WINTHROP NATIONAL FISH HATCHERY
SPRING CHINOOK SALMON ANNUAL REPORT
- 2018 -

Michael Humling¹
Chris Pasley²
Sara Reese²
Trista Becker³
Matt Cooper¹

U.S. Fish & Wildlife Service
¹Mid-Columbia Fish & Wildlife Conservation Office
²Winthrop National Fish Hatchery
³Pacific Region Fish Health Program
On the cover: USFWS Biological Science Technician John Box records data from a spring Chinook Salmon redd on the Methow River, near Winthrop NFH – Photo: M. Humling

The correct citation for this report is:

WINTHROP NATIONAL FISH HATCHERY
SPRING CHINOOK SALMON ANNUAL REPORT
- 2018 -

Authored by

Michael Humling¹
Chris Pasley²
Sara Reese²
Trista Becker, DVM³
Matt Cooper¹

U.S. Fish and Wildlife Service
¹Mid-Columbia Fish & Wildlife Conservation Office, Winthrop/Leavenworth, WA
²Winthrop National Fish Hatchery, Winthrop, WA
³Pacific Region Fish Health Program, Leavenworth, WA
Disclaimers

Any findings and conclusions presented in this report are those of the authors and may not necessarily represent the views of the U.S. Fish and Wildlife Service.

The mention of trade names or commercial products in this report does not constitute endorsement or recommendation for use by the federal government.
Executive Summary – This report summarizes the Winthrop National Fish Hatchery’s (WNFH) broodyear (BY) 2016 spring Chinook Salmon program (i.e. production spawned in fall 2016 and released in spring 2018), encapsulating hatchery production from broodstock collection through juvenile release. As available, BY16 production metrics are reported in the context of longer-term datasets. The report provides comprehensive evaluation of program performance and fulfills ESA reporting requirements identified under NOAA’s Scientific Research/Enhancement Permit #18927.

Following evaluation of in-hatchery fish culture metrics, escapement and adult monitoring metrics (e.g., fishery contribution, straying, etc.) are updated through BY13, which completed its lifecycle in 2018. Following presentation of these results is discussion of goals, objectives, and permit condition compliance.

Production of BY16 spring Chinook at WNFH generally met all fish culture-related goals. Full broodstock collection, stepping stone adult management, eggtake, rearing, and release-related goals were attained. Additionally, managers supported the Okanogan 10(j) reintroduction program through transfer of eyed Methow Composite stock eggs to the Colville Tribes’ Chief Joseph Hatchery.

The BY16 rearing cycle had fully completed prior to issuance of Scientific Research/Enhancement Permit #18927; however, managers anticipated developing permit terms and conditions and program management tiered towards these expectations. All general ESA-species special handling, notification, and reporting requirements were followed. Juvenile releases were conducted as planned and described in the program’s HGMP, and pre-release data collection supported that spring Chinook Salmon smolts released from WNFH were migration-ready with low precocialism/residualism rates that were within permitted values.

In the natural environment, retrospective analyses of collective programs’ gene flow management objectives show that goals remained challenging in the Methow Subbasin between return years 2015 and 2017; however, we are observing an improving trend - subbasin PNI was estimated to exceed 0.50 in 2018 for the first time since measurement began. WNFH’s partial pHOS was not achieved in 2016 but was in 2017 and 2018. We are optimistic that results in 2018 prove that project partners’ hard work to improve broodstock/adult management in accordance with the stepping stone hatchery model is beginning to pay off.
# TABLE OF CONTENTS

TABLE OF CONTENTS ................................................................................................................. i

LIST OF TABLES ....................................................................................................................... iii

LIST OF FIGURES ...................................................................................................................... iv

INTRODUCTION ...........................................................................................................................1
  Leavenworth Fisheries Complex .................................................................................................1
  Winthrop National Fish Hatchery .............................................................................................1
  Hatchery Evaluation Program ................................................................................................2
  Fish Health Program .................................................................................................................2
  Hatchery Evaluation Team Approach ....................................................................................2
  WNFH Spring Chinook Salmon Program ................................................................................3
  Spring Chinook Program Performance Goals and Objectives ................................................3
  Data Sources ..........................................................................................................................5
  Reporting Organization .........................................................................................................6

RESULTS ........................................................................................................................................8
  Return Year 2016 Adult Management/Broodstock Collection monitoring .................................8
    2016 Adult Management Efforts ............................................................................................8
    Broodstock Allocation ..........................................................................................................14
    Broodstock Fish Health Monitoring ....................................................................................16
  Broodyear 2016 Juvenile Rearing Monitoring ......................................................................17
    Eggtake and Incubation ........................................................................................................17
    Juvenile Rearing ..................................................................................................................18
    Juvenile Marking Summary ................................................................................................19
    Juvenile Release ...................................................................................................................19
    Smolt Outmigration .............................................................................................................22
    Early Maturation and Residualism .......................................................................................24
  2018 Adult Return .....................................................................................................................26
    Run Forecasting ....................................................................................................................26
    Run Timing ..........................................................................................................................26
    Run Conversion ....................................................................................................................28
    Harvest ................................................................................................................................29
    Straying ...............................................................................................................................30
    Smolt-to-Adult Return (SAR) Update ....................................................................................32
    Hatchery Replacement Rate (HRR) Update .........................................................................34
  Natural Environment Monitoring .............................................................................................35
    Escapement Estimate/Summary ............................................................................................35
    Spawner Composition and Gene Flow Metrics ......................................................................36

Discussion of Performance against Program Targets .................................................................38
  Summary of Broodstock Collection Objectives ....................................................................38
LIST OF TABLES

Table 1. Return year 2016 Winthrop NFH Spring Chinook collections by approximate age and collection source. ................................................................. 9
Table 2. Adult Management Ledger for 2016 WNFH Spring Chinook ................................................................. 10
Table 3. Winthrop NFH Spring Chinook Adult Management Summary, 2000-2016 .............................................. 11
Table 4. 2016 Spring Chinook exceeding event summary – Excess fish program of origin by collection source. ................................................................................................................. 12
Table 5. Expanded sex and age-structure of 2016 spring Chinook adult total collection at WNFH, by program. .......................................................................................................................... 12
Table 6. Sex composition of returning WNFH adult spring Chinook 2000-2016 ................................................ 13
Table 7. WNFH adult approximate collections by origin/program ................................................................. 14
Table 8. Length-at-maturity of adult spring Chinook at Winthrop NFH by hatchery program......................... 14
Table 9. Broodyear 2016 WNFH spring Chinook broodstock composition by age, program, and collection location. .................................................................................................. 15
Table 10. Mean fecundity by age and program of 2016 spring Chinook broodstock at WNFH. ....................... 15
Table 11. WNFH Spring Chinook program – annual broodstock fecundity statistics by age. ............................ 16
Table 12. Bacterial Kidney Disease risk profile (ELISA rankings) for recent WNFH spring Chinook egg takes. ................................................................................................................................. 17
Table 13. 2006-2016 Winthrop NFH spring Chinook egg take and incubation summary. ............................... 17
Table 14. Juvenile rearing performance for release year 2018 ................................................................. 19
Table 15. Summary of Broodyear 2016 WNFH spring Chinook mass marking ............................................. 19
Table 16. Broodyear 2016 (2018 release year) spring Chinook coded-wire tag release groups ....................... 21
Table 17. Winthrop NFH spring Chinook release and mark summary for release years 2001-2018 ............... 21
Table 18. WNFH broodyear 2016 spring Chinook size and condition at pre-release ................................. 21
Table 19. 2018 Upper Columbia hatchery spring Chinook PIT-based juvenile survival rates and travel times to Rocky Reach Juvenile bypass (RRJ) and Bonneville Dam (BON) ........................................... 22
Table 20. 2018 WNFH Spring Chinook release population breakdown and early maturation ....................... 25
Table 21. Estimated migratory minijack rates for WNFH spring Chinook release groups .......................... 26
Table 22. Run completion passage dates for WNFH-origin spring Chinook at Bonneville Dam .................... 27
Table 23. Winthrop NFH spring Chinook adult travel times through Columbia River dam system ............... 28
Table 24. WNFH spring Chinook passage success from Bonneville Dam to Winthrop NFH ...................... 29
Table 25. Winthrop NFH Spring Chinook estimated harvest rates ............................................................. 30
Table 26. Winthrop NFH spring Chinook stray and homing rates ............................................................. 31
Table 27. Estimated WNFH spring Chinook stray frequency and annual contribution to Entiat Subbasin spawn escapement ........................................................................................................ 32
Table 28. Winthrop NFH spring Chinook smolt-to-adult return (SAR) summary .......................................... 33
Table 29. Estimated Winthrop NFH Spring Chinook hatchery replacement rate (HRR) ............................... 35
Table 30. Winthrop NFH Spring Chinook general freshwater escapement and management patterns ...... 36
Table 31. Methow Spring Chinook spawning ground gene flow metrics, including PNI and program partial pHOS .................................................................................................................. 37
Table 32. Target partial pHOS for WNFH based on natural run size (NOAA 2016b) ................................. 51
Table 33. 2016-2018 WNFH program partial pHOS targets and estimates relative to NOR return rates. 52
LIST OF FIGURES

Figure 1. Winthrop National Fish Hatchery location.................................................................1
Figure 2. Methow Subbasin spring Chinook hatchery supplementation conceptual. ..................3
Figure 3. Overview map of Methow Fish Hatchery (Douglas PUD), Winthrop NFH (USFWS/BOR) and Foghorn Irrigation Canal. (SCP = WNFH outfall channel; CRW=Chewuch River at Winthrop)............. 8
Figure 4. Adult spring Chinook collections for BY16 WNFH spring Chinook program, for ladder operational period (24 May to 26 Aug.). .................................................................................................. 10
Figure 5. 2018 WNFH spring Chinook release and hydrologic conditions in the Methow River compared to flow at Pateros, WA. .............................................................................................................. 20
Figure 6. Comparative juvenile survival rates (error bars show SE) of Upper Columbia spring Chinook hatchery programs from release to Rocky Reach (top), McNary (middle), and Bonneville dams (bottom). ............................................................................................................. 23
Figure 7. Upper Columbia (above-Wells) hatchery spring Chinook travel time from release to Rocky Reach Juvenile, 2010-2018. ......................................................................................................................... 24
Figure 8. Winthrop NFH spring Chinook annual smolt-to-adult return (SAR) values (%) by broodyear. 34
Figure 9. Comparison of 3-pop (strays excluded) and 4-pop (strays included) PNI model results for Methow Subbasin Spring Chinook ........................................................................................................... 38
Figure 10. Comparison of 2016 ladder operational period to 2016, 2017, and 2018 adult spring Chinook arrivals to WNFH ladder area (PTAGIS site SCP). ................................................................. 53
INTRODUCTION

Leavenworth Fisheries Complex

The US Fish & Wildlife Service (USFWS) operates the Entiat, Leavenworth, and Winthrop National Fish Hatcheries as mitigation hatcheries authorized by the Grand Coulee Fish Maintenance Project April 3, 1937, and reauthorized by the Mitchell Act (52 Stat. 345) May 11, 1938. The three hatcheries, along with the Mid-Columbia Fish & Wildlife Conservation Office (MCFWCO), comprise the Leavenworth Fisheries Complex (Complex). Funding for the Complex is provided by the U.S. Bureau of Reclamation. Production, marking, and tagging goals for the facilities are determined through the management framework established as an outcome of the U.S. v Oregon decision and are described in the 2008-2017 U.S. v Oregon Management Agreement.

Winthrop National Fish Hatchery

Winthrop National Fish Hatchery (WNFH) is located adjacent to the Methow River at approximately river-mile (RM) 50 or river kilometer (rkm) 80, near the town of Winthrop, Washington (Figure 1). The Methow River is a tributary to the Columbia River, entering at RM 524 (rkm 843), near the town of Pateros, Washington. Fish migrating from the hatchery to the ocean (or vice versa) must traverse nine mainstem Columbia River dams over approximately 923 rkm of river.

WNFH has a rich and diverse history of fish culture and currently produces ESA-listed spring Chinook (Oncorhynchus tshawytscha) and summer steelhead (O. mykiss) and assists the Yakama Nation with reintroducing Coho Salmon (O. kisutch) to the Methow Subbasin.

Figure 1. Winthrop National Fish Hatchery location.
All federal programs and activities are subject to compliance with the Endangered Species Act (ESA) of 1973. As such, all WNHF programs (spring Chinook Salmon, summer steelhead, and Coho Salmon), as well as general facility operation and maintenance have undergone ESA consultation with NOAA Fisheries and USFWS. This process includes submitting Hatchery and Genetics Management Plans (HGMP; to NOAA) and Biological Assessments (to USFWS), then operating under terms and conditions of resulting Biological Opinions (BiOps) and associated permits.

Specifically for the spring Chinook Salmon program, ESA consultation with NOAA Fisheries was initiated through the submission of an HGMP (USFWS 2009) and issuance of a Biological Opinion (NOAA 2016a) and ESA take permit (NOAA 2016b). ESA effects specific to Bull Trout were analyzed through submission of a Biological Assessment (USFWS 2014) and issuance of a Biological Opinion (USFWS 2016). Reporting requirements associated with this Bull Trout BiOp are not specific to the spring Chinook program and provided in annual reports elsewhere. No further discussion of Bull Trout is included.

**Hatchery Evaluation Program**

The MCFWCO’s Hatchery Evaluation (HE) program assists Complex programs through implementation of targeted research, monitoring, and evaluation (RM&E) activities focused on helping programs meet mitigation goals while balancing responsibilities under the Endangered Species Act (ESA) and other permit conditions.

The goals of the HE program can be categorized into three main areas of focus:

1. *Performance Optimization* - Evaluate hatchery operation and practices to maximize program performance.
2. *Risk Management* - Research, assess, and recommend methods to minimize impacts of hatchery production and operations on natural fish populations and their environment.
3. *Facilitation and Coordination* – Actively facilitate coordination between partners and managers involved in artificial production, RM&E, and management of fisheries and habitat within and beyond the Columbia River Basin.

**Fish Health Program**

The Pacific Region Fish Health Program staff support the WNHF spring Chinook program fish health goals. The focus of the fish health program is to support the release of healthy smolts through a preventative medicine ethos. Regular monthly examination of fish at the hatchery aims at the identification and treatment of disease issues early in their course to both mitigate potential future disease losses and to optimize in-hatchery rearing conditions. In addition to following USFWS National Fish Healthy Policy, disease surveillance and party notification of regulated pathogens is conducted in concordance with “The Salmonid Disease Control Policy of the Fisheries Co-managers’ of Washington State” (2006). Sample collection and laboratory testing follows nationally recognized standards outlined in the American Fisheries Society “Blue Book” (AFS, 2014). Any disease treatments are performed under veterinary guidance.

**Hatchery Evaluation Team Approach**

The Complex uses a consensus-based advisory body, the Hatchery Evaluation Team (HET) composed of NFH staff, Fish Health specialists, and representatives from the HE program. The HET works together to shape management of NFH programs according to the USFWS Pacific Region’s HET guidance document.
(Peery, 2016), address technical challenges, establish performance goals, and shape the scope of RM&E efforts and reporting. Annual reports are ideally co-authored by representatives of each of these entities.

**WNFH Spring Chinook Salmon Program**

The WNFH spring Chinook Salmon (hereafter ‘spring Chinook’) program has dual roles as mitigation and recovery in the Upper Columbia Region. Its functions are integrated with the Douglas County Public Utility District’s Methow Fish Hatchery (MFH) program within the *stepping stone* context (HSRG 2014). Specifically, WNFH functions as a *safety-net* program with hybrid goals of providing mitigation harvest opportunity when appropriate and supporting conservation goals by returning genetically-related fish to the subbasin to provide a genetic reserve when needed (Figure 2). The program provides further conservation function through support of Section 10(j) reintroduction efforts in the Okanogan Subbasin, where spring Chinook were extirpated. While the program’s eggtake goal continues to support a smolt release target of 600,000, releases in the Methow Subbasin have been reduced to 400,000. The balance was recently shifted to the Okanogan Subbasin via annual eyed eggs transfers to the Confederated Colville Tribes in support of their Okanogan Subbasin spring Chinook program.

![Figure 2. Methow Subbasin spring Chinook hatchery supplementation conceptual.](image)

Historically, Carson stock (non-listed, ad-mixture of run-at-large Columbia River spring Chinook) were propagated at WNFH. Use of Carson ancestry adults was phased out over several years beginning in 1999. The program now exclusively uses Methow Composite (hereafter, “MetComp”) stock fish, prioritizing returning adults released from MFH, which are typically progeny of natural-origin broodstock (high percentage of natural parentage; pNOB). Natural-origin fish and fish produced from both hatcheries are included within the listed Evolutionary Significant Unit (ESU). During years of poor escapement, production goals can be met using WNFH adults as necessary.

**Spring Chinook Program Performance Goals and Objectives**

The hatchery programs at WNFH are operated with an over-arching goal of compensating for the lost fish production associated with the construction and operation of Grand Coulee Dam. Specifically, the WNFH spring Chinook program partially meets this mitigation goal through two sub-goals – 1) Provision of a harvestable surplus of adult Chinook Salmon, and 2) Supporting ESA Recovery efforts for spring Chinook salmon in the Methow River sub-basin – each of these has an associated suite of objectives and
operational guidelines deriving from a myriad of sources. These include a combination of legally-binding terms and conditions (e.g., maximum stray rates in program Biological Opinions; [“BiOp”; NOAA 2016a]), USFWS and/or co-manager policy (e.g., fish health monitoring and prophylaxis), operational details developed by the HET and described in the program’s Hatchery and Genetics Management Plan (USFWS 2009), case law and associated agreements (e.g., external marking requirements within the US v OR Management Agreement), and procedural best management practices that developed over time based on good fish culture and/or HET agreement (e.g., target pre-spawn survival rates). Below are broad program goals and associated objectives. Appendix A describes specific monitoring attributes and targets comprehensively.

**Goal – Provide a harvestable surplus of Spring Chinook Salmon.**

Associated Objectives:

- Annually rear and release 400,000 spring Chinook Salmon smolts to produce returning adults available for harvest and provide sufficient broodstock for production.
- Healthy smolts released in a manner that optimizes post-release performance.
- Smolt release numbers and external marking strategies employed consistent with US v OR management agreement.
- Returning adults support selective harvest fisheries as deemed appropriate by co-managers.
- Excess program returning adults provided to inland Northwest Indian tribal subsistence food programs when available.

**Goal – Support the recovery of ESA listed Upper Columbia River Spring-run Chinook ESU in the Methow River Sub-basin.**

**Objective – Support efforts to increase the natural spawner abundance (when appropriate) and provide a genetic safety-net during periods of low adult returns.**

Associated Sub-objectives:

- Operate under the Hatchery Scientific Review Group’s (HRSG) “stepping stone” model of broodstock management using Methow Composite stock fish and serving as a potential genetic “safety-net” for the ESU when necessary. This strategy includes sub-objectives of:
  - Prioritize returning Methow Composite stock adults returning from Methow Fish Hatchery for production broodstock.
  - Maintain local stock structure, diversity, representation of the entirety of the run, etc.

**Objective – Contribute to and support USFWS and partners’ Recovery efforts in the Upper Columbia.**

Associated Sub-objectives:

- Annually transfer sufficient Methow Composite eggs for a 200,000 smolt release as part of the Section 10(j) reintroduction effort in the Okanogan Subbasin.
- Provide facility and expertise to support cooperative, inter-agency adult management efforts to help achieve gene flow targets on the spawning grounds.

**Objective – Minimize genetic and ecological risks and impacts to natural-origin spring Chinook, non-target taxa, and their associated habitats.**
Associated Sub-objectives:

- (redundant to above) Provide facility and expertise to support cooperative, inter-agency adult management efforts to help achieve gene flow targets (pHOS/PNI) on the spawning grounds.
- Operate the WNFH hatchery ladder throughout the adult migration season to maximize attraction and removal of hatchery-origin adult spring Chinook to achieve targets promulgated in the BiOp.
- Prevent or minimize ecological considerations of juvenile releases by releasing migration-ready smolts.
- Prevent or minimize ecological considerations associated with operation/maintenance of the hatchery facility

To effectively monitor and evaluate the spring Chinook program at WNFH, specific performance metrics/targets are tracked through the rearing cycle and post-release (Appendix A). These metrics/targets are intended to give a point of comparison between cohorts and amongst similar hatchery programs, specifically answer terms and conditions required by various entities (e.g., BiOp reporting), and ultimately determine if program goals/objectives are being met.

The Complex’s Hatchery Evaluation Plan (HEP; Cooper et al. 2017) synthesizes each program’s range of goals and objectives and the Complex’s myriad permits and guidance documents (BiOp/take permits, NEPA documents, USFWS National and Regional guidance/policy, Washington Department of Fish & Wildlife’s (WDFW) Scientific Collectors permit, etc.). The HEP assesses whether the programs met mitigation objectives and complied with existing permits, rules, and regulations. These efforts simultaneously inform broader regional data collection efforts (e.g., inter-agency redd surveys, coded-wire tag (CWT) recoveries in regional tagging databases, PTAGIS, etc.).

Reporting metrics and methods are intended to consistent with, and complimentary to, those presented in Habitat Conservation Plan-governed mitigation hatchery programs and their associated plans (e.g., Hillman et al. 2013 and 2017, Willard 2017, Murdoch and Peven 2005, etc.), as feasible.

**Data Sources**

Data used for evaluation came from direct collection, collection by other management agencies, and/or industry-specific databases. Most data used in this report are directly collected by Complex staff. Other commonly used data sources include:

**RMIS** – The Regional Mark Information System (RMIS) is an online database operated by the Pacific States Marine Fisheries Commission and designed to house Coded-Wire Tag (CWT) data for the west coast of North America and the northern Pacific Ocean. When a group of fish is tagged with a CWT, tagging metadata are submitted to RMIS by the tagging entity. If/when a fish is lethally sampled either for scientific or commercial purposes, (e.g., creel census, spawning ground carcass recovery), the tag code recovery information is also submitted. RMIS allows managers to calculate survival, stray rates, fishery contribution, and other metrics for target groups.

**PTAGIS** – The PIT Tag Information System (PTAGIS) is an online database operated by the Pacific States Marine Fisheries Commission, and designed to house Passive Integrated Transponder (PIT) tag data. When a group of fish is tagged with a PIT tag, individually unique codes and tagging event metadata are submitted to PTAGIS by the tagging entity. Subsequently, if/when the PIT tag is read remotely by a transceiver antenna (“interrogated”) or recovered directly, the tag code information is submitted to the database. PTAGIS allows tagged fish to be tracked in almost real time provides the means to calculate survival rates and travel times through the hydro system, etc.
**DART** – The Columbia River Data Access in Real Time (DART) is an online database operated by the Columbia Basin Research Department of the School of Aquatic and Fishery Sciences at the University of Washington. DART uses data from RMIS and PTAGIS to provide summaries of juvenile fish survival and counts fish passing hydroelectric facilities on the Columbia River and its tributaries.

**Reporting Organization**

There are inherent organizational difficulties in balancing the desire to report up-to-date escapement status and trends against the desire to organize fish culture metrics by broodyear. Stream-type salmonids with maximum lifespans greater than 5-years are particularly difficult since data reporting lag-times (e.g. CWT reporting and associated derivatives including stray rates, smolt-to-adult ratios [SARs], and harvest contributions) extend meaningful reporting multiple years beyond a full cohort’s lifespan.

This report follows reporting timelines established in the Biological Opinion and Scientific Research/Enhancement Permit #18927 (NOAA 2016b) which require submission of reports each November the year following release (i.e., broodyear 2015, release year 2017, report due November 2018).

Within this strategy, fish culture metrics tied to the most recently-released cohort are reported starting with broodstock collection and finishing with outward migration through the Columbia River hydro system (e.g. travel time, smolt survival). This timeframe allows focus on brood-specific in-hatchery performance indicative of current hatchery practices.

Monitoring metrics dependent on adult escapement completion (e.g. SAR, stray rates, run composition, effectiveness of adult management efforts) are reported consistent with reasonable schedules predicated by biology and incoming data streams. For example, in-hatchery metrics for BY16 programs (released in 2018 and reported on in 2019) may be accompanied by adult performance data current only to BY13 spring Chinook that completed their lifecycles in 2018 as age-5 adults.

**Return Year 2016 Adult Management/Broodstock Collection monitoring includes summaries of:**

- Dates of ladder operation and counts by date
- Trapping summary (timing/transfers/excessed adults)
- Surplusing to PNW Indian Tribes
- Number and composition/demographics of adults collected and spawned
- *Note: this section is culture-focused, dealing with broodstock allocation for the current broodyear reporting cycle – adult management in terms of gene flow management follows in a later section.*

**Broodyear 2016 Juvenile Rearing Monitoring includes summaries of:**

- Eggtake
- Rearing performance
- Disease occurrence and mortality events
- Rearing parameters (e.g. density index, flow index, feed conversion, etc.)
- Marking/tagging
- Survival rates for life stages between egg and smolt

**Broodyear 2016 Juvenile Release Monitoring includes summaries of:**

- Number, dates, size at release, and tag/mark dispositions
- Migration survival through the Columbia River corridor
- Travel times to key points
• Estimates of residualism, precocial maturation, and over-winter survival/out-year migration

2018 Adult Return Monitoring includes summaries of:
• Fishery contribution
• Returns and timing to key Columbia River locations (Bonneville and Wells dams)
• Returns and timing to key Methow Subbasin locations (Lower Methow river and WNFH)
• Age structure of run
• Out-of-basin straying
• Smolt-to-Adult ratios (pre- and post-harvest) and Hatchery Replacement Rate estimates

2018 Natural Environment Monitoring includes summaries of:
• Escapement estimates/summary
• Effectiveness of pHOS management efforts – program partial pHOS (ppHOS)
• Spawning ground gene flow dynamics
RESULTS

Return Year 2016 Adult Management/Broodstock Collection monitoring

2016 Adult Management Efforts

The 2016 adult spring Chinook counts (run at large) at Bonneville were below the median value for the period of 2000-2015, yet above median at Wells Dam (2016, 2014, and 2015, were 3rd, 2nd, and 1st highest returns, respectively), suggesting that Upper Columbia returns have proportionately increased in recent years (FPC.org) with respect to the run at Bonneville Dam. WNFH and MFH managers collaboratively managed adult returns to support tribal subsistence programs by surpling excess hatchery fish, and maximizing use of MFH Conservation Program returns into brood for the WNFH program.

Winthrop NFH and MFH are just 1.1km apart and share a common surface water source (Foghorn Irrigation Canal; Figure 3). Returning adult spring Chinook maintain some fidelity to their release sites but mixing between release and return sites is common.

Figure 3. Overview map of Methow Fish Hatchery (Douglas PUD), Winthrop NFH (USFWS/BOR) and Foghorn Irrigation Canal. (SCP = WNFH outfall channel; CRW=Chewuch River at Winthrop)

Adult collection sources for the WNFH spring Chinook program include WNFH ladder volunteers and transfers from MFH. Transfers were enumerated and sexed daily by WDFW staff. WNFH uses a Northwest Marine Technology fish counter to enumerate fish as they enter the adult holding pond. Counter accuracy decreases with volume of fish passing it and age-3 “jack” counts are imperfect, particularly when residualized steelhead or other resident/juvenile fish are present (C. Pasley, pers. comm.). Counter accuracy was estimated at 101.5% in 2016 (over counted adults) compared to total fish counted during all management events. The total ladder count was 2,948 compared to 2,904 (including
jacks). The sources and nature of errors may be a combination of false-counting juveniles as jacks/adults and misinterpretation of fallback fish when the trap area was crowded, etc. This compares to a counter accuracy of 95% in 2015 (Humling et al. 2018). Even though the counter is not 100% accurate it continues to meet the hatchery’s needs for enumerating returns and minimizes the need for additional fish handing events.

Final collection estimates are the result of analysis of the WNFH Fish Removal File (FRF), which accounts for fish as they are spawned, excessed, transferred, or recovered as mortalities. Complete accounting of broodstock collection (Table 1) was determined by process of elimination starting with the FRF and removing tallied fish from WDFW transfer data to provide a final ladder count through subtraction. **A total of 3,362 adult spring Chinook comprised WNFH collections in 2016** to set the stage for broodstock and adult management efforts.

In 2016, a total of 33 unmarked fish were sampled for origin determination via scale analysis; 32 were verified as unmarked hatchery-origin while one natural-origin adult verified and transferred to the MFH for use in the conservation program (C. Frady pers. comm.). **Adult collections at the WNFH ladder in 2016 comprised almost entirely (>99.98%) hatchery-origin fish.** This is consistent with average NOR encounter rates of <1/year going back to the 1990s. WDFW staff provided assistance during spring Chinook excessing events through scale-based origin determination of unmarked spring Chinook.

<table>
<thead>
<tr>
<th>Return year &amp; disposition</th>
<th>WNFH Adult Ladder</th>
<th>Methow FH Trap</th>
<th>Total Collection</th>
</tr>
</thead>
<tbody>
<tr>
<td>2016 Number collected</td>
<td>Adults 2,679</td>
<td>Adults 329</td>
<td>Adults 3,008</td>
</tr>
<tr>
<td></td>
<td>Jacks 225</td>
<td>Jacks 129</td>
<td>Jacks 354</td>
</tr>
<tr>
<td>Total (%) by source</td>
<td>2,904 (86.4%)</td>
<td>458 (13.6%)</td>
<td>3,362</td>
</tr>
</tbody>
</table>

In 2016, the WNFH ladder was operated almost continuously from May 24 to August 26, at which time daily escapees exceeded net incoming fish. Ladder collections and incoming transfers from MFH were all held in mixed holding. Figure 4 shows the timing of collections over the course of the return as well as allocation of broodstock from mixed holding. WNFH attempted to retain broodstock representative of the run-at-large (though selects for MFH returns) and minimizes handling by allocating fish during adult excessing events, generally weekly from late-May through late-June.
Figure 4. Adult spring Chinook collections for BY16 WNFH spring Chinook program, for ladder operational period (24 May to 26 Aug.).

Notes for Figure 4: Some collection totals were lumped across date ranges in hatchery/transfer records. These were averaged and displayed across lumped dates to spread out catch for illustrative purposes and avoid suggestion that large pulses occurred (e.g., many swim-ins over the holiday weekend and MFH transfers were recorded multi-day intervals were spread event across appropriate timeframes).

Pre-spawn mortality for combined adults held in 2016 was 1.0%, slightly below average and well below the <7% target (Table 2; Table 3; Appendix A). The potential for stress and associated mortality has increased with adult management activities hosted at WNFH in recent years. The adult holding facility at WNFH can hold approximately 3,000 adult Chinook (C. Pasley pers. comm.). During large escapement years, managers coordinate with hatchery, tribal, hatchery evaluation, and fish health personnel to conduct regular excessing events to manage pond inventory while simultaneously minimizing stressful handling events.

Table 2. Adult Management Ledger for 2016 WNFH Spring Chinook

<table>
<thead>
<tr>
<th>Disposition</th>
<th>Male</th>
<th>Female</th>
<th>Jack</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total collected, all sources</td>
<td>1,211</td>
<td>1,797</td>
<td>354</td>
<td>3,362</td>
</tr>
<tr>
<td>Pre-Spawn Mortality¹</td>
<td>8</td>
<td>26</td>
<td>1</td>
<td>35 (1.0%)</td>
</tr>
<tr>
<td>Surplus</td>
<td>1,019</td>
<td>1,569</td>
<td>352</td>
<td>2,941 (87.5%)</td>
</tr>
<tr>
<td>Retained as broodstock</td>
<td>183</td>
<td>202</td>
<td>1</td>
<td>386 (11.5%)</td>
</tr>
<tr>
<td>Green or bad gametes</td>
<td>1</td>
<td>201</td>
<td>1</td>
<td>1 (0.0%)</td>
</tr>
<tr>
<td>Spawned²</td>
<td>183</td>
<td>201</td>
<td>1</td>
<td>385 (11.5%)</td>
</tr>
</tbody>
</table>

¹Pre-spawn mortality includes lumped totals during pre-excessing and fish set aside for broodstock.
²Spawned totals include fish later culled for ELISA or other reasons.
Table 3. Winthrop NFH Spring Chinook Adult Management Summary, 2000-2016.

<table>
<thead>
<tr>
<th>Return Year</th>
<th>Total Collection by source</th>
<th>Total Collected</th>
<th>Pre-spawn # mortality</th>
<th>Green, spent, or bad</th>
<th>Released</th>
<th>Spawned</th>
<th>Surplus</th>
<th>Transfer (MFH)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>MFH</td>
<td>WNFH</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2000²</td>
<td>150</td>
<td>942</td>
<td>1,092</td>
<td>33</td>
<td>3.0%</td>
<td>1</td>
<td>1,058</td>
<td></td>
</tr>
<tr>
<td>2001²</td>
<td>385</td>
<td>0</td>
<td>385</td>
<td>53</td>
<td>13.8%</td>
<td>2</td>
<td>330</td>
<td></td>
</tr>
<tr>
<td>2002²</td>
<td>388</td>
<td>0</td>
<td>388</td>
<td>11</td>
<td>2.8%</td>
<td>3</td>
<td>374</td>
<td></td>
</tr>
<tr>
<td>2003</td>
<td>904</td>
<td>0</td>
<td>904</td>
<td>35</td>
<td>3.9%</td>
<td>471</td>
<td>398</td>
<td></td>
</tr>
<tr>
<td>2004</td>
<td>452</td>
<td>0</td>
<td>452</td>
<td>10</td>
<td>2.2%</td>
<td>334</td>
<td>24</td>
<td>84</td>
</tr>
<tr>
<td>2005</td>
<td>499</td>
<td>0</td>
<td>499</td>
<td>4</td>
<td>0.8%</td>
<td>400</td>
<td>75</td>
<td>20</td>
</tr>
<tr>
<td>2006</td>
<td>733</td>
<td>0</td>
<td>733</td>
<td>23</td>
<td>3.1%</td>
<td>318</td>
<td>366</td>
<td>24</td>
</tr>
<tr>
<td>2007</td>
<td>708</td>
<td>0</td>
<td>708</td>
<td>17</td>
<td>2.4%</td>
<td>368</td>
<td>323</td>
<td></td>
</tr>
<tr>
<td>2008</td>
<td>705</td>
<td>0</td>
<td>705</td>
<td>6</td>
<td>0.9%</td>
<td>288</td>
<td>411</td>
<td></td>
</tr>
<tr>
<td>2009</td>
<td>1,415</td>
<td>0</td>
<td>1,415</td>
<td>19</td>
<td>1.3%</td>
<td>986</td>
<td>348</td>
<td>53</td>
</tr>
<tr>
<td>2010</td>
<td>2,319</td>
<td>0</td>
<td>2,319</td>
<td>30</td>
<td>1.3%</td>
<td>11</td>
<td>402</td>
<td>1,850</td>
</tr>
<tr>
<td>2011</td>
<td>1,965</td>
<td>0</td>
<td>1,965</td>
<td>48</td>
<td>2.4%</td>
<td>1</td>
<td>377</td>
<td>1,538</td>
</tr>
<tr>
<td>2012</td>
<td>2,088</td>
<td>0</td>
<td>2,088</td>
<td>16</td>
<td>0.8%</td>
<td>1</td>
<td>453</td>
<td>1,619</td>
</tr>
<tr>
<td>2013</td>
<td>3,137</td>
<td>0</td>
<td>3,137</td>
<td>7</td>
<td>0.2%</td>
<td>1</td>
<td>494</td>
<td>2,617</td>
</tr>
<tr>
<td>2014</td>
<td>5,365</td>
<td>0</td>
<td>5,365</td>
<td>109</td>
<td>2.0%</td>
<td>1</td>
<td>408</td>
<td>4,848</td>
</tr>
<tr>
<td>2015</td>
<td>1,440</td>
<td>4,509</td>
<td>5,949</td>
<td>95</td>
<td>1.6%</td>
<td>1</td>
<td>383</td>
<td>5,470</td>
</tr>
<tr>
<td>2016</td>
<td>458</td>
<td>2,904</td>
<td>3,362</td>
<td>35</td>
<td>1.0%</td>
<td>1</td>
<td>385</td>
<td>2,941</td>
</tr>
<tr>
<td>Mean³</td>
<td>3,471</td>
<td>2,940</td>
<td>3,362</td>
<td>35</td>
<td>1.4%</td>
<td>&lt;1</td>
<td>2</td>
<td>2,990</td>
</tr>
</tbody>
</table>

¹Pre-spawn mortality, combined from fish held for surplus and, later for broodstock purposes.
²Carson stock phase-out effort.
³Blue shading indicates years of consistent adult mgmt. strategy (emphasized pHOS mgmt.; 2010-2015) and average values for comparison.

The 2016 return to Methow Subbasin hatcheries was not as robust as 2014 or 2015 but still allowed maximization of conservation program returns into the WNFH Safety-net program broodstock, and surplusing of excess hatchery-origin adults to inland Northwest Indian subsistence food programs.

A total of 2,941 excess spring Chinook were surplused in 2016, most (2733; 93%) of which went to tribal subsistence food programs. Surplused fish were about 92% WNFH returns (Table 4). Surplused MFH returns were primarily age-3 jacks or adults in poor condition (injuries, etc.), which are less desired for use in broodstock.
Table 4. 2016 Spring Chinook excessing event summary – Excess fish program of origin by collection source.

<table>
<thead>
<tr>
<th>Date</th>
<th>Excessing Event Details</th>
<th>Source: Winthrop NFH Ladder</th>
<th>Source: Methow FH Transfers</th>
<th>Total Excesed</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>WNFH Safety-net</td>
<td>MFH¹ Cons Prog</td>
<td>Total</td>
</tr>
<tr>
<td>6/1</td>
<td>Tribal subsistence</td>
<td>1038</td>
<td>6</td>
<td>1044</td>
</tr>
<tr>
<td>6/11</td>
<td>Tribal subsistence²</td>
<td>3</td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td>6/16</td>
<td>Tribal subsistence</td>
<td>1065</td>
<td>40</td>
<td>1105</td>
</tr>
<tr>
<td>6/22</td>
<td>Tribal subsistence</td>
<td>325</td>
<td>51</td>
<td>376</td>
</tr>
<tr>
<td>7/7</td>
<td>Tribal subsistence</td>
<td>64</td>
<td>64</td>
<td>128</td>
</tr>
<tr>
<td>7/20–8/23</td>
<td>WNFH Outfall Trap³</td>
<td>142</td>
<td>3</td>
<td>145</td>
</tr>
<tr>
<td>8/12–8/26</td>
<td>Late WNFH Ladder⁴</td>
<td>2,637</td>
<td>(96.3%)</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>Sum/Proportion by location</td>
<td>100</td>
<td>2,737</td>
<td>2,737</td>
</tr>
</tbody>
</table>

¹Conservation program fish surplused were primarily age-3 jacks or adults in poor condition (injuries, etc.).
²Surplus to Yakama Nation for WNFH Kids Fishing Day traditional fishing/cooking demonstration.
³Most volunteers to Spring Cr. trap were excessed on site and recycled for nutrient enhancement.
⁴WNFH late surplus event including late swim-ins and adults netted from ladder pools.

During the 2016 spawning escapement, broodyear 2011, 2012, and 2013 cohorts were expected to return at total ages of 5, 4, and 3, respectively. All age returns from WNFH were 100% adipose-clipped, allowing for preliminary allocation to broodstock (Ad+) or surplusing (Ad-). Coded-wire tags were used post-spawn to verify programs and ages.

Table 5 displays expanded age and sex composition of overall collection in 2016, by program. Note that transfers from MFH occurred after some adult management was conducted (i.e., sample not likely representative of MFH-specific return). Note also that exact values in Table 5 do not match totals for sex or program reported in Table 2 since initial collection and transfer data from MFH are based on early visual mark and sex determinations, whereas final age and sex determinations are made following bio-sampling, internal exam, and CWT-decoding. Final sex ratio was 0.87:1 for the aggregate WNFH program collection, which compares to a 2000-2015 average ratio of 1.07:1, heavily biased by high M:F ratios in 2013 (Table 6). Note these sex ratios differ from the sex ratio of retained broodstock, reported in Table 9.

Table 5. Expanded sex and age-structure of 2016 spring Chinook adult total collection at WNFH, by program.

<table>
<thead>
<tr>
<th>Program</th>
<th>Male</th>
<th></th>
<th>Female</th>
<th></th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Age-2</td>
<td>Age-3</td>
<td>Age-4</td>
<td>Age-5</td>
<td>Sum¹</td>
</tr>
<tr>
<td>Safety-net (WNFH)</td>
<td>1</td>
<td>260</td>
<td>972</td>
<td>51</td>
<td>1,283</td>
</tr>
<tr>
<td>Conservation (MFH)</td>
<td>3</td>
<td>92</td>
<td>159</td>
<td>22</td>
<td>273</td>
</tr>
<tr>
<td>Conservation (Twisp)</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Stray (CJH; Okanogan)</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Stray (LNFH; Wenatchee)</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>6²</td>
<td>6²</td>
</tr>
<tr>
<td>TOTAL</td>
<td>4</td>
<td>354</td>
<td>1,132</td>
<td>79</td>
<td>1,565</td>
</tr>
<tr>
<td></td>
<td>1,686</td>
<td>112</td>
<td>1,797</td>
<td></td>
<td>3,362</td>
</tr>
</tbody>
</table>

¹Excludes age-2 minijacks.
²Estimated 6 recoveries based off single CWT recovery expanded by approximately 1:6 sample rate for sampling event.

<table>
<thead>
<tr>
<th>Return Year</th>
<th>Sample Rate(^1)</th>
<th># Males</th>
<th># Jacks</th>
<th># Females</th>
<th>Male:Female Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000</td>
<td>100%</td>
<td>369</td>
<td>104</td>
<td>585</td>
<td>0.81:1</td>
</tr>
<tr>
<td>2001</td>
<td>100%</td>
<td>93</td>
<td>35</td>
<td>201</td>
<td>0.64:1</td>
</tr>
<tr>
<td>2002</td>
<td>100%</td>
<td>119</td>
<td>0</td>
<td>258</td>
<td>0.46:1</td>
</tr>
<tr>
<td>2003</td>
<td>100%</td>
<td>68</td>
<td>86</td>
<td>243</td>
<td>0.63:1</td>
</tr>
<tr>
<td>2004</td>
<td>100%</td>
<td>90</td>
<td>51</td>
<td>221</td>
<td>0.64:1</td>
</tr>
<tr>
<td>2005</td>
<td>100%</td>
<td>78</td>
<td>119</td>
<td>223</td>
<td>0.88:1</td>
</tr>
<tr>
<td>2006</td>
<td>100%</td>
<td>191</td>
<td>21</td>
<td>183</td>
<td>1.16:1</td>
</tr>
<tr>
<td>2007</td>
<td>100%</td>
<td>87</td>
<td>120</td>
<td>140</td>
<td>1.48:1</td>
</tr>
<tr>
<td>2008</td>
<td>100%</td>
<td>145</td>
<td>36</td>
<td>229</td>
<td>0.79:1</td>
</tr>
<tr>
<td>2009</td>
<td>100%</td>
<td>107</td>
<td>96</td>
<td>200</td>
<td>1.02:1</td>
</tr>
<tr>
<td>2010</td>
<td>100%</td>
<td>799</td>
<td>233</td>
<td>1,201</td>
<td>0.86:1</td>
</tr>
<tr>
<td>2011</td>
<td>100%</td>
<td>420</td>
<td>900</td>
<td>589</td>
<td>2.24:1</td>
</tr>
<tr>
<td>2012</td>
<td>100%</td>
<td>724</td>
<td>285</td>
<td>1,058</td>
<td>0.95:1</td>
</tr>
<tr>
<td>2013</td>
<td>100%</td>
<td>569</td>
<td>1,642</td>
<td>902</td>
<td>2.45:1</td>
</tr>
<tr>
<td>2014</td>
<td>100%, 25%</td>
<td>2,097</td>
<td>902</td>
<td>2,390</td>
<td>1.25:1</td>
</tr>
<tr>
<td>2015</td>
<td>100%, 20%</td>
<td>2,435</td>
<td>791</td>
<td>2,845</td>
<td>1.13:1</td>
</tr>
<tr>
<td>2016</td>
<td>100%, 16.6%</td>
<td>1,205</td>
<td>352</td>
<td>1,789</td>
<td>0.87:1</td>
</tr>
<tr>
<td>Avg. (00-15)</td>
<td></td>
<td>564</td>
<td>361</td>
<td>780</td>
<td>1.07:1</td>
</tr>
<tr>
<td>Min</td>
<td>68</td>
<td>0</td>
<td>140</td>
<td></td>
<td>0.46:1</td>
</tr>
<tr>
<td>Max</td>
<td>2,435</td>
<td>1,642</td>
<td>2,845</td>
<td></td>
<td>2.45:1</td>
</tr>
</tbody>
</table>

\(^1\)Sample rates of adult hatchery returns, which are mixed composition. Broodstock in 2014-2016 were 100% sampled while surplused fish were sub-sampled at shown rates. M:F data reflect WNFH program returns only – MFH, strays, or unknown hatchery returns excluded.

Stray recoveries at WNFH have been historically rare and continued to be so in 2016, with an estimated 0.1% of the total collection being out-of-basin strays (Table 7). Strays were limited to one age-3 Okanogan 10(j) program (Chief Joseph Hatchery) stray and one age-5 Leavenworth NFH adult (expanded to 6 recoveries by sample rate). Neither fish was incorporated into the safety-net program. An estimated 98.4% of recoveries were MetComp program fish from WNFH or MFH programs and the majority of these were from on-station hatchery releases. Relatively few recoveries derived from MetComp remote acclimation sites (15 Chewuch Pond and 2 Mid-Valley Pond). A total of two Twisp Conservation Program adults were encountered in 2016 – as these are externally indistinguishable (CWT detected) from MFH Conservation Program adults, both were prioritized and incorporated as broodstock.

All CWT recoveries were expanded for sampling rate and reported in the Regional Mark Information System (RMPC.org) as of June 2019.

Length at maturity summary information is provided in Table 8. No statistical relationships/trends were discovered across programs.
Return broodstock were selected from mixed holding during excessing events, they were placed in a separate, upstream holding compartment, eliminating the need for re-handling (to minimize stress) until spawning. In total, 386 adult spring Chinook were retained for use as broodstock in 2016 (Table 2; Table 9).

To improve adult management and follow judicious use guidelines for antimicrobials as per FWS Fish Health Policy (2004), antibiotic injections of adult broodstock are not currently used as standard practice. However, held broodstock receive a prophylactic formalin treatment 3 days per week in the form of a...
one-hour flow-through treatment to prevent fungal infestations. Formalin treatments are not initiated until tribal surplus events have been completed.

Despite MFH and WNFH’s proximity and partially-shared water source, returning fish exhibit high degrees of fidelity to their respective hatcheries of origin (Table 9). Despite this, WNFH collected most (249 of 345; 72%) of its conservation program broodstock through its own ladder. The remainder derived from hatchery transfers. The total retained for spawning was 386 adults, with 202 females and 184 males (Table 9). A small number of conservation program males were used to meet production needs, within stepping stone allowances. Based on total effective crosses, the conservation program parental composition of the BY16 WNFH Safety-net program was 89.9%, exceeding the >75% (NOAA 2016a). This is the recommended value for use in subsequent multi-population PNI calculations.

Table 9. Broodyear 2016 WNFH spring Chinook broodstock composition by age, program, and collection location.

<table>
<thead>
<tr>
<th>Collection site</th>
<th>Program</th>
<th>Male Age-3</th>
<th>Male Age-4</th>
<th>Male Age-5</th>
<th>Male Sum</th>
<th>Female Age-4</th>
<th>Female Age-5</th>
<th>Female Sum</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>MFH</td>
<td>Conservation (MFH)</td>
<td>0</td>
<td>34</td>
<td>7</td>
<td>41</td>
<td>50</td>
<td>5</td>
<td>55</td>
<td>96</td>
</tr>
<tr>
<td></td>
<td>Safety-net (WNFH)</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Combined</td>
<td>0</td>
<td>35</td>
<td>7</td>
<td>42</td>
<td>50</td>
<td>5</td>
<td>55</td>
<td>97</td>
</tr>
<tr>
<td>WNFH</td>
<td>Conservation (MFH)</td>
<td>1</td>
<td>102</td>
<td>12</td>
<td>115</td>
<td>106</td>
<td>28</td>
<td>134</td>
<td>249</td>
</tr>
<tr>
<td></td>
<td>Safety-net (WNFH)</td>
<td>0</td>
<td>24</td>
<td>3</td>
<td>27</td>
<td>12</td>
<td>1</td>
<td>13</td>
<td>40</td>
</tr>
<tr>
<td></td>
<td>Combined</td>
<td>1</td>
<td>126</td>
<td>15</td>
<td>142</td>
<td>118</td>
<td>29</td>
<td>147</td>
<td>289</td>
</tr>
<tr>
<td>Combined Brood</td>
<td>Conservation (MFH)</td>
<td>1</td>
<td>136</td>
<td>19</td>
<td>156</td>
<td>156</td>
<td>33</td>
<td>189</td>
<td>345</td>
</tr>
<tr>
<td></td>
<td>Safety-net (WNFH)</td>
<td>0</td>
<td>25</td>
<td>3</td>
<td>28</td>
<td>12</td>
<td>1</td>
<td>13</td>
<td>41</td>
</tr>
<tr>
<td></td>
<td>TOTAL</td>
<td>1</td>
<td>161</td>
<td>22</td>
<td>184</td>
<td>168</td>
<td>34</td>
<td>202</td>
<td>386</td>
</tr>
</tbody>
</table>

Fecundities between WNFH and MFH females (2016 only) were compared using 2-sample T-tests. Age-4 MFH females (only those transferred to WNFH) were slightly less fecund than WNFH females, though this difference was not significant ($p=0.13$). This disparity may be partially explained by the slightly larger size (also non-significant) of WNFH females retained for spawning. During broodstock allocation, few safety-net brood are chosen from many, allowing “high-grading” to occur. In contrast, limited availability of MFH females could result in smaller average size – and resulting fecundity. Samples size of age-5 WFNH females (N=1) precluded comparison of age-5 female fecundities, though the single age-5 WNFH female was the most fecund fish sampled (6,071) in 2016. Mean fecundity values by age and program are shown in Table 10 and compared to recent years’ values in Table 11.

Table 10. Mean fecundity by age and program of 2016 spring Chinook broodstock at WNFH.

<table>
<thead>
<tr>
<th>Program, by age</th>
<th>Samples (N)</th>
<th>Mean Fecundity</th>
<th>StDev Fecundity</th>
</tr>
</thead>
<tbody>
<tr>
<td>MFH Age-4</td>
<td>127</td>
<td>3,625</td>
<td>907</td>
</tr>
<tr>
<td>WNFH Age-4</td>
<td>11</td>
<td>4,057</td>
<td>760</td>
</tr>
<tr>
<td>Combined Age-4</td>
<td>138</td>
<td>3,660</td>
<td>902</td>
</tr>
<tr>
<td>MFH Age-5</td>
<td>27</td>
<td>4,367</td>
<td>1,162</td>
</tr>
<tr>
<td>WNFH Age-5</td>
<td>1</td>
<td>6,071</td>
<td>N/A</td>
</tr>
<tr>
<td>Combined Age-5</td>
<td>28</td>
<td>4,428</td>
<td>1,185</td>
</tr>
<tr>
<td>All broodstock</td>
<td>166</td>
<td>3,789</td>
<td>994</td>
</tr>
</tbody>
</table>
Table 11. WNFH Spring Chinook program – annual broodstock fecundity statistics by age.

<table>
<thead>
<tr>
<th>Brood year</th>
<th>All Samples</th>
<th>Age-4</th>
<th>Age-5</th>
<th>Broodstock age comp.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean StDev N=</td>
<td>Mean StDev N=</td>
<td>Mean StDev N=</td>
<td>Age-4 Age-5</td>
</tr>
<tr>
<td>2013</td>
<td>3,858 825 192</td>
<td>3,649 661 139</td>
<td>5,023 732 30</td>
<td>85.1% 14.9%</td>
</tr>
<tr>
<td>2014</td>
<td>4,694 760 174</td>
<td>4,713 773 156</td>
<td>5,148 876 3</td>
<td>98.4% 1.6%</td>
</tr>
<tr>
<td>2015</td>
<td>4,313 879 169</td>
<td>4,035 675 133</td>
<td>5,266 797 38</td>
<td>79.7% 20.3%</td>
</tr>
<tr>
<td>2016</td>
<td>3,789 994 166</td>
<td>3,660 902 138</td>
<td>4,428 1,185 28</td>
<td>83.1% 16.9%</td>
</tr>
<tr>
<td>2017</td>
<td>4,211 940 206</td>
<td>4,172 897 192</td>
<td>4,742 1,328 14</td>
<td>93.2% 6.8%</td>
</tr>
</tbody>
</table>

1Age composition doesn’t necessarily match samples by age in this table – based on positively verified fish via CWT only.

The overall green eggtake for 2016 at WNFH was estimated at 761,576, approximately 95% of the HGMP’s stated eggtake goal of 800,000 eggs (Appendix A).

Broodstock Fish Health Monitoring

Portions of the broodstock retained were tested for pathogens, including Viral Hemorrhagic Septicemia Virus (VHSV), Infectious Pancreatic Necrosis Virus (IPNV), and Infectious Hematopoietic Necrosis Virus (IHNV). Pathogen profiles for broodstock used were supplied by Olympia Fish Health Center, USFWS. Sampling protocols included testing broodstock females for presence and relative abundance of *Renibacterium salmoninarum*, the causative agent of bacterial kidney disease (BKD) in salmonid fishes. Additionally, bacteriology and virology testing were performed on kidney/spleen samples from 60 fish and virology testing was conducted on ovarian fluid from 60 females.

The Olympia Fish Health Center stores ELISA samples for *R. salmoninarum* until completion of all spawn events for a particular run/stock. Due to variability in the ELISA process - collection and processing of samples, reagents (for example a batch of antibodies), and actual machine variation day-to-day - optical densities from all samples must be run compared to a specific "blank" (or negative) which is accounted for in each particular batch (subtracted from the obtained value). This helps to account for variability within a particular lab between runs, but variation in collection protocols and processing procedures between different labs prevents exact comparison of results between labs and often even facilities utilizing the same lab.

Rather than utilize a strict value cutoff for ELISA culling of eggs, the protocol for Olympia Fish Health Center uses a ranking system for all samples’ relative risk of disease outbreak. ELISA raw values are ranked on a log scale into categories of risk, which may vary year to year depending on that particular run/stock and ELISA batch. ELISA optical density (OD) values are grouped into six levels, ranging from “No Detection” to “Very High” risk. Of all collected and sampled egg lots in 2016, an estimated 84% of the females were considered “low” risk, 12% were considered “moderate” risk, and about 4% “high” risk (Table 12). Post-spawning, egg lot is held in a separate tray such that gametes in excess to program needs can be culled in rank with relative risk, as predicted by ELISA score. In 2016, about 7% of collected gametes (estimate 48.5K of 710K eyed eggs at the time) were culled allowing lower risk gametes to remain on-station at WNFH or be transferred to the Chief Joseph Hatchery Okanogan reintroduction program operated by the Colville Tribe (CCT; Table 12).
Table 12. Bacterial Kidney Disease risk profile (ELISA rankings) for recent WNFH spring Chinook eggtakes.

<table>
<thead>
<tr>
<th>ELISA Rank</th>
<th>Females Collected/Sampled (% of total)</th>
<th>ELISA Culled (% of total)</th>
<th>CCT Transfers (% of total)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>VL Low Mod High VH Total</td>
<td>Low Mod High VH Total</td>
<td>Low Mod High Total</td>
</tr>
<tr>
<td>BY13</td>
<td>- - 86.2 13.0 0.8 0.0 253</td>
<td>- - - - - 0</td>
<td>- - - - 0</td>
</tr>
<tr>
<td>BY14</td>
<td>- - 92.2 7.8 0.0 0.0 204</td>
<td>46.7 53.3 0.0 0.0 30</td>
<td>49 0 0 49</td>
</tr>
<tr>
<td>BY15</td>
<td>- - 79.0 16.0 1.5 3.5 200</td>
<td>9.7 71.0 3.2 16.1 31</td>
<td>47 8 1 56</td>
</tr>
<tr>
<td>BY16</td>
<td>- - 84.1 11.9 1.0 3.0 201 (^1)</td>
<td>14.3 28.6 14.3 42.9 14</td>
<td>57 13 0 70</td>
</tr>
<tr>
<td>BY17</td>
<td>- - 78.6 16.7 3.3 1.4 215</td>
<td>19.3 63.2 12.3 5.3 57</td>
<td>54 0 0 54</td>
</tr>
</tbody>
</table>

\(^1\)ELISA sample/data lost on one female’s eggs.

Broodyear 2016 Juvenile Rearing Monitoring

Eggtake and Incubation

The BY16 in-hatchery production phase began with an estimated total 761,576 green eggs from 202 families. No green egg transfers occurred in 2016 (Table 13). Following a 93.3% eye-up rate, an estimated 710,649 eyed eggs remained, which exceeded the HGMP’s >90% eye-up and eyed egg targets of 650,000 (Appendix A). Of these, 210,748 eyed eggs were transferred to the Colville Tribes’ Chief Joseph Hatchery Okanogan 10(j) reintroduction program. The remaining ~500,000 eyed eggs exceeded the program’s post-transfer retention target of 430,000 eyed eggs so 75,772 eyed eggs were culled. To reduce risk and incidence of BKD, relatively large margins of culling is allowed in the program design. All egg culls are prioritized by risk (ELISA test results) and all BY16 eggs from high-ELISA females were culled, as per co-manager agreement.

In December, an estimated 416,614 emergent fry were ponded into indoor start tanks to begin the rearing cycle.

Table 13. 2006-2016 Winthrop NFH spring Chinook eggtake and incubation summary.

<table>
<thead>
<tr>
<th>Brood year</th>
<th>Females Spawned</th>
<th>Green Eggs</th>
<th>Eyed Eggs</th>
<th>Fry</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total Eggtake</td>
<td>Avg./female</td>
<td>Transfer (out)</td>
<td>Culled</td>
</tr>
<tr>
<td>2006</td>
<td>182</td>
<td>632,964</td>
<td>3,478</td>
<td>34,200</td>
</tr>
<tr>
<td>2007</td>
<td>140</td>
<td>527,132</td>
<td>3,765</td>
<td>3,800</td>
</tr>
<tr>
<td>2008</td>
<td>229</td>
<td>912,368</td>
<td>3,984</td>
<td>3,800</td>
</tr>
<tr>
<td>2009</td>
<td>200</td>
<td>808,505</td>
<td>4,043</td>
<td>3,800</td>
</tr>
<tr>
<td>2010</td>
<td>202</td>
<td>803,724</td>
<td>3,979</td>
<td>4,000</td>
</tr>
<tr>
<td>2011</td>
<td>189</td>
<td>694,940</td>
<td>3,677</td>
<td>3,800</td>
</tr>
<tr>
<td>2012</td>
<td>226</td>
<td>759,174</td>
<td>3,359</td>
<td>3,800</td>
</tr>
<tr>
<td>2013</td>
<td>253</td>
<td>973,829</td>
<td>3,849</td>
<td>3,858</td>
</tr>
<tr>
<td>2014</td>
<td>204</td>
<td>875,902</td>
<td>4,294</td>
<td>4,000</td>
</tr>
<tr>
<td>2015</td>
<td>199</td>
<td>851,151</td>
<td>4,277</td>
<td>0</td>
</tr>
<tr>
<td>2016</td>
<td>202</td>
<td>761,576</td>
<td>3,770</td>
<td>0</td>
</tr>
</tbody>
</table>
Juvenile Rearing

BY16 spring Chinook performed very well through the rearing period. Eyed-egg to smolt survival was calculated at 95.6%, exceeding the HGMP’s target of >93% (Appendix A). Fry were first ponded into 34 early rearing tanks inside the hatchery nursery on February 27, 2017. To prevent coagulated yolk disease, fish were not fed until March 1, allowing fish to absorb remaining yolk stores. This population was moved outside into 5 A-bank Foster-Lucas rearing units in two intervals, the first on March 24 and the second on March 31. Fish remained there until July when mass marking occurred. Post-marking, fish were distributed to 10 E-bank raceways and 11 C-bank raceways, and remained there until release. In June of 2017, fish health staff detected the internal parasite *Hexamita*. Fish were fed 3.0% Epsom salts for several days to help flush the parasite out of the fish. In late August, *Ichthyophthirius multifilis* (“Ich”) was detected on the E-bank population. Fish were treated with 4 flow-through formalin treatments during August and September. Neither *Hexamita* nor Ich substantially increased mortality. Fish were released in April 2018 at 16.8 fish/lb. They were fed a total of 18,421 lbs. of feed at an approximate cost of $24,346.

Throughout the rearing cycle staff monitored fish density of fish the flowrates through the rearing vessels. Reduced densities and increased flow are desired to mitigate disease risk and subsequently improve post-release performance. For the RY18 rearing cycle, the mean monthly Density Index (DI) and Flow Index (FI) was 0.07 and 0.46, respectively which met the performance goals (DI <0.11 & FI <1.0) for these categories (Table 14; Appendix A).

<table>
<thead>
<tr>
<th>Month</th>
<th>Life Stage</th>
<th>Inventory</th>
<th>Fish/lb.</th>
<th>Mortality (%)</th>
<th>Survival (%)</th>
<th>Avg-temp (°C)</th>
<th>Water Source (%)</th>
<th>Flow (GPM)</th>
<th>Flow Index¹</th>
<th>Density Index²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aug.</td>
<td>Green Egg</td>
<td>761,576</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>11.1</td>
<td>100</td>
<td>0</td>
<td>0</td>
<td>42</td>
</tr>
<tr>
<td>Sept.</td>
<td>Green Egg</td>
<td>761,576</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>3.9</td>
<td>100</td>
<td>0</td>
<td>0</td>
<td>42</td>
</tr>
<tr>
<td>Oct.</td>
<td>Eyed Egg³</td>
<td>424,129</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>3.9</td>
<td>100</td>
<td>0</td>
<td>0</td>
<td>30</td>
</tr>
<tr>
<td>Nov.</td>
<td>Sac Fry</td>
<td>424,129</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>3.9</td>
<td>100</td>
<td>0</td>
<td>0</td>
<td>30</td>
</tr>
<tr>
<td>Dec.</td>
<td>Sac Fry</td>
<td>424,129</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>3.9</td>
<td>100</td>
<td>0</td>
<td>0</td>
<td>30</td>
</tr>
<tr>
<td>Jan.</td>
<td>Sac Fry</td>
<td>420,887</td>
<td>NA</td>
<td>99.2</td>
<td>3.9</td>
<td>100</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>30</td>
</tr>
<tr>
<td>Feb.</td>
<td>Fry⁴</td>
<td>412,420</td>
<td>NA</td>
<td>98.0</td>
<td>8.1</td>
<td>100</td>
<td>0</td>
<td>680</td>
<td>0.37</td>
<td>0.08</td>
</tr>
<tr>
<td>Mar.</td>
<td>Fry</td>
<td>411,523</td>
<td>1,199</td>
<td>0.2</td>
<td>99.8</td>
<td>7.4</td>
<td>100</td>
<td>0</td>
<td>1,500</td>
<td>0.26</td>
</tr>
<tr>
<td>Apr.</td>
<td>Fry</td>
<td>410,878</td>
<td>606</td>
<td>0.2</td>
<td>99.8</td>
<td>7.4</td>
<td>100</td>
<td>0</td>
<td>1,500</td>
<td>0.42</td>
</tr>
<tr>
<td>May</td>
<td>Fingerling</td>
<td>410,662</td>
<td>300</td>
<td>0.1</td>
<td>99.9</td>
<td>7.5</td>
<td>100</td>
<td>0</td>
<td>1,500</td>
<td>0.60</td>
</tr>
<tr>
<td>Jun.</td>
<td>Fingerling</td>
<td>410,411</td>
<td>106</td>
<td>0.1</td>
<td>99.9</td>
<td>8.8</td>
<td>100</td>
<td>0</td>
<td>1,500</td>
<td>0.83</td>
</tr>
<tr>
<td>Jul.</td>
<td>Fingerling</td>
<td>406,456</td>
<td>64</td>
<td>0.1</td>
<td>99.9</td>
<td>11.3</td>
<td>30</td>
<td>70</td>
<td>0</td>
<td>4,800</td>
</tr>
<tr>
<td>Aug.</td>
<td>Fingerling</td>
<td>406,336</td>
<td>43</td>
<td>0.1</td>
<td>99.9</td>
<td>12.2</td>
<td>50</td>
<td>50</td>
<td>0</td>
<td>4,800</td>
</tr>
<tr>
<td>Sept.</td>
<td>Fingerling</td>
<td>406,216</td>
<td>32</td>
<td>0.1</td>
<td>99.9</td>
<td>11.1</td>
<td>40</td>
<td>60</td>
<td>0</td>
<td>4,800</td>
</tr>
<tr>
<td>Oct.</td>
<td>Fingerling</td>
<td>406,120</td>
<td>27</td>
<td>0.1</td>
<td>99.9</td>
<td>11.1</td>
<td>40</td>
<td>60</td>
<td>0</td>
<td>6,850</td>
</tr>
<tr>
<td>Nov.</td>
<td>Yearling</td>
<td>406,072</td>
<td>27</td>
<td>0.1</td>
<td>99.9</td>
<td>6.9</td>
<td>30</td>
<td>70</td>
<td>0</td>
<td>6,850</td>
</tr>
<tr>
<td>Dec.</td>
<td>Yearling</td>
<td>406,046</td>
<td>26</td>
<td>0.1</td>
<td>99.9</td>
<td>6.3</td>
<td>30</td>
<td>70</td>
<td>0</td>
<td>6,850</td>
</tr>
<tr>
<td>Jan.</td>
<td>Yearling</td>
<td>406,000</td>
<td>25</td>
<td>0.1</td>
<td>99.9</td>
<td>6.9</td>
<td>30</td>
<td>70</td>
<td>0</td>
<td>6,850</td>
</tr>
<tr>
<td>Feb.</td>
<td>Yearling</td>
<td>405,950</td>
<td>25</td>
<td>0.1</td>
<td>99.9</td>
<td>6.9</td>
<td>30</td>
<td>70</td>
<td>0</td>
<td>6,850</td>
</tr>
<tr>
<td>Mar.</td>
<td>Yearling</td>
<td>405,905</td>
<td>20</td>
<td>0.1</td>
<td>99.9</td>
<td>7.8</td>
<td>30</td>
<td>70</td>
<td>0</td>
<td>6,850</td>
</tr>
<tr>
<td>Apr.</td>
<td>Smolt</td>
<td>405,566</td>
<td>17</td>
<td>0.1</td>
<td>99.9</td>
<td>8.4</td>
<td>30</td>
<td>70</td>
<td>0</td>
<td>6,850</td>
</tr>
</tbody>
</table>

¹Flow index calculated by fish weight (lbs.) divided by flow in GPM.
²Density Index calculated by fish weight (lbs.) divided by average fish length (in.) multiplied by volume of water (ft³)
³Cull and transfers
⁴Ponding
⁵Total inventory adjustment by automated counting done during mark/tagging event.

Juvenile Marking Summary

Columbia River FWCO staff (USFWS, Vancouver, WA) are annually contracted to conduct mass marking of spring Chinook at Complex hatcheries. The 2018-release spring Chinook mark strategy target (as per US v OR) was 100% CWT and adipose-clip. BY16 spring Chinook were marked July 5-14, 2017. Marking in 2017 was very successful – CWT retention was estimated at 99.0% and external marking (adipose clip) rate was estimated at 99.6% (Table 15). To allow smolt migration timing/survival evaluation, residualization estimates, straying, and aid adult return projection, approximately 20,000 spring Chinook were PIT-tagged on October 2-6, 2017.

Table 15. Summary of Broodyear 2016 WNFH spring Chinook mass marking.

<table>
<thead>
<tr>
<th>Brood year</th>
<th>Tagcode</th>
<th>Inventory @ tagging</th>
<th>Est'd CWT retention</th>
<th>Ad-clipped (actual)</th>
<th>Ad-clip rate</th>
<th># PIT tagged</th>
</tr>
</thead>
<tbody>
<tr>
<td>2016</td>
<td>055234</td>
<td>150,200</td>
<td>99.4%</td>
<td>149,344</td>
<td>99.4%</td>
<td>7,968</td>
</tr>
<tr>
<td>056130</td>
<td>256,587</td>
<td>98.7%</td>
<td>253,226</td>
<td>99.8%</td>
<td>11,935</td>
<td></td>
</tr>
<tr>
<td>TOTAL</td>
<td>406,787</td>
<td>99.0%</td>
<td>402,570</td>
<td>99.6%</td>
<td>19,903</td>
<td></td>
</tr>
</tbody>
</table>

Juvenile Release

WNFH staff initiated a 4-day, semi-volitional release of spring Chinook at 15:00 on April 19, 2018. Spring Chinook were released before other species at WNFH because they typically migrate rapidly and completely, which minimizes PIT tag collisions in the hatchery outfall’s interrogation system during the
longer Coho and steelhead volitional release periods. A total of 405,566 spring Chinook were released (Table 16), which is 101% of the HGMP’s smolt release goal (Appendix A), and within the +10% maximum program release size target (Table 17). Release of spring Chinook from Winthrop NFH preceded spring runoff conditions in the Methow River (Figure 5) by about a week in 2018.

Figure 5. 2018 WNFH spring Chinook release and hydrologic conditions in the Methow River compared to flow at Pateros, WA.
Table 16. Broodyear 2016 (2018 release year) spring Chinook coded-wire tag release groups.

<table>
<thead>
<tr>
<th>CWT code</th>
<th>Release Site</th>
<th>Release Date(s)</th>
<th>CWT+ release</th>
<th>CWT- release</th>
<th>Total Release</th>
<th>PITs Released</th>
</tr>
</thead>
<tbody>
<tr>
<td>055234</td>
<td>Methow River @ WNFH (Spring Cr.)</td>
<td>April 19-20</td>
<td>148,849</td>
<td>859</td>
<td>149,707</td>
<td>7,962</td>
</tr>
<tr>
<td>056130</td>
<td></td>
<td></td>
<td>252,511</td>
<td>3,348</td>
<td>255,859</td>
<td>11,920</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td>401,360</td>
<td>4,206</td>
<td>405,566</td>
<td>19,882</td>
</tr>
</tbody>
</table>

Table 17. Winthrop NFH spring Chinook release and mark summary for release years 2001-2018.

<table>
<thead>
<tr>
<th>Brood year</th>
<th>Release Year</th>
<th>Release start date</th>
<th># CWT</th>
<th>% CWT</th>
<th># Ad-clip</th>
<th>% Ad-clip</th>
<th># PIT tagged</th>
<th>Total Released</th>
<th>Release 5-year avg.1</th>
</tr>
</thead>
<tbody>
<tr>
<td>1999</td>
<td>2001</td>
<td>4/17</td>
<td>171,496</td>
<td>97.5%</td>
<td>172,718</td>
<td>98.2%</td>
<td>7,423</td>
<td>175,869</td>
<td>363,071</td>
</tr>
<tr>
<td>2000</td>
<td>2002</td>
<td>4/15</td>
<td>190,368</td>
<td>100.0%</td>
<td>190,368</td>
<td>0.0%</td>
<td>27,457</td>
<td>190,368</td>
<td>369,720</td>
</tr>
<tr>
<td>2001</td>
<td>2003</td>
<td>4/15</td>
<td>499,259</td>
<td>94.9%</td>
<td>265,039</td>
<td>50.4%</td>
<td>19,881</td>
<td>526,361</td>
<td>404,224</td>
</tr>
<tr>
<td>2002</td>
<td>2004</td>
<td>4/13</td>
<td>513,687</td>
<td>88.8%</td>
<td>40,777</td>
<td>7.1%</td>
<td>19,887</td>
<td>578,307</td>
<td>465,868</td>
</tr>
<tr>
<td>2003</td>
<td>2005</td>
<td>4/15</td>
<td>527,836</td>
<td>95.9%</td>
<td>165,611</td>
<td>30.1%</td>
<td>19,881</td>
<td>550,214</td>
<td>545,733</td>
</tr>
<tr>
<td>2004</td>
<td>2006</td>
<td>4/20</td>
<td>457,074</td>
<td>94.4%</td>
<td>40,777</td>
<td>7.1%</td>
<td>4,489</td>
<td>484,090</td>
<td>465,868</td>
</tr>
<tr>
<td>2005</td>
<td>2007</td>
<td>4/14</td>
<td>588,654</td>
<td>99.8%</td>
<td>220,776</td>
<td>37.4%</td>
<td>3,833</td>
<td>589,693</td>
<td>501,000</td>
</tr>
<tr>
<td>2006</td>
<td>2008</td>
<td>4/11</td>
<td>496,067</td>
<td>97.5%</td>
<td>190,368</td>
<td>98.2%</td>
<td>27,457</td>
<td>490,153</td>
<td>490,153</td>
</tr>
<tr>
<td>2007</td>
<td>2009</td>
<td>4/16</td>
<td>348,728</td>
<td>93.8%</td>
<td>74,877</td>
<td>20.1%</td>
<td>2,987</td>
<td>378,707</td>
<td>478,731</td>
</tr>
<tr>
<td>2008</td>
<td>2010</td>
<td>4/13</td>
<td>483,382</td>
<td>97.5%</td>
<td>121,542</td>
<td>24.5%</td>
<td>4,985</td>
<td>495,978</td>
<td>470,958</td>
</tr>
<tr>
<td>2009</td>
<td>2011</td>
<td>4/14</td>
<td>419,751</td>
<td>98.3%</td>
<td>325,008</td>
<td>86.6%</td>
<td>10,917</td>
<td>426,980</td>
<td>444,176</td>
</tr>
<tr>
<td>2010</td>
<td>2012</td>
<td>4/16</td>
<td>548,558</td>
<td>99.6%</td>
<td>325,008</td>
<td>86.6%</td>
<td>10,916</td>
<td>550,828</td>
<td>481,860</td>
</tr>
<tr>
<td>2011</td>
<td>2013</td>
<td>4/15</td>
<td>359,541</td>
<td>95.8%</td>
<td>325,008</td>
<td>86.6%</td>
<td>10,916</td>
<td>426,980</td>
<td>444,176</td>
</tr>
<tr>
<td>2012</td>
<td>2014</td>
<td>4/15</td>
<td>546,955</td>
<td>97.6%</td>
<td>553,677</td>
<td>98.8%</td>
<td>4,991</td>
<td>560,379</td>
<td>458,858</td>
</tr>
<tr>
<td>2013</td>
<td>2015</td>
<td>4/14</td>
<td>389,204</td>
<td>96.5%</td>
<td>402,310</td>
<td>99.7%</td>
<td>9,937</td>
<td>403,510</td>
<td>433,611</td>
</tr>
<tr>
<td>2014</td>
<td>2016</td>
<td>4/11</td>
<td>396,945</td>
<td>98.1%</td>
<td>401,415</td>
<td>99.3%</td>
<td>19,960</td>
<td>404,441</td>
<td>448,230</td>
</tr>
<tr>
<td>2015</td>
<td>2017</td>
<td>4/19</td>
<td>416,018</td>
<td>98.0%</td>
<td>420,855</td>
<td>99.1%</td>
<td>19,916</td>
<td>424,591</td>
<td>410,847</td>
</tr>
<tr>
<td>2016</td>
<td>2017</td>
<td>4/19</td>
<td>416,018</td>
<td>98.0%</td>
<td>420,855</td>
<td>99.1%</td>
<td>19,916</td>
<td>424,591</td>
<td>410,847</td>
</tr>
<tr>
<td>2017 2018</td>
<td>4/19</td>
<td>401,360</td>
<td>99.0%</td>
<td>404,229</td>
<td>99.7%</td>
<td>19,822</td>
<td>405,566</td>
<td>411,533</td>
<td></td>
</tr>
</tbody>
</table>

15-year moving average values for broodyears 2015, and 2016, calculated using nearest available years.

Visual pre-release sampling of Spring Chinook showed a homogenous group made up almost entirely (99.7%) of sexually immature transitional smolts (Smolt Index [SI]-2) and smolts (SI-3) and only a single fish with visual indication of likelihood to residualize (Table 18; see Table 20 for further discussion).

Average condition factor (K) and fish size (fish/lb.) for the group were calculated at 1.15, and 16.4 fish/lb., respectively, consistent with operational targets (Appendix A).

Table 18. WNFH broodyear 2016 spring Chinook size and condition at pre-release.

<table>
<thead>
<tr>
<th>Smolt Index (SI) Groups</th>
<th>FL (mm)</th>
<th>Weight (g)</th>
<th>N; %</th>
<th>K</th>
</tr>
</thead>
<tbody>
<tr>
<td>SCS Pre Release (sampled – 4/17/2018)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 (parr)</td>
<td>109</td>
<td>N/A</td>
<td>15.1</td>
<td>30.0</td>
</tr>
<tr>
<td>2 (transitionals)</td>
<td>131.6</td>
<td>7.7</td>
<td>26.7</td>
<td>17.0</td>
</tr>
<tr>
<td>3 (smolts)</td>
<td>135.5</td>
<td>5.6</td>
<td>28.8</td>
<td>15.7</td>
</tr>
<tr>
<td>4 (prec. males)</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Combined average</td>
<td>133.3</td>
<td>7.0</td>
<td>27.6</td>
<td>16.4</td>
</tr>
</tbody>
</table>
Smolt Outmigration

The majority of spring Chinook had departed ponds by the first morning following initiation of release and exhibited a rapid downstream migration. By day 4 following release, PIT interrogation below the hatchery (PTAGIS site SCP, ~250 meters below the hatchery ladder) had detected 99.5% of all PIT-tagged spring Chinook that migrated in 2018 had passed. Similarly, 99.5% of all spring Chinook PITs ultimately detected passing Rocky Reach Dam (RRJ) in 2018 were detected within 30 days post-release (May 19), with >90% passing by day 18. **If these average speeds are applied to the distance from WNFH to Wells Dam, >90% of smolts would have passed Wells Dam in 10.4 days in 2018, consistent with the BiOp’s Take surrogate of maximum 14 days.** This estimate is probably conservative because travel time within the undammed Methow River during spring runoff is likely faster due to higher water velocity than within the impounded mainstem Columbia, though exact movement patterns in the Lake Pateros (Wells Dam impoundment) are unknown. More detailed discussion of the expected residualism rate follows in the Early Maturation and Residualism section.

WNFH migrants in 2018 had the fastest travel times to RRJ and Bonneville Dam (BON) among releases above Wells Dam (Figure 7). All tag files used for this analysis were obtained via Columbia River DART (Univ. of Washington, 2019).

WNFH migrants in 2018 had the highest survival to RRJ of similar programs above Wells Dam (Figure 6; Table 19). Juvenile apparent survival rates through the Columbia River hydro system were calculated using Cormack-Jolly-Seber (CJS) models (Cormack, 1964; Jolly, 1965; Seber, 1965). Survival estimates to BON lacked required precision across programs to make meaningful comparisons, likely due to limited recaptures in estuary tows, which inform capture probability estimates and consequently error estimates at BON. Data suggest that WNFH spring Chinook survival are similar to other similar programs, in terms of survival to RRJ and McNary Dam. Survival to BON in 2018 of both WNFH and MFH spring Chinook may have been lower than other Upper Columbia Region programs (Figure 6, lower), though error around other programs’ estimates is large, particularly at BON.

**Table 19. 2018 Upper Columbia hatchery spring Chinook PIT-based juvenile survival rates and travel times to Rocky Reach Juvenile bypass (RRJ) and Bonneville Dam (BON).**

<table>
<thead>
<tr>
<th>Release Group</th>
<th>Travel Time (days&lt;sup&gt;1&lt;/sup&gt; [SE; sample size] to RRJ)</th>
<th>Survival to RRJ (SE)</th>
<th>Avg. speed (km/day), release to RRJ</th>
<th>Travel Time (days&lt;sup&gt;1&lt;/sup&gt; [SE; sample size] to BON)</th>
<th>Survival to BON (SE)&lt;sup&gt;2&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>WNFH on-station</td>
<td>9.4 (0.06; 4,427)</td>
<td>75.7% (2.2%)</td>
<td>17.3</td>
<td>25.1 (0.18; 846)</td>
<td>33.8% (9.9%)</td>
</tr>
<tr>
<td>MFH on-station&lt;sup&gt;3&lt;/sup&gt;</td>
<td>13.2 (0.30; 879)</td>
<td>67.6% (4.8%)</td>
<td>12.4</td>
<td>29.6 (0.44; 183)</td>
<td>21.9% (11.5%)</td>
</tr>
<tr>
<td>CJH Segregated</td>
<td>10.4 (0.19; 853)</td>
<td>71.1% (5.3%)</td>
<td>10.3</td>
<td>29.8 (0.69; 121)</td>
<td>n/a&lt;sup&gt;4&lt;/sup&gt;</td>
</tr>
<tr>
<td>CJH 10(j) Integrated</td>
<td>15.0 (0.25; 650)</td>
<td>70.0% (5.4%)</td>
<td>10.4</td>
<td>28.9 (0.46; 114)</td>
<td>n/a&lt;sup&gt;4&lt;/sup&gt;</td>
</tr>
<tr>
<td>Avg., all programs</td>
<td>12.0 days</td>
<td>71.1%</td>
<td>12.6</td>
<td>28.4 days</td>
<td>27.9%</td>
</tr>
</tbody>
</table>

<sup>1</sup>Travel time calculated as harmonic mean via Columbia River DART.

<sup>2</sup>Release to Bonneville Dam.

<sup>3</sup>Excludes release groups at offsite acclimation facilities.

<sup>4</sup>Insufficient PIT detections to conduct estimate.
Figure 6. Comparative juvenile survival rates (error bars show SE) of Upper Columbia spring Chinook hatchery programs from release to Rocky Reach (top), McNary (middle), and Bonneville dams (bottom).

1LNFH release groups do not pass Rocky Reach Dam, thus are not shown in top chart.
2Chief Joseph Hatchery segregated/Okanogan 10(j) programs did not begin until RY2015
3Other blank values indicate insufficient PIT detection data for survival analysis in DART, not zero survival
Early Maturation and Residualism

Spring Chinook returning to the Upper Columbia River region commonly mature in the ocean after one to three years in the ocean. Early maturation of spring Chinook is defined as complete gonadal development and expression of reproductive behavior before age-3 and without a winter at sea. This phenomenon is typically restricted to males called “precocial parr”, “minijacks”, “microjacks”, etc. Some Chinook initiate maturation prior to traditional seaward migration and may remain near the point of origin/release, or begin to migrate toward the ocean to various degrees, then re-ascent and attempt to spawn (Mullan et al. 1992, Beckman and Larsen 2005). Unlike maturing juvenile steelhead that generally appear to remain in the upper tributaries after release, initiating spring Chinook may exhibit a mixture of early-maturation life history strategies, consistent with those described by Johnson et al. (2012). These include fish that co-migrate with immature smolts and spend about two months in the estuary or nearshore ocean then re-ascent the Columbia River to the spawning tributaries (“minijacks”), as well as fish that make shorter migrations to various degrees within the Columbia River (“large river parr”) or remain in the tributaries (“headwater parr”).

Early male maturation may be induced or exacerbated through hatchery practices, particularly rapid growth and high adiposity (Clark and Blackburn 1994; Silverstein et al. 1998; Beckman et al. 1999, 2000; Shearer and Swanson 2000; Larsen et al. 2004). Modern hatcheries work to minimize early maturation (and associated loss to harvestable production) through dietary regulation and other rearing conditions.

Some level of early maturation occurs naturally; however, the scale and magnitude of some production-scale hatchery operations may vastly out-pace the natural population. Even at relatively low rates of early maturation, large hatchery programs can cause unacceptable ecological and genetic risks to depressed local populations.

Juvenile monitoring of Leavenworth Complex hatchery programs consists of a combination of internal/histological examination and post-release behavioral observation. The former is conducted via assessment of the gonadosomatic index (GSI; de Vlaming et al. 1982) and smolt index (SI) for a representative sub-sample of population at pre-release. Post-release behavioral patterns are assessed by monitoring PIT detections in the natural environment.
Prior to release, a sample of 300 fish was examined to describe condition of the release group. Using the qualitative SI, only one fish (0.3%) presented outward indication of a non-migrant life history strategy (Table 18). Internally, GSI comparison suggests that 4.7% of the Spring Chinook release group were males initiating maturation, despite an outward smolt/transitional appearance (Table 20), highlighting the importance of internal assays for the WNFH spring Chinook program.

Table 20. 2018 WNFH Spring Chinook release population breakdown and early maturation.

<table>
<thead>
<tr>
<th>Phenotype</th>
<th>Life history strategy</th>
<th>Release Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maturing Males</td>
<td>Residuals, minijack varieties</td>
<td>19,058</td>
</tr>
<tr>
<td>Migrant Males</td>
<td>Anadromy</td>
<td>176,966</td>
</tr>
<tr>
<td>Migrant Females</td>
<td></td>
<td>209,542</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>405,566</td>
</tr>
</tbody>
</table>

Post-release PIT interrogation data (PTAGIS.org) provided support for the low residualism estimates observed via SI and GSI methods. A total of 31 PITs (about 0.16% of the release) were detected in the sub-basin after June 1. Eleven of these were detected downstream of the hatchery release site at the Twisp or Carlton arrays (Methow River), likely indicative of delayed emigration. The remainder (20 unique PITs) were detected in locations off the migration route suggestive of a mature headwater parr residualization strategy, as described by Johnson et al. (2012).

Nineteen PIT tags (0.1% of the release group) were detected at mainstem Columbia River dams in 2018 suggesting an early maturing life history strategy. Of these, 15 descended and re-ascended Bonneville Dam and 4 re-ascended dams upstream of Bonneville. Only 3 of these PIT-tagged fish appeared to successfully ascend Wells Dam; two were later detected in the Methow Subbasin where they may have attempted to spawn. All others appeared to have died (or remained) in the mainstem Columbia River.

Assuming interrogation probability of mini-jacks in mainstem dams is near-100% (like adults), mini-jack rates appear very low (~0.1%). Effective rates (i.e. those that successfully spawn) were even lower in 2018 (<0.02%) due to their apparent high mortality. We lack capture probability estimates for the Methow Subbasin’s combined PIT interrogation system and cannot generate a census estimate for headwater parr. However, the few PIT detections and GSI results both support that the residualism rate was minimal in 2018. The 4.7% early male maturation rate estimated via GSI sampling provides a conservative potential residualism rate, while the effective residualism rate is better explained by the PIT-derived mini-jack rate (0.1 - 1%). Observations in 2018 were similar to average values estimated across a 17-year period in Table 21.

Residualization to later attain a smoltification threshold size for migration the following year does not appear to occur (or is extremely rare) in the WNFH spring Chinook program. Of approximately 250,000 PITs released since 2000, zero WNFH spring Chinook have been detected emigrating through Columbia River juvenile interrogation sites (Rocky Reach, McNary, and Bonneville dams) the year after release.
Table 21. Estimated migratory minijack rates for WNFH spring Chinook release groups.

<table>
<thead>
<tr>
<th>Release Year</th>
<th># Fish released</th>
<th># PITs</th>
<th>Fish/PIT</th>
<th>Unique Columbia R. minijack PITs¹</th>
<th>Expanded Col. River minijacks</th>
<th>Minijack Rate (%)²</th>
<th>Passage above Wells Dam</th>
<th>Minijack success rate (%)³</th>
</tr>
</thead>
<tbody>
<tr>
<td>2002</td>
<td>190,368</td>
<td>27,457</td>
<td>6.9</td>
<td>44</td>
<td>305</td>
<td>0.16%</td>
<td>7</td>
<td>0.03%</td>
</tr>
<tr>
<td>2003</td>
<td>526,361</td>
<td>19,881</td>
<td>26.5</td>
<td>4</td>
<td>106</td>
<td>0.02%</td>
<td>2</td>
<td>0.01%</td>
</tr>
<tr>
<td>2004</td>
<td>578,307</td>
<td>19,887</td>
<td>29.1</td>
<td>13</td>
<td>378</td>
<td>0.07%</td>
<td>6</td>
<td>0.03%</td>
</tr>
<tr>
<td>2005</td>
<td>550,214</td>
<td>3,600</td>
<td>152.8</td>
<td>2</td>
<td>306</td>
<td>0.06%</td>
<td>0</td>
<td>0.00%</td>
</tr>
<tr>
<td>2006</td>
<td>484,090</td>
<td>4,489</td>
<td>107.8</td>
<td>2</td>
<td>216</td>
<td>0.04%</td>
<td>0</td>
<td>0.00%</td>
</tr>
<tr>
<td>2007</td>
<td>589,693</td>
<td>3,833</td>
<td>153.8</td>
<td>4</td>
<td>615</td>
<td>0.10%</td>
<td>1</td>
<td>0.03%</td>
</tr>
<tr>
<td>2008</td>
<td>509,045</td>
<td>2,987</td>
<td>170.4</td>
<td>8</td>
<td>1363</td>
<td>0.27%</td>
<td>0</td>
<td>0.00%</td>
</tr>
<tr>
<td>2009</td>
<td>371,959</td>
<td>1,999</td>
<td>186.1</td>
<td>2</td>
<td>372</td>
<td>0.10%</td>
<td>1</td>
<td>0.05%</td>
</tr>
<tr>
<td>2010</td>
<td>495,978</td>
<td>4,985</td>
<td>99.5</td>
<td>4</td>
<td>398</td>
<td>0.08%</td>
<td>0</td>
<td>0.00%</td>
</tr>
<tr>
<td>2011</td>
<td>426,980</td>
<td>10,917</td>
<td>39.1</td>
<td>2</td>
<td>78</td>
<td>0.02%</td>
<td>0</td>
<td>0.00%</td>
</tr>
<tr>
<td>2012</td>
<td>550,828</td>
<td>10,916</td>
<td>50.5</td>
<td>21</td>
<td>1060</td>
<td>0.19%</td>
<td>5</td>
<td>0.05%</td>
</tr>
<tr>
<td>2013</td>
<td>375,134</td>
<td>16,872</td>
<td>22.2</td>
<td>26</td>
<td>578</td>
<td>0.15%</td>
<td>5</td>
<td>0.03%</td>
</tr>
<tr>
<td>2014</td>
<td>560,379</td>
<td>4,991</td>
<td>112.3</td>
<td>7</td>
<td>786</td>
<td>0.14%</td>
<td>2</td>
<td>0.04%</td>
</tr>
<tr>
<td>2015</td>
<td>403,510</td>
<td>9,937</td>
<td>40.6</td>
<td>4</td>
<td>162</td>
<td>0.04%</td>
<td>3</td>
<td>0.03%</td>
</tr>
<tr>
<td>2016</td>
<td>404,441</td>
<td>17,361</td>
<td>23.3</td>
<td>27</td>
<td>629</td>
<td>0.16%</td>
<td>2</td>
<td>0.01%</td>
</tr>
<tr>
<td>2017</td>
<td>424,591</td>
<td>19,918</td>
<td>21.3</td>
<td>17</td>
<td>362</td>
<td>0.09%</td>
<td>1</td>
<td>0.01%</td>
</tr>
<tr>
<td>2018</td>
<td>405,566</td>
<td>19,822</td>
<td>20.5</td>
<td>19</td>
<td>389</td>
<td>0.10%</td>
<td>3</td>
<td>0.02%</td>
</tr>
</tbody>
</table>

¹Behaviorally-suggested minijack individuals in year of release; likely conservative as single-dam-ascensions could be downstream detections.
²Estimates exclude headwater parr strategy.
³Defined by re-ascension of Wells Dam only and should not be misinterpreted as contribution on spawning grounds.

2018 Adult Return

Run Forecasting

Chinook returns from Leavenworth and Entiat National Fish Hatchery programs are more closely monitored than those from Winthrop NFH due to fishery management needs. Pre-season and in-season estimates inform managers who administer recreational and tribal fisheries in these hatcheries’ respective areas. No spring Chinook recreational fisheries have opened in the Methow Subbasin in many years. Consequently, we have provided basic pre-season forecasts, based on US v OR Technical Advisory Committee and/or NOAA pre-season forecasts, for the purposes of developing HCP Hatchery Committee annual broodstock collection protocols. These forecasts have not been further scrutinized and management adjusts based on Bonneville escapement as it develops. This would likely change if spring Chinook conservation fisheries were implemented in the tributaries.

Run Timing

The first arriving 2018 WNFH-origin adult was detected at Bonneville Dam on April 24, about a week later than average. The first half of the run was a week late in 2018, with the 50% mark passing the dam...
on May 15, 8 days later than average. The latter half of the run progressed more quickly than first first half with the 75th and 95th percentiles passing Bonneville Dam two days and ten days earlier than average, respectively (Table 22).

In 2018, average travel time for WNFH adults from Bonneville Dam to WNFH (combined Bonneville sites to PTAGIS site SCP, 175m downstream of WNFH) was 34 days, about 2.5 days faster than the average for the 2010-2017 period (Table 23).

Table 22. Run completion passage dates for WNFH-origin spring Chinook at Bonneville Dam.

<table>
<thead>
<tr>
<th>Escapement Year</th>
<th>First fish %5</th>
<th>10%</th>
<th>25%</th>
<th>50%</th>
<th>75%</th>
<th>90%</th>
<th>95%</th>
<th>Last fish</th>
</tr>
</thead>
<tbody>
<tr>
<td>2001</td>
<td>8-Apr</td>
<td>8-Apr</td>
<td>12-Apr</td>
<td>14-Apr</td>
<td>22-Apr</td>
<td>6-May</td>
<td>10-Jun</td>
<td>4-Jul</td>
</tr>
<tr>
<td>2003</td>
<td>2-Mar</td>
<td>4-Mar</td>
<td>6-Mar</td>
<td>27-Mar</td>
<td>22-Apr</td>
<td>7-May</td>
<td>22-Jun</td>
<td>30-Jun</td>
</tr>
<tr>
<td>2004</td>
<td>13-Apr</td>
<td>15-Apr</td>
<td>16-Apr</td>
<td>19-Apr</td>
<td>22-Apr</td>
<td>30-Apr</td>
<td>9-May</td>
<td>19-May</td>
</tr>
<tr>
<td>2006</td>
<td>1-May</td>
<td>1-May</td>
<td>1-May</td>
<td>4-May</td>
<td>7-May</td>
<td>12-May</td>
<td>26-Jun</td>
<td>1-Jul</td>
</tr>
<tr>
<td>2008</td>
<td>4-May</td>
<td>4-May</td>
<td>4-May</td>
<td>7-May</td>
<td>14-May</td>
<td>26-Jun</td>
<td>4-Jul</td>
<td>10-Jul</td>
</tr>
<tr>
<td>2011</td>
<td>2-May</td>
<td>5-May</td>
<td>6-May</td>
<td>10-May</td>
<td>12-May</td>
<td>18-May</td>
<td>3-Jun</td>
<td>27-Jun</td>
</tr>
<tr>
<td>2012</td>
<td>29-Apr</td>
<td>30-Apr</td>
<td>4-May</td>
<td>9-May</td>
<td>18-May</td>
<td>24-Jun</td>
<td>28-Jun</td>
<td>30-Jun</td>
</tr>
<tr>
<td>2013</td>
<td>14-Apr</td>
<td>24-Apr</td>
<td>26-Apr</td>
<td>2-May</td>
<td>10-May</td>
<td>22-Jun</td>
<td>27-Jun</td>
<td>29-Jun</td>
</tr>
<tr>
<td>2014</td>
<td>8-Apr</td>
<td>20-Apr</td>
<td>26-Apr</td>
<td>30-Apr</td>
<td>6-May</td>
<td>13-May</td>
<td>22-May</td>
<td>28-Jun</td>
</tr>
<tr>
<td>2015</td>
<td>1-Apr</td>
<td>15-Apr</td>
<td>18-Apr</td>
<td>20-Apr</td>
<td>27-Apr</td>
<td>4-May</td>
<td>18-May</td>
<td>19-May</td>
</tr>
<tr>
<td>2016</td>
<td>22-Apr</td>
<td>24-Apr</td>
<td>25-Apr</td>
<td>2-May</td>
<td>20-May</td>
<td>28-Jun</td>
<td>7-Jul</td>
<td>20-Jul</td>
</tr>
<tr>
<td>2017</td>
<td>1-May</td>
<td>4-May</td>
<td>7-May</td>
<td>19-May</td>
<td>23-May</td>
<td>23-Jun</td>
<td>8-Jul</td>
<td>20-Jul</td>
</tr>
<tr>
<td><strong>2018</strong></td>
<td><strong>24-Apr</strong></td>
<td><strong>28-Apr</strong></td>
<td><strong>29-Apr</strong></td>
<td><strong>6-May</strong></td>
<td><strong>15-May</strong></td>
<td><strong>23-May</strong></td>
<td><strong>2-Jul</strong></td>
<td><strong>12-Jul</strong></td>
</tr>
</tbody>
</table>

| Min             | 2-Mar         | 4-Mar  | 6-Mar  | 27-Mar | 22-Apr | 30-Apr | 9-May  | 15-May | 15-May |
| Max             | 4-May         | 5-May  | 7-May  | 19-May | 23-May | 28-Jun | 8-Jul  | 20-Jul | 8-Aug |
| Avg. ‘01-’17    | 16-Apr        | 20-Apr | 22-Apr | 28-Apr | 6-May  | 25-May | 9-Jun  | 22-Jun | 30-Jun |

1 All data derived for Columbia River DART (Univ. of Washington, 2019)
Table 23. WNFH spring Chinook adult travel times (days) through Columbia River dam system.

<table>
<thead>
<tr>
<th>Return Year</th>
<th>BON &gt; MCN</th>
<th>MCN &gt; PRD</th>
<th>PRD &gt; RI</th>
<th>RI &gt; Wells</th>
<th>Wells &gt; SCP</th>
<th>BON &gt; SCP</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Avg.</td>
<td>SD</td>
<td>N</td>
<td>Avg.</td>
<td>SD</td>
<td>N</td>
</tr>
<tr>
<td>2002</td>
<td>8.8</td>
<td>5.5</td>
<td>29</td>
<td>5.3</td>
<td>2.3</td>
<td>14</td>
</tr>
<tr>
<td>2003</td>
<td>10.8</td>
<td>7.0</td>
<td>22</td>
<td>6.9</td>
<td>3.4</td>
<td>22</td>
</tr>
<tr>
<td>2004</td>
<td>5.3</td>
<td>1.2</td>
<td>69</td>
<td>5.7</td>
<td>5.8</td>
<td>51</td>
</tr>
<tr>
<td>2005</td>
<td>5.8</td>
<td>1.4</td>
<td>9</td>
<td>4.4</td>
<td>1.3</td>
<td>7</td>
</tr>
<tr>
<td>2006</td>
<td>6.8</td>
<td>2.2</td>
<td>15</td>
<td>3.9</td>
<td>0.9</td>
<td>15</td>
</tr>
<tr>
<td>2007</td>
<td>5.6</td>
<td>0.9</td>
<td>6</td>
<td>5.7</td>
<td>1.8</td>
<td>5</td>
</tr>
<tr>
<td>2008</td>
<td>6.5</td>
<td>1.9</td>
<td>6</td>
<td>4.2</td>
<td>0.9</td>
<td>6</td>
</tr>
<tr>
<td>2009</td>
<td>5.3</td>
<td>1.2</td>
<td>7</td>
<td>4.5</td>
<td>1.8</td>
<td>7</td>
</tr>
<tr>
<td>2010</td>
<td>6.8</td>
<td>4.7</td>
<td>18</td>
<td>4.3</td>
<td>1.0</td>
<td>18</td>
</tr>
<tr>
<td>2011</td>
<td>9.1</td>
<td>7.3</td>
<td>31</td>
<td>7.7</td>
<td>5.0</td>
<td>32</td>
</tr>
<tr>
<td>2012</td>
<td>7.1</td>
<td>2.2</td>
<td>14</td>
<td>5.5</td>
<td>1.8</td>
<td>10</td>
</tr>
<tr>
<td>2013</td>
<td>6.8</td>
<td>3.7</td>
<td>26</td>
<td>6.3</td>
<td>3.1</td>
<td>26</td>
</tr>
<tr>
<td>2014</td>
<td>6.5</td>
<td>3.3</td>
<td>73</td>
<td>5.1</td>
<td>1.5</td>
<td>69</td>
</tr>
<tr>
<td>2015</td>
<td>4.8</td>
<td>1.3</td>
<td>70</td>
<td>3.8</td>
<td>0.8</td>
<td>71</td>
</tr>
<tr>
<td>2016</td>
<td>6.3</td>
<td>3.4</td>
<td>24</td>
<td>4.2</td>
<td>1.2</td>
<td>24</td>
</tr>
<tr>
<td>2017</td>
<td>7.9</td>
<td>5.4</td>
<td>28</td>
<td>5.4</td>
<td>2.4</td>
<td>28</td>
</tr>
<tr>
<td>2018</td>
<td>8.3</td>
<td>3.8</td>
<td>53</td>
<td>5.3</td>
<td>2.5</td>
<td>53</td>
</tr>
<tr>
<td>Min</td>
<td>4.8</td>
<td>0.9</td>
<td>6</td>
<td>3.8</td>
<td>0.8</td>
<td>5</td>
</tr>
<tr>
<td>Max</td>
<td>10.8</td>
<td>7.3</td>
<td>73</td>
<td>7.7</td>
<td>5.8</td>
<td>71</td>
</tr>
<tr>
<td>Avg.</td>
<td>6.9</td>
<td>3.3</td>
<td>28</td>
<td>5.2</td>
<td>2.2</td>
<td>26</td>
</tr>
</tbody>
</table>

*BON – Bonneville Dam; MCN – McNary Dam; PRD – Priest Rapids Dam; RI – Rock Island Dam; SCP – Spring Cr. (WNFH)

**Run Conversion**

After passing Bonneville Dam, returning WNFH adults must ascend another seven dams before reaching Wells Dam, the last robust counting and detection location prior to entering the Methow Subbasin. Burke et al. (2006) reported that PIT tag detection efficiency at Bonneville Dam was >90%. Analysis of WNFH adult PIT tags at Wells Dam between 2002 and 2017 (using PTAGIS data) suggests that detection efficiency has improved to about 98%. Similarly, 2015-2017 PIT data from adult spring Chinook interrogated in the Methow Subbasin found the Wells Dam adult ladder PIT detection efficiency to be 100%.

In 2018, an estimated 60% of WNFH adults to Bonneville safely made passage to the SCP array. This is slightly less than the 2010-2017 average (Table 24). Conversion of fish between mainstem dams in 2018 was near-average with the exception of the reach between Bonneville and McNary dams where mortality was slightly higher than average. Mixed freshwater fisheries removed an estimated 83 WNFH spring Chinook below McNary Dam (RMPC.org); however, recoveries were reported as a mix of below- and above Bonneville.
Table 24. WNFH spring Chinook passage success from Bonneville Dam to Winthrop NFH.

<table>
<thead>
<tr>
<th>Return Year</th>
<th>Adjusted PIT detections12</th>
<th>Conversion efficiency by reach2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>BONN</td>
<td>MCN</td>
</tr>
<tr>
<td>2002</td>
<td>39</td>
<td>30</td>
</tr>
<tr>
<td>2003</td>
<td>25</td>
<td>22</td>
</tr>
<tr>
<td>2004</td>
<td>82</td>
<td>69</td>
</tr>
<tr>
<td>2005</td>
<td>11</td>
<td>9</td>
</tr>
<tr>
<td>2006</td>
<td>17</td>
<td>15</td>
</tr>
<tr>
<td>2007</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>2008</td>
<td>9</td>
<td>6</td>
</tr>
<tr>
<td>2009</td>
<td>9</td>
<td>7</td>
</tr>
<tr>
<td>2010</td>
<td>23</td>
<td>19</td>
</tr>
<tr>
<td>2011</td>
<td>36</td>
<td>33</td>
</tr>
<tr>
<td>2012</td>
<td>20</td>
<td>14</td>
</tr>
<tr>
<td>2013</td>
<td>29</td>
<td>27</td>
</tr>
<tr>
<td>2014</td>
<td>84</td>
<td>73</td>
</tr>
<tr>
<td>2015</td>
<td>81</td>
<td>73</td>
</tr>
<tr>
<td>2016</td>
<td>28</td>
<td>24</td>
</tr>
<tr>
<td>2017</td>
<td>41</td>
<td>29</td>
</tr>
<tr>
<td>2018</td>
<td>75</td>
<td>54</td>
</tr>
<tr>
<td>Min3</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Max3</td>
<td>84</td>
<td>73</td>
</tr>
<tr>
<td>Avg3</td>
<td>34</td>
<td>29</td>
</tr>
</tbody>
</table>

1Detection efficiency at mainstem projects adjusted by back-applying upstream detects to all downstream sites.
2BONN – Bonneville; MCN – McNary; PRD – Priest Rapids; RI – Rock Island; WEA – Wells; SCP – Spring Cr. (WNFH).
3Annual statistics based on 2002-2017 data.

Harvest

WNFH adults are subjected to ocean and mixed Columbia River fisheries. In 2018, there were no spring Chinook fisheries authorized in the Upper Columbia or Methow rivers. All freshwater recoveries were from the Columbia River mainstem below McNary Dam. There were fisheries on other Mid- and Upper Columbia tributaries but WNFH contributions were rare so we combined them with freshwater sport interceptions. Estimated total harvest contributions for completed broodyears have ranged from <1% to >18%. The harvest rate on the most recent complete broodyear, BY12, was above-average (RMPC.org; Table 25). BY13 is currently reporting the highest harvest levels of any broodyear, but this is expected to change once 2018 and 2019 CWT recovery data is finalized.
Table 25. Winthrop NFH Spring Chinook estimated harvest rates.

<table>
<thead>
<tr>
<th>Brood Year</th>
<th>Mixed Fishery/Harvest</th>
<th>Freshwater Escape.</th>
<th>Total Escapement + Harvest</th>
<th>Harvest Rate (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1999</td>
<td>4</td>
<td>6</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>2000</td>
<td>0</td>
<td>0</td>
<td>15</td>
<td>0</td>
</tr>
<tr>
<td>2001</td>
<td>0</td>
<td>40</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>2002</td>
<td>0</td>
<td>4</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>2003</td>
<td>0</td>
<td>6</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>2004</td>
<td>0</td>
<td>0</td>
<td>116</td>
<td>0</td>
</tr>
<tr>
<td>2005</td>
<td>0</td>
<td>28</td>
<td>8</td>
<td>0</td>
</tr>
<tr>
<td>2006</td>
<td>0</td>
<td>0</td>
<td>315</td>
<td>0</td>
</tr>
<tr>
<td>2007</td>
<td>0</td>
<td>23</td>
<td>35</td>
<td>1</td>
</tr>
<tr>
<td>2008</td>
<td>5</td>
<td>86</td>
<td>106</td>
<td>1</td>
</tr>
<tr>
<td>2009</td>
<td>0</td>
<td>0</td>
<td>10</td>
<td>0</td>
</tr>
<tr>
<td>2010</td>
<td>0</td>
<td>0</td>
<td>53</td>
<td>0</td>
</tr>
<tr>
<td>2011</td>
<td>0</td>
<td>88</td>
<td>161</td>
<td>3</td>
</tr>
<tr>
<td>2012</td>
<td>0</td>
<td>304</td>
<td>185</td>
<td>1</td>
</tr>
<tr>
<td>2013²</td>
<td>2</td>
<td>184</td>
<td>53</td>
<td>6</td>
</tr>
<tr>
<td>Avg.</td>
<td>1</td>
<td>51</td>
<td>71</td>
<td>1</td>
</tr>
</tbody>
</table>

¹Includes research recoveries, test fisheries, etc.
²Broodyear 2013 recovery data incomplete.

Straying

WNFH spring Chinook have low out-of-basin stray rates (Table 26). We analyzed CWT recovery data (RMIS) to describe broodyear escapement patterns, including out-of-basin straying. Recoveries in locations non-indicative of a final destination (e.g. mainstem Columbia River hatcheries and fisheries) were omitted from stray calculations. Only CWT recoveries at locations indicative of straying (e.g. Sherar’s Falls, 44 miles up the Deschutes River, or out-of-basin spawning ground recoveries) and terminal locations in the Methow Subbasin (hatchery and spawning ground recoveries) were included in the analysis. As such, effective, or post-management, stray rates may be slightly lower that values shown.

Estimated out-of-basin stray rate for the latest complete broodyear (2012) was 0.4%, which is consistent with previous years’ pattern of very low out-of-basin stray rates. The stray rate for BY13 is incomplete but shows the highest stray rate yet observed from WNFH spring Chinook. Deeper investigation suggests the high estimate may be due to limitations in recreational fishery creeling methodology; a single WNFH CWT recovery in a recreational fishery on the Similkameen River (Okanogan Subbasin) was expanded to represent 37 estimated recoveries of age-3 jacks in 2016 (G. Lensegrav, pers. comm.). Further recoveries of age-4 and age-5 fish will likely alter the current estimate.

WNFH-origin adults are not desirable on the spawning grounds except during periods of very low escapement when their genetic contribution and boost to effective population size outweigh the risk of domestication. They are considered “management strays” when spawning naturally amongst other MetComp stock spring Chinook, despite being part of the ESU in the Methow Subbasin. The Fishery Parties attempt to mitigate WNFH-origin spawners on the spawning grounds by maximizing WNFH program fish extraction from run most years. This effort has become more coordinated and effective since 2010 and the increased “hatchery homing” rates are seen beginning with broodyear 2006, most of which
returned as age-4 adults in 2010 (Table 26). The push-pull relationship between hatchery homing and management strays is highly affected by management actions (e.g., hatchery ladder/trap opening/closure) and interpretation of these data should be done carefully, particularly in the first decade of the 2000s.

Table 26. Winthrop NFH spring Chinook stray and homing rates.

<table>
<thead>
<tr>
<th>Brood year</th>
<th>Methow spawning grounds</th>
<th>Hatchery returns</th>
<th>OOB stray</th>
<th>Non-biased sample</th>
<th>Stray and homing rates (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Out-of-basin</td>
</tr>
<tr>
<td>2003</td>
<td>153</td>
<td>227</td>
<td>0</td>
<td>380</td>
<td>0.0%</td>
</tr>
<tr>
<td>2004</td>
<td>372</td>
<td>571</td>
<td>1</td>
<td>944</td>
<td>0.1%</td>
</tr>
<tr>
<td>2005</td>
<td>319</td>
<td>315</td>
<td>0</td>
<td>634</td>
<td>0.0%</td>
</tr>
<tr>
<td>2006</td>
<td>1066</td>
<td>1766</td>
<td>18</td>
<td>2850</td>
<td>0.6%</td>
</tr>
<tr>
<td>2007</td>
<td>290</td>
<td>92</td>
<td>1</td>
<td>383</td>
<td>0.3%</td>
</tr>
<tr>
<td>2008</td>
<td>194</td>
<td>2209</td>
<td>0</td>
<td>2403</td>
<td>0.0%</td>
</tr>
<tr>
<td>2009</td>
<td>18</td>
<td>2211</td>
<td>0</td>
<td>2229</td>
<td>0.0%</td>
</tr>
<tr>
<td>2010</td>
<td>9</td>
<td>1080</td>
<td>0</td>
<td>1089</td>
<td>0.0%</td>
</tr>
<tr>
<td>2011</td>
<td>73</td>
<td>5039</td>
<td>0</td>
<td>5112</td>
<td>0.0%</td>
</tr>
<tr>
<td>2012</td>
<td>122</td>
<td>2981</td>
<td>11</td>
<td>3114</td>
<td>0.4%</td>
</tr>
<tr>
<td>2013(^5)</td>
<td>124</td>
<td>306</td>
<td>49</td>
<td>479</td>
<td>10.2%(^5)</td>
</tr>
<tr>
<td>Avg.</td>
<td>249</td>
<td>1527</td>
<td>7</td>
<td>1783</td>
<td>1.1%</td>
</tr>
</tbody>
</table>

\(^1\)Methow Subbasin hatchery returns incl. WNFH & MFH. Hatchery management is coordinated and biological linked.

\(^2\)OOB – Out-of-basin stray, strays recovered outside of the Methow Subbasin (HUC 8).

\(^3\)Non-biased sample excludes ocean and fishery removals non-indicative of final destination.

\(^4\)Within the integrated/stepping stone/safety-net context, WNFH spring Chinook aren’t generally intended for natural spawning.

\(^5\)BY13 data incomplete. High stray rates appear associated with largely-expanded recovery in Similkameen River.

Small numbers of WNFH strays (typically 0-1/year) have occasionally been reported out-of-basin (e.g., Deschutes R. (OR), Icicle Cr. (Wenatchee tributary), and Similkameen R. (Okanogan tributary). In most years, no out-of-basin strays are recovered. The most frequent stray recoveries where robust monitoring occur are in the Entiat Subbasin. WNFH strays have comprised an average of 0.4% of spawner escapement per year since 2004 (Table 27).
Table 27. Estimated WNFH spring Chinook stray frequency and annual contribution to Entiat Subbasin spawn escapement.

<table>
<thead>
<tr>
<th>Year</th>
<th>Est'd spawner escapement</th>
<th>Carcass sample rate (%)</th>
<th>Est'd NORs</th>
<th>Est'd HORs</th>
<th>WNFH CWT rec's (actual)</th>
<th>Est'd WNFH Strays</th>
<th>% WNFH Stray composition</th>
</tr>
</thead>
<tbody>
<tr>
<td>2004</td>
<td>302</td>
<td>14%</td>
<td>47</td>
<td>53</td>
<td>0</td>
<td>0</td>
<td>0.0%</td>
</tr>
<tr>
<td>2005</td>
<td>367</td>
<td>14%</td>
<td>44</td>
<td>56</td>
<td>0</td>
<td>0</td>
<td>0.0%</td>
</tr>
<tr>
<td>2006</td>
<td>254</td>
<td>30%</td>
<td>43</td>
<td>57</td>
<td>2</td>
<td>8</td>
<td>3.1%</td>
</tr>
<tr>
<td>2007</td>
<td>245</td>
<td>17%</td>
<td>43</td>
<td>58</td>
<td>0</td>
<td>0</td>
<td>0.0%</td>
</tr>
<tr>
<td>2008</td>
<td>276</td>
<td>29%</td>
<td>46</td>
<td>54</td>
<td>0</td>
<td>0</td>
<td>0.0%</td>
</tr>
<tr>
<td>2009</td>
<td>276</td>
<td>29%</td>
<td>48</td>
<td>52</td>
<td>0</td>
<td>0</td>
<td>0.0%</td>
</tr>
<tr>
<td>2010</td>
<td>490</td>
<td>19%</td>
<td>75</td>
<td>25</td>
<td>2</td>
<td>11</td>
<td>2.2%</td>
</tr>
<tr>
<td>2011</td>
<td>595</td>
<td>29%</td>
<td>54</td>
<td>46</td>
<td>0</td>
<td>0</td>
<td>0.0%</td>
</tr>
<tr>
<td>2012</td>
<td>566</td>
<td>22%</td>
<td>59</td>
<td>41</td>
<td>0</td>
<td>0</td>
<td>0.0%</td>
</tr>
<tr>
<td>2013</td>
<td>238</td>
<td>9%</td>
<td>79</td>
<td>21</td>
<td>0</td>
<td>0</td>
<td>0.0%</td>
</tr>
<tr>
<td>2014</td>
<td>245</td>
<td>11%</td>
<td>92</td>
<td>8</td>
<td>0</td>
<td>0</td>
<td>0.0%</td>
</tr>
<tr>
<td>2015</td>
<td>509</td>
<td>26%</td>
<td>82</td>
<td>18</td>
<td>0</td>
<td>0</td>
<td>0.0%</td>
</tr>
<tr>
<td>2016</td>
<td>353</td>
<td>15%</td>
<td>84</td>
<td>16</td>
<td>0</td>
<td>0</td>
<td>0.0%</td>
</tr>
<tr>
<td>2017</td>
<td>101</td>
<td>19%</td>
<td>63</td>
<td>37</td>
<td>0</td>
<td>0</td>
<td>0.0%</td>
</tr>
<tr>
<td>2018</td>
<td>92</td>
<td>30%</td>
<td>46</td>
<td>46</td>
<td>0</td>
<td>0</td>
<td>0.0%</td>
</tr>
<tr>
<td>Avg.</td>
<td>327</td>
<td>21%</td>
<td>60</td>
<td>39</td>
<td>0.3</td>
<td>1.3</td>
<td>0.4%</td>
</tr>
</tbody>
</table>

*Data courtesy of G. Fraser, USFWS.

Smolt-to-Adult Return (SAR) Update

The Smolt-to-Adult Return (SAR) is the primary post-release metric for evaluating hatchery program performance for a broodyear because it directly describes the number of adults produced from a juvenile release. SARs are calculated using RMIS CWT juvenile release and adult recovery data. Adult recovery data are used to estimate fishery removals, recoveries on spawning grounds, and hatchery returns, all expanded by sampling effort and tagging rates. SAR estimates do not include early-maturing life histories such as age-2 minijacks. Generally, recovery information is considered complete five years after release (e.g. BY2000 spring Chinook, released 2002, age-5 returns complete 2005, CWT data complete by 2007); however, recovery data come from many sources and new data and/or revisions may continue for multiple years beyond lifecycle completion.

WNFH spring Chinook SARs have averaged 0.4% since BY2000. BY10 and BY11 cohorts achieved >1.0% SAR during periods of good ocean conditions. The BY12 SAR is stabilizing at about 0.55%, slightly above average (Table 28). Spring Chinook released from MFH generally outperformed WNFH spring Chinook from BY2000 through BY08; however, the WNFH outperformed MFH for three of the four most recent broodyears (Figure 8).
<table>
<thead>
<tr>
<th>Brood year</th>
<th>Release year</th>
<th>Smolt release</th>
<th>Fishery Recoveries</th>
<th>Adult Escapement</th>
<th>Total Adults</th>
<th>Smolt-to-Adult (SAR)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Hatchery Return</td>
<td>Spawning Ground</td>
<td></td>
</tr>
<tr>
<td>2000</td>
<td>2002</td>
<td>190,368</td>
<td>15</td>
<td>434</td>
<td>131</td>
<td>581</td>
</tr>
<tr>
<td>2001</td>
<td>2003</td>
<td>586,361</td>
<td>45</td>
<td>334</td>
<td>135</td>
<td>514</td>
</tr>
<tr>
<td>2002</td>
<td>2004</td>
<td>583,307</td>
<td>6</td>
<td>388</td>
<td>222</td>
<td>616</td>
</tr>
<tr>
<td>2003</td>
<td>2005</td>
<td>565,214</td>
<td>10</td>
<td>227</td>
<td>153</td>
<td>390</td>
</tr>
<tr>
<td>2004</td>
<td>2006</td>
<td>484,090</td>
<td>118</td>
<td>571</td>
<td>369</td>
<td>1056</td>
</tr>
<tr>
<td>2005</td>
<td>2007</td>
<td>609,693</td>
<td>36</td>
<td>315</td>
<td>318</td>
<td>668</td>
</tr>
<tr>
<td>2006</td>
<td>2008</td>
<td>509,045</td>
<td>315</td>
<td>1766</td>
<td>1078</td>
<td>3160</td>
</tr>
<tr>
<td>2007</td>
<td>2009</td>
<td>376,959</td>
<td>58</td>
<td>923</td>
<td>289</td>
<td>1270</td>
</tr>
<tr>
<td>2008</td>
<td>2010</td>
<td>505,978</td>
<td>198</td>
<td>2212</td>
<td>194</td>
<td>2603</td>
</tr>
<tr>
<td>2009</td>
<td>2011</td>
<td>426,980</td>
<td>10</td>
<td>1080</td>
<td>17</td>
<td>1107</td>
</tr>
<tr>
<td>2010</td>
<td>2012</td>
<td>499,959</td>
<td>182</td>
<td>5039</td>
<td>245</td>
<td>5467</td>
</tr>
<tr>
<td>2011</td>
<td>2013</td>
<td>359,541</td>
<td>528</td>
<td>2981</td>
<td>228</td>
<td>3738</td>
</tr>
<tr>
<td>2012</td>
<td>2014</td>
<td>560,379</td>
<td>493</td>
<td>2483</td>
<td>128</td>
<td>3104</td>
</tr>
<tr>
<td>2013(^{1})</td>
<td>2015</td>
<td>403,510</td>
<td>246</td>
<td>317</td>
<td>123</td>
<td>686</td>
</tr>
<tr>
<td>Avg.</td>
<td></td>
<td>481,375</td>
<td>155</td>
<td>1443</td>
<td>270</td>
<td>1867</td>
</tr>
</tbody>
</table>

\(^{1}\)BY13 data likely incomplete and subject to review and update as additional CWT data is reported to RMIS.org.
Figure 8. Winthrop NFH spring Chinook annual smolt-to-adult return (SAR) values (%) by broodyear.

Hatchery Replacement Rate (HRR) Update

Hatchery Replacement Rate (HRR) is the ratio of the number of returning hatchery adults relative to the number of broodstock used to produce them, and is also known as the adult-to-adult replacement rate. WNFH adult return estimates were back-assigned to broodyear and associated numbers of broodstock held. In years when large numbers of adults were collected and held for adult management purposes it becomes increasingly difficult to calculate HRR, particularly in a retrospective analysis. The BY12 HRR of 6.8 was above-average, which was consistent with higher HRR values seen since BY06 (Table 29). In all years reported, HRR values greatly exceed Methow Subbasin NRR estimates reported by Snow et al. (2019). Only during several years of very low escapement in the mid-to-late 1990s do NRR values exceed 1.0 (Snow et al. 2017). However, number of broodstock held in a given year is likely more correlated with management direction than run strength or hatchery performance in most years.
Table 29. Estimated Winthrop NFH Spring Chinook hatchery replacement rate (HRR).

<table>
<thead>
<tr>
<th>Brood Year</th>
<th>Broodstock Held</th>
<th>Total Adult Returns</th>
<th>Hatchery Replacement Rate (HRR)</th>
<th>Methow Subbasin Broodyear Natural Replacement Rate (NRR)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000</td>
<td>112</td>
<td>581</td>
<td>5.2</td>
<td>0.7</td>
</tr>
<tr>
<td>2001</td>
<td>330</td>
<td>514</td>
<td>1.6</td>
<td>0.1</td>
</tr>
<tr>
<td>2002</td>
<td>374</td>
<td>616</td>
<td>1.6</td>
<td>0.2</td>
</tr>
<tr>
<td>2003</td>
<td>398</td>
<td>390</td>
<td>1.0</td>
<td>0.1</td>
</tr>
<tr>
<td>2004</td>
<td>334</td>
<td>1056</td>
<td>3.2</td>
<td>0.3</td>
</tr>
<tr>
<td>2005</td>
<td>400</td>
<td>668</td>
<td>1.7</td>
<td>0.5</td>
</tr>
<tr>
<td>2006</td>
<td>367</td>
<td>3160</td>
<td>8.6</td>
<td>1.0</td>
</tr>
<tr>
<td>2007</td>
<td>323</td>
<td>1270</td>
<td>3.9</td>
<td>0.8</td>
</tr>
<tr>
<td>2008</td>
<td>411</td>
<td>2603</td>
<td>6.3</td>
<td>0.4</td>
</tr>
<tr>
<td>2009</td>
<td>348</td>
<td>1107</td>
<td>3.2</td>
<td>0.1</td>
</tr>
<tr>
<td>2010</td>
<td>406</td>
<td>5443</td>
<td>13.4</td>
<td>0.4</td>
</tr>
<tr>
<td>2011</td>
<td>400</td>
<td>3320</td>
<td>8.3</td>
<td>0.2</td>
</tr>
<tr>
<td>2012</td>
<td>453</td>
<td>3096</td>
<td>6.8</td>
<td>0.3</td>
</tr>
<tr>
<td>2013</td>
<td>505</td>
<td>686</td>
<td>1.4</td>
<td>N/A</td>
</tr>
<tr>
<td>Avg.³</td>
<td>358</td>
<td>1867</td>
<td>5.1</td>
<td>0.4</td>
</tr>
</tbody>
</table>

¹Broodstock held was compilation of different data sources. Assignment of pre-spawn mortality when adult management activities increase total held fish was apportioned by time of occurrence and proportion of pond population.
²Data distilled from estimated values for Methow R., Twisp R. and Chewuch R. sub-watersheds (Snow et al. 2019)
³Average values calculated through BY12 to avoid incomplete BY13 life-cycle and immature datastreams.

Natural Environment Monitoring

Escapement Estimate/Summary

Escapement patterns in 2018 demonstrated that fish were primarily recovered at hatcheries (91.3%; WNFH and MFH), had a low out-of-basin stray rate (0.6%), and a small proportion spawned naturally (8.0%). These trends were similar to recent years and were associated with increased efforts to maximize extraction via hatchery infrastructure, especially since 2012 (Table 30). The primary data source for WNFH-origin adult returns was CWT recovery data (as reported in RMIS), except when more accurate data were available for particular recovery categories (e.g., hatchery recovery data not yet uploaded to RMIS.org). Spawning ground recoveries outside the Methow Subbasin (e.g., Entiat River) were considered out-of-basin strays, not spawning ground recoveries.
Table 30. Winthrop NFH Spring Chinook general freshwater escapement and management patterns.

<table>
<thead>
<tr>
<th>Run Year</th>
<th>Hatchery Removals</th>
<th>Out-of-basin Strays</th>
<th>Spawning Grounds</th>
<th>Total Freshwater Escapement</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N = %</td>
<td>N = %</td>
<td>N = %</td>
<td></td>
</tr>
<tr>
<td>2000</td>
<td>897 87.3%</td>
<td>0 0.0%</td>
<td>131 12.7%</td>
<td>1,028</td>
</tr>
<tr>
<td>2001</td>
<td>525 92.6%</td>
<td>4 0.7%</td>
<td>38 6.7%</td>
<td>567</td>
</tr>
<tr>
<td>2002</td>
<td>463 92.4%</td>
<td>10 2.0%</td>
<td>28 5.6%</td>
<td>501</td>
</tr>
<tr>
<td>2003</td>
<td>321 60.6%</td>
<td>6 1.1%</td>
<td>203 38.3%</td>
<td>530</td>
</tr>
<tr>
<td>2004</td>
<td>397 70.5%</td>
<td>1 0.2%</td>
<td>165 29.3%</td>
<td>563</td>
</tr>
<tr>
<td>2005</td>
<td>346 75.7%</td>
<td>3 0.7%</td>
<td>108 23.6%</td>
<td>457</td>
</tr>
<tr>
<td>2006</td>
<td>324 52.2%</td>
<td>4 0.6%</td>
<td>293 47.2%</td>
<td>621</td>
</tr>
<tr>
<td>2007</td>
<td>363 50.9%</td>
<td>0 0.0%</td>
<td>350 49.1%</td>
<td>713</td>
</tr>
<tr>
<td>2008</td>
<td>482 66.9%</td>
<td>0 0.0%</td>
<td>239 33.1%</td>
<td>721</td>
</tr>
<tr>
<td>2009</td>
<td>353 32.3%</td>
<td>1 0.1%</td>
<td>740 67.6%</td>
<td>1,094</td>
</tr>
<tr>
<td>2010</td>
<td>1,782 76.8%</td>
<td>17 0.7%</td>
<td>521 22.5%</td>
<td>2,320</td>
</tr>
<tr>
<td>2011</td>
<td>1,486 75.4%</td>
<td>0 0.0%</td>
<td>484 24.6%</td>
<td>1,970</td>
</tr>
<tr>
<td>2012</td>
<td>1,727 95.9%</td>
<td>0 0.0%</td>
<td>74 4.1%</td>
<td>1,801</td>
</tr>
<tr>
<td>2013</td>
<td>2,156 97.9%</td>
<td>0 0.0%</td>
<td>46 2.1%</td>
<td>2,202</td>
</tr>
<tr>
<td>2014</td>
<td>4,299 94.1%</td>
<td>0 0.0%</td>
<td>268 5.9%</td>
<td>4,567</td>
</tr>
<tr>
<td>2015</td>
<td>4,001 94.6%</td>
<td>5 0.1%</td>
<td>224 5.3%</td>
<td>4,230</td>
</tr>
<tr>
<td>2016</td>
<td>2,807 94.4%</td>
<td>6 0.2%</td>
<td>161 5.4%</td>
<td>2,974</td>
</tr>
<tr>
<td>2017</td>
<td>1,409 86.6%</td>
<td>124 7.6%</td>
<td>94 5.8%</td>
<td>1,627</td>
</tr>
<tr>
<td>2018</td>
<td>1,182 91.3%</td>
<td>8 0.6%</td>
<td>104 8.0%</td>
<td>1,294</td>
</tr>
<tr>
<td>Min</td>
<td>321 31.7%</td>
<td>0 0.0%</td>
<td>28 2.0%</td>
<td>457</td>
</tr>
<tr>
<td>Max</td>
<td>4,299 98.0%</td>
<td>124 2.7%</td>
<td>740 68.2%</td>
<td>4,567</td>
</tr>
<tr>
<td>Avg.</td>
<td>1,341 78.8%</td>
<td>10 0.4%</td>
<td>232 20.9%</td>
<td>1,583</td>
</tr>
</tbody>
</table>

1 Hatchery removals restricted to Methow Subbasin hatcheries (WNFH and MFH). Other mainstem hatcheries excluded. Removal rate calculated from total freshwater escapement and exclude pre-spawn mortalities. Run extraction rates reported elsewhere likely exclude pre-spawn mortalities and, as such, are likely lower rates.

2 Data for 2003-2018 courtesy of C. Snow, WDFW.

3 Freshwater escapement estimates exclude mainstem fishery/hatchery removals.

4 Unique observed CWT recoveries from recreational fishery in Similkameen River, each expanded by to >37.3 recoveries each.

**Spawner Composition and Gene Flow Metrics**

ESA consultations and evaluation of hatchery supplementation programs focus increasingly on gene flow metrics, particularly the proportion of hatchery-origin spawners (pHOS) and proportionate natural influence (PNI). Snow et al. (2019) summarized escapement and both pHOS and PNI in sub-watersheds of the Methow Subbasin (upper Methow, Chewuch, and Twisp rivers), using redd survey and carcass recovery data. These data were compiled and re-calculated at the subbasin-scale and PNI was recalculated using the 3-population model (Busack, 2015). The subbasin-scale 3-pop PNI was estimated at 0.57 in 2018, the first time the PNI target of >0.5 (NOAA 2016a) has been met since being estimated (Table 31; Figure 9).

Partial program pHOS (ppHOS) of WNFH spawners was below maximum limits of <0.2 in 11 of the last 16 years, and 7 of the last 8 (Table 31). The ability to meet annual ppHOS targets has been more
successful in recent years when WNFH and partners have coordinated to remove large proportions (>90%) of returning WNFH adults.

Despite success removing WNFH adults in recent years, NOR abundance on the spawning grounds has remained sufficiently low that ppHOS targets have been very difficult to reach. PNI values and ppHOS values attained in 2018 are the best results yet seen in the reporting period; however, hatchery selective forces have continued to dominate on the spawning grounds most years. Increasing out-of-basin stray rates documented in recent years also complicate gene flow analysis and affect pHOS/PNI (Figure 9).

Table 31. Methow Spring Chinook spawning ground gene flow metrics, including PNI and program partial pHOS.

<table>
<thead>
<tr>
<th>Year</th>
<th>Total Spawner Escapement</th>
<th>Methow Subbasin Escapement</th>
<th>Program partial pHOS estimates</th>
<th>Out-of-basin Strays</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total Spawner Escapement</td>
<td>Methow Subbasin Escapement</td>
<td>Program partial pHOS estimates</td>
<td>Out-of-basin Strays</td>
</tr>
<tr>
<td></td>
<td>Escapement</td>
<td>Combined pHOS</td>
<td>PNI_2,3</td>
<td>PNI 5y moving avg.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>WPNI</td>
<td></td>
</tr>
<tr>
<td>2003</td>
<td>1,138</td>
<td>0.95</td>
<td>0.30</td>
<td>0.27</td>
</tr>
<tr>
<td>2004</td>
<td>1,497</td>
<td>0.67</td>
<td>0.09</td>
<td>0.22</td>
</tr>
<tr>
<td>2005</td>
<td>1,376</td>
<td>0.62</td>
<td>0.42</td>
<td>0.22</td>
</tr>
<tr>
<td>2006</td>
<td>1,748</td>
<td>0.81</td>
<td>0.06</td>
<td>0.21</td>
</tr>
<tr>
<td>2007</td>
<td>1,079</td>
<td>0.75</td>
<td>0.24</td>
<td>0.24</td>
</tr>
<tr>
<td>2008</td>
<td>1,002</td>
<td>0.70</td>
<td>0.24</td>
<td>0.17</td>
</tr>
<tr>
<td>2009</td>
<td>2,641</td>
<td>0.79</td>
<td>0.22</td>
<td>0.19</td>
</tr>
<tr>
<td>2010</td>
<td>2,369</td>
<td>0.75</td>
<td>0.09</td>
<td>0.20</td>
</tr>
<tr>
<td>2011</td>
<td>2,936</td>
<td>0.67</td>
<td>0.18</td>
<td>0.22</td>
</tr>
<tr>
<td>2012</td>
<td>1,298</td>
<td>0.8</td>
<td>0.25</td>
<td>0.25</td>
</tr>
<tr>
<td>2013</td>
<td>1,089</td>
<td>0.78</td>
<td>0.37</td>
<td>0.30</td>
</tr>
<tr>
<td>2014</td>
<td>2,063</td>
<td>0.75</td>
<td>0.38</td>
<td>0.33</td>
</tr>
<tr>
<td>2015</td>
<td>1,353</td>
<td>0.71</td>
<td>0.34</td>
<td>0.36</td>
</tr>
<tr>
<td>2016</td>
<td>697</td>
<td>0.54</td>
<td>0.30</td>
<td>0.40</td>
</tr>
<tr>
<td>2017</td>
<td>464</td>
<td>0.62</td>
<td>0.40</td>
<td>0.40</td>
</tr>
<tr>
<td>2018</td>
<td>500</td>
<td>0.47</td>
<td>0.57</td>
<td>0.42</td>
</tr>
<tr>
<td>Avg.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1Escapement estimates and derivatives from Snow et al. (2019) data.
2PNI estimates re-calculated using Snow et al. (2019) data and NOAA 3-pop PNI tool (Busack 2015)
3PNI values differ slightly from Snow et al. (2019) estimates due exclusion of out-of-basin strays in this analysis.
45y moving average data for early and late years based on nearest available years’ data.
5Program ppHOS target from in NOAA biological opinion, based on estimated NOR run size; red indicates exceedance.
Discussion of Performance against Program Targets

Summary of Broodstock Collection Objectives

WNFH operated its adult ladder almost continuously from May 24 to August 26 in 2016. Cooperative adult collection at MFH coincided with this timeframe. A total of 3,362 adults passed through WNFH in 2016 which easily achieved full broodstock allocation. WNFH considers 96.5% (N=386) of the official target (N=400) to be adequate for eggtake needs. Due to large returns (including both programs), BY16 adult composition was 90% conservation program adults, exceeding the BiOp target of >75%. The high conservation program portion will benefit PNI calculations in 2019-2021 when these adults return. Full eggtake also allowed WNFH to transfer gametes to the Okanogan 10(j) reintroduction program and to cull for BKD risk. Adult pre-spawn mortality was low in 2016 (1.0%; Table 2), exceeding the operational goal of >93% adult survival.

Summary of Adult Management Objectives

The 3,362 adult spring Chinook collected at WNFH and transfers from MFH comprised the vast majority of the subbasin’s estimated total escapement. WDFW reported that the remaining 2016 subbasin spawner escapement consisted of 697 spring Chinook, of which 377 were hatchery origin (Snow et al. 2017). This data confirmed that adult management efforts at WNFH and MFH significantly reduced the number of hatchery-origin spawners and improved pHOS/PNI metrics.

Removal of the hatchery-origin return resulted in a subbasin-wide pHOS of 0.54 on the spawning grounds in 2016, substantially less than the preceding 5y average pHOS of 0.74. The WNFH program ppHOS value of 0.27 on the spawning grounds exceeded the (yet un-official) target of <0.2. Notably, 2016 is the only year between 2012 and 2018 this target was missed (Table 31). In 2016, the ppHOS goal was mathematically difficult to achieve due to low NOR abundance despite a high HOR extraction rate of
>94% (Table 31). High safety-net program removal rates resulted in significant improvement of ppHOS compared to pre-management condition of the run.

The 2016 3-pop PNI calculation value at the subbasin-scale was 0.30 indicating that selective forces on the spawning grounds were likely dominated by hatchery-origin fish. This is not identified in Permit #18927 (NOAA 2016b) as a WNFH program reporting requirement but is discussed retrospectively in association with 2016 adult management activities (Table 31).

**Summary of In-hatchery Rearing/Fish Culture Objectives**

The BY16 green eggtake (761,576) was 95.2% of the 800K target but sufficient to meet smolt release targets. The post-cull (ELISA) target of 650K was almost achieved (97.7%; 634,877), and WNFH estimated its pre-transfer eyed egg total at 710,649. Estimated eye-up rate was 93.3%, exceeding the target value of >90%. An estimated 210,748 eyed eggs were transferred to the Colville Tribes’ Chief Joseph Hatchery Okanogan 10(j) reintroduction program, which was 95.8% of the 220K target.

An estimated 416,614 fry were ponded, compared to an estimated 405,566 smolts released, equating to a parr-to-smolt survival of 97.3%, exceeding the 95% target.

**Summary of Juvenile Release Objectives**

Juvenile release targets were successfully achieved for the BY16 group. In April 2018 WNFH released 405,566 smolts (101.3% of goal). Post-tagging surveys of marked fish showed them to be 99.0% CWT-tagged and 99.7% adipose clipped, well within target levels. Pre-release GSI sampling indicated that 4.7% of the total population were early-maturing males, which was within the 25% maximum identified in the BiOp.

**Summary of Fishery Contribution and Harvest Objectives**

There are no current fishery contribution and/or harvest targets for the WNFH spring Chinook program. An estimated 15.9% of BY12 (latest complete BY) was harvested, which is higher than the 1999-2012 average of 7.6%. These recent increase in harvest rate around BY11/BY12 likely correlates with a shift in the external mark strategy making WNFH spring Chinook available to mark-select fisheries. CWT recovery data for BY13 is incomplete; however, these data suggest the harvest rate for this group is above average (Table 25).

WNFH has surplused substantial proportions of the adult hatchery return to inland Northwest Indian tribes’ subsistence food programs over the last few years. Although there is no defined target for the quantity of fish WNFH surpluses to these programs, the objective is to maximize the number of excess fish going to the tribal programs once escapement and broodstock needs are met. A mark-selective spring Chinook fishery in the Methow River would reduce hatchery-origin fish on the spawning grounds and improve gene flow metrics (PNI/pHOS). We suggest that a selective fishery in the Methow River be considered during years of large returns such as in 2014 and 2015, when large numbers of hatchery-origin spawners remained on the spawning grounds and gene flow targets were not achieved.

**Summary of Escapement-based Objectives**

Program implementation, from broodstock collection through juvenile release of BY16 spring Chinook, all occurred prior to publishing of Permit #18927; however, escapement and gene flow objectives were anticipated and guiding documents were readily available (e.g. HSRG, etc.). Managers had been
attempting to manage excess returning adults and implement the stepping stone hatchery model for several years by 2016.

Gene flow targets pertinent to WNFH management were partially achieved in 2016, and further improved in 2017 and 2018 (Table 31). The program partial pHOS target/maximum (0.20) was exceeded in 2016 (0.27) but fell to 0.19 in 2017 and 0.10 in 2018. We expect that this target will be achievable in most future years, though may be difficult to achieve in years of proportionately low NOR abundance. Overall subbasin PNI targets (0.50 in BiOp, 0.67 from HSRG) for the co-managers remain elusive; however, the highest single PNI value recorded in the Methow Subbasin, 0.57, occurred in 2018. We are optimistic that even the HSRG target for integrated populations may be achievable through continued aggressive removal of safety-net adults, and judicious broodstock management in both the conservation program (maximize pNOB) and safety-net program (maximize inclusion of conservation program brood).

Experimental manipulation of the PNI model demonstrates the importance of the following four components in achieving program partial pHOS and, more importantly, PNI targets, to be applied when escapement thresholds described in the HGMP/BiOp are met:

1) Maintain high pNOB in conservation program broodstock
2) Maintain high proportion of conservation program adults in the safety-net broodstock
3) Maximize removal of WNFH Safety-net adults via fisheries and aggressive adult management, when appropriate.
4) Under certain run conditions, removal of more conservation program adults than necessary may hinder the ability to attain safety-net partial pHOS targets, even in situations where PNI targets are theoretically attained or approached.

Collaborative interagency coordination, planning, and implementation of recommendations will be critical in ensuring gene flow objectives of conservation and safety-net programs (both spring Chinook and steelhead) are achievable in future years. It is likely that adult management (removal efficiency) for combined programs is maximized under existing infrastructure and fishery management paradigms. Judicious implementation of broodstock allocation (i.e. broodstock pNOB and % conservation program inclusion in the safety-net program) will be as, or more, critical than returning adult management in achieving PNI targets – it is also the component managers retain the most control over. Success in broodstock management may help reduce/alleviate situations where achieving PNI targets comes in conflict with meeting production targets.
LITERATURE CITED


Frady, Charles. Fish Biologist, Washington Department of Fish & Wildlife, Twisp, WA. Personal communication September 2019.


Lensegrav, G. WDFW Stock Identification and Abundance Unit Manager. Olympia, WA. Personal communication October 2019.


USFWS. 2009. Hatchery and Genetic Management Plan (HGMP) for the Winthrop National Fish Hatchery, Leavenworth Hatchery Complex. Leavenworth, WA.


USFWS. 2016. Biological Opinion for the operations and maintenance of the Winthrop National Fish Hatchery. USFWS Ref# 01EWF00-2015-F-1041. USFWS, Ecological Services, Central Washington Field Office, Wenatchee, WA.


## Appendix A. WNFH Spring Chinook Program Monitoring Goals & Objectives.

<table>
<thead>
<tr>
<th>Stage</th>
<th>Monitoring Attribute</th>
<th>Operational Criteria/Target</th>
<th>Source of Criterion/Target</th>
</tr>
</thead>
<tbody>
<tr>
<td>Broodstock Collection &amp; Management</td>
<td>Stock &amp; ESU</td>
<td>Methow Composite, Upper Columbia Spring-run ESU</td>
<td>HGMP</td>
</tr>
<tr>
<td></td>
<td>Strategy</td>
<td>Integrated harvest/stepping stone</td>
<td>HGMP</td>
</tr>
<tr>
<td></td>
<td>Collection locations</td>
<td>Hatchery ladder &amp; transfers from Methow Fish Hatchery</td>
<td>HGMP</td>
</tr>
<tr>
<td></td>
<td>Ladder operation</td>
<td>Continuous (throughout run)</td>
<td>HGMP</td>
</tr>
<tr>
<td></td>
<td>Broodstock coll. target</td>
<td>400 total (267 for WNFH + 133 for Chief Joseph)</td>
<td>HGMP</td>
</tr>
<tr>
<td></td>
<td>Prophylaxis</td>
<td>Formalin treat ADHP</td>
<td>WA Co-managers Disease Control Policy</td>
</tr>
<tr>
<td></td>
<td>Adult holding temperature</td>
<td>&lt;52°F (&lt;11°C)</td>
<td>Facility-specific operational detail</td>
</tr>
<tr>
<td></td>
<td>Adult pre-spawn survival</td>
<td>&gt;93%</td>
<td>Facility-specific operational detail</td>
</tr>
<tr>
<td></td>
<td>Adult sampling</td>
<td>Representative sub-sample</td>
<td>HEP</td>
</tr>
<tr>
<td></td>
<td>Adult monitoring</td>
<td>Origin/sex/age/length/external mark/Tag ID</td>
<td>HEP</td>
</tr>
<tr>
<td>Spawning</td>
<td>Spawner M:F ratio</td>
<td>1:1 (backup - yes)</td>
<td>HGMP</td>
</tr>
<tr>
<td></td>
<td>Fish Health Monitoring</td>
<td>BKD 100% females, virology/bacteriology</td>
<td>Washington State Co-managers Disease Control Policy</td>
</tr>
<tr>
<td></td>
<td>Adult sampling</td>
<td>100%</td>
<td>HEP</td>
</tr>
<tr>
<td></td>
<td>Adult monitoring</td>
<td>Origin, sex, age, length, mark, CWT</td>
<td>HEP</td>
</tr>
<tr>
<td></td>
<td>Jack (age-3) males in brood</td>
<td>&lt;10% of males</td>
<td>HGMP</td>
</tr>
<tr>
<td>Eggtake, incubation, &amp; Gamete Management</td>
<td>Green egg target</td>
<td>800,000</td>
<td>HGMP</td>
</tr>
<tr>
<td></td>
<td>Prophylaxis</td>
<td>Disinfect, water harden</td>
<td>WA Co-managers Disease Control Policy</td>
</tr>
<tr>
<td></td>
<td>Incubation units</td>
<td>Heath trays</td>
<td>Facility-specific operational detail</td>
</tr>
<tr>
<td></td>
<td>Water source</td>
<td>Well/Infiltration galleries</td>
<td>Facility-specific operational detail</td>
</tr>
<tr>
<td></td>
<td>Water quality monitoring</td>
<td>Temperature, flow rate, &amp; gases if suspect</td>
<td>Facility-specific operational detail</td>
</tr>
<tr>
<td></td>
<td>BKD Culling</td>
<td>15% by ELISA rank unless high number of moderate risk</td>
<td>HGMP</td>
</tr>
<tr>
<td></td>
<td>Post-cull egg total</td>
<td>650,000</td>
<td>Facility-specific operational detail</td>
</tr>
<tr>
<td></td>
<td>Shocking</td>
<td>Eggs kept at 1 female per tray</td>
<td>Facility-specific operational detail</td>
</tr>
<tr>
<td></td>
<td>% green-to-eyed egg</td>
<td>&gt;90%/430,000 +220K to CJH</td>
<td>HGMP</td>
</tr>
<tr>
<td></td>
<td>% eyed-to-fry</td>
<td>&gt;95%/408,000 fry</td>
<td>Facility-specific operational detail</td>
</tr>
</tbody>
</table>

1Reportable metric.
### Early Rearing Parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rearing units</td>
<td>Starter tanks</td>
<td>Facility-specific operational detail</td>
</tr>
<tr>
<td>Water source</td>
<td>Well/Infiltration Galleries</td>
<td>Facility-specific operational detail</td>
</tr>
<tr>
<td>Water quality monitoring</td>
<td>Temperature, flow rates, dissolved gases when needed</td>
<td>Facility-specific operational detail</td>
</tr>
<tr>
<td>Feed type</td>
<td>Bio Oregon Starter Feeds</td>
<td>Facility-specific operational detail</td>
</tr>
<tr>
<td>Feed frequency</td>
<td>6-8 times/day</td>
<td>Facility-specific operational detail</td>
</tr>
<tr>
<td>Feed amount (%BW/Day)</td>
<td>1.0-2.0%</td>
<td>Facility-specific operational detail</td>
</tr>
<tr>
<td>Cleaning frequency</td>
<td>Daily</td>
<td>Washington State Co-managers Disease Control Policy</td>
</tr>
<tr>
<td>Monthly monitoring</td>
<td>Len/ft./K/CV</td>
<td>Facility-specific operational detail</td>
</tr>
</tbody>
</table>

### Pre-Tagging Rearing Parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rearing units</td>
<td>Small FL's, 8X80 raceways and 12x100's</td>
<td>Facility-specific operational detail</td>
</tr>
<tr>
<td>Water source</td>
<td>Well/Infiltration gallery</td>
<td>Facility-specific operational detail</td>
</tr>
<tr>
<td>Water quality monitoring</td>
<td>Temperature, dissolved gases when needed, &amp; flow rates</td>
<td>Facility-specific operational detail</td>
</tr>
<tr>
<td>Feed type</td>
<td>Bio Oregon Feeds; Vita, Bio Pro 2</td>
<td>Facility-specific operational detail</td>
</tr>
<tr>
<td>Feed frequency</td>
<td>2-4 times/day</td>
<td>Facility-specific operational detail</td>
</tr>
<tr>
<td>Feed amount (%BW/Day)</td>
<td>1.0-2.0%</td>
<td>Facility-specific operational detail</td>
</tr>
<tr>
<td>Feed application</td>
<td>Hand</td>
<td>Facility-specific operational detail</td>
</tr>
<tr>
<td>Cleaning frequency</td>
<td>Daily</td>
<td>Washington State Co-managers Disease Control Policy</td>
</tr>
<tr>
<td>Mass marking (^1)</td>
<td>100% Ad-clip + CWT, including 20K PIT</td>
<td>US v OR (marking), HEP describes PIT use/objectives</td>
</tr>
<tr>
<td>Monthly monitoring</td>
<td>Monthly fish health &amp; biometrics, CWT &amp; PIT retentions</td>
<td>Washington State Co-managers Disease Control Policy, HEP</td>
</tr>
</tbody>
</table>

\(^1\)Reportable metric.
<table>
<thead>
<tr>
<th>Post-Tagging Rearing Parameters</th>
<th>Facility-specific operational detail</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Rearing units</strong></td>
<td>8X80’s &amp; 12X100’s</td>
</tr>
<tr>
<td><strong>Water source</strong></td>
<td>Well/Infiltration Galleries/River</td>
</tr>
<tr>
<td><strong>Water quality monitoring</strong></td>
<td>Temp., dissolved gases when needed, &amp; flow rates</td>
</tr>
<tr>
<td><strong>Feed type</strong></td>
<td>BioVita</td>
</tr>
<tr>
<td><strong>Feed frequency</strong></td>
<td>Variable: Daily to 3x/week</td>
</tr>
<tr>
<td><strong>Feed amount (%BW/Day)</strong></td>
<td>1.0-2.0%</td>
</tr>
<tr>
<td><strong>Cleaning frequency</strong></td>
<td>Brushed 1-2x/wk</td>
</tr>
<tr>
<td><strong>Monthly monitoring</strong></td>
<td>Monthly fish health &amp; biometrics</td>
</tr>
<tr>
<td><strong>Water temperature</strong></td>
<td>&lt;60°F</td>
</tr>
<tr>
<td><strong>Dissolved O₂</strong></td>
<td>&gt;80% saturation &amp; 5ppm</td>
</tr>
<tr>
<td><strong>Turnover rate</strong></td>
<td>≤ 1/hour</td>
</tr>
<tr>
<td><strong>Density Index</strong></td>
<td>≤ 0.11</td>
</tr>
<tr>
<td><strong>Flow Index</strong></td>
<td>≤ 1.0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Smolt Release</th>
<th>Facility-specific operational detail</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Condition factor (K)(^1)</strong></td>
<td>1</td>
</tr>
<tr>
<td><strong>Size (FPP)(^1)</strong></td>
<td>15-17</td>
</tr>
<tr>
<td><strong>Early maturation (% males)(^1)</strong></td>
<td>&lt;25% (5y-avg. beginning with 2016 release)</td>
</tr>
<tr>
<td><strong>Release type</strong></td>
<td>Semi-forced, must swim over one dam board</td>
</tr>
<tr>
<td><strong>Release time(^1)</strong></td>
<td>3(^{rd}) week of April</td>
</tr>
<tr>
<td><strong>Release Goal(^1)</strong></td>
<td>400,000</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Survival and Escapement Metrics</th>
<th>Facility-specific operational detail</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Green egg to smolt survival(^1)</strong></td>
<td>85%</td>
</tr>
<tr>
<td><strong>Green egg to fry survival(^1)</strong></td>
<td>95%</td>
</tr>
<tr>
<td><strong>Fry to smolt survival(^1)</strong></td>
<td>95%</td>
</tr>
<tr>
<td><strong>Smolt to adult survival(^1)</strong></td>
<td>0.30%-1.0%</td>
</tr>
<tr>
<td><strong>Hatchery return rate (HRR)(^1)</strong></td>
<td>&gt;1, see BiOp: dependent on pNOB/pHOS/PNI</td>
</tr>
<tr>
<td><strong>Partial pHOS on spawn.grd(^1)</strong></td>
<td>0.1-0.2, sliding scale with natural run</td>
</tr>
<tr>
<td><strong>Subbasin PNI(^1)</strong></td>
<td>&gt;0.67</td>
</tr>
<tr>
<td><strong>Stray rate to Entiat(^1)</strong></td>
<td>WNFH comprise &lt;5% of Entiat Subbasin natural spawners</td>
</tr>
</tbody>
</table>

\(^1\)Reportable metric
Appendix B. Permit #18927 Reporting Requirement Summary.

NMFS’s Section 10(a)(1)(A) Permit for Take of Endangered/Threatened Species for the Winthrop NFH Spring Chinook Salmon program includes authorization/provision of take as well as specification of special conditions, general handling requirements, terms and conditions, and minimum permit reporting requirements.

This summary appendix was generated to accompany the WNFH annual report and is consistent with activities through completion of the BY16 release period.

Authorized Take Compliance Statement

The WNFH Spring Chinook program complied with Permit #18927 take authorization allowances during the BY16 production cycle. The original table from Permit #18927 is displayed below with modifications (in italics) to compare actual values against values authorized in the permit for both WNFH program and associated RM&E activities.

<table>
<thead>
<tr>
<th>Type of take</th>
<th>Amount of Take</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Harass</td>
</tr>
<tr>
<td></td>
<td>Mortality</td>
</tr>
<tr>
<td></td>
<td>Adult</td>
</tr>
<tr>
<td>Enhancement activities</td>
<td></td>
</tr>
<tr>
<td>Broodstock collection (allowance)</td>
<td></td>
</tr>
<tr>
<td>Broodstock collection (actual)</td>
<td>&lt;100% of return</td>
</tr>
<tr>
<td>Adult removal for gene flow management (allowance)</td>
<td>Up to 100% of return</td>
</tr>
<tr>
<td>Adult removal (actual)</td>
<td>3,362 (~94%)</td>
</tr>
<tr>
<td>Juvenile rearing (allowance)</td>
<td></td>
</tr>
<tr>
<td>Juvenile rearing (actual)</td>
<td>Not applicable</td>
</tr>
<tr>
<td></td>
<td>Not applicable</td>
</tr>
<tr>
<td>RM&amp;E activities (cumulative for permits 18925, 18927 and 20533)</td>
<td></td>
</tr>
<tr>
<td>Juvenile emigration monitoring (allowance)</td>
<td></td>
</tr>
<tr>
<td>Juvenile emigration monitoring (actual)</td>
<td>Not applicable</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Spawning ground surveys (allowance)</td>
<td>100% of return</td>
</tr>
<tr>
<td>Spawning ground surveys (actual)</td>
<td>Small, unknown %</td>
</tr>
</tbody>
</table>

¹Includes a 10% overage for BKD management
²This number includes the broodstock needed to supply eggs for the 10(j) spring Chinook salmon population transferred to Chief Joseph Hatchery for release into the Okanogan Subbasin.
³WNFH broodstock collection includes overage for Colville/Okanogan 10(j) program. Eye-up, transfers, culling all overlap. Estimate pro-rates WNFH on-station group in isolation.
Statement on Annual Planning

No special program adjustments requiring coordination or permit modification were required during the BY16 production cycle. Regular coordination of production and RM&E activities, particularly those that involved coordination with the Methow FH program (i.e. stepping stone partner) were conducted regularly both direction between hatchery and RM&E staff and via the HCP Hatchery Committee monthly meetings.

Statement on General Handling of ESA-listed Fish

All special requirements pertaining to handling of ESA-listed spring Chinook (as well as steelhead and Bull Trout) were implemented during hatchery and RM&E operations. Specific requirements and responses follow below:

3. The Permit Holder shall apply measures to minimize harm to ESA-listed fish. These measures include, but are not limited to: limits on the duration (hourly, daily, weekly) of trapping; limits on holding time before release; and allowance for free passage through trapping sites when those sites are not actively operated.

*Standard care was routinely used during hatchery and RM&E activities while handling ESA species, not limited to Chinook salmon. No limits were placed on duration of activities as no free passage issues exist at the hatchery and temperature concerns do not exist at the facility due to naturally cold surface and well water used at WNFH.*

4. All ESA-listed species must be handled carefully. Should NMFS determine that a procedure provided for under this permit is no longer acceptable, the Permit Holder will be notified by NMFS and must immediately cease such activity until NMFS promptly identifies and approves an acceptable substitute procedure.

*See #3.*

5. Each ESA-listed fish handled for the purpose of obtaining biological information must be anesthetized. Anesthetized fish must be allowed to recover (e.g., in a recovery tank) before being released. Fish that are assessed without handling must remain in water, but do not need to be anesthetized.

*All fish lethally sampled were killed through an overdose of MS-222 (juveniles) or were exposed to a pre-anesthetic CO2 treatment, then killed by a pneumatic impact hammer (adults). MS-222 was used according to label instructions. Sampling-related mortality rates on non-lethal assays were routinely low (or zero) during the BY16 brood cycle.*

6. ESA-listed fish must be handled with extreme care and kept in water to the maximum extent possible during sampling and processing. Adequate circulation and replenishment of water in holding units is required. When using methods that capture a mix of species, ESA-listed fish must be processed first. The transfer of ESA-listed fish must be conducted using equipment that adequately holds water during transfer.

*See above. This handling requirement was complied with.*
7. ESA-listed fish must not be handled when water temperature exceeds 21°C (69.8°F) at the capture site. Trap operation shall cease until either temperature drops below the threshold, or pending further consultation with NMFS to determine if continued trap operation poses substantial risk to ESA-listed species. Under these conditions, ESA-listed fish may only be identified and counted.

N/A. Even mid-summer water temperatures at Winthrop NFH and Methow River surface water are significantly below 21°C, averaging closer to 12-15°C.

8. Visual observation protocols must be used instead of intrusive sampling methods whenever possible. This is especially appropriate when merely ascertaining the presence of anadromous fish.

N/A. This requirement was complied with and snorkel observations were utilized on multiple occasions.

**Statement on Broodstock Collection Activities**

All special requirements pertaining to broodstock collection activities were complied with during the BY16 production cycle. Specific requirements and responses follow below:

9. Up to 100% of returning Methow River adult spring Chinook salmon may be captured, handled, transported, and/or released at trapping sites to collect broodstock and remove WNFH hatchery-origin spring Chinook for pHOS management.

For return-year 2016, a total of 3,362 hatchery-origin adult spring Chinook salmon were handled at Winthrop NFH, which was roughly 70% of the total run, including NORs.

10. Broodstock will consist of 100% hatchery-origin fish, but will maximize the number of Methow Hatchery origin fish before using WNFH fish, with a target of ≥ 75% of the WNFH broodstock. In a low return year, WNFH origin fish may be used to supplement broodstock.

Broodstock retained were 100% hatchery-origin (see #11 below). WNFH staff attempted to maximize use of Methow FH program returns. For the 2016 broodstock compliment, about 90% were conservation program returns from Methow FH, easily surpassing the >75% target.

11. No natural-origin Methow River adult spring Chinook salmon may be retained for broodstock. Any natural-origin adults encountered will be transferred to the Methow hatchery program for broodstock use or released. Natural-origin fish intended for broodstock may be spawned at WNFH and gametes transferred to the Methow Hatchery.

Since 2014, WDFW staff have assisted FWS RM&E staff during excessing/brood sort events at WNFH to assess for possible natural-origin spring Chinook in the broodstock collection. During these events, fish that lack external mark or CWT are scale sampled, Floy tagged, and returned to broodstock holding. Scale samples are analyzed by WDFW’s Olympia aging lab so that wild adults can be transferred to the conservation program at Methow FH. A single natural-origin fish was found and transferred to MFH for inclusion in the conservation program in 2016.

12. Annually, 110 percent of the broodstock requirement may be retained to provide for BKD management. However, the Permit Holder must be in compliance with all other broodstock
collection limits and requirements. BKD prevalence shall be reduced, to the extent practicable, by implementing the following management actions:

a. Hatchery-origin eggs/progeny with ELISA titers of OD ≥ 0.12 will be culled.

USFWS Olympia Fish Health Center’s protocol for conducting BKD risk assessment uses a blank/background value subtracted from each sample’s OD value to allow for a more accurate/comparable value across all samples within a broodyear by removing variation associated with each lab, technician, and other factors. For BY16, all samples >0.095 (OD-BLK) were culled. Generally, WNFH gamete culling is prioritized by OD-BLK value; however, some culling associated with parentage (e.g. WNFH x WNFH crosses) occurs as a gene flow management tactic, i.e., some culled gametes may be low-ELISA WNFHxWNFH crosses.

b. At the first signs of BKD infection, juvenile spring Chinook salmon will be treated in accordance with recommendations from USFWS fish health specialists, and consistent with the Investigational New Animal Drug (INAD) permit.

N/A – no incidences of BKD rising to a level requiring treatment were reported.

Statement on Gene Flow Management

Gene flow management is discussed for return years 2016, 2017, and 2018. Future WNFH spring Chinook annual reports will focus only on the most recently available return year.

Permit #18927 had not been issued by summer 2016 but managers were aware of the body of science and management guidance indicating that excess hatchery-origin adults on the spawning grounds were likely inhibiting recovery of the ESU. Efforts to remove excess HORs from the spawning grounds have been underway at WNFH since 2010. Return year 2016 marked the second year that WDFW and Douglas PUD (Methow FH) provided additional collaborative management of gene flow through coordinated surplusing efforts centered on WNFH. For return years 2017 and 2018, the permit was issued and valid for all adult management strategies. Since returning adults from older broodyears preceding permit issuance, all broodstock management components (e.g. maximized broodstock pNOB) may not have been optimized for current gene flow management purposes.

13. Hatchery-origin adults will be removed at the Methow Hatchery and/or WNFH with the intent to achieve an average¹ partial pHOS (calculated as HOS_{WNFH}/(HOS_{PUD} + HOS_{WNFH} + NOS) according to Table 32 below based on natural run size.

<table>
<thead>
<tr>
<th>Natural Run</th>
<th>WNFH pHOS</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-899</td>
<td>0.2</td>
</tr>
<tr>
<td>900-1499</td>
<td>0.15</td>
</tr>
<tr>
<td>&gt; 1500</td>
<td>0.1</td>
</tr>
</tbody>
</table>

Table 32. Target partial pHOS for WNFH based on natural run size (NOAA 2016b).

¹ The average of the most recent four years for each partial pHOS target level.
Adult management in the last three years has shown a positive trend. WNFH ppHOS exceeded the NOR-based target of <20% in 2016 but improved in 2017 and 2018, meeting the target both years (Table 33). We expect this trend will continue and, provided both facilities continue to implement aggressive removal of adipose-clipped WNFH adults, the ppHOS goal should be consistently attained, particularly as measured as a 5-year average.

Table 33. 2016-2018 WNFH program partial pHOS targets and estimates relative to NOR return rates.

<table>
<thead>
<tr>
<th>Return year</th>
<th>NOR abundance-based WNFH ppHOS target</th>
<th>Pre-season PIT-based WNFH abundance&lt;sup&gt;1&lt;/sup&gt;</th>
<th>WNFH adults surplused</th>
<th>WNFH spawners&lt;sup&gt;2&lt;/sup&gt;</th>
<th>WNFH ppHOS&lt;sup&gt;2&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>2016</td>
<td>&lt;0.2</td>
<td>&gt;2,500</td>
<td>4,181</td>
<td>188</td>
<td>0.27</td>
</tr>
<tr>
<td>2017</td>
<td>&lt;0.2</td>
<td>&gt;1,168</td>
<td>1,443</td>
<td>88</td>
<td>0.19</td>
</tr>
<tr>
<td>2018</td>
<td>&lt;0.2</td>
<td>&gt;1,434</td>
<td>1,336</td>
<td>50</td>
<td>0.10</td>
</tr>
</tbody>
</table>

<sup>1</sup>Recent analysis of PIT-expanded escapement estimates suggests consistent under-estimate of true escapement.

<sup>2</sup>From, or derived from data from, Snow et al. 2019. Red indicates exceedance. Value inclusive of complete population, including stray component.

14. NMFS recognizes that due to the lack of control structures in the Methow Subbasin, removal of hatchery-origin adults is challenging, and thus the pHOS target may be difficult to achieve initially while removal options are explored further. NMFS also recognizes that there may a substantial disparity in spawning success of hatchery-origin fish in different areas. Therefore:

a. To facilitate meeting gene flow targets, hatchery ladders need to be operated full-time during a large portion of the run to remove hatchery-origin fish. If gene flow targets for the Methow Hatchery program have been met, then it is the Permit Holder’s responsibility to continue operation of the Methow Hatchery ladder to meet the WNFH pHOS targets.

Standard operating procedure at WNFH is typically for the ladder to be open in anticipation of the first arriving spring Chinook with 24-7 operation through the run as feasible (it is closed briefly (a few hours) during spawning/excessing operations to allow the mechanical crowder to operate).

In 2016, the WNFH ladder was operated almost continuously from May 25 to August 26, overlapping well with the arrival of spring Chinook in the vicinity (Figure 10). The vast majority of unique adult PIT detections at site SCP (~175 meters downstream of ladder) occurred by the end of July and support the notion that the ladder was open consistently throughout the run allowing for both effective adult collection and a collection representative of the run-at-large.
b. NMFS expects that the pHOS goal may not be met initially while operators are experimenting with removal options, but does expect aggressive attempts to substantially decrease pHOS from existing levels.  

*See above.*

c. NMFS is open to scientifically defensible calculations of effective subbasin-wide pHOS based on relative effectiveness of hatchery-origin spawners.

*This is an area of interest and at some point, we may investigate PBT-based investigations or juvenile production investigations to learn more about natural production in Spring Creek but this has not yet occurred.*

15. Hatchery-origin spring Chinook salmon from outside the Methow Subbasin that are encountered incidentally at any of the fish collection sites in the Methow Subbasin shall not be returned to waters of the Methow Subbasin.

*An estimated total of up to 7 strays were recovered at WNFH in 2016 (Table 7). These were surplused to Inland Northwest tribal subsistence food programs and not returned to the river.*

16. WDFW will be responsible for calculating the overall subbasin proportionate natural influence (PNI) value based on the three population model developed by Busack (2015). The target for this value is a minimum of 0.5, based on a 4-year arithmetic mean.

*This is the first year in which a PNI >0.5 has been measured in the Methow Subbasin. See Snow et al. 2019 and discussions in the Spawner Composition and Gene Flow Metrics section (Table 31).*
17. In the event that the target(s) are not met three years after implementation of this permit, the Permit Holder will discuss with NMFS the remaining challenges and potential solutions for achieving gene flow targets.

Yet to be determined

18. NMFS expects that the contribution of WNFH to the spring Chinook salmon population in the Entiat Subbasin will remain under 5%, averaged over four years beginning in 2016.

No WNFH strays have been reported in the Entiat Subbasin over the last several years. See Table 27.

Statement on Fish Culture

19. NMFS recognizes the need for management flexibility. Therefore, changes in fish culture consistent with best management practices, conforming to the intent of the program, and having no substantial effects on the survival of any ESA-listed species, will be permitted upon request.

No major management changes in fish culture methods or management occurred during the BY16 rearing cycle.

Statement on Juvenile Releases

20. Annually, the Permit Holder shall limit releases of WNFH spring Chinook salmon to less than 110 percent of the overall production goal (400,000). The 10 percent overage is intended to account for variances in pre-spawn survival, fecundity and within-hatchery survival. Consecutive years of overproduction (≥ 110 percent of 400,000) shall trigger an adjustment in the parameters used in the calculation of broodstock targets to reduce over-collection of broodstock.

An estimated total of 405,566 spring Chinook were released from WNFH in 2016. This is about 101.4% of the overall production goal component limited to release in the Methow Subbasin, and well within the +/- 10% allowance.

21. Hatchery release strategies will be managed adaptively to improve homing fidelity of adult returns to the release site, minimize precocity rates of hatchery-origin fish, and minimize ecological interactions between hatchery- and natural-origin juveniles.

WNFH stray rates outside of the subbasin have historically been low (Table 26, Table 27), precocity rates are also within allowable limits (Table 20) and travel times and late summer or redetections of WNFH spring Chinook juveniles in years following release year suggest that residualism/precocity rates were controlled (Table 21). Some indication of increased stray rates in recent, incomplete release cohorts (BY13; Table 26) may suggest an increase in straying; however, we suspect this is a statistical anomaly associated with grossly expanded recreational creel data.

22. The Permit Holder will force release hatchery-origin smolts at approximately 15-17 fish per pound in April. If a large proportion of juveniles residualize, the Permit Holder will discuss alternatives with NMFS for juvenile spring Chinook salmon releases.
BY16 WNFH spring Chinook were released semi-volitionally (over 4 days) starting at 15:00 on April 19, 2018 at an average of 16.4 fish/lb. Subsequent PIT monitoring data suggest that residualism is well-managed and that most fish rapidly depart and begin seaward migration.

23. In the event of an emergency, such as flooding, water loss to raceways, epizootic outbreak, or vandalism that necessitates early release of ESA-listed spring Chinook salmon to prevent catastrophic mortality, any such release shall be reported within 48 hours to NMFS (see Section C for contact information).

N/A for the BY16 rearing period.

24. All WNFH spring Chinook are externally marked with an adipose fin clip and have an internal coded-wire tag.

Tag retention investigations conducted 30-days post-tagging showed that the BY16 group had average 99.0% CWT retention rate and 99.7% adipose clip rate (Table 17).

Statement on Facility Operations

25. The Permit Holder shall ensure that water intakes into artificial propagation facilities are properly screened in compliance with NMFS 1995 screening criteria and as per the 1996 addendum to those criteria (NMFS 1996) or, in the case of repair or reconstruction, subsequent updates to those criteria (NMFS 2011).

Compliant, routinely examined.

26. The Permit Holder shall inspect and monitor the water intake structure screens at their hatchery facilities to determine if listed salmon and steelhead are being harmed or being drawn into the facility; the results of this monitoring shall be included in annual reports.

Compliant, routinely examined. No encounters of naturally-produced ESA-listed species have been reported passing through into the facility behind fish exclusion screens.

27. Water withdrawals shall not exceed levels permitted by the Water Use Permits issued to each of the facilities.

Compliant, routinely monitored.

28. The Permit Holder shall implement fish health policies and guidelines (USFWS 2004) (Pacific Northwest Fish Health Protection Committee (PNFHPC) 1989), or subsequent updates, to minimize the risk of fish pathogen amplification and transfer, and to ensure that hatchery fish would be released in good health.

Compliant, part of standard operating procedure, see discussion on Fish Health Program.

Statement on Research, Monitoring, and Evaluation

29. Any activities or methodologies associated with RM&E including, but not limited to: PIT tagging, smolt trapping, spawning ground surveys, and redd surveys must be done according to
the general guidelines for handling listed fish detailed above and within the direct take limits defined in Permit #18927 and the ITS.

See Statement on General Handling of ESA-listed Fish section.

30. NMFS strongly encourages the Permit Holder to coordinate RM&E with the Methow Hatchery program to avoid duplication of effort and data, and minimize take of ESA-listed species.

Noted – Spawning ground surveys and adult management activities have become increasingly coordinated between agencies since 2014.