**U.S. Fish and Wildlife Service**
**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 2017 Annual Report*

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***On the cover:*** *Hatchery staff at Little White Salmon National Fish Hatchery located in Cook, WA pose with two adult upriver bright fall Chinook salmon that returned to the facility during the spawning season. Adult returns are utilized as broodstock to meet tribal trust mandated responsibilities and mitigation requirements.*

**Disclaimers**

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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

## 2017 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 11.2 million juvenile tules into the Columbia River, and contributed a mean of 74,464 adult tules (including 47,276 for harvest) annually to the JDTD program TAP goal. Since 2007, Little White Salmon NFH has annually released a mean of 4.2M juvenile upriver brights into the Little White Salmon River, and supported JDTD programs at other facilities through egg and juvenile transfers. The program at Little White Salmon NFH contributes a mean of 21,251 adult upriver brights (including 10,192 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. Collectively, both facilities are successfully contributing to their mitigation obligations. Additional monitoring and evaluation projects for both facilities are being developed to determine the success and longevity of the programs in meeting their mitigation goals (and ESA compliance) as part of the JDTD program.

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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. 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 include 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 July. Additionally, as part of the JDTD program, the facility transfers URB eggs to the state-operated Bonneville Hatchery to support the Umatilla/Yakima River program, and URB juveniles to the Yakima River-Prosser Hatchery program. Juvenile production fish released as part of the JDTD program provide locally adapted adult broodstock as well as harvest opportunities for sport, commercial, and tribal fisherman, contributing to the TAP goal and mitigation agreements negotiated by *U.S. v Oregon* parties and USACE.

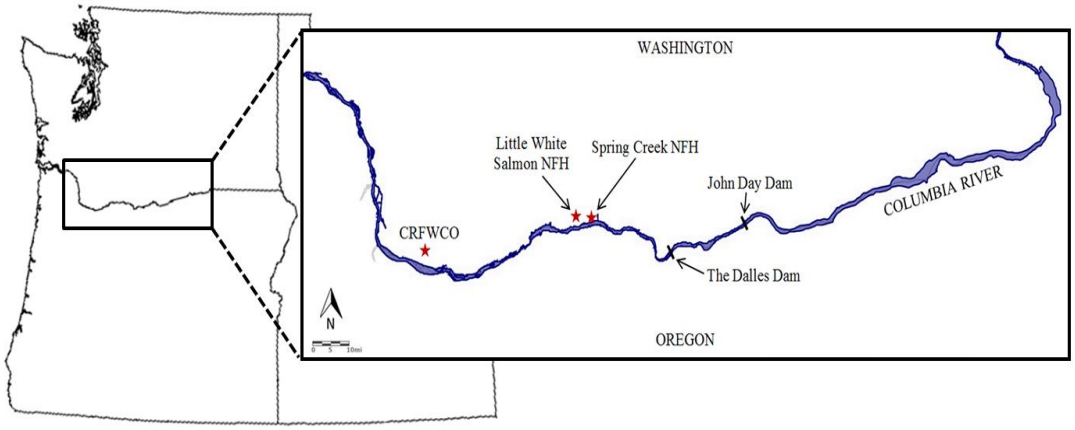


**Figure 1. Spring Creek and Little White Salmon NFHs are located on the Washington side of the Columbia River (purple) downstream of the John Day and The Dalles Dams. Monitoring and evaluation of the fall Chinook production programs at these facilities is conducted by staff at the Columbia River Fish 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 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-clipped 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) 2017, the U.S. Fish and Wildlife Service (USFWS) requested funding from the USACE in the amount of $3,930,175 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 Biological Opinion. The purpose of this report is to provide an annual update (similar to Dammerman et al. 2016) 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 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. 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 currently listed as threatened under the ESA (70 FR 37160). 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 10.5M tule released in April and May. The actual number of juvenile

tule released annually has varied with a mean of 11,219,864 since 2008 (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). Since release year 2008, the mean size of juveniles released in April and May are 117.77 and 86.91 fish/lb, respectively. Ninety-three percent (~10M) of the annual production is mass marked with an adipose fin-clip (AD) only. The remaining fish are marked with CWTs with ~405K being AD and marked with CWTs, and ~405K 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 2008 are presented below (Table 1). Coded-wire tag codes are stored in the USFWS CRiS database at the CRFWCO, and reported annually to the Regional Mark Information System (RMIS).

**Table 1. Annual release dates, marking and tagging information, number of juveniles released, and mean size at release in March (M), April (A), and May (My) for juvenile tule fall Chinook released from Spring Creek NFH.**

| Release Year | Release Dates | AD + CWT | CWT (DIT) | AD ONLY | Total Released | Mean Size (fish/lb) |
|---|---|---|---|---|---|---|
| 2008 | 5,6-Mar, 10-Apr, 2-May | 445,962 | 445,588 | 14,007,720 | 14,899,270 | M: 145.23<br>A: 79.77<br>My: 65.45 |
| 2009 | 13-Apr, 1-May | 359,866 | 359,967 | 10,533,116 | 11,252,949[a] | A: 144.36<br>My: 90.95 |
| 2010 | 12-Apr, 10-May | 403,624 | 404,157 | 9,942,780 | 10,750,561 | A: 111.26<br>My: 75.64 |
| 2011 | 12-Apr, 4-May | 402,835 | 402,060 | 10,056,397 | 10,861,292 | A: 112.11<br>My: 88.68 |
| 2012 | 11,13-Apr, 1-May | 413,213 | 402,692 | 10,262,799 | 11,078,704 | A: 123.87<br>My: 98.32 |
| 2013 | 11-Apr, 2-May | 217,377 | 403,726 | 10,621,583 | 11,242,686 | A: 99.00<br>My: 78.72 |
| 2014 | 11-Apr, 6-May | 404,982 | 403,898 | 9,945,602 | 10,754,482 | A: 121.83<br>My: 87.80 |
| 2015 | 13-Apr, 1-May | 393,567 | 393,339 | 9,628,728 | 10,415,634 | A: 147.59<br>My: 105.44 |
| 2016 | 11-Apr, 9-May | 398,278 | 399,510 | 9,370,160 | 10,167,948 | A: 112.30<br>My: 89.55 |
| 2017 | 10-Apr, 8-May | 400,514 | 398,903 | 9,975,697 | 10,775,114 | A: 125.56<br>My: 84.41 |
| **Means** | **Apr/May** | **384,022** | **401,384** | **10,434,458** | **11,219,864** | **M:145.23<br>A: 117.77<br>My: 86.50** |

[a] ***Reprogramming in release year 2009 reduced the release goal from 15.1M to 10.5M juvenile tules.***

### *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 (BONN) located 35 kilometers downstream from the facility as they migrate to the Pacific Ocean. 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 operating turbines, etc.). Travel times and detection rates to BONN are estimated annually (Table 2). The facility has an annual mean of 14,684 juveniles that have been PIT tagged since release year 2008. A mean of 831 juveniles released from Spring Creek NFH are detected annually at BONN for a mean detection rate of 5.67%. Mean travel time to BONN is 1.88 days with the majority of juveniles (90$^{th}$ percentile) passing over BONN within 2 days of release. However, some juveniles have spent up to 105 days upstream of BONN before migrating downstream.

**Table 2. The number of PIT tagged juvenile tule released from Spring Creek NFH and juvenile travel times to BONN.**

| Release Year | # PIT Tagged | # Detected at BONN | % Detected | Travel Time (Days) | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Mean | Median | Range | Percentile | | |
| | | | | | | | 50th | 75th | 90$^{th}$ |
| 2008 | 14,077 | 946 | 6.72 | 3.47 | 2.00 | (1 – 105) | 2 | 3 | 4 |
| 2009 | 14,636 | 840 | 5.74 | 2.39 | 1.00 | (1 – 62) | 1 | 2 | 3 |
| 2010 | 14,933 | 1,277 | 8.55 | 2.57 | 2.00 | (0.5 – 42) | 2 | 3 | 3 |
| 2011 | 14,939 | 922 | 6.17 | 1.38 | 1.00 | (0.5 – 20) | 1 | 1 | 2 |
| 2012 | 14,750 | 668 | 4.53 | 1.02 | 1.00 | (0.5 – 24) | 1 | 1 | 1 |
| 2013 | 14,940 | 825 | 5.52 | 1.89 | 1.00 | (0.5 – 38) | 1 | 2 | 3 |
| 2014 | 14,866 | 757 | 5.09 | 1.70 | 1.00 | (0.5 – 37) | 1 | 1 | 2 |
| 2015 | 13,827 | 788 | 5.70 | 2.51 | 2.00 | (1 – 54) | 2 | 2 | 3 |
| 2016 | 14,954 | 779 | 5.21 | 1.11 | 1.00 | (0.5 – 9) | 1 | 1 | 1 |
| 2017 | 14,918 | 510[a] | 3.42 | 0.80 | 0.50 | (0.5 – 12) | 0.5 | 1 | 1 |
| **Means** | **14,684** | **831** | **5.67** | **1.88** | **1.25** | **-** | **1** | **2** | **2** |

[a]***Current estimate as of 10/15/2017.***

### *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* 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 2001-2010, the facility has a mean smolt-to-adult survival rate of 0.541 (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 a mean of 74,464 adults for the past ten years. CWT recoveries beyond brood year 2010 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 data from RMIS for tules released from Spring Creek NFH. Adult returns are used to estimate smolt-to-adult survival rates.**

| Brood Year | Hatchery Returns[a] | Columbia River Harvest | Ocean Harvest | Spawning Grounds | Total # of Adults | Smolt-to-Adult Survival (%) |
|---|---|---|---|---|---|---|
| 2001 | 68,208 | 42,325 | 66,246 | 4,479 | 181,258 | 1.187 |
| 2002 | 18,703 | 12,448 | 12,516 | 740 | 44,407 | 0.295 |
| 2003 | 8,309 | 8,110 | 7,073 | 406 | 23,898 | 0.163 |
| 2004 | 3,037 | 4,452 | 2,593 | 329 | 10,411 | 0.072 |
| 2005 | 37,852 | 41,451 | 19,360 | 140 | 98,803 | 0.648 |
| 2006 | 11,617 | 12,493 | 4,415 | 0 | 28,525 | 0.184 |
| 2007 | 56,468 | 68,333 | 41,303 | 520 | 166,624 | 1.118 |
| 2008 | 21,174 | 27,924 | 20,009 | 175 | 69,282 | 0.616 |
| 2009 | 20,980 | 30,019 | 22,343 | 151 | 73,493 | 0.684 |
| 2010 | 11,366 | 21,600 | 14,946 | 28 | 47,940 | 0.441 |
| **Means** | **25,771** | **26,196** | **21,080** | **697** | **74,464** | **0.541** |

[a]***Hatchery returns include fish collected at all hatcheries within the Columbia River basin.***

Adult returns to Spring Creek NFH are estimated by hatchery personnel and the USFWS marking and biosampling crew from CRFWCO (Table A1). 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 (Table 4; Table A1). The majority of adult tule (~71%) return to Spring Creek NFH at Age-3, but 17%

**Table 4. Estimated age structure of adult tule returns to Spring Creek NFH by brood year. Total number of adults is used to estimate the smolt-to-adult return rate (%) to the facility.**

| Brood Year | Age-2 | Age-3 | Age-4 | Age-5 | Total Adults | Smolt-to-Adult Return Rate (%) |
|---|---|---|---|---|---|---|
| 2003 | 2,268 | 6,950 | 2,160 | 0 | 11,378 | 0.078 |
| 2004 | 757 | 3,667 | 810 | 228 | 5,462 | 0.038 |
| 2005 | 8,303 | 32,912 | 5,008 | 0 | 46,223 | 0.303 |
| 2006 | 956 | 8,463 | 1,444 | 34 | 10,897 | 0.070 |
| 2007 | 11,988 | 43,835 | 2,108 | 50 | 57,981 | 0.389 |
| 2008 | 4,856 | 14,618 | 4,321 | 29 | 23,824 | 0.212 |
| 2009 | 4,049 | 20,852 | 3,178 | 119 | 28,198 | 0.262 |
| 2010 | 1,912 | 12,615 | 3,433 | 66 | 18,026 | 0.166 |
| 2011 | 2,827 | 18,221 | 5,203 | 124 | 26,375 | 0.238 |
| 2012 | 10,028 | 36,152 | 3,865 | 0 | 50,045 | 0.445 |
| 2013[a] | *2,738* | *4,823* | *487* | - | - | - |
| 2014[a] | *8,566* | *11,327* | - | - | - | - |
| 2015[a] | *6,101* | - | - | - | - | - |
| **Means** | **4,794** | **19,829** | **3,153** | **65** | **27,841** | **0.220** |

[a]***Denotes incomplete brood years given that adults have either not yet returned to the hatchery or have not been aged. Incomplete years were not used in estimating means given that the information will be updated.***

return at Age-2 as precocially mature males ("jacks") or precocially-mature females ("jills"). Approximately 11% of adults return at Age-4 and less than 1% return at Age-5. The facility has produced an annual mean of 27,841 adult returns to Spring Creek NFH, and a mean smolt-to-adult return rate of 0.220% since brood year 2003. See Appendix A for a table of adult returns by return year to Spring Creek NFH (Table A1).

### *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 natural-origin (wild) spawners present on the spawning grounds in the White Salmon River (J.T. Wilson, 2017 memorandum to WDFW).

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 12.54) 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.

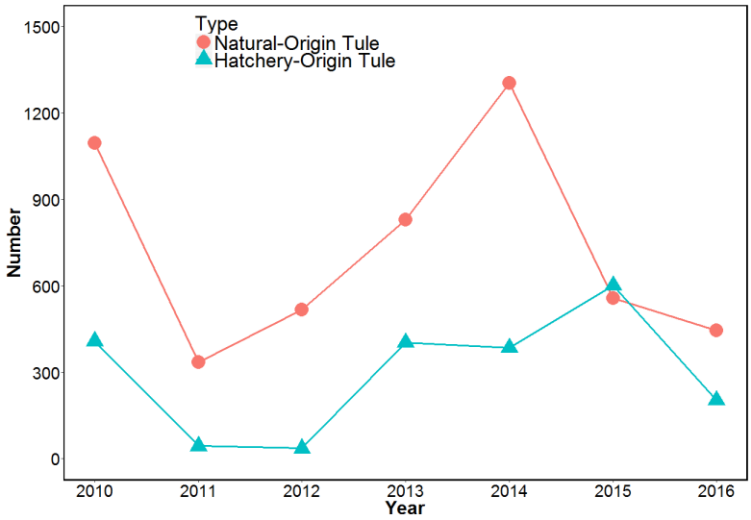


**Figure 3. Escapement estimates of natural-origin and hatchery-origin tule spawning in the White Salmon River during annual spawning surveys. Data belongs to WDFW, and was accessed from the SCoRE website.**

As part of the JDTD program, data downloaded from SCoRE is used to estimate the proportion of hatchery-origin spawners (pHOS) for tule on the White Salmon River. These estimates can include tule released from Spring Creek NFH. Based on escapement estimates of natural and hatchery-origin tule for spawning ground surveys from 2010 to 2016 (Fig. 3), pHOS estimates range from 6.51 to 51.90% with a mean pHOS of 26.28%. Using the 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 2010-2016 is (Pearson's) $r = 0.60$. Monitoring and evaluation plans being developed for assessing hatchery-origin fish straying into the White Salmon River are discussed in more detail under the future studies section of this report.

# SECTION 2. Little White Salmon NFH: URB Program

### *2.1) Program Description*

Little White Salmon NFH (Fig. 4) 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 river kilometer 261. The facility began rearing URB fall Chinook in 1982 to fulfill mitigation agreements for the JDTD program. The USACE 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 the Klickitat Hatchery URB Program and Willard NFH URB program as well as the rearing and release of spring-run Chinook salmon (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 4. 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 2.0M juvenile URBs into the Little White Salmon River (NMFS 2007); however, production expanded in RY 2009 to a release goal of 4.5M juvenile URBs. 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 5) with 4,695,028 juveniles being released in July of 2017. 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 2008, the facility has annually released approximately 4.2M juveniles with a mean size of 82.88 fish/lb. Eighty-eight percent (~3.7M) 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 since 2008 are presented below (Table 5).

**Table 5. Annual release dates, marking and tagging information, total number of juveniles released, and mean juvenile size for URBs released from Little White Salmon NFH.**

| Release Year | Release Dates | AD + CWT | CWT (DIT) | AD ONLY | Total Released | Mean Size (fish/lb) |
|---|---|---|---|---|---|---|
| 2008 | 3-Jul | 199,665 | 199,740 | 1,602,355 | 2,001,760 | 96.00 |
| 2009 | 18-Jun, 25-Jun | 361,948 | 197,857 | 4,126,102 | 4,685,907[a] | 77.08 |
| 2010 | 17-Jun, 24-Jun | 362,931 | 199,338 | 3,988,990 | 4,551,259 | 84.96 |
| 2011 | 23-Jun | 366,279 | 197,794 | 3,911,795 | 4,475,868 | 86.80 |
| 2012 | 26-Jun, 3-Jul | 565,914 | 194,722 | 3,808,793 | 4,569,429 | 87.10 |
| 2013 | 2-Jul | 360,089 | 198,443 | 3,863,046 | 4,421,578 | 65.80 |
| 2014 | 1-Jul, 2-Jul | 267,804 | 99,702 | 4,038,886 | 4,406,392 | 85.90 |
| 2015 | 2-Jul | 188,763 | 186,398 | 3,597,365 | 3,972,526 | 82.44 |
| 2016 | 11-Jul | 196,105 | 196,772 | 3,568,238 | 3,961,115 | 85.40 |
| 2017 | 5-Jul | 197,829 | 198,487 | 4,298,712 | 4,695,028 | 77.28 |
| **Means** | **Jun/Jul** | **306,733** | **186,925** | **3,680,428** | **4,174,086** | **82.88** |

[a]***The annual release goal was increased from 2.05M to 4.5M juvenile URBs in RY 2009.***

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 6). The transferred URB juveniles are marked prior to release with 1.5M being adipose fin-clipped only, and 200,000 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 2008 are presented in Table 6. 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/Yakima River program. These egg and juvenile

transfer programs are planned through brood year 2017, but may change in the future depending on survival and program broodstock needs.

**Table 6. Annual transfer dates, number of marked and tagged individuals, and total number of juvenile URBs transferred to the Prosser program from Little White Salmon NFH.**

| Transfer Year | Transfer Dates | Number AD ONLY | Number ADCWT | Total # Transferred |
|---|---|---|---|---|
| 2008 | 4/22 | 98,615[a] | 199,810[a] | 298,425[a] |
| 2009 | 4/2, 4/9, 4/20 | 1,030,096 | 199,657 | 1,229,753 |
| 2010 | 4/15, 4/16, 4/19, 4/21 | 1,023,272 | 199,016 | 1,222,288 |
| 2011 | 4/25 | 1,499,853 | 200,809 | 1,700,662 |
| 2012 | 4/2, 4/9, 4/13, 4/23 | 1,305,624 | 201,493 | 1,507,117 |
| 2013 | 4/4, 4/8, 4/15, 4/18 | 1,350,364 | 200,751 | 1,551,115 |
| 2014 | 4/9, 4/15, 4/22, 4/30 | 1,348,712 | 200,914 | 1,549,626 |
| 2015 | 4/6, 4/13, 4/15, 4/21, 4/28 | 1,500,536 | 200,113 | 1,700,649 |
| 2016 | 4/19 | 1,450,055 | 200,015 | 1,650,070 |
| 2017 | 4/4, 4/10, 4/13, 4/19, 4/21 | 1,498,078 | 203,772 | 1,701,850 |

[a]***Low egg takes in brood year 2007 prevented the Little White Salmon NFH URB program from meeting the juvenile URB transfer goal.***

### *2.3) Off-Station Juvenile Survival*

*a) PIT Tagging Program: Juvenile Survival and Migration Time*

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, 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.).

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 7). In RY 2017, 14,478 juveniles were PIT tagged prior to release from Little White Salmon NFH. A mean of 1,948 juveniles released from Little White Salmon NFH are detected annually at BONN for a mean detection rate of 10.15%. Mean travel time to BONN is 18.06 days with the majority of juveniles ($90^{th}$ percentile) passing over BONN within 31 days of release. However, some juveniles have spent up to 154 days upstream of BONN before migrating downstream.

**Table 7. The number of PIT tagged juvenile URBs released from Little White Salmon NFH and juvenile travel times to BONN.**

| Release Year | # PIT Tagged | # Detected at BONN | % Detected | Travel Time (Days) | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Mean | Median | Range | Percentile 50th | Percentile 75th | Percentile 90th |
| 2008 | 24,885 | 2,650 | 10.65 | 19.21 | 16.00 | (1 – 139) | 16 | 23 | 34 |
| 2009 | 24,947 | 2,354 | 9.44 | 31.45 | 28.00 | (9 – 154) | 28 | 39 | 44 |
| 2010 | 24,951 | 2,247 | 9.01 | 25.68 | 22.00 | (1 – 149) | 22 | 30 | 44 |
| 2011 | 24,640 | 2,313 | 9.39 | 20.23 | 12.00 | (2 – 126) | 12 | 32 | 41 |
| 2012 | 24,964 | 1,440 | 5.77 | 16.03 | 10.00 | (0.5 – 127) | 10 | 19 | 37 |
| 2013 | 14,959[a] | 1,978 | 13.22 | 14.52 | 12.00 | (0.5 – 143) | 12 | 20 | 25 |
| 2014 | 14,925 | 1,806 | 12.10 | 19.16 | 17.00 | (1 – 137) | 17 | 26 | 36 |
| 2015 | 14,958 | 1,194 | 7.98 | 11.24 | 10.00 | (1 – 44) | 10 | 12 | 16 |
| 2016 | 14,823 | 1,647 | 11.11 | 11.28 | 11.00 | (2 – 50) | 11 | 13 | 15 |
| 2017 | 14,478 | 1,855[b] | 12.81 | 11.79 | 10.00 | (1 – 121) | 10 | 14 | 20 |
| **Means** | **19,853** | **1,948** | **10.15** | **18.06** | **14.80** | **-** | **15** | **23** | **31** |

[a]***The PIT tagging goal was decreased in release year 2013 from 25K to 15K juveniles.***
[b]***Current estimate as of 10/31/2017.***

### *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 8; 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 2001, the facility has a mean smolt-to-adult survival rate of 0.661 (Table 8) which is within the range reported in the facility's HGMP (USFWS 2004b and 2015). Additionally, the URB program has contributed a mean of 21,251 adults annually for the past ten years. CWT recoveries beyond brood year 2010 were not included in this report given that adult returns reported to RMIS can take several years to be finalized.

**Table 8. 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 URBs released from Little White Salmon NFH. Adult returns are used to estimate smolt-to-adult survival rates.**

| Brood Year | Hatchery Returns[a] | Columbia River Harvest | Ocean Harvest | Spawning Ground | Total # of Adults | Smolt-to-Adult Survival (%) |
|---|---|---|---|---|---|---|
| 2001 | 1,350 | 1,440 | 1,490 | 1,650 | 5,930 | 0.286 |
| 2002 | 352 | 748 | 924 | 814 | 2,838 | 0.136 |
| 2003 | 1,600 | 530 | 980 | 360 | 3,470 | 0.171 |
| 2004 | 1,774 | 323 | 1,185 | 70 | 3,352 | 0.176 |
| 2005 | 6,912 | 2,856 | 3,234 | 174 | 13,176 | 0.731 |
| 2006 | 6,868 | 2,233 | 1,777 | 613 | 11,491 | 0.557 |
| 2007 | 14,804 | 6,303 | 4,406 | 1,043 | 26,556 | 1.328 |
| 2008 | 8,132 | 5,020 | 4,841 | 1,813 | 19,806 | 0.423 |
| 2009 | 18,292 | 13,765 | 9,987 | 9,747 | 51,791 | 1.143 |
| 2010 | 27,818 | 17,372 | 22,506 | 6,406 | 74,102 | 1.658 |
| **Means** | **8,790** | **5,059** | **5,133** | **2,269** | **21,251** | **0.661** |

[a]***Hatchery returns include fish collected at all hatcheries within the Columbia River basin.***

Adult returns to Little White Salmon NFH are estimated annually by hatchery personnel and the USFWS marking and biosampling crew from CRFWCO (Table A2). 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 9; Table A2). 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 11,208 adult returns with a mean smolt-to-adult return rate of 0.353 since brood year 2002. See Appendix A for a table of adult returns by return year to Little White Salmon NFH (Table A2).

**Table 9. Estimated age structure of adult URB returns to Little White Salmon NFH by brood year. Total number of adults is used to estimate the smolt-to-adult return rate (%) to the facility.**

| Brood Year | Age-2 | Age-3 | Age-4 | Age-5 | Age-6 | Total Adults | Smolt-to-Adult Return Rate (%) |
|---|---|---|---|---|---|---|---|
| 2002 | 13 | 218 | 618 | 246 | 6 | 1,101 | 0.053 |
| 2003 | 39 | 373 | 1,331 | 1,096 | 10 | 2,849 | 0.140 |
| 2004 | 283 | 543 | 2,526 | 706 | 34 | 4,092 | 0.280 |
| 2005 | 156 | 1,164 | 1,942 | 2,263 | 47 | 5,572 | 0.309 |
| 2006 | 652 | 961 | 3,009 | 1,174 | 12 | 5,808 | 0.282 |
| 2007 | 1,156 | 5,675 | 6,863 | 1,229 | 73 | 14,996 | 0.749 |
| 2008 | 1,021 | 2,990 | 2,770 | 1,501 | 0 | 8,282 | 0.177 |
| 2009 | 612 | 4,551 | 18,377 | 2,363 | 13 | 25,916 | 0.569 |
| 2010 | 587 | 15,644 | 17,023 | 2,956 | 75 | 36,285 | 0.811 |
| 2011 | 374 | 1,480 | 3,568 | 1,713 | 39 | 7,174 | 0.157 |
| 2012[a] | *658* | *5,558* | *5,675* | *2,000* | - | - | - |
| 2013[a] | *65* | *759* | *3,384* | - | - | - | - |
| 2014[a] | *0* | *300* | - | - | - | - | - |
| 2015[a] | *101* | - | - | - | - | - | - |
| **Means** | **489** | **3,360** | **5,803** | **1,525** | **31** | **11,208** | **0.353** |

***[a]Denotes incomplete brood years given that adults have either not yet returned to the hatchery or have not been aged. Incomplete years were not used in estimating means given that the information will be updated.***

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 Chinook towards the TAP goal. Release and adult recoveries for the Prosser Hatchery are monitored by the Yakama Nation.

### *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 8) 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 (Fig. 5).

Data accessible from the SCoRE website allow for estimation of the pHOS for URBs. The pHOS estimates for URBs observed on the White Salmon River spawning grounds range

from 33.66 to 80.04% with a mean pHOS of 61.81%. 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) r = 0.06. Monitoring and evaluation plans for assessing hatchery-origin fish straying into the White Salmon River are discussed under the future studies section of this report.

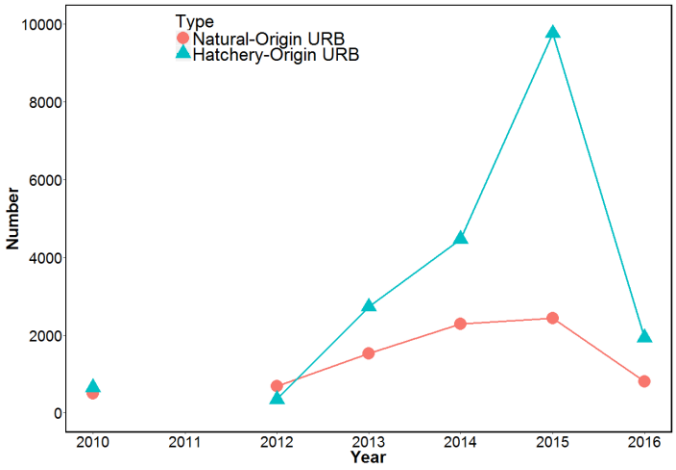


**Figure 5. Escapement estimates of natural-origin and hatchery-origin URBs in the White Salmon River during annual spawning surveys. 2011 escapement estimates were unavailable due to the breach of Condit Dam. Data belongs to WDFW, and was accessed from the SCoRE website.**

*b) Genetic Introgression of URBs and Tules in the White Salmon River*

URB fall Chinook typically spawn later in the fall than tule fall Chinook. However, the construction of BONN and rearing of URBs at Little White Salmon NFH has led to the synchronous escapement of tule and URBs to the White Salmon River over the past twenty years. Concerns of genetic introgression between the lineages led to a study funded by the USFWS from 2006 to 2008 (Smith and Engle 2011). The authors 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 suggest 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. However, the authors suggest future studies examining potential demographic and ecological risks that hatchery-reared URBs may have on the ESA-listed, native tule stock in the White Salmon River (Smith and Engle 2011). Since the USFWS study was conducted, production levels at Little White Salmon NFH have doubled, and the current risk of straying URBs on the White Salmon River tule stock is unknown. Study plans being developed for assessing current genetic introgression rates between hatchery-origin URBs and ESA-listed tules in the White Salmon River are discussed in more detail under the future studies section of this report.

## Summaries and Future Studies

*a) Spring Creek NFH Tule Program*

Since production levels were changed to 10.5M juveniles being released annually, the tule program at Spring Creek NFH has exceeded the annual release goal by an average 4% except in 2015 and 2016. In 2017, the program exceeded the number of juvenile release goal by nearly 3%. PIT tagging efforts by the USFWS have been a valuable resource for monitoring post-release juvenile detection rates, survival, and downstream migration times. PIT tag detections at BONN indicate that juvenile tule released from the facility migrate downstream quickly with the majority of juveniles passing over BONN within 2 days of release.

Mass marking efforts of juveniles has provided reliable adult return information and smolt-to-adult survival rates. Since brood year 2001, the mean smolt-to-adult survival rate for juveniles released from the facility is 0.54% indicating an increase from the previous average of 0.47% used for mitigation planning. Additionally, reprogramming of the tule program to release fewer juveniles per year has not substantially affected the smolt-to-adult survival rate which has been 0.4% or higher since brood year 2007. Through juvenile releases, the program has produced a mean of 74,464 adults since brood year 2001 with a mean of 47,276 being harvested in sport, tribal, and commercial fisheries. Additionally, the tule program has produced a mean of 27,841 adult returns to Spring Creek NFH since brood year 2003 with a mean smolt-to-adult return rate to the facility of 0.220%. Collectively, these results indicate that the program is successfully contributing to the TAP goal agreed upon by the USACE and *U.S. v. Oregon* parties.

Since brood year 2003, annual adult returns to the facility have ranged from 5,462 to 57,981 adults (Table 4) providing adequate numbers to satisfy broodstock needs. The estimated age structure of the adult returns based on aging of a subsample of the adults indicate that the mean proportion of Age-2 returns is low compared to the number of Age-3 and Age-4 fish; however, approximately 17% of the adult returns are precocial fish (i.e. jacks or jills). Jacks are utilized as broodstock at the facility and naturally occur at low rates in wild populations of Chinook, Coho, and Sockeye salmon, but at lower rates than observed at hatcheries (Berejikian et al. 2010). Hatchery rearing environments have been shown to cause early maturation leading to high rates of jack returns to the facilities (Harstad et al. 2014). Monitoring the prevalence of jacks at Spring Creek NFH would be beneficial for optimizing hatchery procedures, and determining whether the program will continually fulfill the JDTD program goals.

Data from the spawning ground surveys conducted by the WDFW indicate that the proportion of hatchery-origin tule in the White Salmon River has been high (mean pHOS of 26.28%) suggesting high levels of straying. However, biologists are not able to determine the hatchery of origin for a straying tule during the spawning ground surveys unless the fish contains a CWT. The number of adult tules that are released from Spring Creek NFH as juveniles and stray into the White Salmon River will be investigated in future monitoring projects. Currently, there is a possible correlation between the number of adult returns to Spring Creek NFH and the number of hatchery-origin tule on the spawning grounds ($r = 0.60$), but additional data is needed to determine the strength of the correlation.

*b) Little White Salmon NFH URB Program*

In the past ten years, the URB program has exceeded the annual juvenile release goal of 4.5M juveniles in four release years. The program has a mean juvenile production of 7% below the release goal, but has met the juvenile size at release goals every year since reprogramming in

brood year 2009. Additionally, the facility has successfully provided URB juveniles on an annual basis to the Yakima River-Prosser Hatchery program for the Yakama Nation. PIT tagging of juvenile URBs released from Little White Salmon NFH indicate that juveniles reach BONN in a mean of 14.8 days post-release. However, some individuals take up to 154 days to reach BONN indicating that juveniles are either residing within the Little White Salmon River, Drano Lake, the mainstem of the Columbia River, or straying into other streams before beginning their migration to the Pacific Ocean.

Since brood year 2001, the mean smolt-to-adult survival rate for the facility is 0.66% which is greater than the 0.32% rate used for mitigation planning for the program. Since brood year 2001, the URB program has produced a mean of 21,251 adults which includes 10,192 adults for harvest by sport, tribal, and commercial fishermen. Additionally, the juvenile URB program has produced a mean of 11,208 adult returns to Little White Salmon NFH with a smolt-to-adult return rate of 0.353%. The number of annual adult returns to the facility has ranged from 1,101 to 36,285 adults since brood year 2002 (Table 9). Since reprogramming in 2009, the number of adult returns has increased providing adequate numbers to satisfy broodstock needs. Aging of adult returns indicate that the majority of fish are returning to the facility at Age-3 and Age-4. Approximately 4% of adults return to the facility as precocial fish (i.e. jacks or jills). Collectively, the program has been successfully contributing to the TAP goal agreed upon by USACE and *U.S. v. Oregon* parties.

Data accessed from the SCoRE website operated by WDFW indicate that a high proportion of hatchery-origin URBs are present on the spawning grounds in the White Salmon River. Since 2010 (excluding 2011 when Condit Dam was removed), the mean pHOS is 61.8% indicating high levels of hatchery strays into the White Salmon River. Similar to the tule, determining what proportion of those hatchery-origin fish originated from the Little White Salmon NFH can only be determined if the fish contains a CWT. Determining the number of URBs released from Little White Salmon NFH that stray into the White Salmon River will be investigated in future monitoring projects. Unlike the tules from Spring Creek NFH, there appears to be no correlation between the number of adult returns to Little White Salmon NFH and the number of hatchery-origin URBs on the spawning grounds ($r = 0.06$); however, this will be investigated further in the White Salmon River monitoring project discussed below.

*c) Future Monitoring and Evaluation Studies*

Collectively, monitoring and evaluation of the tule and URB programs at Spring Creek and Little White Salmon NFHs indicate that both programs are successfully contributing to their mitigation obligations. Both programs have been sufficiently rearing and releasing numbers of juveniles that are close to their release goals as well as satisfying any egg and juvenile transfer requirements as part of the JDTD program. Additionally, both programs are exceeding their expected adult contributions to the TAP adult goal when considering the mean number of adults being produced by the facilities. However, there are several monitoring projects that should be conducted and/or are currently being developed in order to determine the success and longevity of both programs in terms of salmonid production and mitigation. These projects include:

1. **Assessment of potential demographic and genetic impacts of hatchery upriver bright fall Chinook salmon production on the ESA listed tule fall Chinook salmon population in the White Salmon River.** The high proportion of hatchery-origin spawners (particularly for the URBs) on the spawning grounds of the White Salmon River suggests a high level of straying. Both the USFWS and NMFS have concerns regarding the potential

impacts potential hatchery strays from Little White Salmon NFH have on the tule fall Chinook population in the White Salmon River. As part of a recently-issued Biological Opinion on the Little White Salmon upriver bright program (NMFS 2017), the USFWS, with USACE funding, is implementing a monitoring program in the White Salmon River with the goals of estimating the annual abundance of adult URB fall Chinook salmon present in the river, and estimating the level of hybridization between naturally produced juvenile tule and URB fall Chinook salmon. USFWS staff at the CRFWCO are currently coordinating with staff at the USFWS Abernathy Fish Technology Center and WDFW personnel on the development of a juvenile sampling design to genetically determine hybridization levels using similar techniques as reported in Smith and Engle 2011. Given the changes to the river morphology due to the removal of Condit Dam, several juvenile sampling techniques are being discussed including the use of rotary screw traps and seining. Testing of juvenile sampling methods will begin in spring of 2018 with full implementation of the juvenile sampling and hybridization analysis expected in the spring of 2019.

2. **Determining the effect of hatchery-rearing practices on male maturity including jack production.** Although the presence of jacks (and jills) is a natural occurrence in captive and wild populations of salmonids, the high proportion of jack returning to Spring Creek NFH should be monitored to determine whether hatchery practices are influencing the timing of male maturity. Research has shown that growth rates and fat levels due to hatchery feeding regimes can promote early male maturation (Spangenberg et al. 2015; Poirier and Olson 2017). A study examining the influence of feed ration during critical growth periods on precocial male maturation and smoltification rates for juvenile URB reared at Willard NFH (a Mitchell-Act funded program near Little White Salmon NFH) was conducted from March to August of 2017. Laboratory work for the study is ongoing. Pending results on precocial male maturation rates, the study may be expanded to the URB program at Little White Salmon NFH or the tule program at Spring Creek NFH to determine whether hatchery practices (including high feeding rates to meet size at release goals) are influencing the number of jacks returning to the facilities.
3. **Understanding the influence of environmental conditions on post-release movement of juveniles.** Juvenile travel times to BONN can vary among release years, facilities, and runs (tule versus URB). In 2017, the maximum travel time to BONN for juvenile tule released from Spring Creek NFH was 12 days which was less than half the mean travel time observed in previous years. For juvenile URBs released from Little White Salmon NFH, mean travel times for the past three years have been lower than observed in previous years. Elevated temperatures in the mainstem of the Columbia River is known to strongly influence juvenile downstream migration; however, knowledge on how additional environmental covariates at the time of release influence juvenile post-release movement is lacking. Studies utilizing PIT tag detections, downstream migration data calculated at the CRFWCO, and environmental data for the mainstem of the Columbia River collected at BONN are being developed to determine the influence of post-release environmental conditions on juvenile behavior and potential survival. Results can be used to determine "optimal" juvenile release dates from the facilities while accounting for annual fluctuations in environmental conditions.
4. **Use long-term data collected at the facilities and environmental covariates to develop improved forecasting models.** Long-term datasets of run reconstruction information and

smolt-to-adult survival rates have been compiled from monitoring of the juvenile tule and URB programs at Spring Creek and Little White Salmon NFHs. Utilization of these datasets in conjunction with environmental covariates (ocean and freshwater) to develop improved forecasting tools for predicting the number of adult returns to the facilities is ongoing. Accurately predicting the number of adult returns is essential for determining whether the programs will continue to fulfill their mitigation agreements and have access to adequate levels of broodstock for the JDTD program.

## Acknowledgements

Data used in this report was downloaded from the Columbia River Information System (CRiS) maintained at the Columbia River Fish and Wildlife Conservation Office, the Regional Mark Information System (RMIS), and from the Columbia Basin PIT Tag Information System (PTAGIS). Hatchery personnel at Spring Creek and Little White Salmon NFHs collected data on release dates, adult returns, and annual number of juveniles released from the facilities. Marking crews from the USFWS adipose fin-clipped, coded-wire tagged, and PIT-tagged juveniles prior to release. Thank you to Jeremy Wilson and the Washington Department of Fish and Wildlife (WDFW) for providing background information on methods used during annual spawning ground surveys. Escapement estimates from the spawning ground surveys belongs to the WDFW and can be accessed on the SCoRE website. Funding for the tule production program at Spring Creek NFH and juvenile upriver bright program at Little White Salmon NFH was provided by the U.S. Army Corps of Engineers as part of the John Day/The Dalles Dam Mitigation program.

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# Appendix A

**Table A1. Total number of adult tule returns to Spring Creek NFH and estimated age structure by return year.**

| Return Year | Age-2 | Age-3 | Age-4 | Age-5 | Total Adults |
|---|---|---|---|---|---|
| 2008 | 956 | 32,912 | 810 | 0 | 34,678 |
| 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 | 1,912 | 20,852 | 4,321 | 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 |
| **Means** | **5,402** | **20,382** | **2,986** | **65** | **28,835** |

**Table A2. Total number of adult URB 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 |
|---|---|---|---|---|---|---|
| 2008 | 652 | 1,164 | 2,526 | 1,096 | 6 | 5,444 |
| 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 |
| **Means** | **523** | **3,908** | **6,514** | **1,700** | **31** | **12,676** |

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