FINAL

DOWNSTREAM JUVENILE FISH PASSAGE MONITORING VIA ROTARY SCREW TRAPS ABOVE DETROIT, GREEN PETER, and HILLS CREEK RESERVOIRS

Bi-Annual Report

Prepared for

US Army Corps of Engineers

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Acronyms and Abbreviations

BiOp	Willamette Project Biological Opinion
BY	Brood Year
EAS	Environmental Assessment Services, LLC
ESA	Endangered Species Act
NMFS	National Marine Fisheries Service
ODFW	Oregon Department of Fish and Wildlife
PIT	Passive Integrated Transponder
RO	Regulating Outlet
RST	Rotary screw traps
TE	Trapping Efficiency
USACE	US Army Corps of Engineers
USGS	US Geological Survey
VIE	Visible Implant Elastomer
WVP	Willamette Valley Project

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Rotary Screw Trap Program Bi-Annual Report

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 much differently than the run of river 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 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 that set forth specific actions 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 Reasonable and Prudent Alternative, 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).

Rotary screw traps (RST) 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/weight data of natural origin juvenile salmonids migrating into WVP reservoirs, migration timing, evaluating juvenile salmonids for presence of injuries, and gathering information on relative abundance of incidental fish species. At sites where trapping efficiency trials provided sufficiently robust results, an objective of the RSTs was to estimate the abundance of out-migrating juvenile salmonids.

This report was written by Environmental Assessment Services, LLC (EAS) for Cramer Fish Sciences under contract W9127N19D0009 with the USACE and contains a summary and analysis of the field study implemented by EAS for RST sampling efforts starting February 1, 2023, through June 30, 2023, at four sampling locations: Breitenbush River, Detroit Head of Reservoir- North Santiam River, Green Peter Head of Reservoir- Middle Santiam River, and Hills Creek Head of Reservoir- Middle Fork Willamette River.

Additional RST sampling was conducted by EAS for the USACE under 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. Results from sampling at these sites from January 1, 2023, to June 30, 2023, are reported separately (EAS 2023).

Additional RST sampling was conducted by Cramer Fish Sciences at certain sites through November 2021 to meet interim injunctive measure requirements (Cramer Fish Sciences 2023) and the Corps at Fall Creek Tailrace through winter 2022. Additionally, EAS has operated traps at other locations in the WVP through June 30, 2023 (EAS 2023).

Methods

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 livewell supported on a pontoon system. RSTs are commonly built in two sizes denominated 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 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 F. Traps are set in the river thalweg or in positions likely to capture juvenile fish as they travel downstream through the sampling area. Traps were accessed either by wading or with inflatable kayaks. 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.

RSTs were operated at four locations in the southern Willamette River watershed: Breitenbush River, Detroit Head of Reservoir- North Santiam River, Green Peter Head of Reservoir- Middle Santiam River, and Hills Creek Head of Reservoir- Middle Fork Willamette River. 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. 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 June 16, 2023, and continued through the end of the reporting period.
- A 5-foot RST operated at the Detroit Head of Reservoir- North Santiam River below the Cooper's Ridge Road bridge on May 4, 2023, and continued sampling through the end of the reporting period.
- A 5-foot trap operated at the Green Peter Head of Reservoir- Middle Santiam River from May 4, 2023, to the end of the reporting period. The RST site is located approximately 200 meters downstream from the US Geological Survey (USGS) gauging station.
- A 5-foot RST operated at the Hills Creek Head of Reservoir site in the Middle Fork Willamette River above Hills Creek Reservoir from May 9, 2023, through the end of the reporting period. The RST site is located at the USGS gauging station.

Maps showing trap deployment locations for each site can be found Appendix A. Sampling at various sites had to be stopped for short periods of time due to damage and environmental conditions. A summary table of these outages by site is shown in Appendix B. Information on trap installation and sampling periods by site are provided in Table 1.

Table 1. Rotary screw trap locations, installation dates, and sampling periods and total days sampled for the report period.

Site	Trap Installation	Target Sampling Period	Total Days Sampled
Breitenbush River	6/16/2023a	2/1/2023–11/30/2023	15
Detroit Head of Reservoir- North Santiam	5/4/2023b	2/1/2023–11/30/2023	57
Green Peter Head of Reservoir- Middle Santiam	5/4/2023b	2/1/2023–11/30/2023	57
Hills Creek Head of Reservoir- Middle Fork Willamette River	5/9/2023a	2/1/2023–11/30/2023	52

[a] Initiation of sampling delayed until trap was delivered by manufacturer.
[b] Initiation of sampling delayed following contract award in March 2023 until take permits were approved.

Data Collection

Fish Collection, Trap and Environmental Metrics

RSTs were checked once per day unless conditions necessitated additional checks for fish or trap safety. 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 loggers in the trap livewells and from USGS gages and included inflow and water temperature where available. Fish were removed from trap livewells and transported to a safe work-up location. 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. 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 replaced if temperature increased 2°C. 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 species were transported to a safe work-up location for further processing. At sites located in the Santiam basin, all unmarked juvenile *Oncorhynchus mykiss* (*O. mykiss*) were treated and reported as Winter Steelhead.

Biological Data and Tagging

Biological data was collected for each target fish we captured. Target fish were those that did not display any clip, tag, or dye and were presumed to be of natural origin. At sites in the Santiam River Basin where Winter Steelhead were target fish, all juvenile *O. mykiss* captured were treated as targets, as it is not possible to accurately distinguish between resident rainbow trout and anadromous steelhead trout. Table 3 lists all sites and which species are considered targets at each. Data collected included species, fork length to the nearest millimeter, weight to the nearest 0.1 gram, fish condition, injuries, lifestage, and assessment of presence of tags or other marks. Lifestage in the field was delineated as fry, parr, or smolt 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. A list of injury codes used for assessments is provided in Table 2. In addition to the injury codes listed, we 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). 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 at head of reservoir sites. Aged fish were then delineated as yearlings or sub-yearlings and assigned an appropriate brood year category based on the age class determined from scales and time of capture. Fish were reported as sub-yearling or yearling along with the brood year 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 were PIT tagged and released. All PIT tag data was uploaded into PTAGIS. Appendix C contains information on PIT tags and tag files. Fish that were non-sac-fry, smaller than 65 mm, and larger than 35 mm were marked with visible implant elastomer. Photos of species encountered and injuries were collected throughout the sampling periods and are provided in Appendix D. A summary of data collected by site is provided in Table 3.

Table 2. 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

Table 3. 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-hr 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), FL (mm), Injuries	Yes	No	Yes	Yes
Detroit Head of Reservoir- North Santiam River	Yes, Run of River Fish, Hatchery Fish	Spring Chinook and *O. mykiss*	Yes, weight (nearest 0.1 g), FL (mm), Injuries	Yes	No	Yes	Yes
Green Peter Head of Reservoir- Middle Santiam River	Yes, Run of River Fish, Hatchery Fish	Spring Chinook and *O. mykiss*	Yes, weight (nearest 0.1 g), FL (mm), Injuries	Yes	No	Yes	Yes
Hills Creek Head of Reservoir- Middle Fork Willamette River	Yes, Run of River Fish, Hatchery Fish	Spring Chinook	Yes, weight (nearest 0.1 g), FL (mm), Injuries	Yes	No	Yes	Yes

Trapping Efficiency Trials and Approach

Approach

Hatchery reared Chinook salmon were utilized for trapping efficiency trials as catch of run of river fish for such use is frequently insufficient to perform effective trials. Due to limited hatchery fish availability and inconsistent catch of run of river fish for use in mark recapture studies for trapping efficiency, we used a flow-based approach to evaluate the efficiency of each trap. Flow categories were assigned for each trap that were tailored to the specific location and range of conditions the trap could operate in. Multiple trials with marked hatchery fish were conducted across the range of flows in a category and pooled together to calculate weekly estimates for each location based on the flows occurring during that time period. When sufficient numbers of run of river fish were available, captured fish were marked with a caudal clip that alternated weekly between the lower or upper lobe and released upstream of the trap. We also tracked trials based on size of hatchery fish used. This allowed us to evaluate differences in capture efficiency by flow, fish size, and origin. Using this approach, we can also use historical data to supplement our efficiency calculations and continue to add to data in subsequent years as more trials are performed. It is important to note that RSTs are designed to capture fish actively out-migrating and generally do not capture fish that are moving upstreaming or rearing near sampling sites. Many sites experience a wide range of flows throughout sampling and the performance of the trap 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 easily escape before they are captured. 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 traps effectively sampled. Furthermore, it is assumed that all fish released for efficiency trials migrate downstream past the trapping site within a one-week period. Additional assumptions are provided in the subsequent trapping efficiency trial sections.

Trapping Efficiency Trials

Hatchery Fish. Due to environmental conditions and fish availability, we were unable to test each site to the extent we had planned. We performed trapping efficiency trials with large groups of marked hatchery fish at all sites but often were unable to perform replicate trials at the flow levels sampled. In order to utilize trapping efficiencies from hatchery fish to calculate run of river passage, we have to assume that hatchery fish and run of river fish have the same probability of being captured in an RST. When possible, we performed run of river fish trials to interrogate this assumption. All hatchery fish utilized in trapping efficiency trials were adipose clipped at minimum. Additional fin clips and Bismarck brown dye 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 grams, and had injury assessments performed prior to release. Hatchery fish for use in trials were collected from ODFW hatcheries. 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 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 at least one riffle pool complex above the trap, or upstream ~500m, to allow for dispersal across the channel. Fish were released in small groups from alternating banks when possible. 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.

Run of River Fish. Run of river fish were captured, marked, and released upstream of the trapping sites to assess the capture efficiency of the trap. These run of river trials only occurred at sites where hatchery fish were not allowed for release and at locations when sufficient numbers of natural origin fish were captured to allow for trials to be performed. We were unable to perform run of river trapping efficiency trials this spring as we did not capture enough fish that were large enough for us to safely mark for use in trials. 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. We are unable to utilize VIE marked fish for run of river trapping efficiency trials as we cannot uniquely mark fish for this purpose without biasing results of downstream recaptures of VIE marked fish. 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. A summary of trapping efficiency trials performed at each site is provided in subsequent results and discussion sections.

Data Analysis

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). Across all sites, traps were fished a total of 168 successful start/stop times with an average duration of 23.96 hours between checks (st dev. 2.12 hours). Trap sampling time between checks ranged from 17.8 to 29.7 hours. All traps were fished overnight, but due to logistics trap checks occurred at various times the following day. Data was excluded prior to analysis (5% n=9) if a trap was not functioning properly upon arrival, typically due to debris clogging. 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.

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 Cramer Fish Sciences (2023). We calculated trap capture efficiency by marking hatchery Chinook for each trap efficiency trail. Fish were released upstream ~500 m from the trap, or as far upstream as possible below dam sites. Fish for trap efficiency 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), Bismarck brown staining. Unique marking was especially important for sites 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 trap efficiency trials for each trap. Weekly abundance estimates for outmigration were calculated by using equations modified from Romer (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.

One novel difference from previous work in this area is that we attempt to account for flow rates. Water flow has been shown to be the dominant factor affecting trap efficiency 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). 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. Ideally, the run of River 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.

Flow rates are likely a major factor in trap efficiency, but the response is likely to be on a site-by-site basis. At the time of this report all sites had too few successful TE trials (total trials, at specific flow rates, or not enough recaptures) conducted in 2023 to model TE.

Brood Year

A subset of scales collected from juvenile Chinook (and *O. mykiss* in Santiam basin sites) were mounted and read to determine 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 brood year (BY) for size class of fish throughout the year. Brood year determinations were made by considering all information gathered for the fish, including length, date of capture, and age classification.

Results

Breitenbush River

A single 5-foot RST was deployed in the Breitenbush River above Detroit Reservoir on June 16, 2023. The trap sampled a total of 15 days during the reporting period. The installation of the 5-foot RST was delayed to June 16th due to limited availability of screw traps and supply chain issues that prevented the manufacturer from building a new trap on the timeline originally quoted.

Target Catch and Passage Timing

A total of 30 juvenile Chinook salmon and 4 juvenile *O. mykiss* were captured during the reporting period (Figures 1 and 2). Based on data from sampling in 2015 by Romer et al. and observations from other nearby sites, it is likely that a majority of BY 2022 Chinook sub-yearlings passed through the trap site prior to the initiation of sampling. Peak passage during previous sampling efforts occurred in March and April (Romer et al. 2016). All juvenile Chinook captured were BY 2022 sub-yearlings (Figure 3). The average length of BY 22 Chinook caught during the spring period was 55.5 mm (n=30, min: 44 mm, max: 68 mm, median: 55 mm) and the average weight was 2.1 g (min: 1.0 g, max: 3.3 g, median: 2.2 g). The length and weight of sub-yearling Chinook exiting the Breitenbush River was similar to observations from previous work (Romer 2016).

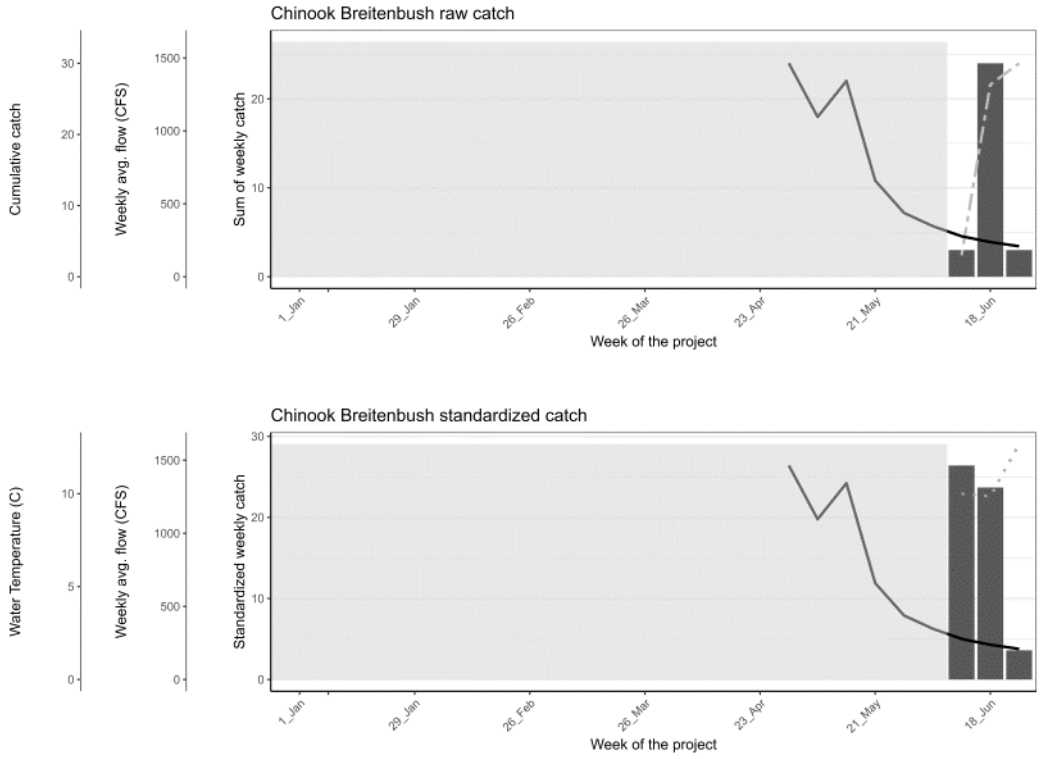


Figure 1. Raw catch (top panel) and standardized catch (bottom panel) of natural origin juvenile Chinook at the Breitenbush River site overlayed with flow (black line), stream temperature (gray dot dash line), and non-sampling weeks shaded out (gray) for 2023.

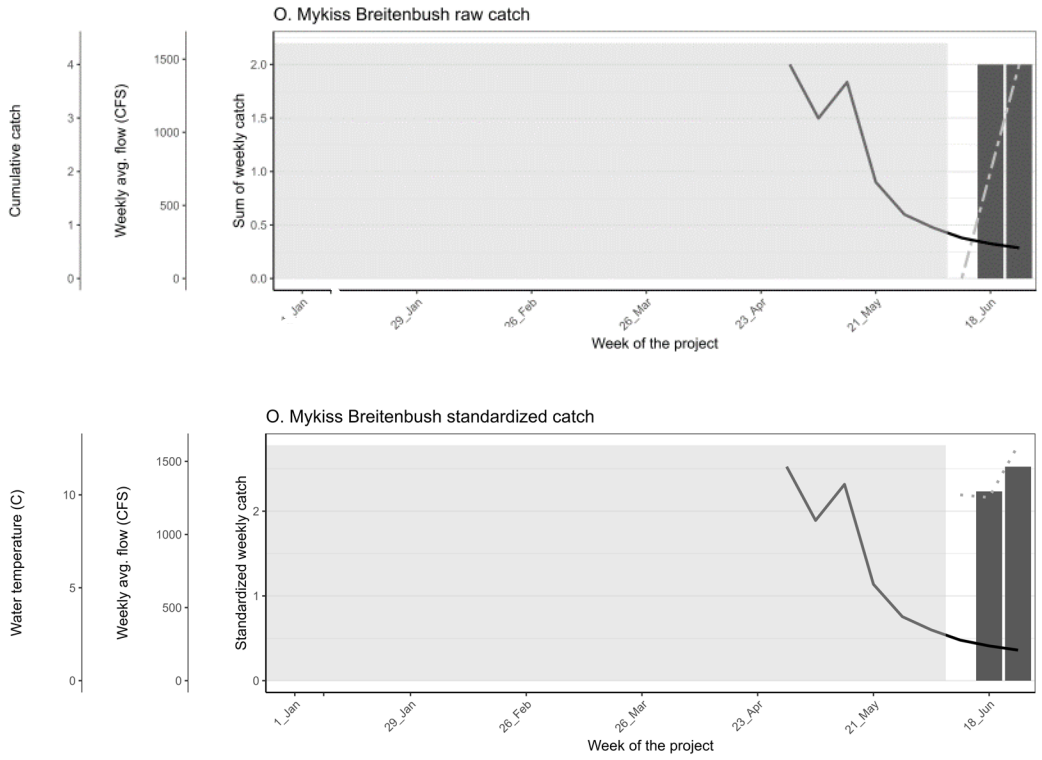


Figure 2. Raw (top panel) and weekly standardized (bottom panel) catch of juvenile *O. mykiss* overlayed with flow (black line), stream temperature (gray dotted line), and non-sampling weeks shaded out (gray) at the Breitenbush River site for 2023.

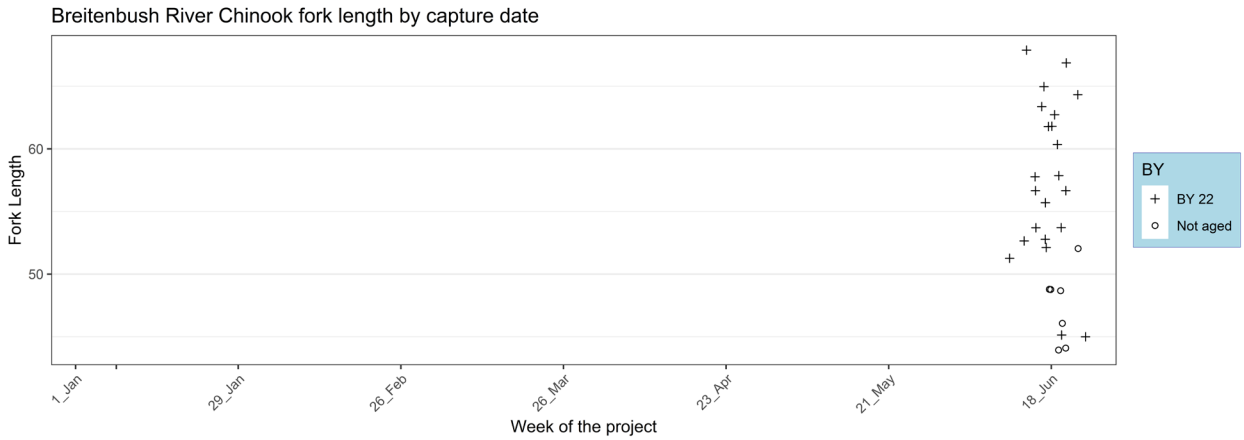


Figure 3. Length-frequency analysis for juvenile Chinook at the Breitenbush River site for 2023.

The *O. mykiss* captured at this site consists of juveniles from two brood years: BY 2022 and BY 2023 (Figure 4). The average fork length of sub-yearling BY 23 *O. mykiss* captured during the spring sampling period was 51.5 mm (n=2, min: 27 mm, max: 76 mm). Age 1 (BY 2022) *O. mykiss* had an average length of 113.5 mm (n= 2, min: 107 mm, max: 120 mm) with an average weight of 17.6 g (min: 15.1 g, max: 20.0 g).

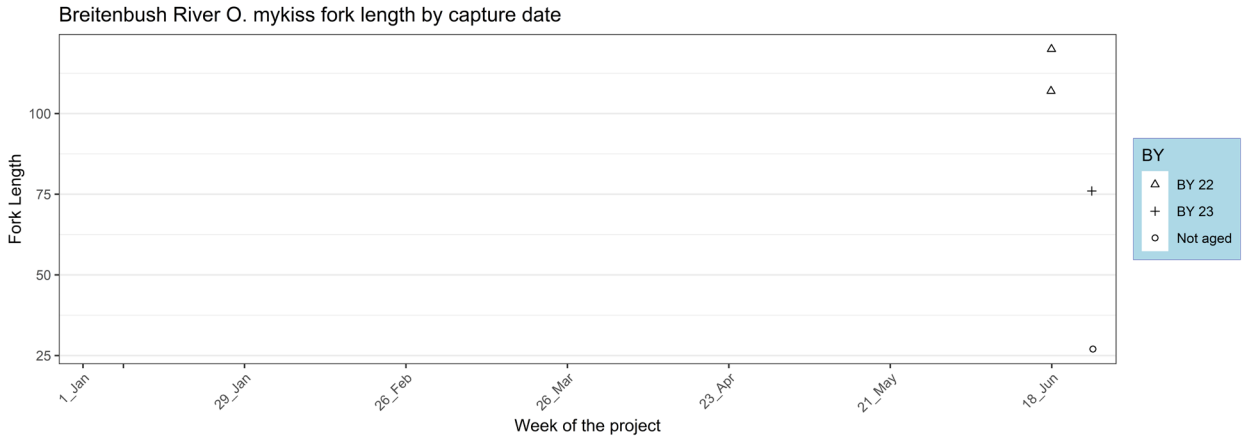


Figure 4. Length-frequency analysis by brood year for juvenile *O. mykiss* at the Breitenbush River site for 2023.

Trapping Efficiency Trials

A total of one trapping efficiency trial occurred using hatchery reared Chinook salmon in the Breitenbush River. A summary of fish release numbers, recaptures, and flow level for each trial is provided in Table 4. Trapping efficiency for the trial was 7.1%. Due to trap availability, we were unable to install the RST at this site until June 16, 2023, and were only able to perform one trial during the sampling period. At this time, we are unable to calculate weekly passage estimates for this site, as more trials are needed to perform passage estimates.

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

Release Location	Date of Release	Flow at Release (CFS)	Number of Fish Released	Number of Fish Recaptured	Percent Efficiency
Breitenbush River	6/21/2023	234	749	53	7.1%

Injury Data

A total of 12 juvenile Chinook (40.0% of total Chinook catch) and 1 juvenile *O. mykiss* (25.0% of total *O. mykiss* catch) displayed at least one of the injury code conditions listed in Table 2. Injuries observed at this site include descaling less than 20% and fin damage. These injuries were likely incurred upon capture in the RST due to debris or contact with various surfaces in the trap. Table 5 provides a summary of injuries observed on Chinook and *O. mykiss* at the Breitenbush River site.

Table 5. Summary of injuries observed on juvenile Chinook and *O. mykiss* at the Breitenbush River RST site.

Injury Code	Chinook Injuries	*O. mykiss* Injuries
NXI	60.0%	75.0%
MUNK	0.0%	0.0%
DS<2	10.0%	25.0%
DS>2	0.0%	0.0%
BLO	0.0%	0.0%
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	0.0%	0.0%
TEA	0.0%	0.0%
BRU	0.0%	0.0%
HBP	0.0%	0.0%
HO	0.0%	0.0%
BO	0.0%	0.0%
HBO	0.0%	0.0%
FID	30.0%	25.0%
PRD	0.0%	0.0%
COP	0.0%	0.0%
BKD	0.0%	0.0%
FUN	0.0%	0.0%

PIT Tagged and VIE Marked Fish

A total of 4 juvenile Chinook and 3 Juvenile *O. mykiss* were PIT tagged and released at the Breitenbush River site in 2023. Additionally, a total of 23 Chinook and 1 *O. mykiss* were VIE marked at the Breitenbush site in 2023. Some fish were not tagged, as they were still sac-fry or too small to safely mark. None of the PIT tagged or VIE marked fish have been redetected as of July 20, 2023. A summary of VIE marked fish is provided in Table 6. Information regarding PIT tags and redetections at the RST and other sites can be found in Appendix C.

Table 6. Summary table of VIE marked Chinook at the Breitenbush River RST site.

Date Tagged	Species	Tag Location	VIE Color	# Tagged	#Recaptured
6/16/2023–6/30/2023	Chinook	Head	Pink	23	0
6/16/2023–6/30/2023	Chinook	Right Dorsal[a]	Pink	1	0

[a] Denotes fish marked in wrong location

Non-Target Capture Data

We captured 4 non-target fish in addition to natural origin juvenile Chinook and *O. mykiss* at the Breitenbush River site (Table 7).

Table 7. Summary of non-target fish capture at the Breitenbush River RST site.

Species	Season Total	Season Total Mortality (subset of total)
O. mykiss (clipped)	3	2
Sculpin	1	0
Totals	**4**	**2**

Detroit Head of Reservoir- North Santiam River

Monitoring of a single 5-foot RST in the North Santiam River above Detroit Reservoir began on May 4, 2023. The trap sampled 56 days during the reporting period. The trap did not sample from May 30, 2023, to May 31, 2023, to prevent damage to Chinook fry in the livewell after ODFW released hatchery *O. mykiss* at the RST site. A summary of trap sampling outages can be found in Appendix B.

Target Catch and Passage Timing

The trap captured 9,125 juvenile Chinook salmon and 492 juvenile *O. mykiss* (Figures 5 and 6). Chinook catch was composed almost entirely of BY 2022 juveniles (n=9,124) (Figure 7). A single BY 2021 Chinook was captured on May 24, 2023, with a fork length of 61 mm and weight of 2.6 g. BY 2022 Chinook were captured throughout the sampling period and had an average fork length of 35.6 mm (min: 28 mm, max: 70 mm, median: 35 mm). The first BY 2022 sub-yearling captured at the trap occurred on May 5, on the first day of sampling. Previous monitoring efforts observed median migration dates in May with the earliest median date of migration being April 20th. This coupled with the capture of fry on the first day of sampling suggests that many fish migrated into Detroit Reservoir prior to the initiation of sampling.

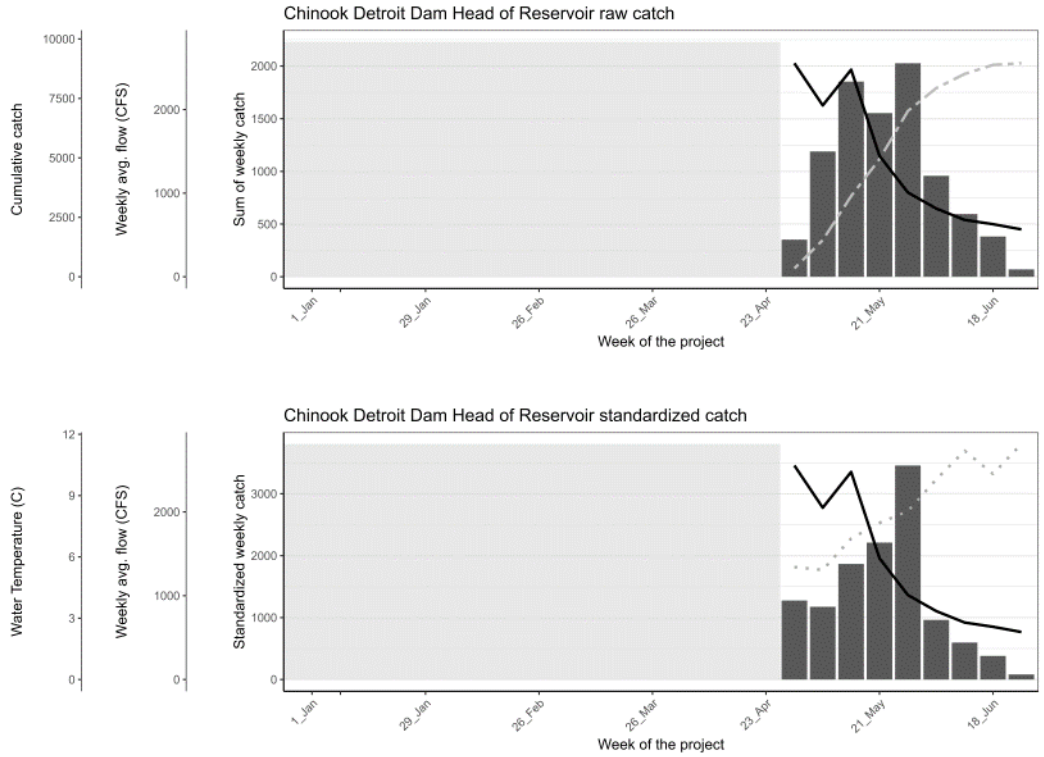
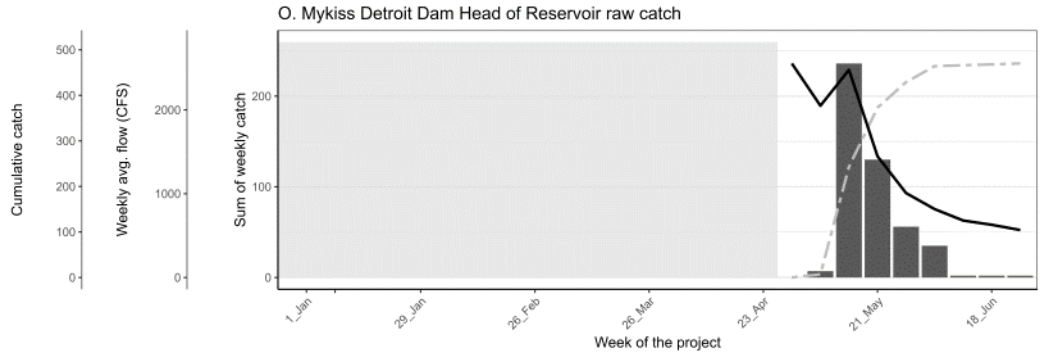


Figure 5. Raw catch (top panel) and weekly standardized catch (bottom panel) of natural origin juvenile Chinook at the Detroit Head of Reservoir- North Santiam River site with stream flow (black line), cumulative catch (gray dot dash line), water temperature (gray dots), and non-sampling weeks shaded out (gray) for January 1, 2023, to June 30, 2023.



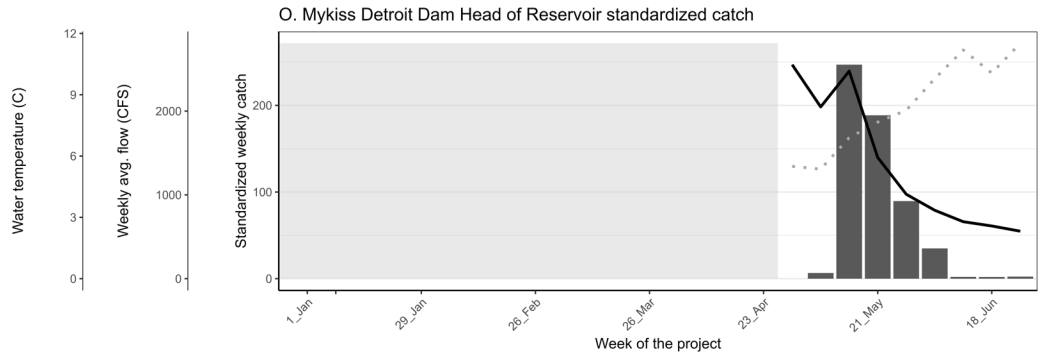


Figure 6. Shows raw (top panel) and weekly standardized (bottom panel) catch of juvenile *O. mykiss* overlayed with flow (black line), stream temperature (gray dotted line), and non-sampling weeks shaded out (gray) at the Detroit Head of Reservoir- North Santiam River site for 2023.

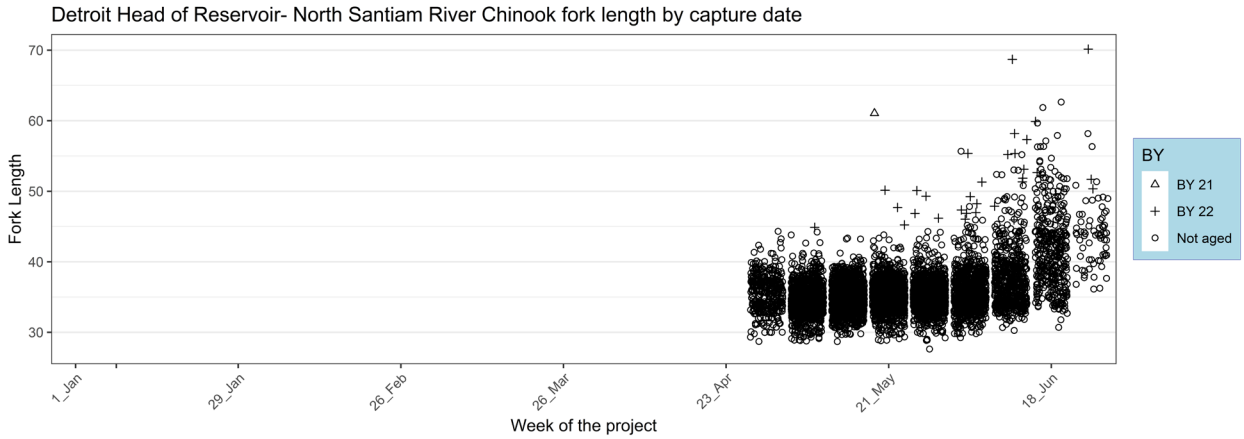


Figure 7. Length-frequency of juvenile Chinook salmon by brood year at the Detroit Head of Reservoir- North Santiam River site.

O. mykiss catch consisted of four brood years: BY 2019, 2021, 2022, and 2023 (Figure 8). BY 2023 was the dominant age class captured at the site and had an average fork length of 35.5 mm (n= 484, min: 25 mm, max: 46 mm, median: 35 mm). Catch of BY 2022 *O. mykiss* consisted of 7 individuals (1.4% of total *O. mykiss* capture) with an average fork length of 79.4 mm (min: 49 mm, max: 99 mm, median: 82 mm) and an average weight of 7.0 g (min: 2.3 g, max: 10.6 g, median: 6.4 g). A single BY 2021 fish was captured that had a length of 188 mm and weight of 66.5 g. The trap also captured 1 BY 2019 fish that had a length of 408 mm and was too large for our scale. Peak catch of juvenile *O. mykiss* occurred in May when 451 fish were captured (91.7% of *O. mykiss* capture).

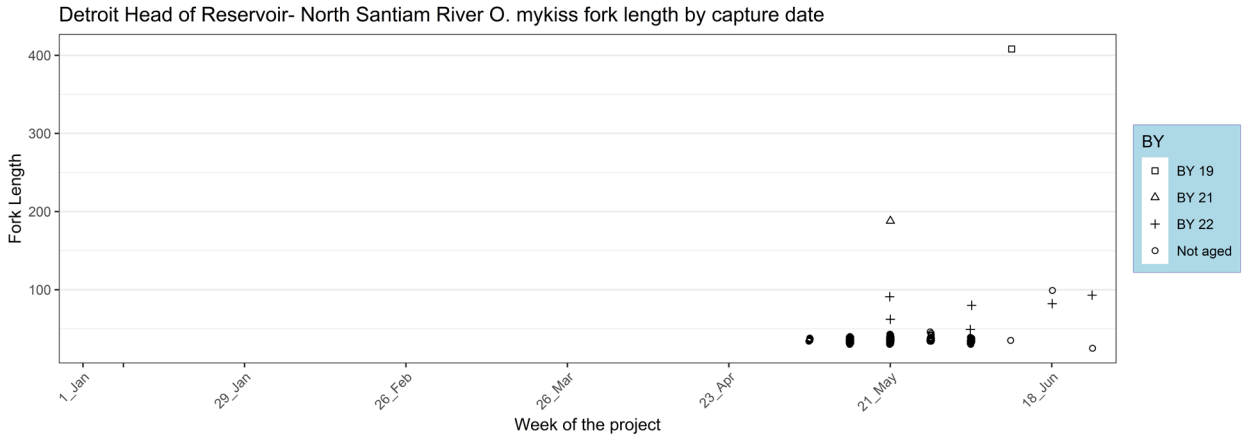


Figure 8. Length-frequency of juvenile *O. mykiss* salmon by brood year at the Detroit Head of Reservoir- North Santiam River site.

Trapping Efficiency Trials

A total of two trapping efficiency trials occurred using hatchery reared Chinook salmon at the Detroit Head of Reservoir- North Santiam site. A summary of fish release numbers, recaptures, and flow level for each trial is provided in Table 8. Trapping efficiencies ranged from 5.2% to 8.1%. Due to delays in the initiation of sampling and process to gain access to the trapping efficiency release site, we were only able to test the efficiency of the trap twice in June. The tests occurred at flows in the lower end of the range we sampled (average weekly min: 566 cfs, average weekly max: 2,554 cfs), as sampling in May experienced a larger range of flows and June sampling experienced only low flows. For this reason, we were unable to calculate an estimate for passage at this site. Future efficiency trials across the range of flows sampled will be needed to create future estimates.

Table 8. Summary table of marked hatchery Chinook releases at the Detroit Head of Reservoir- North Santiam River RST site for trapping efficiency.

Release Location	Date of Release	Flow at Release (CFS)	Number of Fish Released	Number of Fish Recaptured	Percent Efficiency
Detroit Head of Reservoir- North Santiam River	6/6/2023	833	540	28	5.2%
Detroit Head of Reservoir- North Santiam River	6/20/2023	629	750	61	8.1%

Injury Data

A total of 321 juvenile Chinook (3.5% of total Chinook catch) and 49 *O. mykiss* (10.0% of total *O. mykiss* catch) displayed at least one of the injury code conditions listed in Table 9. Observed injuries were likely incurred upon capture in the RST due to debris or contact with various surfaces in the trap. There were 13 Chinook mortalities (0.1% of Chinook catch) likely resulting from high debris in the trap.

Table 9. Summary of injuries observed on juvenile Chinook and *O. mykiss* at the Detroit Head of Reservoir- North Santiam River RST site.

Injury Code	Chinook Injuries	*O. mykiss* Injuries
NXI	97.4%	94.7%
MUNK	0.0%	0.2%
DS<2	0.3%	1.0%
DS>2	0.1%	0.8%
BLO	0.0%	0.0%

Injury Code	Chinook Injuries	*O. mykiss* Injuries
EYB	0.1%	1.0%
BVT	0.2%	0.2%
FVB	0.5%	0.4%
GBD	0.0%	0.2%
POP	0.0%	0.4%
HIN	0.2%	1.0%
OPD	0.4%	0.8%
TEA	0.3%	0.4%
BRU	0.7%	1.0%
HBP	0.0%	0.0%
HO	0.0%	0.0%
BO	0.0%	0.0%
HBO	0.0%	0.0%
FID	0.6%	1.8%
PRD	0.1%	0.2%
COP	0.0%	0.2%
BKD	0.0%	0.0%
FUN	0.0%	0.2%

PIT Tagged/VIE Marked Fish and Downstream Detections

A total of 9 fish were PIT tagged at this site in 2023, 2 Chinook and 7 *O. mykiss*. A total of 5,174 Chinook and 319 *O. mykiss* were VIE marked during the reporting period. Some fish were not marked, as they were still sac-fry or too small to safely mark. As of July 20, 2023, none of the PIT tagged or VIE marked fish have been detected at downstream sites. Table 10 provides a summary of VIE marked fish for the reporting period.

Table 10. 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
5/01/2023–5/15/2023	Chinook	Right Dorsal	Orange	889	0
5/01/2023–5/15/2023	*O. mykiss*	Right Dorsal	Orange	60	0
5/16/2023–5/31/2023	Chinook	Right Dorsal	Orange	2,700	0
5/16/2023–5/31/2023	*O. mykiss*	Right Dorsal	Orange	237	0
6/1/2023–6/15/2023	Chinook	Right Dorsal	Pink	1,048	0
6/1/2023–6/15/2023	*O. mykiss*	Right Dorsal	Pink	21	0
6/16/2023–6/30/2023	Chinook	Right Dorsal	Pink	539	0

Non-Target Capture Data

We captured 99 non-target fish in addition to natural origin juvenile Chinook. A summary of species and numbers of fish caught is provided in Table 11. The most commonly captured non-target species were adipose clipped rainbow trout and kokanee.

Table 11. Summary of non-target fish capture at the Detroit Head of Reservoir- North Santiam RST site.

Species	Season Total	Season Total Mortality (subset of total)
Chinook (clipped)	1	0
Cutthroat Trout	1	0
Dace	1	0
Kokanee	80	1
Mountain Whitefish	2	0
O. mykiss (clipped)	6	0
Sculpin	7	1
Unknown	1	1
Totals	**99**	**3**

Green Peter Head of Reservoir – Middle Santiam River

Monitoring of a single 5-foot RST in the Middle Santiam River above Green Peter Reservoir began on May 4, 2023. The trap began sampling much later than the target date of February 1, 2023, likely missing a significant portion of juvenile Chinook that out-migrated in the spring. The USACE out planted 600 adult Chinook salmon above the trapping site on private land. The landowner denied access for spawning ground surveys in the Middle Santiam River; thus, spawning success in the fall of 2022 for the fish released here is unknown (USACE 2022). The trap sampled 57 days in 2023. Additional information regarding sampling outages is listed in Appendix B.

Target Catch and Passage Timing

The trap captured 21 juvenile Chinook salmon and 1 juvenile *O. mykiss*. All captures of juvenile Chinook and *O. mykiss* occurred prior to May 16, 2023. Chinook catch was composed entirely of BY 2022 fish (Figure 10). The first BY 2022 sub-yearling captured at the trap occurred on May 5, one day after the start of sampling. This, combined with observations of early sub-yearling out migration in the nearby South Santiam system, suggest that many Chinook sub-yearlings likely passed the trapping site prior to the initiation of sampling (EAS 2023). The average fork length of BY 22 Chinook was 36.4 mm (n= 22, min: 33 mm, max: 45 mm, median: 36 mm). Figure 9 shows raw and standardized catch overlayed with flow at the Green Peter Head of Reservoir- Middle Santiam site. The one *O. mykiss* captured was a sub-yearling (BY 2023) with a fork length of 36 mm.

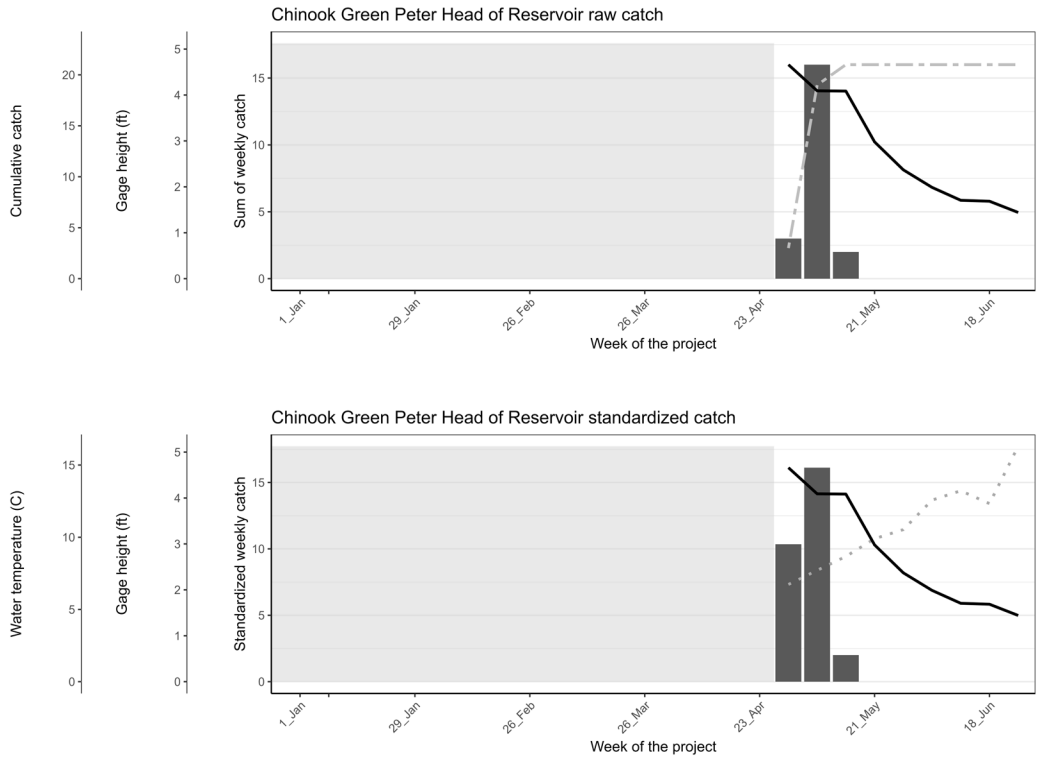


Figure 9. Raw catch (top panel) and weekly standardized catch (bottom panel) of natural origin juvenile Chinook at the Green Peter Head of Reservoir with stream gage height (black line), cumulative catch (gray dot dash line), stream temperature (gray dash line), and non-sampling weeks shaded out (gray) for 2023.

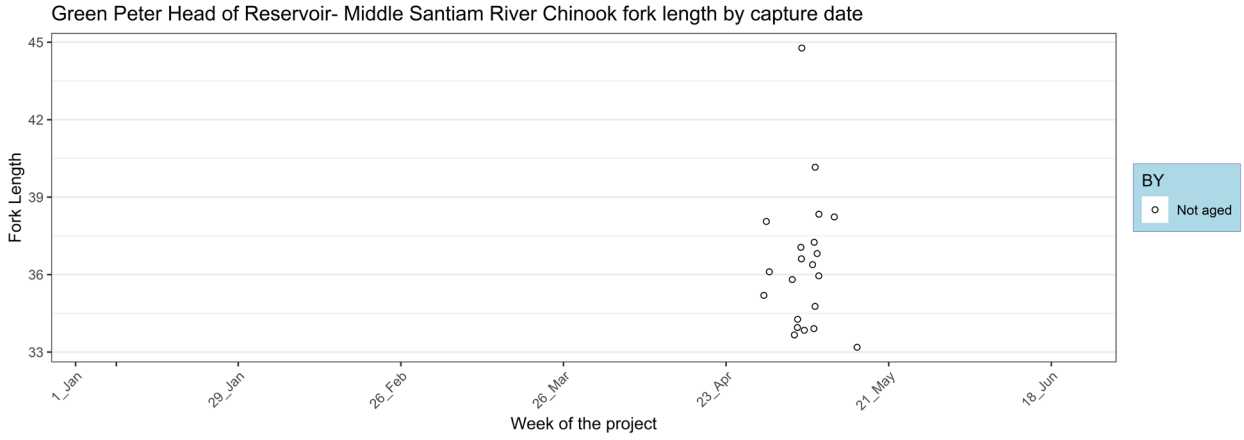


Figure 10. Length-frequency of juvenile Chinook salmon at the Green Peter Head of Reservoir site.

Trapping Efficiency Trials

Due to a delay in the initiation of sampling and confirmation of access to the release site, we were unable to perform enough trials to calculate a weekly passage estimate for this site. We were unable to test this site until June, at which point flows at the site had dropped to a level that resulted in the trap rotating slowly, allowing fish to easily avoid the trap. The location of the RST is limited by the fact that the trap and its associated highline must be wholly contained on land owned by the Bureau of Land Management. This restricts the sampling location to a single pool in a relatively wide and flat section of the river. As such, trap efficiency at this site is anticipated to increase with flow as faster water velocity through this site allows the

trap to sample more effectively. A total of two trapping efficiency trials occurred using hatchery reared Chinook salmon at the Green Peter Head of Reservoir- Middle Santiam site. A summary of fish release numbers, recaptures, and flow level for each trial is provided in Table 12. Trapping efficiencies ranged from 0 to 0.1%. Neither trial yielded the minimum number of recaptures necessary to consider them successful trials. These low flow trials suggest that below a certain flow level, the trap cannot efficiently sample and capture out-migrating fish. Additional trials across more flow ranges are planned to allow for passage estimates in future reports. In the past year, gage height at this site ranged from 0.86 ft to 8.64 ft.

Table 12. Summary of trapping efficiency trials at the Green Peter Head of Reservoir- Middle Santiam River RST site in 2023.

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	6/7/2023	2.1	1,000 (dead fish)	0	0%
Green Peter Head of Reservoir- Middle Santiam	6/7/2023	2.1	750	1	0.1%

Injury Data

A total of 2 juvenile Chinook (9.5% of total Chinook catch) displayed at least one of the injury code conditions listed in Table 2. The only injuries observed at this site include bruising and fin damage (Table 13). These injuries were likely incurred upon capture in the RST due to debris or contact with various surfaces in the trap.

Table 13. Summary of injuries observed on juvenile Chinook and *O. mykiss* at the Green Peter Head of Reservoir- Middle Santiam River RST site.

Injury Code	Chinook Injuries	*O. mykiss* Injuries
NXI	90.5%	100.0%
MUNK	0.0%	0.0%
DS<2	0.0%	0.0%
DS>2	0.0%	0.0%
BLO	0.0%	0.0%
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	0.0%	0.0%
TEA	0.0%	0.0%
BRU	4.8%	0.0%
HBP	0.0%	0.0%
HO	0.0%	0.0%
BO	0.0%	0.0%
HBO	0.0%	0.0%
FID	4.8%	0.0%
PRD	0.0%	0.0%
COP	0.0%	0.0%
BKD	0.0%	0.0%
FUN	0.0%	0.0%

PIT Tagged/VIE Marked Fish and Downstream Detections

A total of 0 juvenile Chinook were PIT tagged and 15 were VIE marked at the Green Peter Head of Reservoir- Middle Santiam site in 2023. The 1 juvenile *O. mykiss* captured was VIE marked. The rest of the fish captured did not meet length requirements or were still sac-fry that were not able to be marked. No VIE marked fish were redetected at downstream sites. Table 14 shows a summary of VIE marked fish with the tagging period and mark details.

Table 14. 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 to Date
5/01/2023–5/15/2023	Chinook	Right Dorsal	Orange	14	0
5/01/2023–5/15/2023	*O. mykiss*	Right Dorsal	Orange	1	0
5/16/2023–5/31/2023	Chinook	Right Dorsal	Orange	1	0

Non-Target Capture Data

We captured 22 non-target fish in addition to natural origin juvenile Chinook and *O. mykiss*. A summary of species and numbers of fish caught are provided in Table 15. The most commonly captured non-target species were Dace and sculpin.

Table 15. Summary of non-target fish capture at the Green Peter Head of Reservoir- Middle Santiam River RST site.

Species	Season Total	Season Total Mortality (subset of total)
Cutthroat Trout	0	0
Dace	8	0
Kokanee	5	0
Sculpin	9	0
Totals	**22**	**0**

Hills Creek Head of Reservoir- Middle Fork Willamette River

Monitoring in the Middle Fork Willamette River above Hills Creek Dam began on May 9, 2023. The 5-foot RST sampled 52 days in 2023. A summary of sampling outages at this site can be found in Appendix B. In calendar year 2022, a total of 468 adult spring Chinook were out planted above Hills Creek Dam. This consisted of 198 females, 250 males, and 14 jack Chinook (USACE 2022).

Target Catch and Passage Timing

A total of 93 natural origin juvenile Chinook salmon were captured in the RST above Hills Creek Dam in 2023. Scale age analysis showed that all of the Chinook captured were BY 2022 sub-yearlings (Figure 12). The average length of BY 2022 fish was 43.7 mm (min: 30 mm, max: 76 mm, median: 44 mm) (Figure 11). The first Chinook sub-yearling was captured on May 10, 2023, on the first day of sampling. Sampling in 2015 found that the median migration date for sub-yearling Chinook was March 29th and speculated that fry moved into the reservoir prior to their sampling start in March (Romer et al. 2016). It is likely that many fish migrated into Hills Creek Reservoir prior to the initiation of sampling on May 9, 2023.

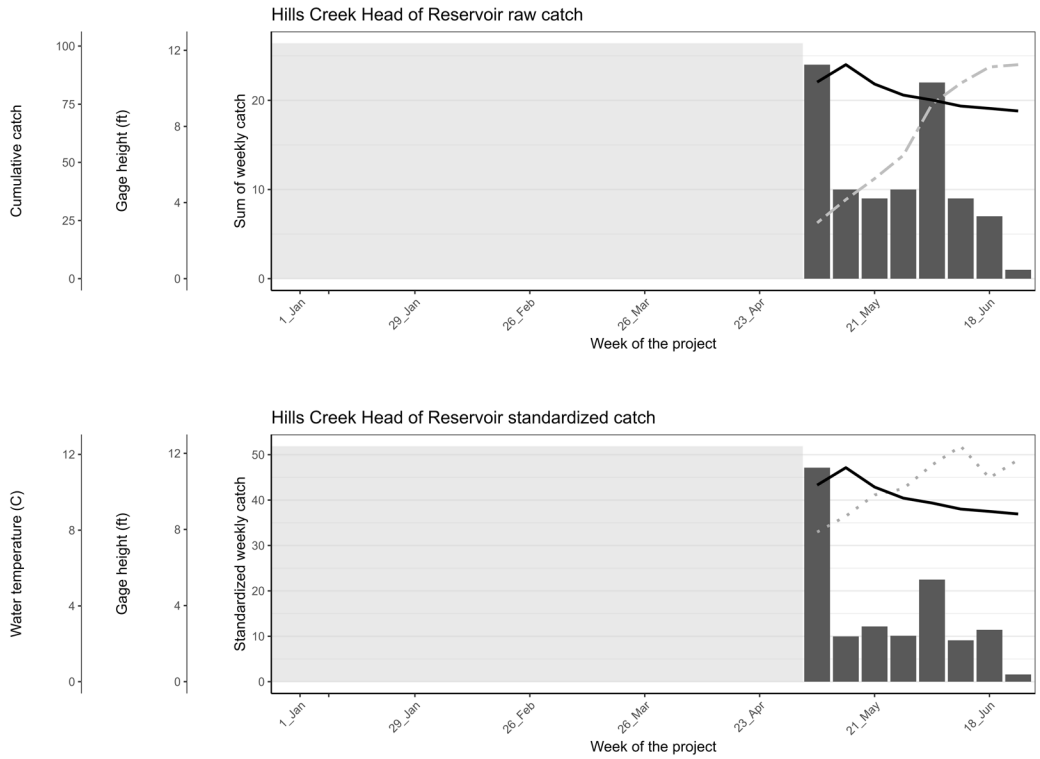


Figure 11. Raw (top panel) and weekly standardized (bottom panel) catch with stream gage height (black line), stream temperature (gray dot line), cumulative catch (gray dash dot line), and non-sampling weeks shaded out (gray) for the Hills Creek Head of Reservoir- Middle Fork Willamette River RST for sampling from January 1, 2023, through June 30, 2023.

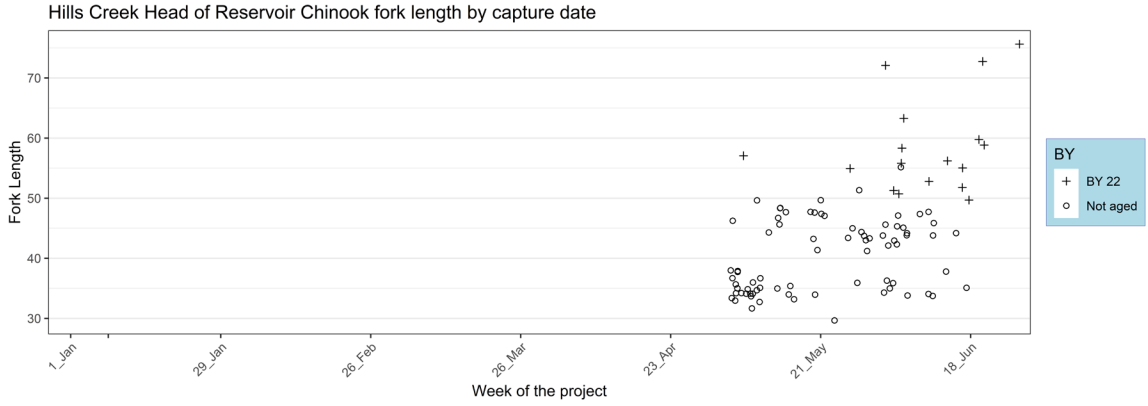


Figure 12. Length-frequency of juvenile Chinook salmon by brood year at the Hills Creek Head of Reservoir- Middle Fork Willamette River.

Trapping Efficiency Trials

A total of 2 trapping efficiency trials occurred using hatchery reared Chinook salmon at the Hills Creek Head of Reservoir- Middle Fork Willamette River sites. Trapping efficiencies ranged from 0.9% to 8.5%. Due to the delay in the initiation of sampling at this site and shortened sampling period, we were unable to perform enough trials to perform passage estimates. More trapping efficiency trials over the range of flows sampled will be needed to provide passage estimates in the future. In the last year, gage height at this site ranged from 8.47 ft to 13.54 ft. A summary of trapping efficiency trials is provided in Table 16.

Table 16. Summary of trapping efficiency trials at the Hills Creek Head of Reservoir- Middle Fork Willamette River RST site.

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	5/18/2023	10.2	519	44	8.5%
Hills Creek Head of Reservoir-Middle Fork Willamette River	6/19/2023	8.9	760	7	0.9%

Injury Data

A total of 8 (8.6% of total Chinook catch) juvenile Chinook displayed at least one of the injury code conditions listed in Table 2. Injuries at this site are likely due to being captured in the RST. A summary of observed injuries can be found in Table 17.

Table 17. Summary of injuries observed on juvenile Chinook at the Hills Creek Head of Reservoir-Middle Fork Willamette River RST site.

Injury Code	Chinook Injuries
NXI	91.4%
MUNK	0%
DS<2	6.5%
DS>2	0%
BLO	0%
EYB	0%
BVT	0%
FVB	0%
GBD	0%
POP	0%
HIN	0%
OPD	0%
TEA	0%
BRU	0%
HBP	0%
HO	0%
BO	0%
HBO	0%
FID	2.2%
PRD	0%
COP	0%
BKD	0%
FUN	0%

PIT Tagged/VIE Marked Fish and Downstream Detections

A total of 3 fish were PIT tagged and 71 fish were VIE marked. Some Chinook were not tagged, as they were still sac-fry or too small to safely mark. No PIT tagged or VIE marked fish were redetected downstream. Table 18 provides a summary of VIE marked fish at the Hills Creek Head of Reservoir- Middle Fork Willamette River site.

Table 18. Summary table of VIE marked Chinook at the Hills Creek Head of Reservoir- Middle Fork Willamette River RST site.

Date Tagged	Species	Tag Location	VIE Color	# Tagged	# Recaptured to Date
5/1/2023–5/30/2023	Chinook	Left Dorsal	Orange	19	0
5/1/2023–5/30/2023	Chinook	Right Dorsal	Orange	11	0
6/1/2023–6/30/2023	Chinook	Left Dorsal	Pink	37	0
6/1/2023–6/30/2023	Chinook	Right Dorsal	Pink	4	0

Non-Target Species

In addition to natural origin juvenile Chinook, a total of 197 non-target fish were captured. A summary of species and numbers of fish caught is provided in Table 19. The most commonly captured non-target species were Dace and Largescale Sucker. The Bull Trout captured at this site was reported to ODFW staff. Information regarding Bull Trout captures, fork lengths, and PIT tags is provided in Appendix C.

Table 19. Summary of non-target fish capture at the Hills Creek Head of Reservoir- Middle Fork Willamette River RST site.

Species	Season Total	Season Total Mortality (subset of total)
Brook Lamprey	18	2
Bull Trout	1	0
Cutthroat Trout	2	0
Dace	87	1
Largescale Sucker	64	1
Mountain Whitefish	2	0
O. mykiss	26	0
Redside Shiner	12	0
Sculpin	20	1
Totals	**197**	**3**

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Appendix A –
Locations of Rotary Screw Traps

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Appendix A: Locations of Rotary Screw Traps

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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
North Santiam Above Detroit

RST Locations

500 Feet

N

EAS ENVIRONMENTAL ASSESSMENT SERVICES
Wholly Owned Subsidiary of Natives of Kodiak

FIGURE A-3
Middle Santiam River

RST Locations

500 Feet

EAS ENVIRONMENTAL ASSESSMENT SERVICES
Wholly Owned Subsidiary of Natives of Kodiak

FIGURE A-4
Middle Fork Willamette Above Hills Creek

RST Locations

500 Feet

N

EAS ENVIRONMENTAL ASSESSMENT SERVICES
Wholly Owned Subsidiary of Natives of Kodiak

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
Breitenbush River	2/1/2023–6/16/2023	The manufacturer experienced delays and could not manufacture traps during this reporting period. No other traps were available until 6/16/2023. Trap was installed and began sampling on 6/16/2023.
Detroit Head of Reservoir-North Santiam River	2/1/2023–5/4/2023	Contract with USACE was not approved until March. The initiation of sampling was further delayed until permits were approved by ODFW and NOAA.
Detroit Head of Reservoir-North Santiam River	5/30/2023–5/31/2023	Trap was raised into the non-sampling position to prevent damage to Chinook fry resulting from overcrowding of trap after a hatchery *O. mykiss* release in front of the trap.
Green Peter Head of Reservoir- Middle Santiam River	2/1/2023–5/4/2023	Contract with USACE was not approved until March. The initiation of sampling was further delayed until permits were approved by ODFW and NOAA.
Hills Creek Head of Reservoir- Middle Fork Willamette River	2/1/2023–5/9/2023	The initiation of sampling was delayed until permits were approved by ODFW and NOAA. The trap manufacturer experienced delays and could not build a new trap for this site in time to start sampling. A trap from another location was prioritized to this site.

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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

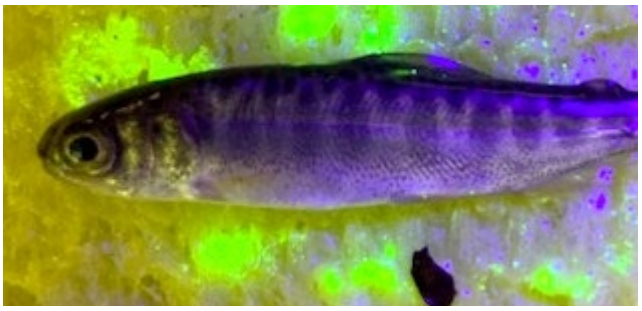

Figure C-1. Example of a VIE marked Chinook salmon. A green, fluorescent elastomer mark can be seen along the dorsal fin.

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
Green Peter Head of Reservoir- Middle Santiam River	GPA	MSANTR
Hills Creek Head of Reservoir- Middle Fork Willamette River	HCA	WILRMF
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 fish PIT tagged at RST sites.

Tagging Site	Total Number of Fish PIT Tagged
Breitenbush River	7
Detroit Head of Reservoir- North Santiam River	10
Green Peter Head of Reservoir- Middle Santiam River	0
Hills Creek Head of Reservoir- Middle Fork Willamette River	3

Table C-3. Summary of VIE marked fish at RST sites.

Site	Date	Species	Date Tagged	VIE Color	# Tagged	# Recaptured
Breitenbush	6/16/2023–6/30/2023	Chinook	Head	Pink	24	0
Breitenbush	6/16/2023–6/30/2023	Chinook	Right Dorsal*	Pink	1	0
Detroit Head of Reservoir-North Santiam	5/01/2023–5/15/2023	Chinook	Right Dorsal	Orange	889	0
Detroit Head of Reservoir-North Santiam	5/01/2023–5/15/2023	*O. mykiss*	Right Dorsal	Orange	60	0
Detroit Head of Reservoir-North Santiam	5/16/202–5/31/2023	Chinook	Right Dorsal	Orange	2,700	0
Detroit Head of Reservoir-North Santiam	5/16/2023–5/31/2023	*O. mykiss*	Right Dorsal	Orange	237	0
Detroit Head of Reservoir-North Santiam	6/1/2023–6/15/2023	Chinook	Right Dorsal	Pink	1048	0
Detroit Head of Reservoir-North Santiam	6/1/2023–6/15/2023	*O. mykiss*	Right Dorsal	Pink	21	0
Detroit Head of Reservoir-North Santiam	6/16/2023–6/30/2023	Chinook	Right Dorsal	Pink	539	0
Green Peter Head of Reservoir- Middle Santiam	5/01/2023–5/15/2023	Chinook	Right Dorsal	Orange	14	0
Green Peter Head of Reservoir- Middle Santiam	5/01/2023–5/15/2023	*O. mykiss*	Right Dorsal	Orange	1	0
Green Peter Head of Reservoir- Middle Santiam	5/16/2023–5/31/2023	Chinook	Right Dorsal	Orange	1	0
Hills Creek Head of Reservoir-Middle Fork Willamette	5/1/2023–5/30/2023	Chinook	Left Dorsal	Orange	19	0
Hills Creek Head of Reservoir-Middle Fork Willamette	5/1/2023–5/30/2023	Chinook	Right Dorsal	Orange	11	0
Hills Creek Head of Reservoir-Middle Fork Willamette	6/1/2023–6/30/2023	Chinook	Left Dorsal	Pink	37	0
Hills Creek Head of Reservoir-Middle Fork Willamette	6/1/2023–6/30/2023	Chinook	Right Dorsal	Pink	4	0

Table C-4. List of PIT tagged fish at RST sites.

Site	Trap	PIT Tag	Date	Species
Breitenbush River	5 ft	3DD.003BEE0FCE	6/17/2023	Chinook
Breitenbush River	5 ft	3DD.003BEE0FF6	6/20/2023	Chinook
Breitenbush River	5 ft	3DD.003BEE0FAC	6/20/2023	Chinook
Breitenbush River	5 ft	3DD.003BEE0FF3	6/21/2023	Chinook
Breitenbush River	5 ft	3DD.003BEEOFDF	6/22/2023	*O. mykiss*
Breitenbush River	5 ft	3DD.003BEE0FAF	6/24/2023	*O. mykiss*
Breitenbush River	5 ft	3DD.003BD39619	6/27/2023	*O. mykiss*
Detroit Head of Reservoir- North Santiam River	5 ft	3DD.003BD22575	6/16/2023	Chinook
Detroit Head of Reservoir- North Santiam River	5 ft	3DD.003BEE1006	6/18/2023	*O. mykiss*
Detroit Head of Reservoir- North Santiam River	5 ft	3DD.003BEE0FD8	6/23/2023	*O. mykiss*
Detroit Head of Reservoir- North Santiam River	5 ft	3DD.003BD395FA	6/27/2023	*O. mykiss*
Detroit Head of Reservoir- North Santiam River	5 ft	3DD.003BD395F9	6/28/2023	Chinook
Detroit Head of Reservoir- North Santiam River	5 ft	3DD.003BD2256E	6/8/2023	*O. mykiss*
Detroit Head of Reservoir- North Santiam River	5 ft	3DD.003BEEEF0D	6/13/2023	*O. mykiss*
Detroit Head of Reservoir- North Santiam River	5 ft	3DD.003BEE0C2E	5/23/2023	*O. mykiss*
Detroit Head of Reservoir- North Santiam River	5 ft	3DD.003BEE0C4F	5/24/2023	*O. mykiss*
Hills Creek Head of Reservoir- Middle Fork Willamette	5 ft	3DD.003BD2272B	6/5/2023	Chinook
Hills Creek Head of Reservoir- Middle Fork Willamette	5 ft	3DD.003BD397D9	6/19/2023	Chinook
Hills Creek Head of Reservoir- Middle Fork Willamette	5 ft	3DD.003BD2273E	6/28/2023	Chinook

Table C-5. List of Bull Trout captured at RST sites and collected data.

Site	Date	Length (est. mm)	Tag(s)	Condition
Hills Creek Head of Reservoir- Middle Fork Willamette	5/31/2023	245	None	Unharmed

Table C-6. List of PIT tagged fish captured at RST sites.

Site	Trap	PIT Tag	Date	Species
Hills Creek Head of Reservoir	5 ft	3D6.15348025FC	5/21/2023	Chinook
Hills Creek Head of Reservoir	5 ft	3D6.1534802C21	5/21/2023	Chinook
Hills Creek Head of Reservoir	5 ft	3D6.15348029E7	5/20/2023	Chinook
Hills Creek Head of Reservoir	5 ft	3D6.1534802DDD	5/20/2023	Chinook
Hills Creek Head of Reservoir	5 ft	3D6.1534803003	5/20/2023	Chinook
Hills Creek Head of Reservoir	5 ft	3D6.1534802FD8	5/19/2023	Chinook
Hills Creek Head of Reservoir	5 ft	3D6.1534803017	5/19/2023	Chinook
Hills Creek Head of Reservoir	5 ft	3D6.1534802C37	5/19/2023	Chinook
Hills Creek Head of Reservoir	5 ft	3D6.153480264B	5/19/2023	Chinook
Hills Creek Head of Reservoir	5 ft	3D6.1534802C22	5/19/2023	Chinook
Hills Creek Head of Reservoir	5 ft	3D6.1534802641	5/19/2023	Chinook
Hills Creek Head of Reservoir	5 ft	3D6.1534802DD2	5/19/2023	Chinook
Hills Creek Head of Reservoir	5 ft	3D6.1534802A28	5/19/2023	Chinook
Hills Creek Head of Reservoir	5 ft	3D6.1534803020	5/19/2023	Chinook
Hills Creek Head of Reservoir	5 ft	3D6.153480281D	5/19/2023	Chinook
Hills Creek Head of Reservoir	5 ft	3D6.1534802C0C	5/19/2023	Chinook
Hills Creek Head of Reservoir	5 ft	3D6.1534802FD0	5/19/2023	Chinook
Hills Creek Head of Reservoir	5 ft	3D6.1534802A37	5/19/2023	Chinook
Hills Creek Head of Reservoir	5 ft	3D6.1534802800	5/19/2023	Chinook
Hills Creek Head of Reservoir	5 ft	3D6.153480284A	5/19/2023	Chinook
Hills Creek Head of Reservoir	5 ft	3D6.1534802DF8	5/19/2023	Chinook
Hills Creek Head of Reservoir	5 ft	3D6.15348027F7	5/19/2023	Chinook
Hills Creek Head of Reservoir	5 ft	3D6.1534802A06	5/19/2023	Chinook
Hills Creek Head of Reservoir	5 ft	3D6.1534802FE5	5/19/2023	Chinook
Hills Creek Head of Reservoir	5 ft	3D6.1534802850	5/19/2023	Chinook
Hills Creek Head of Reservoir	5 ft	3D6.1534802FE2	5/19/2023	Chinook
Hills Creek Head of Reservoir	5 ft	3D6.1534802FD9	5/19/2023	Chinook
Hills Creek Head of Reservoir	5 ft	3D6.1534802A25	5/19/2023	Chinook
Hills Creek Head of Reservoir	5 ft	3D6.153480262D	5/19/2023	Chinook
Hills Creek Head of Reservoir	5 ft	3D6.1534802638	5/19/2023	Chinook
Hills Creek Head of Reservoir	5 ft	3D6.1534802BEE	5/19/2023	Chinook
Hills Creek Head of Reservoir	5 ft	3D6.1534802C18	5/19/2023	Chinook
Hills Creek Head of Reservoir	5 ft	3D6.1534802E07	5/19/2023	Chinook
Hills Creek Head of Reservoir	5 ft	3D6.1534802A23	5/19/2023	Chinook
Hills Creek Head of Reservoir	5 ft	3D6.1534802FEA	5/19/2023	Chinook
Hills Creek Head of Reservoir	5 ft	3D6.1534802C35	5/19/2023	Chinook

Site	Trap	PIT Tag	Date	Species
Hills Creek Head of Reservoir	5 ft	3D6.1534802642	5/19/2023	Chinook
Hills Creek Head of Reservoir	5 ft	3D6.1534802A16	5/19/2023	Chinook
Hills Creek Head of Reservoir	5 ft	3D6.1534802A1F	5/19/2023	Chinook
Hills Creek Head of Reservoir	5 ft	3D6.1534802830	5/19/2023	Chinook
Hills Creek Head of Reservoir	5 ft	3D6.15348029E4	5/19/2023	Chinook
Hills Creek Head of Reservoir	5 ft	3D6.1534802C0D	5/19/2023	Chinook
Hills Creek Head of Reservoir	5 ft	3D6.15348029F8	5/19/2023	Chinook
Detroit Head of Reservoir- North Santiam River	5 ft	3DD.003E4BA25E	6/17/2023	Chinook

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Appendix D –
Example of Injury Photos

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Appendix D: Example of Injury Photos

Figures

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Figure D-1. Live fish with no external injuries (NXI)

Figure D-2. Descaling less than 20% (DS<2)

Figure D-3. Bloody Eye (hemorrhage) (EYB)

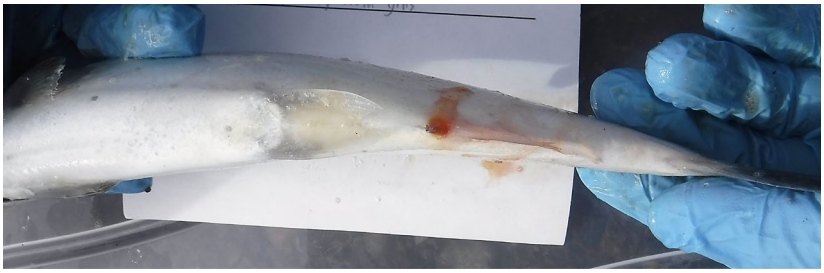

Figure D-4. Bleeding from Vent (BVT)

Figure D-5. Fin Blood Vessels Broken (FVB)

Figure D-6. Gas Bubble Disease (fin ray/eye inclusions) (GBD)

Figure D-7. Pop Eye (eye popping out of head/missing eye) (POP)

Figure D-8. Head Injury (HIN)

Figure D-9. Operculum Damage (OPD)

Figure D-10. Body Injury (tears, scrapes, mechanical damage) (TEA)

Figure D-11. Bruising (any part of the body) (BRU)

Figure D-12. Hole Behind Pectoral Fin (HBP)

Figure D-13. Descaling greater than 20% (DS>2)

Figure D-14. Head Only (HO)

Figure D-15. Body Only (BO)

Figure D-16. Head Barely Connected (HBO)

Figure D-17. Fin Damage (FID)

Figure D-18. Predation Marks (vert. claw or teeth marks) (PRD)

Figure D-19. Copepods (on gills or fins) (COP)

Figure D-20. Fungus (FUN)

Appendix E –
Images of Non-Target Species

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Appendix E: Images of Non-Target Species

Figures

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Figure E-1. Bluegill

Figure E-2. Brook Lamprey

Figure E-3. Brown Bullhead

Figure E-4. Bull Trout

Figure E-5. Crappie

Figure E-6. Cutthroat Trout

Figure E-7. Longnose Dace

Figure E-8. Kokanee

Figure E-9. Sculpin

Figure E-10. Smallmouth Bass

Figure E-11. Spotted Bass

Figure E-12. Walleye

Figure E-13. Western Mosquitofish

Appendix F –
Images of Traps

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Appendix F: Images of Traps Sampling in Various Conditions

Figures

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Figure F-1. Labelled image of a rotary screw trap showing parts and terminology.

Figure F-2. RST sampling at the Breitenbush River site in low flow.

Figure F-3. RST sampling at the Detroit Head of Reservoir site in medium flow.

Figure F-4. RST sampling at the Green Peter Head of Reservoir – Middle Santiam site in low flow.

Figure F-5. RST sampling at the Hills Creek Head of Reservoir – Middle Fork Willamette River site in medium flow.