FINAL
2021 ANNUAL REPORT

Hatchery and Supplementation Program

North Fork Lewis River

FERC Hydroelectric Projects 935, 2071, 2111, 2213

JUNE 8, 2022

PACIFICORP
A BERKSHIRE HATHAWAY ENERGY COMPANY

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1.0 INTRODUCTION

This report documents results from monitoring and evaluation activities associated with implementing the Hatchery and Supplementation (H&S) program in 2021. The format of this report follows the reporting requirements provided in the 2021 Annual Operating Plan (ATS 2021). This (2021) report represents a transitional year in the development of monitoring protocols to answer key questions provided in the revised Hatchery and Supplementation Plan (PacifiCorp and Cowlitz County PUD 2020). Development of detailed monitoring protocols are presently under development by the ATS, and therefore, not included in our 2021 reporting. It is anticipated that the ATS will finalize the monitoring protocols in 2022 and include these in the 2022 Annual Operating Plan (AOP).

The following key activities were completed as part of the 2021 AOP:

1. Transport of returning adult late winter steelhead, spring Chinook and coho salmon upstream of Swift Dam
2. Estimates of abundance and distribution of spawning Chinook, coho and late winter steelhead downstream of Merwin Dam.
3. Hatchery production of trout and salmon as stipulated in Section 8 of the Lewis River Settlement Agreement to support harvest opportunity and transport of adults upstream of Swift Dam.
4. Monitoring of spring Chinook rearing strategies, including precocity evaluations of hatchery reared smolts.
5. Monitoring of hatchery practices consistent with HSRG recommendations and objectives of the 2021 Annual Operating Plan.

This report is required by Section 8.2.4 of the Lewis River Settlement Agreement (PacifiCorp and Cowlitz County PUD 2004) that states:

"On an annual basis, the Licensees shall provide to the ACC for review and comment a report compiling all information gathered pursuant to implementation of the Hatchery and Supplementation Plan. The report also will include recommendations for ongoing management of the Hatchery and Supplementation Program. The ACC shall have 60 days to comment on the annual report. Within 60 days of the close of the comment period, the Licensees shall finalize the report after consideration of all comments. The Licensees shall also provide the comprehensive periodic review undertaken pursuant to Section 8.2.6 below to the ACC. The Licensees shall provide final annual reports and the comprehensive periodic review to the Services during the development of any required ESA permit or authorization for hatchery operations, including NOAA Fisheries' HGMP process. The report may be included as part of the detailed annual reports of the ACC activities required by Section 14.2.6."

2.0 LATE WINTER STEELHEAD

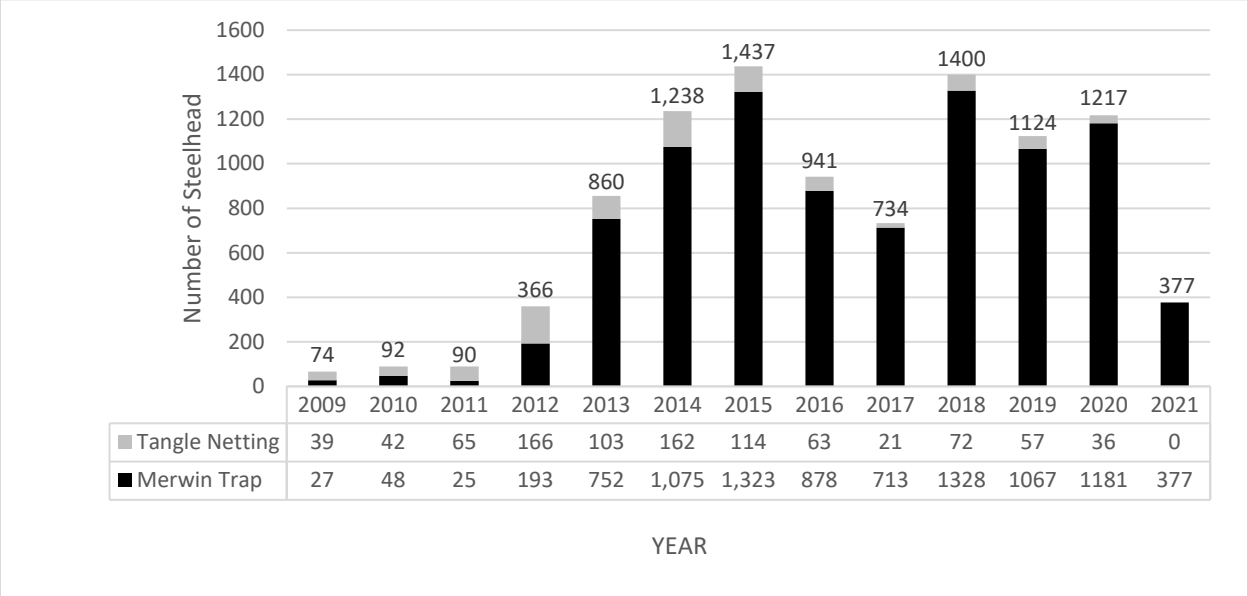
In 2021, the North Fork Lewis River supported three stocks of winter running steelhead:

1. A hatchery produced winter steelhead stock derived from Chambers Creek (Puget Sound) with a peak spawn time of December
2. An endemic natural stock with a peak spawn time in April
3. A fully integrated stock derived from the endemic population but spawned and reared in the hatchery (program or supplementation stock).

The primary goal of the fully integrated program is to produce adult returns that are genetically identical to the late winter steelhead endemic stocks to be used for upstream supplementation.

This program has three main components:

- Collection of broodstock at traps
- Spawning and rearing at Merwin Hatchery
- Transport of returning adults upstream of Swift Dam.



	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Tangle Netting	39	42	65	166	103	162	114	63	21	72	57	36	0
Merwin Trap	27	48	25	193	752	1,075	1,323	878	713	1328	1067	1181	377

Figure 2-1. Total captures of NOR and BWT late winter steelhead by method between 2009 and 2021 (excludes same year recaptures and adipose fin clipped steelhead, between Jan 1 – Aug 1).

2.1 Broodstock Collection

In 2021, broodstock collection relied entirely on NOR returns from the Merwin trap. All NOR steelhead collected at the Merwin Trap were either transferred to Merwin Hatchery as

potential broodstock or released upstream of Swift Dam. Sampling data for all steelhead transported to Merwin hatchery as potential broodstock are provided in Appendix A.

2.1.1 Merwin Trap

During the period from January 1 through June 12, 2021, a total of 169 NOR and 208 blank wire tagged[1] (BWT) winter steelhead were captured at the Merwin trap (Table 2-1).

Table 2-1. Origin and gender of late winter steelhead captured at the Merwin Trap from 2015 to 2021

	2015	2016	2017	2018	2019	2020	2021
NOR							
Males	40	26	47	46	51	245	72
Females	28	23	43	72	28	210	97
	68	**49**	**90**	**118**	**79**	**455**	**169**
HOR (BWT)							
Males	743	403	340	680	511	341	84
Females	504	414	283	530	477	385	124
	1,247	**817**	**623**	**1,210**	**988**	**726**	**208**

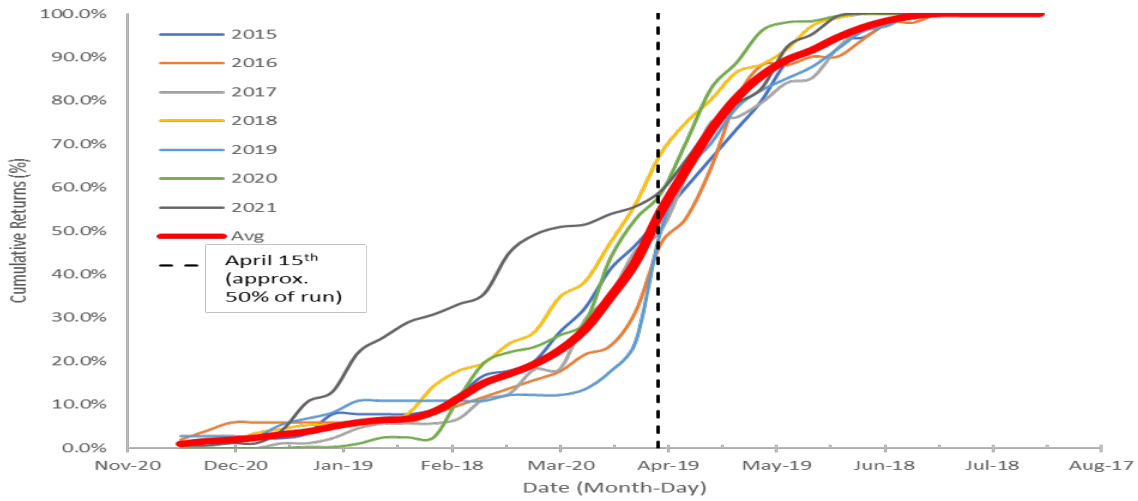


Figure provided by Kale Bentley, WDFW

Figure 2-2. Percent cumulative returns of adult NOR winter steelhead at the Merwin Trap by year (2015 – 2021) and the non-weighted average (solid red).

[1] Adult steelhead that possess a blank wire tag in their snout are referred to as BWT steelhead and represent returns from the hatchery supplementation program using only verified NOR broodstock (i.e., pNOB = 1).

2.1.2 Tangle Netting

No tangle netting occurred in 2021.

2.2 Late Winter Steelhead Broodstock Collection Timing

The ability to conform to predetermined collection curves presents several difficulties in the field. Several variables continue to make broodstock collection challenging including:

- Genetic assignment results may reduce available broodstock being held.
- Spawning maturity in females is highly variable creating uncertainty when deciding to retain or release male broodstock.
- The number of kelts increases substantially from mid to late April.
- Variable individual fecundity

The collection curve proposed in the annual operating plan is intended to help ensure that broodstock are collected across their spawning period. Up to 75 steelhead are spawned over the course of the run with a collection goal total of 96.

In 2021, a total of 61 (31 males, 30 females) NOR steelhead were transferred to Merwin Hatchery as potential broodstock. Of these, 52 (27 males, 25 females) were spawned; 2 died while being held. All spawned steelhead including 7 unspawned steelhead were returned to river. Table 2-2 shows the actual collection timing of broodstock retained at Merwin compared to the proposed timing curve.

Table 2-2. Actual collection and retention of late winter steelhead broodstock by year and period: 2015 – 2021

Period	Collection Curve (2018 - present)	2015	2016	2017	2018	2019	2020	2021
Jan - Feb	3	5	3	4	3	0	3	2
Mar 1 – 15	6	4	2	4	7	1	10	13
Mar 16 – 31	9	13	2	7	8	2	16	3
Apr 1 – 15	21	12	15	16	20	25	21	12
Apr 16 – 30	24	10	8	15	14	13	16	17
May 1 – 15	9	5	6	2	7	4	8	14
May 16 – 31	3	1	1	0	1	0	0	0
Total	75	50	37	48	60	45	74	61

2.3 Genetic Analysis of Potential Broodstock

The ATS agreed to use a primary genetic assignment target level of 50 percent or greater to the NF Lewis River or Cedar Creek stock(s) to be considered acceptable broodstock. After April 1, steelhead may be considered broodstock if assignment probability is 50 percent or greater to Cascade Strata. The only exception to these requirements is any steelhead indicating assignment probabilities to any hatchery stock of more than 5 percent will never be incorporated in the broodstock.

A total of 61 samples were taken from steelhead broodstock transferred to Merwin hatchery from the MFCF. All sampled steelhead were assigned a probability percentage as to likelihood of assignment to known baselines established for Lower Columbia River tributaries including the North Fork Lewis River. Probabilities are classified as primary, secondary and tertiary to account for introgression from other basins and provide a more complete picture of diversity present within the samples. Figure 2-3 illustrates the results of primary assignment for all samples between 2009 and 2021. Appendix C provides the tabular genetic assignments results for each individual unclipped steelhead captured at the Merwin trap and tangle netting in 2021.

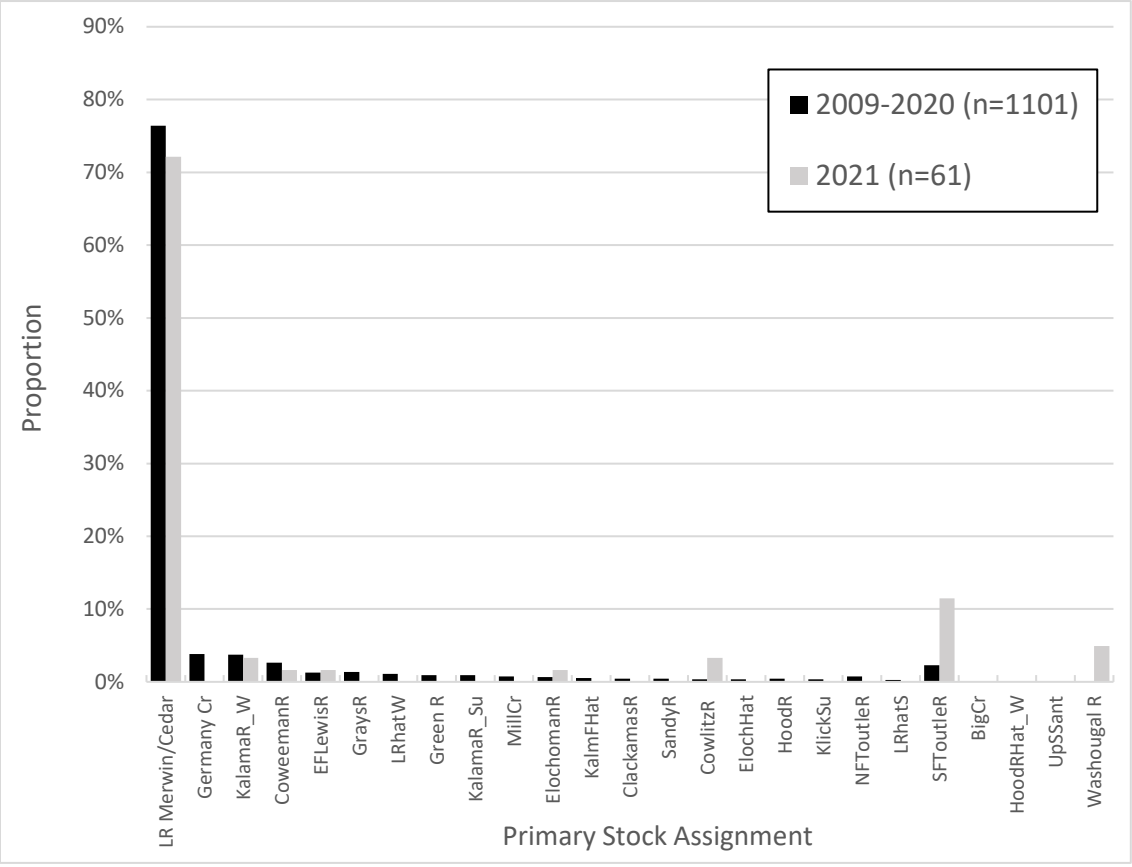


Figure 2-3. Proportion of primary genetic assignment of NOR late winter steelhead collected from the Merwin trap and tangle netting: 2009 - 2021

2.4 Spawning

A total of 52 NOR winter steelhead (25 females, 27 males) were spawned at Merwin Hatchery. There were 25 spawning crosses representing 55 potential families (Table 2-5, Appendix B).

Table 2-3. Number of spawning crosses and parents including the duration of each spawning periods for brood years between 2009 and 2021

Brood Year	Crosses	Females	Males	Potential Families	Spawn Period	Days
2009	10	12	19		Mar 2 - May 21	81
2010	22	22	24		Mar 17 - May 14	56
2011	9	16	19		Mar 30 - May 18	49
2012	12	19	23		Apr 10 - May 29	49
2013	8	8	11		Apr 10 - May 6	26
2014	26	26	25		Apr 7 - May 16	39
2015	25	25	25		Mar 26 - May 22	58
2016	10	17	20		Apr 8 - May 27	49
2017	10	25	24		Apr 7 - May 19	43
2018	22	22	23	54	Mar 23 - May 25	63
2019	14	14	14	28	Apr 16 - May 17	32
2020	25	25	25	65	Apr 10 - May 15	35
2021	25	25	27	55	Apr 12 - May 21	39

2.5 Spawn Timing

Steelhead broodstock are captured over a collection period that extends from February through May. The purpose of this protocol is to collect steelhead over the course of the run so that a representative sample of the total run is spawned to limit selection bias in spawn time or other variables. However, collection timing is not always a reliable predictor of spawn timing as most NOR winter steelhead, regardless of collection time, typically spawn between mid-April and mid-May (Figure 2-4).

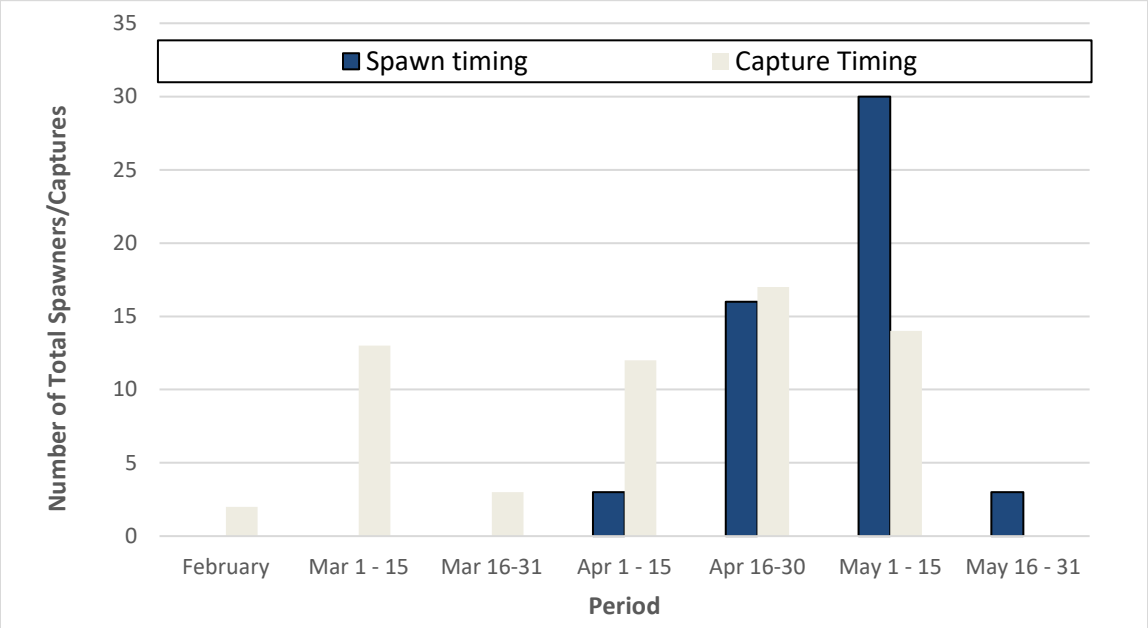


Figure 2-4. Proportion of spawners relative to broodstock collection timing by period: 2021

2.5.1 Tagging

All sub yearling steelhead were tagged with a blank wire snout tag in December 2021.

2.5.2 Release

All 2021 brood year late winter steelhead juveniles will be volitionally released starting on May 1, 2022 at the Merwin boat launch. Volitional release will continue until June 1, 2022. Any fish remaining in the ponds on June 1, 2022 will be forced out and released downstream at the Pekins Ferry Boat Launch (RM 3.1) near the confluence with the East Fork Lewis River. Projected average release size is 8 to 10 fish per pound. A total release number of between 50,000 and 60,000 smolts is projected. As of February 2022, total brood year 2021 juveniles on site were about 63,475 smolts.

3.0 MONITORING AND EVALUATION

OBJECTIVE 1: Evaluate the Effects of Hatchery Plants on Reintroduced Species.

This objective was moved to the Aquatic Monitoring and Evaluation Plan in 2016 and serves only as a placeholder until the H&S Plan is updated with revised objectives for 2021.

OBJECTIVE 2: Determine Proportion of Hatchery Origin Winter Steelhead, Spring Chinook and Coho Salmon on Spawning Grounds Downstream of Merwin Dam

Late Winter Steelhead

Program returns (BWT) are treated as hatchery origin (HOR) steelhead despite their genotype derived completely from verified NOR broodstock. This is due to the hatchery influence during mating and captive rearing conditions during their first year of life. As these program fish return as adults, there is opportunity for these (HOR) fish to spawn with NOR (and HOR) stocks. It has been shown that reproductive success (fitness) declines rapidly (up to 37 percent per captive reared generation) within a natural population (Araki et. al. 2007). The evolutionary mechanisms for declines in fitness are not fully understood, but hatchery protected rearing environments and controlled mating selection are suspected contributors to this decline (Araki et. al. 2007). Inbreeding between program fish is also a concern because of loss in genetic diversity or effective population size further limits fitness and adaptability of the natural spawning population.

In 2021, no estimates of pHOS for late winter steelhead are available. This is due to a couple of reasons: 1) tangle netting downstream of Merwin was terminated due to concerns with adverse impacts to the natural spawning population and 2) the late winter steelhead population is currently in a recolonization phase and estimates of pHOS are not a primary metric until the population transitions into a local adaptation phase. The ATS will need to develop an alternate collection and tagging strategy (other than tangle netting) that will provide and adequate number of marks to provide statistically valid estimates of pHOS for late winter steelhead once the population transitions into the local adaptation phase.

Coho Salmon

Carcass surveys are used to estimate abundance of Coho salmon spawning in the mainstem North Fork Lewis River. The origin (hatchery or natural) of each carcass sampled is determined by the presence or absence of an adipose fin. To assign proper origin, all fish are wanded for the presence of a CWT as a portion of the return includes double index tagging (DIT). That is, adipose fin intact, but presence of CWT. An estimate of pHOS is generated by pooling the total number of carcasses sampled (including surveyed tributaries) over the sampling period (Table 3-1). Appendix E provides data and analysis related to coho sampling in the mainstem and tributaries of the North Fork Lewis River during the 2021-2022 season.

Table 3-1. Origin of sampled Coho carcasses from pooled mainstem and tributary surveys downstream of Merwin Dam with implied pHOS: 2016 – 2021

Year	Carcasses Sampled			pHOS %
	HOR	NOR	TOTAL	
2016	42	39	81	52%
2017	17	20	37	46%
2018	51	11	62	82%
2019	24	26	50	48%
2020	184	39	223	83%
2021	78	20	98	80%

Chinook Salmon

Table 3-2. Fall Chinook pHOS estimates for tule and bright stocks and total fall Chinook downstream of Merwin Dam on the North Fork Lewis River mainstem: 2013 – 2021; annual pHOS estimates for spring Chinook 2020 and 2021.

Year	Stock	Type	pHOS
2013	*Fall Chinook*		**7.7%**
		Tule	33.0%
		Bright	2.0%
2014	*Fall Chinook*		**10.5%**
		Tule	51.0%
		Bright	1.0%
2015	*Fall Chinook*		**18.0%**
		Tule	63.0%
		Bright	1.0%
2016	*Fall Chinook*		**22.9%**
		Tule	60.0%
		Bright	1.0%
2017	*Fall Chinook*		**17.6%**
		Tule	58.0%
		Bright	2.0%
2018	*Fall Chinook*		**12.0%**
		Tule	42.1%
		Bright	0.8%
2019	*Fall Chinook*		**3.8%**
		Tule	30.3%
		Bright	1.0%
2020	*Fall Chinook*		**5.4%**
		Tule	39.6%
		Bright	1.4%
	Spring Chinook		**68.2%**
2021	*Fall Chinook*		**11.8%**
		Tule	54.2%
		Bright	2.0%
	Spring Chinook		**79.0%**

OBJECTIVE 3: Develop and Monitor Hatchery Protocols to Reduce Hatchery Effects on Juvenile Native and Listed Species Present Downstream of Merwin Dam

Interactions between hatchery released juveniles and ESA listed species cannot be observed directly. Therefore, evaluation of this objective relies on "take surrogates" as described by NOAA Fisheries (NMFS 2017) to reduce the potential of adverse interactions between hatchery and natural-origin salmon and steelhead. Monitoring indicators are designed to reduce potential spatial and temporal overlap between hatchery and NOR species.

Monitoring indicators under this objective are estimated as part of other objectives in this report. Specifically, objectives 6,8 and 9 (Table 3-3).

Table 3-3. Location of monitoring indicators related to take surrogates.

Monitoring Indicator	Relevant Objective
Number of smolts released	Objective 9
Timing of smolts released	Objective 8
Location of smolts released	Objective 8
Size (length or weight) of smolts released	Objective 8
Precocity Rates	Objective 6
Migration timing of hatchery released smolts	Objective 6

OBJECTIVE 4: Estimate Juvenile Release Behavior or Residualism after Release from Hatcheries Downstream of Merwin Dam.

Specific evaluations to quantify residualism or post-release behavior from the Lewis River hatcheries were not conducted in 2021. However, monitoring indicators estimated to address other objectives (e.g., size at release, release location, migration rates) may be used to indicate the potential for life history traits such as residualism. Metrics to address specific post-release smolt behavior have not been developed, and therefore, not assessed in 2021.

OBJECTIVE 5: Produce an Annual Hatchery Operations Report

The annual hatchery operations report is provided in Appendix G

OBJECTIVE 6: Monitor Rearing Conditions to be Consistent with Producing a High Quality Smolt that Emigrates Quickly with a Relatively High Rate of Survival

Rearing and Release Evaluation

In 2017, the ATS initiated a rearing and release evaluation for spring Chinook (Strategy A). This evaluation consists of rearing a number of treatment groups that differ in the size at release (80, 12 and 8 fish per pound) and release timing (June, October and February). A key

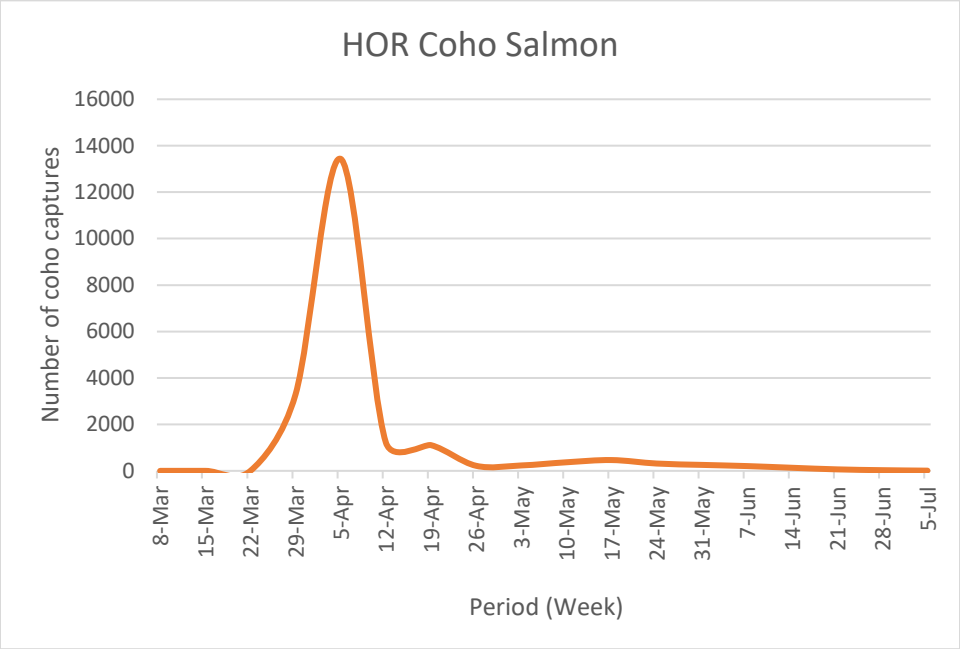
performance metric in evaluating the various treatment groups is estimating survival or the smolt to adult ratio (SAR) for each group. The specific methods to evaluate specific SAR's for each treatment group is currently in development. It is anticipated that initial SAR estimates will be provided once a complete release (5-year) cohort is available, and all CWT recoveries have been entered into RMIS – likely in late 2023. Therefore, we anticipate providing SAR metrics beginning with the 2023 annual report and on an annual basis until all full cohorts from the rearing evaluation have returned to the North Fork Lewis River.

Other indicators to evaluate rearing and migration performance of hatchery released smolts include migration, precocity sampling and age at maturity.

Migration Rates of hatchery releases

In 2021, screwtraps operating at the Lewis River golf course site provide an indication of the timing for coho released from Lewis River hatchery to be captured and the capture duration of the hatchery released coho (Figure 3-1). Early coho were released from Lewis River hatchery between April 1 and April 30, 2021; Late coho were released from April 1 through April 19, 2021.

Figure 3-1. Weekly captures of coho salmon juveniles released from the Lewis River hatchery in April 2021



Precocity evaluation of spring Chinook

In February and March 2021, a total of 1,007 juvenile spring Chinook were sampled to screen for microjacks (mature young of the year Chinook). A subset of this sample (707 smolts) were lethally sampled to assess two approaches in assessing precocity. First a gonadosomatic index

(GSI), and secondly, a blood plasma 11-ketotestosterone test. The intent of this evaluation is to develop a reliable and practical method to accurately predict the proportion of spring Chinook that will become precocious at age 2 (i.e., minijacks). GSI sampling was completed on site at Lewis River hatchery. 11-kt assays were collected on site and sent to the Center for Aquatic health Sciences in Campbell, BC for analysis.

Microjack rates

Microjacks are spring Chinook that reach sexual maturity at age 1. To determine whether smolts are microjacks samples from each rearing pond are visually examined to determine if they are expressing milt. Morphological characteristics such as color and body shape are also suggestive of precocity, however, only actively militing fish are notes as microjacks during their first year. Figure 3-2 provides a summary of microjack proportion during two years of sampling at Lewis River hatchery.

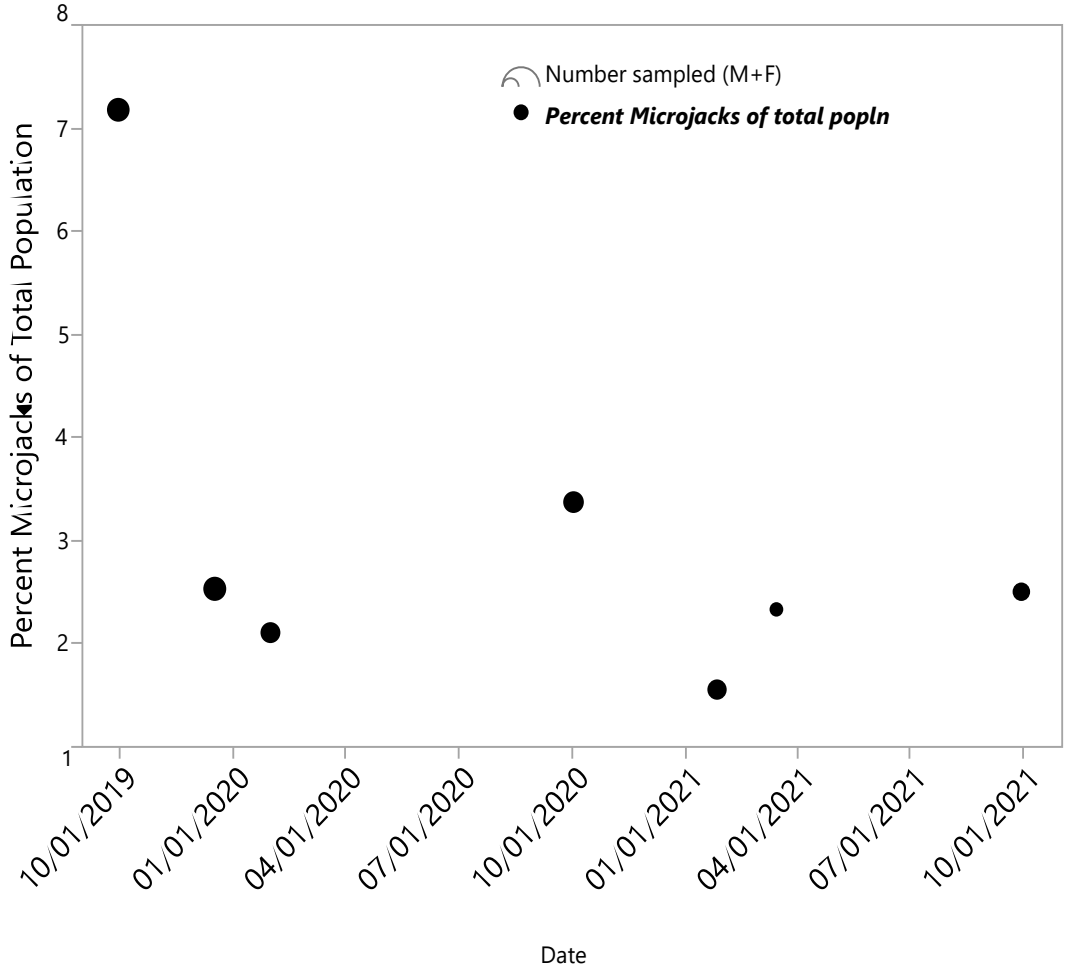


Figure 3-2. Observed spring Chinook microjack proportion from sampling between October 2019 and October 2021

Validation of GSI and 11-kt methods

Testing of both GSI and 11-kt methods showed that 11-kt may improve detection of precocity in yearling Chinook. This is especially true during later sampling in March when accuracy is expected to improve as yearlings approach their second year.

Table 3-4. Results from spring Chinook minijack detection methods

Method	Release Date	N Sampled (Males, SI = 1, 2, 3)	N Minijacks	Percent Minijacks
GSI	February 1	399	8	2.0
	March 15	293	10	3.4
11-kt	February 1	150	9	6.0
	March 15	153	15	9.8

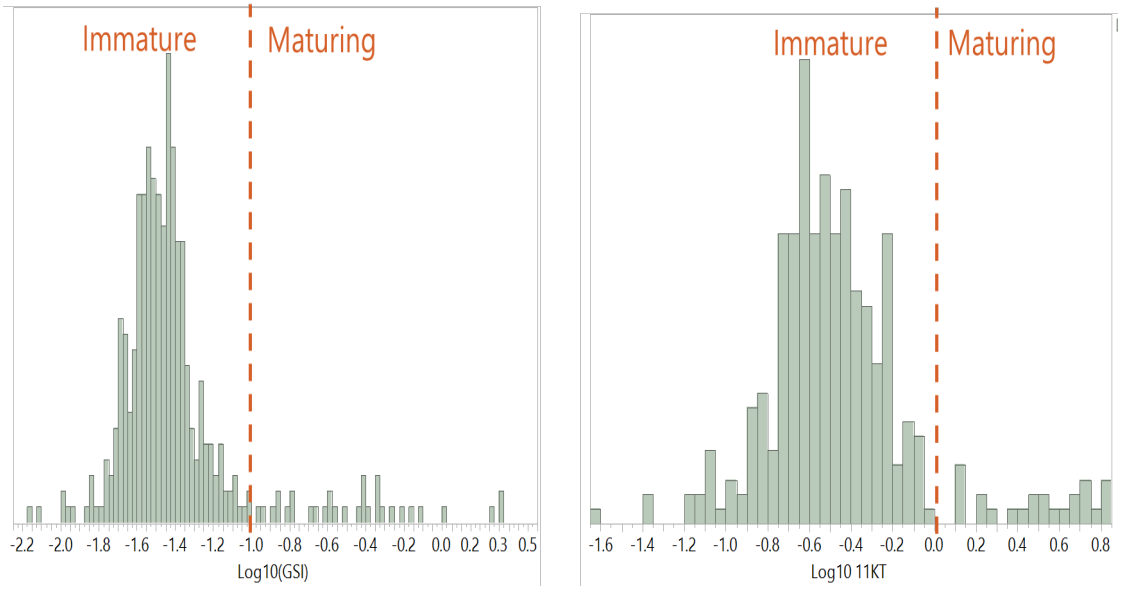


Figure 3-3. Comparison of GSI and 11-KT methods as a predictor of precocity in yearling spring Chinook

Age at Maturity

Table 3-5. Age at maturity derived from scale samples collected from returning adult spring Chinook at the MFCF in 2021.

	NOR		HOR		
AGE	*Male*	*Female*	*Male*	*Female*	
3_1	4	2	1	0	**7**
4_1	11	13	3	6	**33**
5_1	2	6	0	0	**8**
3_2	0	0	0	0	**0**
4_2	25	11	5	2	**43**
5_2	3	3	0	0	**6**
				Total	**97**

OBJECTIVE 7: Monitor Hatchery Upgrades

All projects as prescribed by the Agreement have been completed (Table 3-6). Appendix G provides all operation and maintenance (including capital) projects completed in 2021.

Table 3-6. Schedule of completion of hatchery upgrades contained in the Agreement

	COMPLETION YEAR							
Lewis River Hatchery	2008	2009	2010	2011	2012	2013	2014	2015
Pond 15 and Sorting Facility upgrades		✓						
Convert rearing ponds to raceways			✓	✓				
Modify downstream water intake								✓
Inspect Intake Pipe				✓				
Merwin Hatchery								
Ozone PLC upgrade							✓	
Rearing pond flow Enhancement			✓	✓				
Modify smolt release ponds			✓					
Purchase two fish hauling trucks	✓		✓					
Speelyai Hatchery								
Convert Pond 14 into raceways						✓		
Convert burrow's ponds into raceways		✓	✓					
Improve water intake structure								✓
Improve and Expand adult fertilization area			✓					
Improve adult kokanee trap			✓					
Net Pen purchase and installation			✓					

OBJECTIVE 8: Adopt Release Strategies that are Consistent with Hatchery Scientific Review Group and HGMP Recommendations

Release Strategies

See Objective 6 and Strategy A for spring Chinook rearing and release evaluation

Volitional Releases

All hatchery releases include voluntary release period whereby rearing ponds are lowered and screens are pulled to provide a means for smolts to voluntarily migrate from the rearing ponds. After a specified volitional release period, all smolts are forced out of the rearing ponds and either released directly to river or transported downstream and released to river. Table 3-7 provides the volitional release periods for each species including the release location.

Table 3-7. Volitional release schedule, location and target size at release.

Species	Volitional Release Periods	Release Location
Late Winter Steelhead	May 1 - May 30	Merwin boat Ramp, Martin Access Site (RM 5)
Early Winter Steelhead	April 1 - April 15	Martin Access Site (RM 5)
coho salmon	April 1 - April 15	Lewis River Hatchery
spring Chinook	Oct 1 - 15, Feb1-15	Lewis River Hatchery

Sampling of volitional and forced release groups

Since 2018, morphological sampling of smolts has been implemented prior to (volitional) and at the end of (forced) volitional release periods. Sampling serves two primary purposes. First, a comparison can be made between hatchery smolts that volitionally leave the facility and those that do not. Secondly, handling smolts allows assessments to be made regarding maturity (e.g., smolt index or precocity). This is especially relevant for spring Chinook which are known to achieve sexual maturity as subyearlings (i.e., microjacks) and yearlings (i.e., minijacks).

As a result of ongoing COVID-19 restrictions in 2021, on site morphology sampling did not occur for several rearing groups. No sampling of late coho or Chambers winter steelhead occurred during planned releases in April 2021. Sampling of pre and post release spring Chinook for releases in October 2021 and February 2022, and early coho in April 2021 occurred as normal.

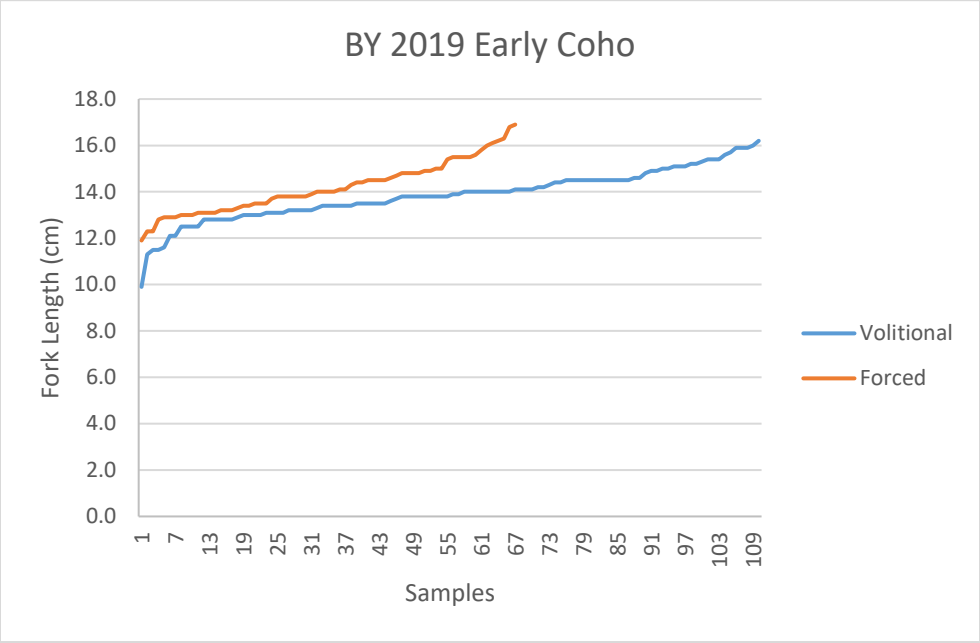


Figure 3-4. Fork length comparison between volitional and forced early coho released in April 2021

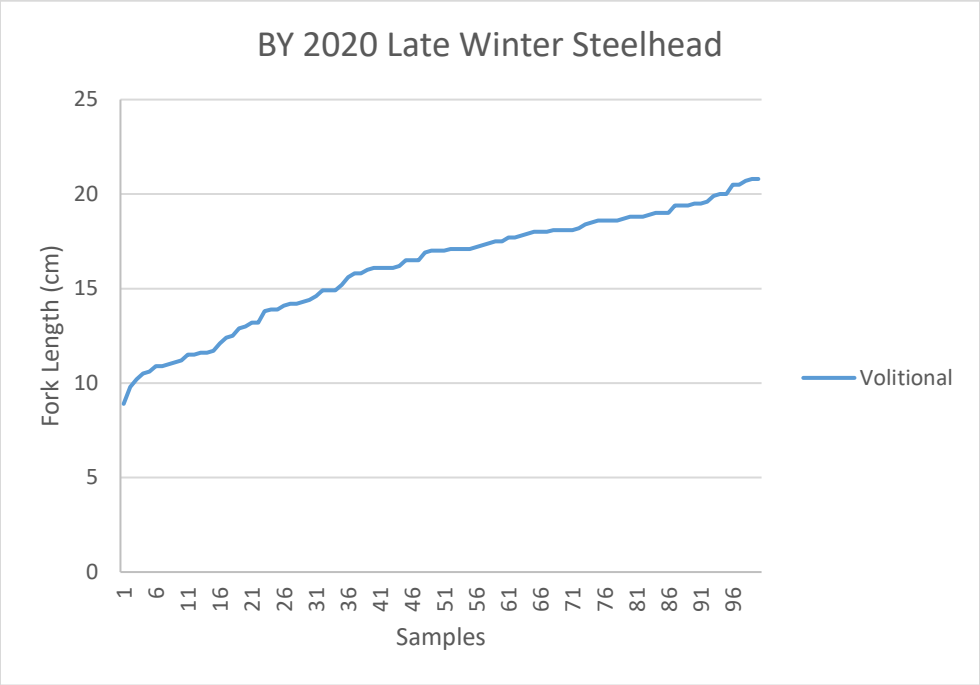


Figure 3-5. Fork length of volitional late winter steelhead released in May 2021

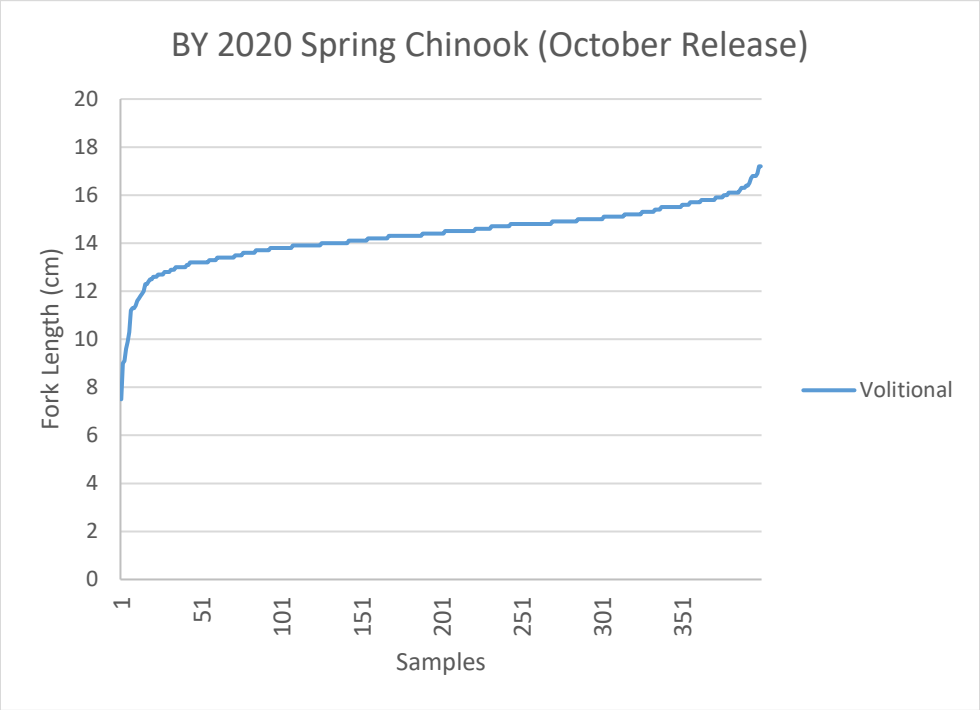


Figure 3-6. Fork length of volitional spring Chinook released in October 2021

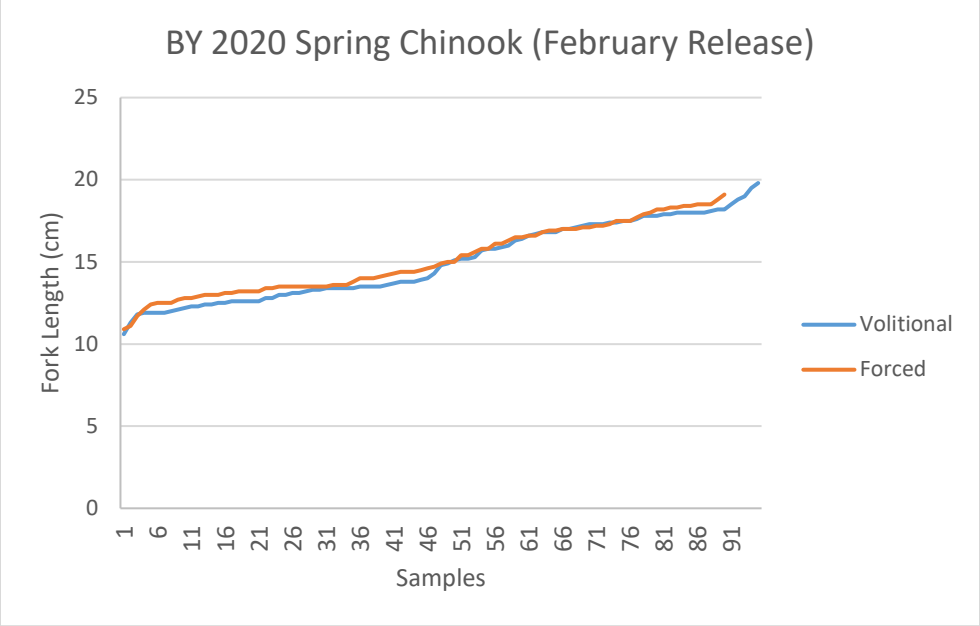


Figure 3-7. Fork lengths of volitional and forced spring Chinook released in February 2022

Table 3-8. Average length, weight, smolt index and K factors sampled during volitional and forced release groups of Chinook, coho and late winter steelhead

Sample Date	Brood Year	Group Type	N	Length (avg, mm)	Weight (avg, g)	Smolt Index (avg)	K factor (avg)
Spring Chinook							
Sep 2018	2017	Volitional	100	144	37.7	2.6	1.2
Oct 2018		Forced	112	141	34.9	2.5	1.2
Jan 2019		Volitional	223	161	49.2		1.1
Feb 2019		Forced	180	144	35.8		1.1
Sep 2019	2018	Volitional	101	148	37.9		1.2
Oct 2019		Forced	126	136	39.4		1.6
Dec 2019		NA	293	146	38.6		1.2
Jan 2020		Volitional	300	162	47.4		
Feb 2021	2019	Forced	300	151	39.4	2.9	1.1
Sep 2021	2020	Volitional	400	144	37.0	3.0	1.2
Jan 2022		Volitional	95	150	45.6		1.3
Feb 2022		Forced	90	151	40.5		1.1
Winter Steelhead (Chambers Stock)							
Apr 2018	2017	Volitional	100	201	84.7	2.8	1.0
May 2008		Forced	150	195	73.5	2.8	1.0
Winter Steelhead (NOR)							
Apr 2018	2017	Volitional	150	165	48.5	2.3	1.0
May 2018		Forced	201	147	31.1	2.2	0.9
Apr 2019	2018	Volitional	100	161	52.0	1.9	1.1
May 2019		Forced	101	177	55.2	1.5	1.0
May 2020	2019	Forced	100	149	38.5		
May 2021	2020	Volitional	42	163	49.4	2.7	1.1
Coho Salmon							
Mar 2018	2017	Volitional	802	131	25.6	1.7	1.1
Apr 2018		Forced	310	131	27.2	1.8	1.2
Mar 2019	2018	Volitional	347	134	28.7	2.0	1.2
Apr 2019		Forced	262	135	28.9	2.0	1.2
Mar 2021	2019	Volitional	110	140	32.0		1.2
Apr 2021		Forced	67	140	33.2		1.2

OBJECTIVE 9: Monitor Production Levels and Program Release Numbers

Table 3-9. Total green egg takes of hatchery spring Chinook, coho and late winter steelhead broodstock: 2013 - 2021

Broodyear	Spring Chinook	Early Coho	Late Coho	Late Winter Steelhead
2013	2,099,865	1,948,980	3,333,388	36,555
2014	1,488,540	1,932,442	3,305,396	106,038
2015	877,960	1,182,472	4,772,532	97,265
2016	538,365	1,652,894	3,217,383	72,649
2017	1,459,300	1,512,300	4,762,524	86,406
2018	2,527,850	1,556,439	1,849,024	76,724
2019	1,649,400	1,603,903	2,763,787	63,985
2020	1,923,900	1,844,956	2,815,754	91,103
2021	1,851,100	1,685,270	2,854,957	123,391

Table 3-10. Average fecundity of hatchery spring Chinook, coho and late winter steelhead: 2013 - 2021

	2013	2014	2015	2016	2017	2018	2019	2020	2021
Spring Chinook	3,352	3,495	3,410	3,278	3,017	3,152	3,429	3,278	3,095
Early Coho	3,089	2,842	2,079	3,235	2,479	2,607	2,445	3,075	2,670
Late Coho	3,465	3,046	2,387	3,506	3,205	3,374	3,158	3,686	3,053
Late Winter Steelhead	4,569	4,260	3,891	4,273	3,456	3,487	3,999	3,460	4,381

Table 3-11. Hatchery target and actual smolt releases by species by year: 2013-2021

Species (or stock)	Target Production	Annual Hatchery Smolt Releases (by release year)								
	(smolts)	2013	2014	2015	2016	2017	2018	2019	2020	2021
Spring Chinook	1,350,000	1,286,171	1,086,637	1,244,910	600,967	402,224	802,048	1,278,855	1,314,441	1,321,373
Coho	2,000,000	1,864,208	2,055,206	2,148,984	2,177,701	1,666,442	2,016,371	2,193,389	1,916,165	1,957,690
Summer Steelhead[1]	175,000	192,325	179,431	176,498	175,504	175,647	182,178	180,146	184,809	179,871
Winter Steelhead	100,000	128,360	98,344	110,592	100,000	116,436	104,746	108,128	105,088	104,424
Late Winter Steelhead	50,000	49,650	22,295	70,805	67,922	51,816	52,119	44,861	45,153	57,498
Kokanee (pounds)[2]	12,500 pounds	12,910	9,206	8,263	10,091	7,435	11,269	12,866	11,076	11,807
Rainbow[3]	50,000	71,361	52,080	51,800	50,640	56,650	47,893	43,800	51,070	45,000
Acclimation Spring Chinook[4]	100,000	16,200	81,212	48,000	29,900	53,470				
		3,621,185	3,584,411	3,859,852	3,212,725	2,530,120	3,216,624	3,862,045	3,627,802	3,677,663

[1] Excludes Echo Bay net pen production (~150,000)

[2] Mitigation is based on pounds,average release size of kokanee is 7 to 8 fpp.

[3] Mitigation is based on pounds, average release size of rainbow trout is 2.5 fpp.

[4] This program was suspended by ACC decision in 2018 in favor of releasing acclimation allotment downstream of Merwin Dam due to poor adult returns

Table 3-12. Release size compared to target goal between broodyear's 2016 and 2021 including corresponding coefficient of variation

Stock	Goal (fpp)	BY 2020		BY 2019		BY 2018		BY 2017		BY 2016	
		fpp	*CV*	*fpp*	*CV*	*fpp*	*CV*	*fpp*	*CV*	*fpp*	*CV*
Late Winter Steelhead	5 to 8	**9.2**	NA	8.1	8.0%	**8.7**	**18.8%**	9.4	13.5%	NA	NA
Early Winter Steelhead	5 to 8	4.9	7.2%	5.1	8.7%	**4.6**	NA	5.4	7.1%	NA	NA
Early Coho Salmon	16	NA	NA	15.3	6.9%	15.3	6.8%	**15.6**	**7.5%**	18.1	8.2%
Late Coho Salmon	16	NA	NA	16.0	7.5%	16.0	7.7%	16.4	8.8%	17.3	7.3%
Spring Chinook	8 to 12	NA	NA	12.2	7.7%	**12.0**	**6.0%**	12.0	10.3%	NA	NA

Note: bold indicates values derived from morphological sampling

Table 3-13. Actual juvenile releases and adult HOR and NOR returns to the in-river traps by year: 2013 - 2021.

		2013	2014	2015	2016	2017	2018	2019	2020	2021
COHO SALMON	Juvenile Release	1,864,208	2,055,206	2,148,984	2,177,701	1,666,442	2,016,371	2,193,389	1,916,165	1,957,690
	Adult HOR Trap Return	28,752	72,847	21,453	33,331	23,064	21,226	14,035	38,310	59,052
	Adult NOR Trap Return	218	2,098	202	2,009	2,613	1,011	1,725	5,548	3,551
	Total Return (inc. jacks)	**28,970**	**74,945**	**21,655**	**35,340**	**25,677**	**22,237**	**15,760**	**43,858**	**62,603**
SPRING CHINOOK	Juvenile Release	1,286,171	1,086,637	1,244,910	600,967	402,224	802,048	1,278,855	1,314,441	1,321,373
	Adult HOR Trap Return	1,907	997	945	547	2,871	2,668	1,065	2,259	2,778
	Adult NOR Trap Return	41	22	42	16	40	26	36	175	288
	Total Return (inc. jacks)	**1,948**	**1,019**	**987**	**563**	**2,911**	**2,694**	**1,101**	**2,434**	**3,066**
LATE WINTER STEELHEAD	Juvenile Release	49,650	22,295	70,805	67,922	51,816	52,119	44,861	45,153	57,498
	Adult HOR Trap Return	714	1,048	1,252	851	634	1,217	992	726	208
	Adult NOR Trap Return	19	29	72	54	95	120	76	455	169
	Total Return (inc. jacks)	**733**	**1,077**	**1,324**	**905**	**729**	**1,337**	**1,068**	**1,181**	**377**

OBJECTIVE 10: Submit and Gain HGMP Approval for all Hatchery Programs on the Lewis River

As of the date of this draft report, no HGMP's have been submitted to NOAA for approval.

OBJECTIVE 11: Determine the Genetic Effective Population Size of Late Winter Steelhead Downstream of Merwin Dam.

The utilities are waiting for a final report from NOAA on late winter steelhead tissue samples submitted since the program began in 2009.

OBJECTIVE 12: Develop Sampling Protocols for Supplementation Adults Returning to Traps or In-River Capture

Sampling and handling protocols are currently being developed as part of the 2022 AOP. Once developed, these protocols will replace general sampling protocols includd in previous versions

of the AOP and annual operating reports. The new protocols will include guidance on data collection methodology, processes, storage, and responsibility to be assigned to various field crews. It is anticipated that the new protocols will be included in the 2022 AOP and reported on as part of the 2022 annual operations report.

OBJECTIVE 13: Effects of Upstream Adult and Juvenile Supplementation on Listed Species

This objective was moved to the Aquatic Monitoring and Evaluation Plan and is provided here only as a placeholder to ensure that numbering of each objective remains consistent with the Hatchery and Supplementation Plan.

OBJECTIVE 14: Estimate Adult and Juvenile Abundance of Winter Steelhead, Coho and Spring Chinook Downstream of Merwin Dam

Spawning Abundance

Spawning abundance estimates the number of spawners in the North Fork Lewis River mainstem downstream of Merwin Dam. This is not a total abundance estimate as spawner abundance estimates do not account for fish trapped and either used as broodstock or transported upstream as part of the supplementation program. Therefore, North Fork Lewis River total abundance should include trap counts regardless of their disposition after trapping.

Late Winter Steelhead

Spawning abundance estimates rely on new redd census data, assumed sex ratio and females per redd to calculate total spawner abundance (Freymond and Foley 1986). Females per redd follow WDFW generalized guidelines of 0.81 females per redd and sex ratio is assumed to be equal (Table 3-14). Beginning in 2013, we also calculate the spawner abundance using the observed sex ratio of late winter steelhead entering the Merwin Trap. This may be a more accurate estimate of female to male ratio in the river because of the large numbers captured in the trap and is unbiased in terms of capture efficiency for males or females.

Redd surveys are used to estimate spawning abundance and distribution of winter steelhead in the mainstem North Fork Lewis River. Surveys are conducted weekly throughout the spawning period, which starts on March 1 and extends into mid-June.

A total of 226 individual redds were counted during redd surveys in 2021. Surveys began on March 1 and continued on a weekly basis until June 3. Each survey reach begins at Merwin Dam and continues to the downstream end of Eagle Island.

Using Merwin Trap capture data between January 1 and June 21, 2021, a total of 337 late winter steelhead were trapped. This total includes 208 BWT and 169 NOR late winter steelhead. Of this total, 156 were male and 221 were female, or 0.70 males to every female.

Table 3-14. Late winter steelhead abundance downstream of Merwin Dam 2008 through 2021 based on redd counts

Year	Number of Redds observed	Spawner Estimate	Observed sex ratio (females : males)	Spawner Estimate (corrected)[3]
2008	131	212		
2009	176	286		
2010	248	402		
2011	108	174		
2012	343	556		
2013	456	739	1 : 1.4	898
2014	364	590	1 : 0.8	531
2015	384	622	1 : 1.5	765
2016[2]	NA	357 (± 82)[1]	1 : 1.0	NA
2017[2]	NA	NA	1 : 1.2	NA
2018	317	514	1 : 0.9	493
2019	292	473	1 : 1.1	500
2020	301	488	1 : 1.1	508
2021	226	366	1 : 0.7	313

[1] Estimate is derived through H&S pHOS model using mark-recapture of tangle netted fish (See 2019 H&S AOP)

[2] Redd surveys were cancelled due to extreme river turbidity during spawning period

[3] Estimate uses the observed sex ratio provided by the total MFCF adult steelhead returns.

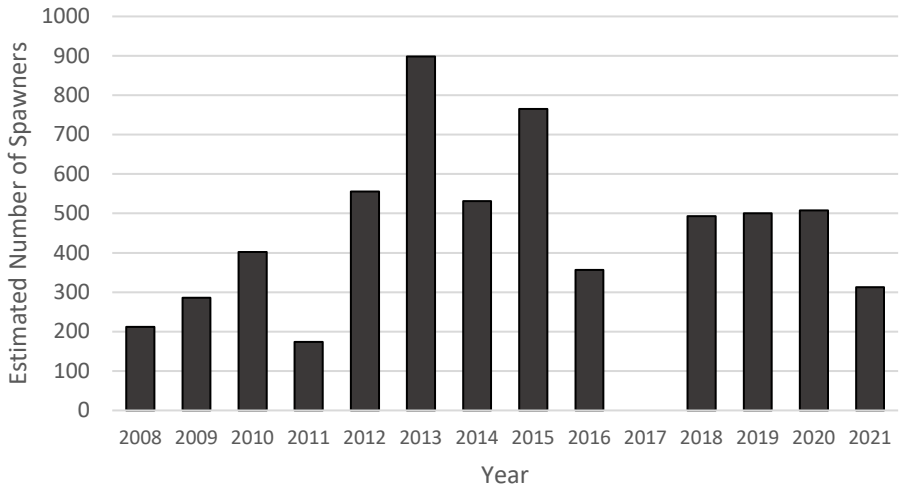


Figure 3-8. Estimated spawner abundance of late winter steelhead in the mainstem North Fork Lewis River: 2008 -2021

Chinook Salmon

See Objective 16 in this report.

Coho Salmon

Table 3-15. Adult Coho escapement estimates for the mainstem North Fork Lewis River downstream of Merwin Dam: 2013 to 2021

Year	Number of marked carcasses	Number (%) of recaptured carcasses	Est. Gross Population Size	Bootstrap SE	95%-Confidence Interval	CV	Total Weeks Surveyable	Average Daily Flow during Surveys (cfs)	Average Daily Flow Oct 16-Jan-31
2013	328	41 (13%)	**1,970**	297	1,523 - 2,679	0.17	15	4,700	4,804
2014	431	18 (4%)	**7,805**	2,106	5,172 - 13,186	0.27	15	7,765	7,876
2015	12	2 (17%)	**NA**	NA	NA	NA	12	5,632	8,429
2016	65	20 (31%)	**124**	17	103 - 169	0.14	16	4,587	6,721
2017	24	8 (33.3%)	**44**	5	33 - 55	0.11	16	8,817	8,587
2018	61	22 (36%)	**137**	20	98 - 176	0.15	16	5,009	5,044
2019	40	7 (17.5%)	**83**	10	64 - 102	0.12	15	6,181	6,761
2020	223	65 (29%)	**527**	54	421 - 632	0.1	15	4,968	7,182
2021	94	14 (15%)	**407**	93	225 - 590	0.23	14	6,683	8,403

Juvenile Abundance

In 2021, two 8-foot rotary screw traps operated in tandem (side by side) at the Lewis River golf course site (RKM 21.6) between March 1 and June 30, 2021. For detailed results please see Appendix D. A summary of total captures and estimated number of fish passing the trap site is provided in Tables 3-16 and 3-17.

Table 3-16. Summary of the total number of coho, Chinook and steelhead juvenile captures during screw trapping operations in the mainstem North Fork Lewis River downstream of Merwin Dam: 2016 to 2021.

Year	HOR Coho	NOR Coho	NOR Chinook	NOR Steelhead
2016	25,539	1,509	53,404	556
2017	7,774	6,847	12,403	147
2018	21,753	177	13,380	27
2019	No trapping			
2020	12,114	580	16,111	690
2021	21,359	744	163,556	597

Table 3-17. Mean bootstrap estimates of the number of coho, Chinook and steelhead passing the screw traps by year: 2016 to 2021

Year	HOR Coho	NOR Coho	NOR Chinook	NOR Steelhead
2016	1,309,518	74,065	2,327	20,404
2017	811,302	62,075	14,763	6,866
2018	1,852,836	16,488	1,250,158	2,212
2019	No trapping			
2020	1,820,357	29,161		
2021		63,781	4,595,197	52,193

OBJECTIVE 15: Determine Spatial and Temporal Distribution of Spawning Late Winter Steelhead, Coho and Spring Chinook Downstream of Merwin Dam

Late Winter Steelhead

Figure 3-9. Distribution of late winter steelhead redds downstream of Merwin Dam – 2021

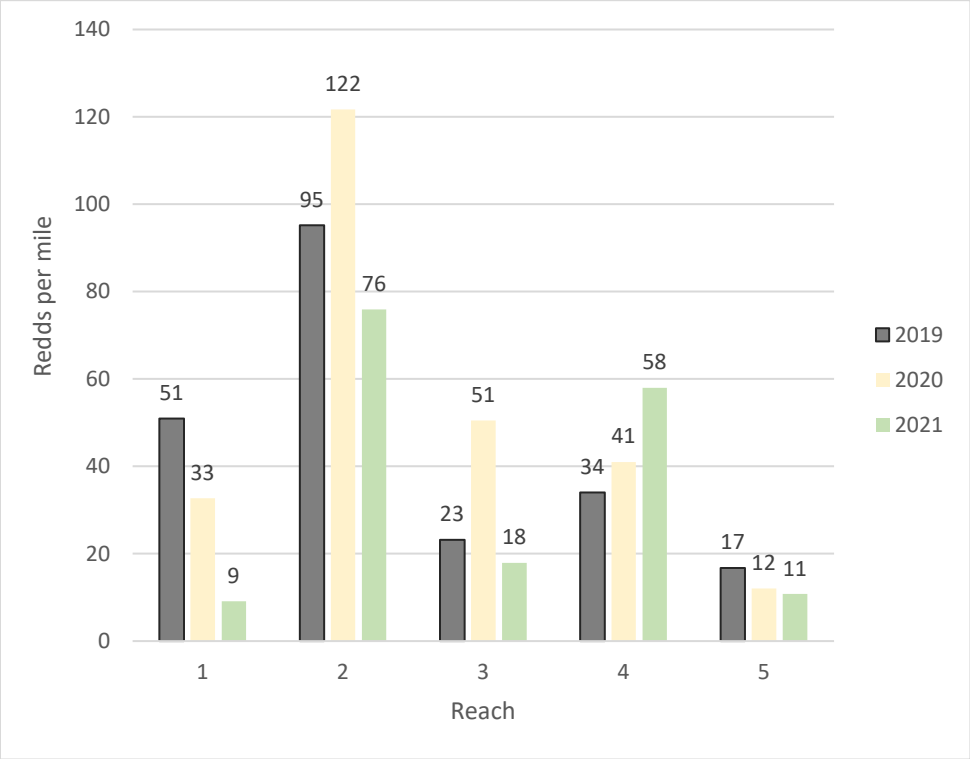


Figure 3-10. Distribution and density of late winter steelhead redds by reach for the years 2019-2021

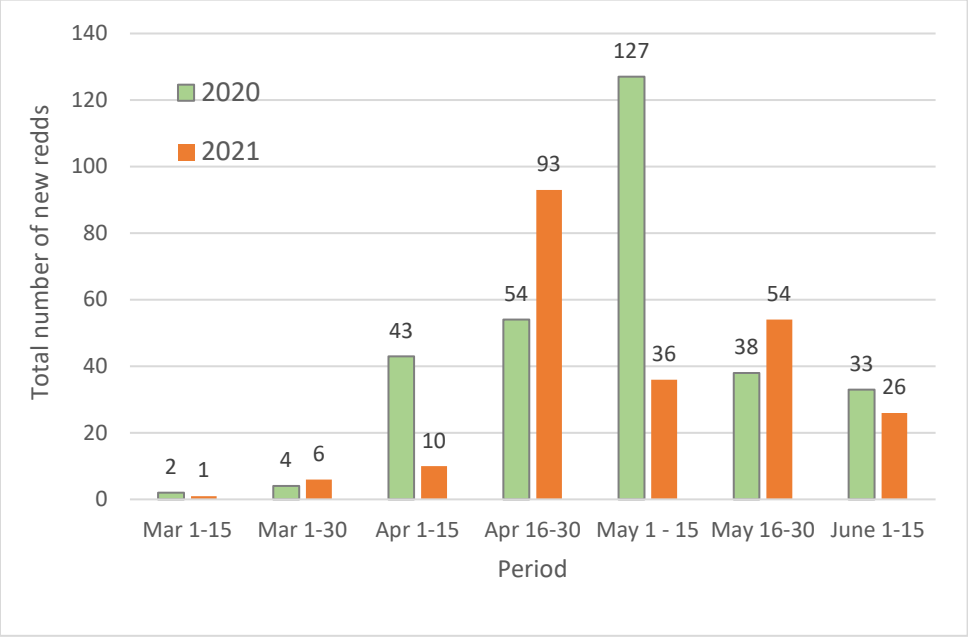


Figure 3-11. Total new late winter steelhead redds observed by time period in 2020 and 2021

Coho Salmon

Table 3-18. Mainsten coho distribution data downstream of Merwin Dam: 2016 to 2021

	NF Lewis River	Reach Length (miles)	Total Weeks (mid-Oct to Jan 31)	Total Weeks Surveyable	Total Live Holders	Total Live Spawners	Total Carcass Unable to Sample	Hatchery Male Carcass	Hatchery Female Carcass	Unmarked Male Carcass	Unmarked Female Carcass	Total Carcass	Total Carcass Tagged	Total Carcass Recoveries	% Pre-spawn Mortality (Females)	Carcass Wanded for CWT	CWT Positive Carcass
2016																	
	Reach 1	0.57	16	16	1	24	NA	3	3	1	1	8	7	4	0%	8	1
	Reach 2	0.68	16	16	6	44	NA	0	2	0	1	3	3	1	50%	3	0
	Reach 3	0.97	16	16	0	108	NA	2	1	0	2	5	4	1	0%	5	1
	Reach 4	1.32	16	16	56	78	NA	2	3	6	3	14	14	7	33%	14	0
	Reach 5	7.3	16	15	0	25	NA	12	9	13	5	39	37	7	14%	39	0
	Total	10.84	16	16	63	279	NA	19	18	20	12	69	65	20	18%	69	2
2017																	
	Reach 1	0.57	16	16	6	4	NA	0	0	0	0	0	0	0	NA	0	0
	Reach 2	0.68	16	16	4	14	NA	0	1	1	0	2	2	1	0%	2	0
	Reach 3	0.97	16	16	0	8	NA	0	0	0	0	0	0	0	NA	0	0
	Reach 4	1.32	16	16	20	25	NA	1	3	1	3	8	8	3	0%	8	0
	Reach 5	7.3	16	15	20	12	NA	7	2	3	2	14	14	4	25%	14	0
	Total	10.84	16	16	50	63	NA	8	6	5	5	24	24	8	9%	24	0
2018																	
	Reach 1	0.57	16	16	30	15	3	4	4	0	0	11	8	4	0%	8	0
	Reach 2	0.68	16	16	50	20	0	3	3	1	0	7	7	2	33%	7	0
	Reach 3	0.97	16	16	25	5	0	0	1	1	2	4	4	0	33%	4	0
	Reach 4	1.32	16	16	100	30	1	4	4	1	2	12	11	3	50%	11	5
	Reach 5	7.3	16	15	50	20	4	13	15	2	2	36	31	13	53%	32	3
	Total	10.84	16	16	255	90	8	24	27	5	6	70	61	22	42%	62	8
2019																	
	Reach 1	0.57	16	15	16	0	1	1	2	2	1	7	6	2	33%	6	0
	Reach 2	0.68	16	15	23	0	0	0	1	2	0	3	3	0	0%	3	0
	Reach 3	0.97	16	15	13	0	1	1	0	1	0	3	2	0	0%	2	0
	Reach 4	1.32	16	15	25	0	0	2	1	4	1	8	8	0	0%	8	0
	Reach 5	7.3	16	15	45	0	2	7	6	6	2	23	21	5	63%	21	0
	Total	10.84	16	15	122	0	4	11	10	15	4	44	40	7	43%	40	0
2020																	
	Reach 1	0.57	16	15	NA	NA	4	6	10	4	1	25	21	7	45%	21	0
	Reach 2	0.68	16	15	NA	NA	3	7	12	2	2	26	23	8	57%	23	0
	Reach 3	0.97	16	15	NA	NA	4	16	20	0	0	40	36	16	70%	36	0
	Reach 4	1.32	16	15	NA	NA	58	30	34	10	5	137	79	23	38%	79	1
	Reach 5	7.3	16	15	NA	NA	22	24	25	8	7	86	64	11	47%	64	0
	Total	10.84	16	15	NA	NA	91	83	101	24	15	314	223	65	49%	223	1
2021																	
	Reach 1	0.57	16	14	NA	NA	2	1	7	2	0	12	10	2	57%	10	0
	Reach 2	0.68	16	14	NA	NA	1	4	3	4	1	13	12	2	0%	12	0
	Reach 3	0.97	16	14	NA	NA	0	6	5	0	1	12	12	0	33%	12	1
	Reach 4	1.32	16	14	NA	NA	0	9	19	2	2	32	32	7	67%	32	0
	Reach 5	7.3	16	14	NA	NA	0	10	12	2	4	28	28	3	56%	28	0
	Total	10.84	16	14	NA	NA	3	30	46	10	8	97	94	14	54%	94	1

Coho Salmon (tributary surveys)

Table 3-19. Tributary coho salmon survey summary: 2016 to 2021

	Stream	Reach Length (miles)	Total Weeks (mid-Oct through Jan)	Total Weeks Surveyable	Total New Redds	Total Live Holders	Total Live Spawners	Total Carcass Unable to Sample	Hatchery Male Carcass	Hatchery Female Carcass	Unmarked Male Carcass	Unmarked Female Carcass	Total Carcass	% Pre-spawn Mortality (Females)	Carcass Wanded for CWT	CWT Positive Carcass
2016																
	Hayes Trib 2	0.5	16	9	0	0	0		0	0	0	0	0	NA	0	0
	Lower Houghton	1	16	13	0	1	0		0	0	0	0	0	NA	0	0
	Ross Creek	1	16	15	33	9	49		2	1	5	2	10	0%	10	1
	Upper Houghton	1	16	16	10	7	10		2	0	0	0	2	NA	2	0
2017																
	Hayes Trib 1	1	16	16	2	0	0		0	0	0	0	0	NA	0	0
	Hayes Trib 2	0.5	16	16	0	0	0		0	0	0	0	0	NA	0	0
	Robinson Creek	1	16	16	15	0	16		0	0	1	1	2	0%	2	0
	Ross Creek	1	16	16	30	0	20		0	3	5	3	11	0%	11	0
2018																
	Ross Creek	1	16	15	12	1	10	0	1	2	0	0	3	0%	3	0
	Johnson Creek	0.95	16	16	17	2	8	1	1	0	0	1	3	0%	2	0
	Hayes Creek	1	16	13	1	0	1	0	0	0	0	0	0	0%	0	0
	Hayes Trib. 2	1	16	13	0	0	0	0	0	0	0	0	0	NA	0	0
	Bratton Creek	1	16	16	0	0	0	0	0	0	0	0	0	NA	0	0
2019																
	Ross Creek	1	15	12	13	2	29	2	0	2	2	4	10	0%	8	0
	Houghton Creek R1	1	15	14	16	0	5	0	0	1	0	1	2	0%	2	0
	Houghton Creek R2	1	15	11	0	0	0	0	0	0	0	0	0	NA	0	0
	Hayes Creek Trib 2	1	15	11	0	0	0	0	0	0	0	0	0	NA	0	0
2020																
	Robinson Creek	1	16	12	24	0	6	0	1	0	0	0	1	NA	1	0
	Hayes Creek	1	16	10	0	0	0	0	0	0	0	0	0	NA	NA	NA
	Hayes Trib 1	1	16	10	0	0	0	0	0	0	0	0	0	NA	NA	NA
	Hayes Trib 2	1	16	10	0	0	0	0	0	0	0	0	0	NA	NA	NA
2021																
	Johnson Creek R1		16	14	41	8	72	2	0	0	2	0	4	NA	2	0
	Bratton Creek R1		16	13	2	0	2	0	1	1	0	0	2	0%	2	0
	Hayes Creek R1		16	11	0	0	0	0	0	0	0	0	0	NA	NA	NA
	Hayes Creek Trib 2		16	11	0	0	0	0	0	0	0	0	0	NA	NA	NA

OBJECTIVE 16: Evaluate Fall Chinook and Chum Populations Downstream of Merwin Dam

Detailed information regarding Chinook monitoring downstream of Merwin Dam is available in Appendix F. Below is a summary of that information contained in a memo from WDFW biologists Kale Bentley and Erin Peterson dated April 25, 2022.

Chinook Abundance

Table 3-20. Annual estimates of abundance for North Fork Lewis fall Chinook 2013-2021 and spring Chinook 2020-2021

Year	Stock	Mean	SD	L.95%	Median	U.95%	CV
2013	Fall Chinook	**20,862**	**496**	**19,990**	**20,830**	**21,940**	**2%**
	Tule	*3,511*	*462*	*2,642*	*3,495*	*4,533*	*13%*
	Bright	*17,351*	*450*	*16,500*	*17,340*	*18,300*	*3%*
2014	Fall Chinook	**24,859**	**588**	**23,790**	**24,830**	**26,100**	**2%**
	Tule	*4,055*	*409*	*3,326*	*4,027*	*4,902*	*10%*
	Bright	*20,803*	*620*	*19,670*	*20,780*	*22,050*	*3%*
2015	Fall Chinook	**24,364**	**981**	**22,550**	**24,310**	**26,431**	**4%**
	Tule	*5,449*	*381*	*4,759*	*5,440*	*6,265*	*7%*
	Bright	*18,915*	*992*	*17,120*	*18,850*	*21,080*	*5%*
2016	Fall Chinook	**13,487**	**496**	**12,660**	**13,440**	**14,600**	**4%**
	Tule	4,127	482	3,329	4,073	5,225	12%
	Bright	9,360	243	8,912	9,357	9,863	3%
2017	Fall Chinook	**9,523**	**536**	**8,632**	**9,470**	**10,720**	**6%**
	Tule	*2,255*	*450*	*1,560*	*2,203*	*3,258*	*20%*
	Bright	*7,268*	*355*	*6,664*	*7,240*	*8,084*	*5%*
2018	Fall Chinook	**6,455**					
	Tule	*1,744*	*248*	*1,281*	*1,727*	*2,290*	*14%*
	Bright	*4,711*	*206*	*4,281*	*4,706*	*5,147*	*4%*
2019	Fall Chinook	**13,281**					
	Tule	*1,302*	*38*	*706*	*7,251*	*2,194*	*29%*
	Bright	*11,979*	*470*	*10,988*	*12,001*	*12,838*	*4%*
2020	Fall Chinook	**29,384**					
	Tule	*3,104*	*542*	*2,172*	*3,055*	*4,315*	*17%*
	Bright	*26,280*	*819*	*24,697*	*26,266*	*27,927*	*3%*
	Spring Chinook	*129*	*96*	*35*	*101*	*401*	*74%*
2021	Fall Chinook	**15,848**					
	Tule	*2,968*	*467*	*2,133*	*2,946*	*3,989*	*16%*
	Bright	*12,880*	*607*	*11,730*	*12,866*	*14,108*	*5%*
	Spring Chinook	*708*	*382*	*278*	*611*	*1,688*	*54%*

Chinook Spawner Distribution

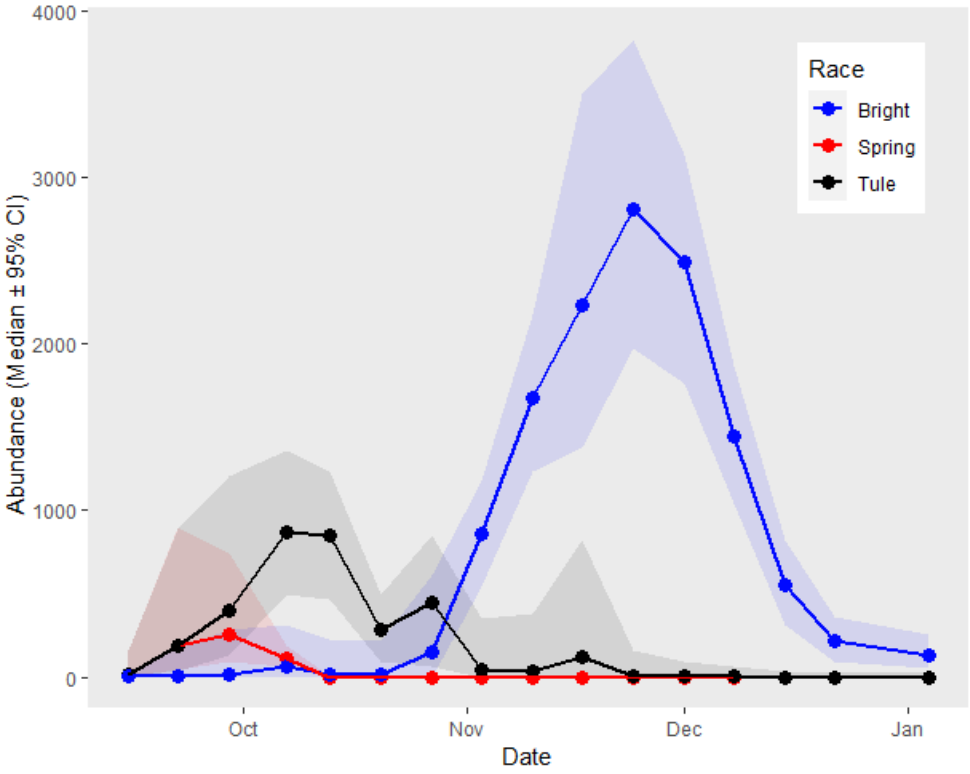


Figure 3-12. Weekly estimated abundance of Chinook in the North Fork Lewis River September 2021 - January 2022

OBJECTIVE 17: Annual Review of Existing and Proposed Harvest Regulations (if any) to Determine if Recommendations are Warranted to Protect Supplementation Program Objectives

No recommendations were received by the ATS or ACC during 2021.

3.4 Upstream Transport of Steelhead, Coho and Spring Chinook

Table 3-21. Number of fish transported upstream of Swift Dam: 2012 to 2021

YEAR	WINTER STEELHEAD			COHO				SPRING CHINOOK				
	Male	Female	Total	Male	Female	Jack	Total	Male	Female	Jack	Total	
2012	141	48	189				206	0	0	0	0	
2013	440	301	741	3,858	3,104	73	7,035	270	243	66	579	
2014	452	581	1,033	4,788	4,217	174	9,179	0	0	0	0	
2015	746	477	1,223	2,030	1,694	30	3,754	0	0	0	0	
2016	382	390	772	3,430	3,377	539	7,346	0	0	0	0	
2017	331	261	592	3,254	3,494	65	6,813	370	430	310	1,110	
2018	682	535	1,227	3,999	2,659	402	7,060	491	177	32	700	
2019	527	486	1,013	2,946	2,373	268	5,587	12	12	85	109	
2020	517	535	1,052	4,319	4,911	256	9,486	193	56	385	634	
2021	123	191	314	3,995	4,913	353	9,261	657	232	286	1,175	
TOTAL	4,341	3,805	8,156	32,619	30,742	2,160	65,727	1,993	1,150	1,164	4,307	78,190

4.0 RECOMMENDATIONS FOR ONGOING MANAGEMENT

The annual operating plan (AOP) for the Hatchery and Supplementation program continues to be updated and used as an adaptive management tool to address both ongoing and new priorities as they relate to hatchery operations, supplementation activities and development of effective monitoring designs.

In 2020, the ATS finalized a revised H&S Plan which was submitted to the FERC in December 2020 and approved by the FERC in April 2022. This revised plan includes substantial revisions to the monitoring objectives incorporating HSRG recommendations, NMFS guidance in the form of VSP guidance and draws from recent hatchery Biological Opinions.

During the next 5 years it is expected that HGMP's will be finalized and NMFS will issue a Biological Opinion(s) for each of the hatchery programs on the North Fork Lewis River. The content of these Opinions may require some revisions to the existing set of monitoring objectives. However, we expect any revisions to be captured in the annual planning efforts of the ATS and AOP.

A key step in determining the success of the hatchery and supplementation program is contained in the program key questions of the H&S plan. As we continue to implement the AOP, we should work towards providing the data necessary to address these key questions. In 2025, the Services are required to determine whether the program is achieving the stated goals

in the Agreement. It is therefore the responsibility of the ATS and ACC to ensure that the data collected under the H&S plan, AOP and AMEP provides sufficient detail and accuracy for the Services to make this determination as required by the Agreement.

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APPENDIX A –

Late winter steelhead captured at the Merwin Trap and and transported to Merwin Hatchery - 2021

APPENDIX A - Late winter steelhead captured at the Merwin Trap and transported to Merwin hatchery - 2021

Capture Date	Sex	Fork Length	Scale Card Number	Scale Card Position	PIT Code	DNA Number	Release Location	Spawned ✓, Mortality ✗, Released ⇨
2/24/2021	M	67	59027	1	3DD.003D91E08C	1	Pekins Ferry Access	✓
2/25/2021	F	84	59027	2	3DD.003D91E056	2	Landfill	✗
3/1/2021	M	84	59027	3	3DD.003D91E040	3	Pekins Ferry Access	✓
3/1/2021	F	81	59027	4	3DD.003D91E05E	4	Merwin boat Launch	✓
3/3/2021	F	76	59027	5	3DD.003D91E052	5	Pekins Ferry Access	✓
3/3/2021	M	87	59027	6	3DD.003D91E07F	6	Pekins Ferry Access	✓
3/3/2021	M	84	59027	7	3DD.003D91E053	7	Pekins Ferry Access	✓
3/3/2021	M	72	59027	8	3DD.003D91E041	8	Pekins Ferry Access	✓
3/4/2021	M	74	59027	9	3DD.003D91E08F	9	Pekins Ferry Access	✓
3/4/2021	F	73	59028	1	3DD.003D91E06A	10	Pekins Ferry Access	✓
3/8/2021	F	71	59028	2	3DD.003D47BDC3	11	Pekins Ferry Access	✓
3/8/2021	F	79	59028	3	3DD.003D47BDC7	12	Merwin boat Launch	✓
3/12/2021	M	76	59028	4	3DD.003D47BDCA	13	Pekins Ferry Access	✓
3/12/2021	M	65	59028	5	3DD.003D47BDB6	14	Merwin boat Launch	✓
3/15/2021	M	91	59028	6	3DD.003D47BACD	15	Pekins Ferry Access	✓
3/16/2021	M	54	59028	7	3DD.003D47BAF3	16	Pekins Ferry Access	✓
3/27/2021	M	85	59028	8	3DD.003D47BAC5	17	Merwin boat Launch	✓
3/28/2021	M	85	59028	9	3DD.003D47BAF7	18	Pekins Ferry Access	✓
4/1/2021	M	68	59029	1	3DD.003D47BAB1	19	Pekins Ferry Access	✓
4/1/2021	M	88	59029	2	3DD.003D47BB10	20	Pekins Ferry Access	✓
4/2/2021	M	59	59029	3	3DD.003D47BB00	21	Pekins Ferry Access	✓
4/4/2021	M	77	59029	4	3DD.003D47BAF8	22	Pekins Ferry Access	✓
4/4/2021	M	90	59029	5	3DD.003D47BAFC	23	Pekins Ferry Access	✓
4/4/2021	F	86	59029	6	3DD.003D47BB06	24	Pekins Ferry Access	✓
4/11/2021	M	68	59029	7	3DD.003D47BABD	25	Pekins Ferry Access	✓
4/11/2021	M	85	59029	8	3DD.003D47BAD9	26	Pekins Ferry Access	✓
4/13/2021	F	79	59029	9	3DD.003D47BAFB	27	Pekins Ferry Access	✓
4/13/2021	F	81	59030	1	3DD.003D47BAD8	28	Pekins Ferry Access	✓
4/15/2021	M	48	59030	2	3DD.003D47BC01	29	Pekins Ferry Access	✓
4/15/2021	M	51	59030	3	3DD.003D47BBFE	30	Pekins Ferry Access	✓
4/20/2021	F	83	59030	4	3DD.003D47BC37	31	Pekins Ferry Access	✓
4/21/2021	F	85	59030	5	3DD.003D47BBF9	32	Pekins Ferry Access	✓
4/21/2021	M	76	59030	6	3DD.003D47BC3D	33	Pekins Ferry Access	✓

Capture Date	Sex	Fork Length	Scale Card Number	Scale Card Position	PIT Code	DNA Number	Release Location	Spawned ✓, Mortality ✖, Released ⇨
4/21/2021	F	84	59030	7	3DD.003D47BC3E	34	Pekins Ferry Access	✓
4/22/2021	F	82	59030	8	3DD.003D47BBF5	35	Pekins Ferry Access	✓
4/23/2021	F	66	59030	9	3DD.003D47BBE5	36	Pekins Ferry Access	✓
4/24/2021	M	46	59031	1	3DD.003D47BC07	37	Merwin boat Launch	⇨
4/24/2021	M	63	59031	2	3DD.003D47BC21	38	Pekins Ferry Access	⇨
4/24/2021	F	81	59031	3	3DD.003D47BC20	39	Landfill	✖
4/25/2021	F	73	59031	4	3DD.003D47BBFF	40	Pekins Ferry Access	✓
4/25/2021	M	50	59031	5	3DD.003D47BBF2	41	Pekins Ferry Access	✓
4/25/2021	F	82	59031	6	3DD.003D47BC1D	42	Pekins Ferry Access	✓
4/25/2021	M	57	59031	7	3DD.003D47BBF6	43	Pekins Ferry Access	✓
4/25/2021	M	92	59031	8	3DD.003D47BC1E	44	Pekins Ferry Access	✓
4/28/2021	F	76	59031	9	3DD.003D47BBEC	45	Pekins Ferry Access	✓
4/30/2021	M	63	59032	1	3DD.003D47BC38	46	Pekins Ferry Access	⇨
4/30/2021	F	74	59032	2	3DD.003D47BC23	47	Pekins Ferry Access	✓
5/2/2021	F	67	59032	3	3DD.003D47BBEE	48	Pekins Ferry Access	✓
5/3/2021	F	72	59032	4	3DD.003D47BD23	49	Pekins Ferry Access	✓
5/3/2021	F	73	59032	5	3DD.003D47BD13	50	Pekins Ferry Access	✓
5/3/2021	F	75	59032	6	3DD.003D47BD1B	51	Pekins Ferry Access	✓
5/3/2021	F	68	59032	7	3DD.003D47BD29	52	Merwin Boat Launch	✓
5/3/2021	F	53	59032	8	3DD.003D47BC2E	53	Pekins Ferry Access	✓
5/4/2021	M	70	59032	9	3DD.003D47BC0A	54	Pekins Ferry Access	✓
5/4/2021	F	85	59083	1	3DD.003D47BBE1	55	Pekins Ferry Access	✓
5/4/2021	M	51	59083	2	3DD.003D47BBF0	56	Merwin Boat Launch	⇨
5/6/2021	F	69	59083	3	3DD.003D47BC59	57	Pekins Ferry Access	✓
5/6/2021	F	54	59083	4	3DD.003D47BC19	58	Pekins Ferry Access	⇨
5/7/2021	F	75	59083	5	3DD.003D47BC4D	59	Pekins Ferry Access	⇨
5/10/2021	F	65	59083	6	3DD.003D47BC89	60	Pekins Ferry Access	⇨
5/10/2021	M	85	59083	7	3DD.003D47BC44	61	Pekins Ferry Access	✓

APPENDIX B –

NOR late winter steelhead spawning crosses -2021

Appendix B - NOR Late Winter Steelhead Spawning Crosses - 2021

SPAWN DATE	FEMALE ID	MALE ID	2ND MALE ID	3RD MALE ID	NOTES
4/12/2021	10	7	13		
4/21/2021	4	14	17		
4/21/2021	12	14	17		
4/27/2021	5	3	19		
4/27/2021	11	3	19		
4/27/2021	34	1	23		
4/27/2021	31	1	23		
4/27/2021	36	6	8		Unfed fry plant
4/27/2021	42	6	8		
5/4/2021	45	22	9		
5/4/2021	47	22	9		
5/4/2021	27	15	25		
5/4/2021	24	15	25		
5/4/2021	35	29	26		
5/4/2021	51	29	26		
5/7/2021	57	41	43	44	
5/7/2021	55	41	43	44	
5/7/2021	53	41	43	44	
5/7/2021	32	16	33		
5/7/2021	49	16	33		
5/14/2021	40	30	18		
5/14/2021	50	30	18		
5/14/2021	48	20	21		
5/14/2021	28	20	21		
5/21/2021	52	54	61		

APPENDIX C –

Late winter steelhead genetic screening results - 2021

Appendix C - 2021 Late Winter Steelhead Genetic Screening Results

DATE	LABEL	CAPTURE	Primary Stock	P	Secondary Stock	P2	Tertiary Stock	P3
2/24/2021	21AQ0001	MFCF	SFToutleR	0.58	LR Merwin	0.42		
2/25/2021	21AQ0002	MFCF	LR Merwin	0.98	WashougalR	0.02		
3/1/2021	21AQ0003	MFCF	LR Merwin	0.98	WashougalR	0.08		
3/1/2021	21AQ0004	MFCF	SFToutleR	0.96	LR Merwin	0.04		
3/3/2021	21AQ0005	MFCF	LR Merwin	0.62	SFToutleR	0.38		
3/3/2021	21AQ0006	MFCF	LR Merwin	0.51	WashougalR	0.49		
3/3/2021	21AQ0007	MFCF	LR Merwin	0.91	SFToutleR	0.09		
3/3/2021	21AQ0008	MFCF	SFToutleR	0.57	LR Merwin	0.35		
3/4/2021	21AQ0009	MFCF	LR Merwin	0.58	SFToutleR	0.42		
3/4/2021	21AQ0010	MFCF	SFToutleR	0.84	LR Merwin	0.16		
3/8/2021	21AQ0011	MFCF	LR Merwin	0.89	SFToutleR	0.11		
3/8/2021	21AQ0012	MFCF	SFToutleR	0.95	LR Merwin	0.05		
3/12/2021	21AQ0013	MFCF	LR Merwin	0.96	SFToutleR	0.04		
3/12/2021	21AQ0014	MFCF	LR Merwin	1.00				
3/15/2021	21AQ0015	MFCF	LR Merwin	1.00				
3/16/2021	21AQ0016	MFCF	SFToutleR	0.93	LR Merwin	0.07		
3/27/2021	21AQ0017	MFCF	LR Merwin	0.98	KalamaR_W	0.02		
3/28/2021	21AQ0018	MFCF	WashougalR	0.99				
4/1/2021	21AQ0019	MFCF	LR Merwin	0.94	KalamaR_W	0.04	SFToutleR	0.01
4/1/2021	21AQ0020	MFCF	KalamaR_W	1.00				
4/2/2021	21AQ0021	MFCF	KalamaR_W	0.88	SFToutleR	0.10	WashougalR	0.02
4/4/2021	21AQ0022	MFCF	LR Merwin	1.00				
4/4/2021	21AQ0023	MFCF	SFToutleR	0.86	LR Merwin	0.14		
4/4/2021	21AQ0024	MFCF	LR Merwin	1.00				
4/11/2021	21AQ0025	MFCF	LR Merwin	1.00				
4/11/2021	21AQ0026	MFCF	LR Merwin	1.00				
4/13/2021	21AQ0027	MFCF	LR Merwin	1.00				
4/13/2021	21AQ0028	MFCF	WashougalR	0.56	LR Merwin	0.44		
4/15/2021	21AQ0029	MFCF	LR Merwin	1.00				
4/15/2021	21AQ0030	MFCF	LR Merwin	1.00				
4/20/2021	21AQ0031	MFCF	EFLewisR	0.96	LR Merwin	0.03		
4/21/2021	21AQ0032	MFCF	LR Merwin	1.00				
4/21/2021	21AQ0033	MFCF	LR Merwin	0.85	CoweemanR	0.14		
4/21/2021	21AQ0034	MFCF	LR Merwin	0.88	SFToutleR	0.12		
4/22/2021	21AQ0035	MFCF	LR Merwin	1.00				
4/23/2021	21AQ0036	MFCF	ElochomanR	0.90	LR Merwin	0.10		
4/24/2021	21AQ0037	MFCF	LR Merwin	1.00				
4/24/2021	21AQ0038	MFCF	LR Merwin	1.00				
4/24/2021	21AQ0039	MFCF	LR Merwin	1.00				
4/25/2021	21AQ0040	MFCF	LR Merwin	1.00				
4/25/2021	21AQ0041	MFCF	LR Merwin	0.99				
4/25/2021	21AQ0042	MFCF	LR Merwin	1.00				

DATE	LABEL	CAPTURE	Primary Stock	P	Secondary Stock	P2	Tertiary Stock	P3
4/25/2021	21AQ0043	MFCF	LR Merwin	1.00				
4/25/2021	21AQ0044	MFCF	LR Merwin	1.00				
4/28/2021	21AQ0045	MFCF	LR Merwin	1.00				
4/30/2021	21AQ0046	MFCF	LR Merwin	1.00				
4/30/2021	21AQ0047	MFCF	LR Merwin	1.00				
5/2/2021	21AQ0048	MFCF	LR Merwin	1.00				
5/3/2021	21AQ0049	MFCF	LR Merwin	1.00				
5/3/2021	21AQ0050	MFCF	LR Merwin	1.00				
5/3/2021	21AQ0051	MFCF	LR Merwin	0.98				
5/3/2021	21AQ0052	MFCF	SFToutleR	0.93	LR Merwin	0.06		
5/3/2021	21AQ0053	MFCF	LR Merwin	1.00				
5/4/2021	21AQ0054	MFCF	CowlitzR	0.76	CoweemanR	0.13	LR Merwin	0.10
5/4/2021	21AQ0055	MFCF	LR Merwin	1.00				
5/4/2021	21AQ0056	MFCF	LR Merwin	1.00				
5/6/2021	21AQ0057	MFCF	LR Merwin	1.00				
5/6/2021	21AQ0058	MFCF	LR Merwin	1.00				
5/7/2021	21AQ0059	MFCF	LR Merwin	1.00				
5/10/2021	21AQ0060	MFCF	CowlitzR	0.73	LR Merwin	0.27		
5/10/2021	21AQ0061	MFCF	CoweemanR	0.99				

APPENDIX D –

Screw trapping results from lower North Fork Lewis River sampling 2021

JMX Smolt Trap Protocols and Reporting
(1/12/2022)

This document includes three sections:

- **Part 1 – Data Collection is to be completed prior to the trapping season.**
- **Part 2 – Implementation Notes is to be completed once data are collected in preparation for analysis.**
- **Part 3 – Analysis and Results is to be completed as the last step.**

All protocols reported in this document reflect standardized Region 5 smolt trapping and analysis methods. The purpose of this document is to ensure consistency among projects and to document protocols for posterity.

****

Part 1: DATA COLLECTION PROTOCOLS

Protocol Name: North Fork Lewis River (downstream of Merwin Dam) - 2021

Project Supervisor: Jason Shappart (Meridian Environmental, Inc. – PacifiCorp contractor)

Science Leader: Jason Shappart (Meridian Environmental, Inc. – PacifiCorp contractor)

ESA Take Permit No. (if applicable): ESA Section 7(a)(2) Consultation, Biological Opinion for PacifiCorp's operation of the Lewis River Hydroelectric Projects (NMFS Consultation No. 2005/05891). August 27, 2007.

Trap information:

Trap Name	Type of Trap	Trap Location RKM	Start Date (Planned)	End Date (Planned)
Lewis River Upper Golf Course Traps	Two 8-foot rotary screw traps fished in tandem strapped together side-by-side	21.6	03/01/2021	06/30/2021

1.1 Field Objectives:

Trap Name	Lewis River Upper Golf Course Traps							
Species	**Origin**	**Life Stage**	**Age Class**	**Catch**	**Efficiency Trials**	**Fork Length**	**Scales**	**Other**
Chinook	All	All	All	Y	Y	Y	N	Scan for CWT/BWT
Chum	All	All	All	Y	N	Y	N	
Steelhead	All	F	Subyearling	Y	N	Y	N	
Steelhead	All	P	Subyearling	Y	Y	Y	N	Scan for BWT
Steelhead	All	T/S	Yearling	Y	Y	Y	N	Scan for BWT
Coho	All	F	Subyearling	Y	N	Y	N	Scan for CWT
Coho	All	P	Subyearling	Y	Y	Y	N	
Coho	All	T/S	Yearling	Y	Y	Y	N	Scan for CWT
Cutthroat	All	T/S/A	All	Y	Y	Y	N	
Additional Comments/Narrative: Fry (F), Parr (P), Transitional (T), Smolt (S), Adult (A), Blank Wire Tag (BWT), Coded Wire Tag (CWT)								

1.2 Site Selection:	
• *Why was this site selected for the smolt trap?*	Anchoring, permitting, laminar flow, ease of access and downstream of the majority of spawning
• *Are there spawner estimates above the trap site that can be used to estimate freshwater productivity, capacity, and smolt-to-adult return?*	Mainstem Chinook, Coho and Steelhead: Yes Chum: No
• *Describe the method used for adult escapement estimates (e.g., Carcass tagging, adult MR, AUC, redds, PCE, other).*	Chinook and Coho: Carcass tagging in mainstem NF Lewis River, WDFW GRTS redd surveys in tributaries Steelhead: Redd Surveys
• *Estimated % of the total basin-specific population that spawn above the trap. Include source for this information (% can be a range).*	Steelhead: > 90% (Annual Operations Report) Chinook: unknown Coho: unknown
• *Estimated % of yearling life stage juveniles that continuously rear) above the trap (summer and winter) prior to outmigrating. Include source for this information.*	Unknown
• *Additional Information*	Juvenile anadromous fish transported from upstream of the Lewis River Projects are released downstream of the trap locations (spring Chinook, Steelhead, Coho, Cutthroat).

1.3 Collection Event:	
• *Describe the planned frequency for enumerating and sampling fish caught in the trap.*	Traps to be checked daily (between 09:00 and 15:00 hours).
• *Describe and explain any planned trap outages.*	None
• *Describe process of handling and anaesthetizing fish.*	Dip nets used to transfer all fish to buckets or bins with battery aeration units. Salmonids to be anesthetized in solution of 1 ml Aqui-S to 2 gallons river water prior to sampling.
• *Describe method for measuring rotation per minute (RPM)*	Visually for 1 minute (daily)
• *List flow gauge associated with the trap.*	USGS Lewis River at Ariel Gage Station - 14220500
• *Describe method for measuring visibility and frequency of measurements.*	Not estimated
• *Describe method for measuring stream temperature and frequency of measurements.*	Not measured
• *Describe additional environmental variables measured, the method for the measurement, and the frequency of measurements.*	None

1.4 Fish Count by Group and Individual Measures:	
• *Life stage will be assigned according to the Region 5 Decision Tree (see appendix). Note any exceptions to the Decision Tree for species/life stage. Exceptions need to be approved by your Science Leader in advance!*	No exceptions to the Region 5 Decision Tree.
• *Describe how origin is assigned.*	Combination of presence and absence of adipose fin clips and CWT or BWT snout tags.
• *Describe the characteristics of individual fish (species/life stage, condition, and mark status) that are sorted and released downstream of the trap.*	All non-salmonids and Chum to be released downstream of trap regardless of life stage.
• *Describe that characteristics of individual fish (species/life stage, condition, and mark status) that are selected for efficiency trials.*	All Coho, Chinook. and Steelhead regardless of life stage; all Cutthroat ≥50. Fish with visual injury or other impairment shall not be used for trials regardless of species or life stage.

Table 1.4a. Date and length criteria used for field calls of Chinook age classes.

Life Stage	Age Class	Date Range	Length Range (mm FL)	Phenotype
Fry		3/1 to 6/30	<50 mm	
Parr/Trans/Smolt		3/1 to 6/30	≥50 mm	Determined by using Region 5 Decision Tree based on physical appearance
Individual Fish Measures:				
• *Sample rate for fork length*			F – 10 per day; P/T/S – up to 50 per day per each category	
• *Sample rate for scales*			NA	

Table 1.4b. Date and length criteria used for field calls of Coho age classes.

Life Stage	Age Class	Date Range	Length Range (mm FL)	Phenotype
Fry		3/1 to 6/30	<50 mm	
Parr/Trans/Smolt		3/1 to 6/30	≥50 mm	Determined by using Region 5 Decision Tree based on physical appearance
Individual Fish Measures:				
• *Sample rate for fork length*			F – 10 per day; P/T/S – up to 50 per day per each category	
• *Sample rate for scales*			NA	

Table 1.4c. Date and length criteria used for field calls of Steelhead age classes.

Life Stage	Age Class	Date Range	Length Range (mm FL)	Phenotype
Fry		3/1 to 6/30	<50 mm	
Parr/Trans/Smolt		3/1 to 6/30	≥50 mm	Determined by using Region 5 Decision Tree based on physical appearance
Individual Fish Measures:				
• *Sample rate for fork length*			F – 10 per day; P/T/S – up to 50 per day per each category	
• *Sample rate for scales*			NA	

Table 1.4d. Date and length criteria used for field calls of Cutthroat age classes.				
Life Stage	**Age Class**	**Date Range**	**Length Range (mm FL)**	**Phenotype**
Fry		3/1 to 6/30	<50 mm	
Parr/Trans/Smolt		3/1 to 6/30	≥50 mm	Determined by using Region 5 Decision Tree based on physical appearance
Individual Fish Measures:				
• *Sample rate for fork length*		F – 10 per day; P/T/S – up to 50 per day per each category		
• *Sample rate for scales*		NA		

1.5 Marking and Release:	
• *Explain purpose of applying marks or tags to fish prior to release (if applicable).*	Marks are used to calibrate trap efficiency.
• *Describe the schedule for which fish will be released to determine trap efficiency.*	Daily (seven days per week)
• *Describe the target number of fish for each release group (species/life stage/age class).*	For all species in which outmigration estimates are planned (Chinook, Coho, Steelhead, and Cutthroat) all captured fish in good condition are marked and used in efficiency trials.
• *Describe marking or tagging method used for each species/origin/life stage/age class.*	**For Chinook fry**: Bismarck brown dye. Use 0.4 grams of dye per approximately 4 gallons of water. **For all maiden capture salmonids (≥50 mm FL):** Alcian Blue tattoo marks varied by week.
• *Describe release location for efficiency trials (rkm).*	In pool/run with bank habitat structures located at N45.937741, W-122.644367 about 0.85 miles upstream of trap site.
• *Describe where and how long marked or tagged fish are held prior to release for efficiency trials.*	Marked fish are held in aerated buckets for recovery after sampling and released immediately after each trap is sampled.
• *Describe what time of day marked or tagged fish are released for efficiency trials.*	Between 0900 and 1500 hours – depending on the number of fish sampled each day.
• *Describe plans to evaluate mark retention and mark-related mortality.*	None
• *Describe plans to evaluate mark-recapture assumption that the second sample is a random representative sample (i.e., marked and unmarked fish are completely mixed)*	None planned for 2021

Table 1.5. Marking Plan for Trap Efficiency Trials							
Species	**Origin**	**Life Stage**	**Age Class**	**Start Date (Planned)**	**Stop Date (Planned)**	**Mark Rotation (Frequency)**	**Mark Type**
Chinook	all	F		3/1	6/30	Same all season	Bismark Brown dye
Chinook	all	P/T/S		3/1	6/30	Weekly	tattoo (dye)
Steelhead	all	P/T/S		3/1	6/30	Weekly	tattoo (dye)
Coho	all	P/T/S		3/1	6/30	Weekly	tattoo (dye)
Cutthroat	all	P/T/S		3/1	6/30	Weekly	tattoo (dye)

1.6 Recapture:	
• *Describe how fish are examined for all marks (visual, PIT scan, CWT wand).*	Visual inspection for Alcian Blue tattoo marks or Bismark Brown dye, and adipose fin clip. When applicable, fish will be wanded for presence of CWT or BWT.
• *Describe how maiden/recapture status is assigned.*	Captured fish indicating the presence of Alcian Blue tattoo marks and Bismark Brown Dye are considered recaptures. All other fish are considered maiden captures.
• *Describe effort to accurately detect marked fish used in efficiency trial. Include methods used to evaluate detection rates.*	All fish captured are visually evaluated for a previous mark.

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Part 2: IMPLEMENTATION NOTES

The Lewis River Upper Golf Course screw traps were operated from March 10 to July 9, 2021. The Lewis River is developing a meander bend just upstream of the screw trap location by cutting into the bank on the north side of the river with a developing point-bar on the south side of the river. This meander bend development is forcing the thalweg to the south side of the river where the screw traps have been historically operated. Therefore, the traps were located about 100 yards downstream of prior years' location and along the south bank within the thalweg in an attempt to increase trap cone RPMs and fish catch rate compared to recent years (Photo 2a).

Photo 2a. Lewis River Upper Golf Course traps fishing location (2021).

The Lewis River Upper Golf Course Traps were fished in the same location continuously the entire season with no alterations (Table 2.1). Missed trapping periods were brief and caused by logs stuck in a trap cone (Table 2.2).

2.1 Trap Alterations		
Trap Name: Lewis River Upper Golf Course Traps		
Date	**Type of Alteration**	**Details**
NA	none	NA

2.2 Missed Trapping Periods				
Trap Name: Lewis River Upper Golf Course Traps				
Last Time Observed Fishing	**Time Stopped Fishing**	**Method to Determine Trap Not Fishing**	**Time Start Fishing again**	**Comments**
4/3/2021 ~3:36pm	unknown	NA	4/4/2021 ~12:00pm	Left Trap cone stopper: logs/brush
4/11/2021 ~2:05pm	unknown	NA	4/12/2021 ~9:00am	Right Trap cone stopper: logs/brush
7/4/2021 ~1:50pm	unknown	NA	7/5/2021 ~9:00am	Left Trap cone stopper: logs/brush

2.3 Raw Data for Mark-Recapture Analysis

For the purpose of this analysis, capture data from both traps was combined to treat the traps fished side-by-side as one functional unit. Total maiden naturally produced salmonids caught included 744 Coho, 163,556 Chinook, 747 Steelhead, and 112 Cutthroat. Most naturally produced Chinook were young-of-year (YOY). Total maiden hatchery produced salmonids caught included 21,359 Coho, 24 Chinook and 1,599 Steelhead. In addition, the traps caught four (4) 3-Spine Stickleback, one (1) Bluegill, two (2) Dace, 3,008 adult Eulachon, 10 Lamprey, 100 Northern Pikeminnow, eight (8) Peamouth Chub, one (1) Redside Shiner, 639 Sculpin, and six (6) Whitefish.

The total number of salmonids captured, released upstream, and recaptured during each weekly period by origin and species from March 10 to July 9, 2021 is summarized in Table 2.3a (Coho), Table 2.3b (Chinook), Table 2.3c (Steelhead), and Table 2.3d (Cutthroat). Fork length (FL) distributions of Coho and Chinook are summarized in Table 2.3e, and in Table 2.3f for Steelhead and Cutthroat. Nearly all recaptures of fish larger than YOY fry were hatchery Coho, though a few naturally produced Coho, Chinook, Steelhead, and Cutthroat were recaptured. All YOY fry recaptured were naturally produced Chinook. Overall trap efficiency was significantly higher for fish <50mm in length compared to fish ≥50 mm. Therefore, weekly trap efficiency estimates were calculated separately for these two discrete size classes. Relatively few recaptured fish ≥50 mm were available to determine weekly trap efficiency. Therefore, trap efficiency by period (week) was calculated by pooling all hatchery and naturally produced Coho, Chinook and Steelhead. Cutthroat were not included in this pooling due to uncertainty of being actual downstream migrants. Similarly, all Coho, Chinook, and Steelhead <50 mm in length were pooled to estimate weekly trap efficiency for fry-sized fish.

Table 2.3a - Summary of Coho captured at the Lewis River Upper Golf Course Traps during 2021 by period.

Lewis River below Merwin Dam – Screw Traps 2021			Naturally Produced Coho								Hatchery Produced Coho				Ave. Weekly Flow (cfs)[a]	Ave. Weekly Cone RPMs Index[b]
			Maiden		Mark-Release Up		Recapture		Efficiency		Maiden	Mark-Release Up	Recapture	Efficiency		
Period	Start	End	<50mm	≥50mm	<50mm	≥50mm	<50mm	≥50mm	<50mm	≥50mm	≥50mm	≥50mm	≥50mm	≥50mm		
1	8-Mar	14-Mar	8	2		1									3,296	10.8
2	15-Mar	21-Mar	25	1		1									2,997	10.4
3	22-Mar	28-Mar	31	3		3									3,010	10.7
4	29-Mar	4-Apr	14	9		7					3,294	461	6	0.0130	4,186	8.9
5	5-Apr	11-Apr	17	7		7		1		0.1429	13,434	1,308	20	0.0153	3,074	9.1
6	12-Apr	18-Apr	7	7		7					1,226	772	5	0.0065	2,777	7.7
7	19-Apr	25-Apr	22	9	4	9		1		0.1111	1,107	769	6	0.0078	2,780	7.6
8	26-Apr	2-May	35	13	2	12					218	203	1	0.0049	2,780	7.3
9	3-May	9-May	89	39	2	38					233	221	1	0.0045	2,780	8.8
10	10-May	16-May	38	75		64					369	238			2,774	9.1
11	17-May	23-May	4	130		126					465	454	2	0.0044	2,773	7.9
12	24-May	30-May	1	75		51		1		0.0196	315	278			2,910	7.5
13	31-May	6-Jun	1	24		21					257	243			3,370	8.1
14	7-Jun	13-Jun	8	15		14		1		0.0714	206	193			2,886	8.3
15	14-Jun	20-Jun	1	8		6					133	110			3,107	7.5
16	21-Jun	27-Jun	1	6	1	5					64	45			2,811	7.8
17	28-Jun	4-Jul	2	4	1	2					29	10			2,611	6.6
18	5-Jul	11-Jul	4	9							9				2,356	4.6
Total:			308	436	10	374	0	4	NA	0.0107	21,359	5,305	41	0.0077		

[a]Note: USGS Lewis River at Ariel, WA (Gage No. 14220500).

[b]Note: Weekly average left cone RPMs plus weekly average of right cone RPMs.

Table 2.3b - Summary of Chinook captured at the Lewis River Upper Golf Course Traps during 2021 by period.

Lewis River below Merwin Dam – Screw Traps 2021			Naturally Produced Chinook								Hatchery Produced Chinook				Ave. Weekly Flow (cfs)[a]	Ave. Weekly Cone RPMs Index[b]
			Maiden		Mark-Release Up		Recapture		Efficiency		Maiden	Mark-Release Up	Recapture	Efficiency		
Period	Start	End	<50mm	≥50mm	<50mm	≥50mm	<50mm	≥50mm	<50mm	≥50mm	≥50mm	≥50mm	≥50mm	≥50mm		
1	8-Mar	14-Mar	6,672												3,296	10.8
2	15-Mar	21-Mar	18,181								22	22			2,997	10.4
3	22-Mar	28-Mar	32,529	1		1									3,010	10.7
4	29-Mar	4-Apr	21,389		1,000		30		0.0300						4,186	8.9
5	5-Apr	11-Apr	859[c]	1											3,074	9.1
6	12-Apr	18-Apr	18,442	4		3									2,777	7.7
7	19-Apr	25-Apr	30,408	1	1,000	1	56		0.0560						2,780	7.6
8	26-Apr	2-May	9,267	4	1,000		28		0.0280						2,780	7.3
9	3-May	9-May	11,455	7	998	6	44		0.0441						2,780	8.8
10	10-May	16-May	6,318	11		7									2,774	9.1
11	17-May	23-May	1,371	10		6									2,773	7.9
12	24-May	30-May	584	13		7					1	1			2,910	7.5
13	31-May	6-Jun	1,232	339		68									3,370	8.1
14	7-Jun	13-Jun	797	208		190		1		0.0053					2,886	8.3
15	14-Jun	20-Jun	1,376	293		239		2		0.0084					3,107	7.5
16	21-Jun	27-Jun	960	43	712	21	22		0.0309						2,811	7.8
17	28-Jun	4-Jul	473	33	70	13					1				2,611	6.6
18	5-Jul	11-Jul	177	98											2,356	4.6
Total:			162,490	1,066	4,780	562	180	3	0.0377	0.0053	24	23	NA	NA		

[a]Note: USGS Lewis River at Ariel, WA (Gage No. 14220500).

[b]Note: Weekly average left cone RPMs plus weekly average of right cone RPMs.

[c]Note: Predation of hatchery Coho smolts on Chinook fry within the trap box and/or within the river likely resulted in very low Chinook fry observed within the trap during week 5, which coincided with the peak of hatchery Coho smolt captures within the traps.

Table 2.3c - Summary of Steelhead at the Lewis River Upper Golf Course Traps during 2021 by period.

Lewis River below Merwin Dam – Screw Traps 2021			Naturally Produced Steelhead								Hatchery Produced Steelhead				Ave. Weekly Flow (cfs)[a]	Ave. Weekly Cone RPMs Index[b]
			Maiden		Mark-Release Up		Recapture		Efficiency		Maiden	Mark-Release Up	Recapture	Efficiency		
Period	Start	End	<50mm	≥50mm	<50mm	≥50mm	<50mm	≥50mm	<50mm	≥50mm	≥50mm	≥50mm	≥50mm	≥50mm		
1	8-Mar	14-Mar									1	1			3,296	10.8
2	15-Mar	21-Mar													2,997	10.4
3	22-Mar	28-Mar									1	1			3,010	10.7
4	29-Mar	4-Apr		3		3					1				4,186	8.9
5	5-Apr	11-Apr		3		3					2	1			3,074	9.1
6	12-Apr	18-Apr		4		4					10	8			2,777	7.7
7	19-Apr	25-Apr		8		8					13	13			2,780	7.6
8	26-Apr	2-May		11		11					11	11			2,780	7.3
9	3-May	9-May		29		29		1		0.0345	10	9			2,780	8.8
10	10-May	16-May		49		28		2		0.0714	982	518	5	0.0097	2,774	9.1
11	17-May	23-May		12		12					413	1[c]			2,773	7.9
12	24-May	30-May		8		7					88	9			2,910	7.5
13	31-May	6-Jun		14		13					34	32			3,370	8.1
14	7-Jun	13-Jun	4	5		5					26	26			2,886	8.3
15	14-Jun	20-Jun	86	3		2					5	4			3,107	7.5
16	21-Jun	27-Jun	183	1	98	1					2	2			2,811	7.8
17	28-Jun	4-Jul	157		33										2,611	6.6
18	5-Jul	11-Jul	167												2,356	4.6
Total:			597	150	131	126	0	3	NA	0.0238	1,599	636	5	0.0079		

[a]Note: USGS Lewis River at Ariel, WA (Gage No. 14220500).

[b]Note: Weekly average left cone RPMs plus weekly average of right cone RPMs.

[c]Note: Hatchery BWT Steelhead were avoided for marking as BWT Steelhead exhibited poor recovery after marking the prior week.

Table 2.3d - Summary of Cutthroat at the Lewis River Upper Golf Course Traps during 2021 by period.

Lewis River below Merwin Dam – Screw Traps 2021			Naturally Produced Cutthroat								Ave. Weekly Flow (cfs)[a]	Ave. Weekly Cone RPMs Index[b]
			Maiden		Mark-Release Up		Recapture		Efficiency			
Period	Start	End	<50mm	≥50mm	<50mm	≥50mm	<50mm	≥50mm	<50mm	≥50mm		
1	8-Mar	14-Mar									3,296	10.8
2	15-Mar	21-Mar									2,997	10.4
3	22-Mar	28-Mar		3		3					3,010	10.7
4	29-Mar	4-Apr		2		1					4,186	8.9
5	5-Apr	11-Apr		1							3,074	9.1
6	12-Apr	18-Apr		3		2					2,777	7.7
7	19-Apr	25-Apr		7		5					2,780	7.6
8	26-Apr	2-May		4		4					2,780	7.3
9	3-May	9-May		17		17					2,780	8.8
10	10-May	16-May		18		17					2,774	9.1
11	17-May	23-May		20		17		1		0.0588	2,773	7.9
12	24-May	30-May		16		15					2,910	7.5
13	31-May	6-Jun		8		8					3,370	8.1
14	7-Jun	13-Jun		5		5					2,886	8.3
15	14-Jun	20-Jun		7		6					3,107	7.5
16	21-Jun	27-Jun									2,811	7.8
17	28-Jun	4-Jul									2,611	6.6
18	5-Jul	11-Jul		1							2,356	4.6
Total:			0	112	0	100	0	1	NA	0.0100		

[a]Note: USGS Lewis River at Ariel, WA (Gage No. 14220500).

[b]Note: Weekly average left cone RPMs plus weekly average of right cone RPMs.

Table 2.3e - Summary of Coho and Chinook captured at the Lewis River Upper Golf Course Traps during 2021 by size class.

	Naturally Produced Coho				Hatchery Produced Coho				Naturally Produced Chinook				Hatchery Produced Chinook			
Fork Length Bin	Maiden	Mark/ Release Up	Recapture	Efficiency	Maiden	Mark/ Release Up	Recapture	Efficiency	Maiden	Mark/ Release Up	Recapture	Efficiency	Maiden	Mark/ Release Up	Recapture	Efficiency
20-29mm																
30-39mm	268	8							34,805	1,129	54	0.0478				
40-49mm	40	2							127,685	3,651	126	0.0345				
50-59mm	25	7							771	366	2	0.0055				
60-69mm	17	12			2				209	139	1	0.0072				
70-79mm	6	6			4	1			65	46						
80-89mm	6	5			8	8			16	9						
90-99mm	14	12			10	9			3	1						
100-109mm	40	36			37	37							1	1		
110-119mm	133	120	2	0.0167	263	258										
120-129mm	122	119	1	0.0084	818	797	3	0.0038					1	1		
130-139mm	43	38			2,157	1,512	13	0.0086					3	3		
140-149mm	13	10			16,736	1,578	13	0.0082					5	5		
150-159mm	14	6	1	0.1667	1,049	838	11	0.0131	1				3	3		
160-169mm	1	1			233	228	1	0.0044					4	4		
170-179mm	2	2			39	36			1	1			4	4		
180-189mm					3	3							3	2		
190-199mm																
200-249mm																
250-299mm																
Total	**744**	**384**	**4**	**0.0104**	**21,359**	**5,305**	**41**	**0.0077**	**163,556**	**5,342**	**183**	**0.0343**	**24**	**23**	**0**	**NA**
<50 mm	308	10	0	NA	0	0	0	NA	162,490	4,780	180	0.0377	0	0	0	NA
≥50mm	436	374	4	0.0107	21,359	5,305	41	0.0077	1,066	562	3	0.0053	24	23	0	NA

Table 2.3f - Summary of Steelhead and Cutthroat captured at the Lewis River Upper Golf Course Traps during 2021 by size class.

	Naturally Produced Steelhead				Hatchery Produced Steelhead				Naturally Produced Cutthroat			
Fork Length Bin	Maiden	Mark/ Release Up	Recapture	Efficiency	Maiden	Mark/ Release Up	Recapture	Efficiency	Maiden	Mark/ Release Up	Recapture	Efficiency
20-29mm	22	6										
30-39mm	490	125										
40-49mm	85											
50-59mm	1	1							1			
60-69mm												
70-79mm	1	1										
80-89mm	3	3										
90-99mm	4	4										
100-109mm	4	4			1	1			1	1		
110-119mm	4	4							1	1		
120-129mm	2	2			4	3			2	2		
130-139mm	4	4			4	4			2	2		
140-149mm	5	5	1	0.2000	7	7			2	2		
150-159mm	42	22	1	0.0455	740	32	1	0.0313	8	4		
160-169mm	22	22			61	61			16	16		
170-179mm	25	24	1	0.0417	217	149			22	22		
180-189mm	17	16			198	188	2	0.0106	25	22	1	0.0455
190-199mm	6	6			311	135	2	0.0148	9	8		
200-249mm	9	7			56	56			22	19		
250-299mm	1	1							1	1		
Total	**747**	**257**	**3**	**0.0117**	**1,599**	**636**	**5**	**0.0079**	**112**	**100**	**1**	**0.0100**
<50 mm	597	131	0	NA	0	0	0	NA	0	0	0	NA
≥50mm	150	126	3	0.0238	1,599	636	5	0.0079	112	100	1	0.0100

2.4 Age Results from Scale Data

Scale and age data were not collected. Age at length data are not available for this site. However, age at length data based on scale analysis for the Kalama River was reviewed to aid in assessing potential age-length brackets (WDFW 2019).

2.5 Data Collected to Evaluate Mark-Recapture Assumption that Marking the Fish Does Not Affect Behavior (e.g., Mark-Related Mortality) and that Marks Are Not Lost

Mark-recapture assumptions were not tested.

2.6 Data Collected to Evaluate Mark-Recapture Assumption that the Second Sample is a Random Representative sample (i.e., Marked and Unmarked Fish are Completely Mixed)

Mark-recapture assumptions were not tested.

2.7 Smolt Trapping Assumption Testing Summary

Trap Name: Lewis River Upper Golf Course Traps			
Species: All Salmonids	**Origin(s): All**	**Life Stage(s): All**	**Age Class(es): All**

Place "X"	**Method to test/satisfy assumption**	**Comments**

Closure - Population is geographically closed to immigration, emigration, births, and deaths.

Unknown	Minimized by trapping over entire run	
	Minimized predation by checking trap box multiple times per day	
	Tested optimal release location to minimize predation on fry	
	Test predation by lavaging Coho, steelhead, and cutthroat and enumerating marked and unmarked fry [fry migrants only]	
	Adjusted for missed trapping days	

*Assumption Met? (**Unknown**) Comments: Trapping is conducted from early March to the end of June as specified by PacifiCorp Contract.*

Marks are not lost

X	Minimized by following standard marking/tagging protocols with known mortality	
	Minimized by double tagging experiment	
	Tested by holding fish for 1-3 days to test mark/tag retention and adjusted marks released	
	Tested by double tagging experiment, estimated tag loss, and adjusted marks released	

*Assumption Met? (**Yes**) Comments: Marking follows standard procedures.*

Marking does not affect behavior

X	Minimized by using standard procedures for marking and only releasing healthy marked fish	
	Tested by holding marked fish overnight to assess mark related mortality; adjust mark release numbers accordingly	

*Assumption Met? (**Yes**) Comments: Marking follows standard procedures.*

Capture probabilities are homogeneous by strata

X	Minimized heterogeneous capture probability by stratifying the trap efficiency data	
X	Tested for differences in capture probabilities among trap efficiency trials	
X	Tested for differences in initial capture probability (e.g., due to body size)	

*Assumption Met? (**Yes**) Comments:*

Second Sample is random representative sample (i.e., marked and unmarked fish are completely mixed)

X	Maximize mixing by releasing fish upstream of sinuous reaches above trap site	
	Maximize mixing by releasing fish during the time of migration (e.g., night releases)	
	Tested optimum release site for mixing (consider statistical power to detect differences)	

*Assumption Met? (**Unknown**) Comments: Typical recapture rates preclude statistical testing of release sites.*

Mark status is reported correctly

X	Minimized error through staff training and careful examination of all fish	
X	Minimize error associated with subsampling high catch numbers by obtaining a representative subsample for evaluating mark status	All fish are examined, no subsampling occurs
	Tested by having samplers counting known numbers of marked and unmarked fish mixed in a bin	
	Tested by having a second sampler check first samplers placement of fish into marked and unmarked bins	

*Assumption Met? (**Yes**) Comments:*

2.8 Graphical presentation of catch, trap efficiency, and flow

As discussed previously, because relatively few fish were available to determine mark-recapture rates, trap efficiency by period (week) was calculated by pooling all Coho, Chinook, and Steelhead separately for two size classes, <50mm FL and ≥50mm FL. A regression analysis was conducted comparing the weekly trap cone RPMs index to weekly trap efficiency based on mark-recapture tests for fish <50mm FL and ≥50mm FL. For fish ≥50mm FL, there is a positive relationship between these two parameters. Minimum and maximum trap efficiency values were added to the regression to force asymptotes at each end of the sigmoid curve to bound the likely range of potential trap efficiency at the site. As not all weekly periods had recaptured fish to estimate trap efficiency, the regression equation was used to estimate trap efficiency on a weekly basis for fish ≥50mm FL. There was no apparent relationship with stream flow or RPMs and trap efficiency for fish <50mm FL; however, the individual weekly values of trap efficiency were relatively similar. Therefore, the pooled seasonal trap efficiency was applied to each week for fish <50mm FL. These weekly trap efficiency estimates were applied to the total maiden catch to estimate the total number of fish passing the trap for each salmonid species by age class. Age class/brood-year size class brackets were determined by assessing the seasonal length distribution patterns over time. Kalama River age at length data was also reviewed to aid in assessing potential age-length brackets (WDFW 2019); note the Kalama River is the adjacent river basin to the north of the Lewis River.

Length frequency is presented in Figures 2.8a (Coho), 2.8b (Chinook) and 2.8c (Steelhead and Cutthroat). Scatter plots of the fork lengths of all fish caught each day and average daily flow are presented in Figures 2.8d (Coho), 2.8e (Chinook), 2.8f (Steelhead) and 2.8g (Cutthroat). The size class demarcations used to infer age classes for naturally produced salmonids are depicted on each of the length scatter plots of each species. The regression equation used to estimate weekly trap efficiency for salmonids ≥50mm FL is presented in Figure 2.8h. The pooled weekly mark-recapture data and weekly trap efficiencies applied are summarized in Table 2.8a. The migration timing (estimated total number of fish passing the trap on a weekly basis for each salmonid species by inferred age class) is depicted in Figures 2.8i (salmon species) and 2.8j (trout species). Note that migration timing is not presented for naturally produced Chinook (1+ age class) and Cutthroat (0+ age class) as only two Chinook and one Cutthroat were captured within these age classes. Estimates of total fish passing the trap during the monitoring period for each naturally produced salmonid species are presented in Section 3.

It is important to note that the timing of naturally produced Chinook fry (0+ age class) captures, as depicted in Figure 2.8i, is likely affected by the timing of hatchery Coho smolt captures, which peaked during the week of April 5. During this week, thousands of hatchery Coho smolts were captured each day within the traps, with very few Chinook fry present. Limited examination of gut contents of hatchery Coho smolts suggests substantial predation on Chinook fry during this week (16 Chinook fry in one stomach sample, see Photo 2.8.a). It is unknown if predation was primarily occurring within the river at large or just within the trap boxes.

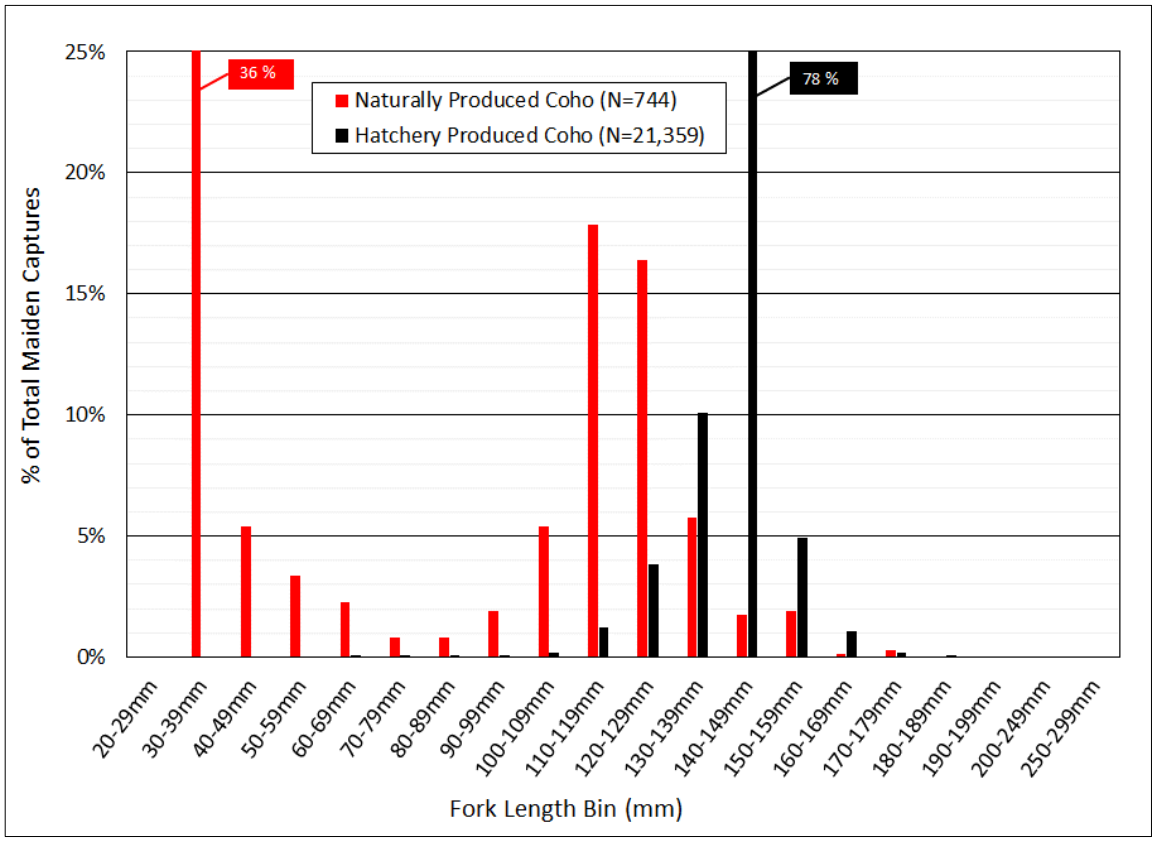


Figure 2.8a - Length frequency of all Coho maiden catch.

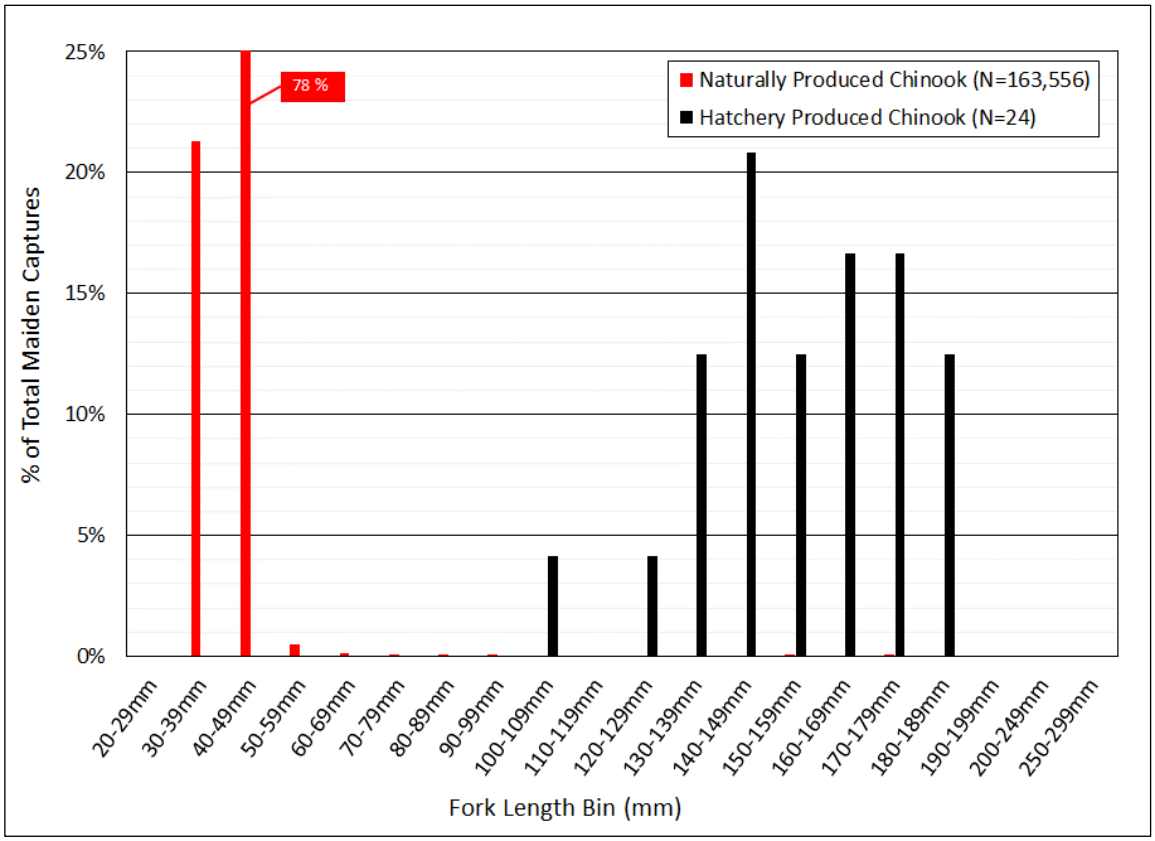


Figure 2.8b - Length frequency of all Chinook maiden catch.

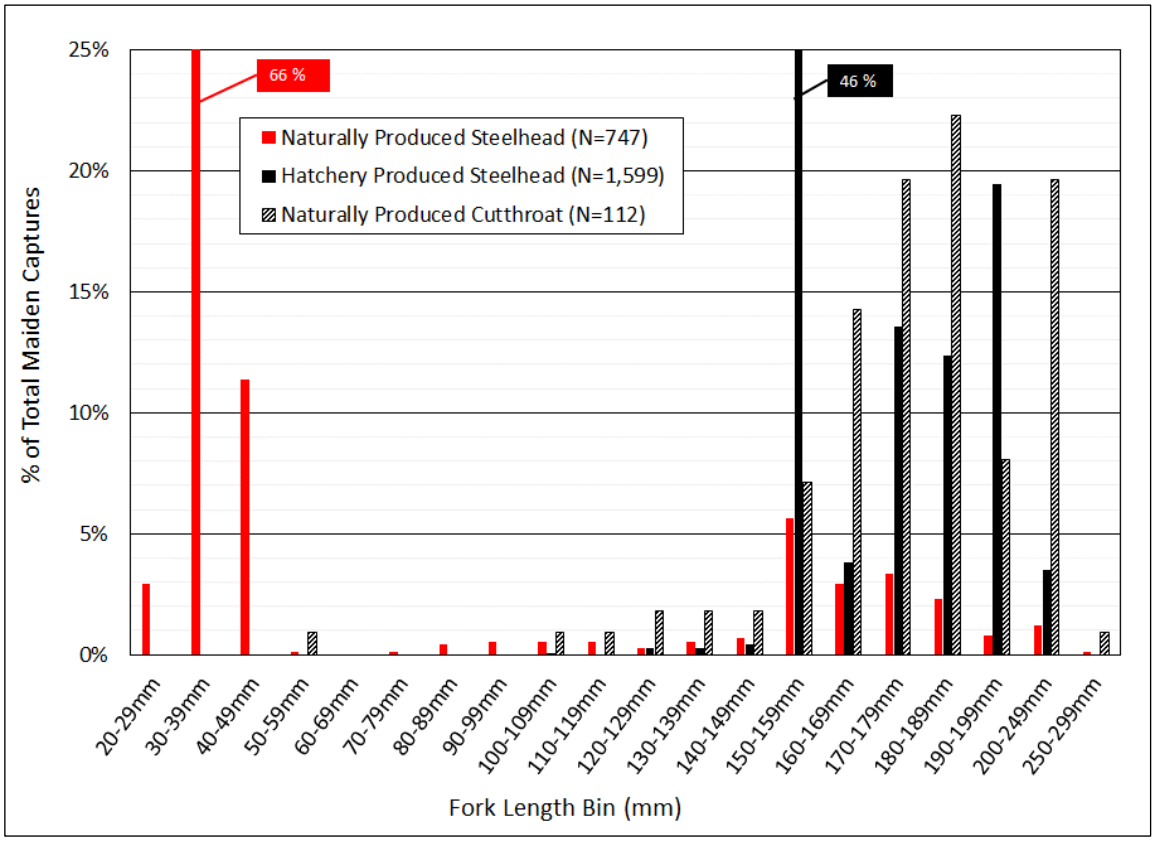
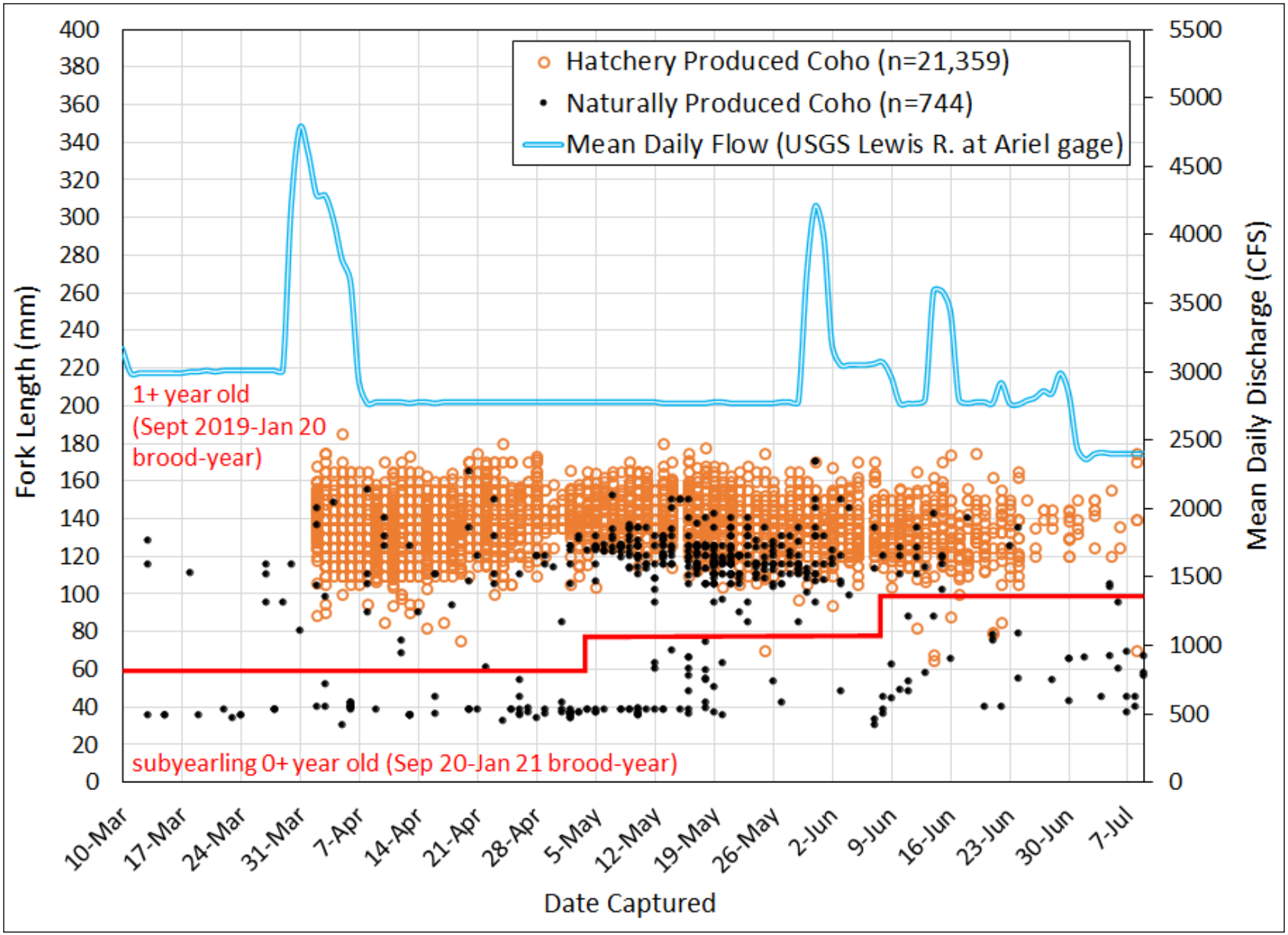
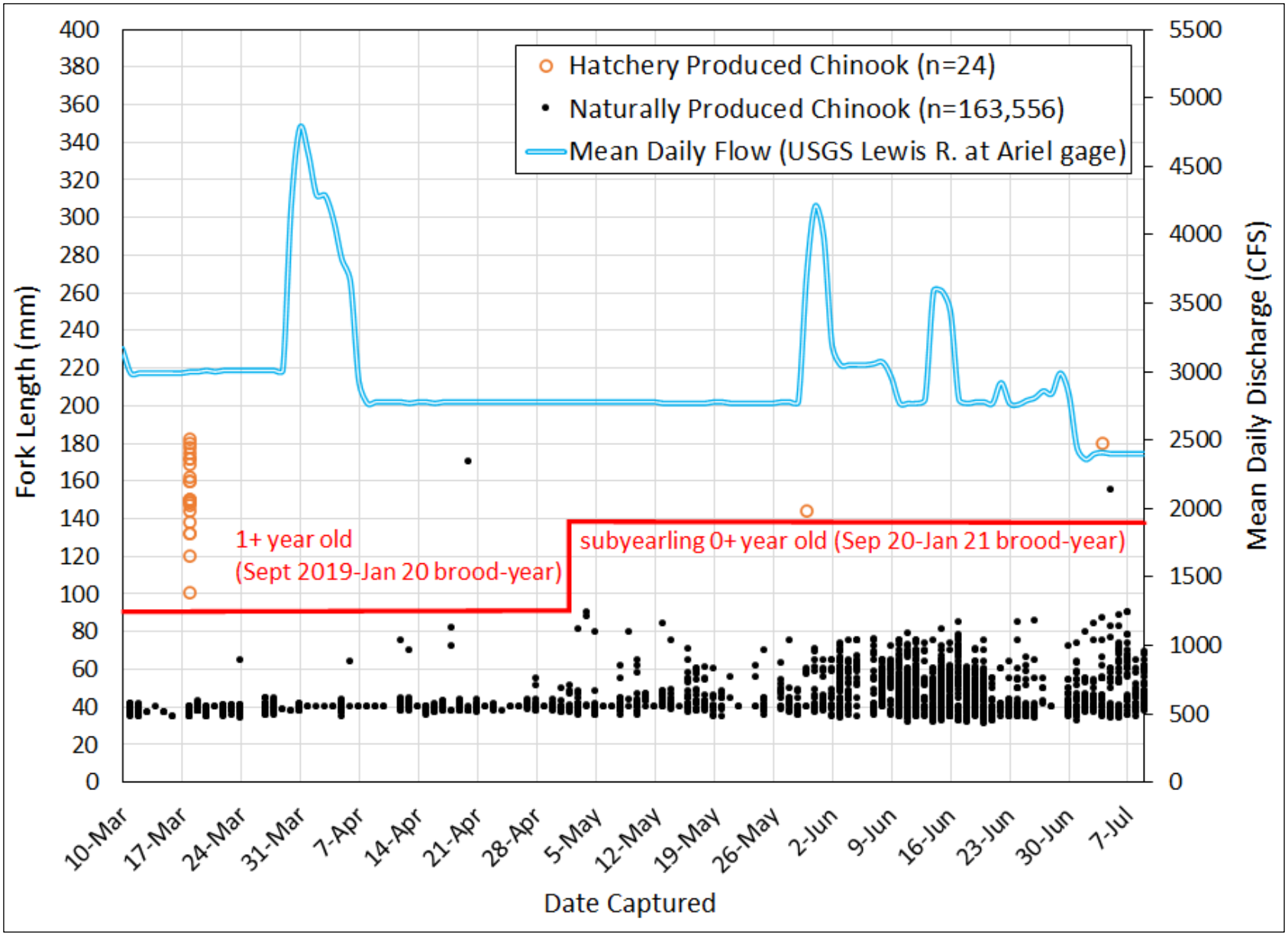


Figure 2.8c - Length frequency of all Steelhead and Cutthroat trout maiden catch



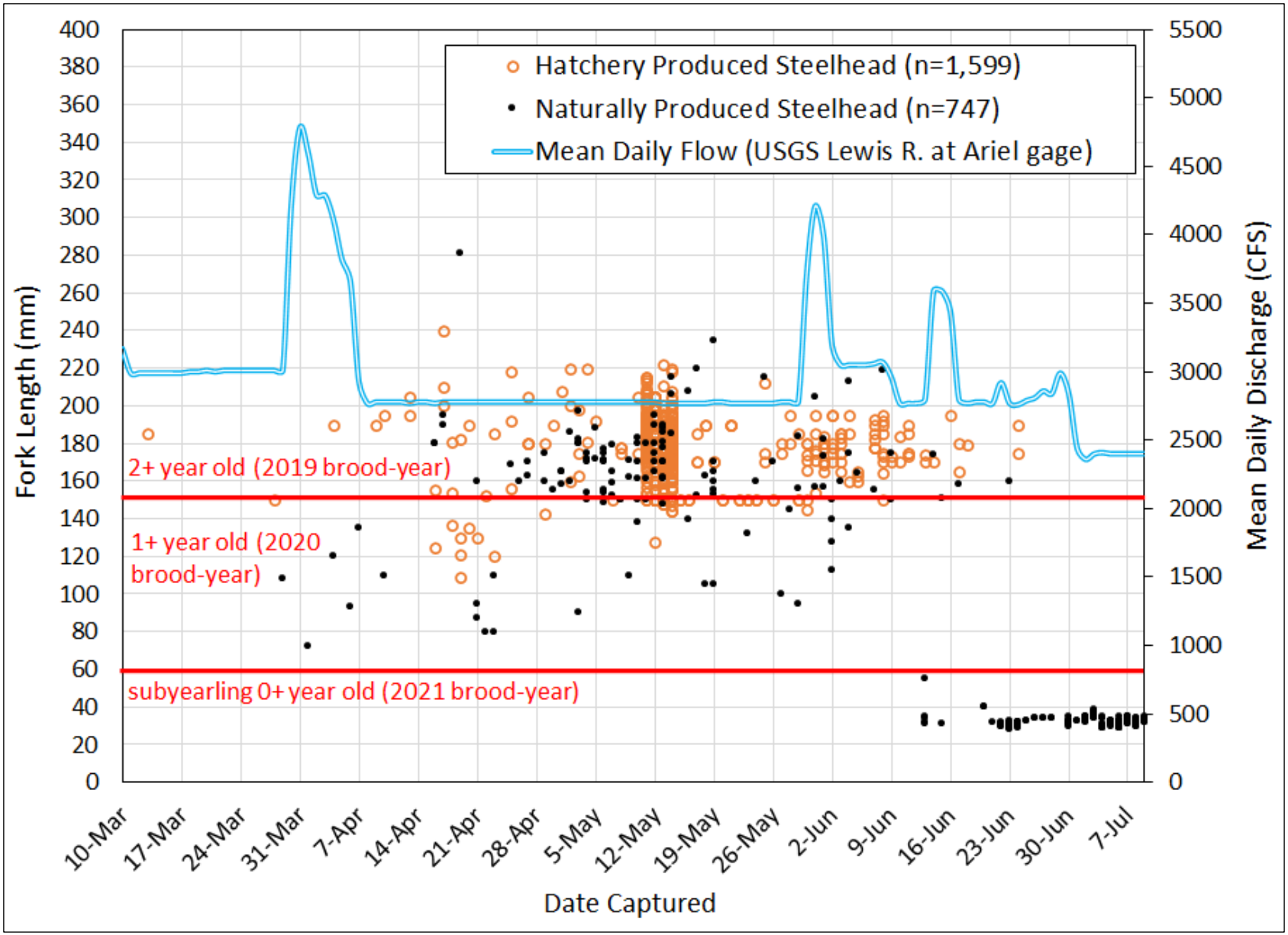
Note: The red line splits naturally produced Coho into two age classes/brood-years (subyearlings/0+ and yearlings/1+).

Figure 2.8d - Fork lengths of all Coho maiden catch and flow by day in 2021.



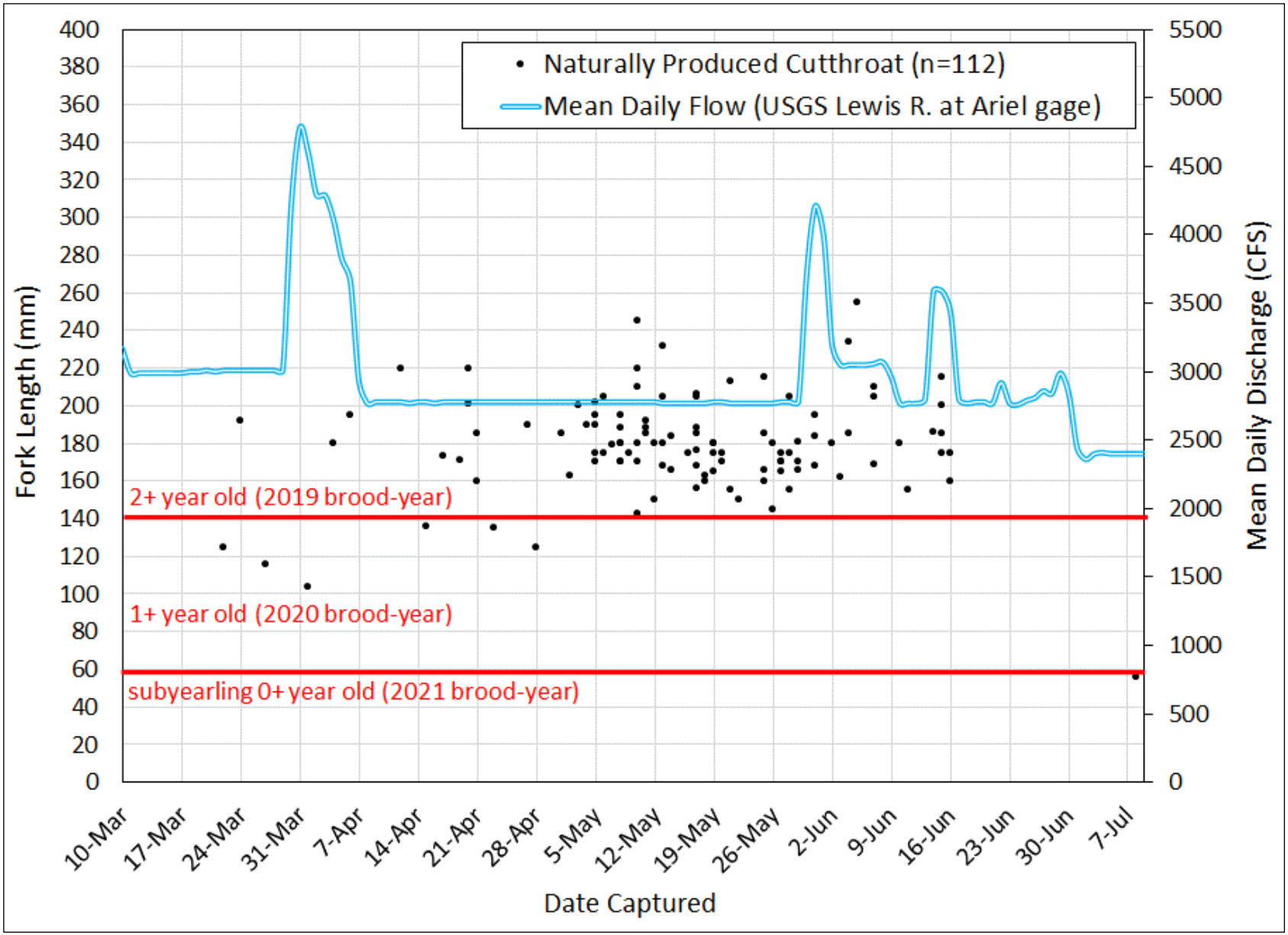
Note: The red line splits naturally produced Chinook into two age classes/brood-years.

Figure 2.8e - Fork lengths of all Chinook maiden catch and flow by day in 2021.



Note: The red lines bracket the age classes/brood-years for naturally produced Steelhead.

Figure 2.8f - Fork lengths of all Steelhead maiden catch and flow by day in 2021.



Note: The red lines bracket the age classes/brood-years for naturally produced Cutthroat.

Figure 2.8g - Fork lengths of all Cutthroat maiden catch and flow by day in 2021.

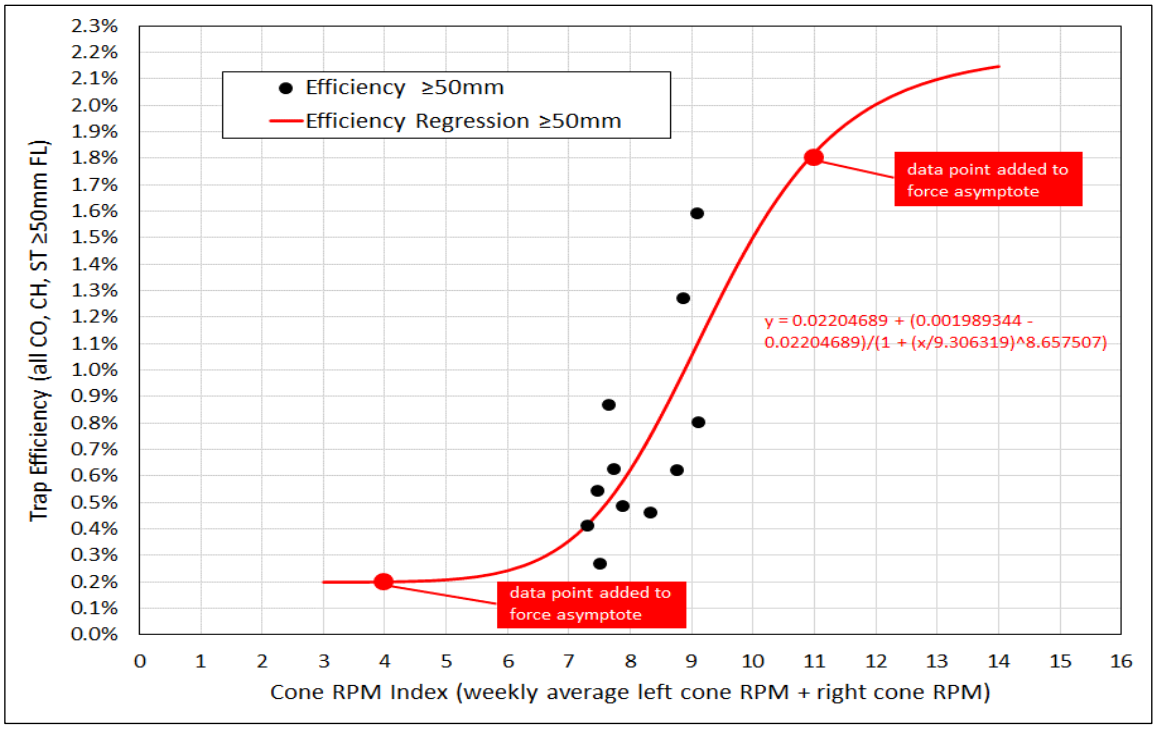


Figure 2.8h - Weekly trap cone RPM index and trap efficiency (fish ≥50 mm FL) regression.

Table 2.8a - Weekly pooled mark-recaptured and regression analysis estimates of trap efficiency.

Lewis River Upper Golf Course Screw Traps 2021			All Natural and Hatchery Coho, Chinook, and Steelhead Combined								Ave. Weekly Flow (cfs)[a]	Ave. Weekly Cone RPMs Index[b]	Regression Predicted Efficiency ≥50mm
			Maiden		Mark-Release Up		Recapture		Efficiency				
Period	Start	End	<50mm	≥50mm	<50mm	≥50mm	<50mm	≥50mm	<50mm	≥50mm			
1	8-Mar	14-Mar	6,680	3	0	2	0	0			3,296	10.8	0.0176
2	15-Mar	21-Mar	18,206	23	0	23	0	0			2,997	10.4	0.0164
3	22-Mar	28-Mar	32,560	5	0	5	0	0			3,010	10.7	0.0175
4	29-Mar	4-Apr	21,403	3,307	1,000	471	30	6	0.0300	0.0127	4,186	8.9	0.0099
5	5-Apr	11-Apr	876	13,447	0	1,319	0	21		0.0159	3,074	9.1	0.0109
6	12-Apr	18-Apr	18,449	1,251	0	794	0	5		0.0063	2,777	7.7	0.0053
7	19-Apr	25-Apr	30,430	1,138	1,004	800	56	7	0.0558	0.0088	2,780	7.6	0.0051
8	26-Apr	2-May	9,302	257	1,002	237	28	1	0.0279	0.0042	2,780	7.3	0.0041
9	3-May	9-May	11,544	318	1,000	303	44	2	0.0440	0.0066	2,780	8.8	0.0094
10	10-May	16-May	6,356	1,486	0	855	0	7		0.0082	2,774	9.1	0.0111
11	17-May	23-May	1,375	1,030	0	599	0	2		0.0033	2,773	7.9	0.0058
12	24-May	30-May	585	500	0	353	0	1		0.0028	2,910	7.5	0.0047
13	31-May	6-Jun	1,233	668	0	377	0	0			3,370	8.1	0.0068
14	7-Jun	13-Jun	809	460	0	428	0	2		0.0047	2,886	8.3	0.0075
15	14-Jun	20-Jun	1,463	442	0	361	0	2		0.0055	3,107	7.5	0.0046
16	21-Jun	27-Jun	1,144	116	811	74	22	0	0.0271		2,811	7.8	0.0056
17	28-Jun	4-Jul	632	67	104	25	0	0			2,611	6.6	0.0029
18	5-Jul	11-Jul	348	116	0	0	0	0			2,356	4.6	0.0020
Total:			163,395	24,634	4,921	7,026	180	56	0.0366	0.0080			

[a]Note: USGS Lewis River at Ariel, WA (Gage No. 14220500).

[b]Note: Weekly average left cone RPMs plus weekly average of right cone RPMs.

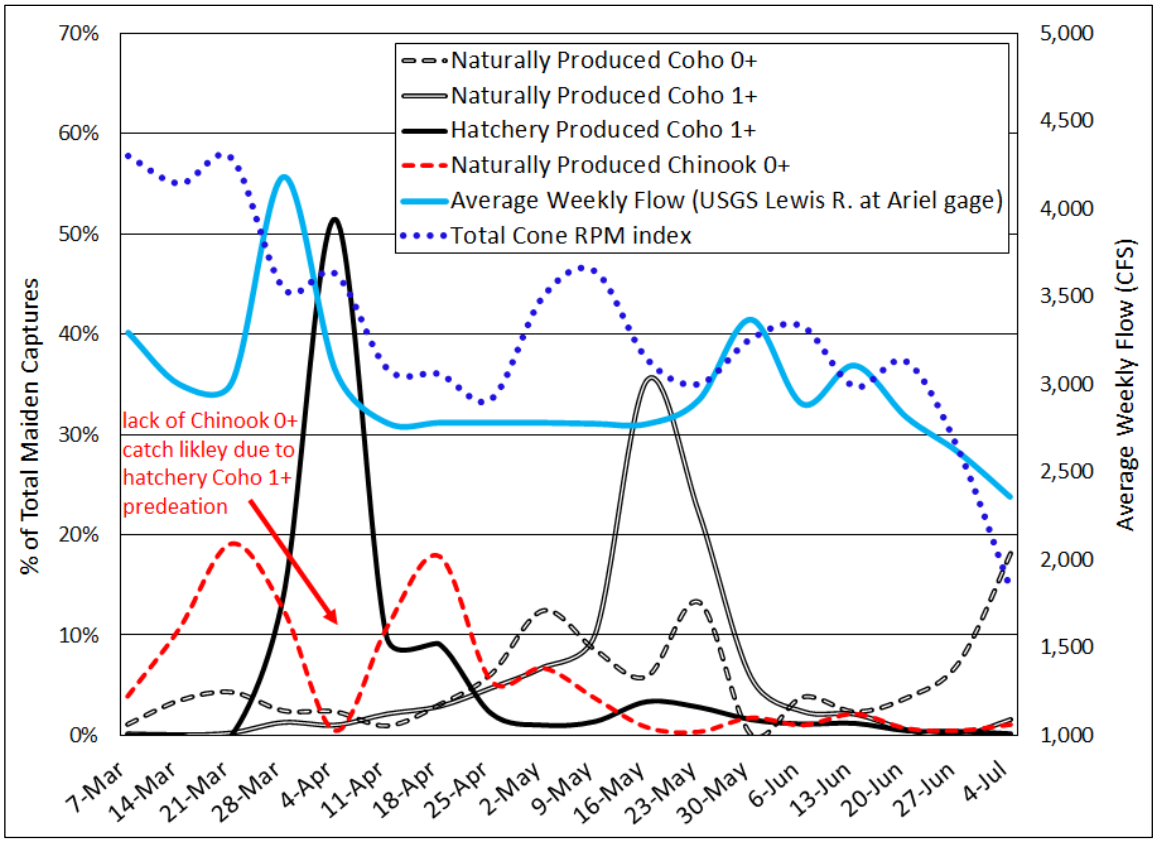


Figure 2.8i - Percent of estimated total salmon species passing the trap by age class.

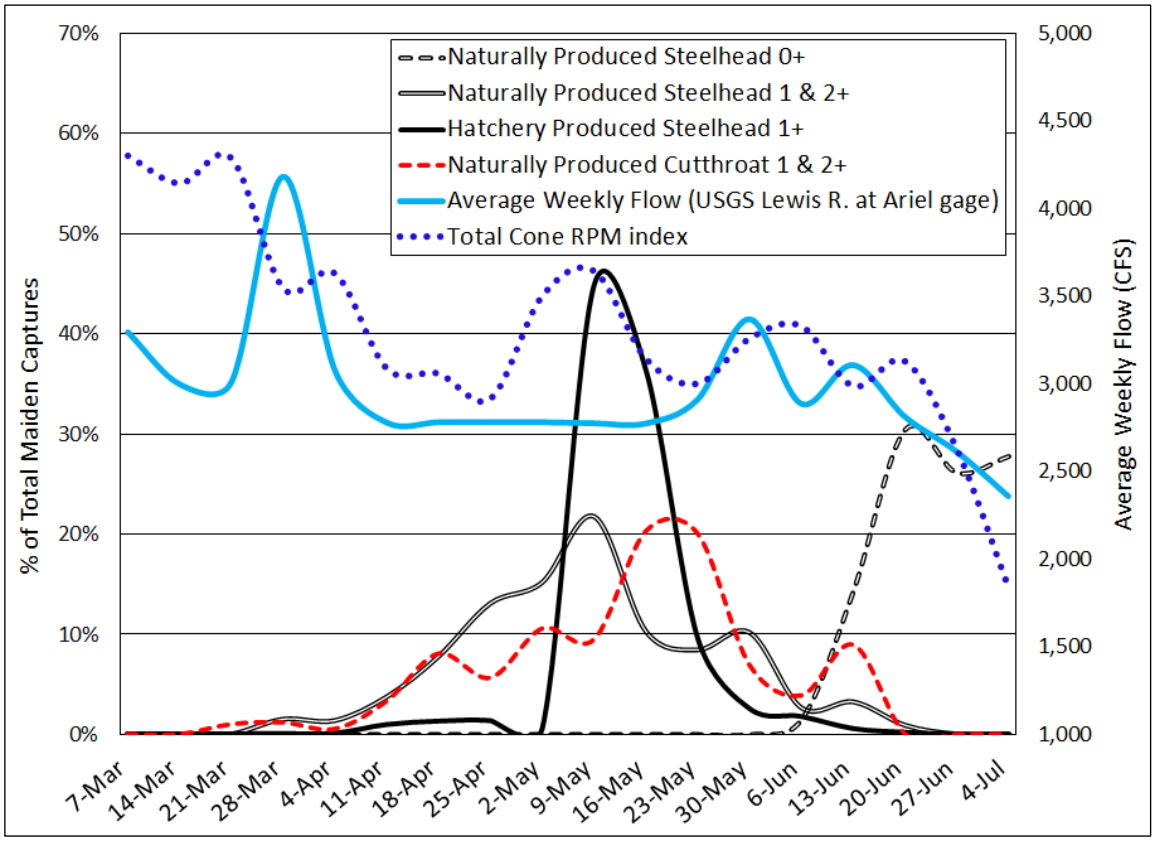


Figure 2.8j - Percent of estimated total trout species passing the trap by age class.

Figure 2.8a - Example of hatchery Coho smolt predation on Chinook fry (week of April 5, 2021).

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Part 3: ANALYSIS AND RESULTS

3.1 Description of changes made to raw Capture-Mark-Recapture Data (Tables 2.3a and 2.3b) prior to generating the final Capture-Mark-Recapture Data (Tables under 3.2). Add additional bullets as needed.		
• *Were capture, mark, and/or recapture data from multiple trapping periods combined (i.e., pooled)?*	Yes	All hatchery and naturally produced Coho, Chinook and Steelhead were pooled at two different size classes (<50mm FL and ≥50mm FL)
• *Were capture, mark, and/or recapture data from an entire period omitted prior to or as part of the analysis?*	No	
• *Were capture, mark, and/or recapture data from a single day or multiple days with a period or periods omitted?*	No	
• *Describe any additional changes that were made to the raw data set prior to generating the final data set*	None	

3.2 Final Data Summary for Mark-Recapture Analysis

Total estimates of naturally produced juvenile Coho, Chinook, Steelhead, and Cutthroat passing the trap by inferred age class/brood-year (based on size) and the associated 95% confidence intervals (CI) were generated using the Bootstrap Method (Thedinga et al. 1994, Manly 2007, Efron and Tibshirani 1986). The trap efficiency used to make these estimates for each species/age class combination was based on the total pooled mark-recapture data corresponding to the total time when each species' age class was captured. Trap efficiency was significantly higher for fish <50mm in length compared to fish ≥50 mm. Therefore, individual estimates of the total number of fish <50mm FL and ≥50mm FL were made then summed to estimate the total number of fish passing the traps for the age 0+ bracket where fish smaller and larger than 50 mm FL were captured over the trapping season. Relatively few fish ≥50 mm were recaptured. Therefore, trap efficiency was calculated by pooling all hatchery and naturally produced Coho, Chinook and Steelhead. Cutthroat were not included in this pooling due to uncertainty of being actual downstream migrants. Similarly, all Coho, Chinook, and Steelhead <50 mm in length were pooled to estimate weekly trap efficiency for fry-sized fish.

The data used to generate the Bootstrap estimates for each species inferred age class are summarized in Tables 3.2a through 3.2j below. The data in these tables is presented in the Bayesian Time-Stratified Population Analysis (BTSPAS) model format for informational purposes. Note that all recaptured fish were recaptured within "Period 0", which is defined as the same week as initially marked and released upstream. Note that following the JMX Protocol, fish recaptured with the same mark-type one day after the release week ends are assigned to being recaptured in Period 0. If a fish were to be recaptured more than one day after the release week ends, then it would be assigned to Period 1, Period 2, etc. based on actual recapture date compared to when that specific mark-type batch was released. As all recaptured fish were assigned to Period 0, the data in tables 3.2a through 3.2j are in the BTSPAS diagonal format. Note that non-diagonal format would be applied if some recaptured fish were encountered latter in time than Period 0 after initial release.

Table 3.2a - Final capture-mark-recapture data used to estimate total naturally produced Coho (age 0+).

Trap Name: Lewis River Upper Golf Course Traps	**Species:** Coho	**Origin:** Naturally Produced	**Age Class/Brood Year:** 0+ / Sep 2020-Jan 2021

Analysis: Bootstrap (listed below in BTSPAS diagonal format for informational purposes)

			[c]**Life Stage & Size Classes by Period:** Fry <50mm (Periods 1 to 18)						[c]**Life Stage & Size Classes by Period:** Parr, Transitional, Smolt 50 to 59mm (Periods 1 to 8) 50 to 79mm (Periods 9 to 13) 50 to 99mm (Periods 14 to 18)					
Period	**Period Start Date**	**Period End Date**	**Total Marked**	**Mark Group[a]**	**Period 0 Recaps**	**Total Recaps**	**Total Maiden Capture**	**Prop Fished**	**Total Marked**	**Mark Group[b]**	**Period 0 Recaps**	**Total Recaps**	**Total Maiden Captured**	**Prop Fished**
1	8-Mar	14-Mar	0	M, S	0	0	8	1					0	1
2	15-Mar	21-Mar	0	M, S	0	0	25	1					0	1
3	22-Mar	28-Mar	0	M, S	0	0	31	1					0	1
4	29-Mar	4-Apr	1,000	M, S	30	30	14	1	471	M, S	6	6	1	1
5	5-Apr	11-Apr	0	M, S	0	0	17	1	1,319	M, S	21	21	0	1
6	12-Apr	18-Apr	0	M, S	0	0	7	1	794	M, S	5	5	0	1
7	19-Apr	25-Apr	1,004	M, S	56	56	22	1	800	M, S	7	7	0	1
8	26-Apr	2-May	1,002	M, S	28	28	35	1	237	M, S	1	1	1	1
9	3-May	9-May	1,000	M, S	44	44	89	1	303	M, S	2	2	0	1
10	10-May	16-May	0	M, S	0	0	38	1	855	M, S	7	7	7	1
11	17-May	23-May	0	M, S	0	0	4	1	599	M, S	2	2	6	1
12	24-May	30-May	0	M, S	0	0	1	1	353	M, S	1	1	12	1
13	31-May	6-Jun	0	M, S	0	0	1	1	377	M, S	0	0	0	1
14	7-Jun	13-Jun	0	M, S	0	0	8	1	428	M, S	2	2	4	1
15	14-Jun	20-Jun	0	M, S	0	0	1	1	361	M, S	2	2	2	1
16	21-Jun	27-Jun	811	M, S	22	22	1	1	74	M, S	0	0	4	1
17	28-Jun	4-Jul	104	M, S	0	0	2	1	25	M, S	0	0	4	1
18	5-Jul	11-Jul	0	M, S	0	0	4	1	0	M, S	0	0	7	1
		Total:	4,921		180	180	308		6,996		56	56	48	

[a]Note: Mark Group for all periods = all marked Coho, Chinook and Steelhead <50mm FL combined.

[b]Note: Mark Group for all periods = all marked Coho, Chinook and Steelhead ≥50mm FL combined.

[c]Note: Same as inferred age backets based on size class as depicted in Figure 2.8d for Coho.

Table 3.2b - Final capture-mark-recapture data used to estimate total naturally produced Coho (age 1+).

Trap Name: Lewis River Upper Golf Course Traps			**Species:** Coho			**Origin:** Naturally Produced		
Age Class / Brood Year: 1+ / Sep 2019-Jan 2020								
Analysis: Bootstrap (listed below in BTSPAS diagonal format for informational purposes)								
			[b]**Life Stage & Size Classes by Period:** Parr, Transitional, Smolt 60 to 179mm (Periods 1 to 8) 80 to 179mm (Periods 9 to 13) 100 to 179mm (Periods 14 to 18)					
Period	**Period Start Date**	**Period End Date**	**Total Marked**	**Mark Group[a]**	**Period 0 Recaps**	**Total Recaps**	**Total Maiden Captured**	**Prop Fished**
1	8-Mar	14-Mar	2	M, S	0	0	2	1
2	15-Mar	21-Mar	23	M, S	0	0	1	1
3	22-Mar	28-Mar	5	M, S	0	0	3	1
4	29-Mar	4-Apr	471	M, S	6	6	8	1
5	5-Apr	11-Apr	1,319	M, S	21	21	7	1
6	12-Apr	18-Apr	794	M, S	5	5	7	1
7	19-Apr	25-Apr	800	M, S	7	7	9	1
8	26-Apr	2-May	237	M, S	1	1	12	1
9	3-May	9-May	303	M, S	2	2	39	1
10	10-May	16-May	855	M, S	7	7	68	1
11	17-May	23-May	599	M, S	2	2	124	1
12	24-May	30-May	353	M, S	1	1	63	1
13	31-May	6-Jun	377	M, S	0	0	24	1
14	7-Jun	13-Jun	428	M, S	2	2	11	1
15	14-Jun	20-Jun	361	M, S	2	2	6	1
16	21-Jun	27-Jun	74	M, S	0	0	2	1
17	28-Jun	4-Jul	25	M, S	0	0	0	1
18	5-Jul	11-Jul	0	M, S	0	0	2	1
		Total:	7,026		56	56	388	

[a]Note: Mark Group for all periods = all marked Coho, Chinook and Steelhead ≥50mm FL combined.

[b]Note: Same as inferred age backets based on size class as depicted in Figure 2.8d for Coho.

Table 3.2c - Final capture-mark-recapture data used to estimate total naturally produced Chinook (age 0+).

Trap Name: Lewis River Upper Golf Course Traps	**Species:** Chinook	**Origin:** Naturally Produced	**Age Class/Brood Year:** 0+ / Sep-Dec 2020

Analysis: Bootstrap (listed below in BTSPAS diagonal format for informational purposes)

			[c]**Life Stage & Size Classes by Period:** Fry <50mm (Periods 1 to 18)						[c]**Life Stage & Size Classes by Period:** Parr, Transitional, Smolt 50 to 89mm (Periods 1 to 8) 50 to 139mm (Periods 9 to 18)					
Period	**Period Start Date**	**Period End Date**	**Total Marked**	**Mark Group[a]**	**Period 0 Recaps**	**Total Recaps**	**Total Maiden Capture**	**Prop Fished**	**Total Marked**	**Mark Group[b]**	**Period 0 Recaps**	**Total Recaps**	**Total Maiden Captured**	**Prop Fished**
1	8-Mar	14-Mar	0	M, S	0	0	6,672	1					0	1
2	15-Mar	21-Mar	0	M, S	0	0	18,181	1					0	1
3	22-Mar	28-Mar	0	M, S	0	0	32,529	1	5	M, S	0	0	1	1
4	29-Mar	4-Apr	1,000	M, S	30	30	21,389	1	471	M, S	6	6	0	1
5	5-Apr	11-Apr	0	M, S	0	0	859	1	1,319	M, S	21	21	1	1
6	12-Apr	18-Apr	0	M, S	0	0	18,442	1	794	M, S	5	5	4	1
7	19-Apr	25-Apr	1,004	M, S	56	56	30,408	1	800	M, S	7	7	0	1
8	26-Apr	2-May	1,002	M, S	28	28	9,267	1	237	M, S	1	1	4	1
9	3-May	9-May	1,000	M, S	44	44	11,455	1	303	M, S	2	2	7	1
10	10-May	16-May	0	M, S	0	0	6,318	1	855	M, S	7	7	11	1
11	17-May	23-May	0	M, S	0	0	1,371	1	599	M, S	2	2	10	1
12	24-May	30-May	0	M, S	0	0	584	1	353	M, S	1	1	13	1
13	31-May	6-Jun	0	M, S	0	0	1,232	1	377	M, S	0	0	339	1
14	7-Jun	13-Jun	0	M, S	0	0	797	1	428	M, S	2	2	208	1
15	14-Jun	20-Jun	0	M, S	0	0	1,376	1	361	M, S	2	2	293	1
16	21-Jun	27-Jun	811	M, S	22	22	960	1	74	M, S	0	0	43	1
17	28-Jun	4-Jul	104	M, S	0	0	473	1	25	M, S	0	0	33	1
18	5-Jul	11-Jul	0	M, S	0	0	177	1	0	M, S	0	0	97	1
		Total:	4,921		180	180	162,490		5,001		56	56	1,640	

[a]Note: Mark Group for all periods = all marked Coho, Chinook and Steelhead <50mm FL combined.
[b]Note: Mark Group for all periods = all marked Coho, Chinook and Steelhead ≥50mm FL combined.
[c]Note: Same as inferred age backets based on size class as depicted in Figure 2.8e for Chinook.

Table 3.2d - Final capture-mark-recapture data used to estimate total naturally produced Chinook (age 1+).

Trap Name: Lewis River Upper Golf Course Traps			**Species:** Chinook			**Origin:** Naturally Produced		
Age Class / Brood Year: 1+ / Sep 2019-Jan 2020								
Analysis: Bootstrap (listed below in BTSPAS diagonal format for informational purposes)								
			[b]**Life Stage & Size Classes by Period:** Parr, Transitional, Smolt 90 to 179mm (Periods 1 to 8) 140 to 179mm (Periods 9 to 18)					
Period	**Period Start Date**	**Period End Date**	**Total Marked**	**Mark Group[a]**	**Period 0 Recaps**	**Total Recaps**	**Total Maiden Captured**	**Prop Fished**
1	8-Mar	14-Mar					0	1
2	15-Mar	21-Mar					0	1
3	22-Mar	28-Mar					0	1
4	29-Mar	4-Apr					0	1
5	5-Apr	11-Apr					0	1
6	12-Apr	18-Apr					0	1
7	19-Apr	25-Apr	800	M, S	7	7	1	1
8	26-Apr	2-May	237	M, S	1	1	0	1
9	3-May	9-May	303	M, S	2	2	0	1
10	10-May	16-May	855	M, S	7	7	0	1
11	17-May	23-May	599	M, S	2	2	0	1
12	24-May	30-May	353	M, S	1	1	0	1
13	31-May	6-Jun	377	M, S	0	0	0	1
14	7-Jun	13-Jun	428	M, S	2	2	0	1
15	14-Jun	20-Jun	361	M, S	2	2	0	1
16	21-Jun	27-Jun	74	M, S	0	0	0	1
17	28-Jun	4-Jul	25	M, S	0	0	0	1
18	5-Jul	11-Jul	0	M, S	0	0	1	1
		Total:	4,412		24	24	2	

[a]Note: Mark Group for all periods = all marked Coho, Chinook and Steelhead ≥50mm FL combined.
[b]Note: Same as inferred age backets based on size class as depicted in Figure 2.8e for Chinook.

Table 3.2e - Final capture-mark-recapture data used to estimate total naturally produced Steelhead (age 0+).

Trap Name: Lewis River Upper Golf Course Traps	**Species:** Steelhead	**Origin:** Naturally Produced	**Age Class/Brood Year:** 0+ / 2021

Analysis: Bootstrap (listed below in BTSPAS diagonal format for informational purposes)

			[c]**Life Stage & Size Classes by Period:** Fry <50mm (Periods 1 to 18)						[c]**Life Stage & Size Classes by Period:** Parr 50 to 59mm (Periods 1 to 18)					
Period	**Period Start Date**	**Period End Date**	**Total Marked**	**Mark Group[a]**	**Period 0 Recaps**	**Total Recaps**	**Total Maiden Capture**	**Prop Fished**	**Total Marked**	**Mark Group[b]**	**Period 0 Recaps**	**Total Recaps**	**Total Maiden Captured**	**Prop Fished**
1	8-Mar	14-Mar					0	1					0	1
2	15-Mar	21-Mar					0	1					0	1
3	22-Mar	28-Mar					0	1					0	1
4	29-Mar	4-Apr					0	1					0	1
5	5-Apr	11-Apr					0	1					0	1
6	12-Apr	18-Apr					0	1					0	1
7	19-Apr	25-Apr					0	1					0	1
8	26-Apr	2-May					0	1					0	1
9	3-May	9-May					0	1					0	1
10	10-May	16-May					0	1					0	1
11	17-May	23-May					0	1					0	1
12	24-May	30-May					0	1					0	1
13	31-May	6-Jun					0	1					0	1
14	7-Jun	13-Jun	0	M, S	0	0	4	1	428	M, S	2	2	1	1
15	14-Jun	20-Jun	0	M, S	0	0	86	1	361	M, S	2	2	0	1
16	21-Jun	27-Jun	811	M, S	22	22	183	1	74	M, S	0	0	0	1
17	28-Jun	4-Jul	104	M, S	0	0	157	1	25	M, S	0	0	0	1
18	5-Jul	11-Jul	0	M, S	0	0	167	1	0	M, S	0	0	0	1
		Total:	915		22	22	597		888		4	4	1	

[a]Note: Mark Group for all periods = all marked Coho, Chinook and Steelhead <50mm FL combined.

[b]Note: Mark Group for all periods = all marked Coho, Chinook and Steelhead ≥50mm FL combined.

[c]Note: Same as inferred age backets based on size class as depicted in Figure 2.8f for Steelhead.

Table 3.2f - Final capture-mark-recapture data used to estimate total naturally produced Steelhead (age 1+).

Trap Name: Lewis River Upper Golf Course Traps			**Species:** Steelhead			**Origin:** Naturally Produced		
Age Class / Brood Year: 1+ / 2020								
Analysis: Bootstrap (listed below in BTSPAS diagonal format for informational purposes)								
			[b]**Life Stage & Size Classes by Period:** Parr, Transitional, Smolt 60 to 149mm (Periods 1 to 18)					
Period	**Period Start Date**	**Period End Date**	**Total Marked**	**Mark Group[a]**	**Period 0 Recaps**	**Total Recaps**	**Total Maiden Captured**	**Prop Fished**
1	8-Mar	14-Mar					0	1
2	15-Mar	21-Mar					0	1
3	22-Mar	28-Mar					0	1
4	29-Mar	4-Apr	471	M, S	6	6	3	1
5	5-Apr	11-Apr	1,319	M, S	21	21	3	1
6	12-Apr	18-Apr	794	M, S	5	5	0	1
7	19-Apr	25-Apr	800	M, S	7	7	5	1
8	26-Apr	2-May	237	M, S	1	1	0	1
9	3-May	9-May	303	M, S	2	2	3	1
10	10-May	16-May	855	M, S	7	7	3	1
11	17-May	23-May	599	M, S	2	2	3	1
12	24-May	30-May	353	M, S	1	1	3	1
13	31-May	6-Jun	377	M, S	0	0	4	1
14	7-Jun	13-Jun					0	1
15	14-Jun	20-Jun					0	1
16	21-Jun	27-Jun					0	1
17	28-Jun	4-Jul					0	1
18	5-Jul	11-Jul					0	1
		Total:	6,108		52	52	27	

[a]Note: Mark Group for all periods = all marked Coho, Chinook and Steelhead ≥50mm FL combined.
[b]Note: Same as inferred age backets based on size class as depicted in Figure 2.8f for Steelhead.

Table 3.2g - Final capture-mark-recapture data used to estimate total naturally produced Steelhead (age 2+).

Trap Name: Lewis River Upper Golf Course Traps			**Species:** Steelhead			**Origin:** Naturally Produced		
Age Class / Brood Year: 2+ / 2019								
Analysis: Bootstrap (listed below in BTSPAS diagonal format for informational purposes)								
			[b]**Life Stage & Size Classes by Period:** Transitional, Smolt ≥150mm (Periods 1 to 18)					
Period	**Period Start Date**	**Period End Date**	**Total Marked**	**Mark Group[a]**	**Period 0 Recaps**	**Total Recaps**	**Total Maiden Captured**	**Prop Fished**
1	8-Mar	14-Mar					0	1
2	15-Mar	21-Mar					0	1
3	22-Mar	28-Mar					0	1
4	29-Mar	4-Apr					0	1
5	5-Apr	11-Apr					0	1
6	12-Apr	18-Apr	794	M, S	5	5	4	1
7	19-Apr	25-Apr	800	M, S	7	7	3	1
8	26-Apr	2-May	237	M, S	1	1	11	1
9	3-May	9-May	303	M, S	2	2	26	1
10	10-May	16-May	855	M, S	7	7	46	1
11	17-May	23-May	599	M, S	2	2	9	1
12	24-May	30-May	353	M, S	1	1	5	1
13	31-May	6-Jun	377	M, S	0	0	10	1
14	7-Jun	13-Jun	428	M, S	2	2	4	1
15	14-Jun	20-Jun	361	M, S	2	2	3	1
16	21-Jun	27-Jun	74	M, S	0	0	1	1
17	28-Jun	4-Jul					0	1
18	5-Jul	11-Jul					0	1
		Total:	5,181		29	29	122	

[a]Note: Mark Group for all periods = all marked Coho, Chinook and Steelhead ≥50mm FL combined.
[b]Note: Same as inferred age backets based on size class as depicted in Figure 2.8f for Steelhead.

Table 3.2h - Final capture-mark-recapture data used to estimate total naturally produced Cutthroat (age 0+).

Trap Name: Lewis River Upper Golf Course Traps	**Species:** Cutthroat	**Origin:** Naturally Produced	**Age Class/Brood Year:** 0+ / 2021

Analysis: Bootstrap (listed below in BTSPAS diagonal format for informational purposes)

			[c]**Life Stage & Size Classes by Period:** Fry <50mm (Periods 1 to 18)						[c]**Life Stage & Size Classes by Period:** Parr 50 to 59mm (Periods 1 to 18)					
Period	**Period Start Date**	**Period End Date**	**Total Marked**	**Mark Group**	**Period 0 Recaps**	**Total Recaps**	**Total Maiden Capture**	**Prop Fished**	**Total Marked**	**Mark Group[a]**	**Period 0 Recaps**	**Total Recaps**	**Total Maiden Captured**	**Prop Fished**
1	8-Mar	14-Mar					0	1					0	1
2	15-Mar	21-Mar					0	1					0	1
3	22-Mar	28-Mar					0	1					0	1
4	29-Mar	4-Apr					0	1					0	1
5	5-Apr	11-Apr					0	1					0	1
6	12-Apr	18-Apr					0	1					0	1
7	19-Apr	25-Apr					0	1					0	1
8	26-Apr	2-May					0	1					0	1
9	3-May	9-May					0	1					0	1
10	10-May	16-May					0	1					0	1
11	17-May	23-May					0	1					0	1
12	24-May	30-May					0	1					0	1
13	31-May	6-Jun					0	1					0	1
14	7-Jun	13-Jun					0	1	428	S	2	2	0	1
15	14-Jun	20-Jun					0	1	361	S	2	2	0	1
16	21-Jun	27-Jun					0	1	74	S	0	0	0	1
17	28-Jun	4-Jul					0	1	25	S	0	0	0	1
18	5-Jul	11-Jul					0	1	0	S	0	0	1	1
		Total:					0		888		4	4	1	

[a]Note: Mark Group for all periods = all marked Coho, Chinook and Steelhead ≥50mm FL combined.

[c]Note: Same as inferred age backets based on size class as depicted in Figure 2.8g for Cutthroat.

Table 3.2i - Final capture-mark-recapture data used to estimate total naturally produced Cutthroat (age 1+).

Trap Name: Lewis River Upper Golf Course Traps			**Species:** Cutthroat			**Origin:** Naturally Produced		
Age Class / Brood Year: 1+ / 2020								
Analysis: Bootstrap (listed below in BTSPAS diagonal format for informational purposes)								
			[b]**Life Stage & Size Classes by Period:** Parr, Transitional, Smolt 60 to 139mm (Periods 1 to 18)					
Period	**Period Start Date**	**Period End Date**	**Total Marked**	**Mark Group[a]**	**Period 0 Recaps**	**Total Recaps**	**Total Maiden Captured**	**Prop Fished**
1	8-Mar	14-Mar					0	1
2	15-Mar	21-Mar					0	1
3	22-Mar	28-Mar	5	S	0	0	2	1
4	29-Mar	4-Apr	471	S	6	6	1	1
5	5-Apr	11-Apr	1,319	S	21	21	0	1
6	12-Apr	18-Apr	794	S	5	5	1	1
7	19-Apr	25-Apr	800	S	7	7	1	1
8	26-Apr	2-May	237	S	1	1	1	1
9	3-May	9-May					0	1
10	10-May	16-May					0	1
11	17-May	23-May					0	1
12	24-May	30-May					0	1
13	31-May	6-Jun					0	1
14	7-Jun	13-Jun					0	1
15	14-Jun	20-Jun					0	1
16	21-Jun	27-Jun					0	1
17	28-Jun	4-Jul					0	1
18	5-Jul	11-Jul					0	1
		Total:	3,626		40	40	6	

[a]Note: Mark Group for all periods = all marked Coho, Chinook and Steelhead ≥50mm FL combined.

[b]Note: Same as inferred age backets based on size class as depicted in Figure 2.8g for Cutthroat.

Table 3.2j - Final capture-mark-recapture data used to estimate total naturally produced Cutthroat (age 2+).

Trap Name: Lewis River Upper Golf Course Traps			**Species:** Cutthroat			**Origin:** Naturally Produced		
Age Class / Brood Year: 2+ / 2019								
Analysis: Bootstrap (listed below in BTSPAS diagonal format for informational purposes)								
			[b]**Life Stage & Size Classes by Period:** Transitional, Smolt ≥140mm (Periods 1 to 18)					
Period	**Period Start Date**	**Period End Date**	**Total Marked**	**Mark Group[a]**	**Period 0 Recaps**	**Total Recaps**	**Total Maiden Captured**	**Prop Fished**
1	8-Mar	14-Mar					0	1
2	15-Mar	21-Mar					0	1
3	22-Mar	28-Mar	5	S	0	0	1	1
4	29-Mar	4-Apr	471	S	6	6	1	1
5	5-Apr	11-Apr	1,319	S	21	21	1	1
6	12-Apr	18-Apr	794	S	5	5	2	1
7	19-Apr	25-Apr	800	S	7	7	6	1
8	26-Apr	2-May	237	S	1	1	3	1
9	3-May	9-May	303	S	2	2	17	1
10	10-May	16-May	855	S	7	7	18	1
11	17-May	23-May	599	S	2	2	20	1
12	24-May	30-May	353	S	1	1	16	1
13	31-May	6-Jun	377	S	0	0	8	1
14	7-Jun	13-Jun	428	S	2	2	5	1
15	14-Jun	20-Jun	361	S	2	2	7	1
16	21-Jun	27-Jun					0	1
17	28-Jun	4-Jul					0	1
18	5-Jul	11-Jul					0	1
		Total:	6,902		56	56	105	

[a]Note: Mark Group for all periods = all marked Coho, Chinook and Steelhead ≥50mm FL combined.
[b]Note: Same as inferred age backets based on size class as depicted in Figure 2.8g for Cutthroat.

3.3 Equations or Software Used to Complete Analysis

A nonparametric Bootstrap Method (Thedinga et al. 1994, Manly 2007, Efron and Tibshirani 1986) was used to calculate the mean population estimate, variance, and 95% confidence interval for naturally produced salmonids by inferred age class passing the Lewis River Upper Golf Course Traps during the 2021 monitoring period. The Bootstrap was run with 1,000 iterations. The 95% confidence interval was calculated as the square root of the mean Bootstrap variance multiplied by 1.96. The coefficient of variation was calculated by dividing the standard deviation by the mean population estimate.

3.4 Final Outmigrant Abundance Estimates

The final data tables listed in section 3.3 were used to generate total estimates of naturally produced salmonids passing the trap during the monitoring period for each species/inferred age class using the Bootstrap Method (Table 3.1).

Table 3.1 - Bootstrap estimates of total naturally produced juvenile salmonids passing the Lewis River Upper Golf Course Traps for the period of March 10 to July 9, 2021.

Species	Brood- Year / Cohort	2021 Sample Weeks[a]	Age Class	Mean Bootstrap Abundance Estimate	Bootstrap Estimated Variance	95% CI	CV
Coho	Sep 2020-Jan 2021	1 to 18	<50mm / 0+	8,448	597,567	1,515	9%
		4 to 18	≥50mm / 0+	6,103	1,411,565	2,329	19%
		1 to 18	**Total 0+**	**14,551**	**2,009,132**	**2,778**	**10%**
	Sep 2019-Jan 2020	1 to 18	**Total 1+**	**49,230**	**49,336,660**	**13,767**	**14%**
Chinook	Sep-Dec 2020	1 to 18	<50mm / 0+	4,459,416	101,018,900,000	622,956	7%
		3 to 18	≥50mm / 0+	135,781	403,011,400	39,347	15%
		1 to 18	**Total 0+**	**4,595,197**	**101,421,911,400**	**624,197**	**7%**
	Sep-Dec 2019	7 to 18	**Total 1+**	**385[b]**	**87,039**	**578**	**77%**
Steelhead	2021	4 to 18	<50mm / 0+	25,994	38,437,740	12,152	24%
		4 to 18	≥50mm / 0+	296[c]	185,311	844	145%
		4 to 18	**Total 0+**	**26,290**	**38,623,051**	**12,181**	**24%**
	2020	4 to 13	**Total 1+**	**3,271**	**611,074**	**1,532**	**24%**
	2019	6 to 16	**Total 2+**	**22,632**	**23,925,400**	**9,587**	**22%**
Cutthroat	2021	14 to 18	**Total 0+**	**296[d]**	**185,311**	**844**	**145%**
	2020	3 to 8	**Total 1+**	**571**	**59,879**	**480**	**43%**
	2029	3 to 15	**Total 2+**	**13,447**	**5,034,413**	**4,398**	**17%**

[a]Note: Sample weeks (periods) bracketing the time when the specific species/origin/age/size class were captured in the screw traps.
[b]Note: Estimate based on only 2 Chinook captured in the screw traps estimated to be within the 1+ age class.
[c]Note: Estimate based on only 1 Steelhead captured in the screw traps ≥50mm FL estimated to be within the 0+ age class.
[d]Note: Estimate based on only 1 Cutthroat captured in the screw traps ≥50mm FL estimated to be within the 0+ age class.

3.5 Graphical Presentation of Results

Period (weekly) specific outmigrant abundance with confidence intervals was not estimated due to the limited number of periods with recaptures for each species/age class combination. Therefore, time series abundance estimates with confidence intervals are not provided. However, the migration timing depicted in Figures 2.8i (salmon species) and 2.8j (trout species) approximate total estimates of abundance by week.

3.6 Project Assessment

The overall low number of recaptures limits the potential to make species/size/origin/period specific outmigration estimates based on mark-recapture data for the 2021 Lewis River trapping season. However, pooled data allows estimates to be made. The estimates of fish passing the Lewis River Upper Golf Course Traps (Section 3.4) rely on the following key assumptions:

- The pooled trap efficiency used in this analysis is representative of the true trap efficiency for each species/size/origin/period specific categories for which estimates were made.
- The inferred age classes based on length distribution over time for each species are representative of the true proportion of the total fish captured by age class.
- Marking does not affect catchability or survival.
- All fish (marked and unmarked) have an equal probability of being caught.
- Fish do not lose their marks and marks are recognizable.

- All hatchery fish are actually marked with an adipose fin clip and/or CWT so as to be distinguishable from naturally produced fish.
- All recovered marks are reported.

The efficiency of the Lewis River Upper Golf Course Traps for hatchery Coho for weeks 4 through 11 combined (periods when hatchery Coho were recaptured) was 0.93% (41 recaptured / 4,426 marked and placed upstream). Almost all (95%) of hatchery Coho maiden captures occurred during this time. The Lewis River Hatchery released a total of 1,957,690 hatchery Coho smolts during the screw trapping season. Assuming hatchery Coho catch timing was representative of the out-migration timing of all hatchery Coho released during the monitoring period, an estimated 1,864,842 hatchery Coho passed the traps during weeks 4 through 11. Using the total number of hatchery Coho as a marked group released upstream of the trap, the trap efficiency for hatchery Coho (weeks 4 through 11 combined) is estimated to be 1.09% (20,346 maiden captures / 1,864,842 hatchery Coho). As these two estimates of trap efficiency are similar, these results suggest that capture rates of marked and released hatchery Coho at the Lewis River Upper Golf Course Traps are likely representative of hatchery Coho moving past the trap during the 2021 monitoring period. The trap efficiency for naturally produced Coho ≥50mm FL was not significantly different from that measured for hatchery Coho, though the confidence in the naturally produced Coho measured trap efficiency is reduced by low sample size. Only two naturally produced Coho were recaptured between weeks 4 and 11.

WDFW also captured 68,129 naturally produced Chinook parr by seining; marked them with an adipose fin clip and CWT; and released them at the Lewis River Hatchery (upstream of the traps) in June. These naturally produced and marked Chinook parr were captured at the Lewis River Upper Golf Course Traps during weeks 14 through 16. Using the total number of naturally produced Chinook with CWT and adipose fin clip as a marked group released upstream of the trap, the trap efficiency is estimated to be 0.43% (295 maiden captures / 68,129 marked Chinook). The estimate of trap efficiency based on mark-release of all Coho, Chinook, and Steelhead ≥50mm combined for weeks 14 through 16 is estimated as 0.46% (4 recaptures / 863 fish marked and released upstream). As these two estimates of trap efficiency are very similar, these results suggest that the true trap efficiency for salmonids ≥50mm is likely approximated by the mark-recapture tests during weeks 14 through 16, though the confidence in the measured trap efficiency is reduced by the low sample size of only 4 recaptures.

3.7 Self-Assessment

The objectives of operating two screw traps in tandem at the Lewis River Upper Golf Course site in 2021 were to significantly increase trap cone RPMs, increase total fish captures and marked fish placed upstream, and increase trap efficiency compared to 2020 results. Only one trap was fished at the Lewis River Upper Golf Course site in 2020, with a second trap located about 0.75 miles downstream. The lower Golf Course trap was deemed ineffective due to chronically low cone RPMs due to low river velocity, which resulted in very low fish capture rates. Adding a second trap fished in tandem at the upper Golf Course location in 2021 nearly tripled (2.8 times higher) the total season upper trap site efficiency compared to that measured in 2020 for the single upper trap (2021 = 0.81%; 2020 = 0.29%) for all Coho, Chinook and Steelhead combined ≥50 mm FL. Note that if the individual trap efficiency had remained the same in 2021, then about double the trap efficiency would be expected when combining the data of two traps fished side by side. The higher trap efficiency in 2021 is likely due in part to increased cone RPMs; the left and right cone season average RPMs in 2021 was 4.1 and 4.2 (respectively) compared to 3.5 RPMs for the single trap cone in 2020.

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APPENDIX E –

Coho salmon spawning survey results, North Fork Lewis River (October 2021 through January 2022)

Memorandum

To: Erik Lesko and Chris Karchesky, PacifiCorp

From: Jason Shappart (Senior Fisheries Scientist) and Tyler McClure (Fish and Wildlife Biologist)

Date: April 15, 2022

Re: North Fork Lewis River Downstream of Merwin Dam – 2021 Coho Salmon Spawning Survey Results (mid-October 2021 through January 2022)

Introduction

As a component of its existing FERC license, PacifiCorp conducts annual Coho Salmon spawning surveys from mid-October through January to facilitate estimating Coho Salmon spawning escapement in the North Fork (NF) Lewis River downstream of Merwin Dam (PacifiCorp and Cowlitz PUD 2017). Meridian Environmental, Inc. (Meridian) has performed these surveys under contract with PacifiCorp since 2013 using the same survey crew each year. This memorandum summarizes the results of the Coho Salmon spawning surveys from mid-October 2021 through January 2022.

Methods

The NF Lewis River tributary spawning survey reaches are defined annually by Washington Department of Fish and Wildlife (WDFW) using a Generalized Random Tessellation Stratified (GRTS) sample design. The tributary survey data summarized in this report is combined with spawning survey data throughout the region and used by WDFW to estimate Coho escapement within the lower Columbia River area. In 2021, WDFW designated two survey reaches within the Hayes Creek watershed, one reach each in the Bratton Creek and Johnson Creek watersheds (Figure 1). Each survey reach was approximately one mile in length.

All tributary surveys were conducted weekly by foot as environmental conditions allowed (flow, turbidity, etc.) following the methods described in Brown et al. (2021). During each tributary survey, the number of live Coho were enumerated. Coho carcasses were enumerated by species, sex, and origin. All carcasses were scanned for a coded wire tag (CWT) and all external marks were noted. Scale samples were taken from all unmarked carcasses (assumed natural origin return). The tail was removed from each carcass after counting so that it would not be counted as a new carcass on subsequent surveys. All new redds were counted and given a uniquely numbered flag by date. GPS coordinates were recorded for all redds. On subsequent surveys the visibility of each previously flagged redd was recorded. Once a redd was deemed no longer visible, the flag was removed.

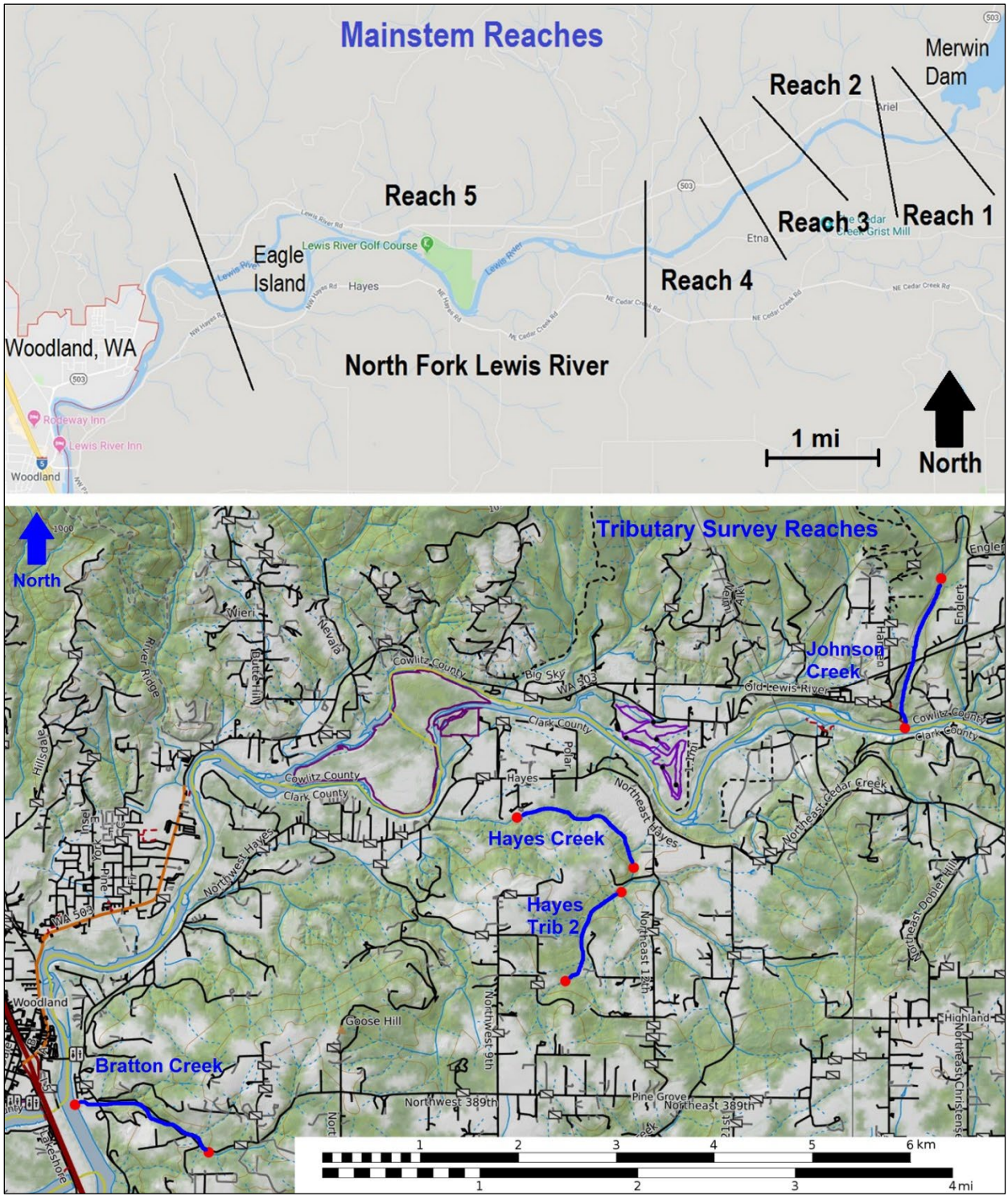

Figure 1. NF Lewis River mainstem and tributary Coho spawning survey reaches below Merwin Dam in 2021.

Mainstem NF Lewis River spawning surveys were conducted as stipulated in PacifiCorp and Cowlitz PUD (2020). The mainstem NF Lewis River spawning survey area is divided into five index reaches as defined previously by WDFW (Bentley et al. 2018), extending from the boat barrier downstream of Merwin Dam to the downstream end of Eagle Island (Figure 1) encompassing 10.84 river miles (mainstem channel and Eagle Island side channel). All five mainstem NF Lewis River reaches were surveyed weekly via jet boat during a single day. In prior years, PacifiCorp conducted river drawdowns once per week during the Coho and fall Chinook spawning survey seasons at the request of WDFW to facilitate WDFW's ability to recover fall Chinook carcasses. From 2013 to 2015, Meridian purposefully avoided conducting Coho surveys during the weekly drawdowns at the request of WDFW. However, additional data analyses suggested that Coho carcass recovery rates may be improved during lower flows. As a result, starting in 2016, Meridian conducted mainstem NF Lewis River Coho surveys during drawdown days to improve carcass detection probability and increase carcass resight probability. Drawdown days continued to be targeted for surveys during the 2021 season to the extent possible.

As in prior years, Meridian biologists conducting Coho spawning surveys in the mainstem NF Lewis River found it difficult to differentiate Coho redds from fall Chinook redds due to the relatively large number of fall Chinook spawning in the mainstem NF Lewis River compared to Coho. Therefore, only Coho carcass surveys were conducted in the mainstem NF Lewis River. During each mainstem NF Lewis River survey, all carcasses that could be recovered (not too deep) were counted and sampled as described previously for tributary surveys. In addition, all recovered carcasses were tagged and left where found (as recommended by WDFW after the 2015 spawning survey season). Prior to 2015, tagged carcasses were placed back into the thalweg per WDFW recommended methods. Tags consisted of uniquely numbered plastic strips, which were stapled to the inside of both opercula. The tails were not removed after counting. On subsequent surveys, previously tagged carcasses were recorded and were left in place for potential subsequent resights. Carcasses too deep to recover were also enumerated if identified as Coho.

As described in Starcevich (2022), the carcass mark-resight data was used to generate an estimate of total Coho carcasses over time with associated 95% confidence interval, and were analyzed assuming the super-population parameterization (Schwarz and Arnason 1996) of the Jolly-Seber model (POPAN model). Analysis was conducted in the R statistical consulting environment (2020) with the RMark package (Laake 2013). Intercept-only models were used for capture and survival probabilities.

Survey Conditions

In 2021, NF Lewis River flows downstream of Merwin Dam were variable.; however, flows were generally above median flow conditions for the majority of the survey season (Figure 2). Conditions were surveyable during every week of the survey period for the mainstem NF Lewis River except the weeks of November 8 and November 22 due to spill at Merwin Dam and/or low visibility due to high turbidity following a spill event (Figure 3). Tributary survey reaches were generally surveyable every week; however, conditions in all tributaries were not surveyable during the middle of November and first half of December due to low visibility caused by high turbidity. Survey days and mainstem NF Lewis River discharge are depicted in Figure 3.

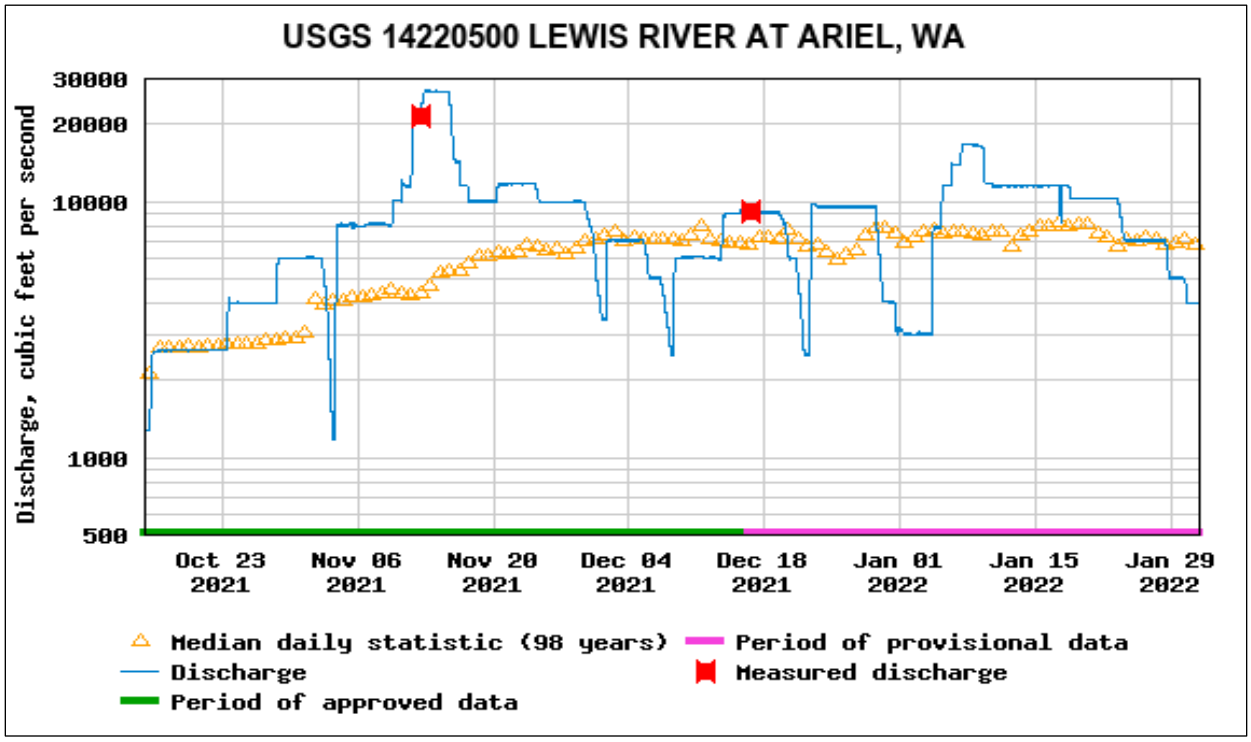

Figure 2. USGS Lewis River Ariel Gage – 15 minute interval reported discharge (cfs) during the 2021 survey season and period of record median daily statistic.

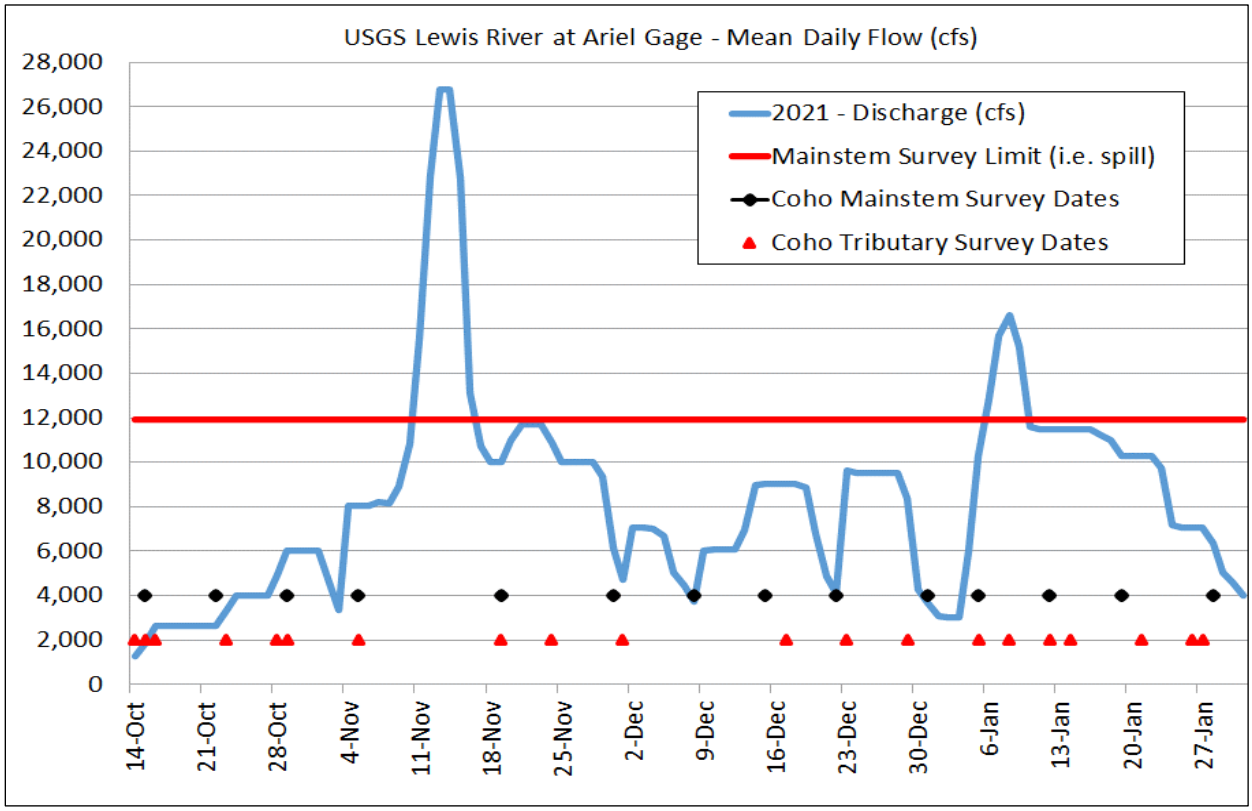

Figure 3. USGS Lewis River Ariel Gage – mean daily discharge (cfs) and survey timing in 2021.

Results

NF Lewis River Tributary Surveys

Meridian biologists counted 72 live Coho spawners and 41 redds in Johnson Creek and 2 Coho spawners and 2 redds in Bratton Creek (Table 1). Meridian biologists did not observe any live Coho, carcasses, or redds in the Hayes Creek or Hayes Creek Tributary 2 survey reaches (Table 1). Coho spawning activity has not been observed in Hayes Creek Tributary 2 since Meridian began surveys in 2013 (Table 2).

Table 1. Summary of tributary Coho Salmon spawning surveys downstream of Merwin Dam (mid-October 2021 through January 2022).

Stream	Reach Length (miles)	Total Weeks (mid-Oct to Jan 31)	Total Weeks Surveyable	Total New Redds	Total Live Holders	Total Live Spawners	Total Carcass Not Sampled[a]	Hatchery Male Carcass	Hatchery Female Carcass	Unmarked Male Carcass	Unmarked Female Carcass	Total Carcass	% Pre-spawn Mortality (Females)	Carcass Wanded for CWT	CWT Positive Carcass
Johnson Creek Reach 1		16	14	41	8	72	2	0	0	2	0	4	NA	2	0
Bratton Creek Reach 1		16	13	2	0	2	0	1	1	0	0	2	0%	2	0
Hayes Creek Reach 1		16	11	0	0	0	0	0	0	0	0	0	NA	NA	NA
Hayes Creek Tributary 2		16	11	0	0	0	0	0	0	0	0	0	NA	NA	NA

NA = Not Applicable

[a]Note: Carcasses too deep to sample.

Table 2. Summary of tributary survey data (2013-2021) for stream reaches selected for survey in 2021 (if a year is not shown under a specific stream reach, then it was not selected for survey during that year by WDFW).

Year	Weeks Surveyable	Total Live Spawners	Total Carcasses	Total Redds
Johnson Creek				
2015	10	2	0	0
2018	16	8	3	17
2021	14	72	4	41
Bratton Creek				
2015	10	0	1	0
2018	13	0	0	0
2021	13	2	2	2
Hayes Creek				
2014	4	0	0	0
2015	11	0	1	0
2018 (2 reaches surveyed)[a]	13	1	0	1
2020	10	0	0	0
2021	11	0	0	0
Hayes Creek Tributary 2				
2013	14	0	0	0
2014	2	0	0	0
2016	9	0	0	0
2017	16	0	0	0
2018	13	0	0	0
2019	11	0	0	0
2020	10	0	0	0
2021	11	0	0	0

[a]Note: A single one mile-long reach was surveyed in each year for each stream, except two reaches (one mile-long each) were surveyed in Hayes Creek in 2018.

NF Lewis River Mainstem Surveys

A total of 97 Coho carcasses were observed in the entire mainstem NF Lewis River survey area over the 16-week survey period (Table 3). Of those, 3 carcasses could not be sampled (i.e., were too deep to recover). The remaining 94 Coho carcasses were sampled and tagged. A total of 1 carcass had a CWT present. A total of 90% of sampled carcasses were of hatchery origin (identified as having an adipose fin clipped or CWT present). All sampled carcasses were tagged and released to complete the mark-resight estimate of total carcasses. After a subsequent resight occasion, the tagged carcass was left in place for potential subsequent resights. A total of 14 (15%) of the tagged carcasses were resighted at least once during the survey season (Table 3). A total of 11 carcasses were resighted once and 3 carcasses were resighted twice.

Total Coho carcasses in the NF Lewis River mainstem between the downstream end of Eagle Island and the boat barrier downstream of Merwin Dam during the 2021 survey season was estimated to be 407 carcasses; bootstrap 95% confidence interval: 225 to 590 (Starcevich 2022). The coefficient of variation for the total carcass estimate was 0.23. The carcass sighting probability was estimated as 0.14 (95% confidence interval of 0.07 to 0.24).

Table 3. Summary of NF Lewis River mainstem Coho Salmon spawning surveys downstream of Merwin Dam (mid-October 2021 through January 2022).

NF Lewis River	Reach Length (miles)	Total Weeks (mid-Oct to Jan 31)	Total Weeks Surveyable	Total Carcass Not Sample (too deep)	Hatchery Male Carcass	Hatchery Female Carcass	Unmarked Male Carcass	Unmarked Female Carcass	Total Carcass[a]	Total Carcass Tagged	Total Carcass Recoveries	% Pre-spawn Mortality (Females)	Carcass Wanded for CWT	CWT Positive Carcass
Reach 1	0.57	16	14	2	1	7	2	0	12	10	2	57%	10	0
Reach 2	0.68	16	14	1	4	3	4	1	13	12	2	0%	12	0
Reach 3	0.97	16	14	0	6	5	0	1	12	12	0	33%	12	1
Reach 4	1.32	16	14	0	9	19	2	2	32	32	7	67%	32	0
Reach 5	7.3	16	14	0	10	12	2	4	28	28	3	56%	28	0
Total	**10.84**	**16**	**14**	**3**	**30**	**46**	**10**	**8**	**97**	**94**	**14**	**54%**	**94**	**1**

[a]Note: Includes carcasses too deep to sample (3 total) and carcasses sampled.

Discussion and Conclusions

Incorporating surveys on drawdown days in 2016 nearly doubled the proportion of tagged carcasses that were resighted compared to the highest resight proportion in previous years (2013 to 2015) when surveys were conducted on non-drawdown days (Table 4). It is important to note that the same crew conducted all surveys during all eight years covering the same reaches and season. Average flows during survey days and average daily flow during the entire survey period were relatively high in 2021 compared to prior years (Table 4). Drawdowns for carcass surveys occurred during only 5 of the 16 weeks during the survey period. Drawdown day timing in relation to subsequent high flows likely washed Coho carcasses downstream before they could be re-sighted on the next survey day, which likely resulted in the relatively low carcass resight probability experienced during the 2021 survey season.

Table 4. Total Coho redd estimates for 2013 to 2021.

Year	Total Carcasses Tagged	Total Carcasses Resighted	% Carcasses Resighted	Total Weeks Surveyable	Average Daily Flow during Survey Days (cfs)	Average Daily Flow All Days Mid-Oct to Jan-31	Total Carcass Estimate	Bootstrap SE	95% Confidence Interval	CV
2013 Season Total	328	41	13%	15	4,700	4,804	1,970	297	1,523 to 2,679	0.17
2014 Season Total	431	18	4%	15	7,765	7,876	7,805	2,106	5,172 to 13,186	0.27
2015 Season Total	12	2	17%	12	5,632	8,429	no estimate due to low sample size 52 (simple Chapman estimator)			
2016 Season Total	65	20	31%	16	4,587	6,721	124	17	103 to 169	0.14
2017 Season Total[a]	24	8	33%	16	8,817	8,587	44	5	33 to 56	0.11
2018 Season Total	61	22	36%	16	5,009	5,044	137	20	98 to 176	0.15
2019 Oct 18-Dec 20	21	6	29%	10	3,491	3,240	Low water period			
2019 Dec 21-Jan 31	19	1	5%	5	10,942	10,440	High water period			
2019 Season Total[a]	40	7	18%	15	6,181	6,761	83	10	64 to 102	0.12
2020 Season Total	223	65	29%	15	4,968	7,182	527	54	421 to 632	0.10
2021 Season Total	94	14	15%	14	6,683	8,403	407	93	225 to 590	0.23

[a]Drawdowns for spawning surveys generally did not occur during the Coho spawning survey season.

Comparing the total number of adult Coho trapped annually at the Lewis River Hatchery and Merwin Adult Fish Collection Facility traps to the total carcass estimates since 2013 (Figure 4) suggests that as the trap-and-haul upstream passage program has been implemented to transport Coho upstream of the Lewis River Hydroelectric Projects (beginning in 2012 and refined over time), returning Coho are electing to travel further upstream to spawn or spawn in lower NF Lewis River tributaries, rather than spawn in the lower mainstem NF Lewis River. The primary evidence of this effect is that thousands of adult Coho have been captured at the fish passage facilities annually since 2013, while the number of Coho carcasses encountered in the lower NF Lewis River mainstem downstream of the fish passage facilities appears to have declined greatly after 2014 (Figure 4). From 2013 to 2014, total carcass estimates as a percentage of total Coho trapped annually ranged from 7 to 11%; but have dropped to 0.2 to 0.5% from 2015 through 2019 (Figure 4). Even with the relatively large return of Coho, the total carcass estimate as a percentage of total Coho trapped was only 1.2% in 2020. Similarly, a larger number of Coho returned in 2021 and the total carcass estimate as a percentage of toto Coho trapped was only 0.8%

It is also important to note that Coho spawning surveys have started in mid-October through PacifiCorp contract since 2013. In 2021, a large portion of the adult return was composed of the early-Coho run. By the end of September nearly 50% of the Coho for the entire year had already been trapped at the Lewis River Hatchery and Merwin Fish Collection Facilities before spawning surveys had even started. This suggests that a large portion of early-Coho carcasses were likely missed due to the contracted survey start timing in relation to the early-Coho run timing.

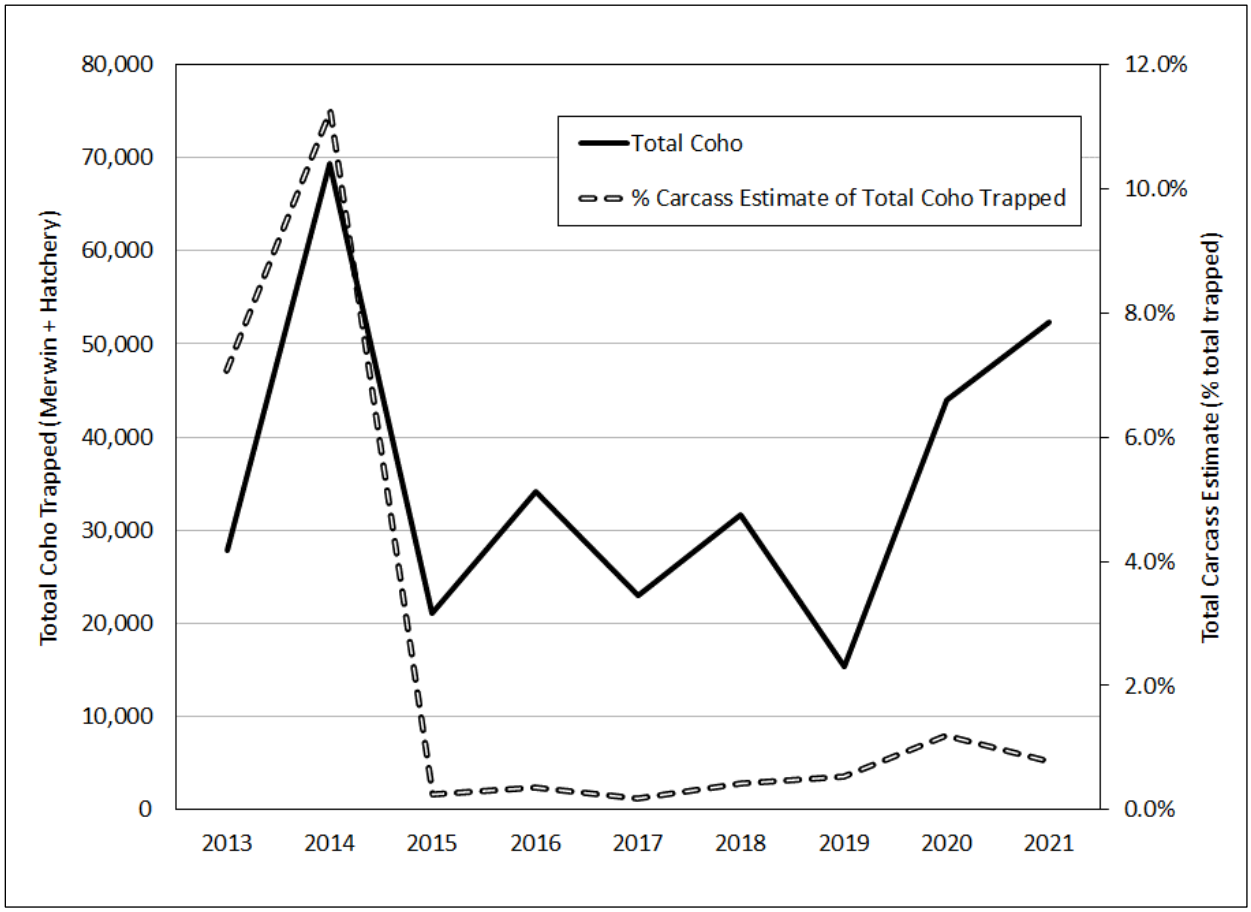

Figure 7. Total Coho captured vs. carcass estimates.

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ENVIRONMENTAL & STATISTICAL CONSULTANTS

2725 NW Walnut Blvd, Corvallis, OR 97330
Phone: 541-738-6198 www.west-inc.com

Date: April 9, 2022
To: Jason Shappart (Meridian Environmental, Inc.)
From: Leigh Ann Starcevich and Lauren Hoskovec (WEST, Inc.)
Re: Estimates of 2021 Coho Adult Escapement from Tagged Carcass Surveys in the Lower North Fork Lewis River downstream of Merwin Dam

Introduction

Meridian Environmental, Inc. (Meridian) conducts annual Coho salmon spawning surveys (including carcass tagging) for PacifiCorp to estimate escapement in the mainstem North Fork Lewis River downstream of Merwin Dam to the downstream end of Eagle Island. The area of interest, previously defined by Washington Department of Fish and Wildlife (WDFW), consists of five reaches ranging from 0.57 to 7.30 miles long.

Coho carcass surveys were conducted on 14 occasions between October 15, 2021 and January 28, 2022. All observed Coho carcasses in adequate condition were tagged with a uniquely-numbered plastic disk behind the gills (two tags per carcass) so that tagging would not impact resighting probabilities. As recommended by WDFW, carcasses were counted by reach during successive survey occasions, and observed tagged carcasses were recorded and returned to the river in the same location where initially observed.

Statistical Methods

The carcass data were analyzed assuming the super-population parameterization (Schwarz and Arnason 1996) of the Jolly-Seber model (POPAN model). Analysis was conducted in the R statistical consulting environment (2020) with the RMark package (Laake 2013). Intercept-only models were used for capture and survival probabilities. The resulting estimate of total escapement, defined by Schwarz and Arnason (1996) as the total number of gross "births" in the area of interest, accounts for Coho present at the beginning of the study, those that move into the study area during the monitoring period, and those that do not survive to the end of the monitoring period.

Results

The results of the 2021 carcass survey, as well as surveys extending back to 2013, are provided in Table 1. In the 2021 surveys, 97 carcasses were observed and 94 carcasses were in sufficient condition to mark. Of the 94 marked carcasses, 14 were re-sighted at least once for an observed resighting probability of 0.15. Eleven carcasses were re-sighted once, and three carcasses were re-sighted twice. The 2021 estimate of escapement was 407 (95%-CI: 225, 590) individuals. The carcass sighting probability was estimated as 0.14 (95%-CI: 0.07, 0.24).

Table 1. Estimated 2013-2021 Coho spawner escapement to the mainstem North Fork Lewis River from Merwin Dam to the downstream end of Eagle Island, with 95%-confidence intervals.

Year	Number of marked carcasses	Number (%) of captured carcasses	Est. Gross Population Size	SE	95%-Confidence Interval	Coefficient of Variation (SE/Est. Size)
2013	328	41	1970	297	(1523, 2679)	0.15
2014	431	18	7805	2106	(5172, 13186)	0.27
2016	65	20	124	17	(103, 169)	0.14
2017	24	8	44	5	(35, 56)	0.11
2018	61	22	137	20	(98, 176)	0.15
2019	40	7	83	10	(64, 102)	0.12
2020	223	65	527	54	(421, 632)	0.10
2021	94	14	407	93	(225, 590)	0.23

Table 2. Estimated 2016-2021 carcass sighting probabilities, with 95%-confidence intervals.

Year	Number of marked carcasses	Number (%) of captured carcasses	Observed proportion of captured carcasses	Est. Carcass Sighting Probability	SE	95%-Confidence Interval
2013*	328	41	0.13	-	-	-
2014*	431	18	0.04	-	-	-
2016	65	20	0.31	0.45	0.13	(0.23, 0.68)
2017†	24	8	0.33	1.00	0.00	(1.00, 1.00)
2018	61	22	0.36	0.46	0.09	(0.30, 0.63)
2019†	40	7	0.18	1.00	0.00	(1.00, 1.00)
2020	223	65	0.29	0.44	0.09	(0.27, 0.62)
2021	94	14	0.15	0.14	0.04	(0.07, 0.24)

* Estimates of carcass sighting probabilities were not generated these years.
† Standard errors for estimates of carcass sighting probabilities were impacted by lack of convergence due to small sample sizes.

Discussion

Estimates of escapement and precision of the estimates have varied across years (Table 1). The low carcass sighting rate observed in 2021 resulted in a less precise estimate of the Coho salmon escapement with a coefficient of variation of 0.23. The estimated carcass sighting probability was 0.14 (95%-CI: 0.07, 0.24). Of the years when interpretable standard errors were obtained, previous carcass sighting probabilities were estimated as 0.45 (95%-CI: 0.23, 0.68) in 2016, 0.46 (95%-CI: 0.30, 0.63) in 2018, and 0.44 (95%-CI: 0.27, 0.62) in 2020.

2725 NW Walnut Blvd, Corvallis, OR 97330
Phone: 541-738-6198 www.west-inc.com

Literature Cited

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APPENDIX F –

Abundance estimates and composition of adult Chinook downstream of Merwin Dam 2018-2021

memo

Washington Department of Fish and Wildlife

To: Erik Lesko and Chris Karchesky, PacifiCorp

From: Kale Bentley and Erin Peterson, WDFW

CC: Lewis ATS

Date: 4/25/2022

Subject: Estimates of abundance for adult Chinook downstream of Merwin Dam, 2021

Executive Summary

In 2021, the Washington Department of Fish and Wildlife (WDFW) conducted weekly mark-recapture surveys from September 15th, 2021, through January 4th, 2022. Across all surveys, 8,153 unique carcasses were recovered of which 2,474 were tagged and 927 were recaptured. High precipitation, high flows, and no drawdown events throughout the majority of November resulted in fewer carcass recoveries during the typical peak recovery period in mid-to-late November. Despite these atypical conditions, survey crews worked diligently to tag as many carcasses as possible throughout the entire season so that when the drawdown events did eventually occur in early to mid-December, a relatively high number were recovered leading to a robust estimate of abundance throughout the entire spawning duration. Using a Jolly-Seber (JS) open population model, the total estimate of abundance (mean; %CV) for spring-, fall- (tule), and late fall-run (bright) Chinook salmon was 708 (54%), 2,968 (16%), and 12,880 (5%), respectively. Out of the total estimated abundance for the three run-types, the proportion that was hatchery-origin spawners (pHOS) was estimated to be 0.79, 0.59, and 0.02, respectively. Detailed estimates of abundance for return years 2018 – 2020 are included in Appendix D.

Project Overview

WDFW has been conducting spawning ground surveys for adult Chinook salmon in the mainstem North Fork (NF) Lewis River downstream of Merwin Dam for over five decades. Over this time, the methods used to assess the status of NF Lewis Chinook have varied. Since 2013, WDFW has been implementing weekly mark-recapture surveys using carcasses that are recovered from the river and adjacent streambanks to estimate the abundance and composition of Chinook salmon spawners throughout their entire spatial and temporal extent each year. The estimates of abundance and composition are used by WDFW, NOAA, and other entities to assess the status and trend of NF Lewis populations of Chinook, which represent three of the 32 historical independent populations with the Lower Columbia River (LCR) Chinook salmon Evolutionarily Significant Unit (ESU). The monitoring of wild fall Chinook spawner populations in the NF Lewis River is also a requirement of the Lewis River Hydroelectric Projects FERC Settlement Agreement of 2004 and details are outlined in PacifiCorp's most up-to-date Hatchery and Supplemental (H&S) Plan of 2020.

Project Goals

(1) Conduct spawning ground surveys for Chinook salmon in the NF Lewis River downstream of Merwin Dam throughout the entire spawning period. Spawning ground surveys include both weekly mark-recapture surveys for carcasses and peak-count visual surveys of live spawners, carcasses, and redds

(2) Generate an unbiased estimate of the total abundance for Chinook salmon spawners with uncertainty in the NF Lewis River downstream of Merwin Dam

(3) Estimate the composition of spawner abundance by management population (spring, tule, and bright), origin (hatchery, wild), and age (ages 2 – 6)

(4) Evaluate the spatial and temporal spawning distribution of Chinook salmon downstream of Merwin Dam

Methods

A brief description of the survey approach, data collection, and data analysis are outlined below. For a more in-depth description of each aspect of the project, see Bentley et al. (2018) and the annually updated Spawning Ground Survey Protocol for NF Lewis River adult Chinook salmon.

Survey Approach

Spawning ground surveys are conducted for Chinook salmon in the NF Lewis River from the bottom of Eagle Island upstream to just below Merwin Dam (Figure 1), which comprises the entire spawning distribution for Chinook salmon in the mainstem Lewis. Spawning ground surveys begin the third week of September (14^{th} – 18^{th}) and typically continue into January to encompass the entire spawning duration of all three populations (i.e., stocks, run types) of Chinook salmon. Surveys are typically conducted 1 – 2 days per week so long as river conditions are conducive to staff safety and fish visibility. One to four jet boats are used to navigate the river and complete spawning ground surveys, which primarily are focused on recovering carcasses to conduct mark-recapture.

Data Collection

During each carcass survey, Chinook salmon carcasses are located, recovered, accessed, sorted, and processed sequentially. All recovered carcasses are enumerated while a subset is sampled for biological data (e.g., fork length – FL –, sex, scales, CWTs) and carcass tagged. Visual surveys are also conducted to count the number of live spawners and redds during the presumed peak spawning periods for all three populations of Chinook salmon. Data are captured on scale cards and whiteboards in the field and entered into WDFW's Traps, Weirs, and Surveys (TWS) Access database. Further data collection and carcass handling protocols are detailed in Bentley et al. (2018).

Data Analysis

Carcass recoveries and associated biological data were queried, summarized, and analyzed to generate estimates of abundance of NF Lewis Chinook salmon using nearly the same methods outlined in Bentley et al. (2018). Briefly, estimates were generated using the "super-population"

Jolly-Seber (JS) estimator that was developed by Schwarz et al. (1993) and Schwarz and Arnason (1996) and previously implemented in a Bayesian framework by (Rawding et al. 2014). The one main change to mark-recapture (M-R) data analysis was that we updated one of the Jolly-Seber (J-S) models, which simplified the analysis and improved parsimony in the estimates. A more detailed description of the data analysis and the J-S model can be found in Appendix A and Appendix B, respectively.

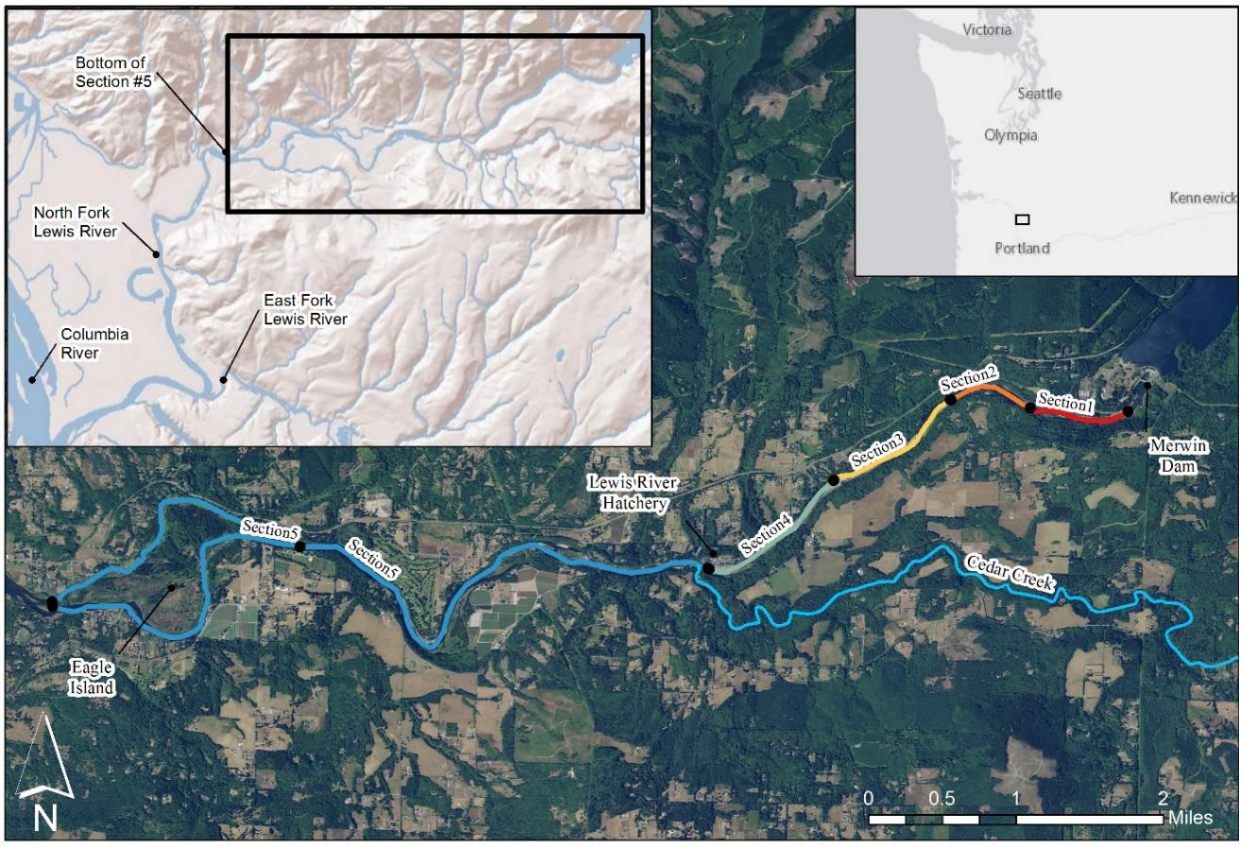

Figure 1. Map of spawning ground survey sections for Chinook salmon in the NF Lewis River.

Results

Data Collection

Mark-recapture carcass tagging surveys were conducted for Chinook salmon in the NF Lewis River downstream of Merwin Dam from September 15th, 2021, through January 4th, 2022. In total, 28 individual days were surveyed over 16 weeks and utilized 49 boat days to complete. One scheduled survey was canceled in late December due to poor survey conditions but this missed week did not have any negative effect on the estimates due to its relative timing.

Across all survey days, a total of 8,153 unique carcasses were recovered of which 2,474 were tagged and 927 were recaptured (Table 1). The total number of carcasses recovered, tagged, and recapture varied among survey weeks and carcass groupings (Appendix C). Overall, the carcass recoveries were comprised of 64% females, 35% large males, and 1% small males ("jacks").

Table 1. Summary of the total carcass recoveries by grouping, tag status, and recovery rate in 2021.

Carcass Grouping	Maiden	Tagged	Recaptured	Recovery Rate (%)
Jack	87	85	13	15.3
Female	5,253	1,533	606	39.5
Male	2,813	856	308	36.0
Total	8,153	2,474	927	37.5

Across the entire survey period, recovery rates of females and large males were similar while the recovery rate of jacks was approximately 60% lower. However, as observed in previous years, the recovery probability of carcasses varied throughout the fall (Figure 2). In general, recovery probabilities for females and large males were relatively low in September and then hovered around 30% in October when flows were less than 4,000 CFS. Recovery probabilities declined for most of November due to increased flows (>10,000 CFS) and poor survey conditions but improved through most of December as flows receded and weekly drawdowns were implemented.

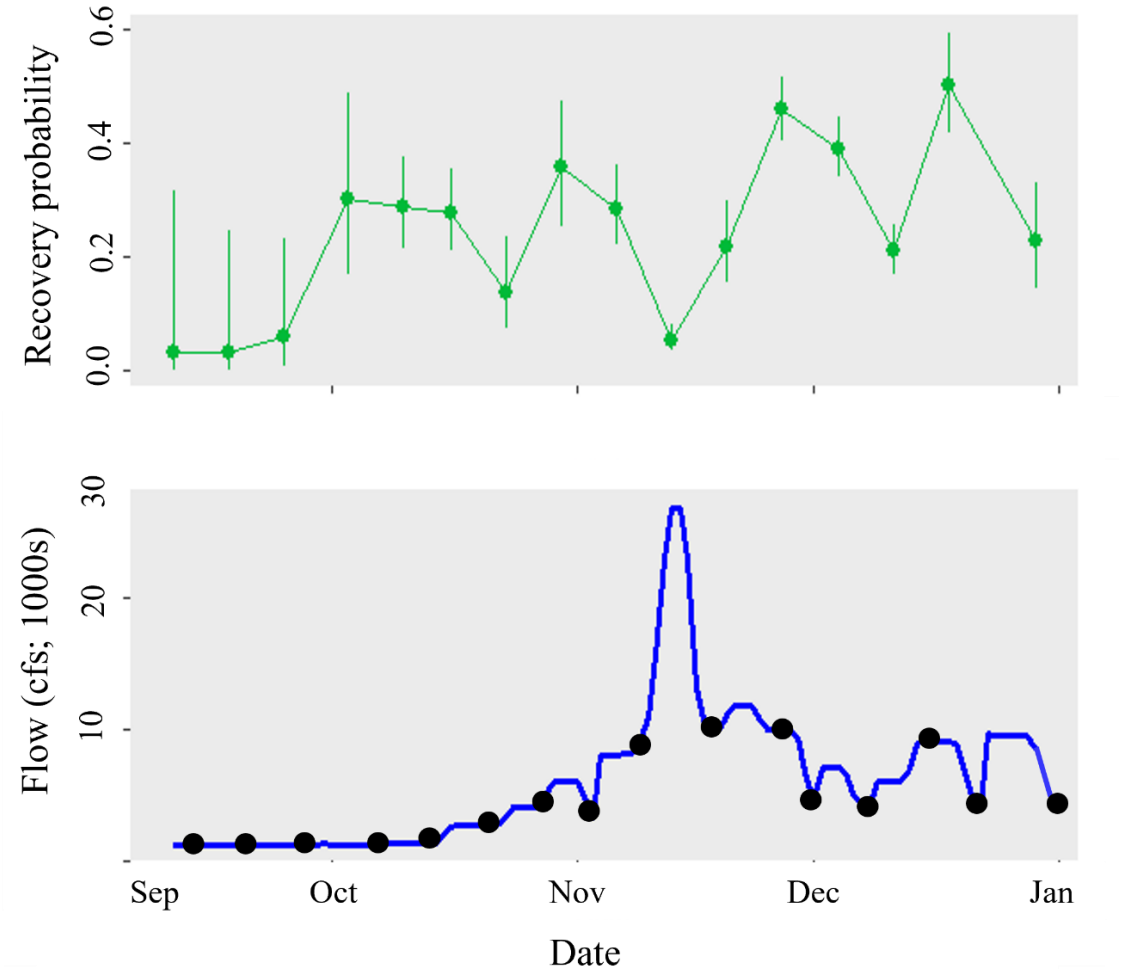

Figure 2. Recovery probability of female carcasses by period (top) and average daily flow below Merwin Dam (bottom) in the fall of 2021. Carcass survey dates are shown with black dots (NOTE: one dot comprises 1-3 individual survey days).

Abundance and Composition

Estimates of abundance were generated for NF Lewis Chinook salmon for return year 2021 (Table 3 – Table 4). Overall, the estimated abundance for all three runs was higher in 2021 than the five-year geomean (aka, average; 2016 – 2020) but generally "average" over the length of the time series since mark-recapture was re-instituted (Figure 3). Spring Chinook abundance in 2021 was 708 (mean; CV; 54%), which was 5.5-fold higher than the five-year average (109). However, mark-recapture estimates have only been generated for the past two years (2020, 2021) so this pattern should be interpreted with caution. Tule abundance in 2021 was 2,968 (16%), which was approximately 30% higher than the five-year average (2,303). Bright abundance in 2021 was 12,880 (5%), which was also approximately 30% higher than the five-year average (10,017), but approximately 50% less than the abundance in 2020 which was the highest on record.

The proportion of each run that was comprised of hatchery-origin spawners (i.e., pHOS) was 0.79, 0.59, and 0.02, respectively (Table 5). As was previously explained in Bentley et al. (2018), there are no hatchery releases of bright-run Chinook salmon in the lower Columbia Basin. Specifically, the small, estimated proportion of bright-run Chinook that were assigned as hatchery-origin (0.02) is simply an artifact of how biological data are partitioned in the analyses. Thus, the 235 hatchery-origin Chinook that the model estimated as bright-run Chinook are likely hatchery-origin tule-run Chinook.

Table 2. Estimates of abundance (i.e., escapement) and composition for NF Lewis spring-run Chinook salmon in 2021.

Origin	Age	Mean	SD	L95%	Median	U95%	%CV
Hatchery	-	564	310	217	487	1,343	55
	2	9	12	1	5	37	135
	3	77	47	28	64	201	61
	4	409	229	154	352	996	56
	5	68	43	22	57	179	63
	6	1	1	-	-	3	118
Wild	-	144	84	56	121	364	58
	2	8	11	1	4	34	149
	3	23	15	8	19	61	67
	4	97	59	37	81	251	60
	5	16	11	5	13	45	69
	6	-	-	-	-	1	161
Total	**-**	**708**	**382**	**278**	**611**	**1,688**	**54**

Table 3. Estimates of abundance (i.e., escapement) and composition for NF Lewis fall-run Chinook salmon (i.e., tules) in 2021.

Origin	Age	Mean	SD	L95%	Median	U95%	%CV
Hatchery	-	1,608	187	1,244	1,606	1,988	12
	2	16	16	3	12	56	95
	3	214	39	145	211	298	18
	4	1,195	142	920	1,191	1,480	12
	5	182	32	126	180	249	18
	6	2	1	-	1	5	79
Wild	-	1,359	369	763	1,311	2,212	27
	2	44	32	11	35	125	73
	3	170	47	94	164	280	28
	4	970	263	549	937	1,588	27
	5	175	57	88	165	311	33
	6	1	1	-	1	4	80
Total	**-**	**2,968**	**467**	**2,133**	**2,946**	**3,989**	**16**

Table 4. Estimates of abundance (i.e., escapement) and composition for NF Lewis late fall-run Chinook salmon (i.e., brights) in 2021.

Origin	Age	Mean	SD	L95%	Median	U95%	%CV
Hatchery	-	256	117	97	235	534	46
	2	2	3	-	1	9	122
	3	31	16	9	28	69	52
	4	187	87	69	171	394	46
	5	35	14	16	33	70	40
	6	-	-	-	-	1	94
Wild	-	12,624	569	11,540	12,616	13,768	5
	2	202	58	122	192	342	29
	3	1,112	112	907	1,106	1,349	10
	4	8,844	436	8,009	8,833	9,731	5
	5	2,455	156	2,164	2,452	2,775	6
	6	11	8	2	10	31	67
Total	**-**	**12,880**	**607**	**11,730**	**12,866**	**14,108**	**5**

Table 5. Estimates of pHOS and pNOS for NF Lewis Chinook salmon by population in 2021.

Population	Variable	Mean	SD	L95%	Median	U95%
Spring	pHOS	0.79	0.04	0.70	0.80	0.87
	pNOS	0.21	0.04	0.13	0.20	0.30
Tule	pHOS	0.59	0.06	0.46	0.59	0.70
	pNOS	0.41	0.06	0.30	0.41	0.54
Bright	pHOS	0.02	0.01	0.01	0.02	0.05
	pNOS	0.98	0.01	0.95	0.98	0.99

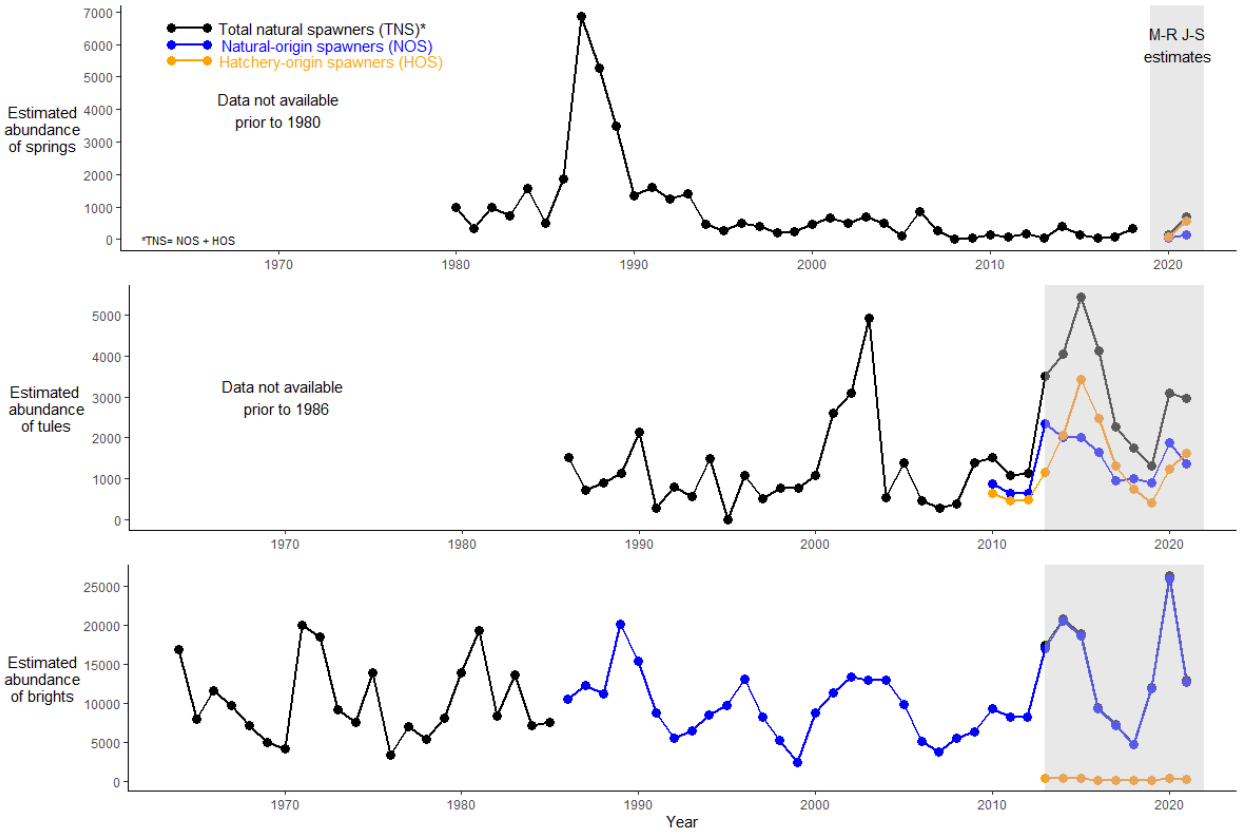

Figure 3. Estimated annual abundance of spring- (top), tule- (middle), and bright-run (bottom) Chinook salmon in the North Fork Lewis River. Total natural spawners (black) are the sum of natural-origin spawners (NOS) and hatchery-origin spawners (HOS). For years in which NOS and HOS abundances were estimated separately, abundances are shown with blue (NOS) and orange (HOS) lines. Mark-recapture Jolly-Seber (M-R J-S) abundance estimates have been used for tules and brights since 2013 (shaded area), and springs since 2020 (details in Bentley et al. 2018). Data were retrieved from WDFW's Salmon Conservation Reporting Engine. Mass marking of Chinook in the lower Columbia was fully implemented and had adults returning in 2010 thereby allowing for NOS and HOS to be differentiated.

Timing and Distribution

Estimates of abundance were generated via a time-stratified model and thus period-specific estimates can be visualized to assess run-timing (Figure 4). Because these data are carcass recoveries, as opposed to live spawners, the observed patterns are a function of relative spawner abundance and recovery probability, which is a function of survey conditions and survey effort. Overall, patterns of run-timing are similar to previous years where spring Chinook are present in the NF Lewis from mid-September through early October with peak carcass abundance in late September, tules are present from mid-September through early November with peak carcass abundance in mid-October, and brights are present from late October through January with peak carcass abundance in late November.

Surveys of live spawners, carcasses, and redds are typically conducted across several weeks corresponding to the peak abundance for each of the three runs. These data have been collected with the intent of monitoring spawning distribution within and among years. For these surveys to be successful, flows must be relatively low (<5,000 CFS) and clarity high. In 2021, there were a total of seven peak count surveys. However, due to the abnormally high precipitation in November, there was only one drawdown event in November. Therefore, peak visual counts were canceled due to the unfavorable survey conditions.

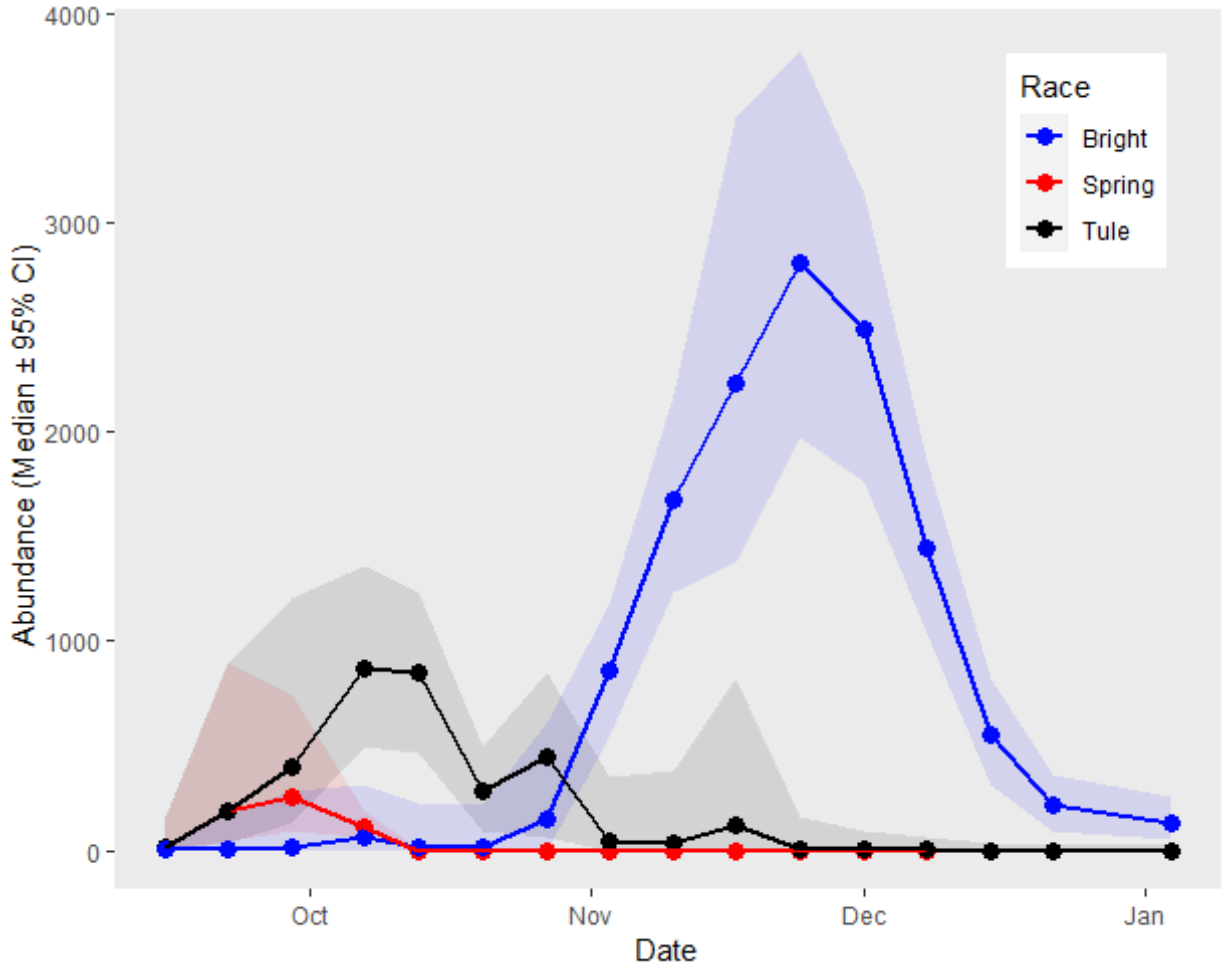

Figure 4. Weekly estimated abundance of spring- (red), tule- (black), and bright- (blue) run Chinook in the NF Lewis River, 2021.

Assessment and Recommendations

Monitoring efforts in 2021 for Chinook salmon in the lower NF Lewis River were highly successful. Estimates of abundance were generated for NF Lewis Chinook via mark-recapture carcass surveys and the composition of the total run was partitioned by population (spring, tule, fall), origin (hatchery, wild), and age using stratified biological data. As discussed in Bentley et al. (2018) and our Spawning Ground Protocol, partitioning the total estimate by population requires the use of visual stock identification (VSI) to differentiate spring- and fall-run Chinook

and we use the ratio of CWT recoveries to split tules and brights. Both approaches require assumptions that have not been fully evaluated. However, given the low absolute abundance of spring Chinook, and particularly wild-origin adults, and the limited temporal overlap of tules and brights, we have minimal concerns over the potential bias that may be induced due to violation of assumptions. That said, the Lewis ATS should work to better understand the population structure of NF Lewis Chinook (e.g., SNP-based genetic analysis), which may subsequently provide alternative information and methods to estimate population composition.

The success of the monitoring program for Chinook salmon in lower NF Lewis is a function of a sound study design, the ability to satisfy the assumption of the estimator, and the high survey effort that routinely results in a large absolute number of carcasses recoveries and resights. In 2021, abnormally high precipitation throughout most of November resulted in high flows and poor survey conditions in the lower NF Lewis. Despite these poor survey conditions, exacerbated by having no drawdown events in 3 of the 4 requested weeks in November, robust estimates of abundance were still generated. This occurred due to two reasons. First, survey crews worked diligently to recover and tag a large absolute number of carcasses across all weeks (see Appendix C). This high survey effort paid dividends because even when recovery probabilities were relatively low, there were still dozens of overall recaptures resulting in precise estimates. Second, subsiding precipitation and reduced flows in early December paired with drawdowns and continued high survey effort resulted in the highest two weeks of recoveries and recaptures. For instance, 40% of all maiden recoveries and recaptures occurred in the first two survey weeks of December despite peak abundance occurring in mid-to-late November. While in some years high survey effort may result in diminishing returns, as it pertains to the precision of the abundance estimates, in years such as 2021 it helps ensure model assumptions are met and unbiased estimates with high levels of precision can be reliably generated. Therefore, we recommend that the survey effort showcased in 2021 should be emulated in future years at least until past Bright-eye method (BEM) estimates of abundance are bias-corrected and an alternative estimator is developed that incorporates covariates which may allow the frequency and/or intensity of mark-capture surveys to be reduced (see *Recommendations* in Bentley et al. 2018).

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Appendices

Appendix A – Description of Data Analysis

Carcass survey data were queried from the TWS Access database and ran through a standardized set of summarizations in R (R Core Team 2022) via RStudio (RStudio Team 2022). Briefly, each tagged carcass was first designated as either a jack (i.e., males <60 cm), female, or male (males ≥60) based on field calls and/or associated biological data. Capture histories were then generated for each tagged carcass and mark-recapture (M-R) summary statistics were generated by carcass grouping (jack, female, male) and survey period/week using the R package *RMark* (Laake 2013). Biological data were summarized by carcass grouping and survey period/week where visual-stock identification was used to partition spring- and fall-run carcasses, coded-wire tag (CWT) recoveries were used to partition tule and bright run carcasses, adipose clip and CWT status were paired to identify and partition hatchery- and natural-origin carcasses, and scale-age reading were used to partition carcasses into total age 2 – 6.

Estimates of abundance were generated using the "super-population" Jolly-Seber (JS) estimator that was developed by Schwarz et al. (1993) and Schwarz and Arnason (1996) specifically for estimating salmon spawning escapement using mark-capture methods. The super-population JS model has been previously implemented in a Bayesian framework by WDFW and a comprehensive description of the model, including summary statistics, fundamental parameters, derived parameters, and likelihoods, is provided in Rawding et al. (2014). Previously model selection had compared four versions of this model, each with a time-dependent probability of entry, but with combinations of either time-dependent or constant probabilities of survival and capture. A limitation of this approach was that the model with both time-dependent capture and survival probabilities had a considerably larger parameter count, and therefore greater variance, and could not be implemented without first pooling capture periods (thereby inducing bias) if the raw data lacked sufficient statistics for identifiability without pooling.

To address these limitations, in 2020, we modified the fully time-dependent version of the model (a.k.a. the "*ttt*" model). Specifically, the period-specific probabilities of survival (*phi*) and capture (*p*) were estimated using logit-normal random walks while the probability of entry (*pent*) was estimated via a softmax construction and subject to a simplex constraint where the log-components followed a random walk except for the first period, which by convention is fixed to 0. Additionally, the model was modified so that it could generate separate capture, survival, and entry probabilities for distinct groups of fish (e.g., jack, female, and male salmon), but rather than estimate their parameters entirely independently, it was assumed that temporal evolution in their probabilities of entry, survival, and capture might be correlated. Therefore, the process errors of their random walks were estimated via a multivariate-normal distribution with an inverse Wishart prior, allowing the model to estimate the extent of covariance in parameter evolution among the groups of fish. In contrast to the previous model version, this improved super-population JS model enables estimation of the full-rank time-dependent model regardless of data sparsity by enforcing parsimony through random effects "shrinkage"; probabilities of survival, capture, and entry experience shrinkage by modeling the period-to-period differences in as a random effect (i.e., a random walk model is a random-effects model on first-order differences). Definitions of the data, stochastic parameters, and derived parameters that

comprise the model are outlined in Table A-1, Table A-2, and Table A-3, respectively. Model code is shared in Appendix B.

Samples from the posterior distribution were obtained using Markov chain Monte Carlo (MCMC) simulations (Gilks 2005) in JAGS (Plummer 2007) using the R2jags package (Su and Yajima 2021). We ran four chains with 500,000 iterations, a burn-in period of 250,000, and a thinning rate of 250 so that the number of independent samples, as measured by effective sample size (ESS), was approximately 4,000 for each parameter of interest. Initial values for each chain were automatically generated within the JAGS package. Modeled convergence was assessed in the same manner as the JS models (i.e., assessment of ESS and BGR statistics).

Table A-1. Notation and definition of data used in the updated Jolly-Seber model.

Statistic	Definition
s	number of sample periods (note: each period denoted with an "i"; i = 1, …, s)
num_strata	number of carcass groupings (note: each grouping denoted with a "k"; k = 1, …, num_strata)
$time_i$	Amount of time (e.g., days) between subsequent periods (e.g., $time_i$ = time between $period_{i+1}$ and $period_i$); length of $time_i$ = s-1
$u_{i,k}$	number of carcasses that were handled per period that were unmarked (i.e., maiden captures)
$m_{i,k}$	number of carcasses that were handled per period that were previously marked (i.e., recaptures)
$n_{i,k}$	total number of carcasses that were handled per period (i.e., n = m + u)
$R_{i,k}$	number of carcasses that were marked and released back into the sample area per period (i.e., new marks deployed; subset of n)
$r_{i,k}$	Total number of marked carcasses from each specific period that were subsequently recaptured in any period after release (i.e., number of "R" that are recaptured)
$T_{i,k}$	number of previously marked carcasses that are recaptured during or after a given period (T = m + z; z = number of previously marked carcasses that are recaptured after
$uTot_k$	total number of unmarked carcasses handled across all sample periods (i.e., sum of "u")
ex_tule_i	number of examined carcasses that were tules by period (note: current parameterization does NOT split up race bio-data by "strata" - not enough data)
ex_race_i	number of carcasses examined for race by period (note: current parameterization does NOT split up race bio-data by "strata" - not enough data)
$ex\_clip_{i,k}$	number of examined carcasses that were adipose clipped by period
$ex\_adfin_{i,k}$	number of carcasses examined for adipose clip status by period
$age\_dat_{i,k,1:num\_ages}$	number of examined carcasses by age and period
$age\_tot_{i,k}$	number of carcasses with a specified (read) age by period
num_ages	Number of age groups

Table A-2. Notation and definition of stochastic (a.k.a. fundamental) parameters used in the updated Jolly-Seber model.

Parameter	Definition
inv_Sigma_p	prior on process error variance/covariance matrix for p
inv_Sigma_phi	prior on process error variance/covariance matrix for phi
inv_Sigma_pent	prior on process error variance/covariance matrix for pent
$logit\_p_{1,k}$	prior on p (probability of capture) in the first period
$logit\_phi_{1,k}$	prior on phi (probability of survival) in the first period
$log\_delta_{1,k}$	prior on delta (probability of entry) in the first period
$logit\_p_{i,k}$	prior on p for periods 2:s
$logit\_phi_{i,k}$	prior on phi for periods 2:s
$log\_delta_{i,k}$	prior on delta for periods 2:s
$sigma\_lambda_k$	prior on shape and rate parameters for gamma distribution prior on total abundance (note: shape = rate = sigma_lambda^-2)
$v_{i,k}$	probability that a carcass that was handled in a given period will be marked and re-released back into the sample area
$Ntot_k$	continuous total abundance
$Nsuper_k$	discrete total abundance
inv_Sigma_pclip	prior on process error variance/covariance matrix for pclip
$logit\_ptule_1$	prior on ptule (portion of carcasses that were tule) in the first period
$logit\_pclip_{1,k}$	prior on pclip (portion of carcasses that were clipped) in the first period
$log\_delta\_age_{1,k,a}$	prior on delta_age (age distribution of carcasses) in the first period
$logit\_ptule_i$	prior on ptule for periods 2:s
$logit\_pclip_{i,k}$	prior on pclip for periods 2:s
$log\_delta\_age_{i,k,a}$	prior on delta_age for periods 2:s
$sigma\_ptule_i$	process error standard deviation for ptule
sigma_p.age	process error standard deviation for p.age

Table A-3. Notation and definition of derived parameters used in the updated Jolly-Seber model.

Parameter	Definition
$p_{i,k}$	probability that a carcass will be handled (i.e., captured) for a given period given that it is in the sample area
$phi_{i,k}$	probability that a carcass that is in the sample area for given period will remain (i.e., survive) in the sample area until the following sample period
$pent_{i,k}$	probability that a carcass enters the sample area between subsequent periods (i.e., the fraction of the total number of carcasses that enter the sample area between each period)
$psi_{i,k}$	probability that a carcass enters the sample area, is still available for capture, and is not seen before a specific period; $psi_{1,k} = pent_{1,k}$
$lambda_{i,k}$	probability that a carcass that has been captured will be captured again (i.e., recaptured); $lambda_{s,k} = 0$
$Bstar_{i,k}$	number of carcasses that enter the sample area between two subsequent sample periods (note: these include animals that enter and "leave" before the next sampling period)
$delta_{i,k}$	odds of entering in period
$temp_{i,k}$	probability of recovery = probability of survival ($phi_{i,k}$) X probability of capture ($p_{i,k}$)
$psiPtot_k$	overall probability of recovery a carcass in the sample area across all periods
$multP_{i,k}$	proportion of maiden captures in each period
$tau_{i,k}$	conditional probability that a carcass is recaptured during a specific period given that it was recaptured at or after that sampled period
$Sigma\_p_{k,k}$	Covariance matrix for p process errors; Inverse of "inv_sigma_p"
$Sigma\_phi_{k,k}$	Covariance matrix for phi process errors; Inverse of "inv_sigma_phi"
$Sigma\_pent_{k,k}$	Covariance matrix for pent process errors; Inverse of "inv_sigma_pent"
$sigma\_p\_process_k$	process error standard deviation for p
$sigma\_phi\_process_k$	process error standard deviation for phi
$sigma\_pent\_process_k$	process error standard deviation for pent
$rho\_p_{k,k}$	among strata process error correlation in p
$rho\_phi_{k,k}$	among strata process error correlation in phi
$rho\_pent_{k,k}$	among strata process error correlation in pent
$ptule_i$	proportion of total abundance that was of the run type tule (opposed to bright) by period
$pclip_{i,k}$	proportion of total abundance that was adipose clipped (opposed to UM - adipose intact) by period
$p.age_{i,k,a}$	proportion of total abundance that was of age "a" by period
$Sigma\_pclip_{k,k}$	Covariance matrix for the "pclip" process errors; Inverse of "inv_sigma_p"
$Sigma\_pclip\_process_k$	process error standard deviation for pclip
$rho\_pclip_{k,k}$	among strata process error correlation in pclip
$delta\_age_{i,k,a}$	odds of the age distribution in carcasses' by period

Appendix B – Code for the Multivariate, Randon-Walk Mark-Recapture Jolly-Seber Model

```
model{
#-----------------------
#Derived parameters
#-----------------------
Sigma_p<-inverse(inv_Sigma_p)
Sigma_phi<-inverse(inv_Sigma_phi)
Sigma_pent<-inverse(inv_Sigma_pent)
for(k in 1:num_strata){
  pent[1,k]<-1/(1+sum(delta[1:(s-1),k]))
  psi[1,k]<-pent[1,k]
  lambda[s,k] <- 0
  psiPtot[k] <- sum(temp[1:s,k])
  Bstar[1:s,k] ~ dmulti(pent[1:s,k], Nsuper[k])
  for (i in 1:(s-1)){
    phi[i,k] <- ilogit(logit_phi[i,k]) ^ time[i]
    delta[i,k]<-exp(log_delta[i,k]) * time[i]
    psi[i+1,k] <- psi[i,k]*(1-p[i,k])*phi[i,k] + pent[i+1,k] *(phi[i,k]-1)/log(phi[i,k])
    lambda[i,k] <- phi[i,k]*(p[i+1,k]+(1-p[i+1,k])*lambda[i+1,k])
  }
  for(i in 2:s){
    pent[i,k]<-delta[i-1,k]/(1+sum(delta[1:(s-1),k]))
  }
  for (i in 1:s){
    p[i,k] <- ilogit(logit_p[i,k])
    temp[i,k] <- psi[i,k]*p[i,k]
    multP[i,k] <- temp[i,k]/sum(temp[1:s,k])
    tau[i,k] <-p[i,k]/(p[i,k]+(1-p[i,k])*lambda[i,k])
  }
  #calculate process error variance and correlation matrix
  sigma_phi_process[k] <- sqrt(Sigma_phi[k,k])
  sigma_p_process[k] <- sqrt(Sigma_p[k,k])
  sigma_pent_process[k] <- sqrt(Sigma_pent[k,k])
  for (j in 1:num_strata){
    rho_phi[k,j] <- (Sigma_phi[k,j]/(sigma_phi_process[k]*sigma_phi_process[j]))
    rho_p[k,j] <- (Sigma_p[k,j]/(sigma_p_process[k]*sigma_p_process[j]))
    rho_pent[k,j] <- (Sigma_pent[k,j]/(sigma_pent_process[k]*sigma_pent_process[j]))
  }
}
#------
#priors
#------
for(k in 1:num_strata){
  sigma_lambda[k] ~ dt(hyper_value_sigma_lambda_mu, hyper_value_sigma_lambda_sd^-2, 1) T(0,)
  #nuisance variable to detect if n>0
  for (i in 1:s){
    v[i,k] ~ dbeta(hyper_value_beta_v, hyper_value_beta_v)
  }
  #Priors for first states in process model of prob capture, survival, birth:
  logit_phi[1,k] ~ dnorm(hyper_value_logit_phi_1_mu, hyper_value_logit_phi_1_sd^-2)
  logit_p[1,k]   ~ dnorm(hyper_value_logit_p_1_mu,   hyper_value_logit_p_1_sd^-2)
  log_delta[1,k] ~ dnorm(hyper_value_log_delta_1_mu, hyper_value_log_delta_1_sd^-2)
  #priors on abundance
```

```
  Ntot[k] ~ dgamma(sigma_lambda[k]^-2, sigma_lambda[k]^-2)
  Nsuper[k] ~ dpois(Ntot[k])
}
#process model priors
for (i in 2:(s-1)){
  logit_phi[i,1:num_strata] ~ dmnorm(logit_phi[i-1,1:num_strata], inv_Sigma_phi)
  log_delta[i,1:num_strata] ~ dmnorm(log_delta[i-1,1:num_strata], inv_Sigma_pent)#similar to dirichlet
trick except used additive log ratios
}
for(i in 2:s){
  logit_p[i,1:num_strata] ~ dmnorm(logit_p[i-1,1:num_strata], inv_Sigma_p)
}
#priors for process error covariance matrices
inv_Sigma_p    ~ dwish(Rmat[1:num_strata,1:num_strata],num_strata + 1)
inv_Sigma_phi  ~ dwish(Rmat[1:num_strata,1:num_strata],num_strata + 1)
inv_Sigma_pent ~ dwish(Rmat[1:num_strata,1:num_strata],num_strata + 1)
#-----------
#Likelihoods
#-----------
for(k in 1:num_strata){
  uTot[k] ~ dbin(psiPtot[k],Nsuper[k])
  u[1:s, k] ~ dmulti(multP[1:s,k],uTot[k])
  for (i in 1:(s-1)){
    R[i,k] ~ dbin(v[i,k], n[i,k])
    r[i,k] ~ dbin(lambda[i,k],R[i,k])
  }
  for (i in 2:(s-1)){
    m[i,k] ~dbin(tau[i,k],T[i,k])
  }
}
#~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
#         Partition Bstar estimates by proportional data: race, clips, sex and age
#~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
#derived
Sigma_pclip<-inverse(inv_Sigma_pclip)
for(i in 1:s){
    ptule[i] <- ilogit(logit_ptule[i])
    pfall[i] <- ilogit(logit_pfall[i])
}
for(k in 1:num_strata){
sigma_pclip_process[k] <- sqrt(Sigma_pclip[k,k])
  for (j in 1:num_strata){
    rho_pclip[k,j] <- (Sigma_pclip[k,j]/(sigma_pclip_process[k]*sigma_pclip_process[j]))
  }
  for(i in 1:s){
    pclip[i,k] <-ilogit(logit_pclip[i,k])
    for(a in 1:num_ages){
      delta_age[i, k, a] <- exp(log_delta_age[i,k,a])
      p.age[i, k, a] <- delta_age[i,k,a]/sum(delta_age[i,k,1:num_ages])
    }
  }
}
#priors
inv_Sigma_pclip ~ dwish(Rmat[1:num_strata,1:num_strata],num_strata + 1)
```

```
sigma_ptule ~ dt(hyper_value_sigma_ptule_mu,hyper_value_sigma_ptule_sd^-2,1) T(0,)
sigma_pfall ~ dt(hyper_value_sigma_pfall_mu, hyper_value_sigma_pfall_sd^-2,1) T(0,)
sigma_p.age  ~ dt(hyper_value_sigma_p.age_mu,hyper_value_sigma_p.age_sd^-2,1) T(0,)
for(i in 2:s){
  logit_ptule[i] ~ dnorm(logit_ptule[i-1],sigma_ptule^-2)
  logit_pfall[i] ~ dnorm(logit_pfall[i-1],sigma_pfall^-2)
  logit_pclip[i,1:num_strata] ~ dmnorm(logit_pclip[i-1,1:num_strata],inv_Sigma_pclip)
}
logit_ptule[1] ~ dnorm(hyper_value_logit_ptule_1_mu, hyper_value_logit_ptule_1_sd^-2)
logit_pfall[1] ~ dnorm(hyper_value_logit_pfall_1_mu, hyper_value_logit_pfall_1_sd^-2)
for(k in 1:num_strata){
  logit_pclip[1,k] ~ dnorm(hyper_value_logit_pclip_1_mu, hyper_value_logit_pclip_1_sd^-2)
  for(a in 1:num_ages){
    log_delta_age[1, k, a] ~ dnorm(hyper_value_log_delta_age_1_mu,hyper_value_log_delta_age_1_sd^-2)
    for(i in 2:s){
      log_delta_age[i, k, a] ~ dnorm(log_delta_age[i-1, k, a],sigma_p.age^-2)
    }
  }
}
#Likelihoods
for(k in 1:num_strata){
  for(i in 1:s){
    ex_clip[i, k] ~ dbin(pclip[i, k],ex_adfin[i, k])
    age_dat[i, k, 1:num_ages] ~ dmulti(p.age[i, k, 1:num_ages], age_tot[i, k])
}
for(i in 1:s){
    ex_tule[i] ~ dbin(ptule[i], ex_race[i])
    ex_fall[i] ~ dbin(pfall[i], ex_run[i])
}
}
```

Appendix C – Summarized mark-recapture recovery data by carcass grouping

Table C-1. Summary of mark-recapture statistics by date/period for the **jack** carcass grouping in 2021.

Period	Date (mm-dd)	Handled (n_i)	Maidens (u_i)	Tagged (R_i)	Recaptures in a Period (m_i)	Recaptures from a Release (r_i)	Eventual Recaps at Large (z_i)	Percent Recaptured (r_i/R_i)
1	09-15	0	0	0	0	0	0	-
2	09-22	0	0	0	0	0	0	-
3	09-29	3	3	2	0	0	0	0%
4	10-07	1	1	1	0	0	0	0%
5	10-13	4	4	4	0	0	0	0%
6	10-20	0	0	0	0	0	0	-
7	10-27	2	2	2	0	0	0	0%
8	11-03	14	14	14	0	2	0	14%
9	11-10	18	16	16	2	0	0	0%
10	11-17	4	4	4	0	1	0	25%
11	11-24	18	18	18	0	6	1	33%
12	12-01	20	16	16	4	3	3	19%
13	12-08	11	6	6	5	1	1	17%
14	12-15	3	1	1	2	0	0	0%
15	12-22	1	1	1	0	0	0	0%
16	01-04	1	1	0	0	0	0	-
Total	-	100	87	85	13	13	5	15%

Table C-2. Summary of mark-recapture statistics by date/period for the **female** carcass grouping in 2021.

Period	Date (mm-dd)	Handled (n_i)	Maidens (u_i)	Tagged (R_i)	Recaptures in a Period (m_i)	Recaptures from a Release (r_i)	Eventual Recaps at Large (z_i)	Percent Recaptured (r_i/R_i)
1	09-15	2	2	1	0	0	0	-
2	09-22	8	8	5	0	0	0	-
3	09-29	32	32	19	0	11	0	58%
4	10-07	226	217	67	9	25	2	37%
5	10-13	304	287	105	17	33	10	31%
6	10-20	238	198	43	40	9	3	21%
7	10-27	121	113	49	8	21	4	43%
8	11-03	319	299	124	20	38	5	31%
9	11-10	513	472	237	41	31	2	13%
10	11-17	176	162	74	14	33	19	45%
11	11-24	645	617	226	28	138	24	61%
12	12-01	1,568	1,447	257	121	131	41	51%
13	12-08	944	810	183	134	77	38	42%
14	12-15	284	229	75	55	40	60	53%
15	12-22	433	337	68	96	18	4	26%
16	01-04	76	54	0	22	0	0	-
Total		5,889	5,284	1,533	605	605	212	39%

Table C-3. Summary of mark-recapture statistics by date/period for the **male** carcass grouping in 2021.

Period	Date (mm-dd)	Handled (n_i)	Maidens (u_i)	Tagged (R_i)	Recaptures in a Period (m_i)	Recaptures from a Release (r_i)	Eventual Recaps at Large (z_i)	Percent Recaptured (r_i/R_i)
1	09-15	1	1	0	0	0	0	-
2	09-22	9	9	6	0	0	0	0%
3	09-29	29	29	19	0	9	0	47%
4	10-07	249	242	62	7	25	2	40%
5	10-13	169	151	47	18	9	9	19%
6	10-20	86	69	15	17	1	1	7%
7	10-27	86	84	33	2	20	0	61%
8	11-03	209	191	88	18	27	2	31%
9	11-10	292	268	134	24	21	5	16%
10	11-17	143	138	60	5	24	21	40%
11	11-24	367	351	125	16	67	29	54%
12	12-01	747	670	117	77	50	19	43%
13	12-08	418	369	84	49	36	20	43%
14	12-15	144	117	38	27	15	29	39%
15	12-22	162	121	28	41	4	3	14%
16	01-04	24	17	0	7	0	0	-
Total		3,135	2,827	856	308	308	140	36%

Appendix D – Estimates of Chinook abundance, 2018 – 2020

Table D-1. Estimates of abundance (i.e., escapement) and composition for Chinook salmon in the NF Lewis River below Merwin Dam by population (tule, bright), origin (hatchery, wild), and age in **2018**.

Population	Origin	Age	Mean	SD	L95%	Median	U95%	%CV
Tule	-	-	1,744	248	1,281	1,727	2,290	14
	Hatchery	-	735	104	565	724	969	14
		2	41	37	10	31	135	88
		3	185	32	131	182	255	17
		4	477	68	362	470	630	14
		5	30	9	15	28	51	32
		6	2	1	-	2	6	77
	Wild	-	1,009	195	637	999	1,449	19
		2	112	56	43	99	255	50
		3	249	56	150	245	376	23
		4	566	98	367	565	770	17
		5	80	26	38	76	141	32
		6	3	2	1	2	7	64
Bright	-	-	4,711	206	4,281	4,706	5,147	4
	Hatchery	-	40	31	15	30	131	78
		2	5	4	1	4	13	74
		3	11	8	4	9	34	70
		4	20	20	6	13	79	102
		5	4	2	2	3	9	46
		6	-	-	-	-	-	113
	Wild	-	4,671	196	4,245	4,672	5,072	4
		2	532	56	431	528	650	11
		3	1,197	74	1,048	1,198	1,340	6
		4	1,945	108	1,736	1,942	2,168	6
		5	982	61	864	981	1,104	6
		6	15	7	5	14	31	47

Table D-2. Estimates of abundance (i.e., escapement) and composition for Chinook salmon in the NF Lewis River below Merwin Dam by population (tule, bright), origin (hatchery, wild), and age in **2019**.

Population	Origin	Age	Mean	SD	L95%	Median	U95%	%CV
Tule	-	-	1,302	380	706	1,251	2,194	29
	Hatchery	-	395	82	228	395	560	21
		2	1	1	-	1	3	133
		3	112	28	61	110	172	25
		4	262	57	148	261	379	22
		5	19	7	8	18	36	37
		6	1	1	-	1	3	83
	Wild	-	907	356	387	847	1,761	39
		2	49	23	17	45	106	48
		3	269	111	108	250	535	41
		4	552	217	236	516	1,078	39
		5	35	15	14	33	71	41
		6	2	1	-	2	5	69
Bright	-	-	11,979	470	10,988	12,001	12,838	4
	Hatchery	-	116	58	49	99	270	50
		2	-	1	-	-	2	149
		3	34	17	14	29	80	51
		4	75	39	31	64	177	51
		5	5	3	2	5	14	59
		6	-	-	-	-	1	94
	Wild	-	11,863	457	10,895	11,888	12,694	4
		2	409	52	320	405	523	13
		3	3,419	196	3,030	3,420	3,802	6
		4	7,462	322	6,807	7,471	8,069	4
		5	547	73	415	542	701	13
		6	26	14	7	24	60	52

Table D-3. Estimates of abundance (i.e., escapement) and composition for Chinook salmon in the NF Lewis River below Merwin Dam by population (spring, tule, bright), origin (hatchery, wild), and age in **2020**.

Population	Origin	Age	Mean	SD	L95%	Median	U95%	%CV
Spring	-	-	129	96	35	101	401	74
	Hatchery	-	88	68	23	68	280	77
		2	1	1	-	-	2	163
		3	18	15	4	13	60	84
		4	67	52	17	51	215	78
		5	3	3	1	2	11	92
		6	0	0	0	0	0	0
	Wild	-	41	33	10	32	132	80
		2	1	2	-	1	7	152
		3	8	7	2	6	29	87
		4	30	25	7	23	99	83
		5	1	1	-	1	5	97
		6	0	0	0	0	0	0
Tule	-	-	3,104	542	2,172	3,055	4,315	17
	Hatchery	-	1,228	180	889	1,222	1,606	15
		2	6	4	1	4	16	78
		3	250	52	164	245	365	21
		4	933	135	675	930	1,209	14
		5	40	11	21	38	65	29
		6	0	0	0	0	0	0
	Wild	-	1,876	449	1,167	1,817	2,929	24
		2	47	23	17	43	104	48
		3	351	80	219	342	529	23
		4	1,412	346	864	1,366	2,227	25
		5	67	23	33	63	120	34
		6	0	0	0	0	0	0
Bright	-	-	26,280	819	24,697	26,266	27,927	3
	Hatchery	-	365	125	182	344	664	34
		2	12	6	4	11	26	47
		3	67	27	30	62	132	40
		4	273	95	133	257	501	35
		5	13	5	6	12	24	37
		6	0	0	0	0	0	0
	Wild	-	25,915	783	24,394	25,906	27,474	3
		2	603	84	461	595	788	14
		3	3,047	229	2,615	3,042	3,515	8
		4	20,542	669	19,273	20,533	21,901	3
		5	1,722	182	1,386	1,716	2,102	11
		6	0	0	0	0	0	0

APPENDIX G –

Annual Hatchery Complex Report, North Fork Lewis River 2021

WASHINGTON STATE DEPARTMENT OF FISH AND WILDLIFE
FISH PROGRAM
HATCHERIES DIVISION

LEWIS RIVER COMPLEX OPERATIONS
FOR
JANUARY 1, 2021 TO DECEMBER 31, 2021

Funded By
PACIFICORP ENERGY & COWLITZ PUD

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Merwin Hatchery Introduction

The Merwin Hatchery is a PacifiCorp owned and funded facility that is operated by the State of Washington Department of Fish and Wildlife. The facility has been in operation since 1993.

Merwin Hatchery is located 11 miles east of Woodland off state route 503 adjacent to PacifiCorp Merwin Dam and Merwin Reservoir.

Program Goals

- 175,000 summer Steelhead @ 4.8 f/lb planted into N.F. Lewis River
- 100,000 winter Steelhead @ 4.8 f/lb planted into N.F. Lewis River
- 50,000 wild winter Steelhead @ 6-8 f/lb planted into N.F. Lewis River
- 7,000 Rainbow Trout planted into Swift Power Canal
- 45,000 Rainbow Trout transferred to Speelyai Hatchery

Approximately 5000 gallons per minute can be delivered to the hatchery by three intake pumps located on Merwin Dam which draft water from Merwin Reservoir. Two screened intakes located at depths of fifteen and ninety feet below the surface of the reservoir enable some temperature manipulation for fish rearing.

Ozone water sterilization is part of the design criteria to meet fish health needs not only at the hatchery but also for fish stocks and the Lewis River Hatchery downstream of our effluent discharge. Two ozone generators fed by compressed air supply ozone gas to a water/ozone contact chamber. A maximum flow of 3800 gallons per minute can be sterilized and supplied to the hatchery.

There is approximately 216,470 cubic feet of rearing space. These areas consist of four one quarter acre rearing ponds, ten 9.5’ x 80’ x 2.5’ fingerling raceways, four 7.5’ x 33’ x 4’ adult holding ponds, six 4.5’ x 34’ x 2’ intermediate raceway and 15 double stack Mari Source incubation trays.

The hatchery has an operations building housing the office, feed room, shop, lab, day room, locker room and restrooms. Other buildings associated with this facility are hatchery building with attached covered adult holding ponds, water treatment facility including the ozone generator building, one three bay storage building, chemical storage building and three residences.

Brood Stock & Spawning – Merwin Hatchery

During this reporting period, trapping was conducted at the Merwin Dam Fish Collection Facility, Lewis River Hatchery, and the lower river, pending on the species. In the below stocks the carcass distribution line represents surplus fish not needed for program goals and may go to food bank/tribes, nutrient enhancement, or landfill.

2022 Brood Merwin Hatchery Origin Summer Steelhead

A total of 347 adults were received for spawning purposes. All fish were trapped at the Merwin Dam FCF and The Lewis River Ladder. Spawned carcasses, mortality, and surplus fish were disposed by landfill. Disposition is as follows:

Final Trapping & Disposition

Adults Received from FCF	336
Adults Received from Lewis Ladder	11
Adults Spawned	212
Non-viable Females	2
Adult Mortality (9.8%)	33
Adult Carcass Distribution	100

2022 Brood Merwin Hatchery Origin Winter Steelhead

A total of 262 adults were received for spawning purposes. All fish were trapped at the Merwin Dam FCF and Lewis River Hatchery. Spawned carcasses, mortality, and surplus fish were disposed by landfill. Disposition is as follows:

In-Season Trapping & Disposition

Adults Received from Lewis Ladder	0
Adults Received from FCF	262
Adults Spawned	84
Non-viable Females	0
Adult Mortality (0.0%)	0
Adult Carcass Distribution	178

2021 Brood Lewis River Wild Origin Late Winter Steelhead

A total of 61 adults were received for live spawning purposes. These fish were collected at various sites to include Merwin FCF, tangle net fishing in the lower river and Lewis River Hatchery. Mortality and culled fish are disposed by landfill, all live spawned fish were hauled downstream to North Fork Lewis River, at river mile five, Martin's access site. Disposition is as follows:

Final Trapping & Disposition

Adults Received from FCF	61
Adults Spawned	52
Non-viable Females	0
Adult Mortality (3.3%)	2
Males Culled (Hatchery Genetics)	0
Females Culled (Hatchery Genetics)	0
Adults Planted Downstream	59

Adult Trapping – Merwin Dam FCF

2021 Brood Lewis River Hatchery Origin Spring Chinook

The first spring chinook was trapped at the Merwin FCF on March 6, 2021. Spring chinook are planted in the upper watershed of North Fork Lewis River, hauled to Speelyai Hatchery for brood, and donated to food banks / tribes. Mortality is disposed by landfill.

Final Trapping & Disposition

Adults Trapped	1,753
Jacks Trapped	696
Adult Mortality (0.1%)	2
Jack Mortality (0.6%)	4
Adults Planted Upstream	375
Jacks Planted Upstream	230
Males Shipped	639
Females Shipped	737
Jacks Shipped	81
Jacks Carcass Distribution	381

2021 Brood Lewis River Wild Origin Spring Chinook

The first wild spring chinook returned to the FCF on February 16, 2021. This stock is planted in the upper watershed of North Fork Lewis River. All Mortality is disposed by landfill.

Final Trapping & Disposition

Adults Trapped	266
Jacks Trapped	18
Adult Mortality (0.0%)	1
Jack Mortality (0.0%)	0
Adults Planted Upstream	265
Jacks Planted Upstream	18

2021 Brood Hatchery Unknown Origin Fall Chinook

This first arrival of unknown hatchery origin fall chinook was August 19, 2021. This unknown origin hatchery stock is surplus to food banks and tribes. Mortality can be disposed by landfill or donated to American Canadian Fisheries.

Final Trapping & Disposition

Adults Trapped	396
Jacks Trapped	23
Adult Mortality (7.6%)	30
Jack Mortality (0.0%)	0
Adult Carcass Distribution	366
Jack Carcass Distribution	23

2021 Brood Lewis River Wild Origin Fall Chinook

Lewis River Wild Origin Fall Chinook first arrived at Merwin FCF on August 10, 2021. This stock is planted downstream to North Fork Lewis River, river mile 5 at Martin's access site. All mortality is disposed by landfill.

Final Trapping & Disposition

Adults Trapped	299
Jacks Trapped	65
Adult Mortality	0
Jack Mortality	0
Adults Planted Downstream	299
Jacks Planted Downstream	65

2021 Brood Lewis River Hatchery Origin (Type S) Early Coho

On August 17, 2021 the first hatchery origin early Coho showed up to Merwin FCF. This stock is planted upstream to North Fork Lewis River, shipped to Speelyai Hatchery for brood, and surplus to food banks / tribes. Low grade quality surplus carcasses and mortality are used for nutrient enhancement, donated to American Canadian Fisheries and or disposed by landfill.

Final Trapping & Disposition

Adults Trapped	11,380
Jacks Trapped	3,027
Adult Mortality (5.9%)	668
Jack Mortality (2.5%)	76
Adults Planted Upstream	4,088
Jacks Planted Upstream	0
Adults Shipped	0
Jacks Shipped	0
Adult Carcass Distribution	6,624
Jack Carcass Distribution	2,951

2021 Brood Lewis River Wild Origin (Type S) Early Coho

This stock first arrived at Merwin FCF on August 18, 2021. These fish are planted upstream to the North Fork Lewis River at Eagle Creek site. Mortality is disposed by landfill.

Final Trapping & Disposition

Adults Trapped	1,296
Jacks Trapped	263
Adult Mortality (0.0%)	0
Jacks Mortality (0.0%)	0
Adults Planted Upstream	1,296
Jacks Planted Upstream	263

2021 Brood Lewis River Hatchery Origin (Type N) Late Coho

The first hatchery origin late Coho was trapped at the Merwin FCF on October 13, 2021. These fish are planted upstream to the North Fork Lewis River at Eagle Creek site, shipped to Lewis River Hatchery for brood stock, and surplus to food banks / tribes. Low grade carcasses and mortality can be used for nutrient enhancement, donated to American Canadian Fisheries, or disposed by landfill.

In-Season Trapping & Disposition

Adults Trapped	4,831
Jacks Trapped	1,159
Adult Mortality (8.2%)	397
Jack Mortality (3.3%)	38
Adults Planted Upstream	1,991
Jacks Planted Upstream	0
Adults Shipped to Lewis River	0
Adult Carcass Distribution	2,443
Jacks Carcass Distribution	1,121

2021 Brood Lewis River Wild Origin (Type N) Late Coho

The first returning wild origin late Coho to Merwin FCF was on October 19, 2021. This stock is planted upstream to the North Fork Lewis River at Eagle Creek site and shipped to Lewis River Hatchery for an intergraded brood stock. Mortality is disposed by landfill.

In-Season Trapping & Disposition

Adults Trapped	880
Jacks Trapped	82
Adult Mortality (0.0%)	0
Jack Mortality (0.0%)	0
Adults Planted Upstream	880
Jacks Planted Upstream	82
Males Shipped to Lewis River	0
Jacks Shipped to Lewis River	0

2020 Brood Lewis River Hatchery Origin (Type N) Late Coho

The first late hatchery origin Coho was trapped at the Merwin FCF on October 20, 2020. Adult late Coho are planted upstream to North Fork Lewis River at Eagle Creek sit, shipped to Lewis River Hatchery for brood, and surplus to food banks / tribes. Low grade carcasses and mortality can be used for nutrient enhancement, donated to American Canadian Fisheries, or disposed by landfill.

Final Trapping & Disposition

Adults Trapped	1,341
Jacks Trapped	290
Adult Mortality (2.0%)	27
Jack Mortality (2.8%)	8
Adults Planted Upstream	365
Adults Planted Upstream	13
Adults Shipped to Lewis River	71
Jacks Shipped to Lewis River	0
Adult Carcass Distribution	878
Jacks Carcass Distribution	269

2020 Brood Lewis River Wild Origin Late Coho

The first wild origin late Coho was trapped at Merwin FCF on November 5, 2020. Wild late Coho are shipped to Lewis River Hatchery for an integrated brood stock and planted upstream to North Fork Lewis River at Eagle Creek Site. Mortality is disposed by landfill

Final Trapping & Disposition

Adults Trapped	782
Jacks Trapped	18
Adults Mortality (0.13%)	1
Jack Mortality	0
Adults Planted Upstream	417
Jacks Planted Upstream	17
Adults Shipped to Lewis River	364
Jacks Shipped to Lewis River	1

2022 Brood Merwin Hatchery Origin Summer Steelhead

The first Merwin Hatchery origin summer steelhead was trapped at Merwin FCF on April 9, 2021. Summer steelhead are shipped for brood to Merwin Hatchery, hauled downstream to river mile 5 on the North Fork Lewis River at Martin's access site to enhance sport fisheries, and surplus to food banks / tribes. Mortality is disposed by landfill.

Final Trapping &Disposition

Adults Trapped	835
Adults Mortality (0.6%)	5
Adults Recycled Downstream	169
Adults Shipped to Merwin	336
Adult Carcass Distribution	325

2022 Brood Lewis River Wild Origin Summer Steelhead

The first Lewis River wild origin summer steelhead was collected at Merwin FCF on June 12, 2021. This stock is planted downstream to the North Fork Lewis River, river mile 5 at Martin's access site. Mortality is disposed by landfill.

Finale Trapping and Disposition

Adults Trapped	12
Adult Mortality	0
Adults Planted Downstream	12

2021 Brood Merwin Hatchery Origin Winter Steelhead

This stock began returning last period and the first winter steelhead was trapped at Merwin FCF on December 2, 2020 and the last was trapped on May 27, 2021. Merwin Hatchery origin winter steelhead are shipped for brood to Merwin Hatchery, planted to Horseshoe Lake (Cowlitz County) to enhance sport fisheries, and surplus to food banks / tribes. Mortality is disposed by landfill

Final Trapping & Disposition

Adults Trapped	479
Adult Mortality (0.4%)	2
Adults Planted to Horseshoe Lake	143
Adults Shipped to Merwin	75
Adult Carcass Distribution	259

2022 Brood Merwin Hatchery Origin Winter Steelhead

The first winter steelhead arrived at the Merwin FCF on November 30, 2021. Merwin Hatchery origin winter steelhead are shipped for brood to Merwin Hatchery, planted into Horseshoe Lake (Cowlitz County) to enhance sport fisheries, and surplus to food banks / tribes. Mortality is disposed by landfill.

In-season Trapping & Disposition

Adults Trapped	542
Adult Mortality (6.3%)	34
Adults Shipped to Merwin	116
Adult Carcass Distribution	392

2021 Brood Lewis River Late Winter Hatchery Origin Steelhead

This stock is a result of live spawning wild winter Steelhead brood stock at Merwin Hatchery. The adult wild steelhead were collected from the Merwin FCF, tangle netting in the lower river and Lewis River Hatchery. These fish are reared at Merwin Hatchery and blank wire tagged as juveniles. Upon return as adults, they are transported upstream by PacifiCorp staff as part of a supplementation project. No fish were hauled downstream this season for trapping efficiency study. The first arrival at Merwin FCF was on February 3, 2020 and the last was trapped on June 7, 2020. All upstream fish are planted on the North Fork Lewis River at Eagle Creek site. Mortality is disposed by landfill.

Final Trapping & Disposition

Adults Trapped	210
Adult Mortality (0.5%)	1
Adults Planted Upstream	209
Adults Planted Downstream	0

2022 Brood Lewis River Wild Origin Late Winter Steelhead

The first wild origin late-winter steelhead was trapped at Merwin FCF on November 24, 2021. Wild origin late winter steelhead are planted upstream, downstream, and shipped to Merwin Hatchery for brood stock. Upstream adults are planted on the North Fork Lewis River at Eagle Creek site. Mortality is disposed by landfill.

In-season Trapping & Disposition

Adults Trapped	6
Adult Mortality	0
Adults Planted Upstream	6
Adults Planted Downstream	0

2021 Brood Lewis River Wild Origin Late Winter Steelhead

This stock began returning last period and the first adult retuned to Merwin FCF on November 24, 2020. Wild late-winter steelhead can be trapped at the FCF or tangle netted on the Lewis River. Wild late-winter steelhead are planted upstream / downstream, shipped for brood to Merwin Hatchery. Returning downstream planted adults were planted upstream after trapped. Upstream fish are planted on the North Fork Lewis River at the Eagle Creek site. Mortality is disposed by landfill.

Final Trapping & Disposition

Adults trapped	168
Adult Mortality (0.6%)	1
Adults Planted Upstream	106
Adults Planted Downstream	0
Adults Recaptured & Planted Upstream	0
Total Adults Planted Upstream	106
Adults Shipped to Merwin	61

2022 Brood Lewis River Late Winter Hatchery Origin Steelhead

This stock is a result of live spawning wild winter Steelhead brood stock at Merwin Hatchery. The adult wild steelhead were collected from the Merwin FCF, tangle netting in the lower river and Lewis River Hatchery. These fish are reared at Merwin Hatchery and blank wire tagged as juveniles. Upon return as adults, they are transported upstream by PacifiCorp staff as part of a supplementation project. No fish were hauled downstream this season for trapping efficiency study. The first arrival at Merwin FCF was on December 9, 2021. All upstream fish are planted on the North Fork Lewis River at Eagle Creek site. Mortality is disposed by landfill.

In-season Trapping & Disposition

Adults Trapped	3
Adult Mortality	0
Adults Planted Upstream	3
Adults Planted Downstream	0

INCIDENTAL TRAPPING

2021 Brood Unknown Stock & Wild Origin Sockeye

No wild origin sockeye returned to the Merwin FCF this year. This stock is planted downstream on the North Fork Lewis River at Martin's access site. Mortality is disposed by landfill.

Final Trapping & Disposition

Adults Trapped	0
Mortality (0.0%)	0
Adults Planted Downstream	0

2021 Brood Lewis River Wild Origin Chum

The first Lewis River wild origin Chum salmon was trapped at the Merwin FCF on October 22, 2021. This stock is planted downstream on the North Fork Lewis River at Martin's access site. Mortality is disposed by landfill.

Final Trapping & Disposition

Adults Trapped	2
Mortality (0.0%)	0
Adults Planted Downstream	2

2021 Brood Lewis River Wild Origin Pink

The first Lewis River wild origin Pink salmon was trapped at the Merwin FCF on October 16, 2021. This stock is planted downstream on the North Fork Lewis River at Martin's access site. Mortality is disposed by landfill.

Final Trapping & Disposition

Adults Trapped	2
Mortality (0.0%)	0
Adults Planted Downstream	2

2021 Brood Lewis River Wild Origin Anadromous Coastal Cutthroat

The first returning wild origin anadromous coastal cutthroat was collected at the Merwin FCF on April 1, 2020 and the last was on January 19, 2021. These fish are planted upstream on the North Fork Lewis River at Eagle Creek access site. Mortality is disposed by landfill.

Final Trapping & Disposition

Adults Trapped	93
Adult Mortality (1.1%)	1
Adults Planted Upstream	93

2022 Brood Lewis River Wild Origin Anadromous Coastal Cutthroat

The first trapped wild origin anadromous coastal cutthroat was collected at the Merwin FCF on March 6, 2021. These fish are planted upstream on the North Fork Lewis River at Eagle Creek access site. Mortality is disposed by landfill.

In-Season Trapping & Disposition

Adults Trapped	147
Adult Mortality (0.0%)	0
Adult Planted Upstream	147

	CK:SP:LEHA:21:H			CK:SP:LEWI:21:W			CK:FA:UNKN:21:H			CK:FA:LEWI:21:W		
	M	F	J	M	F	J	M	F	J	M	F	J
Planted Downstream										120	179	65
Recycled Fish Trapped												
Planted Upstream	283	92	230	153	112	18						
Shipped	639	737	81									
Mortalities		2	4				20	10				
Carcass Distribution			381				184	182	23			
Total	**922**	**831**	**696**	**153**	**112**	**18**	**204**	**192**	**23**	**120**	**179**	**65**

	CO:SO:LEHA:21:H			CO:SO:LEWI:21:W			CO:NO:LEWI:21:H			CO:NO:LEWI:21:W		
	M	F	J	M	F	J	M	F	J	M	F	J
Planted Downstream												
Recycled Fish Trapped												
Planted Upstream	1706	2382		721	575	263	762	1229		454	426	82
Shipped												
Mortalities	279	389	76				154	243	38			
Carcass Distribution	3819	2805	2951				1432	1011	1121			
Total	**5804**	**5576**	**3027**	**721**	**575**	**263**	**2348**	**2483**	**1159**	**454**	**426**	**82**

	CO:NO:LEWI:20:H			CO:NO:LEWI:20:W		
	M	F	J	M	F	J
Planted Downstream						
Recycled Fish Trapped						
Planted Upstream	176	189	13	220	197	17
Shipped	24	47		182	182	1
Mortalities	8	19	8	1		
Carcass Distribution	565	313	269			
Total	**773**	**568**	**290**	**403**	**379**	**18**

	SH:SU:MEHA:22:H			SH:SU:LEWI:22:W		
	M	F	J	M	F	J
Planted Downstream	20	149		2	10	
Recycled Fish Trapped						
Planted Upstream						
Shipped	151	185				
Mortalities	2	3				
Carcass Distribution	92	233				
Total	**265**	**570**	**0**	**2**	**10**	**0**

	SH:WI:MEHA:21:H			SH:WI:MEHA:22:H		
	M	F	J	M	F	J
Planted Downstream						
Recycled Fish Trapped						
Planted Upstream						
Shipped	29	46		57	59	
Mortalities		2		14	20	
Carcass Distribution	78	181		297	95	
Planted Horseshoe Lake	38	105				
Total	**145**	**334**	**0**	**368**	**174**	**0**

	SH:WL:LEWIS:21:H			SH:WL:LEWIS:21:W			SH:WL:LEWIS:22:W			SH:WL:LEWIS:22:H		
	M	F	J	M	F	J	M	F	J	M	F	J
Planted Downstream				0	0							
Recycled Fish Trapped				0	0							
Planted Upstream	84	125		42	64		1	5			3	
Shipped				31	30							
Mortalities	1			1								
Carcass Distribution												
Total	**85**	**125**	**0**	**74**	**94**	**0**	**1**	**5**	**0**	**0**	**3**	**0**

	PK:OD:UNKN:21:W			CH:NA:LEWI:21:W			CT:AC:LEWI:21:W			CT:AC:LEWI:22:W		
	M	F	J	M	F	J	M	F	J	M	F	J
Planted Downstream	1	1		1	1							
Recycled Fish Trapped												
Planted Upstream							93	1		147		
Shipped												
Mortalities												
Carcass Distribution												
Total	**1**	**1**	**0**	**1**	**1**	**0**	**93**	**1**	**0**	**147**	**0**	**0**

Incubation Summary

2021 Brood Goldendale Rainbow

Merwin Hatchery received 85,000 eyed eggs from Goldendale Hatchery on December 22, 2021.

2022 Brood Lewis River Summer Steelhead

The first eggs were taken on November 22, 2021. Disposition of this stock to date is as follows:

Total Egg Take	449,055
Egg Loss (16.5%)	73,925
Eggs Culled	73,998
Fecundity	4,236

2022 Brood Lewis River Winter Steelhead

The first eggs were taken on December 27, 2021. All eggs are currently in incubation trays and have not been shocked or picked. Disposition of this stock to date is as follows:

Estimated Total Egg Take	184,800
Estimated Fecundity	4,400

2021 Brood Lewis River Winter Steelhead

The first eggs were taken on December 22, 2020 and finalized on January 6, 2021. Disposition of this stock to date is as follows:

Total Egg Take	184,800
Egg Loss (4.7%)	10,168
Eggs Culled	84,209
Fecundity	5,116

2021 Brood Lewis River Wild Winter Steelhead

These fish were spawned from April 12, 2021 to May 21, 2021. Disposition is as follows.

Total Egg Take	123,391
Egg Loss (4.1%)	4,559
Fecundity	4,421

Rearing Summary

2020 Brood Lewis River Summer Steelhead

The overall rearing of this brood went a well and program goals were achieved for Merwin Hatchery. However, due to gill disease, 8,762 juveniles @ 16.4 f/lb totaling 534 lbs. were shipped from Skamania Hatchery on November 4, 2020 to achieve Echo Net Pen plant goals. During this rearing cycle, these fish were diagnosed with ichthyopthirius and gill disease. They were therapeutically treated accordingly with higher-than-average loss. Hatchery staff began releasing the fish on station in April 2021. All these fish were trucked and planted at river mile five on the North Fork Lewis River or released from Echo Net Pens.

Final Stock Inventory

Fry Ponded	269,193
Fry Pounds Ponded	108
Juveniles Shipped	61,444
Juvenile Pounds Shipped (6.8 f/lb)	9,036
Smolts Planted	179,871
Smolt Pounds Planted @ Release (5.4 f/lb)	33,309
Rearing Mortality (9.7%)	26,198
Feed Fed (lbs.)	44,678
Net Gain (lbs.)	42,345
Feed Conversion	1.06
Average CV @ Release	7.63

2020 Brood Lewis River Summer Steelhead @ Echo Net Pens

Final Stock Inventory

Juveniles Shipped	61,444
Juvenile Pounds Shipped (6.8f/lb)	9,036
Smolts Planted	61,444
Smolt Pounds Planted @ Release (5.6 f/lb)	10,972
Rearing Mortality (0.0%)	0
Feed Fed (lbs.)	1,716
Net Gain (lbs.)	1,936
Feed Conversion	0.89
Average CV @ Release	8.30

2020 Brood Lewis River Winter Steelhead

The overall rearing of this brood has gone exceptional, and program goals were achieved. During this rearing cycle, these fish were diagnosed with ichthyopthirius. They were therapeutically treated accordingly with average loss. Hatchery staff began releasing the fish on station in April 2021. All these fish were trucked and planted at river mile five on the North Fork Lewis River.

Final Stock Inventory

Fry Ponded	117,809
Fry Pounds Ponded	47
Juveniles Shipped	0
Juvenile Pounds Shipped	0
Smolts Planted	104,424
Smolt Pounds Planted @ Release (4.9 f/lb)	21,311
Rearing Mortality (8.7%)	10,217
Feed Fed (lbs.)	18,129
Net Gain (lbs.)	21,264
Feed Conversion	0.85
Average CV @ Release	7.23

2020 Brood Lewis River Wild Winter Steelhead

The overall rearing of this brood has well, and programs goals were achieved. During this rearing cycle, these fish were diagnosed with ichthyopthirius. They were therapeutically treated accordingly with average loss. Hatchery staff began releasing these fish in May 2021. All volitional release fish were planted at the Merwin Boat Launch on NF Lewis River, the remaining forced out fish were planted at Martin Access river mile five on the NF Lewis River.

Final Stock Inventory

Fry Ponded	77,222
Fry Pounds Ponded	31
Juveniles Shipped	0
Juvenile Pounds Shipped	0
Smolts Planted	57,498
Smolt Pounds Planted @ Release (7.8 f/lb)	7,372
Rearing Mortality (25.0%)	19,303
Unfed Fry Plant	0
Feed Fed (lbs.)	6,767
Net Gain (lbs.)	7,341
Feed Conversion	0.92
Average CV @ Release	8.10

2021 Brood Lewis River Summer Steelhead

The rearing of this brood has been a bit bumpy this period. This stock suffered higher than average rearing loss due pinhead dropouts in early rearing in the incubation room. Problems with starter feed quality were guessed to be the culprit. All stocks were switched from Ewos to Bio-Oregon after quality issues were revealed. During this rearing cycle this stock was diagnosed with ichthyopthirius as well. These fish were therapeutically treated accordingly with much higher-than-average loss. To maintain program goals, 11,249 fish @ 13.7fpp totaling 821 pounds were shipped from Skamania Hatchery to Merwin Hatchery on November 4, 2021. They were added to Rearing vessel RP-11 and will be shipped to Echo Net Pen site in March 2022. Hatchery staff will begin planting the remaining fish on station to Martin Access river mile five on the North Fork Lewis River starting April 2022.

Stock Inventory This Period

Fry Ponded	272,021
Fry Pounds Ponded	109
Juveniles On-Hand	239,330
Juvenile Pounds (10.0 f/lb)	23,933
Rearing Mortality (18.7%)	50,850
Feed Fed (lbs.)	22,457
Net Gain (lbs.)	23,824
Feed Conversion	0.94

2021 Brood Lewis River Winter Steelhead

The rearing cycle for this stock has been excellent this period with no problems. These fish were diagnosed with ichthyopthirius and therapeutically treated with little to no mortality. Hatchery staff will begin planted this stock to Martin Access river mile five of the North Fork Lewis River on April 2022.

Stock Inventory This Period

Fry Ponded	119,295
Fry Pounds Ponded	48
Juveniles On-Hand	109,455
Juvenile Pounds (10.5 f/lb)	10,424
Rearing Mortality (6.9%)	7,540
Feed Fed (lbs.)	11,760
Net Gain (lbs.)	10,376
Feed Conversion	1.13

2021 Brood Lewis River Wild Winter Steelhead

The overall rearing of this brood has good with some early rearing issues. They were diagnosed with gill disease and external cold-water disease while inside the incubation. During this rearing cycle, these fish were also diagnosed with ichthyopthirius. They were therapeutically treated accordingly for all three with higher-than-average loss. Hatchery staff will began releasing these fish in May 2022. All volitional release fish were planted at the Merwin Boat Launch on NF Lewis River, the remaining forced out fish were planted at Martin Access river mile five on the NF Lewis River.

Stock Inventory This Period

Fry Ponded	104,393
Fry Pounds Ponded	42
Juveniles On-Hand	63,475
Juvenile Pounds (21.0 f/lb)	3,023
Rearing Mortality (32.8%)	34,292
Feed Fed (lbs.)	2,451
Net Gain (lbs.)	2,981
Feed Conversion	0.82

2020 Brood Goldendale Rainbow

The rearing cycle of this stock has okay this period as they suffered a significant egg loss, approximately 8,000 eyed eggs (11%), after inventory and receiving them form Goldendale Hatchery. This year, these fish were diagnosed with ichthyopthirius and therapeutically treated accordingly with little to no mortality. 41,433 fish @ 13.0 f/lb and totaling 3,187 pounds were shipped to Speelyai Hatchery on November 8, 2021 and they are to be planted as part of Speelyai's program goal to Swift Reservoir / Power Canal in 2022. The stocking plan for this stock is as follows: Merwin Hatchery will plant to Swift Power Canal in 2022; 3,500 @ 2.5 f/lb in April 2,100 @ 1.5 f/lb in May, and 1,400 @ 1.0 f/lb in June. This will total 4,200 pounds. Merwin Hatchery will also retain 1,500 fish for MSKD in July 2022, 1,500 fish for the Forest Service Derby held at Merwin Park in June 2022, and 2,000 fish for MSKD in July 2023.

Stock Inventory This Period

Fry Ponded	65,344
Fry Pounds Ponded	22
Fish Planted	0
Fish Transferred	41,433
Pounds Transferred	3,187
Rearing Mortality (13.8%)	9,035
Fish On-Hand (Derby 2022/2023)	5,495
Fish On-Hand (Swift Power Canal Plant)	7,000
Pounds On-Hand (6.0 f/lb)	2,083
Feed Fed (lbs.)	3,833
Net Gain (lbs.)	5,248
Feed Conversion	0.73

2021 Merwin special Kids Derby and Forest Service Derby

The 2021 fishing derbies were cancelled again due to COVID-19 pandemic. All derby fish were planted into Merwin Reservoir in April and June 2021 or Swift Power Canal in April thru June 2021. Disposition is as follows:

Stock Inventory This Period 2018 Brood:

Beginning Balance	2,632
Rearing Mortality (7.7%)	201
Planted to Merwin Reservoir 2021	2,431
Pounds Planted (0.25 fpp)	9,724

Stock Inventory This Period 2019 Brood:

Beginning Balance	18,321
Rearing Mortality (1.5%)	269
Planted to Swift Power Canal 2021	13,098
Pounds Planted to Swift Power Canal (1.80 f/lb)	7,263
Planted to Merwin Reservoir 2021	3,000
Pounds Planted to Merwin Reservoir (2.5f/lb)	1,200
On hand for 2021 MSKD	2,413

Temperature & Rainfall

	Jan	*Feb*	*Mar*	*Apr*	*May*	*June*	*July*	*Aug*	*Sept*	*Oct*	*Nov*	*Dec*
Avg High (F)	44.1	41.5	42.5	45.5	50.2	56.3	60.4	63.5	65.1	64.7	56.9	50.3
Avg Low (F)	43.1	40.9	41.3	44.3	47.6	54.4	57.9	60.7	63.4	63.1	55.0	49.1
****Rain (inches)***	13.8	14.2	5.75	1.41	4.45	3.05	0	0.62	7.3	9.85	15.06	14.45

** 2021 total rainfall accumulation 89.95 inches*

Treatments

Date	Brood Year / Species	Pond Numbers	Treatment Chemical	Disease
January – July	2021 Summer, Winter, & Late-Winter Steelhead eggs	Incubators	Formalin	Fungus
June – November	2022 Summer Steelhead adults (Brood)	Smolt Pond 1 & Smolt Pond 2	Formalin	Fungus
September – October	2019 Goldendale Rainbow derby fish	Raceways 9 & 10	Formalin	Ichthyopthirius
September – October	2020 Goldendale Rainbow Juveniles	Raceways 1, 5, & 6	Formalin	Ichthyopthirius
September – October	2021 Winter Steelhead	Raceway 4 & Rearing Pond 12	Formalin	Ichthyopthirius
September – October	2021 Summer Steelhead	Raceway 3 & Rearing Ponds 11, 13, & 14	Formalin	Ichthyopthirius
June	2021 Late-Winter Steelhead	Intermediate Raceways 3, 4, & 5	Potassium Permanganate	Bacterial Gill Disease
September – October	2021 Late-Winter Steelhead	Raceways 7 & 8	Formalin	Ichthyopthirius
December	2021 Goldendale Rainbow eggs	Incubators	Formalin	Fungus
November – December	2022 Summer & Winter Steelhead eggs	Incubators	Formalin	Fungus
December	2022 Winter Steelhead Adults (Brood)	AP-2	Formalin	Fungus
February – June	2021 Late-Winter Steelhead Adults (Brood)	AP-1	Formalin	Fungus

Maintenance & Capital Projects

Maintenance

- Cleaned all dielectric tubes, inspected all fuses and rings, replaced any damaged or worn-out parts on Ozone Generator #1
- Replaced all elements and filters on Kaeser Compressor supply lines and Pure Gas air dryers
- Routine Maintenance on Kaeser Compressors
- Annual calibration for ambient ozone sensors and generators
- Routine maintenance for Ford Cargo planting truck
- Routine maintenance for international planting truck
- Aerator replaced on international planting truck
- Air stone replaced on international planting truck
- Routine maintenance for Ford F-350
- Routine maintenance for Ford F-250
- Routine maintenance for Chevy Silverado
- Installed new alarm panel and system for fire suppression
- Routine maintenance on forklift and attempt to repair stalling issues
- Replaced air compressor in Ozone Plant
- Replaced air compressor for fire suppression
- Replaced air conditioning unit for the Chemical Storage Building
- Replaced alarm floats on rearing ponds and intermediate raceways
- Replaced voltage regulator for Z-Trak mower
- Routine service for all on station equipment; gator, mowers, pumps, trimmers, blowers, saws, etc.
- Trimmed all deciduous trees, bushes, & hedges around facility
- Residence professionally carpets cleaned
- Routine service for hatchery building walk in freezer compressor & heat pump
- Routine service for residence heat pumps

Capital

- No capital projects this year

Lewis River Hatchery Introduction

The Lewis River Salmon Hatchery is located approximately eight miles east of Woodland, WA on the North Fork Lewis River. Originally constructed in 1909 on Johnson Creek, the hatchery was moved to its present site in 1923.

Program Goals

- 1,350,000 yearling Spring Chinook @ 8-12 f/lb planted into N.F. Lewis River
- 1,100,000 yearling Early Coho @ 16 f/lb planted into N.F. Lewis River
- 9000,000 yearling Late Coho @ 16 f/lb planted into N.F. Lewis River

Approximately 29,000 gallons of water per minute can be delivered to the hatchery by eight pumps that are located at two separate intakes. Four booster pumps permit further distribution of water to other areas of the facility as needed. Three gas stabilization towers and one packed column are available to remove supersaturated gases from the water supply when necessary.

There is approximately 312,000 cubic feet of available rearing space. This space consists of 14 super raceways and 12 standard raceways. Adult holding space consists of four large concrete ponds with a common center channel totaling 53,000 cubic feet.

The incubation facility houses fifty stacks (16 trays/stack) of vertical incubators and four shallow troughs.

The Lewis River Hatchery also includes three residence, hatchery/office building, freezer building, two three bay storage buildings, two small storage buildings, public restrooms, two intake structures, two generator/pump control buildings, two compressor buildings, domestic water pump house and a two-story adult handling facility.

Adult Trapping and Brood Stock

The Lewis River Ladder operates continuously year around. Once the fish are captured, staff identify, numerate and sort for hatchery brood stock and watershed escapement goals. In the below stocks the carcass distribution line represents surplus fish not needed for program goals and may go to food bank/tribes, nutrient enhancement, or landfill. The trapping and disposition of the stocks below only represent fish that were trapped at the Lewis River Hatchery Ladder.

2021 Lewis River Winter Steelhead

The last 2021 brood winter steelhead was trapped at the Lewis Ladder on January 26, 2021. Brood stock was collected at the Lewis Ladder and shipped to Merwin Hatchery.

Final Trapping & Disposition

Total Trapped	180
Mortality (.05%)	1
Brood Stock Shipped	82
Carcass Distribution	97

2021 Brood Lewis River Late Winter Steelhead, Hatchery Origin

The were no Late Winter Steelhead trapped at Lewis River Hatchery in 2021.

Final Trapping & Disposition

Total Trapped	0
Planted Upstream	0

2022 Brood Lewis River Summer Steelhead

The first summer steelhead trapped at the Lewis River Ladder was on July 6, 2021. Brood shipped was to Merwin Hatchery.

Final Trapping & Disposition

Total Trapped	124
Recycled	14
Mortality (1.6%)	2
Carcass Distribution	82
Brood Shipped	26

2022 Brood Lewis River Winter Steelhead

The first Winter Steelhead was trapped November 30, 2021, at the Lewis River Ladder.

In-season Trapping & Disposition

Total Trapped	74
Trap Mortality	2
Brood Shipped	0
Carcass Distribution	24

2020 Brood Lewis River (Type N) Coho

The last Late Coho captured at the Lewis River Ladder was on January 26, 2021.

Final Trapping & Disposition

Adults Trapped	11,381
Jacks Trapped	4,878
Adult Mortality (7.5%)	861
Jack Mortality (2.1%)	105
Adults Spawned	1,305
Jacks Spawned	8
Adult Carcass Distribution	9,286
Jack Carcass Distribution	4,765
Adults Planted Upstream	0
Jacks Planted Upstream	0
Adults Received from Merwin FCF	71
Jacks Received from Merwin FCF	0

2021 Brood Lewis River Spring Chinook

The first arrival at the Lewis Ladder was on April 30, 2021. Brood stock was collected and shipped to Speelyai Hatchery.

Final Trapping & Disposition

Adults Trapped	288
Jacks Trapped	41
Adult Mortality (0%)	0
Jack Mortality	0
Adult Carcass Distribution	0
Jacks Carcass Distribution	0
Adult Brood Shipped	42
Jack Brood Shipped	5
Adults Planted Upstream	246
Jacks Planted Upstream	36

2021 Brood Lewis River (Type S) Early Coho

The first early Coho trapped at the Lewis River Ladder was on September 2, 2021. Brood stock for hatchery production is collected and then shipped to Speelyai Hatchery.

Final Trapping & Disposition

Adults Trapped	16,718
Jacks Trapped	6,412
Adult Mortality (1.8%)	302
Jack Mortality (3.8%)	250
Adult Carcass Distribution	15,018
Jack Carcass Distribution	6,124
Adult Brood Shipped	1,314
Jack Brood Shipped	38
Adults Planted Upstream	84
Jacks Planted Upstream	0
Adults spawned	0

2021 Brood Lewis River (Type N) Late Coho

The first Late Coho trapped at the Lewis River Ladder was on October 19, 2021. All brood stock is held and spawned at the Lewis River Hatchery.

Final Trapping & Disposition

Adults Trapped	11,208
Jacks Trapped	4,318
Adult Mortality (3.2%)	359
Jack Mortality (1.2%)	52
Adults Spawned	1,486
Jacks Spawned	2
Adult Carcass Distribution	9,363
Jack Carcass Distribution	4,264

INCIDENTAL TRAPPING

2021 Brood Lewis River Wild Spring Chinook

The first wild Spring Chinook trapped at the Lewis River Ladder was on May 26, 2021. Merwin F.C.F. on February 16, 2021. All fish trapped were planted into the Lewis River.

Final Trapping & Disposition

Adults Trapped	3
Jacks Trapped	2
Adults Planted Upstream	3

2020 Brood Lewis River Wild Fall Chinook

The last wild Fall Chinook trapped at the Lewis Ladder was on January 5, 2021. All fish were returned to the Lewis River.

Final Trapping & Disposition

Adults Trapped	8
Jacks Trapped	2
Adult Planted Downstream	8
Jacks Planted Downstream	2

2021 Brood Lewis River Wild Fall Chinook

The first Wild Fall Chinook was trapped at the Lewis River Ladder was on September 2, 2021. All fish were returned to the Lewis River.

Final Trapping & Disposition

Adults Trapped (Lewis)	9
Jacks Trapped (Lewis)	0
Adult Planted Downstream	9
Jacks Planted Downstream	0

2021 Brood Fall Chinook (Unknown Hatchery Origin)

There is no hatchery released Fall Chinook on the Lewis River, we identify any adipose clipped Fall Chinook as "unknown" origin. The first Fall Chinook of hatchery origin was trapped at the Lewis River Ladder on September 2, 2021.

Final Trapping & Disposition

Adults Trapped	76
Jacks Trapped	8
Adult Mortality (39.4%)	30
Jack Mortality (37.5%)	3
Adult Carcass Distribution	46
Jack Carcass Distribution	5

2021 Brood Lewis River Wild Early Coho

The first natural origin Early Coho was trapped at the Lewis River Ladder was on September 2, 2021. All wild Early Coho were planted into the Lewis River.

Final Trapping & Disposition

Adults Trapped	395
Jacks Trapped	6
Adults Planted Upstream	392
Jacks Planted Upstream	6

2021 Brood Lewis River Wild Late Coho

The first wild Late Coho was trapped at the Lewis River Ladder on October 19, 2021. Lewis River Hatchery received some wild Late Coho from the Merwin FCF that were used for brood stock as part of the integrated portion of the Late Coho hatchery program. Fish not used for brood stock were planted into the Lewis River.

Final Trapping & Disposition

Adults Trapped	615
Jacks Trapped	14
Adult Mortality (9.4%)	58
Jack Mortality (21.4%)	3
Adults Spawned	380
Jacks Spawned	9
Adults Planted Upstream	177
Jacks Planted Upstream	2
Adults Received from Merwin FCF	0
Jacks Received from Merwin FCF	0

Adult Trapping – Lewis Hatchery Ladder

	CK:SP:LEHA:21:H			CK:SP:LEWI:21:W			CK:FA:UNKN:21:H			CK:FA:LEWI:21:W		
	M	F	J	M	F	J	M	F	J	M	F	J
Return to Stream										7	2	
Planted Upstream	219	27	36	2	1	2						
Shipped	8	34	5									
Mortalities							21	9	3			
Carcass Distribution							36	10	5			
Total	**227**	**61**	**41**	**2**	**1**	**2**	**57**	**19**	**8**	**7**	**2**	**0**

	CO:SO:LEHA:21:H			CO:SO:LEWI:21:W			CO:NO:LEWI:21:H			CO:NO:LEWI:21:W		
	M	F	J	M	F	J	M	F	J	M	F	J
Return to Stream												
Planted Upstream	47	37	0	207	185	6				98	79	2
Shipped	630	684	38									
Mortalities	130	172	250	1	2		151	201	52	26	32	3
Carcass Distribution	9042	5976	6124				5115	4248	4264			
Spaw ned							755	731	8	170	210	9
Total	**9849**	**6869**	**6412**	**208**	**187**	**6**	**6021**	**5180**	**4324**	**294**	**321**	**14**

	CO:NO:LEWI:20:H			CO:NO:LEWI:20:W		
	M	F	J	M	F	J
Return to Stream						
Planted Upstream				12	11	
Shipped						
Mortalities	17	14	2			
Carcass Distribution	15	18	3			
Spaw ned						
Total	**32**	**32**	**5**	**12**	**11**	**0**

	SH:SU:MEHA:22:H		SH:WI:MEHA:21:H		SH:WI:MEHA:22:H		SH:WL:LEWIS:21:H	
	M	F	M	F	M	F	M	F
Return Downstream	12	2						
Planted Upstream								
Shipped to Merwin Hatchery	16	10						
Mortalities		2	1		2			
Carcass Distribution	28	54	21	56	17	7		
Total	**56**	**68**	**22**	**56**	**19**	**7**	**0**	**0**

Incubation Summary

2020 Brood Lewis River Late Coho (Integrated and Segregated)

Once a strong eye developed, the eggs were shocked and picked to remove dead eggs. After the morbid eggs were removed, the eyed eggs were inventoried and laid down to hatch or ship. Total egg loss (roughly 19.9%) was 561,834. The integrated on-station program of 1,163,585 eyed eggs for the Lewis River program were kept on station for the entirety.

A total of 1,606,384 segregated eyed and green eggs were shipped out of Lewis River Hatchery. Washougal Hatchery received 1,540,784 green eggs. The 72,500 eyed eggs were distributed as follows: The Steve Syverson Project 5,000; Ridgefield High School 10,000; Clark PUD 46,000; Columbia Springs 11,500. Egg inventory and distribution was as follows:

Total Egg Take (green)	2,815,754
Egg Loss	561,834
Short/Over	-33294
Adjusted Egg Take	2,782,460
Total Eyed Eggs	2,220,626
Shipped (Green)	1,526,951
Adjusted Shipped (Green)	1,540,784
Shipped (Eyed)	72,500
Females Spawned	764
Fecundity	3,686

2021 Brood Lewis River Early Coho

Most of the Early Coho brood stock were shipped to Speelyai and spawned there. Speelyai spawned the brood and incubated the resulting eggs to the eyed stage. From October through December, the 1,414,271 eyed eggs were shipped to Lewis River Hatchery to finish their incubation.

2021 Brood Lewis River Late Coho (Integrated and Segregated)

Over 2.8 million eggs were taken in 2021. The first spawn of late Coho took place on November 16, 2021, and the last was on December 14, 2021. The Washougal Hatchery received about 1.47 million (segregated) green eggs. The remaining eggs were laid down for incubation at Lewis River Hatchery. Of the remaining eggs, 74,100 were incubated to the eyed stage and were distributed to the following schools and coops: 46,000 to Clark County PUD, 5,000 to the Steve Syverson Project, 100 to Captain Strong Primary School, and 10,000 to Ridgefield High School. An additional 13,000 eyed eggs will be shipped to Columbia Springs Coop in January of 2021. The remaining eggs on hand, approximately 1.1 million, are the integrated portion of the egg take, and will be kept at Lewis River Hatchery, reared and released into the Lewis River in April of 2023. At the time of this report eggs are still in incubation and have not been inventoried.

Total Egg Take (green)	2,854,957
Egg Loss	0
Short/Over	0
Shipped (green)	1,476,964
Adult Females Spawned	935
Fecundity	3,053

Rearing Summary

2019 Brood Lewis River Late Coho

Lewis River Hatchery volitionally released 1,047,267 Late Coho averaging 16 f/lb, between April 1 and 19, 2021. Approximately 75K were adipose clipped and coded wire tagged; while 75K were coded wire tagged only. The remaining fish were only adipose fin clipped.

Final Stock Inventory

Beginning Balance	1,095,792
Pounds Ponded	776
Rearing Mortality (2.6%)	29,486
Adjustment	(19,039)
Fish Planted	1,047,267
Pounds Planted	65,532
Feed Fed (lbs.)	57,147
Net Gain (lbs.)	64,756
Conversion	0.88:1
CV	7.54

2019 Brood Spring Chinook

The last of the 2019 brood Spring Chinook were volitionally released from February 3 through March 15, of 2021. This group totaled 467,488 and was a mix of fish that were at 8 and 12 f/lb. The prior October release consisted of 853,885 smolts released, making a total of 1,321,373 fish planted from the 2019 brood year. Of the 2019 brood Spring Chinook, 32-36k out of each of the four unique release groups (October 12 f/lb early transfer, February 8fpp early transfer, February 12 f/lb late transfer, and February 8 f/lb late transfer) were adipose clipped with a coded wire tag, and another 32-36k out of each group were coded wire tagged with adipose fin present. The remaining fish in each group were adipose marked.

Final Stock Inventory

Fish Received	1,369,750
Pounds Received	27,291
Rearing Mortality (3.5%)	48,377
Fish Planted	1,321,373
Pounds Planted	116,704
Feed Fed (lbs.)	72,899
Net Gain (lbs.)	89,413
Conversion	0.81:1
Average CV of Groups Planted	8.02

2019 Brood Lewis River Early Coho

Lewis River Hatchery volitionally released 910,423 Early Coho, averaging 15.3 f/lb, between April 1st and 30th of 2021. Approximately 75K were coded wire tagged and adipose clipped and another 75K were only coded wire tagged. All other fish in the release group were adipose fin clipped.

Final Stock Inventory

Beginning Balance	1,322,453
Pounds Ponded	779
Rearing Mortality (17.7%)	234,046
Adjustment	(177,984)
Fish Planted	910,423
Pounds Planted	59,292
Feed Fed (lbs.)	55,464
Net Gain (lbs.)	58,513
Conversion	0.94:1
Average CV	6.94

2020 Brood Lewis River Spring Chinook

On April 26th and May 3rd of 2021, the Lewis River Hatchery received 1,053,880 Spring Chinook from Speelyai Hatchery. In addition, 328,780 were shipped from Speelyai to Lewis River Hatchery on December 3rd and 6th of 2021. Out of each size and release group of 2019 brood springers (May transfer 12 f/lb, May transfer 8 f/lb, December transfer 12fpp, December transfer 8 f/lb), approximately 37k were coded wire tagged and adipose fin clipped, 37k were only coded wire tagged, and the remaining were only adipose fin clipped. From October 21st through 29th of 2020, a total of 870,201 of the 2020 brood year Spring Chinook were released into the Lewis River and the remaining group of approximately 154k is being held on site, to be released with the December transfer groups in February of 2022.

Stock Inventory This Period

Fish Received	1,382,660
Pounds Received	28,011
Rearing Mortality (3.4%)	31,645
Planted as of December 31st	870,201
On Hand as of December 31st	480,814
Pounds Planted	69,352
Pounds on Hand	42,900
Feed Fed (lbs.)	64,996
Net Gain (lbs.)	84,241
Conversion	0.77:1
CV of Fish Planted	5.42

2020 Brood Lewis River Early Coho

The last take of Early Coho was ponded on February 10, 2021. Approximately 75k were snout tagged with an adipose mark, and 75k were snout tagged without an adipose mark. The remaining were only adipose fin marked. The 2020 brood Early Coho are scheduled for release in April of 2022.

Stock Inventory This Period

Balance Prior To Ponding	1,510,956
Fry Loss	12,000
Beginning Rearing Balance	1,498,956
Pounds Ponded	1,238
Rearing Mortality (3.8%)	58,250
Adjustment	(84,608)
Fish on Hand	1,356,098
Pounds on Hand	67,039
Feed Fed (lbs.)	55,202
Net Gain (lbs.)	65,801
Conversion	0.83:1

2020 Brood Lewis River Late Coho

The 2020 brood Late Coho were moved from the incubation room to the standard raceways between February 17th and March 24th of 2021. Approximately 75k were coded wire tagged and adipose fin clipped, 75k were only coded wire tagged, and the remaining fish were only adipose fin clipped. The 2020 brood Late Coho are scheduled for release in April of 2022.

Stock Inventory This Period

Balance Prior to Ponding	1,163,585
Fry Loss	4,250
Beginning Balance	823,049
Pounds Ponded	653
Rearing Mortality (1.9%)	21,167
Rearing Adjustment	9,596
Fish on Hand	811,478
Pounds on Hand	36,170
Feed Fed (lbs.)	30,713
Net Gain (lbs.)	35,517
Conversion	0.86:1

Temperature and Rainfall

	Jan.	*Feb.*	*Mar.*	*Apr.*	*May*	*June*	*July*	*Aug.*	*Sept.*	*Oct.*	*Nov.*	*Dec.*
Average High (F)	45.6	43.2	43.5	46.1	48.6	54.1	59.2	60.5	61.9	62.5	54.4	47.9
Avg. Low (F)	45.1	43.0	42.3	43.4	45.9	51.0	55.3	57.4	59.5	61.3	53.8	47.5
****Rain (inches)***	12.9	12.4	5.8	1.5	3.9	3.1	0.0	.25	8.25	10.6	12.4	13.0

** 2021 total rainfall accumulation 84.1 inches*

Treatments

Date	Brood Year / Species	Pond Numbers	Treatment Chemicals	Disease
January	2020 Late Coho	Incubators	Formalin	Fungus
February	2019 Late Coho	Raceway 14-1	Formalin	Costia Fungus
April	2020 Late Coho	Raceways 2-8	Formalin	Gill Fungus Costia
April	2020 Late Coho	Raceways 9-12	Formalin	Gill Fungus Costia
May - June	2021 Spring Chinook Adults (Brood)	Raceway 15-4	Formalin	Fungus

Maintenance and Capital Projects

Maintenance:

- Routine service of walk-in freezer and compressor
- Routine service of Residence's heat pumps
- Routine service of all hatchery compressors
- Replaced stove top in Residence #1
- Routine maintenance of both Gators
- Upgraded hatchery alarm system with new batteries and charging system
- Replaced bad pond alarm switches and upgraded yelpers and strobes
- Replaced cracked toilet in Residence #1
- Serviced both forklifts
- Routine service preformed on F-250 and F-450 1-ton flat bed
- Repainted Hatchery restrooms
- Routine service of domestic water plant
- Replaced bad patio deck boards at Residence #2
- New landscape beauty bark around Hatchery and Residence's
- Repaired a broken irrigation water line under driveway to Residence #3
- USI Generator day tank was replaced and upgraded
- Replaced old diesel fuel feed lines from the tank to the USI generator
- Had preventative maintenance done to all on station pumps except R2D2 VFD
- Routine maintenance preformed to on station equipment i.e.: mowers, pumps, trimmers, blowers, saw's etc.

Capital:

- No Capital projects this year.

Speelyai Hatchery Introduction

Speelyai Hatchery is a PacifiCorp owned and funded facility that is operated by the Washington Department of Fish and Wildlife. It has been in operation since 1958.

Speelyai Hatchery is located 21 miles east of Woodland, WA just off Highway 503. The hatchery is adjacent to Speelyai Creek on the north shore of Lake Merwin.

Program Goals

- 1,050,000 Spring Chinook transferred to Lewis River Hatchery in May
- 360,000 Spring Chinook transferred to Lewis River Hatchery in December
- 50,000 sub-yearling Spring Chinook @ 80 f/lb planted into the N.F Lewis River
- 1,325,000 Type S Coho eyed eggs transferred to Lewis River Hatchery
- 45,000 Kokanee @ 8.0 f/lb planted into Merwin Reservoir
- 48,000 Kokanee @ 6.9 f/lb planted into Merwin Reservoir
- 36,000 Rainbow Trout @ 2.5 f/lb planted into Swift Reservoir
- 3,500 Rainbow Trout @ 2.5 f/lb planted into Swift power Canal

Approximately 9,200 gallons per minute can be delivered to the hatchery system by gravity flow from Speelyai Creek.

There is approximately 166,450 cubic feet of rearing space available. This space consists of four 17x3'x3' intermediate troughs, twenty-four 10'x80'x4' raceways, four 115'x10'x5' raceways and one large asphalt pond for adult holding/spawning. Incubation consists of fifty stacks of FAL vertical incubators, two deep troughs and one shallow trough. Staff is also responsible for ten 20'x20'x20' net pens located in Merwin Reservoir.

Speelyai Hatchery site also includes two residence, hatchery building, two bay storage building, shop/garage, domestic pump house, small storage building and two chemical storage buildings.

Adult Holding

All Spring Chinook and Coho are trapped at the Merwin Fish Collection Facility or the Lewis River Hatchery Ladder and hauled by truck to Speelyai Hatchery. Kokanee are trapped on-site thru the hatchery effluent trap on Speelyai Creek. In the below stocks the carcass distribution line represents surplus fish not needed for program goals and may go to food banks/tribes, nutrient enhancement, or landfill.

2021 Lewis River Spring Chinook, Hatchery Origin

The first Spring Chinook was received on March 11, 2021. Both ELISA and PCR (Polymerase Chain Reaction) testing that checks DNA extracts for bacterium in salmonid eggs was performed. Adequate number of females were tested to ensure that only gametes from females that tested in the "Below Low" range will be used in the February release groups.

Final Trapping & Disposition

Adults Received	1,292
Jacks Received	53
Adult Mortality (6.6%)	85
Jack Mortality (37.7%)	15
Adults Spawned	1,185
Non-Viable	1
Jack Carcass Distribution	22

2021 Lewis River Type S Coho

The first Early Coho was received on September 7, 2021.

Final Trapping & Disposition

Adults Received	1,314
Jacks Received	38
Adult Mortality (5.6%)	74
Jack Mortality (7.9%)	3
Adults Spawned	1,204
Jacks Spawned	13
Non-Viable	6
Adult Carcass Distribution	30
Jack Carcass Distribution	22

2021 Lake Merwin Kokanee

Adult collection started September 9, 2021. Fish were collected from the hatchery effluent Kokanee trap and held in raceway 25.

Final Trapping & Disposition

Adults Received 640
Adults Spawned 640

	CK:SP:LEHA:21:H				KO:NA:MERL:21:U		CO:SO:LEHA:21:H			
	M	F	NVF	J	M	F	M	F	NVF	J
Planted Upstream										
Mortalities	41	44		20			34	40		3
Carcass Distribution	21			22			2	28		22
Lethal Spawn	587	598	1	11	440	200	594	610	6	13
Live Spawn										
Tags Recovered	207	144		55						
Total	649	642	1	53	440	200	630	678	6	38

Incubation Summary

2021 Lewis River Spring Chinook, Hatchery Origin

Egg Inventory and distribution is as follows: A total of 60,000 eggs ELISA tested above the level of "Below Low" and were destroyed.

Total Egg Take	1,851,100
Egg Loss (4.9%)	91,100
Destroyed	60,000
Fecundity	3,095
Ponded	1,700,000

2021 Lewis River Type S Coho, Hatchery Origin

Egg Inventory and distribution is as follows:

Total Egg Take	1,685,270
Egg Loss (16.1%)	271,000
Shipped	1,414,270
Fecundity	2,670

2021 Lake Merwin Kokanee, Mixed Origin

Egg Inventory and distribution is as follows: At the time of this report, the 2021 Kokanee are still in incubation and will be ponded in January 2021.

Total Egg Take	185,800
Egg Loss (32.6%)	60,500
Destroyed	0
Fecundity	850

Rearing Summary

2019 Lake Merwin Kokanee

On March 1, 2021, the remaining 32,870 Kokanee were released from Speelyai hatchery at an average size of 6.97 f/lb.

Final Stock Inventory

Beginning Balance	113,000
Pounds Ponded	25
Rearing Mortality (14.2%)	16,040
Adjustment	-2,500
Fish Planted	94,460
Pounds Planted	11,807
Feed Fed (lbs.)	9,249
Net Gain (lbs.)	11,782
Conversion	0.79:1

2019 Goldendale Rainbow Trout

On May 17, 2021, 45,000 fish at 2.67 f/lb were hauled to Swift reservoir.

Final Stock Inventory

Beginning Balance	52,300
Pounds Ponded	N/A
Rearing Mortality (2.5%)	1,155
Adjustment	-7,000
Fish Planted	45,000
Pounds Planted	16,854
Feed Fed (lbs.)	12,318
Net Gain (lbs.)	11,815
Conversion	0.97:1

2020 Lewis River Spring Chinook, Hatchery Origin

Coded wire tagging and mass marking were completed on April 25, 2021. In May, 1,053,880 hatchery origin spring Chinook were shipped to Lewis River hatchery at an average size of 120 f/lb. In June, 402,270 were planted in the Lewis River at Pekins boat launch. In December, the remaining 328,780 were shipped to Lewis River hatchery.

Final Stock Inventory

Beginning Balance	1,709,700
Pounds Ponded	1,487
Rearing Mortality (5.1%)	90,413
Adjustment	60,145
Fish Shipped	1,382,660
Pounds Shipped	23,560
Fish Planted	402,270
Pounds Planted	5,118
Feed Fed (lbs.)	25,923
Net Gain (lbs.)	27,191
Conversion	0.95:1

2020 Lake Merwin Kokanee

On October 29, 2021, 48,500 Kokanee at 11.1 f/lb were released into Speelyai bay. At the time of this report, there are 45,310 on hand at an average size of 9.13 f/lb scheduled to be released into Speelyai Bay on March 1, 2021.

2020 Goldendale Rainbow Trout

On November 8, 2021, 41,433 fish were received from Merwin hatchery at an average size of 13.0 f/lb. At the time of this report, there are 41,100 on hand at 8.24 f/lb. These fish are currently being reared in pond 13 and are on schedule to be released into Swift reservoir and the Swift Power Canal starting in May 2022.

2021 Lewis River Spring Chinook, Hatchery Origin

At the time of this report, 1,646,700 have been ponded and are at an average size of 708 f/lb. There are an additional 16,000 in incubation that will be ponded in early January. Mass marking and coded-wire tagging will begin on March 1, 2022.

2021 Lake Merwin Kokanee

At the time of this report, there are 125,300 fish in incubation to be ponded in early January 2022.

Temperature & Rainfall

	Jan	*Feb*	*Mar*	*Apr*	*May*	*June*	*July*	*Aug*	*Sept*	*Oct*	*Nov*	*Dec*
Avg High (F)	48.5	47.3	49.1	50.2	52.2	54.7	56.1	56.5	54.8	52.0	50.9	48.4
Avg Low (F)	46.8	45.2	46.2	49.2	51.4	53.9	55.4	55.2	51.3	49.6	49.1	47.0
****Rain (inches)***	14.1	15.5	6.8	0.9	3.7	2.6	0.01	0.44	7.7	10.9	19.4	17.2

** 2021 total rainfall accumulation 109.6 inches*

Treatments

Date	Brood Year / Species	Pond Numbers	Treatment Chemical	Disease
2/1 – 4/27	2020 Lewis spring Chinook	Raceways	Formalin Drip	Prophylactic for Costia
2/1 – 4/27	2020 Kokanee	Raceways	Formalin Drip	Prophylactic for Costia
4/6 – 9/18	2021 spring Chinook Brood	Raceways 25-28	Formalin Drip	Fungus
9/15 – 10/28	2021 Type S Coho Brood	Adult pond	Hydrogen Peroxide	Fungus
9/15 – 10/7	2021 kokanee Brood	RW 25	Formalin Drip	Fungus
9/1 – 11/19	2021 spring Chinook	Incubation	Formalin Drip	Fungus
9/28 – 12/6	2021 Kokanee	Incubation	Formalin Drip	Fungus
10/14 – 11/21	2021 Type S Coho	Incubation	Formalin Drip	Fungus

Maintenance & Capital Projects

Maintenance:

- Routine service and maintenance to Ford F250
- Replaced worn outlets on marking trailer cords
- Routine service and maintenance to Chevy 3500
- Annual service to three phase compressors
- Bi-Annual maintenance to residential HVAC
- Routine service and maintenance to small motors and pumps
- Replace hydraulic pump on Neilson fish pump
- Annual pruning of trees
- Annual maintenance to back up generator
- Build net pens to hold CWT retention fish
- Annual maintenance to domestic water system
- Rebuild vacuum diaphragm pump
- Upgrade both interior and exterior light fixtures to LED
- Replaced propane tank for generator fuel supply
- New septic riser at Residence #2
- Replaced floor and desks in office
- Rebuilt valves on raceways 1 – 8

Capital

- Installed shade covers on raceways
- Rebuild submersible spray-bar pump at intake
- Replace underground valve at spawning area

Fish & Carcass Distribution

2021 Total Carcass DistributionSummary

	M	F	J
CK:SP:LEHA:21:H	608	601	418
CK:SP:LEWI:21:W	1		
CK:FA:UNKN:21:H	261	211	31
CO:SO:LEHA:21:H	13,900	10026	9439
CO:SO:LEWI:21:W	1	1	0
CO:NO:LEWI:21:H	7,782	6642	5474
CO:NO:LEWI:21:W	196	243	12
CO:NO:LEWI:20:H	1	5	0
CT:AC:LEWI:21:W	1	0	0
SH:SU:MEHA:22:H	302	459	0
SH:WI:MEHA:21:H	384	227	0
SH:WI:MEHA:22:H	223	224	0
SH:WL:LEWI:21:W	0	1	0
SH:WL:LEWI:21:H	0	1	0
KO:NA:MERL:21:M	440	200	0
Total	**24,100**	**18,841**	**15,374**

	Lower Columbia (CAP) Community Action Team			NW Harvest			Cowlitz Tribe			Total
	M	F	J	M	F	J	M	F	J	
CK:SP:LEHA:21:H									9	**9**
CK:FA:UNKN:21:H				218	189	28	2	3		**440**
CO:SO:LEHA:21:H	203	114	333	11,176	8,008	8,695	1,478	657		**30,664**
CO:SO:LEWI:21:W										**0**
CO:NO:LEWI:21:H				5,453	4,187	5,005	668	389		**15,702**
CO:NO:LEWI:21:W										**0**
CO:NO:LEWI:20:H										**0**
CT:AC:LEWI:21:W										**0**
SH:SU:MEHA:22:H				22	47		98	240		**407**
SH:WI:MEHA:21:H							318	151		**469**
SH:WI:MEHA:22:H				10			51	118		**179**
SH:WL:LEWI:21:W										**0**
SH:WL:LEWI:21:H										**0**
KO:NA:MERL:21:M										**0**
Total	**203**	**114**	**333**	**16,879**	**12,431**	**13,728**	**2,615**	**1,558**	**9**	

	American Canadian			Landfill			Nutrient Enhancement			Total
	M	F	J	M	F	J	M	F	J	
CK:SP:LEHA:21:H				608	601	409				**1,618**
CK:SP:LEWI:21:W	1									
CK:FA:UNKN:21:H	41	19	3							**63**
CO:SO:LEHA:21:H	409	560	326	38	43	50	596	644	35	**2,701**
CO:SO:LEWI:21:W				1	1					**2**
CO:NO:LEWI:21:H	169	191	187	141	253	39	1,351	1,622	243	**4,196**
CO:NO:LEWI:21:W	1	3		25	30	3	170	210	9	**451**
CO:NO:LEWI:20:H								1	5	**6**
CT:AC:LEWI:21:W				1						**1**
SH:SU:MEHA:22:H		2		182	170					**354**
SH:WI:MEHA:21:H				66	126					**192**
SH:WI:MEHA:22:H				162	106					**268**
SH:WL:LEWI:21:W					3					**3**
SH:WL:LEWI:21:H					1					**1**
KO:NA:MERL:21:M				440	200					**640**
Total	**621**	**775**	**516**	**1,664**	**1,534**	**501**	**2,117**	**2,477**	**292**	

Mitigation Summary

Stock	Program Goals	Actual Production
*Spring Chinook	1,350,000 @ 8-12 f/lb	** 1,745,606 @ 8-12 f/lb
Early Coho	1,100,000 @ 16 f/lb	910,423 @ 15.2 f/lb
Late Coho	900,000 @ 16 f/lb	1,047,267 @ 15.6 f/lb
Summer Steelhead	175,000 @ 4.8 f/lb	179,997 @ 5.3 f/lb
Winter Steelhead	100,000 @ 4.8 f/lb	104,592 @ 4.8 f/lb
Late Winter Steelhead	50,000 @ 6-8 f/lb	57,749 @ 7.8 f/lb
Kokanee	12,500 pounds	9091 pounds
Rainbow Trout	20,000 pounds	21,053 pounds

**100,000 Spring Chinook upstream production was suspended and moved to the hatchery downstream production.*

*** Additional fish planted were in June and agreed upon thru the ATS group and funded thru the Southern Resident Killer Whale cost code.*

Lewis River Complex Staff

Complex Manager	Aaron Roberts
Fish Hatchery Specialist 4	Mike Chamberlain
Fish Hatchery Specialist 4	Kevin Young
Fish Hatchery Specialist 3	Scott Peterson
Fish Hatchery Specialist 3	Jesse Cody
Fish Hatchery Specialist 3	Luke Miller
Fish Hatchery Specialist 2	Jim Trammell
Fish Hatchery Specialist 2	Doni Calstoy/Vacant October 18th - December
Fish Hatchery Specialist 2	Tiffany Farrar
Fish Hatchery Specialist 2	Jay VonBargen
Fish Hatchery Specialist 2	Chris Roe
Fish Hatchery Specialist 2	Bryan Coyle
Fish Hatchery Specialist 2	Dwayne Fossen/Vacant Oct 18 - December
Fish Hatchery Specialist 2	Grant Sill
Fish Pathologist	Sean Roon

Executive Summary

Adult returns for 2021 for the Lewis River were decent on some but others were low. Early and Late Coho combined exceeded 50,000 adults and provided all program goals for brood stock, shipping fish upstream and achieving our egg take goal, Spring Chinook returned 2041 adults which is about what was projected for the pre-season run forecast and is showing signs of improvements. We were able to meet program goals for brood stock and egg take. Summer Steelhead returns were low this year as they were region wide, we had 959 Summer Steelhead and as of December 31st we have had 568 Winter Steelhead returned. We were able to meet program goals for brood stock, egg take and managed to continue our Summer Steelhead recycling program to allow anglers another chance to catch them. We also planted Horseshoe Lake with 151 adult winter Steelhead to give anglers an opportunity.

The overall juvenile rearing for all stocks went well with no major issues. Our Spring Chinook release strategies continued in 2021 with an October group, 3 groups in February and a June release group. We are just starting to see our returns from these strategies and the next few years we will be able to pull some data and determine how the future of this program will continue. As for Coho, Steelhead and Kokanee, rearing was good with nothing significant to report. Rainbow Trout were planted into Swift Reservoir and the Swift Power Canal. This year due to COVID-19 there were no fishing derbies held at the Merwin Park or Merwin Hatchery. The fish for those derbies were planted into Swift Power Canal and Merwin Reservoir.

All facilities kept up with maintenance of equipment, infrastructure, and hatchery grounds. There was only one major capital project done in 2021 and that was at Speelyai Hatchery where 26 of the 28 raceways were provided shade covers to help with juvenile rearing and adult holding. All facilities are looking and operating well thanks to the staff of WDFW and PacifiCorp.

Staff here on the Lewis River system both WDFW and PacifiCorp are some of the best in the industry and committed to facing challenges in front of us now and in the future with both professionalism and dedication.

APPENDIX H –

2021 Annual Operating Plan, Working Draft

Final Working Draft

2021 Annual Operating Plan

HATCHERY AND SUPPLEMENTATION PROGRAM
NORTH FORK LEWIS RIVER

Prepared by
the
North Fork Lewis River
Aquatic Technical Subgroup

May 27, 2021

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STRATEGIES AND APPENDICES

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DEFINITION OF TERMS AND ACRONYMS

Area Under the Curve (AUC): a method for estimating salmon escapement by dividing the integral of the escapement curve by the average residence time in the survey area.

Annual Operating Plan (AOP): An annual planning document that describes the methods and protocols needed to implement the North Fork Lewis River Hatchery and Supplementation Plan and Program.

Aquatic Coordination Committee (ACC): Committee formed after signing of the North Fork Lewis River Settlement Agreement (Settlement Agreement) and composed of its signatories. Many of the measures contained in the Settlement Agreement require review and consultation with the ACC prior to implementation. Thus, the committee acts as the governing body for implementing aquatic measures contained within the Settlement Agreement. The committee also approves aquatic habitat funds on an annual basis.

Aquatic Monitoring and Evaluation Plan (AMEP): A comprehensive planning document required by the North Fork Lewis River Settlement Agreement (Section 9). The purpose of the AMEP is to develop methods to evaluate aquatic monitoring and evaluation objectives contained within the North Fork Lewis River Settlement Agreement. These objectives relate to fish passage, reintroduction outcome goals, anadromous and resident species monitoring, and development of the North Fork Lewis River Hatchery and Supplementation Plan.

Aquatic Technical Subgroup (ATS): A group composed of representatives of North Fork Lewis River Settlement Agreement signatories formed under the Aquatic Coordination Committee to draft and finalize Hatchery and Supplementation Plans and develop Annual Operating Plans for the Hatchery and Supplementation Program.

Bacterial Coldwater Disease (BCD): Bacterial disease of salmonid fish caused by *Flavobacterium psychrophilum*.

Bacterial Kidney Disease (BKD): Bacterial disease of salmonid fish caused by *Renibacterium salmoninarum.*

Bayesian Goodness of Fit (GOF): a test used to determine whether sample data are consistent with a hypothesized distribution.

Blank wire tag (BWT): A small wire that is uncoded (blank), inserted in the snout of fish, and detectible with handheld wire detection wands or devices.

Brood year (BY): year in which spawning occurs, used to track a single cohort over time.

Coded wire tag (CWT): A small wire with unique codes etched onto the wire, inserted in the snout of fish, and detectible with handheld wire detection wands or devices.

Coefficient of Variation (CV): The ratio of the population standard deviation (σ) to the population mean (μ) *or* in instances when only a sample of data from the population is available CV is estimated by using the sample standard deviation (*S*) to the sample mean ($\bar{x}$) which shows the extent of variability in relation to the mean of the population. The absolute value of the CV, sometimes known as relative standard deviation, is expressed as a percentage.

- Population CV = σ/μ
- Sample CV = $s/\bar{x}$

Columbia Basin PIT Tag Information System (PTAGIS): A regional database that stores and tracks data from fish with passive integrated transponder (PIT) tags.

Condition factor (K): Fulton's condition factor, K, is a measure of individual fish health that assumes the standard weight of a fish is proportional to the cube of its length:

$$K = 100\left(\frac{W}{L^3}\right)$$

where *W* is the whole body wet weight in grams and *L* is the length in centimeters; the factor 100 is used to bring K close to a value of one (Fulton, 1904).

Distinct Population Segment (DPS): A population or group of populations that is discrete from other populations of the species and significant in relation to the entire species. This along with Evolutionarily Significant Unit (ESU) are used to define Endangered Species Act-listed species (DPS for steelhead and ESU for salmon species).

Effective Population Size (N_e): The average size of a population in terms of the number of individuals that can contribute genes equally to the next generation. Therefore, the effective population size is typically smaller than the actual census size of the population.

Enzyme-Linked Immunosorbent Assay (ELISA): This test uses antibodies and color change to identify viral antigens present in sampled fish tissues.

Ecosystem Diagnostic and Treatment (EDT) model: An analytical habitat-based model that evaluates environmental constraints on a fish population(s) and used to predict the carrying capacity or production potential of specific areas of the North Fork Lewis River such as upstream of Swift Dam.

Endangered Species Act (ESA): Passed in 1973, this piece of United States legislation was designed to protect species from extinction as well as the ecosystems upon which they depend. Listed species are classified as "threatened" or "endangered." The ESA is administered by the U.S. Fish and Wildlife Service and the National Marine Fisheries Service.

Evolutionarily Significant Unit (ESU): A distinct population unit that is reproductively isolated and an important component for the legacy of a species, considered a separate "species" for the purposes of conservation.

F1 generation: First generation offspring, in this case, typically referring to offspring of fish spawned in the hatchery and therefore of hatchery-origin.

F2 generation: Offspring of F1 parents that have spawned naturally and therefore of natural-origin.

Feed conversion ratio (FCR): The amount of feed an animal must consume to gain one kilogram of body weight.

Fish per pound (fpp): Number of juvenile salmon per pound batch weight

Floy tag: Visible tags with unique codes and colors applied to the dorsal side of fish to identify individual fish upon capture or through visual surveys. Floy tags are inserted near the posterior side of the dorsal fin and are intended to lock within the dorsal skeletal bones by means of a T-anchor.

Generalized Random Tessellation Stratified (GRTS) design: provides a probability sample with design-based variance estimators by establishing a spatially balanced, random sample allowing for unequal probability sampling to accommodate field implementation issues.

Hatchery and Genetic Management Plan (HGMP): a technical document that describes artificial propagation management strategies that ensure conservation and recovery of ESA-listed salmon and steelhead populations.

Hatchery and Supplementation Plan (H&S Plan): A 5-year planning document intended to provide the plan and process for implementing the goals of Section 8 (Hatchery and Supplementation Program) of the North Fork Lewis River Settlement Agreement.

Hatchery and Supplementation Program (Program): Defined in Section 8 of the Lewis River Settlement Agreement. The goals of the program are to support (i) self-sustaining, naturally producing, harvestable native anadromous salmonid species throughout their historical range in the North Fork Lewis River Basin, and (ii) the continued harvest of resident and native anadromous fish species.

Hatchery and Supplementation Subgroup (H&S Subgroup): Name of ATS prior to December 2018.

HOB: Hatchery Origin Broodstock**.**

HOR: Hatchery Origin Recruit. Fish that are spawned in a hatchery or reared in a controlled environment prior to release into the natural environment.

HOS: Hatchery Origin Spawners.

Hatchery Production: Describes the artificial propagation of fish that occurs in a hatchery as opposed to propagation resulting from natural reproduction. In the North Fork Lewis River, the hatchery production program is designed to maintain harvest opportunities downstream of Merwin Dam and in project reservoirs (residents) and to provide both adult and juvenile anadromous fish for early supplementation efforts in the basin.

Hatchery Scientific Review Group (HSRG): An independent scientific review group established by the United States Congress to initiate hatchery reform that balances both conservation and harvest goals.

Infectious hematopoietic necrosis virus (IHNV): Severe viral disease in the *Novirhabdovirus* genus affecting salmonid fish, particularly smolts and younger life stages.

Infectious pancreatic necrosis virus (IPNV): Severe viral disease in the *Birnaviridae* family affecting salmonid fish, particularly smolts and younger life stages.

Jolly-Seber (JS) mark-recapture model: Provides estimates of abundance, survival, and capture rates from capture-recapture experiments. A fully open-population model (allows for births, deaths, immigration and emigration from a population) estimating both recruitment to the population and survival.

Juvenile life stages (parr, transitional, smolt, precocious male):

- Parr – Juvenile salmonid in a non-migratory stage adapted for freshwater residence. Exhibits distinct parr marks, yellow to brown body and fin coloration, or no signs of smoltification.
- Transitional – Juvenile salmonid exhibiting initial signs of smoltification (i.e., a silvery sheen with visible parr marks). Black pigment may be present on dorsal and caudal fins.
- Smolt – Juvenile salmonid that is entering a stage of seaward migration and adapted for survival in sea water. Exhibits a silvery sheen, mostly or completely absent of parr marks, deciduous scales, white or transparent abdominal fins, and black pigment on dorsal and caudal fins.
- Precocious male – Juvenile male fish that mature in their first or second year, prior to going to sea. Fully mature males have soft abdomens and milt may be expressed. Deeper body morphology compared to smolts. Dark body color. Parr marks may be visible. Dark body and abdomen coloration compared to parr and smolt life stages.
- Post smolt – A salmonid that has previously undergone smoltification and has reverted to a freshwater-adapted stage, typically due to being held in captivity in freshwater. Visual indicators of this phenotype are not well described in the literature. Some fading of silver coloration. Parr marks are not expected to re-emerge. Some yellow or brown-orange coloration of the fins. Fading of intense black pigmentation in the fins.

Kelt: A post-spawn iteroparous fish such as a steelhead or cutthroat.

Lewis River Hatchery Complex: Hatchery fish production in the Lewis River Basin originates from the Lewis River, Speelyai, and Merwin hatcheries, collectively known as the Lewis River Hatchery Complex. The three hatcheries share adult return, rearing, and release functions. A detailed description of each of these facilities is presented in Appendix A of the H&S Plan.

Lower Columbia River (LCR): for the purposes of salmon recovery, referring to the Sub-domain of the Columbia River Basin that includes the estuary and all sub-basins upstream to the towns of While Salmon, Washington and Hood River, Oregon.

Major Population Group (MPG): Group of populations, or strata, sharing similar genetic, life-history, and spatial distribution that make up a subgroup of an Endangered Species Act-listed species (e.g., Coastal MPG, Cascade MPG). Viability of all MPGs are necessary for viability of Endangered Species Act-listed species.

Merwin Collection Facility (MCF): A trapping, collection, and sorting facility located at the base of Merwin Dam. The MCF processes fish for transport upstream as well as broodstock for hatchery operations.

Native (or indigenous): Fish species that have become established in the North Fork Lewis River Basin without human intervention or being substantially affected by genetic interactions through non-native stocks. Native North Fork Lewis River stocks may be present in areas outside the North Fork Lewis River Basin.

NOB: Natural Origin Broodstock

NOR: Natural Origin Recruit. Fish that are derived from natural production only.

NOS: Natural Origin Spawners

Natural Production: Fish that are produced in the natural environment without human intervention as opposed to artificial propagation in a hatchery.

North Fork Lewis River (Lewis River): Includes the mainstem Lewis River from its confluence with the Columbia River to its origin (RM 94.2) on the northwestern slope of Mt. Adams, including free flowing sections between hydroelectric dams. Excludes the East Fork Lewis which enters the North Fork Lewis River at RM 3.5.

North Fork Lewis River Settlement Agreement (Settlement Agreement): A binding agreement between the utilities; federal, state, and regional regulatory entities; tribal entities; and non-governmental organizations. The Settlement Agreement establishes the collective agreement of all signatories with respect to the utilities' obligations in mitigating effects of hydropower operation on fisheries, wildlife, recreation, and cultural and aesthetic resources. The Settlement Agreement forms the basis for issuing hydroelectric operating licenses by the

Federal Energy Regulatory Commission for the four hydroelectric projects on the North Fork Lewis River.

Ocean Recruits: Total escapement of hatchery- and natural-origin fish including those harvested in the ocean, Columbia River, and terminal fisheries.

Proportion of Hatchery Origin Spawners (pHOS): Proportion of natural origin spawners composed of hatchery origin spawners. Equals HOS/(NOS + HOS).

Proportion of Natural Origin Brood (pNOB): Mean proportion of natural origin spawners contributing to broodstock in a hatchery program. Equals NOB/(HOB + NOB).

Passive Integrated Transponder (PIT) tags: Electronic tags inserted into the dorsal sinus or body cavity of fish that transmit data indefinitely when activated by a specialized antenna or reader. All PIT tags have a unique code allowing on-site identification of individual tagged fish.

Proportionate Natural Influence (PNI): Proportionate natural influence on a population composed of hatchery- and natural-origin fish. Equals pNOB/(pNOB + pHOS).

Regional Mark Information System (RMIS): a collection of online databases that maintain records of coded wire tag release, recoveries and locations.

Residual or Residualism: Salmonids that fail to migrate from their natal streams or stream basin after the majority of their cohort have emigrated in a given year. Depending on the species, residuals may take on several different life-histories including precocious sexual maturation, freshwater residence for a season (e.g., to overwinter) or for an additional year followed by anadromy, or in steelhead, permanent freshwater residence and spawning in multiple years. Salmonids with the potential to express anadromy are considered residuals as long as they reside in freshwater and do not become anadromous.

Returns: Adult steelhead or salmon that have spent at least 1 year at sea and have become sexually mature and have returned to the North Fork Lewis River to spawn.

Smolt Index: A number assigned to juvenile salmon that describes the stage of smolt development based on a visual assessment of skin and fin pigmentation (silvering) and body shape. 1 = parr, 2 = transitional, 3 = smolt, 4 = precocious male, 5 = post-smolt or residual (modified from Gorbman et al., 1982).

Smolt to Adult Ratio (SAR): Survival from the beginning point as a smolt (release) to an ending point as an adult.

Supplementation: The use of artificial propagation to develop, maintain, or increase natural production while maintaining the long-term fitness of the target population, and keeping the ecological and genetic impacts to non-target populations within specified biological limits. In the North Fork Lewis River, the supplementation program is designed to reintroduce spring Chinook, late winter steelhead, and early coho to habitat upstream of Merwin Dam.

Single Nucleotide Polymorphism (SNP): SNP genotyping is the measurement of genetic variations of between members of a species. A SNP is a single base pair mutation at a specific locus, usually consisting of two alleles. SNP arrays can be used to analyze large numbers of samples such as outmigrating smolts or transported steelhead upstream of Swift Dam for less cost than microsatellite genotyping.

Steelhead broodstock: Steelhead captured either through traps or in-river netting that meet predetermined genetic assignment probabilities.

Stubby dorsal fin: A dorsal fin in which the rays have become crooked especially along the leading edge and depressed as compared to naturally produced fish. Stubby dorsal fins are indicative of fish reared in a hatchery environment.

Swift Floating Surface Collector (FSC): A trap and haul facility used to collect, sort, sample, and tag outmigrating smolts from adult and juvenile supplementation programs upstream of Swift Dam. The FSC is located on the forebay of Swift Reservoir and has the ability to operate year-round and through fluctuating reservoir levels. All fish are sorted in the FSC and trucked either downstream of Merwin Dam or returned to the reservoir.

Tangle net: A net designed to entangle the snout (not the gills) of target species through use of smaller mesh sizes. This method is considered a safer alternative to traditional gill netting in which the net material may become wedged under the fish operculum, potentially causing lacerations of the gill lamellae.

Viral hemorrhagic septicemia virus (VHSV): Virus in the genus *Novirhabdovirus,* exclusive to fish and related to IHNV.

EXECUTIVE SUMMARY

The Annual Operating Plan (AOP) focuses on developing methods and protocols for monitoring and evaluating objectives of the North Fork Lewis River Hatchery and Supplementation program (Program). The AOP is not intended to develop program objectives or goals, rather, the AOP describes 'how' these objectives will be implemented, monitored, and evaluated. The goals and objectives of the current program are identified and described in the Hatchery and Supplementation Plan (H&S Plan, 2014)
https://www.pacificorp.com/content/dam/pcorp/documents/en/pacificorp/energy/hydro/lewis-river/license-implementation/acc/FINAL%20H_S%20cvr%20ltr%20to%20FERC.pdf

In December 2020, the Utilities submitted a revised final H&S Plan to the FERC.
https://www.pacificorp.com/content/dam/pcorp/documents/en/pacificorp/energy/hydro/lewis-river/license-implementation/ats/A%20-%20HS%20PLAN%20FINAL%202020.pdf

As of May 2021, the FERC has not yet approved the final H&S Plan. Because the 2020 H&S Plan is pending approval, this AOP is considered an interim or transitional version that continues to incorporate the monitoring objectives and protocols of the 2014 H&S plan while also adding some new monitoring components of the revised 2020 H&S Plan (e.g., GSI sampling). The Aquatic Technical Subgroup (ATS) assumes that the 2020 H&S Plan will receive FERC approval in 2021 and is currently developing a revised AOP for implementation in 2022 that conforms to the new objectives and formatting of the 2020 H&S Plan.

A summary of major changes between the 2020 AOP and the 2021 AOP is included in Table ES1.

This AOP is required under Section 8.2.3 of the North Fork Lewis River Settlement Agreement (Settlement Agreement). Section 8.2.3 states that, at a minimum, the AOP must contain the following information:

1. A production section specifying the species and broodstock sources
2. Current hatchery target and juvenile production targets
3. A release section identifying, by species, the rearing schedule and planned distribution of fish and the schedules and location for release
4. A list of facility upgrades to be undertaken in the current year
5. A description of relevant monitoring and evaluation to be undertaken

Sections A, B, and C of this plan are dedicated to each hatchery production species: Late winter steelhead, spring Chinook, and Coho salmon. Each section is organized and formatted similarly to maintain consistency within this document and make it easier to locate information for each species. Other sections include Monitoring and Evaluation (Section D) and Reporting Requirements (Section E).

The monitoring and evaluation section of this AOP (Section D) is being revised in 2021 and is included in this document as a placeholder. Objectives provided in Section D represent the minimum monitoring benchmarks necessary to meet the requirements of the Settlement

Agreement as well as recommendations from the Hatchery and Scientific Review Group (HSRG). The most recent Aquatic Monitoring and Evaluation Plan was finalized on April 3, 2017, and is available here:

http://www.pacificorp.com/content/dam/pacificorp/doc/Energy_Sources/Hydro/Hydro_Licensing/Lewis_River/li/acc/04032017%20LR%20ME%20Plan%20-%20Final%20Revised%20Master%20to%20FERC.pdf

A revised Aquatic Monitoring and Evaluation Plan is being revised in 2021 and will be submitted to the FERC for approval in the spring of 2022.

RECOMMENDATIONS AND ADAPTIVE MANAGEMENT

The AOP is updated annually through a collaborative effort and participation of resource agency and utility representatives collectively referred to as the Aquatic Technical Subgroup (ATS).

The ATS meets regularly to discuss implementation of the H&S Plan as well as development of the AOP and is tasked with adaptively managing plans and recommending changes. It is important to note that the ATS is not a decision-making entity recognized under the Settlement Agreement. Therefore, recommendations made by the ATS that result in program changes must be brought to the Aquatic Coordination Committee (ACC) for approval and documented in the meeting notes.

AREA OF FOCUS

The area of focus of this AOP is the lower Lewis River, Washington, downstream of Merwin Dam at river mile (RM) 19.5. Two major tributaries, Cedar Creek and the East Fork Lewis River, enter the Lewis River at RM 15.7 and 3.5, respectively. The section of the Lewis River between the confluence of the East Fork Lewis River and Merwin Dam is often referred to as the North Fork Lewis River or more simply, Lewis River, when referenced in this Annual Operating Plan.

Hatchery fish production in the Lewis River Basin originates from the Lewis River, Speelyai, and Merwin hatcheries (collectively known as the Lewis River Hatchery Complex). The three hatcheries are currently operated as a complex, sharing adult return, rearing, and release functions. A detailed description of each of these facilities is included in 2020 and previous versions of the AOP but is no longer included in the 2021 version.

Table ES - 1. Summary of Significant Changes to AOP, 2020 to 2021

Section(s)	Change	Rationale
Section D, Monitoring and Evaluation	Added placeholder for 2021 content	The ATS is in the process of drafting this section for the 2022 AOP. Approval of the 2020 H&S Plan by FERC is needed to move forward with including 2020 H&S Plan objectives in the 2021 or 2022 AOPs.
Strategy B	Incorporated Screw Trapping Plan as a component to the AOP	Incorporate all strategies into AOP to better organize annual plans
Strategy C	Wrote and incorporated Fish Health Strategy as a component to the AOP	Formalize Fish Health Strategy with input from Sean Roon and WDFW staff. Incorporate all strategies into AOP to better organize annual plans.
Strategy E	Wrote and incorporated Precocity Study Plan for Spring Chinook Salmon	Drafted and finalized Precocity Study Plan with input from ATS. Incorporate all strategies into AOP to better organize annual plans.
Strategy D	Moved methods previous in Objective 2, Methods to Determine pHOS for Winter Steelhead, Spring Chinook Salmon, and Coho Salmon on Spawning Grounds Downstream of Merwin Dam and Evaluate Precision of pHOS Estimates and Ability to Determine the Trend Toward Hatchery and Genetic Management Plan Targets Over Time, to Strategy D.	Methods for how to collect data that support M&E Objectives are now included as Strategies.
Strategy G	Moved methods previously in Objective 14, Estimating Adult and Juvenile Abundance of Winter Steelhead, Coho, and Spring Chinook Downstream of Merwin Dam, to Strategy G.	Methods for how to collect data that support M&E Objectives are now included as Strategies.
Strategy H	Moved methods previously in Objective 15, Determining the Spatial and Temporal Distribution of Spawning Winter Steelhead, Spring Chinook, and Coho Downstream of Merwin Dam, to Strategy H.	Methods for how to collect data that support M&E Objectives are now included as Strategies.
Strategy I	Moved methods previously in Objective 16, Evaluating Fall Chinook and Chum Populations Downstream of Merwin Dam, to Strategy I.	Methods for how to collect data that support M&E Objectives are now included as Strategies.
Appendix B	New component of AOP, ATS Work Plan for 2021	The ATS uses a spreadsheet-based calendar to review action items and track and upcoming discussions and actions; for the sake of organization, it is included in the AOP as a working file.
Executive Summary	Updated language about H&S Plan to reflect 2020 update	Consistency with H&S Plan
Sections A, B, C	Added placeholders for handling and sampling protocols	Work in progress for 2022

Section(s)	Change	Rationale
Appendix A	Remade Handling and Sampling Protocols based on input from ATS and ATS subgroup	Protocols were out of date and lacked detail, they are still in progress but will be included in 2022 AOP

SECTION A LATE WINTER STEELHEAD

1.0 INTRODUCTION

The Lewis River late winter steelhead hatchery program has three main components, described in Sections 2, 3, and 4 below: Section 2) broodstock collection and processing for adult program implementation; Section 3) juvenile rearing and release; and Section 4) adult supplementation upstream of Swift Dam. The following sections describe the protocols for implementing the Lewis River late winter steelhead portion of the Hatchery and Supplementation Plan (H&S Plan; PacifiCorp and Cowlitz County PUD, 2014).

2.0 ADULT PROGRAM IMPLEMENTATION

Broodstock collection is based on the genetic assignment of individually collected adults (Section 2.1), the total collection goal (Section 2.2) and timing (Section 2.3). Adult NOR steelhead are collected and sampled following a standardized protocol (Section 2.5). Individuals that are collected and considered for broodstock are genetically assessed using SNP genotyping (Section 2.6). After genetic screening results are complete, adults are either held for spawning as potential broodstock, or released back to river (Section 2.7). As the broodstock reach maturation, individuals are spawned following standardized protocols (Section 2.8). All fish are released back to river after spawning.

2.1 Broodstock Source and Selection

The Lewis River late winter steelhead supplementation program strives to use the most locally adapted adults for its broodstock in order to improve the survival and productivity of program offspring. Therefore, specific criteria have been developed to guide broodstock collection based on the origin, source (i.e., genetic assignment), and timing of returning adults (see Table A1). First, the program only uses natural-origin winter steelhead that return to the Lewis River. Any returning adult that is a first-generation hatchery recruit (i.e., an adult with an intact adipose fin that also possess a BWT) will not be considered for broodstock. Second, priority is given to individuals that are most likely to be adapted to the Lewis River Basin based on their genetic profile. Lastly, broodstock collection is divided into two phases: Phase I (January 30 to March 31) and Phase II (April 1 through the end of collection).

Regardless of the Phase, the highest priority broodstock source are steelhead that were naturally produced in the Lewis River Basin (i.e., genetically assign back to the North Fork Lewis River or its tributary, Cedar Creek). When the number of Lewis River Basin source adults do not meet broodstock collection needs, steelhead that genetically assign to other basins within the Cascade MPG (e.g., Kalama, Cowlitz, Toutle rivers) can be used for brood during both phases. If insufficient adults are available from the Cascade MPG, adults assigning to the Gorge MPG may also be used but only during Phase II. Steelhead that genetically assign to the Coastal MPG cannot be used for broodstock unless the Coastal assignment probability is 20% or less, the primary assignment is to the Cascade or Gorge MPG, and collection is in Phase II. Any winter steelhead with assignment to a hatchery stock (i.e., Chambers or Skamania) at levels greater

than 5% will not be incorporated into the broodstock despite genetic probability assignment of 50% or greater to the Lewis River winter steelhead stock.

Table A-1. Priority for late winter steelhead broodstock source during Phase I and II collection based on genetic assignment probabilities

Phase	Priority	River or MPG
Phase I (Jan – Mar)	**1**	North Fork Lewis River
	2	Cedar Creek[1]
	3	Cascade MPG
Phase II (Apr – May)	**1**	North Fork Lewis River
	2	Cedar Creek[1]
	3	Cascade MPG
	4	Gorge MPG
	5	Coastal MPG[2]

[1] The SNP baseline used in 2020 did not include a collection from Cedar Creek and thus no steelhead collected for brood will have assigned to Cedar Creek.

[2] Steelhead that assign to the Coastal MPG can only be used for brood if their assignment probability is < 20% AND the remaining probability is composed of Cascade or Gorge MPGs.

2.2 Broodstock Collection Goal

Based on average fecundities, the current steelhead broodstock spawning goal is set at a total of 50 adults consisting of 25 females and 25 males. Depending on fecundity levels, partial spawning may occur with females to assist in meeting the 25-female target without exceeding the egg take goal. However, this decision must be coordinated with WDFW and NMFS prior to implementation.

To meet the broodstock spawning goal, an adult collection goal has been established that considers three factors: sex ratios (Section 2.3), genetic assignment rates (Section 2.6), and spawn timing (Section 2.3). Additional adults may be collected based on the rate at which steelhead genetically assign to acceptable broodstock sources. Additional collection of adults is included in the proposed collection curve too buffer for lower than expected genetic assignment rates. However, additional collection shall not increase the total number of adults spawned for a given brood year (see Section 2.3).

The last available spawning day is approximately June 1, 2021, in order to meet the program size goals at release. If the rearing goal is exceeded, surplus fish will continue to be reared and released with the program fish. However, this will require notification to NMFS prior to release. The intention of the spawning program is to never exceed the egg take goal and precautions should be employed (e.g., partial spawning) if it is in jeopardy of exceeding the production limits set in this plan.

2.3 Broodstock Collection Timing

Broodstock collection at all locations should occur proportionately over the entire run timing of the Lewis River late winter steelhead return. The collection curve for 2021 detailed in Table A2 and Figure A1. Brood goals reflect the number of steelhead that need to be collected and spawned to meet the overall broodstock collection goal. The collection goal reflects the number of steelhead that need to be collected and genetically assessed. The collection goal is greater than the brood goal because not all collected adults will be spawned based on broodstock selection requirements (Section 2.1).

Table A-2. Broodstock collection goals for winter steelhead in 2021 by period and sex

			Brood Goal			Collection Goal*			
Phase	Period	Dates (Sun-Sat)	Females	Males	Total	Females	Males	Total	Assignment Rate (avg.)
I	1	Jan 30-Feb 29	1	2	3	2	3	5	0.60
	2	Mar 1-7	1	2	3	2	3	5	0.60
	3	Mar 8-14	1	2	3	2	3	5	0.60
	4	Mar 15-21	2	3	5	3	4	7	0.70
	5	Mar 22 -28	2	3	5	3	4	7	0.75
	6	Mar 29 - Apr 4	2	5	7	3	6	9	0.78
II	7	Apr 5-11	3	7	10	4	9	13	0.79
	8	Apr 12-18	4	8	12	5	9	14	0.84
	9	Apr 19-23	3	8	11	3	9	13	0.87
	10	Apr 26-May 2	2	3	5	2	3	6	0.89
	11	May 3-9	2	3	5	2	3	6	0.89
	12	May 10-16	1	2	3	1	2	3	0.90
	13	May 17-23	1	2	3	1	2	3	0.90
TOTALS			25	50	75	33	60	96	

**Collection goals are calculated by dividing the brood goal by the genetic assignment rate. The genetic assignment rate listed in this table are hypothetical based on previous year's results. However, the assignment rate and thus the collection goals can be adjusted in-season using genetic screening results.*

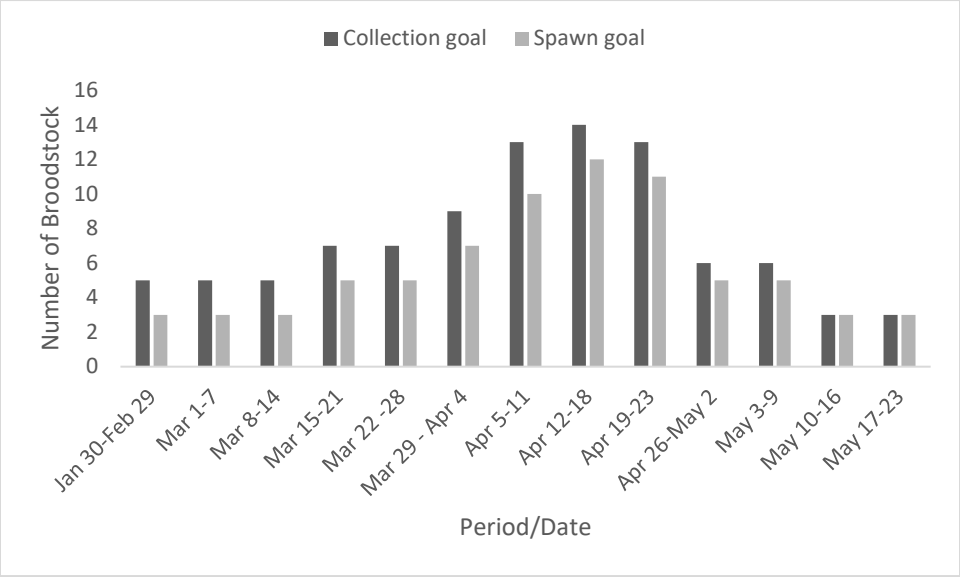


Figure A-1. Broodstock collection curve for the late winter steelhead supplementation program.

Collection goals are intended to be a guide to direct in-season collections. Collections are reviewed weekly to determine if additional in river collection efforts are needed. In-season management decisions pertaining to collection goals by location and collection periods are made by the Hatchery and Supplementation steelhead program coordinator in consultation with hatchery staff. Hatchery staff may consult with the ATS prior to making decisions related to collection goals.

Fish collected prior to February 1 may contain a higher proportion of individuals with genetic assignment to early winter hatchery stocks due to the advanced run/spawn timing of these stocks and the likelihood that some hatchery fish successfully spawn naturally (Glaser, 2009). Genetic analysis of fish captured prior to January 25 will provide valuable information pertaining to the proportion of NOR Lewis River stocks prior to the collection window. Therefore, unmarked steelhead captured in either the Lewis River trap or MCF between December 15 and January 29 will be PIT tagged and have a genetic sample taken before release back to the river. Recaptures will continually be released unharmed from the traps during this period. After January 30, 2021, NOR steelhead will be held at Merwin Hatchery pending genetic results for possible use as broodstock.

Progeny from broodstock spawned towards the end of the spawning period in late May through June may be difficult to rear to appropriate release size by May of the following year. Risks of releasing under-sized fish include decreased survival and a potential increase in residualism (Hausch and Melnychuk 2012), which may increase ecological interaction with other Endangered Species Act (ESA) listed salmonid populations (i.e., competition and predation). This risk should be balanced with the need to preserve the genetic diversity represented by late arriving or spawning fish. Adaptive management should be used to direct

collections of broodstock from these early and late "tails" of the run as more information is gathered from this annual effort. Currently, broodstock collection ends on or before May 31 (Table A2).

2.4 Broodstock Collection Methods

The MCF is the main collection point for winter steelhead. The Lewis River ladder collects some winter steelhead but is not a primary capture point. The MCF is cleared daily and sorting of fish occurs on site. All potential broodstock are transported from the MCF or Lewis River ladder to Merwin Hatchery for holding.

2.5 Broodstock Holding Protocols

The following list represents recommendations from WDFW hatchery staff used to reduce handling related stress, injury, or mortality of steelhead held at the Merwin Hatchery.

1. The use of only rubberized nets to hold or move steelhead: Rubberized nets are known to reduce descaling and abrasion.
2. Eliminating the use of cotton gloves to handle steelhead in favor of bare hands: Cotton gloves are abrasive on fish and remove the protective mucous on the skin of fish.
3. Aqui-S is used for the safety of the employee and to prevent injury and stress to fish during air spawning from the females and live spawning of the males.
4. Floy tags of several colors are used for quick visual identification of individual fish to limit the number of fish handled when checking for ripeness.
5. Salt and Formalin are used in holding raceways or circular tanks for steelhead. Salt reduces stress and improves oxygen uptake. Formalin is used to control fungi and parasites.

All NOR winter steelhead broodstock will be held at the Merwin Hatchery. Hatchery staff will check broodstock weekly for maturity. Once the genetic results are available (every other week), hatchery staff will follow one of the following steps.

1. Any NOR winter steelhead that genetically assigns to a population/MPG that has been identified as "useable" based on criteria outlined in Section 2.1 (see Table A1) will be retained for broodstock. Each fish will be Floy tagged and placed into adult holding pond(s).
2. Adults collected for broodstock but unspawned due to their genetic assignment are returned back to the lower Lewis River. Each of these fish are PIT tagged so they can be easily be identified if recaptured.
3. Unclipped steelhead that assign to a hatchery stock (greater or equal to 50%) will be euthanized.

Unlike previous years, where hatchery staff tried to follow the bi-weekly brood goal exactly, the protocol outlined above may result in minor deviations from the weekly brood goal. Specifically, there may be some weeks where more (or less) steelhead adults are retained, and ultimately spawned, relative to the weekly broodstock collection goal (See Section 2.3 – Table

A2). For example, in a week there may be four females scheduled to be collected but only three are needed to meet the brood goal. As a reminder, four females would have been scheduled to be collected based on known/hypothesized "assignment rates" (i.e., an assignment rate <1 assumes that a portion of the adults collected will not assign to a "useable" population/MPG based on our broodstock source guidelines). If the genetic results come back and all four females assign out as "useable", all four females will be spawned. Although spawning all four females will cause a deviation from the outlined brood collection goal, the total (season-long) brood collection should stay on track assuming our collection goal is based on an accurate "assignment rate". This is because, in some weeks, more than the expected number of steelhead will be spawned and in some weeks less, but on average, the total broodstock goal of 75 adults (50 males, 25 females) will be met. In fact, there is a 50% probability that the total broodstock collection will be within 2 – 4 fish of the total goal and a 95% probability that the total broodstock collection will be within 8 - 9 fish of the total goal.

The slight change in the broodstock collection in 2020 and 2021 was primarily as result of the frequency at which genetic results were analyzed. In previous years, the genetic assessment was done weekly. Therefore, it was easier to adjust the number of adults collected per two-week period by collecting more or less during the second week based on the collection and genetic results from the first week of the period. Now that the genetic results will be run every other week, this in-season, ad-hoc adjustment will not be possible. However, this update protocol will still result in broodstock goal being met, while simultaneously allowing for some year-to-year "run-timing" variation in broodstock collection, which is observed in wild populations.

If a female becomes ripe to spawn and no male broodstock are available or the fish is being held as excess and has not yet been incorporated into broodstock that fish will be returned to the river; however, all possible precautions will be made to prevent this situation from occurring. The Hatchery and Supplementation steelhead program coordinator in consultation with hatchery management staff will make decisions regarding release of fish. Collection goals should be reviewed to evaluate the risk to project goals of releasing the fish (i.e., will more females likely be available through future collections).

Based on previous genetic results, the potential of encountering a naturally-produced hatchery derivative early winter steelhead (i.e., Chambers stock) during Phase II is rare. Therefore, ripe females caught in-river or by trap after March 30 may be available for broodstock prior to genetic assignment. In these instances, ripe females will be spawned with males that have been genetically assigned to the Cascade or Gorge strata. If females collected during Phase II are not ripe, they will undergo the routine genetic assignment protocol before spawning. Any females that ripen before genetic assignment is complete prior to April 1 will be released as the potential of encountering hatchery derivatives is higher during the early part of the run.

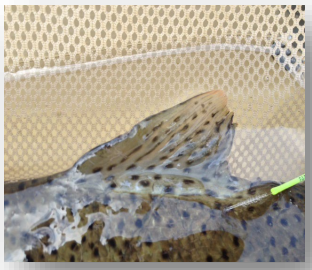
2.6 Data Collection Protocols

A common suite of biological data will be collected from all steelhead that possess an adipose fin regardless of their capture location, which includes:

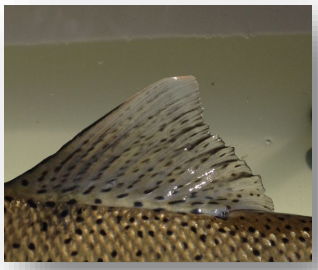
1. **Date of capture** (mm-dd-yyyy)
2. **Capture location** (Merwin or Lewis River Ladder)
3. **Sex** (M/F)
4. **Fork length** (mm)
5. **Scale sampled** (Y/N)

   Up to 100 BWT and all NOR steelhead captured in either the traps or in-river will be have scales taken. Six scale will be taken for each sampled fish (three from each side). Scales will be removed and placed on a scale card including relevant data to identify each sample.

6. **Ripeness** (green, ripe, kelt)
7. **Dorsal fin status** (stubby dorsal fin present Y/N)



Hatchery-origin dorsal fin



Natural-origin dorsal fin

8. **Life Stage** (residual or anadromous)

   Residuals are identified by color, body shape, and size. Residuals exhibit deep (and often vibrant) coloration and spotting as opposed to anadromous fish that possess silvery sheens and subdued spotting. Residuals also possess a distinct red or pink lateral stripe. Body shape of residuals is more rotund and are always smaller in size, typically less than 500 mm in length (Figure A3).

9. **Mark and Tag status (PIT, BWT, AD clip)**

   All fish entering the MCF are scanned for tags and marks. Based on the presence or absence of marks or tags, crews at the MCF shall sort and distribute steelhead either to Merwin Hatchery or upstream as supplementation adults (Figure A2). All steelhead

possessing a PIT tag upon capture at the MCF shall be transported upstream of Swift Dam.

Steelhead transferred to Merwin Hatchery are sampled by hatchery staff and held as potential broodstock (pending genetic assignment), released back to lower river or euthanized if adipose clipped. A small number of steelhead captured have no adipose clip or BWT, but display a stubby dorsal fin. It is believed that these fish have likely lost their BWT. If these fish are collected prior to March 1, they will be transferred to Merwin Hatchery and held for genetic assignment analysis. If fish assign as NOR they will be considered program returns from the supplementation program and transported upstream. If they assign as hatchery origin they will be euthanized (Section 2.8). After March 1, all AD intact stubby dorsal fin steelhead lacking a BWT will be passed upstream for adult supplementation without genetic assignment (Figure A2). Note that the genetic analysis plan may change in 2022.

All steelhead handled either at the MCF or Merwin Hatchery will receive a PIT tag in the dorsal sinus. PIT tags allow individual fish to be identified upon recapture whether they are transported upriver, or released back to river after spawning or as surplus. PIT tagging is performed using injectors and tag trays provided by Biomark® to ensure sterility. PIT-tag code verification will take place prior to insertion. All PIT-tag data will be uploaded into PTAGIS within 48 hours. Additionally, fish transported to Merwin Hatchery that are held as broodstock will receive individually number Floy Tags to help identify individual fish when sorting for spawning.

10. **Genotyping (tissue sampling)**

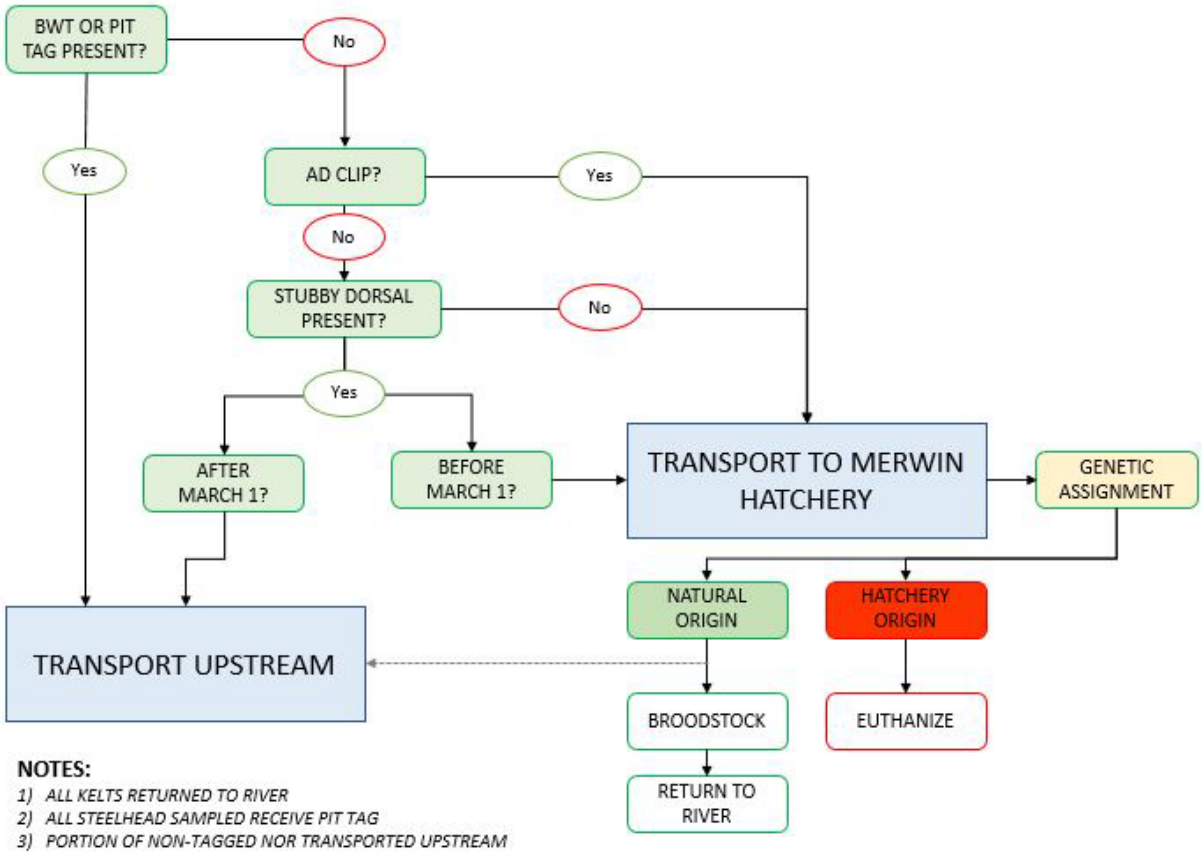
    Tissue samples will be collected from all NOR adults and a portion of BWT returns to the MCF. Tissue samples will consist of either a caudal punch or exterior swabs. For NOR steelhead transported to Merwin hatchery, genetic samples are assembled and sent to the WDFW genetics lab (Olympia, Washington) for assignment analysis every other via express overnight mail. For BWT returns handled at the MCF, every 5th capture (20% sample rate) and up to 200 adults will be tissue sampled. Samples will be analyzed after the collection period ends to assess family representation of program returns and the potential for implementing a genetic mark recapture (parentage) methodology to assess steelhead population abundance and structure upstream of Swift Dam as part of the Aquatic Monitoring and Evaluation Plan (AMEP). Note that tissue sampling may change in 2022.

11. Other marks (e.g., pinniped scratches, lamprey, hooking marks or other notable injuries)

2.7 Sorting Distribution of captured Late Winter Steelhead

Steelhead captured at the MCF or Lewis River hatchery ladder are either transported upstream or to Merwin hatchery depending on a variety of factors including: capture timing, presence of marks or tags, presence of stubby dorsal fins and results of genetic assignment analysis. Figure

A2 illustrates the sorting protocol to be used for captured steelhead. Note that Figure A2 is being revised in 2021 and therefore may not fully represent in-season plans for 2021.



Note: The dashed line indicates that a portion of steelhead held at Merwin Hatchery that assign as NOR may be transported upstream. Steelhead will be transported upstream only after the broodstock collection goal has been met for the specified period (i.e., surplus).

Figure A-2. Sorting and distribution protocol for adult late winter steelhead captured at the Merwin Collection Facility (MCF) and Lewis River Ladder.

Figure A-3. Residual steelhead encountered during annual tangle netting (note stubby dorsal fin)

2.8 Genetic Assignment and Analysis

Since the inception of the hatchery steelhead supplementation program, genetic stock identification (GSI) has been used to genetically categorize returning adults and help information broodstock collection. Originally, the GSI work was completed by National Marine Fisheries Service (NMFS) under a contract with PacifiCorp. NMFS used a microsatellite (13 mSAT loci) based on a reference baseline almost exclusively composed of Lower Columbia steelhead used in Blankenship et al. (2011). In 2020, NMFS declined to renew the contract. In 2020 and 2021, WDFW's Molecular Genetics Laboratory (MGL) was awarded the contract to perform this analysis. WDFW MGL has a more recently assembled Lower Columbia steelhead reference baseline comprised of single nucleotide polymorphism (SNP) genotypes.

The WDFW Lower Columbia River steelhead SNP reference baseline is a 379-SNP *O. mykiss* GTseq panel. This panel of SNPs includes three SNPs that distinguish O. mykiss from O. clarki and mykiss/clarki hybrids, a sex ID SNP, six markers known to be highly correlated with run-timing in coastal lineage steelhead (O. mykiss irideus), in addition to the putatively neutral markers suitable for population genetic analyses. The reference baseline contains populations representing the Puget Sound-derived so-called Chambers Creek winter run hatchery steelhead, Skamania summer run hatchery steelhead, Upper Willamette River DPS steelhead, natural Lower Columbia River summer steelhead, Southwest Washington DPS steelhead ("Coastal"), and Lower Columbia DPS winter run populations from the "Gorge" and "Cascade" groups (Table A-3).

To estimate the stock of origin for samples of "unknowns", genotypes of individuals are compared to the reference baseline using the partial Bayesian maximum likelihood algorithms employed by the software ONCOR (Rannala & Mountain 1997, Anderson et al. 2008, Kalinowski et al. 2008). A critical assumption of GSI analysis is that all possible source populations are in

the reference baseline. This assumption is often violated; however, steelhead population structure is known to be hierarchical with isolation by distance such that near neighbor populations are usually more genetically similar to one another than are more distant populations. GSI assignments are often done to aggregates of genetically similar reference populations. Indeed, the "coastal", "gorge", and "cascade" groupings are understood to be genetic aggregates. Because of the genetic similarity of populations within aggregates, GSI assignments to aggregates may be accurate even if the actual source population (i.e., specific watershed/river) for an individual is not in the reference baseline.

Table A-3. Populations included in the WDFW steelhead SNP reference baseline for NF Lewis GSI analysis

Population	WDFW code	N used (N total)	Aggregate
Chambers@Merwin	13PT	24 (24)	Chambers
Chambers@Kalama	14NX	22 (22)	Chambers
Chambers@Grays	15GP	18 (18)	Chambers
Skamania@Sandy	16NO	35 (35)	Summer
Skamania@Clackamas	16NP	24 (24)	Summer
Skamania@Cowlitz	09AY	25 (25)	Summer
EF Lewis summers	14GL	40 (66)	Summer
Kalama summers	14FK	40 (81)	Summer
Washougal summers	15GL	40 (89)	Summer
Hood Summers	05BT	19 (19)	Summer
Wind Summers 2013	13HL	27 (27)	Summer
Wind Summers 2014	14RS	19 (19)	Summer
Elochoman winters	04AW	40 (50)	Coastal
Grays/Chinook winters	06AN	40 (56)	Coastal
MAG@Abernathy winters	11PV	39 (39)	Coastal
Lower Cowlitz@Delameter winters	12IX	35 (35)	Cascade
Lower Cowlitz@Olequa winters	12IY	22 (22)	Cascade
Coweeman winters	06AP	40 (49)	Cascade
EF Lewis winters 2005	05CG	32 (32)	Cascade
Washougal winters	06AL	40 (47)	Cascade
EF Lewis winters 2006	06AO	39 (39)	Cascade
SF Toutle winters	07BB	40 (49)	Cascade
Kalama winters	14AD	40 (98)	Cascade
NF Toutle winters	14DE	40 (94)	Cascade
NF Lewis@Merwin winters	15PX	41 (41)	Cascade
Lower Gorge@Hamilton	15IE	40 (65)	Gorge
Sandy winters	05BV	40 (49)	Gorge
Hood Winters	06BD	40 (50)	Gorge
Eagle Creek winters	96ED	40 (50)	Gorge
Clackamas winters	05BU	40 (40)	Willamette

SF Santiam winters	05BY	40 (48)	Willamette

2.9 Spawning Protocols

All collected fully mature broodstock will be spawned according to the following protocols, without regard to age, size, or other physical characteristics:

1. No fish shall be excluded except for those with overt disease symptoms or physical injuries that may compromise gamete fertility or viability.
2. All spawned fish will be returned to the river.
3. Females will be air spawned.
4. Use fully randomized mating protocols to avoid or reduce selection biases. (Note: mating protocols may change in 2022.)
5. Single pairwise mating protocols with one or more backup males are preferred to reduce the potential of and concerns with infertile males.
6. If two females and only one male are ripe, a 2x1 cross can occur. However, this is not preferred and efforts should be made to collect additional males from the MCF if in Phase II collection.
7. Holding males for additional spawning crosses is not permissible.
8. In the event that a ripe spawning female has no mate, that fish will be returned to the river downstream of Merwin Dam in hopes of spawning naturally (see Section 2.10 Release Protocols). All precautions will be taken to prevent this situation from occurring. Whenever possible the decision to release females should occur prior to the female becoming ripe.
9. During spawning, a fish health specialist will take the necessary viral samples according to standard protocols (see Strategy C).
10. Ovarian fluid will not be drained prior to fertilization.
11. Eliminate green egg samples: Total egg mass weight will be used to estimate fecundity.

Additional males may be held at the hatchery to ensure that more than one male is available when a female becomes ripe. This reduces the risk of infertile males and resulting egg loss. This action may increase the total number of male broodstock held at the hatchery, but female targets will remain unchanged at 25.

If a ripe female is spawned prior to a genetic assignment and later found to assign to the Coastal strata with a probability greater than 20%, the eggs will be incubated, and released to the lower Lewis River as unfed fry.

3.0 JUVENILE PROGRAM IMPLEMENTATION

3.1 Egg Take Goals

The egg take goal for this program is 90,000 +/- 20%. Fecundity is highly variable among native females and this goal is intended to be flexible; however, total egg take should never exceed the maximum level of 108,000. In-season adaptive management will be used to meet egg collection goals through broodstock management.

3.2 Egg Incubation

Eggs from each female are placed into their own individual tray to incubate. To reduce the risk of Bacterial Coldwater Disease (BCWD), each egg tray is partitioned in half, which subsequently increases egg density and reduces the flow and mobility of the eggs. Each spawned fish will have its own ozonated water supply. Eggs or fish will not be combined until viral results are known.

3.3 Rearing and Release Schedule

Fish will be transferred to the intermediate raceways located within the incubation building after incubation and hatching. Fish will remain in the intermediate raceways for a period of 6 to 8 months. All source water passes through the hatchery ozone plant for sterilization prior to entering the incubation building. After 6 to 8 months, or once fish outgrow the intermediate raceways, fish are transferred to outside raceways and ponds where they are subject to untreated water. Table A-4 presents a timeline for movement of fish by life stage at the Merwin Hatchery.

In addition to monitoring rearing densities and feeding, hatchery staff assesses performance and growth by implementing sampling methods to calculate condition factor (K), estimated variation in length (CV), and feed conversion factor (FCR) for each raceway. For this stock, these assessments are typically completed prior to first feeding (July) and prior to release (May). This is done by sampling 100 fish from each raceway from three locations (upper, middle and lower) for a total of 300 fish per raceway. If needed, fish are sedated using MS-222. Individual lengths and total sample group weight are recorded. These data are used to estimate K, CV (for length), and FCR for each raceway. Prior to volitional release, additional sampling is conducted to individually measure, weigh and assign a smolt index for a minimum of 100 smolts as part of ongoing morphology sampling (See Strategy F). Note that in 2021, the ATS will discuss revisions to the morphological monitoring strategy and whether sampling will continue in 2022. Smolt indexing assigns a numerical code based on observed morphology into four categories: parr (1), transitional (2), smolt (3) and precocious (4).

Table A-4. Generalized hatchery production and collection timeline for late winter steelhead

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Adult Collection												
Spawning												
Incubation												
Ponding												
Tagging (BWT)												
Volitional Release												

3.4 Feeding Type and Requirements

All fish that are ponded for rearing at Merwin Hatchery will be fed the best quality feed available through WDFW vendors. These formulations provide high protein and fat percentages and have proven to provide optimal growth from start to finish (Roberts, 2013).

There is a combination of feeding methods used. Hand feeding is typically done for early rearing troughs and raceways. Hand feeding occurs 2 to 8 times per day depending on life stage. Once fish are transferred to the large rearing ponds, demand feeders are used along with hand feedings 2 to 3 times per week if needed. The incorporation of belt feeders, or other options (underwater feeders) may be employed to provide for extended feeding schedules, or provide more natural methods for fish feeding.

3.5 Marking and Tagging

Once these fish reach a size of 20 to 25 fish per pound (fpp) in December, all are tagged with BWTs in their snout and placed into the rearing ponds until their scheduled release the following May. No other marks or clips are used for the late winter steelhead supplementation program.

3.6 Release Size and Number

Target release size is 5 to 8 fpp. Some fish released may be smaller than the target depending on growth rates achieved while reared at the Merwin Hatchery. A review of smolt size (fpp) will be conducted prior to release. The target number released is 50,000 smolts +/- 20%. Volumetric methods are used to enumerate fish planted and are reported in WDFW Fishbooks and annual reports.

3.7 Release Timing and Locations

Steelhead smolts are volitionally released over a six-week period, which is scheduled to begin by May 1 of each year.

Fish that actively migrate during the volitional release window are transported to the Merwin boat ramp (RM 19) for planting. Once the volitional window has ended, any remaining fish are transported and planted at Pekins Ferry Boat Ramp (RM 3.1). Alternate lower river release locations may be used if significant bird or pinniped predation is observed at the Pekins Ferry site (e.g., Woodland release ponds, county bridge, island boat ramp, etc.)

4.0 ADULT SUPPLEMENTATION UPSTREAM OF SWIFT DAM

Adult supplementation relies primarily on returns from hatchery program releases (BWT's). However, there are also a portion of returning adults that are offspring from supplementation efforts upstream of Swift Dam. Because only about 10 percent of steelhead smolts are PIT tagged at the Swift FSC (and thus confirmed as upstream recruits), there remains an unknown portion of natural origin returns that cannot be classified as originating upstream of Swift Dam or downstream of Merwin Dam. However, based on the portion of PIT tagged adults returning from a known number of marks, inferences can be made on the estimated number of returning steelhead that originated upstream of Swift Dam. Therefore, steelhead transported upstream

of Swift Dam will include all BWT returns and a portion of NOR returns to the trap. The portion of NOR returns transported upstream will be predicted by the ATS using PIT tag return rates and other factors deemed appropriate by the ATS (e.g., total number of smolts released from the FSC and hatchery production program by year).

A minimum number of 500 transported adult steelhead are needed to meet the current supplementation program transport goal. Note that the number of transported adults will change to 1,700 in 2022.

There is known BWT loss that occurs for each brood year (BY). Based on previous genetic assignment results collected since 2009, the number of stubby dorsal fish lacking a BWT that assign to MPGs outside the basin is low (~2%). The probability of encountering out-of-basin hatchery steelhead after March 1 diminishes due to the separation of spawn timing between early-run timed hatchery derivatives and NOR steelhead. Therefore, prior to March 1, captured fish that lack a BWT, but have a stubby dorsal fin, will be taken to Merwin Hatchery and genetically assigned. If results meet the minimum genetic assignment probability threshold, those fish will be transported upstream. After March 1, stubby dorsal fin fish captured that lack a BWT but have intact adipose fins most likely represent F1 returns that have lost their BWT and will be transported upstream without any genetic assignment.

Steelhead that are transported above Swift Dam are typically released at the Eagle Cliff Bridge Site. If the Eagle Cliff Bridge site is unavailable or inaccessible, steelhead may also be released at the Swift Camp boat ramp or Swift Dam. In some instances, fish may be released at alternate locations to enhance their distribution into tributaries of upper North Fork Lewis River. These alternate release locations include but are not limited to: Muddy River Bridge, Clear Creek Bridge, and Curly Creek Bridge. If alternate distribution sites are selected, planting trucks will work on a rotating basis for each haul. For example, the first load may be released at Curly Creek Bridge, the second at Muddy River Bridge, and so on. This may not equate to equal portions for each site but should be reasonably close.

A subsample of Steelhead smolts collected at the Swift FSC will also be genetically sampled using SNP protocols. Genotypes of outmigrating smolts will be compared to baselines established prior to anadromous reintroduction for rainbow (including HOR Goldendale and Spokane stocks) and cutthroat trout. This analysis will determine the extent of spawning interaction between resident species and reintroduced anadromous steelhead. The actual number of smolts selected for testing will be based on capture rates, but the target is to collect at least 1000 samples during the outmigration period. Genetic information may also be used to develop parentage-based evaluations of spawning success and smolt production and abundance derived from the supplementation program.

SECTION B SPRING CHINOOK

1.0 INTRODUCTION

The Lewis River spring Chinook salmon program is composed of two parts: adult supplementation upstream of Swift Dam and juvenile hatchery production for release downstream of Merwin Dam. Adult supplementation will provide up to 3,000 adults for release upstream of Swift Dam each year to spawn naturally. Juvenile supplementation will rear up to 1,350,000 spring Chinook for release downstream of Merwin Dam.[1] Release timing of juvenile supplementation fish will vary depending on planned evaluations described in Appendix D. Returns from both the adult and juvenile supplementation programs comprise the foundation to meet the primary goals of providing harvest opportunity and creating a self-sustaining population that does not rely on hatchery support (see Settlement Agreement Section 8.4). This section describes the implementation of both the supplementation and hatchery programs for 2021.

2.0 ADULT PROGRAM IMPLEMENTATION

The following sections describe the detailed protocols for implementation of the spring Chinook portion of the H&S Plan (2014). Note that the ATS will revise these protocols in 2021 to meet requirements of the 2020 H&S Plan.

Prioritized goals for management of returning spring Chinook:

1. Lewis River hatchery broodstock goal
2. Additional upper Lewis River supplementation (target is 3,000 fish) and other in-basin programs (e.g., Southern Resident Killer Whale prey enhancement)
3. A fishery managed to allow for #1 and #2 to be achieved.
4. Out-of-basin programs (e.g., other Southern Resident Killer Whale programs, Deep River Net Pen project)

2.1 Broodstock Source and Selection

The Lewis River spring Chinook hatchery program is operated as a segregated program. Therefore, all broodstock transported to hatcheries will be of hatchery origin. Adult returns identified as NOR will be transported to the Lewis River above Swift Dam to help meet the transport target of 3,000 fish. No NOR Chinook will be used to meet juvenile production needs at the hatchery. Adult HOR (adipose fin missing, or adipose fin intact AND CWT snout tag) spring Chinook returns will be used to meet juvenile production (mitigation) targets. Broodstock will be selected over the course of the run, and any surplus spring Chinook will be transported upstream to achieve adult supplementation targets. In years when hatchery returns are weak, it may be necessary to hold surplus Chinook at Lewis River Hatchery in the

[1] Beginning in 2018, the spring Chinook upper river acclimation program (up to 100,000 juveniles) was suspended by the ACC in favor of releasing these juveniles downstream of Merwin Dam for a period of at least 5 years. This decision was made in an effort to improve adult returns. Annual review of this modification will occur annually between the ACC and the ATS.

early portion of the run until it becomes clear the annual broodstock goal will be met. After 50% of the run has been realized, a decision will be made on whether to transport all (or a portion of) surplus Chinook being held at Lewis River Hatchery upstream of Swift Reservoir. Planning should be coordinated with hatchery staff to ensure that broodstock are collected proportionately over the run curve.

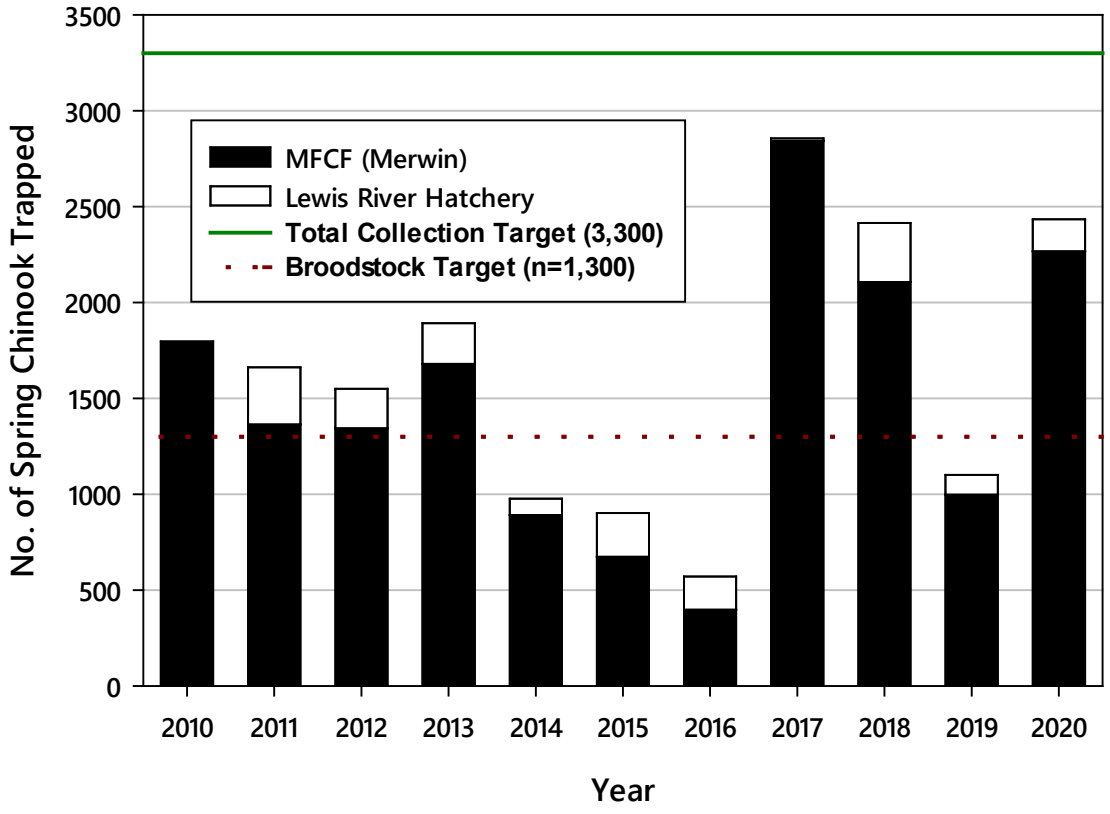


Figure B-1. Total number of spring Chinook trapped annually between 2010 and 2020 at both the Merwin Collection Facility and Lewis Hatchery ladder

*Note: *Total collection target line includes broodstock (1,300) and adult supplementation target (2,000) upstream of Swift Dam.*

2.2 Broodstock Collection Goal

Spring Chinook broodstock collection goals for the Lewis River programs are as follows:

- Hatchery Broodstock: Approximately 1,300, depending on fecundity, holding mortality, and sex ratios, over the full range of the run.

Collection for hatchery broodstock will be given priority each week. All fish allocated for hatchery broodstock will be transported and held at Speelyai or Lewis River Hatchery. If the weekly quota for hatchery broodstock is not met, then all fish collected during subsequent

weeks will be allocated for broodstock until the quota meets the predetermined broodstock collection curve.

All HOR fish collected prior to the week ending May 24, 2021, designated as adult supplementation (upstream) fish will be transported and temporarily held at Lewis River Hatchery. All fish containing CWTs will be allocated to hatchery broodstock and transported to Speelyai Hatchery. A meeting will be held between PacifiCorp Aquatics Team and WDFW Fish Managers during that week to discuss current run numbers and whether fish being held at Lewis River Hatchery can be taken upstream. If adult spring Chinook are returning at a rate at or above the projected running curve for that period, then all fish being held at Lewis River Hatchery will be taken upstream as well as any subsequent fish allocated for adult supplementation. If it appears that adult spring Chinook are returning at a rate exceeding the projected run curve, then it is possible that adults being held at Lewis River Hatchery could be taken upstream earlier. If it is decided that fish being held at Lewis River Hatchery will not be transported upstream by May 24, 2021, they will continue to be held until hatchery broodstock goals have been met. Fish allocated for adult supplementation may be reallocated for hatchery broodstock if the adult return rate remains below the projected number.

All spring Chinook less than 24 inches will be considered jacks. Jacks will not comprise more than 5% of the broodstock collection or adult supplementation. Variations to this guidance will be decided in-season through ATS agreement.

2.3 Broodstock Collection Timing

Broodstock collection for the juvenile supplementation program should occur proportionately over the entire run timing. NOR Chinook should be transported upstream at the time of capture if at MCF or as soon as possible if at Lewis Hatchery trap. Figure B2 illustrates the trap timing of spring Chinook entering the MCF. Table B1 illustrates the 2021 spring Chinook generalized collection curve for each part of the program described in the previous section.

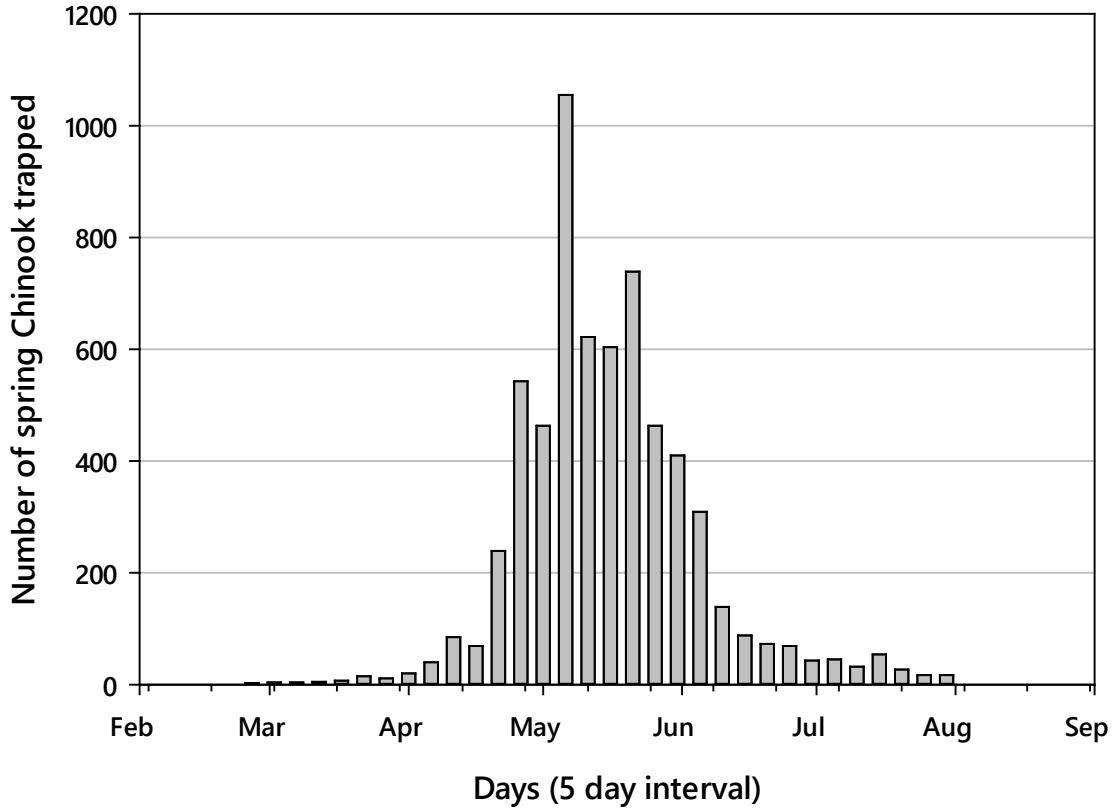


Figure B-2. Total number and timing (5-day intervals) of spring Chinook trapped at the Merwin Collection Facility (MCF) for the years 2016 – 2019. (source: PacifiCorp fish database)

Table B-1. Spring Chinook generalized collection curve for each program allocation in 2021

Week Ending	Hatchery Brood Stock	Adult Supplementation (Upstream)	TOTAL
6-Apr	21	32	53
13-Apr	6	10	16
20-Apr	13	19	32
27-Apr	61	94	155
4-May	69	106	175
11-May	153	234	387
18-May	169	259	428
25-May	226	344	570
1-Jun	243	372	615
8-Jun	155	236	391
15-Jun	92	141	233
22-Jun	29	45	74
29-Jun	26	39	65
6-Jul	16	25	41
13-Jul	6	10	16
20-Jul	11	17	28
27-Jul	7	11	18
3-Aug	4	6	10
TOTAL	1,307	2,000	3,307

2.4 Broodstock Collection Methods

All broodstock are collected at either the MFCF or Lewis River ladder.

2.5 Broodstock Holding Protocols

Broodstock are typically collected daily from April 1 through as late as August at the MCF or Lewis River ladder and transported to Speelyai Hatchery and held until spawning begins in mid-August (Table B2). The exception to this protocol is if the run size forecast is relatively low, fish collection may begin early and fish above weekly broodstock goals prior to the approximate 50% point in the run may be held at Lewis Hatchery. While being held at Lewis Hatchery, these fish would be treated as if they were to be transported and released above Merwin Dam; transport would occur when it appears highly likely the broodstock goal will be met. Broodstock that receive antibiotic injections are not released, used for nutrient enhancement, or donated to any food banks or tribes because of mandatory injection withdrawal periods.

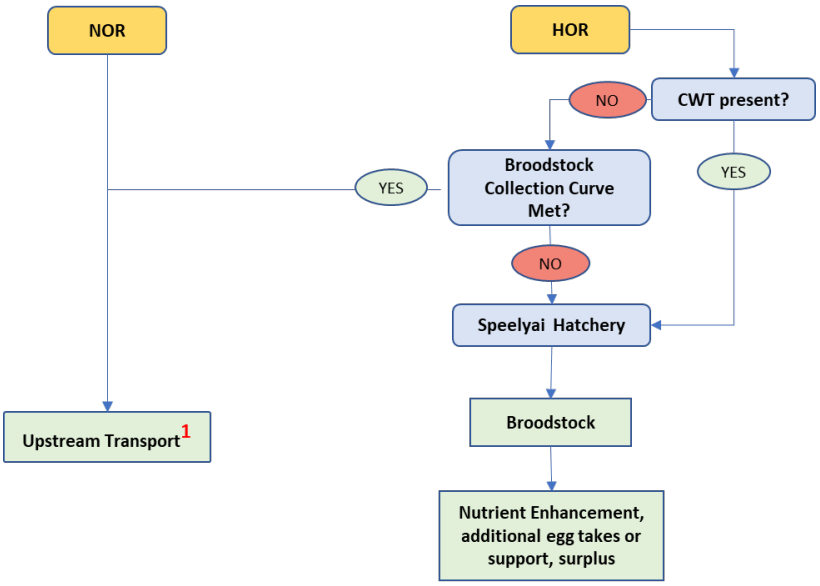
2.6 Data Collection Protocols

A common suite of biological data will be collected from all (or subsample) spring chinook regardless of their capture location, which includes:

1. Capture Date (mm-dd-yyyy)
2. Capture Location (Merwin or Lewis River ladder)
3. Origin (NOR or HOR)
4. Sex (M/F)
5. Fork Length (mm)
6. Life Stage (adult, jack, minijack, residual)
7. Age (scale samples)
   For spring chinook, which fish, how many scales? Scales will be removed and placed on a scale card including relevant data to identify each sample.
8. Genotyping (tissue sample)
   Tissue samples will be collected from a subsample of returning adults.
9. Mark and Tag Status (PIT, CWT, AD only, AD+CWT, fin clips)
10. Other marks (e.g., pinniped scratches, lamprey, hooking marks or other notable injuries)

2.7 Sorting Distribution of captured spring Chinook salmon

Spring Chinook are either transported upstream or held for broodstock at Speelyai (or temporarily at Lewis River) hatchery depending on broodstock needs, origin and the presence of a CWT. Figure A2 illustrates the distribution protocol to be used for captured spring Chinook salmon.



1 ACC may approve increased upstream transport numbers of NOR's based on run size. If not approved, all NOR's in excess of approved transport goal would be returned to lower river (i.e., never surplused)

Figure B-3. Sorting and distribution protocol for Lewis River spring Chinook collected at the Merwin trap or Lewis River Ladder

2.8 Genetic Assignment and Analysis

PLACEHOLDER

2.9 Spawning Protocols

All collected fully mature broodstock will be spawned using a pairwise (1x1) mating cross with a backup male. No fish shall be excluded except for those with overt disease symptoms or physical injuries that may compromise gamete fertility or viability. All fish are kill spawned, and disposition of carcasses is directed by the WDFW. Note that spawning protocols may change during the transition planning process.

3.0 JUVENILE PROGRAM IMPLEMENTATION

3.1 Egg Take Goals

Total spring Chinook eggs needed to meet hatchery production is 1,755,000 to produce and release 1,350,000 smolts for the juvenile supplementation program.

3.2 Egg Incubation

Eggs are incubated in vertical stack incubators. Each female is assigned a number and only one female per tray, unless there are not enough trays towards the last egg take, then two or three fish will be pooled together until results are in from the enzyme-linked immunosorbent assay (ELISA) testing, if testing is performed (see Attachment A - Fish Health and Disease Strategy Plan).

3.3 Rearing and Release Schedule

All spring Chinook from fry to smolt are fed the highest quality feed available from WDFW contracted vendors. Fry will start out being fed 7 days per week. As they grow, the number of days fed per week will be reduced but will not be less than 3 days per week.

Hatchery staff will implement monthly performance sampling and a QA/QC sampling prior to release. These methods are described in detail in Appendix D.

Table B-2. Hatchery production and collection timeline for North Fork Lewis River spring Chinook

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Adult Collection												
Spawning												
Incubation												
Rearing												
Tagging												
Volitional Release												
Direct Release												

3.4 Feeding Type and Requirements

PLACEHOLDER

3.5 Juvenile Marking and Tagging

Juvenile tagging type and location for hatchery-produced spring Chinook are presented in Table 6-1 of the H&S Plan (PacifiCorp and Cowlitz County PUD 2014). The number of tags and tagging groups may be modified annually as part of ongoing evaluations of rearing and release strategies (Appendix D).

A subset of juvenile spring Chinook that are collected at the FSC will be PIT tagged to provide additional information on juvenile transport survival at the release ponds and preliminary information on smolt out-migration timing (based on lower Columbia River detections) and out-of-basin avian predation (based on detections at bird colonies such as East Sand Island). The target is to tag approximately 10-15% of the parr or smolts (> 90mm) that are passed downstream from the Swift FSC. Juveniles captured at the FSC may be fish that were hatchery-reared and released from the juvenile supplementation program in previous years and overwintered upstream of Swift Dam or may be offspring of supplementation program adults.

The hatchery production goal is 1,350,000 smolts with the following three tagging groups:

- Adipose fin clip: 1,050,000
- Adipose fin clip and CWT: 150,000
- CWT only (DIT group): 150,000

3.6 Release Size and Number

As described in Appendix D of this plan, most Lewis program spring Chinook (1,350,000) are volitionally released as yearlings in October or February from Lewis River Hatchery directly into the Lewis River. The volitional release includes pulling the screens, lowering the water level slowly over a 2-week period or until 90% or more of the smolts have left on their own. The remaining fish left are then flushed out.

Target Release Size:

- *Hatchery Program*: 8, 12, or 80 fpp depending on release group (see Table B3)

3.7 Release Timing and Locations

2021 is the fourth year of a study designed to test release strategies and survival between up to five release groups. The study began with BY 2017 and is described in detail in Strategy A. Table B3 shows a summary of the different release groups planned as part of this study, which were designed to test the following variables: release month, date transferred to Lewis River Hatchery, rearing environment, ration level and size at release. This study will continue for at least 3 BYs and strategies will be evaluated each year and changes made if substantial problems are discovered. After 3 years of implementation, in-hatchery survival rates, size-at-release, condition factor at release, fish health (frequency or rates of disease), and physiological status

at the time of release will be compared between treatment groups as described in Appendix D. All juveniles are released from the Lewis River Hatchery. Planned releases for 2021 (BY2020) are summarized in Table B3. Deviations from this plan will be described during reporting.

Table B-3. Summary of planned annual release groups as part of the spring Chinook rearing and release evaluation (Strategy D)

Release Group	Transfer Month to Lewis River Hatchery	Release Month	Size at Release (fpp)	Planned Tagging[2]		Planned Release (smolts)	Group Description
				AD + CWT	CWT ONLY		
1	May	February	8	37,500	37,500	150,000	Control group
2	December	February	12	37,500	37,500	175,000	Low ration, reared at Speelyai 6 months
3	December	February	8	37,500	37,500	150,000	Normal ration, reared at Speelyai 6 months
4	May	October	12	37,500	37,500	825,000	Released in October
5[1]	NA	June	80	0	50,000	50,000	Released in June
		TOTAL		**150,000**	**200,000**	**1,350,000**	

[1] *A minimum of 50,000 fish will be planted, but if surplus juveniles are available due to better than expected survival etc., they would be released in this group. All fish from this release group will be adipose fin-clipped; up to 50,000 fish will be marked with CWT.*

[2] *The number and type of tags distributed for each release group may be modified as recommended by the ATS based on projected surplus or deficit to planned release numbers.*

4.0 ADULT SUPPLEMENTATION UPSTREAM OF SWIFT DAM

Up to 2,000 spring Chinook (when available) will be transported from the MCF and Lewis River traps (or acceptable alternative stock) to Eagle Cliff or designated areas upstream of Swift Dam. Due to low returns of NOR spring Chinook, a majority of transported adults are of hatchery origin. A minimum of two tanker fish trucks will be used weekly to move captured spring Chinook upstream. Each tanker truck can transport about 100 adult Chinook salmon. Figure B3 provides a proposed transportation schedule, indicating weekly numbers to achieve the transport goal of 2,000 over the run period; however, this schedule will not be possible to achieve if run sizes are low relative to the broodstock goal. In years with low pre-season run forecasts, fish will be held at Lewis Hatchery until broodstock goals are met, as described in AOP sections 2.1 and 2.2.

Prior to 2017, transported spring Chinook were released at different locations upstream of Swift Dam to enhance their distribution into streams (seed planting). Eagle Cliff, Muddy River Bridge, Clear Creek Bridge, and Curly Creek Bridge were used to release an approximately equal portion of the transported spring Chinook. To simplify the logistics, fish trucks rotated the release location of each haul. For example, the first load was released at Eagle Cliff, the second at Muddy River Bridge, and so on, resulting in nearly equal portions released at each site. Eagle Cliff was chosen as a preferred site for release as it is not affected by reservoir fluctuations and

provides the opportunity for released fish to migrate upstream immediately without having to migrate through reservoir waters that can exceed optimal water temperatures. Distribution of spawning will be monitored annually to determine if spawning distribution is adequate and protocols are adapted as needed.

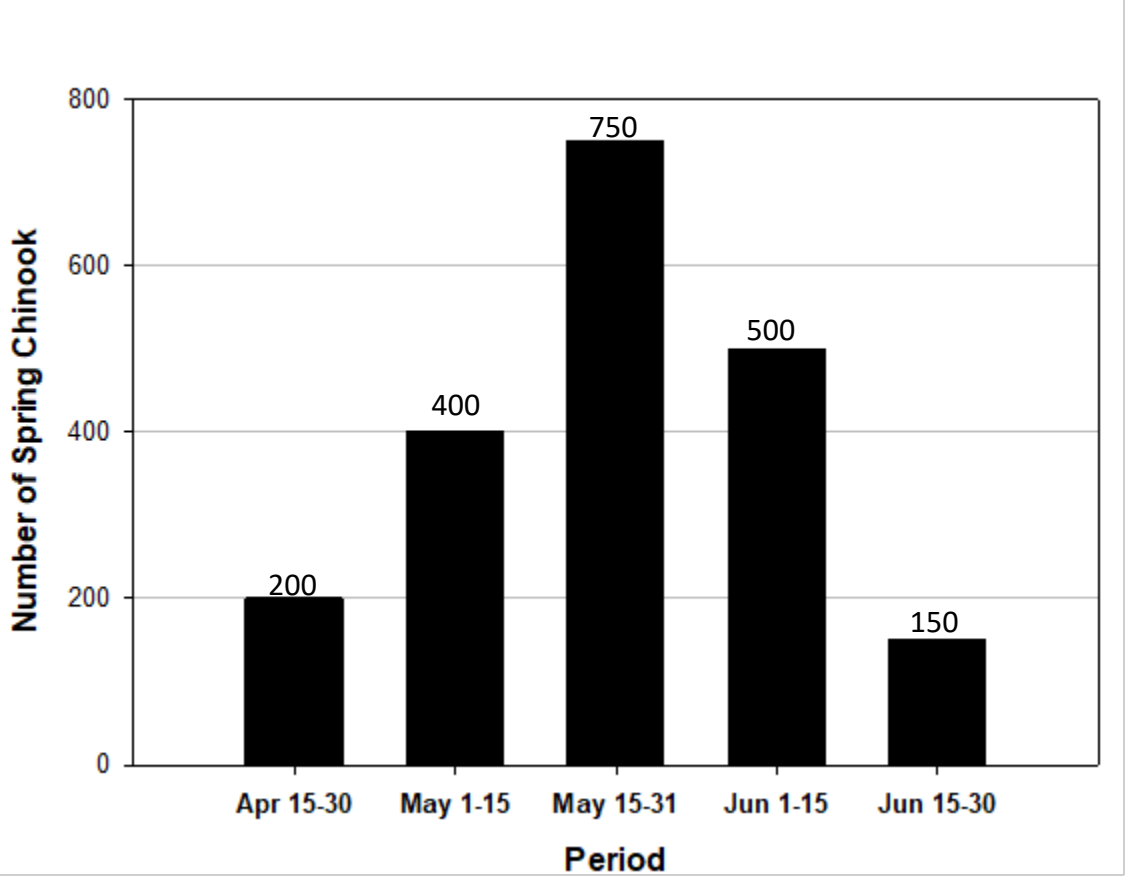


Figure B-4. Recommended transportation timing of adult spring Chinook (n=2,000) for supplementation upstream of Swift Dam.

*Note: *Values based on actual MCF data between 2003 and 2009*

SECTION C COHO SALMON

1.0 INTRODUCTION

The Lewis River coho salmon program has two components, upstream adult supplementation and downstream hatchery production. The goal of the adult supplementation program is to transport up to 7,500 early and late adult coho (both NOR and HOR) to the upstream end of Swift Reservoir. This target number of adults was determined through the Ecosystem Diagnostic and Treatment (EDT) process which defines habitat capacity upstream of Swift Dam. The intent of the adult supplementation program is to increase the number of NOR coho salmon returning to the North Fork Lewis River with a long-term goal of passing only NOR coho salmon. The hatchery production goal is to release 1,100,000 segregated early coho smolts and 900,000 integrated late coho smolts annually. The minimum target for NOR integration into late coho hatchery production is 30% per HSRG guidance (HSRG 2014).

2.0 ADULT PROGRAM IMPLEMENTATION

The following section describes the protocols for implementing the coho program of the H&S Plan.

Prioritized Goals for management of returning Lewis River Early Coho:

1. Lewis River broodstock goal
2. Minimum upstream supplementation goal (1,000 Pairs may include NORs and some HORs as needed – early/late Coho)
3. A fishery managed to allow for #1 and #2 to be achieved
4. Additional upstream supplementation (target is 7,500 early and/or lates) and other in-basin programs (none currently planned)
5. Out of basin programs (none currently planned)

Prioritized Goals for management of returning Lewis River Late Coho:

1. Lewis River broodstock goal
2. U.S. v. OR[2] (in combination with other Cascade stratum sources, i.e., Washougal/Kalama)
3. Minimum upstream supplementation goal (1,000 Pairs may include NORs and some HORs as needed – early/late Coho)
4. A fishery managed to allow for #1 -#3 to be achieved
5. Additional upstream supplementation (target is 7,500 early and/or lates) and other in-basin programs (e.g., Educational Remote Site Incubators)
6. Other out of basin programs (none currently planned)

[2] See 2008-2017 *United States v. Oregon* Management Agreement, May 2008

2.1 Broodstock Source and Selection

Broodstock source for the supplementation program shall be composed of both early (Type S) and late coho (Type N) returning to either the MCF or Lewis River Hatchery ladder.[3] For adult supplementation, the MCF is preferred because these fish are assumed to be upstream migrants attempting to reach areas above Merwin Dam. The Lewis River Hatchery ladder will be used primarily for hatchery broodstock collection. All early coho NORs should be passed upstream. A portion of late coho NORs are used for the late coho integrated hatchery program (integration rate minimum goal of 30%).

2.2 Broodstock Collection Goal

In most years, the number of coho salmon returning to traps has been sufficient to achieve both hatchery and upstream supplementation targets of about 10,000 adults (Figure C1). Broodstock comprise both returning adult and precocious males (jacks). The proportion of jacks integrated into the hatchery broodstock may include up to 10% of male spawners (HSRG recommendations). WDFW guidance is for at least 2% of male spawners to be jacks (WDFW HEAT Summer Meetings Handout – Jack Utilization Guidelines and Spawning Citations).

Upstream Supplementation: Up to 7,500 early and late adult coho (both NOR and HOR) will be collected and transported to the upstream end of Swift Reservoir. The number of NOR coho available for upstream supplementation depends on return rates to the traps and needs of the integrated late coho hatchery program.

Hatchery Broodstock: Up to 1,400 HOR early adults, depending on fecundity, will be used as broodstock to support the segregated hatchery production goal of 1,100,000 smolts (released annually). An additional 1,000 late returning HOR and NOR adults will be used to support integrated hatchery production of about 900,000 smolts (released annually). The minimum target for NOR integration is 30% for late coho per HSRG guidance. Note that the ATS may discuss changing the broodstock target for 2022 in order to meet requirements of the transition plan.

[3] On July 21, 2015, the H&S Subgroup agreed to incorporate late coho as a supplementation stock. This decision was affirmed by the ACC on August 13, 2015.

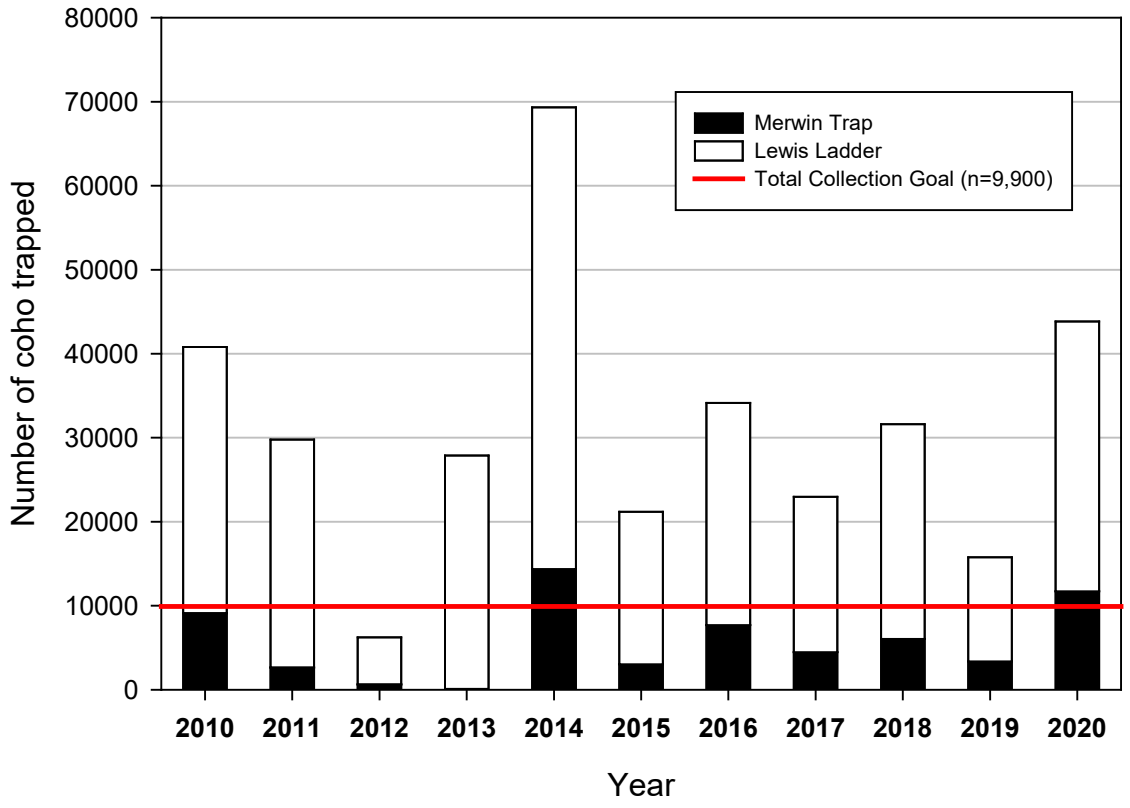


Figure C-1. Total number of coho trapped annually between 2010 and 2020 at the Merwin Collection Facility and Lewis Hatchery ladder

*Note: *Collection target line represents number of early and late coho needed to meet hatchery broodstock and adult supplementation goals. Broodstock target represents number required to meet hatchery production as specified in the Lewis River Settlement Agreement. Source: PacifiCorp and Cowlitz County PUD, 2004.*

2.3 Broodstock Collection Timing

Because the coho program relies on trapping, broodstock collection should occur proportionately over the trap collection curve. Early coho begin entering trapping facilities in early September and peak capture rates are observed in mid to late October. Late coho begin entering trapping facilities in late October and continue through December (Figure C2).

During the last 2 weeks of October when both early and late stocks are arriving at the traps, staff will visually assign fish to a stock based on coloration and maturation. Fish that cannot be clearly identified by stock are passed upstream unless they are in poor condition, in that case they would be used for nutrient enhancement or surplussed.

2.4 Broodstock Collection Methods

Coho salmon are collected from both the MFCF and Lewis River Ladder. Coho designated as broodstock are held at either Speelyai (earlies) or Lewis River (lates).

2.5 Broodstock Holding Protocols

Coho broodstock collected at Lewis River Hatchery trap or MCF are either transported to Speelyai Hatchery for spawning (early coho) or held and spawned at Lewis River Hatchery (late coho).

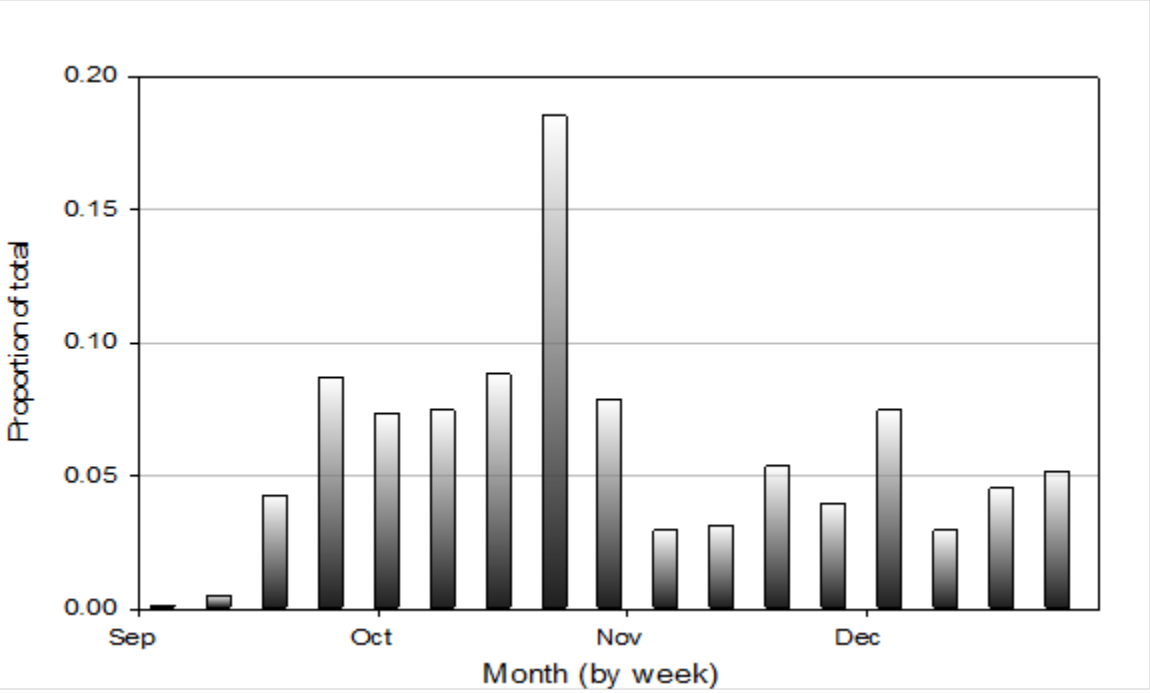


Figure C-2. Proportion of natural origin coho captured by week at the base of Merwin Dam (2010 – 2014) and Lewis River Hatchery ladder (2004 – 2010)

2.6 Data Collection Protocols

A common suite of biological data will be collected from all (or subsample) coho regardless of their capture location, which includes:

1. Capture Date (mm-dd-yyyy)
2. Capture Location (Merwin or Lewis River ladder)
3. Origin (NOR or HOR)
4. Sex (M/F)
5. Fork Length (mm)
6. Life Stage (adult, jack, minijack, residual)
7. Age (scale samples)
   Placeholder: how many scales? Scales will be removed and placed on a scale card including relevant data to identify each sample.
8. Genotyping (tissue sample)

Tissue samples will be collected from a subsample of returning adults.

9. Mark and Tag Status (PIT, CWT, AD only, AD+CWT, fin clips)
10. Other marks (e.g., pinniped scratches, lamprey, hooking marks or other notable injuries)

2.7 Sorting Distribution of Coho Salmon

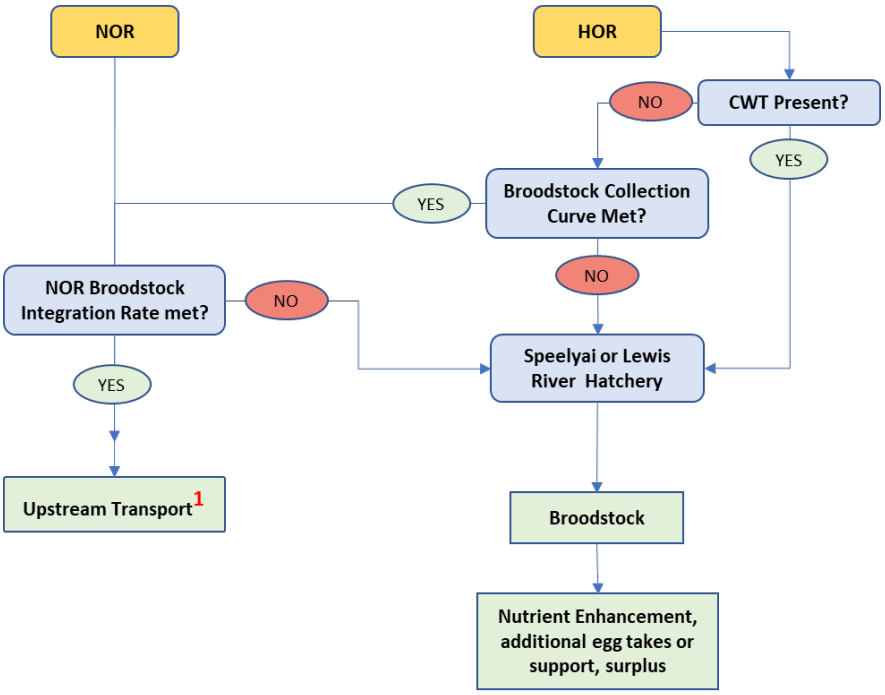


Figure C-3. Sorting and distribution protocol for Lewis River coho salmon collected at the Merwin trap or Lewis River Ladder

[1] *ACC may approve increased upstream transport numbers of NOR's based on run size. If not approved, all NOR's in excess of approved transport number would either be returned to lower river or integrated into the hatchery broodstock (i.e, never surplused)*

2.8 Genetic Assignment and Analysis

Placeholder, to be filled in by ATS in 2021.

2.9 Spawning Protocols

Placeholder, to be filled in by ATS in 2021.

3.0 JUVENILE PROGRAM IMPLEMENTATION

3.1 Egg Take Goals

Egg take required to meet hatchery production goals as set forth in the Lewis River Settlement Agreement (Settlement Agreement) include the following:

- Early Coho: 1,800,500 (to produce 1,100,000 smolts)
- Late Coho: 1,400,000 (to produce 900,000 smolts)

3.2 Egg Incubation and Juvenile Rearing

Early Lewis River coho are spawned at Speelyai Hatchery and the resulting eyed eggs are shipped to the Lewis River Hatchery in November for incubation in vertical stack incubators. Late Lewis River coho are spawned and reared at Lewis River Hatchery.

According to WDFW, incubation conditions are consistent with loading densities recommended by Piper et al. (1982). Water quality and temperatures are generally very good. Stack flows during incubation are 3.6 gallons per minute and all eggs are treated with formalin to keep them free of fungus (WDFW and PacifiCorp 2014).

Hatchery staff will implement performance sampling prior to first feeding and a QA/QC sampling prior to release. These methods are the same as described above in late winter steelhead Section 2.16.

3.3 Rearing and Release Program Schedule

Table C-1. Hatchery production and collection timeline for North Fork Lewis River coho salmon

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Adult Collection												
Spawning												
Incubation												
Rearing												
Tagging												
Volitional Release												

3.4 Feeding Type and Requirement

Placeholder, to be filled in by ATS in 2021.

3.5 Juvenile Marking and Tagging

Juvenile tagging type and location for coho salmon are presented in Table 5-1 of the H&S Plan (PacifiCorp and Cowlitz County PUD, 2014) and summarized below. Coho are mass-marked in June when they are about 120 fpp, as follows:

- 1,700,000 AD only
- 150,000 CWT only (double-index tag group)

- 150,000 CWT + AD

A subset of juvenile coho that are collected at the FSC will be PIT tagged to provide additional information on juvenile transport survival at the release ponds and preliminary information on smolt out-migration timing (based on lower Columbia River detections) and out-of-basin avian predation (based on detections at bird colonies such as East Sand Island). The target is to tag approximately 10-15% of the parr or smolts (> 90mm) that are passed downstream from the Swift FSC. Juveniles captured at the Swift FSC are most likely offspring from adult supplementation, or alternatively from residualized coho that eventually become mature and spawn. This scenario, however, has not been observed during fall spawning ground surveys in the upper basin or reservoir tributaries.

3.6 Release Size and Number

Placeholder, to be filled in by ATS in 2021.

3.7 Release Timing and Location

Coho are volitionally released at Lewis River Hatchery beginning in April by pulling the screens, lowering the water level slowly over an approximately 2-week period (up to 6 weeks) or until approximately 90% or more of the smolts have left on their own. Remaining fish are flushed directly to the river prior to May 20. Prior to beginning the volitional release, an area Fish Health Specialist will evaluate the coho release group's health and condition.

4.0 ADULT SUPPLEMENTATION UPSTREAM OF SWIFT DAM

The supplementation program relies exclusively on transporting adults upstream of Swift Dam, which began in 2012. Supplementation adults are able to spawn naturally using all available habitats upstream of Swift Dam. Progeny from these transported adults will be collected at the FSC and transported downstream of Merwin Dam to begin their migration to the sea. The program targets up to 7,500 early or late adult coho to be transported over the duration of the run timing. This target was selected through the EDT process to define the spawning capacity upstream of Merwin Dam.

Previous trapping data for natural origin coho[4] (Figure C2) are used to create a potential collection schedule to meet the target goal of 7,500 coho (Table C2) for transport in 2021. Ideally, all transported coho would be NORs. However, there are not enough NOR coho to meet the supplementation goal. In addition, Lewis River Hatchery is currently implementing an integrated late coho program on the Lewis River that will use a portion of NOR late coho as broodstock. The supplementation program will use all NORs available that are not used for the integrated late coho hatchery production program.

[4] NOR coho returns may be progeny from upper river (supplementation program) or lower river spawners. There is no way to differentiate the two groups; However, this is not required because both groups are treated as the same population in this plan.

Transported coho may be released at different locations upstream of Swift Dam to enhance distribution into streams and tributaries. Eagle Cliff, Muddy River Bridge, Clear Creek Bridge, and Curly Creek Bridge will be used to release an equal portion of the transported coho. To simplify the logistics, fish trucks will work on a rotating basis for each haul. For example, the first load will be released at Eagle Cliff, the second at Muddy River Bridge, and so on. This may not equate to equal portions for each site but should be reasonably close.

Table C-2. Proposed collection rate of coho for upstream transport indicting relative and cumulative proportion by two-week period over the collection window

Period	Number of Coho*	Relative Proportion	Cumulative Proportion
Sep 1-15	300	0.04	
Sep 16-30	1,200	0.16	0.20
Oct 1-15	1,300	0.17	0.37
Oct 16-31	2,000	0.27	0.64
Nov 1-15	600	0.08	0.72
Nov 16-30	800	0.11	0.83
Dec 1-15	700	0.09	0.92
Dec 16-31	600	0.08	1.00

Note:
** Values based on supplementation goal of 7,500 adults*

SECTION D MONITORING AND EVALUATION

1.0 INTRODUCTION

Monitoring activities described in this section are intended to meet monitoring objectives contained in the 2014 H&S Plan. The ATS is currently revising this section to conform to the objectives and formatting of the 2020 H&S Plan. Reporting of the Lewis River monitoring programs will be summarized in the 2021 Annual Operating Report in accordance with the objectives of the most recently approved H&S Plan at the end of 2021.

2.0 MONITORING AND EVALUATION STRATEGIES

This is a new section of the AOP for 2021. The ATS reorganized the methods used to address different Objectives of the H&S Plan into Strategies. Strategies are designed to address data collection needs for the M&E Objectives. Some are long-term monitoring strategies and others are specific study plans to address a question.

Each strategy is designed to collect and analyze information that is relevant to meeting M&E requirements for these programs. Each strategy has a defined set of objectives and agreed-upon methods, both in the field and analytical. Each strategy has deliverables that the ATS will review. The strategies are appended to this document as living plans that can be updated throughout the season as needed. Each strategy should include at least the following components:

<u>Example Strategy Format</u>

- Introduction
- General Approach
- Field Methods
- Frequency/Duration
- Analytical Methods
- Deliverables
- Limitations/Concerns

SECTION E ADAPTIVE MANAGEMENT

The ATS is tasked with periodically reviewing program components and monitoring and evaluation strategies. The timing for these tasks varies by program, species, and objective. The ATS Work Plan (Appendix B) presents a calendar of ATS activities, program production tasks, and monitoring and evaluation strategies and includes callouts for decision points that the ATS tracks throughout the year.

In 2021, some of the ATS' priority tasks related to adaptive management are summarized below:

- Developing a plan for reviewing programs to consider transitioning programs from segregated to integrated
- Reframing program production and monitoring and evaluation components to align with the 2020 H&S Plan
- Determining the timeline for addressing Key Questions in the 2020 H&S Plan and preparing revised methodologies and study plans for implementation in 2022 and future years.

SECTION F REPORTING REQUIREMENTS

Annual reporting of plan implementation and monitoring of objectives is provided each year as part of the Lewis River Annual Operations Report distributed in April of each year. At a minimum, the annual report will include the following:

1.0 ADULT COLLECTION AND SPAWNING

- Collection numbers by location and method
- Collection numbers compared to targets
- Genetic assignment results for steelhead
- Spawning protocols and numbers
- Transportation numbers by date, species, and sex ratios (actual versus goals)
- Distribution of all collected species
- Disposition of any species

2.0 EGG INCUBATION AND JUVENILE REARING/RELEASE

- Egg take – actual versus goals
- Egg to fry survival – numbers of fish ponded
- Pathogen screening results
- Rearing strategies that differ from routine operations (e.g., use of circular rearing strategies)
- Smolt releases, length, and location (actual versus goals)
- Tagging and marking summary (PIT tags and BWTs)

3.0 MONITORING AND EVALUATION

Results obtained for each monitoring and evaluation objective. Reporting in 2021 will be completed in accordance with the 2020 H&S Plan Objectives; however, these objectives are not described in this 2021 version of the AOP because it has yet to be approved by FERC. At a minimum, these results will include the following along with associated confidence intervals and coefficient of variance where applicable:

- Adult escapement estimates (abundance) downstream of Merwin Dam
- Adult composition (hatchery versus natural origin) on spawning grounds downstream of Merwin Dam
- Spatial and temporal distribution of spawning downstream of Merwin Dam
- Juvenile migration and residualism estimates of hatchery releases downstream of Merwin Dam
- Hatchery juvenile monitoring for ecological interactions with NOR smolts
- Summaries of screw trapping results including locations fished, time periods fished, catch rates (relative abundance) by species (composition), trapping efficiency, and estimates of juvenile abundance by species
- Distribution maps of redd locations and counts for each species

4.0 CONSISTENCY AND ADHERENCE WITH HSRG GUIDELINES

Annual reporting will provide the status and measures implemented to track the consistency of hatchery operations with recommendations of the HSRG recommendations for the Lewis River Hatchery complex.

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Chapter 2 Strategy A: Lewis Spring Chinook Salmon Rearing and Release Evaluation Plan

2021 Plan: ATS is determining how to analyze CWT data and calculate SARs for treatment groups in order to initiate analysis as described in the plan. ATS will revise plan in 2021 as needed. Reporting for this strategy is anticipated to begin in the 2021 AOR.

Chapter 3 Strategy B: Screw Trapping Strategy for Lewis River Hatchery Programs, 2021

2021 Plan: Continue trapping, similar to previous years but in different location (tandem traps further downstream), fall Chinook fry are marked, and data are reported in JMS process. In summer/fall 2021, ATS will evaluate 2021 results and revise the strategy for 2022.

Chapter 4 Strategy C: Fish Health Monitoring and Disease Prevention Strategy for Lewis River Hatchery Programs 2021

2021 Plan: No major changes from previous years; in 2021 ATS will discuss fish health practices and protocols at the Lewis River hatchery facilities with biannual updates from fish health staff. An annual report is anticipated at year-end 2021 or early 2022, which the ATS will review.

Chapter 5 Strategy D: Methods to Determine pHOS for Winter Steelhead, Spring Chinook Salmon, and Coho Salmon on Spawning Grounds Downstream of Merwin Dam and Evaluate Precision of pHOS Estimates and Ability to Determine the Trend Toward Hatchery and Genetic Management Plan Targets Over Time

2021 Plan: Continue running the model in 2021 if feasible. In 2021, ATS will consider alternate collection methods (e.g. anglers) to collect fish for implementation in 2022, and will revise strategy accordingly.

Chapter 6 Strategy E: Precocity Study Plan for Spring Chinook Salmon

2021 Plan: Implement plan as described. Evaluate results and discuss plans for 2022.

Chapter 7 Strategy F: Morphological Sampling Plan for Spring Chinook, Coho, and Winter Steelhead

2021 Plan: Continue morphological monitoring as in previous years. Note that additional detail about spring Chinook monitoring is included in the Precocity Plan (Strategy E). In 2021, the ATS will discuss what data are needed to meet 2020 H&S Plan key questions and the most efficient way for hatchery staff to collect needed data in 2022.

Chapter 8 Strategy G: Estimating Adult and Juvenile Abundance of Winter Steelhead, Coho, and Chinook Downstream of Merwin Dam

2021 Plan: No changes to methods in 2021. In 2021, ATS plans to update methods to estimate mainstem coho abundance for implementation in 2022 (but no changes to tributary surveys). ATS may merge Strategies G, H, I because the data collection includes significant overlap.

Chapter 9 Strategy H: Determining the Spatial and Temporal Distribution of Spawning Winter Steelhead, Spring Chinook, and Coho Downstream of Merwin Dam

2021 Plan: The ATS will discuss potential changes to genetic sampling for Chinook carcasses which would begin in September 2021. The ATS may also be updating methods to differentiate between Chinook and Coho. No changes to steelhead or coho for 2021. There are possible changes to coho in 2022 (in relation to Strategy G). ATS may merge Strategies G, H, I because because the data collection includes significant overlap.

Chapter 10 Strategy I: Evaluating Fall Chinook and Chum Populations Downstream of Merwin Dam

2021 Plan: No changes to methods in 2021. ATS may merge Strategies G, H, I because the data collection includes significant overlap.

Chapter 11 Strategy J: Trout Stocking Plan 2021

2021 Plan: Continue improving plan and finalize through the ACC.

Chapter 12 APPENDIX A: Handling and Sampling Protocols

Chapter 13 APPENDIX B: Aquatic Technical Subgroup Work Plan for 2021 (living document)

Chapter 14 APPENDIX C: Placeholder: Metrics/Key Questions Data Matrix for Lewis River Programs