WILLAMETTE VALLEY FISH PASSAGE MONITORING VIA ROTARY SCREW TRAPS

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Environmental Assessment Services (EAS) has conducted fish passage monitoring, utilizing rotary screw traps (RSTs), for the U.S. Army Corps of Engineers – Portland District (USACE) starting in October 2021 and which is ongoing with data presented herein through 31 December 2022. The purpose of this study is to evaluate the biological effects of certain measures being implemented to improve fish passage and water quality at several WVP dam sites to benefit UWR spring Chinook salmon and winter steelhead as required under the Interim Injunction Order issued by the U.S. District Court for the District of Oregon. RST sampling, as part of this project, has occurred at Big Cliff Dam tailrace, Green Peter Dam tailrace, Foster Dam Head of Reservoir- South Santiam River, Cougar Dam tailrace, Cougar Dam Head of Reservoir, Fall Creek Dam RO tailrace, Fall Creek Dam Head of Reservoir, Dexter Dam tailrace, Lookout Dam tailrace, Lookout Point Head of Reservoir, and Hills Creek Dam tailrace.

The goals of this study are to provide juvenile salmonid data (e.g. passage, injuries, and survival) in relation to dam passage and Army Corps operations including passage by route (e.g. powerhouse vs spillway, where feasible), and characterize injuries including mortality after 24 hour holds following capture in RSTs. Target species include wild Chinook salmon (*Oncorhynchus tshawytscha*) at all sites, and steelhead (*Oncorhynchus mykiss*) on the Santiam River (Big Cliff Dam, Green Peter Dam, and Foster Dam Head of Reservoir). Additionally, trap efficiency (TE) trials were conducted with hatchery Chinook, and natural origin run of river (RoR) Chinook and Steelhead where possible.

During the monitoring period from October 2021 to December 31, 2022, the primary objectives were to operate RSTs to determine species composition and collect biological information including injuries of fish passing the respective sample sites. RSTs were checked once per day unless conditions necessitated additional checks for fish and/or trap safety. Upon arrival at a trap site, crews collected data on cone rotation speed, cone rotation count from last check to current check, water temperature at trap, and time of fish collection. Additional environmental data was collected from U.S. Geological Survey gauges and USACE dam operations data and included inflow, outflow by route, water temperature, and dissolved oxygen concentration where available. Biological data was collected for each target fish we captured. Data collected included species, fork length (FL), weight, fish condition, injuries, and assessment of presence of tags or other marks. Scales were collected from fish >50 mm FL, and fin clips for future DNA analysis were collected from fish >45 mm FL. All fish with a FL 65 mm or larger, not being placed into a 24-hour hold to investigate delayed mortality from passage and capture, were PIT tagged and released. At the Cougar Dam Head of Reservoir, Fall Creek Head of Reservoir, and Lookout Point Head of Reservoir sites, fish smaller than 65 mm and larger than 35 mm were marked with visible implant elastomer (VIE). A summary of data in the 2021 and 2022 sampling period collected by site is provided in Table 1.

Table 1. Summary of data collected at each RST site in 2021 and 2022.

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)
Big Cliff Dam	Yes- Hatchery Fish	Spring Chinook and O. mykiss	Yes- weight (nearest 0.1 g), FL (mm), Injuries	Yes	Yes	Yes- on fish not included in 24-hr holds.	No
Green Peter Dam Tailrace- Middle Santiam	Yes- Hatchery Fish	Spring Chinook and O. mykiss	Yes- weight (nearest 0.1 g), FL (mm), Injuries	Yes	Yes	Yes- on fish not included in 24-hr holds.	No
Foster Dam Head of Reservoir- South Santiam	Yes- Run of River Fish, Hatchery Fish in Fall	Spring Chinook and O. mykiss	Yes- weight (nearest 0.1 g), FL (mm), Injuries	Yes	No	Yes	No
Cougar Dam Tailrace	Yes- Hatchery Fish	Spring Chinook	Yes- weight (nearest 0.1 g), FL (mm), Injuries	Yes	Yes	Yes- on fish not included in 24-hr holds.	No
Cougar Dam Head of Reservoir	Yes- Hatchery Fish	Spring Chinook	Yes- weight (nearest 0.1 g), FL (mm), Injuries	Yes	No	Yes	Yes
Fall Creek Dam	Yes- Hatchery Fish	Spring Chinook	Yes- weight (nearest 0.1 g), FL (mm), Injuries	Yes	Yes	Yes- on fish not included in 24-hr holds.	No
Fall Creek Head of Reservoir	Yes- Run of River	Spring Chinook	Yes- weight (nearest 0.1 g), FL (mm), Injuries	Yes	No	Yes	No
Dexter Dam Tailrace	Yes- Hatchery Fish	Spring Chinook	Yes- weight (nearest 0.1 g), FL (mm), Injuries	Yes	Yes	Yes- on fish not included in 24-hr holds.	No
Lookout Dam Tailrace	Yes- Hatchery Fish	Spring Chinook	Yes- weight (nearest 0.1 g), FL (mm), Injuries	Yes	Yes	Yes- on fish not included in 24-hr holds.	Yes- Started 9/30/2022
Lookout Point Head of Reservoir	Yes- Hatchery Fish	Spring Chinook	Yes- weight (nearest 0.1 g), FL (mm), Injuries	Yes	No	Yes	Yes
Hills Creek Dam	Yes- Hatchery Fish	Spring Chinook	Yes- weight (nearest 0.1 g), FL (mm), Injuries	Yes	Yes	Yes- on fish not included in 24-hr holds.	Yes- Started 9/30/2022

Target catch and passage. Total target raw catch consisted of 5522 juvenile Chinook and 337 O. mykiss captured at all sites during sampling in 2021 and 2022. Where dam operations allowed daily catch rates were standardized and weekly catch was calculated from the standardized daily catch rates. Building on the work of previous studies in the area we calculated weekly passage estimates based on trap efficiency (TE) trials (see below) and additionally attempted to account for flow rates, which are known to be a major factor in trap efficiency. Response to flow rates appear to be on a site-by-site basis, and more TE trials need to be

conducted in 2023 to further test this hypothesis. Passage estimates by site are presented in Table 2.

Table 2. Raw catch, Passage Estimates with 95% confidence intervals of target species by site and route captured in 2022, where possible.

Site	Route	Species	n	Passage est.	95% C.I.
Big Cliff Dam	Tailrace	Chinook	1,255	23,617	18,854 to 32,245
Big Cliff Dam	Tailrace	*O. mykiss*	107		
Green Peter Dam	Tailrace	Chinook	0		
Green Peter Dam	Tailrace	*O. mykiss*	6		
Foster Dam HOR		Chinook	128	1,054	689 to 2,238
Foster Dam HOR		*O. mykiss*	224		
Cougar Dam	Powerhouse	Chinook	1,193	7,912	4,743 to 23,823
Cougar Dam	RO	Chinook	1,803	24,956	19,095 to 36,007
Cougar Dam HOR		Chinook	710	18,952	14,462 to 27,482
Fall Creek Dam HOR		Chinook	7		
Fall Creek Dam	Tailrace	Chinook	1		
Dexter Dam	Tailrace	Chinook	99		
Lookout Dam	Powerhouse	Chinook	40		
Lookout Dam	Spill	Chinook	38		
Lookout Point HOR		Chinook	108		
Hills Creek Dam	Powerhouse	Chinook	56	4,339	2,705 to 10,949
Hills Creek Dam	RO	Chinook	84		

Trap Efficiency 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 specific 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. 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 locations summarized in Table 3.

Table 3. Trap Efficiency trial summary data. Trial types: Hatchery L= Hatchery fish trials with low flows, Hatchery M=Hatchery fish trials with medium flows, Hatchery H= Hatchery fish trials with high flows, Hatchery= hatchery fish trials not assigned a flow category, RoR=Run of River * indicates days were pooled to get 5 returns. A successful trial had 5 or more recaptures within a week. **Predation was likely occurring at Lookout Point HOR and 2022 TE trials are suspect.

Site	Route	Trial type	Number of trials	Successful trials	T.E. (±95% C.I.)
Big Cliff Dam	Tailrace	Hatchery L	7	7	5.4% (±1.6%)
Big Cliff Dam	Tailrace	Hatchery M	4	4	3.0% (±0.7%)
Big Cliff Dam	Tailrace	Hatchery H	2	2	4.4% (±0.4%)
Green Peter Dam	Tailrace	Hatchery	2	1	1.7%
Foster Dam HOR		Hatchery	6	5	8.4% (±7.4%)
Foster Dam HOR		RoR *O. mykiss*	1*	1*	16.7%
Cougar Dam	Powerhouse	Hatchery	4	4	15.9% (±10.6%)
Cougar Dam	RO	Hatchery	8	8	7.1% (±2.2%)
Cougar Dam	RO	RoR CHS	>25	5	7.4% (±3.0%)
Cougar Dam HOR		Hatchery	8	8	5.7% (±1.8%)
Fall Creek Dam HOR		N/A	N/A	N/A	N/A
Fall Creek Dam	Tailrace	Hatchery	3	1	2.1%
Dexter Dam	Spill	Hatchery	3	2	5.4% (±2.2%)
Dexter Dam	Powerhouse	Hatchery	6	0	N/A
Lookout Dam	Powerhouse	Hatchery	1	0	N/A
Lookout Dam	Spill	Hatchery	1	0	N/A
Lookout Point HOR		Hatchery	7	5**	4.5% (±4.1%)
Hills Creek Dam	Powerhouse	Hatchery	4	4	3.0% (±2.0%)
Hills Creek Dam	RO	Hatchery	4	3	2.1% (±1.3%)
Hills Creek Dam	RO via PH	Hatchery	4	1	0.8%

Injuries. A total of 4292 (78%) juvenile Chinook and 167 (50%) juvenile O. mykiss displayed at least one of the injury code conditions listed in Table 4. The most common injuries observed excluding the presence of copepods were descaling less than 20% and fin damage, some of which likely incurred upon capture in the RST. Table 4 provides a list of injuries assessed on captured fish by type.

Table 4. Injury codes for Willamette Valley Downstream Fish Passage Monitoring Injury Assessments.

Description of Injury/Condition	Injury Code	Injury Category
Live fish with no external injuries	NXI	N/A
Mortality with no external injuries	MUNK	N/A
Descaling <20%	DS<2	N/A
Bloated	BLO	Barotrauma
Bloody Eye (hemorrhage)	EYB	Barotrauma
Bleeding from Vent	BVT	Barotrauma
Fin Blood Vessels Broken	FVB	Barotrauma
Gas Bubble Disease (fin ray/eye inclusions)	GBD	Barotrauma

Pop Eye (eye popping out of head)	POP	Baro/Mech
Head Injury	HIN	Mechanical
Operculum Damage	OPD	Mechanical
Body Injury (tears, scrapes, mechanical damage)	TEA	Mechanical
Bruising (any part of the body)	BRU	Mechanical
Hole Behind Pectoral Fin	HBP	Mechanical
Descaling >20%	DS>2	Mechanical
Head Only	HO	Mechanical
Body Only	BO	Mechanical
Head Barely Connected	HBO	Mechanical
Fin Damage	FID	N/A
Predation Marks (vert. claw or teeth marks)	PRD	N/A
Copepods (on gills or fins)	COP	N/A
BKD (distended abdomen)	BKD	N/A
Fungus	FUN	N/A

Hold trials. 24-hour hold trials were performed on targets captured following dam passage and collection in rotary screw traps to assess mortality potentially from dam passage, collection, or holding. A total of 1830 Chinook and 78 O. mykiss were held in 2022 (Table 5). A total of 121 target fish died during holding - 163 of the 1,830 Chinook (8.9%) and 12 of the 78 O. mykiss (15%). Weekly mortality rates for fish in hold varied from 0 to 100%.

Table 5. Trap Efficiency trial summary data. Trial types: Hatchery L= Hatchery fish trials with low flows, Hatchery M=Hatchery fish trials with medium flows, Hatchery H= Hatchery fish trials with high flows, RoR=Run of River * indicates days were pooled to get 5 returns. A successful trial had 5 or more recaptures within a week. **Predation was likely occurring at Lookout Point HOR and 2022 TE trials are suspect.

Site	Route	Chinook Held	Mortality	O. mykiss Held	Mortality
Big Cliff Dam	Tailrace	473	11.0%	72	11.40%
Green Peter Dam	Tailrace	N/A	N/A	6	100%
Cougar Dam	Powerhouse	584	9.4%	N/A	N/A
Cougar Dam	RO	635	7.1%	N/A	N/A
Dexter Dam		68	16.2%	N/A	N/A
Lookout Dam		50	24.0%	N/A	N/A
Hills Creek Dam		20	0%	N/A	N/A

Tagged fish and downstream detections. A total of 2465 fish were PIT tagged or VIE marked at all sites in 2022. 2264 juvenile Chinook were tagged (2227 PIT tagged and 37 VIE marked) throughout the four sub-basins where RST sampling occurred, of which 41 PIT tagged Chinook were redetected downstream. 201 juvenile O. mykiss were PIT tagged in the North and South Santiam sub-basins, of which 1 was redetected downstream.

Non-Target Capture Data. We captured 113,991 non-target fish (Table 6). Clipped Chinook are reported as non-targets as are O. mykiss collected outside the Santiam river. The catch was dominated by juvenile crappie captured below Lookout Dam (79%). The next most abundant species was dace (5%), mostly captured at Fall Creek Dam and Cougar Powerhouse. Juvenile bass captured below Lookout Dam composed 4.5% of the catch followed by clipped Chinook (2.8%) caught at various locations, and then bluegill and pumpkinseed (~3% combined). Non-target O. mykiss made up 1.4% and the remaining species account for 4% of non-target catch.

Table 6. Summary of non-target catch at all sites.

Taxa	Catch
Crappie	89720
Dace	6317
Bass	5119
Adipose Fin Clipped Chinook (juvenile)	3282
Bluegill	3027
Pumpkinseed	1622
O. mykiss	1541
Sculpin	983
Brown Bullhead catfish	402
Kokanee	344
Lamprey	302
Cutthroat trout	284
Largescale Sucker	235
Mosquitofish	113
Unknown fish	103
Northern Pikeminnow	100
Mountain Whitefish	95
Smallmouth Bass	81
Spotted Bass	78
Speckled Dace	67
Longnose Dace	66
Redside Shiner	42
Peamouth	16
Bull Trout	13
Walleye	13
Brook Lamprey	12
Sucker	9
Largemouth Bass	3
Pacific Lamprey (juveniles)	2
Total	113,991