U.S. Fish and Wildlife Service

WINTHROP NATIONAL FISH HATCHERY SPRING CHINOOK SALMON ANNUAL REPORT - 2017 -

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On the cover: *Adult spring Chinook Salmon ascending Spring Creek, en route to Winthrop NFH, Michael Humling, Mid-Columbia FWCO.*

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Disclaimers

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Executive Summary – This report summarizes the Winthrop National Fish Hatchery's (WNFH) broodyear (BY) 2015 spring Chinook Salmon program (i.e. production spawned in fall 2015 and released in spring 2017), encapsulating hatchery production from broodstock collection through juvenile release. Where appropriate and available, BY'15 production metrics are reported in the context of longer-term datasets. It was prepared to provide comprehensive evaluation of program performance as well as to consolidate 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 to the extent practicable, in this case, through BY2012, which completed its lifecycle in 2017 as returning age-5 adults. Following presentation of these results is discussion of goals, objectives, and permit condition compliance.

Production of BY2015 Spring Chinook at WNFH generally met all fish culture-related goals. Full broodstock collection, implementation of Stepping Stone model, eggtake, rearing, and release-related goals were attained. Additionally, managers were able to continue support of the Okanogan 10(j) reintroduction program through transfer of eyed Methow Composite stock eggs to the Chief Joseph Hatchery.

The BY2015 rearing cycle had fully completed prior to issuance of Scientific Research/Enhancement Permit #18927; however managers were able to anticipate developing permit terms and conditions. As such, 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 well within permitted values. Via retrospective analyses, collective programs and gene flow management objectives remained challenging in the Methow Sub-basin between return years 2015 and 2017. Relatively low natural-origin adult returns continued to make it mathematically difficult to achieve gene flow targets on the spawning grounds; program partial pHOS were achieved in 2015 but not in 2016 or 2017. Subbasin-wide PNI targets were not achieved in any year; however recent experimental work with multi-population PNI models have increased managers' understanding of these metrics and will hopefully increase ability to attain gene flow conditions favoring selective pressures from the natural environment rather than the hatchery environment.

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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), and the USFWS Fish Health Program, 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 (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 history of fish culture but currently produces ESA-listed spring Chinook and summer steelhead and assists the Yakama Nation with reintroducing Coho Salmon to the Methow Subbasin.

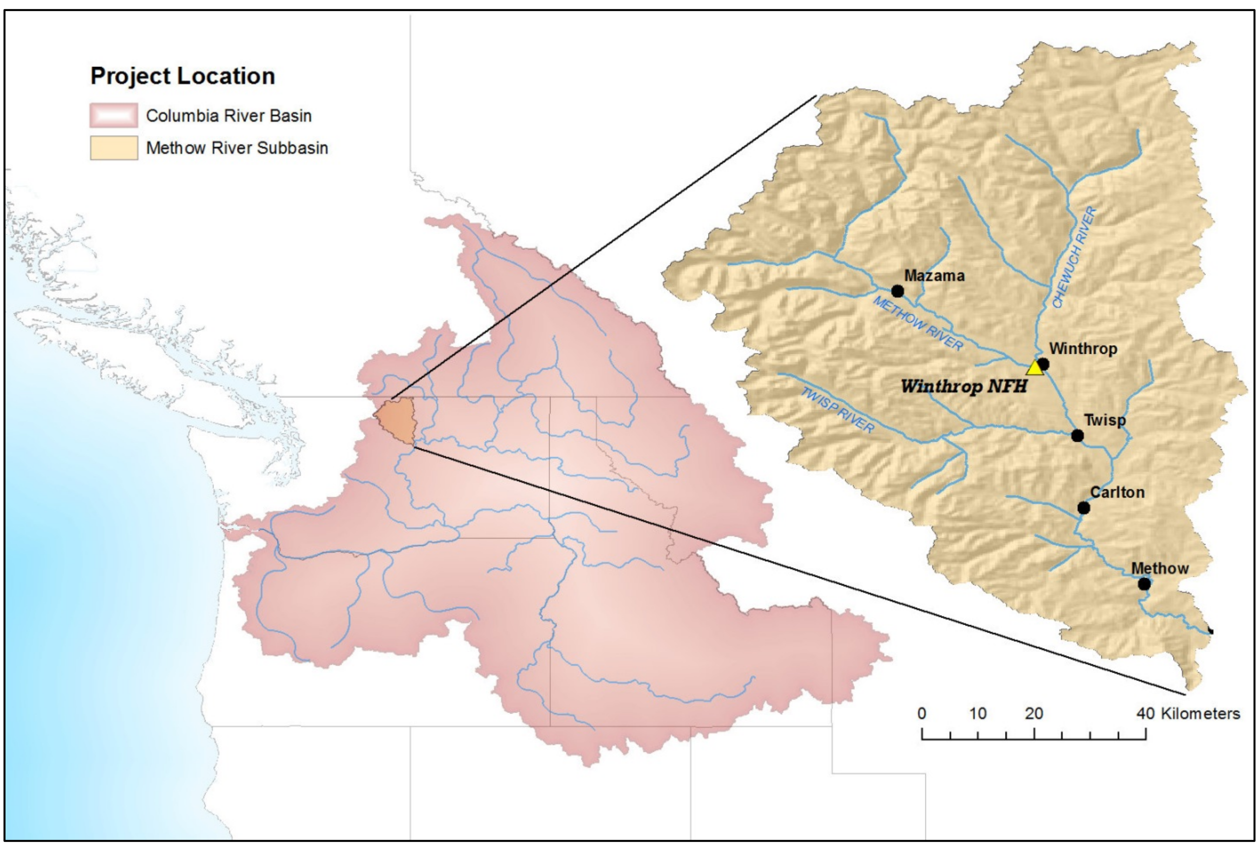

Figure 1. Winthrop National Fish Hatchery location.

All federal programs and activities are subject to compliance with the Endangered Species Act (ESA) of 1973. As such, all WNFH programs (spring Chinook Salmon, summer steelhead, and Coho Salmon), as well as general facility operation and maintenance have undergone ESA consultation with the National Marine Fisheries Service 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 spring chinook program fish health goals at the WNFH as part of the Complex. 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 the 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, 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 sub-basin 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.

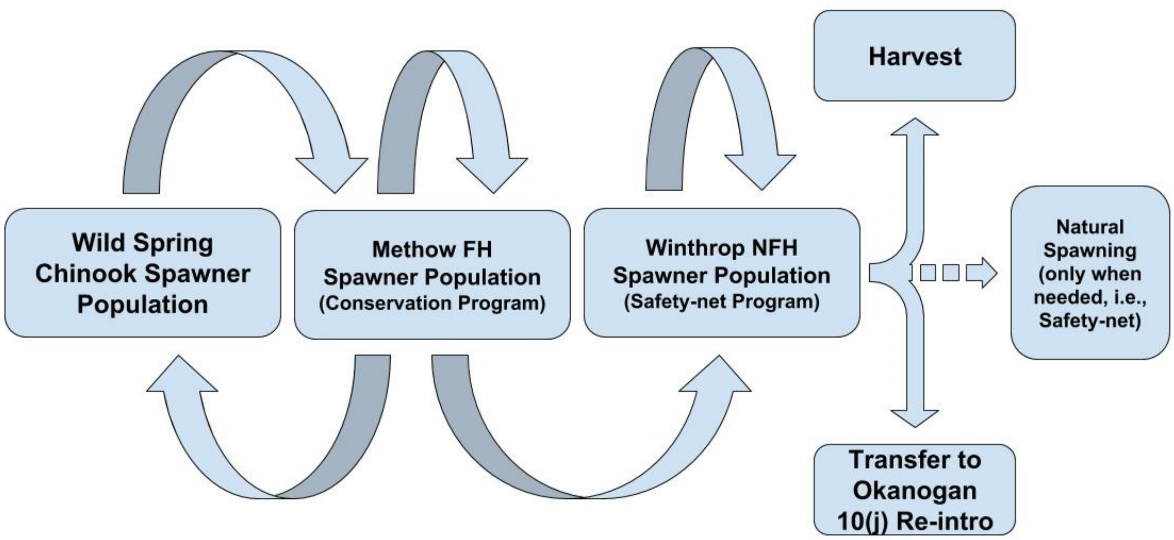

Figure 2. Methow Subbasin spring Chinook hatchery supplementation conceptual.

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 stock fish, prioritizing returning adults released from MFH, which are typically progeny of natural-origin broodstock. 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 WNFH spring Chinook program is managed and operated according to two broad primary goals – Mitigation and Recovery – each with 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 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 (Mitigation) Compensate for lost fish production associated with construction of Grand Coulee Dam

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 are released in a manner that optimizes post-release performance.
- Smolt release numbers and external marking strategies employed are consistent with US v OR management agreement.
- Returning adults support selective harvest fisheries as deemed appropriate by co-managers.
- Excess program returning adults are provided to inland Northwest Indian tribal subsistence food programs when available.

Goal (Recovery) Contribute to recovery of the Upper Columbia River Spring-run Chinook ESU by increasing the natural spawner abundance when appropriate and providing a genetic safety-net during periods of low adult returns.

Associated 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.

Goal (Recovery) Contribute to and support USFWS and partners' Recovery efforts in the Upper Columbia.

Associated 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.

Goal (Recovery) Minimize genetic and ecological risks and impacts to natural-origin spring Chinook, non-target taxa, and their associated habitats.

Associated 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 Salmon 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.) to assess whether the programs met mitigation objectives and maintain compliance 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.).

Generally, monitoring and evaluation categories can be grouped into broad categories associated with risk and performance of fish in, or released from, the hatchery. Though organized and presented differently, metrics are highly 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.).

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. Subsequently, if/when a fish is lethally sampled, either for scientific or commercial purposes, the tag code information is submitted. RMIS allows managers to calculate survival, stray rates, 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, tag 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 tracked, calculation of 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.

At WNFH, all mass marking (CWT and PIT tags) is administered by the Columbia River Fish and Wildlife Conservation Offices' hatchery marking team. This team marks and tags for a majority of the National Fish Hatcheries in the Columbia River basin, as well as other hatchery facilities in the region.

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 stream 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 BY'18 programs may be accompanied by adult performance data current only to BY'12 spring Chinook that completed their lifecycles in 2017 as age-5 adults.

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.*

In-hatchery/Fish Culture Monitoring includes summaries of:

- Eggtake summary
- Rearing performance
- Disease Occurrence
- Rearing parameters (e.g. density index, flow index, feed conversion, etc.)
- Marking summary
- Survival rate summary for all life stages between green egg and smolt

Juvenile Release Monitoring includes summaries of:

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

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 (LMR, SCP, hatchery infrastructure)
- Age Structure of run
- Out-of-basin straying
- Other basin stray rate contribution (e.g., Entiat Subbasin)
- Smolt-to-Adult ratios (pre- and post-harvest) and Hatchery Replacement Rate estimates

Natural Environment Monitoring includes summaries of:

- Escapement estimates/summary
- Effectiveness of pHOS management efforts – program partial pHOS
- Overall subbasin PNI (provided by WDFW)

RESULTS

Adult Management & Broodstock Collection

2015 Environmental Conditions

In 2015, the Pacific Northwest was impacted by below average snowfall, early snowmelt, and warmer than average air temperatures resulting the lowest snowpack in 67 years (Natural Resource Conservation Service). Remaining snow-water equivalent at Methow Subbasin NRCS Snotel sites was at about 79% of average as of May 1, 2015, but dropped to just 9% by June 1 due to warm May temperatures. These conditions resulted in May-July streamflow averaging 40% of normal (Figure 3).

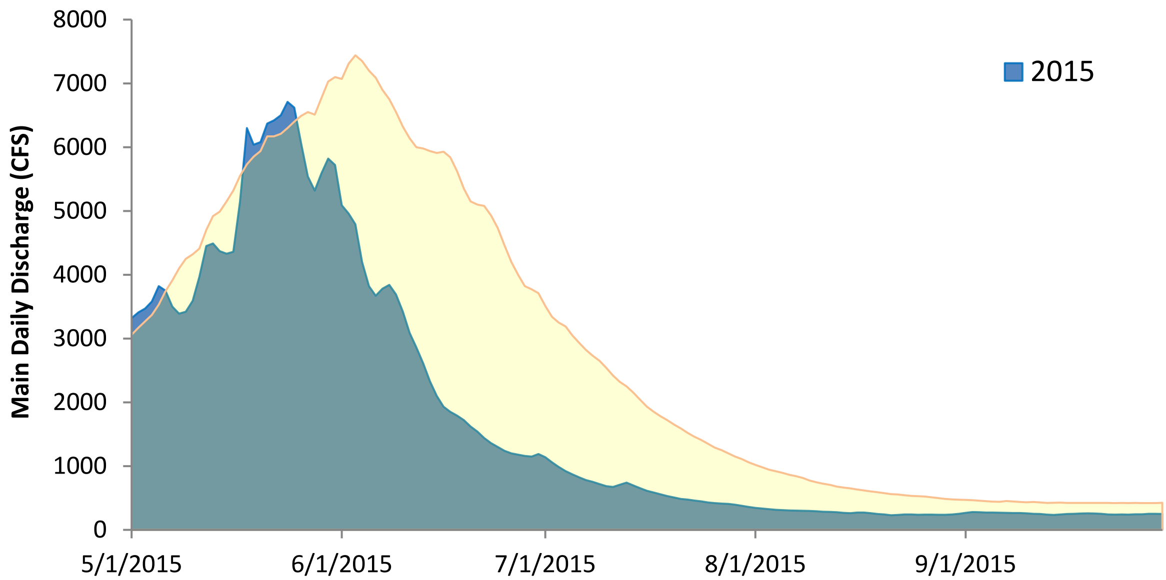

Figure 3. Spring and summer 2015 flow conditions for the Methow River (USGS Station #12449950 at Pateros, WA) compared to site average flows (1958-2018).

2015 Adult Management Efforts

In 2015, adult spring Chinook counts at Bonneville and Wells dams were 4th and 1st highest for the period of 2000-2015, respectively (FPC.org). While gene flow management guidelines were not yet developed and promulgated by a Biological Opinion, there was agreement that WNFH and MFH would conduct collaborative adult management, support tribal subsistence programs by surplusing excess hatchery fish, and implement the stepping stone program model by maximizing use of MFH conservation program returns into brood for the WNFH program.

Winthrop NFH and MFH are in close proximity (approximately 1.1km apart) and share a common surface water source (Foghorn Irrigation Canal; Figure 4). Returning adult spring Chinook maintain some fidelity to their release sites but mixing between release and homing sites is common.

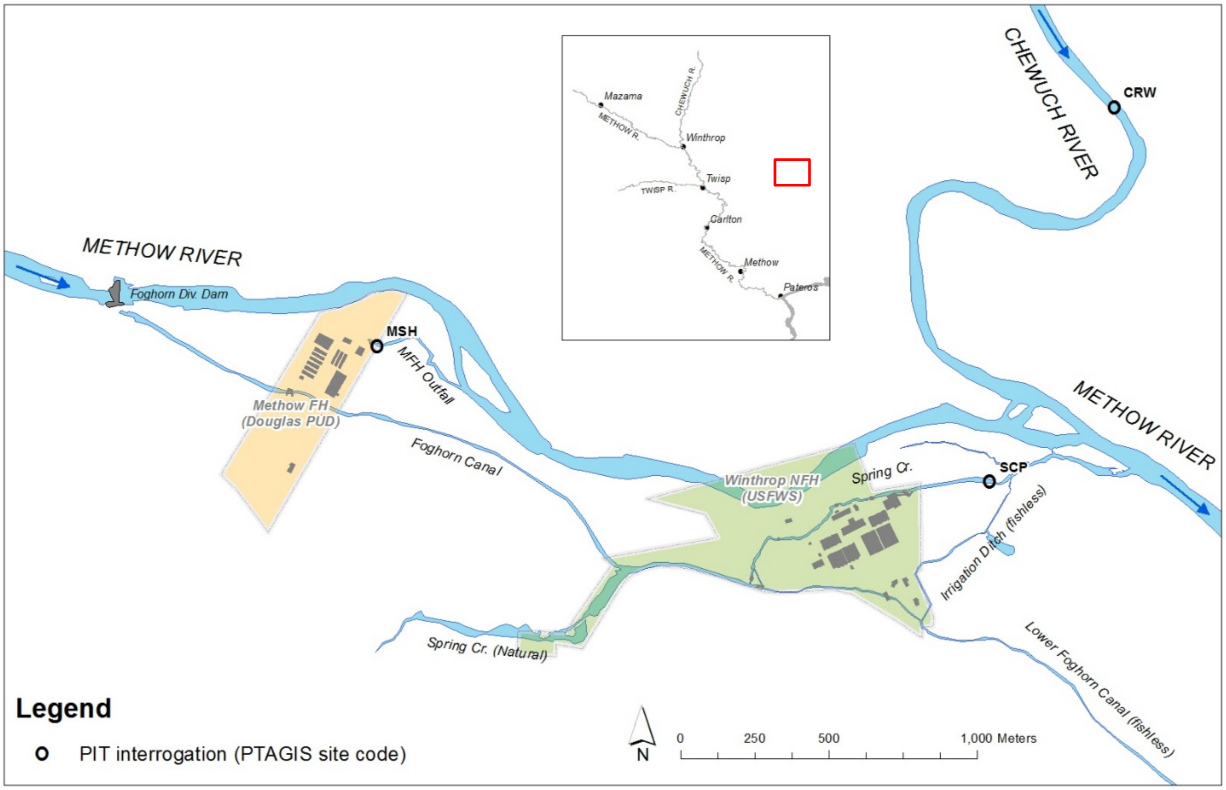

Figure 4. Overview map of Methow Fish Hatchery (Douglas PUD), Winthrop NFH (USFWS/BOR) and Foghorn Irrigation Canal. (SCP = WNFH outfall channel; CRW=Chewuch River at Winthrop)

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. Winthrop NFH does not directly count or bio-sample ladder volunteers at the time of entry but rather 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.). Despite the large 2015 escapement, counter accuracy was estimated at about 95%; the total adult ladder count was 4,441 compared to an estimated 4,236 adults. The sources and nature of errors may be a combination false-counting age-3 jacks as adults, misinterpretation of fallback fish when the trap area was crowded, etc.

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 5,949 adult spring Chinook salmon comprised WNFH collections in 2015** to set the stage for broodstock and adult management efforts.

WDFW staff provided assistance during spring Chinook excessing events by assisting USFWS staff in bio-sampling as well as verifying origin of unmarked spring Chinook. In 2015, a total of 45 unmarked fish were sampled and verified to be unmarked hatchery-origin fish through scale analysis (C. Frady pers. comm.). As such, **we conclude that adult collection efforts in 2015 were restricted to 100% hatchery-origin fish**. Any verified natural-origin adults would be either released to the river or transferred to MFH for use in the conservation program (if needed); none were identified or transferred in 2015.

Table 1. Return year 2015 Winthrop NFH Spring Chinook collections by approximate age and collection source.

Return year & disposition		WNFH Adult Ladder		Methow FH Trap		Total Collected	
		Adults	Jacks	Adults	Jacks	Adults	Jack
2015	Number collected	4,236	273	1,255	185	5,491	458
	Total (%) by source	4,509 (75.8%)		1,440 (24.2%)		5,949	

Figure 5 shows the timing of collections by source over the course of the return as well as allocation of broodstock from mixed holding. In 2015, the WNFH ladder was operated almost continuously from May 13 to September 2. Though there are some operational constraints, the method by which WNFH collects broodstock is proportionate and representative of the run-at-large (purposely biased towards MFH returns). Potential broodstock are held in a mixed population, then allocated during several adult excessing events, generally weekly from late-May through late-June. Within the "stepping stone" context, WNFH prioritizes returns released from MFH; however these fish readily volunteer into the WNFH ladder so the program relies on a mix of transfers from MFH and ladder volunteers for broodstock allocation.

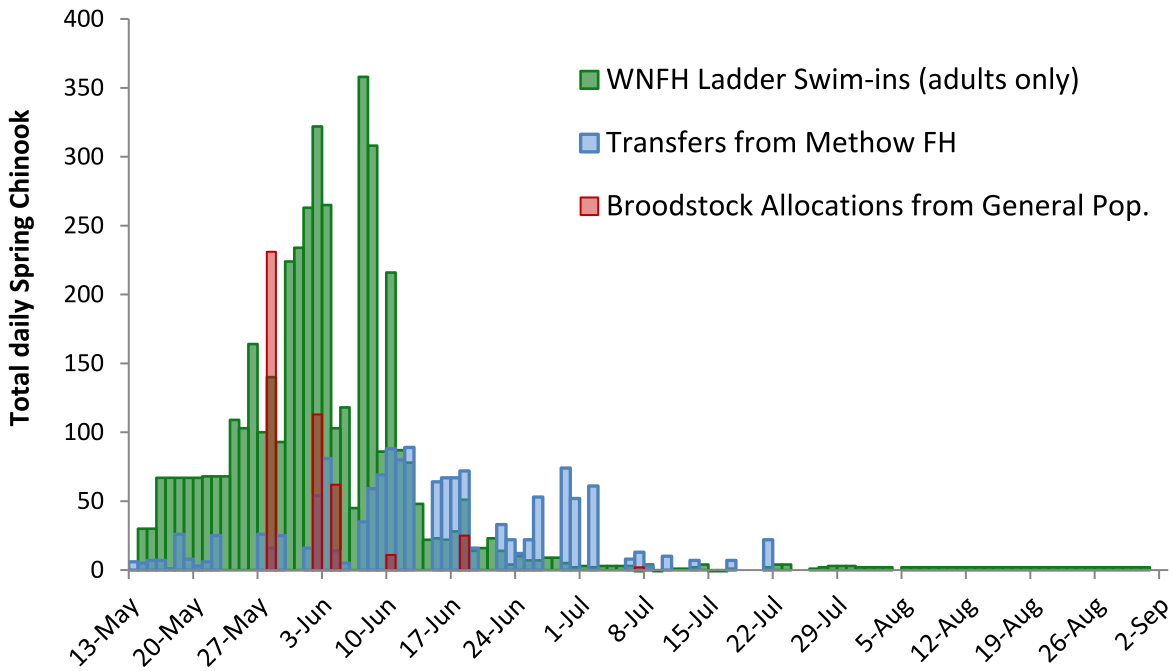

Figure 5. Adult spring Chinook collections for BY'15 WNFH spring Chinook program, for ladder operational period (13 May to 2 Sept.).

Notes for Figure 5: 1) only adult daily data were collected at WNFH due to many residualized steelhead triggering the counter as age-3 spring Chinook. 2) Some collection totals were lumped across date ranges in hatchery/transfer records. These were averaged across lumped dates to spread out catch for illustrative purposes and avoid suggestion that large pulses occurred (e.g., final month of collection was lumped together).

Following, and simultaneous to, collection and broodstock allocation, were adult surplusing and ongoing pre-spawn mortalities. These are summarized in Table 2 and compared to previous years in Table 3.

Pre-spawn mortality for all adults held in 2015 was estimated at 4.5%. This was relatively high for WNFH in comparison to previous years and like associated with the high number of surplus adults held. Increased mortality was primarily due to two separate incidents where 1) 30 adults were killed when impinged by the mechanical crowder and 2) 171 fish awaiting a surplusing event died in low-dissolved oxygen conditions when the water supply was temporarily cut off. Fortunately, no held broodstock were affected and fish killed were suitable for a planned surplus event the following day. Excluding these, pre-spawn mortality was a much lower 1.1%. It should be noted that potential for stress and associated mortality likely increases with adult management activities hosted at WNFH. The adult holding facility at WNFH can hold approximately 3,000 adult Chinook salmon (C. Pasley pers. comm.). During large escapement years, managers must work to coordinate hatchery, northwest Indian tribal, hatchery evaluation, and fish health staffers to conduct regular excessing events to manage pond inventory while simultaneously minimizing stressful handling events. While mortality was low, it is likely that reported pre-spawn mortality rates would be reduced if the hatchery restricted adult collections to only those fish needed for broodstock. Pre-spawn mortality in 2015 was less than the <7% operational target for the WNFH spring Chinook program (Appendix A).

Table 2. Adult Management Ledger for 2015 WNFH Spring Chinook

Disposition	**Male**	**Female**	**Jack**	**Total**
Total collected, all sources	**2,369**	**2,817**	**764**	**5,949**
Pre-Spawn Mortality[1]	24	41	0	65 (1.1%)
Water supply/low-DO	*56*	*103*	*12*	*171 (2.9%)*
Mechanical	5	21	4	30 (0.5%)[2]
Surplus	2,156	2,555	760	5,470 (91.9%)
Retained as broodstock	184	200	0	384 (6.5%)
Green[2]	0	1	0	1 (0.3%)
Spawned	184	199	0	383 (6.4%)

[1]Pre-spawn mortality does not include mortality events caused by mechanical crowder or a water shortage/low DO event, each separately noted in this table. Fish that died during low DO event are included in Surplus category as they were suitable for consumption and surplused immediately.
[2]Green rate calculated from total retained for broodstock.

Table 3. Winthrop NFH Spring Chinook Adult Management Summary, 2000-2015.

Return Year	Total Collection by source		Total Collected	Pre-spawn mortality[1]	Green, spent, or bad	Released	Spawned	Surplus	Transfer (>MFH)
	MFH	WNFH							
2000[2]	150	942	1,092	33	1		1,058		
2001[2]	385	0	385	53		2	330		
2002[2]	388	0	388	11	3		374		
2003			904	35		471	398		
2004			452	10			334	24	84
2005			499	4			400	75	20
2006			733	23	2	318	366	24	
2007			708	17		368	323		
2008			705	6		288	411		
2009			1,415	19		986	348	53	9
2010			2,319	30		11	402	1,850	26
2011			1,965	48	1		377	1,538	1
2012			2,088	16			453	1,619	
2013			3,137	7			494	2,617	
2014			5,365	109			408	4,848	
2015	**1,440**	**4,509**	**5,949**	**95**	**1**		**383[4]**	**5,470**	
Min[3]	N/A	N/A	1,965	7	1	11	377	1,538	0
Max[3]	N/A	N/A	5,949	109	1	11	494	5,470	26
Mean[3]	N/A	N/A	3,471	51	1	11	420	2,990	14

[1]Pre-spawn mortality, combined sources
[2]Carson stock phase-out effort.
[3]Blue shading indicates current adult mgmt. strategy (2010-2015) and summary data restricted to those years
[4]383 adults report spawned conflicts with other tables. Total of 384 were spawned, single female's eggs were discard due to being green/bad.

Associated with the large volume of hatchery returns to WNFH, managers were afforded the ability to maximize use of returning conservation program fish from MFH into broodstock, minimizing the number of returning WNFH safety-net fish for broodstock, and surplus a large number of hatchery-origin adults to inland Northwest Indian subsistence food programs and local foodbank organizations. A total of 5,470 excess spring Chinook were surplused in 2015, with most of these (74%) being WNFH program fish. Because sufficient MFH Conservation Program fish were available for WNFH Safety-net Program broodstock, these then became available for surplusing to tribes as well, comprising the remaining 26% of surplused fish. Table 4 displays a summary of surplusing events and the number of spring Chinook donated to various sources. These data suggest the typical site fidelity of each program's returning adults, though these should not be considered unbiased samples of the return-at-large as allocation to transfer, broodstock, and surplusing each have bias.

Table 4. 2015 Spring Chinook excessing event summary – Excess fish program of origin by collection source.

Date	Excessing Event Details	Source: Winthrop NFH Ladder			Source: Methow FH Transfers			Total Excessed
		WNFH Returns	MFH Returns	Total	WNFH Returns	MFH Returns	Total	
5/27	Colville Tribe	807	5	812	30	0	30	842
6/2	Kalispel Tribe	329	15	344	0	15	15	359
6/4	Colville Tribe	729	168	897	20	118	138	1035
6/10	Kalispel Tribe	342	60	402	5	58	63	465
6/10	Coeur d'Alene Tribe	441	74	515	10	71	81	596
6/13	Yakama Nation[1]	5	0	5	0	3	3	8
6/17	Spokane Tribe[2]	86	10	96	5	70	75	171
6/18	Spokane Tribe	750	135	884	14	461	476	1360
7/1	The Cove[3]	22	3	25	0	79	79	104
7/21	NW Harvest	97	53	151	321	15	335	486
9/2	Post-spawn/Buried[4]	33	6	40	0	4	4	44
Sum/Proportion by location		3,641 (87.3%)	530 (12.7%)	4171	404 (31.1%)	895 (68.9%)	1299	5470

[1]Small excessing event for Kids Fishing Day
[2]Mortalities from the low-DO event referenced in Table 3 were suitable for surplusing the next day
[3]Non-profit foodbank/organization in Twisp, WA
[4]Excess adults at final spawn day, no longer fit for human consumption

During the 2015 spawning escapement, broodyear (BY) 2010, 2011, and 2012 cohorts were expected to return at total ages of 5, 4, and 3, respectively. Both age-4 and age-3 returns from WNFH were 100% adipose-clipped; only age-5 adults from WNFH remained adipose-present. This allowed for preliminary prioritization conservation program (MFH) fish into broodstock and prioritized surplusing of WNFH returns. Coded-wire tags and PITs were used post-spawn to verify programs and ages.

Table 5 displays expanded age and sex composition of overall collection in 2015, by program. Note that transfers from MFH occurred after some adult management was conducted (i.e., sample may not be representative of the 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 ratios were 0.95:1 and 1.24:1 for the aggregate MFH Program and WNFH SafetyNet program collections, respectively, and 1.12:1 overall, which is slightly less males per female than the 2000-2015 average (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 2015 spring Chinook adult *total collection* at WNFH, by program.

Program	Male					Female			Total
	Age-2	Age-3	Age-4	Age-5	Sum[1]	Age-4	Age-5	Sum	
Conservation (MFH)	4	98	856	6	960	1,096	13	1,109	2,069
SafetyNet (WNFH)	3	659	1,483	44	2,186	1,592	102	1,694	3,880
TOTAL	**7**	**757**	**2,339**	**50**	**3,146**	**2,687**	**115**	**2,803**	**5,949**

[1]Excludes age-2 minijacks.

Table 6. Sex composition of returning WNFH adult spring Chinook Salmon 2000-2015.

Return Year	Sample Rate[1]	# Males	# Females	Male:Female Ratio
2000	100%	304	426	0.71:1
2001	100%	51	97	0.53:1
2002	100%	46	126	0.37:1
2003	100%	108	142	0.76:1
2004	100%	116	174	0.67:1
2005	100%	97	168	0.58:1
2006	100%	133	112	1.19:1
2007	100%	169	116	1.46:1
2008	100%	155	186	0.83:1
2009	100%	154	149	1.03:1
2010	100%	779	921	0.85:1
2011	100%	958	450	2.13:1
2012	100%	806	852	0.95:1
2013	100%	1552	558	2.78:1
2014	100%, 25%	2384	1880	1.27:1
2015	100%, 20%	2049	1540	1.33:1
Min		46	97	0.37:1
Max		2384	1880	2.78:1
Mean (00-15)		616	494	1.09:1

[1]Sample rates of adult hatchery returns, which are mixed composition. Broodstock in '14-'15 were 100% sampled while surplused fish were sub-sampled at shown rates. M:F data reflect WNFH program returns only – MFH or unknown hatchery returns excluded.

Neither natural-origin nor out-of-basin hatchery-origin strays were detected in 2015 adult collections and both have been historically rare at WNFH (Table 7). All recoveries were estimated to be Methow Composite program fish sourced from WNFH or MFH. Some MFH recoveries were from release groups from the Chewuch Acclimation Pond or the Mid-Valley Acclimation Facility on the Methow River approximately 7km upstream from WNFH. No Twisp program adults were encountered in 2015. All CWT recoveries were expanded for sub-sample and tagging rates and reported in the Regional Mark Information System (rmpc.org) as of June 2018. Length at maturity summary information is provided in Table 8.

Table 7. WNFH adult approximate collections by origin/program

Return Year	Met-Comp Release locations: WNFH	MFH	Chewuch Acc. Pd.	Mid-Val Acc. Pd.	Wolf Cr. Acc. Pd.	Twisp	Wild	Out-of-basin strays[1]: Okanogan	ENFH	LNFH	Wenatchee	Skagit	Estimated contribution: Met-Comp	Twisp	Out-of-basin
2000	750	169	38	0	0	33	0	0	5	1	0	0	96.1%	3.3%	0.6%
2001	169	155	43	0	0	2	0	0	0	0	0	0	99.4%	0.6%	0.0%
2002	179	9	181	0	0	3	0	0	0	0	0	0	99.2%	0.8%	0.0%
2003	264	53	72	0	0	17	0	0	0	0	0	0	95.8%	4.2%	0.0%
2004	296	11	34	0	0	1	1	0	0	0	0	0	99.7%	0.3%	0.0%
2005	340	88	22	0	2	24	1	0	0	0	0	0	94.9%	5.1%	0.0%
2006	258	70	16	0	6	16	0	0	0	1	0	0	95.3%	4.4%	0.3%
2007	305	26	4	0	0	3	0	0	0	0	0	0	99.1%	0.9%	0.0%
2008	424	38	10	0	0	1	0	0	0	0	0	0	99.8%	0.2%	0.0%
2009	331	84	0	0	0	1	0	0	0	0	0	0	99.8%	0.3%	0.0%
2010	1756	321	20	0	0	24	0	0	0	4	1	2	98.5%	1.1%	0.3%
2011	1453	302	121	0	0	31	0	0	0	0	0	0	98.4%	1.6%	0.0%
2012	1722	208	95	0	2	20	0	0	0	1	0	0	99.0%	1.0%	0.1%
2013	2170	662	107	45	32	68	0	0	0	0	0	0	97.8%	2.2%	0.0%
2014	4296	752	49	110	0	19	0	0	0	0	0	0	99.6%	0.4%	0.0%
2015	3099	2053	199	80	0	0	0	0	0	0	0	0	100.0%	0.0%	0.0%
Avg.	**1113**	**313**	**63**	**15**	**3**	**17**	**0**	**0**	**0**	**0**	**0**	**0**	**98.3%**	**1.7%**	**0.1%**

[1]Hatchery-origin out-of-basin strays only, representative of WNFH recoveries only.

Table 8. Length-at-maturity of adult spring Chinook at Winthrop NFH by hatchery program.

Program	Males: Age-3 Avg.	N=	SD	Age-4 Avg.	N=	SD	Age-5 Avg.	N=	SD	Females: Age-4 Avg.	N=	SD	Age-5 Avg.	N=	SD
MFH	54.0	18	4.5	70.7	261	6.3	93.0	2	1.4	72.8	256	3.8	84.6	5	3.6
WNFH	50.4	120	4.3	72.5	251	7.1	92.0	25	7.1	73.6	209	3.8	86.2	56	4.1
All	50.8	138	4.5	71.6	512	6.8	92.1	27	6.8	73.2	465	3.8	86.0	61	4.0

Broodstock Allocation

Broodstock and adult management efforts were simultaneous and all fish were retained in mixed holding, from which broodstock were selected (MFH program returns prioritized) and appropriate fish (typically WNFH program returns) while surplus fish were removed for tribal subsistence programs. To minimize handling stress, selected broodstock were placed in a separate compartment of the west holding pond eliminating the need for re-handling until spawn events. In total, 384 adult spring Chinook were retained for use as broodstock in 2015 (Table 1; 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 adults receive a prophylactic formalin treatment 3 days per week in the form of a one-hour flow-through treatment to prevent fungus infestations. The formalin treatments are not initiated until tribal surplus events have been completed.

Recoveries at MFH are typically biased toward MFH program returns and vice versa for WNFH-collections. However, due to the large surplus of total fish in 2015, only an estimated 87 of the 384 fish allocated to broodstock (22.7%) were collected and transferred from MFH. Nonetheless, the majority (81%) of broodstock allocated were conservation (MFH) program returns (Table 9). Though ESA consultation had not yet been completed in 2015, this value exceeds the current >75% target for conservation program (MFH) adults in WNFH broodstock each year (NOAA 2016a).

Table 9. Broodyear 2015 WNFH spring Chinook broodstock composition by age, program, and collection location.

Collection site	Program	Male				Female			Total
		Age-3	Age-4	Age-5	Sum	Age-4	Age-5	Sum	
MFH	Conservation (MFH)	0	46	0	46	36	2	38	**84**
	SafetyNet (WNFH)	0	1	0	1	0	2	2	**3**
	Combined	0	47	0	47	36	4	40	**87**
WNFH	Conservation (MFH)	1	108	1	110	115	1	116	**226**
	SafetyNet (WNFH)	0	11	16	27	8	36	44	**71**
	Combined	1	119	17	137	123	37	160	**297**
Combined Brood	Conservation (MFH)	1	154	1	156	151	3	154	**310**
	SafetyNet (WNFH)	0	12	16	28	8	38	46	**74**
	TOTAL	**1**	**166**	**17**	**184**	**159**	**41**	**200**	**384**

Mean fecundity values by age and program are show in Table 10 and compared to recent years' values in Table 11. Fecundities between WNFH and MFH females (2015 only) were compared using 2-sample T-tests. Age-4 females by program were compared and sample populations lacked significant difference ($p>0.61$). Samples sizes were small for age-5 females and not compared. As expected, age-5 females (programs combined) were significantly more fecund than age-4 females ($p<0.01$).

Table 10. Mean fecundity by age and program of 2015 spring Chinook broodstock at Winthrop NFH.

Program, by age	Samples (N)	Mean Fecundity	StDev Fecundity
MFH Age-4	125	4,043	670
WNFH Age-4	8	3,916	795
Combined Age-4	**133**	**4,035**	**675**
MFH Age-5	2	4,832	416
WNFH Age-5	36	5,291	810
Combined Age-5	**38**	**5,266**	**797**
All broodstock	**169**	**4,313**	**879**

Table 11. WNFH Spring Chinook program – annual broodstock fecundity statistics by age.

Brood year	All Samples			Age-4			Age-5			Broodstock age comp.[1]	
	Mean	StDev	N=	Mean	StDev	N=	Mean	StDev	N=	Age-4	Age-5
2013	3858	825	192	3649	661	139	5023	732	30	85.1%	14.9%
2014	4694	760	174	4713	773	156	5148	876	3	98.4%	1.6%
2015	4313	879	169	4035	675	133	5266	797	38	79.7%	20.3%
2016	3808	996	166	3674	903	138	4465	1181	28	83.6%	16.4%
2017	4211	940	206	4172	897	192	4742	1328	14	93.2%	6.8%

[1]Age composition doesn't necessarily match samples by age in this table and reflects actual females spawned each year.

The overall green eggtake for 2015 at WNFH was estimated at 851,151, approximately 106% 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 2015, an estimated 79% of the females were considered "low" risk and about 16% were considered "moderate" risk (Table 12). At the time of spawning, the eggs from each female were held in separate trays. When the ELISA results were returned from the Fish Health program, gametes in excess to program needs were culled according to their relative risk category. In 2015, about 15% of collected gametes 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.

ELISA Rank	Females Collected/Sampled (% of total)						ELISA Culled (% of total)					CCT Transfers (% of total)			
	VL	Low	Mod	High	VH	Total	Low	Mod	High	VH	Total	Low	Mod	High	Total
BY '13	- -	86.2	13.0	0.8	0.0	253	- -	- -	- -	- -	0	- -	- -	- -	0
BY '14	- -	92.2	7.8	0.0	0.0	204	46.7	53.3	0.0	0.0	30	49	0	0	49
BY '15	**- -**	**79.0**	**16.0**	**1.5**	**3.5**	**200**	**9.7**	**71.0**	**3.2**	**16.1**	**31**	**47**	**8**	**1**	**56**
BY '16	- -	84.1	11.9	1.0	3.0	201	14.3	28.6	14.3	42.9	14	57	13	0	70
BY '17	- -	78.6	16.7	3.3	1.4	215	19.3	63.2	12.3	5.3	57	54	0	0	54

Broodyear 2015 Within-Hatchery Monitoring

Eggtake and Incubation

The broodyear 2015 in-hatchery production phase began with an estimated total 851,151 green eggs from 199 families. No green egg transfers occurred in 2015. Following a 94.5% eye-up rate, an estimated 804,754 eyed eggs remained on-station. These values exceeded the HGMP's >90% eye-up and eyed egg targets of 650,000 (Appendix A). Of these 218,094 eyed eggs were transferred to the Colville Tribes' Chief Joseph Hatchery Okanogan 10(j) reintroduction program. The remaining 586,660 eyed eggs exceeded the programs post-transfer retention target of 430,000 eyed eggs so 142,922 eyed eggs were culled. All culling was prioritized consistent with BKD risk (ELISA values); nearly all culled families were from high or moderate ELISA females. Historic and 2015 eggtake and egg management through ponding are summarized in (Table 13).

In December, an estimated 440,080 emergent fry were ponded into indoor start tanks to begin the rearing cycle.

Table 13. 2006-2015 Winthrop NFH spring Chinook eggtake and incubation summary.

Brood year	Females Spawned	Green Eggs				Eyed Eggs					Fry		
		Total Eggtake	Avg./ female	Transfer (out)	Culled	Total	Transfer (in)	Transfer (out)	Culled	Eye-up %	Total hatched	% Hatched	Total Ponded
2006	182	632,964	3,478	34,200	0	558,932	49,659	9,667	0	93.3	544,412	92.4	542,332
2007	140	527,132	3,765	3,800	0	503,608	0	11,400	0	96.2	490,431	95.8	486,274
2008	229	912,368	3,984	3,800	0	884,923	0	0	218,264	97.4	661,806	95.9	659,727
2009	200	808,505	4,043	3,800	0	768,737	0	0	98,388	95.5	661,796	93.7	658,132
2010	202	803,724	3,979	4,000	0	776,700	0	0	140,157	97.1	635,409	96.3	634,277
2011	189	694,940	3,677	3,800	242,284	415,766	0	0	0	92.6	414,401	92.3	413,036
2012	226	759,174	3,359	3,800	0	728,987	0	0	87,733	96.5	637,650	95.5	634,696
2013	253	973,829	3,849	3,858	0	929,971	0	70,053	232,167	95.9	626,499	93.8	625,248
2014	204	875,902	4,294	4,000	0	853,563	0	219,881	205,252	97.9	425,614	95.3	422,800
2015	**199**	**851,151**	**4,277**	**0**	**0**	**804,754**	**0**	**218,094**	**142,922**	**94.5**	**441,909**	**90.2**	**440,080**

Juvenile Rearing

Broodyear 2015 spring Chinook performed very well through the rearing period. Eyed-egg to smolt survival was calculated at 95.7%, exceeding the HGMP's target of >93% (Appendix A). Fry were first ponded into 36 early rearing tanks inside the hatchery nursery on March 2, 2016. In an attempt to prevent coagulated yolk disease fish were not fed until March 9, 2016, thereby allowing fish to absorb remaining yolk stores. This population was reared inside the early rearing tanks until March 30, when they were moved into 6 A-bank Foster-Lucas rearing units. Mortality during the early rearing period accounted for 33.5% of all observed mortalities during rearing; this is not uncommon as fish with congenital defects typically drop out during this timeframe. Fish remained in A-bank ponds until July when mass marking occurred. Tagging-related mortality accounted for about 19.0% of all observed mortalities. Fish were then distributed to 9 D-bank raceways and 11 C-bank raceways following marking/tagging, where they resided until release. Fish performed well for the remainder of rearing except for an increase in mortality in October 2016, when several D-bank raceways were affected by the ectoparasite, *Ichthyopthirius multifillis* ("Ich"). Affected raceways were treated with three flow-through formalin treatments in mid-October. Affected groups responded positively to the treatments. Ich was responsible for 20.6% of all observed rearing period mortality. The population of spring Chinook was fed a total of 18,749 lbs. of feed and expressed a conversion rate for the entire rearing period of 0.82.

Throughout the rearing cycle, the density of fish per rearing vessel, and the flow of water through the rearing vessel were monitored. Reduced densities and increased flow are desired to mitigate disease risk. For the release year (RY) 2017 rearing cycle, the mean monthly Density Index (DI) and Flow Index (FI) was 0.06 and 0.45, respectively which met the performance goals (DI <0.11 &FI<1.0) for these categories (Table 14; Appendix A).

Table 14. Juvenile rearing performance for release year 2017.

Month	Life Stage	Inventory	Fish/ lb.	Mortality (%)	Survival (%)	Avg. temp (˚C)	Water Source (%)			Flow (GPM)	Flow Index[2]	Density Index[3]
							Well	River	Reuse			
Aug.	Egg	851,151	NA	NA	NA	10.6	100	0	0	42	NA	NA
Sept.	Egg(cull)	661,832	NA	NA	NA	9.9	100	0	0	42	NA	NA
Oct.	Egg (transfer)	443,738	NA	NA	NA	10.1	100	0	0	30	NA	NA
Nov.	Sac Fry	441,909	NA	NA	99.5	10.0	100	0	0	30	NA	NA
Dec.	Sac Fry	441,909	NA	NA	99.5	10.0	100	0	0	30	NA	NA
Jan.	Sac Fry	441,909	NA	NA	99.5	8.9	100	0	0	30	NA	NA
Feb.	Sac Fry	438,326	NA	NA	98.7	8.3	100	0	0	30	NA	NA
Mar.	Fry	424,353	801	3.2	95.6	7.7	100	0	0	540	0.18	0.02
Apr.	Fry	419,176	409	0.1	94.5	8.8	100	0	0	1,500	0.29	0.03
May	Fingerling	418,646	202	0.1	94.3	8.3	100	0	0	1,750	0.46	0.05
Jun.	Fingerling	418,313	113	0.1	94.3	9.3	100	0	0	1,750	0.68	0.07
Jul.	Fingerling (mark/tag)	427,193[1]	74	0.2	96.3	10.9	90	10	0	5,200	0.25	0.04
Aug.	Fingerling	426,672	47	0.1	96.2	11.6	90	10	0	5,200	0.34	0.05
Sept.	Fingerling	426,421	35	0.1	96.1	10.7	90	10	0	5,200	0.41	0.06
Oct.	Fingerling	425,316	31	0.3	95.8	8.5	80	20	0	6,550	0.45	0.07
Nov.	Yearling	425,156	28	0.03	95.8	6.8	70	30	0	6,550	0.48	0.07
Dec.	Yearling	425,059	27	0.02	95.8	4.8	70	30	0	6,550	0.49	0.08
Jan.	Yearling	424,837	28	0.05	95.7	4.3	60	40	0	6,550	0.48	0.07
Feb.	Yearling	424,742	26	0.02	95.7	4.7	50	50	0	6,550	0.50	0.08
Mar.	Yearling	424,645	18	0.02	95.7	6.7	40	60	0	6,550	0.64	0.10
Apr.	Smolt	424,591	17	0.01	95.7	7.4	30	70	0	6,550	0.70	0.10

[1]Total inventory adjusted (upwards) by automated counting done during mark/tagging event.
[2]Flow index calculated by fish weight (lbs.) divided by flow in GPM.
[3]Density Index calculated by fish weight (lbs.) divided by average fish length (in.) multiplied by volume of water (ft^3)

Juvenile Marking Summary

Columbia River FWCO staff (USFWS, Vancouver, WA) are annually contracted to conduct mass marking of spring Chinook at Complex hatcheries. For 2017-release spring Chinook the target (as per US v OR) was 100% CWT and adipose-clip. BY2015 Spring Chinook were marked July 5-14, 2016. 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 3-7, 2016. Mass marking is summarized in Table 15, with release summaries in the following section.

Table 15. Summary of Broodyear 2015 WNFH spring Chinook mass marking.

Brood year	Tagcode	Inventory @ tagging	Est'd CWT retention	Ad-clipped (actual)	Ad-clip rate	# PIT tagged
2015	055714	58,516	98.2%	56,916	97.3%	4,984
	055757	234,261	98.5%	231,619	98.9%	14,971
	055711	45,277	96.5%	45,015	99.4%	0
	055715	90,090	96.7%	90,090	100.0%	0
	TOTAL	**428,144**	**97.9%**	**423,716**	**99.0%**	**19,955**

Juvenile Release

WNFH staff initiated a semi-volitional release (over 2 days) of spring Chinook at 15:00 on April 19, 2017. Spring Chinook were allowed to migrate before other species at WNFH to capitalize on their typical migration behavior (rapid, complete departure) to minimize tag collisions in the hatchery outfall's PIT interrogation system during the longer, more protracted Coho and steelhead volitional release periods. A total of 424,591 spring Chinook were released (Table 16), which is 106% of the HGMP's smolt release goal (Appendix A), yet within the Biological Opinion's allowable +10% maximum program release size (measured on a 5-year avg.). Release of spring Chinook from Winthrop NFH preceded true spring runoff conditions in the Methow River (Figure 7) by 2+ weeks in 2017. The more gradual departure of steelhead, via volitional release, is shown in Figure 7 for comparison. Table 17 displays the BY15 release group in the context of previous release years.

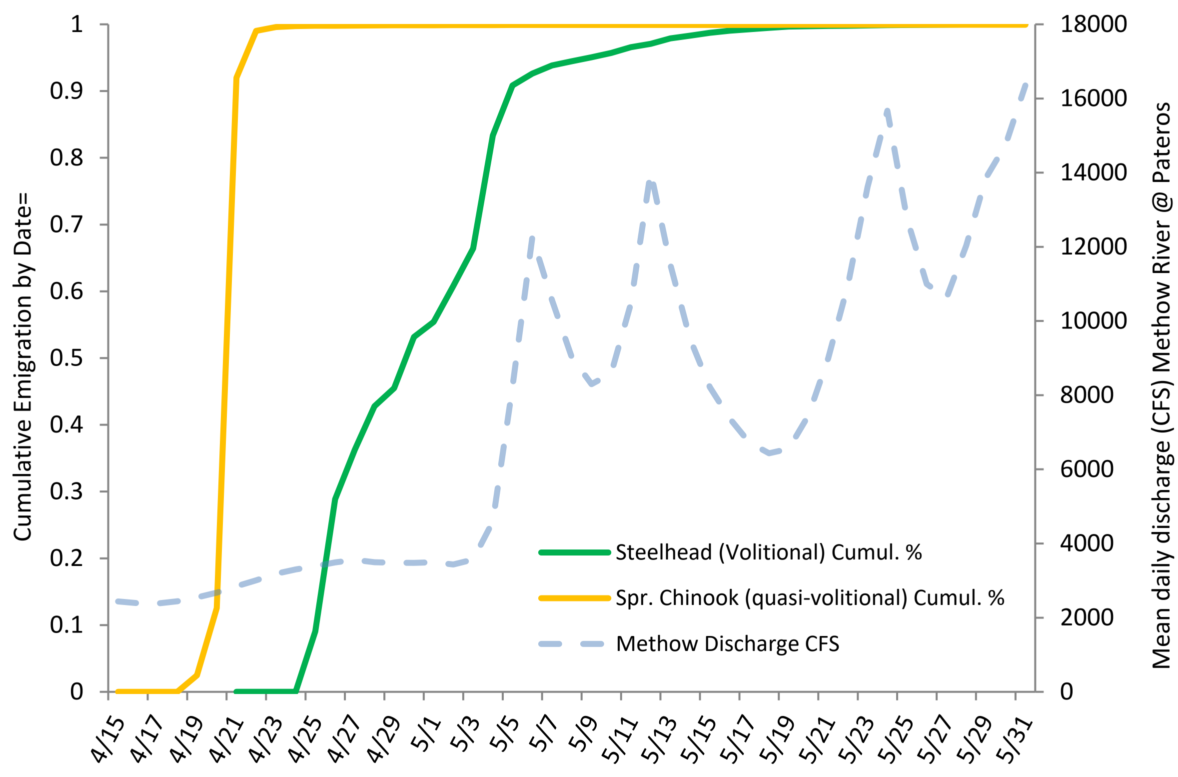

Figure 6. Broodyear 2015 spring Chinook and steelhead release and hydrologic conditions in the Methow River (detections leaving WNFH at PTAGIS site SCP) compared to flow at Pateros, WA.

Table 16. Broodyear 2015 (2017 release year) spring Chinook code-wire tag release groups.

CWT code	Release Site	Release Date(s)	CWT+ release	CWT- release	Total Release	PITs Released
055714	Methow River @ Winthrop	April 19-20	78,222	934	79,156	4,974
055757			208,571	3,176	211,747	14,944
055711			43,481	1,563	45,044	0
055715			85,754	2,890	88,644	0
Total			**416,028**	**8,563**	**424,591**	**19,918**

Table 17. Winthrop NFH spring Chinook release and mark summary for release years 2001-2017.

Brood year	Release Year	Release start date	# CWT	% CWT	# Ad-clip	% Ad-clip	# PIT tagged	Total Released	5-year moving avg.[1]
1999	2001	4/17	171,496	97.5%	172,718	98.2%	7,423	175,869	363,071
2000	2002	4/15	190,368	100.0%	-	0.0%	27,457	190,368	369,720
2001	2003	4/15	499,259	94.9%	265,039	50.4%	19,881	526,361	404,224
2002	2004	4/13	513,687	88.8%	40,777	7.1%	19,887	578,307	465,868
2003	2005	4/15	527,836	95.9%	165,611	30.1%	3,600	550,214	545,733
2004	2006	4/20	457,074	94.4%	-	0.0%	4,489	484,090	542,270
2005	2007	4/11	588,654	99.8%	220,776	37.4%	3,833	589,693	501,000
2006	2008	4/14	496,067	97.5%	-	0.0%	2,987	509,045	490,153
2007	2009	4/16	348,728	93.8%	74,877	20.1%	1,999	371,959	478,731
2008	2010	4/19	483,382	97.5%	121,542	24.5%	4,985	495,978	470,958
2009	2011	4/18	419,751	98.3%	-	0.0%	10,917	426,980	444,176
2010	2012	4/16	548,558	99.6%	-	0.0%	10,916	550,828	481,860
2011	2013	4/15	359,541	95.8%	325,008	86.6%	16,872	375,134	463,366
2012	2014	4/15	546,955	97.6%	553,677	98.8%	4,991	560,379	458,858
2013	2015	4/14	389,204	96.5%	402,310	99.7%	9,937	403,510	433,611
2014	2016	4/11	396,945	98.1%	401,415	99.3%	19,960	404,441	448,230
2015	2017	4/19	416,018	98.0%	420,855	99.1%	19,918	424,591	410,847

[1]5y moving average values for broodyears 2014, and 2015, calculated using nearest available years.

Pre-release sampling of Spring Chinook showed a homogenous group made up primarily (89.3%) of sexually immature transitional smolts (Smolt Index [SI]-2) and smolts (10.7%; SI-3) and no 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 1.17, and 17 fish/lb., respective, consistent with operational targets (Appendix A).

Table 18. WNFH Spring Chinook size and condition at pre-release.

Smolt Index (SI) Groups	FL (mm)		Weight (g)		N; %	K
	Avg.	CV	Avg.	Fish/lb.		
SCS Pre Release (collection and sampling – April 18)						
1 (parr)	N/A	N/A	N/A	N/A	0	N/A
2 (transitionals)	130.1	0.07	26.2	17.3	268; 89.3%	1.17
3 (smolts)	136.2	0.05	30.7	14.8	32 (10.7%)	1.20
4 (prec. males)	N/A	N/A	N/A	N/A	0	N/A
Combined average	130.8	0.07	26.7	17.0	300	1.17

Smolt Outmigration

The majority (visually observed) of spring Chinook had emigrated from ponds by the first morning following initiation of release with very few remnants visible in the ponds. Released smolts do not linger in the area of release. Indeed, by day 5 following release, PIT interrogation data from Spring Creek MUX (site SCP, ~250 meters below the hatchery ladder) showed that 99.5% of all PIT-tagged spring Chinook in the release group that migrated in 2017 had done so in less than 5 days. Similarly, 99.5% of all spring Chinook PITs ultimately detected at Rocky Reach Juvenile Fish Bypass (RRJ) in 2017, were detected within 39 days post-release (i.e., by May 28; Figure 8). More detailed discussion of the expected residualism rate follows in the Early Maturation, Precocialism, and Residualism section.

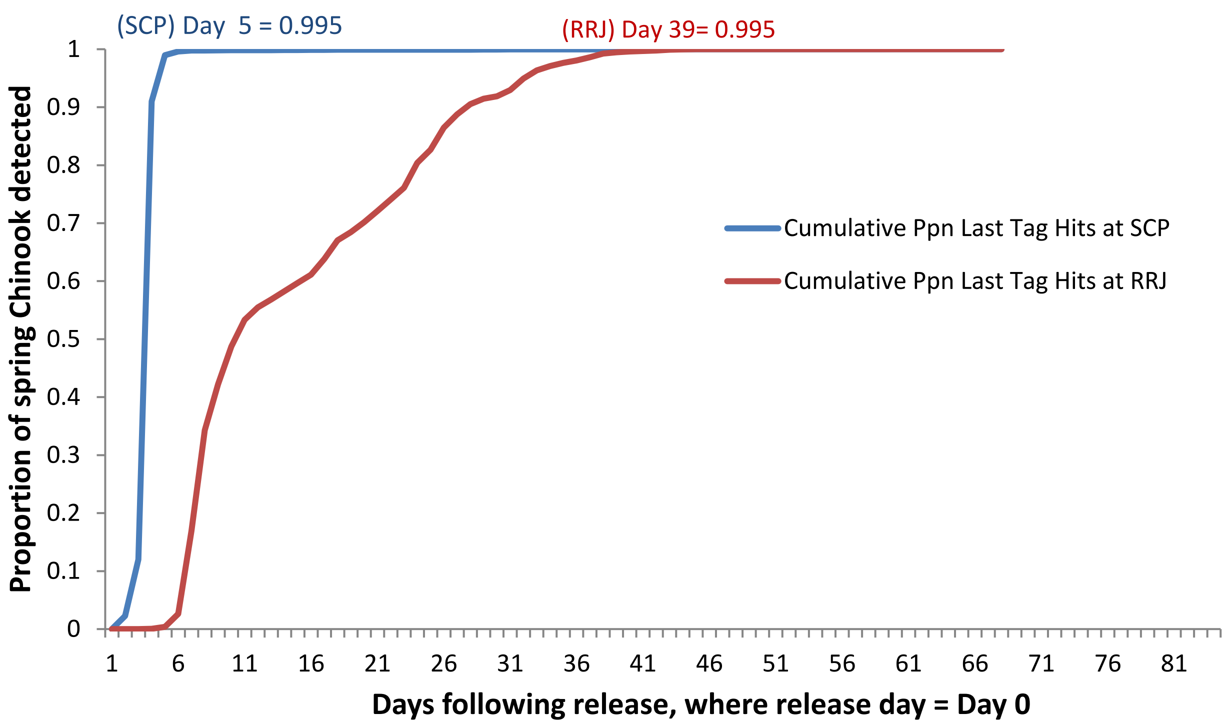

Figure 7. Cumulative downstream spring Chinook PIT tag detections following release, beginning April 19, 2017.

Juvenile apparent survival rates through the Columbia River hydro system were calculated using Cormack-Jolly-Seber (CJS) models (Cormack, 1964; Jolly, 1965; Seber, 1965) and travel times to key geographic features along the migration corridor were calculated and compared to other regional spring Chinook programs. All data were obtained and are available via Columbia River DART (Univ. of Washington, 2017). WNFH migrants in 2017 had above-average travel times to RRJ, the highest average speed to RRJ, and the highest survival to RRJ of similar programs in the Upper Columbia River (statistically similar to CJH segregated program), and 2nd fastest travel time to Bonneville Dam. Survival and travel time estimates to Bonneville Dam lacked required precision across programs to make meaningful comparisons, likely due to limited recaptures in the estuary tows, which inform capture probability estimates and consequently SE at BON (Table 19). Inter-annual survival rates across programs are displayed in Figure 9 and travel times of above-Wells programs to RRJ are shown in Figure 10. Data suggest that WNFH spring Chinook survival compare very favorably to other similar programs, at least in terms of survival and travel time to RRJ and McNary Dam.

Table 19. 2017 Upper Columbia hatchery spring Chinook PIT-based juvenile survival rates and travel times to Rocky Reach Juvenile bypass (RRJ) and Bonneville Dam (BON).

Release Group	Travel Time (days (SE); *sample size*) to RRJ	Survival to RRJ (SE)	Avg. speed (km/day), release to RRJ	Travel Time (days (SE); *sample size*) to BON	Survival, release to BON (SE)
WNFH on-station	**14.1 (0.14); *4,366***	**83.4% (2.1%)**	**11.5**	**29.9 (0.21); 1143**	**42.4% (11.3%)**
MFH on-station	21.6 (0.38); *843*	68.2% (3.9%)	7.6	33.9 (0.41); *288*	57.2% (38.2%)
CJH Segregated	10.4 (0.28); *781*	81.4% (5.0%)	10.3	21.4 (0.46); *257*	38.4% (20.4%)
CJH 10(j) Integrated	23.2 (0.47); *476*	52.2 (4.4%)	6.8	35.3 (0.61); *143*	n/a
Average, all programs	**19.1 days**	**70.8%**	**8.7**	**32.3 days**	**48.3%**

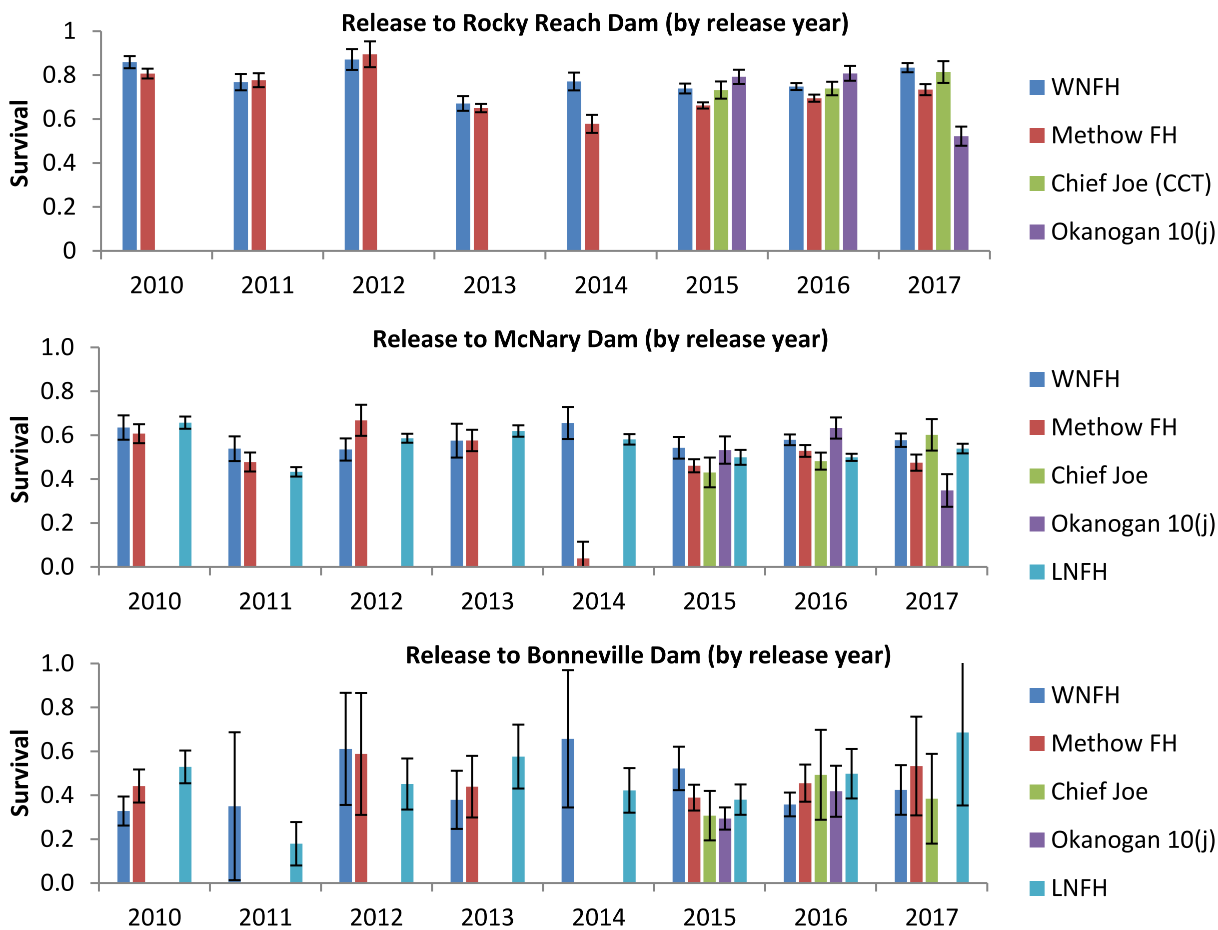

Figure 8. Comparative juvenile survival rates (error bars show SE) of Upper Columbia spring Chinook hatchery programs from release to Rocky Reach (top), McNary (middle), and Bonneville dams (bottom).

[1]LNFH release groups do not pass Rocky Reach Dam, thus are not shown
[2]Chief Joe/Okanogan programs did not begin until RY2015
[3]Other blank values indicate insufficient PIT detection data for survival analysis in DART, not zero survival

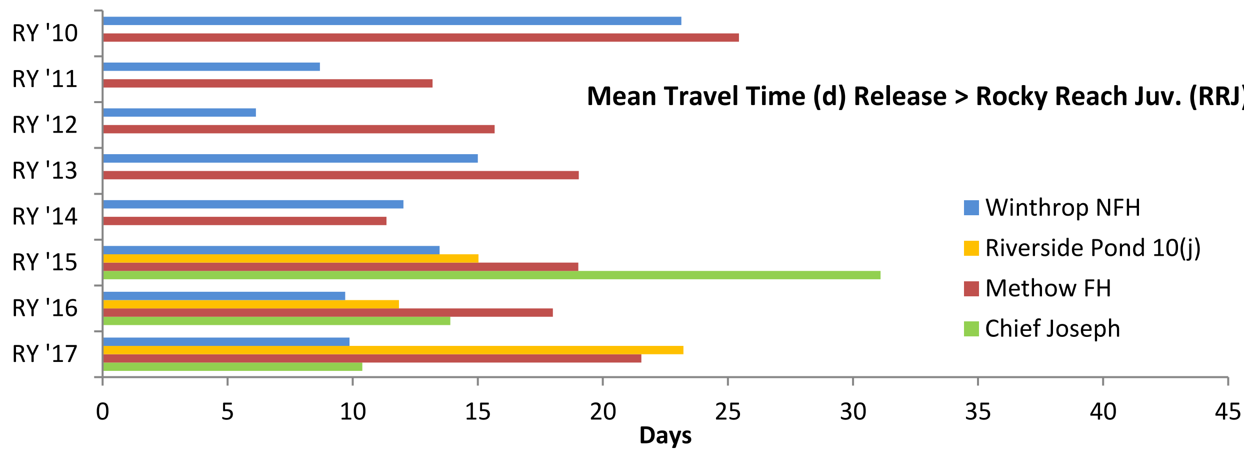

Figure 9. Upper Columbia hatchery spring Chinook mean travel time estimates from release to Rocky Reach Juvenile, 2010-2017.

Early Maturation and Residualism

Spring Chinook Salmon returning to the Upper Columbia River region most commonly mature in the ocean at age-3, age-4, or age-5 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. In the hatchery environment, fish initiate maturation prior to release and may remain near the point of release, or begin to migrate toward the ocean to various degrees, then re-ascend and attempt to spawn (Mullan et al. 1992, Beckman and Larsen 2005).

Early male maturation may be induced through hatchery practices, particularly the promotion of 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 in the natural environment; 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, contributing to unacceptable ecological and genetic risks to already depressed local populations.

Juvenile monitoring of Leavenworth Complex hatchery programs is accomplished through a combination of physiological 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.

Of sampled fish, none presented outward (SI) indication of non-migrant life history strategies. Internally, GSI comparison revealed that 3.4% of the Spring Chinook release group were males initiating maturation, despite an outward smolt/transitional appearance (Table 20). 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), including some fish that co-migrate with immature smolts and spend about two months in the estuary or nearshore ocean then re-ascending 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”).

Table 20. 2017 WNFH Spring Chinook release population breakdown and early maturation.

Phenotype	Life history strategy	Release Group	
		Estimated number	% of Population
Maturing Males	Residuals, minijack varieties	14,436	3.4%
Migrant Males	Anadromy	199,982	47.1%
Migrant Females		210,172	49.5%
Total		**424,591**	

Physiological observation data were supported by RY17 PIT tag detection data (PTAGIS.org) from summer 2017; 30 PITs (about 0.15% of the release) were detected in the sub-basin after June 1. The majority of these was detected in the Methow River between Winthrop and Twisp and would seem to be indicative of a mature headwater parr strategy of residualization, as described by Johnson et al. (2012). We lack capture probability estimates for the subbasin’s combined PIT interrogation system. We also recognize that census estimates for populations require that individuals move randomly and across detection sites, making robust population estimates impossible to achieve. Nonetheless, this small recapture sample is less than (and thus consistent with) the 3.4% early male maturation rate estimated via physiologic assay.

Migratory forms of early-maturing males can be estimated using PIT data of re-ascending fish in the Columbia River mainstem in year-of-release. Mainstem dam detections in 2017 showed a total of 17 PIT tags (0.1% of the release group) indicative of minijack life history behavior. These included 16 minijacks that descended and re-ascended Bonneville Dam and one PIT suggesting a large river parr life history (outmigration into the mainstem Columbia River but not fully to the estuary/ocean with subsequent re-ascension). One of the early maturing parr was detected successfully returning to Wells Dam but never detected in the Methow Subbasin. All others appeared to have died (or remained) in the mainstem Columbia River. Overall, background residualism rates of various forms at WNFH appear to be low (3.4%; GSI-based). Further, due to the low apparent survival of these life histories within the current hydro system, their effective rate is even lower (~0.1%; PIT-based) such that an insignificant number survive through fall spawning to pose ecological risks in the tributaries or genetic risks on the spawning grounds. Observations in 2017 were similar to those retrospectively analyzed for previous years in Table 21.

Table 21. Estimated migratory minijack rates for WNFH spring Chinook release groups.

Release Year	# Fish released	# PITs	Fish/ PIT	Apparent Columbia R. minijack PITs	Expanded Col. River minijacks[1]	Minijack Rate (%)[2]	Passage above Wells Dam	Minijack success rate (%)[3]
2002	190,368	27,457	6.9	47	326	0.2%	7	0.03%
2003	526,361	19,881	26.5	6	159	0.0%	2	0.01%
2004	578,307	19,887	29.1	18	523	0.1%	6	0.03%
2005	550,214	3,600	152.8	1	153	0.0%	0	0.00%
2006	484,090	4,489	107.8	3	324	0.1%	0	0.00%
2007	589,693	3,833	153.8	4	615	0.1%	1	0.03%
2008	509,045	2,987	170.4	9	1,534	0.3%	0	0.00%
2009	371,959	1,999	186.1	3	558	0.2%	1	0.05%
2010	495,978	4,985	99.5	5	497	0.1%	0	0.00%
2011	426,980	10,917	39.1	18	704	0.2%	0	0.00%
2012	550,828	10,916	50.5	28	1,413	0.3%	5	0.05%
2013	375,134	16,872	22.2	42	934	0.2%	6	0.04%
2014	560,379	4,991	112.3	7	786	0.1%	2	0.04%
2015	403,510	9,937	40.6	12	487	0.1%	3	0.03%
2016	404,441	17,361	23.3	39	909	0.2%	2	0.01%
2017	424,591	19,918	21.3	20	426	0.1%	1	0.01%

[1]Values suggest assumed/possible minijack individuals via observation of re-ascension of a mainstem dam in year of release.
[2]Minijack rate estimates include only migratory minijack life histories and exclude headwater parr strategy.
[3]Minijack success rate reflects only potential of returning to Methow Subbasin (via re-ascension of Wells Dam) only and shouldn't be misinterpreted as contribution on spawning grounds. The very low rates are intended to communicate that the life history is not a successful one.

Adult Return

Run Forecasting

Spring- and summer-run Chinook Salmon runs are closely monitored in association with the Leavenworth and Entiat National Fish Hatcheries. Pre-season and in-season estimates are made to help inform managers charged with administering recreational and tribal fisheries in these hatcheries' respective areas. No spring Chinook Salmon recreational fisheries have been opened in the Methow Subbasin in many years. Consequently, we do not currently conduct run forecasting efforts beyond those provided by the US v OR Technical Advisory Committee or NOAA Fisheries. This would likely change in the event that spring Chinook run strength was sufficient to open conservation fishery openings targeting listed stocks above Priest Rapids Dam or in the tributaries.

Run Timing

Returning adult spring Chinook from WNFH are typically detected at Bonneville Dam (Columbia River mile 146.1) by about the second week of April and the run typically passes Bonneville by early July. The first arriving 2017 adult was detected at Bonneville Dam on May 1, about two weeks later than average and only three days earlier than the latest reported date (May 4, 2008). Half of the run had passed by May 23, about 2.5 weeks later than average. Most of the run (95%) had passed Bonneville Dam by July 20, roughly a month later than average (Table 22).

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

Escapement Year	Cumulative run passage								
	First fish	%5	10%	25%	50%	75%	90%	95%	Last fish
2001	8-Apr	8-Apr	12-Apr	14-Apr	22-Apr	6-May	10-Jun	4-Jul	4-Jul
2002	31-Mar	23-Apr	26-Apr	30-Apr	14-May	26-Jun	5-Jul	12-Jul	25-Jul
2003	2-Mar	4-Mar	6-Mar	27-Mar	22-Apr	7-May	22-Jun	30-Jun	2-Jul
2004	13-Apr	15-Apr	16-Apr	19-Apr	22-Apr	30-Apr	9-May	19-May	8-Jul
2005	21-Apr	21-Apr	23-Apr	25-Apr	4-May	13-May	14-May	15-May	15-May
2006	1-May	1-May	1-May	4-May	7-May	12-May	26-Jun	1-Jul	1-Jul
2007	23-Apr	23-Apr	23-Apr	29-Apr	11-May	18-May	5-Jul	5-Jul	5-Jul
2008	4-May	4-May	4-May	7-May	14-May	26-Jun	4-Jul	10-Jul	10-Jul
2009	8-Apr	8-Apr	8-Apr	11-May	13-May	17-May	18-May	12-Jul	12-Jul
2010	15-Apr	19-Apr	21-Apr	23-Apr	28-Apr	6-May	9-May	29-Jun	3-Jul
2011	2-May	5-May	6-May	10-May	12-May	18-May	3-Jun	27-Jun	5-Jul
2012	29-Apr	30-Apr	4-May	9-May	18-May	24-Jun	28-Jun	30-Jun	14-Jul
2013	14-Apr	24-Apr	26-Apr	2-May	10-May	22-Jun	27-Jun	29-Jun	6-Jul
2014	8-Apr	20-Apr	26-Apr	30-Apr	6-May	13-May	22-May	28-Jun	20-Jul
2015	1-Apr	15-Apr	18-Apr	20-Apr	27-Apr	4-May	18-May	19-May	25-May
2016	22-Apr	24-Apr	25-Apr	2-May	20-May	28-Jun	7-Jul	20-Jul	8-Aug
2017	1-May	4-May	7-May	19-May	23-May	23-Jun	8-Jul	20-Jul	20-Jul
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

In 2017, adults traveled from Bonneville Dam to Winthrop NFH (detections at PTAGIS site SCP, about 175m downstream of the hatchery) in an average of 33.7 days, about three days slower than the average for the 2010-2017 period that SCP has operated (Table 23).

Table 23. Winthrop NFH spring Chinook adult travel times from Bonneville Dam.

Return Year	BONN > MCN			MCN > PRD			PRD > RI			RI > Wells			Wells > SCP			BONN > SCP		
	Avg.	SD	N=	Avg.	SD	N =	Avg.	SD	N =	Avg.	SD	N =	Avg.	SD	N =	Avg.	SD	N =
2002	8.9	5.5	29		*n/a*			*n/a*			*n/a*			*n/a*			*n/a*	
2003	10.9	6.9	22	6.8	3.5	22	5.4	2.3	14	16.8	12.4	14		*n/a*			*n/a*	
2004	5.5	1.2	69	5.5	5.8	51	9.5	10.6	21	15.0	17.3	24		*n/a*			*n/a*	
2005	5.8	1.5	9	4.3	1.5	7	3.9	2.2	7	6.1	3.8	7		*n/a*			*n/a*	
2006	6.8	2.2	15	4.0	0.9	15	4.8	3.5	14	8.8	12.7	13		*n/a*			*n/a*	
2007	5.7	1.0	6	5.6	1.8	5	3.6	1.9	5	5.3	1.0	4		*n/a*			*n/a*	
2008	6.5	1.6	6	4.2	0.8	6	3.2	1.1	5	5.0	4.1	4		*n/a*			*n/a*	
2009	5.6	1.1	7	4.3	2.0	7	3.3	1.4	7	3.3	0.5	7		*n/a*			*n/a*	
2010	6.9	4.7	18	4.3	1.1	19	3.6	1.3	19	6.5	4.1	19	16.8	6.2	10	35.9	9.1	10
2011	9.2	7.3	31	7.6	5.1	32	3.8	1.6	30	4.8	2.3	29	25.4	5.8	27	50.6	9.7	26
2012	7.2	2.1	14	5.4	1.8	10	4.4	1.9	10	5.9	5.5	14	17.1	4.6	11	39.8	11.3	11
2013	6.9	3.7	26	6.2	3.1	26	4.5	3.3	24	4.2	2.6	24	12.8	4.2	19	33.8	6.6	18
2014	6.7	3.3	73	5.0	1.6	69	4.5	2.9	54	4.3	1.6	54	13.6	4.9	61	33.3	6.9	61
2015	5.0	1.3	70	3.7	0.9	71	2.9	1.1	64	4.1	1.7	65	15.7	5.9	70	32.0	7.0	67
2016	6.4	3.4	24	4.1	1.3	24	4.2	5.3	21	8.4	8.0	21	14.9	6.1	21	34.3	11.1	20
2017	8.0	5.4	28	5.3	2.4	28	2.7	0.9	17	3.4	0.8	17	14.6	5.4	22	33.7	8.2	21
Min	5.0	1.0	6	3.7	0.8	5	2.7	0.9	5	3.3	0.5	4	12.8	4.2	10	32.0	6.6	10
Max	10.9	7.3	73	7.6	5.8	71	9.5	10.6	64	16.8	17.3	65	25.4	6.2	70	50.6	11.3	67
Avg.	7.0	3.3	28	5.1	2.2	26	4.3	2.8	21	6.8	5.2	21	16.4	5.4	30	36.7	26.3	29.3

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

Run Conversion

From Bonneville Dam, returning WNFH adults pass another seven dams before reaching Wells Dam, the last robust counting location prior to entering the Methow Sub-basin. PIT tag detection efficiency at Bonneville Dam was reported to be >90% more than a decade ago (Burke et al 2006). Analysis of WNFH adult PIT tags at Wells Dam between 2002 and 2017 (using PTAGIS data) suggests that detection efficiency has improved closer to 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 2017, slightly over half (53.7%) of WNFH adults to Bonneville safely made passage to the SCP array, just below the hatchery. This is slightly less than the 2010-2017 average (Table 24). Conversion of fish between mainstem projects in 2017 was generally average or above-average with the exception of Bonneville-to-McNary conversion, which was below average, indicating higher mortality, perhaps associated with higher fishery removals.

Table 24. WNFH spring Chinook passage success from Bonneville Dam to Winthrop NFH.

Return Year	Adjusted PIT detections[1,2]						Conversion efficiency by reach[2]					
	BONN	MCN	PRD	RI	WEA	SCP	BONN > MCN	MCN > PRD	PRD > RI	RI > WEA	WEA > SCP	BONN > SCP
2002	39	30	24	24	24	- -	76.9%	80.0%	100.0%	100.0%	- -	
2003	25	22	22	22	22	- -	88.0%	100.0%	100.0%	100.0%	- -	
2004	82	69	66	65	64	- -	84.1%	95.7%	98.5%	98.5%	- -	
2005	11	9	9	9	9	- -	81.8%	100.0%	100.0%	100.0%	- -	
2006	17	15	15	14	13	- -	88.2%	100.0%	93.3%	92.9%	- -	
2007	6	6	5	5	4	- -	100.0%	83.3%	100.0%	80.0%	- -	
2008	9	6	6	6	5	- -	66.7%	100.0%	100.0%	83.3%	- -	
2009	10	8	8	8	8	- -	80.0%	100.0%	100.0%	100.0%	- -	
2010	23	19	19	19	19	10	82.6%	100.0%	100.0%	100.0%	52.6%	43.5%
2011	36	33	33	33	32	27	91.7%	100.0%	100.0%	97.0%	84.4%	75.0%
2012	20	14	14	14	14	11	70.0%	100.0%	100.0%	100.0%	78.6%	55.0%
2013	29	27	27	26	25	19	93.1%	100.0%	96.3%	96.2%	76.0%	65.5%
2014	85	75	71	70	70	63	88.2%	94.7%	98.6%	100.0%	90.0%	74.1%
2015	81	73	72	72	72	70	90.1%	98.6%	100.0%	100.0%	97.2%	86.4%
2016	30	27	26	26	26	23	90.0%	96.3%	100.0%	100.0%	88.5%	76.7%
2017	41	29	28	27	27	22	70.7%	96.6%	96.4%	100.0%	81.5%	53.7%
Min	6.0	6.0	5.0	5.0	4.0	10.0	66.7%	80.0%	93.3%	80.0%	52.6%	43.5%
Max	85.0	75.0	72.0	72.0	72.0	70.0	100.0%	100.0%	100.0%	100.0%	97.2%	86.4%
Avg.	34.0	28.9	27.8	27.5	27.1	30.6	83.9%	96.6%	98.9%	96.7%	81.1%	66.2%

[1]Detection efficiency at mainstem projects adjust only by back-applying upstream detects to all downstream sites.
[2]BONN – Bonneville; MCN – McNary; PRD – Priest Rapids; RI – Rock Island; WEA – Wells; SCP – Spring Cr. (WNFH).

Harvest

WNFH Adults are subjected to ocean and mixed Columbia River fisheries. There were no targeted spring Chinook fisheries authorized on the Upper Columbia or Methow rivers during the analysis period so nearly all freshwater recoveries are from the Columbia River mainstem below McNary Dam. There are tributary fisheries on other Mid- and Upper Columbia tributaries but WNFH contributions to these are rare and, in this analysis, lumped in with freshwater sport interceptions. Estimated total harvest contributions for completed broodyears (up to BY2012), have ranged from <1% to above 18%, with the most recent complete broodyear, 2012, being above-average (RMIS.org; Table 25).

Table 25. Winthrop NFH Spring Chinook estimated harvest rates.

Brood Year	Mixed Fishery/Harvest				Total Freshwater Escapement + Harvest	Harvest Rate (%)
	Comm. Ocean	Freshwater Sport	Freshwater Tribal	Misc.		
1999	4	6	4		74	18.9
2000			15		581	2.6
2001		40	5		514	8.8
2002		4	2		616	1.0
2003	2	6	2		390	2.6
2004			118		1,056	11.2
2005		28	8		668	5.4
2006			315		3,160	10.0
2007		22	35	1	1,270	4.6
2008	5	86	106	1	2,603	7.6
2009			10		1,107	0.9
2010			182		5,467	3.3
2011	6	298	219	5	3,738	14.1
2012[1]		303	185	1	3,091	15.8
Avg.	4	88	86	2	1,738	7.6

[1]Broodyear 2012 CWT recovery data were complete in 2017 with age-5 adults returns; however CWT reporting data streams include many sources with expected lag times. Data subject to review.

Straying

Historically, WNFH spring Chinook have shown relatively low out-of-basin stray rates (Table 26). Expanded coded-wire recovery data from the Regional Mark Information System (rmis.org) were used to analyze complete broodyear escapement patterns, particularly out-of-basin straying. Fishery interceptions and recoveries in locations non-indicative of final destination (e.g. removal at mainstem Columbia River hatcheries such as Wells Dam/Hatchery) were omitted from the analysis unless the location was substantially outside the expected return route of WNFH adults. Both fishery and hatchery recovery locations suggestive of straying (e.g. Leavenworth NFH adult ladder or Sherar's Falls, 44 miles up the Deschutes River, OR) were included and considered strays. Locations were interpreted on a case-by-case basis, according to the biologist's professional judgement. Recovery data are often removal from the run (e.g. fishery, hatchery collection). As such, *effective*, or *post-management,* stray rates would be reported as lower rates than those herein. Estimated out-of-basin stray rate for the last complete broodyear (2012) was 1.1%, the highest value derived across 14 years of data during which the overall average out-of-basin stray rate was just 0.2%.

Within the HSRG's "stepping stone" hatchery model, spawners from the WNFH "safety-net" program are not desirable on the spawning grounds except during periods of very low escapement. They are considered "management strays" in this analysis despite being part of the ESU in the Methow Subbasin. The Fishery Parties attempt to mitigate excess hatchery-origin spawners on the spawning grounds by maximizing WNFH program fish extraction from run most years. This effort has increased and become more coordinated since 2010 and the increased "hatchery homing" rates are seen in Table 26 beginning in broodyear 2006, which returned as age-4 adults in 2010. The push-pull relationship between hatchery homing and management strays is highly affected by management (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.

Brood year	Methow spawning grounds	Hatchery returns[1]	OOB stray[2]	Non-biased sample[3]	Stray and homing rates (%)		
					Out-of-basin	Mgmt[4]	Hatchery homed
2003	45	186	0	231	0.0%	19.5%	80.5%
2004	161	530	1	692	0.1%	23.3%	76.6%
2005	131	299	0	430	0.0%	30.5%	69.5%
2006	495	1712	6	2213	0.3%	22.4%	77.4%
2007	105	900	0	1005	0.0%	10.4%	89.6%
2008	99	2158	0	2257	0.0%	4.4%	95.6%
2009	11	1046	0	1057	0.0%	1.0%	99.0%
2010	137	2376	0	2513	0.0%	5.5%	94.5%
2011	96	787	1	884	0.1%	10.9%	89.0%
2012	44	860	10	914	1.1%	4.8%	94.1%
Avg.	105	857	2	964	0.2%	12.4%	87.4%

[1]Hatchery returns include WNFH & MFH collections as 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.

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, though survey effort is variable/unknown. The highest frequency and regularity of stray recoveries where robust monitoring occurs is in the Entiat Subbasin where WNFH strays have comprised an average 0.4% of spawner escapement per year (Table 27).

Table 27. Estimated WNFH spring Chinook stray frequency and annual contribution to Entiat Subbasin spawn escapement.

Year	Est'd spawner escapement	Carcass sample rate (%)	Est'd NORs	Est'd HORs	WNFH CWT rec's (actual)	Est'd WNFH Strays	% WNFH Stray composition
2004	302	14%	47	53	0	0	0.0%
2005	367	14%	44	56	0	0	0.0%
2006	254	30%	43	57	2	8	3.1%
2007	245	17%	43	58	0	0	0.0%
2008	276	29%	46	54	0	0	0.0%
2009	276	29%	48	52	0	0	0.0%
2010	490	19%	75	25	2	11	2.2%
2011	595	29%	54	46	0	0	0.0%
2012	566	22%	59	41	0	0	0.0%
2013	238	9%	79	21	0	0	0.0%
2014	245	11%	92	8	0	0	0.0%
2015	509	26%	82	18	0	0	0.0%
2016	353	15%	84	16	0	0	0.0%
2017	101	19%	63	37	0	0	0.0%
Avg.	**344**	**20%**	**61**	**39**	**0**	**1**	**0.4%**

*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 as it directly describes the number of adults produced from a juvenile release. This is typically accomplished 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. Early-maturing life histories such as age-2 minijacks are not considered adults and their recoveries are excluded from these estimates. Incoming datastreams to RMIS are extensive and not all data recovery sources update data rapidly, as such values reported in annual reports are subject to revision, particularly those most recent. 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).

WNFH spring Chinook SARs since broodyear 2000 have averaged 0.4%. Recent broodyear cohorts have achieved >1.0% SAR and BY2012 (though age-5 returns are not yet included) is approaching this value (Table 28). Figure 11 graphically displays annual SARs against spring Chinook released from nearby MFH and Leavenworth NFH. Spring Chinook released from MFH generally outperformed WNFH spring Chinook from BY2000 through BY2008; however this trend appears to be reversing with WNFH SARs exceeding those of MFH-released fish from BY2009-2011.

Table 28. Winthrop NFH spring Chinook smolt-to-adult return (SAR) summary.

Brood year	Release year	Smolt release	Fishery Recoveries	Adult Escapement		Total Adults	Smolt-to-Adult (SAR)
				Hatchery Return	Spawning Ground		
2000	2002	190,368	15	434	131	581	0.30%
2001	2003	586,361	45	334	135	514	0.09%
2002	2004	583,307	6	388	222	616	0.11%
2003	2005	565,214	10	227	153	390	0.07%
2004	2006	484,090	118	571	369	1056	0.22%
2005	2007	609,693	36	315	318	668	0.11%
2006	2008	509,045	315	1766	1078	3160	0.62%
2007	2009	376,959	58	923	289	1270	0.34%
2008	2010	505,978	198	2212	194	2603	0.51%
2009	2011	426,980	10	1080	17	1107	0.26%
2010	2012	499,959	182	5039	245	5467	1.09%
2011	2013	359,541	528	2981	228	3738	1.04%
2012[1]	2014	560,379	489	2474	128	3091	0.55%
Avg.		481,375	196	1442	270	1886	0.41%

[1]2017 data may be subject to review and update as incoming data streams submit CWT data to RMIS.org.

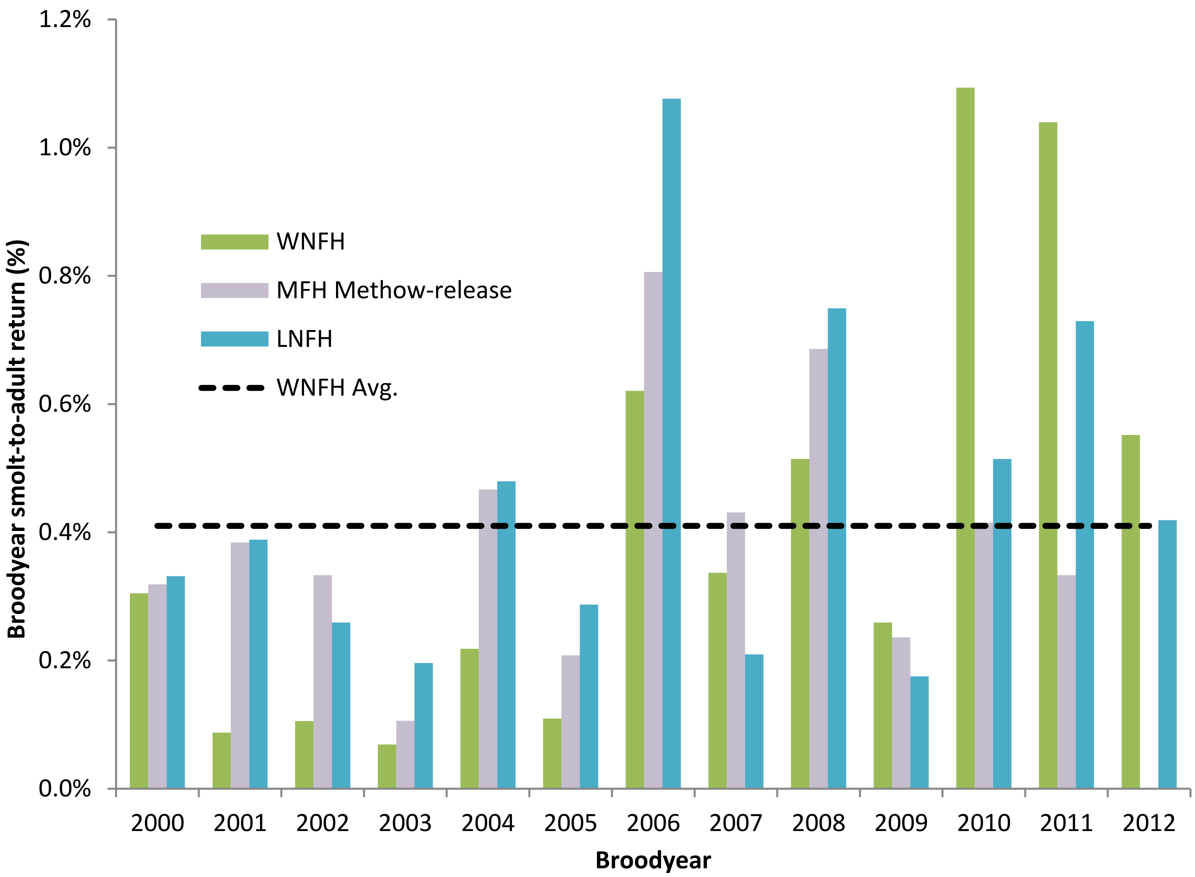

Figure 10. Winthrop NFH spring Chinook annual smolt-to-adult return (SAR) values (%) by broodyear.

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 adults taken to produce them, and is also known as the adult-to-adult replacement rate (Murdoch and Peven 2005). WNFH adult return estimates were back-assigned to broodyear and associated numbers of broodstock held. In some cases, total broodstock held data were difficult to obtain as mortalities in years when large numbers of adults were collected for adult management purposes, assigning or partitioning mortality can be challenging, particularly when conducting a retrospective analysis. Table 29 shows estimated HRRs for broodyears 2000-2012. BY2012 performance was above-average with an HRR of 5.0 and is generally consistent with higher HRR values seen since BY2006. In all years reported, HRR values greatly exceed Methow Subbasin NRR estimates reported by Snow et al. (2017). Only during several years of very low escapement in the mid-to-late 1990s do NRR values exceed 1.0 (Snow et al. 2017).

Table 29. Estimated Winthrop NFH Spring Chinook hatchery replacement rate (HRR).

Brood Year	Broodstock Held[1]	Total Adult Returns	Hatchery Replacement Rate (HRR)	Methow Subbasin Broodyear Natural Replacement Rate (NRR)[2]
2000	112	581	5.2	0.7
2001	330	514	1.6	0.1
2002	374	616	1.6	0.2
2003	398	390	1.0	0.1
2004	334	1056	3.2	0.3
2005	400	668	1.7	0.5
2006	367	3160	8.6	1.0
2007	323	1270	3.9	0.8
2008	411	2603	6.3	0.4
2009	348	1107	3.2	0.1
2010	406	5443	13.4	0.3
2011	400	3320	8.3	N/A
2012	453	3091	6.8	N/A
Avg.	**358**	**1886**	**5.0**	**0.4**

[1]Broodstock held was compilation of different data sources. Assignment of pre-spawn mortality when adult management activities increase total held fish is apportioned by time of occurrence and proportion of pond population.
[2]Data distilled from estimated values for Methow, Twisp and Chewuch watersheds (Snow et al. 2016)

Natural Environment Monitoring

Escapement Estimate/Summary

Returning WNFH adult final adult freshwater dispositions were derived primarily from RMIS.org. Freshwater returns were generally summarized as hatchery removals (local Methow Subbasin hatcheries), out-of-basin strays, and in-basin spawning ground recoveries. Escapement and management patterns in 2017 were typical of recent years with most fish in the run recovered at hatchery infrastructure (primarily WNFH and MFH), low out-of-basin stray rates, and a small proportion of the return spawned naturally. These trends are associated with concerted and increased efforts to maximize extraction via hatchery infrastructure, especially since 2012 (Table 30).

Table 30. Winthrop NFH Spring Chinook general freshwater escapement and management patterns.

Run Year	Hatchery Removals N =	%[1]	Out-of-basin Strays N =	%	Spawning Grounds N =	%	Total Freshwater Escapement[1]
2000	897	87.3%		0.0%	131	12.7%	1028
2001	525	92.5%	4	0.8%	38	6.7%	568
2002	463	91.8%	14	2.7%	28	5.6%	504
2003	321	65.7%	6	1.2%	162	33.1%	489
2004	397	72.2%		0.0%	153	27.8%	550
2005	346	74.5%	3	0.6%	116	24.9%	465
2006	324	59.6%	4	0.6%	216	39.8%	543
2007	363	57.8%		0.0%	266	42.2%	629
2008	482	63.1%		0.0%	282	36.9%	764
2009	353	31.7%	1	0.1%	758	68.2%	1112
2010	1782	75.9%	17	0.7%	548	23.4%	2347
2011	1486	76.1%		0.0%	466	23.9%	1951
2012	1727	96.2%		0.0%	68	3.8%	1795
2013	2156	98.0%		0.0%	44	2.0%	2200
2014	4299	94.2%		0.0%	264	5.8%	4563
2015	3241	94.3%	2	0.1%	195	5.7%	3439
2016	2197	93.8%	1	0.0%	144	6.2%	2342
2017	1418[2]	92.8%		0.0%	110	7.2%	1528
Min	321	31.7%	1	0.0%	28	2.0%	465
Max	4299	98.0%	17	2.7%	758	68.2%	4563
Avg.	1265	78.8%	6	0.4%	222	20.9%	1490

[1]Hatchery removal rates were calculated from the total of fish collected at hatcheries, recovered strays, and estimated spawners; these exclude pre-spawn mortalities. Run extraction rates reported elsewhere likely exclude pre-spawn mortalities and, as such, are likely lower rates.
[2]Preliminary estimate subject to review associated with maturation of RMIS CWT data streams.

Spawner Composition and Gene Flow Metrics

ESA consultations for hatchery supplementation programs are increasingly focused on gene flow metrics, particularly the proportion of hatchery-origin spawners (pHOS) and proportionate natural influence (PNI). Prior to the release of the most recent NOAA Biological Opinion for the Winthrop NFH spring Chinook program (NOAA 2016a), tracking these metrics had not been required; however WDFW has been estimating most of these values for some time in association with monitoring and evaluation of Douglas County PUD spring Chinook programs associated with Wells Dam mitigation programs. Snow et al. (2017) summarized both pHOS and PNI on the spawning grounds, based on redd-based escapement values and carcass recoveries. Carcass recovery data from the RMIS were used to apportion Snow et al.'s hatchery-origin spawner escapement estimates into WNFH, MFH, and out-of-basin strays for the purpose of estimating partial pHOS for discrete programs (Table 31). Winthrop NFH has maintained partial program pHOS values below the maximum limits now promulgated by the biological opinion in about half of years. Generally, exceedance of the partial pHOS target occurred prior to years when surplus returning WNFH adults were not excessed to inland Northwest Indian Tribes. In more recent years (2012-2017) large proportions of returning WNFH adults have been removed (>90% of run), yet NOR abundance on the spawning grounds is sufficiently low that attaining partial pHOS targets is mathematically difficult.

The 2016 Spring Chinook biological opinion and Permit #18927 do not identify a PNI target specific to the WNFH program; however high abundance of low-pNOB adults on the spawning grounds poorly affects overall PNI. The HSRG guidelines identify PNI target values of at least 0.67 for integrated programs (HSRG 2009). NOAA has developed several multi-population models (e.g., Busack 2015) purposed to account for gene flow benefits associated with using high pNOB broodstock, whereas the original PNI equation was focused on segregated programs. PNI values re-calculated using the 3-population model (Table 31) using WNFH broodstock data and escapement data from Snow et al. (2017 and *in press*; see Table 31) indicate that hatchery selective forces likely continue to dominate on Methow spawning grounds in most years.

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

Year	Methow Subbasin Escapement[1]				Program partial pHOS estimates[2]			
	Total Spawner Escapement	Combined pHOS	PNI[3]	PNI 5y moving avg.[4]	WNFH	NOR-based ppHOS target[5]	MFH	Out-of-basin Strays
2003	1138	0.95	0.32	0.29	0.18	<0.20	0.75	0.01
2004	1497	0.67	0.15	0.24	0.13	<0.20	0.54	0.01
2005	1376	0.62	0.39	0.23	0.07	<0.20	0.52	0.01
2006	1748	0.81	0.08	0.20	0.17	<0.20	0.59	0.03
2007	1079	0.75	0.20	0.19	**0.42**	**<0.20**	0.33	0.04
2008	1002	0.70	0.19	0.14	**0.32**	**<0.20**	0.38	0.03
2009	2641	0.79	0.10	0.16	**0.34**	**<0.20**	0.45	0.01
2010	2369	0.75	0.11	0.17	**0.26**	**<0.15**	0.49	0.01
2011	2936	0.67	0.19	0.20	**0.24**	**<0.20**	0.43	0.03
2012	1298	0.85	0.24	0.25	0.08	<0.20	0.72	0.02
2013	1089	0.78	0.36	0.29	0.06	<0.20	0.72	0.01
2014	2063	0.75	0.37	0.31	0.15	<0.20	0.60	0.00
2015	1353	0.71	0.30	0.34	0.17	<0.20	0.51	0.01
2016	697	0.54	0.29	0.34	**0.29**	**<0.20**	0.25	0.02
2017	464	0.63	0.38	0.32	**0.27**	**<0.20**	0.35	N/A
Avg.	**1592**	**0.74**	**0.24**	**0.24**	**0.18**	**N/A**	**0.54**	**0.02**

[1]Escapment estimates from (or derived from) Snow et al. 2017
[2]Program-specific data derived from Snow et al. 2017, expanded by RMIS carcass recoveries
[3]PNI estimates re-calculated using NOAA's 3-pop tool (Busack 2015)
[4]5y moving average data for early and late years adjust with available years' data.
[5]Program partial pHOS 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

In 2015, the Winthrop NFH ladder was operated almost continuously from May 13 to September 2, and capture data suggest that any fish not collected were due to other factors beyond operational timeframes. A total of 5,949 adult spring Chinook were collectively trapped and handled in 2015. This is about 80% of the total estimated escapement to the Methow Subbasin. Sufficient adults were collected to fulfil the broodstock collection target of 400 adults (actual 384) and conduct gene-flow management objectives on the spawning grounds through adult surplusing to local tribes. The large surplus of adult salmon also allowed for effective transfer of gametes to the Okanogan 10(j) program and for sufficient gamete culling for BKD risk (ELISA profiles). Adult pre-spawn mortality was relatively high in 2015 due to several mortality events affecting held adults for surplusing (Table 2); however, pre-spawn mortality of held broodstock was typically low, at about 1.1%. Both values/methods remained consistent with the operational goal of >93% adult survival.

Summary of Adult Management Objectives

An estimated 5,470 adult spring Chinook, comprising fish collected at WNFH and transfers from Methow Fish Hatchery, were surplused to local tribes. Removal of this large number of hatchery-origin returns aided in attaining an estimated program partial pHOS value of 0.17 on the spawning grounds in 2015, which is consistent with the NOR-run target of <0.20. The 2015 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 2015 adult management activities (Table 31).

Summary of In-hatchery Rearing/Fish Culture Objectives

The combined broodyear 2015 green eggtake was successful. Total green eggtake of 851,151 exceeded target (800,000) by about 6%. The post-cull (ELISA) target of 650,000 was slightly exceeded (1.8%) with a pre-transfer eyed egg total of about 661,832. Estimated eye-up rate for BY2015 eggs was 94.5%, exceeding the target value of >90%. An estimated 218,094 eyed eggs were transferred to the Colville Tribes' Chief Joseph Hatchery Okanogan 10(j) reintroduction program, which was 99.1% of the target 220,000.

An estimated total of 440,080 fry were ponded with an estimated 424,591 smolts released (106% of production goal), equating to a parr-to-smolt survival rate of 96.5%, exceeding the target of 95%.

Summary of Juvenile Release Objectives

Juvenile release targets were successfully achieved - an estimated 97.9% of fish released were CWT-marked and an estimated 99.0% were adipose-clipped. Total release (424,591) exceeded the 400K target by 6%, and the total remained within the 110% maximum identified in Permit #18927. Pre-release sampling estimates of early-maturation suggest about 3.4% of the total population was early-maturing males, well within the 25% maximum identified in the BiOp.

Summary of Fishery Contribution and Harvest Objectives

There are no identified quantitative fishery contribution and/or harvest targets and much of these would be beyond the control of Winthrop NFH or Mid-Columbia FWCO staff. Fishery contribution values are summarized in the Harvest Contributions section. Harvest contribution of the latest cohort of fish (BY2012) was estimated at 15.8% of returning adults, higher than the 1999-2012 average of 7.6%.

Substantial numbers of additional adults were surplused to inland Northwest Indian tribes, inarguably a related objective; however additional success (in terms of gene flow dynamics) and benefit to people outside of coastal and lower Columbia regions would have been gained through opening of tributary fisheries in the Upper Columbia, including the Methow River when escapement conditions support removal of adipose-clipped spring Chinook from the run, as they did in 2015.

Summary of Escapement-based Objectives

Program implementation, from broodstock collection through juvenile release of BY2012 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 excessing returning adults and implement the Stepping Stone hatchery model for several years by 2015. Consequently, gene flow targets pertinent to WNFH management were at least partially achieved in 2015. The program partial pHOS target/maximum (0.20) was not exceeded in 2015 as a partial pHOS value of 0.17 was estimated; however, these are exceeded in roughly half of all years reported. Overall subbasin PNI targets (0.50 in BiOp, 0.67 from HSRG) for the co-managers remain elusive however and a PNI exceeding 0.50 has not yet been achieved. Experimentation with the models and retrospective analysis of past year's data have demonstrated the importance of four components in achieving program partial pHOS and, more importantly, PNI targets. These are described in the following recommendations:

1) Maintain high pNOB in the Conservation Program broodstock
2) Maintain high proportion of Conservation Program adults in the SafetyNet broodstock
3) Maximize removal of WNFH/SafetyNet adults via fisheries and/or through aggressive adult management
4) Removal of more Conservation Program adults than necessary can hinder the ability to attain SafetyNet 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 that gene flow of Conservation and Safety-Net programs (both spring Chinook and steelhead) gene flow objectives are achievable in future years.

LITERATURE CITED

American Fisheries Society (AFS). 2014. Suggested Procedures for the Detection and Identification of Finfish and Shellfish Pathogens. Blue Book Index. Available from http://www.afs-fhs.org/bluebook/bluebook-index.php. American Fisheries Society, Fish Health Section. Bethesda, MD.

Beckman, B., W. Dickoff, W. Zuagg, C. Sharpe, S. Hirtzel, R. Schrock, D. Larsen, R. Ewing, A. Palmisano, C. Schreck, and C. Mahnken. 1999. Growth, smoltification, and smolt-to-adult return of spring Chinook salmon (O*ncorhynchus tshawytscha*) from hatcheries on the Deschutes River, Oregon. Transactions of the American Fisheries Society 128: 1125–1150.

Beckman, B., D. Larsen, C. Sharpe, B. Lee-Pawlak, and W. Dickoff. 2000. Physiological status of naturally rearing juvenile Chinook salmon (*Oncorhynchus tshawytscha*) in the Yakima River: seasonal dynamics and changes associated with the parr-smolt transformation. Transactions of the American Fisheries Society 129: 727–753.

Beckman, B. and D. Larsen. 2005. Upstream Migration of Minijack (Age-2) Chinook salmon in the Columbia River: Behavior, Abundance, Distribution, and Origin. Transactions of the American Fisheries Society 134:1520–1541

Burke, B., M.A. Jepson, K.E. Frick, and C.A. Peery. 2006. Detection efficiency of a passive integrated transponder (PIT) tag interrogator for adult Chinook salmon at Bonneville Dam, 2005. NOAA FWFCC, Seattle, WA.

Busack, C. 2015. Extending the Ford model to three or more populations. National Marine Fisheries Service, West Coast Region, Sustainable Fisheries Division. August 2015. Portland, OR.

Clarke, W. and J. Blackburn.1994. Effect of growth on early sexual maturation in stream-type Chinook salmon (*Oncorhynchus tshawytscha)*. Aquaculture, 121: 95–103.

Columbia River DART, Columbia Basin Research, University of Washington. (2018). PIT Tag File Selection for Generating Survival and Travel Time Estimates. Accessed 15 December, 2017. Available from http://www.cbr.washington.edu/dart/query/pit_sum_tagfiles

Cooper, M., M. Humling, G. Fraser, and H. Potter. 2017 Hatchery Evaluation Plan for the Leavenworth Hatchery Complex. Version 01. U.S. Fish and Wildlife Service, Leavenworth WA.

Cormack, R.M. 1964. Estimates of survival from the sighting of marked animals. Biometrika 51:429–438.

De Vlaming, VL, G. Grossman, G., and F. Chapman. 1982. On the use of the gonadosomatic index. Comp. Biochem. Physiol. A 73, 31-39.

Frady, Charles. Fish Biologist, Washington Department of Fish & Wildlife, Twisp, WA. Personal communication June 2018.

Fraser, Greg. Fish Biologist, US Fish & Wildlife Service, Mid-Columbia Fish & Wildlife Conservation Office, Leavenworth, WA. Personal communication, September 2018.

HSRG (Hatchery Scientific Review Group). 2009. Columbia River Hatchery Reform System-Wide Report. Prepared by Hatchery Scientific Review Group. 278p.

HSRG (Hatchery Scientific Review Group). 2014. On the Science of Hatcheries: An updated perspective on the role of hatcheries in salmon and steelhead management in the Pacific Northwest. A. Appleby, H.L. Blankenship, D. Campton, K. Currens, T. Evelyn, D. Fast, T. Flagg, J. Gislason, P. Kline, C. Mahnken, B. Missildine, L. Mobrand, G. Nandor, P. Paquet, S. Patterson, L. Seeb, S. Smith, and K. Warheit. June 2014.

Hillman, T., T. Kahler, G. Mackey, J. Murauskas, A. Murdoch, K. Murdoch, T. Pearsons, and M. Tonseth. 2013. Monitoring and evaluation plan for PUD Hatchery Programs, 2013 update. Report to the HCP and PRCC Hatchery Committees, Wenatchee, WA

Hillman, T., T. Kahler, G. Mackey, Andrew Murdoch, K. Murdoch, T. Pearsons, M. Tonseth, and C. Willard. 2017. Monitoring and evaluation plan for PUD hatchery programs: 2017 update. Report to the HCP and PRCC Hatchery Committees, Wenatchee and Ephrata, WA.

Johnson, J. T. Johnson, and T. Copeland. 2012. Defining Life Histories of Precocious Male Parr, Minijack, and Jack Chinook Salmon Using Scale Patterns, Transactions of the American Fisheries Society, 141:6, 1545-1556.

Jolly, G.M. 1965. Explicit estimates from capture–recapture data with both death and immigration-stochastic model. Biometrika 52:225–247.

Larsen, D. B. Beckman, K. Cooper, D. Barrett, M. Johnston, P. Swanson, and W. Dickhoff. 2004. Assessment of high rates of precocious male maturation in a spring Chinook salmon supplementation hatchery program. Transactions of the American Fisheries Society 133:98–120.

Mullen, J. K. Williams, G. Rhodus, T. Hillman, and J. McIntrye. 1992. Production and habitat of salmonids in Mid-Columbia River tributary streams. US Fish & Wildlife Service (Monograph No. 1). 489pp.

Murdoch, A. and C. Peven. 2005. Conceptual Approach to Monitoring and Evaluating the Chelan county Public Utility District Hatchery Programs. Chelan PUD Habitat Conservation Plan Hatchery Committee, Wenatchee, WA.

NMFS. 1996. Juvenile fish screen criteria for pump intakes. National Marine Fisheries Service, Northwest Region. Available at http://www.nwr.noaa.gov/1hydrop/pumpcrit1.htm

NMFS. 2011. Anadromous Salmonid passage facility design. National Marine Fisheries Service, Northwest Region. July 2011. Portland, OR.

NOAA. 2016a. Endangered Species Act (ESA) Section 7(a)(2) Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat (EFH) Consultation for Issuance of Four Section 10(a)(1)(A) Permits for Spring Chinook Hatchery Programs in the Methow Subbasin. NMFS Consultation Number WCR-2015-3845. West Coast Region. Portland.

NOAA. 2016b. ESA Section 10(a)1)(A) Permit for Take of Endangered/Threatened Species. Permit #18927 for the Winthrop National Fish Hatchery Spring Chinook Salmon program. NOAA National Marine Fisheries Service, West Coast Region. Seattle.

Pacific Northwest Fish Health Protection Committee (PNFHPC). 1989. Model Comprehensive Fish Health Protection Program. Approved September 1989, revised February 2007. Olympia, WA.

Pasley, Chris. Fish Biologist/Hatchery Manager, Winthrop National Fish Hatchery, Winthrop, WA. Personal communications August 2015.

Peery, C. 2016. Update on Hatchery Evaluation Teams operations and procedures. White paper prepared for USFWS Region 1 Hatchery Evaluation Teams. USFWS, Portland, OR.

Seber, G.A.F. 1965. A note on the multiple-recapture census. Biometrika 52:249–259.

Shearer, K. and P. Swanson. 2000. The effect of whole body lipid on early sexual maturation of 1+ age male Chinook salmon (*Oncorhynchus tshawytscha*). Aquaculture 190: 343-367.

Silverstein, J., K. Shearer, W. Dickoff, and E. Plisetskaya. 1998. Effects of growth and fatness on sexual development of Chinook salmon (*Oncorhynchus tshawytscha*) parr. Canadian Journal of Fisheries and Aquatic Sciences 55: 2376–2382.

Snow, C. C. Frady, D. Grundy, B. Goodman, and A. Murdoch. 2016. Monitoring and Evaluation of the Wells Hatchery and Methow Hatchery Programs. 2015 Annual Report prepared for Douglas PUD, Grant PUD, Chelan PUD, and the Wells and Rocky Reach HCP Hatchery Committees and the Priest Rapids Hatchery Subcommittee. WDFW, Twisp, WA.

Snow, C. C. Frady, D. Grundy, B. Goodman, and A. Haukenes. 2017. Monitoring and Evaluation of the Wells Hatchery and Methow Hatchery Programs. 2016 Annual Report. Report to Douglas PUD, Grant PUD, Chelan PUD, and the Wells and Rocky Reach HCP Hatchery Committees and the Priest Rapids Hatchery Subcommittees. WDFW, Twisp, WA.

Snow, C. C. Frady, D. Grundy, B. Goodman, and A. Haukenes. *In press*. Monitoring and Evaluation of the Wells Hatchery and Methow Hatchery Programs. 2017 Annual Report. Report to Douglas PUD, Grant PUD, Chelan PUD, and the Wells and Rocky Reach HCP Hatchery Committees and the Priest Rapids Hatchery Subcommittees. WDFW, Twisp, WA.

USFWS. 2004. USFWS Aquatic Animal Health Policy. Division of the National Fish Hatchery System. Available at https://www.fws.gov/policy/e1713fw1.pdf.

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

USFWS. 2013. Review of U.S. Fish and Wildlife Service Hatcheries in Washington, Oregon, and Idaho. Region-Wide Issues, Guidelines and Recommendations, March 2013. Hatchery Review Team, Pacific Region. U.S. Fish and Wildlife Service, Portland, Oregon. Available at: http://www.fws.gov/Pacific/fisheries/Hatcheryreview/reports.html.

USFWS. 2014. Biological Assessment for the operation and maintenance of Winthrop National Fish Hatchery. March 2014. U.S. Fish and Wildlife Service, Leavenworth Fishery Complex, Leavenworth, WA.

USFWS. 2016. Biological Opinion for the operations and maintenance of the Winthrop National Fish Hatchery. USFWS Ref# 01EWFW00-2015-F-1041. USFWS, Ecological Services, Central Washington Field Office, Wenatchee, WA.

Washington State Co-Managers. 2006. The Salmonid Disease Control Policy of the Fisheries Co-Managers of Washington State. Revised July 2006.

Willard, C. 2017. Chelan County PUD Hatchery Monitoring and Evaluation Implementation Plan 2018.

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

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

[1]Reportable metric.

Appendix A. Continued

Early Rearing Parameters	*Rearing units*	Starter tanks	Facility-specific operational detail
	Water source	Well/Infiltration Galleries	Facility-specific operational detail
	Water quality monitoring	Temperature, flow rates, dissolved gases when needed	Facility-specific operational detail
	Feed type	Bio Oregon Starter Feeds	Facility-specific operational detail
	Feed frequency	6-8 times/day	Facility-specific operational detail
	Feed amount (%BW/Day)	1.0-2.0%	Facility-specific operational detail
	Cleaning frequency	Daily	Washington State Co-managers Disease Control Policy
	Monthly monitoring	Len/wt./K/CV	Facility-specific operational detail
Pre-Tagging Rearing Parameters	*Rearing units*	Small FL's, 8X80 raceways and 12x100's	Facility-specific operational detail
	Water source	Well/Infiltration gallery	Facility-specific operational detail
	Water quality monitoring	Temperature, dissolved gases when needed, & flow rates	Facility-specific operational detail
	Feed type	Bio Oregon Feeds; Vita, Bio Pro 2	Facility-specific operational detail
	Feed frequency	2-4 times/day	Facility-specific operational detail
	Feed amount (%BW/Day)	1.0-2.0%	Facility-specific operational detail
	Feed application	Hand	Facility-specific operational detail
	Cleaning frequency	Daily	Washington State Co-managers Disease Control Policy
	Mass marking[1]	100% Ad-clip + CWT, including 20K PIT	US v OR (marking), HEP describes PIT use/objectives
	Monthly monitoring	Monthly fish health & biometrics, CWT & PIT retentions	Washington State Co-managers Disease Control Policy, HEP

Appendix A. Continued

Post-Tagging Rearing Parameters	*Rearing units*	8X80's & 12X100's	Facility-specific operational detail
	Water source	Well/Infiltration Galleries/River	Facility-specific operational detail
	Water quality monitoring	Temp., dissolved gases when needed, & flow rates	Facility-specific operational detail
	Feed type	BioVita	Facility-specific operational detail
	Feed frequency	Variable: Daily to 3x/week	Facility-specific operational detail
	Feed amount (%BW/Day)	1.0-2.0%	Facility-specific operational detail
	Cleaning frequency	Brushed 1-2x/wk	Washington State Co-managers Disease Control Policy
	Monthly monitoring	Monthly fish health & biometrics	Washington State Co-managers Disease Control Policy
	Water temperature	<60°F	Facility-specific operational detail
	Dissolved O_2	<80% saturation & 5ppm	Facility-specific operational detail
	Turnover rate	≤ 1/hour	Facility-specific operational detail
	Density Index	≤ 0.11	Facility-specific operational detail
	Flow Index	≤ 1.0	Facility-specific operational detail
Smolt Release	*Condition factor (K)* [1]	1	Facility-specific operational detail
	Size (FPP) [1]	15-17	HGMP
	Early maturation (% males) [1]	<25% (5y-avg. beginning with 2016 release)	BiOp
	Release type	Semi-forced, must swim over one dam board	HGMP
	Release time[1]	3rd week of April	HGMP
	Release Goal[1]	400,000	US v OR
Survival and Escapement Metrics	*Green egg to smolt survival*[1]	85%	Facility-specific operational detail
	Green egg to fry survival[1]	95%	IHOT, HGMP
	Fry to smolt survival[1]	95%	IHOT, HGMP
	Smolt to adult survival[1]	0.30%-1.0%	Facility-specific operational detail
	Hatchery return rate (HRR) [1]	>1, see BiOp: dependent on pNOB/pHOS/PNI	BiOp
	Partial pHOS on spawn.grd [1]	0.1-0.2, sliding scale with natural run	BiOp
	Sub-basin PNI[1]	>0.67	BiOp
	Stray rate to Entiat[1]	WNFH comprise <5% of Entiat Subbasin natural spawners	BiOp (in Permit 18927)

Appendix B. Permit #18927 Reporting Requirement Summary.

NMFS's Section 10(a)(1)(A) Permit for Takes 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 BY2015 release period.

Authorized Take Compliance Statement

The WNFH Spring Chinook program complied with Permit #18927 take authorization allowances during the BY2015 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.

Type of take	**Amount of Take**			
	Harass		**Mortality**	
	Adult	**Juvenile**	**Adult**	**Juvenile**
Enhancement activities				
Broodstock collection (allowance)	Up to 100% of return	Not applicable	400 HOR[1,2]	Not applicable
Broodstock collection (actual)	*<100% of return*		384	
Adult removal for gene flow management (allowance)	Up to 100% of return		Up to 100% of HOR	
Adult removal (actual)	5,949		5,949	
Juvenile rearing (allowance)	Not applicable	100% of fish in culture	Not applicable	20% of eggs taken
Juvenile rearing (actual)		*100% of fish in culture*		*14.5%*[3]
RM&E activities (cumulative for permits 18925, 18927 and 20533)				
Juvenile emigration monitoring (allowance)	Not applicable	20% hatchery and natural	Not applicable	2% hatchery and natural
Juvenile emigration monitoring (actual)		*4.8%*		*0.12% of hatchery only*
Spawning ground surveys (allowance)	100% of return	Not applicable	< 5	Not applicable
Spawning ground surveys (actual)	*Small, unknown %*		*0*	

[1]Includes a 10% overage for BKD management

[2]This 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.

[3]WNFH 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 BY2015 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 handled were humanely anesthetized with MS-222 or CO_2 as appropriate, and within label instructions. Sampling-related mortality rates were routinely low (or zero) during the BY2015 brood cycle supporting that hatchery and RM&E staff are proficient with methods of anesthesia.

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 BY2015 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 2015, a total of 5949 hatchery-origin adult spring Chinook salmon were handled at Winthrop NFH, roughly 80% of the combined run. No natural-origin adults were handled at WNFH in 2015.

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 2015 broodstock compliment, 80.7% were conservation program returns from Methow FH.

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. No natural-origin adults were identified and transferred to Methow FH in 2015.

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 BY2015, 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.

    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

Permit #18927 hadn't been issued during summer of 2015 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. 2015 marked the first year that WDFW and Douglas PUD (Methow FH) provided additional collaborative management of gene flow through coordinated surplusing efforts centered on WNFH.

13. Hatchery-origin adults will be removed at the Methow Hatchery and/or WNFH with the intent to achieve an average[1] partial pHOS (calculated as $HOS_{WNFH}/(HOS_{PUD} + HOS_{WNFH} + NOS)$ according to Table 32 below based on natural run size.

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

Natural Run	WNFH pHOS
0-899	0.2
900-1499	0.15
> 1500	0.1

Snow et al. (2016) estimated the 2015 natural origin run of spring Chinook to the Methow Subbasin at 705 adults, resulting in a partial pHOS target for WNFH of ≤0.2. Expansion of WNFH-origin PITs interrogated at Wells Dam (which are presumed destined for the Methow Subbasin) suggested a run escapement of 4000-4500 WNFH adults. Knowing that a large surplus was available managers proceeded with aggressive adult management in the subbasin. An

[1] The average of the most recent four years for each partial pHOS target level.

estimated 4,045 WNFH origin adults were removed through inter-agency surplusing adult management efforts in 2015.

Total spawning escapement at was estimated between 1,213 (rmis.org) and 1,353 spawners (Snow et al. 2016), with total pHOS of 0.71 and PNI of 0.27 (Snow et al. 2016; 0.34 via the 3-pop model). Escapement components included 576-589 MFH returns (rmis.org, Snow et al. 2016), 193-197 WNFH returns (rmis.org, Snow et al. 2016), 29 out-of-basin strays (Snow et al. 2016), and 398 wild adults. These values result in the following recovery metrics: partial pHOS MFH = 0.49 and partial pHOS WNFH = 0.16. Meeting the partial pHOS target of WNFH in 2015 would not have been possible without drastic reduction in excess returns that was accomplished by MFH and WNFH staff. Unless pre-spawn mortality was extreme, we estimate that >90% of the WNFH run was removed by WNFH and MFH collaborative efforts in 2015.

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 2015, the WNFH ladder was operated almost continuously from May 13 to September 2. The vast majority of unique adult PIT detections at site SCP (~175 meters downstream of ladder) occurred by the first week of August and support the notion that the ladder was open consistently throughout the run.

    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 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.

No out-of-basin strays were detected in WNFH collections in 2015.

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.

    See Snow et al. 2016 and discussions in Spawner Escapement and Gene Flow Metrics section.

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.

    YTBD

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 CWT recoveries were reported in 2015 (G. Fraser, pers. comm.). 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 in 2015. The only significant recent changes near this timeframe were Okanogan 10(j) program transfers to Chief Joseph Hatchery. Broodyear 2013 spring Chinook were approved for transfer to CJH as pre-smolts in 2014, and broodyear 2014 eggs were successfully transferred as eyed eggs (as per design). Broodyear 2015 transfers were thus routine and as permitted.

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 ($\geq$ 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.

    A total of 424,591 spring Chinook were released from WNFH in 2015. This is about 106% of the overall production goal component limited to release in the Methow Subbasin.

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 been regularly low (Table 27), precocity rates are also within allowable limits (Table 20) and travel times and late summer or post-RY redetections *of WNFH spring Chinook juveniles suggest that residualism/precocity rates were controlled (Table 21).*

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.

    BY2015 WNFH spring Chinook were released semi-volitionally (over 2 days) starting at 15:00 on April 19, 2017 at an average of 17 fish/lb. Subsequent PIT monitoring data suggest that precocialism 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 in 2015.

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 BY2015 group had average 97.9% CWT retention rate and 99.0% 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.