Monitoring and Evaluation Updates for John Day/The Dalles Dam Mitigation Programs at Spring Creek and Little White Salmon National Fish Hatcheries - FY 2022 Annual Report

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Abstract - The John Day/The Dalles Dam Mitigation (JDTD) program provides mitigation for the escapement of 30,000 adult fall Chinook salmon (Oncorhynchus tshawytscha) due to the loss of spawning habitat and production caused by construction of the John Day and The Dalles Dams in the Columbia River. The program is funded by the U.S. Army Corps of Engineers (USACE) and operates with a total adult production (TAP) goal of 107,000 adults which include all adults harvested in saltwater and freshwater, returns to the hatchery, strays to other facilities, and any adults observed on the spawning grounds. Working towards this TAP goal, juvenile fall Chinook are reared and released from numerous state, tribal, and federally-operated hatcheries. Spring Creek and Little White Salmon National Fish Hatcheries (NFHs) annually contribute to the TAP goal of the JDTD program through the coordinated rearing and release of juvenile tule and upriver bright fall Chinook. In the past ten years, Spring Creek NFH has annually released a mean of 10.8 million juvenile tules into the Columbia River. Over the past 10 brood years, the program has contributed a mean of 86,407 adult tules (including 65,326 for harvest) annually to the JDTD program TAP goal. Since 2013, Little White Salmon NFH has annually released a mean of 4.4 M juvenile upriver brights into the Little White Salmon River. Over the past 10 brood years, the program at Little White Salmon NFH contributed a mean of 31,643 adult upriver brights (including 16,205 for harvest) annually to the JDTD program TAP goal. Congressional mandated mass marking of juveniles prior to release from both Spring Creek and Little White Salmon NFHs has been conducted to allow selective harvest of hatchery-reared individuals and protection of wild fish stocks. Additionally, coded-wire and PIT tagging of juveniles at both facilities has provided knowledge on timing of juvenile migration, downstream survival, number of adult returns to the facilities by brood year, smolt-to-adult survival rates, and tracking of fish straying. Additional monitoring and evaluation projects for both facilities are ongoing or currently being developed to determine the success and longevity of the programs in meeting their mitigation goals as well as ESA compliance through Biological Opinions as part of the JDTD program.

Disclaimer:

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Introduction

Extensive hydropower development on the Columbia River during the 20th century altered habitats and led to rapid declines of wild salmonid populations in the mainstem (Fraley et al. 1989; Bottom et al. 2005). A prominent change in hydromorphology within the Columbia River Gorge occurred in 1957 due to the completion of The Dalles Dam which was constructed by the U.S. Army Corps of Engineers (USACE) for hydropower generation and navigation. The impoundment created by The Dalles Dam flooded the town of Celilo and submerged Celilo Falls, a productive fishing site which was utilized by several native tribes on the Columbia River. In 1971, the John Day Dam was completed approximately 40 kilometers upstream of The Dalles (Figure 1), leading to further loss of spawning habitat and decreased production of fall Chinook salmon (*Oncorhynchus tshawytscha*) in the mainstem of the Columbia River.

To offset the inundation of spawning habitat and reduced fall Chinook salmon production due to construction of the John Day and The Dalles Dams, Congress authorized the John Day/The Dalles Dam Mitigation (JDTD) program. Mitigation included financial settlements to the Confederated Tribes and Bands of the Yakama Nation, Confederated Tribes of Warm Springs Reservation, Confederated Tribes of the Umatilla Indian Reservation, and the Nez Perce Tribe for the submergence of Celilo Falls, and the development of hatchery programs to compensate for the loss of spawning adult Chinook in the mainstem. Using historical data on adult returns and smolt-to-adult survival rates, the USACE negotiated with *U.S. v Oregon* parties in 2013 to provide mitigation for the escapement of 30,000 adult Chinook salmon as part of the JDTD program. To meet the escapement goal, hatchery programs collectively operate with a total adult production (TAP) goal of 107,000 adults which includes all adults harvested in saltwater and freshwater, returns to the hatchery, strays to other facilities, and any adults observed on spawning grounds. Approximately, 25% of the TAP goal is composed of tule (or early-run) fall Chinook which begin migrating from the Pacific Ocean in August to spawn from late September to November (PFMC 2011). The other 75% of the TAP goal consists of upriver bright (URB; or late-run) fall Chinook which begin migrating up the Columbia River in August, but spawn from mid-October to December. The 25% tule and 75% URB split was an “In Kind” goal set when considering the impact that both The Dalles and John Day Dams had on spawning and rearing habitat as well as upstream and downstream fisheries. Collectively, the TAP goal is to be

achieved through the coordinated rearing and release of juvenile tule and URB fall Chinook from numerous existing (and planned) state, tribal, and federally-operated facilities.

Spring Creek National Fish Hatchery (NFH) and Little White Salmon NFH (Figure 1) are two federally-operated facilities with fall Chinook production programs that are part of the JDTD program. At Spring Creek NFH, juvenile tules are annually released from the hatchery directly into the mainstem of the Columbia River in April and May. For the production program at Little White Salmon NFH, a proportion of juvenile URBs are annually reared and released from the facility into the Little White Salmon River in June and July. Additionally, as part of the JDTD program, the facility transfers URB juveniles to the Yakima River-Prosser Hatchery program, and URB eggs to the state-operated Bonneville Hatchery to support the Umatilla and Yakima River programs. Juvenile fish released as part of the JDTD program provide locally adapted adult broodstock as well as harvest opportunities for sport, commercial, and tribal fishermen, contributing to the TAP goal and mitigation agreements negotiated by *U.S. v Oregon* parties and USACE.

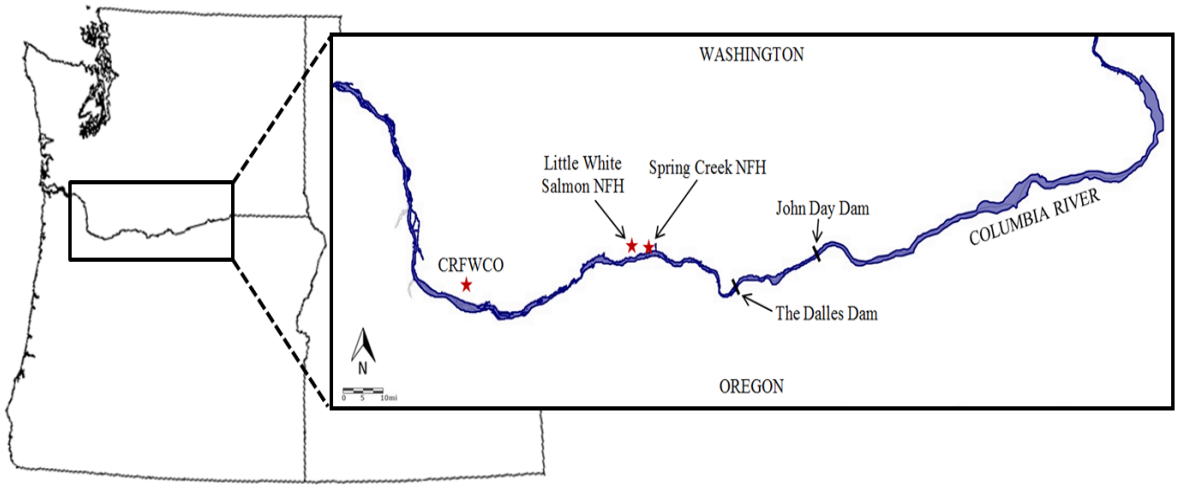

Figure 1. Spring Creek and Little White Salmon NFHs are located on the Washington side of the Columbia River downstream of the John Day and The Dalles Dams. Monitoring and evaluation of the fall Chinook production programs at these facilities is conducted by staff at the Columbia River Fish and Wildlife Conservation Office (CRFWCO) located in Vancouver, Washington.

A significant proportion of the juvenile fish reared at Spring Creek and Little White Salmon NFHs are mass marked by removal (clipping) of the adipose fin due to a congressional mandate (February 12, 2003, Congressional Record, Sec. 138) implemented in release year 2005 requiring all production fish from federal facilities (except those explicitly reared for conservation) to be externally marked. Absence of an adipose fin delineates hatchery-reared fish from wild stocks allowing for selective harvest of adult returns in both saltwater and freshwater fisheries. In addition to an adipose fin-mark, a proportion of the juveniles are marked with coded-wire tags (CWT) in the snout prior to release. CWT marking allows researchers to estimate smolt-to-adult survival, determine age structure of adult returns, and evaluate the contribution of the annual juvenile release to the TAP goal by tracking the number of adults recovered during harvest, at the spawning grounds, and as returns to the hatchery. Data is utilized by staff at the facilities and

the Columbia River Fish and Wildlife Conservation Office (CRFWCO) for monitoring and evaluating the effectiveness of the production programs in meeting overall mitigation agreements, and for limiting the effects of production programs on fish stocks listed under the U.S. Endangered Species Act (ESA). Fish that have CWTs but are not adipose fin-marked are referred to as double-index tagged (or DIT) fish and are utilized by harvest managers as a proxy for determining the impacts of catch-and-release fisheries on wild fish.

For fiscal year (FY) 2022, the U.S. Fish and Wildlife Service (USFWS) requested funding from the USACE to support the JDTD programs at Spring Creek and Little White Salmon NFHs. Funds supported costs associated with juvenile production, mass marking, tagging, facility operations, and monitoring and evaluation efforts at the CRFWCO to allow for best management practices as outlined in the National Marine Fisheries Service (2007) and (2017) Biological Opinions. The purpose of this report is to provide an annual update summarizing results of the monitoring and evaluation programs conducted over the past ten years, discuss whether facilities are meeting objectives outlined in their Hatchery and Genetic Management Plans (HGMPs), and identify any special studies or notable trends with the fall Chinook production programs at Spring Creek and Little White Salmon NFHs that are supported by JDTD funds.

For previous Columbia River Fish and Wildlife Program Office reports, please see:
https://www.fws.gov/office/columbia-river-fish-and-wildlife-conservation/reports

Spring Creek NFH: Tule Program

Spring Creek NFH (Figure 2) was established in 1901 and is located at river kilometer (rkm) 269 of the Columbia River near the towns of Underwood and White Salmon, WA. The tule fall Chinook program at the facility contributes to fulfilling tribal trust mandated responsibilities and mitigation requirements for recreational and commercial fisheries. Previous financial support to produce tule fall Chinook and monitoring and evaluation studies at the facility have been provided by funds from the Mitchell Act (administered by NMFS), USFWS (mass marking), and from the USACE as part of the JDTD program. The USACE has been providing 100% of the funding for the tule program since FY 2015 (brood year 2014). Broodstock for the tule program originated from the White Salmon River located approximately 1.5 kilometers upstream of the hatchery. The lower Columbia River White Salmon River tule stock is listed as threatened under the ESA (70 FR 37160). Presently, 100% of the adults used for broodstock at Spring Creek NFH are provided by hatchery-reared, adult returns to the facility as a segregated program.

Figure 2. Aerial photograph of Spring Creek NFH located along the Columbia River. U.S. Fish and Wildlife Service stock photograph by Cheri Anderson.

On-Station Juvenile Production

a) Egg-to-Smolt Survival

Survival objectives during the early life stages are important monitoring and evaluation metrics for determining whether the hatchery is equipped to meet mitigation goals being funded by the USACE. These survival objectives include:

1. 95% or higher survival from the egg to eye up stage
2. 90% survival from the egg to fry stage; and
3. 97% survival from fry to smolt stage

Mortality can occur during each of these life stages due to disease, injury, predation, starvation, deformities, genetic anomalies, and hatchery equipment malfunction. Throughout the rearing cycle, the hatchery has a maximum Flow Index ≤ 1.5 and Density Index ≤ 0.3 to minimize disease risk (USFWS 2004a). Hatchery staff monitor these objectives to make sure facilities are meeting their production levels and determine whether alternative rearing and release practices are needed to improve on-station survival.

b) Juvenile Mass Marking, Tagging, and Release Data

Historically, Spring Creek NFH released 15.1M juvenile tule into the Columbia River in March, April, and May. Beginning in release year 2009, reprogramming at the facility changed the production level goal to 10.5M tule released in April and May. For Brood Years (BYs) 20 - 22, the Pacific Salmon Treaty funded an increase of up to two million juveniles for Southern Resident Killer Whale (SRKW) production. A proposal for additional BY23 funding will be determined in the Spring of 2023. Any fish produced above 10.5M (*U.S. v Oregon* obligation) for are credited to SRKW production. The actual number of juvenile tule released annually has varied with a mean of 10,826,980 since release year 2013 (Table 1). The facility has mean juvenile size goals of 90-120 fish/lb for the April release and 60-80 fish/lb for the May release as outlined in the hatchery's Hatchery and Genetics Management Plan (USFWS 2004a). Ninety-

two percent (~10M) of the annual production is mass marked with an adipose fin-mark (AD) only. The remaining fish are tagged with CWTs with ~405K being AD and tagged with CWTs, and ~405K being tagged with CWTs only (DIT fish). The CWT marking and tagging goals comply with the minimum suggested 200,000 per release group level recommended for sub-yearling fall Chinook by the Coast-wide CWT Database Expert Panel for Pacific Salmon Commission. The actual numbers of juveniles that have been mass marked and tagged since release year 2013 are presented below (Table 1).

Table 1. Annual release dates, marking and tagging information, number of juveniles released, and mean size at release in April and May for juvenile tule fall Chinook released from Spring Creek NFH. Brood year is one year before release year. Data retrieved from CRiS SR80s File: 12/20/2022.

Release Year	Release Dates	Temp. (°C)	AD + CWT	CWT (DIT)	AD Only	No Mark/No CWT*	Total Released	Mean Size (Fish/lb)	Annual Total Release
2013	11-Apr	7.7	196,681	203,834	6,040,240	820	6,441,575	99	11,242,686
	2-May	10.6	200,696	199,892	4,398,952	1,571	4,801,111	79	
2014	11-Apr	8.9	205,922	205,548	5,757,948	0	6,169,418	122	10,754,482
	6-May	11.1	199,060	198,350	4,186,873	781	4,585,064	88	
2015	13-Apr	9.2	201,918	196,759	5,975,115	5,370	6,379,162	148	10,415,634
	27-Apr	10.6	190,848	191,210	3,654,414	0	4,036,472	105	
2016	11-Apr	-	203,461	201,944	5,941,689	2,278	6,349,372	112	10,167,948
	9-May	8.9	194,817	197,566	3,425,802	391	3,818,576	90	
2017	10-Apr	8.9	204,714	204,431	6,168,828	393	6,578,366	126	10,775,114
	8-May	11.3	195,800	194,472	3,802,122	4,354	4,196,748	84	
2018	9-Apr	4.4	203,899	201,850	6,266,724	2,907	6,675,380	135	10,737,862
	7-May	7.0	197,100	197,321	3,666,549	1,512	4,062,482	87	
2019	8-Apr	7.7	204,668	204,551	6,228,055	218,575	6,855,849	223	11,226,628
	6-May	8.3	197,627	197,565	3,975,216	371	4,370,779	152	
2020**	10-Apr	-	153,161	152,451	4,391,178	2,199,589	6,896,379	99	11,184,169
	13-Apr	-	149,020	147,850	2,028,753	1,962,167	4,287,790	104	
2021†	12-Apr	5.0	163,427	164,049	6,219,089	321	6,546,886	95	11,188,509
	20-Apr	6.1	196,581	196,643	4,247,245	1,154	4,641,623	83	
2022**†	14-Mar	-	150,585	116,714	2,011,145	8,287,850	10,566,294	204	10,576,764
	28-Apr‡	8.4	-	-	-	-	10,470	-	
Mean	**Group 1 April**	**7.4**	**189,405**	**189,083**	**5,387,715**	**399,416**	**5,652,689**	**122.4**	**10,826,980**
	Group 2 Apr/May	**9.7**	**196,564**	**196,625**	**3,872,847**	**1,283**	**4,267,319**	**97.9**	

*Fish with No Mark/No CWT include unmarked releases and double index tagged fish that shed their coded-wire tag prior to release.
**An increased number of No Mark/No CWT fish were released in 2020 when marking was suspended due to COVID-19 and in 2022 when fish were released early due to bacterial gill disease.
†All RY 2021 and 2022 juveniles produced above 10.5M for are credited to SRKW production.
‡Fish released in April 2022 were part of a study and isolated from the population that was released in early March

Off-Station Survival

a) PIT Tagging Program: Juvenile Migration Time

Approximately 15,000 juveniles are annually tagged by crews from the USFWS with Passive Integrated Transponder (PIT) tags prior to release from Spring Creek NFH (Table 2). PIT tagging juveniles provides real-time data as fish migrate to the Pacific Ocean and is accessible from the regional database called the Columbia Basin PIT Tag Information System (PTAGIS). PIT tag detections at fish ladders, hydropower dams, bird colonies, and the Columbia River estuary are utilized by staff at the CRFWCO to estimate juvenile migration time and survival through the Columbia River Basin. This information was also used to inform spill timing and duration need at Bonneville Dam for juvenile tule released early from Spring Creek NFH in 2022. Additionally, PIT tagged fish provide adult return run time information, estimation of straying rates, and knowledge on ecological interactions with ESA listed stocks in the Columbia River.

PIT tagged juvenile tule released from Spring Creek NFH are typically detected at Bonneville Dam located 35 kilometers downstream from the facility as they migrate to the Pacific Ocean. The detection rate of PIT tagged fish at Bonneville Dam is a function of a) migration survival from release to the dam, and b) the detection efficiency of the PIT antenna arrays at the dam. Detection efficiency at Bonneville Dam varies between and within years due to flow levels and dam operations (e.g., amount of spill, number of operating turbines, etc.). Travel times and detection rates to Bonneville Dam are estimated annually (Table 2). The average detection rate at Bonneville Dam of PIT tagged tule fall Chinook juveniles from Spring Creek NFH is approximately 5.8%, with an average median travel time from the hatchery to the dam of 1 day.

Due the low detection rate of Spring Creek PIT tagged juveniles downstream of Bonneville Dam, at bird colony recovery sites and at the estuary trawl survey site (NOAA), no juvenile survival estimates can be accurately calculated.

Table 2. The number of PIT tagged juvenile tule released from Spring Creek NFH and juvenile travel time (days) to Bonneville Dam (BONN). Data retrieved from PTAGIS: 12/2/2022

				Travel Time (Days)				
						Percentile		
Release Year	# PIT Tagged*	# Detected at BONN	% Detected	Mean	Range	50th	75th	90th
2013	14,940	825	5.5	2	(0.5 - 38)	1	2.0	3.0
2014	14,866	757	5.1	2	(0.5 - 37)	1	1.5	2.0
2015	14,929	847	5.7	3	(1 - 55)	2	2.5	3.5
2016	14,954	779	5.2	1	(0.5 - 10)	1	1.5	1.5
2017	14,918	513	3.4	1	(0.5 - 12)	1	1.0	1.0
2018	14,907	619	4.2	1	(0.5 - 54)	1	1.5	1.5
2019	15,225	1,519	10.0	1	(0.5 - 47)	1	1.5	2.0
2020†	-	-	-	-	-	-	-	-
2021	14,979	1,064	7.1	4	(2 - 56)	3	3.5	5.0
2022‡	-	-	-	-	-	-	-	-
Average	**14,965**	**865**	**5.8**	**1.9**	**(0.5 - 56)**	**1**	**2**	**2**

* Number tagged is adjusted for shed tags and pre-release mortality
† PIT tagging operations were cancelled in 2020 due to COVID-19, outmigration timing for Brood Year 2019 (Release Year 2020) could not be determined.
‡ In spring 2022, juveniles were released early due to bacterial gill disease and were not PIT tagged; outmigration timing for Brood Year 2021 (Release Year 2022) could not be determined.

Adult Returns

a) Harvest Data and Smolt-to-Adult Survival

CWT recoveries, collected by federal, state, and tribal agencies and maintained in the RMIS database, are used to estimate adult returns to hatcheries in the Columbia River basin, harvested adults, and adults recovered on the spawning grounds in all watersheds [Table 3; Pastor (2004); Pastor (2016)]. Based on CWT recoveries from brood years 1990 to 2004, Spring Creek NFH was estimated to have a mean smolt-to-adult survival rate of 0.47%. *U.S. v. Oregon* parties utilized this rate to set the juvenile production goal and estimated that the facility would contribute an estimated 49,592 adult tule Chinook, on average, towards the TAP goal of 107,000 with 28,000 adults supplied for harvest. However, for brood years 2006-2015, the facility has a mean smolt-to-adult survival rate of 0.74% (Table 3) which exceeds the program's goal of a 10-year-average of 0.5% smolt-to-adult survival rate outlined in the facility's HGMP (USFWS 2004a). Additionally, the tule program has contributed an average 86,407 adults for the past ten Brood Years 2006 – 2015 with the highest number of returns from the April juvenile release group (Table 4). Off-station CWT recoveries for harvest and spawning grounds beyond BY15 may be incomplete due to a lag in RMIS reporting.

Table 3. The estimated number of hatchery returns, harvested adults, and fish present on the spawning grounds based on coded wire tag recovery and expansion data from RMIS for tule fall Chinook released from Spring Creek NFH. Data downloaded from RMIS on 2/28/2023.

Brood Year	Hatchery Returns*	Columbia River Harvest	Ocean Harvest	Spawning Grounds	Total Adults†	Smolt-to-Adult Survival (%)
2006	11,121	12,497	4,433	0	27,951	0.18
2007	55,022	69,779	41,278	520	166,599	1.12
2008	19,087	30,011	18,773	175	68,046	0.60
2009	20,376	30,740	21,245	151	72,512	0.67
2010	12,711	29,611	15,989	28	58,339	0.54
2011	18,558	67,380	35,933	355	122,226	1.10
2012	34,518	99,768	57,780	1,060	193,256	1.72
2013	8,842	18,898	7,791	90	35,621	0.33
2014	13,712	32,243	25,579	189	71,723	0.69
2015	13,939	18,203	15,332	150	47,801	0.47
2016§	8,933	20,145	7,001	704	37,095	0.34
2017§	14,412	34,864	10,907	406	60,786	0.56
Average §	**20,789**	**40,913**	**24,413**	**272**	**86,407**	**0.74**

* Hatchery returns are returns to Spring Creek NFH.
† Total Adults include other recovery locations not listed, such as strays to other hatcheries.
‡ Due to delays in reporting to RMIS, CWT recoveries may be adjusted every year for accuracy.
§ Average calculated for Brood Years 2006-2015

Table 4. Group 1 (April) and Group 2 (Late April/May) survival rates based on CWT expansion. Data retrieved from RMIS 3/28/2023.

Brood Year	Release Year	Release Date	Release Group	Mean Size (Fish/lb)	Mean % Survival
2006	2007	Apr-12	1	89	0.17
		May-1	2	74	0.12
2007	2008	Apr-10	1	80	1.11
		May-2	2	65	1.25
2008	2009	Apr-13	1	144	0.62
		May-1	2	91	0.44
2009	2010	Apr-12	1	111	0.69
		May-10	2	76	0.34
2010	2011	Apr-12	1	112	0.46
		May-4	2	87	0.34
2011	2012	Apr-13	1	124	0.55
		Apr-30	2	98	1.04
2012	2013	Apr-11	1	99	1.45
		May-2	2	79	1.10
2013	2014	Apr-11	1	122	0.34
		May-6	2	88	0.12
2014	2014	Apr-13	1	148	0.59
		Apr-27	2	105	0.49
2015	2016	Apr-11	1	112	0.47
		May-9	2	90	0.39
2016	2017	Apr-10	1	126	0.29
		May-8	2	84	0.23
2017	2018	Apr-9	1	135	0.46
		May-7	2	87	0.35
Mean			**1**	**117**	**0.60**
			2	**85**	**0.51**

An average 634 CWTs have been recovered each year at Spring Creek NFH since 2013 (Table 5). The Spring Creek NFH tule fall Chinook program accounts for 99.8 percent of all recoveries; tule fall Chinook from other programs include Little White Salmon NFH (0.1%), Bonneville Hatchery (0.1%), and the Coleman NFH (<0.1%).

Table 5. Coded Wire Tag (CWT) recoveries for all hatchery programs collected at Spring Creek NFH 2013 - 2022. Number of CWT recoveries are not expanded and do not reflect sample or tagging rates. Data retrieved from RMIS: 1/30/2023

Return Year	CWT Recoveries	Hatchery Origin	% of CWT Total Return
2013	699	Spring Creek NFH	100
2014	484	Spring Creek NFH	100
2015	452	Spring Creek NFH	98
	8	L. White Salmon NFH	2
2016	646	Spring Creek NFH	99.4
	3	Bonneville Hatchery	0.5
	1	Coleman NFH	0.2
2017	529	Spring Creek NFH	99.8
	1	Bonneville Hatchery	0.2
2018	655	Spring Creek NFH	100
2019	719	Spring Creek NFH	100
2020	630	Spring Creek NFH	100
2021	719	Spring Creek NFH	99.7
	2	Bonneville Hatchery	0.3
2022	789	Spring Creek NFH	100
Average	**634**		

b) Age Structure

Age structure of returning adult fish is used in pre-season forecast models and to evaluate brood year productivity. The estimated age structure can also identify potential changes and trends in age composition over dime due to ecological or anthropogenic factors. Adult returns to Spring Creek NFH are sampled by hatchery personnel and the USFWS marking and biosampling crew from CRFWCO (Table 6: brood year; Table 7: return year). A subsample of adults (500 minimum) are aged by the biosampling crew using scales and CWT sampling, and the age ratios are applied to the total number of adults to estimate the overall age structure of the adult returns. The majority (~62%) of adult tule (21,339 of 34,276) return to Spring Creek NFH at Age-3, but 31% return at Age-2 (10,526 of 34,276) as precocially mature males/females. Approximately 7% of adults return at Age-4 (2,377 of 34,276) and less than 1% return at Age-5 (34 of 34,276). The facility has produced an annual mean of 34,276 adult returns to Spring Creek NFH for return years 2013-2022.

Table 6. Estimated age structure of adult tule fall Chinook returns to Spring Creek NFH by *brood year*. Data retrieved from CRiS Age Composition reports run on: 12/21/2022

Brood Year	Age-2	Age-3	Age-4	Age-5	Total # Adults
2008	4,856	14,618	4,328	29	23,831
2009	4,049	20,890	3,178	119	28,236
2010	1,867	12,615	3,433	66	17,981
2011	2,827	18,221	5,203	124	26,375
2012	10,028	36,152	3,865	0	50,045
2013	2,738	4,823	487	0	8,048
2014	8,566	11,327	352	0	20,245
2015	6,101	10,045	1,047	0	17,193
2016	5,018	6,290	486	0	11,794
2017	7,695	9,938	3,657	0	21,290
2018*	7,259	20,775	2,060	NA	NA
2019*	28,740	83,202	NA	NA	NA
2020*	26,292	NA	NA	NA	NA
Average	**8,926**	**20,741**	**2,554**	**34**	**22,504**

* Denotes incomplete brood years given that adults have either not yet returned to the hatchery or have not been aged.

Table 7. Total number of adult tule fall Chinook returns to Spring Creek NFH and estimated age structure by *return year*. Data retrieved from CRiS Age Composition reports run on: 12/21/2022

Return Year	Age-2	Age-3	Age-4	Age-5	Total # Adults
2013	2,827	12,615	3,178	29	18,649
2014	10,028	18,221	3,433	119	31,801
2015	2,738	36,152	5,203	66	44,159
2016	8,566	4,823	3,865	124	17,378
2017	6,101	11,327	487	0	17,915
2018	5,018	10,045	352	0	15,415
2019	7,695	6,290	1,047	0	15,032
2020	7,259	9,938	486	0	17,683
2021	28,740	20,775	3,657	0	53,172
2022	26,292	83,202	2,060	0	111,554
Average	**10,526**	**21,339**	**2,377**	**34**	**34,276**

c) Bonneville Dam Detections

Since Return Year 2013, tule fall Chinook adults (≥ Age 2) PIT tagged and released from Spring Creek NFH returned to Bonneville Dam as early as Jul-31 and as late as Sep-29 with the average median Sep-04 (Table 8). Based on expansion of PIT tags, 73% of tule fall Chinook adults released from Spring Creek NFH that pass upstream through Bonneville Dam's adult ladders return to Spring Creek NFH (not including return years with BY19 fish). No fish from BY 19 were PIT tagged due to COVID-19 restrictions in 2020. Fish from this brood year are not included in the average expanded returns in 2021 and 2022 (jacks and age-3 respectively).

Table 8. Median Bonneville Dam passage date of adult tule fall Chinook PIT tagged and released from Spring Creek NFH (≥ Age 2). Data retrieved from PTAGIS: 12/21/2022

Return Year	Median Passage Date	First Detection Date	Last Detection Date	# of Fish Detected	Bonneville Expansion	95% CI	Hat. Return	Hat. Return/Bonn. Expansion (%)
2013	Sep-05	Aug-15	Sep-26	33	24,132	(13,121 - 38,590)	18,649	77
2014	Sep-08	Aug-24	Sep-25	59	44,216	(29,839 - 72, 541)	31,801	72
2015	Sep-10	Aug-20	Sep-29	80	60,056	(46,583 - 82,880)	44,159	74
2016	Sep-03	Aug-08	Sep-26	32	23,861	(13,498 - 48,476)	17,378	73
2017	Sep-08	Aug-23	Sep-20	22	16,131	(8,729 - 31,296)	17,915	111
2018	Sep-01	Aug-21	Sep-13	29	20,131	(11,743 - 35,637)	15,415	77
2019	Sep-06	Jul-31	Sep-23	40	28,814	(18,133 - 46,369)	15,032	52
2020	Sep-02	Aug-02	Sep-18	51	36,977	(24,891 - 55,895)	17,683	48
2021*	Aug-31	Aug-22	Sep-19	39	28,656	(19,318 - 47,116)	53,172	186
2022*	Sep-05	Aug-24	Sep-15	33	24,655	(16,093 - 42,899)	111,554	452
Average	**Sep-04**	**Aug-15**	**Sep-21**	**42**	**30,763**		**34,276**	**73**

* Pit tagging operations were cancelled in 2020 due to COVID-19, return timing for brood year 2019 (Release Year 2020) could not be determined; the average expanded returns do not include 2021 and 2022.

d) Hatchery Ladder Detections

Since Return Year 2013, tule fall Chinook adults (≥ Age 2) PIT tagged and released from Spring Creek NFH returned to the Spring Creek NFH Ladder as early as Aug-23 and as late as Oct-02 with the average median Sep-08 (Table 9). Fish from brood year 2020 are not included in the average expanded returns in 2021 and 2022.

Table 9. Median detection date of adult tule fall Chinook PIT tagged and released from Spring Creek NFH at the Spring Creek NFH Adult Ladder (≥ Age 2). Data retrieved from PTAGIS: 12/21/2022

Return Year	Median Passage Date	First Detection Date	Last Detection Date	# of Fish Detected	Ladder Expansion	95% CI*	Hat. Return	Hat. Return/ Ladder Expansion (%)
2013	Sep-10	Sep-04	Sep-24	12	8,774	(3,956 - 15,159)	18,649	213
2014	Sep-10	Aug-31	Oct-01	24	18,015	(9,839 - 34,036)	31,801	177
2015	Sep-13	Sep-04	Oct-02	22	16,526	(10,341 - 25,523)	44,159	267
2016	Sep-06	Aug-23	Sep-20	11	7,861	(1,924 - 11,402)	17,378	221
2017	Aug-31	Aug-30	Sep-11	5	3,435	(NA - NA)	17,915	522
2018	Sep-08	Aug-29	Sep-14	16	10,964	(5,676 - 17,407)	15,415	141
2019	Sep-13	Aug-27	Sep-22	14	10,056	(4,441 - 24,342)	15,032	149
2020	Sep-08	Aug-31	Sep-25	24	17,428	(2,926 - 12,174)	17,683	101
2021**	Sep-08	Aug-30	Sep-19	19	13,959	(7,268 - 20,635)	53,172	381
2022**	Sep-08	Aug-30	Sep-23	25	18,710	(12,083 - 28,044)	111,554	596
Average	**Sep-08**	**Aug-30**	**Sep-22**	**17**	**12,573**		**34,276**	**224**

* Confidence limits do not include detections of five fish or fewer per age group to reduce the variability and increase the accuracy of the estimate

** Pit tagging operations were cancelled in 2020 due to COVID-19, return timing for brood year 2019 (Release Year 2020) could not be determined; the average expanded returns do not include 2021 and 2022.

Additional Monitoring and Evaluation Projects

a) Escapement of Hatchery Fish to Spawning Grounds

Coded-wire tag recovery data stored in the RMIS database allows for the estimation of the number of adults that were released from Spring Creek NFH as juveniles and observed on spawning grounds in nearby watersheds (Table 3) including the White Salmon River (Pastor 2004). Biologists at the Washington Department of Fish and Wildlife (WDFW) have been monitoring the abundance, age structure, and CWT recovery of adult tule in the White Salmon basin since 1965. Beginning in 2010, the monitoring program was expanded to include estimates for the number of hatchery-origin (for all facilities including Spring Creek NFH) versus natural-origin (wild) spawners present on the spawning grounds in the White Salmon River.

Annual spawning ground surveys conducted in the White Salmon River begin in August and end near mid-December once spawning has been completed. Included in the surveys are identification of run types (spring, tule, or URB Chinook), and escapement estimates for both hatchery-origin and natural-origin spawners (Figure 3). Escapement estimates include the number of live and dead spawners observed from Husum Falls (at rkm 12.5) to the confluence of the Columbia River during the annual surveys. Hatchery-origin individuals are identified by the lack of an adipose fin and/or the presence of a CWT (J. Wilson, WDFW, 2018 memorandum to interested parties, Washington Department of Fish and Wildlife, on the 2017 White Salmon Chinook survey methods and results). Data from the spawning surveys is accessible on the Salmon Conservation Reporting Engine (SCoRE) website operated by WDFW. Preliminary 2022 data will not be available until spring 2023.

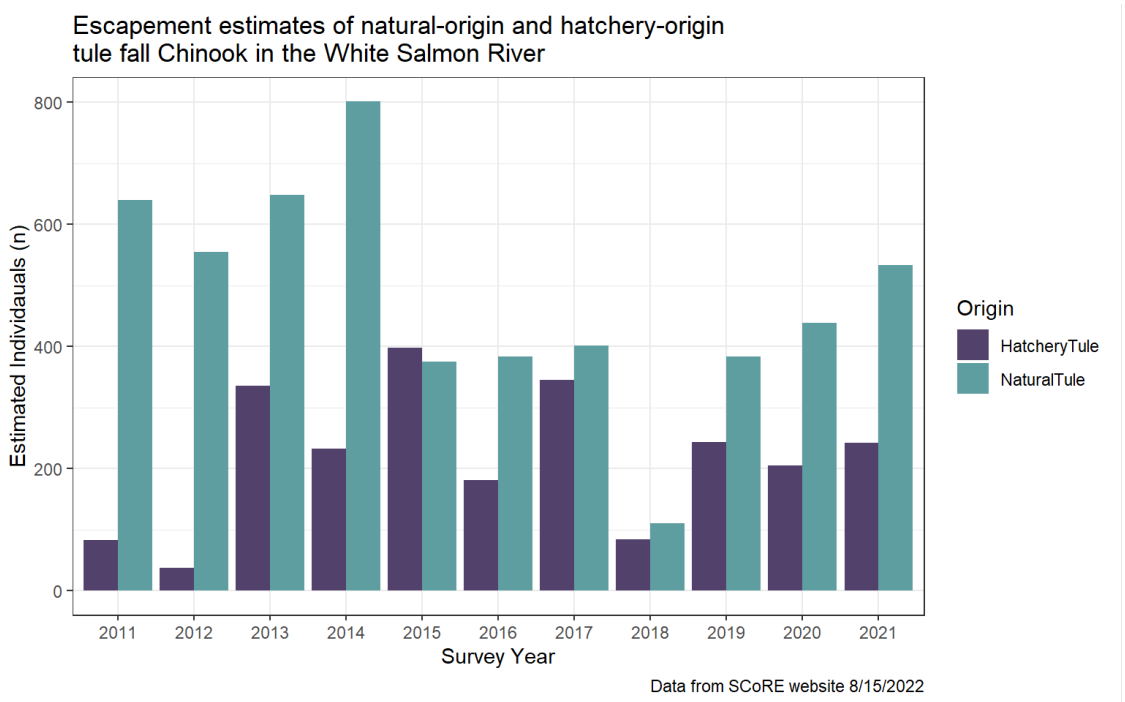

Figure 3. Annual escapement estimates of natural-origin and hatchery-origin tule fall Chinook spawning in the White Salmon River during annual spawning surveys (2011 - 2021)

As part of the JDTD program, data downloaded from SCoRE is used to estimate the proportion of hatchery-origin spawners (pHOS) for tule fall Chinook on the White Salmon River. These estimates can include hatchery fish released from Spring Creek NFH or other hatchery programs. Based on escapement estimates of natural and hatchery-origin tule for spawning ground surveys from 2011 to 2021, pHOS estimates ranged from 6% to 51% with a mean pHOS of 32% (Figure 4). It appears that the proportion of hatchery origin spawners in the White Salmon River was increasing after 2012 and reached a high of 51% in 2015 before decreasing in recent years. Reasons for this apparent increase and decrease are not known and may warrant further study. Based on adult return data from Spring Creek NFH, there is a positive correlation between the number of hatchery-origin tule on the White Salmon River spawning grounds and the number of total adult returns to the facility from 2010 - 2021 is (Pearson's) r = 0.51.

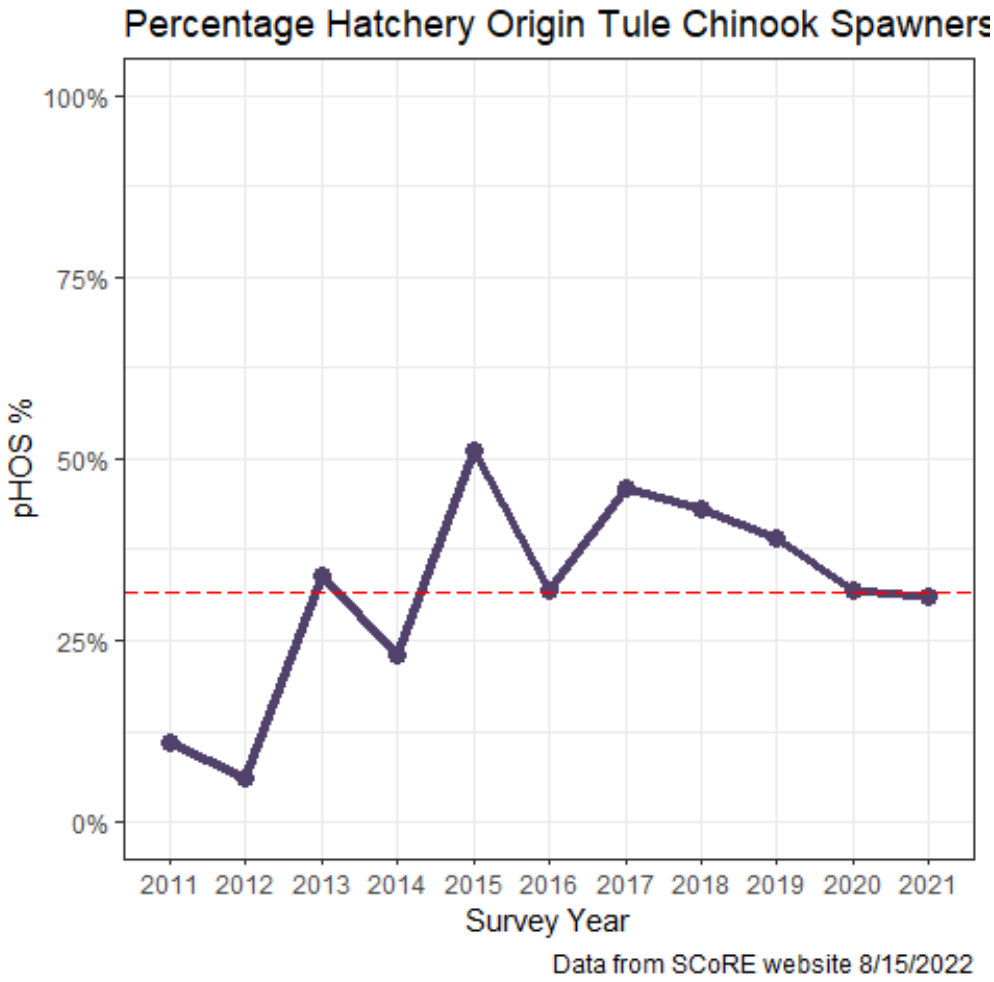

Figure 4. Estimated proportion of tule fall Chinook hatchery origin spawners (pHOS) in the White Salmon River (2011 - 2021). Dotted line is the mean (32 %).

b) Noise Mechanosensory Study

A research project was conducted at Spring Creek NFH analyzing the effect that anthropogenic noise has on the mechanosensory development of juvenile Chinook Salmon. This experiment

specifically measured the development of lateral line neuromasts, inner ear hair cell density, otolith composition, and rheotactic response of fish exposed to varying levels of noise. These measures are indicators of hearing threshold and swimming efficiency in salmonids and may affect overall fitness. Spring Creek provided 12,000 fertilized Chinook eggs for this study. All specimens were reared on station and released by Spring Creek staff. Fish were housed in Spring Creek NFH's Incubation room throughout experimental treatments and never came into proximity the production population. Prior to release, 10,470 pre-smolt fry not used for sampling were PIT tagged for future tracking. This experimental population was distinct and separate from the production population at Spring Creek National Fish hatchery. At the conclusion of the study, once fish return as adults, a standalone report will be written.

Little White Salmon NFH: URB Program

Little White Salmon (LWS) NFH (Figure 5) was established in 1898 and is located on the Little White Salmon River just upstream of Drano Lake, a small body of water that converges with the Columbia River at rkm 261. The facility began rearing Upriver Bright (URB) fall Chinook in 1982 for the Mitchell Act program and to partially fulfill mitigation agreements for the JDTD program. The USACE currently provides funding for the annual production and mass marking of juvenile URBs into the Little White Salmon River, transfer of URB fingerlings to the Yakama Nation for the Yakima River-Prosser hatchery program, and transfer of URB eggs to the Bonneville Hatchery operated by the Oregon Department of Fish and Wildlife to support the Umatilla/Yakima River programs. The facility is also supported by funds from the Mitchell Act (administered by the NMFS) for egg transfers to Willard NFH and to the Yakama Nation Klickitat Hatchery URB Program, as well as the rearing and release of spring-run Chinook salmon from Little White Salmon NFH (Dammerman et al. 2017). The facility has a broodstock need of 9,300 adults to meet all program requests including USACE, Mitchell Act, and Bonneville Power Administration funded programs. The nearly 4,000 adults used as broodstock for the JDTD URB program are adult returns of hatchery-reared URB to the facility.

Figure 5. Aerial photograph of Little White Salmon NFH located on the Little White Salmon River. U.S. Fish and Wildlife Service stock photograph by Speros Doulos.

On-Station Juvenile Production

a) Production Goals

The LWS NFH URB program has on-station JDM releases, on-station SRKW releases (BY19-20 only), Willard Mitchell Act URB broodstock collection, egg transfers for the Prosser/Umatilla programs, and transfers juveniles/eggs for the Klickitat program. Table 10 summarizes the production goals for each program (not the actual releases or transfers for each year). For brood years 2019 and 2020, LWS NFH reared an extra ~450k URBs and Willard an extra ~200k URBs for SRKW production.

Table 10. Broodstock target collected at Little White Salmon NFH for URB Fall Chinook programs 2019 - 2022.

Brood Year	Funding	Program	Total Broodstock need (1:1, M:F)	Target Green Egg Take	Target Release Number	Lifestage
2019 - 2020	MA/COE	LWS NFH/ Prosser	1,000	1,900,000	1,700,000	0+
	COE	LWS NFH	2,556	4,900,000	4,500,000	0+
	MA	Willard NFH	1,186	2,250,000	2,000,000	0+
	PST	Klickitat Hatchery	3,324	6,300,000	1,000,000	0+
	MA	Klickitat Hatchery			4,000,000	0+
	COE	Bonneville/Prosser	166	300,000	210,000	1+
	NOAA	SRKW- Willard NFH	130	247,500	220,000	0+
	NOAA	SRKW- Little White Salmon NFH	256	490,000	450,000	0+
2021 - 2022	MA/COE	LWS NFH/ Prosser	652	1,240,000	1,100,000	0+
	MA/COE	LWS NFH/ Prosser		600,000	NA	Eggs
	COE	LWS NFH	2,556	4,900,000	4,500,000	0+
	MA	Willard NFH	1,186	2,250,000	2,000,000	0+
	PST	Klickitat Hatchery	3,324	6,300,000	1,000,000	0+
	MA	Klickitat Hatchery			4,000,000	0+
	COE	Bonneville/Prosser	166	300,000	210,000	1+

b) Egg-to-Smolt Survival

The survival objectives for the facility are the same as Spring Creek NFH. Hatchery staff at Little White Salmon NFH monitor these objectives to make sure the facilities are meeting their production goals, and design alternative rearing and release practices to improve on-station survival as needed. Throughout the rearing cycle, the hatchery has a maximum Flow Index ≤ 1.5 and Density Index < 0.25 to minimize disease risk (USFWS 2004b)

c) Juvenile Mass Marking, Tagging, and Release Data

The original goal for the facility was to release 2.0M juvenile URBs into the Little White Salmon River (NMFS 2007); however, production expanded in RY09 (BY08) to a release goal of 4.5M juvenile URBs (NMFS 2017). For BYs 19 and 20, the Pacific Salmon Treaty funded an increase of up to 450,000 juvenile upriver bright fall Chinook for SRKW production. Any fish produced above 4.5M *(U.S. v Oregon obligation)* for these brood years are credited to SRKW production. Juveniles are released from the facility in late June to mid-July. The actual number of juvenile

URBs released from the facility is recorded by hatchery personnel and has varied for the past ten years (Table 11). Little White Salmon NFH has a mean juvenile size goal of 70-90 fish/lb at the time of release as outlined in the facility's HGMP (USFWS 2004b, 2015). Since release year 2013, the facility has annually released an average 4,396,441 juveniles with a mean size of 81.2 fish/lb. Ninety percent (~4 M) of the annual production released into the Little White Salmon River is AD only. Approximately 5% are AD and CWT, and the remaining 5% are CWT only (DIT fish). The actual numbers of juveniles that have been mass marked and tagged by USFWS crews over the past 10 years are presented below (Table 11).

Table 11. Annual release dates, marking and tagging information, total number of juveniles released, and mean juvenile size for URB fall Chinook released from Little White Salmon NFH. Brood year is one year before release year. Data retrieved from CRiS SR80s File: 1/30/2023

Release Year	Release Dates	Water Temp. at Release (°C)	AD + CWT	CWT (DIT)	AD Only	No Mark/No CWT*	Total Released	Mean Size (Fish/lb)
2013	2-Jul	8.3	360,089	198,443	3,862,277	769	4,421,578	66
2014	1-Jul, 2-Jul	7.2	267,804	99,702	4,038,588	298	4,406,392	86
2015	2-Jul	9.8	188,763	186,398	3,583,770	13,595	3,972,526	82
2016	11-Jul	7.6	196,105	196,772	3,565,052	3,186	3,961,115	85
2017	5-Jul	6.8	197,829	198,487	4,297,331	1,381	4,695,028	77
2018	11-Jul	9.0	189,005	186,872	3,475,401	13,093 (419,000) †	3,864,371 (419,000) †	78
2019	9-Jul	9.0	104,346	98,088	2,961,342	3,545	3,167,321	81
	15-Jul	9.1	97,123	96,545	1,120,176	3,490	1,317,334	90
2020‡	14-Jul	7.3	198,573	199,339	2,225,542	2,149,865§	4,773,319	85
2021‡	29-Jun	7.7	169,522	169,256	4,610,216	1,006	4,950,000	79
2022	5-Jul	7.2	196,833	198,706	4,038,267	1,621	4,435,427	89
Average		**8**	**216,599**	**182,861**	**3,777,796**	**219,185**	**4,396,441**	**81.2**

* Fish with No Mark/No CWT include unmarked releases and are double index tagged fish that shed their coded-wire tag prior to release.

† Approximately 419,000 unmarked fish accidentally released on 4/18/2018 due to a loose screen. These fish are not included in totals.

‡ All juveniles produced above 4.5M for are credited to SRKW production in release years 2020 and 2021

§ In 2020 marking and tagging operations were suspended due to COVID-19. Only a portion of fish released were marked

d) Transfer Data

The facility also transfers 1.7M URB juveniles and/or eggs to the Yakima River-Prosser Hatchery program for the Yakama Nation in late March to late April (Table 12). The transferred URB juveniles are marked prior to release with ~1.5M being adipose marked only, and ~200K juveniles being adipose marked and CWT tagged with a half-length tag due to small size at marking. In 2018 and 2021, a portion (500K and 600K, respectively) of the 1.7M fish transferred to Prosser Hatchery were transferred as eggs. The current transfer request for the Yakima River-Prosser Hatchery program is 1.1M sub-yearlings from Little White Salmon NFH and 600k from either Little White Salmon NFH or Priest Rapids Hatchery. The actual number of URB juveniles that have been transferred to the Prosser program since 2013 are presented in Table 12. Little White Salmon NFH also transfers between 1.55M and 2.48M (depending on program needs and requests) URB eggs to Bonneville Hatchery operated by the Oregon Department of Fish and Wildlife to support the Umatilla and Yakima River yearling programs. In 2019, no fish or eggs were transferred due to low adult returns to Little White Salmon NFH in 2018. To fulfill full production at Little White Salmon NFH for BY 2018, approximately one million eggs were received from Priest Rapids Hatchery. Egg and juvenile production may change in the future depending on survival and program broodstock needs. In 2020 marking and tagging operations were suspended due to COVID-19, no fish were marked or CWT tagged before their transfer to Prosser Hatchery. In July 2021, an excess ~160K marked and untagged BY20 fingerlings were transferred to the Klickitat Tribal Hatchery for release into the Klickitat River due to excess overproduction at LWS NFH.

Table 12. Annual transfer dates and total number of juveniles transferred *to* the Prosser program from Little White Salmon NFH. Data retrieved from CRiS: 1/30/2023

Transfer Year	Transfer Dates	Transfer Location	Total
2013	4/4, 4/8, 4/15, 4/18	Prosser	1,551,115
2014	4/9, 4/15, 4/22, 4/30	Prosser	1,549,626
2015	4/6, 4/13, 4/15, 4/21, 4/28	Prosser	1,700,649
2016	3/30,4/5,4/11,4,14/4,18	Prosser	1,650,070
2017	4/4, 4/10, 4/13, 4/19, 4/21	Prosser	1,701,850
2018	4/16, 4/18, 4/23, 5/2	Prosser	1,203,675
	Fall	Prosser	500,000
2019	No Transfers	-	-
2020	3/31, 4/1, 4/6, 4/7, 4/9, 4/10	Prosser	1,701,568
2021	3/25, 3/31, 4/6, 4/13	Prosser	1,100,069
	14-Jul	Klickitat Tribal Hatchery	161,633
2022	3/28, 4/12, 4/18, 4/21	Prosser	1,100,000
Annual Mean			**1,546,695**

Off-Station Juvenile Survival

a) PIT Tagging Program

PIT tagging juveniles provides real-time data as fish migrate to the Pacific Ocean and is accessible from PTAGIS. PIT tag detections at fish ladders, hydropower dams, bird colonies, and the Columbia River estuary are utilized by staff at CRFWCO to estimate juvenile migration time and survival through the Columbia River Basin. Additionally, PIT tagged fish provide adult return run time information, in-season run forecasts, estimation of straying rates, and knowledge on ecological interactions with ESA listed stocks in the Columbia River. Tagged juvenile URBs from Little White Salmon NFH are typically detected at BONN, approximately 30 kilometers downstream from the confluence of the Little White Salmon and Columbia Rivers. The detection rate of PIT tagged fish at BONN is a function of a) migration survival from release to BONN, and b) the detection efficiency of the PIT antenna arrays at the dam. Detection efficiency at BONN varies between and within years due to flow levels and dam operations (e.g., amount of spill, number of turbines in operation, etc.).

b) Migration Timing

PIT tagging of the juvenile production began with BY07 with 25,000 juvenile URBs being PIT tagged annually to monitor juvenile migration through the Columbia River basin. Beginning with BY12, the number of juveniles that were PIT tagged was decreased to 15,000 (Table 13). The average detection rate at Bonneville Dam of PIT tagged URB juveniles from Little White Salmon is approximately 13.1%, with an average median travel time from the hatchery to the dam of 12 days. A few PIT tagged juveniles take a substantially longer time to migrate downstream each year, with the longest migration time per year ranging from 44 to 252 days.

Table 13. The number of PIT tagged juvenile URB fall Chinook released from Little White Salmon NFH and juvenile travel time (days) to Bonneville Dam (BONN). Data retrieved from PTAGIS: 1/10/2023

					Travel Time (Days)				
							Percentile		
Release Year	Release Dates	# PIT Tagged*	# Detected at BONN	% Det.	Mean	Range	50th	75th	90th
2013	2-Jul	14,959*	1,977	13.2	15	(0.5 - 252)	12	20	26
2014	2-Jul	14,925	1,787	12.0	19	(1.5 - 138)	17	26	36
2015	2-Jul	14,958	1,194	8.0	12	(1.5 - 44)	10	13	16
2016	11-Jul	14,823	1,647	11.1	12	(2 - 50)	11	13	16
2017	5-Jul	14,438	1,855	12.8	12	(1 - 121)	11	14	21
2018	11-Jul	14,840	2,468	16.6	11	(0.5 - 106)	10	12	16
2019	7/9, 7/15	14,775	1,950	13.2	14	(1.5 - 45)	13	17	21
2020	14-Jul	14,848	2,481	16.7	11	(1 - 77)	10	13	19
2021	29-Jun	14,982	2,561	17.1	12	(1.5 - 57)	12	15	16
2022	5-Jul	15,234	1,509	9.9	12	(1 - 128)	11	14	19
Average		**14,878**	**1,943**	**13.1**	**13**		**12**	**16**	**21**

* Number tagged is adjusted for shed tags and pre-release mortality

c) Juvenile Survival

PIT tag detection histories are used to estimate the apparent juvenile survival from hatchery release downstream to Bonneville Dam for Little White Salmon NFH URBs. A PIT tagged downstream migrating juvenile fish can pass Bonneville Dam using a variety of routes, some of which have PIT tag detection arrays and some of which do not. For example, tagged fish passing through the turbines or through spillways would not be detected, while a fish passing through the juvenile bypass or corner collector could be detected. Since there is not 100% detection capability at Bonneville Dam, detection probability must be estimated to separate out a tagged fish that died before reaching Bonneville Dam from a tagged fish that was alive but was not detected as it passed Bonneville Dam. For this analysis, apparent survival from release to Bonneville Dam was estimated using the live recapture Cormack-Jolly-Seber model in Program MARK. The model uses encounter histories of tagged fish to estimate the detection probability at Bonneville Dam and estimate the apparent survival of fish from release to Bonneville Dam. Survival estimates are reported on a scale from 0.0 to 1.0. As a note, the term “apparent survival” is used to indicate that a tagged fish that is alive, but never migrates past Bonneville Dam, is considered a “mortality” in the model.

For the juvenile survival analysis, a PIT tagged juvenile could be encountered on three occasions: 1) at release, 2) passing downstream at Bonneville Dam, and 3) encountered after

passing downstream of Bonneville Dam. Encounter histories for each PIT tagged juvenile released in a particular release were developed based on the following criteria:

- **Released**: All PIT tags in the tagging file query
- **Passing downstream at Bonneville Dam**: Tagged fish detected passing downstream of Bonneville Dam on the following PIT antenna arrays:
  - Juvenile Bypass: B2J PIT antenna site
  - Corner Collector: BCC PIT antenna site
  - Adult Ladders: PIT antennas within the adult ladders. Juvenile fish can pass downstream through the adult ladders; however mini-jacks (mature fish in year of release) can also move upstream through the ladders during the year of release. Based on the configuration of antenna sites, the directionality of ladder detections was used to separate out juvenile fish passing downstream from upstream moving mini-jacks.

- **After passing downstream of Bonneville Dam**:
  - Lower river trawl (TWX and PD7 interrogation sites)
  - Lower river bird colony recoveries on East Sand Island, Rice Island, Miller Sands Island, and Troutdale Transmission Towers (ESANIS, RICEIS, MLRSNI, and TTOWER mortality sites). The assumption is that the PIT tagged fish were predated on downstream of Bonneville Dam.
  - Adult ladder detections at Bonneville Dam, including mini-jack detections. The assumption is that mini-jacks at Bonneville and subsequent adult returns must have passed downstream of Bonneville Dam as juveniles.

Estimated apparent juvenile survival of the Little White Salmon NFH URBs for brood years 2012-2020 (release years 2013-2021) ranged from 0.44 to 0.7 (Table 14; Fig. 6). Due to the limited time and number of fish detections downstream, survival is not reported for the current release year. The variance of the estimates for each year reported (represented by the credible intervals) decreases as adult returns are added into the detection histories (as “downstream of Bonneville” detections). Since recent years do not have adult returns, or at least not the full age complement of adult returns, the more recent estimates have larger variances. In subsequent years, as more adults from a brood year return, the variance of the estimates should decrease.

Table 14. Little White Salmon NFH Upriver Bright Fall Chinook apparent juvenile survival from release to Bonneville Dam. Estimates are median survival, and lower and upper credible intervals. The Markov chain Monte Carlo Bayesian parameter estimation method in MARK was used to estimate the variance of the estimated survival. Note: Due to the limited time and number of fish detections downstream, survival is not reported for the most recent release year. Data retrieved from PTAGIS: 12/16/2022

Brood Year	Release Year	Median Survival	95% Lower	95% Upper
2012	2013	0.70	0.63	0.77
2013	2014	0.58	0.47	0.68
2014	2015	0.51	0.41	0.63
2015	2016	0.58	0.46	0.71
2016	2017	0.58	0.45	0.72
2017	2018	0.67	0.58	0.76
2018	2019	0.44	0.38	0.53
2019	2020	0.51	0.42	0.60
2020	2021	0.55	0.41	0.72
Average		**0.57**	**0.47**	**0.68**

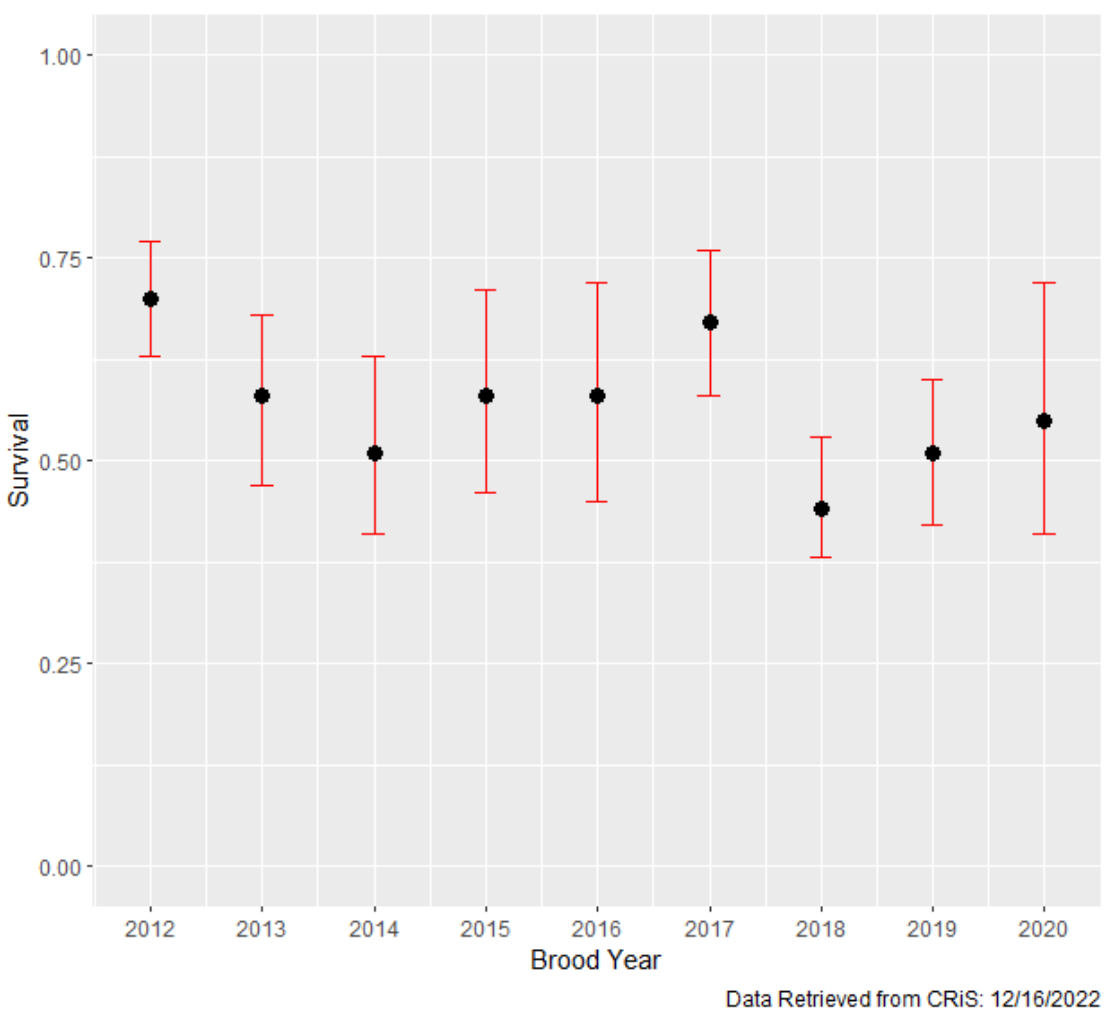

Figure 6. Little White Salmon NFH Upriver Bright Fall Chinook apparent juvenile survival from release to Bonneville Dam, (2012 - 2020). Note: Due to the limited time and number of fish detections downstream, survival is not reported for the most recent release year. Error bars are lower and upper credible intervals.

Adult Returns

a) Harvest Data and Smolt-to-Adult Survival

CWT recoveries maintained in RMIS are used to estimate adult returns to hatcheries in the Columbia River basin, harvested adults, and adults recovered on the spawning grounds in all watersheds [Table 15; Pastor (2004); Pastor (2016)]. Based on a mean smolt-to-adult survival rate of 0.32% estimated for brood years 1990 to 2004, the facility was expected to contribute an average of 14,382 adults (5,900 for harvest) to the TAP goal of 107,000. Since BY06, the facility has a mean smolt-to-adult survival rate of 0.82% (Table 15) which is still within the range reported in the facility's HGMP (USFWS 2004b, 2015). Additionally, the URB program has contributed an average 31,643 (39% of the overall TAP target of 80,250) adults annually to

freshwater and ocean recoveries for BY06 to BY15. Off-station CWT recoveries for harvest and spawning grounds beyond BY15 may be incomplete due to a lag in RMIS reporting.

The Yakima River-Prosser Hatchery program has a mean smolt-to-adult survival of 0.20% (based on brood years 1990-2004) contributing an additional 3,383 adult URB fall Chinook towards the TAP goal. Release and adult recoveries for the Prosser Hatchery are monitored by the Yakama Nation.

Table 15. The estimated number of hatchery returns, harvested adults, and fish present on the spawning grounds based on coded wire tag recovery data from RMIS for URB fall Chinook released from Little White Salmon NFH. Adult returns are used to estimate smolt-to-adult survival rates. Data downloaded from RMIS on 3/7/2023.

Brood Year	Hatchery Returns*	Columbia River Harvest	Ocean Harvest	Spawning Grounds	Total # Adults†	Smolt-to-Adult Survival (%)
2006	6,793	2,308	1,777	613	11,491	0.56
2007	14,689	6,418	5,243	1,241	27,591	1.38
2008	7,983	5,317	5,120	1,813	20,233	0.43
2009	19,289	16,154	14,902	11,909	62,254	1.37
2010	30,192	29,100	28,460	12,129	100,591	2.25
2011	4,502	4,071	3,216	3,270	15,059	0.33
2012	10,633	11,622	9,885	4,797	36,967	0.84
2013	2,571	4,234	1,981	779	9,565	0.22
2014	606	748	202	30	1,586	0.04
2015	11,871	6,886	4,405	7,824	31,093	0.78
2016§	14,137	10,698	7,275	4,282	36,392	0.78
2017§	5,368	4,503	6,386	3,028	19,285	0.45
Average§	**10,913**	**8,686**	**7,519**	**4,440**	**31,643**	**0.82**

* Hatchery returns are returns to Little White Salmon NFH.
† Total Adults includes other recovery locations not listed, such as strays to other hatcheries.
‡ Due to delays in reporting to RMIS, CWT recoveries may be adjusted every year for accuracy
§ Average calculated for Brood Years 2006-2015

An average 672 CWTs have been recovered each year at Little White Salmon NFH since 2013 (Table 16). The Little White Salmon NFH URB fall Chinook program accounts for 94.2 percent of all recoveries; URB fall Chinook from other programs include Willard NFH (4.7%), Bonneville Hatchery (0.8%), other hatchery programs account for 0.3%.

Table 16. Coded Wire Tag (CWT) recoveries for all hatchery programs collected at Little White NFH 2013 - 2022. Number of CWT recoveries are unexpanded and do not reflect sample or tagging rates. Data retrieved from CRiS CWT Recovery Report: 12/9/2022

Return Year	CWT Recoveries	Hatchery Origin	% of Total CWT Return
2013	856	L White Salmon NFH	97.6
	21	Bonneville Hatchery	2.4
2014	538	L White Salmon NFH	95.7
	21	Bonneville Hatchery	3.7
	2	Lyons Ferry Hatchery	0.4
	1	Nez Perce Hatchery	0.2
2015	346	L White Salmon NFH	98
	6	Bonneville Hatchery	1.7
	1	Lyons Ferry Hatchery	0.3
2016	535	L White Salmon NFH	100
2017	262	L White Salmon NFH	91
	26	Willard NFH@Little White	9
2018	492	L White Salmon NFH	100
2019	1,315	L White Salmon NFH	99.7
	1	Klickitat Hatchery	0.1
	1	Willard NFH@Little White	0.1
	2	Willard NFH@Drano	0.2
2020	871	L White Salmon NFH	90.4
	76	Willard NFH@Little White	7.9
	12	Willard NFH@Drano	1.2
	1	Lyons Ferry Hatchery	0.1
	3	Nez Perce Hatchery	0.3
2021	562	L White Salmon NFH	89.3
	36	Willard NFH	5.7
	22	Willard NFH@Drano	3.5
	2	Bonneville Hatchery	0.3
	3	Nez Perce Hatchery	0.5
	2	Lyons Ferry Hatchery	0.3
	2	Washougal Hatchery	0.3
2022	552	L White Salmon NFH	79
	139	Willard NFH	19.9
	7	Bonneville Hatchery	1
	1	Nez Perce Hatchery	0.1
Average	**672**		

b) Age Structure

Age structure of returning adult fish is used in pre-season forecast models and to evaluate brood year productivity. The estimated age structure can also identify potential changes and trends in age composition over dime due to ecological or anthropogenic factors. Adult returns to Little White Salmon NFH are sampled annually by hatchery personnel and the USFWS marking and biosampling crew from CRFWCO. A subsample of adults (minimum of 500) are aged annually by the biosampling crew using scales and CWT sampling and the age ratios are then applied to the total number of adults to estimate the overall age structure of the adult returns (Table 17: brood year; Table 18: return year). The facility has produced an average 13,906 adult returns to the hatchery each year between 2013 and 2022 (Table 18). The majority (59%) of adult URBs return to the facility at Age-4 (8,175of 13,906), but 29% return at Age-3 (3,986 of 13,906). Approximately 2% (272 of 13,906) mature precocially returning as jacks or jills at Age-2. Approximately 11% of adults return at Age-5 (1,466 of 13,906) and less than 1% of adults return at Age-6 (25 of 13,906).

Table 17. Estimated age structure of adult URB fall Chinook returns to Little White Salmon NFH by *brood year*. CRiS age composition reports run on 12/21/2022

Brood Year	Age-2	Age-3	Age-4	Age-5	Age-6	Total # Adults
2006	652	961	3,009	1,174	12	5,808
2007	1,156	5,675	6,863	1,229	73	14,996
2008	1,021	2,990	2,770	1,501	0	8,282
2009	612	4,551	18,377	2,363	13	25,916
2010	587	15,644	17,023	2,956	75	36,285
2011	374	1,480	3,568	1,713	39	7,174
2012	658	5,558	5,675	2,000	23	13,914
2013	65	759	3,384	638	0	4,846
2014	0	300	1,179	185	0	1,664
2015	101	2,282	8,194	1,374	0	11,951
2016	676	5,861	10,812	735	25	18,109
2017*	246	2,444	6,946	1,193	NA	NA
2018*	354	3,000	6,594	NA	NA	NA
2019*	35	2,348	NA	NA	NA	NA
2020*	215	NA	NA	NA	NA	NA
Average	**450**	**3,847**	**7,261**	**1,422**	**24**	**13,540**

* Denotes incomplete brood years given that adults have either not yet returned to the hatchery or have not been aged.

Table 18. Total number of adult URB fall Chinook returns to Little White Salmon NFH and estimated age structure by *return year*. CRiS age composition reports run on 12/21/2022

Return Year	Age-2	Age-3	Age-4	Age-5	Age-6	Total # Adults
2013	374	15,644	18,377	1,501	73	35,969
2014	658	1,480	17,023	2,363	0	21,524
2015	65	5,558	3,568	2,956	13	12,160
2016	0	759	5,675	1,713	75	8,222
2017	101	300	3,384	2,000	39	5,824
2018	676	2,282	1,179	638	23	4,798
2019	246	5,861	8,194	185	0	14,486
2020	354	2,444	10,812	1,374	0	14,984
2021	35	3,000	6,946	735	0	10,716
2022	215	2,348	6,594	1,193	25	10,375
Average	**272**	**3,968**	**8,175**	**1,466**	**25**	**13,906**

c) Bonneville Dam Detections

Since Return Year 2013, URB fall Chinook adults (Ages 2 - 6) PIT tagged and released from Little White NFH returned to Bonneville Dam as early as Jul-07 and as late as Nov-05 with the average median Sep-08 (Table 19). On average, 41% of URB fall Chinook adults released from Little White NFH are counted returning to the Little White Salmon NFH after passing upstream through Bonneville Dam's adult ladders (based on expansion of PIT tags).

Table 19. Median Bonneville Dam passage date of URB Fall Chinook adults PIT tagged and released from Little White NFH (Ages 2 - 6). Data retrieved from PTAGIS 12/21/2022

Return Year	Median Passage Date	First Detection Date	Last Detection Date	# of Fish Detected	Bonneville Expansion	95% CI	Hat. Return	Hat. Return/Bonn. Expansion (%)
2013	Sep-09	Aug-07	Nov-02	466	84,976	(72,739 - 101,248)	35,969	42
2014	Sep-10	Aug-17	Oct-15	375	70,175	(58,673 - 86,198)	21,524	31
2015	Sep-11	Aug-15	Oct-22	302	66,095	(54,249 - 81,529)	12,160	18
2016	Sep-04	Jul-29	Sep-22	92	24,941	(17,816 - 38,159)	8,222	33
2017	Sep-12	Aug-24	Oct-12	62	18,174	(11,725 - 25,210)	5,824	32
2018	Sep-11	Aug-20	Oct-13	41	11,581	(6,472 - 24,149)	4,798	41
2019	Sep-13	Aug-22	Nov-05	83	23,703	(16,608 - 31,836)	14,486	61
2020	Sep-08	Jul-16	Oct-07	84	25,507	(17,138 - 36,442)	14,984	59
2021	Sep-02	Jul-07	Oct-01	81	24,119	(16,925 - 36,654)	10,716	44
2022	Sep-06	Aug-13	Oct-08	74	22,533	(15,140 - 33,904)	10,375	46
Average	**Sep-08**	**Aug-07**	**Oct-13**	**166**	**37,180**		**13,906**	**41**

d) Hatchery Ladder Detections

Since Return Year 2013, upriver bright fall Chinook adults (Ages 2 - 6) PIT tagged and released from Little White Salmon NFH returned to the Little White Salmon NFH Ladder as early as Jul-08 and as late as Nov-19 with the average median passage date on Oct-21 (Table 20). Upriver bright fall Chinook released from Willard NFH also return to Little White Salmon NFH for spawning. Since Return Year 2018, an average of 5 upriver bright fall Chinook adults (Ages 2 - 6) reared and PIT tagged at Willard NFH returned to the Little White Salmon NFH Ladder as early as Sep-30 and as late as Nov-08 with the average median passage date on Oct-19. The total number of upriver bright fall Chinook adults reared at Willard NFH that return to the Little White Salmon NFH is unknown because not all returning fish have CWTs to indicate their hatchery of origin. All adult returns, regardless of their origin, are included in the Little White Salmon NFH hatchery count (Table 20).

Table 20. Median detection date of adult upriver bright fall Chinook PIT tagged and released from Little White Salmon NFH (LW) and Willard NFH (WI) at the Little White NFH Adult Ladder (Ages 2 - 6). Data retrieved from PTAGIS 12/21/2022.

Return Year	Mark Site	Median Passage Date	First Detection Date	Last Detection Date	# of Fish Detected	Ladder Expansion	95% CI	Hat. Return	Hat. Return /Ladder Expansion (%)
2013	LW	Oct-30	Jul-08	Nov-19	196	35,567	(28,181 - 47,387)	35,969	101
2014	LW	Oct-23	Sep-24	Nov-05	101	18,712	(12,985 - 25,402)	21,524	115
2015	LW	Oct-27	Oct-09	Nov-08	81	17,529	(12,068 - 26,644)	12,160	69
2016	LW	Oct-16	Sep-27	Nov-05	39	10,286	(6,166 - 19,076)	8,222	80
2017	LW	Oct-20	Oct-17	Oct-26	15	4,403	(2,071 - 10,490)	5,824	132
2018	LW	Oct-24	Sep-29	Nov-14	24	6,670	(2,840 - 7,793)	4,798	72
	WI	Oct-25	Oct-20	Oct-30	3	362	-	-	-
2019	LW	Oct-22	Oct-07	Nov-16	34	9,951	(5,800 - 16,503)	14,486	146
	WI	Oct-27	Oct-20	Nov-03	2	230	-	-	-
2020	LW	Oct-23	Sep-30	Oct-05	33	10,295	(5,608 - 16,234)	14,984	146
	WI	Oct-12	Sep-30	Oct-30	6	789	-	-	-
2021	LW	Oct-22	Oct-15	Nov-14	32	9,540	(5,157 - 15,480)	10,716	112
	WI	Oct-24	Oct-19	Nov-08	10	857	-	-	-
2022	LW	Oct-12	Oct-04	Oct-18	12	3,636	(652 - 4,670)	10,375	285
	WI	Oct-10	Oct-09	Oct-10	3	269	-	-	-
Average	**LW**	**Oct-21**	**Sep-25**	**Nov-03**	**57**	**12,659**	**-**	**13,906**	**110**
	WI	**Oct-19**	**Oct-13**	**Oct-28**	**5**	**501**	**-**	**-**	**-**

Additional Monitoring and Evaluation Projects

a) Other Fish Counted and Handled at Little White Salmon NFH

The Little White Salmon NFH ladder is opened in mid-September with the goal to remain open throughout the entire URB fall Chinook salmon return to collect adult URB broodstock (if the brood pond reaches capacity, the ladder is closed until an adequate number of fish can be processed before the ladder is re-opened). Salmon and other non-target species volitionally enter and leave the fish ladder located immediately below the hatchery barrier dam before reaching the Little White Salmon NFH spawning facility. Tule fall Chinook salmon, coho salmon, chum salmon, sockeye salmon and steelhead that volunteer into the trap are sorted and those that are not adipose fin-marked or tagged with a CWT are assumed to be natural-origin and released back into the Little White Salmon River below the ladder (Table 21).

In recent years, coho salmon have returned in high numbers. In 2021, detections of PIT tagged coho confirmed that coho salmon re-entered the fish ladder multiple times after being released (Baker 2021). The majority of the coho detected by the PIT antennas were reared at Willard NFH and released at other acclimation ponds or hatcheries in the mid-Columbia River. For the 2022 fall Chinook salmon return, Parentage-Based Tagging (PBT) is being used to determine potential hatchery origin of unmarked, untagged coho salmon collected at the Little White Salmon NFH. The results of a post-season PBT analysis could help managers make more informed decisions when planning for future returns on how to handle unmarked, untagged coho salmon. Data obtained from the proposed PBT study would also provide parties with important information that could be used during reinitiation of consultation on the BiOp in 2024 (NMFS 2017; Page 133, Section 2.10).

Table 21. Counts of non-production target fish removed and returned to river (), at the Little White Salmon NFH 2013 – 2022. Totals include both hatchery and wild fish. Data retrieved from Fish Removal files 1/31/2023.

Year	Coho Salmon	Fall Chinook Salmon	Sockeye Salmon	Chum Salmon	Rainbow Trout	Steelhead Trout
2013	158	983	0	0	0	1
2014	615	3,520	0	0	0	1
2015	77	1,872	26	0	0	4
2016	156	472	2	0	4	6
2017	265	116	0	0	3 (1)	1 (6)
2018	139	80	1	0	0	1 (10)
2019	749	308	0	1	0	0 (4)
2020	1,065	426	0	0	0	0
2021	174 (2,488*)	618	0 (3)	0 (2)	0	1 (35)
2022	1,984 (470*)	786	0	0	0 (1)	0 (8)
Average	**538**	**918**	**3**	**0**	**1**	**8**

*In 2021 and 2022, unmarked Coho were returned to the river. Returned to river fish were encountered multiple times and are included in the total, the actual number of unique fish encountered is not known.

b) Escapement of Hatchery Fish to the White Salmon River Spawning Grounds and Impacts on Tule Populations

The White Salmon River is a tributary of the Columbia River located approximately 9 river kilometers upstream from Little White Salmon NFH. The White Salmon River supports a natural population of tule fall Chinook Salmon that are part of the Lower Columbia River Chinook Salmon ESU listed as threatened under the Endangered Species Act. Hatchery origin upriver bright fall Chinook from the Little White Salmon NFH program are known to stray into the White Salmon River, potentially negatively impacting the listed tule population (NMFS 2017). The URB hatchery stocks in the Columbia River basin were derived from fall Chinook stocks that spawned above the historic Celilo Falls area and are not considered to be part of the Lower Columbia River Chinook Salmon ESU. Monitoring of the abundance of adult URBs in the White Salmon River Basin has been conducted since 1989 (J. Wilson, WDFW, 2018 memorandum to interested parties, Washington Department of Fish and Wildlife, on the 2017 White Salmon Chinook survey methods and results), and spawning ground surveys conducted by the Washington Department of Fish and Wildlife since 2010 have included the identification of hatchery-origin (for all facilities, including Little White Salmon NFH) and natural-origin adult URB and tule fall Chinook in the White Salmon River (SCoRE Website) (Table 22; Fig. 7).

Table 22. Estimated number of hatchery origin and natural origin upriver bright (URB) fall Chinook Salmon in the White Salmon River. Data is from WDFW spawning surveys (SCoRE website 12/21/2022).

Year	Hatchery URB	Natural URB
2010	1,093	841
2011*	-	-
2012	361	743
2013	2,135	1,221
2014	3,208	1,636
2015	6,944	1,741
2016	1,508	621
2017	753	487
2018	1,446	991
2019	7,177	2,058
2020	2,264	1,382
2021	3,531	2,472
Average	**2,765**	**1,290**

* 2011 escapement estimates were unavailable due to the breach of Condit Dam.

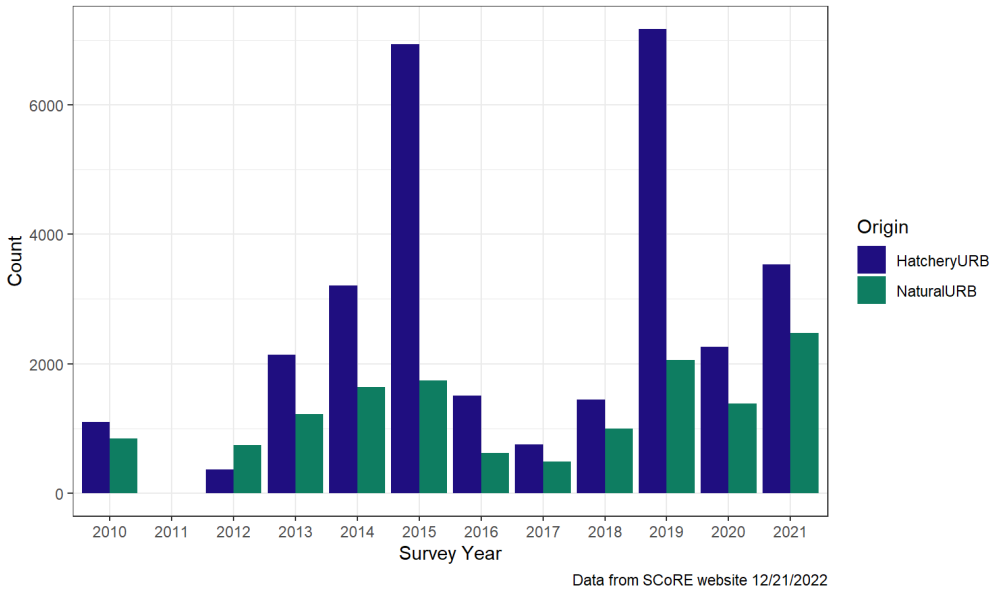

Figure 7. Escapement estimates of hatchery-origin and natural-origin upriver bright (URB) fall Chinook in the White Salmon River during annual spawning surveys (2010 - 2021). 2011 escapement estimates were unavailable due to the breach of Condit Dam.

It is likely that the natural-origin URBs spawning in the White Salmon River are predominately progeny of hatchery URBs that strayed and naturally spawned in the White Salmon River in previous years. Historically, natural URB populations primarily spawned in the Middle and Upper Columbia River areas, and limited spawning in areas of the lower Columbia River, including the White Salmon River. For the URB spawning population (2010-2021), the mean percentage of hatchery-origin spawners was 63%, with a range of 33% to 80% (Fig. 8). There appears to be little correlation between the number of hatchery-origin URBs on the spawning grounds of the White Salmon River and either the number of hatchery fish collected at Little White Salmon NFH (Pearson's r = 0.10) or the estimated total number of Little White Salmon URBs (based on PIT tag expansions) passing Bonneville Dam (Pearson's r = 0.23) each year. Return years 2015 and 2019 saw large numbers of hatchery-origin strays in the White Salmon River but relatively lower counts at Little White Salmon NFH (Table 23). The preliminary 2022 estimates of the number of hatchery-origin URBs spawning in the White Salmon River will not be available until spring 2023.

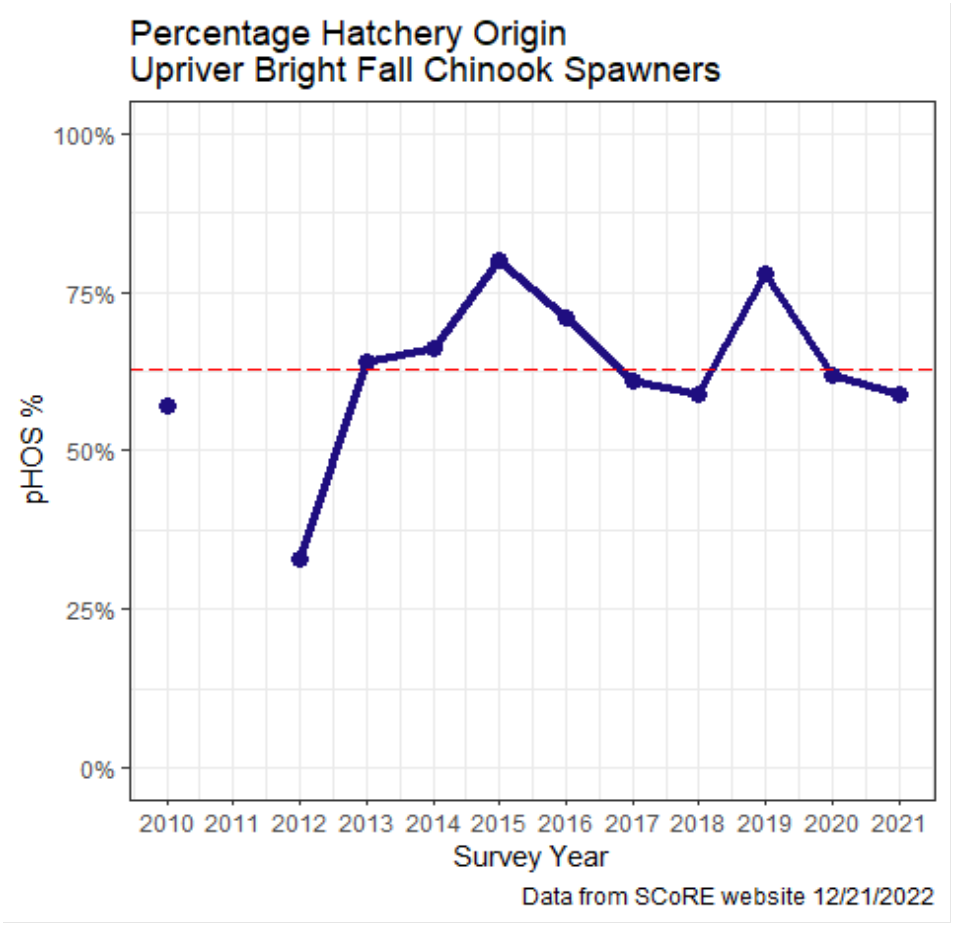

Figure 8. Estimated proportion of upriver bright (URB) fall Chinook hatchery origin spawners (pHOS) in the White Salmon River (2010 - 2021). Dotted line is the mean (63%).

Table 23. Number of hatchery upriver bright fall Chinook Salmon collected at Little White Salmon NFH and the estimated number of hatchery upriver bright fall Chinook spawning in the White Salmon River (2013-2021). Hatchery counts are from the CRiS database,

WDFW estimates are from the SCORE website. The 2022 WDFW estimate will be available spring 2023. Data retrieved from SCoRE website 12/21/2022.

Year	Hatchery Count	WDFW Estimate
2013	35,969	2,135
2014	21,524	3,208
2015	12,160	6,944
2016	8,222	1,508
2017	5,824	753
2018	4,798	1,446
2019	14,513	7,117
2020	14,992	2,264
2021	10,716	3,531

Coded-wire tag recoveries from hatchery fish in the White Salmon River, collected during WDFW's spawning surveys, are used to estimate the total number of URB hatchery strays from an individual hatchery program. Coded-wire tags from adult returns expected to return to Little White Salmon NFH (i.e., Little White Salmon NFH program releases and releases from the Mitchell Act Willard NFH program) represented 90%-100% of the annual total coded-wire tag recoveries in the White Salmon River (recovery years 2013-2021), with the Little White NFH component averaging 90% of the total annual recoveries. The total number of coded-wire tags recovered on the spawning grounds each year ranged from 6 to 124. Expansions of coded-wire tag recoveries to account for a) the tagging rate at juvenile release, and b) the sampling rate during the spawning surveys, can be used to estimate the total number of hatchery fish from the Little White Salmon NFH programs that are spawning in the White Salmon River (Table 24). In all years (2013-2021) except 2016-2017, the WDFW estimates of the total number of hatchery URBs on the spawning grounds were within the 80% confidence intervals of the total estimated number of URBs from the Little White Salmon and Willard NFH programs (Figure 9).

Table 24. Estimated number of hatchery upriver bright fall Chinook Salmon on the spawning grounds of the White Salmon River from the Little White Salmon and Willard NFH programs, and the total number of hatchery URBs estimated on the spawning ground from WDFW surveys. Coded-wire tag estimates are based on coded-wire tag recoveries and expansions for tagging rate and sampling rate. Confidence intervals (C.I.) are calculated based on proportions (i.e., tagging rate). Data from RMIS and WDFW SCORE website 12/19/2022.

Year	CWT Estimate	80% Lower C.I.	80% Upper C.I.	WDFW Estimate
2013	2,147	1,217	4,030	2,135
2014	3,219	2,388	4,510	3,208
2015	5,679	3,994	8,622	6,944
2016	703	496	1,135	1,508
2017	518	417	655	753
2018	1,286	887	1,983	1,446
2019	5,187	3,646	7,704	7,117
2020	1,892	1,378	2,760	2,264
2021	2,716	1,887	4,143	3,531

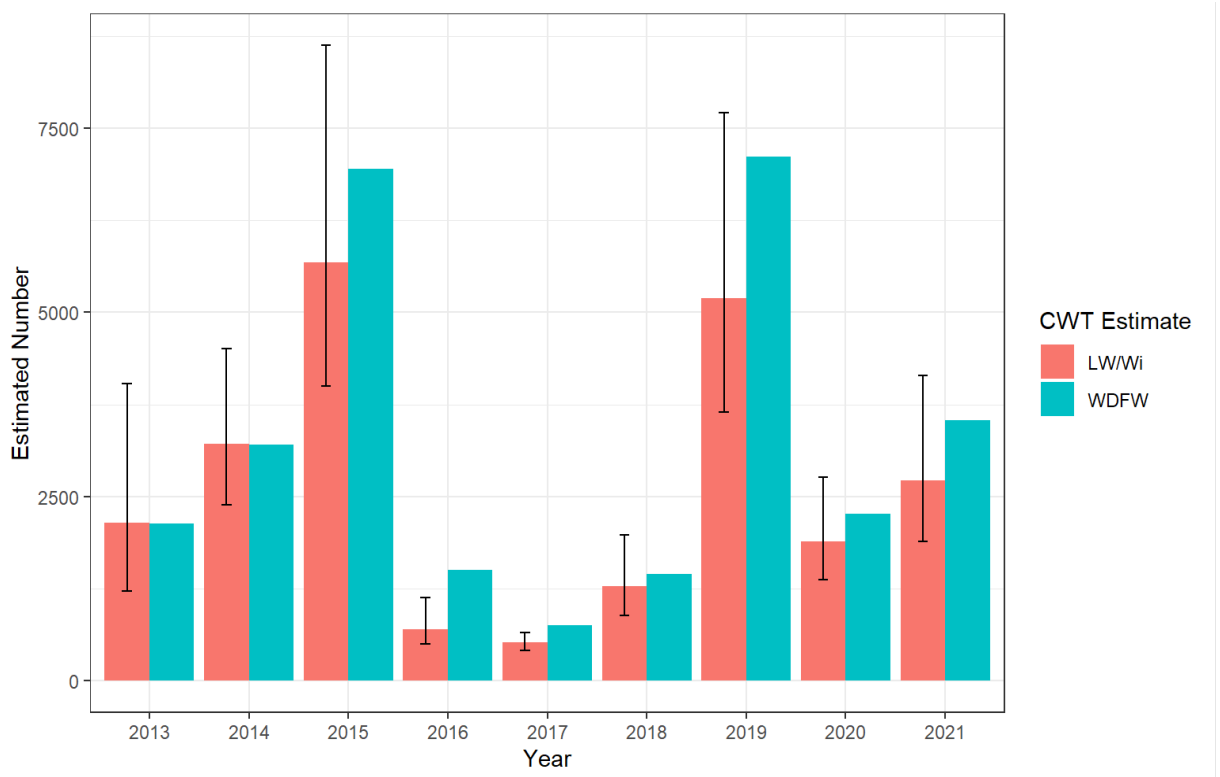

Figure 9. Estimated number of hatchery upriver bright fall Chinook from the Little White and Willard NFH programs, based on coded-wire tag expansions for tagging rate and sampling rate, and the total number of estimated hatchery Upriver Bright Fall Chinook spawning in the White Salmon River (WDFW estimate). Confidence intervals for the coded-wire tag estimates are based on the proportions of fish tagged versus total release. Coded wire tag data from RMIS 12/8/22. WDFW data 2013-2021 from SCORE website.

A variety of environmental and anthropogenic factors have been proposed to explain the incidence of hatchery-origin strays entering the White Salmon River, though the exact causes are not well known (Silver et al. 2021). Interactions between hatchery-origin URB strays and native tule fall Chinook are believed to lead to a loss in productivity of the native tule population (e.g., through hybridization and redd superimposition) (NMFS 2017). As part of the Terms and Conditions (T&C) in the Biological Opinion for upriver bright fall Chinook increased production at Little White Salmon NFH (NMFS 2017; T&C 2b), the USFWS is to manage the abundance of hatchery-origin URB fall Chinook that spawn naturally in the White Salmon River so that the abundance does not exceed 3,000 adults, based on a 3-year moving average. Several different methods have been previously discussed for assessing whether the 3,000 hatchery adults from the Little White Salmon NFH URB program threshold has been exceeded, including WDFW point estimates, expanded coded-wire tag recoveries, and assuming 90% of hatchery fish are from the Little White Salmon River NFH (Silver et al. 2021). Using the WDFW estimates of total hatchery spawners, the 3-year average for 2019 – 2021 was 4,304. Regardless of the approach, the general assessment is that the 3-year average for 2019 – 2021 would exceed the 3,000-hatchery adult threshold. Exceedance of this T&C triggered a review by the USFWS, in cooperation with NMFS, to see what happened and what actions could be taken to address this exceedance (NMFS 2021). Based on the review, the exceedance was caused by a high level of

Little White Salmon NFH URB fall Chinook salmon that strayed into the White Salmon River in 2019, which was believed to be an anomaly (NMFS 2021). A few factors outside the Little White Salmon NFH URB hatchery releases and adult trap operations may have contributed the high stray rate in 2019 including hatchery returns higher than forecasted and reduced harvest combined with low Bonneville Pool levels (NMFS 2021). For return years 2021 and 2022, the Little White Salmon NFH executed several actions to manage hatchery URB fall Chinook salmon staying including maximizing adult ladder operation to collect adults, surplussing adult fish earlier in the run, and coordinating with BPA and USACE to maintain a minimum Bonneville Dam forebay pool level of 74 feet during the URB run.

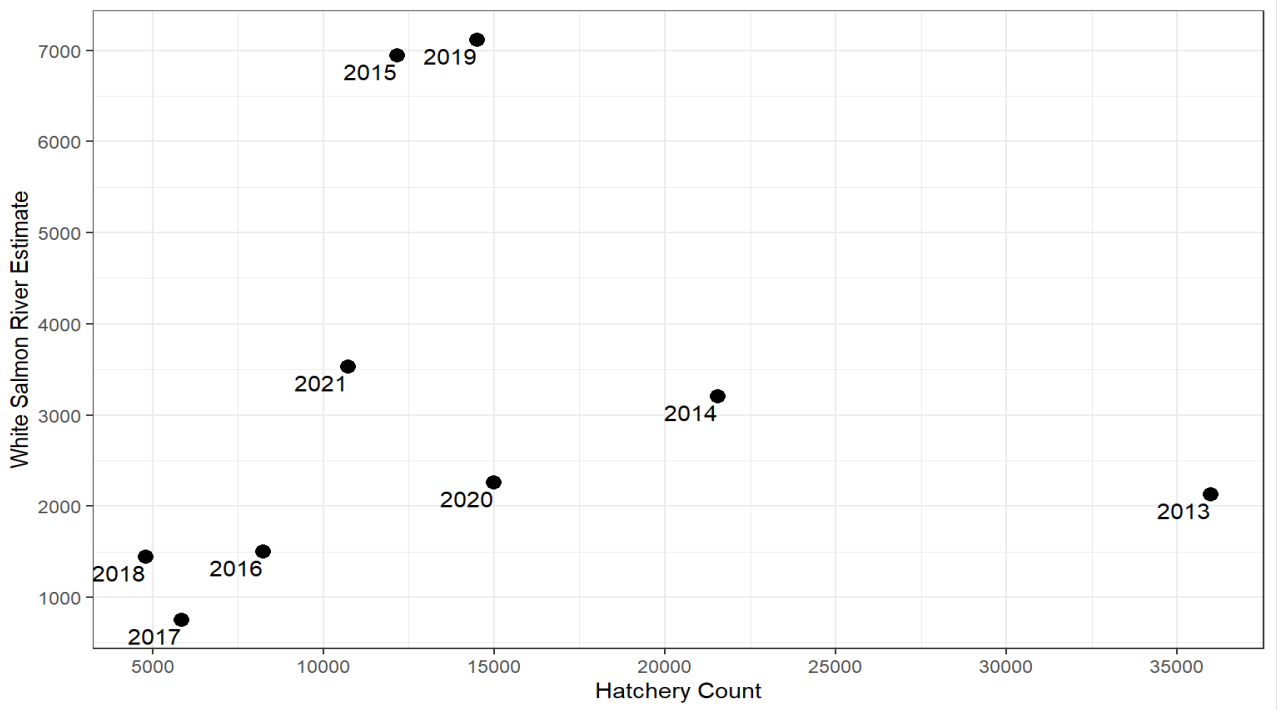

Figure 10. Estimated total hatchery Upriver Bright Fall Chinook Salmon spawning in the White Salmon River versus total number of hatchery Upriver Bright Fall Chinook Salmon collected at Little White Salmon NFH (2013-2021). Little White Salmon NFH counts are from the CRiS database. White Salmon River estimates 2013-2021 are from WDFW spawning survey data on the SCORE website (12/8/2022).

c) Monitoring Studies of URB Movement

A previous assessment of ladder operations at the Little White Salmon NFH suggested an increase in straying due to ladder closures, with most movement away from the hatchery occurring from late October to early November (Engle et al. 2006). In this previous study a total of 253 adult URBs were tagged with radio transmitters in 2004 and 35 adult URBs were tagged in 2005 with 45 and 28 recoveries in each year, respectively Inferences of increased straying due to ladder closures were made based on the proportion of tag recoveries at adjacent tributaries (e.g., White Salmon River recoveries were 31 percent of recoveries in 2004 versus 4 percent in 2005) and differences in ladder operation among years (i.e., the ladder was open for only 2.75 hrs over seven days in 2004 versus 557 hrs over 33 days in 2005) (Engle et al. 2006). Based on

these results, leaving the ladder open throughout the URB return was believed to remove more URBs from the Little White Salmon River and prevent those adults from straying to the White Salmon River.

A re-evaluation of CWT recoveries obtained from the RMIS database, however, revealed that the proportion of strays were higher in 2005 when the ladder remained open for most of the URB return then in 2004 when the ladder was closed. Due to delayed reporting of recoveries in the RMIS database these data were not available at the time of Engle et al.'s study. The percent of hatchery-origin strays recovered in the White Salmon River was 30.8 percent of the total estimated CWT freshwater return in 2005 versus 18.9 percent of the total estimated CWT freshwater return in 2004. These results are somewhat contradictory to those presented by Engle et al. 2006 study of radio tagged fish and suggest that additional monitoring studies of URB movement may be warranted to help identify factors contributing to straying.

In 2022, an investigation of the timing and movement of returning adult URBs in the Little White Salmon River and potential straying into the White Salmon River was conducted using submersible PIT antennas placed at strategic locations. One PIT antenna was located adjacent to the Little White Salmon NFH's acclimation ponds in the Little White Salmon River (latitude: 45.7205; longitude: -121.6417). A second PIT antenna was located at RM 0.5 in the White Salmon River (latitude: 45.7360; longitude: -121.5224). At each location a six-foot diameter submersible PIT antenna (Biomark, Boise, Idaho) was weighed down and positioned resting on the bottom substrate at each of these locations. Fish with a PIT tag were detected if they swam overtop within approximately three feet of the antenna. Both antennas provided up to 50 days of continuous operation on a single battery pack and had a data storage capacity of one million records. Data from the antennas were downloaded monthly by retrieving the device and downloading the data via Bluetooth. Battery packs were also switched out at this time to allow for extended field operation over the entire URB return.

A total of 23 unique PIT tags were detected over 83 days (September 09 through November 29, 2022) at the antenna in the Little White Salmon River near the Little White Salmon NFH (Table 25). Several species were detected during this period including hatchery fall Chinook salmon, spring Chinook salmon, coho salmon, and summer steelhead (Table 25). Only three URBs were detected at the submersible antenna; two from the Little White Salmon NFH and one from Willard NFH (Table 25). These three individuals were detected at different dates during the adult return with initial detections on 9/7, 10/25, and 11/06. Additionally, one fall Chinook salmon tagged at Lyle Falls, Klickitat River and nine Chinook salmon (unknown run) tagged at Bonneville dam were also detected. Hatchery coho salmon that were detected at the antenna were reared at Eagle Creek NFH and Leavenworth NFH. Only four individuals that were detected at the antenna were also detected at the Little White Salmon NFH fish ladder (Table 25).

A total of 22 unique PIT tags were detected over 121 days (August 29 through December 28, 2022) at the antenna in the White Salmon River at RM 0.5 (Table 26). Several species were detected during this period including hatchery fall Chinook salmon (tule and URBs), spring Chinook salmon, and summer steelhead (Tables 25). Two URBs from the Little White Salmon NFH were detected at the submersible antenna (Table 26). There was one hatchery tule from Spring Creek NFH that was also detected. Additionally, five adult fall Chinook salmon tagged at Lyle Falls, Klickitat River and ten Chinook salmon (unknown run) tagged at Bonneville dam

were also detected. None of the fish detected at the antenna in the White Salmon River were detected at the Little White Salmon NFH fish ladder or the antenna in the Little White Salmon River adjacent to the hatchery's acclimation ponds.

Table 25. Number of Detections at the Submersible PIT Antenna in the Little White Salmon River by Species, Run, Rearing and Mark/Release Locations

Species-Run-Rear Name	Number of Detections	Mark Location	Release Location	Number of Detections at LWS Ladder
Hat. Spring Chinook	3	LWSH	LWSH	0
Fall Chinook	1	LYLFAT	LYLFAT	0
Chinook (unknown run)	9	BONAFF	BONAFF	1
Hat. Fall Chinook (URB)	2	LWSH	LWSH	0
Hat. Fall Chinook (URB)	1	WILL	WILL	0
Hat. Coho	3	EAGH	NLVP	1
Hat. Coho	2	LEAV	LEAV	2
Steelhead (unknown run)	1	BONAFF	BONAFF	0
Hat. Summer Steelhead	1	SKAM	SKAM	0
Total	**23**	**7 locations**	**7 locations**	**4**

Codes for Mark/Release Locations: BONAFF-Bonneville Dam; EAGH - Eagle Creek National Fish Hatchery; LEAV - Leavenworth National Fish Hatchery; LWSH - Little White Salmon National Fish Hatchery; LYLFAT - Lyle Falls Adult Fish Trap, Klickitat River; SKAM - Skamania Hatchery (WDFW); WILL - Willard National Fish Hatchery

Table 26. Number of Detections at the Submersible PIT Antenna in the White Salmon River by Species, Run, Rearing and Mark/Release Locations

Species-Run-Rear Name	Number of Detections	Mark Location	Release Location	Number of Detections at LWS Ladder
Hat. Spring Chinook	1	CARS	CARS	0
Hat. Spring Chinook	1	MVFLAP	MVFLAP	0
Hat. Fall Chinook (Tule)	1	SPRC	SPRC	0
Fall Chinook	5	LYLFAT	LYLFAT	0
Chinook (unknown run)	10	BONAFF	BONAFF	0
Hat. Fall Chinook (URB)	2	LWSH	LWSH	0
Steelhead (unknown run)	1	BONAFF	BONAFF	0
Hat. Summer Steelhead	1	SKAM	SKAM	0
Total	**22**	**7 locations**	**7 locations**	**0**

Codes for Mark/Release Locations: BONAFF-Bonneville Dam; CARS - Carson National Fish Hatchery; LWSH - Little White Salmon National Fish Hatchery; LYLFAT - Lyle Falls Adult Fish Trap, Klickitat River; MVFLAP - Moving Falls Acc. Ponds, WF Hood River; SKAM - Skamania Hatchery (WDFW); SPRC - Spring Creek National Fish Hatchery

In 2023, an investigation of the timing and movement of returning adult URBs in and out of the Little White Salmon River and straying into the White Salmon River will continue using submersible PIT antennas placed at strategic locations. Detection data of adult URB movement in the Little White Salmon and White Salmon Rivers collected will be used to assess factors that may be leading to straying.

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Appendix: Annual Hatchery Notes

Spring Creek NFH: Tule Fall Chinook

- Emergency early release due to bacterial gill disease. Fish were released on-station mid-March prior to the completion of marking and PIT tag operations (approximately 21% of the population was marked and/or CWT).
- SRKW proposals for FY22 were funded pending fiscal agreements and brood stock availability: +2M fall Chinook at Spring Creek

Little White Salmon NFH: Upriver Bright Chinook

- SRKW proposals for FY22 were funded pending fiscal agreements and brood stock availability: +650K Spring Chinook at Little White Salmon

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