# U.S. Fish and Wildlife Service <br> Columbia River Fish and Wildlife Conservation Office 

# Monitoring and Evaluation Updates for John Day/ The Dalles Dam Mitigation Programs at Spring Creek and Little White Salmon National Fish Hatcheries 

FY 2019 Annual Report



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# MONITORING AND EVALUATION UPDATES FOR JOHN DAY/THE DALLES DAM MITIGATION PROGRAMS AT SPRING CREEK AND LITTLE WHITE SALMON NATIONAL FISH HATCHERIES 

2019 ANNUAL REPORT<br>Kari Dammerman, David Hand ${ }^{1}$, Todd Gilmore, Brook Silver, Doug Olson, Jesse Rivera<br>U.S. Fish and Wildlife Service<br>Columbia River Fish and Wildlife Conservation Office<br>1211 SE Cardinal Court, Suite 100<br>Vancouver, WA 98683


#### 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 84,244 adult tules (including 59,572 for harvest) annually to the JDTD program TAP goal. Since 2009, 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 27,795 adult upriver brights (including 13,525 for harvest) 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.


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## Introduction

Extensive hydropower development on the Columbia River during the $20^{\text {th }}$ 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. Slackwater 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 (Fig. 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 the 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 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 (Fig. 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-clip, a proportion of the juveniles are marked with codedwire 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 finclipped 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) 2019, the U.S. Fish and Wildlife Service (USFWS) requested funding from the USACE in the amount of $\$ 4,798,021$ 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 (NMFS) 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.

## SECTION 1. Spring Creek NFH: Tule Program

## 1.1) Program Description

Spring Creek NFH (Fig. 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 for the production of 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). The Spring Creek NFH hatchery stock is considered part of the ESA, but surplus to the conservation and recovery needs of the population. Presently, $100 \%$ of the 6,000 adults used for broodstock at Spring Creek NFH are provided by hatchery-reared, adult returns to the facility.


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

## 1.2) 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. 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

Traditionally, 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 10.5 M tule released in April and May. The actual number of juvenile tule released annually has varied with a mean of $10,801,091$ since release year 2010 (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 HGMP (USFWS 2004a). Ninety-two percent ( $\sim 10 \mathrm{M}$ ) of the annual production is mass marked with an adipose fin-clip (AD) only. The remaining fish are marked with CWTs with $\sim 405 \mathrm{~K}$ being AD and marked with CWTs, and $\sim 405 \mathrm{~K}$ being marked with CWTs only (DIT fish). The CWT marking 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 2010 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 (A) and May (M) for juvenile tule fall Chinook released from Spring Creek NFH.

| Release Year | Release Dates | $\begin{aligned} & \text { AD + } \\ & \text { CWT } \end{aligned}$ | $\begin{aligned} & \text { CWT } \\ & \text { (DIT) } \end{aligned}$ | $\begin{gathered} \hline \text { AD } \\ \text { ONLY } \end{gathered}$ | No <br> Mark/CWT ${ }^{\text {a }}$ | Total Released | $\begin{gathered} \text { Mean } \\ \text { Size } \\ \text { (fish/lb) } \end{gathered}$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 2010 | 12-Apr | 204,288 | 204,772 | 5,789,796 | 1,651 | 10,750,561 | A: 111 |
|  | 10-May | 199,336 | 199,385 | 4,151,333 | 0 |  | M: 76 |
| 2011 | 12-Apr | 203,259 | 202,650 | 5,823,184 | 2,047 | 10,861,292 | A: 112 |
|  | 4-May | 199,576 | 199,410 | 4,232,812 | 401 |  | M: 87 |
| 2012 | 11,13-Apr | 205,066 | 203,460 | 5,862,141 | 1,115 | 11,078,704 | A: 124 |
|  | 10-Apr | 208,147 | 199,232 | 4,399,138 | 405 |  | M: 98 |
| 2013 | 11-Apr | 196,681 | 203,834 | 6,040,240 | 820 | 11,242,686 | A: 99 |
|  | 2-May | 200,696 | 199,892 | 4,398,952 | 1,571 |  | M: 79 |
| 2014 | 11-Apr | 205,922 | 205,548 | 5,757,948 | 0 | 10,754,482 | A: 122 |
|  | 6-May | 199,060 | 198,350 | 4,186,873 | 781 |  | M: 88 |
| 2015 | 13-Apr | 201,918 | 196,759 | 5,975,115 | 5,370 | 10,415,634 | A: 148 |
|  | 27-Apr | 190,848 | 191,210 | 3,654,414 | 0 |  | M: 105 |
| 2016 | 11-Apr | 203,461 | 201,944 | 5,941,689 | 2,278 | 10,167,948 | A: 112 |
|  | 9-May | 194,817 | 197,566 | 3,425,802 | 391 |  | M: 90 |
| 2017 | 10-Apr | 204,714 | 204,431 | 6,168,828 | 393 | 10,775,114 | A: 126 |
|  | 8-May | 195,800 | 194,472 | 3,802,122 | 4,354 |  | M:84 |
| 2018 | $9-\mathrm{Apr}$ | 203,899 | 201,850 | 6,266,724 | 2,907 | 10,737,862 | A: 135 |
|  | 7-May | 197,100 | 197,321 | 3,666,549 | 1,512 |  | M:87 |
| 2019 | 8-Apr | 204,668 | 204,551 | 6,227,655 | 0 | 11,322,122 |  |
|  | 6-May | 197,627 | 197,565 | 3,974,836 | 371 |  | M:152 |
| Means | Apr | 193,838 | 202,980 | 6,016,779 | 1,658 | $10,801,091$ | A: 125 |
|  | May | 198,301 | 197,440 | 3,989,321 | 979 |  | M: 90 |

${ }^{\mathrm{a}}$ Fish with no mark/cwt are double index tagged fish that shed their coded-wire tag prior to release.

## 1.3) Off-Station Juvenile Survival

a) PIT Tagging Program: Juvenile Survival and Migration Time

Approximately 15,000 juveniles have been 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 CRFWCO to estimate juvenile migration time and survival through the Columbia River basin. 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 Bonnveille 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). Due the low detection rate of Spring Creek PIT tagged juveniles downstream of Bonneville Dam, no juvenile survival estimates can be calculated.
Table 2. The number of PIT tagged juvenile tule released from Spring Creek NFH and juvenile travel times to Bonneville Dam (BONN).

| Release <br> Year | $\begin{gathered} \text { \# PIT } \\ \text { Tagged } \end{gathered}$ | \# <br> Detected at BONN | Detected | Travel Time (Days) |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  | Mean | Median |  |  | rcent |  |
|  |  |  |  | Mean | Median | Range | 50th | 75th | $90^{\text {th }}$ |
| 2010 | 14,933 | 1,277 | 9 | 3 | 2 | (0.5-42) | 2 | 3 | 3 |
| 2011 | 14,939 | 922 | 6 | 1 | 1 | (0.5-20) | 1 | 1 | 2 |
| 2012 | 14,750 | 668 | 5 | 1 | 1 | (0.5-24) | 1 | 1 | 1 |
| 2013 | 14,940 | 825 | 6 | 2 | 1 | $(0.5-38)$ | 1 | 2 | 3 |
| 2014 | 14,866 | 757 | 5 | 2 | 1 | (0.5-37) | 1 | 1 | 2 |
| 2015 | 13,827 | 788 | 6 | 3 | 1 | ( $1-54$ ) | 2 | 2 | 3 |
| 2016 | 14,954 | 779 | 5 | 1 | 1 | $(0.5-9)$ | 1 | 1 | 1 |
| 2017 | 14,918 | 513 | 3 | 1 | . 5 | $(0.5-12)$ | 0.5 | 1 | 1 |
| 2018 | 14,907 | 619 | 4 | 1 | 1 | (0.5-53) | 1 | 1 | 1 |
| 2019 | 15,225 | 1,519 | 10 | 1 | 1 | (1-46) |  | 1 | 1 |
| Mean | 14,826 | 867 | 5.5 | 1.7 | 1.2 | - | 1 | 2 | 2 |

## 1.4) Adult Returns, 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 Chinook, on average, towards the TAP goal of 107,000 with 28,000 adults supplied for harvest. However, for brood years 2003-2012, the facility has a mean smolt-to-adult survival rate of 0.68 (Table 3 ) which exceeds the program's goal of a 10 -yearaverage of $0.5 \%$ smolt-to-adult survival rate outlined in the facility's HGMP (USFWS 2004a). Additionally, the tule program has contributed a mean of over 84,000 adults for the past ten years with the highest number of returns from the April juvenile release group. CWT recoveries beyond brood year 2012 were not included in this report given that adult returns reported to RMIS can take several years to be finalized.

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.

| Brood <br> Year | Ocean <br> Harvest | Columbia <br> River <br> Harvest | Hatchery $_{\text {Returns }^{\mathbf{a}}}$ | Spawning <br> Ground | Total <br> Adults $^{\mathbf{b}}$ | Release <br> to Adult <br> Survival <br> (\%) |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 2003 | 7,073 | 8,429 | 8,031 | 203 | 23,898 | 0.16 |
| 2004 | 2,593 | 4,452 | 2,909 | 329 | 10,411 | 0.07 |
| 2005 | 19,360 | 41,451 | 36,278 | 140 | 98,826 | 0.65 |
| 2006 | 4,415 | 12,001 | 11,121 | - | 28,159 | 0.18 |
| 2007 | 41,303 | 68,333 | 55,022 | 520 | 166,627 | 1.12 |
| 2008 | 20,009 | 27,924 | 19,087 | 175 | 68,045 | 0.61 |
| 2009 | 21,222 | 30,136 | 20,376 | 151 | 72,511 | 0.67 |
| 2010 | 15,984 | 28,225 | 12,711 | 28 | 58,484 | 0.54 |
| 2011 | 35,014 | 57,781 | 18,558 | 355 | 122,226 | 1.09 |
| 2012 | 57,910 | 92,103 | 34,518 | 1,060 | 193,256 | 1.72 |
| Mean | $\mathbf{2 2 , 4 8 8}$ | $\mathbf{3 7 , 0 8 4}$ | $\mathbf{2 1 , 8 6 1}$ | $\mathbf{3 2 9}$ | $\mathbf{8 4 , 2 4 4}$ | $\mathbf{0 . 6 8}$ |

${ }^{\mathrm{a}}$ Hatchery returns are returns to Spring Creek NFH.
${ }^{\mathrm{b}}$ Total Adults includes other recovery locations not listed, such as strays to other hatcheries.
${ }^{\mathrm{c}}$ Due to delays in reporting to RMIS, CWT recoveries may be adjusted every year for accuracy. RMIS data queried on 8/31/2019 and CRiS stock assessment reports run on 11/14/19.

Adult returns to Spring Creek NFH are estimated by hatchery personnel and the USFWS marking and biosampling crew from CRFWCO (Table 4: brood year) and 5: 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 of adult tule ( $\sim 64 \%$ ) return to Spring Creek NFH at Age3, but $18 \%$ return at Age- 2 as precocially mature males/females. Approximately $11 \%$ of adults return at Age-4 and less than $1 \%$ return at Age-5. The facility has produced an annual mean of 26,908 adult returns to Spring Creek NFH for return years 2009-2018.

Table 4. Estimated age structure of adult tule fall Chinook returns to Spring Creek NFH by brood year.

| Brood Year | Age-2 | Age-3 | Age-4 | Age-5 | Total Adults |
| :--- | :---: | :---: | :---: | :---: | :---: |
| 2003 | 2,268 | 6,950 | 2,160 | 0 | 11,378 |
| 2004 | 757 | 3,667 | 810 | 228 | 5,462 |
| 2005 | 8,303 | 32,912 | 5,008 | 0 | 46,223 |
| 2006 | 956 | 8,463 | 1,444 | 34 | 10,897 |
| 2007 | 11,988 | 43,835 | 2,108 | 50 | 57,981 |
| 2008 | 4,856 | 14,618 | 4,321 | 29 | 23,824 |
| 2009 | 4,049 | 20,852 | 3,178 | 119 | 28,198 |
| 2010 | 1,912 | 12,615 | 3,433 | 66 | 18,026 |
| 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 |
| $2014^{\text {a }}$ | 8,566 | 11,327 | 352 | - | - |
| $2015^{\text {a }}$ | 6,101 | 10,045 | - | - | - |
| $2016^{\text {a }}$ | 5,018 | - | - | - | - |
| Mean | $\mathbf{5 , 0 2 6}$ | $\mathbf{1 7 , 2 6 8}$ | $\mathbf{2 , 6 9 7}$ | $\mathbf{5 9}$ | $\mathbf{2 6 , 0 4 2}$ |

${ }^{a}$ Denotes incomplete brood years given that adults have either not yet returned to the hatchery or have not been aged.

Table 5. Total number of adult tule fall Chinook returns to Spring Creek NFH and estimated age structure by return year.

| Return Year | Age-2 | Age-3 | Age-4 | Age-5 | Total Adults |
| :--- | :---: | :---: | :---: | :---: | :---: |
| 2009 | 11,988 | 8,463 | 5,008 | 228 | 25,687 |
| 2010 | 4,856 | 43,835 | 1,444 | 0 | 50,135 |
| 2011 | 4,049 | 14,618 | 2,108 | 34 | 20,809 |
| 2012 | 1,867 | 20,890 | 4,328 | 50 | 27,135 |
| 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 |
| Mean | $\mathbf{8 , 1 2 2}$ | $\mathbf{1 8 , 0 9 5}$ | $\mathbf{2 , 9 4 0}$ | $\mathbf{6 5}$ | $\mathbf{2 6 , 9 0 8}$ |

## 1.5) 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 naturalorigin (wild) spawners present on the spawning grounds in the White Salmon River (personal communication, K Dammerman WDFW 2019.

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 (Fig. 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 (Wilson, 2017 memorandum). Data from the spawning surveys is accessible on the Salmon Conservation Reporting Engine (SCoRE) website operated by WDFW.


Figure 3. Annual escapement estimates of natural-origin and hatchery-origin tule fall Chinook spawning in the White Salmon River during annual spawning surveys (20102018). (SCoRE website 11/22/19; 2018 data from K. Dammerman, WDFW, preliminary).


Figure 4. Estimated proportion of tule fall Chinook hatchery origin spawners (pHOS) in the White Salmon River (2010-2018). (SCoRE website 11/22/19; 2018 data from K. Dammerman, WDFW, preliminary).

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 2010 to 2018, pHOS estimates ranged from $6 \%$ to $51 \%$ with a mean pHOS of $31 \%$ (Fig. 4). It appears that the proportion of hatchery origin spawners in the White Salmon River has been increasing since 2012. Reasons for this apparent increase are not known and may warrant further study. Based on adult return data from Spring Creek NFH, the 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 2010-2017 is (Pearson's) $\mathrm{r}=0.53$.

## SECTION 2. Little White Salmon NFH: URB Program

## 2.1) Program Description

Little White Salmon NFH (Fig. 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 and 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.

## 2.2) On-Station Juvenile Production

a) Egg-to-Smolt Survival

The survival objectives for the facility are the same as Spring Creek NFH (section 1.2a). 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.

## b) Juvenile Mass Marking, Tagging, and Release Data

The original goal for the facility was to release 2.0 M juvenile URBs into the Little White Salmon River (NMFS 2007); however, production expanded in RY 2009 (brood year 2008) to a release goal of 4.5 M juvenile URBs (NMFS 2017). 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 6). 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 and 2015). Since release year 2009, the facility has annually released approximately 4.4 M juveniles with a mean size of 81.08 fish/lb. Eighty-eight percent ( $\sim 3.8 \mathrm{M}$ ) of the annual production released into the Little White Salmon River is AD only. Approximately $7 \%$ 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 6).

The facility also transfers 1.7M URB juveniles to the Yakima River-Prosser Hatchery program for the Yakama Nation in late March to late April (Table 7). The transferred URB juveniles are marked prior to release with $\sim 1.5 \mathrm{M}$ being adipose fin-clipped only, and $\sim 200 \mathrm{~K}$ juveniles being adipose fin-clipped and CWT. The actual number of URB juveniles that have been marked, tagged, and transferred to the Prosser program since 2010 are presented in Table 7. 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 programs. In 2018, no eggs were transferred and 2019 no fish were transferred due to low adult returns to Little White Salmon. To fulfill full production at Little White Salmon NFH for BY2018, 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.

Table 6. 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.

| Release <br> Year | Release <br> Dates | AD + <br> CWT | CWT <br> (DIT) | AD ONLY | No <br> Mark/CWT | Total <br> Released | Mean <br> Size <br> (fish/lb) |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 2010 | 17-Jun, | 362,931 | 199,338 | $3,988,400$ | 590 | $4,551,259$ | 85 |
| 2011 | 24-Jun | 23-Jun | 366,279 | 197,794 | $3,909,595$ | 2,200 | $4,475,868$ |
| 2012 | 26-Jun, | 565,914 | 194,722 | $3,803,310$ | 5,483 | $4,569,429$ | 87 |
| 2013 | 2-Jul | 2-Jul | 360,089 | 198,443 | $3,862,277$ | 769 | $4,421,578$ |
| 2014 | 1-Jul, | 267,804 | 99,702 | $4,038,588$ | 298 | $4,406,392$ | 86 |
| 2015 | 2-Jul | 2-Jul | 188,763 | 186,398 | $3,583,770$ | 13,595 | $3,972,526$ |
| 2016 | 11-Jul | 196,105 | 196,772 | $3,565,052$ | 3,186 | $3,961,115$ | 82 |
| 2017 | 5-Jul | 197,829 | 198,487 | $4,297,331$ | 1,381 | $4,695,028$ | 77 |
| 2018 | 11-Jul | 189,005 | 186,872 | $3,475,851$ | 13,093 | $3,864,371$ | 78 |
| 2019 | 9-Jul, | 201,469 | 194,633 | $4,081,518$ | 7,035 | $4,484,655$ | 81 |
| Mean |  | $\mathbf{2 8 9 , 6 1 9}$ | $\mathbf{1 8 5 , 3 1 6}$ | $\mathbf{3 , 8 6 0 , 5 6 9}$ | $\mathbf{4 , 7 6 3}$ | $\mathbf{4 , 3 4 0 , 2 2 2}$ | $\mathbf{8 1}$ |

${ }^{a}$ Fish with no mark/CWT are double index tagged fish that shed their coded-wire tag prior to release
${ }^{b}$ Approximately 419,000 unmarked fish accidentally released on 4/18/2018 due to a loose screen. These fish are not included in totals.

Table 7. Annual transfer dates and total number of juveniles transferred to the Prosser program from Little White Salmon NFH.

| Transfer <br> Year | Transfer Dates | Total \# <br> Transferred |
| :---: | :---: | :---: |
| 2010 | $4 / 15,4 / 16,4 / 19,4 / 21$ | $1,222,288$ |
| 2011 | $25-\mathrm{Apr}$ | $1,700,662$ |
| 2012 | $4 / 2,4 / 9,4 / 13,4 / 23$ | $1,507,117$ |
| 2013 | $4 / 4,4 / 8,4 / 15,4 / 18$ | $1,551,115$ |
| 2014 | $4 / 9,4 / 15,4 / 22,4 / 30$ | $1,549,626$ |
| 2015 | $4 / 6,4 / 13,4 / 15,4 / 21$, | $1,700,649$ |
| 2016 | $3 / 30,4 / 5,4 / 11,4,14 / 4,18$ | $1,650,070$ |
| 2017 | $4 / 4,4 / 10,4 / 13,4 / 19$, | $1,701,850$ |
| 2018 | $4 / 16,4 / 18,4 / 23,5 / 2$ | $1,203,675$ |
| 2019 | No Transfers | 0 |
| Mean |  | $\mathbf{1 , 3 7 8 , 7 0 5}$ |

## 2.3) 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.).

## Migration Timing

PIT tagging of the juvenile production began with brood year 2007 with 25,000 juvenile URBs being PIT tagged annually. Beginning in brood year 2012, the number of juveniles that were PIT tagged was decreased to 15,000 to monitor juvenile migration through the Columbia River basin (Table 8). The mean detection rate at Bonneville Dam of PIT tagged URB juveniles from Little White Salmon is approximately $11 \%$, with a median travel time from the hatchery to the dam of 14 days. Interestingly, a few PIT tagged juveniles take a substantially longer time to migrate downstream, with the longest migration time per year ranging from 45 to 149 days.

Table 8. The number of PIT tagged juvenile URB fall Chinook released from Little White Salmon NFH and juvenile travel times to Bonneville Dam (BONN).

| Release Year | Release Date | \# PIT <br> Tagged | \# Detected at BONN | $\begin{gathered} \% \\ \text { Detected } \end{gathered}$ | Travel Time (Days) |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  | Median | Range | Percentile |  |  |
|  |  |  |  |  | Median |  | 50th | 75th | 90 ${ }^{\text {th }}$ |
| 2010 | 6/24 | 24,951 | 2,247 | 9.0 | 22 | (1-149) | 22 | 30 | 44 |
| 2011 | 6/23 | 24,638 | 2,313 | 9.4 | 12 | $(2-126)$ | 12 | 32 | 41 |
| 2012 | 7/3 | 24,937 | 1,440 | 5.8 | 10 | (0.5-127) | 10 | 19 | 37 |
| 2013 | 7/2 | 14,959 | 1,978 | 13.2 | 12 | (0.5-143) | 12 | 20 | 25 |
| 2014 | 7/2 | 14,925 | 1,806 | 12.1 | 17 | $(1-137)$ | 17 | 26 | 36 |
| 2015 | 7/2 | 14,958 | 1,194 | 8 | 10 | $(1-44)$ | 10 | 12 | 16 |
| 2016 | 7/11 | 14,823 | 1,647 | 11.1 | 11 | $(2-50)$ | 11 | 13 | 15 |
| 2017 | 7/5 | 14,438 | 1,854 | 12.8 | 10 | $(1-47)$ | 10 | 14 | 20 |
| 2018 | 7/11 | 14,840 | 2,467 | 16.6 | 10 | $(0.5-45)$ | 10 | 12 | 16 |
| 2019 | 7/9,7/15 | 13,695 | 1,803 | 13.2 | 11 | (1-45) | 11 | 15 | 20 |
| Means |  | 17,716 | 1,930 | 11.1 | 14 | - | 14 | 22 | 29 |

The PIT tagging goal was decreased in release year 2013 from 25 K to 15 K juveniles. Number tagged is adjusted for shed tags and pre-release mortality.

## 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 in order 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 subsequent to 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 a review of directionality of ladder detections for a sub-sample of each stock of fish, a day of year cut-off, September 1, was used to separate out likely juvenile downstream fish from upstream moving mini-jacks.

Subsequent to passing downstream of Bonneville Dam:

- Lower river trawl (TWX and PD7 interrogation sites)
- Lower river bird colony recoveries on East Sand Island, Rice Island and Miller Sands Island (ESANIS, RICEIS, and MLRSNI mortality sites). The assumption is that the PIT tagged fish were predated on downstream of Bonneville Dam.
- Adult ladder detections at Bonneville Dam after the mini-jack cut-off date. 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 2007-2017 (release years 2008-2018) ranged from .49 to . 74 (Table 9; Fig. 6). The variance of the estimates for each year (represented by the credible intervals) increases in the more recent years. This is due to the fact that adult returns are added in to the detection histories (as "downstream of Bonneville" detections), which in turn decreases the variance. Since recent years do not have adult returns, or at least not the full age complement of adult returns, the more recent estimates have a larger variances. In subsequent years, as more adults from a brood year return, the variance of the estimates should decrease.

Table 9. 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.

| Brood <br> Year | Release <br> Year | Median <br> Survival | $95 \%$ <br> Lower | $95 \%$ <br> Upper |
| ---: | ---: | ---: | ---: | ---: |
| 2007 | 2008 | 0.58 | 0.53 | 0.64 |
| 2008 | 2009 | 0.61 | 0.55 | 0.68 |
| 2009 | 2010 | 0.59 | 0.52 | 0.67 |
| 2010 | 2011 | 0.69 | 0.57 | 0.81 |
| 2011 | 2012 | 0.67 | 0.56 | 0.8 |
| 2012 | 2013 | 0.70 | 0.63 | 0.77 |
| 2013 | 2014 | 0.58 | 0.50 | 0.70 |
| 2014 | 2015 | 0.49 | 0.41 | 0.64 |
| 2015 | 2016 | 0.74 | 0.58 | 0.94 |
| 2016 | 2017 | 0.55 | 0.42 | 0.71 |
| 2017 | 2018 | 0.67 | 0.55 | 0.78 |



Figure 6. Little White Salmon NFH Upriver Bright Fall Chinook apparent juvenile survival from release to Bonneville Dam. Error bars are lower and upper credible intervals.

## 2.4) Adult Returns, 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 10; 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 . However, since brood year 2003, the facility has a mean smolt-to-adult survival rate of 0.78 (Table 9) which is within the range reported in the facility's HGMP (USFWS 2004b and 2015). Additionally, the URB program has contributed a mean of 27,795 adults annually for the past ten years. CWT recoveries beyond brood year 2012 were not included in this report given that adult returns reported to RMIS can take several years to be finalized.

Table 10. 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.

| Brood <br> Year | Ocean <br> Harvest | Columbia <br> River <br> Harvest | Hatchery $^{\text {Returns }}$ | Spawning <br> Ground | Total <br> Adults $^{\mathbf{b}}$ | Release <br> to Adult <br> Survival <br> $\mathbf{( \% )}$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 2003 | 990 | 530 | 1,600 | 360 | 3,480 | 0.17 |
| 2004 | 1,185 | 323 | 1,774 | 70 | 3,352 | 0.18 |
| 2005 | 3,234 | 2,737 | 6,903 | 174 | 13,057 | 0.73 |
| 2006 | 1,777 | 2,233 | 6,793 | 613 | 11,491 | 0.56 |
| 2007 | 4,426 | 6,256 | 14,689 | 1,043 | 26,529 | 1.33 |
| 2008 | 5,043 | 5,152 | 7,983 | 1,812 | 20,139 | 0.42 |
| 2009 | 10,483 | 14,670 | 17,171 | 9,705 | 53,276 | 1.17 |
| 2010 | 25,435 | 24,160 | 29,993 | 9,424 | 93,475 | 2.09 |
| 2011 | 3,254 | 3,510 | 4,530 | 3,250 | 15,105 | 0.33 |
| 2012 | 9,894 | 9,956 | 11,737 | 4,797 | 38,050 | 0.86 |
| Mean | $\mathbf{6 , 5 7 2}$ | $\mathbf{6 , 9 5 3}$ | $\mathbf{1 0 , 3 1 7}$ | $\mathbf{3 , 1 2 5}$ | $\mathbf{2 7 , 7 9 5}$ | $\mathbf{0 . 7 8}$ |

${ }^{\mathrm{a}}$ Hatchery returns are returns to Little White Salmon NFH.
${ }^{b}$ Total Adults includes other recovery locations not listed, such as strays to other hatcheries. ${ }^{\text {c Due }}$ Do delays in reporting to RMIS, CWT recoveries may be adjusted every year for accuracy. All recovery information presented above is current as of 8/31/2019. CRiS stock assessment reports run on 11/14/19.

Adult returns to Little White Salmon NFH are estimated 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 11: brood year; Table 12: return year). The majority ( $52 \%$ ) of adult URBs return to the facility at Age-4, but 30\% return at Age-3. Approximately 4\% of fish mature
precocially returning as jacks or jills at Age-2. Less than 1\% of adults return at Age-6. The facility has produced a mean of 12,611 adult returns to the hatchery between 2009 and 2018.

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 11. Estimated age structure of adult URB fall Chinook returns to Little White Salmon NFH by brood year.

| Brood <br> Year | Age-2 | Age-3 | Age-4 | Age-5 | Age-6 | Total <br> Adults |
| :--- | :---: | :---: | :---: | :---: | :---: | :---: |
| 2003 | 39 | 373 | 1,331 | 1,096 | 10 | 2,849 |
| 2004 | 283 | 543 | 2,526 | 706 | 34 | 4,092 |
| 2005 | 156 | 1,164 | 1,942 | 2,263 | 47 | 5,572 |
| 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 |
| $2013^{\text {a }}$ | 65 | 759 | 3,384 | 638 | - | - |
| $2014^{\text {a }}$ | 0 | 300 | 1,179 | - | - | - |
| $2015^{\text {a }}$ | 101 | 2,282 | - | - | - | - |
| $2016^{\text {a }}$ | 676 | - | - | - | - | - |
| Mean $^{206}$ | $\mathbf{4 5 6}$ | $\mathbf{3 , 2 5 2}$ | $\mathbf{5 , 6 3 7}$ | $\mathbf{1 , 6 0 4}$ | $\mathbf{3 3}$ | $\mathbf{1 2 , 4 8 9}$ |

${ }^{\mathrm{a}}$ Incomplete returns given that adults have either not yet returned to the hatchery or have not been aged.

Table 12. Total number of adult URB fall Chinook returns to Little White Salmon NFH and estimated age structure by return year.

| Return Year | Age-2 | Age-3 | Age-4 | Age-5 | Age-6 | Total Adults |
| :--- | :---: | :---: | :---: | :---: | :---: | :---: |
| 2009 | 1,156 | 961 | 1,942 | 706 | 10 | 4,775 |
| 2010 | 1,021 | 5,675 | 3,009 | 2,263 | 34 | 12,002 |
| 2011 | 612 | 2,990 | 6,863 | 1,174 | 47 | 11,686 |
| 2012 | 587 | 4,551 | 2,770 | 1,229 | 12 | 9,149 |
| 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 |
| Mean | $\mathbf{5 2 5}$ | $\mathbf{4 , 0 2 0}$ | $\mathbf{6 , 3 7 9}$ | $\mathbf{1 , 6 5 4}$ | $\mathbf{3 3}$ | $\mathbf{1 2 , 6 1 1}$ |

## 2.5) Additional Monitoring and Evaluation Projects

a) Escapement of Hatchery Fish to Spawning Grounds

Coded-wire tag recovery data stored in the RMIS database has been useful for estimating the number of adults that originated from Little White Salmon NFH and were observed on spawning grounds in nearby watersheds (Table 9) including the White Salmon River (Pastor 2004). Monitoring on the abundance of adult URB in the White Salmon basin has been conducted since 1989 (Wilson, 2017 memorandum). Spawning ground surveys conducted since 2010 by the WDFW include identification of hatchery-origin (for all facilities including Little White Salmon NFH) and natural-origin (wild) adult URBs in the White Salmon River (Table 13; Fig. 7).

Data accessible from the SCoRE website allows for estimation of the pHOS for URBs. The pHOS estimates for URBs observed on the White Salmon River spawning grounds range from $34 \%$ to $80 \%$ with a mean pHOS of $61 \%$ (Fig. 8). Using the adult return data from Little White Salmon NFH, the correlation between the number of hatchery-origin URBs on the White Salmon River spawning grounds and the number of total adult returns to the facility is (Pearson's) $\mathrm{r}=0.17$. Monitoring and evaluation plans for assessing the effects of hatchery-origin fish straying into the White Salmon River are discussed under the ongoing and future studies section of this report.

Table 13. Estimated number of hatchery origin and natural origin Upriver Bright Fall Chinook Salmon in the White Salmon River. Data is from WDFW spawning surveys (SCoRE website 11/22/19; 2018 data from K. Dammerman, WDFW, preliminary).

| Year | Hatchery <br> Origin | Natural <br> Origin |
| :---: | ---: | ---: |
| 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 | 1,377 | 947 |



Figure 7. Escapement estimates of hatchery-origin and natural-origin URB fall Chinook in the White Salmon River during annual spawning surveys. 2011 escapement estimates were unavailable due to the breach of Condit Dam. (SCoRE website 11/22/19; 2018 data from K. Dammerman, WDFW, preliminary).


Figure 8. Estimated proportion of Upriver Bright (URB) fall Chinook hatchery origin spawners (pHOS) in the White Salmon River (2010-2018). (SCoRE website 11/22/19; 2018 data from K. Dammerman, WDFW, preliminary)
b) Genetic Introgression and impacts of hatchery origin URBs and Tules in the White Salmon River

As part of the Reasonable and Prudent Measures in the Biological Opinion for Upriver Bright Fall Chinook increased production at Little White (NMFS 2017; RPA 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. For the most recent 3 year data set (2016-2018) the average abundance of hatchery origin URBs was 1,213 (Table 12), below the 3,000 adult limit. Currently, the Washington Department of Fish and Wildlife (WDFW) conducts annual spawning surveys of the White Salmon River as part of their adult salmonid monitoring program. The USFWS will continue to coordinate with WDFW to assess the number of hatchery strays that are present in the river. In addition to monitoring adult hatchery abundance in the White Salmon River, Reasonable and Prudent Measure 3a of the 2017 BiOP required the USFWS to submit to NMFS and the Corps a study proposal to repeat an evaluation similar to that described in Smith and Engle (2011). The authors of that study found:

1) a small proportion of hybrid juveniles
2) no hybrid adults suggesting that hybrid juveniles do not survive; and
3) genetic divergence among the lineages that is comparable to allopatric populations suggesting that gene flow in the White Salmon River is not higher than other locations
Collectively, results suggested that URBs from the Little White Salmon NFH were not posing a genetic risk to the tule stock in the White Salmon River based on the level of introgression observed in the study. With the increase in URB production at Little White Salmon NFH since the time of that study, the USFWS has initiated, in coordination with NMFS and the Corps, a study to try to assess the hybridization rate of URB and tule fall Chinook in the White Salmon River. The previous study of juvenile outmigrants in the river (Smith and Engle 2011) utilized a rotary screw trap operated by the USGS in the lower section of the river to collect samples. With the removal of Condit Dam, the river morphology in the lower section of river changed dramatically, with the lower section now characterized by shallow, swift moving water. Due to these changes, the USGS moved the location of the screw trap upstream, to approximately river kilometer 2.3.

The current location of the screw trap is located upstream of approximately $70 \%$ of the fall Chinook spawning population. In both 2018 and 2019, the USFWS attempted to collect young-of-year fall Chinook at river kilometer 1.3, in the area of the majority of fall Chinook spawning. The USFWs employed minnow traps, beach seines, and margin area electrofishing to capture juvenile fall Chinook in April and May of both 2018 and 2019. Unfortunately, due to the river characteristics, trapping was largely unsuccessful with only five fall Chinook juveniles in 2018 and one fall Chinook juvenile in 2019 sampled. In 2019, approximately 400 fall Chinook juveniles collected by USGS at the rotary trap at rkm 2.3 between 2017 and 2019 were sent to the USFWS Genetic Lab at Abernathy Fish Technology Center for analysis. The Genetics Lab will analyze the sample to determine run type (tule vs URB) as well the presence of any hybrids. Since the samples were collected upstream of the majority of fall Chinook spawning habitat, inferences about the level of hybridization rate in the White Salmon River will be limited. Discussions between the USFWS, NOAA, and the Corps will be ongoing over the winter of 2019-2020 to determine future monitoring plans.

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