min. F.L. (mm)	Max F.L. (mm)	Median F.L. (mm)	Average Weight (g)	Min. Weight (g)	Max Weight (g)	Median Weight (g)
Chinook	2/1/24–6/30/24	22	47	86.7	62	122	89	7.3	2.3	17.5	7.2

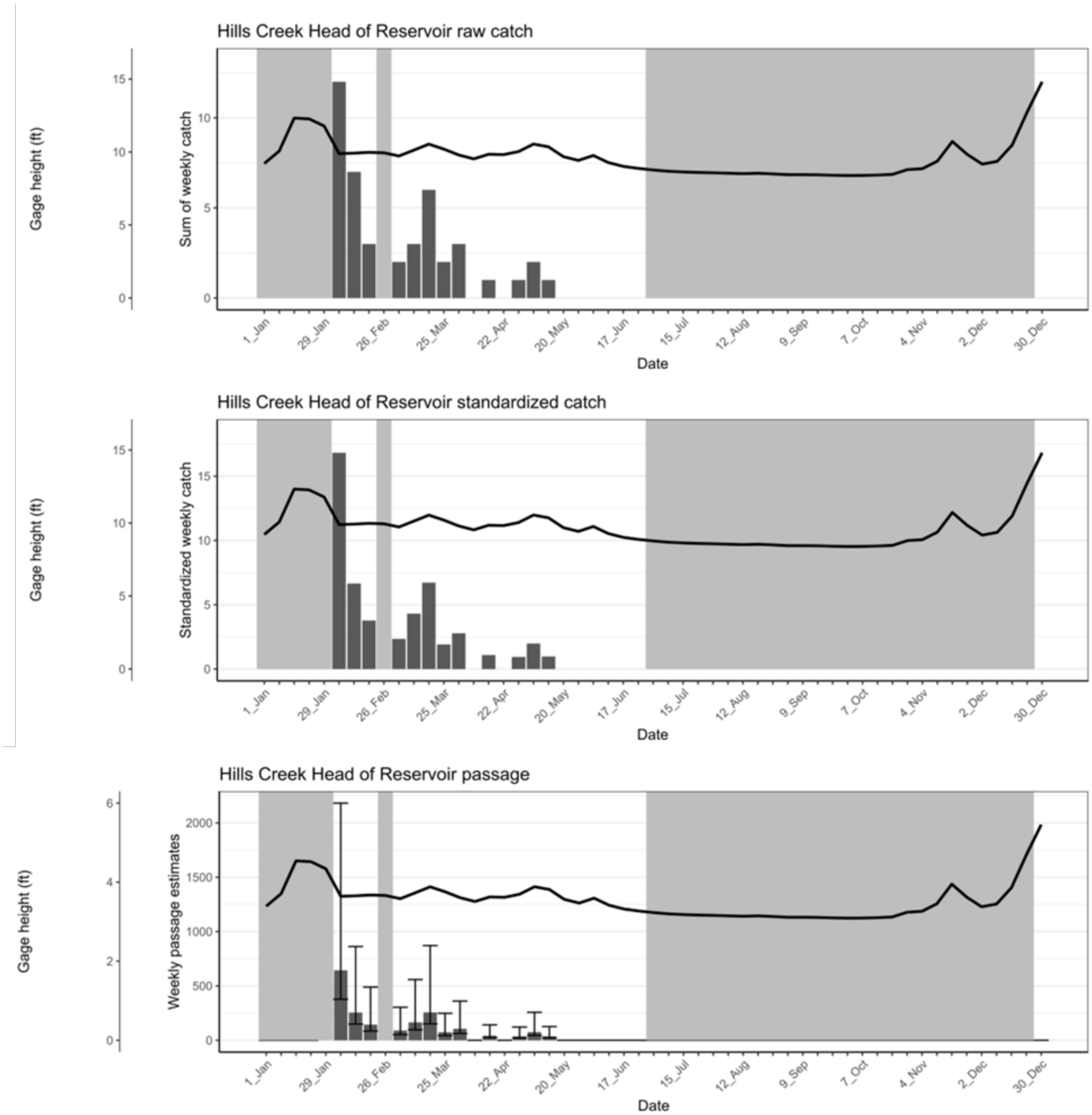

Figure 53. Raw catch (top panel) and weekly standardized catch (bottom panel) with stream gage height (black line) and non-sampling weeks shaded out (gray) for the Hills Creek Head of Reservoir – Middle Fork Willamette River RST.

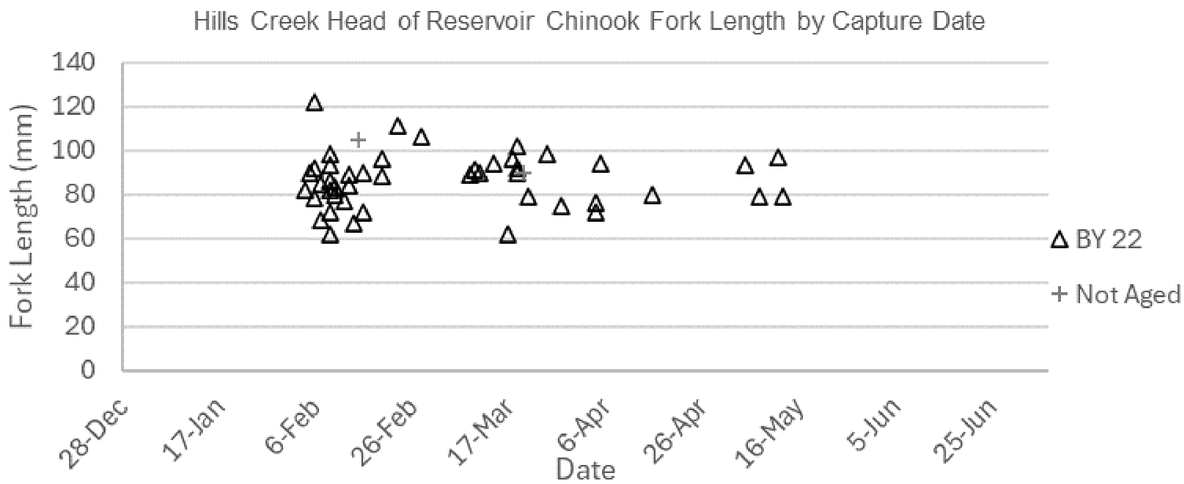

Figure 54. Length-frequency of juvenile Chinook salmon by brood year at the Hills Creek Head of Reservoir – Middle Fork Willamette River.

1.3.11.4 Injury Data

A total of 41 (87.2% of total Chinook salmon catch) juvenile Chinook salmon displayed at least one of the injury code conditions listed in Table 3. Table 71 provides a summary of observed injuries.

The most common injuries exhibited at the Hills Creek Head of Reservoir RST site are descaling less than 20%, fin damage. These injuries are frequently observed at the Head of Reservoir sites and can most likely be associated with contact from the RST itself. Captured TE hatchery Chinook salmon were found to have higher percentages of descaling greater than and less than 20%fin damage, and fungus when compared to NOR Chinook (Table 71).

No copepods were observed attached to fish captured at this site in 2023. However, data through the spring and fall of 2024 illustrates that 14.9% of the Chinook salmon catch had copepods present (Figure 55). Copepod presence on Chinook salmon were only observed on fish with fork lengths greater than 60 mm and less than 100 mm. Additional information regarding injuries by size and average injuries per fish is available in Appendix D: Additional Injury Information.

Data collected on the injury rates of TE hatchery fish illustrated that both the percentage of fish with injuries and the average number of injuries per fish generally decreased from pre-release to recaptured observations at the Hills Creek Head of Reservoir RST site. Detailed findings on injury type are further presented in Appendix D: Additional Injury Information.

Table 71. Summary of injuries observed on NOR and TE hatchery Chinook salmon at the Hills Creek Head of Reservoir – Middle Fork Willamette River RST site.

Injury Code	Chinook Injuries (NOR) (n=47)	Trapping Efficiency Hatchery Chinook (n=93)
NXI (no external injury)	12.8%	0.0%
MUNK	0.0%	0.0%
DS<2	78.7%	82.8%
DS>2	4.3%	14.0%
BLO	0.0%	1.1%
EYB	0.0%	0.0%
BVT	0.0%	0.0%
FVB	0.0%	0.0%
GBD	0.0%	0.0%
POP	0.0%	0.0%
HIN	0.0%	0.0%
OPD	4.3%	2.2%
TEA	0.0%	0.0%
BRU	4.3%	1.1%
HBP	0.0%	0.0%
HO	0.0%	0.0%
BO	0.0%	0.0%
HBO	0.0%	0.0%
FID	34.0%	64.5%
PRD	2.1%	0.0%
COP	14.9%	0.0%
BKD	0.0%	0.0%
FUN	4.3%	1.1%

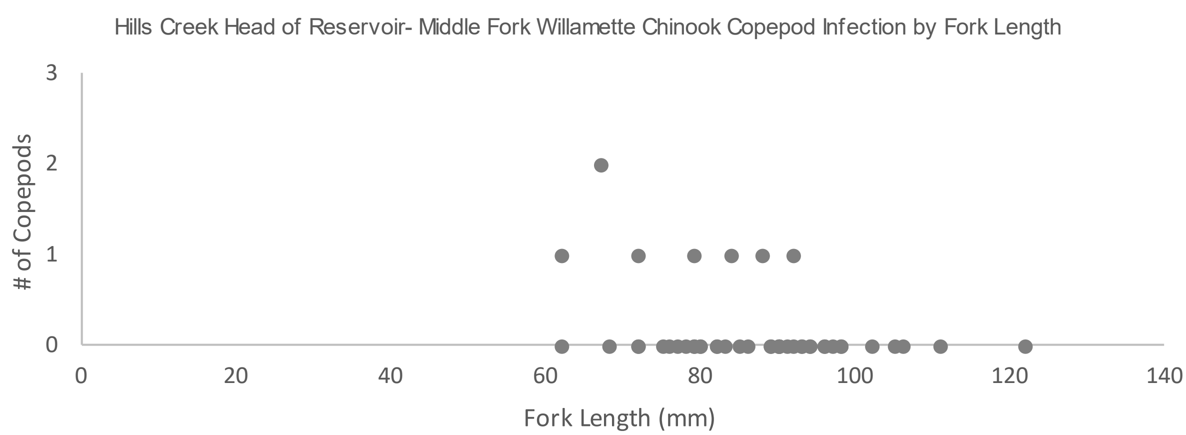

Figure 55. Copepod prevalence vs fork length on juvenile Chinook salmon captured at Hills Creek Head of Reservoir.

1.3.11.5 PIT Tagged/VIE Marked Fish and Downstream Detections

A total of 45 NOR Chinook were PIT tagged and 2 fish were VIE marked in 2024. No PIT tagged or VIE marked fish were redetected downstream. Table 72 provides a summary of VIE marked fish at the Hills Creek Head of Reservoir – Middle Fork Willamette River site. Further information on tagged and VIE marked fish at this site is available in Appendix C: PIT Tags and VIE Tagging.

Table 72. Summary table of VIE marked Chinook salmon at the Hills Creek Head of Reservoir – Middle Fork Willamette River RST site.

Date Tagged	Tag Location	VIE Color	# Tagged	# Recaptured
02/01/2024–02/15/2024	Left Dorsal	Yellow	1	0
02/16/2024–02/29/2024	Left Dorsal	Yellow	0	0
03/01/2024–03/15/2024	Left Dorsal	Red	0	0
03/16/2024–03/31/2024	Left Dorsal	Red	1	0
04/01/2024–04/15/2024	Left Dorsal	Blue	0	0
04/16/2024–04/30/2024	Left Dorsal	Blue	0	0
05/01/2024–05/15/2024	Left Dorsal	Orange	0	0
05/16/2024–05/31/2024	Left Dorsal	Orange	0	0
06/01/2024–06/15/2024	Left Dorsal	Pink	0	0
06/16/2024–06/30/2024	Left Dorsal	Pink	0	0

1.3.11.6 Non-Target Species

A total of 198 non-target fish were captured in addition to NOR juvenile Chinook salmon at the Hills Creek Head of Reservoir RST in 2024. The most captured non-target species were dace and *O. mykiss*. The bull trout captured at this site was tagged by EAS and reported to ODFW. Information regarding bull trout captures, fork lengths, and PIT tags is provided in Appendix C: PIT Tags and VIE Tagging. A summary of species and number of fish caught is provided in Table 73.

Table 73. Summary of non-target fish capture at the Hills Creek Head of Reservoir – Middle Fork Willamette River RST site in 2024.

Species	Season Total	Season Total Mortality (subset of total)
Juvenile Chinook (clipped)	2	0
Bull Trout	1	0
Lamprey	9	1
Cutthroat Trout	9	1
Dace	56	0
Largescale Sucker	22	2
O. mykiss	52	0
O. mykiss (clipped)	1	0
Redside Shiner	15	1
Sculpin	31	1
Totals	**198**	**6**

1.3.12 Hills Creek Dam Tailrace

One 5-foot RST and one 8-foot RST continued monitoring activities in the Middle Fork Willamette River in the Hills Creek Dam Tailrace and sampled from January 1, 2024, through June 30, 2024. These traps did not sample from July 1, 2024, to September 14, 2024. Sampling recommenced from September 15, 2024, to December 31, 2024. The 5-foot RST is positioned below the confluence of the RO and PH outlet channels and is referred to as the RO trap. The 8-foot RST is positioned in the outlet of the PH and is referred to as the PH trap.

Sampling outages resulting from high flows, excessive debris, severe weather, localized flood evacuations, and additional issues are listed in Appendix B: Sampling Outages by Site. Non-sampling periods illustrated in the figures below are further detailed in Appendix B: Sampling Outages by Site.

Additionally, the RSTs were not sampled from January 23, 2024, to February 6, 2024, due to flows increasing to unsafe thresholds, potentially putting EAS crew and fish safety at immediate risk.

For interpretation of results, it is important to note that no BY 2020 juvenile hatchery Chinook salmon (i.e., yearlings typically released in June 2021) or adult Chinook salmon in 2021 were out-planted above Hills Creek Dam due to low adult returns (i.e., no production of BY 2021 juvenile Chinook salmon above Hills Creek Dam). In calendar year 2022, a total of 462 adult spring Chinook salmon were out-planted above Hills Creek Dam. This consisted of 198 females, 250 males, and 14 jack Chinook salmon (USACE 2022). In calendar year 2023, no adult spring Chinook salmon were out-planted above Hills Creek Dam. A total of 77,917 ad-clipped sub-yearling juvenile spring Chinook salmon were released into Hills Creek Reservoir in early July of 2023 by ODFW. Additionally, 20,000 PIT tagged juvenile hatchery Chinook salmon and approximately 2,500 yearling Chinook for use in TE trials were released at locations above Hills Creek Dam in 2023 and 2024, respectively. For more information regarding these releases, please refer to the Willamette Valley Downstream Fish Passage Monitoring Annual Report (CFS 2024).

1.3.12.1 Trapping Efficiency Trials

A total of 6 TE trials occurred at the Hills Creek Dam Tailrace sites in 2024 using hatchery reared Chinook salmon. Of these, five occurred in the powerhouse (PH) channel and one in the RO channel. Collectively, 28 TE trials have occurred at this site (18 in the PH channel and 10 in the RO channel) since January 2022. A summary of the fish release numbers, recaptures, and flow level for each trial is provided in Table 74. Hatchery fish availability for TE trials in the Middle Fork Willamette River basin in 2024 were limited due to shortfalls in BY 2023 Chinook made available by ODFW. Thus, TE trials did not occur to the extent that were originally planned for 2024.

TEs ranged from 1.0% to 3.2% for the RO channel and 0.7% to 12.3% for the PH channel with a pooled average of 1.9% (95% CI ± 0.8%, n=5) for the RO channel and a pooled average of 4.2% (95% CI ± 1.6%, n=18) for the PH channel for all successful trials with five or more recaptures. Passage is not estimated at the RO channel because the RO trap captures fish from both routes. Therefore, we cannot be certain a fish captured in the RO trap passed through the RO route.

For the PH channel, log-transformed discharge, trap revolutions per hour, mean fork length and the interaction between the three covariates had the highest pseudo R^2 value (0.74, n=18) of all models. However, this model also had the highest AICc score for the PH site. Due to the RO trap capturing fish from both routes of passage, a trap efficiency analysis was deemed unnecessary because a passage estimate is not feasible. Full results and methods for the trap efficiency modeling are in Appendix E: Trap Efficiency Plots.

Table 74. Summary table of marked hatchery Chinook salmon releases below Hills Creek Dam for trapping efficiency.

Release Location	Date of Release	cfs at Release	Number of Fish Released	Number of Fish Recaptured	Percent Efficiency
Hills Creek Dam Tailrace – PH*	01/06/2022	810	596	20	3.4%
Hills Creek Dam Tailrace PH – RO Trial*	01/06/2022	810	596	5	0.8%
Hills Creek Dam Tailrace – RO*	01/06/2022	820	605	13	2.1%
Hills Creek Dam Tailrace – PH*	02/16/2022	410	600	12	2.0%
Hills Creek Dam Tailrace PH – RO Trial*	02/16/2022	410	600	0	0.0%
Hills Creek Dam Tailrace – RO*	02/16/2022	410	593	19	3.2%
Hills Creek Dam Tailrace – PH*	02/25/2022	410	604	6	1.0%
Hills Creek Dam Tailrace PH – RO Trial*	02/25/2022	410	604	1	0.2%
Hills Creek Dam Tailrace – RO*	02/25/2022	420	625	6	1.0%
Hills Creek Dam Tailrace – PH*	12/07/2022	890	514	29	5.6%
Hills Creek Dam Tailrace PH – RO Trial*	12/07/2022	890	514	3	0.6%
Hills Creek Dam Tailrace – RO*	12/13/2022	610	516	1	0.2%
Hills Creek Dam Tailrace – PH*	02/25/2023	910	519	15	2.9%
Hills Creek Dam Tailrace PH – RO Trial*	02/25/2023	910	519	0	0.0%
Hills Creek Dam Tailrace – RO*	02/25/2023	870	478	0	0.0%
Hills Creek Dam Tailrace – PH*	04/26/2023	540	506	62	12.3%
Hills Creek Dam Tailrace PH – RO Trial*	04/26/2023	530	506	12	2.4%
Hills Creek Dam Tailrace – PH*	05/17/2023	440	505	57	11.3%
Hills Creek Dam Tailrace PH – RO Trial*	05/17/2023	450	505	2	0.4%
Hills Creek Dam Tailrace – PH*	06/03/2023	710	508	36	7.1%
Hills Creek Dam Tailrace PH – RO Trial*	06/03/2023	710	508	2	0.4%
Hills Creek Dam Tailrace – RO*	06/13/2023	500	760	0	0.0%
Hills Creek Dam Tailrace – PH*	06/27/2023	720	507	22	4.3%
Hills Creek Dam Tailrace PH – RO Trial*	06/27/2023	720	507	0	0.0%
Hills Creek Dam Tailrace – PH	09/27/2023	400	510	9	1.8%
Hills Creek Dam Tailrace PH – RO Trial	09/27/2023	400	510	1	0.2%
Hills Creek Dam Tailrace – PH	10/17/2023	460	509	8	1.6%
Hills Creek Dam Tailrace PH – RO Trial	10/17/2023	2630	509	0	0.0%
Hills Creek Dam Tailrace – PH	10/31/2023	470	503	8	1.6%
Hills Creek Dam Tailrace PH – RO Trial	10/31/2023	461	503	2	0.4%
Hills Creek Dam Tailrace – PH	11/15/2023	660	500	46	9.2%
Hills Creek Dam Tailrace PH – RO Trial	11/15/2023	660	500	1	0.2%
Hills Creek Dam Tailrace – RO	11/21/2023	1,800	503	3	0.6%
Hills Creek Dam Tailrace – RO	11/29/2023	1,800	504	2	0.4%

Release Location	Date of Release	cfs at Release	Number of Fish Released	Number of Fish Recaptured	Percent Efficiency
Hills Creek Dam Tailrace – RO	12/26/2023	110	505	10	2.0%
Hills Creek Dam Tailrace – RO	01/04/2024	100	503	5	1.0%
Hills Creek Dam Tailrace – PH	01/23/2024	910	505	8	1.6%
Hills Creek Dam Tailrace – PH	02/22/2024	410	1,473	31	2.1%
Hills Creek Dam Tailrace PH – RO Trial	02/22/2024	420	1,473	0	0.0%
Hills Creek Dam Tailrace – PH	03/13/2024	430	1,494	11	0.7%
Hills Creek Dam Tailrace PH – RO Trial	03/13/2024	450	1,494	0	0.0%
Hills Creek Dam Tailrace – PH	04/11/2024	830	3,996	68	1.7%
Hills Creek Dam Tailrace PH – RO Trial	04/11/2024	830	3,996	6	0.2%
Hills Creek Dam Tailrace – PH	06/04/2024	200	1,250	45	3.6%
Hills Creek Dam Tailrace PH – RO Trial	06/04/2024	200	1,250	6	0.5%

*Release performed by EAS for the USACE under contract W9127N19D0007.

1.3.12.2 Run of River Trapping Efficiency Trials

No TE trials using live ROR fish were performed at Hills Creek Dam Tailrace in 2024. The first 60 wild fish caught per week are prioritized for the 24-hour hold mortality study. Sufficient numbers of NOR fish were not available to perform live ROR TE trials. During the fall drawdown period, there were sufficient numbers to run a dead fish ROR TE trial. A total of 44 dead Chinook were used for a ROR TE trial. These fish were encountered dead in the RST. They were differentially marked and released in the powerhouse channel (Table 75).

Table 75. Summary table of run of river releases at the Hills Creek Dam site for trapping efficiency.

Release Location	Date of Release	Number of Fish Released	Recapture Location	Number of Fish Recaptured	Percent Efficiency
Powerhouse	September 2024	35	PH	2	5.7%
			RO	1	2.9%
Powerhouse	October 2024	9	PH	0	0.0%
			RO	1	11.1%

1.3.12.3 Target Catch, Passage Estimates and Passage Timing

A total of 242 juvenile Chinook salmon were captured in the Hills Creek Dam Tailrace RSTs during sampling in 2024. Of these, 154 were captured in the PH RST (63.6% of total catch) and 88 in the RO trap (36.4% of total catch).

A total of 60 juvenile Chinook salmon (24.8% of total catch) were captured in the Hills Creek Dam RSTs during spring sampling in 2024, 36 in the PH trap (60.0% of spring catch) and 24 in the RO trap (40.0% of spring catch) (Figure 56 and Figure 57). Peak capture of juvenile Chinook salmon during the spring monitoring period occurred in January when 54 fish were captured (90.0% of spring catch). Scale age analysis showed that Chinook salmon captured from January 1, 2024, to June 30, 2024, consisted of two BYs 2021 and 2022 (Figure 58). BY 2021 Chinook comprised a majority of the catch below Hills Creek Dam in the spring monitoring period (n=42, 70.0% of spring catch). BY 21 Chinook were encountered from January 1, 2024, through the latter part of January while BY 2022 Chinook were captured throughout the entire reporting period.

Fall catch of juvenile Chinook below Hills Creek Dam consisted of 182 fish (75.2% of total catch), 118 captured in the PH trap (64.8% of fall catch) and 64 in the RO trap (35.2% of fall catch). Peak capture of Chinook occurred in September (n=103, 56.5% of fall catch). Chinook captured in the fall consisted entirely of BY 2022 fish (Figure 58). Fork length and weight data for Chinook salmon captured in the Hills Creek Dam Tailrace RSTs by BY is provided in Table 76.

Using pooled averages of Powerhouse channel released hatchery Chinook TE trials, we estimate that 3,612 (95% CI: 2,606 to 5,884) juvenile Chinook salmon passed through the PH during sampling in 2024 (Figure 57). Additionally, using pooled hatchery Chinook TE trials for the RO trap from both powerhouse and RO releases, we estimate that 4,980 (95% CI: 3,461 to 8,880) juvenile Chinook passed the RO trap during sampling in 2024 (Table 76). It is important to note that this estimate for the RO trap is not an estimate of RO passage but the combined passage of Chinook from both RO and Powerhouse routes. Each RST is only checked once in a 24 hour period; therefore, EAS cannot distinguish between daytime PH and nighttime RO operations for those fish captured in the RO trap. Thus, a NOR fish captured in the RO trap cannot be assigned to a specific route of passage.

Prior monitoring found that peak passage at Hills Creek Dam occurred November through January (Keefer et al. 2012). Similar to previous observations, no small sub-yearling Chinook salmon were observed in the RSTs below Hills Creek Dam in the spring of 2024. This is likely a result of no adult Chinook salmon being out-planted above Hills Creek Reservoir in 2023. Much like our data, previous catch at this site contained fish from multiple BYs, suggesting that some Chinook salmon rear in the reservoir for multiple years or remain as adfluvial Chinook salmon in Hills Creek Reservoir. Capture of Chinook salmon in the RO and PWR RSTs in the spring monitoring period coincided with RO spill operations. Catch in the fall of 2024 peaked earlier than previous observations from monitoring in 2022 and 2023 in which peak passage of Chinook occurred from November through January with the RO spill operations. Peak capture in the fall of 2024 occurred in September (n=103, 42.6% of total catch) prior to the initiation of RO spill when the only route of passage available to fish was through the powerhouse. However, even during times in which RO spill was active in the spring and fall, many of the fish captured were in the PH trap, suggesting that most fish passed through the PH instead of the RO. This implies that other factors such as pool elevation, depth to reservoir outlets or time of year may be influencing Chinook salmon movement out of Hills Creek Reservoir and that fish may pass through the RO channel at lower relative percentages, when compared directly to the PH. However, more clarity on passage estimates of fish coming through the RO is needed to draw conclusions on this matter. For raw weekly Chinook catch at the Hills Creek Dam RSTs for sampling from 2021 through 2023, refer to Appendix I: Adult Chinook Out-planting Above Willamette Valley Projects.

Table 76. Summary of fork length and weight observed on juvenile Chinook salmon of NOR at the Hills Creek Dam Tailrace RST site by brood year.

Species	Date Range	BY	Number of Fish	Average F.L. (mm)	Min. F.L. (mm)	Max F.L. (mm)	Median F.L. (mm)	Average Weight (g)	Min. Weight (g)	Max Weight (g)	Median Weight (g)
Chinook	1/1/2024–6/30/2024	21	42	199.7	155	237	199.5	90.5	41.7	136.9	91.6
Chinook	1/1/2024–6/30/2024	22	18	122.8	90	174	122	21.8	5.1	60.1	18.5
Chinook	7/1/2024–12/31/2024	22	182	224.9	106	287	225	126.3	14.4	218.7	122.8

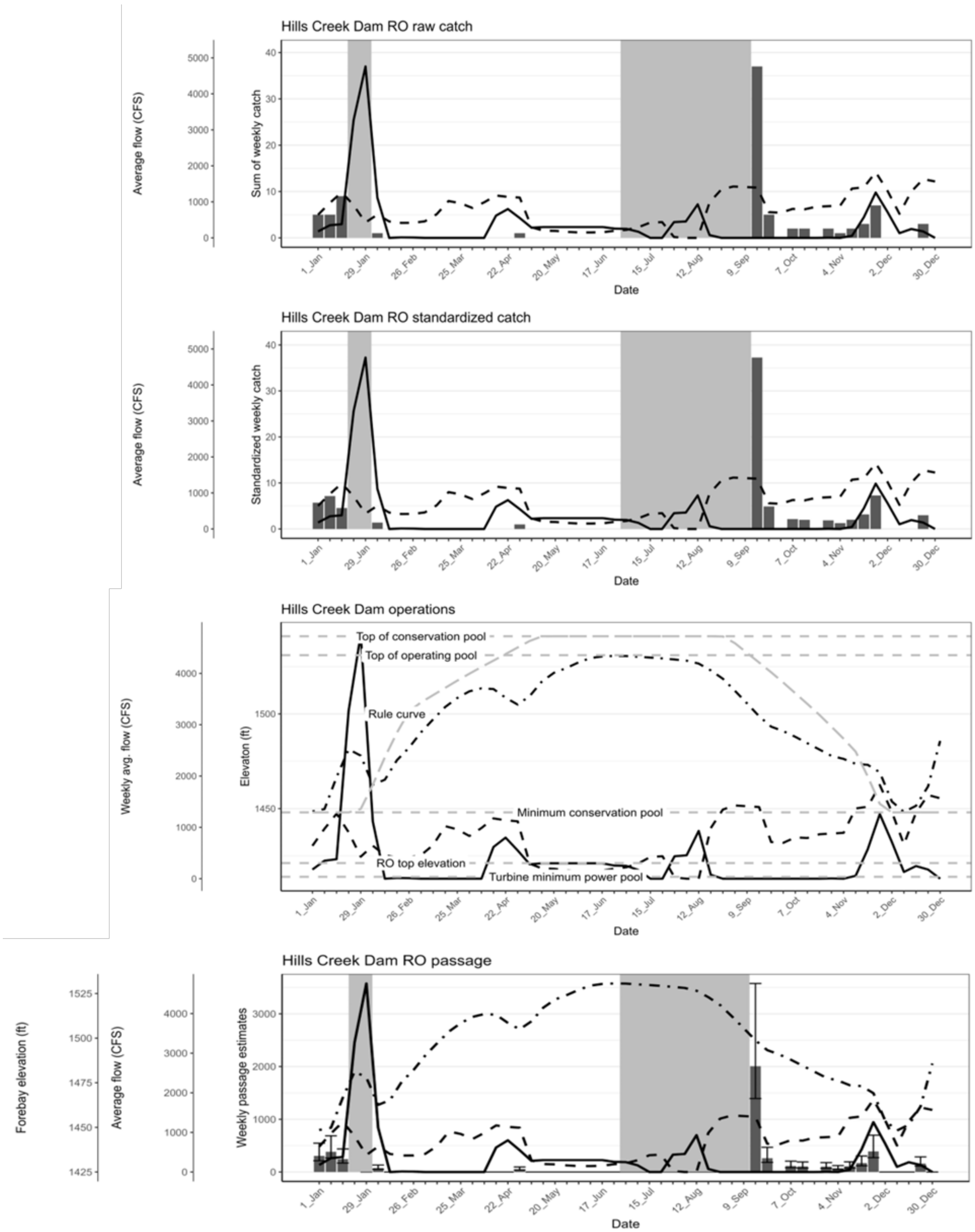

Figure 56. Raw catch (top panel), weekly standardized catch (second panel), and weekly passage estimates (bottom panel) overlayed with RO outflow (black line), Powerhouse outflow (black dash line), and forebay elevation (black dot dash line) for the RO trap below Hills Creek Dam. The third panel shows Hills Creek Dam operations and features of interest with RO outflow (black line), Powerhouse outflow (black dash line), and forebay elevation (black dot dash line).

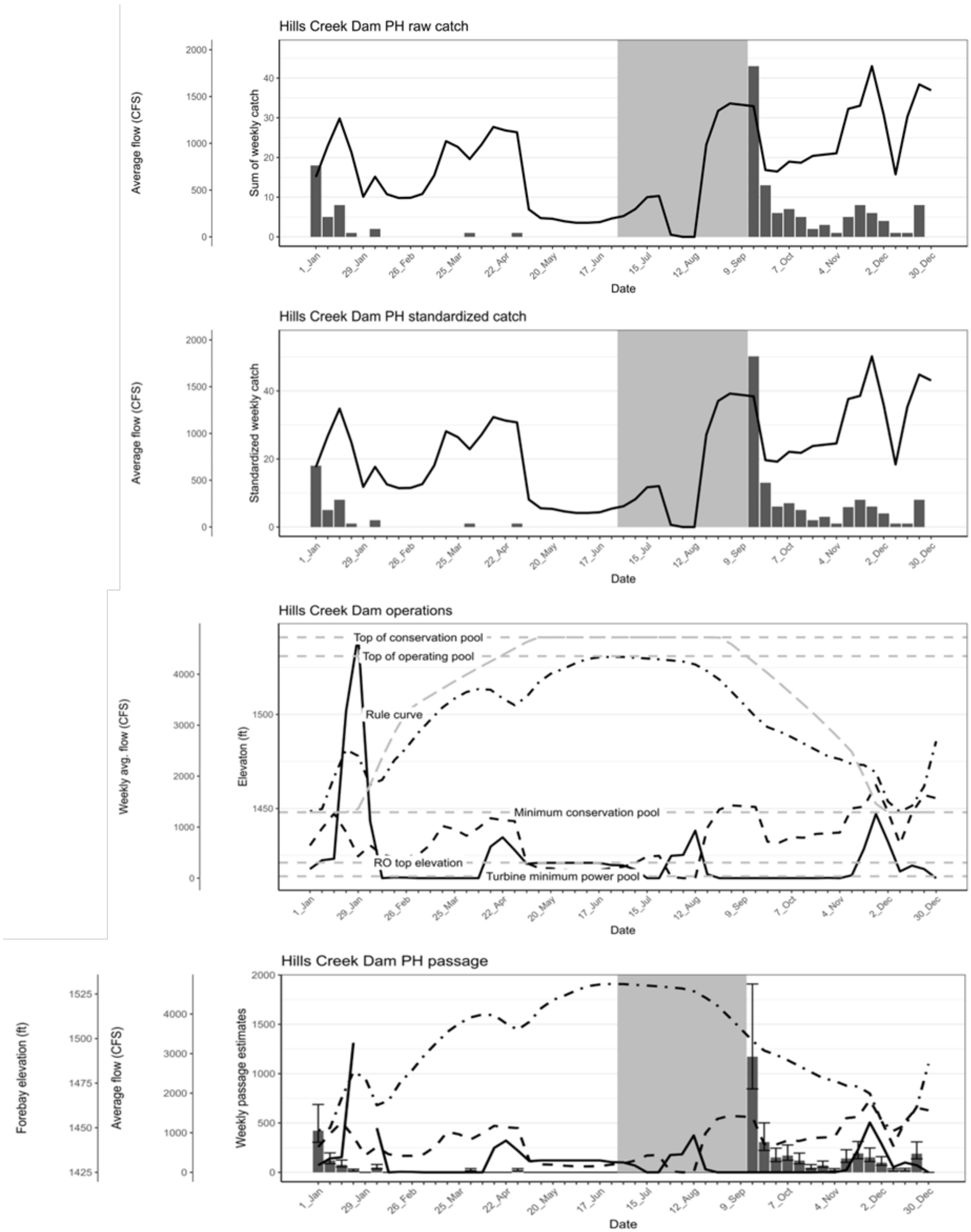

Figure 57. Raw catch (top panel), weekly standardized catch (second panel), Hills Creek Dam operations and features of interest (third panel), and weekly passage estimates (bottom panel) overlayed with Powerhouse outflow (black dash line), RO outflow (black line), and forebay elevation (black dot dash line) for the PH trap below Hills Creek Dam.

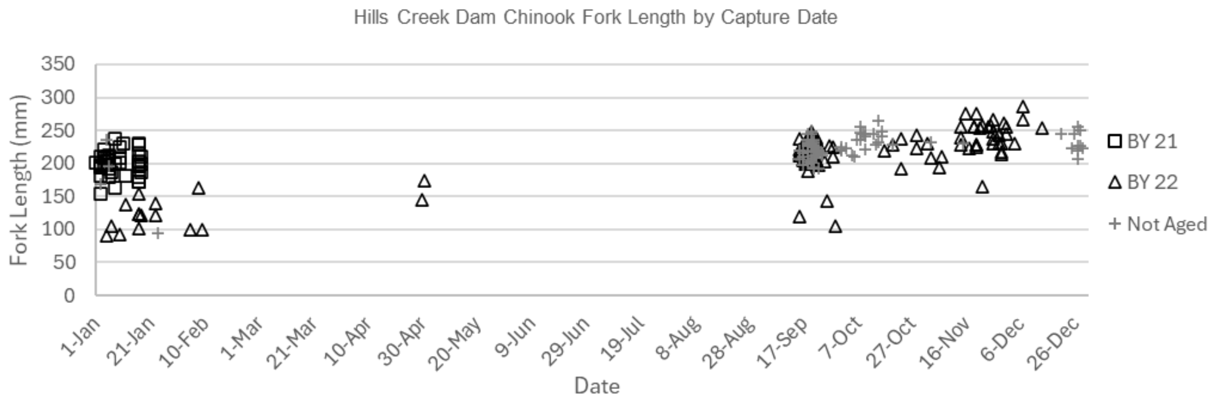

Figure 58. Length-frequency of juvenile Chinook salmon by brood year at the Hills Creek Dam site.

1.3.12.4 Injury Data

A total of 241 juvenile Chinook salmon (99.6% of total Chinook salmon catch) displayed at least one of the injury code conditions listed in Table 3. To provide insight on injuries associated with capture in a RST, injury data was collected from bulk marked released fish and hatchery fish utilized for TE trials.

The most common injuries observed at this site include descaling greater than 20%, fin damage, and the presence of copepods (Table 77 and Table 78). Chinook captured at this site exhibited a significant number of injuries overall. It is likely that observations of gas bubble disease are higher for RST captured fish than those that are not captured in an RST as these fish are often captured and held in areas of higher dissolved gas. The proportion of fish displaying injuries over time is displayed in Figure 59. Copepod presence on captured Chinook salmon at this site illustrated a positive correlation with the size of fish, like observations made by previous studies (CFS 2023a; Monzyk et al. 2015) (Figure 60).

Bulk marked release and TE hatchery Chinook salmon injuries were highly variable between the Hills Creek Dam PH and RO traps. Observed Chinook salmon injuries and bulk marking recapture injuries were more similarly related with the predominant injuries assessed being descaling, fin damage, the presence of copepods, bleeding from vent, fin blood vessels broken, and operculum damage (Table 77 and Table 78). TE hatchery Chinook salmon were found to have higher percentages of descaling less than 20% and fin damage when compared to both NOR and bulk marked released Chinook.

There were 165 mortalities (68.2% of total Chinook salmon capture) at the time of trap check for this site: 100 in PH trap (64.9% of PH capture) and 65 in the RO trap (73.9% of RO capture). RO spill operations coincided with an increase in observed bodily injury, including descaling and the presence of copepods in Chinook salmon at the Hills Creek Dam site (Figure 59). Additional information regarding injuries by size and average injuries per fish is available in Appendix D: Additional Injury Information.

Data collected on the injury rates of TE hatchery fish illustrated that both the percentage of fish with injuries and the average number of injuries per fish generally increased from pre-release to recaptured observations. Detailed findings on injury type are further presented in Appendix D: Additional Injury Information.

Table 77. Summary of injuries observed on NOR, bulk marked, and TE hatchery Chinook salmon at the Hills Creek Dam Powerhouse RST.

Injury Code	Observed Chinook Injuries (NOR) (n=154)	Bulk Marked Released Chinook (n=97)	Trapping Efficiency Hatchery Chinook (n=163)
NXI (no external injury)	0.6%	0.0%	0.0%
MUNK	0.0%	0.0%	0.0%
DS<2	38.3%	54.6%	77.9%
DS>2	61.0%	44.3%	22.1%
BLO	3.9%	7.2%	0.6%
EYB	20.8%	8.2%	0.6%
BVT	46.1%	13.4%	0.0%
FVB	28.6%	16.5%	0.0%
GBD	9.7%	6.2%	0.0%
POP	1.3%	2.1%	0.6%
HIN	17.5%	4.1%	0.0%
OPD	21.4%	14.4%	4.9%
TEA	4.5%	5.2%	1.2%
BRU	27.3%	20.6%	0.0%
HBP	7.1%	2.1%	0.0%
HO	0.0%	0.0%	0.0%
BO	3.9%	6.2%	0.0%
HBO	2.6%	0.0%	0.0%
FID	97.4%	97.9%	98.8%
PRD	0.0%	0.0%	0.0%
COP	96.1%	48.5%	0.0%
BKD	0.0%	0.0%	0.0%
FUN	7.1%	24.7%	1.8%

Table 78. Summary of injuries observed on NOR, bulk marked, and TE hatchery Chinook salmon at the Hills Creek Dam Regulatory Outlet RST.

Injury Code	Observed Chinook Injuries (n=88)	Bulk Marked Released Chinook (n=37)	Trapping Efficiency Hatchery Chinook (n=17)
NXI (no external injury)	0.0%	0.0%	0.0%
MUNK	0.0%	0.0%	0.0%
DS<2	34.1%	62.2%	88.2%
DS>2	64.8%	37.8%	11.8%
BLO	10.2%	8.1%	0.0%
EYB	21.6%	18.9%	0.0%
BVT	52.3%	18.9%	0.0%
FVB	37.5%	21.6%	0.0%
GBD	12.5%	16.2%	0.0%
POP	6.8%	2.7%	0.0%
HIN	17.0%	18.9%	0.0%
OPD	29.5%	13.5%	17.6%
TEA	4.5%	8.1%	0.0%
BRU	34.1%	18.9%	0.0%
HBP	6.8%	2.7%	0.0%
HO	0.0%	0.0%	0.0%
BO	3.4%	0.0%	0.0%
HBO	2.3%	0.0%	0.0%
FID	97.7%	94.6%	94.1%
PRD	0.0%	0.0%	0.0%
COP	92.0%	67.6%	0.0%
BKD	0.0%	0.0%	0.0%
FUN	5.7%	8.1%	23.5%

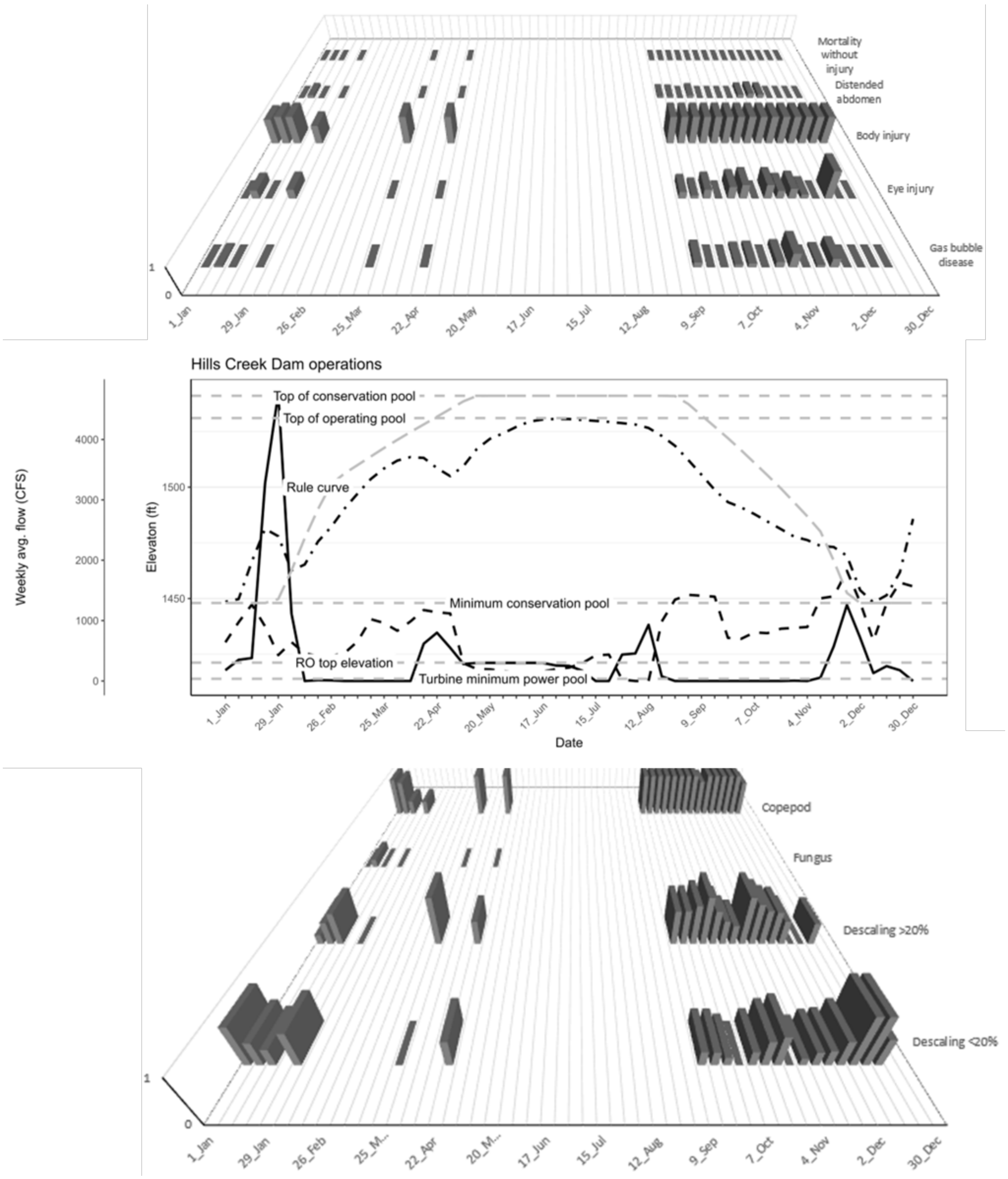

Figure 59. Proportion of captured juvenile Chinook salmon displaying injuries by type (top panel), operations data from the Hills Creek Dam (middle panel) showing spill flow (black line) and Powerhouse flow (black dash line), and proportion of captured juvenile Chinook salmon displaying descaling injuries and copepods (bottom panel).

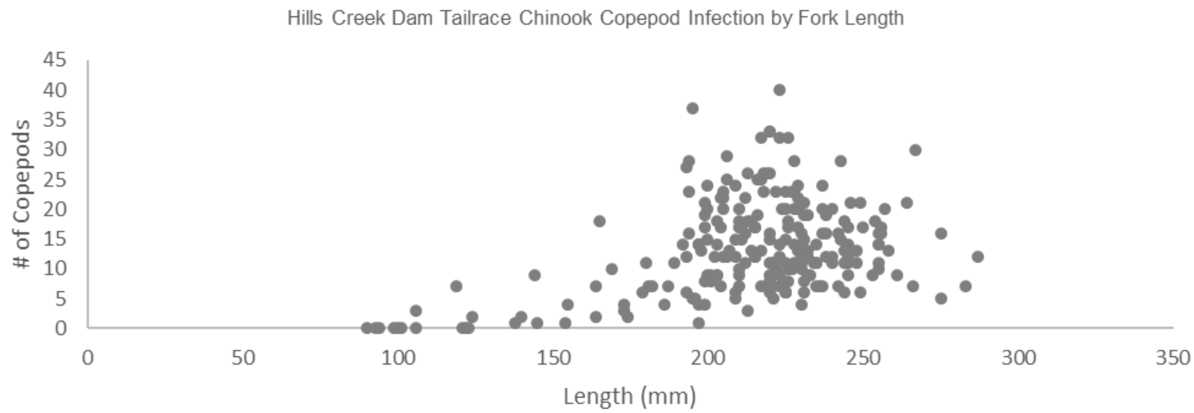

Figure 60. Copepod presence vs fork length on juvenile Chinook salmon captured at Hills Creek Dam Tailrace.

1.3.12.5 24-Hour Hold Trials

24-hour hold trials were performed on NOR juvenile Chinook salmon captured at Hills Creek Dam Tailrace to assess delayed mortality resulting from dam passage. A total of 68 fish, 18 from the RO and 50 from the PH traps, were held in 2024 (Table 79). A total of 9 fish died during hold (13.2%). 2 of the 18 RO Chinook salmon died (11.1%) and 7 of the 50 PH Chinook salmon died (14.0%). Mortality rates across the two-week periods in which fish were held ranged from 0 to 50.0%.

Table 79. Summary of 24-hour hold trials for Chinook salmon captured in the RST at the Hills Creek Dam site.

Hold Period	Trap	Number of Fish Held	Mortalities	% Survived
01/01–15/2024	PH	15	0	100.0%
01/01–15/2024	RO	7	1	85.7%
01/16–31/2024	PH	1	0	100.0%
01/16–31/2024	RO	2	0	100.0%
02/01–15/2024	PH	2	0	100.0%
02/01–15/2024	RO	1	0	100.0%
02/16–29/2024	PH	0	0	--
02/16–29/2024	RO	0	0	--
03/01–15/2024	PH	0	0	--
03/01–15/2024	RO	0	0	--
03/16–31/2024	PH	0	0	--
03/16–31/2024	RO	0	0	--
04/01–15/2024	PH	0	0	--
04/01–15/2024	RO	0	0	--
04/16–30/2024	PH	0	0	--
04/16–30/2024	RO	0	0	--
05/01–15/2024	PH	0	0	--
05/01–15/2024	RO	0	0	--
05/16–31/2024	PH	0	0	--
05/16–31/2024	RO	0	0	--
06/01–15/2024	PH	0	0	--
06/01–15/2024	RO	0	0	--
06/16–30/2024	PH	0	0	--
06/16–30/2024	RO	0	0	--
09/16–30/2024	PH	9	3	66.7%
09/16–30/2024	RO	1	0	100.0%
10/01–15/2024	PH	2	1	50.0%
10/01–15/2024	RO	2	0	100.0%
10/16–31/2024	PH	3	0	100.0%
10/16–31/2024	RO	0	0	--
11/01–15/2024	PH	3	0	100.0%
11/01–15/2024	RO	1	0	100.0%
11/16–30/2024	PH	6	1	83.3%
11/16–30/2024	RO	2	0	100.0%
12/01–15/2024	PH	2	0	100.0%
12/01–15/2024	RO	0	0	--
12/16–31/2024	PH	7	2	71.4%
12/16–31/2024	RO	2	1	50.0%

1.3.12.6 PIT Tagged/VIE Marked Fish and Downstream Detections

A total of 7 NOR Chinook salmon were PIT tagged and zero were VIE marked at the Hills Creek Dam RST sites in 2024. All other captured Chinook salmon were not tagged as they were prioritized for the 24-hour hold study. No VIE marked fish have been redetected at downstream sites in 2024 and no VIE marked fish from upstream sites were detected. No PIT tagged fish were redetected downstream. A summary of VIE marked Chinook salmon by month at this site is provided in Table 80. Further information on tagged and VIE marked fish at this site is available in Appendix C: PIT Tags and VIE Tagging.

Table 80. Summary of VIE tagged Chinook salmon at the Hills Creek Dam site.

Date Tagged	Tag Location	VIE Color	# Tagged	# Recaptured
N/A	Head	N/A	0	0

1.3.12.7 Willamette Valley Projects Encounters

A total of 136 adipose clipped and PIT tagged Chinook salmon were captured in the RSTs below Hills Creek Dam in 2024. These fish are a part of Cramer Fish Science's bulk mark release project. For more information on redetections of fish in the bulk mark release study, refer to the *Bulk Mark Release and Reservoir Distribution Study Annual Report* (CFS 2024).

1.3.12.8 Non-Target Species

A total of 2,273 non-target fish were captured in addition to NOR juvenile Chinook salmon at the Hills Creek Dam RSTs in 2024. The most captured non-target species were crappie and bluegill. A summary of species and numbers of fish caught is provided in Table 81.

Table 81. Summary of non-target catch for the RSTs in the Hills Creek Dam in 2024.

Species	Season Total	Season Total Mortality (subset of total)
Bluegill	364	225
Brown Bullhead catfish	12	3
Juvenile Chinook (clipped)	314	126
Crappie	799	644
Cutthroat Trout	4	1
Dace	74	7
Lamprey	8	0
Largemouth Bass	12	4
Largescale Sucker	246	63
Mountain Whitefish	5	0
Northern Pikeminnow	1	0
O. mykiss	99	5
O. mykiss (clipped)	30	16
Redside Shiner	4	0
Sculpin	169	3
Smallmouth Bass	45	39
Spotted Bass	35	11
Unknown*	52	52
Totals	**2,273**	**1,199**

*Species denoted as "unknown" were too small and/or too decomposed to identify.

1.3.13 Lookout Point Head of Reservoir – Middle Fork Willamette River

A single 5-foot RST in the Middle Fork Willamette River above Lookout Point Reservoir continued monitoring activities and sampled from January 1, 2024, through December 31, 2024.

Sampling outages resulting from high flows, excessive debris, severe weather, localized flood evacuations, and additional issues are listed in Appendix B: Sampling Outages by Site. Non-sampling periods illustrated in the figures below are further detailed in Appendix B: Sampling Outages by Site.

Additionally, the RST was raised to its non-sampling position from January 23, 2024, to February 6, 2024, due to high debris loads from increased flows which caused severe damage to the trap. The RST was also raised from November 17, 2024, to November 28, 2024, due to projected high flows which surpassed preset safety thresholds of 5,000 cfs for the site.

1.3.13.1 Trapping Efficiency Trials

A total of 9 TE trials occurred at the Lookout Point Head of Reservoir site in 2024 using hatchery reared Chinook salmon. Collectively, 28 TE trials have occurred at this site since April 2022. A summary of the fish release numbers, recaptures, and flow level for each trial is provided in Table 82. Hatchery fish availability for TE trials in the Middle Fork Willamette River basin in 2024 were limited due to shortfalls in BY 2023 Chinook made available by ODFW. Thus, TE trials did not occur to the extent that were originally planned for 2024.

TEs ranged from 0.4% to 12.5% with a pooled average of 2.7% (95% CI ± 1.6%, n=14) of all successful trials with five or more recaptures. Thirteen of the trials did not recapture enough fish to be used in the passage estimate calculation.

Trap efficiency analysis identified the full model—incorporating weekly average discharge, average trap revolutions per hour, mean fork length, and interactions among these covariates—as having the highest pseudo R^2 (0.51, n=28) indicating a moderate model fit. This model also had the highest AICc score, suggesting that while the additional covariates and interactions improved the fit, the improvement may not justify the added complexity compared to simpler models. Detailed methods and full results of the trap efficiency modeling are provided in Appendix E: Trap Efficiency Plots.

Table 82. Summary table of marked hatchery Chinook salmon releases on the Middle Fork Willamette above Lookout Point Dam for trapping efficiency

Release Location	Date of Release	cfs at Release	Number of Fish Released	Number of Fish Recaptured	Percent Efficiency
Lookout Point Head of Reservoir	04/05/2022	3,620	993	53	5.3%
Lookout Point Head of Reservoir	04/14/2022	3,821	987	19	1.9%
Lookout Point Head of Reservoir	05/18/2022	4,100	1,004	125	12.5%
Lookout Point Head of Reservoir	07/20/2022	1,110	1,005	9	0.9%
Lookout Point Head of Reservoir	10/27/2022	1,680	506	9	1.8%
Lookout Point Head of Reservoir	11/17/2022	1,520	510	0	0.0%
Lookout Point Head of Reservoir	12/12/2022	1,510	510	0	0.0%
Lookout Point Head of Reservoir	01/13/2023	2,940	516	10	1.9%
Lookout Point Head of Reservoir	06/02/2023	2,605	760	13	1.7%
Lookout Point Head of Reservoir	06/15/2023	1,610	765	6	0.8%
Lookout Point Head of Reservoir	06/29/2023	1,340	769	2	0.3%
Lookout Point Head of Reservoir	07/19/2023	1,180	765	1	0.0%
Lookout Point Head of Reservoir	08/22/2023	1,470	677	13	1.9%
Lookout Point Head of Reservoir	08/31/2023	1,660	751	0	0.0%
Lookout Point Head of Reservoir	09/20/2023	776	787	1	0.1%
Lookout Point Head of Reservoir	10/26/2023	1,190	755	0	0.0%
Lookout Point Head of Reservoir	11/15/2023	1,630	755	3	0.4%
Lookout Point Head of Reservoir	11/29/2023	3,020	760	2	0.3%
Lookout Point Head of Reservoir	12/19/2023	5,680	1,504	9	0.6%
Lookout Point Head of Reservoir	01/03/2024	2,010	1,505	2	0.1%
Lookout Point Head of Reservoir	02/14/2024	2,120	761	2	0.3%
Lookout Point Head of Reservoir	03/13/2024	3,170	1,498	15	1.0%
Lookout Point Head of Reservoir	04/08/2024	2,670	1,997	7	0.4%
Lookout Point Head of Reservoir	04/15/2024	4,130	2,002	20	1.0%
Lookout Point Head of Reservoir	05/01/2024	4,620	751	35	4.7%
Lookout Point Head of Reservoir	05/23/2024	2,440	751	14	1.9%
Lookout Point Head of Reservoir	06/19/2024	1,300	756	0	0%
Lookout Point Head of Reservoir	09/05/2024	1885	750	6	0.80%

1.3.13.2 Run of River Trapping Efficiency Trials

No TE trials using ROR fish were performed at Lookout Point Head of Reservoir in 2024. Sufficient numbers of NOR fish were not available to perform ROR TE trials.

1.3.13.3 Target Catch, Passage Estimates, and Passage Timing

The trap captured 56 juvenile Chinook salmon during monitoring in 2024. The trap captured 49 juvenile Chinook salmon (87.5% of total catch) during spring sampling. Peak capture of juvenile Chinook salmon entering Lookout Point Reservoir occurred in March (n=19, 33.9% of total catch). This timing is consistent with past observations from sampling in 2022 (EAS 2023) and from previous study by Romer (2015). Spring capture comprised fish from BY 2022 (n=15, 30.6% of spring catch) and BY 2023 (n=34, 69.4% of spring catch). The first BY 2023 sub-yearling captured at the trap occurred on February 27, 2024. This timing was considerably later than was observed in previous years by EAS (EAS 2023). Chinook catch at this site in the spring of 2024 was lower than the observed catch in previous studies. This is likely tied to the lower number of adult out plants that occurred in 2023. For more information on adult out plants in the Willamette basin, please refer to Appendix I: Adult Chinook Out-planting Above Willamette Valley Projects.

A total of 7 fish were captured during sampling efforts in the fall with peak fall capture occurring in September (n=3, 5.4% of total catch). Figure 61 shows raw and standardized catch overlayed with flow at the Lookout Point Head of Reservoir site. This timing differs from observations in 2022 and 2023 when fall passage of Chinook occurred in November and December. However, few fish were encountered at this site in the fall of 2024 and interpretation of peak passage may be misleading. All Chinook captured in the fall were BY 2023 sub-yearlings. Previous observations from RST sampling in the North Fork Middle Fork by Romer et al. (2016) showed that substantial numbers of sub-yearlings out migrated in the fall from September through December. It is possible that some fish passed that RST site during outage in December of 2024 however, catch in recent years during the fall period has been much lower than the observations mentioned above. Fork length and weight data by BY for Chinook salmon captured at this site is provided in Table 83.

Chinook salmon catch at this site in 2024 consisted of two brood year classes: BY 2022 yearlings (n=15, 26.8% of total catch) and BY 2023 sub-yearlings (n=41, 73.2%) (Figure 62). Using pooled averages of hatchery Chinook TEs, EAS estimate that 2,283 (95% CI: 1,420 to 5,816) juvenile Chinook salmon passed the sampling site during monitoring in 2024 (Figure 61). This estimate is likely low as it does not include any fish that may have passed the site when the RST was raised for high flow for extended periods of time in which catch cannot be standardized across the outage period.

Table 83. Summary of fork length and weight observed on juvenile Chinook salmon of NOR at the Lookout Point Head of Reservoir RST site by brood year.

Species	Date Range	BY	Number of Fish	Average F.L. (mm)	Min. F.L. (mm)	Max F.L. (mm)	Median F.L. (mm)	Average Weight (g)	Min. Weight (g)	Max Weight (g)	Median Weight (g)
Chinook	1/1/24–6/30/24	22	15	96.2	75	112	95	9.6	4.6	13.8	9.2
Chinook	1/1/24–6/30/24	23	34	59.3	32	89	56.5	3.6	1.0	8.0	3.5
Chinook	7/1/2024-12/31/2024	23	7	116.4	91	142	113	18.4	7.8	33.9	16.9

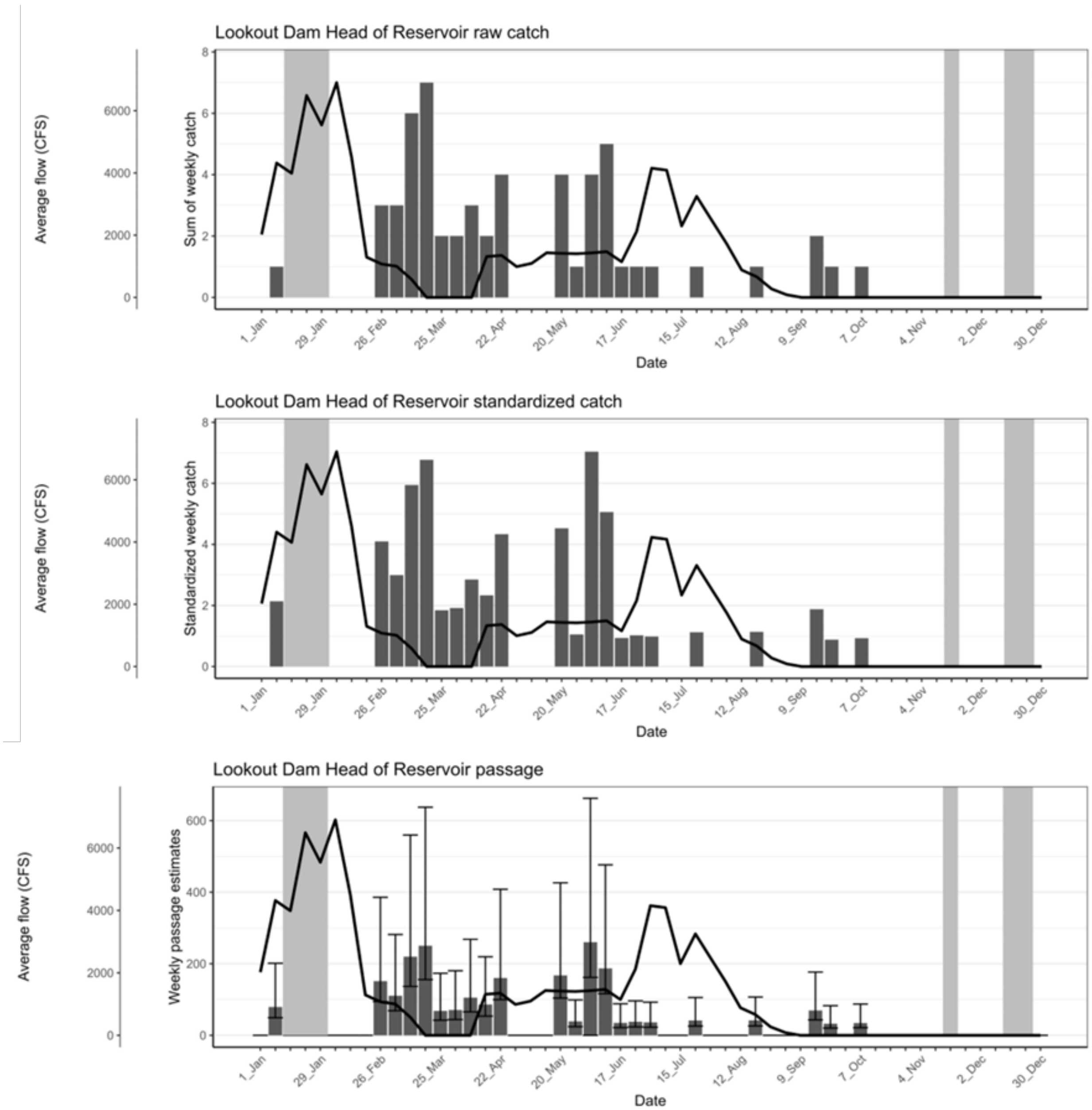

Figure 61. Raw catch (top panel), standardized catch (middle panel), and weekly passage estimates (bottom panel) of NOR juvenile Chinook salmon at the Lookout Point Head of Reservoir site with stream flow (black line) and non-sampling weeks shaded out (gray).

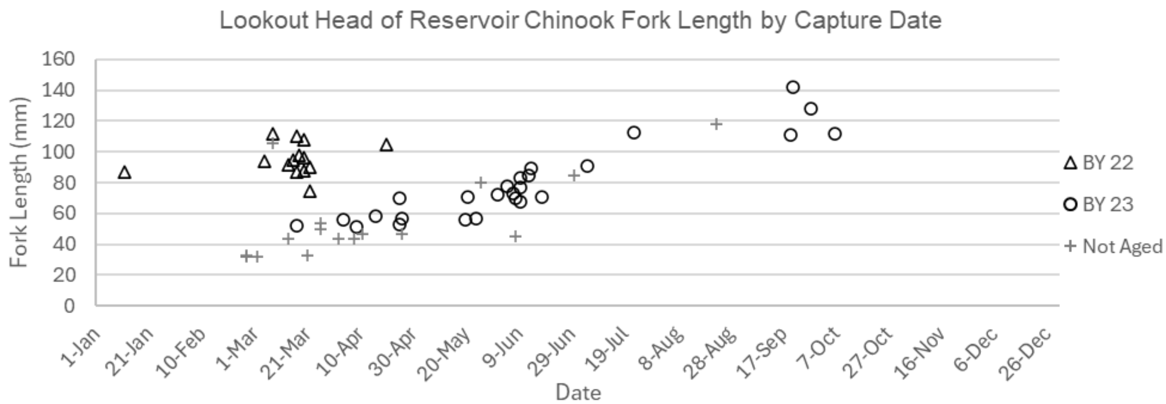

Figure 62. Length-frequency of juvenile Chinook salmon at the Lookout Point Head of Reservoir site.

1.3.13.4 Injury Data

A total of 34 juvenile Chinook salmon (60.7% of total Chinook salmon catch) displayed at least one of the injury code conditions listed in Table 3. The most common injuries observed at this site include descaling less than 20% and fin damage (Table 84).

Copepod presence on captured Chinook salmon within our studies generally showed a positive correlation with the size of fish, similar to observations made by previous studies (CFS 2023a; Monzyk et al. 2015). However, at the Lookout Point Head of Reservoir RST site, zero NOR fish were observed with copepods present on their fins or within their gills (Figure 63). Additional information regarding injuries by size and average injuries per fish is available in Appendix D: Additional Injury Information.

There were no mortalities (0.0% of total Chinook salmon catch) observed upon trap check during the reporting period. Documented injuries were likely incurred upon capture in the RST due to debris or contact with various surfaces in the trap. Bulk marked released Chinook salmon at the Lookout Point Head of Reservoir RST site were found to exhibit a higher percentage of descaling less than 20%, tears, fin damage, and the presence of copepods. It should be noted that there was only one recaptured bulk marked released Chinook salmon at this site. Furthermore, TE hatchery Chinook salmon were observed having higher percentages of descaling, operculum damage, fin damage, and fungus when compared to NOR fish (Table 84). Additional information regarding injuries by size and average injuries per fish is available in Appendix D: Additional Injury Information.

Data collected on the injury rates of TE hatchery fish illustrated that both the percentage of fish with injuries and the average number of injuries per fish generally decreased from pre-release to recaptured observations at the Lookout Point Head of Reservoir RST site. Detailed findings on injury type are further presented in Appendix D: Additional Injury Information.

Similar to other sites detailed within this report, results illustrated that Chinook salmon less than 60 mm were more likely to have less significant external injuries than those above 60 mm (Appendix D, Table D-7). Additionally, 100% of the Chinook salmon encountered that were above 60 mm had at least one injury denoted. The most common of these injuries was descaling and fin damage (Appendix D, Table D-7).

Table 84. Summary of injuries observed on NOR, bulk marked, and TE hatchery Chinook salmon at the Lookout Point Head of Reservoir RST site.

Injury Code	Chinook Injuries (NOR) (n=56)	Bulk Marked Released Chinook (n=1)	Trapping Efficiency Hatchery Chinook (n=101)
NXI (no external injury)	39.3%	0.0%	2.0%
MUNK	0.0%	0.0%	0.0%
DS<2	57.1%	100.0%	86.1%
DS>2	0.0%	0.0%	10.9%
BLO	0.0%	0.0%	0.0%
EYB	0.0%	0.0%	0.0%
BVT	1.8%	0.0%	0.0%
FVB	0.0%	0.0%	1.0%
GBD	0.0%	0.0%	0.0%
POP	0.0%	0.0%	0.0%
HIN	1.8%	0.0%	0.0%
OPD	1.8%	0.0%	3.0%
TEA	1.8%	100.0%	1.0%
BRU	5.4%	0.0%	0.0%
HBP	0.0%	0.0%	0.0%
HO	0.0%	0.0%	0.0%
BO	0.0%	0.0%	0.0%
HBO	0.0%	0.0%	0.0%
FID	37.5%	100.0%	63.4%
PRD	0.0%	0.0%	0.0%
COP	0.0%	100.0%	0.0%
BKD	0.0%	0.0%	0.0%
FUN	0.0%	0.0%	2.0%

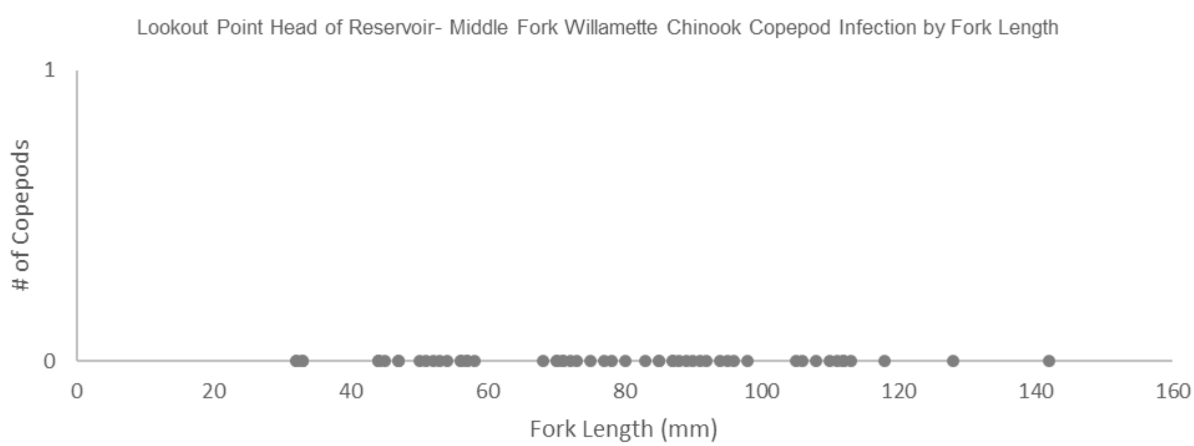

Figure 63. Copepod prevalence vs fork length on juvenile Chinook salmon captured at Lookout Point Head of Reservoir.

1.3.13.5 PIT Tagged/VIE Marked Fish and Downstream Detections

A total of 36 juvenile Chinook salmon were PIT tagged and 16 were VIE marked at the Lookout Point Head of Reservoir site in 2024. Fish that were not tagged were either still sac-fry or below minimum length requirements for tagging. Two PIT tagged fish were recaptured at the Lookout Dam Tailrace traps in 2024. The average travel time was 65 days. No VIE marked fish have been redetected at downstream sites in 2024 and no VIE marked fish from upstream sites were detected. A summary of downstream PIT tag detections is provided in Table 85 and a summary of VIE marked Chinook salmon by month at this site is provided in Table 86. Further information on tagged and VIE marked fish at this site is available in Appendix C: PIT Tags and VIE Tagging.

Table 85. Summary of redetections of PIT tagged Chinook at the Lookout Point Head of Reservoir site.

PIT Tag #	Mark Date	Redetection Date	Recap Site	Travel Time (Days)
3DD.003BD22E41	03/05/2024	05/22/2024	Lookout Dam Tailrace	78
3DD.003BD22E45	05/26/2024	07/18/2024	Lookout Dam Tailrace	53

Table 86. Summary of VIE tagged Chinook salmon at the Lookout Point Head of Reservoir site.

Date Tagged	Tag Location	VIE Color	# Tagged	# Recaptured
01/01–15/2024	Left Dorsal	Green	0	0
01/16–31/2024	Left Dorsal	Green	0	0
02/01–15/2024	Left Dorsal	Yellow	0	0
02/16–29/2024	Left Dorsal	Yellow	0	0
03/01–15/2024	Left Dorsal	Red	1	0
03/16–31/2024	Left Dorsal	Red	3	0
04/01–15/2024	Left Dorsal	Blue	5	0
04/16–30/2024	Left Dorsal	Blue	4	0
05/01–15/2024	Left Dorsal	Orange	0	0
05/16–31/2024	Left Dorsal	Orange	2	0
06/01–15/2024	Left Dorsal	Pink	1	0
06/16–30/2024	Left Dorsal	Pink	0	0
07/01–15/2024	Left Dorsal	Green x2	0	0
07/16–31/2024	Left Dorsal	Green x2	0	0
08/01–15/2024	Left Dorsal	Yellow x2	0	0
08/16–31/2024	Left Dorsal	Yellow x2	0	0
09/01–15/2024	Left Dorsal	Red x2	0	0
09/16–30/2024	Left Dorsal	Red x2	0	0
10/01–15/2024	Left Dorsal	Blue x2	0	0
10/16–31/2024	Left Dorsal	Blue x2	0	0
11/01–15/2024	Left Dorsal	Orange x2	0	0
11/16–30/2024	Left Dorsal	Orange x2	0	0
12/01–15/2024	Left Dorsal	Pink x2	0	0
12/16–31/2024	Left Dorsal	Pink x2	0	0

1.3.13.6 Willamette Valley Projects Encounters

A total of one adipose clipped and PIT tagged Chinook salmon were captured at the Lookout Point Head of Reservoir trap in 2024. This fish was a part of the Cramer Fish Science’s bulk mark release project. For information regarding bulk mark releases, dates of release, and redetections, refer to the *Bulk Mark Release and Reservoir Distribution Study Annual Report* (CFS 2024).

1.3.13.7 Non-Target Capture Data

A total of 649 non-target fish were captured at the Lookout Point Head of Reservoir site in addition to NOR juvenile Chinook salmon in 2024. The most captured non-target species were largescale suckers and dace. A summary of species and numbers of fish caught is provided in Table 87.

Table 87. Summary of non-target fish capture at the Lookout Point Head of Reservoir site in 2024.

Species	Season Total	Season Total Mortality (subset of total)
Bluegill	1	0
Juvenile Chinook (clipped)	51	1
Cutthroat Trout	12	0
Dace	196	8
Lamprey	8	0
Largemouth Bass	1	0
Largescale Sucker	151	5
Mountain Whitefish	9	1
Northern Pikeminnow	59	5
O. mykiss	107	2
O. mykiss (clipped)	2	0
Oregon Chub	2	0
Redside Shiner	4	2
Sculpin	19	2
Smallmouth Bass	7	1
Spotted Bass	13	0
Unknown*	6	3
Walleye	1	0
Totals	**649**	**30**

*Species denoted as “unknown” were too small and/or too decomposed to identify.

1.3.14 Lookout Dam Tailrace

Three 8-foot RSTs in the Middle Fork Willamette River in the Lookout Dam Tailrace continued monitoring activities and sampled from January 1, 2024, through December 31, 2024. Within the tailrace below Lookout Dam, there are two RSTs located in the channel downstream of the PH Outlet, referred to as PH1 and PH2, and one RST in the channel on the south side of the island, referred to as the RO, or Spill.

Sampling outages resulting from high flows, excessive debris, severe weather, localized flood evacuations, and additional issues are listed in Appendix B: Sampling Outages by Site. Non-sampling periods illustrated in the figures below are further detailed in Appendix B: Sampling Outages by Site.

Additionally, the RSTs were not sampled from February 1, 2024, to February 13, 2024, due to high flows which exceeded EAS' predefined safety thresholds for flow. During this period, all three of the RSTs were safety checked from shore to ensure any issues could be addressed in a timely manner.

1.3.14.1 Trapping Efficiency Trials

A total of 3 TE trials occurred below Lookout Point Dam tailrace in 2024 using hatchery reared Chinook salmon. Collectively, 16 TE trials have occurred at this site since April 2022. A summary of fish release numbers, recaptures, and flow level for each trial is provided in Table 88.

The trapping efficiencies at this site are poor and complex. One trap is located in a spill channel, occasionally catching fish from the powerhouse (PH) route, though only in very low abundances under specific conditions. Two additional traps are positioned on the PH side channel. Prior to September 5, 2023, these two traps were set up in the PH channel: one upstream near the north shore and the other downstream, offset to the south. To enhance personnel safety while checking the traps, a decision was made to reorient them side by side. This new setup was expected to maintain, if not improve, the traps' effectiveness, as the adjacent positioning allows them to sample more efficiently compared to the previous setup, which could be affected by changing flow conditions.

Spill TE from the spill route ranged from 0.0% to 1.8% and had a pooled average TE of 0.7% (95%CI ± 0.8%, n=3). Six of the nine spill trials were not successful in capturing the minimum number of fish (five) to be included in the passage estimate. Spill TE from the single PH route trial with the minimum number of recaptures was 0.2%. Four of the five PH route trials were not successful in capturing the minimum number of fish to be included in the passage estimate.

PH1 TE from the PH route 0.1% for the single successful trial out of six. The pooled average of all trials (regardless of recaptures <5) was <0.01% (95%CI ± 0.1%, n=6). PH1 TE from the spill route ranged from 0.0% to 0.1% and had only three successful trials out of 11. The pooled average of those three trials was 0.2% (95%CI ± 0.1%, n=3).

PH2 TE from the PH route ranged from <0.1% to 0.1% and had only three successful trials out of seven. The pooled average of all trials regardless of recapture numbers is 0.01% (95%CI ± 0.02%, n=7). PH2 TE from the spill route ranged from 0.0% to 0.01% and did not have a successful trial. The pooled average of all of the trials (regardless of recaptures <5) is <0.01% (95%CI ± 0.02%, n=7).

These TEs are extremely low and to get accurate estimates for PH fish caught via spill route and spill fish caught via PH route would take a substantial TE release to recapture enough fish to determine TE with any accuracy. Even with the new configuration of the PH1 and PH2 traps and large release groups, passage estimates could not be calculated for this site and more trials across a wide range of flows will be needed in the future. For these reasons, these sites were excluded from the trap efficiency analysis. Low numbers of brood year 2023 Chinook from Willamette Hatchery limited the number of fish available for TE trials in the Middle Fork Willamette basin in 2024.

Table 88. Summary table of marked hatchery Chinook salmon releases below Lookout Point Dam for trapping efficiency.

Release Location	Date of Release	cfs at Release	Number of Fish Released	Number of Fish Recaptured	Percent Efficiency
Lookout Dam Powerhouse	04/13/2022	2,925	998	0	0.0%
Lookout Dam Powerhouse	05/23/2023	2,920	3,999	32	0.8%
Lookout Dam Powerhouse	06/01/2023	2,950	4,011	6	0.1%
Lookout Dam Powerhouse	06/14/2023	3,130	4,010	4	0.1%
Lookout Dam Powerhouse	06/28/2023	3,160	4,010	3	0.1%
Lookout Dam Powerhouse	07/18/2023	2,700	4,012	9	0.2%
Lookout Dam Spillway	09/13/2023	1,850	3,636	0	0.0%
Lookout Dam Spillway	09/14/2003	1,850	3,998	0	0.0%
Lookout Dam Spillway	10/25/2023	1,730	4,042	0	0.0%
Lookout Dam Spillway	11/16/2023	1,600	4,005	12	0.3%
Lookout Dam Spillway	12/06/2023	2,100	8,007	18	0.2%
Lookout Dam Spillway	12/13/2023	6,000	8,011	148	1.8%
Lookout Dam Powerhouse	12/20/2023	4,910	16,007	29	0.2%
Lookout Dam Powerhouse*	01/10/2024	6,986	17,553	3	0.02%
Lookout Dam Spillway	03/27/2024	3,600	7,800	11	0.1%
Lookout Dam Spillway	04/03/2024	3,100	6,599	7	0.1%

*5 separate releases on this day, but all are counted as one trial. The numbers reflect the total number of fish released on 1/10/2024, and the average flow was taken.

1.3.14.2 Run of River Trapping Efficiency Trials

No TE trials using ROR fish were performed at Lookout Point Dam in 2024. The first 60 wild fish caught per week are prioritized for the 24-hour hold mortality study and are not tagged. Sufficient numbers of NOR fish were not available to perform ROR TE trials.

1.3.14.3 Target Catch and Passage Timing

A total of 99 juvenile Chinook salmon were captured in the Lookout Dam Tailrace traps in 2024. Of these, 71 were captured in the PH traps (71.7% of total catch, 27 in PH 1, 44 in PH 2) and 28 in the Spill trap (28.3% of total catch).

In the spring, 87 juvenile Chinook salmon (87.9% of total catch) were captured, 63 in the PH traps (72.4% of spring catch, 21 in PH1, 42 in PH2) (Figure 64 and Figure 65) and 24 in the Spill trap (27.6% of spring catch) (Figure 66). Chinook salmon capture in the spring comprised individuals from BY 2021 (n=2, 12.3% of spring catch) and BY 2022 (n=85, 97.7% of spring catch) (Figure 67). No BY 2023 sub-yearlings were encountered at this site during sampling in the spring of 2024. Peak capture of Chinook below Lookout Point Dam occurred in January (n=60, 60.6% of total Chinook catch).

Fall catch of Chinook comprised 12 fish (12.1% of total catch) from three brood years: BY 2022 (n=7, 58.3% of fall catch), 2023 (n=4, 33.3% of fall catch) and 2024 (n=1, 8.3% of fall catch). The PH traps captured 8 fish (66.7% of fall catch, 6 in PH 1, 2 in PH 2) and the spill trap captured 4 fish (33.3% of fall catch). A summary of fork length and weight data for Chinook salmon captured in the Lookout Dam Tailrace RSTs by BY is provided in Table 89.

Our trapping rate in the Lookout Dam Tailrace was approximately 0.3 fish per day. This is similar to rates observed from sampling in 2022, 2023, and those reported for sampling conducted from 2011 to 2015, in which the traps averaged roughly 0.3 fish per day (Romer et al. 2012–2016; EAS 2023). However, these rates are all lower than those observed from sampling by Keefer et al. (2007–2010), which had a capture rate of 0.7 fish per day. Adult out-planting above Lookout Reservoir has often been low in recent years which may result in the decreased rate of catch in the Lookout Dam Tailrace RST's. For more information on adult Chinook out-planting in the Middle Fork Willamette basin, please refer to Appendix I: Adult Chinook Out-planting Above Willamette Valley Projects.

Due to the low number of successful TE trials and low efficiency of the RSTs at this location, we are unable to create passage estimates for fish exiting Lookout Dam at this time. However, we were able to provide passage estimates for the trap in the tailrace of Dexter Dam and as Dexter Reservoir and Dexter Dam are immediately below Lookout Dam, estimates from Dexter can be used to provide some insight on passage at Lookout Dam.

Observations from sampling in 2012 and 2013 found that fish passed in the summer when spill occurred at the Lookout Dam Tailrace (Keefer et al. 2013). On years when no spring/summer spill occurred and water primarily passed through the turbines, Chinook salmon passage occurred predominantly in the fall months (Romer et al. 2013). Peak catch in the spring of 2024 occurred in January during a high flow event prior to the initiation of spill. However, an increase in catch was observed in late April and May during spill operations. Using the raw passage counts to infer relative passage timing, this change in peak capture could be a result of the decreased number of adult Chinook out-planted at locations above Lookout Point Reservoir in 2023 and the resulting change in proportion of yearling and sub-yearling Chinook passing through Lookout Dam in the spring. Previous monitoring by EAS found that relatively few fry exited Lookout Reservoir in the spring (EAS 2024). This is similar to results from other studies and suggests that fry either enter the reservoir later in the year, rear in the reservoir upon entry, or do not survive the migration to the dam. Of note, the first BY 2024 fry was captured below Lookout Dam on December 26, 2024. This timing is significantly earlier than has been observed in the past and should be interpreted cautiously as no adult Chinook were out planted above Lookout Point Reservoir in 2023. It is possible that this fish could be an escaped fish from Willamette Fish hatchery or the result of an adfluvial population. Fall capture of Chinook occurred in late November when the reservoir was near its lowest elevation. This timing is consistent with past observations. However, these results should be interpreted with caution due to the low number of fish captured in the RSTs below Lookout Dam in 2024. For raw weekly catch of Chinook at the Lookout Dam RST sites for sampling from 2021 to 2023, refer to Appendix I: Adult Chinook Out-planting Above Willamette Valley Projects. A total of 6 Chinook from a USGS JSATS tag study were captured in the RSTs below Lookout Point Dam between November 19th and 25th. For more information and insight on fish passage and survival of Chinook at Lookout Point Dam in the Fall of 2024, please refer to the associated USGS report (USGS in-prep).

Table 89. Summary of fork length and weight observed on juvenile Chinook salmon of NOR at the Lookout Point Dam Tailrace RST sites by brood year.

Species	Date Range	BY	Number of Fish	Average F.L. (mm)	Min. F.L. (mm)	Max F.L. (mm)	Median F.L. (mm)	Average Weight (g)	Min. Weight (g)	Max Weight (g)	Median Weight (g)
Chinook	1/1/2024–6/30/2024	21	2	208.5	208	209	N/A	95.7	95.7	96	N/A
Chinook	1/1/2024–6/30/2024	22	85	124.1	82	180	115	24.6	4.8	78.4	18.5
Chinook	7/1/2024–12/31/2024	22	7	202.0	115	253	239	101.8	15.8	187.6	99.3
Chinook	7/1/2024–12/31/2024	23	4	111.5	99	117	106	13.9	9.1	16.1	11.9
Chinook	7/1/2024–12/31/2024	24	1	35	35	35	N/A	<1	<1	<1	N/A

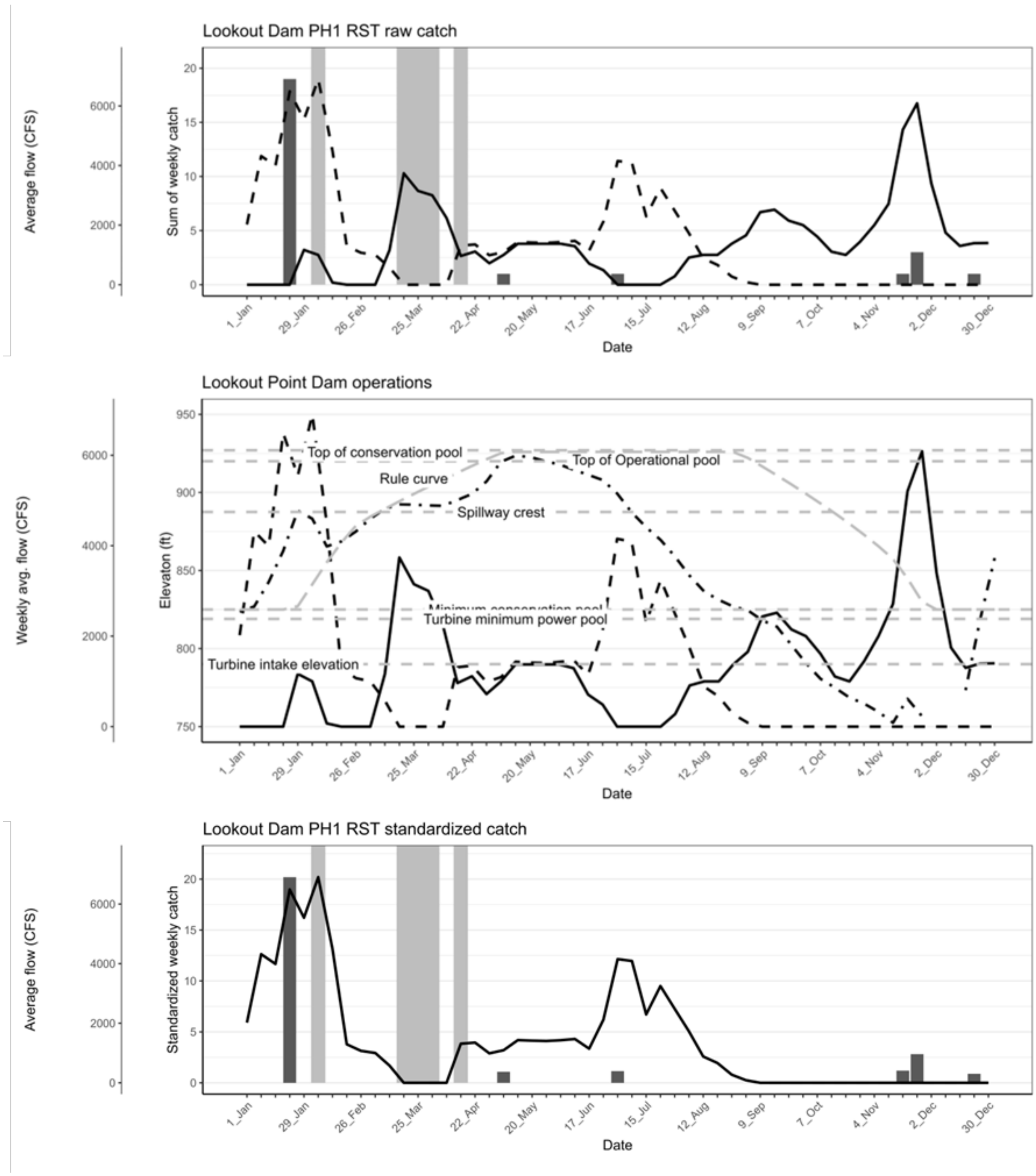

Figure 64. Raw catch (top panel), Lookout Point Dam operations and features of interest (middle panel), and weekly standardized catch (bottom panel) of NOR juvenile Chinook salmon at Lookout Point Dam Tailrace PH1 trap with spill (black line), Powerhouse outflow (black dash line), forebay elevation (black dot dash line), and intake elevations (gray dash line).

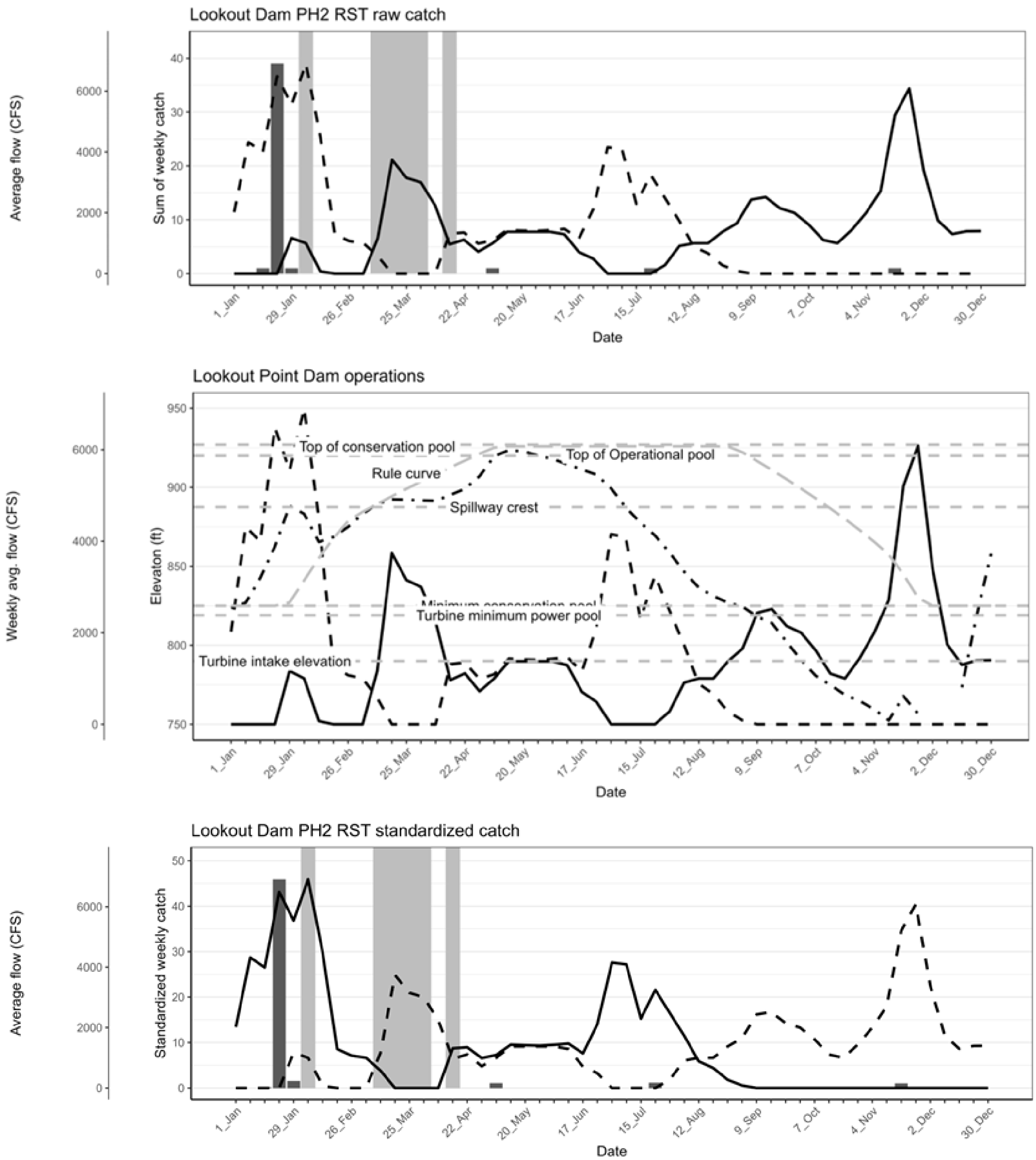

Figure 65. Raw catch (top panel), Lookout Point Dam operations and features of interest (middle panel), and weekly standardized catch (bottom panel) of NOR juvenile Chinook salmon at Lookout Dam Tailrace PH2 trap with spill (black line), Powerhouse outflow (black dash line), forebay elevation (black dot dash line), and intake elevations (gray dash line).

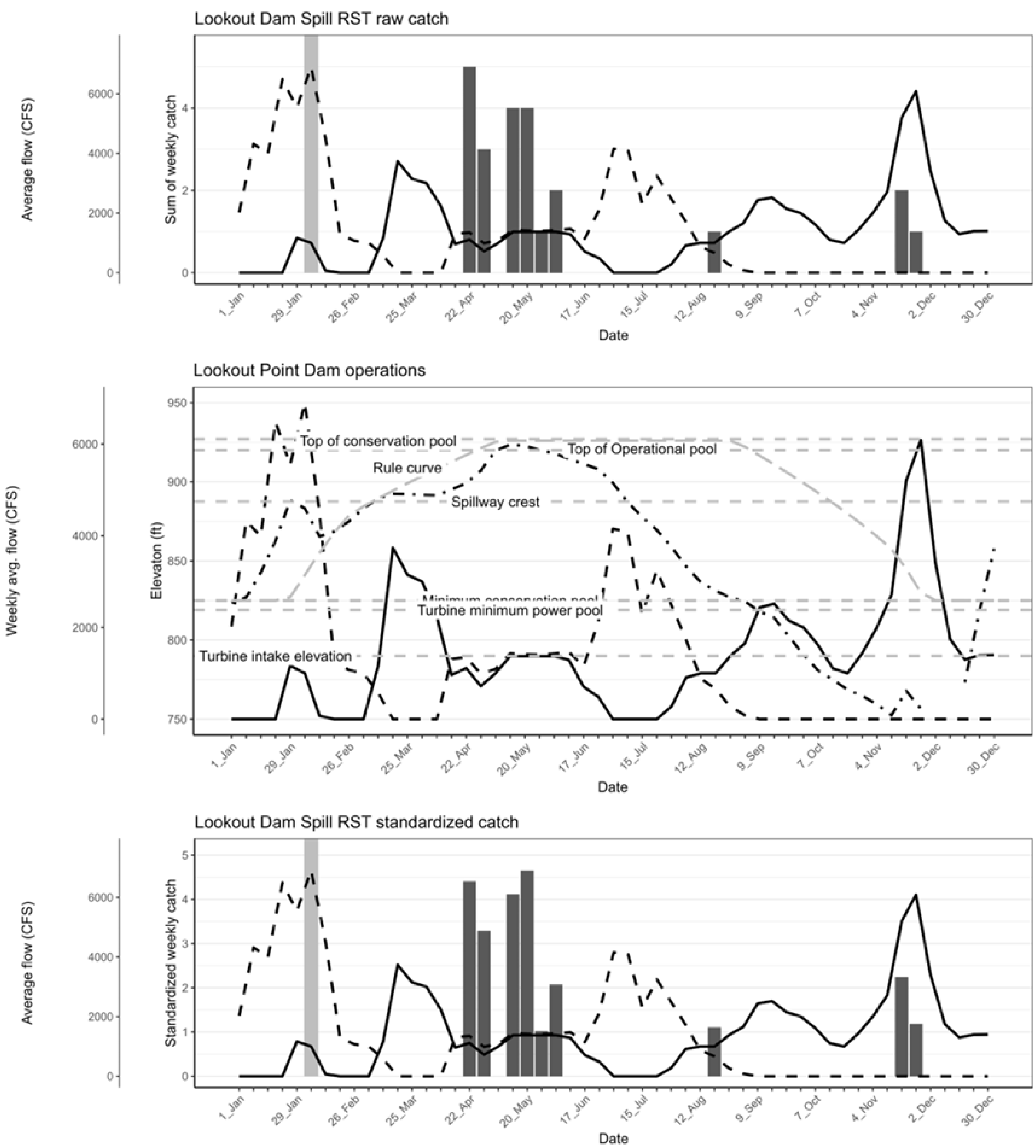

Figure 66. Raw catch (top panel), Lookout Point Dam operations and features of interest (middle panel), and weekly standardized catch (bottom panel) of NOR juvenile Chinook salmon at Lookout Point Dam Tailrace Spill trap with spill (black line), Powerhouse outflow (black dash line), forebay elevation (black dot dash line), and intake elevations (gray dash line).

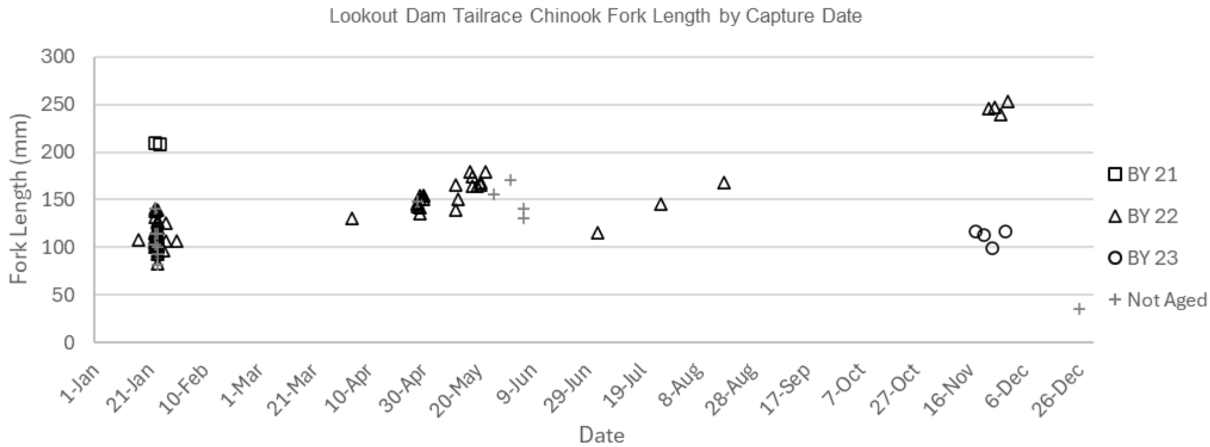

Figure 67. Length-frequency analysis for age of juvenile Chinook salmon captured below Lookout Point Dam.

1.3.14.4 Injury Data

A total of 97 juvenile Chinook salmon (98.0% of total Chinook salmon catch) displayed at least one of the injury code conditions listed in Table 3. All observed injuries from capture at all traps are combined for reporting purposes due to the uncertainty of a fish's route of passage based on which trap it was captured in. A total of 3 juvenile Chinook salmon (3.0% of total Chinook salmon catch) were found dead at the time of trap check (2 in PH1and 1 in Spill).

The most common injuries observed at this site include descaling less than 20%, descaling greater than 20%, gas bubble disease, the presence of copepods, and fin damage (Table 90). At the Lookout Point Dam RST site, NOR juvenile Chinook salmon and PIT tagged bulk mark released recaptures exhibited many similar injuries (Table 90). The most observed injuries with these bulk marked released fish were descaling less than 20% and fin damage (Table 90). TE hatchery Chinook salmon exhibited similar injuries to their NOR and bulk marked released counterparts. However, as was illustrated across a significant portion of the monitored RST sites, descaling, fin damage, and fungus were the most commonly observed injuries.

Figure 68 shows the proportion of captured Chinook salmon and bulk marked Chinook salmon, from Cramer releases, displaying injuries by type over the sampling period. Injury rates were highest during spill operations across all traps. Observations of gas bubble disease are likely higher for RST captured fish than those that are not captured in an RST as these fish are often captured and held in areas of higher dissolved gas. Copepod presence showed a positive correlation with increasing size of fish as has been observed here and at other sites in the past (Figure 69). Additional information regarding injuries by size and average injuries per fish is available in Appendix D: Additional Injury Information. Surface spill periods are displayed in Table 91 and denoted in Figure 68.

Data collected on the injury rates of TE hatchery fish illustrated that both the percentage of fish with injuries and the average number of injuries per fish generally decreased from pre-release to recaptured observations at the Lookout Point Dam RST site. Detailed findings on injury type are further presented in Appendix D: Additional Injury Information.

Like other sites detailed within this report, results illustrated that Chinook salmon less than 60 mm in length were more likely to have less significant external injuries than those above 60 mm in length (Appendix D, Table D-7). Additionally, 100% of the Chinook salmon encountered that were above 60 mm in length had at least one injury denoted. The most common of these injuries was descaling and fin damage (Appendix D, Table D-7).

Table 90. Summary of injuries observed on NOR, bulk marked, and TE hatchery Chinook salmon at the Lookout Point Dam Tailrace.

Injury Code	Chinook Injuries (NOR) (n=99)	Bulk Marked Released Chinook (n=221)	Trapping Efficiency Hatchery Chinook (n=21)
NXI (no external injury)	2.0%	0.0%	0.0%
MUNK	0.0%	0.0%	0.0%
DS<2	21.2%	81.0%	66.7%
DS>2	11.1%	19.0%	33.3%
BLO	0.0%	0.5%	0.0%
EYB	3.0%	6.3%	9.5%
BVT	3.0%	0.5%	0.0%
FVB	8.1%	10.9%	9.5%
GBD	17.2%	10.0%	23.8%
POP	0.0%	0.9%	9.5%
HIN	5.1%	8.1%	4.8%
OPD	11.1%	12.2%	14.3%
TEA	2.0%	3.6%	4.8%
BRU	9.1%	14.5%	0.0%
HBP	0.0%	0.0%	0.0%
HO	0.0%	0.0%	0.0%
BO	0.0%	0.0%	0.0%
HBO	0.0%	0.0%	4.8%
FID	73.7%	99.5%	100.0%
PRD	1.0%	2.7%	14.3%
COP	24.2%	9.0%	0.0%
BKD	0.0%	0.0%	0.0%
FUN	6.1%	7.7%	42.9%

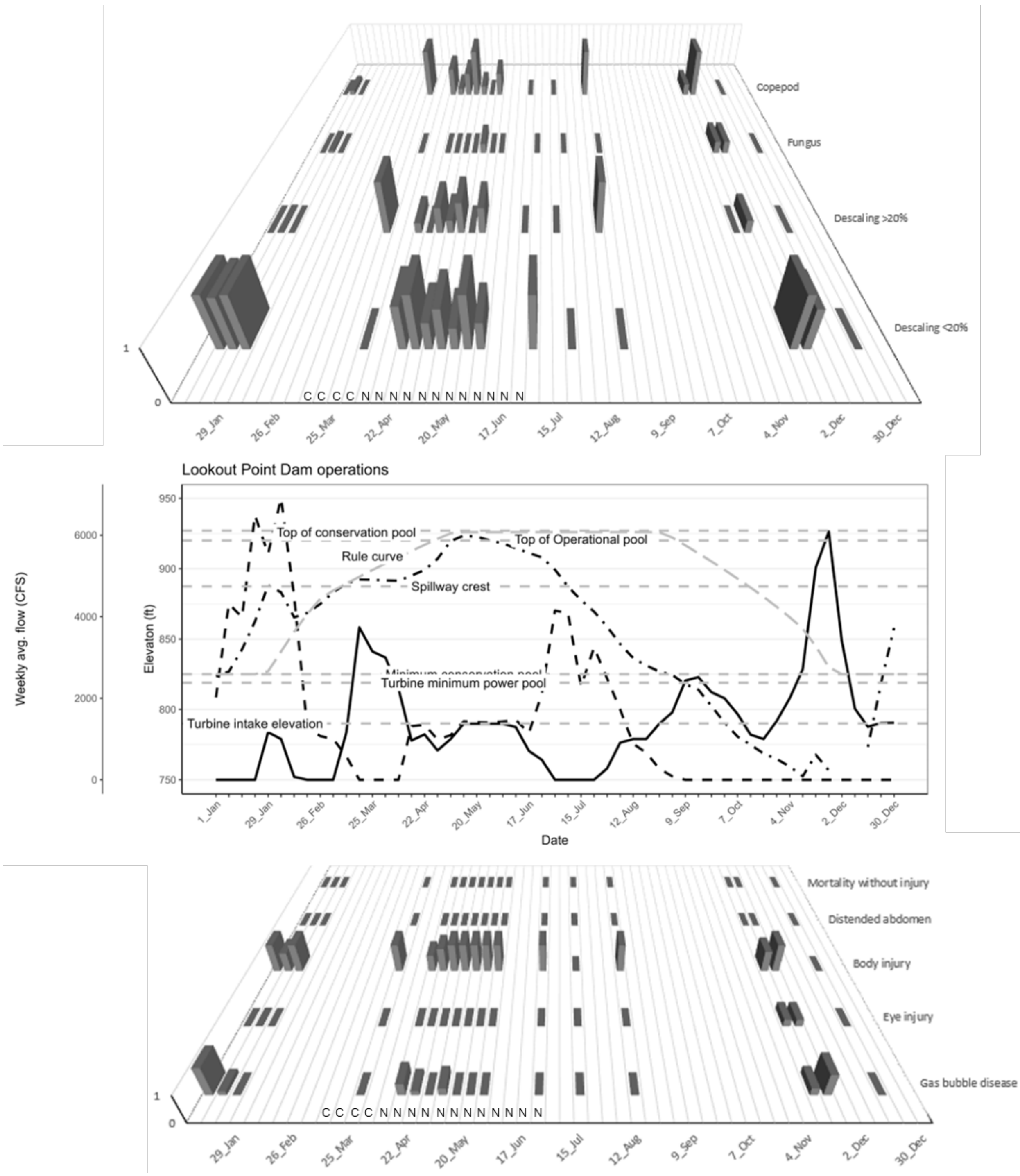

Figure 68. Proportion of captured juvenile Chinook salmon displaying injuries by type (top panel), operations and features of interest at Lookout Dam with spill (black line) and Powerhouse (black dashed line) outflow (middle panel), and proportion of captured juvenile Chinook salmon displaying descaling injuries and copepod presence (bottom panel). Bars denoted with "C" show weeks in which Continuous Ungated Surface Spill occurred while those denoted with "N" show weeks in which Gated Nighttime Spill Operations occurred.

Table 91. Summary of surface spill operations at Lookout Dam Tailrace.

Site	Dates	Description
Lookout Dam	03/18/2024–04/15/2024	Continuous Ungated Surface Spill
Lookout Dam	04/15/2024–06/27/2024	Nighttime Gated Surface Spill Operations

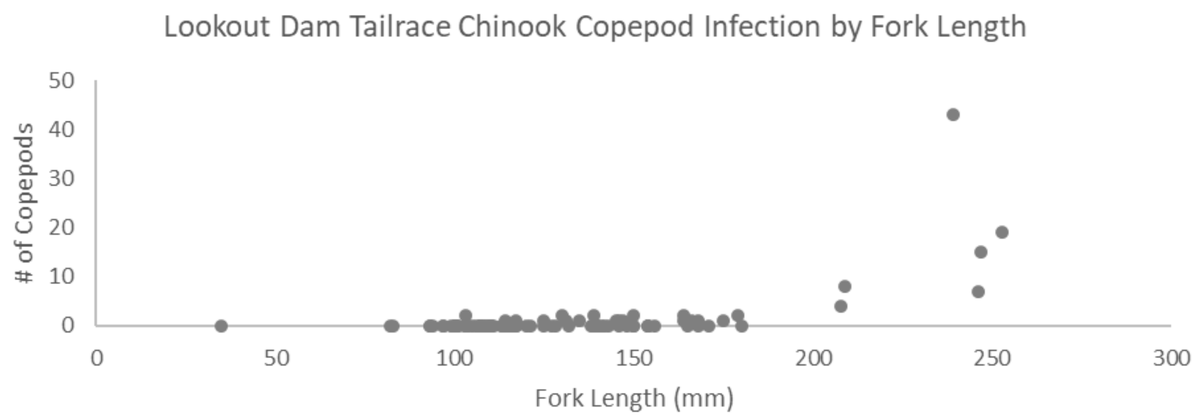

Figure 69. Copepod prevalence vs fork length on juvenile Chinook salmon captured at the Lookout Point Dam Tailrace.

1.3.14.5 24-Hour Hold Trials

24-hour hold trials were performed on NOR juvenile Chinook salmon captured at Lookout Dam Tailrace to assess delayed mortality resulting from dam passage. A total of 88 fish, 27 from the Spill and 61 from the PH traps, were held in 2024 (Table 92). A total of 13 fish died during hold (14.8%), 10 of the 27 Spill Chinook salmon died (37.0%) and 3 of the 61 PH Chinook salmon died (4.9%). Three fish were removed from this study, as they could not be found the next day. Otter scat was present on the trap, suggesting predation. Mortality rates across the two-week periods in which fish were held ranged from 0.0% to 100%.

Table 92. Summary of 24-hour trials for Chinook salmon captured in the RSTs at the Lookout Dam Tailrace sites.

Hold Period	Route	Number of Fish Held	Mortalities	% Survived
01/01–15/2024	PH	0	0	--
01/01–15/2024	Spill	0	0	--
01/16–31/2024	PH	56	0	100.0%
01/16–31/2024	Spill	0	0	--
02/01–15/2024	PH	0	0	--
02/01–15/2024	Spill	0	0	--
02/16–29/2024	PH	0	0	--
02/16–29/2024	Spill	0	0	--
03/01–15/2024	PH	0	0	--
03/01–15/2024	Spill	0	0	--
03/16–31/2024	PH	0	0	--
03/16–31/2024	Spill	0	0	--
04/01–15/2024	PH	0	0	--
04/01–15/2024	Spill	0	0	--
04/16–30/2024	PH	0	0	--
04/16–30/2024	Spill	11	3	72.7%
05/01–15/2024	PH	1	1	0.0%
05/01–15/2024	Spill	1	1	0.0%
05/16–31/2024	PH	0	0	--
05/16–31/2024	Spill	7	0	100.0%
06/01–15/2024	PH	0	0	--
06/01–15/2024	Spill	3	2	33.3%
06/16–30/2024	PH	0	0	--
06/16–30/2024	Spill	0	0	--
07/01–15/2024	PH	1	0	100.0%
07/01–15/2024	Spill	0	0	--
07/16–31/2024	PH	1	0	100.0%
07/16–31/2024	Spill	0	0	--
08/01–15/2024	PH	0	0	--
08/01–15/2024	Spill	0	0	--
08/16–31/2024	PH	0	0	--
08/16–31/2024	Spill	1	1	0.0%
09/01–15/2024	PH	0	0	--
09/01–15/2024	Spill	0	0	--
09/16–30/2024	PH	0	0	--
09/16–30/2024	Spill	0	0	--
10/01–15/2024	PH	0	0	--
10/01–15/2024	Spill	0	0	--
10/16–31/2024	PH	0	0	--
10/16–31/2024	Spill	0	0	--
11/01–15/2024	PH	0	0	--
11/01–15/2024	Spill	0	0	--
11/16–30/2024	PH	2	2	0.0%
11/16–30/2024	Spill	4	3	25.0%
12/01–15/2024	PH	0	0	--
12/01–15/2024	Spill	0	0	--
12/16–31/2024	PH	0	0	--

Hold Period	Route	Number of Fish Held	Mortalities	% Survived
12/16–31/2024	Spill	0	0	--

1.3.14.6 PIT Tagged/VIE Marked Fish and Downstream Detections

One juvenile Chinook salmon was PIT tagged at the RST sites below Lookout Point Dam in 2024. All other captured fish were placed into the 24-hour hold study. No fish were VIE marked at this location in 2024 as fish were prioritized for the 24-hour hold study and no VIE marked fish from upstream sites were detected. The single PIT tagged NOR Chinook has not been redetected downstream. Two PIT tagged Chinook that were tagged at the Lookout Point Head of Reservoir RST were recaptured at this site in 2024. The average travel time was 65 days. Further information on tagged and VIE marked fish at this site is available in Appendix C: PIT Tags and VIE Tagging.

1.3.14.7 Willamette Valley Projects Encounters

A total of six acoustic and PIT tagged Chinook were encountered at the Lookout Dam Tailrace traps in 2024. These are a part of a USGS acoustic tag study. A total of 221 adipose clipped and PIT tagged Chinook salmon were encountered below Lookout Point Dam in 2024. Two of these Chinook were also encountered downstream in the Dexter Dam Tailrace RST by EAS crew. These fish were associated with bulk mark fish releases performed by CFS. For more information regarding bulk mark releases and detections, refer to the *Bulk Mark Release and Reservoir Distribution Study Annual Report* (CFS 2024).

1.3.14.8 Non-Target Species

A total of 31,584 non-target fish were captured in the Lookout Dam Tailrace RSTs in addition to NOR juvenile Chinook in 2024 (Table 93). The most common non-target species encountered were crappie and smallmouth bass. For information on non-target catch during sampling in 2023, Appendix G: Images of Non-Target Species.

Table 93. Summary of non-target fish capture below Lookout Point Dam in 2024.

Species	Season Total	Season Total Mortality (subset of total)
Bluegill	34	10
Brown Bullhead catfish	5	3
Juvenile Chinook (clipped)	317	17
Crappie	29,490	25,053
Cutthroat Trout	1	0
Dace	2	0
Largemouth Bass	119	106
Largescale Sucker	11	10
Northern Pikeminnow	14	5
O. mykiss	17	4
O. mykiss (clipped)	3	0
Sculpin	261	16
Smallmouth Bass	1,100	950
Spotted Bass	15	1
Unknown*	82	63
Walleye	113	20
Totals	**31,584**	**26,258**

*Species denoted as “unknown” were too small and/or too decomposed to identify.

1.3.15 Dexter Dam Tailrace

A single 5-foot RST in the Dexter Dam Tailrace continued monitoring activities and sampled from January 1, 2024, through December 31, 2024.

Sampling outages resulting from high flows, excessive debris, severe weather, localized flood evacuations, and additional issues are listed in Appendix B: Sampling Outages by Site. Non-sampling periods illustrated in the figures below are further detailed in Appendix B: Sampling Outages by Site.

1.3.15.1 Trapping Efficiency Trials

Construction at the Dexter Dam Tailrace Hatchery required the relocation of the RST on November 6, 2023. This construction was necessary due to improvements being implemented on Dexter Dam Hatchery infrastructure. The RST stayed on the north side of the river but moved over 300 yards downstream. Because of this, TE, weekly passage estimates and weekly discharge and revolution per hour modeling include only TE trial data after the RST was moved. A total of 6 TE trials occurred at the Dexter Dam Tailrace in 2024 using hatchery reared juvenile Chinook salmon. Collectively, 11 TE trials have occurred at this site since the site RST was moved. A summary of the fish release numbers, recaptures, and flow level for each trial is provided in Table 94.

TEs ranged from 0.1% to 0.9% with a pooled average of 0.6% (95%CI ± 0.2%, n=7) of all successful trials with five or more recaptures. Eight of the trials did not recapture enough fish to be used in the passage estimate calculation, and one trial was discounted due to an ODFW fish release upstream of Dexter Dam. Low numbers of brood year 2023 Chinook from Willamette Hatchery limited the number of fish available for TE trials in the Middle Fork Willamette basin in 2024.

Trap efficiency analysis identified the full model—incorporating weekly average discharge, average trap revolutions per hour, mean fork length, and interactions among these covariates—as having the highest pseudo R^2 (0.95, n=9), suggesting a strong fit to the data. However, these results likely reflect overfitting due to the small sample size and limited variability in the response data, driven by the low trap efficiencies. In such cases, models may be capturing site-specific noise rather than generalizable patterns. Detailed methods and full results of the flow modeling are provided in Appendix E: Trap Efficiency Plots.

Table 94. Summary table of marked hatchery Chinook salmon releases at Dexter Dam Tailrace for trapping efficiency.

Release Location	Date of Release	cfs at Release	Number of Fish Released	Number of Fish Recaptured	Percent Efficiency
Dexter Dam Spillway	03/23/2022	1,240	988	2	0.2%
Dexter Dam Spillway	05/04/2022	5,040	995	43	4.3%
Dexter Dam Spillway	05/24/2022	2,620	1018	67	6.6%
Dexter Dam Powerhouse	07/21/2022	1,560	976	2	0.2%
Dexter Dam Powerhouse	10/26/2022	2,950	1007	1	0.1%
Dexter Dam Powerhouse	11/01/2022	3,670	755	1	0.1%
Dexter Dam Powerhouse	11/17/2022	3,450	991	4	0.4%
Dexter Dam Powerhouse	12/06/2022	1,610	1010	10	1.0%
Dexter Dam Powerhouse	12/15/2022	1,540	1025	1	0.1%
Dexter Dam Powerhouse	03/16/2023	1,550	1,200	2	0.2%
Dexter Dam Spillway	03/29/2023	1,280	1,199	5	0.4%
Dexter Dam Powerhouse	05/25/2023	3,030	4,003	14	0.3%
Dexter Dam Powerhouse	06/07/2023	3,200	4,010	4	0.1%
Dexter Dam Powerhouse	06/21/2023	2,720	4,028	15	0.4%
Dexter Dam Powerhouse	07/06/2023	2,640	4,000	5	0.1%
Dexter Dam Powerhouse	08/02/2023	2,240	1,505	3	0.2%
Dexter Dam Powerhouse	08/23/2023	1,710	4,012	14	0.3%
Dexter Dam Powerhouse	09/06/2023	1,800	4,037	13	0.3%
Dexter Dam Powerhouse	10/04/2023	1,720	4,001	5	0.1%
Dexter Dam Spillway	10/24/2023	1,590	1,514	18	1.2%
Dexter Dam Spillway	11/01/2023	1,450	1,506	9	0.6%
Dexter Dam Spillway	11/22/2023	3,480	1,516	0	0.0%
Dexter Dam Spillway	12/05/2023	2,050	4,006	10	0.2%
Dexter Dam Spillway	12/12/2023	4,050	4,001	13	0.3%
Dexter Dam Spillway and Powerhouse	12/21/2023	4,850	4,005	3	0.1%
Dexter Dam Powerhouse	12/28/2023	1,990	8,032	46	0.6%
Dexter Dam Powerhouse	01/09/2024	3,360	4,004	6	0.1%
Dexter Dam Spillway	02/08/2024	8,500	2,067	0	0.0%
Dexter Dam Spillway	02/28/2024	1,200	1,959	17	0.9%
Dexter Dam Spillway	03/06/2024	1,250	2,000	4	0.2%
Dexter Dam Spillway	04/02/2024	3,370	1,962	0	0.0%
Dexter Dam Spillway*	04/10/2024	2,800	6,000	9	0.2%

*ODFW mistakenly released fish above Dexter Dam instead of downstream in February, March, and April of 2024. The TE trial in April had only marked fish with an ad-clip, so these fish cannot be distinguished from the ODFW release.

1.3.15.2 Run of River Trapping Efficiency Trials

No TE trials using ROR fish were performed at Dexter Dam Tailrace in 2024. The first 60 wild fish caught per week are prioritized for the 24-hour hold mortality study and are not tagged. Sufficient numbers of NOR fish were not available to perform ROR TE trials.

1.3.15.3 Target Catch, Passage Estimates and Passage Timing

The trap below Dexter Dam captured 35 fish during sampling efforts in 2024. A total of 28 juvenile Chinook salmon (80.0% of total catch) were captured during the spring and 7 (20.0% of total catch) were captured in the fall (Figure 70). Chinook salmon catch below Dexter Dam was primarily composed of BY 2022 yearlings (n=31, 88.6% of total catch). Additionally, three BY 2023 sub-yearlings (8.6% of total catch) and a single BY 2021 Chinook salmon were also captured at the site (Figure 72). No BY 2023 sub-yearlings were encountered at this site until December 10, 2024. Data summarizing fork lengths and weights of Chinook salmon captured at Dexter Dam is provided in Table 95.

Peak capture of juvenile Chinook salmon leaving Dexter Reservoir occurred in January (n=10, 28.6%). Previously, peak capture at Dexter Dam in the spring showed an association with the concurrent surface spill events at Lookout and Dexter Dams. Catch in the spring of 2024 was spread throughout the sampling period and surface spill was the only route of passage available to fish after the powerhouse went offline in early January (Figure 71). No clear association with spill at Lookout Dam and catch below Dexter was observed during sampling in 2024. The timing of fall capture of Chinook at Dexter Dam was similar to that of sampling in 2023 (EAS 2024). Catch at Dexter showed loose associations with catch in the Lookout Dam Tailrace and the drawdown of Lookout Reservoir. However, relatively few fish were captured at both Lookout Dam and Dexter Dam Tailraces in 2024 and results should be interpreted with caution. We estimate that during sampling in 2024, 6,587 (95% CI: 5,013 to 9,600) juvenile Chinook salmon migrated past the trapping site (Figure 71). For figures displaying raw weekly catch of Chinook at this site for sampling in 2022 and 2023, refer to Appendix I: Adult Chinook Out-planting Above Willamette Valley Projects.

Table 95. Summary of fork length and weight observed on juvenile Chinook salmon of NOR at the Dexter Dam Tailrace RST site by brood year.

Species	Date Range	BY	Number of Fish	Average F.L. (mm)	Min. F.L. (mm)	Max F.L. (mm)	Median F.L. (mm)	Average Weight (g)	Min. Weight (g)	Max Weight (g)	Median Weight (g)
Chinook	1/1/2024–6/30/2024	21	1	227	227	227	N/A	101.5	101.5	101.5	N/A
Chinook	1/1/2024–6/30/2024	22	27	130.3	77	177	129	26.9	7.7	60.1	24.6
Chinook	7/1/2024–12/31/2024	22	4	199	133	260	201.5	114.4	29.5	232.2	98.0
Chinook	7/1/2024–12/31/2024	23	3	111.3	93	123	118	14.9	8.4	19.9	16.3

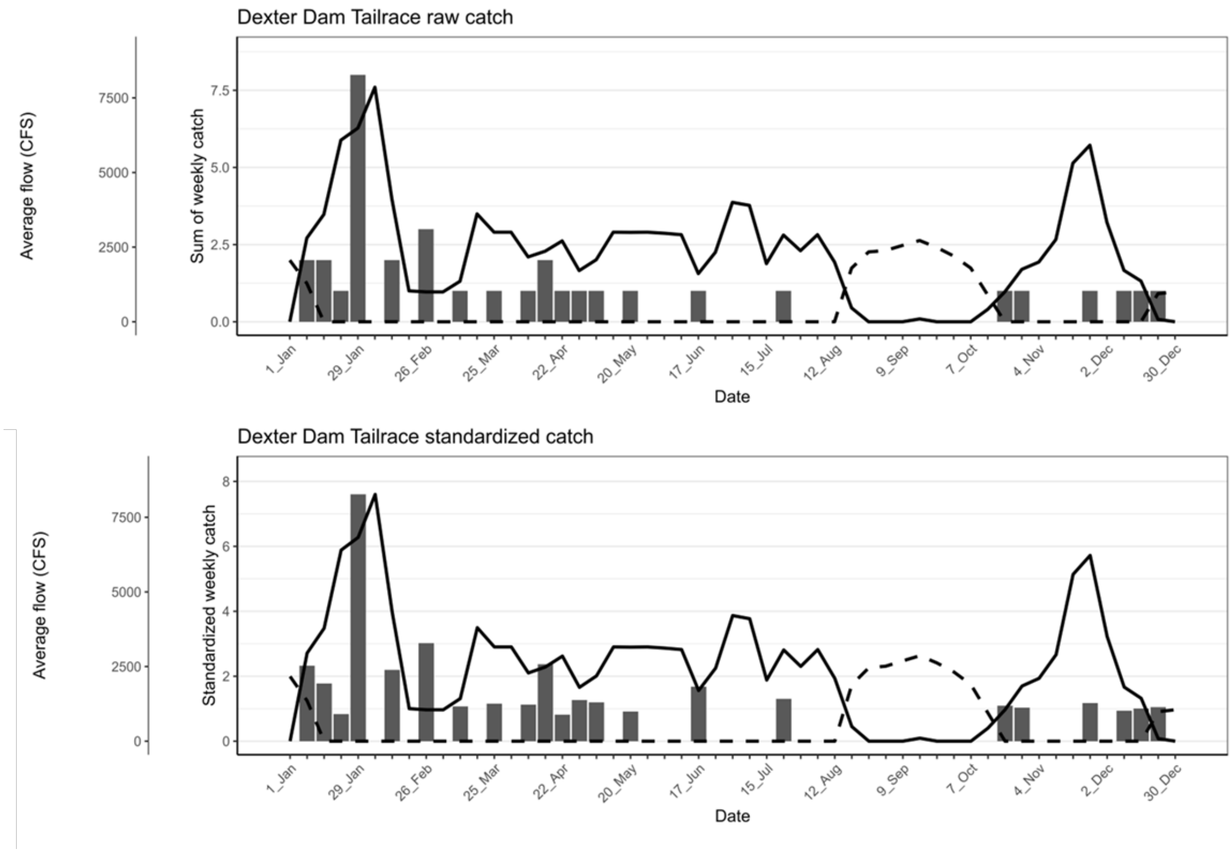

Figure 70. Raw catch Dexter Dam (top panel) and weekly standardized catch (bottom panel) of NOR juvenile Chinook salmon at the Dexter Dam Tailrace site with spill (black line) and Powerhouse outflow (black dash line).

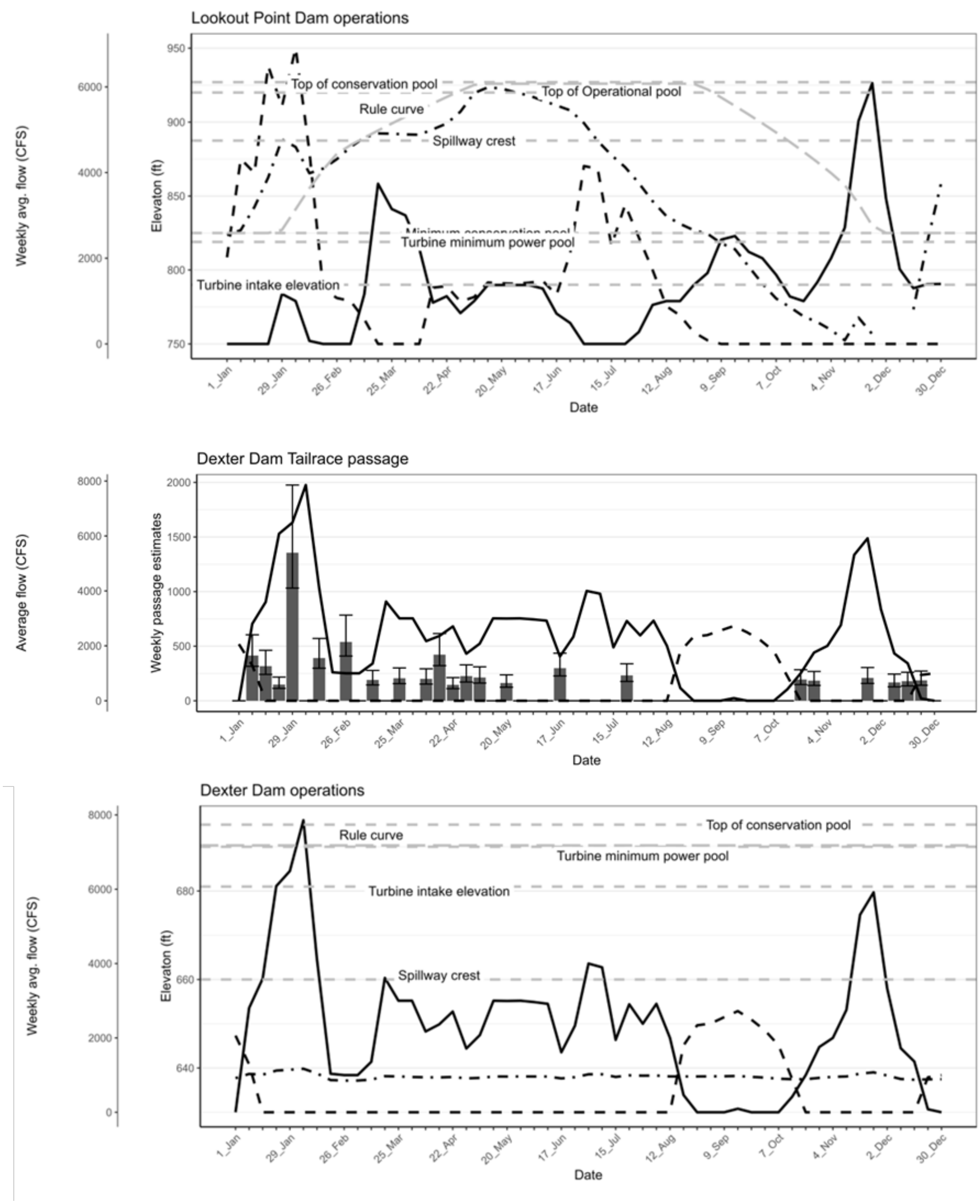

Figure 71. Lookout Dam (top panel) and Dexter Dam (bottom panel) operations with forebay elevation (black dot dash line), spill/RO outflow (black line) and Powerhouse outflow (black dash line). Weekly passage estimates with 95% confidence for juvenile Chinook salmon at Dexter Dam (middle panel) with spill (black line) and Powerhouse outflow (black dash line).

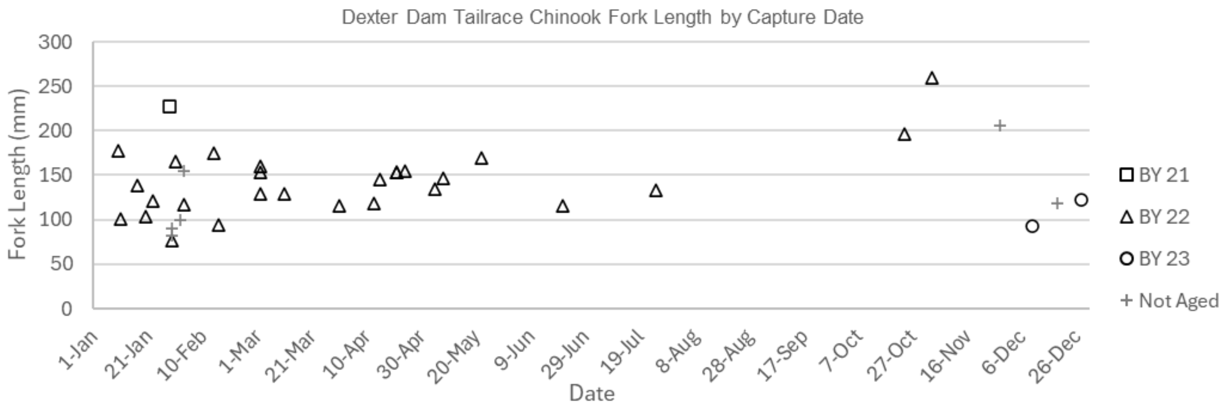

Figure 72. Length-frequency of juvenile Chinook salmon by brood year at the Dexter Dam Tailrace site.

1.3.15.4 Injury Data

A total of 33 juvenile Chinook salmon (94.3% of total Chinook salmon catch) displayed at least one of the injury code conditions listed in Table 3. One mortality was observed during the spring monitoring period (2.9% of total Chinook salmon catch).

To provide insight on injuries associated with capture in a RST, injury data was collected from bulk marked release and hatchery fish utilized for TE trials. The most common injuries observed at this site include descaling less than 20% and fin damage for NOR Chinook (Table 96). It is also worth noting that Chinook salmon at this site exhibited higher percentages of gas bubble disease and copepod presence as compared to other sites with a similar sample size. Additionally, more Chinook salmon were found to have gas bubble disease following the downstream relocation of the RST. It is worth noting that the overall sample size of Chinook salmon being discussed at the Dexter Dam Tailrace is relatively small and additional data will be collected in 2024 to provide further clarity regarding injuries at this location.

Bulk marked released and TE hatchery Chinook salmon exhibited higher percentages of descaling greater than 20% and fin damage as compared to NOR fish, however, these values are relatively close (Table 96). TE hatchery Chinook at Dexter Dam had a lower gas bubble disease percentage (2.5%), when compared to both NOR and bulk marked released Chinook (25.7% and 26.0%), respectively (Table 96). Injuries among NOR Chinook, bulk marked released Chinook and TE hatchery Chinook were consistent among all fields. Overall, very few of the aforementioned fish exhibited no external injuries.

Figure 73 illustrates the proportion of fish displaying injuries by type over the sampling period. Observed injury rates at this site increased during spill operations. However, relatively few fish were captured during this reporting period and more data is needed to draw more accurate conclusions. Copepod presence on captured Chinook salmon showed a weak positive correlation with the size of fish, similar to observations from other sites within the basin (Figure 74). It is likely that observations of gas bubble disease are higher for RST captured fish than those not captured in an RST, as these fish are often captured and held in areas of higher dissolved gas. Additional information regarding injuries by size and average injuries per fish is available in Appendix D: Additional Injury Information.

Almost identical to other sites detailed within this report, results illustrated that Chinook salmon less than 60 mm in length were more likely to have no external injuries than those measuring above 60 mm (Appendix D, Table D-6). Additionally, 100% of the Chinook salmon encountered that were measured above 60 mm had at least one injury denoted. The most common of these injuries was descaling and fin damage (Appendix D, Table D-6).

Data collected on the injury rates of TE hatchery fish illustrated that both the percentage of fish with injuries and the average number of injuries per fish generally increased from pre-release to recaptured observations. Detailed findings on injury type are further presented in Appendix D: Additional Injury Information.

Table 96. Summary of injuries observed on NOR, bulk marked, and TE hatchery Chinook salmon at the Dexter Dam RST.

Injury Code	Chinook Injuries (NOR) (n=35)	Bulk Marked Released Chinook (n=77)	Trapping Efficiency Hatchery Chinook (n=79)
NXI (no external injury)	5.7%	0.0%	0.0%
MUNK	0.0%	0.0%	0.0%
DS<2	77.1%	80.5%	74.7%
DS>2	17.1%	19.5%	22.8%
BLO	0.0%	0.0%	0.0%
EYB	2.9%	5.2%	0.0%
BVT	2.9%	2.6%	0.0%
FVB	5.7%	3.9%	1.3%
GBD	25.7%	26.0%	2.5%
POP	0.0%	0.0%	0.0%
HIN	5.7%	6.5%	0.0%
OPD	5.7%	16.9%	3.8%
TEA	5.7%	3.9%	0.0%
BRU	11.4%	9.1%	1.3%
HBP	0.0%	0.0%	0.0%
HO	0.0%	0.0%	0.0%
BO	0.0%	0.0%	0.0%
HBO	0.0%	0.0%	0.0%
FID	77.1%	92.2%	97.5%
PRD	0.0%	0.0%	0.0%
COP	28.6%	11.7%	0.0%
BKD	0.0%	0.0%	0.0%
FUN	2.9%	7.8%	2.5%

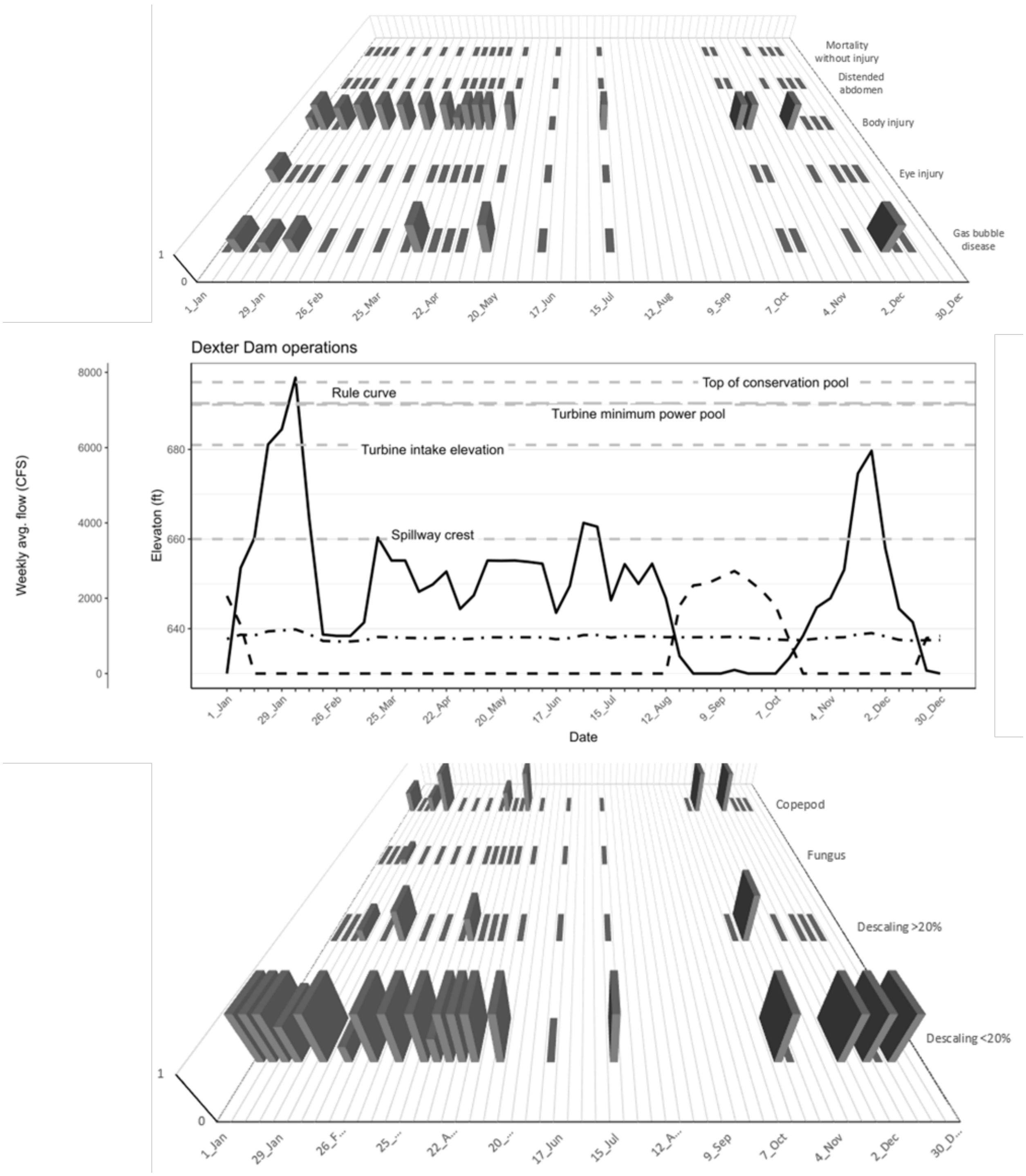

Figure 73. Proportion of captured juvenile Chinook salmon displaying injuries by type (top panel), operations data and features of interest for Dexter Dam Tailrace (middle panel) with spill outflow (black line), Powerhouse outflow (black dash line), forebay elevation (black dot dash line), and proportion of captured juvenile Chinook salmon displaying descaling injuries and copepods (bottom panel).

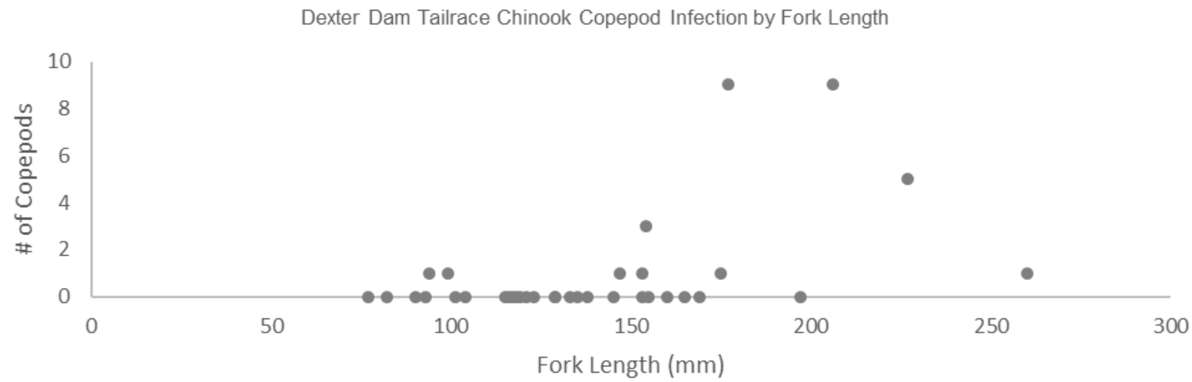

Figure 74. Copepod prevalence vs fork length on juvenile Chinook salmon captured at Dexter Dam Tailrace.

1.3.15.5 24-Hour Hold Trials

24-hour hold trials were performed on NOR juvenile Chinook salmon captured at Dexter Dam Tailrace to assess delayed mortality resulting from dam passage. 35 Chinook salmon were held in 2024 (Table 97). A total of 1 Chinook salmon died during hold (2.9%). Mortality rates between the two-week reporting periods ranged from 0.0% to 25.0%.

Table 97. Summary of 24-hour hold trials for Chinook salmon captured in the RST at the Dexter Dam Tailrace site.

Hold Period	Species	Number of Fish Held	Mortalities	% Survived
01/01–15/2024	Chinook	2	0	100.0%
01/16–31/2024	Chinook	7	0	100.0%
02/01–15/2024	Chinook	3	0	100.0%
02/16–29/2024	Chinook	1	0	100.0%
03/01–15/2024	Chinook	4	0	100.0%
03/16–31/2024	Chinook	1	0	100.0%
04/01–15/2024	Chinook	2	0	100.0%
04/16–30/2024	Chinook	4	1	75.0%
05/01–15/2024	Chinook	2	0	100.0%
05/16–31/2024	Chinook	1	0	100.0%
06/01–15/2024	Chinook	0	0	--
06/16–30/2024	Chinook	1	0	100.0%
07/01–15/2024	Chinook	0	0	--
11/01–15/2024	Chinook	1	0	100.0%
11/16–30/2024	Chinook	0	0	--
12/01–15/2024	Chinook	0	0	--
12/16–31/2024	Chinook	0	0	--
01/01–15/2024	Chinook	0	0	--
01/16–31/2024	Chinook	0	0	--
02/01–15/2024	Chinook	1	0	100.0%
02/16–29/2024	Chinook	1	0	100.0%
03/01–15/2024	Chinook	1	0	100.0%
03/16–31/2024	Chinook	1	0	100.0%
04/01–15/2024	Chinook	2	0	100.0%

1.3.15.6 PIT Tagged/VIE Marked Fish and Downstream Detections

One Chinook salmon was PIT tagged at the Dexter Dam Tailrace in 2024. All other fish captured were placed into the 24-hour hold study. No VIE marked fish from upstream sites were detected at the Dexter Dam Tailrace RST site. The single PIT tagged NOR Chinook has not been redetected at downstream sites. Further information on tagged and VIE marked fish at this site is available in Appendix C: PIT Tags and VIE Tagging.

1.3.15.7 Willamette Valley Projects Encounters

A total of 17 acoustic and PIT tagged Chinook were encountered at Dexter Dam Tailrace in 2024. These are a part of a USGS acoustic tag study. A total of 77 adipose clipped and PIT tagged Chinook salmon were captured at the Dexter Dam Tailrace site in 2024. Two of these Chinook were also encountered in the Lookout Dam Tailrace RSTs by EAS crew prior to their recapture at the Dexter Dam Tailrace RST. For more information regarding bulk mark releases and detections, refer to the *Bulk Mark Release and Reservoir Distribution Study Annual Report* (CFS 2024).

1.3.15.8 Non-Target Capture Data

A total of 3,802 non-target fish were captured at the Dexter Dam Tailrace RST in addition to NOR juvenile Chinook salmon in 2024. The most commonly captured non-target species were crappie, sculpin, and clipped Chinook. A summary of species and numbers of fish caught are provided in Table 98.

Table 98. Summary of non-target fish capture in the RST at the Dexter Dam Tailrace site in 2024.

Species	Season Total	Season Total Mortality (subset of total)
Bluegill	49	2
Juvenile Chinook (clipped)	736	9
Crappie	2,160	151
Cutthroat Trout	9	1
Dace	65	1
Lamprey	3	0
Largescale Sucker	12	2
Mountain Whitefish	6	0
Northern Pikeminnow	17	0
O. mykiss	31	2
O. mykiss (clipped)	8	0
Pacific Lamprey	2	0
Redside Shiner	14	0
Sculpin	619	84
Smallmouth Bass	7	0
Unknown*	2	2
Walleye	62	17
Totals	**3,802**	**271**

*Species denoted as “unknown” were too small and/or too decomposed to identify.

1.4 Citations

Cheng, Yuk W., and Michael P. Gallinat. 2004. "Statistical analysis of the relationship among environmental variables, inter-annual variability and smolt trap efficiency of salmonids in the Tucannon River." Fisheries Research 70, no. 2-3 (2004): 229-238.

Cohen, J., Cohen, P., West, S. G., & Aiken, L. S. (2003). Applied Multiple Regression/Correlation Analysis for the Behavioral Sciences (3rd ed.). Lawrence Erlbaum Associates.

CFS (Cramer Fish Sciences). 2023a. Willamette Valley Fish Passage Monitoring via Rotary Screw Traps, 2021 Final Report. Prepared for: United States Army Corps of Engineers under Contract W9127N19D0009-W9127N21F0030. Prepared by: Ryan Flaherty, Hans Berge, and Caitlyn Jobanek of Cramer Fish Sciences, Portland Oregon. February 2023.

CFS. 2023b. 2022 Spring Chinook Salmon Spawning Surveys in Quartzville Creek 2023 Final Report. Prepared for: United States Army Corps of Engineers under Contract W9127N19D009. Prepared by: Cramer Fish Sciences, Portland Oregon. May 2023.

CFS. 2024. Bulk Marking and Reservoir Distribution Study Annual Report.

Dambacher, J.M. 1991. Distribution, Abundance, and Emigration of Juvenile Steelhead (*Oncorhynchus mykiss*), and Analysis of Stream Habitat in the Steamboat Creek Basin, Oregon.: Oregon State University.

Environmental Assessment Services. 2023. Willamette Valley Fish Passage Monitoring Via Rotary Screw Traps Bi-Annual Report, Spring 2023. Prepared for: United States Army Corps of Engineers under Contract W9127N19D0007. Prepared by: Dillon Alegre, Jason Phillips, and Rachel Ellison of Environmental Assessment Services, Richland Washington. August 2023.

Garletts, D. 2023. Personal Communications via email to Dillon Alegre. July 13, 2023.

Hair, J. F., Black, W. C., Babin, B. J., & Anderson, R. E. (2019). Multivariate Data Analysis (8th ed.). Cengage Learning.

Hansen, A.C., Kock, T.J., and Hansen, G.S., 2017, Synthesis of downstream fish passage information at projects owned by the US Army Corps of Engineers in the Willamette River Basin, Oregon: US Geological Survey Open File Report 2017-1101, 118 p., https://doi.org/10.3133/ofr20171101.

Keefer, M.L., Taylor, G.A., Garletts, D.F., Helms, C.K., Gauthier, G.A., Pierce, T M., and Caudill, C.C. 2012. Reservoir entrapment and dam passage mortality of juvenile Chinook salmon in the Middle Fork Willamette River. Ecology of Freshwater Fish 2012: 21: 222–234. DOI: 10.1111/j.1600-0633.2011.00540.x.

Keefer, M.L., Taylor, G.A., Garletts, D.F., Helms, C.K., Gauthier, G.A., Pierce, T.M., and Caudill, C.C. 2013. High-Head Dams Affect Downstream Fish Passage Timing and Survival in the Middle Fork Willamette River. River Research and Applications 29: 483–492. Published online 6 January 2012 in Wiley Online Library (wileyonlinelibrary.com) DOI: 10.1002/rra.1613.

Myers. J., Busack, C., Rawding, D., Marshall, A., Teel, D., Van Soornik, D.M. and Maher, M.T. 2006. Historical population of Pacific salmonids in the Willamette and lower Columbia River basins. Seattle, WA, USA: NMFS, NMFSWFSC-73.

Montgomery, D. C., Peck, E. A., & Vining, G. G. (2012). Introduction to Linear Regression Analysis (5th ed.). John Wiley & Sons.

Monzyk, F.R., Romer, J.D., Emig, R. and Friesen, T.A., 2011. Pilot head-of-reservoir juvenile salmonid monitoring. *Annual Report of Oregon Department of Fish and Wildlife (ODFW) to US Army Corps of Engineers, Portland, Oregon*.

Monzyk, F.R., Friesen, T.A. and Romer, J.D., 2015. Infection of juvenile salmonids by Salmincola californiensis (*Copepoda: Lernaeopodidae*) in reservoirs and streams of the Willamette River basin, Oregon. *Transactions of the American Fisheries Society*, *144*(5), pp.891-902.

Monzyk, F. and Romer, J.D., 2015, August. Juvenile Chinook Salmon Use of Reservoirs behind High-Head Dams in the Willamette River Basin, Oregon. In *145th Annual Meeting of the American Fisheries Society*. AFS.

NMFS (National Marine Fisheries Service) 2008a. Endangered Species Act Section 7 (a)(2) Consultation Biological Opinion and Magnuson- Stevens Fishery Conservation and Management Act Essential Fish Habitat Consultation: Consultation on Remand for Operation of the Federal Columbia River Power System, 11 Bureau of Reclamation Projects in the Columbia Basin and ESA Section 10(a)(1)(A) Permit for Juvenile Fish Transportation Program. Revised and reissued pursuant to court order NWF v. NMFS Civ. No. CV 01-640-RE (D. Oregon). NMFS Northwest Region, Portland, Oregon.

NMFS. 2008b 2008–2023 Willamette River Basin Project Biological Opinion. NOAA's National Marine Fisheries Service, Northwest Region, Seattle, WA. F/NWR/2000/02117.

Rayton, Michael D., and Wagner, P. 2006. "Field Manual: Okanogan Basin monitoring and evaluation program rotary screw trap protocols." *The Colville Confederated Tribes. Omak, WA* (2006).

Romer, J.D., 2010. Survival and behavior of juvenile steelhead trout (Oncorhynchus mykiss) in two small estuaries in Oregon.

Romer, J.D., Monzyk, F.R., Emig, R., and Friesen T.A. 2012. Juvenile salmonid outmigration monitoring at Willamette Valley Project reservoirs. 2011 Annual Report to US Army Corps of Engineers, Portland, Oregon. Task Order W9127N-10-2-0008-0006. Oregon Department of Fish and Wildlife, Corvallis, OR.

Romer, J.D., Monzyk, F.R., Emig, R., and Friesen, T.A. 2013. Juvenile salmonid outmigration monitoring at Willamette Valley Project reservoirs. 2012 Annual Report to US Army Corps of Engineers, Portland, Oregon. Task Order W9127N-10-2-0008-0010. Oregon Department of Fish and Wildlife, Corvallis, OR.

Romer, J.D., Monzyk, F.R., Emig, R., and Friesen, T.A. 2014. Juvenile Salmond Outmigration Monitoring at Willamette Valley Project Reservoirs. Prepared by Oregon Department of Fish and Wildlife, Willamette Research, Monitoring, and Evaluation Program for US Army Corps of Engineers, Portland District during 2013 with final report delivered August 2014; Contract W9127N-10-2-0008-0019.

Romer, J.D., Monzyk, F.R., Emig, R., and Friesen, T.A. 2015. Juvenile Salmond Outmigration Monitoring at Willamette Valley Project Reservoirs. Prepared by Oregon Department of Fish and Wildlife, Willamette Research, Monitoring, and Evaluation Program for US Army Corps of Engineers, Portland District during 2014 with final report delivered June 2015; Contract W9127N-10-2-0008-0026.

Romer, J.D., Monzyk, F.R., Emig, R., and Friesen, T.A. 2016. Juvenile Salmond Outmigration Monitoring at Willamette Valley Project Reservoirs. Prepared by Oregon Department of Fish and Wildlife, Willamette Research, Monitoring, and Evaluation Program for US Army Corps of Engineers, Portland District during 2015 with final report delivered June 2016; Contract W9127N-10-2-0008-0035.

Romer, J.D., Monzyk, F.R., Emig, R., and Friesen, T.A. 2017. Juvenile Salmond Outmigration Monitoring at Willamette Valley Project Reservoirs. Prepared by Oregon Department of Fish and Wildlife, Willamette Research, Monitoring, and Evaluation Program for US Army Corps of Engineers, Portland District during 2016 with final report delivered September 2017; Contract W9127N-10-2-0008-0035.

USACE (United States Army Corps of Engineers). 2022. Willamette Basin Bi-Annual Status Report August 29, 2022. Portland District, Portland Oregon.

Volkhardt, Gregory C., Johnson, Steven L., Miller, Bruce A., Nickelson, Thomas E., and Seiler, David E. 2007. “Rotary screw traps and inclined plane screen traps.” Salmonid field protocols handbook: techniques for assessing status and trends in salmon and trout populations. American Fisheries Society, Bethesda, Maryland 6, no. 8 (2007): 235-266.

Voss, Scott D. and Poytress, William R. 2020. “Brood year 2018 juvenile salmonid production and passage indices at the Red Bluff Diversion Dam.” Red Bluff, CA: US Fish and Wildlife Service (2020).

Whitman, L. 2023. Personal Communications via email to Dillon Alegre, July 14, 2023.

Appendix A – Locations of Rotary Screw Traps

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Appendix A: Locations of Rotary Screw Traps

Figures and Tables

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FIGURE A-1
Breitenbush River

RST Locations

500 Feet

N

EAS ENVIRONMENTAL ASSESSMENT SERVICES
Wholly Owned Subsidiary of Natives of Kodiak

FIGURE A-2
Detroit Head of Reservoir –
North Santiam River

RST Locations

500 Feet

N

EAS ENVIRONMENTAL ASSESSMENT SERVICES
Wholly Owned Subsidiary of Natives of Kodiak

FIGURE A-3
Big Cliff Dam Tailrace

RST Locations

500 Feet

N

EAS ENVIRONMENTAL ASSESSMENT SERVICES
Wholly Owned Subsidiary of Natives of Kodiak

FIGURE A-4
Green Peter Head of Reservoir – Middle Santiam River

RST Locations

500 Feet

EAS ENVIRONMENTAL ASSESSMENT SERVICES

Wholly Owned Subsidiary of Natives of Kodiak

FIGURE A-5
Green Peter Tailrace – Middle Santiam River

RST Locations

500 Feet

N

EAS ENVIRONMENTAL ASSESSMENT SERVICES
Wholly Owned Subsidiary of Natives of Kodiak

FIGURE A-6
Foster Dam Head of Reservoir – South Santiam River

RST Locations

500 Feet

N

EAS ENVIRONMENTAL ASSESSMENT SERVICES
Wholly Owned Subsidiary of Natives of Kodiak

FIGURE A-7
Cougar Dam Head of Reservoir

RST Locations

500 Feet

EAS ENVIRONMENTAL ASSESSMENT SERVICES
Wholly Owned Subsidiary of Natives of Kodiak

FIGURE A-8
Cougar Dam Tailrace

EAS ENVIRONMENTAL ASSESSMENT SERVICES
Wholly Owned Subsidiary of Natives of Kodiak

FIGURE A-9
Fall Creek Head of Reservoir

RST Locations

500 Feet

N

EAS ENVIRONMENTAL ASSESSMENT SERVICES
Wholly Owned Subsidiary of Natives of Kodiak

FIGURE A-10
Fall Creek Dam Tailrace

RST Locations

500 Feet

EAS ENVIRONMENTAL ASSESSMENT SERVICES
Wholly Owned Subsidiary of Natives of Kodiak

FIGURE A-11
Hills Creek Head of Reservoir – Middle Fork Willamette

RST Locations

500 Feet

N

EAS ENVIRONMENTAL ASSESSMENT SERVICES
Wholly Owned Subsidiary of Natives of Kodiak

FIGURE A-12
Hills Creek Dam Tailrace

RST Locations

500 Feet

N

EAS ENVIRONMENTAL ASSESSMENT SERVICES
Wholly Owned Subsidiary of Natives of Kodiak

FIGURE A-13
Lookout Point Head of Reservoir –
Middle Fork Willamette

RST Locations

500 Feet

N

EAS ENVIRONMENTAL ASSESSMENT SERVICES
Wholly Owned Subsidiary of Natives of Kodiak

FIGURE A-14
Lookout Dam Tailrace

RST Locations

500 Feet

N

EAS ENVIRONMENTAL ASSESSMENT SERVICES
Wholly Owned Subsidiary of Natives of Kodiak

FIGURE A-15
Dexter Dam Tailrace

RST location prior to 11/6/2023
RST location after 11/6/2023

Table A-1. RST locations at sampling sites for previous and current monitoring efforts

RST Location	Previous Monitoring Effort Location (lat. long.)	Historic RST Size (5ft or 8ft)	Current Monitoring Effort Location (lat. long.)	Current RST Size (5ft or 8ft)	Current TE Fish Release Location (lat. long.)
Breitenbush River	44.75168, -122.131006	One 5ft (2010–2013)	44.76769, -122.09685	One 5ft	44.76740, -122.09479
Big Cliff Dam Tailrace	44.75269, -122.28713	One 5ft (2014–2016)	44.75269, -122.28713	One 8ft	44.75150, -122.28368
Detroit Head of Reservoir-North Santiam	44.69251, -122.05029	One 5ft (2010–2016)	44.69251, -122.05029	One 5ft	44.69064, -122.04641
Green Peter Head of Reservoir-Middle Santiam River	N/A	N/A	44.51444, -122.37605	One 5ft	44.51551, -122.37138
Green Peter Dam Tailrace	N/A	N/A	44.44756, -122.55153	One 8ft	44.44917, -122.54941
Foster Head of Reservoir-South Santiam River	44.391496, -122.499065	One 5ft (2010–2016)	44.39085, -122.50114	One 5ft	44.39805, -122.48116
Cougar Head of Reservoir	44.048185, -122.217893	One 5ft (2010–2016)	44.048185, -122.217893	One 5ft	44.04723, -122.21779
Cougar Dam Tailrace	44.12871, -122.24396	PWR two 8ft, RO two 5ft (2011) PWR two 8ft, RO one 5ft (2012–2016)	44.12871, -122.24396	PWR two 8ft, RO one 5ft	44.13061, -122.24352 (Powerhouse) 44.13074, -122.24485 (RO)
Fall Creek Head of Reservoir	43.96467, -122.61917	One 8ft (2005–2008)	43.96467, -122.61917	One 8ft	43.96292, -122.61831
Fall Creek Dam Tailrace	43.945477, -122.760329	One 8ft (2006–2009, 2015–2016)	43.945477, -122.760329	One 8ft	43.94594, -122.75834
Hills Creek Head of Reservoir-Middle Fork Willamette River	43.60359, -122.45622	One 5ft	43.60359, -122.45622	One 5ft	43.60161, -122.45727
Hills Creek Dam Tailrace RO	43.71208, -122.42340	One 5ft	43.71304, -122.42497	One 5ft	43.71177, -122.42326
Hills Creek Dam Tailrace	43.71113, -122.42464	One 8ft (2003–2004)	43.71113, -122.42464	One 8ft	43.71071, -122.42394
Lookout Point Head of Reservoir-Middle Fork Willamette River	43.76669, -122.53139	One 8ft (2007–2008, 2010–2016)	43.76669, -122.53139	One 5ft	43.76481, -122.52903
Lookout Dam Tailrace	43.91442, -122.75658	One 8ft (2007–2008, 2011–2016) Two 8ft (2009–2010)	43.91442, -122.75658	Three 8ft[a]	43.91521, -122.75381 (PH) 43.91430, -122.75340 (Spill)

RST Location	Previous Monitoring Effort Location (lat. long.)	Historic RST Size (5ft or 8ft)	Current Monitoring Effort Location (lat. long.)	Current RST Size (5ft or 8ft)	Current TE Fish Release Location (lat. long.)
Dexter Dam Tailrace	43.92440, -122.80694	One 5ft (March 3, 2022, to November 6, 2023)	43.92527, -122.81147	One 5ft	43.92433, -122.80596 (PH) 43.92332, -122.80640 (Spill)

[a] PH traps were reoriented from a staggered orientation to a side-by-side orientation on September 5, 2023.

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Appendix B –
Sampling Outages by Site

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Appendix B: Sampling Outages by Site

Site	Date(s) of Trap Outage*	Reason for Outage
Fall Creek Dam Tailrace	1/1/2024–1/12/2024	The RST cone was raised to its non-sampling position due to increased sediment, logs, and debris. The RST attempted to fish multiple times over this time period, but silt was constantly covering the perf panel, and excessive amounts of mud were shoveled from within the cone.
Fall Creek Head of Reservoir	1/9/2024–1/22/2024	The RST cone was raised to its non-sampling position because the trap was physically submerged due to high flows. Although there was a large incoming winter storm, EAS personnel storm sampled the RST on multiple occasions, resulting in excessive amounts of debris accumulation.
Lookout Point Head of Reservoir	1/9/2024–1/11/2024	The RST cone was raised to its non-sampling position as it was observed to be full of large, woody debris by EAS personnel. Additionally, there was an incoming winter storm that had severely increased projections in flow.
Big Cliff Dam Tailrace Green Peter Head of Reservoir Green Peter Dam Tailrace Cougar Dam Tailrace Fall Creek Head of Reservoir Fall Creek Dam Tailrace Hills Creek Dam Tailrace Lookout Point Head of Reservoir Lookout Dam Tailrace Dexter Dam Tailrace	1/13/2024	The RST was not monitored and/or sampled due to a severe ice storm which resulted in the declaration of an Oregon State of Emergency. During this time, roads were inaccessible, power lines and trees were down, and travel was extremely unsafe given the conditions.
Big Cliff Dam Tailrace	1/14/2024	The RST was not monitored and/or sampled due to a severe ice storm which resulted in the declaration of an Oregon State of Emergency. During this time, roads were inaccessible, power lines and trees were down, and travel was extremely unsafe given the conditions. When EAS personnel observed the RST on 1/14/2024, it was fully covered in ice and was completely inaccessible.
Dexter Dam Tailrace	1/14/2024	The RST was not monitored and/or sampled due to a severe ice storm which resulted in the declaration of an Oregon State of Emergency. During this time, roads were inaccessible, power lines and trees were down, and travel was extremely unsafe given the conditions. EAS personnel observed the Dexter Dam RST on 1/14/2024 and left it fishing.
Lookout Point Head of Reservoir	1/14/2024	The RST was not monitored and/or sampled due to a severe ice storm which resulted in the declaration of an Oregon State of Emergency. During this time, roads were inaccessible, power lines and trees were down, and travel was extremely unsafe given the conditions. EAS personnel were unable to raise the LOPHOR RST due to excessive amounts of debris and a broken winch on the trap.
Green Peter Head of Reservoir Green Peter Dam Tailrace Cougar Dam Tailrace Fall Creek Head of Reservoir Fall Creek Dam Tailrace Hills Creek Dam Tailrace Lookout Dam Tailrace	1/14/2024	The RST was not monitored and/or sampled due to a severe ice storm which resulted in the declaration of an Oregon State of Emergency. During this time, roads were inaccessible, power lines and trees were down, and travel was extremely unsafe given the conditions.

Site	Date(s) of Trap Outage*	Reason for Outage
Green Peter Dam Tailrace	1/15/2024	The RST was observed from afar, but due to the severe ice storm, EAS personnel were unable to safely access the RST. Flows were high, ice covered rocks and kayaks, and EAS personnel did not feel safe kayaking to the trap. Furthermore, trees and power lines had fallen along the roads, making conditions unsafe.
Big Cliff Dam Tailrace Green Peter Head of Reservoir Green Peter Dam Tailrace Cougar Dam Tailrace Fall Creek Head of Reservoir Fall Creek Dam Tailrace Hills Creek Dam Tailrace Lookout Point Head of Reservoir Lookout Dam Tailrace Dexter Dam Tailrace	1/15/2024	The RST was not monitored and/or sampled due to a severe ice storm which resulted in the declaration of an Oregon State of Emergency. During this time, roads were inaccessible, power lines and trees were down, and travel was extremely unsafe given the conditions.
Big Cliff Dam Tailrace Green Peter Head of Reservoir Green Peter Dam Tailrace Cougar Dam Tailrace Fall Creek Head of Reservoir Fall Creek Dam Tailrace Hills Creek Dam Tailrace Lookout Point Head of Reservoir Lookout Dam Tailrace Dexter Dam Tailrace	1/16/2024	The RST was not monitored and/or sampled due to a severe ice storm which resulted in the declaration of an Oregon State of Emergency. During this time, roads were inaccessible, power lines and trees were down, and travel was extremely unsafe given the conditions.
Big Cliff Dam Tailrace	1/17/2024–2/9/2024	The RST was not monitored and/or sampled, and the cone was raised to its non-sampling position due to high flows resulting from localized flood evacuations.
Lookout Point Head of Reservoir	1/17/2024–2/7/2024	The RST cone was raised to its non-sampling position due to an increased amount of debris which resulted in damage to the RST winch and difficulties in raising and lowering the cone.
Cougar Dam Tailrace	1/19/2024–1/20/2024	The RST cone was grounded out due to low flow from the Powerhouse Channel and was, therefore, not operating and/or spinning.
Green Peter Dam Tailrace	1/19/2024–2/9/2024	The RST cone was raised to its non-sampling position due to elevated flows that had the potential to make sampling unsafe to fish and travel to the RST via kayak unsafe for EAS personnel.
Hills Creek Dam Tailrace	1/23/2024–2/6/2024	The RST cone was raised to its non-sampling position due to elevated flows subsequently increasing water levels to an unsafe height for EAS personnel.
Hills Creek Head of Reservoir	2/1/2024–2/2/2024	The RST cone was raised to its non-sampling position because the loop line auxiliary tree had severely sagged, and the ground was starting to give way. Initially, EAS personnel were unable to lower the cone due to tension from the tree and concerns of its foundational support. However, EAS personnel went back to the RST on 2/2/2024 and were able to consolidate cables and fish the trap safely.

Site	Date(s) of Trap Outage*	Reason for Outage
Lookout Dam Tailrace	2/1/2024–2/7/2024	The RST cone positioned in the Spill was raised to its non-sampling position due to severely increased flows. These flows exceeded the preset 10,000 cubic feet per second threshold, and in doing so, traps were safety checked from the shoreline to ensure there was no visible damage to cables and associated lines, while prioritizing EAS safety.
Lookout Dam Tailrace	2/1/2024–2/13/2024	The RST cones positioned in Powerhouse 1 and Powerhouse 2 flows were raised to their non-sampling position due to severely increased flows. These flows exceeded the preset 10,000 cubic feet per second threshold, and in doing so, traps were safety checked from the shoreline to ensure there was no visible damage to cables and associated lines, while prioritizing EAS safety.
Hills Creek Head of Reservoir	2/7/2024–2/8/2024	The RST cone was raised to its non-sampling position due to the loop line actively snapping on the trap. The cone was therefore raised for repairs and a new loop line was added.
Lookout Dam Tailrace	2/9/2024–2/13/2024	The RST cone positioned in the Spill was raised to its non-sampling position due to severely increased flows. These flows exceeded the preset 10,000 cubic feet per second threshold, and in doing so, traps were safety checked from the shoreline to ensure there was no visible damage to cables and associated lines, while prioritizing EAS safety.
Green Peter Dam Tailrace	2/12/2024–2/12/2024	The RST was not checked due to extremely high flows, making it difficult and unsafe for EAS personnel to monitor and/or sample the trap via kayak.
Lookout Point Head of Reservoir	2/12/2024–2/13/2024	The RST cone was raised to its non-sampling position due to necessary winch and collar repairs on the trap. Without these repairs being made, it could have caused potential safety issues to both fish and EAS personnel.
Breitenbush River	2/27/2024–3/2/2024	The RST cone was raised to its non-sampling position because of an incoming storm. The storm caused severe increases in expected flow and led to uncertainties surrounding travel and weather, potentially causing safety concerns to both EAS staff and fish being monitored.
Detroit Head of Reservoir	2/27/2024–3/3/2024	The RST cone was raised to its non-sampling position because of an incoming storm. The storm caused severe increases in expected flow and led to uncertainties surrounding travel and weather, potentially causing safety concerns to both EAS staff and fish being monitored.
Green Peter Head of Reservoir	2/27/2024–3/4/2024	The RST cone was raised to its non-sampling position because of an incoming storm. The storm caused severe increases in expected flow and led to uncertainties surrounding travel and weather, potentially causing safety concerns to both EAS staff and fish being monitored.
Foster Dam Head of Reservoir	2/27/2024–3/1/2024	The RST cone was raised to its non-sampling position because of an incoming storm. The storm caused severe increases in expected flow and led to uncertainties surrounding travel and weather, potentially causing safety concerns to both EAS staff and fish being monitored.
Fall Creek Head of Reservoir	2/28/2024–3/4/2024	The RST cone was raised to its non-sampling position because of an incoming storm. The storm caused severe increases in expected flow and led to uncertainties surrounding travel and weather, potentially causing safety concerns to both EAS staff and fish being monitored.

Site	Date(s) of Trap Outage*	Reason for Outage
Cougar Head of Reservoir	2/28/2024–3/3/2024	The RST cone was raised to its non-sampling position because of an incoming storm. The storm caused severe increases in expected flow and led to uncertainties surrounding travel and weather, potentially causing safety concerns to both EAS staff and fish being monitored.
Lookout Point Head of Reservoir	2/28/2024–3/1/2024	The RST cone was raised to its non-sampling position because of an incoming storm. The storm caused severe increases in expected flow and led to uncertainties surrounding travel and weather, potentially causing safety concerns to both EAS staff and fish being monitored.
Hills Creek Head of Reservoir	2/28/2024–3/4/2024	The RST cone was raised to its non-sampling position because of an incoming storm. The storm caused severe increases in expected flow and led to uncertainties surrounding travel and weather, potentially causing safety concerns to both EAS staff and fish being monitored.
Green Peter Dam Tailrace	2/29/2024–3/4/2024	The RST cone was raised to its non-sampling position because the Green Peter Dam Operator informed EAS staff of potential flows resulting from an incoming storm exceeding preset safety thresholds.
Detroit Head of Reservoir	3/2/2024–3/3/2024	The RST cone was raised to its non-sampling position because the foam collar sheared, and the RST was unable to operate safely and without additional mechanical damage.
Foster Dam Head of Reservoir	3/12/2024–3/13/2024	The RST cone was raised to its non-sampling position because of an incoming storm. The storm caused severe increases in expected flow and led to uncertainties surrounding travel and weather, potentially causing safety concerns to both EAS staff and fish being monitored.
Green Peter Dam Tailrace	3/13/2024–3/14/2024	The RST cone was raised to its non-sampling position because Spill flow had commenced and there was a subsequent flush of debris.
Hills Creek Head of Reservoir	3/11/2024–3/13/2024	The RST cone was raised to its non-sampling position because of an incoming storm. The storm caused severe increases in expected flow and led to uncertainties surrounding travel and weather, potentially causing safety concerns to both EAS staff and fish being monitored.
Green Peter Dam Tailrace	3/15/2024–3/19/2024	The RST cone was raised to its non-sampling position because Spill flow had commenced on 3/13/2024 and there was a subsequent flush of debris. The high levels of debris made operating and accessing the RST unsafe for both fish and EAS personnel.
Lookout Dam Tailrace	3/15/2024–3/20/2024	The RST cone of the Powerhouse 1 trap was raised to its non-sampling position due to high levels of debris. The heightened levels of debris made operating and accessing the RST unsafe for both fish and EAS personnel.
Lookout Dam Tailrace	3/15/2024–3/20/2024	The RST cone of the Powerhouse 2 trap was raised to its non-sampling position due to high levels of debris. The heightened levels of debris made operating and accessing the RST unsafe for both fish and EAS personnel.
Lookout Dam Tailrace	3/15/2024–3/20/2024	The RST cone of the Spill trap was raised to its non-sampling position due to high levels of debris. The heightened levels of debris made operating and accessing the RST unsafe for both fish and EAS personnel.
Lookout Dam Tailrace	3/29/2024–3/30/2024	The RST cone of the Powerhouse 1 trap was raised to its non-sampling position due to necessary repairs being made to ensure the traps operational capabilities related to catch and safety.

Site	Date(s) of Trap Outage*	Reason for Outage
Fall Creek Head of Reservoir	4/25/2024–4/28/2024	The RST cone was raised to its non-sampling position due to a flow spike which resulted in a high debris load.
Fall Creek Head of Reservoir	5/3/2024–5/9/2024	The RST cone was raised to its non-sampling position due to a flow spike which resulted in a high debris load.
Lookout Point Head of Reservoir	5/3/2024–5/8/2024	The RST cone was raised to its non-sampling position due to a flow spike which resulted in a high debris load.
Breitenbush River	5/9/2024–5/10/2024	The RST cone was raised to its non-sampling position due to a localized windstorm resulting in falling trees both upstream and within the immediate vicinity of the RST. This was a significant safety concern to EAS staff, fish, and the RST itself.
Big Cliff Dam Tailrace	5/9/2024–5/10/2024	The RST cone was raised to its non-sampling position due to excessive amounts of debris from a debris flush subsequent of Spill operations. Additionally, localized windstorms were causing trees to fall upstream of the RST and within its immediate vicinity.
Lookout Dam Tailrace	5/16/2024–5/18/2024	The RST cone of the Powerhouse 1 trap was raised to its non-sampling position because sealant was utilized to remove gaps (voids) between the RST panel and fins. The sealant needed to cure and dry for 24 hours.
Breitenbush River	6/2/2024–6/5/2024	The RST cone was raised to its non-sampling position because excessive rain and ongoing snowmelt was forecasted to cause increased flow events. These flow events have the potential to surpass preset safety thresholds, and/or cause localized debris flushes resulting in RST damage.
Detroit Head of Reservoir	6/2/2024–6/4/2024	The RST cone was raised to its non-sampling position because excessive rain and ongoing snowmelt was forecasted to cause increased flow events. These flow events have the potential to surpass preset safety thresholds, and/or cause localized debris flushes resulting in RST damage.
Green Peter Head of Reservoir	6/2/2024–6/4/2024	The RST cone was raised to its non-sampling position because excessive rain and ongoing snowmelt was forecasted to cause increased flow events. These flow events have the potential to surpass preset safety thresholds, and/or cause localized debris flushes resulting in RST damage.
Foster Dam Head of Reservoir	6/2/2024–6/4/2024	The RST cone was raised to its non-sampling position because excessive rain and ongoing snowmelt was forecasted to cause increased flow events. These flow events have the potential to surpass preset safety thresholds, and/or cause localized debris flushes resulting in RST damage.
Cougar Head of Reservoir	6/2/2024–6/4/2024	The RST cone was raised to its non-sampling position because excessive rain and ongoing snowmelt was forecasted to cause increased flow events. These flow events have the potential to surpass preset safety thresholds, and/or cause localized debris flushes resulting in RST damage.
Fall Creek head of Reservoir	6/2/2024–6/4/2024	The RST cone was raised to its non-sampling position because excessive rain and ongoing snowmelt was forecasted to cause increased flow events. These flow events have the potential to surpass preset safety thresholds, and/or cause localized debris flushes resulting in RST damage.
Lookout Point Head of Reservoir	6/2/2024–6/4/2024	The RST cone was raised to its non-sampling position because excessive rain and ongoing snowmelt was forecasted to cause increased flow events. These flow events have the potential to surpass preset safety thresholds, and/or cause localized debris flushes resulting in RST damage.

Site	Date(s) of Trap Outage*	Reason for Outage
Hills Creek Head of Reservoir	6/2/2024–6/4/2024	The RST cone was raised to its non-sampling position because excessive rain and ongoing snowmelt was forecasted to cause increased flow events. These flow events have the potential to surpass preset safety thresholds, and/or cause localized debris flushes resulting in RST damage.
Dexter Dam Tailrace	6/11/2024	The RST cone was not monitored and/or sampled due to miscommunication with EAS crew and personnel.
Fall Creek Dam Tailrace	6/11/2024	The RST cone was not monitored and/or sampled due to miscommunication with EAS crew and personnel.
Lookout Dam Tailrace	6/12/2024–6/13/2024	The RST cone of the Powerhouse 1 trap was raised to its non-sampling position because sealant was utilized to remove gaps (voids) between the RST panel and fins. The sealant needed to cure and dry for 24 hours.
Fall Creek Head of Reservoir	6/26/2024–6/30/2024	The RST cone was raised to its non-sampling position due to severely decreased flows leading to the RST grounding out. The cone was raised to prevent any damage. Additionally, the cone was raised due to issues with personnel residing at the Fall Creek Head of Reservoir access point and being disruptive.
Foster Dam Head of Reservoir	7/13/2024–7/23/2024	The RST was raised for surpassing permitted temperature thresholds.
Cougar Dam Powerhouse	7/20/2024–8/1/2024	The RSTs were raised to the non-sampling position due to a buildup of debris in the cone. This clogged the throat of the cone making it unsafe for fish passage.
Cougar Dam Powerhouse	8/2/2024–8/3/2024	The RSTs were raised to the non-sampling position due to a buildup of debris in the cone. This clogged the throat of the cone making it unsafe for fish passage.
Cougar Dam Powerhouse	8/6/2024–8/7/2024	The RSTs were raised to the non-sampling position due to a buildup of debris in the cone. This clogged the throat of the cone making it unsafe for fish passage.
Lookout Point Head of Reservoir	8/8/2024–8/13/2024	The RST was raised to the non-sampling position due to low flow in the Middle Fork Willamette. The cone was lowered again once Hills Creek Dam increased outflow, resulting in sufficient flow for fish passage.
Green Peter Dam Tailrace	8/12/2024–8/13/2024	The RST was raised to the non-sampling position due to initiation of spillway flow and a subsequent debris flush.
Green Peter Dam Tailrace	8/20/2024–8/21/2024	The RST was raised to the non-sampling position due to a debris flush.
Green Peter Dam Tailrace	8/25/2024–8/26/2024	The RST was raised to the non-sampling position for critical repairs.
Cougar Head of Reservoir	9/4/2024–9/11/2024	The RST was raised to the non-sampling position due to low flow resulting in unsafe fish conditions, as well as an excessive heat warning.
Foster Dam Head of Reservoir	9/7/2024–9/9/2024	The RST was raised to the non-sampling position due to low flow resulting in unsafe fish conditions, as well as an excessive heat warning.
Big Cliff Dam Tailrace	9/8/2024–9/9/2024	The RST was raised to the non-sampling position due to damage to the cone. The trap was repaired and resumed fishing the next day.
Cougar Dam Powerhouse	10/2/2024–10/15/2024	The RST was raised to the non-sampling position due to low flow in the Powerhouse channel.
Cougar Head of Reservoir	10/5/2024–10/7/2024	The RST was raised to the non-sampling position due to low flow and high debris.
Cougar Head of Reservoir	10/28/2024–10/29/2024	The RST was raised to the non-sampling position due to high debris causing unsafe fish conditions.
Breitenbush River	11/1/2024–11/2/2024	The RST was raised to the non-sampling position due to high debris and damage to the trap.
Cougar Head of Reservoir	11/2/2024–11/3/2024	The RST was raised to the non-sampling position due to high debris.

Site	Date(s) of Trap Outage*	Reason for Outage
Green Peter Dam Tailrace	11/11/2024–11/22/2024	The RST was raised to the non-sampling position due to high flow surpassing safety thresholds.
Breitenbush River	11/14/2024–11/16/2024	The RST was raised to the non-sampling position due to high debris and damage to the trap.
Breitenbush River	11/17/2024–11/18/2024	The RST was raised to the non-sampling position due to high flow and high debris in the livewell.
Detroit Head of Reservoir	11/17/2024–11/22/2024	The RST was raised to the non-sampling position due to high flow and high debris in the livewell.
Foster Dam Head of Reservoir	11/17/2024–11/23/2024	The RST was raised to the non-sampling position due to high flow and high debris in the livewell.
Lookout Point Head of Reservoir	11/17/2024–11/28/2024	The RST was raised to the non-sampling position due to high flow surpassing safety thresholds.
Green Peter Head of Reservoir	11/17/2024–11/22/2024	The RST was raised to the non-sampling position due to high flow and high debris in the livewell.
Fall Creek Dam Tailrace	11/17/2024–11/18/2024	The RST was not checked due to lack of daylight and crew safety. A visual inspection from shore was performed.
Cougar Head of Reservoir	11/18/2024–11/23/2024	The RST was raised to the non-sampling position due to high flow and high debris in the livewell.
Breitenbush River	11/18/2024–11/23/2024	The RST was raised to the non-sampling position due to high flow and high debris in the livewell.
Big Cliff Dam Tailrace	11/19/2024–11/28/2024	The RST was raised to the non-sampling position due to high flow surpassing safety thresholds.
Fall Creek Dam Tailrace	12/12/2024–12/13/2024	The RST was raised to the non-sampling position due to high flow and high debris causing damage to the cone.
Lookout Dam Tailrace	12/14/2024–12/15/2024	The RST was raised to the non-sampling position for cone repairs.
Lookout Point Head of Reservoir	12/18/2024–12/21/2024	The RST was raised to the non-sampling position due to high flow causing damage to the trap.
Big Cliff Dam Tailrace	12/31/2024–TBD	The RST was raised to the non-sampling position due to high flow surpassing safety thresholds.
Lookout Point Head of Reservoir	12/23/2024–TBD	The RST was raised to the non-sampling position due to high flow surpassing safety thresholds.

*The outages table detailed above is a comprehensive list of all sites sampled throughout the 2024 monitoring year. While the report does not include all the dates that are listed within the table above, all outages for 2024 are included to help better visualize survey effort and outages related to environmental variables. It includes every outage documented and the subsequent reason for it.

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Appendix C – PIT Tags and VIE Tagging

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Appendix C: PIT Tags and VIE Tagging

Sections

Figures and Tables

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VIE Mark

Figure C-1. Example of a VIE marked Chinook salmon. A green, fluorescent elastomer mark can be seen along the dorsal fin.

PIT Tags

Table C-1. PIT Tag metadata for fish tagged at RST sites.

Site	UDF	MRR Site/Release Site
Breitenbush River	BRT	BREITR
Detroit Head of Reservoir- North Santiam River	DTA	NSANTR
Big Cliff Dam Tailrace	BCL	BCLTAL
Green Peter Head of Reservoir – Middle Santiam River	GPA	MSANTR
Green Peter Dam Tailrace – Middle Santiam River	GPR	GPDTAL
Foster Head of Reservoir – South Santiam	SAN	SSANTR
Cougar Head of Reservoir	SMK	MCKESF
Cougar Dam Tailrace PWR	CGR	CGRTUR
Cougar Dam Tailrace RO	CGR	CGRREG
Fall Creek Head of Reservoir	FCA	FALL2C
Fall Creek Dam Tailrace	FCR	FALTAL
Hills Creek Head of Reservoir – Middle Fork Willamette River	HCA	WILRMF
Hills Creek Dam Tailrace	HCR	HCRTAL
Hills Creek Dam Tailrace PWR	HCR	HCRREG
Lookout Point Dam Head of Reservoir	LOA	WILRMF
Lookout Dam Tailrace PWR	LOP	LOPTUR
Lookout Dam Tailrace RO	LOP	LOPREG
Dexter Dam Tailrace	DEX	DEXTAL
Species	**SRR Code**	
Wild Spring Chinook	11W	
Hatchery Spring Chinook	11H	
Wild Winter Steelhead	34W	

Conditional Comments	
AI	Adipose intact
AD	Adipose clipped
RE	Recapture

Table C-2. Summary of Chinook and *O. mykiss* PIT tagged and VIE marked at RST sites in 2024.

Tagging Site	Species	Total PIT Tagged	Total VIE Marked
Breitenbush River	Chinook	244	2,363
	O. mykiss	95	39
Detroit Head of Reservoir- North Santiam	Chinook	572	20,391
	O. mykiss	58	66
Big Cliff Dam Tailrace	Chinook	332	0
	O. mykiss	8	4*
Green Peter Head of Reservoir –Middle Santiam	Chinook	6	601
	O. mykiss	23	0
Green Peter Dam Tailrace – Middle Santiam	Chinook	4	0
	O. mykiss	0	0
Foster Dam Head of Reservoir – South Santiam	Chinook	5	1
	O. mykiss	399	0
Cougar Head of Reservoir	Chinook	46	161
Cougar Dam Tailrace	Chinook	349	0
Fall Creek Head of Reservoir	Chinook	7	0
Fall Creek Dam Tailrace	Chinook	0	0
Hills Creek Head of Reservoir – Middle Fork Willamette	Chinook	45	2
Hills Creek Dam Tailrace	Chinook	7	0
Lookout Point Head of Reservoir – Middle Fork Willamette	Chinook	36	16
Lookout Dam Tailrace	Chinook	1	0
Dexter Dam Tailrace	Chinook	1	0

*Denotes incorrect protocol

Table C-3. List of downstream redetections for NOR fish PIT tagged at RST sites in 2024.

PIT Tag #	Mark Date	Mark Site	Recap Date	Travel Time	Recap Site
3DD.003BE9FBA2	04/20/2024	Big Cliff Dam Tailrace	08/14/2024	N/A	HANIS – Hanford Islands (Avian Colony)
3DD.003BE9FE40	04/24/2024	Big Cliff Dam Tailrace	08/14/2024	N/A	HANIS – Hanford Islands (Avian Colony)
3DD.003BE9FE5C	04/26/2024	Big Cliff Dam Tailrace	05/10/2024	14	TWX – Estuary Towed Array (Exp.)
3DD.003BE9F161	05/04/2024	Big Cliff Dam Tailrace	05/09/2024	5	PD7 – Columbia River Estuary rkm 70
3DD.003BEE0FF3	06/21/2023	Breitenbush River	01/01/2024	194	Big Cliff Dam
3DD.003BEE1AB2	09/13/2023	Breitenbush River	05/03/2024	233	Big Cliff Dam
3DD.003BD397FF	10/06/2023	Breitenbush River	04/17/2024	194	Big Cliff Dam
3DD.003BD397FC	10/06/2023	Breitenbush River	04/23/2024	200	Big Cliff Dam
3DD.003BEE1373	10/18/2023	Breitenbush River	05/07/2024	202	Big Cliff Dam
3DD.003E55A58E	03/25/2024	Breitenbush River	05/10/2024	46	TWX – Estuary Towed Array (Exp.)
3DD.003E5283EC	04/04/2024	Breitenbush River	05/02/2024	28	Big Cliff Dam
3DD.003BD224C5	11/04/2023	Cougar Dam Head of Reservoir	03/01/2024	118	Cougar Dam
3DD.003BD224ED	11/04/2023	Cougar Dam Head of Reservoir	10/28/2024	359	Cougar Dam
3DD.003BD224F7	11/05/2023	Cougar Dam Head of Reservoir	11/01/2024	362	Cougar Dam
3DD.003BEE1074	11/01/2023	Cougar Dam Tailrace	04/01/2024	178	PD6 – Columbia River Estuary rkm 68
3DD.003BEE13F6	11/01/2023	Cougar Dam Tailrace	04/05/2024	156	TWX – Estuary Towed Array (Exp.)
3DD.003BE9F60D	03/21/2024	Cougar Dam Tailrace	05/26/2024	66	TWX – Estuary Towed Array (Exp.)
3DD.003BEE1AA8	09/06/2023	Detroit Head of Reservoir	05/02/2024	239	PD5 – Columbia River Estuary rkm 62
3DD.003BD22603	11/02/2023	Detroit Head of Reservoir	06/08/2024	219	PD8 – Columbia River Estuary rkm 82
3DD.003BEE11EF	11/05/2023	Detroit Head of Reservoir	05/06/2024	183	Big Cliff Dam
3DD.003E5281B1	10/13/2024	Detroit Head of Reservoir	12/25/2024	74	Big Cliff Dam
3DD.003BE9F184	02/07/2024	Fall Creek Head of Reservoir	02/15/2024	8	Fall Creek Dam Tailrace
3DD.003BD395E4	06/21/2023	Foster Dam Head of Reservoir	05/06/2024	320	PD8 – Columbia River Estuary rkm 82
3DD.003BD22B76	10/12/2023	Foster Dam Head of Reservoir	04/25/2024	196	PD5 – Columbia River Estuary rkm 62
3DD.003BD22B47	10/12/2023	Foster Dam Head of Reservoir	09/17/2024	N/A	ASMEBR – Astoria-Megler Bridge (Avian Colony)

PIT Tag #	Mark Date	Mark Site	Recap Date	Travel Time	Recap Site
3DD.003BE9EF92	10/31/2024	Foster Dam Head of Reservoir	11/10/2024	10	LD2 – Lebanon Dam North Ladder
3DD.003BD22E41	03/05/2024	Lookout Point Head of Reservoir	05/22/2024	78	Lookout Dam Tailrace
3DD.003BD22E45	05/26/2024	Lookout Point Head of Reservoir	07/18/2024	53	Lookout Dam Tailrace

Table C-4. List of Bull Trout captured at RST sites in 2024.

Site	Date	Length (est. mm)	Tag(s)	Condition
Cougar Dam	2/4/2024	340	N/A	Injured
Cougar Dam Head of Reservoir	2/13/2024	75	N/A	Unharmed
Hills Creek Head of Reservoir	2/15/2024	271	EAS tagged: 132592690	Injured
Cougar Dam Head of Reservoir	3/29/2024	135	N/A	Unharmed
Cougar Dam Head of Reservoir	4/1/2024	115	N/A	Unharmed
Cougar Dam	4/4/2024	295	EAS tagged: 132589913	Injured
Cougar Dam Head of Reservoir	4/26/2024	160	N/A	Unharmed
Cougar Dam	5/3/2024	300	132589913	Injured
Cougar Dam Head of Reservoir	9/3/2024	495	EAS tagged: 132592644	Unharmed
Cougar Dam Head of Reservoir	9/23/2024	400	N/A	Unharmed
Cougar Dam Head of Reservoir	9/28/2024	450	N/A	Unharmed
Cougar Dam Head of Reservoir	10/1/2024	369	EAS tagged: 132592620	Unharmed
Cougar Dam Head of Reservoir	10/4/2024	500	384.3515E4B02 F	Unharmed

Table C-5. Summary of fish containing PIT tags encountered by EAS at RST sites in 2024.

Site	Trap	Species	# Fish Encountered*
Breitenbush River	5 ft	Chinook	25
Breitenbush River	5 ft	*O. mykiss*	9
Detroit Head of Reservoir – North Santiam	5 ft	Chinook	37
Detroit Head of Reservoir – North Santiam	5 ft	*O. mykiss*	0
Big Cliff Dam Tailrace	8 ft	Chinook	125
Big Cliff Dam Tailrace	8 ft	*O. mykiss*	1
Green Peter Head of Reservoir – Middle Santiam	5 ft	Chinook	52
Green Peter Head of Reservoir – Middle Santiam	5 ft	*O. mykiss*	1
Green Peter Tailrace	8 ft	Chinook	177
Green Peter Tailrace	8 ft	*O. mykiss*	0
Foster Dam Head of Reservoir – South Santiam	5 ft	Chinook	28
Foster Dam Head of Reservoir – South Santiam	5 ft	*O. mykiss*	14
Cougar Head of Reservoir	5 ft	Chinook	0
Cougar Dam Tailrace	PH	Chinook	98
Cougar Dam Tailrace	RO	Chinook	532
Fall Creek Head of Reservoir	8 ft	Chinook	0
Fall Creek Dam Tailrace	8 ft	Chinook	279
Hills Creek Head of Reservoir- Middle Fork Willamette	5 ft	Chinook	0
Hills Creek Dam Tailrace	RO	Chinook	39
Hills Creek Dam Tailrace	PH	Chinook	98
Lookout Point Head of Reservoir- Middle Fork Willamette	5 ft	Chinook	1
Lookout Dam Tailrace	Spill	Chinook	73
Lookout Dam Tailrace	PH	Chinook	150
Dexter Dam Tailrace	5 ft	Chinook	77

*Bull Trout, Radio Tagged, and Acoustic Tagged Chinook not included.

Table C-6. List of radio tagged Chinook captured at RST sites in 2024.

Site	Trap	PIT Tag Number	Date	Species
Green Peter Tailrace – Middle Santiam River	8 ft	3DD.003BD57AC1	03/29/2024	Chinook*
Green Peter Tailrace – Middle Santiam River	8 ft	3DD.003BD2BDC1	04/23/2024	Chinook*
Green Peter Tailrace – Middle Santiam River	8 ft	3DD.003BD2BC34	04/25/2024	Chinook*
Green Peter Tailrace – Middle Santiam River	8 ft	3DD.003BD2BD53	05/07/2024	Chinook*
Dexter Dam Tailrace	5 ft	3DD.003BD61B2D	10/03/2024	Chinook+
Dexter Dam Tailrace	5 ft	3DD.003BD61E8B	10/20/2024	Chinook+
Dexter Dam Tailrace	5 ft	3DD.003BD61E47	10/23/2024	Chinook+
Dexter Dam Tailrace	5 ft	3DD.003BD61CEA	10/29/2024	Chinook+
Dexter Dam Tailrace	5 ft	3DD.003BD61FC3	11/02/2024	Chinook+
Dexter Dam Tailrace	5 ft	3DD.003BD620E4	11/02/2024	Chinook+
Dexter Dam Tailrace	5 ft	3DD.003BD62098	11/03/2024	Chinook+
Dexter Dam Tailrace	5 ft	3DD.003BD620E0	11/04/2024	Chinook+
Dexter Dam Tailrace	5 ft	3DD.003BD61F7D	11/06/2024	Chinook+
Dexter Dam Tailrace	5 ft	3DD.003BD620B9	11/06/2024	Chinook+
Green Peter Tailrace – Middle Santiam River	8 ft	3DD.003BD57234	11/08/2024	Chinook*
Green Peter Tailrace – Middle Santiam River	8 ft	3DD.003BD2C545	11/08/2024	Chinook*
Green Peter Tailrace – Middle Santiam River	8 ft	3DD.003BD2C4CC	11/08/2024	Chinook*
Dexter Dam Tailrace	5 ft	3DD.003BD620BD	11/08/2024	Chinook+
Dexter Dam Tailrace	5 ft	3DD.003BD62076	11/08/2024	Chinook+
Green Peter Tailrace – Middle Santiam River	8 ft	3DD.003BD2C46D	11/09/2024	Chinook*
Dexter Dam Tailrace	5 ft	3DD.003BD620A2	11/13/2024	Chinook+
Green Peter Tailrace – Middle Santiam River	8 ft	3DD.003BD2C5E7	11/23/2024	Chinook*
Lookout Dam Tailrace	PH 1	3DD.003BD61FAE	11/23/2024	Chinook+
Dexter Dam Tailrace	5 ft	3DD.003BD61EDF	11/24/2024	Chinook+
Dexter Dam Tailrace	5 ft	3DD.003BD62218	11/24/2024	Chinook+
Dexter Dam Tailrace	5 ft	3DD.003BD62164	11/24/2024	Chinook+
Lookout Dam Tailrace	Spill	3DD.003BD622D3	11/25/2024	Chinook+
Dexter Dam Tailrace	5 ft	3DD.003BD6223C	11/27/2024	Chinook+
Green Peter Tailrace – Middle Santiam River	8 ft	3DD.003BD2BF74	12/05/2024	Chinook*

*Denotes fish encountered with both radio and PIT tags. These fish were tagged by PNNL for studies in Green Peter Reservoir. + Denotes fish encountered with both acoustic and PIT tags. These fish were tagged by the USGS for studies in the Middle Fork Willamette River.

Appendix D – Additional Injury Information

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Appendix D: Additional Injury Information

Tables

Table D-1. Big Cliff Dam Tailrace injuries for NOR Chinook, by size and by Biannual period.

	Spring Biannual period (Dec 1 - Jun 30)			Fall Biannual period (Jul 1 - Dec 31)		
Total Chinook (n=1436)*	**<60mm (n=5)**	**>=60mm and <=110mm (n=54)**	**>110mm (n=842)**	**<60mm (n=1)**	**>=60mm and <=110mm (n=29)**	**>110mm (n=505)**
Injury Code	**Injuries for (%) <60mm**	**Injuries (%) >=60mm and <=110mm**	**Injuries (%) >110mm**	**Injuries for (%) <60mm**	**Injuries (%) >=60mm and <=110mm**	**Injuries (%) >110mm**
NXI (no external injury)	60.0%	0.0%	0.1%	0.0%	0.0%	0.6%
MUNK	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
DS<2	0.0%	81.5%	74.1%	0.0%	79.3%	70.7%
DS>2	0.0%	16.7%	24.5%	100.0%	20.7%	24.8%
BLO	0.0%	0.0%	2.6%	100.0%	0.0%	1.8%
EYB	0.0%	5.6%	10.6%	100.0%	3.4%	6.3%
BVT	0.0%	3.7%	5.9%	100.0%	3.4%	4.4%
FVB	0.0%	14.8%	10.7%	100.0%	10.3%	12.1%
GBD	0.0%	0.0%	3.3%	0.0%	6.9%	10.3%
POP	20.0%	7.4%	2.4%	0.0%	3.4%	1.6%
HIN	40.0%	3.7%	12.5%	100.0%	13.8%	6.5%
OPD	20.0%	9.3%	20.8%	100.0%	10.3%	13.9%
TEA	20.0%	7.4%	4.0%	0.0%	6.9%	5.0%
BRU	20.0%	5.6%	15.4%	100.0%	17.2%	10.9%
HBP	0.0%	1.9%	1.1%	0.0%	0.0%	2.4%
HO	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
BO	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
HBO	0.0%	0.0%	0.2%	0.0%	0.0%	0.4%
FID	20.0%	79.6%	86.7%	0.0%	86.2%	77.6%
PRD	0.0%	0.0%	0.1%	0.0%	0.0%	0.2%
COP	0.0%	59.3%	85.4%	0.0%	41.4%	86.1%
BKD	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
FUN	0.0%	0.0%	2.5%	0.0%	3.4%	7.9%
Total (%) of captured fish with injuries	40.0%	100.0%	99.9%	100.0%	100.0%	99.4%
Average number of injuries per fish (non-NXI)	**2.0**	**3.0**	**3.6**	**8.0**	**3.1**	**3.4**

*22 NOR Chinook did not have fork lengths for Big Cliff Dam in 2024.

Table D-2. Green Peter Dam Tailrace injuries for NOR Chinook, by size and by Biannual period.

	Spring Biannual period (Dec 1 -Jun 30)			Fall Biannual period (Jul 1 - Dec 31)		
Total Chinook (n=246)*	**<60mm (n=2)**	**>=60mm and <=110mm (n=41)**	**>110mm (n=85)**	**<60mm (n=0)**	**>=60mm and <=110mm (n=1)**	**>110mm (n=118)**
Injury Code	**Injuries for (%) <60mm**	**Injuries (%) >=60mm and <=110mm**	**Injuries (%) >110mm**	**Injuries for (%) <60mm**	**Injuries (%) >=60mm and <=110mm**	**Injuries (%) >110mm**
NXI (no external injury)	50.0%	4.9%	0.0%	--	0.0%	0.0%
MUNK	0.0%	0.0%	0.0%	--	0.0%	0.0%
DS<2	0.0%	78.0%	51.2%	--	0.0%	68.6%
DS>2	0.0%	4.9%	48.8%	--	100.0%	30.5%
BLO	0.0%	0.0%	3.6%	--	0.0%	1.7%
EYB	0.0%	4.9%	23.8%	--	0.0%	9.3%
BVT	0.0%	2.4%	3.6%	--	0.0%	34.7%
FVB	0.0%	14.6%	47.6%	--	0.0%	61.9%
GBD	0.0%	29.3%	59.5%	--	0.0%	76.3%
POP	0.0%	0.0%	4.8%	--	0.0%	0.0%
HIN	0.0%	4.9%	25.0%	--	0.0%	11.0%
OPD	50.0%	14.6%	28.6%	--	0.0%	7.6%
TEA	0.0%	0.0%	8.3%	--	0.0%	0.8%
BRU	0.0%	9.8%	22.6%	--	0.0%	28.8%
HBP	0.0%	2.4%	1.2%	--	0.0%	0.0%
HO	0.0%	0.0%	0.0%	--	0.0%	0.0%
BO	0.0%	0.0%	0.0%	--	0.0%	0.0%
HBO	0.0%	0.0%	0.0%	--	0.0%	0.0%
FID	0.0%	73.2%	92.9%	--	0.0%	96.6%
PRD	0.0%	0.0%	0.0%	--	0.0%	0.0%
COP	0.0%	2.4%	6.0%	--	0.0%	85.6%
BKD	0.0%	0.0%	0.0%	--	0.0%	0.0%
FUN	0.0%	2.4%	4.8%	--	0.0%	7.6%
Total (%) of captured fish with injuries	50.0%	95.1%	100.0%	--	100.0%	100.0%
Average number of injuries per fish (non-NXI)	**1.0**	**2.5**	**4.3**	--	**1.0**	**5.2**

Table D-3. Cougar Dam Powerhouse route injuries for NOR Chinook, by size and by Biannual period.

	Spring Biannual period (Dec 1 - Jun 30)			Fall Biannual period (Jul 1 - Dec 31)		
Total Chinook (n=319)*	**<60mm (n=13)**	**>=60mm and <=110mm (n=140)**	**>110mm (n=148)**	**<60mm (n=0)**	**>=60mm and <=110mm (n=8)**	**>110mm (n=10)**
Injury Code	**Injuries for (%) <60mm**	**Injuries (%) >=60mm and <=110mm**	**Injuries (%) >110mm**	**Injuries for (%) <60mm**	**Injuries (%) >=60mm and <=110mm**	**Injuries (%) >110mm**
NXI (no external injury)	69.2%	4.3%	0.0%	--	0.0%	0.0%
MUNK	0.0%	0.0%	0.0%	--	0.0%	0.0%
DS<2	7.7%	84.3%	79.7%	--	87.5%	70.0%
DS>2	7.7%	5.0%	16.9%	--	12.5%	30.0%
BLO	0.0%	1.4%	1.4%	--	0.0%	0.0%
EYB	0.0%	2.9%	7.4%	--	0.0%	0.0%
BVT	0.0%	2.9%	2.7%	--	0.0%	10.0%
FVB	0.0%	6.4%	16.2%	--	0.0%	10.0%
GBD	0.0%	1.4%	6.1%	--	0.0%	10.0%
POP	7.7%	2.1%	1.4%	--	0.0%	0.0%
HIN	0.0%	2.1%	6.1%	--	0.0%	10.0%
OPD	7.7%	10.0%	20.3%	--	0.0%	20.0%
TEA	7.7%	10.7%	3.4%	--	0.0%	0.0%
BRU	0.0%	7.1%	8.8%	--	12.5%	10.0%
HBP	0.0%	0.0%	6.1%	--	0.0%	0.0%
HO	0.0%	0.0%	0.0%	--	0.0%	0.0%
BO	0.0%	0.0%	0.0%	--	0.0%	0.0%
HBO	0.0%	0.0%	0.7%	--	0.0%	0.0%
FID	23.1%	49.3%	77.0%	--	75.0%	80.0%
PRD	0.0%	0.0%	0.7%	--	0.0%	0.0%
COP	15.4%	49.3%	82.4%	--	12.5%	60.0%
BKD	0.0%	0.0%	0.0%	--	0.0%	0.0%
FUN	0.0%	3.6%	4.7%	--	0.0%	20.0%
Total (%) of captured fish with injuries	30.8%	95.7%	100.0%	--	100.0%	100.0%
Average number of injuries per fish (non-NXI)	**1.5**	**2.4**	**3.4**	--	**2.0**	**3.3**

*4 NOR Chinook did not have fork lengths for Cougar Dam Powerhouse Route in 2024.

Table D-4. Cougar Dam Regulatory Outlet route injuries for NOR Chinook, by size and by Biannual period.

	Spring Biannual period (Dec 1 -Jun 30)			Fall Biannual period (Jul 1 - Dec 31)		
Total Chinook (n=884)*	**<60mm (n=21)**	**>=60mm and <=110mm (n=332)**	**>110mm (n=472)**	**<60mm (n=0)**	**>=60mm and <=110mm (n=5)**	**>110mm (n=54)**
Injury Code	**Injuries for (%) <60mm**	**Injuries (%) >=60mm and <=110mm**	**Injuries (%) >110mm**	**Injuries for (%) <60mm**	**Injuries (%) >=60mm and <=110mm**	**Injuries (%) >110mm**
NXI (no external injury)	0.0%	0.6%	0.0%	--	0.0%	0.0%
MUNK	0.0%	0.0%	0.0%	--	0.0%	0.0%
DS<2	66.7%	74.4%	65.5%	--	80.0%	68.5%
DS>2	33.3%	23.5%	31.8%	--	0.0%	27.8%
BLO	0.0%	3.0%	1.9%	--	0.0%	1.9%
EYB	9.5%	21.4%	20.3%	--	0.0%	9.3%
BVT	0.0%	3.9%	3.4%	--	0.0%	11.1%
FVB	9.5%	9.6%	18.4%	--	0.0%	20.4%
GBD	23.8%	41.0%	53.6%	--	40.0%	51.9%
POP	9.5%	3.9%	3.6%	--	0.0%	0.0%
HIN	4.8%	8.4%	5.9%	--	0.0%	1.9%
OPD	14.3%	16.3%	24.4%	--	0.0%	22.2%
TEA	4.8%	3.3%	3.4%	--	0.0%	3.7%
BRU	0.0%	10.5%	10.2%	--	0.0%	13.0%
HBP	0.0%	2.1%	1.7%	--	0.0%	5.6%
HO	0.0%	0.0%	0.0%	--	0.0%	0.0%
BO	0.0%	0.0%	0.0%	--	0.0%	0.0%
HBO	4.8%	0.0%	0.0%	--	0.0%	0.0%
FID	100.0%	77.7%	85.2%	--	40.0%	79.6%
PRD	14.3%	0.3%	0.4%	--	0.0%	0.0%
COP	0.0%	43.7%	88.3%	--	60.0%	90.7%
BKD	0.0%	0.0%	0.0%	--	0.0%	0.0%
FUN	42.9%	7.5%	7.8%	--	0.0%	1.9%
Total (%) of captured fish with injuries	100.0%	99.4%	100.0%	--	100.0%	100.0%
Average number of injuries per fish (non-NXI)	**3.4**	**3.5**	**4.3**	--	**2.2**	**4.1**

Table D-5. Fall Creek Dam Tailrace injuries for NOR Chinook, by size and by Biannual period.

	Spring Biannual period (Dec 1 -Jun 30)			Fall Biannual period (Jul 1 - Dec 31)		
Total Chinook (n=14)	**<60mm (n=5)**	**>=60mm and <=110mm (n=55)**	**>110mm (n=9)**	**<60mm (n=)**	**>=60mm and <=110mm (n=)**	**>110mm (n=5)**
Injury Code	**Injuries for (%) <60mm**	**Injuries (%) >=60mm and <=110mm**	**Injuries (%) >110mm**	**Injuries for (%) <60mm**	**Injuries (%) >=60mm and <=110mm**	**Injuries (%) >110mm**
NXI (no external injury)	--	--	0.0%	--	--	0.0%
MUNK	--	--	0.0%	--	--	0.0%
DS<2	--	--	88.9%	--	--	60.0%
DS>2	--	--	11.1%	--	--	40.0%
BLO	--	--	0.0%	--	--	20.0%
EYB	--	--	11.1%	--	--	0.0%
BVT	--	--	0.0%	--	--	20.0%
FVB	--	--	11.1%	--	--	0.0%
GBD	--	--	0.0%	--	--	20.0%
POP	--	--	0.0%	--	--	0.0%
HIN	--	--	0.0%	--	--	0.0%
OPD	--	--	33.3%	--	--	0.0%
TEA	--	--	11.1%	--	--	20.0%
BRU	--	--	0.0%	--	--	40.0%
HBP	--	--	0.0%	--	--	0.0%
HO	--	--	0.0%	--	--	0.0%
BO	--	--	0.0%	--	--	0.0%
HBO	--	--	0.0%	--	--	0.0%
FID	--	--	66.7%	--	--	100.0%
PRD	--	--	0.0%	--	--	0.0%
COP	--	--	0.0%	--	--	100.0%
BKD	--	--	0.0%	--	--	0.0%
FUN	--	--	22.2%	--	--	0.0%
Total (%) of captured fish with injuries	--	--	100.0%	--	--	100.0%
Average number of injuries per fish (non-NXI)	--	--	**2.6**	--	--	**4.2**

Note: "---" stands for not applicable

Table D-6. Dexter Dam Tailrace injuries for NOR Chinook, by size and by Biannual period.

	Spring Biannual period (Dec 1 - Jun 30)			Fall Biannual period (Jul 1 - Dec 31)		
Total Chinook (n=35)	**<60mm (n=0)**	**>=60mm and <=110mm (n=7)**	**>110mm (n=21)**	**<60mm (n=0)**	**>=60mm and <=110mm (n=1)**	**>110mm (n=6)**
Injury Code	**Injuries for (%) <60mm**	**Injuries (%) >=60mm and <=110mm**	**Injuries (%) >110mm**	**Injuries for (%) <60mm**	**Injuries (%) >=60mm and <=110mm**	**Injuries (%) >110mm**
NXI (no external injury)	--	0.0%	4.8%	--	0.0%	16.7%
MUNK	--	0.0%	0.0%	--	0.0%	0.0%
DS<2	--	100.0%	71.4%	--	100.0%	66.7%
DS>2	--	0.0%	23.8%	--	0.0%	16.7%
BLO	--	0.0%	0.0%	--	0.0%	0.0%
EYB	--	0.0%	4.8%	--	0.0%	0.0%
BVT	--	0.0%	0.0%	--	0.0%	16.7%
FVB	--	0.0%	0.0%	--	0.0%	33.3%
GBD	--	14.3%	33.3%	--	100.0%	0.0%
POP	--	0.0%	0.0%	--	0.0%	0.0%
HIN	--	0.0%	9.5%	--	0.0%	0.0%
OPD	--	0.0%	9.5%	--	0.0%	0.0%
TEA	--	14.3%	0.0%	--	0.0%	16.7%
BRU	--	28.6%	0.0%	--	0.0%	33.3%
HBP	--	0.0%	0.0%	--	0.0%	0.0%
HO	--	0.0%	0.0%	--	0.0%	0.0%
BO	--	0.0%	0.0%	--	0.0%	0.0%
HBO	--	0.0%	0.0%	--	0.0%	0.0%
FID	--	85.7%	81.0%	--	0.0%	66.7%
PRD	--	0.0%	0.0%	--	0.0%	0.0%
COP	--	28.6%	28.6%	--	0.0%	33.3%
BKD	--	0.0%	0.0%	--	0.0%	0.0%
FUN	--	0.0%	4.8%	--	0.0%	0.0%
Total (%) of captured fish with injuries	--	100.0%	95.2%	--	100.0%	83.3%
Average number of injuries per fish (non-NXI)	**--**	**2.7**	**2.7**	**--**	**2.0**	**3.0**

Table D-7. Lookout Dam Tailrace (RO and PH) injuries for NOR Chinook, by size and by Biannual period.

	Spring Biannual period (Dec 1 -Jun 30)			Fall Biannual period (Jul 1 - Dec 31)		
Total Chinook (n=98)*	**<60mm (n=0)**	**>=60mm and <=110mm (n=35)**	**>110mm (n=51)**	**<60mm (n=1)**	**>=60mm and <=110mm (n=1)**	**>110mm (n=10)**
Injury Code	**Injuries for (%) <60mm**	**Injuries (%) >=60mm and <=110mm**	**Injuries (%) >110mm**	**Injuries for (%) <60mm**	**Injuries (%) >=60mm and <=110mm**	**Injuries (%) >110mm**
NXI (no external injury)	--	0.0%	0.0%	100.0%	0.0%	10.0%
MUNK	--	0.0%	0.0%	0.0%	0.0%	0.0%
DS<2	--	97.1%	82.4%	0.0%	100.0%	70.0%
DS>2	--	2.9%	15.7%	0.0%	0.0%	20.0%
BLO	--	0.0%	0.0%	0.0%	0.0%	0.0%
EYB	--	2.9%	0.0%	0.0%	0.0%	20.0%
BVT	--	2.9%	3.9%	0.0%	0.0%	0.0%
FVB	--	0.0%	11.8%	0.0%	0.0%	20.0%
GBD	--	11.4%	15.7%	0.0%	0.0%	40.0%
POP	--	0.0%	0.0%	0.0%	0.0%	0.0%
HIN	--	0.0%	9.8%	0.0%	0.0%	0.0%
OPD	--	5.7%	13.7%	0.0%	0.0%	20.0%
TEA	--	2.9%	2.0%	0.0%	0.0%	0.0%
BRU	--	5.7%	11.8%	0.0%	0.0%	10.0%
HBP	--	0.0%	0.0%	0.0%	0.0%	0.0%
HO	--	0.0%	0.0%	0.0%	0.0%	0.0%
BO	--	0.0%	0.0%	0.0%	0.0%	0.0%
HBO	--	0.0%	0.0%	0.0%	0.0%	0.0%
FID	--	65.7%	80.4%	0.0%	0.0%	90.0%
PRD	--	0.0%	2.0%	0.0%	0.0%	0.0%
COP	--	2.9%	33.3%	0.0%	0.0%	60.0%
BKD	--	0.0%	0.0%	0.0%	0.0%	0.0%
FUN	--	5.7%	3.9%	0.0%	0.0%	20.0%
Total (%) of captured fish with injuries	--	100.0%	100.0%	0.0%	100.0%	90.0%
Average number of injuries per fish (non-NXI)	**--**	**2.1**	**2.9**	**1.0**	**1.0**	**3.8**

*1 NOR Chinook did not have fork lengths for Lookout Dam Tailrace in 2024.

Table D-8. Hills Creek Dam Powerhouse route injuries for NOR Chinook, by size and by Biannual period.

	Spring Biannual period (Dec 1 -Jun 30)			Fall Biannual period (Jul 1 - Dec 31)		
Total Chinook (n=146)*	**<60mm (n=0)**	**>=60mm and <=110mm (n=4)**	**>110mm (n=31)**	**<60mm (n=)**	**>=60mm and <=110mm (n=1)**	**>110mm (n=110)**
Injury Code	**Injuries for (%) <60mm**	**Injuries (%) >=60mm and <=110mm**	**Injuries (%) >110mm**	**Injuries for (%) <60mm**	**Injuries (%) >=60mm and <=110mm**	**Injuries (%) >110mm**
NXI (no external injury)	--	25.0%	0.0%	--	0.0%	0.0%
MUNK	--	0.0%	0.0%	--	0.0%	0.0%
DS<2	--	75.0%	54.8%	--	100.0%	32.7%
DS>2	--	0.0%	45.2%	--	0.0%	67.3%
BLO	--	0.0%	3.2%	--	0.0%	4.5%
EYB	--	0.0%	32.3%	--	0.0%	19.1%
BVT	--	0.0%	6.5%	--	0.0%	58.2%
FVB	--	0.0%	25.8%	--	0.0%	31.8%
GBD	--	0.0%	3.2%	--	0.0%	12.7%
POP	--	0.0%	0.0%	--	0.0%	1.8%
HIN	--	0.0%	16.1%	--	0.0%	19.1%
OPD	--	0.0%	9.7%	--	0.0%	26.4%
TEA	--	0.0%	3.2%	--	0.0%	5.5%
BRU	--	0.0%	19.4%	--	100.0%	30.0%
HBP	--	0.0%	0.0%	--	0.0%	10.0%
HO	--	0.0%	0.0%	--	0.0%	0.0%
BO	--	0.0%	0.0%	--	0.0%	0.0%
HBO	--	0.0%	0.0%	--	0.0%	1.8%
FID	--	75.0%	96.8%	--	100.0%	99.1%
PRD	--	0.0%	0.0%	--	0.0%	0.0%
COP	--	0.0%	100.0%	--	100.0%	100.0%
BKD	--	0.0%	0.0%	--	0.0%	0.0%
FUN	--	0.0%	6.5%	--	0.0%	8.2%
Total (%) of captured fish with injuries	--	75.0%	100.0%	--	100.0%	100.0%
Average number of injuries per fish (non-NXI)	**--**	**1.8**	**4.2**	**--**	**4.0**	**5.3**

Note: "---" stands for not applicable. *8 NOR Chinook did not have fork lengths for Hills Creek Powerhouse route in 2024.

Table D-9. Hills Creek Dam Regulatory Outlet route injuries for NOR Chinook, by size and by Biannual period.

	Spring Biannual period (Dec 1 -Jun 30)			Fall Biannual period (Jul 1 - Dec 31)		
Total Chinook (n=84)*	**<60mm (n=0)**	**>=60mm and <=110mm (n=3)**	**>110mm (n=21)**	**<60mm (n=0)**	**>=60mm and <=110mm (n=0)**	**>110mm (n=60)**
Injury Code	**Injuries for (%) <60mm**	**Injuries (%) >=60mm and <=110mm**	**Injuries (%) >110mm**	**Injuries for (%) <60mm**	**Injuries (%) >=60mm and <=110mm**	**Injuries (%) >110mm**
NXI (no external injury)	--	0.0%	0.0%	--	--	0.0%
MUNK	--	0.0%	0.0%	--	--	0.0%
DS<2	--	100.0%	57.1%	--	--	25.0%
DS>2	--	0.0%	38.1%	--	--	75.0%
BLO	--	0.0%	4.8%	--	--	13.3%
EYB	--	33.3%	19.0%	--	--	21.7%
BVT	--	0.0%	4.8%	--	--	71.7%
FVB	--	0.0%	38.1%	--	--	36.7%
GBD	--	33.3%	0.0%	--	--	16.7%
POP	--	0.0%	4.8%	--	--	8.3%
HIN	--	0.0%	14.3%	--	--	20.0%
OPD	--	0.0%	23.8%	--	--	35.0%
TEA	--	0.0%	4.8%	--	--	5.0%
BRU	--	33.3%	9.5%	--	--	43.3%
HBP	--	0.0%	4.8%	--	--	8.3%
HO	--	0.0%	0.0%	--	--	0.0%
BO	--	0.0%	0.0%	--	--	0.0%
HBO	--	0.0%	0.0%	--	--	1.7%
FID	--	100.0%	100.0%	--	--	96.7%
PRD	--	0.0%	0.0%	--	--	0.0%
COP	--	0.0%	85.7%	--	--	100.0%
BKD	--	0.0%	0.0%	--	--	0.0%
FUN	--	0.0%	9.5%	--	--	3.3%
Total (%) of captured fish with injuries	--	100.0%	100.0%	--	--	100.0%
Average number of injuries per fish (non-NXI)	**--**	**3.0**	**4.2**	**--**	**--**	**5.8**

Note: "---" stands for not applicable. *4 NOR Chinook did not have fork lengths for Hills Creek Regulatory Outlet route in 2024.

Table D-10. Injury rates of hatchery Trapping Efficiency pre-release and after capture for

Injury Code	Breitenbush		Detroit HOR		Green Peter HOR		Foster HOR	
	Pre-release Injury (%) (n=550)	Recapture Injury (%) (n=489)	Pre-release Injury (%) (n=500)	Recapture Injury (%) (n=562)	Pre-release Injury (%) (n=550)	Recapture Injury (%) (n=107)	Pre-release Injury (%) (n=500)	Recapture Injury (%) (n=153)
NXI (no external injury)	35.1%	3.3%	34.6%	13.2%	2.9%	35.5%	2.2%	0.0%
MUNK	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
DS<2	4.4%	80.2%	4.6%	70.1%	92.7%	38.3%	6.0%	97.4%
DS>2	52.2%	9.8%	50.8%	9.8%	3.8%	3.7%	91.0%	2.0%
BLO	0.2%	0.0%	0.2%	1.1%	0.0%	0.0%	0.0%	0.0%
EYB	0.0%	0.4%	0.0%	0.4%	0.2%	0.0%	0.0%	3.3%
BVT	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
FVB	0.0%	0.8%	0.0%	0.0%	0.0%	2.8%	0.6%	1.3%
GBD	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.7%
POP	0.0%	0.4%	0.0%	0.2%	0.4%	0.0%	0.2%	1.3%
HIN	0.0%	1.0%	0.0%	1.4%	0.0%	0.9%	0.0%	0.7%
OPD	0.9%	6.5%	0.8%	3.2%	1.3%	5.6%	0.6%	11.1%
TEA	0.0%	0.4%	0.0%	0.2%	0.0%	0.0%	0.0%	1.3%
BRU	0.0%	0.8%	0.2%	1.8%	2.2%	2.8%	1.0%	0.7%
HBP	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
HO	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
BO	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
HBO	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
FID	56.4%	90.2%	57.0%	85.1%	76.7%	50.5%	79.0%	89.5%
PRD	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
COP	0.0%	0.0%	0.0%	0.4%	0.0%	0.0%	0.0%	0.0%
BKD	0.2%	0.0%	0.2%	0.0%	0.0%	0.0%	0.0%	0.0%
FUN	0.0%	15.3%	0.0%	10.5%	1.3%	0.0%	1.6%	0.0%
Total (%) of captured fish with injuries	**64.9%**	**96.7%**	**65.4%**	**86.8%**	**97.1%**	**64.5%**	**97.8%**	**100.0%**
Average number of injuries per fish (non-NXI)	**1.8**	**2.1**	**1.7**	**2.1**	**1.8**	**1.6**	**1.8**	**2.1**

Table D-11. Injury rates of hatchery Trapping Efficiency pre-release and after capture for Cougar

Injury Code	Cougar HOR		Fall Creek HOR		Lookout HOR		Hills Creek HOR	
	Pre-release Injury (%) (n=400)	Recapture Injury (%) (n=241)	Pre-release Injury (%) (n=400)	Recapture Injury (%) (n=857)	Pre-release Injury (%) (n=450)	Recapture Injury (%) (n=101)	Pre-release Injury (%) (n=350)	Recapture Injury (%) (n=93)
NXI (no external injury)	0.5%	9.1%	3.5%	1.2%	9.8%	2.0%	8.0%	0.0%
MUNK	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
DS<2	82.3%	80.5%	11.3%	81.2%	7.3%	86.1%	78.6%	82.8%
DS>2	4.3%	5.8%	83.0%	14.6%	79.1%	10.9%	12.6%	14.0%
BLO	0.0%	0.0%	1.5%	0.0%	0.0%	0.0%	0.0%	1.1%
EYB	0.0%	0.0%	0.5%	0.6%	0.7%	0.0%	0.0%	0.0%
BVT	0.0%	0.0%	0.0%	0.0%	0.2%	0.0%	0.0%	0.0%
FVB	0.3%	0.0%	0.3%	0.1%	1.1%	1.0%	0.3%	0.0%
GBD	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
POP	0.0%	0.4%	0.0%	0.0%	0.2%	0.0%	0.0%	0.0%
HIN	0.0%	1.2%	0.0%	0.0%	0.2%	0.0%	0.0%	0.0%
OPD	1.3%	11.2%	0.5%	2.7%	1.1%	3.0%	1.4%	2.2%
TEA	0.3%	0.0%	0.0%	0.1%	0.2%	1.0%	0.9%	0.0%
BRU	0.5%	3.3%	0.3%	2.1%	0.4%	0.0%	0.9%	1.1%
HBP	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
HO	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
BO	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
HBO	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
FID	84.0%	82.6%	88.3%	92.4%	89.3%	63.4%	85.4%	64.5%
PRD	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
COP	0.3%	0.4%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
BKD	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
FUN	2.5%	3.7%	4.0%	3.7%	3.8%	2.0%	4.0%	1.1%
Total (%) of captured fish with injuries	**99.5%**	**90.9%**	**96.5%**	**98.8%**	**90.2%**	**98.0%**	**92.0%**	**100.0%**
Average number of injuries per fish (non-NXI)	**1.8**	**2.1**	**2.0**	**2.0**	**2.0**	**1.7**	**2.0**	**1.7**

Table D-12. Injury rates of hatchery Trapping Efficiency pre-release and after capture for Big Cliff

Injury Code	Big Cliff Dam		Green Peter Dam		Cougar Dam Powerhouse		Cougar Dam Regulatory Outlet	
	Pre-release Injury (%) (n=650)	Recapture Injury (%) (n=436)	Pre-release Injury (%) (n=750)	Recapture Injury (%) (n=105)	Pre-release Injury (%) (n=350)	Recapture Injury (%) (n=413)	Pre-release Injury (%) (n=300)	Recapture Injury (%) (n=173)
NXI (no external injury)	24.0%	3.2%	1.7%	1.0%	0.3%	2.7%	0.7%	0.0%
MUNK	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
DS<2	57.7%	71.6%	90.4%	88.6%	91.1%	78.9%	93.0%	85.0%
DS>2	6.8%	21.8%	6.9%	31.4%	8.6%	8.0%	5.7%	15.0%
BLO	0.2%	0.0%	0.0%	0.0%	0.0%	1.0%	0.0%	4.0%
EYB	0.0%	2.8%	0.1%	1.9%	0.0%	1.2%	0.0%	2.3%
BVT	0.0%	0.2%	0.1%	1.0%	0.0%	0.2%	0.0%	0.0%
FVB	0.0%	0.5%	0.0%	1.9%	0.3%	0.7%	0.3%	0.6%
GBD	0.0%	3.2%	0.0%	18.1%	0.0%	1.7%	0.0%	9.8%
POP	0.3%	0.5%	0.1%	0.0%	0.3%	0.5%	0.0%	3.5%
HIN	0.0%	2.1%	0.0%	1.0%	0.3%	1.5%	0.0%	2.9%
OPD	0.9%	9.6%	1.9%	13.3%	2.6%	5.6%	1.0%	9.2%
TEA	0.0%	0.0%	0.3%	0.0%	0.3%	1.7%	0.3%	4.0%
BRU	0.2%	2.1%	2.0%	3.8%	1.4%	1.0%	0.3%	0.0%
HBP	0.0%	0.0%	0.0%	0.0%	0.0%	0.2%	0.0%	0.6%
HO	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
BO	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	1.2%
HBO	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
FID	64.9%	95.6%	81.1%	63.8%	94.9%	83.5%	97.0%	100.0%
PRD	0.0%	0.0%	0.0%	0.0%	0.0%	0.5%	0.0%	2.3%
COP	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.3%	1.7%
BKD	0.2%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
FUN	0.0%	1.4%	1.5%	6.7%	0.9%	9.2%	2.3%	6.4%
Total (%) of captured fish with injuries	**76.0%**	**96.8%**	**98.3%**	**99.0%**	**99.7%**	**97.3%**	**99.3%**	**100.0%**
Average number of injuries per fish (non-NXI)	**1.7**	**2.2**	**1.9**	**2.3**	**2.0**	**2.0**	**2.0**	**2.5**

Table D-13. Injury rates of hatchery Trapping Efficiency pre-release and after capture for Hills

Injury Code	Hills Creek Dam Powerhouse		Hills Creek Dam Regulatory Outlet		Fall Creek Dam		Dexter Dam	
	Pre-release Injury (%) (n=250)	Recapture Injury (%) (n=163)	Pre-release Injury (%) (n=50)	Recapture Injury (%) (n=17)	Pre-release Injury (%) (n=250)	Recapture Injury (%) (n=74)	Pre-release Injury (%) (n=300)	Recapture Injury (%) (n=79)
NXI (no external injury)	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
MUNK	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
DS<2	78.8%	77.9%	100.0%	88.2%	83.2%	86.5%	88.3%	66.7%
DS>2	18.4%	22.1%	0.0%	11.8%	16.4%	13.5%	11.7%	33.3%
BLO	0.4%	0.6%	0.0%	0.0%	0.0%	1.4%	0.0%	0.0%
EYB	0.8%	0.6%	0.0%	0.0%	2.0%	2.7%	0.3%	9.5%
BVT	0.0%	0.0%	0.0%	0.0%	0.0%	1.4%	0.0%	0.0%
FVB	0.4%	0.0%	4.0%	0.0%	0.4%	0.0%	1.3%	9.5%
GBD	0.0%	0.0%	0.0%	0.0%	0.0%	6.8%	0.0%	23.8%
POP	0.4%	0.6%	0.0%	0.0%	0.4%	0.0%	0.0%	9.5%
HIN	0.4%	0.0%	0.0%	0.0%	0.0%	4.1%	0.0%	4.8%
OPD	0.0%	4.9%	2.0%	17.6%	0.0%	4.1%	0.0%	14.3%
TEA	0.0%	1.2%	0.0%	0.0%	0.4%	0.0%	0.0%	4.8%
BRU	0.4%	0.0%	0.0%	0.0%	0.4%	2.7%	1.0%	0.0%
HBP	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
HO	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
BO	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
HBO	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	4.8%
FID	99.2%	98.8%	100.0%	94.1%	98.4%	100.0%	99.7%	100.0%
PRD	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	14.3%
COP	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
BKD	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
FUN	9.2%	1.8%	2.0%	23.5%	8.0%	1.4%	5.0%	42.9%
Total (%) of captured fish with injuries	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Average number of injuries per fish (non-NXI)	2.1	2.1	2.1	2.4	2.1	2.2	2.1	2.1

Table D-14. Injury rates of hatchery Trapping Efficiency pre-release and after capture for Lookout Dam.

Injury Code	Lookout Dam	
	Pre-release Injury (%) (n=300)	Recapture Injury (%) (n=21)
NXI (no external injury)	0.0%	0.0%
MUNK	0.0%	0.0%
DS<2	84.7%	66.7%
DS>2	15.3%	33.3%
BLO	0.0%	0.0%
EYB	0.0%	9.5%
BVT	0.0%	0.0%
FVB	0.0%	9.5%
GBD	0.0%	23.8%
POP	0.0%	9.5%
HIN	0.0%	4.8%
OPD	0.7%	14.3%
TEA	0.0%	4.8%
BRU	0.3%	0.0%
HBP	0.0%	0.0%
HO	0.0%	0.0%
BO	0.0%	0.0%
HBO	0.0%	4.8%
FID	100.0%	100.0%
PRD	0.0%	14.3%
COP	0.0%	0.0%
BKD	0.0%	0.0%
FUN	3.7%	42.9%
Total (%) of captured fish with injuries	**100.0%**	**100.0%**
Average number of injuries per fish (non-NXI)	**2.0**	**3.4**

Table D-15. Injury rates by year on NOR Chinook captured in the Big Cliff Dam Tailrace RST by injury type. Barotrauma injuries include Chinook with BLO, EYB, BVT, FVB, GBD, or POP injury codes. Mechanical injuries include Chinook with HIN, OPD, TEA, BRU, HBP, DS>2, HO, BO, and HBO injury codes. Other injuries include Chinook with FID, PRD, COP, BKD, and FUN injury codes. Mortalities represent all Chinook found dead in the RST at time of trap check.

Year	Site	Trap Location	NOR Chinook Assessed for Injury	Barotrauma Injuries	Mechanical Injuries	Other Injuries	Mortalities
2024	Big Cliff Dam	Tailrace	1,472	26.8%	45.4%	96.1%	13.6%
2023	Big Cliff Dam	Tailrace	704	18.8%	35.9%	80.0%	7.4%
2022	Big Cliff Dam	Tailrace	1,234	18.5%	38.5%	88.4%	12.6%
2021	Big Cliff Dam	Tailrace	611	4.6%	14.4%	82.2%	6.5%

Data represents all fish captured in the RST for the entire year except for 2024 which only includes data from January 1st to June 30th.

Table D-16. Injury rates by year on NOR Chinook captured in the Green Peter Dam Tailrace RST by injury type. Barotrauma injuries include Chinook with BLO, EYB, BVT, FVB, GBD, or POP injury codes. Mechanical injuries include Chinook with HIN, OPD, TEA, BRU, HBP, DS>2, HO, BO, and HBO injury codes. Other injuries include Chinook with FID, PRD, COP, BKD, and FUN injury codes. Mortalities represent all Chinook found dead in the RST at time of trap check.

Year	Site	Trap Location	NOR Chinook Assessed for Injury	Barotrauma Injuries	Mechanical Injuries	Other Injuries	Mortalities
2024	Green Peter Dam	Tailrace	247	81.0%	53.4%	92.3%	34.0%
2023	Green Peter Dam	Tailrace	107	49.5%	37.4%	67.3%	19.6%

Data represents all fish captured in the RST for the entire year except for 2024 which only includes data from January 1st to June 30th.

Table D-17. Injury rates by year on NOR Chinook captured in the Cougar Dam Tailrace RSTs by injury type. Barotrauma injuries include Chinook with BLO, EYB, BVT, FVB, GBD, or POP injury codes. Mechanical injuries include Chinook with HIN, OPD, TEA, BRU, HBP, DS>2, HO, BO, and HBO injury codes. Other injuries include Chinook with FID, PRD, COP, BKD, and FUN injury codes. Mortalities represent all Chinook found dead in the RST at time of trap check.

Year	Site	Trap Location	NOR Chinook Assessed for Injury	Barotrauma Injuries	Mechanical Injuries	Other Injuries	Mortalities
2024	Cougar Dam	Powerhouse	323	19.2%	33.1%	80.5%	10.5%
2024	Cougar Dam	RO	885	66.1%	46.4%	91.6%	16.3%
2023	Cougar Dam	Powerhouse	427	14.8%	23.2%	78.5%	11.2%
2023	Cougar Dam	RO	5273	47.0%	38.8%	97.9%	9.5%
2022	Cougar Dam	Powerhouse	1178	10.1%	16.1%	86.7%	9.8%
2022	Cougar Dam	RO	1776	40.8%	43.0%	95.4%	17.7%
2021	Cougar Dam	Powerhouse	361	1.1%	5.5%	45.7%	1.7%
2021	Cougar Dam	RO	2889	5.8%	33.2%	80.9%	8.7%

Data represents all fish captured in the RST for the entire year except for 2024 which only includes data from January 1st to June 30th.

Table D-18. Injury rates by year on NOR Chinook captured in the Fall Creek Dam Tailrace RST by injury type. Barotrauma injuries include Chinook with BLO, EYB, BVT, FVB, GBD, or POP injury codes. Mechanical injuries include Chinook with HIN, OPD, TEA, BRU, HBP, DS>2, HO, BO, and HBO injury codes. Other injuries include Chinook with FID, PRD, COP, BKD, and FUN injury codes. Mortalities represent all Chinook found dead in the RST at time of trap check.

Year	Site	Trap Location	NOR Chinook Assessed for Injury	Barotrauma Injuries	Mechanical Injuries	Other Injuries	Mortalities
2024	Fall Creek Dam	RO	14	28.6%	50.0%	92.9%	21.4%
2023	Fall Creek Dam	RO	150	22.7%	42.7%	60.7%	21.3%
2022	Fall Creek Dam	RO	1	0.0%	100.0%	100.0%	0.0%

Data represents all fish captured in the RST for the entire year except for 2024 which only includes data from January 1st to June 30th.

Table D-19. Injury rates by year on NOR Chinook captured in the Hills Creek Dam Tailrace RSTs by injury type. Barotrauma injuries include Chinook with BLO, EYB, BVT, FVB, GBD, or POP injury codes. Mechanical injuries include Chinook with HIN, OPD, TEA, BRU, HBP, DS>2, HO, BO, and HBO injury codes. Other injuries include Chinook with FID, PRD, COP, BKD, and FUN injury codes. Mortalities represent all Chinook found dead in the RST at time of trap check.

Year	Site	Trap Location	NOR Chinook Assessed for Injury	Barotrauma Injuries	Mechanical Injuries	Other Injuries	Mortalities
2024	Hills Creek Dam	PH	154	68.2%	80.5%	98.7%	64.9%
2024	Hills Creek Dam	Tailrace*	88	75.0%	88.6%	100.0%	73.9%
2023	Hills Creek Dam	PH	397	30.0%	35.8%	45.1%	29.2%
2023	Hills Creek Dam	Tailrace*	247	25.9%	34.0%	47.0%	21.1%
2022	Hills Creek Dam	PH	42	57.1%	64.3%	78.6%	59.5%
2022	Hills Creek Dam	Tailrace*	28	60.7%	71.4%	92.9%	32.1%
2021	Hills Creek Dam	PH	14	35.7%	57.1%	92.9%	57.1%
2021	Hills Creek Dam	Tailrace*	56	37.5%	44.6%	83.9%	57.1%

*Tailrace refers to the "RO" trap that captures fish from both the Powerhouse and Regulatory Outlet.
Data represents all fish captured in the RST for the entire year except for 2024 which only includes data from January 1st to June 30th.

Table D-20. Injury rates by year on NOR Chinook captured in the Lookout Dam Tailrace RSTs by injury type. Barotrauma injuries include Chinook with BLO, EYB, BVT, FVB, GBD, or POP injury codes. Mechanical injuries include Chinook with HIN, OPD, TEA, BRU, HBP, DS>2, HO, BO, and HBO injury codes. Other injuries include Chinook with FID, PRD, COP, BKD, and FUN injury codes. Mortalities represent all Chinook found dead in the RST at time of trap check.

Year	Site	Trap Location	NOR Chinook Assessed for Injury	Barotrauma Injuries	Mechanical Injuries	Other Injuries	Mortalities
2024	Lookout Dam	Tailrace	99	25.3%	27.3%	77.8%	3.0%
2023	Lookout Dam	Tailrace	139	56.8%	54.7%	85.6%	30.9%
2022	Lookout Dam	Tailrace	78	34.6%	52.6%	67.9%	19.2%
2021	Lookout Dam	Tailrace	18	0.0%	0.0%	16.7%	0.0%

Data represents all fish captured in the RST for the entire year except for 2024 which only includes data from January 1st to June 30th.

Table D-21. Injury rates by year on NOR Chinook captured in the Dexter Dam Tailrace RST by injury type. Barotrauma injuries include Chinook with BLO, EYB, BVT, FVB, GBD, or POP injury codes. Mechanical injuries include Chinook with HIN, OPD, TEA, BRU, HBP, DS>2, HO, BO, and HBO injury codes. Other injuries include Chinook with FID, PRD, COP, BKD, and FUN injury codes. Mortalities represents all Chinook found dead in the RST at time of trap check.

Year	Site	Trap Location	NOR Chinook Assessed for Injury	Barotrauma Injuries	Mechanical Injuries	Other Injuries	Mortalities
2024	Dexter Dam	Tailrace	28	32.1%	49.1%	89.3%	3.6%
2023	Dexter Dam	Tailrace	57	31.6%	29.3%	80.7%	8.8%
2022	Dexter Dam	Tailrace	99	25.3%	42.5%	54.5%	9.1%

Data represents all fish captured in the RST for the entire year except for 2024 which only includes data from January 1st to June 30th.

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Appendix E – Trap Efficiency Analysis

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Appendix E: Trap Efficiency Plots

Sections

Figures and Tables

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Introduction

Rotary screw traps (RSTs) are commonly used by fisheries biologists to gather data on juvenile salmonids as they migrate downstream through freshwater habitats. Mark-recapture techniques are frequently employed at RSTs to estimate juvenile abundances. This involves marking and releasing fish upstream of the RST and then capturing both marked and unmarked fish in subsequent days. A simple Lincoln-Petersen (L-P) model can be used to estimate the number of unmarked fish passing the RST.

Lincoln-Petersen model:

$$U = u * \frac{n}{m}$$

Where:

- U is the number of unmarked fish passing the RST
- u is the unmarked fish captured at the RST
- n is the number of marked fish available for recapture
- m is the number of marked fish recaptured.

Abundance estimates from the L-P model are influenced by variation in trap capture efficiency, which is affected by environmental variables such as average weekly discharge and trap revolution speed. This analysis expands the previous framework by examining the influence of fish length at release on RST efficiency at sites in the Willamette River Basin. The environmental variables that can influence RST efficiency are often correlated, so a correlation analysis was conducted before expanding the models. We then assessed whether recapture groups exhibited a length bias relative to release groups and quantified the influence of fish length, discharge, and trap revolution speed on RST efficiency.

Methods

Correlation analysis

A correlation analysis was conducted to identify potential issues associated with model assumption violations that could arise from fitting models with discharge, trap revolution speed, and fish size, if they were highly correlated. Pairwise Pearson's correlation values were calculated using the `cor()` function implemented in R (R Core Team, 2024) and inspected for correlations between the weekly discharge (the average of the average daily discharge for the following seven days) following a trap efficiency (TE) trial, the average revolutions per hour for the three days following a TE trial by site, and mean fish size of released fish for the TE trial using data from December 2021 - November 2024.

Fork length distribution analysis

We quantified the influence of fish length at release on RST capture efficiency by comparing the length distributions of release and capture groups by TE trial event. Fork lengths were recorded for approximately 50 released fish per TE trial and all fish captured downstream at the RST.

We analyzed the data using a restricted maximum likelihood (REML) mixed-effects model, fitting a separate model for each RST site. The analysis was conducted with the `lmer()` function from the lme4 package in R (Bates et al. 2015). Fork lengths were modeled with event type (release, capture) as a fixed effect and trial number as a random effect intercept. Including trial as a random effect accounted for correlation due to repeated trials, although trial effects themselves were not of interest. To assess the significance of the capture effect on fork length at each site, models including and excluding event type were compared using `anova()` function in R (R Core Team, 2024). For each site, we estimated the effect of capture and reported the associated Chi-squared p-value.

Trap efficiency analysis

A suite of models were developed to quantify the effect of weekly discharge, trap revolutions per hour, mean fork length, and their interaction on trap efficiencies by site. This was done by fitting a series of beta regression models using a combination of weekly discharge, revolutions per hour, and mean fork length and their interactions with the `betareg()` function from the betareg package in R (Cribari-Neto and Zeileis, 2010). The general structure of the full model is described below:

$$TE_{\{j,i\}} = \beta_0 + \beta_1 Q_{j,i} + \beta_2 R_{j,i} + \beta_3 F_{j,i} + \beta_4 Q_{j,i} R_{j,i} F_{j,i} + \varepsilon_{\{j,i\}}$$

Where:

- $TE_{\{j,i\}}$ is the beta-distributed trap efficiency at site *j* for efficiency trial *i*.
- $Q_{j,i}$ is mean daily flow (or log average daily flow) at site *j* during the seven-day trap efficiency trial window for trial *i*.
- $R_{j,i}$ is mean revolutions per hour at site *j* during the following three days from TE trial release *i.*
- $F_{j,i}$ is the mean fork-length at site *j* during the following three days from TE trial release *i.*
- $Q_{j,i}R_{j,i}F_{j,i}$ is the interaction term between average weekly flow, average revolutions per hour, and mean fork length.
- β0, β1, β2, β3 ,β4 are coefficients estimated by the model representing the relationship between the predictors and the trap efficiency.
- $\varepsilon_{\{j,i\}}$ is the residual error term.

Note: Discharge data were unavailable for several locations so average daily stage height, $GH_{j,i}$, was substituted for discharge for those sites.

Prior to the full analysis, exploratory visualization supports the assumption of logistically-distributed response.

Below is a summary of models identified *a priori* for comparison:

- **null:** No covariates
- **q:** Weekly average discharge
- **logq:** Log-transformed weekly average discharge
- **rph:** Average revolutions per hour
- **mfl:** Mean fork length
- **q_rph:** Weekly average discharge and average revolutions per hour
- **q_int:** Weekly average discharge and the interaction of mean fork length with weekly average discharge
- **q_mfl:** Weekly average discharge and mean fork length
- **logq_rph:** Log-transformed weekly average discharge and average revolutions per hour
- **logq_int:** Log-transformed weekly average discharge and the interaction of mean fork length with log-transformed weekly average discharge
- **logq_mfl:** Log-transformed weekly average discharge and mean fork length
- **logq_rph:** Log-transformed weekly average discharge and average revolutions per hour

- **q_rph_mfl:** Weekly average discharge, average revolutions per hour, and mean fork length
- **logq_rph_mfl:** log-transformed weekly average discharge, average revolutions per hour, and mean fork length
- **full:** Weekly average discharge, average revolutions per hour, and mean fork length with three-way interaction
- **full_log:** Log-transformed weekly average discharge, average revolutions per hour, and mean fork length with three-way interaction

Note: discharge data were unavailable for several sites, so stage height was used at those locations. This was denoted in model names with "gh" instead of "q."

Model outputs were assessed through model fit, residual statistics, AICc, examination of coefficient estimates, and visual inspection of model diagnostic plots.

Results

Correlation results

Correlations among discharge (or stage height), RPH, and fork length revealed general trends and site-specific patterns. In most cases, discharge and RPH were positively correlated, with particularly strong relationships observed at the Breitenbush River (r = 0.93), Detroit Head of Reservoir (r=0.84), Dexter Spillway (r = 0.89), Foster Head of Reservoir (r=0.93), and Fall Creek Tailrace (r = 0.92) (Table E-1). Fork length generally exhibited weaker correlations with discharge and RPH, though moderate positive relationships were observed between fork length and RPH at Big Cliff Dam (r = 0.45) and Fall Creek Head of Reservoir (r = 0.75). At some sites, negative correlations emerged; for instance, RPH was negatively correlated with fork length and discharge at the Cougar Regulating Outlet (r = -0.39 and -0.19, respectively) and fork length was negatively correlated with RPH and discharge at Dexter Spillway (r = -0.08 and -0.24, respectively). Based on these results, we included all three covariates in the trap efficiency analysis, while acknowledging that the correlations among the covariates should be considered when interpreting model results.

Table E-1. Correlations between weekly average discharge following TE trial releases, average revolutions per hour (RPH) over the three days following TE trial releases, and the mean fork length of released fish during TE trial releases at sites within the Willamette River Basin, Oregon (December 2021–November 2024). Note: For sites where discharge data were unavailable, stage height was used as a substitute in the analysis.

Site	Variables	Correlation			Sample Size
		Discharge	RPH	Fork Length	
Big Cliff Dam	Discharge	1.00	-0.22	0.12	38
	RPH	-0.22	1.00	0.45	38
	Fork Length	0.12	0.45	1.00	38
Breitenbush River	Discharge	1.00	0.93	0.30	17
	RPH	0.93	1.00	0.23	17
	Fork Length	0.30	0.23	1.00	17
Cougar Head of Reservoir	Discharge	1.00	-0.10	-0.36	25
	RPH	-0.10	1.00	0.32	25
	Fork Length	-0.36	0.32	1.00	25

Site	Variables	Correlation			Sample Size
		Discharge	RPH	Fork Length	
Cougar Powerhouse	Discharge	1.00	-0.18	-0.04	20
	RPH	-0.18	1.00	-0.19	20
	Fork Length	-0.04	-0.19	1.00	20
Cougar Regulating Outlet	Discharge	1.00	-0.19	0.14	23
	RPH	-0.19	1.00	-0.39	23
	Fork Length	0.14	-0.39	1.00	23
Detroit Head of Reservoir	Discharge	1.00	0.84	-0.08	18
	RPH	0.84	1.00	-0.22	18
	Fork Length	-0.08	-0.22	1.00	18
Dexter Spillway	Discharge	1.00	0.89	-0.24	9
	RPH	0.89	1.00	-0.08	9
	Fork Length	-0.24	-0.08	1.00	9
Fall Creek Tailrace	Discharge	1.00	0.92	0.27	13
	RPH	0.92	1.00	0.44	13
	Fork Length	0.27	0.44	1.00	13
Foster Head of Reservoir	Discharge	1.00	0.93	0.07	26
	RPH	0.93	1.00	0.11	26
	Fork Length	0.07	0.11	1.00	26
Hills Creek Powerhouse	Discharge	1.00	0.45	-0.05	18
	RPH	0.45	1.00	0.09	18
	Fork Length	-0.05	0.09	1.00	18
Lookout Point Head of Reservoir	Discharge	1.00	0.80	0.27	28
	RPH	0.80	1.00	0.40	28
	Fork Length	0.27	0.40	1.00	28
Fall Creek Head of Reservoir	Stage Height	1.00*	0.58	0.45	12
	RPH	0.58*	1.00	0.75	12
	Fork Length	0.45*	0.75	1.00	12
Green Peter Head of Reservoir	Stage Height	1.00*	0.66	0.10	16
	RPH	0.66*	1.00	0.24	16
	Fork Length	0.10*	0.24	1.00	16
Hills Creek Head of Reservoir	Stage Height	1.00*	0.67	-0.01	9
	RPH	0.67*	1.00	0.42	9
	Fork Length	-0.01*	0.42	1.00	9

*Indicates sites where discharge data were unavailable and thus stage height was used as a substitute in the analysis.

Fork length distribution analysis

The likelihood ratio test results on the REML mixed-effects models revealed that the effect of group type (release or recapture) was not consistent between sites. For instance, the effect was -4.91 mm at Hills Creek Head of Reservoir and 1.25 mm at Big Cliff Dam (Table E-2, Figures E1–E15). Statistically significant effects were observed at several sites, including Big Cliff Dam ($p = 0.007$), Cougar Head of Reservoir ($p = 0.003$), Hills Creek Head of Reservoir ($p = 0.001$), Hills Creek Powerhouse ($p < 0.001$), and Lookout Point Head of Reservoir ($p < 0.001$). At these sites, group effects were predominantly negative, indicating that the length distribution of recaptured fish was smaller relative to the distribution of released fish, except at Big Cliff Dam, where the group effect was positive.

Table E-2. Restricted maximum likelihood mixed-effects models and maximum-likelihood ratio test results for rotary screw trap sites in the Willamette River Basin, Oregon, from December 2021 to November 2024. Group effect is the average difference in fork length (mm) between recaptured fish and released fish. Positive values indicate larger recaptured fish and negative values indicating smaller recaptured fish. Statistical significance was defined as p-values less than 0.05.

RST Site	# Fish Sampled	Intercept (mm)	Group Effect (mm)	P-value
Big Cliff Dam	3,416	101.64	1.25	0.0070
Breitenbush River	1,644	96.16	-0.62	0.3459
Cougar Head of Reservoir	2,053	103.82	-2.29	0.0032
Cougar Powerhouse	2,277	103.49	-0.25	0.7453
Cougar Regulating Outlet	1,763	120.43	1.05	0.3082
Detroit Head of Reservoir	1,634	91.25	-0.94	0.1120
Dexter Powerhouse	924	110.80	-0.96	0.4098
Dexter Spillway	1,005	133.93	-2.53	0.1017
Fall Creek Head of Reservoir	1,506	99.61	-0.54	0.5779
Fall Creek Tailrace	749	108.16	-3.39	0.1123
Foster Head of Reservoir	2,009	115.52	0.59	0.4160
Green Peter Head of Reservoir	857	114.20	0.39	0.8503
Hills Creek Head of Reservoir	594	104.69	-4.91	0.0012
Hills Creek Powerhouse	1,442	120.85	-4.61	1.80E-06
Lookout Point Head of Reservoir	1,776	110.99	-3.90	0.0001

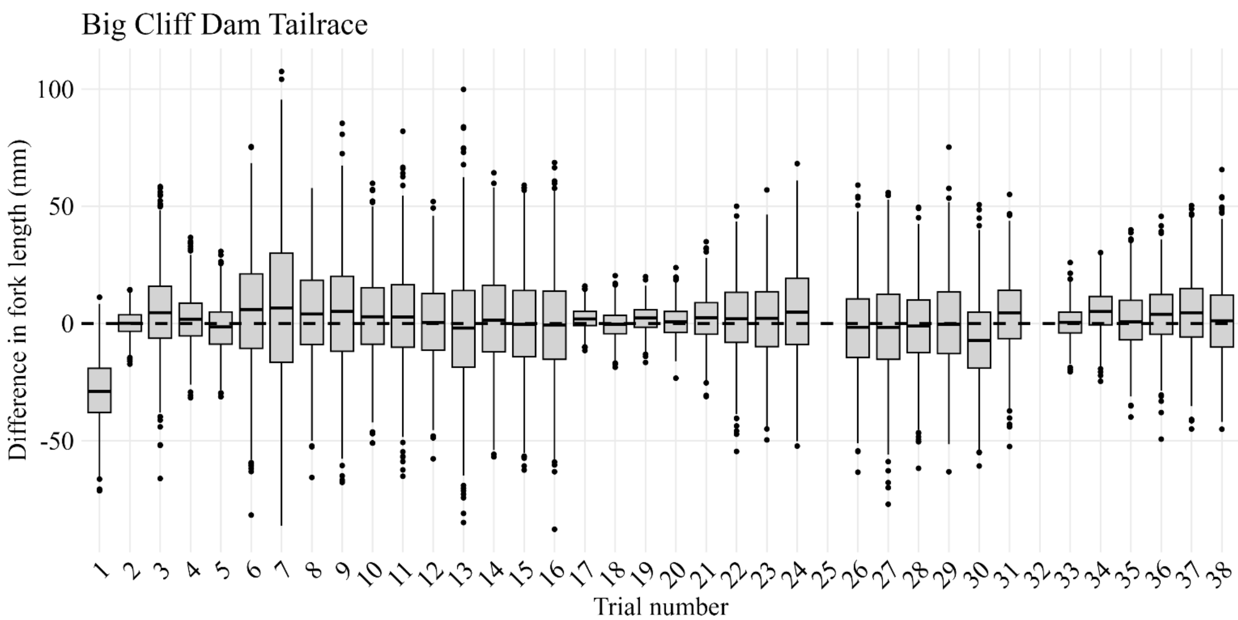

Figure E-1. Estimated differences in fork length between released and recaptured fish by trap efficiency trial at the Big Cliff Dam Tailrace, calculated using a parametric bootstrap procedure. For each trial, 1,000 samples were drawn from normal distributions fitted to the observed fork lengths of the release and recapture groups. Trials without a boxplot indicate that no fish were recaptured in those trials. Boxplots display the distribution of estimated differences, with medians greater than zero signifying that recaptured fish were, on average, larger than released fish.

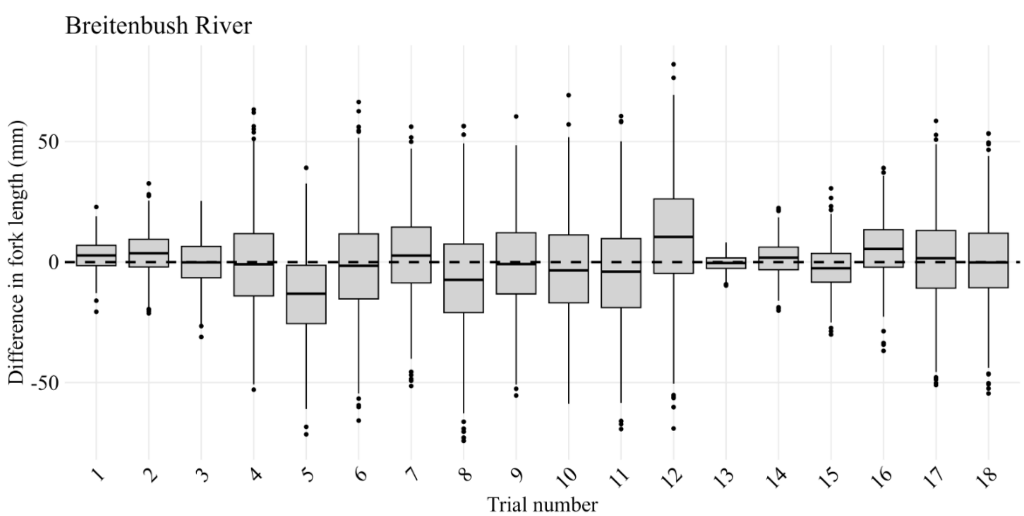

Figure E-2. Estimated differences in fork length between released and recaptured fish by trap efficiency trial at Breitenbush River, calculated using a parametric bootstrap procedure. For each trial, 1,000 samples were drawn from normal distributions fitted to the observed fork lengths of the release and recapture groups. Trials without a boxplot indicate that no fish were recaptured in those trials. Boxplots display the distribution of estimated differences, with medians greater than zero signifying that recaptured fish were, on average, larger than released fish.

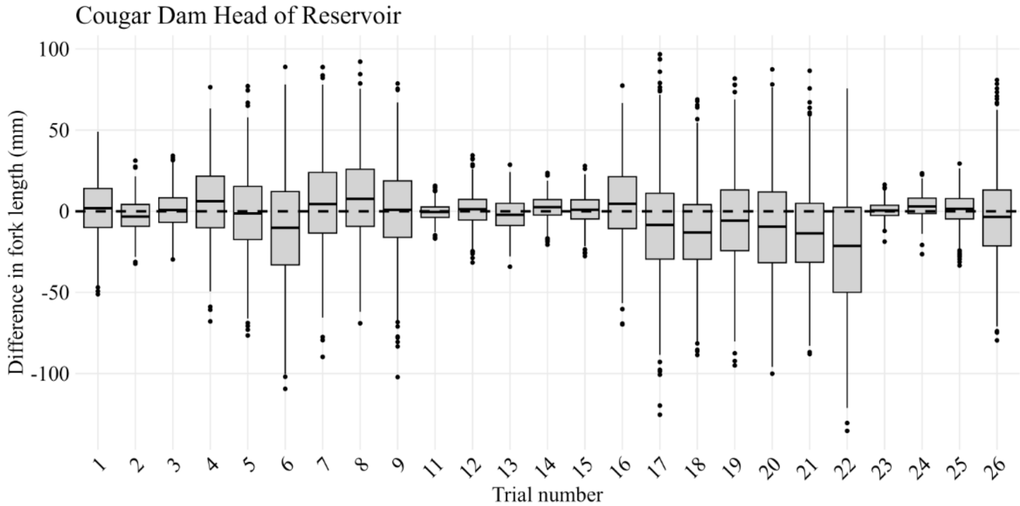

Figure E-3. Estimated differences in fork length between released and recaptured fish by trap efficiency trial at Cougar Dam Head of Reservoir, calculated using a parametric bootstrap procedure. For each trial, 1,000 samples were drawn from normal distributions fitted to the observed fork lengths of the release and recapture groups. Trials without a boxplot indicate that no fish were recaptured in those trials. Boxplots display the distribution of estimated differences, with medians greater than zero signifying that recaptured fish were, on average, larger than released fish.

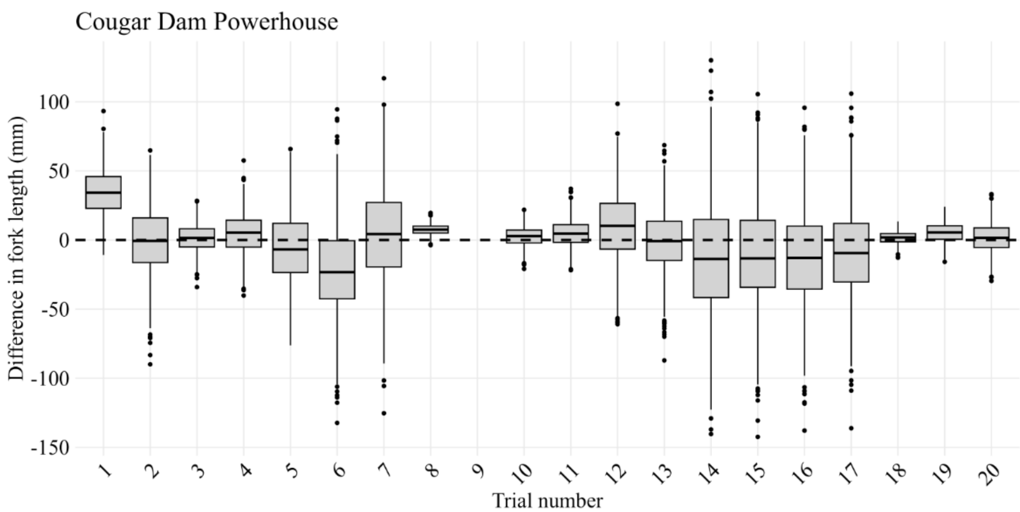

Figure E-4. Estimated differences in fork length between released and recaptured fish by trap efficiency trial at the Cougar Dam Powerhouse, calculated using a parametric bootstrap procedure. For each trial, 1,000 samples were drawn from normal distributions fitted to the observed fork lengths of the release and recapture groups. Trials without a boxplot indicate that no fish were recaptured in those trials. Boxplots display the distribution of estimated differences, with medians greater than zero signifying that recaptured fish were, on average, larger than released fish.

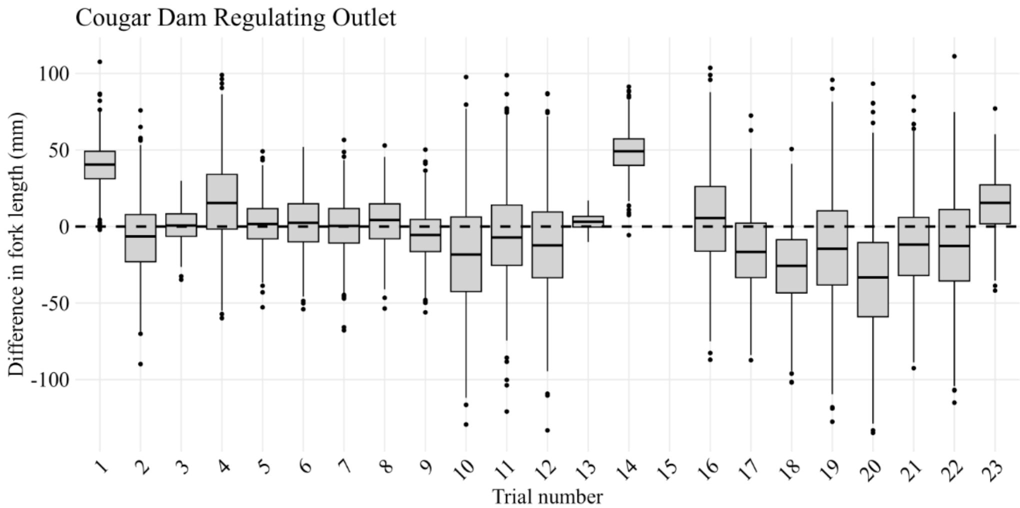

Figure E-5. Estimated differences in fork length between released and recaptured fish by trap efficiency trial at the Cougar Dam Regulating Outlet, calculated using a parametric bootstrap procedure. For each trial, 1,000 samples were drawn from normal distributions fitted to the observed fork lengths of the release and recapture groups. Trials without a boxplot indicate that no fish were recaptured in those trials. Boxplots display the distribution of estimated differences, with medians greater than zero signifying that recaptured fish were, on average, larger than released fish.

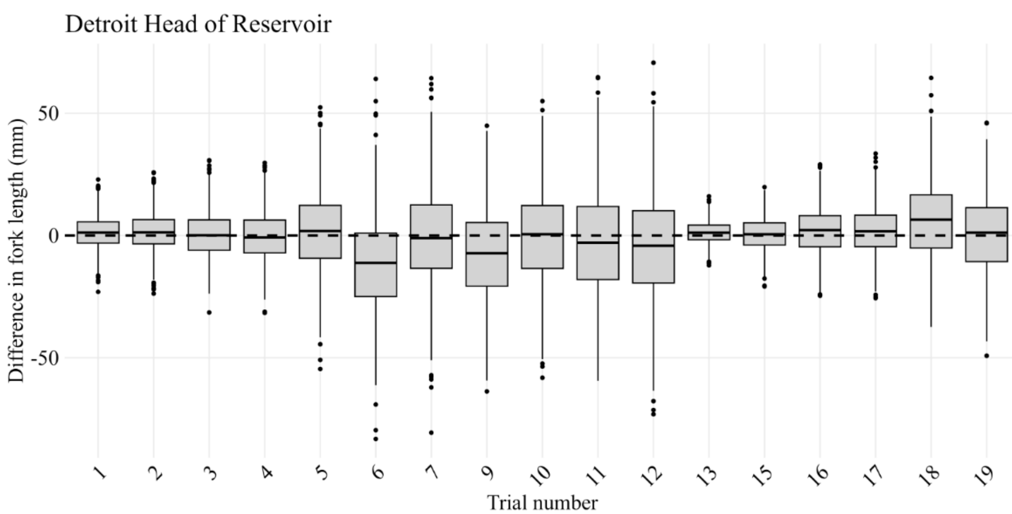

Figure E-6. Estimated differences in fork length between released and recaptured fish by trap efficiency trial at Detroit Head of Reservoir, calculated using a parametric bootstrap procedure. For each trial, 1,000 samples were drawn from normal distributions fitted to the observed fork lengths of the release and recapture groups. Trials without a boxplot indicate that no fish were recaptured in those trials. Boxplots display the distribution of estimated differences, with medians greater than zero signifying that recaptured fish were, on average, larger than released fish.

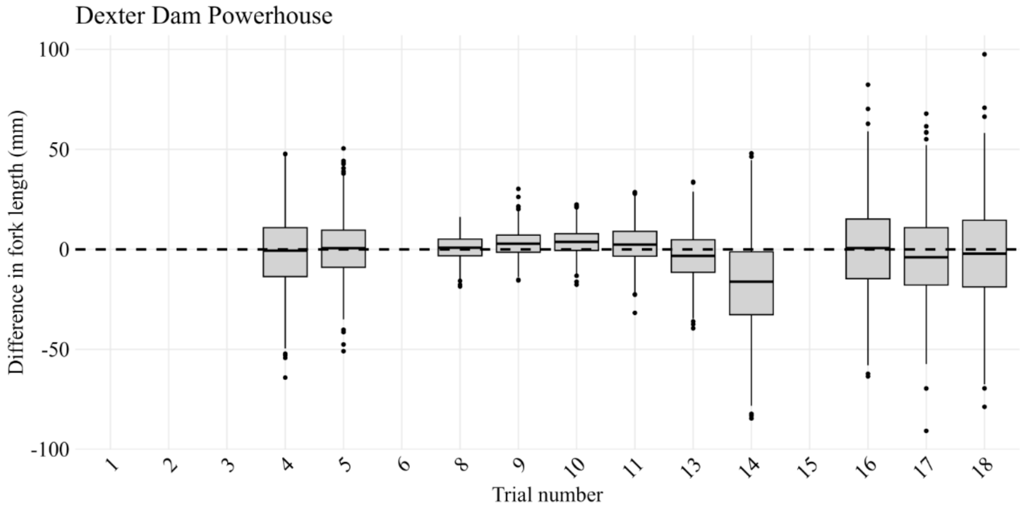

Figure E-7. Estimated differences in fork length between released and recaptured fish by trap efficiency trial at the Dexter Dam Powerhouse, calculated using a parametric bootstrap procedure. For each trial, 1,000 samples were drawn from normal distributions fitted to the observed fork lengths of the release and recapture groups. Trials without a boxplot indicate that no fish were recaptured in those trials. Boxplots display the distribution of estimated differences, with medians greater than zero signifying that recaptured fish were, on average, larger than released fish.

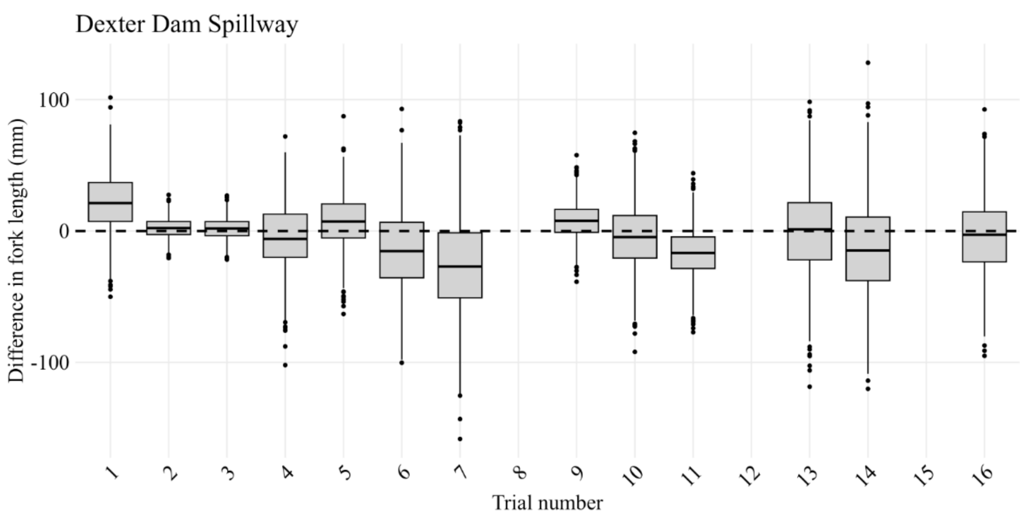

Figure E-8. Estimated differences in fork length between released and recaptured fish by trap efficiency trial at the Dexter Dam Spillway, calculated using a parametric bootstrap procedure. For each trial, 1,000 samples were drawn from normal distributions fitted to the observed fork lengths of the release and recapture groups. Trials without a boxplot indicate that no fish were recaptured in those trials. Boxplots display the distribution of estimated differences, with medians greater than zero signifying that recaptured fish were, on average, larger than released fish.

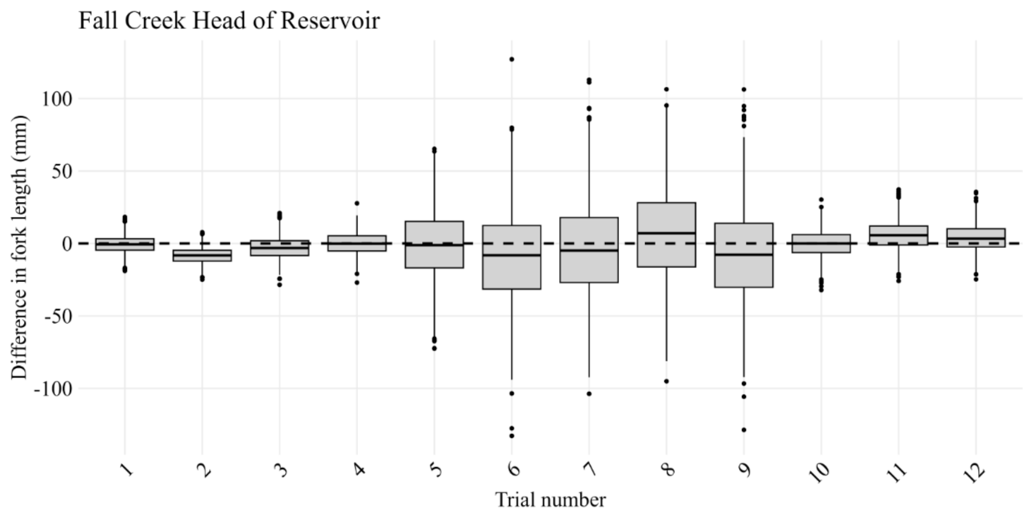

Figure E-9. Estimated differences in fork length between released and recaptured fish by trap efficiency trial at Fall Creek Head of Reservoir, calculated using a parametric bootstrap procedure. For each trial, 1,000 samples were drawn from normal distributions fitted to the observed fork lengths of the release and recapture groups. Trials without a boxplot indicate that no fish were recaptured in those trials. Boxplots display the distribution of estimated differences, with medians greater than zero signifying that recaptured fish were, on average, larger than released fish.

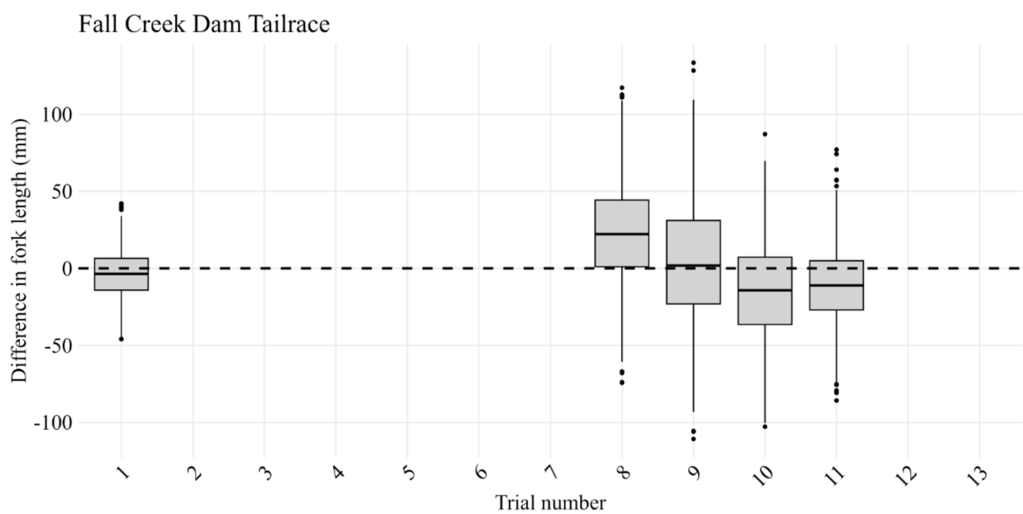

Figure E-10. Estimated differences in fork length between released and recaptured fish by trap efficiency trial at the Fall Creek Dam Tailrace, calculated using a parametric bootstrap procedure. For each trial, 1,000 samples were drawn from normal distributions fitted to the observed fork lengths of the release and recapture groups. Trials without a boxplot indicate that no fish were recaptured in those trials. Boxplots display the distribution of estimated differences, with medians greater than zero signifying that recaptured fish were, on average, larger than released fish.

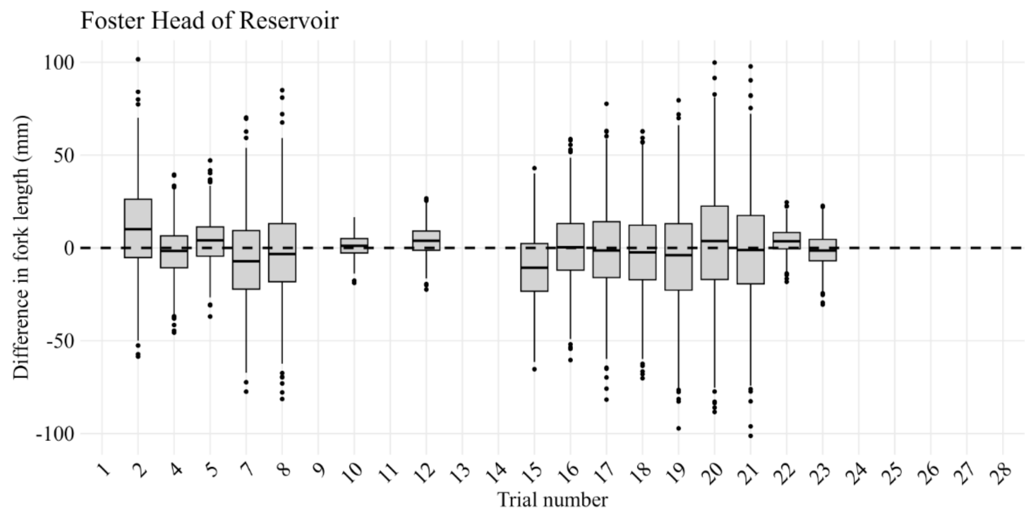

Figure E-11. Estimated differences in fork length between released and recaptured fish by trap efficiency trial at Foster Head of Reservoir, calculated using a parametric bootstrap procedure. For each trial, 1,000 samples were drawn from normal distributions fitted to the observed fork lengths of the release and recapture groups. Trials without a boxplot indicate that no fish were recaptured in those trials. Boxplots display the distribution of estimated differences, with medians greater than zero signifying that recaptured fish were, on average, larger than released fish.

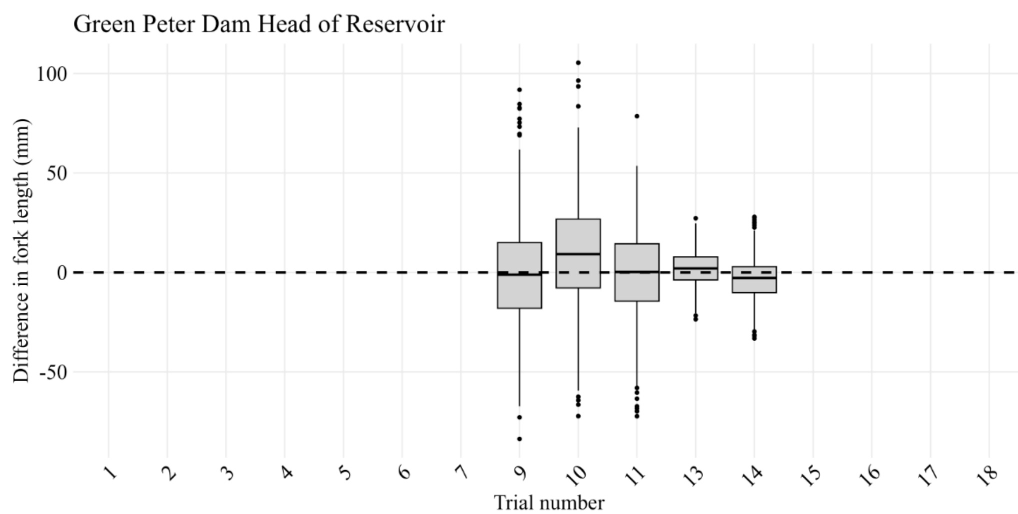

Figure E-12. Estimated differences in fork length between released and recaptured fish by trap efficiency trial at Green Peter Dam Heah of Reservoir, calculated using a parametric bootstrap procedure. For each trial, 1,000 samples were drawn from normal distributions fitted to the observed fork lengths of the release and recapture groups. Trials without a boxplot indicate that no fish were recaptured in those trials. Boxplots display the distribution of estimated differences, with medians greater than zero signifying that recaptured fish were, on average, larger than released fish.

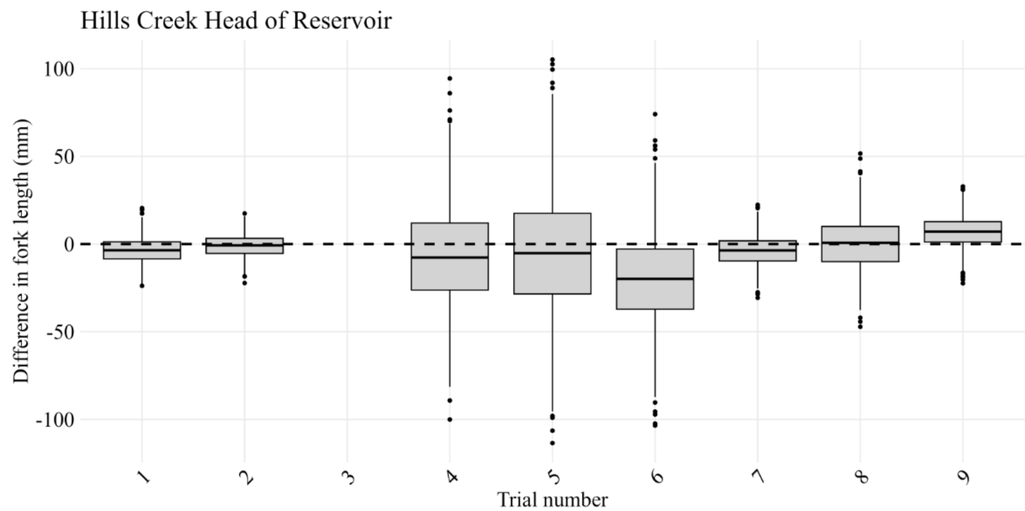

Figure E-13. Estimated differences in fork length between released and recaptured fish by trap efficiency trial at Hills Creek Head of Reservoir, calculated using a parametric bootstrap procedure. For each trial, 1,000 samples were drawn from normal distributions fitted to the observed fork lengths of the release and recapture groups. Trials without a boxplot indicate that no fish were recaptured in those trials. Boxplots display the distribution of estimated differences, with medians greater than zero signifying that recaptured fish were, on average, larger than released fish.

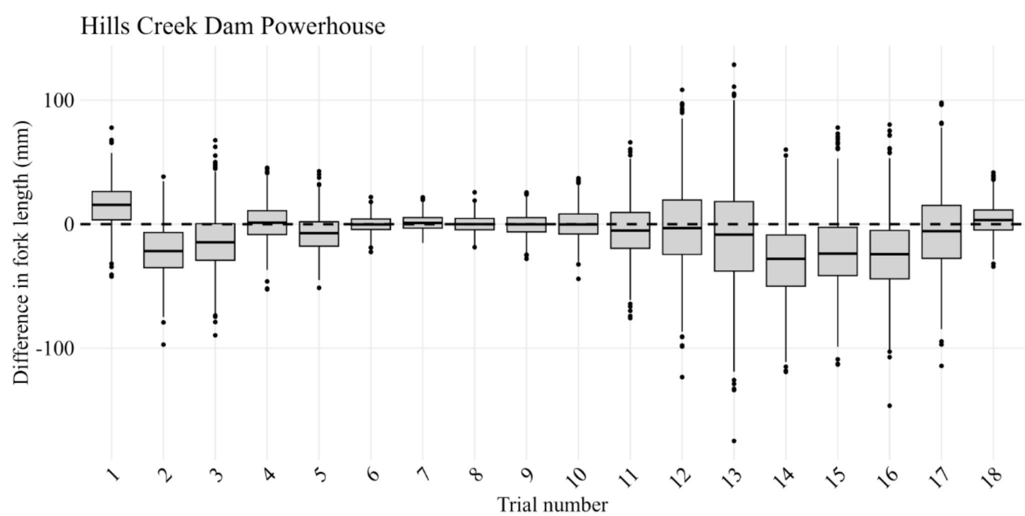

Figure E-14. Estimated differences in fork length between released and recaptured fish by trap efficiency trial at the Hills Creek Dam Powerhouse, calculated using a parametric bootstrap procedure. For each trial, 1,000 samples were drawn from normal distributions fitted to the observed fork lengths of the release and recapture groups. Trials without a boxplot indicate that no fish were recaptured in those trials. Boxplots display the distribution of estimated differences, with medians greater than zero signifying that recaptured fish were, on average, larger than released fish.

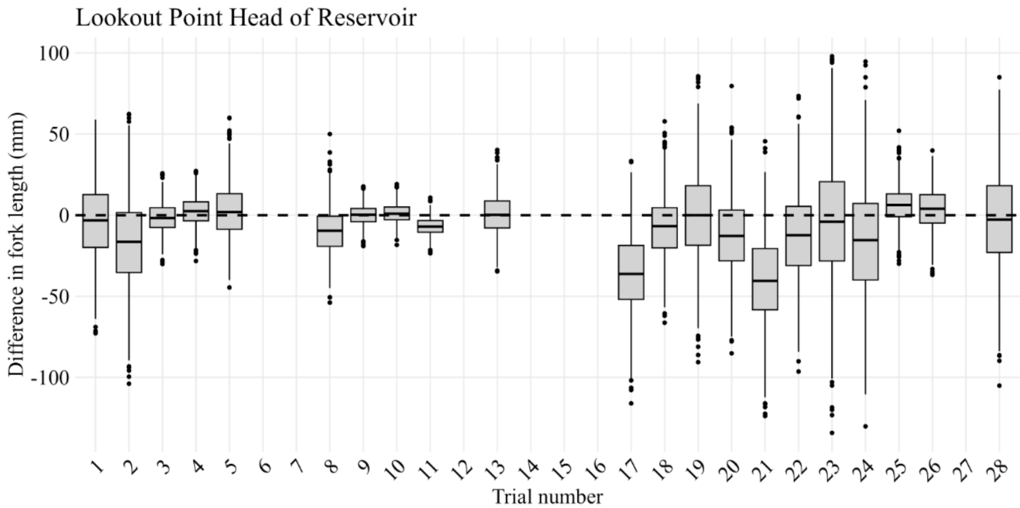

Figure E-15. Estimated differences in fork length between released and recaptured fish by trap efficiency trial at Lookout Point Head of Reservoir, calculated using a parametric bootstrap procedure. For each trial, 1,000 samples were drawn from normal distributions fitted to the observed fork lengths of the release and recapture groups. Trials without a boxplot indicate that no fish were recaptured in those trials. Boxplots display the distribution of estimated differences, with medians greater than zero signifying that recaptured fish were, on average, larger than released fish.

Trap efficiency results

For most sites, models with multiple covariates and interaction terms provided the best fit according to pseudo R^2 (Cragg and Uhler's R-squared) and AICc scores (Table E-3). For Big Cliff Dam, the model with log-transformed discharge and mean fork length (logq_mfl) exhibited the lowest AIC_c (-154.62) and had a pseudo R^2 of 0.46. At Breitenbush River, the log-transformed discharge model (logq) achieved the lowest AIC_c (-61.30) with a pseudo R^2 of 0.33, though the full model achieved a notably higher pseudo R^2 (0.84).

At Lookout Point and Detroit Head of Reservoir, the top models achieved both the lowest AICc and the highest pseudo R^2, indicating a strong balance between model fit and parsimony. At Lookout Point Head of Reservoir (n = 28), the full model had the lowest AICc of -187.87 and a pseudo R^2 of 0.51, suggesting that the inclusion of comprehensive predictors provided meaningful improvements in explanatory power. Similarly, at Detroit Head of Reservoir (n = 18), the model with discharge and the discharge and mean fork length interaction term (q_int) had the lowest AICc (-68.62) and a pseudo R2 of 0.67.

In contrast, at Green Peter Head of Reservoir, Hills Creek Head of Reservoir, and Fall Creek Head of Reservoir, models with exceptionally high pseudo R^2 values and low AICc scores were likely influenced by small sample sizes and consistently low trap efficiencies. For instance, the full model for Green Peter Head of Reservoir (n = 16) and Hills Creek Head of Reservoir (n = 9) had pseudo R^2 values near 0.99, suggesting an almost perfect fit to the observed data. Similarly, at Fall Creek Head of Reservoir (n = 12), the full model achieved a pseudo R^2 of 0.88 with a low AICc of 50.15. However, these results likely reflect overfitting due to small sample sizes and limited variability in the response data, driven by the low trap efficiencies. In such cases, models may be capturing site-specific noise rather than generalizable patterns, emphasizing the need for cautious interpretation of high pseudo R^2 values under these conditions.

The predictive capability of mean fork length (mfl) was inconsistent and depended on site and sample size. At sites with sufficient sample sizes and more variability in trap efficiency, models incorporating mfl tended to rank below interaction-based or full models, which provided a better fit. For example, at Lookout Point Head of Reservoir (n = 28), the rph_mfl model had an AICc of -186.78 and a pseudo R^2 of 0.37. Similarly, at Detroit Head of Reservoir (n = 18), the q_mfl model achieved an AICc of -58.20 and a pseudo R^2 of 0.01, indicating minimal explanatory power compared to models that included interaction terms.

Table E-3. Beta regression model results using a logit-link function for rotary screw trap sites within the Willamette River Basin, Washington, from December 2021 to November 2024. Model abbreviations are defined as follows: discharge (q), log-transformed discharge (logq), stage height (gh), revolutions per hour (rph), mean fork length (mfl), interaction between mean fork length and weekly average discharge or stage height (int), full model (all three covariates and a three-way interaction), and full_log (log-transformed discharge, rph, mfl, and a three-way interaction).

RST Site	Sample Size	Model	AIC_c	Delta AIC_c	LogLik	Pseudo R^2
Big Cliff Dam	38	q_int	-151.25	3.37	82.98	0.50
Big Cliff Dam	38	full_log	-140.54	14.07	82.49	0.48
Big Cliff Dam	38	full	-137.89	16.72	81.16	0.47
Big Cliff Dam	38	logq_int	-152.08	2.54	81.98	0.47
Big Cliff Dam	38	logq_rph_mfl	-152.02	2.60	81.95	0.46
Big Cliff Dam	38	logq_mfl	-154.62	0.00	81.92	0.46
Big Cliff Dam	38	q_rph_mfl	-148.10	6.52	79.99	0.37
Big Cliff Dam	38	q_mfl	-150.73	3.89	79.97	0.37
Big Cliff Dam	38	logq_rph	-145.22	9.39	77.22	0.32
Big Cliff Dam	38	logq	-146.61	8.00	76.66	0.30
Big Cliff Dam	38	q_rph	-142.96	11.66	76.08	0.25
Big Cliff Dam	38	q	-144.32	10.30	75.51	0.23
Big Cliff Dam	38	rph_mfl	-132.46	22.16	70.83	0.13
Big Cliff Dam	38	mfl	-134.35	20.26	70.53	0.12
Big Cliff Dam	38	rph	-132.28	22.34	69.49	0.07
Big Cliff Dam	38	null	-131.92	22.70	68.13	NA
Breitenbush River	17	full	-52.54	8.77	48.13	0.84
Breitenbush River	17	full_log	-38.39	22.91	41.05	0.71
Breitenbush River	17	q_int	-57.80	3.50	39.10	0.69
Breitenbush River	17	logq_int	-55.72	5.59	35.58	0.43
Breitenbush River	17	logq_rph_mfl	-55.19	6.12	35.32	0.37
Breitenbush River	17	logq_mfl	-59.15	2.15	35.24	0.36
Breitenbush River	17	logq_rph	-58.42	2.89	34.88	0.34
Breitenbush River	17	logq	-61.30	0.00	34.58	0.33
Breitenbush River	17	rph_mfl	-58.38	2.93	34.86	0.28
Breitenbush River	17	q_rph_mfl	-54.49	6.82	34.97	0.27
Breitenbush River	17	q_mfl	-57.45	3.86	34.39	0.25
Breitenbush River	17	q_rph	-56.63	4.67	33.98	0.24
Breitenbush River	17	rph	-60.04	1.26	33.94	0.23
Breitenbush River	17	q	-59.92	1.39	33.88	0.23
Breitenbush River	17	mfl	-58.84	2.47	33.34	0.12
Breitenbush River	17	null	-60.07	1.24	32.46	NA
Cougar Head of Reservoir	25	full	-105.22	14.5	67.61	0.45
Cougar Head of Reservoir	25	full_log	-102.44	17.28	66.22	0.37

RST Site	Sample Size	Model	AIC$_c$	Delta AIC$_c$	LogLik	Pseudo R^2
Cougar Head of Reservoir	25	q_int	-116.53	3.18	66.6	0.36
Cougar Head of Reservoir	25	logq_int	-117.8	1.92	65.48	0.32
Cougar Head of Reservoir	25	q_rph_mfl	-116.98	2.74	65.07	0.27
Cougar Head of Reservoir	25	logq_rph_mfl	-116.36	3.36	64.76	0.26
Cougar Head of Reservoir	25	q_mfl	-119.37	0.35	64.69	0.25
Cougar Head of Reservoir	25	logq_mfl	-118.84	0.88	64.42	0.24
Cougar Head of Reservoir	25	rph_mfl	-117.57	2.15	63.79	0.22
Cougar Head of Reservoir	25	mfl	-119.72	0	63.43	0.2
Cougar Head of Reservoir	25	q_rph	-115.73	3.99	62.86	0.14
Cougar Head of Reservoir	25	q	-118.58	1.14	62.86	0.14
Cougar Head of Reservoir	25	logq_rph	-115.12	4.59	62.56	0.12
Cougar Head of Reservoir	25	logq	-117.98	1.74	62.56	0.12
Cougar Head of Reservoir	25	rph	-114.9	4.82	61.02	0
Cougar Head of Reservoir	25	null	-117.49	2.23	61.02	NA
Cougar Dam Powerhouse	20	full	-29.71	17.73	32.86	0.47
Cougar Dam Powerhouse	20	full_log	-29.52	17.93	32.76	0.47
Cougar Dam Powerhouse	20	logq_rph_mfl	-43.71	3.73	29.00	0.25
Cougar Dam Powerhouse	20	q_rph_mfl	-43.37	4.08	28.83	0.25
Cougar Dam Powerhouse	20	q_int	-40.19	7.26	29.33	0.24
Cougar Dam Powerhouse	20	logq_int	-44.24	3.21	29.26	0.24
Cougar Dam Powerhouse	20	rph_mfl	-45.74	1.70	28.21	0.21
Cougar Dam Powerhouse	20	q_rph	-45.61	1.83	28.14	0.15
Cougar Dam Powerhouse	20	logq_rph	-45.70	1.75	28.18	0.15
Cougar Dam Powerhouse	20	rph	-47.14	0.31	27.32	0.11
Cougar Dam Powerhouse	20	logq_mfl	-42.93	4.52	26.80	0.08
Cougar Dam Powerhouse	20	q_mfl	-42.89	4.56	26.78	0.08
Cougar Dam Powerhouse	20	mfl	-45.82	1.62	26.66	0.06
Cougar Dam Powerhouse	20	q	-45.14	2.31	26.32	0.02
Cougar Dam Powerhouse	20	logq	-45.06	2.39	26.28	0.02
Cougar Dam Powerhouse	20	null	-47.44	0.00	26.08	NA
Cougar Dam Regulating Outlet	23	full_log	-65.15	21.12	48.5	0.27
Cougar Dam Regulating Outlet	23	full	-65.63	20.64	48.74	0.26
Cougar Dam Regulating Outlet	23	q_int	-77.22	9.05	47.24	0.17
Cougar Dam Regulating Outlet	23	logq_int	-79	7.28	46.26	0.09
Cougar Dam Regulating Outlet	23	q_mfl	-82.62	3.65	46.42	0.09
Cougar Dam Regulating Outlet	23	q_rph_mfl	-79.46	6.81	46.5	0.09
Cougar Dam Regulating Outlet	23	logq_mfl	-82.24	4.03	46.23	0.09
Cougar Dam Regulating Outlet	23	mfl	-85.11	1.16	46.19	0.08
Cougar Dam Regulating Outlet	23	logq_rph_mfl	-79.01	7.26	46.27	0.08
Cougar Dam Regulating Outlet	23	rph_mfl	-82.22	4.06	46.22	0.08

RST Site	Sample Size	Model	AIC_c	Delta AIC_c	LogLik	Pseudo R^2
Cougar Dam Regulating Outlet	23	q_rph	-81.43	4.84	45.83	0.03
Cougar Dam Regulating Outlet	23	q	-84.31	1.96	45.79	0.02
Cougar Dam Regulating Outlet	23	logq_rph	-81.03	5.24	45.63	0.01
Cougar Dam Regulating Outlet	23	rph	-83.81	2.46	45.54	0.01
Cougar Dam Regulating Outlet	23	logq	-83.83	2.44	45.55	0.01
Cougar Dam Regulating Outlet	23	null	-86.27	0	45.44	NA
Detroit Head of Reservoir	18	q_int	-68.62	0.00	44.13	0.67
Detroit Head of Reservoir	18	full	-40.73	27.89	40.62	0.51
Detroit Head of Reservoir	18	full_log	-39.36	29.26	39.93	0.48
Detroit Head of Reservoir	18	q_rph_mfl	-58.98	9.64	36.99	0.22
Detroit Head of Reservoir	18	q_rph	-61.66	6.96	36.37	0.2
Detroit Head of Reservoir	18	logq_rph_mfl	-57.41	11.21	36.20	0.16
Detroit Head of Reservoir	18	logq_int	-56.50	12.12	35.75	0.15
Detroit Head of Reservoir	18	logq_rph	-60.77	7.84	35.92	0.15
Detroit Head of Reservoir	18	rph_mfl	-60.42	8.19	35.75	0.14
Detroit Head of Reservoir	18	rph	-63.65	4.96	35.68	0.13
Detroit Head of Reservoir	18	logq_mfl	-58.73	9.89	34.90	0.05
Detroit Head of Reservoir	18	logq	-62.09	6.53	34.90	0.05
Detroit Head of Reservoir	18	q	-61.56	7.06	34.64	0.01
Detroit Head of Reservoir	18	q_mfl	-58.20	10.42	34.64	0.01
Detroit Head of Reservoir	18	mfl	-61.37	7.25	34.54	0.00
Detroit Head of Reservoir	18	null	-64.28	4.34	34.54	NA
Dexter Spillway	9	full	-273.8	2.44	55.90	0.95
Dexter Spillway	9	full_log	-276.25	0.00	57.12	0.95
Dexter Spillway	9	q_rph_mfl	-63.00	213.24	46.50	0.64
Dexter Spillway	9	logq_int	-68.30	207.95	49.15	0.64
Dexter Spillway	9	q_int	-44.42	231.83	49.21	0.63
Dexter Spillway	9	logq_rph_mfl	-63.34	212.91	46.67	0.56
Dexter Spillway	9	rph_mfl	-74.08	202.17	46.04	0.56
Dexter Spillway	9	q_rph	-72.63	203.62	45.31	0.44
Dexter Spillway	9	rph	-79.80	196.44	45.30	0.42
Dexter Spillway	9	logq_rph	-72.61	203.64	45.30	0.42
Dexter Spillway	9	logq_mfl	-72.28	203.97	45.14	0.40
Dexter Spillway	9	q_mfl	-72.47	203.78	45.23	0.38
Dexter Spillway	9	logq	-78.93	197.32	44.87	0.32
Dexter Spillway	9	q	-78.75	197.5	44.77	0.28
Dexter Spillway	9	mfl	-78.27	197.98	44.53	0.17
Dexter Spillway	9	null	-81.10	195.15	43.55	NA
Fall Creek Tailrace	13	full	-97.94	9.47	87.97	0.99
Fall Creek Tailrace	13	full_log	-69.65	37.76	73.83	0.92

RST Site	Sample Size	Model	AIC_c	Delta AIC_c	LogLik	Pseudo R^2
Fall Creek Tailrace	13	logq_rph	-103.3	4.12	58.15	0.88
Fall Creek Tailrace	13	q_rph	-100.97	6.44	56.98	0.87
Fall Creek Tailrace	13	logq_mfl	-103.85	3.56	58.43	0.87
Fall Creek Tailrace	13	logq_rph_mfl	-98.28	9.13	58.43	0.87
Fall Creek Tailrace	13	q_rph_mfl	-95.5	11.91	57.03	0.86
Fall Creek Tailrace	13	logq_int	-98.85	8.56	58.71	0.86
Fall Creek Tailrace	13	logq	-107.41	0	58.04	0.86
Fall Creek Tailrace	13	q_int	-91.5	15.92	58.75	0.86
Fall Creek Tailrace	13	rph	-104.14	3.28	56.4	0.85
Fall Creek Tailrace	13	rph_mfl	-99.81	7.6	56.41	0.85
Fall Creek Tailrace	13	q	-102.74	4.67	55.7	0.83
Fall Creek Tailrace	13	q_mfl	-99.02	8.4	56.01	0.81
Fall Creek Tailrace	13	mfl	-91.82	15.6	50.24	0.13
Fall Creek Tailrace	13	null	-94.42	13	49.81	NA
Foster Head of Reservoir	26	full_log	-143.25	15.18	86.25	0.83
Foster Head of Reservoir	26	full	-142.37	16.06	85.81	0.81
Foster Head of Reservoir	26	q_rph	-158.43	0	84.17	0.76
Foster Head of Reservoir	26	q_rph_mfl	-157.19	1.23	85.1	0.74
Foster Head of Reservoir	26	logq_rph_mfl	-144.32	14.1	78.66	0.62
Foster Head of Reservoir	26	logq_rph	-147.35	11.08	78.63	0.61
Foster Head of Reservoir	26	rph_mfl	-139.4	19.03	74.65	0.5
Foster Head of Reservoir	26	rph	-142.21	16.22	74.65	0.5
Foster Head of Reservoir	26	q_int	-136.83	21.6	76.62	0.46
Foster Head of Reservoir	26	logq_int	-130.78	27.65	71.89	0.26
Foster Head of Reservoir	26	logq_mfl	-133.65	24.78	71.78	0.26
Foster Head of Reservoir	26	logq	-136.46	21.96	71.78	0.26
Foster Head of Reservoir	26	q_mfl	-130.57	27.86	70.24	0.07
Foster Head of Reservoir	26	q	-133.38	25.05	70.24	0.07
Foster Head of Reservoir	26	mfl	-132.16	26.26	69.63	0
Foster Head of Reservoir	26	null	-134.68	23.74	69.6	NA
Hills Creek Powerhouse	18	full_log	-66.10	17.99	53.30	0.74
Hills Creek Powerhouse	18	full	-66.14	17.95	53.32	0.73
Hills Creek Powerhouse	18	logq_rph_mfl	-80.44	3.65	47.72	0.57
Hills Creek Powerhouse	18	q_rph_mfl	-80.36	3.73	47.68	0.57
Hills Creek Powerhouse	18	rph_mfl	-84.10	0.00	47.59	0.55
Hills Creek Powerhouse	18	q_int	-75.68	8.42	47.66	0.53
Hills Creek Powerhouse	18	logq_int	-78.80	5.30	46.90	0.52
Hills Creek Powerhouse	18	logq_mfl	-81.83	2.26	46.46	0.51
Hills Creek Powerhouse	18	q_mfl	-81.61	2.48	46.34	0.50
Hills Creek Powerhouse	18	mfl	-83.99	0.10	45.85	0.43

RST Site	Sample Size	Model	AICc	Delta AICc	LogLik	Pseudo R^2
Hills Creek Powerhouse	18	logq_rph	-72.74	11.36	41.91	0.11
Hills Creek Powerhouse	18	logq	-74.35	9.75	41.03	0.10
Hills Creek Powerhouse	18	q_rph	-72.55	11.54	41.81	0.09
Hills Creek Powerhouse	18	rph	-75.81	8.28	41.76	0.09
Hills Creek Powerhouse	18	q	-73.90	10.2	40.81	0.07
Hills Creek Powerhouse	18	null	-75.98	8.11	40.39	NA
Lookout Point Head of Reservoir	28	full	-187.87	0	107.94	0.51
Lookout Point Head of Reservoir	28	full_log	-183.57	4.3	105.78	0.48
Lookout Point Head of Reservoir	28	q_int	-180.74	7.14	98.37	0.39
Lookout Point Head of Reservoir	28	logq_rph_mfl	-184.67	3.2	98.7	0.37
Lookout Point Head of Reservoir	28	q_rph_mfl	-184.66	3.21	98.69	0.37
Lookout Point Head of Reservoir	28	rph_mfl	-186.78	1.09	98.26	0.37
Lookout Point Head of Reservoir	28	logq_int	-182.47	5.4	97.6	0.32
Lookout Point Head of Reservoir	28	logq_rph	-181.4	6.47	95.57	0.32
Lookout Point Head of Reservoir	28	q_rph	-181.36	6.51	95.55	0.32
Lookout Point Head of Reservoir	28	rph	-183.78	4.09	95.39	0.32
Lookout Point Head of Reservoir	28	logq	-180.93	6.94	93.97	0.25
Lookout Point Head of Reservoir	28	logq_mfl	-179.72	8.16	94.73	0.24
Lookout Point Head of Reservoir	28	q	-179.41	8.46	93.2	0.17
Lookout Point Head of Reservoir	28	q_mfl	-177.35	10.52	93.55	0.16
Lookout Point Head of Reservoir	28	mfl	-176.82	11.05	91.91	0
Lookout Point Head of Reservoir	28	null	-179.34	8.53	91.91	NA
Fall Creek Head of Reservoir	12	full	50.15	84.14	28.92	0.88
Fall Creek Head of Reservoir	12	gh_int	-31.81	2.18	25.9	0.74
Fall Creek Head of Reservoir	12	rph_mfl	-30.02	3.97	21.87	0.5
Fall Creek Head of Reservoir	12	gh_rph	-29.29	4.7	21.5	0.5
Fall Creek Head of Reservoir	12	rph	-33.99	0	21.5	0.49
Fall Creek Head of Reservoir	12	gh_rph_mfl	-23.75	10.24	21.88	0.49
Fall Creek Head of Reservoir	12	gh_mfl	-29.09	4.91	21.4	0.4
Fall Creek Head of Reservoir	12	mfl	-33.75	0.24	21.37	0.37
Fall Creek Head of Reservoir	12	gh	-30.6	3.39	19.8	0.23
Fall Creek Head of Reservoir	12	null	-31.64	2.35	18.48	NA

RST Site	Sample Size	Model	AIC_c	Delta AIC_c	LogLik	Pseudo R^2
Green Peter Head of Reservoir	16	full	-183.49	0	115.74	0.99
Green Peter Head of Reservoir	16	rph_mfl	-145.79	37.7	78.71	0.74
Green Peter Head of Reservoir	16	gh_rph_mfl	-141.9	41.58	78.95	0.72
Green Peter Head of Reservoir	16	gh_rph	-138.42	45.07	75.03	0.64
Green Peter Head of Reservoir	16	rph	-142.05	41.44	75.03	0.64
Green Peter Head of Reservoir	16	gh_int	-146.7	36.79	81.35	0.53
Green Peter Head of Reservoir	16	gh_mfl	-136.88	46.6	74.26	0.32
Green Peter Head of Reservoir	16	gh	-138.17	45.32	73.08	0.3
Green Peter Head of Reservoir	16	mfl	-136.21	47.28	72.1	0.02
Green Peter Head of Reservoir	16	null	-139.05	44.43	71.99	NA
Hills Creek Head of Reservoir	9	full	-231.45	0	34.72	0.87
Hills Creek Head of Reservoir	9	gh_rph_mfl	-35.42	196.03	32.71	0.81
Hills Creek Head of Reservoir	9	gh_rph	-44.74	186.7	31.37	0.75
Hills Creek Head of Reservoir	9	gh_int	-33.65	197.8	31.82	0.69
Hills Creek Head of Reservoir	9	gh_mfl	-45.31	186.14	31.65	0.67
Hills Creek Head of Reservoir	9	gh	-45.22	186.23	28.01	0.36
Hills Creek Head of Reservoir	9	rph_mfl	-36.31	195.14	27.15	0.34
Hills Creek Head of Reservoir	9	mfl	-41.49	189.96	26.14	0.33
Hills Creek Head of Reservoir	9	rph	-38.81	192.64	24.8	0.01
Hills Creek Head of Reservoir	9	null	-43.57	187.87	24.79	NA

Discussion

The correlation analysis revealed site-specific relationships among weekly discharge, RPH, and mean fork length of released fish. While discharge and RPH were positively correlated at several sites (e.g., Breitenbush River and Dexter Spillway), weaker or negative correlations were observed at others (e.g., Cougar Regulating Outlet). These site-specific differences likely reflect local hydrodynamic conditions, trap placement, and river morphology, emphasizing the need for site-specific approaches when interpreting trap efficiency data. The generally weak correlations between mean fork length and both discharge and RPH suggest that fish size operates as an independent factor in many contexts, justifying its inclusion in trap efficiency models.

Analysis of fork length distributions identified significant differences between released and recaptured fish at several sites, suggesting potential size-selective bias at some RSTs. For instance, Hills Creek Head of Reservoir and Cougar Head of Reservoir showed significant negative group effects, suggesting smaller fish were more likely to be recaptured. Conversely, sites like Big Cliff Dam exhibited a positive group effect, suggesting a size-selective bias toward larger fish. Sites with non-significant group effects (e.g., Breitenbush River) demonstrated minimal size-selective capture, suggesting more uniform efficiency across fish sizes at these locations. While there is evidence for potential size-selective bias at some of the RSTs, group effect estimates were relatively minor (< 5 mm).

Beta regression modeling confirmed the importance of discharge, RPH, and fork length as predictors of RST efficiency, with interaction terms often resulting in lower AIC_c and higher pseudo R^2. Models incorporating log-transformed discharge frequently outperformed those with untransformed discharge, likely due to the non-linear relationship between discharge and trap efficiency. The interaction between discharge and RPH emerged as a critical determinant of efficiency, with the full models providing the highest pseudo R^2 at sites like Lookout Point Head of Reservoir and Detroit Head of Reservoir.

At some sites, particularly those with low sample sizes or consistently low trap efficiencies (e.g., Green Peter Head of Reservoir and Fall Creek Head of Reservoir), models exhibited exceptionally high pseudo R^2 values. While these results indicate excellent model fit to the observed data, they also suggest overparameterization and overfitting, with models capturing site-specific noise rather than generalizable patterns. This highlights the importance of cautious interpretation, particularly for sites with small sample sizes and limited variability in efficiency.

The performance of models including discharge, RPH, and fork length underscores the potential value of integrating these variables into future RST efficiency calculations. Furthermore, the observed site-specific differences in variable interactions and model performance emphasize the need for localized analyses rather than a one-size-fits-all approach. Site-specific correlations between environmental parameters such as discharge and RPH support that careful consideration must be applied when constructing and interpreting these models. Fisheries biologists and managers should consider the unique hydrodynamic and morphological characteristics of each site when designing monitoring protocols and interpreting efficiency estimates.

The Army Corps of Engineers has requested that data be collected to calculate the percent discharge sampled by RSTs daily and during TE trials so that this metric can be incorporated into subsequent analyses. This approach has been used in other RST studies to predict trap efficiencies (Voss and Poytress 2020). To assess its utility, we will model the relationship between discharge, reveloutions per hour (RPH), and percent discharge to determine if percent discharge provides additional explanatory power relative to the more easily collected discharge and RPH data. If so, we will include this covariate in subsequent TE modeling and report the results.

Several hierarchical Bayesian models have been developed that address the types of issues commonly associated with sparse and missing mark-recapture data (Bonner and Schwarz 2011; Oldemeyer et al. 2018). The hierarchical model structures allow for the sharing of trap efficiency and run information within, or between, years and produce precise and relatively accurate estimates, even with sparse or missing data. Developing hierarchical Bayesian models that incorporate the covariates discussed in this technical report could prove to be a robust approach for estimating trap efficiencies, and subsequent abundances of wild fish, for sites throughout the Willamette River basin.

Table E-4. Summary table of marked hatchery Chinook released in the Willamette Valley for trapping efficiency trials since 2021.

Release Location	Date of Release	Flow at Release	# of Fish Released	# of Fish Recaptured	% Efficiency
Breitenbush River	6/21/2023	231.0	749	53	7.1%
Breitenbush River	7/6/2023	525.0	763	25	3.3%
Breitenbush River	8/2/2023	2230.0	791	12	1.5%
Breitenbush River	9/20/2023	776.0	756	7	0.9%
Breitenbush River	10/5/2023	370.0	789	18	2.3%
Breitenbush River	10/25/2023	539.0	750	51	6.8%
Breitenbush River	11/10/2023	820.0	750	152	20.3%
Breitenbush River	11/21/2023	405.0	900	55	6.1%
Breitenbush River	2/7/2024	730.0	750	15	2.0%
Breitenbush River	2/21/2024	715.0	750	135	18.0%
Breitenbush River	3/6/2024	540.0	748	78	10.4%
Breitenbush River	3/25/2024	822.0	243	11	4.5%
Breitenbush River	5/15/2024	819.0	692	9	1.3%
Breitenbush River	6/25/2024	297.0	752	45	6.0%
Breitenbush River	7/16/2024	188.0	764	18	2.3%
Breitenbush River	8/2/2024	151.0	684	16	2.3%
Breitenbush River	9/10/2024	122.0	774	11	1.4%
Breitenbush River	10/30/2024	193.0	786	29	3.7%
Breitenbush River	11/26/2024	750.0	718	120	16.7%
Detroit Head of Reservoir- North Santiam	6/6/2023	833.0	540	28	5.2%
Detroit Head of Reservoir- North Santiam	6/20/2023	653.0	750	61	8.1%
Detroit Head of Reservoir- North Santiam	7/6/2023	171.0	750	13	1.7%
Detroit Head of Reservoir- North Santiam	8/2/2023	431.0	750	19	2.5%
Detroit Head of Reservoir- North Santiam	9/6/2023	1800.0	700	19	2.7%
Detroit Head of Reservoir- North Santiam	10/5/2023	135.0	750	24	3.2%
Detroit Head of Reservoir- North Santiam	10/25/2023	289.0	757	72	9.5%
Detroit Head of Reservoir- North Santiam	11/10/2023	578.0	813	91	11.2%
Detroit Head of Reservoir- North Santiam	11/21/2023	601.0	1,014	111	10.9%
Detroit Head of Reservoir- North Santiam	2/7/2024	1290.0	749	8	1.1%

Release Location	Date of Release	Flow at Release	# of Fish Released	# of Fish Recaptured	% Efficiency
Detroit Head of Reservoir- North Santiam	2/21/2024	1030.0	749	117	15.6%
Detroit Head of Reservoir- North Santiam	3/6/2024	968.0	751	83	11.0%
Detroit Head of Reservoir- North Santiam	5/15/2024	1400.0	749	30	4.0%
Detroit Head of Reservoir- North Santiam+	6/6/2024	1200.0	450	13	2.9%
Detroit Head of Reservoir- North Santiam	6/18/2024	786.0	836	32	3.8%
Detroit Head of Reservoir- North Santiam	7/19/2024	492.0	843	39	4.6%
Detroit Head of Reservoir- North Santiam	8/2/2024	470.0	749	30	4.0%
Detroit Head of Reservoir- North Santiam	9/5/2024	401.0	733	21	2.9%
Detroit Head of Reservoir- North Santiam	10/30/2024	492.0	750	90	12.0%
Detroit Head of Reservoir- North Santiam	11/15/2024	998.0	686	110	16.0%
Big Cliff Dam Tailrace*	12/22/2021	3080.0	997	39	3.9%
Big Cliff Dam Tailrace*	5/25/2022	3050.0	995	21	2.1%
Big Cliff Dam Tailrace*	8/9/2022	1060.0	1000	92	9.2%
Big Cliff Dam Tailrace*	9/30/2022	1590.0	995	48	4.8%
Big Cliff Dam Tailrace*	10/13/2022	2820.0	500	15	3.0%
Big Cliff Dam Tailrace*	10/24/2022	5520.0	535	25	4.7%
Big Cliff Dam Tailrace*	11/2/2022	5450.0	949	40	4.2%
Big Cliff Dam Tailrace*	11/16/2022	2790.0	509	15	2.9%
Big Cliff Dam Tailrace*	12/14/2022	1380.0	502	60	12.0%
Big Cliff Dam Tailrace*	12/19/2022	1330.0	1010	92	9.1%
Big Cliff Dam Tailrace*	12/21/2022	1350.0	1014	33	3.3%
Big Cliff Dam Tailrace*	12/27/2022	1520.0	704	47	6.7%
Big Cliff Dam Tailrace*	12/29/2022	1480.0	452	22	4.9%
Big Cliff Dam Tailrace*	1/25/2023	1330.0	500	56	11.2%
Big Cliff Dam Tailrace*	2/17/2023	1470.0	499	38	7.6%
Big Cliff Dam Tailrace**	3/7/2023	1080.0	2,968	61	2.1%
Big Cliff Dam Tailrace*	3/10/2023	1180.0	541	112	20.7%
Big Cliff Dam Tailrace*	4/28/2023	1310.0	498	34	6.8%
Big Cliff Dam Tailrace*	5/23/2023	2440.0	500	6	1.2%
Big Cliff Dam Tailrace*	6/21/2023	2740.0	500	8	1.6%
Big Cliff Dam Tailrace*	7/5/2023	1580.0	500	33	6.6%
Big Cliff Dam Tailrace*	8/3/2023	1080.0	474	42	8.9%

Release Location	Date of Release	Flow at Release	# of Fish Released	# of Fish Recaptured	% Efficiency
Big Cliff Dam Tailrace*	9/19/2023	1580.0	424	64	15.1%
Big Cliff Dam Tailrace*	10/6/2023	1590.0	500	56	11.2%
Big Cliff Dam Tailrace	10/25/2023	1730.0	633	99	15.6%
Big Cliff Dam Tailrace	11/16/2023	4050.0	527	0	0.0%
Big Cliff Dam Tailrace	11/21/2023	3450.0	500	30	6.0%
Big Cliff Dam Tailrace	12/28/2023	1990.0	550	56	10.2%
Big Cliff Dam Tailrace	2/14/2024	1550.0	500	16	3.2%
Big Cliff Dam Tailrace	2/21/2024	1060.0	464	52	11.2%
Big Cliff Dam Tailrace	3/6/2024	1810.0	556	18	3.2%
Big Cliff Dam Tailrace**	3/7/2024	1820.0	1,959	1	0.05%
Big Cliff Dam Tailrace	3/12/2024	1780.0	550	18	3.3%
Big Cliff Dam Tailrace	5/7/2024	3310.0	493	1	0.2%
Big Cliff Dam Tailrace	6/18/2024	1440.0	499	18	3.6%
Big Cliff Dam Tailrace	7/26/2024	1300.0	497	23	4.6%
Big Cliff Dam Tailrace	8/16/2024	1080.0	500	48	9.6%
Big Cliff Dam Tailrace	9/5/2024	1640.0	500	31	6.2%
Big Cliff Dam Tailrace	9/11/2024	1610.0	1,054	80	7.6%
Big Cliff Dam Tailrace	10/30/2024	2230.0	500	24	4.8%
Big Cliff Dam Tailrace	11/15/2024	4600.0	500	17	3.4%
Big Cliff Dam Tailrace	12/03/2024	1300.0	500	89	17.8%
Green Peter Head of Reservoir- Middle Santiam (dead fish)	6/7/2023	2.0	1,000	0	0.0%
Green Peter Head of Reservoir- Middle Santiam	6/7/2023	2.0	750	1	0.1%
Green Peter Head of Reservoir- Middle Santiam	7/28/2023	1.0	750	0	0.0%
Green Peter Head of Reservoir- Middle Santiam	8/30/2023	0.9	749	0	0.0%
Green Peter Head of Reservoir- Middle Santiam	9/27/2023	1.3	741	0	0.0%
Green Peter Head of Reservoir- Middle Santiam	10/11/2023	2.9	750	0	0.0%
Green Peter Head of Reservoir- Middle Santiam	10/31/2023	1.5	750	0	0.0%
Green Peter Head of Reservoir- Middle Santiam (dead fish)	10/31/2023	1.5	1,000	0	0.0%
Green Peter Head of Reservoir- Middle Santiam	11/15/2023	2.5	749	1	0.1%
Green Peter Head of Reservoir- Middle Santiam	2/8/2024	3.2	753	4	0.5%

Release Location	Date of Release	Flow at Release	# of Fish Released	# of Fish Recaptured	% Efficiency
Green Peter Head of Reservoir- Middle Santiam+	3/6/2024	3.1	2500	26	1.0%
Green Peter Head of Reservoir- Middle Santiam	3/14/2024	3.4	800	4	0.5%
Green Peter Head of Reservoir- Middle Santiam	4/2/2024	3.4	754	2	0.3%
Green Peter Head of Reservoir- Middle Santiam (dead fish)	4/2/2024	3.4	1,002	1	0.1%
Green Peter Head of Reservoir- Middle Santiam+	4/12/2024	3.0	2,500	23	0.9%
Green Peter Head of Reservoir- Middle Santiam (dead fish)	4/19/2024	2.6	1,000	0	0.0%
Green Peter Head of Reservoir- Middle Santiam	5/15/2024	3.2	998	35	3.5%
Green Peter Head of Reservoir- Middle Santiam	6/5/2024	3.5	1083	10	0.9%
Green Peter Head of Reservoir- Middle Santiam	7/9/2024	1.4	1,001	0	0.0%
Green Peter Head of Reservoir- Middle Santiam	8/14/2024	1.0	1,001	0	0.0%
Green Peter Head of Reservoir- Middle Santiam	9/10/2024	0.9	999	0	0.0%
Green Peter Head of Reservoir- Middle Santiam	10/9/2024	0.8	998	0	0.0%
Green Peter Head of Reservoir- Middle Santiam	11/5/2024	2.7	996	3	0.3%
Green Peter Head of Reservoir- Middle Santiam (dead fish)	11/12/2024	2.8	1,000	1	0.1%
Green Peter Dam Tailrace- Spill*	3/29/2022	970.0	643	4	0.6%
Green Peter Dam Tailrace- Spill*	4/30/2022	1310.0	518	9	1.7%
Green Peter Dam Tailrace- Spill*	5/11/2023	1910.0	999	9	0.9%
Green Peter Dam Tailrace- Spill (dead fish) *	5/11/2023	1910.0	1,001	0	0.0%
Green Peter Dam Tailrace- PH*	5/25/2023	1980.0	1,000	10	1.0%
Green Peter Dam Tailrace- PH*	6/30/2023	2000.0	1,000*	9	0.9%

Release Location	Date of Release	Flow at Release	# of Fish Released	# of Fish Recaptured	% Efficiency
Green Peter Dam Tailrace- PH (dead fish)*	6/30/2023	50	1,000	10	1.00%
Green Peter Dam Tailrace- PH*	7/27/2023	49.4	1,009	13	1.3%
Green Peter Dam Tailrace- PH*	8/16/2023	3905.0	1,008	7	0.7%
Green Peter Dam Tailrace- PH*	8/31/2023	34.6	1,000	8	0.8%
Green Peter Dam Tailrace- PH*	10/4/2023	3060.0	1,005	0	0.0%
Green Peter Dam Tailrace*	11/1/2023	1430.0	1,000	22	2.2%
Green Peter Dam Tailrace*	11/14/2023	1300.0	1,000	7	0.7%
Green Peter Dam Tailrace- Spill*	11/29/2023	630.0	1,000	28	2.8%
Green Peter Dam Tailrace- Spill (dead fish)*	11/29/2023	630.0	3,999	11	0.3%
Green Peter Dam Tailrace*	12/8/2023	3700.0	1,000	25	2.5%
Green Peter Dam Tailrace- Spill*	12/19/2023	50.0	1,000	3	0.3%
Green Peter Dam Tailrace- PH	1/9/2024	3590.0	1,003	9	0.9%
Green Peter Dam Tailrace- Spill	2/16/2024	500.0	1,000	1	0.1%
Green Peter Dam Tailrace- PH	3/26/2024	2120.0	1,014	1	0.1%
Green Peter Dam Tailrace- Spill	3/26/2024	1100.0	1,004	2	0.2%
Green Peter Dam Tailrace- Spill (dead fish)	3/26/2024	1100.0	3,000	0	0.0%
Green Peter Dam Tailrace- Spill	4/18/2024	1270.0	1,011	3	0.3%
Green Peter Dam Tailrace- Spill (dead fish)	4/24/2024	1270.0	3,000	2	0.1%
Green Peter Dam Tailrace- Spill	4/24/2024	1270.0	1,000	2	0.2%
Green Peter Dam Tailrace- PH	6/11/2024	1890.0	1,000	3	0.3%
Green Peter Dam Tailrace- PH	6/18/2024	2010.0	1,001	1	0.1%
Green Peter Dam Tailrace- PH	8/7/2024	2009.0	1,000	12	1.2%
Green Peter Dam Tailrace- PH	8/21/2024	1097.0	1,000	2	0.2%
Green Peter Dam Tailrace- PH	9/4/2024	2070.0	999	0	0.0%
Green Peter Dam Tailrace- PH	10/1/2024	2000.0	1,000	14	1.4%
Green Peter Dam Tailrace- Spill	10/30/2024	2400.0	1,003	28	2.8%

Release Location	Date of Release	Flow at Release	# of Fish Released	# of Fish Recaptured	% Efficiency
Green Peter Dam Tailrace- Spill	11/1/2024	2500.0	1,000	21	2.1%
Green Peter Dam Tailrace- Spill	12/11/2024	800.0	1,000	6	0.6%
Foster Dam Head of Reservoir- South Santiam*	9/29/2022	51.0	1,063	0	0.0%
Foster Dam Head of Reservoir- South Santiam*	10/25/2022	211.0	821	116	14.1%
Foster Dam Head of Reservoir- South Santiam*	11/1/2022	261.0	1006	263	26.1%
Foster Dam Head of Reservoir- South Santiam*	11/9/2022	560.0	1007	68	6.8%
Foster Dam Head of Reservoir- South Santiam*	11/15/2022	240.0	1009	55	5.5%
Foster Dam Head of Reservoir- South Santiam*	11/22/2022	165.0	933	163	17.5%
Foster Dam Head of Reservoir- South Santiam*	2/27/2023	376.0	1,002	21	2.1%
Foster Dam Head of Reservoir- South Santiam*	3/9/2023	313.0	995	62	6.2%
Foster Dam Head of Reservoir- South Santiam*	3/15/2023	966.0	1,025	0	0.0%
Foster Dam Head of Reservoir- South Santiam*	5/11/2023	1130.0	985	20	2.0%
Foster Dam Head of Reservoir- South Santiam*	6/2/2023	317.0	1,003	79	7.9%
Foster Dam Head of Reservoir- South Santiam*	6/29/2023	89.0	1,000	22	2.2%
Foster Dam Head of Reservoir- South Santiam*	7/27/2023	1980.0	989	0	0.0%
Foster Dam Head of Reservoir- South Santiam*	8/31/2023	1630.0	1,000	0	0.0%
Foster Dam Head of Reservoir- South Santiam*	9/27/2023	48.1	1,000	6	0.6%
Foster Dam Head of Reservoir- South Santiam*	10/10/2023	50.6	1,016	55	5.4%
Foster Dam Head of Reservoir- South Santiam*	11/14/2023	446.0	1,000	102	10.2%

Release Location	Date of Release	Flow at Release	# of Fish Released	# of Fish Recaptured	% Efficiency
Foster Dam Head of Reservoir- South Santiam*	11/22/2023	321.0	1,001	79	7.9%
Foster Dam Head of Reservoir- South Santiam	2/2/2024	1290.0	1,005	46	4.6%
Foster Dam Head of Reservoir- South Santiam	3/19/2024	1310.0	1,000	12	1.2%
Foster Dam Head of Reservoir- South Santiam	4/3/2024	923.0	1,003	16	1.6%
Foster Dam Head of Reservoir- South Santiam+	4/4/2024	774.0	1,909	28	1.5%
Foster Dam Head of Reservoir- South Santiam	5/15/2024	753.0	999	30	3.0%
Foster Dam Head of Reservoir- South Santiam	6/5/2024	1160.0	1,000	5	0.5%
Foster Dam Head of Reservoir- South Santiam	8/13/2024	53.2	998	0	0.0%
Foster Dam Head of Reservoir- South Santiam	8/22/2024	50.6	999	0	0.0%
Foster Dam Head of Reservoir- South Santiam	9/18/2024	44.5	1,005	0	0.0%
Foster Dam Head of Reservoir- South Santiam	10/2/2024	36.6	1,000	0	0.0%
Foster Dam Head of Reservoir- South Santiam	11/8/2024	285.0	1,000	16	1.6%
Cougar Head of Reservoir*	3/8/2022	774.0	806	40	5.0%
Cougar Head of Reservoir*	5/19/2022	1385.0	498	23	4.6%
Cougar Head of Reservoir*	6/23/2022	711.0	486	7	1.4%
Cougar Head of Reservoir*	9/22/2022	225.0	551	56	10.2%
Cougar Head of Reservoir*	10/5/2022	207.0	608	47	7.7%
Cougar Head of Reservoir*	11/10/2022	340.0	704	33	4.7%
Cougar Head of Reservoir*	11/16/2022	259.0	719	28	3.9%
Cougar Head of Reservoir*	11/23/2022	292.0	752	48	6.4%
Cougar Head of Reservoir*	11/29/2022	295.0	620	48	7.7%

Release Location	Date of Release	Flow at Release	# of Fish Released	# of Fish Recaptured	% Efficiency
Cougar Head of Reservoir*	4/14/2023	482.0	506	10	2.0%
Cougar Head of Reservoir*	5/10/2023	950.0	508	7	1.4%
Cougar Head of Reservoir*	5/16/2023	1140.0	497	23	4.6%
Cougar Head of Reservoir*	6/8/2023	1670.0	510	23	4.5%
Cougar Head of Reservoir*	7/27/2023	486.0	758	27	3.6%
Cougar Head of Reservoir**	8/30/2023	211.0	5,151	127	2.5%
Cougar Head of Reservoir*	9/21/2023	194.0	745	41	5.5%
Cougar Head of Reservoir*	10/19/2023	211.0	750	42	5.6%
Cougar Head of Reservoir*	11/14/2023	343.0	756	21	2.8%
Cougar Head of Reservoir*	11/28/2023	266.0	760	67	8.8%
Cougar Head of Reservoir	2/6/2024	894.0	768	53	6.9%
Cougar Head of Reservoir	3/12/2024	720.0	756	26	3.4%
Cougar Head of Reservoir	4/1/2024	760.0	754	24	3.2%
Cougar Head of Reservoir	5/22/2024	859.0	760	41	5.4%
Cougar Head of Reservoir	6/12/2024	445.0	750	17	2.3%
Cougar Head of Reservoir	7/10/2024	256.0	749	20	2.5%
Cougar Head of Reservoir	10/8/2024	194.0	751	27	3.6%
Cougar Head of Reservoir	11/25/2024	807.0	749	33	4.4%
Cougar Dam Tailrace-PH*	1/19/2022	925.0	405	37	9.1%
Cougar Dam Tailrace-PH*	4/20/2022	860.0	357	67	18.8%
Cougar Dam Tailrace-PH*	7/19/2022	310.0	495	148	29.9%
Cougar Dam Tailrace-PH*	8/11/2022	700.0	501	29	5.8%
Cougar Dam Tailrace-PH*	1/12/2023	500.0	843	159	18.9%
Cougar Dam Tailrace-PH*	3/23/2023	500.0	500	49	9.8%
Cougar Dam Tailrace-PH*	3/30/2023	490.0	497	95	19.1%
Cougar Dam Tailrace-PH*	4/18/2023	585.0	297	14	4.7%

Release Location	Date of Release	Flow at Release	# of Fish Released	# of Fish Recaptured	% Efficiency
Cougar Dam Tailrace-PH*	5/10/2023	750.0	499	5	1.0%
Cougar Dam Tailrace-PH*	6/6/2023	370.0	507	65	12.8%
Cougar Dam Tailrace-PH*	7/26/2023	370.0	510	63	12.4%
Cougar Dam Tailrace-PH*	9/21/2023	350.0	500	53	10.6%
Cougar Dam Tailrace-PH*	10/11/2023	2.7	500	83	16.6%
Cougar Dam Tailrace-PH	1/30/2024	1000.0	502	70	13.9%
Cougar Dam Tailrace-PH	2/7/2024	1000.0	493	43	8.7%
Cougar Dam Tailrace-PH	3/11/2024	650.0	499	33	6.6%
Cougar Dam Tailrace-PH	4/4/2024	1010.0	501	33	6.6%
Cougar Dam Tailrace-PH	5/22/2024	330.0	500	38	7.6%
Cougar Dam Tailrace-PH	6/12/2024	500.0	501	102	20.4%
Cougar Dam Tailrace-PH	7/10/2024	300.0	503	94	18.7%
Cougar Dam Tailrace-RO*	1/19/2022	1000.0	410	26	6.3%
Cougar Dam Tailrace-RO*	4/20/2022	400.0	378	16	4.2%
Cougar Dam Tailrace-RO*	5/15/2022	2570.0	987	64	6.5%
Cougar Dam Tailrace-RO*	10/14/2022	890.0	442	49	11.1%
Cougar Dam Tailrace-RO*	11/22/2022	350.0	504	24	4.8%
Cougar Dam Tailrace-RO*	12/13/2022	430.0	506	42	8.3%
Cougar Dam Tailrace-RO*	12/15/2022	360.0	1015	56	5.5%
Cougar Dam Tailrace-RO*	12/20/2022	360.0	500	61	12.2%
Cougar Dam Tailrace-RO*	12/28/2022	900.0	443	14	3.2%
Cougar Dam Tailrace-RO*	1/30/2023	500.0	509	6	1.2%
Cougar Dam Tailrace-RO*	3/23/2023	810.0	511	3	0.6%
Cougar Dam Tailrace-RO*	3/30/2023	800.0	491	31	6.3%
Cougar Dam Tailrace-RO*	4/18/2023	800.0	501	2	0.4%
Cougar Dam Tailrace-RO*	5/10/2023	600.0	499	0	0.0%

Release Location	Date of Release	Flow at Release	# of Fish Released	# of Fish Recaptured	% Efficiency
Cougar Dam Tailrace-RO*	10/11/2023	290.0	518	14	2.7%
Cougar Dam Tailrace-RO*	11/8/2023	1100.0	508	43	8.5%
Cougar Dam Tailrace-RO*	11/30/2023	310.0	505	26	5.1%
Cougar Dam Tailrace-RO	12/18/2023	1200.0	505	2	0.4%
Cougar Dam Tailrace-RO	1/11/2024	890.0	505	65	12.9%
Cougar Dam Tailrace-RO	2/7/2024	2000.0	505	9	1.8%
Cougar Dam Tailrace-RO	3/12/2024	720.0	499	16	3.2%
Cougar Dam Tailrace-RO	4/1/2024	950.0	502	52	10.4%
Cougar Dam Tailrace-RO	10/8/2024	480.0	501	19	3.8%
Cougar Dam Tailrace-RO	11/15/2024	700.0	500	12	2.4%
Fall Creek Head of Reservoir*	5/5/2023	3.8	756	15	2.0%
Fall Creek Head of Reservoir*	5/10/2023	3.8	750	23	3.1%
Fall Creek Head of Reservoir*	5/18/2023	3.5	511	7	1.4%
Fall Creek Head of Reservoir*	5/24/2023	3.3	760	4	0.5%
Fall Creek Head of Reservoir	1/2/2024	3.8	755	137	18.1%
Fall Creek Head of Reservoir	2/2/2024	4.1	751	51	6.8%
Fall Creek Head of Reservoir	3/5/2024	4.2	750	74	9.9%
Fall Creek Head of Reservoir	3/26/2024	3.9	998	99	9.9%
Fall Creek Head of Reservoir	4/15/2024	4.1	2,000	241	12.1%
Fall Creek Head of Reservoir	5/21/2024	3.5	749	24	3.2%
Fall Creek Head of Reservoir	5/29/2024	3.4	749	111	14.8%
Fall Creek Head of Reservoir	6/13/2024	3.4	750	120	16.0%
Fall Creek Dam Tailrace-RO*	6/8/2022	957.0	517	11	2.1%
Fall Creek Dam Tailrace-RO*	6/30/2022	231.0	513	0	0.0%
Fall Creek Dam Tailrace-RO*	7/13/2022	228.0	498	0	0.0%
Fall Creek Dam Tailrace-RO*	5/11/2023	83.0	998	0	0.0%

Release Location	Date of Release	Flow at Release	# of Fish Released	# of Fish Recaptured	% Efficiency
Fall Creek Dam Tailrace-RO*	6/28/2023	3240.0	992	0	0.0%
Fall Creek Dam Tailrace-RO	10/3/2023	103.0	1,006	0	0.0%
Fall Creek Dam Tailrace-RO	10/17/2023	2,630	1,020	14	1.40%
Fall Creek Dam Tailrace-RO	7/11/2023	460.0	1,011	0	0.0%
Fall Creek Dam Tailrace-RO	1/22/2024	1028.0	999	12	1.2%
Fall Creek Dam Tailrace-RO	2/13/2024	1700.0	1,004	48	4.8%
Fall Creek Dam Tailrace-RO	3/5/2024	1000.0	1,001	14	1.4%
Fall Creek Dam Tailrace-RO	3/26/2024	55.0	1,600	0	0.0%
Fall Creek Dam Tailrace-RO	4/8/2024	124.0	2,000	0	0.0%
Hills Creek Head of Reservoir- Middle Fork Willamette	5/18/2023	11.1	519	44	8.5%
Hills Creek Head of Reservoir- Middle Fork Willamette	6/19/2023	9.0	760	6	0.8%
Hills Creek Head of Reservoir- Middle Fork Willamette	2/15/2024	10.0	761	0	0.0%
Hills Creek Head of Reservoir- Middle Fork Willamette	2/20/2024	10.1	749	18	2.4%
Hills Creek Head of Reservoir- Middle Fork Willamette	3/20/2024	10.8	752	16	2.1%
Hills Creek Head of Reservoir- Middle Fork Willamette	4/9/2024	9.5	2,001	9	0.4%
Hills Creek Head of Reservoir- Middle Fork Willamette	5/1/2024	9.8	750	32	4.3%
Hills Creek Head of Reservoir- Middle Fork Willamette	5/23/2024	9.6	749	11	1.5%
Hills Creek Head of Reservoir- Middle Fork Willamette	6/20/2024	8.9	750	7	0.9%
Hills Creek Dam Tailrace- PH*	1/6/2022	810.0	596	20	3.4%
Hills Creek Dam Tailrace- PH*	2/16/2022	410.0	600	12	2.0%
Hills Creek Dam Tailrace- PH*	2/25/2022	410.0	604	6	1.0%
Hills Creek Dam Tailrace- PH*	12/7/2022	890.0	514	29	5.6%

Release Location	Date of Release	Flow at Release	# of Fish Released	# of Fish Recaptured	% Efficiency
Hills Creek Dam Tailrace- PH*	2/25/2023	910.0	519	15	2.9%
Hills Creek Dam Tailrace- PH*	4/26/2023	540.0	506	62	12.3%
Hills Creek Dam Tailrace- PH*	5/17/2023	440.0	505	57	11.3%
Hills Creek Dam Tailrace- PH*	6/3/2023	710.0	508	36	7.1%
Hills Creek Dam Tailrace- PH*	6/27/2023	720.0	507	22	4.3%
Hills Creek Dam Tailrace- PH	9/27/2023	400.0	510	9	1.8%
Hills Creek Dam Tailrace- PH	10/17/2023	460.0	509	8	1.6%
Hills Creek Dam Tailrace- PH	10/31/2023	470.0	503	8	1.6%
Hills Creek Dam Tailrace- PH	11/15/2023	660.0	500	46	9.2%
Hills Creek Dam Tailrace- PH	1/23/2024	910.0	505	8	1.6%
Hills Creek Dam Tailrace- PH	2/22/2024	410.0	1,473	31	2.1%
Hills Creek Dam Tailrace- PH	3/13/2024	430.0	1,494	11	0.7%
Hills Creek Dam Tailrace- PH	4/11/2024	830.0	3,996	68	1.7%
Hills Creek Dam Tailrace- PH	6/4/2024	200.0	1,250	45	3.6%
Hills Creek Dam Tailrace PH- RO Trial*	1/6/2022	810.0	596	5	0.8%
Hills Creek Dam Tailrace PH- RO Trial*	2/16/2022	410.0	600	0	0.0%
Hills Creek Dam Tailrace PH- RO Trial*	2/25/2022	410.0	604	1	0.2%
Hills Creek Dam Tailrace PH- RO Trial*	12/7/2022	890.0	514	3	0.6%
Hills Creek Dam Tailrace PH- RO Trial*	2/25/2023	910.0	519	0	0.0%
Hills Creek Dam Tailrace PH- RO Trial*	4/26/2023	530.0	506	12	2.4%
Hills Creek Dam Tailrace PH- RO Trial*	5/17/2023	450.0	505	2	0.4%
Hills Creek Dam Tailrace PH- RO Trial*	6/3/2023	710.0	508	2	0.4%
Hills Creek Dam Tailrace PH- RO Trial*	6/27/2023	720.0	507	0	0.0%
Hills Creek Dam Tailrace PH- RO Trial	9/27/2023	400.0	510	1	0.2%
Hills Creek Dam Tailrace PH- RO Trial	10/17/2023	2630.0	509	0	0.0%
Hills Creek Dam Tailrace PH- RO Trial	10/31/2023	461.0	503	2	0.4%

Release Location	Date of Release	Flow at Release	# of Fish Released	# of Fish Recaptured	% Efficiency
Hills Creek Dam Tailrace PH- RO Trial	11/15/2023	660.0	500	1	0.2%
Hills Creek Dam Tailrace PH- RO Trial	2/22/2024	420.0	1,473	0	0.0%
Hills Creek Dam Tailrace PH- RO Trial	3/13/2024	450.0	1,494	0	0.0%
Hills Creek Dam Tailrace PH- RO Trial	4/11/2024	830.0	3,996	6	0.2%
Hills Creek Dam Tailrace PH- RO Trial	6/4/2024	200.0	1,250	6	0.5%
Hills Creek Dam Tailrace- RO*	1/6/2022	820.0	605	13	2.1%
Hills Creek Dam Tailrace- RO*	2/16/2022	410.0	593	19	3.2%
Hills Creek Dam Tailrace- RO*	2/25/2022	420.0	625	6	1.0%
Hills Creek Dam Tailrace- RO*	12/13/2022	610.0	516	1	0.2%
Hills Creek Dam Tailrace- RO*	2/25/2023	870.0	478	0	0.0%
Hills Creek Dam Tailrace- RO*	6/13/2023	500.0	760	0	0.0%
Hills Creek Dam Tailrace- RO	11/21/2023	1800.0	503	3	0.6%
Hills Creek Dam Tailrace- RO	11/29/2023	1800.0	504	2	0.4%
Hills Creek Dam Tailrace- RO	12/26/2023	110.0	505	10	2.0%
Hills Creek Dam Tailrace- RO	1/4/2024	100.0	503	5	1.0%
Lookout Point Head of Reservoir- Middle Fork Willamette*	4/5/2022	3620.0	993	53	5.3%
Lookout Point Head of Reservoir- Middle Fork Willamette*	4/14/2022	3821.0	987	19	1.9%
Lookout Point Head of Reservoir- Middle Fork Willamette*	5/18/2022	4100.0	1004	125	12.5%
Lookout Point Head of Reservoir- Middle Fork Willamette*	7/20/2022	1110.0	1005	9	0.9%
Lookout Point Head of Reservoir- Middle Fork Willamette*	10/27/2022	1680.0	506	9	1.8%
Lookout Point Head of Reservoir- Middle Fork Willamette*	11/17/2022	1520.0	510	0	0.0%
Lookout Point Head of Reservoir- Middle Fork Willamette*	12/12/2022	1510.0	510	0	0.0%
Lookout Point Head of Reservoir- Middle Fork Willamette*	1/13/2023	3040.0	516	10	1.9%

Release Location	Date of Release	Flow at Release	# of Fish Released	# of Fish Recaptured	% Efficiency
Lookout Point Head of Reservoir- Middle Fork Willamette*	6/2/2023	2690.0	760	15	2.0%
Lookout Point Head of Reservoir- Middle Fork Willamette*	6/15/2023	1550.0	765	6	0.8%
Lookout Point Head of Reservoir- Middle Fork Willamette*	6/29/2023	92.9	769	2	0.3%
Lookout Point Head of Reservoir- Middle Fork Willamette*	7/19/2023	932.0	765	0	0.0%
Lookout Point Head of Reservoir- Middle Fork Willamette*	8/22/2023	1350.0	677	13	1.9%
Lookout Point Head of Reservoir- Middle Fork Willamette*	8/31/2023	3950.0	751	0	0.0%
Lookout Point Head of Reservoir- Middle Fork Willamette*	9/20/2023	103.0	787	1	0.1%
Lookout Point Head of Reservoir- Middle Fork Willamette*	10/26/2023	1220.0	755	0	0.0%
Lookout Point Head of Reservoir- Middle Fork Willamette*	11/15/2023	1600.0	755	3	0.4%
Lookout Point Head of Reservoir- Middle Fork Willamette*	11/29/2023	3020.0	760	2	0.3%
Lookout Point Head of Reservoir- Middle Fork Willamette	12/19/2023	5720.0	1,504	9	0.6%
Lookout Point Head of Reservoir- Middle Fork Willamette	1/3/2024	2010.0	1,505	2	0.1%
Lookout Point Head of Reservoir- Middle Fork Willamette	2/14/2024	2120.0	761	2	0.3%
Lookout Point Head of Reservoir- Middle Fork Willamette	3/13/2024	3170.0	1,498	15	1.0%
Lookout Point Head of Reservoir- Middle Fork Willamette	4/8/2024	2670.0	1,997	7	0.4%
Lookout Point Head of Reservoir- Middle Fork Willamette	4/15/204	4130.0	2,002	20	1.0%
Lookout Point Head of Reservoir- Middle Fork Willamette	5/1/2024	4620.0	751	35	4.7%
Lookout Point Head of Reservoir- Middle Fork Willamette	5/23/2024	2440.0	751	14	1.9%

Release Location	Date of Release	Flow at Release	# of Fish Released	# of Fish Recaptured	% Efficiency
Lookout Point Head of Reservoir- Middle Fork Willamette	6/19/2024	1300.0	756	0	0.0%
Lookout Point Head of Reservoir- Middle Fork Willamette	9/5/2024	1885.0	750	6	0.8%
Lookout Dam Tailrace-PH*	4/13/2022	2925.0	1000	0	0.0%
Lookout Dam Tailrace-PH*	5/23/2023	2900.0	3,999	32	0.8%
Lookout Dam Tailrace-PH*	6/1/2023	2950.0	4,011	6	0.1%
Lookout Dam Tailrace-PH*	6/14/2023	3130.0	4,010	4	0.1%
Lookout Dam Tailrace-PH*	6/28/2023	1340.0	4,010	3	0.1%
Lookout Dam Tailrace-PH*	7/18/2023	2700.0	4,012	9	0.2%
Lookout Dam Tailrace-PH	12/20/2023	4962.5	16,007	29	0.2%
Lookout Dam Tailrace-PH	1/10/2024	6986.0	17,553	3	0.0%
Lookout Dam Tailrace-Spill	9/13/2023	1850.0	3,636	0	0.0%
Lookout Dam Tailrace-Spill	9/14/2023	1850.0	3,998	0	0.0%
Lookout Dam Tailrace-Spill	10/25/2023	1630.0	4,042	0	0.0%
Lookout Dam Tailrace-Spill	11/16/2023	1600.0	4,005	12	0.3%
Lookout Dam Tailrace-Spill	12/6/2023	2450.0	8,007	18	0.2%
Lookout Dam Tailrace-Spill	12/13/2023	6900.0	8,011	148	1.8%
Lookout Dam Tailrace-Spill	3/27/2024	3600.0	7,800	11	0.1%
Lookout Dam Tailrace-Spill	4/3/2024	3100.0	6,599	7	0.1%
Dexter Dam Tailrace-PH*	7/21/2022	1560.0	976	2	0.2%
Dexter Dam Tailrace-PH*	10/26/2022	2950.0	1007	1	0.1%
Dexter Dam Tailrace-PH*	11/1/2022	3670.0	755	1	0.1%
Dexter Dam Tailrace-PH*	11/17/2022	3450.0	991	4	0.4%
Dexter Dam Tailrace-PH*	12/6/2022	1610.0	1010	10	1.0%
Dexter Dam Tailrace-PH*	12/15/2022	1540.0	1025	1	0.1%
Dexter Dam Tailrace-PH*	3/16/2023	1520.0	1,200	2	0.2%

Release Location	Date of Release	Flow at Release	# of Fish Released	# of Fish Recaptured	% Efficiency
Dexter Dam Tailrace-PH*	5/25/2023	3040.0	4,003	14	0.3%
Dexter Dam Tailrace-PH*	6/7/2023	3200.0	4,010	4	0.1%
Dexter Dam Tailrace-PH*	6/21/2023	1270.0	4,028	15	0.4%
Dexter Dam Tailrace-PH*	7/6/2023	2640.0	4,000	5	0.1%
Dexter Dam Tailrace-PH*	8/23/2023	1710.0	4,012	14	0.3%
Dexter Dam Tailrace-PH*	9/6/2023	398.0	4,037	13	0.3%
Dexter Dam Tailrace-PH*	10/4/2023	1680.0	4,001	5	0.1%
Dexter Dam Tailrace- PH	12/28/2023	1755.0	8,032	46	0.6%
Dexter Dam Tailrace- PH	1/9/2024	3360.0	4,004	6	0.1%
Dexter Dam Tailrace-Spill*	3/23/2022	1240.0	988	2	0.2%
Dexter Dam Tailrace-Spill*	5/4/2022	5040.0	995	43	4.3%
Dexter Dam Tailrace-Spill*	5/24/2022	2620.0	1018	67	6.6%
Dexter Dam Tailrace-Spill*	3/29/2023	1590.0	1,199	5	0.4%
Dexter Dam Tailrace-Spill*	8/2/2023	128.0	1,505	3	0.2%
Dexter Dam Tailrace-Spill*	10/24/2023	1590.0	1,514	18	1.2%
Dexter Dam Tailrace-Spill*	11/1/2023	1800.0	1,506	9	0.6%
Dexter Dam Tailrace-Spill*	11/22/2023	3500.0	1,516	0	0.0%
Dexter Dam Tailrace-Spill*	12/5/2023	2060.0	4,006	10	0.2%
Dexter Dam Tailrace-Spill*	12/12/2023	3850.0	4,001	13	0.3%
Dexter Dam Tailrace-Spill	2/8/2024	8500.0	2,067	0	0.0%
Dexter Dam Tailrace-Spill	2/28/2024	1200.0	1,959	17	0.9%
Dexter Dam Tailrace-Spill	3/6/2024	1250.0	2000	4	0.2%
Dexter Dam Tailrace-Spill	4/2/2024	3370.0	1,962	0	0.0%
Dexter Dam Tailrace-Spill	4/10/2024	2800.0	6,000	10	0.2%
Dexter Dam Tailrace PH – Spill	12/21/2023	2400.0	4,005	3	0.1%

*Release performed by EAS for the USACE under contract W9127N19D0007. **Release performed by ODFW. +Release performed by Cramer Fish Sciences.

References

Bates, D., Mächler, M., Bolker, B., & Walker, S. 2015. Fitting Linear Mixed-Effects Models Using lme4. Journal of Statistical Software, 67(1): 1–48.

Bonner, S. J., Schwarz, C. J. 2011. Smoothing population size estimates for time stratified mark–recapture experiments using Bayesian P-splines. Biometrics 67:1498–1507.

Cribari-Neto, F., & Zeileis, A. 2010. Beta regression in R. Journal of Statistical Software, 34(2): 1–24.

Oldemeyer, B.N., Copeland, T., and Kennedy, B.P., 2018. A multiyear hierarchical Bayesian mark-recapture model incorporating data on recurring salmonid behavior to account for sparse or missing data. Fishery Bulletin, 116(3-4): 254-281.

R Core Team. 2024. R: A language and environment for statistical computing. R Foundation for Statistical Computing. https://www.R-project.org/

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Appendix F – Images of Injuries

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Appendix F: Example of Injury Photos

Figures

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Figure F-1. Live fish with no external injuries (NXI)

Figure F-2. Descaling less than 20% (DS<2)

Figure F-3. Bloody Eye (hemorrhage) (EYB)

Figure F-4. Bleeding from Vent (BVT)

Figure F-5. Fin Blood Vessels Broken (FVB)

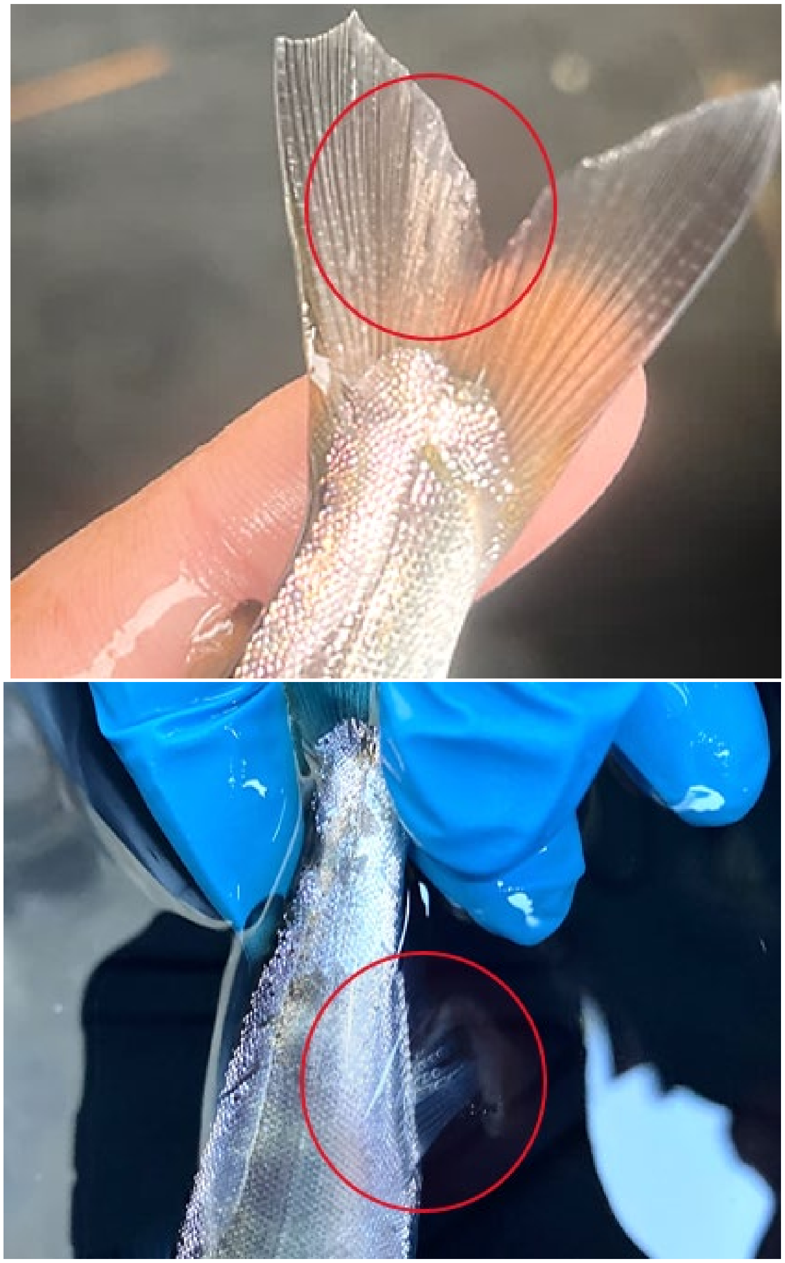

Figure F-6. Gas Bubble Disease (fin ray/eye inclusions) (GBD)

Figure F-7. Pop Eye (eye popping out of head/missing eye) (POP)

Figure F-8. Head Injury (HIN)

Figure F-9. Operculum Damage (OPD)

Figure F-10. Body Injury (tears, scrapes, mechanical damage) (TEA)

Figure F-11. Bruising (any part of the body) (BRU)

Figure F-12. Hole Behind Pectoral Fin (HBP)

Figure F-13. Descaling greater than 20% (DS>2)

Figure F-14. Head Only (HO)

Figure F-15. Body Only (BO)

Figure F-16. Head Barely Connected (HBO)

Figure F-17. Fin Damage (FID)

Figure F-18. Predation Marks (vert. claw or teeth marks) (PRD)

Figure F-19. Copepods (on gills or fins) (COP)

Figure F-20. Fungus (FUN)

Appendix G – Images of Non-Target Species and 2023 Non-Target Catch Tables for Green Peter and Lookout Dam

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Appendix G: Images of Non-Target Species and 2023 Non-Target Catch Tables for Green Peter and Lookout Dam

Figures and Tables

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Figure G-1. Bluegill

Figure G-2. Juvenile Lamprey (Many juvenile lamprey cannot accurately be identified to species in the field)

Figure G-3. Brown Bullhead

Figure G-4. Bull Trout

Figure G-5. Crappie

Figure G-6. Cutthroat Trout

Figure G-7. Longnose Dace

Figure G-8. Kokanee

Figure G-9. Sculpin

Figure G-10. Smallmouth Bass

Figure G-11. Spotted Bass

Figure G-12. Walleye

Figure G-13. Western Mosquitofish

Table G-1. Summary of non-target fish capture at the Green Peter Dam Tailrace site in 2023.

Species	Season Total	Season Total Mortality (subset of total)
Bluegill	1,475	253
Brown Bullhead Catfish	40	1
Chinook (clipped)	107	32
Crappie	903	250
Cutthroat Trout	1	0
Dace	5	1
Kokanee (clipped)	15	6
Kokanee (wild)	24,920	16,350
Largemouth Bass	1	0
Largescale Sucker	3	1
Mountain Whitefish	3	1
Northern Pikeminnow	5	0
O. mykiss (adult)	6	1
O. mykiss (clipped)	31	7
Sculpin	5	1
Smallmouth Bass	34	11
Spotted Bass	3	2
Unknown Bass	89	84
Unknown	2	0
Unknown Salmonid	1	1
Walleye	1	0
Totals	**27,650**	**17,002**

Table G-2. Summary of non-target fish capture at the Green Peter Dam Tailrace site in 2024.

Species	Season Total	Season Total Mortality (subset of total)
Bluegill	123,244	35,949
Brown Bullhead Catfish	33	8
Chinook (clipped)	246	82
Cutthroat Trout	1	1
Dace	7	0
Kokanee	17	6
Kokanee (clipped)	1	1
Largemouth Bass	4	0
Largescale Sucker	3	1
Mountain Whitefish	1	0
Northern Pikeminnow	2	0
O. mykiss (clipped)	19	2
O. mykiss (adult)	1	1
Pumpkinseed	1	0
Sculpin	3	1
Smallmouth Bass	47	20
Spotted Bass	10	5
Unknown	3	3
Totals	**123,643**	**36,080**

Table G-3. Summary of non-target fish capture at the Lookout Dam Tailrace site in 2023.

Species	Season Total	Season Total Mortality (subset of total)
Bass Unknown	27,314	24,329
Bluegill	108	21
Brown Bullhead	6	3
Chinook (clipped)	397	91
Crappie	170,727	118,238
Largemouth Bass	23	23
Largescale Sucker	35	9
Northern Pikeminnow	69	5
O. mykiss	22	3
O. mykiss (clipped)	4	0
Pumpkinseed	1	0
Redside Shiner	2	0
Sculpin	185	13
Smallmouth Bass	619	476
Spotted Bass	2	0
Unknown	7	7
Walleye	218	53
Totals	**199,739**	**143,271**

Table G-4. Summary of non-target fish capture at the Lookout Dam Tailrace site in 2024.

Species	Season Total	Season Total Mortality (subset of total)
Bluegill	34	10
Brown Bullhead catfish	5	3
Chinook (clipped)	317	17
Crappie	29,490	25,053
Cutthroat Trout	1	0
Dace	2	0
Largemouth Bass	119	106
Largescale Sucker	11	10
Northern Pikeminnow	14	5
O. mykiss	17	4
O. mykiss (clipped)	3	0
Sculpin	261	16
Smallmouth Bass	1,100	950
Spotted Bass	15	1
Unknown*	82	63
Walleye	113	20
Totals	**31,584**	**26,258**

Appendix H –
Images of Traps Sampling in Various Conditions

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Appendix H: Images of Traps Sampling in Various Conditions

Figures and Tables

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Figure H-1. Labelled image of a rotary screw trap showing parts and terminology.

Figure H-2. RST sampling at the Breitenbush River site in low flow.

Figure H-3. RST sampling at the Detroit Head of Reservoir site in medium flow.

Figure H-4. RST sampling at the Big Cliff Dam at low flow (left) and high flow (right).

Figure H-5. RST sampling at the Green Peter Head of Reservoir – Middle Santiam site in low flow.

Figure H-6. Green Peter Dam Tailrace – Middle Santiam River at low flow, not sampling, (left) and high flow (right).

Figure H-7. Foster Dam Head of Reservoir – South Santiam River at low (left), medium (middle), and high, not sampling (right) flow.

Figure H-8. Cougar Dam Head of Reservoir not sampling at high flow.

Figure H-9. Cougar Dam – regulating outlet at medium (left) and high (right) flow.

Figure H-10. Cougar Dam – Powerhouse Channel when not sampling (above) and when sampling with high debris (right).

Figure H-11. Fall Creek Head of Reservoir at low (left), medium (middle), and high not sampling (right) flow.

Figure H-12. Fall Creek Dam Tailrace at low (left) and high (right) flow.

Figure H-13. RST sampling at the Hills Creek Head of Reservoir – Middle Fork Willamette River site in medium flow.

Figure H-14. Hills Creek Dam – regulating outlet sampling at high (top) and medium (bottom) flow.

Figure H-15. Hills Creek Dam – Powerhouse Channel sampling at low flow.

Figure H-16. Lookout Point Head of Reservoir sampling at medium (top) and high (bottom) flow.

Figure H-17. Lookout Dam Tailrace – Spillway.

 

Figure H-18. Lookout Dam Tailrace – Powerhouse Channel in the old orientation where one trap was staggered behind the other (left) and in the new orientation side by side (right).

 

Figure H-19. Dexter Dam Tailrace at the old location (left) and the new location (right).

Table H-1. RST sampling constraints by flow/river level and other considerations at sampling sites.

RST Sampling Site	Flow Level Necessitating RST to be Raised to Non-sampling Position	Low Flow Level for RST to Effectively Sample	Other Factors Observed That Result in Sampling Outages
Breitenbush River	Flows near or exceeding 2,500 cfs	Low flow limit in which the trap does not sample has not been encountered at this time.	Rapid increase in flow results in large amounts of debris causing damage to the RST and captured fish. These increases require the RST to be raised and secured.
Detroit Head of Reservoir- North Santiam River	Flows near or exceeding 3,000 cfs	Low flow limit in which the trap does not sample has not been encountered at this time.	Rapid increase in flow results in large amounts of debris causing damage to the RST and captured fish. These increases require the RST to be raised and secured.
Big Cliff Dam Tailrace	Flows exceeding 5,000 cfs	Low flow limit in which the trap does not sample has not been encountered at this time.	Debris passage events require the trap to be raised and secured.
Green Peter Head of Reservoir- Middle Santiam River	Flows near or exceeding 5.5 ft on the gage	Flows near or below 2.0 ft on the gage	Rapid increase in flow results in large amounts of debris causing damage to the RST and captured fish. These increases require the RST to be raised and secured. Due to the time involved to reach this location, inflow projections of 6,000 cfs or more into Green Peter Reservoir necessitate raising the cone. Flows near or below 2 ft on the gage result in water velocities too slow to spin the cone.
Green Peter Dam Tailrace	Flows exceeding 4,000 cfs	Flows below 500 cfs	Surface spill has resulted in significant amounts of woody debris stopping the RST and creating hazardous conditions for captured fish. Flows near or below 500 cfs result in water velocities too slow to spin the cone.
Foster Dam Head of Reservoir- South Santiam	Flows nearing or exceeding 4,000 cfs	Flows at or below 50 cfs	Rapid increase in flow results in large amounts of debris causing damage to the RST and captured fish. These increases require the RST to be raised and secured. Flows near or below 50 cfs result in water velocities too slow to spin the cone.
Cougar Head of Reservoir	Flows exceeding 2,000 cfs	Low flow limit in which the trap does not sample has not been encountered at this time.	Rapid increase in flow results in large amounts of debris causing damage to the RST and captured fish. These increases require the RST to be raised and secured.

RST Sampling Site	Flow Level Necessitating RST to be Raised to Non-sampling Position	Low Flow Level for RST to Effectively Sample	Other Factors Observed That Result in Sampling Outages
Cougar Dam Tailrace RO	Flows exceeding 4,000 cfs	Flows nearing or below 350 cfs	Adjustments need to be made for flow changes above 2,500 cfs in order for sampling above that level to occur. Flows nearing or below 350 cfs result in water velocities too low to spin the cone.
Fall Creek Head of Reservoir	Flows near or exceeding 6 ft on the gage	Flows below 3 ft on the gage	Rapid increase in flow results in large amounts of debris causing damage to the RST and captured fish. These increases require the RST to be raised and secured. Flow nearing and below 3 ft on the gage results in water depths too shallow to lower the cone. This changes with high flows depending on how the flows scour or fill in the sampling area.
Fall Creek Dam	Flows exceeding 3,500 cfs	Flows nearing or below 500 cfs	Sediment and woody debris have resulted in conditions that the RST cannot sample in. These conditions typically occur during drawdown. Flows near or below 500 cfs often result in water velocities too slow to spin the cone.
Hills Creek Head of Reservoir- Middle Fork Willamette	Unknown at this time	Low flow limit in which the trap does not sample has not been encountered at this time.	Rapid increase in flow results in large amounts of debris causing damage to the RST and captured fish. These increases require the RST to be raised and secured.
Hills Creek Dam Tailrace PH	Unknown at this time	Low flow limit in which the trap does not sample has not been encountered at this time while the powerhouse is in operation.	High debris loads have been observed but have not been severe enough to impede sampling to date.
Hills Creek Dam Tailrace RO	Flows exceeding 3,000 cfs	Flows nearing or below 500 cfs	High debris loads have been observed but have not been severe enough to impede sampling to date. Flows near or below 500 cfs often result in water velocities too slow to spin the cone with enough speed to capture fish efficiently.
Lookout Point Head of Reservoir	Flows exceeding 5,000 cfs	Low flow limit in which the trap does not sample has not been encountered at this time	High debris loads can impact RST sampling and damage captured fish.
Lookout Dam	Flows exceeding 10,000 cfs	Flows near or below 1,500 cfs	High debris loads can impact RST sampling. This usually occurs with surface spill.

RST Sampling Site	Flow Level Necessitating RST to be Raised to Non-sampling Position	Low Flow Level for RST to Effectively Sample	Other Factors Observed That Result in Sampling Outages
			Flows near or below 1,500 cfs can result in the cone rotating slowly or stopping and reducing capture efficiency of the RSTs.
Dexter Dam	Unknown at this time	Low flow limit in which the trap does not sample has not been encountered at this time	Trap is sampling in a new location and other factors impacting sampling are still to be determined.

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Appendix I – Adult Chinook Out-Planting Above Willamette Valley Projects 2010 to 2024 and Multi-year Figures and Length Tables of Weekly Chinook Capture for Sites Sampling During the 2021 to 2024 Seasons

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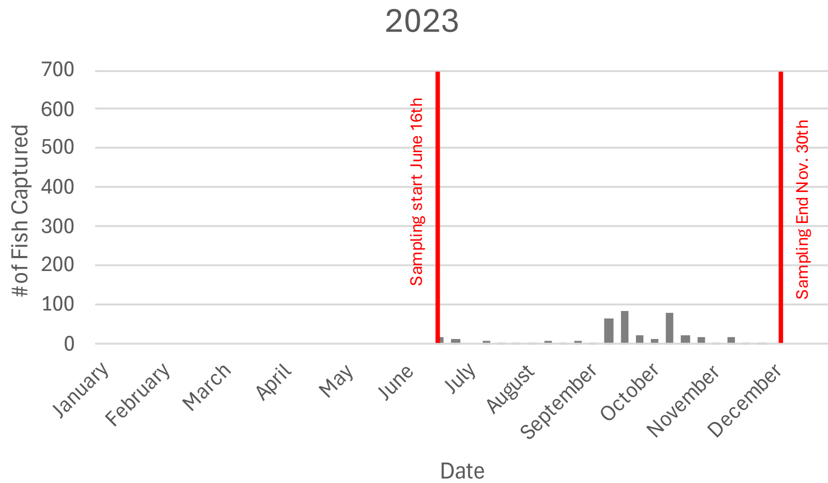
Appendix I: Adult Chinook Out-planting Above Willamette Valley Projects 2010 to 2023 and Multi-year Figures and Length Tables of Weekly Chinook Capture for Sites Sampling During the 2021 to 2024 Seasons

Figures and Tables



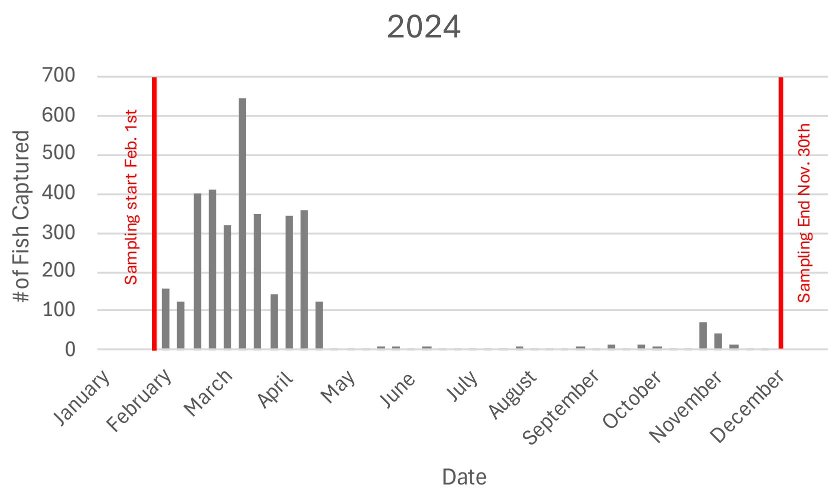


Figure I-1. Weekly Chinook capture at the Breitenbush River RST for 2023 and 2024 sampling.

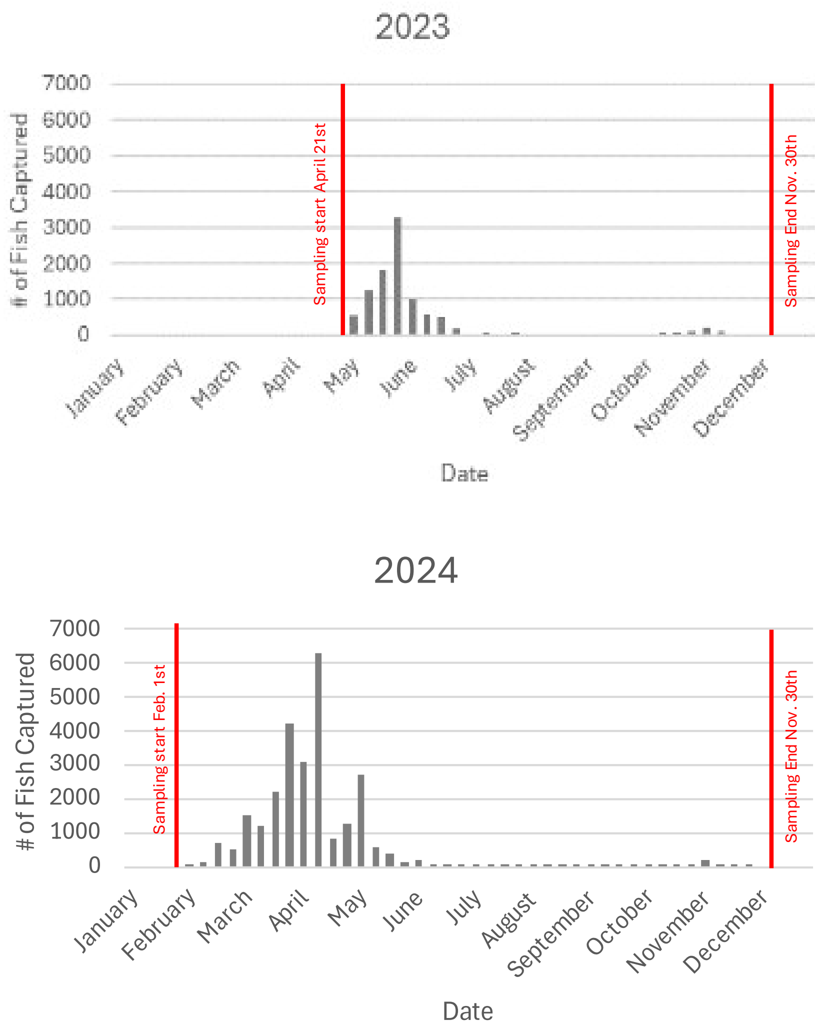


Figure I-2. Weekly Chinook capture at the Detroit Head of Reservoir- North Santiam RST for 2023 and 2024 sampling.

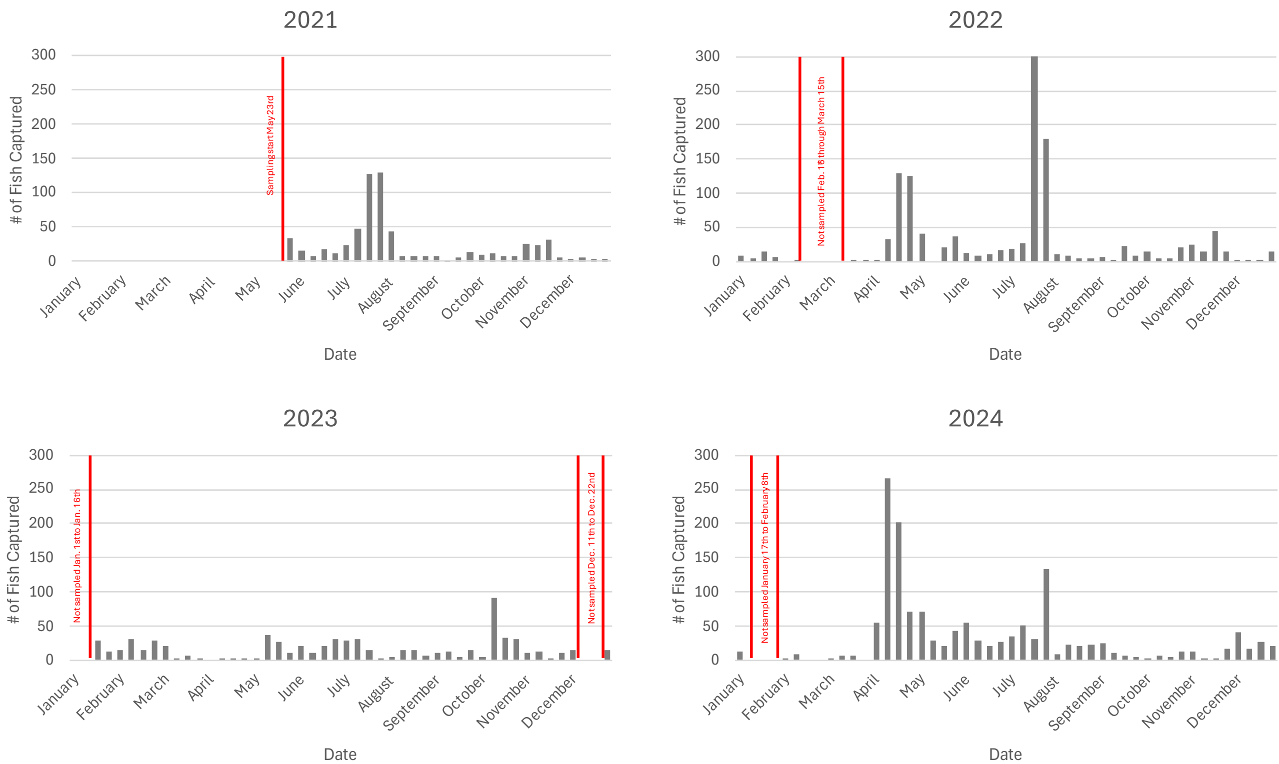


Figure I-3. Weekly Chinook capture at the Big Cliff Dam RST for 2021 through 2024 sampling.

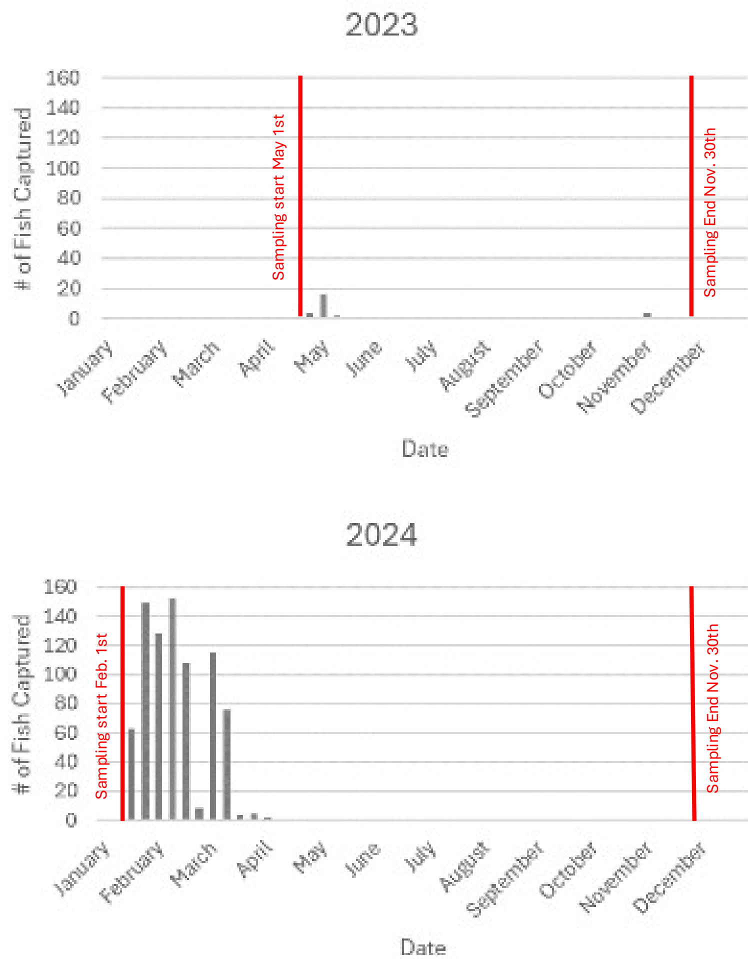
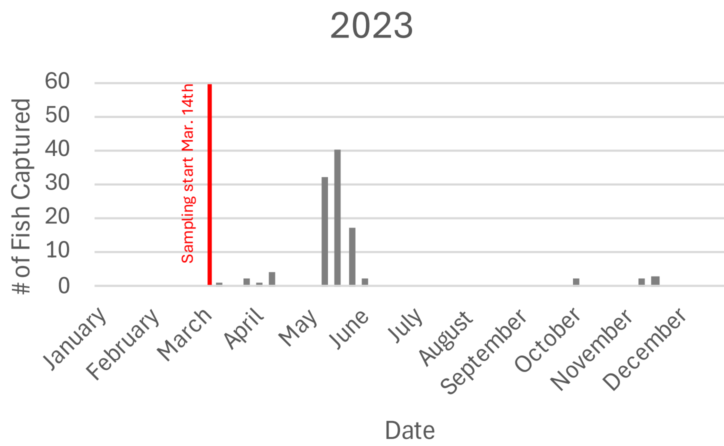


Figure I-4. Weekly Chinook capture at the Green Peter Head of Reservoir RST for 2023 and 2024 sampling.



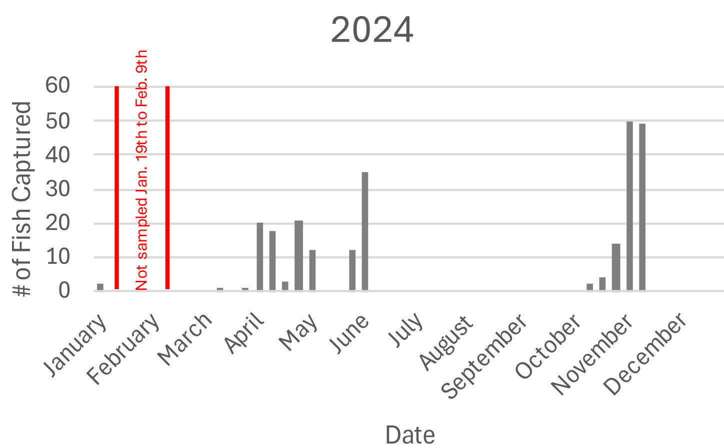


Figure I-5. Weekly Chinook capture at the Green Peter Dam Tailrace RST for 2023 and 2024 sampling.

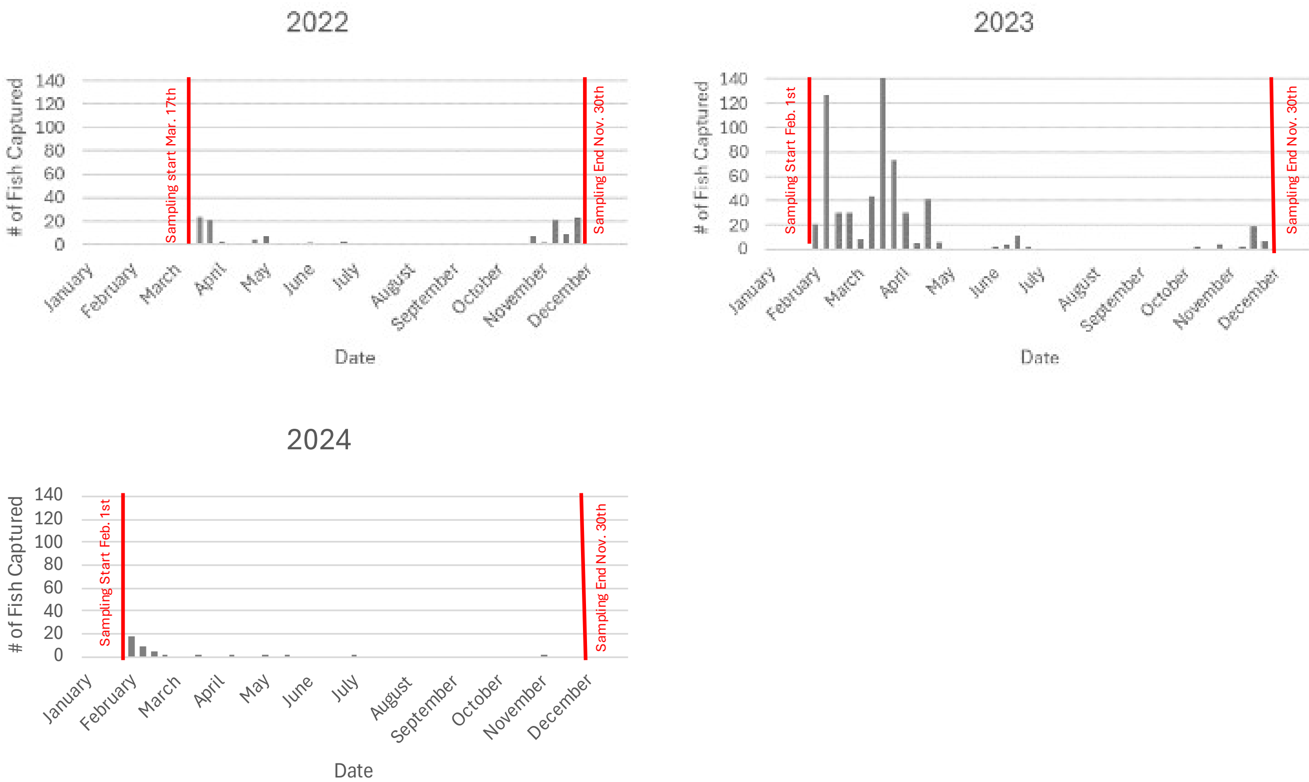


Figure I-6. Weekly Chinook capture at the Foster Head of Reservoir- South Santiam RST for 2022 through 2024 sampling.

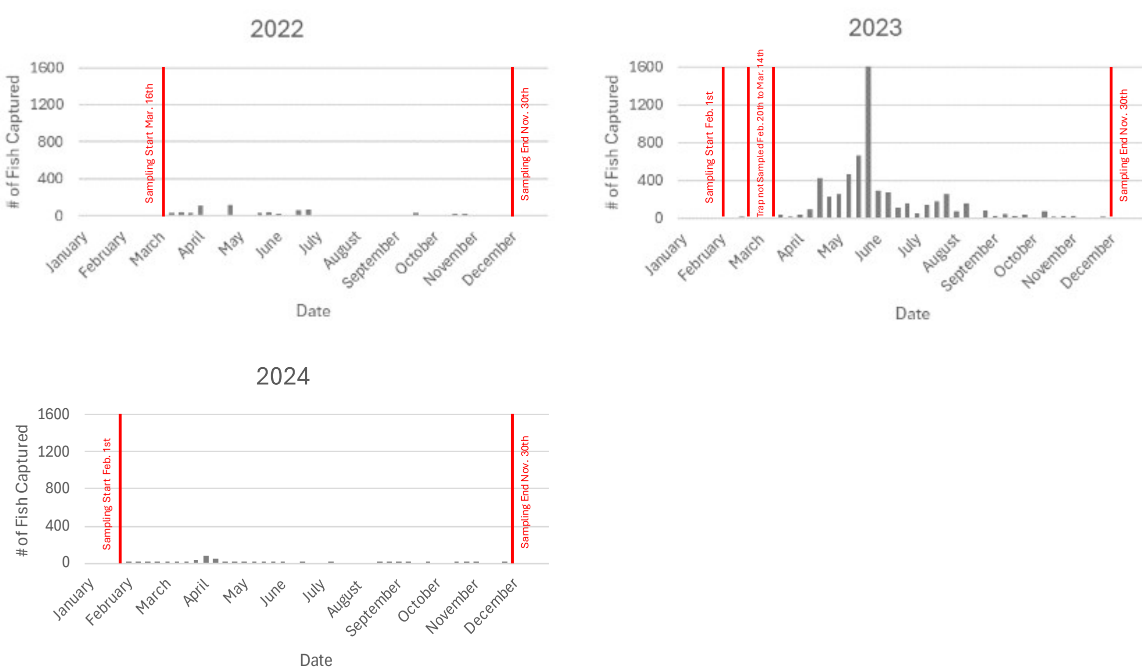


Figure I-7. Weekly Chinook capture at the Cougar Head of Reservoir RST for 2022 through 2024 sampling.

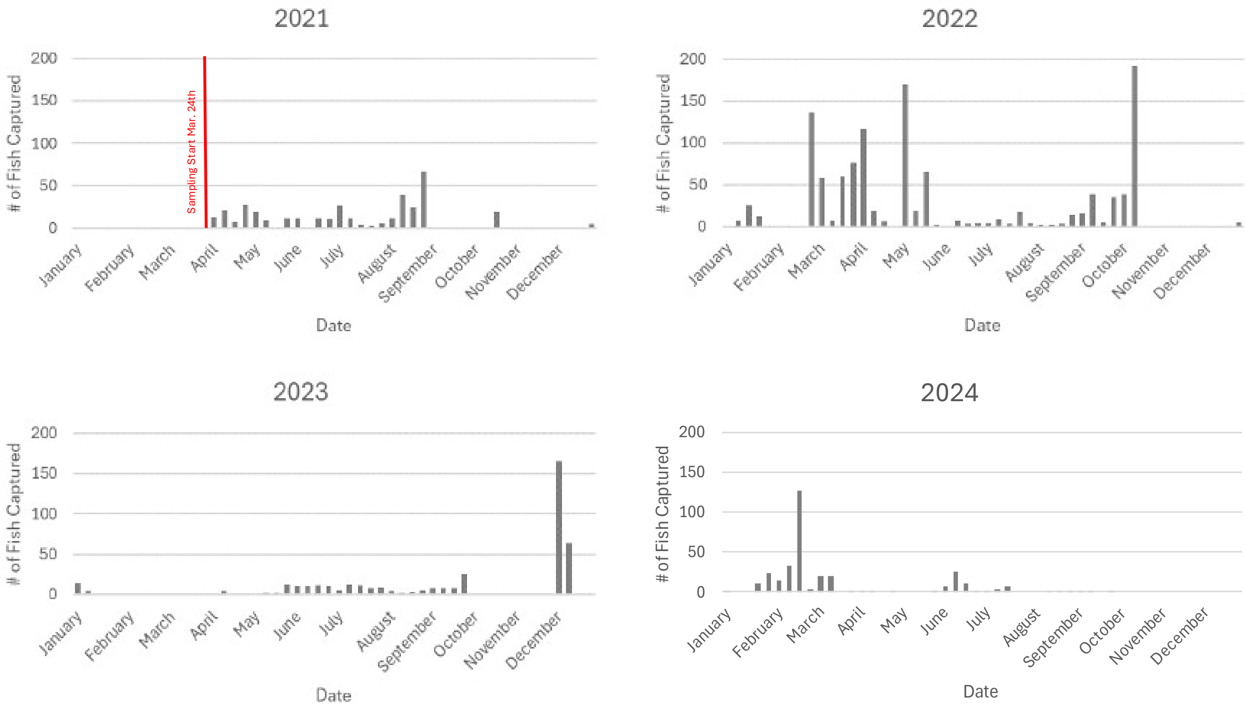


Figure I-8. Weekly Chinook capture at the Cougar Dam PH RSTs for 2021 through 2024 sampling.

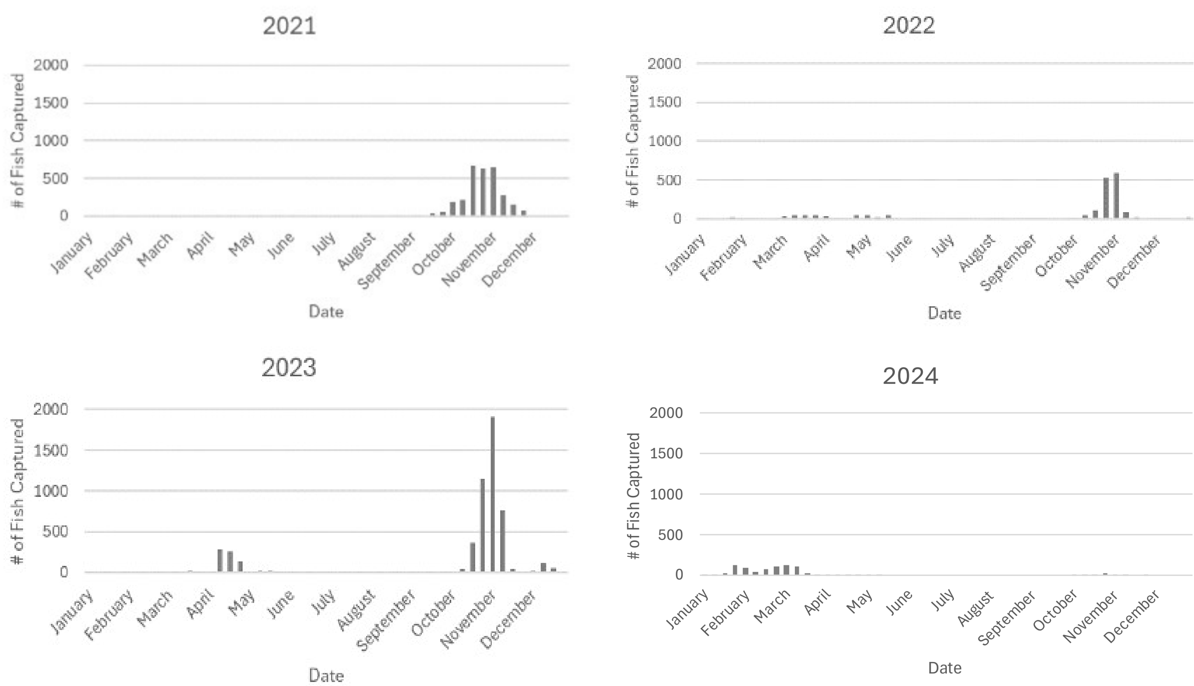


Figure I-9. Weekly Chinook capture at the Cougar Dam RO RST for 2021 through 2024 sampling.

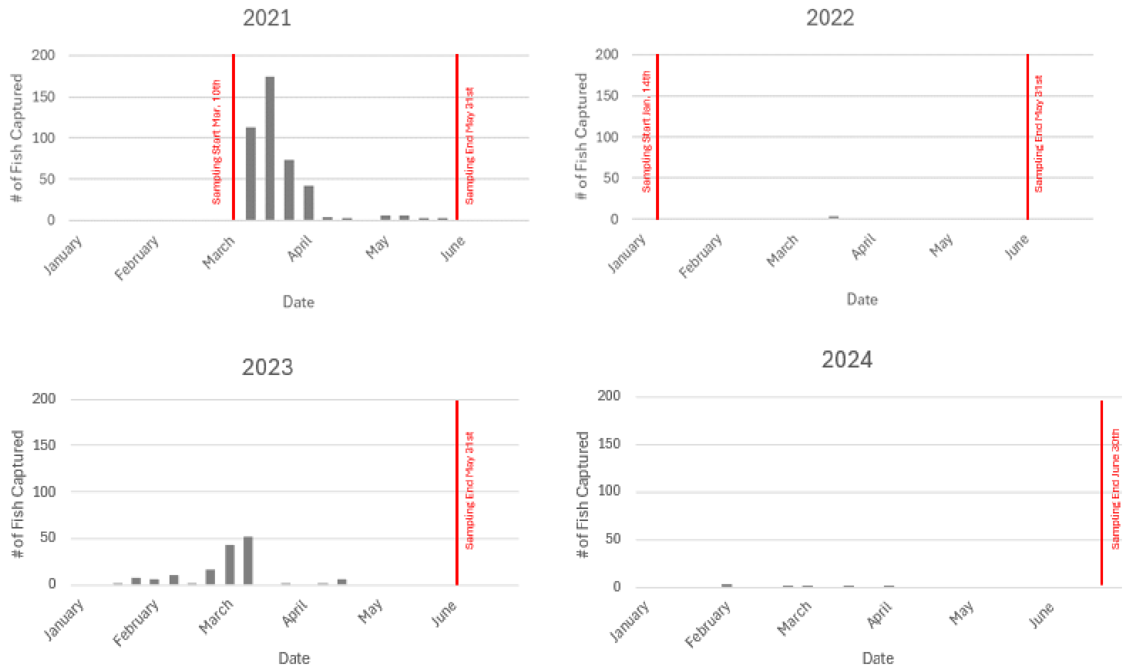


Figure I-10. Weekly Chinook catch at the Fall Creek Head of Reservoir RST for 2021 through 2024 sampling.

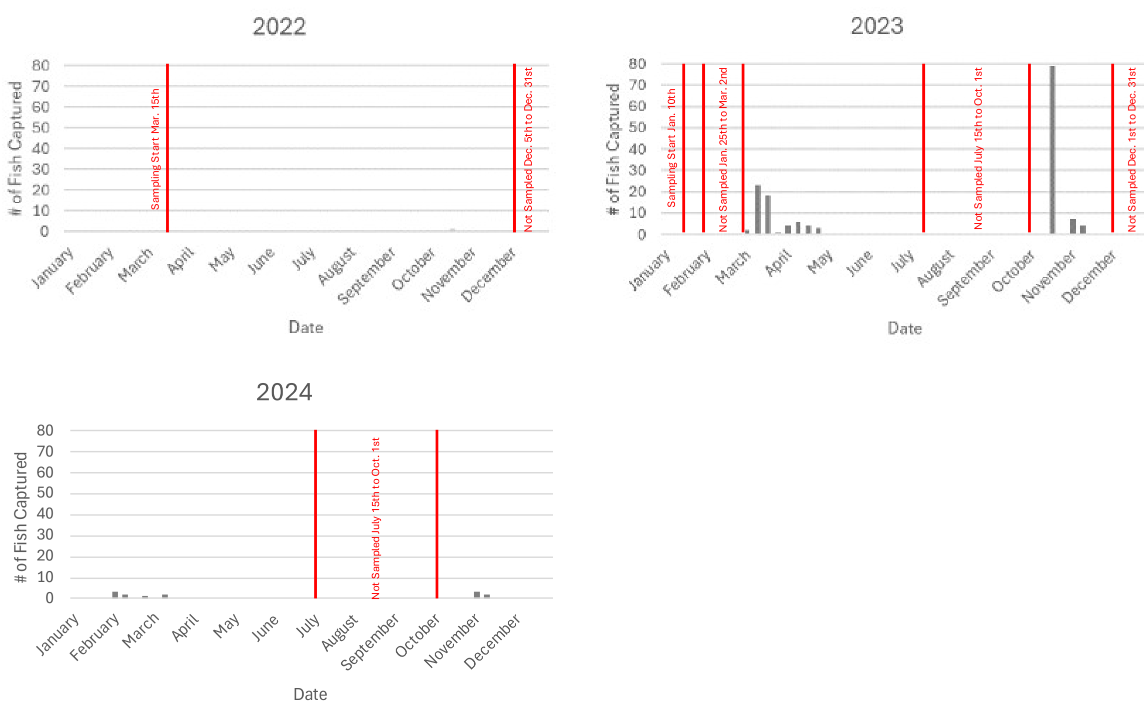


Figure I-11. Weekly Chinook capture at the Fall Creek Dam RST for 2022 through 2024 sampling.

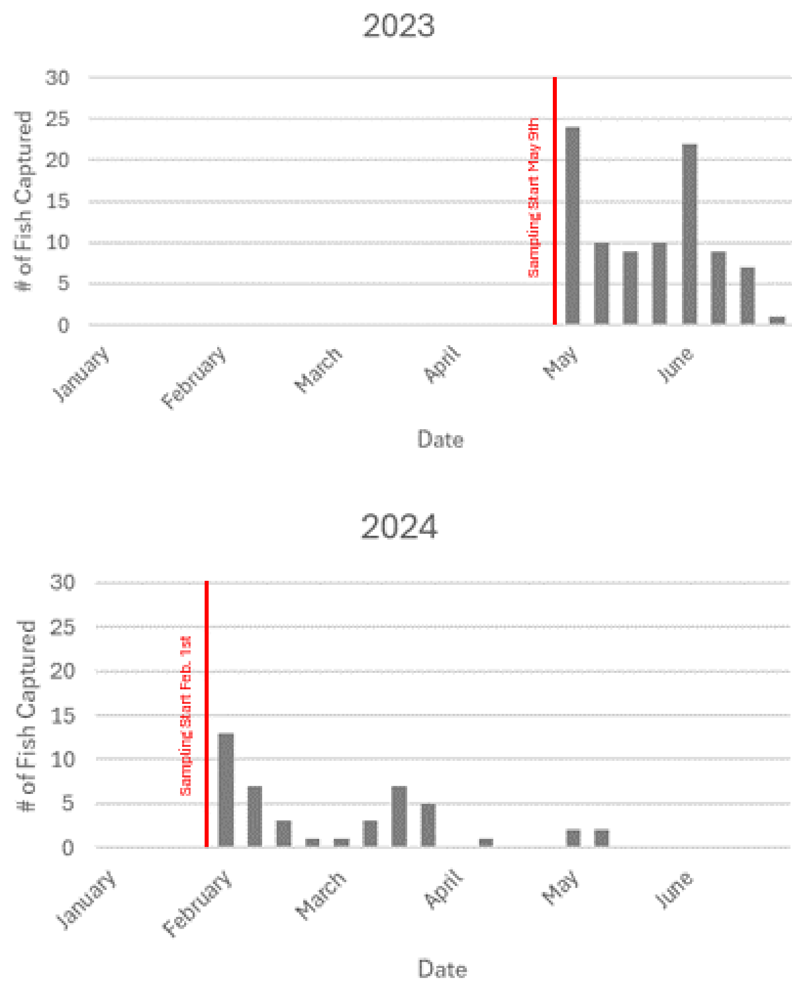


Figure I-12. Weekly Chinook capture at the Hills Creek Head of Reservoir- Middle Fork Willamette RST for 2023 and 2024 sampling.

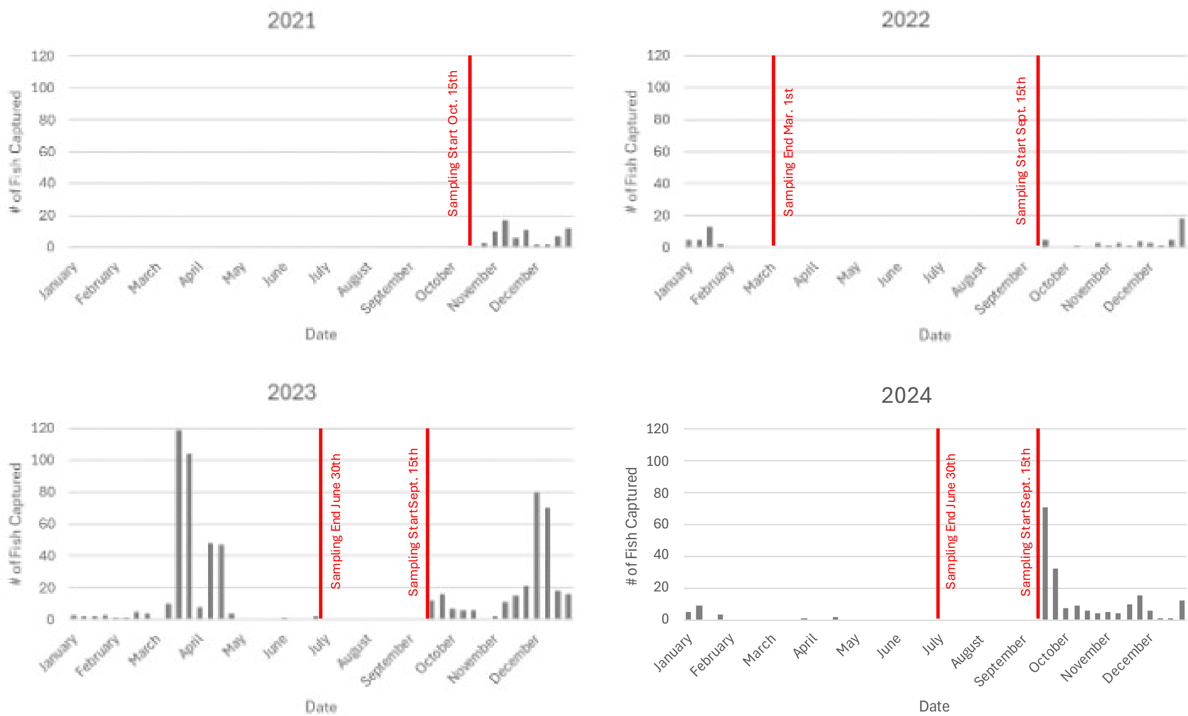


Figure I-13. Weekly Chinook capture at the Hills Creek Dam RSTs for 2021 through 2024 sampling.

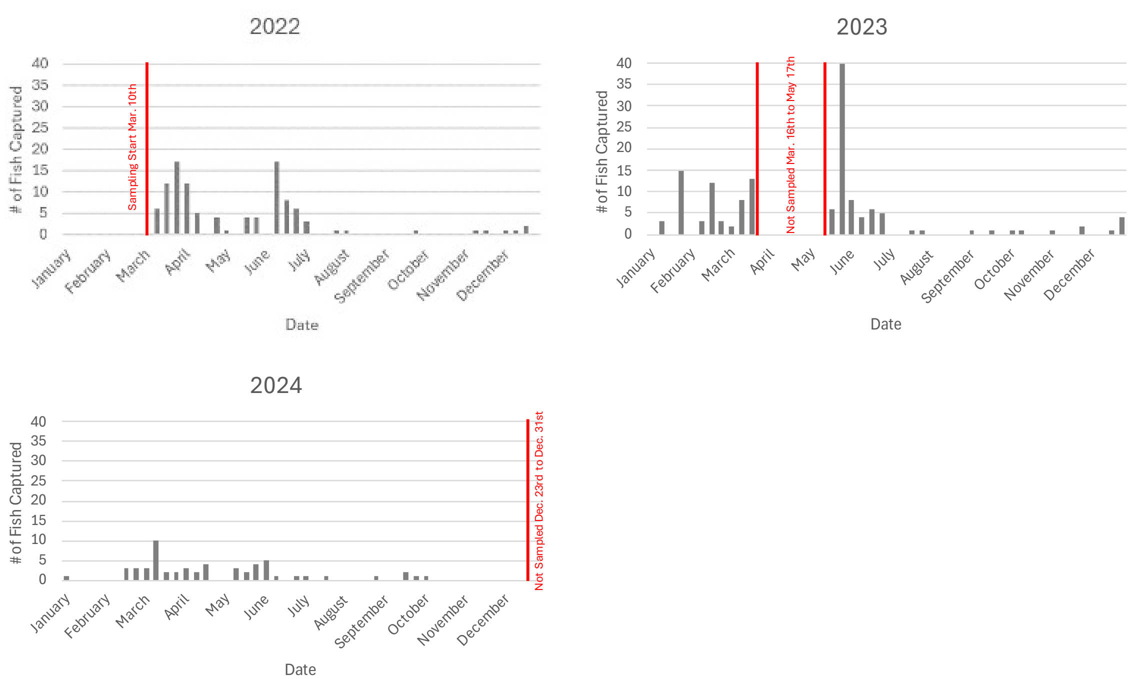


Figure I-14. Weekly Chinook capture at the Lookout Point Head of Reservoir RST for 2022 through 2024 sampling.

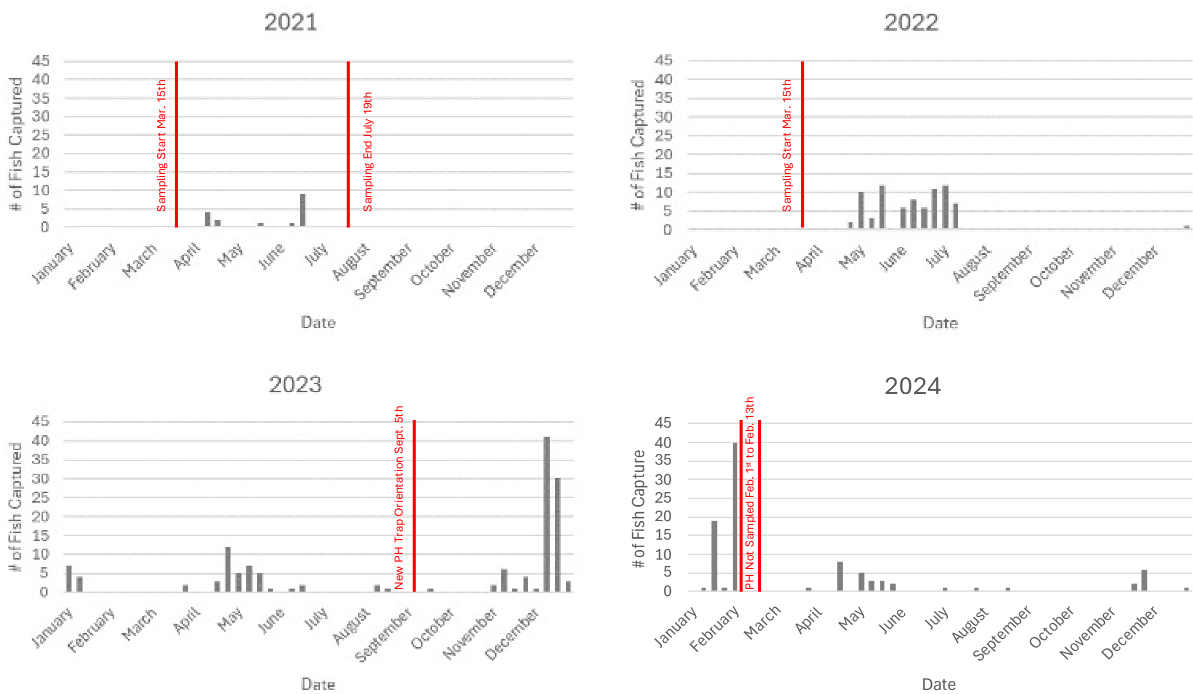


Figure I-15. Weekly Chinook capture at the Lookout Dam Tailrace RSTs for 2021 through 2024 sampling.

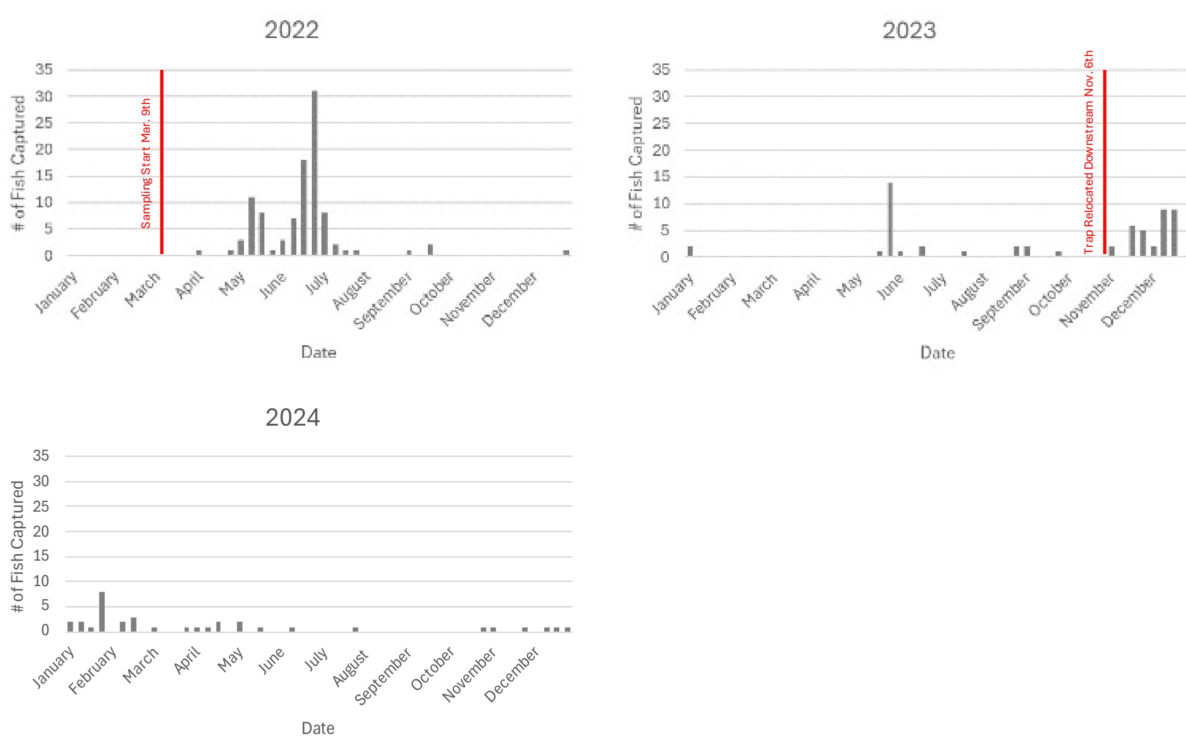


Figure I-16. Weekly Chinook capture at the Dexter Dam Tailrace RST for 2022 through 2024 sampling.

Table I-1. Adult Chinook Out-planting Above Willamette Valley Projects 2010 to 2023.

Sub-Basin	Location	Year	Total Females Out-planted	Total Males Out-planted	Total Chinook Outplants
North Santiam	Above Detroit Reservoir	2010	1143	1341	2484
North Santiam	Above Detroit Reservoir	2011	63	85	148
North Santiam	Above Detroit Reservoir	2012	121	132	253
North Santiam	Above Detroit Reservoir	2013	524	579	1103
North Santiam	Above Detroit Reservoir	2014	299	573	872
North Santiam	Above Detroit Reservoir	2015	689	829	1518
North Santiam	Above Detroit Reservoir	2016	804	434	1238
North Santiam	Above Detroit Reservoir	2017	732	883	1615
North Santiam	North Santiam Above Detroit Reservoir	2018	392	387	779
North Santiam	Breitenbush River Above Detroit Reservoir	2018	104	121	225
North Santiam	North Santiam Above Detroit Reservoir	2019	315	350	665
North Santiam	Breitenbush River Above Detroit Reservoir	2019	143	222	365
North Santiam	North Santiam Above Detroit Reservoir	2020	798	1085	1883
North Santiam	Breitenbush River Above Detroit Reservoir	2020	341	350	691
North Santiam	North Santiam Above Detroit Reservoir	2021	288	466	754
North Santiam	Breitenbush River Above Detroit Reservoir	2021	127	433	560
North Santiam	North Santiam Above Detroit Reservoir	2022	1417	1543	2960
North Santiam	Breitenbush River Above Detroit Reservoir	2022	540	508	1048
North Santiam	North Santiam Above Detroit Reservoir	2023	720	708	1428
North Santiam	Breitenbush River Above Detroit Reservoir	2023	300	296	596
South Santiam	South Santiam above Foster Reservoir	2010	232	488	720
South Santiam	South Santiam above Foster Reservoir	2011	597	618	1215
South Santiam	South Santiam above Foster Reservoir	2012	417	545	962
South Santiam	South Santiam above Foster Reservoir	2013	428	476	904
South Santiam	South Santiam above Foster Reservoir	2014	195	185	380
South Santiam	South Santiam above Foster Reservoir	2015	270	347	617
South Santiam	South Santiam above Foster Reservoir	2016	109	168	277
South Santiam	South Santiam above Foster Reservoir	2017	109	146	255
South Santiam	South Santiam above Foster Reservoir	2018	25	62	87

Sub-Basin	Location	Year	Total Females Out-planted	Total Males Out-planted	Total Chinook Outplants
South Santiam	South Santiam above Foster Reservoir	2019	58	78	136
South Santiam	South Santiam above Foster Reservoir	2020	142	211	353
South Santiam	South Santiam above Foster Reservoir	2021	64	115	179
South Santiam	South Santiam above Foster Reservoir	2022	68	150	218
South Santiam	South Santiam above Foster Reservoir	2023	116	164	280
South Santiam	Above Green Peter Reservoir- Middle Santiam River	2022	300	300	600
South Santiam	Above Green Peter Reservoir- Quartzville Creek	2022	100	100	200
South Santiam	Above Green Peter Reservoir- Middle Santiam River	2023	300	300	600
South Santiam	Above Green Peter Reservoir- Quartzville Creek	2023	100	100	200
McKenzie	South Fork McKenzie above Cougar Reservoir	2010	318	444	762
McKenzie	South Fork McKenzie above Cougar Reservoir	2011	339	391	730
McKenzie	South Fork McKenzie above Cougar Reservoir	2012	447	504	951
McKenzie	South Fork McKenzie above Cougar Reservoir	2013	338	294	632
McKenzie	South Fork McKenzie above Cougar Reservoir	2014	462	235	697
McKenzie	South Fork McKenzie above Cougar Reservoir	2015	456	301	757
McKenzie	South Fork McKenzie above Cougar Reservoir	2016	410	309	719
McKenzie	South Fork McKenzie above Cougar Reservoir	2017	376	235	611
McKenzie	South Fork McKenzie above Cougar Reservoir	2018	404	211	615
McKenzie	South Fork McKenzie above Cougar Reservoir	2019	261	198	459
McKenzie	South Fork McKenzie above Cougar Reservoir	2020	202	204	406
McKenzie	South Fork McKenzie above Cougar Reservoir	2021	121	249	370
McKenzie	South McKenzie above Cougar Reservoir	2022	384	680	1064
McKenzie	South Fork McKenzie above Cougar Reservoir	2023	27	65	92
Middle Fork	North Fork Middle Fork Willamette above Lookout Point Reservoir	2010	Unknown	Unknown	1422
Middle Fork	North Fork Middle Fork Willamette above Lookout Point Reservoir	2011	Unknown	Unknown	1741

Sub-Basin	Location	Year	Total Females Out-planted	Total Males Out-planted	Total Chinook Outplants
Middle Fork	North Fork Middle Fork Willamette above Lookout Point Reservoir	2012	Unknown	Unknown	2520
Middle Fork	North Fork Middle Fork Willamette above Lookout Point Reservoir	2013	Unknown	Unknown	1966
Middle Fork	North Fork Middle Fork Willamette above Lookout Point Reservoir	2014	Unknown	Unknown	1065
Middle Fork	North Fork Middle Fork Willamette above Lookout Point Reservoir	2015	Unknown	Unknown	1086
Middle Fork	North Fork Middle Fork Willamette above Lookout Point Reservoir	2016	Unknown	Unknown	687
Middle Fork	North Fork Middle Fork Willamette above Lookout Point Reservoir	2017	Unknown	Unknown	741
Middle Fork	North Fork Middle Fork Willamette above Lookout Point Reservoir	2018	137	245	382
Middle Fork	North Fork Middle Fork Willamette above Lookout Point Reservoir	2019	358	422	780
Middle Fork	North Fork Middle Fork Willamette above Lookout Point Reservoir	2020	371	519	890
Middle Fork	North Fork Middle Fork Willamette above Lookout Point Reservoir	2021	193	283	476
Middle Fork	North Fork Middle Fork Willamette above Lookout Point Reservoir	2022	386	426	812
Middle Fork	North Fork Middle Fork Willamette above Lookout Point Reservoir	2023	21	50	71
Middle Fork	Middle Fork Willamette above Hills Creek Reservoir	2018	110	225	335
Middle Fork	Middle Fork Willamette above Hills Creek Reservoir	2019	142	159	301
Middle Fork	Middle Fork Willamette above Hills Creek Reservoir	2020	252	275	527
Middle Fork	Middle Fork Willamette above Hills Creek Reservoir	2021	0	0	0
Middle Fork	Middle Fork Willamette above Hills Creek Reservoir	2022	198	264	462
Middle Fork	Middle Fork Willamette above Hills Creek Reservoir	2023	0	0	0
Fall Creek	Fall Creek above Fall Creek Reservoir	2013	Unknown	Unknown	467
Fall Creek	Fall Creek above Fall Creek Reservoir	2014	Unknown	Unknown	456
Fall Creek	Fall Creek above Fall Creek Reservoir	2015	Unknown	Unknown	259

Sub-Basin	Location	Year	Total Females Out-planted	Total Males Out-planted	Total Chinook Outplants
Fall Creek	Fall Creek above Fall Creek Reservoir	2016	Unknown	Unknown	425
Fall Creek	Fall Creek above Fall Creek Reservoir	2017	Unknown	Unknown	294
Fall Creek	Fall Creek above Fall Creek Reservoir	2018	Unknown	Unknown	94
Fall Creek	Fall Creek above Fall Creek Reservoir	2019	58	191	249
Fall Creek	Fall Creek above Fall Creek Reservoir	2020	310	524	834
Fall Creek	Fall Creek above Fall Creek Reservoir	2021	41	55	96
Fall Creek	Fall Creek above Fall Creek Reservoir	2022	58	81	139
Fall Creek	Fall Creek above Fall Creek Reservoir	2023	56	63	119

Table I-2. Length tables of Chinook salmon captured at the Breitenbush RST by brood year from 2023-2024.

Species	Date Range	BY	Number of Fish	Average F.L. (mm)	Min. F.L. (mm)	Max F.L. (mm)	Median F.L. (mm)
Chinook	2/1/23–6/30/23	22	30	55.5	44	68	55
Chinook	7/1/23–11/30/23	22	347	89.7	51	114	91
Chinook	2/1/24–6/30/24	23	3,080	36.4	29	69	36
Chinook	2/1/24–6/30/24	22	29	96.7	81	147	95
Chinook	7/1/24–11/30/24	23	216	92.0	48	113	93
Chinook	7/1/24–11/30/24	22	4	116.8	95	140	116

Table I-3. Length tables of *O. mykiss* captured at the Breitenbush RST by brood year from 2023-2024.

Species	Date Range	BY	Number of Fish	Average F.L. (mm)	Min. F.L. (mm)	Max F.L. (mm)	Median F.L. (mm)
O. mykiss	2/1/23–6/30/23	23	2	51.5	27	76	N/A
O. mykiss	2/1/23–6/30/23	22	2	113.5	107	120	N/A
O. mykiss	7/1/23–11/30/23	21	2	169.0	139	192	N/A
O. mykiss	7/1/23–11/30/23	22	8	125.1	85	151	132
O. mykiss	7/1/23–11/30/23	23	347	31.1	21	165	27
O. mykiss	2/1/24–6/30/24	24	8	28.9	26	31	29
O. mykiss	2/1/24–6/30/24	23	47	101.3	33	193	90
O. mykiss	2/1/24–6/30/24	22	1	270.0	270	270	N/A
O. mykiss	7/1/24–11/30/24	24	420	31.1	20	104	28
O. mykiss	7/1/24–11/30/24	23	34	132.6	96	165	132.5
O. mykiss	7/1/24–11/30/24	22	2	223.5	211	236	N/A

Table I-4. Length tables of Chinook salmon captured at the Detroit Head of Reservoir RST by brood year from 2023-2024.

Species	Date Range	BY	Number of Fish	Average F.L. (mm)	Min. F.L. (mm)	Max F.L. (mm)	Median F.L. (mm)
Chinook	2/1/23-6/30/23	21	1	61.0	61	61	N/A
Chinook	2/1/23-6/30/23	22	9,125	35.6	28	70	35
Chinook	7/1/23-11/30/23	22	1,015	76.0	33	117	79
Chinook	2/1/24–6/30/24	22	49	86.6	69	107	86
Chinook	2/1/24–6/30/24	23	26,809	36.6	28	72	36
Chinook	7/1/24–11/30/24	23	678	85.4	29	117	89

Table I-5. Length tables of *O. mykiss* captured at the Detroit Head of Reservoir RST by brood year from 2023-2024.

Species	Date Range	BY	Number of Fish	Average F.L. (mm)	Min. F.L. (mm)	Max F.L. (mm)	Median F.L. (mm)
O. mykiss	2/1/23-6/30/23	19	1	408.0	408	408	N/A
O. mykiss	2/1/23-6/30/23	21	1	188.0	188	188	N/A
O. mykiss	2/1/23-6/30/23	22	7	79.4	49	99	82
O. mykiss	2/1/23-6/30/23	23	484	35.5	25	46	35
O. mykiss	7/1/23-11/30/23	21	2	199.5	169	230	N/A
O. mykiss	7/1/23-11/30/23	22	1	112.0	112	112	N/A
O. mykiss	7/1/23-11/30/23	23	94	35.8	20	90	26
O. mykiss	2/1/24–6/30/24	21	1	315.0	315	315	N/A
O. mykiss	2/1/24–6/30/24	22	12	170.3	142	197	170
O. mykiss	2/1/24–6/30/24	23	40	72.8	34	115	74
O. mykiss	2/1/24–6/30/24	24	10	30.1	22	39	28.5
O. mykiss	7/1/24–11/30/24	23	4	136.0	114	155	137.5
O. mykiss	7/1/24–11/30/24	24	238	34.7	17	82	28

Table I-6. Length tables of Chinook salmon captured at the Big Cliff Dam RST by brood year from 2022-2024.

Species	Date Range	BY	Number of Fish	Average F.L. (mm)	Min. F.L. (mm)	Max F.L. (mm)	Median F.L. (mm)
Chinook	12/1/21–6/30/22	20	290	165.2	100	260	160
Chinook	5/1/22–12/31/22	20 and 21	897	137.1	31	283	131
Chinook	1/1/23–6/30/23	20	42	202.8	157	340	195
Chinook	1/1/23–6/30/23	21	125	155.8	72	199	160
Chinook	1/1/23–6/30/23	22	156	51.8	29	130	37
Chinook	7/1/23–12/31/23	20	4	234.8	199	300	220
Chinook	7/1/23–12/31/23	21 and 22	377	137.0	91	191	137
Chinook	1/1/24–6/30/24	21 and 22	895	144.8	80	231	142
Chinook	1/1/24–6/30/24	23	42	98.4	35	121	107
Chinook	7/1/24–12/31/24	22 and 23	535	139.2	47	260	132

Table I-7. Length tables of *O. mykiss* captured at the Big Cliff Dam RST by brood year from 2023-2024.

Species	Date Range	BY	Number of Fish	Average F.L. (mm)	Min. F.L. (mm)	Max F.L. (mm)	Median F.L. (mm)
O. mykiss	1/1/23–6/30/23	21	3	297.0	274	335	282
O. mykiss	1/1/23–6/30/23	22	27	200.4	155	269	194
O. mykiss	1/1/23–6/30/23	23	47	29.7	25	71	28
O. mykiss	7/1/23–12/31/23	21	1	295.0	295	295	N/A
O. mykiss	7/1/23–12/31/23	22	2	151.0	145	157	N/A
O. mykiss	7/1/23–12/31/23	23	171	31.8	24	120	29
O. mykiss	1/1/24–6/30/24	21	1	275.0	275	275	N/A
O. mykiss	1/1/24–6/30/24	22	39	199.4	154	260	195
O. mykiss	1/1/24–6/30/24	23	8	78.8	34	124	79
O. mykiss	1/1/24–6/30/24	24	26	30.4	25	39	29
O. mykiss	7/1/24–12/31/24	21	1	285	285	285	N/A
O. mykiss	7/1/24–12/31/24	22	2	213.5	195	232	N/A
O. mykiss	7/1/24–12/31/24	23	2	133	122	144	N/A
O. mykiss	7/1/24–12/31/24	24	43	53.1	25	105	51

Table I-8. Length tables of Chinook salmon captured at the Green Peter Head of Reservoir RST by brood year from 2023-2024.

Species	Date Range	BY	Number of Fish	Average F.L. (mm)	Min. F.L. (mm)	Max F.L. (mm)	Median F.L. (mm)
Chinook	2/1/23–6/30/23	22	21	36.4	33	45	36
Chinook	7/1/23–11/30/23	22	4	105.5	98	114	105
Chinook	2/1/24–6/30/24	22	5	91.6	81	104	92
Chinook	2/1/24–6/30/24	23	806	36.2	32	70	36
Chinook	7/1/24-11/30/24	N/A	0	N/A	N/A	N/A	N/A

Table I-9. Length tables of *O. mykiss* captured at the Green Peter Head of Reservoir RST by brood year from 2023-2024.

Species	Date Range	BY	Number of Fish	Average F.L. (mm)	Min. F.L. (mm)	Max F.L. (mm)	Median F.L. (mm)
O. mykiss	1/1/23–6/30/23	23	1	36.0	36	36	N/A
O. mykiss	7/1/23–11/30/23	N/A	0	N/A	N/A	N/A	N/A
O. mykiss	2/1/24–6/30/24	21	1	255.0	255	255	N/A
O. mykiss	2/1/24–6/30/24	22	3	174	139	215	168
O. mykiss	2/1/24–6/30/24	23	18	95.2	75	115	92
O. mykiss	2/1/24–6/30/24	24	2	23.5	20	27	N/A
O. mykiss	7/1/24–11/30/24	24	2	90.5	87	94	N/A

Table I-10. Length tables of Chinook salmon captured at the Green Peter Dam RST by brood year from 2023-2024.

Species	Date Range	BY	Number of Fish	Average F.L. (mm)	Min. F.L. (mm)	Max F.L. (mm)	Median F.L. (mm)
Chinook	1/1/23–6/30/23	22	100	66.8	33	98	66
Chinook	7/1/23–12/31/23	22	7	112.1	89	155	103
Chinook	1/1/24–6/30/24	22	51	146.6	98	173	149
Chinook	1/1/24–6/30/24	23	77	105.3	36	141	107
Chinook	7/1/24–12/31/24	22	116	256.4	202	301	257.5
Chinook	7/1/24–12/31/24	23	3	128.0	103	159	122

Table I-11. Length tables of *O. mykiss* salmon captured at the Green Peter Dam RST by brood year from 2023-2024.

Species	Date Range	BY	Number of Fish	Average F.L. (mm)	Min. F.L. (mm)	Max F.L. (mm)	Median F.L. (mm)
O. mykiss	1/1/23–6/30/23	21	5	271.4	240	318	268
O. mykiss	1/1/23–6/30/23	22	5	185.8	174	195	185
O. mykiss	1/1/23–6/30/23	23	1	29.0	29	29	N/A
O. mykiss	7/1/23–12/31/23	22	1	125.0	125	125	N/A
O. mykiss	1/1/24–6/30/24	23	8	188.9	162	225	187.5
O. mykiss	7/1/24–12/31/24	23	2	140.5	134	147	N/A

Table I-12. Length tables of Chinook salmon captured at the Foster Head of Reservoir RST by brood year from 2022-2024.

Species	Date Range	BY	Number of Fish	Average F.L. (mm)	Min. F.L. (mm)	Max F.L. (mm)	Median F.L. (mm)
Chinook	5/7/22–6/30/22	20	5	124.4	108	138	127
Chinook	5/7/22–6/30/22	21	61	39.7	31	80	35
Chinook	7/1/22–11/30/22	20 and 21	62	104.5	81	161	142.5
Chinook	2/1/23–6/30/23	21	21	108.6	93	134	109
Chinook	2/1/23–6/30/23	22	555	37.8	30	95	36
Chinook	7/1/23–11/30/23	22	33	105.3	63	123	107
Chinook	2/1/24–6/30/24	22	3	100.7	79	120	103
Chinook	2/1/24–6/30/24	23	36	40.3	35	86	38

Species	Date Range	BY	Number of Fish	Average F.L. (mm)	Min. F.L. (mm)	Max F.L. (mm)	Median F.L. (mm)
Chinook	7/1/24–11/30/24	23	3	63.7	41	106	44

Table I-13. Length tables of *O. mykiss* salmon captured at the Foster Head of Reservoir RST by brood year from 2022-2024.

Species	Date Range	BY	Number of Fish	Average F.L. (mm)	Min. F.L. (mm)	Max F.L. (mm)	Median F.L. (mm)
O. mykiss	5/7/22–6/30/22	22	32	35.5	28	65	35
O. mykiss	5/7/22–6/30/22	21	16	110.5	88	132	111
O. mykiss	5/7/22–6/30/22	20	42	172.3	141	213	170
O. mykiss	7/1/23–11/30/23	22	65	88.2	68	117	85
O. mykiss	7/1/23–11/30/23	21	68	148.1	125	205	145
O. mykiss	2/1/24–6/30/24	22	19	180.1	135	232	186
O. mykiss	2/1/24–6/30/24	23	25	97.3	71	132	98
O. mykiss	2/1/24–6/30/24	24	159	31.1	24	51	30
O. mykiss	7/1/24–11/30/24	22	1	195	195	195	N/A
O. mykiss	7/1/24–11/30/24	23	46	139.8	121	175	139
O. mykiss	7/1/24–11/30/24	24	488	92.9	22	128	65

Table I-14. Length tables of Chinook salmon captured at the Cougar Head of Reservoir RST by brood year from 2022-2024.

Species	Date Range	BY	Number of Fish	Average F.L. (mm)	Min. F.L. (mm)	Max F.L. (mm)	Median F.L. (mm)
Chinook	3/7/22–6/30/22	20	34	91.6	64	150	76
Chinook	3/7/22–6/30/22	21	542	39	27	77	37
Chinook	7/1/22–11/30/22	21	134	78.6	60	99	78
Chinook	2/1/23- 6/30/23	21	32	88.2	73	106	89
Chinook	2/1/23–6/30/23	22	4,592	36.2	25	64	36
Chinook	7/1/23–11/30/23	21	1	104	104	104	N/A
Chinook	7/1/23–11/30/23	22	1,228	58.4	36	98	56
Chinook	2/1/24–6/30/24	22	28	79.6	51	95	82.5
Chinook	2/1/24–6/30/24	23	226	36.1	31	70	36
Chinook	7/1/24–11/30/24	23	24	85.1	59	106	92.5

Table I-15. Length tables of Chinook salmon captured at the Cougar Dam RST by brood year from 2021-2024.

Species	Date Range	BY	Number of Fish	Average F.L. (mm)	Min. F.L. (mm)	Max F.L. (mm)	Median F.L. (mm)
Chinook	12/1/21–6/30/22	20	290	165.2	100	260	160
Chinook	1/1/22–6/30/22	21	408	38.4	27	64	37
Chinook	7/1/22–11/30/22	20 and 21	1,802	142.9	53	247	144
Chinook	1/1/23–6/30/23	21	802	144.1	76	196	149
Chinook	1/1/23–6/30/23	22	62	57.3	33	102	54.5
Chinook	7/1/23–11/30/23	20	141	211.0	182	286	209
Chinook	7/1/23–11/30/23	21 and 22	4,695	114.3	47	176	115
Chinook	1/1/24–6/30/24	21 and 22	1,091	116.2	57	207	118
Chinook	1/1/24–6/30/24	23	40	48.5	35	80	39.5

Species	Date Range	BY	Number of Fish	Average F.L. (mm)	Min. F.L. (mm)	Max F.L. (mm)	Median F.L. (mm)
Chinook	7/1/24–12/31/24	22	37	179.6	119	226	188
Chinook	7/1/24–12/31/24	23	40	118.0	79	160	119

Table I-16. Length tables of Chinook salmon captured at the Fall Creek Head of Reservoir RST by brood year from 2022-2024.

Species	Date Range	BY	Number of Fish	Average F.L. (mm)	Min. F.L. (mm)	Max F.L. (mm)	Median F.L. (mm)
Chinook	1/11/22–5/31/22	19	1	255.0	255	255	N/A
Chinook	1/11/22–5/31/22	20	6	128.3	119	139	128.5
Chinook	1/1/23–5/31/23	22	148	36.7	31	86	34
Chinook	1/1/24–6/30/24	22	7	121.9	114	134	121

Table I-17. Length tables of Chinook salmon captured at the Fall Creek Dam RST by brood year from 2022-2024.

Species	Date Range	BY	Number of Fish	Average F.L. (mm)	Min. F.L. (mm)	Max F.L. (mm)	Median F.L. (mm)
Chinook	10/15/22–12/31/22	20	1	230.0	230	230	N/A
Chinook	1/1/23–6/30/23	22	61	36.8	33	60	37
Chinook	7/1/23–12/31/23	21	85	181.0	142	203	185
Chinook	7/1/23–12/31/23	22	4	100	94	106	100
Chinook	1/1/24–6/30/24	22	9	129.6	112	146	130
Chinook	7/1/24–12/31/24	22	5	211.8	177	261	187

Table I-18. Length tables of Chinook salmon captured at the Hills Creek Head of Reservoir RST by brood year from 2023-2024.

Species	Date Range	BY	Number of Fish	Average F.L. (mm)	Min. F.L. (mm)	Max F.L. (mm)	Median F.L. (mm)
Chinook	2/1/23–6/30/23	22	93	43.7	30	76	44
Chinook	2/1/24–6/30/24	22	47	86.7	62	122	89

Table I-19. Length tables of Chinook salmon captured at the Hills Creek Dam RST by brood year from 2021-2024.

Species	Date Range	BY	Number of Fish	Average F.L. (mm)	Min. F.L. (mm)	Max F.L. (mm)	Median F.L. (mm)
Chinook	10/15/21–3/1/22	19	68	239.1	201	265	245
Chinook	10/15/21–3/1/22	20	20	118.3	69	159	120.5
Chinook	9/15/22–12/31/22	20	45	228.4	188	280	225
Chinook	1/1/23–6/30/23	19	1	314.0	314	314	N/A
Chinook	1/1/23–6/30/23	20	12	255.1	234	285	251.5
Chinook	1/1/23–6/30/23	21	1	122.0	122	122	N/A
Chinook	1/1/23–6/30/23	22	346	36.0	31	61	35
Chinook	1/1/23–6/30/23	N/A	4	N/A	N/A	N/A	N/A
Chinook	7/1/23–12/31/23	20	1	298.0	298	298	N/A
Chinook	7/1/23–12/31/23	21	261	188.4	129	233	193
Chinook	7/1/23–12/31/23	22	18	96.1	69	121	96
Chinook	1/1/24–6/30/24	21	42	199.7	155	237	199.5
Chinook	1/1/24–6/30/24	22	18	122.8	90	174	122
Chinook	7/1/24–12/31/24	22	182	224.9	106	287	225

Table I-20. Length tables of Chinook salmon captured at the Lookout Point Head of Reservoir RST by brood year from 2022-2024.

Species	Date Range	BY	Number of Fish	Average F.L. (mm)	Min. F.L. (mm)	Max F.L. (mm)	Median F.L. (mm)
Chinook	3/10/22–12/31/22	20	24	98.2	86	118	95
Chinook	3/10/22–12/31/22	21	84	56.5	28	119	57
Chinook	2/1/23–6/30/23	21	5	99.8	94	113	97
Chinook	2/1/23–6/30/23	22	123	46.4	30	93	42
Chinook	7/1/23–12/31/23	22	14	101.8	81	126	105
Chinook	1/1/24–6/30/24	22	15	96.2	75	112	95
Chinook	1/1/24–6/30/24	23	34	59.3	32	89	56.5
Chinook	7/1/24-12/31/24	23	7	116.4	91	142	113

Table I-21. Length tables of Chinook salmon captured at the Lookout Point Dam RST by brood year from 2022-2024.

Species	Date Range	BY	Number of Fish	Average F.L. (mm)	Min. F.L. (mm)	Max F.L. (mm)	Median F.L. (mm)
Chinook	4/28/22–12/31/22	20	22	173.0	151	256	265.5
Chinook	4/28/23–6/30/23	21	56	114.6	58	146	119
Chinook	1/1/23–6/30/23	20	5	246.0	227	275	247
Chinook	1/1/23–6/30/23	21	32	155.9	96	199	116.5
Chinook	1/1/23–6/30/23	22	12	57.3	33	113	53.5
Chinook	7/1/23–12/31/23	21	33	175.3	100	227	182
Chinook	7/1/23–12/31/23	22	59	100.4	31	121	101
Chinook	1/1/24–6/30/24	21	2	208.5	208	209	N/A
Chinook	1/1/24–6/30/24	22	85	124.1	82	180	115
Chinook	7/1/24–12/31/24	22	7	202.0	115	253	239
Chinook	7/1/24–12/31/24	23	4	111.5	99	117	106
Chinook	7/1/24–12/31/24	24	1	35	35	35	N/A

Table I-22. Length tables of Chinook salmon captured at the Dexter Dam RST by brood year from 2022-2024.

Species	Date Range	BY	Number of Fish	Average F.L. (mm)	Min. F.L. (mm)	Max F.L. (mm)	Median F.L. (mm)
Chinook	3/7/22–12/31/22	20	28	170.2	142	226	163
Chinook	3/7/22–12/31/22	21	71	112.7	46	145	117
Chinook	1/1/23–6/30/23	21	15	158.2	103	190	162
Chinook	1/1/23–6/30/23	22	5	85.4	54	109	100
Chinook	7/1/23–12/15/23	20	1	345.0	345	345	N/A
Chinook	7/1/23–12/15/23	21	8	169.1	118	206	167
Chinook	7/1/23–12/15/23	22	28	107.4	84	135	106.5
Chinook	1/1/24–6/30/24	21	1	227	227	227	N/A
Chinook	1/1/24–6/30/24	22	27	130.3	77	177	129
Chinook	7/1/24–12/31/24	22	4	199	133	260	201.5
Chinook	7/1/24–12/31/24	23	3	111.3	93	123	118

Appendix J – USGS 2024 Turbidity Gage for the Middle Santiam River Below Green Peter Dam

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Appendix J: USGS 2024 Turbidity Gage for the Middle Santiam River Below Green Peter Dam

Figures

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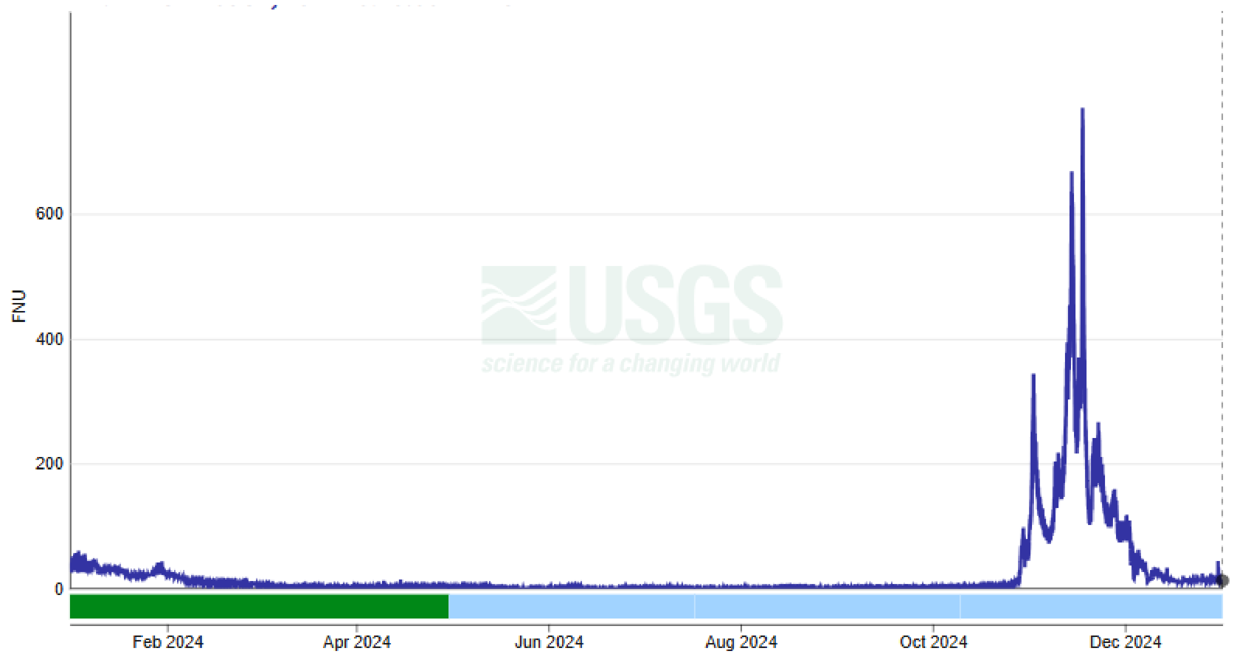

Figure J-1. USGS Turbidity Gage for Calendar Year 2024 for the Middle Santiam River Below Green Peter Dam.

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Appendix K –
2024 Livewell Retention Study

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Appendix K: 2024 Livewell Retention Study

Tables

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Table K-1. Sites and dates where livewell retention studies occurred.

Site	Trap	Date	# of fish held	# of fish recovered	% Retention
Fall Creek Head of Reservoir	8 ft	05/30/2024	20	18	90%
Cougar Head of Reservoir	5 ft	06/13/2024	11	11	100%
Detroit Head of Reservoir	5 ft	09/06/2024	18	18	100%
Big Cliff Dam Tailrace	8 ft	10/31/2024	20	20	100%
Detroit Head of Reservoir	5 ft	10/31/2024	20	20	100%
Breitenbush River	5 ft	11/26/2024	20	20	100%
Big Cliff Dam Tailrace	8 ft	12/03/2024	20	19	95%

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