U.S. Fish and Wildlife Service

MONITORING AND EVALUATION OF THE WINTHROP NATIONAL FISH HATCHERY SUMMER STEELHEAD PROGRAM
- 2021 -

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***On the cover**: Juvenile steelhead at Winthrop National Fish Hatchery arranged by smolt index; parr (top), transitional (second), smolt (third), precocial (bottom). - Photo: Michael Humling.*

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Executive Summary- This report summarizes Winthrop National Fish Hatchery's (WNFH) summer steelhead (*Oncorhynchus mykiss*) production program for brood year (BY) 2019 as well as complete brood year performance metrics (e.g., smolt to adult return, SAR) through brood year 2017. The program dual roles of mitigation and recovery in the Upper Columbia Region and functions as an integrated, conservation program with goals of increasing natural spawner abundance and distribution. In 2021, WNFH released 208,610 juvenile summer steelhead into the Methow River, within 10% of the production goal of 200,000. Juvenile release was conducted as planned and as described in the programs Biological Opinions. Conversion of WNFH adults from Bonneville Dam to Wells Dam was 83% in 2020 which was 118% of the long-term average. Only five WNFH adults were estimated to have strayed and spawned in the Okanogan Subbasin in 2021. This report provides comprehensive evaluation of program performance and fulfills ESA reporting requirements identified under NOAA's Biological Opinion (NOAA 2017) and ESA Section 4(d) Limit 5 authorization (NOAA 2019b).

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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), comprise the Leavenworth Fisheries Complex (hereafter "Complex"). Funding for the Complex is provided by the U.S. Bureau of Reclamation. Production, marking, and tagging goals for the facilities are determined through the management framework established as an outcome of the U.S. v Oregon decision and are described in the 2008-2017 U.S. v Oregon Management Agreement.

Winthrop National Fish Hatchery

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

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

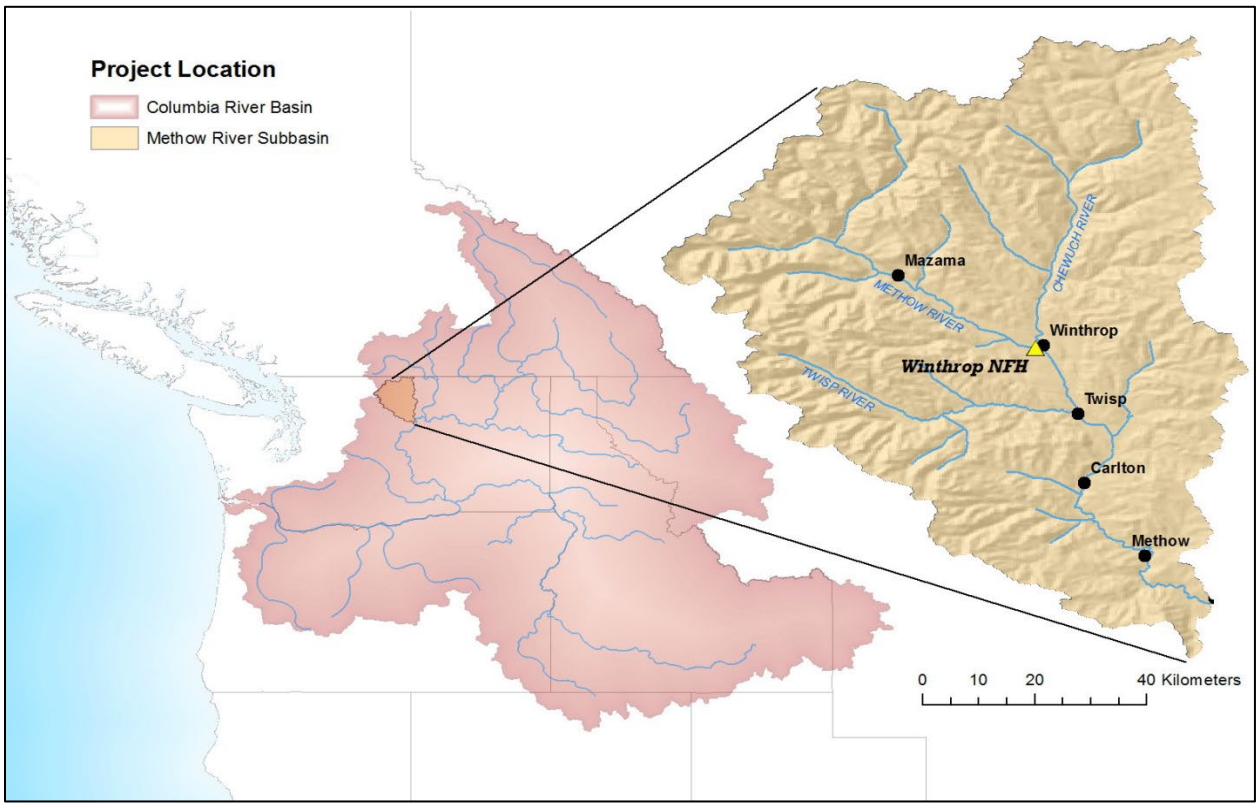

Figure 1. Winthrop National Fish Hatchery and Methow Subbasin location.

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

ESA consultation with NOAA Fisheries for the WNFH summer steelhead program was initiated through the submission of an HGMP (USFWS 2009), which was updated multiple times (USFWS 2012, USFWS 2017, USFWS 2019), and issuance of a Biological Opinion (NOAA 2017). In 2019, NOAA released a decision memo (NOAA 2019b) authorizing the WNFH program under Section 4(d), Limit 5, of the ESA. ESA effects specific to Bull Trout were analyzed through submission of a Biological Assessment (USFWS 2014) and issuance of a separate Biological Opinion (USFWS 2016). Reporting requirements associated with the Bull Trout BiOp are mostly non-specific to the steelhead program and are provided in annual reports elsewhere. The only direct discussion pertinent to Bull Trout occurs in the Non-target Taxa Monitoring section.

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 artificial production 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 WNFH summer steelhead program fish health goals. The focus of the fish health program is to support the release of healthy smolts through a preventative medicine ethos. Regular monthly examination of fish at the hatchery aims to identify and treat 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). In compliance with this policy, Wells Hatchery broodstock are used as a surrogate for WNFH broodstock for fish health disease sampling. Wells Hatchery broodstock are held with WNFH natural-origin broodstock at WNFH. These fish are lethally-spawned at Wells Hatchery and are tested for regulated viral pathogens including (Viral Hemorrhagic Septicemia Virus (VHSV), Infectious Pancreatic Necrosis Virus (IPNV), Infectious Hematopoietic Necrosis Virus (IHNV), *Oncorhynchus masou* Virus (OMV)) and *Renibacterium salmoninarium* (bacterial kidney disease). Protocols include testing for bacteriology, direct fluorescent antibody testing, virology on

kidney/spleen samples (60 males), and virology testing on ovarian fluid (60 females). Tissue and fluids samples are sent to Washington Animal Disease Diagnostic Laboratory (WADDL) at Washington State University for analysis. WADDL is fully accredited by the American Association of Veterinary Laboratory Diagnostics and is a member of the National Animal Health Laboratory Network. Any disease treatments are performed under veterinary guidance.

Hatchery Evaluation Team Approach

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

WNFH Summer Steelhead Trout Program

The WNFH summer steelhead trout (hereafter 'steelhead') 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 (DPUD) Wells Hatchery program within the s*tepping-stone* context (Hatchery Scientific Review Group; HSRG 2014). The WNFH and DPUD Twisp conservation programs function as integrated/conservation programs with goals of increasing natural spawner abundance and distribution. These programs provide excess integrated broodstock to support DPUD's Wells Safety-net program(s) maintaining genetically related fish within the subbasin. Through this process, safety-net adults can provide a genetic reserve to the naturally spawning population when needed (Figure 2). The WNFH and DPUD programs share cooperative and related gene flow targets (pHOS [percent hatchery-origin spawners] and PNI [proportionate natural influence]) on the spawning grounds, which are targeted cooperatively via juvenile release, broodstock management, and adult escapement management strategies.

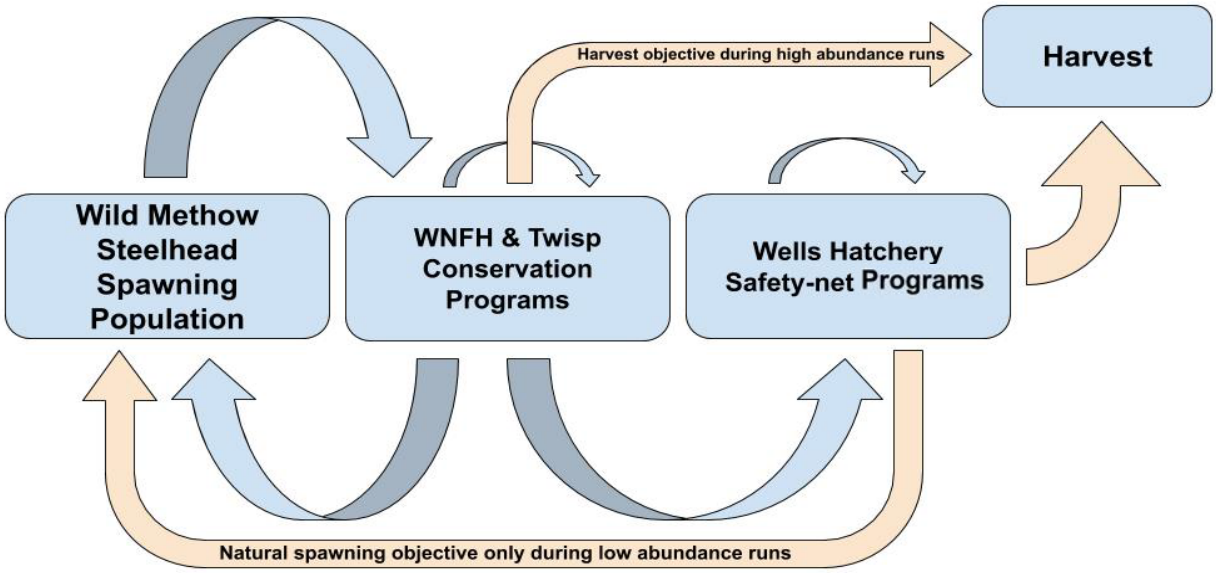

Figure 2. Methow Subbasin steelhead hatchery supplementation conceptual.

Prior to 2008, all steelhead released from WNFH were obtained from Wells Hatchery as eyed eggs and reared to yearling (hereafter 'S1') smolt size at WNFH. Broodstock supporting this strategy were a composition of mixed-stock and origin fish collected at Wells Dam on the mainstem Columbia River (Rkm 830; about 13km downstream of the mouth of the Methow River). Mainstem collection occurred during the upstream migration in the fall prior to the adults apportioning to their respective tributaries of origin. This practice created a commingled brood that included fish from the Methow and Okanogan subbasins, as well as hatchery- and natural-origin fish from a range of tributaries, including populations outside the Upper Columbia distinct population segment (e.g., mid-Columbia and Snake basins). To better integrate the natural-origin and hatchery populations and maintain local stock structure within the Methow Subbasin, WNFH transitioned to 100% locally-collected (Methow Subbasin only) broodstock over the 2008-2014 brood years. Currently, WNFH conservation program's egg take goal supports a smolt release of up to 200,000 age-2 smolts (hereafter 'Production S2') in the Methow Subbasin. In many cases, data reported are specific to the Production S2 group. Unless otherwise stated, the Twisp Release group is assumed to have identical metrics to the remaining Production S2 group.

Broodstock and adult management strategies in 2021 were authorized under NOAA Fisheries BiOp (NOAA 2017), a finalized take permit for DPUD/Wells Hatchery activities (NOAA 2019a), and an ESA Section 4(d) Limit 5 authorization for USFWS/WNFH activities (NOAA 2019b). Management direction continued efforts initiated in 2017 by Joint Fishery Party (JFP) members to address potential low effective population size, inbreeding depression, and emerging Ryman-Laikre effect concerns in the Twisp River (MSSSWG 2018).

Steelhead Program Performance Goals and Objectives

The WNFH steelhead program is managed and operated with an over-arching goal of compensating for lost fish production associated with the construction and operation of Grand Coulee Dam. Specifically, the WNFH steelhead program partially meets this mitigation goal through two broad sub-goals – 1) providing a harvestable surplus of adult steelhead, and 2) supporting ESA recovery efforts for steelhead in the Methow Subbasin. Each of these has an associated suite of objectives and operational guidelines deriving from a myriad of guidance documents. These include a combination of legally-binding terms and conditions (e.g., maximum stray rates in BiOp; NOAA 2017), USFWS and/or co-manager policy (e.g., fish health monitoring and prophylaxis), operational details described in the program's HGMP (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). WNFH and MCFWCO program managers continue to work closely with NOAA Fisheries staff to incorporate consistent consultation direction.

Below are broad program goals and associated objectives. Appendix A collates specific monitoring attributes and targets.

Goal – Mitigate for lost fish production and fishery opportunities

Objective – Provide a harvestable surplus of summer steelhead

Associated Sub-objectives:

- Annually rear and release up to 200,000 steelhead smolts to produce returning adults, some of which are intended to increase natural spawner abundance.
- Healthy, migration-ready smolts are released in a manner optimizing 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 – Support the recovery of ESA-listed Upper Columbia Summer Steelhead DPS in the Methow River Subbasin

Objective – Support efforts to increase natural spawner abundance

Associated Sub-objectives:

- Operate under the Hatchery Scientific Review Group's (HRSG) *stepping-stone* broodstock management model as an integrated conservation program. This component entails many related sub-objectives listed below.

Objective – Minimize genetic and ecological risks and impacts to natural-origin steelhead, non-target taxa, and their associated habitats.

Associated Sub-objectives:

- Target locally-collected (Methow Subbasin), high pNOB (percent natural-origin broodstock) broodstock such that local Methow Subbasin stock structure is supported.
- Prioritize natural-origin adults for broodstock, followed by conservation program hatchery-origin adult according to a production sliding scale aimed at meeting production obligations while balancing risk of domestication.
- Provide facility/resources and work with co-applicants/co-managers in the Methow Subbasin to optimize return gene flow dynamics by managing wild, conservation program, safety-net program, and stray hatchery-origin adults in the run and on the spawning grounds.
- Optimize juvenile rearing/release strategies to maximize the number of migration-ready smolts, while minimizing and/or managing non-migrant life history juveniles within acceptable levels.
- Prevent or minimize ecological considerations associated with operation/maintenance of the hatchery facility.

Objective – Support USFWS and partners' Recovery efforts in the Upper Columbia through operation of an integrated recovery steelhead supplementation program within the HSRG stepping-stone model

Associated Sub-objectives:

- Annually transfer incidentally encountered hatchery-origin adults to appropriate partner programs to support safety-net program broodstock needs.
- Provide facility and expertise to support cooperative, inter-agency adult management efforts to help optimize gene flow dynamics on the spawning grounds.
- Support Joint Fisheries Party and Wells/Rocky Reach HCP Hatchery Committee efforts to implement best management practices for subbasin-wide DPS stock management through cooperative juvenile release strategies.

To effectively monitor and evaluate the steelhead program at WNFH, specific performance metrics/targets are tracked through rearing, juvenile release, and adult return (Appendix A). These metrics/targets are intended to give a point of comparison between cohorts and amongst similar hatchery programs, specifically answer the terms and conditions as 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 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 program 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 escapement analyses, 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 comes from direct collection by Complex staff, collection by other management agencies, and/or industry-specific databases. 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 (PSMFC) and designed to house coded-wire tag (CWT) and juvenile release 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. Coded-wire tag data are less critical to steelhead evaluation since carcass recovery in the wild is rare; however, hatchery and fishery recovery data are often used.

PTAGIS – The PIT Tag Information System (*PTAGIS*) is an online database operated by the PSMFC and designed to house Passive Integrated Transponder (PIT) tag data. When a group of fish is PIT tagged, 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 Office's hatchery marking team. This team marks and tags for the majority of the National Fish Hatcheries in the Columbia River basin, as well as other hatchery facilities in the region.

Reporting Organization

This report attempts to follow reporting timelines established in the BiOp and Section 4(D) authorization (NOAA 2019b), which require report submission by December of the year following release (e.g., BY19, release year (RY) 2021, report due December 2022). Extensions to this deadline can be authorized via request from NOAA. Natural Environment Monitoring, including adult return, escapement, and gene flow metrics on the spawning grounds are highly dependent on monitoring results reported by WDFW as part of Wells Hatchery Complex M&E obligations funded primarily by DPUD. We report elements of their findings (e.g., Snow et al. 2023) as they pertain to WNFH programs and are subject to their publication timeframes. Effort to report results through 2021 spawn escapement was made for this report, as available.

RESULTS

Brood Year 2019 Juvenile Rearing Monitoring

Egg take and Incubation

Production of BY19 WNFH steelhead began with adult broodstock collection and egg take consistent with HGMP and stepping-stone guidelines. BY19 was comprised of 99.2% natural-origin broodstock, (pNOB; proportion of natural-origin broodstock; Humling et al. 2021). The pNOB for BY19 (> 0.75) was sufficient to rear a full program of up to 200,000 smolts (NOAA 2017).

Hatchery rearing began with a green egg take of 313,877 across 60 females (Table 1). This estimate includes the increased egg take goal (~290K vs 233K) associated with adoption of a strategy to mitigate suspected inbreeding depression (Ryman-Laikre effect) in the Twisp Watershed. The specific strategy includes integrating collection of additional broodstock commensurate with DPUD's 48K smolt release total in the Twisp River (MSSSWG 2018).

Eye-up rate was 96.5%, exceeding the >95% target set by the HGMP (Table 2, Appendix A). A total of 55,080 eyed eggs were transferred to Wells Hatchery and 1,500 fry were transferred to NOAA Manchester Research Station in summer 2019 (Tables 1 and 2). After adjustments at marking/tagging, WNFH ponded 241,649 fry for BY19 rearing (Table 1). Approximately 30,000 eyed eggs were reserved for the split brood year (S1/S2) study for size-grading, rapid growth, and release in 2020 (half the group). Early survival metrics for BY19 exceeded targets, yet fry-smolt and green-egg to smolt survival were lower than established targets for brood year 2019 (Table 2).

Table 1. Winthrop NFH steelhead egg take and incubation for brood years 2008-2019.

Brood Year	Females Spawned[1]	Green Eggs		Eyed Eggs					Fry		
		Adjusted Egg Take	Per Female	Total	Eye-up %	Transfer (in)	Transfer (out)	Culled	Total hatched	Transfer (out)	Total Ponded
2008	7	31,811	4,544	138,876	98.4	107,573	0	0	138,299	0	137,721
2009	8	60,368	7,546	133,917	96.6	75,602	0	0	128,483	0	123,048
2010	12	65,662	5,472	133,120	98.6	68,394	0	0	130,442	0	127,764
2011	20	122,643	5,990	189,602	97.8	69,707	6,008	49,100	126,244	0	124,427
2012	23	123,323	5,362	175,120	96.1	56,367	6,160	0	167,026	0	165,091
2013	16	89,906	5,619	143,490	98.2	55,196	4,160	0	139,076	0	138,822
2014	33	150,903	4,573	173,262	98.0	25,416	3,570	0	166,926	840	164,160
2015	53	277,787	5,241	256,866	92.5	0	2,400	20,757	231,392	0	229,074
2016	53	226,540	4,274	213,100	94.1	0	4,765	9,444	195,001	0	191,110
2017	53	303,879	5,734	286,749	94.4	0	57,600	0	227,059	0	224,969
2018	65	321,305	4,943	301,306	93.8	0	58,675	0	240,843	2,543	239,055
2019	60	313,877	5,231	303,019	96.5	0	55,080	0	244,794	1,500	241,649
08-'18 mean	31	161,284	5,404	195,037	96.2	41,660	13,031	7,209	171,890	308	169,567

[1]WNFH steelhead program received eyed egg transfers from Wells Hatchery but was phased out during 2008-2014.

Table 2. Winthrop NFH steelhead survival metrics for brood years 2008-2019.[1]

Brood Year	Survival Metrics				
	Green Egg – Eyed Egg	Eyed Egg - Fry	Green Egg - Fry	Fry - Smolt	Green Egg - Smolt
2008	98.4%	99.3%	97.7%	95.3%	93.4%
2009	96.6%	93.5%	90.4%	89.7%	83.1%
2010	98.6%	98.9%	97.5%	95.4%	92.2%
2011	97.8%	96.7%	92.8%	98.8%	90.7%
2012	96.1%	98.4%	94.4%	91.5%	86.9%
2013	98.2%	95.3%	93.6%	94.5%	92.6%
2014	98.0%	98.3%	96.3%	90.8%	87.6%
2015	92.5%	99.0%	90.9%	95.9%	87.8%
2016	94.1%	98.0%	91.8%	84.4%	77.8%
2017	94.4%	99.1%	92.2%	94.7%	88.6%
2018	93.7%	98.9%	91.3%	93.2%	86.8%
2019	96.5%	98.7%	94.6%	88.8%	84.6%
08-'18 mean	96.2%	97.8%	93.6%	93.1%	88.0%
target	>95.0%	≥95.0%	90.0%	95.0%	85.0%

[2]Survival estimates account for post-tagging adjustments. Survival estimates are for all groups combined by brood year.

Juvenile Rearing

Fry were ponded on July 9, 2019 (split study fish) and July 26, 2019 (production fish). Mortality levels were elevated in August 2019 and accounted for 59.7% of total rearing mortality. The combined on-station survival for all rearing groups in BY19 was 84.6% (Table 2). Data on the S1 portion of the BY19 S1/S2 group can be found in the 2021 juvenile release memo (Smith and Hansch 2024).

The production S2 group was affected by *Costia* in October 2019 and experienced elevated mortality prior to transfer to E-bank raceways. *Costia* does not reproduce well in temperature below 50°F and mortality decreased with cooler water temperatures. This group also was affected by bacterial coldwater disease (BCWD) in late winter but did not result in elevated mortalities. Fish performed well for the remainder of the rearing period prior to release.

Throughout the rearing cycle, WNFH staff monitored fish density and flow through the rearing vessels. Reduced densities and increased flow are desired to mitigate disease risk and are manipulated when possible to optimize the rearing environment. For the RY21 rearing cycle, monthly Density Index (DI; Piper et al. 1982) and Flow Index (FI; Piper et al., 1982) remained below maximum threshold values (Table 3; Appendix A).

Table 3. Winthrop NFH juvenile rearing performance for Production S2 steelhead, brood year 2019.

Month	Life Stage	Inventory	Fish/ lb.	Mortality (%)	Survival (%)	Avg. temp (°C)	Water source (%)		Flow (GPM)	Flow Index	Density Index
							Well	River			
May	Green Egg	314,323	NA	NA	NA	6.4	100	0	21	NA	NA
June	Eyed Egg[1]	248,385	NA	NA	NA	6.1	100	0	15	NA	NA
July	Sac fry	242,095	2,198	0.18	99.8	11.1	100	0	240	0.40	0.08
August	Fry	223,703	743	6.53	93.5	11.7	100	0	280	0.78	0.16
September	Fry	222,265	312	1.06	98.9	11.0	100	0	740	0.67	0.15
October	Fry	219,414	212	1.50	98.5	7.5	30	70	1,800	0.30	0.06
November	Fry	218,963	185	0.24	99.8	6.0	40	60	1,800	0.32	0.06
December	Fry	218,828	167	0.07	99.9	5.2	40	60	1,800	0.35	0.07
January	Fry	218,666	153	0.09	99.9	4.8	30	70	1,800	0.37	0.07
February	Fry	218,425	147	0.12	99.9	4.8	30	70	1,800	0.38	0.08
March	Fingerling	217,900	96	0.11	99.9	5.9	30	70	1,800	0.50	0.10
April	Fingerling[2]	205,411	63	0.07	99.9	6.4	40	60	1,800	0.67	0.13
May	Fingerling	205,171	48	0.13	99.9	8.1	100	0	4,200	0.25	0.05
June	Fingerling	205,541	29	0.18	99.8	9.1	100	0	4,500	0.32	0.06
July	Yearling	205,648	18	0.05	99.9	10.9	60	40	4,500	0.32	0.06
August	Yearling	205,588	11	0.03	100.0	11.9	50	50	4,500	0.42	0.06
September	Yearling	205,556	8	0.01	100.0	10.5	45	55	4,500	0.75	0.15
October	Yearling	205,498	8	0.04	100.0	8.0	30	70	4,500	0.77	0.16
November	Yearling	205,424	7	0.03	100.0	5.5	40	60	4,500	0.82	0.16
December	Yearling	205,336	7	0.04	100.0	4.8	40	60	4,500	0.84	0.17
January	Yearling	205,200	7	0.12	99.9	5.1	40	60	4,500	0.87	0.17
February	Yearling	205,013	6	0.09	99.9	5.2	30	70	4,500	0.87	0.17
March	Transitional	204,630	6	0.18	99.8	6.3	30	70	4,800	0.93	0.18
April	Smolt[3]	179,645	6	0.19	99.8	6.6	45	55	4,200	0.93	0.18
May	Smolt[4]	171,039	5	NA	NA	NA	NA	NA	NA	NA	NA

[1]Total after culling and transfers.
[2]Total inventory adjusted after mark/tagging operations and split study releases.
[3]Total after Twisp River direct plant releases.
[4]Total S2 production group volitional release (does not include non-migrants retained for lowland lakes).

Juvenile Marking Summary

Mass marking of BY19 occurred in early June, 2020. CWT retention for all S2 groups was estimated at 94.9% and external marking (adipose clip) rate was estimated at 96.8% (Table 4). To allow smolt migration timing/survival evaluation, residualism estimates, straying, and aid adult return projection, 24,589 steelhead were PIT-tagged during the week of October 24th, 2020 (all S2 groups including the Twisp release); minimal mortality was observed post-tagging. Detailed marking and release data for all WNFH release groups (e.g. Production S1, Twisp S2) can be found in Appendix C, Table C1.

Table 4. Winthrop NFH marking and release summary for all S2 steelhead from brood years 2008-2019.[1]

Brood Year	Release Year	# CWT	% CWT	# Ad-clip	% Ad-clip	# PIT Released	Total Released
2008	2010	26,230	89.9%	28,645	98.2%	14,756	29,170
2009	2011	41,765	96.7%	42,687	98.8%	14,881	43,205
2010	2012	29,469	49.7%	58,343	98.3%	14,892	59,352
2011	2013	55,816	96.4%	57,240	98.9%	14,475	57,894
2012	2014	86,060	95.0%	90,424	99.8%	14,630	90,599
2013	2015	71,253	94.8%	73,908	98.3%	13,887	75,165
2014	2016	128,071	99.6%	127,416	99.1%	19,562	128,585
2015	2017	207,665	98.1%	210,535	99.5%	19,831	211,621
2016	2018	149,078	99.1%	148,539	98.8%	18,121	150,392
2017	2019	184,221	92.4%	199,233	99.9%	18,714	199,427
2018	2020	188,726	92.7%	203,232	99.8%	25,098	203,621
2019	2021	185,575	94.9%	189,358	96.8%	24,589	195,365
08-'18 mean	-	106,214	91.3%	112,746	99.0%	17,168	113,548

[1]Detailed release information for all release groups can be found in the annual juvenile release memo (Smith et al. 2023) and Appendix C, table C1.

Juvenile Release Monitoring

Pre-release Sampling and Release Implementation

Prior to release, the BY19 production S2 summer steelhead were on average 197.0 mm and were 5.5 fish/lb (FPP), within the HGMP target range of 5-10 fish/lb (Table 5, Appendix A). Average condition factor (K) of fish was 1.05, close to the operational target of 1.00 (Appendix A). Volitional on-station releases were conducted from April 19 to May 17 (28 days), allowing managers to retain non-migrant fish to mitigate negative ecological effects to non-target taxa and natural-origin steelhead (Table 6). A separate group of 24,326 smolts was direct-planted into the Twisp River on April 12, 2021 (Table 6). Twisp-release raceways were sorted to prior to transfer to remove likely residual and obvious precocial steelhead. An additional group of 24,169 DPUD Wells BY20 conservation program steelhead spawned at WNFH but transferred in 2020 for S1 rearing at Wells Hatchery were returned for rapid acclimation and release from WNFH (DPUD production). Transfer occurred April 13-14, 2021, affording these fish at least five days of acclimation time. These smaller groups are part of a continued HCP Hatchery Committee and fishery party effort to mitigate spawner relatedness and small effective population size on the spawning grounds in the Twisp River Watershed (Snow and Humling 2017). A total of 208,610 steelhead were released in 2021 for WNFH production achieving 104.3% of the release goal of 200,000 smolts (Table 6; Appendix A). An additional 7,885 non-migrant fish were planted in non-anadromous waters, representing 3.3% of the population prior to release (Table 6).

Size at release varied among groups yet S2 groups were between 11 and 28 mm larger than S1 groups (Table 7). Visual smolt index varied among groups as well with 8-9% of S2 groups comprised of precocial males while neither S1 group had any precocial males (Table 7). Detailed pre-release data for all WNFH release groups (e.g. Production S1, Twisp S2) can be found in Appendix C, Table C2.

Table 5. Winthrop NFH pre-release metrics for Production S2 steelhead from brood years 2008-2019.[1,2]

Brood Year	Fork length (mm)		Weight (g)		N	K
	Mean	CV	Mean	Fish/lb.		
2008	202.3	7.9	90.4	5.0	259	1.07
2009	187.1	13.7	72.3	6.3	543	1.05
2010	186.7	11.8	70.6	6.4	619	1.05
2011	197.1	11.4	87.5	5.2	642	1.10
2012	187.7	11.3	74.4	6.1	587	1.09
2013	204.2	9.6	94.3	4.8	606	1.08
2014	197.3	9.0	82.1	5.5	275	1.05
2015	204.9	10.8	93.4	4.9	300	1.07
2016	201.4	11.8	89.4	5.1	302	1.07
2017	189.3	12.6	74.5	6.1	300	1.05
2018	197.4	9.4	77.6	5.9	303	0.99
2019	197.0	13.0	83.0	5.5	299	1.05
08-18 mean	195.9	10.8	82.4	5.6	431	1.06

[1]Historic pre-release stats for all release groups can be found in Appendix C, table C2.

Table 6. Winthrop NFH steelhead mass marking and release stats for release year 2021.

Brood Year	Tagcode	Group[1]	Inventory @ tagging	% CWT	% Ad-clip	# PIT tagged	Fish/PIT ratio	Release Strategy	Release Start	Release End	Total released
2019	056326	Prod. S2	159,670	94.2%	96.5%	14,953	10.7	Volitional	4/19/21	5/17/21	157,976
2019	054280	Twisp	27,087	98.6%	99.0%	4,979	5.4	Direct	4/12/21	4/12/21	24,326
2019	056365	Split S2	14,294	97.8%	98.2%	5,996	3.4	Volitional	4/19/21	5/17/21	13,063
2020	056366	Split S1	14,209	94.8%	98.3%	5,975	2.4	Volitional	4/19/21	4/27/21	13,245
2020	637651	Wells C. S1	24,273	99.2%	0.0%	2,426	10.0	Volitional	4/19/21	5/17/21	24,169
					Anadromous release total						*208,610[2]*
2018-2020	Mixed	Spectacle Lake	--	--	--	--	--	Direct	--	--	6,014
2018-2020	Mixed	WNFH Trout Pond	--	--	--	--	--	Direct	--	--	1,871
					Inland lake fishery plant total (non-migrants)						*7,885*

[1]Prod. S2 = WNFH production two-year release; Wells C. S1 = DPUD Wells Hatchery Conservation one-year release.
[2]Total does not include Wells Conservation S1 group as it is not part of WNFH's production and release goal.

Table 7. Winthrop NFH steelhead pre-release stats and smolt index for release groups in 2021.[1]

Smolt Index (SI) Groups	FL (mm)		Weight (g)		N (%)	K
	Mean	CV	Mean	Fish/lb.		
WNFH Production BY19 S2[1]						
1 (parr)	142.1	11.8	30.4	14.9	18 (6.0%)	1.01
2 (transitionals)	191.4	11.7	74.7	6.1	129 (43.2%)	1.02
3 (smolts)	209.6	8.6	96.1	4.7	129 (43.2%)	1.07
4 (prec. males)	200.3	8.8	97.1	4.7	23 (7.6%)	1.18
Combined Total	197.0	13.0	83.0	5.5	299	1.05
WNFH Split Rearing Study BY19 S2						
1 (parr)	152.7	12.8	38.9	11.7	9 (3.0%)	1.03
2 (transitionals)	192.5	9.5	74.3	6.1	146 (48.2%)	1.02
3 (smolts)	205.0	7.3	88.6	5.1	121 (39.9%)	1.01
4 (prec. males)	202.3	8.2	99.2	4.6	27 (8.9%)	1.17
Combined Total	197.2	9.9	81.2	5.6	303	1.03
Split Rearing Study BY20 S1						
1 (parr)	141.3	11	29.7	15.3	23 (8.8%)	1.01
2 (transitionals)	170.5	7.3	52.2	8.7	182 (69.7%)	1.04
3 (smolts)	178.0	5.9	59.2	7.7	56 (21.5%)	1.04
4 (prec. males)	- -	- -	- -	- -	0	- -
Combined Total	169.5	9.1	51.7	8.8	261	1.03
DPUD Wells Conservation BY20 S1 (Wells C. S1, transferred to WNFH)						
1 (parr)	132.1	17.8	24.9	18.2	11 (3.7%)	0.99
2 (transitionals)	181.5	11.4	64.1	7.1	158 (53.4%)	1.03
3 (smolts)	197.4	8.9	80.6	5.6	127 (42.9%)	1.02
4 (prec. males)	- -	- -	- -	- -	0	- -
Combined Total	186.5	12.6	69.7	6.5	296	1.02

[1]Twisp release fish should have similar size and condition to the Production S2 steelhead as they were raised under the same fish culture regime. However, the Twisp release group is sorted to remove parr and precocial males prior to direct release into the Twisp River.

Smolt Outmigration

Release of steelhead from Winthrop NFH began April 19th and was timed with the first major hydrologic increase (Methow River @ Winthrop), preceding peak spring runoff by about four weeks in 2021. Following release, 90.0% of migrating production S2 PIT-tagged smolts were detected leaving the hatchery outfall channel within 19 days of release (PTAGIS site SCP, ~25 m below the hatchery ladder) and were detected migrating through Rocky Reach Juvenile Bypass (RRJ) within 26 days (Figure 3). Juvenile survival rates through the Columbia River hydro system were calculated using Cormack-Jolly-Seber (CJS) models (Cormack, 1964; Jolly, 1965; Seber, 1965) available on DART. PIT interrogation of individual S2 production migrants detected at both SCP and RRJ showed median travel time to RRJ was 6.0 days (mean was 10.7 days; Table 8; data from DART), equivalent to 27.1 km/day based on median or

15.2 km/day based on mean. Survival information for all release groups can be found in the 2021 juvenile release memo (Smith and Hansch 2024).

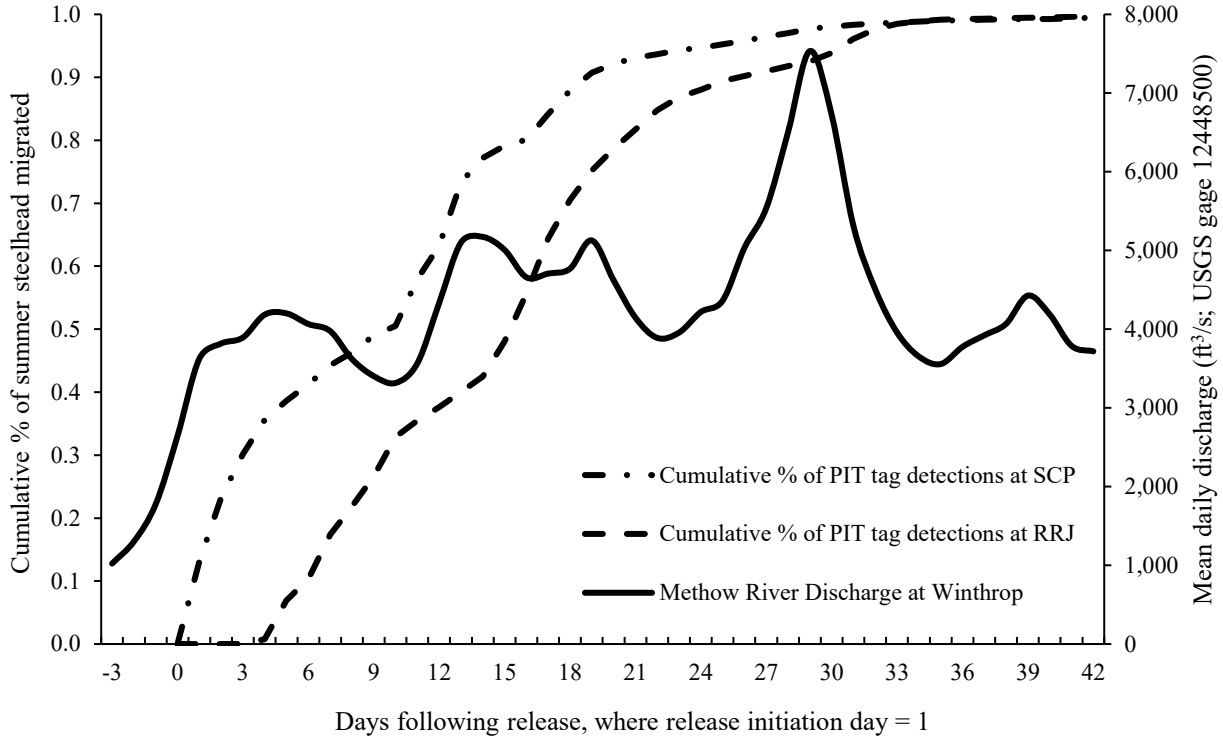

Figure 3. Cumulative downstream steelhead passage using PIT tag detections, following April 18 release initiation in 2021.

Table 8. Winthrop NFH PIT-based juvenile survival rates and travel times to Rocky Reach (RRJ) and Bonneville dams (BON) for Production S2 steelhead from brood years 2008-2019.[1]

Brood Year	Mean speed to RRJ (km/day)	Median Travel Time to RRJ			Survival to RRJ		Median Travel Time to BON			Survival to BON	
		Days	SE	N	%	SE	Days	SE	N	%	SE
2008	23.2	7.0	0.12	2,382	77.7	1.3	23.0	0.16	939	45.2	3.9
2009	11.6	14.0	0.11	1,810	64.1	1.3	22.0	0.33	148	33.5	9.1
2010	46.4	3.5	0.11	1,060	62.1	2.3	14.0	0.41	164	29.0	8.2
2011	32.5	5.0	0.06	3,174	59.1	1.7	14.0	0.15	627	34.1	5.1
2012	40.6	4.0	0.05	4,244	67.0	1.8	14.0	0.16	652	38.6	7.9
2013	27.1	6.0	0.08	4,586	58.8	1.1	21.0	0.16	989	18.7	1.7
2014	32.5	5.0	0.06	5,117	65.0	1.2	16.0	0.13	1,353	30.7	4.1
2015	32.5	5.0	0.06	4,873	67.3	1.5	14.0	0.21	601	43.1	13.0
2016	40.6	4.0	0.05	3,457	68.1	1.9	13.0	0.14	720	49.1	13.8
2017	20.3	8.0	0.11	2,897	63.6	1.6	19.0	0.24	551	18.9	2.5
2018	20.3	8.0	0.09	4,108	62.4	1.5	19.0	0.56	67	24.4	21.1
2019	27.1	6.0	0.09	3,745	59.6	2.2	18.0	0.17	888	26.0	9.7
08-18 mean	29.8	6.3	0.08	3,428	65.0	1.6	17.2	0.24	619	33.2	8.2

[1]Historic survival rates for all release groups can be found in Appendix C, table C3.

Due to a lack of juvenile bypass detection system at Wells Dam, travel time to Wells Dam can be assumed based on data from Rocky Reach juvenile bypass and the distance of river between release and detection points. Rocky Reach Dam is 69 river kilometers downstream of Wells Dam, and Wells Dam is 80 river kilometers downstream of WNFH. Considering outmigrants took six days to travel to Rocky Reach Dam, nearly twice the distance from release to Wells Dam, migrants in 2021 passed Wells Dam much faster than the BiOp's Take surrogate of maximum 14 days after release. Detailed survival rates and travel times for all WNFH release groups (e.g. Production S1, Twisp S2) can be found in Appendix C, Table C3.

Early Maturation, Residualism, and Management

Standard sampling, including fish length, weight, and smoltification state (using smolt index, SI, similar to Gorbman et al., 1982) has occurred most years to describe the release population but has expanded to include metrics (gonadosomatic index) focused on sexual maturation. Release sampling includes three components:

1. Pre-release sampling – demographic sample collected from entire population prior to release
2. Post-release sampling – demographic sample collected from the non-migrant population remaining after conclusion of volitional release period
3. Migrant group demographics can be determined as the difference between pre- and post-release sample demographics.

Peven et al. (1994) documented mid-Columbia River tributary migrants between 1 and 7 years old (freshwater age), and diverse age structures including resident Rainbow Trout, anadromous steelhead, and iteroparous kelts, all contributing to population-level gene flow. Ongoing pedigree studies in the Twisp River has shown that unidentified male parents were likely resident form Rainbow Trout (Goodman, pers. comm.), and significant parental contribution by residualized precocious males in semi-natural spawning trials has been documented (Berejikian et al. 2020). Similar outcomess were found in the Hood (Christie et al. 2011) and Yakima (Courter et al. 2013) Rivers, where anadromous adults have been parentally assigned back to at least one resident parent through pedigree or otolith micro chemistry analyses. Based on this research, juvenile releases from WNFH are intended to include <10% non-migrant composition, on average, to mitigate ecological and gene flow concerns (NOAA 2017).

Juvenile release monitoring for all programs consist of a combination of physiological assessment at time of release along with secondary, retrospective analysis of post-release behavioral patterns using PIT detections in the natural environment. The physiological component includes standard size and smoltification stage assessment (smolt index; SI), cross-referenced with sexual maturation status determination using the gonadosomatic index (GSI; Devlaming et al. 1982). The external assessment (SI) is effective at identifying two types of non-migrant: 1) immature parr that have failed to reach a size-threshold required for smoltification and 2) sexually mature precocious males. This integrated analysis allows for estimates of maturing males, likely to residualize.

Physiological assessment

Integrated sampling prior to release showed that 19.1% of the production S2 group were unlikely to migrate (Table 9). This total includes precocial males (7.7%), maturing females (1.3%) and maturing males (5.4%), and immature female and male parr (4.7% combined). Even though 96.8% of steelhead left the hatchery during the volitional release period, 16.6% (27,084 fish) may not have migrated to the ocean (Table 9). These findings are similar to those in previous years showing that less 4% of the estimated non-migrants are retained at the end of the volitional release (Box et al. 2017, Humling et al. 2018, Box and

Humling 2019, Humling et al. 2023). The estimated proportion of non-migrant fish (16.6%) in the release group was higher than the BiOp target of <10%.

Table 9. Winthrop NFH volitional release effectiveness for Production S2 steelhead in 2021.

Group	Pre-release		Post-release (retained)		Total Released	
	Total	% of Pop.	Total	% of Pop.	Total	% of Pop.
Immature F parr	6,553	4.0%	505	0.3%	6,048	3.7%
Immature M parr	1,092	0.7%	331	0.2%	761	0.5%
Maturing females	2,184	1.3%	383	0.2%	1,801	1.1%
Maturing males	8,737	5.4%	2,404	1.5%	6,333	3.9%
Precocious males	12,559	7.7%	418	0.3%	12,141	7.4%
Migrant females	75,356	46.2%	714	0.4%	74,642	45.7%
Migrant males	56,790	34.8%	540	0.3%	56,250	34.5%
Total	163,271	100.0%	5,295	3.2%	157,976	96.8%
Non-migrant total	31,125	19.1%	4,041	2.5%	27,084	16.6%
Migrant Total	132,146	80.9%	1,254	0.7%	130,892	80.2%

Post-release behavioral assessment

PIT tag detections of potential residual steelhead juveniles in 2021 were used evaluated following an assumed smolt migration window (April through June) for a year after release (July 1, 2021 through June 30, 2022). The majority of these potential residual tagged fish were detected at sites/arrays at the release site or in close proximity to the release site (N = 417, 93.3%; Table 10). Of the 447 tagged fish in this exercise, 395 (88.4%) were only detected between July 1, 2021 and January 31, 2022. The ultimate fate of these fish is largely unknown because they lack a spring PIT detection history, suggesting either mortality or cessation of detectable movement. However, behavior varied among release groups of those detected the year following release. Approximately 21% of the Split Study S1 group eventually displayed migratory behavior though 17 of the 18 fish were not detected at Rocky Reach Dam (RRJ) until spring 2022 (Table 10). A small proportion of fish appear to have been active during the spring 2022 spawning period. A total of 22 fish (4.9%) were detected in spawning locations between February 1 and June 30, 2022 (Table). Some bare tags were also recovered at the Cassimer Bar Cormorant rookery. Diminishing detections over time suggest distribution patterns of non-migrants either stay close to release sites or result in mortalities in the hatchery zone of the Methow Subasin. (discussed further in Tatara et al. 2019).

Table 10. Winthrop NFH post-release period PIT detections from release year 2021.

Group	Location Description	Detection site(s)*	July 2021 - January 2022	February 2022 - June 2022	2023	Total
Production S2	Release site	SCP[1]	220	10	0	230
	Main tributaries	CRW/CML/MRW/ TWR/WFC	44	5	0	49
	Mainstem	MRC	2	0	0	2
	Rocky Reach Dam	RRJ	0	2	0	2
	Bird Colonies	OKRCRY	0	0	6	6
Split Study S2	Release site	SCP[1]	46	3	0	49
	Main tributaries	CRW/MRW/WFC	12	1	0	13
	Rocky Reach Dam	RRJ	0	1	0	1
	Bird Colonies	OKRCRY	0	0	2	2
Twisp S2	Main tributaries	TWR	3	0	0	3
	Mainstem	MRC	3	0	0	3
Split Study S1	Release site	SCP[1]	26	0	0	26
	Main tributaries	CRW/CML/CMU/ MRW/TWR/WFC	19	2	0	21
	Lower River tribs	BVC/LBC	2	1	0	3
	Mainstem	MRC/LMR/WEA	18	0	0	18
	Rocky Reach Dam	RRJ	1	17	0	18
	Bird Colonies	OKRCRY	0	0	1	1
Total	Fate	Unknown/mortalities	395	0	0	395
		Potential spawners	0	22	0	22
		Migrants	1	20	0	21
		Avian Predation	0	0	9	9

[1]Inludes detections at Methow Hatchery outfall (MSH).
*SCP = Spring Creek, CRW = Chewuch River at Winthrop, CML = Lower Chewuch River, MRW = Methow River at Winthrop, TWR = Twisp River at Twisp, WFC = Wolf Creek near the mouth, MRC = Methow River at Carlton, RRJ = Rocky Reach Dam juvenile bypass, OKRCRY = Cassimer Bar cormorant rookery near the Okanogan River mouth, CMU = Upper Chewuch River, BVC = Beaver Creek, LBC = Libby Creek, LMR = Lower Methow River, WEA = Wells Dam adult fishways

Adult Return 2020/2021

Run Forecasting

Upper Columbia summer steelhead returns to the lower Columbia River (i.e., to Bonneville Dam; Rkm 234) are closely monitored and provide managers a timeframe between mid/late-summer entry into the Columbia River, early fall arrival to Wells Dam, and eventual tributary spawning from March to May the following year to make decisions affecting the run at large. PIT detection at Bonneville and Wells Dams between June and October of each year, prior to spawning, allow the generation of return estimates to guide adult management strategies that may include implementation of conservation fisheries in the tributaries. PIT detections suggested that 2020/2021 WNFH returns above Bonneville Dam would be low again, likely a minimum of 287 adult steelhead (compared to a minimum of 175 in 2019/2020) with an estimated escapement of only 200 fish above Wells Dam. The run was biased towards 2-salt adults from the BY17 (RY18/19).

Run Timing

Returning adult steelhead from WNFH are typically detected at Bonneville Dam (Columbia River rkm 234) beginning in late June and the run is completed by early October. In 2020, the first WNFH-origin adult was detected at Bonneville Dam on June 29th, only four days later than the long-term mean (Table 11). The first 10th percentile arrived consistent with the long-term mean, but the remainder of the run (25-95th percentile arrived between one and two weeks later than average (Table 11).

Table 11. Winthrop NFH steelhead run completion passage dates at Bonneville Dam.

Return Year	Cumulative Run Passage Dates								
	First Fish	5%	10%	25%	50%	75%	90%	95%	Last Fish
2009	6-Jul	21-Jul	25-Jul	4-Aug	11-Aug	17-Aug	22-Aug	26-Aug	12-Sep
2010	22-Jun	26-Jun	3-Jul	18-Jul	24-Jul	10-Aug	29-Aug	7-Sep	27-Sep
2011	3-Jul	14-Jul	21-Jul	30-Jul	10-Aug	19-Aug	1-Sep	7-Sep	25-Sep
2012	19-Jun	28-Jun	8-Jul	18-Jul	30-Jul	15-Aug	3-Sep	10-Sep	11-Oct
2013	2-Jul	18-Jul	21-Jul	31-Jul	7-Aug	17-Aug	29-Aug	9-Sep	2-Oct
2014	6-Jul	9-Jul	13-Jul	26-Jul	7-Aug	18-Aug	4-Sep	9-Sep	3-Oct
2015	23-Jun	9-Jul	18-Jul	27-Jul	9-Aug	23-Aug	2-Sep	17-Sep	10-Oct
2016	16-Jun	24-Jun	13-Jul	27-Jul	13-Aug	26-Aug	6-Sep	6-Sep	12-Sep
2017	23-May	23-Jul	2-Aug	6-Aug	20-Aug	28-Aug	4-Sep	12-Sep	19-Sep
2018	10-Jul	19-Jul	25-Jul	3-Aug	10-Aug	27-Aug	2-Sep	3-Oct	4-Oct
2019	1-Jul	1-Jul	3-Jul	29-Jul	16-Aug	25-Aug	7-Sep	9-Sep	9-Sep
2020	29-Jun	29-Jun	15-Jul	5-Aug	16-Aug	2-Sep	17-Sep	20-Sep	20-Sep
09-19 mean	25-Jun	9-Jul	16-Jul	28-Jul	8-Aug	20-Aug	1-Sep	10-Sep	25-Sep

Most Upper Columbia DPS summer steelhead ascend to the lower reaches of their subbasin of origin to overwinter, though some remain in the Columbia River below (and in some cases overshooting) their tributaries of origin, then enter their spawning subbasin in the spring. Fuchs and Caudill (2018) found that roughly two-thirds of Methow Subbasin steelhead enter the Methow River the fall prior to spawning the next spring, while the remaining third enter from the Columbia River in the spring. This is similar to

results found in the Okanogan and Wenatchee Subbasins, but in contrast to the Entiat where all fish entered from the Columbia River in the spring prior to spawning. Travel time was calculated from Bonneville to LMR (Lower Methow River at Pateros), indicating a return to the Methow Subbasin; however, arrival at Wells Dam may be a more appropriate comparison due to the variable tributary-entry timing.

During the 2019/2020 migration period, mean travel time from Bonneville Dam to the Wells Dam for returning adult WNFH steelhead was 43 days (Table 12). Mean travel/residence time from Wells Dam to the lower Methow River PIT array (LMR) was 49 days (Table 12). Travel time from Bonneville Dam to Wells Dam was identical to the previous year but approximately nine days longer than the long-term mean (Table 12). Adults spent around 20 days longer in the Wells pool than the long-term mean but this was largely influenced by two adults that spent at least four months between sites.

Table 2. Winthrop NFH steelhead adult travel times (days) from Bonneville Dam to the Methow Subbasin.

Return Year	BON > MCN			MCN > PRD			PRD > RIA			RIA > WEA			BON > WEA			WEA > LMR[1]		
	Mean	SD	N	Mean	SD	N	Mean	SD	N	Mean	SD	N	Mean	SD	N	Mean	SD	N
09/10	15.7	14.9	51	5.9	2.0	51	4.8	3.1	53	5.2	2.4	53	31.2	16.4	53	32.5	62.1	72
10/11	14.6	12.0	28	5.6	1.6	27	5.0	3.3	25	8.8	16.2	24	33.1	21.8	25	6.1	8.1	37
11/12	10.2	6.1	183	10.6	8.0	181	5.7	4.2	179	6.5	3.9	177	32.9	13.3	180	85.2	80.0	230
12/13	11.3	9.0	124	10.3	10.3	124	4.8	2.8	104	6.4	9.3	105	33.2	19.9	123	36.8	50.0	152
13/14	15.6	14.1	137	7.1	6.8	136	5.5	4.6	124	5.7	4.2	123	33.5	17.0	135	12.1	32.5	183
14/15	14.4	12.3	112	6.9	4.6	110	5.7	4.3	72	7.2	8.5	70	34.5	16.4	106	24.4	32.5	147
15/16	13.1	11.6	138	6.8	5.1	136	5.3	4.2	131	5.4	5.6	130	30.1	13.3	131	26.5	37.0	178
16/17	14.0	10.0	46	6.7	4.3	46	5.5	7.0	39	5.8	3.4	38	32.3	14.8	41	31.4	41.5	70
17/18	18.6	12.1	72	5.1	1.4	72	5.6	7.0	64	4.3	2.2	61	34.5	13.5	67	26.5	17.9	26
18/19	16.2	14.1	22	6.4	2.2	22	5.1	2.1	14	4.9	2.6	14	33.0	14.1	21	7.8	5.5	4
19/20	20.5	18.5	14	6.5	2.0	14	11.6	18.1	12	11.4	16.8	11	43.0	21.6	11	23.5	17.4	6
20/21	14.9	8.4	15	6.6	5.0	15	5.4	1.2	15	16.0	36.7	15	42.9	38.9	15	49.1	58.4	10
10 - 20 mean	14.9	12.2	84	7.1	4.4	84	5.9	5.5	74	6.5	6.8	73	33.8	16.6	81	28.4	35.0	100

*BON – Bonneville; MCN – McNary; PRD – Priest Rapids; RI – Rock Island; WEA – Wells; LMR – Lower Methow River
[1]Widely-ranging travel times to LMR may be associated with inconsistent operational periods, ice damage, and the site moving from Rkm 3 to about Rkm 8 in 2017.

Run Conversion

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 steelhead PITs ascending the Columbia River between 2009 and 2020 suggests detection efficiency has improved to >99% for both Bonneville and Wells dams. For the 2020/21 run, 83% of WNFH adults to Bonneville successfully migrated to Wells Dam (Table 13). This conversion rate of fish between mainstem projects was higher than the long-term average (70.5%) with the largest disparity occurring in the Bonneville to McNary reach (Table 13).

Table 3. Winthrop NFH steelhead passage (conversion rate) from Bonneville Dam to Wells Dam.

Return Year(s)	Adjusted unique PIT detections[1]					Conversion efficiency by reach				
	BON	MCN	PRD	RIA	WEA	BON > MCN	MCN > PRD	PRD > RIA	RIA > WEA	BON > WEA
09/10	72	54	54	53	53	75.0%	100.0%	98.1%	100.0%	73.6%
10/11	38	28	27	27	26	73.7%	96.4%	100.0%	96.3%	68.4%
11/12	230	183	181	178	176	79.6%	98.9%	98.3%	98.9%	76.5%
12/13	155	121	121	121	121	78.1%	100.0%	100.0%	100.0%	78.1%
13/14	183	134	134	130	129	73.2%	100.0%	97.0%	99.2%	70.5%
14/15	148	113	111	108	106	76.4%	98.2%	97.3%	98.1%	71.6%
15/16	178	139	137	135	133	78.1%	98.6%	98.5%	98.5%	74.7%
16/17	70	47	47	43	43	67.1%	100.0%	91.5%	100.0%	61.4%
17/18	98	72	72	71	70	73.5%	100.0%	98.6%	98.6%	71.4%
18/19	32	22	22	21	21	68.8%	100.0%	95.5%	100.0%	65.6%
19/20	19	14	14	12	12	73.7%	100.0%	100.0%	100.0%	63.2%
20/21	18	15	15	15	15	83.3%	100.0%	100.0%	100.0%	83.3%
09-19 mean	111	84	84	82	81	74.3%	99.3%	97.7%	99.1%	70.5%

*BON – Bonneville; MCN – McNary; PRD – Priest Rapids; RI – Rock Island; WEA – Wells
[1]Detections at mainstem projects adjusted by back-applying upstream detects to all downstream sites.

2021 Adult Management & Broodstock Collection

2021 Broodstock Collection and Adult Management-based Collection Effort

Winthrop NFH serves as the lead coordinating entity and centralized summer steelhead brood holding facility for USFWS and DPUD operated programs in the Methow Subbasin. These coordinated efforts use a variety of collection methods including hatchery ladder traps, weirs, and angling to secure needed brood. A total of 265 summer steelhead were retained via angling, weirs, hatchery traps (Table 14). Most fish were collected between February 5th and April 18th, with three additional fish collected from the Twisp weir in the second half of April. More detailed information on collection and effort is available in the project's 2021 broodstock and adult management memo (Smith and Hansch 2024).

All fish were assigned to a preliminary origin and/or program (e.g., safety-net, conservation, or unknown/stray) based on external visual characteristics (e.g., adipose fin presence and dorsal fin condition) and presence of a CWT. Preliminary assignments were used in real-time to guide broodstock allocation and adult management objectives. Initial assignments were later verified through scale verification and CWT identification. Natural-origin returns (NORs) made up only 33.6% (N=89) of the total collection (trapping and angling) while hatchery-origin returns (HORs) comprised 66.4% (N=176) of the total (Table 14).

All adult management decisions were made to optimize implementation of the HSRG stepping-stone model. A total of 153 hatchery-origin fish were transferred to Wells Hatchery to support safety-net programs while 17 fish were surplused at WNFH (Table 14). Most steelhead retained at WNFH were spawned (N=89) but five steelhead were returned to the river and not incorporated in broodstock (Table 14). All fish live-spawned were either transferred to the YN kelt reconditioning facility (females) or returned to the river (males) though one male died in the truck prior to being released.

Table 4. Winthrop NFH collection and management adult steelhead in 2021.

Collection Site / Disposition	Hatchery-origin		Natural-origin		Total		Grand total
	M	F	M	F	M	F	
Collection							
Methow River Angling[1,2]	73	101	30	51	103	152	255
Spring Creek Weir	1	0	0	0	1	0	1
MH Trap	0	0	0	0	0	0	0
Twisp Weir	1	0	3	5	4	5	9
Adult Management and Broodstock							
Pre-Spawn Mortality	0	0	0	1	0	1	1
Transferred to Wells	64	89	0	0	64	89	153
Surplused (buried)	8	9	0	0	8	9	17
Returned to River	1	3	1	0	2	3	5
Lethally Spawned	1	0	0	0	1	0	1
Live-Spawned, –› Kelt Facility	0	0	0	55	0	55	55
Live-Spawned, –› River	1	0	32	0	33	0	33

[1]Does not include fish angled & released or euthanized on site or sent directly to Wells Hatchery.
[2]Does not include two NOR females determined to be wild rainbow trout by scale analysis (returned to river).

2021 Run and Broodstock Demographics

Collection of broodstock in 2021 ($N = 265$; Table 15) was lower than some recent years but slightly above the long-term mean. The number of returning WNFH adults collected was the lowest since the adoption of the current adult management plan ($N = 35$, Table 15). No known out-of-basin strays were collected via angling, weirs, or hatchery traps in 2021. Though some out-of-basin adults have been detected at the lower Methow River site in previous years (PTAGIS site LMR, formerly at Rkm 3, moved to Rkm 8 in 2017), a standard was made to reduce risk of possible inclusion of these fish into local broodstock by restricting collection to above the LMR PIT array (about Rkm 8), beginning in 2018.

The majority of both natural and hatchery-origin fish collected in 2021 were 2-salt in age (Tables 16 and 17). A total of 105 hatchery-origin fish transferred to Wells Hatchery or surplused at WNFH were not sampled for age. If age is inferred for these fish based on length, and added to the group with known ages, natural and hatchery-origin returns were 83% and 84% 2-salts, respectively. Length-at-maturity was generally similar within sex between natural and hatchery-origin adults in 2021 (Table 17) However, both 1 and 2-salt natural origin males were larger than various hatchery counterparts (1-6 cm larger; Table 17).

Table 5. Winthrop NFH adult steelhead collections by origin/program/release location.

Spawn Year	Origin/Program[1]						Total
	Natural-Origin	Winthrop NFH	Wells Hatchery Safety-Nets	Wells Hatchery Twisp Cons.	Unknown Hatchery	Snake River Subbasin	
2010	9	11	6	--	5	0	31
2011	5	12	23	--	0	0	40
2012	13	57	43	--	1	0	114
2013	12	29	29	--	1	1	72
2014	64	14	9	--	0	0	87
2015	49	45	95	1	0	3	193
2016	83	54	81	1	0	0	219
2017	86	158	156	7	9	0	416
2018	134	120	71	7	1	0	333
2019	120	60	86	9	0	0	275
2020	121	42	37	12	0	0	212
2021	89	35	118	18	5	0	265
14-20 mean[2]	94	70	76	6	1	0	248

[1]All fish with adipose clips and no CWTs are assumed to be Wells safety-net fish. It is possible some fish are out-of-basin strays of unknown programs or untagged WNFH returns.
[2]Average values computed beginning in 2014 to reflect current management approach.

Table 6. Age-at-return of adult steelhead collected in the Methow Subbasin in 2021.

Origin	Brood Year	Age	Mark	CWT	Collection Source			Total
					Angling	Outfall Traps	Twisp Trap	
Hatchery	2016	2.2	AD+CWT	054968	20	1	0	21
	2016	2.2	AD+CWT	055645	10	0	0	10
	2016	2.2	AD+CWT	055646	3	0	0	3
	2017	1.2	Ad-only	None	11	0	0	11
	2018	1.1	Ad-only	None	2	0	0	2
	2017	1.2	CWTO	637108	17	0	1	18
	2017	1.2	HFN	None	2	0	0	2
	2018	1.1	HFN	None	1	0	0	1
Natural	2015	3.2	None	N/A	9	0	0	9
	2016	2.2	None	N/A	43	0	8	51
	2016	3.1	None	N/A	2	0	0	2
	2017	1.2	None	N/A	1	0	0	1
	2017	2.1	None	N/A	12	0	0	12
	Unknown	2.1S	None	N/A	1	0	0	1
	Unknown	R.2	None	N/A	13	0	0	13
Total[1]	--	--	--	--	147	1	9	157

[1]Total does not include 105 fish transferred to Wells Hatchery or surplused at WNFH that were not sampled for age.

Table 7. Length-at-maturity of adult steelhead at Winthrop NFH in 2021.

Group	Males						Females					
	1-salt			2-salt			1-salt			2-salt		
	Mean	SD	*N*	Mean	SD	*N*	Mean	SD	*N*	Mean	SD	*N*
Natural-Origin	60.5	2.8	11	78.0	3.2	22	58.8	3.6	4	72.6	4.2	52
WNFH Conservation	--	--	--	74.8	4.2	11	--	--	--	70.9	3.8	23
Twisp Conservation	--	--	--	71.8	3.0	6	--	--	--	71.3	3.8	12
Wells Safety-Nets[1]	58.5	5.4	20	76.7	5.0	37	61.8	2.9	8	73.1	4.0	52
Unknown Hatchery[1]	--	--	--	75.0	--	1	56.0	--	1	75.0	8.6	2
Combined	59.2	4.7	31	76.4	4.5	77	60.4	3.4	13	72.5	4.2	143

[1]Salt age inferred for 107 hatchery-origin fish (≤ 65mm = 1 salt).

Broodstock Fish Health Monitoring

To improve adult management and follow guidelines in the USFWS Fish Health Policy (2004), antibiotic injections are not currently used for adult broodstock. However, adults receive a prophylactic formalin treatment three days per week in the form of a one-hour flow-through treatment to prevent saprolegniasis. Formalin treatments are not initiated until tribal surplus events have been completed. In 2021, no steelhead from WNFH were surplused to PNW tribes due to lack of interest from tribes. A small number of fish were surplused and buried.

Natural-origin steelhead in the Methow Subbasin spawn from as early as late-February through late-May. To shorten the window of spawn events WNFH and Fish Health staff administered luteinizing hormone – releasing hormone analogue (LHRHa) injections to 21 females in 2021 to increase maturation timing (38% of all females spawned). LHRHa was administered under an Investigational New Animal Drug study (INAD) protocol #8061 at a dose of 15 ug/kg fish weight.

Egg take, Gamete Management, and Stepping-Stone Implementation (BY21)

Fecundity data was collected from all fish spawned and compared by salt-age and origin. Hatchery-origin brood fish have mostly been phased out since 2016. Overall mean fecundity in 2021 was 5,664 eggs per female (Table 18). The majority of females in the 2021 brood were 2-salt in age (94.5%; $N = 52$) though this age class had lower fecundity than the previous three years (averaging ~500 eggs less). Overall green egg take for WNFH broodstock in 2021 was estimated at 315,103, approximately 109% of the HGMP's stated egg take goal of 289,000 eggs (Appendix A). Though the egg take was within the 10% bounds, the overage was three times more than that in 2020.

Table 18. Mean fecundity by salt-age for natural-and-hatchery-origin steelhead used for the Winthrop NFH steelhead program.

Brood Year	1 salt						2 salt						Combined					
	Natural			Hatchery			Natural			Hatchery			Natural			Hatchery		
	Mean	StDev	*N*	Mean	StDev	*N*	Mean	StDev	*N*	Mean	StDev	*N*	Mean	StDev	*N*	Mean	StDev	*N*
2011	--	--	--	--	--	--	6,151	194	3	6,450	1,348	12	6,151	194	3	6,450	1,348	12
2012[1]	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
2013	5,117	1,634	2	4,005	260	5	6,324	1,335	4	7,013	762	5	5,921	1,412	6	5,510	1,674	10
2014	4,303	955	19	4,049	788	4	5,568	1,043	10	--	--	--	4,739	1,144	29	4,049	788	4
2015	3,121	678	5	5,111	1,523	4	5,107	1,397	19	5,535	894	22	4,639	1,505	25	5,470	987	26
2016	4,155	868	19	4,198	1,094	11	4,790	1,050	10	6,168	1,116	10	4,374	966	29	5,136	1,475	21
2017	4,212	728	4	--	--	--	5,685	1,015	49	--	--	--	5,574	1,057	53	5,574	1,057	53
2018	5,109	1,012	57	--	--	--	6,513	1,263	8	--	--	--	5,281	1,134	65	--	--	--
2019	4,492	979	38	--	--	--	6,151	1,335	21	5,455	--	1	5,083	1,366	59	5,455	--	1
2020[2]	4,661	1,345	21	--	--	--	6,114	1,356	36	--	--	--	5,579	1,515	57	--	--	--
2021	3,441	379	3	--	--	--	5,792	1,270	52	--	--	--	5,664	1,348	55	--	--	--
11-20 mean	4,396	1,025	21	4,341	916	6	5,823	1,110	18	6,124	1,030	10	5,260	1,144	36	5,378	1,222	18

[1]Egg mortality not recorded (or lost) in 2012.
[2]Salt-age assignments in 2020 were inferred using 2009-2019 length-at-age data.

Spawning crosses were typically 2x2 factorial for all matings in the Methow and Twisp conservation programs. A total of 52 parents contributed to 109 factorial spawning crosses. The pNOB for both BY21 conservation programs was 1.000, meeting the maximum value for releases in the Methow Subbasin and allowing a release target for WNFH between 150k and 200k (Table 19; NOAA 2017). This value matches that in 2020 and is higher than the long term mean of 0.875 (Appendix C, Table C4).

Table 19. Winthrop NFH spawn matrix and pNOB in 2021.[1,2]

Origin Combinations (F x M)	pNOB Value	Number of Crosses	% of Brood	Contribution to NOB
HxH	0.0	0	0.000	0.000
WxH	0.5	0	0.000	0.000
WxW	1.0	109	1.000	1.000
Total		109	1.000	1.000

[1]Combined WNFH and Twisp (DPUD) conservation programs.
[2]Long-term data are found in Appendix C, Table C4.

Cohort Performance

Smolt-to-Adult Return (SAR) and Hatchery Replacement Rate (HRR)

The Smolt-to-Adult Return (SAR) is the primary post-release metric for evaluating hatchery program performance for a brood year as it directly describes the number of adults produced from a juvenile release.

$$SAR = \frac{\#\ returning\ adults\ by\ broodyear}{total\ \#\ smolts\ released}$$

The Hatchery Replacement Rate (HRR) is a similar metric that explains the number of adult returns (recruits) produced relative to the number of broodstock adults collected to produce them. The number of adults collected includes those fish used in spawning crosses, associated pre-spawn mortalities, and extras collected and spawned but later culled (e.g., expected disease risk-based culling, as is done with spring Chinook programs). Fish removed from the run for pHOS management or collected for inter-program transfers are not included in HRR because they are not specifically part of the program's fish culture plan. The metric is organized by brood year and involves estimating returns in multiple spawn escapement years attributed back to a particular brood year.

$$HRR = \frac{\#\ adult\ recruits}{\#\ broodstock\ collected}$$

For steelhead, populating these equations is done using hatchery release and spawn data and PIT-based escapement estimates. Because WNFH operates with dual objectives of recovery (increase natural spawners) and mitigation (contribute to fisheries) we consider adult returns to comprise escapement into the Columbia River, including fishery recoveries. Early-maturing life history varieties are not considered adults and these recoveries are excluded from SAR and HRR estimates. Some case-by-case interpretation is required, particularly for atypical PIT observations such as repeat-spawner steelhead kelts.

Between 2008 and 2016, production S2 WNFH steelhead averaged a SAR of 0.44% (Table 20). The highest value in this range was 1.09% (BY08) while the previous low was 0.02% (BY13). Most years fall below the low end of the target range (0.5-2.0; Appendix A) while none of the years come close to the upper end. The most recent cohort for which complete adult return data are available (BY17) had the lowest SAR to date (0.01%; one adult return at BON; Table 20). Hatchery Replacement Rate (HRR) for BY17 was extremely low as seen with BY13 (0.16 and 0.54, respectively; Table 20). These low returns are likely due to a combination of factors at various life stages including but not limited to poor outmigration conditions, poor ocean survival, and warmer river temperatures during adult migration. The long-term HRR mean for the production S2 group is nearly 10 recruits per parent though this value is largely influenced the high recruits from brood years 2008-2010 (Table 20). In most years, HRR is orders of magnitude greater than the natural replacement rate (NRR) estimated in the Methow Subbasin (Table 20; Snow et al. 2023). Detailed SARs and HRR for all WNFH release groups (e.g. Production S1, Twisp S2) can be found in Appendix C, Table C5.

Table 20. PIT tag-based smolt-to-adult return (SAR) and Hatchery Replacement Rate (HRR) for Winthrop NFH steelhead Production S2 groups. Returns are based on adult detection at Bonneville Dam (BON). NRR = Natural Replacement Rate in the Methow Subbasin (Snow et al. 2023).[1]

Brood Year	Release Year	Adults Used[2]	Smolts Released	# PITs Released	Fish/PIT tag	Adult PITs at BON	Exp. Adults	Smolt-to-Adult (SAR)	HRR	NRR
2008	2010	14	29,170	14,756	2.0	161	318	1.09%	22.73	0.26
2009	2011	14	43,205	14,881	2.9	88	255	0.59%	18.25	0.30
2010	2012	27	59,352	14,892	4.0	102	407	0.68%	15.06	0.25
2011	2013	34	57,894	14,475	4.0	47	188	0.32%	5.53	0.31
2012	2014	44	90,599	14,630	6.2	65	403	0.44%	9.15	0.33
2013	2015	30	75,165	13,887	5.4	3	16	0.02%	0.54	0.09
2014	2016	69	128,585	19,562	6.6	95	624	0.49%	9.05	0.30
2015[3]	2017	81	212,570	19,831	10.7	35	375	0.18%	4.63	0.31
2016	2018	90	126,299	13,392	9.4	19	179	0.14%	1.99	0.37
2017	2019	76	175,120	14,183	12.3	1	12	0.01%	0.16	--
08-16 mean		45	91,427	15,590	5.7	68	307	0.44%	9.66	0.28

[1]Detailed information for all release groups can be found Appendix C, table C5.
[2]Estimated from total adults in brood apportioned to various rearing groups based on release totals.
[3]Includes Twisp Release Group for SAR estimate (one PIT-tag file for all S2 fish).

Harvest Contribution and Straying

WNFH steelhead are primarily subjected to mixed Columbia River basin fisheries; ocean fishery interceptions of WNFH steelhead have not been reported via the Regional Mark Processing Center (rmpc.org). Estimating total adult returns is challenging because naturally spawning fish are not recovered on spawning grounds. Furthermore, Upper Columbia sport fishery harvest totals (in rmpc.org) are not expanded by sample rate. To rectify these data gaps, a combination of PIT-based escapement at Wells Dam (expanded by tag rate), combined with known CWT recoveries and data from Upper Columbia creel reports, and local broodstock collections were used to estimate total natural spawners and harvest rates. Upper Columbia sport fisheries were not implemented during recent brood returns (BY16 and BY17) yet adults were intercepted in lower river tribal fisheries. Total adult returns for the BY17 Production S2 group were the lowest on record (N = 7; Table 21) As such, the harvest rate for BY17 (42.9%) was 8.5% higher than the long-term average of 34.5% (Table 21). In some years when sport fisheries were conducted in the Upper Columbia, harvest rates on Production S2 adult returns exceeded 70% (BY09 and BY10; Table 21). Detailed harvest and stray rates for all WNFH release groups (e.g. Production S1, Twisp S2) can be found in Appendix C, Table C6.

Table 21. Winthrop NFH harvest and stray rates for Production S2 steelhead.[1]

Brood Year	Expanded Recoveries							Harvest Rate (%)	Stray Rate (%)
	Tribal (all)	Sport – Col. R.	Sport – Trib.[2]	Hatchery (all)	Methow Subbasin Spawners[3]	Stray Spawners[3]	Total		
2008	16	23	107	47	102	6	301	48.5%	2.0%
2009	11	40	123	17	53	3	247	70.4%	1.2%
2010	4	82	292	82	46	4	510	74.1%	0.8%
2011	9	5	73	32	66	12	197	44.2%	6.1%
2012	25	0	38	133	125	12	333	18.9%	3.6%
2013	5	0	0	12	6	0	23	21.7%	0.0%
2014	23	26	4	260	270	40	623	8.5%	6.4%
2015	16	28	0	120	175	0	339	13.0%	0.0%
2016	15	0	0	52	75	0	142	10.6%	0.0%
2017	3	0	0	4	0	0	7	42.9%	0.0%
08-16 mean	14	23	71	84	102	9	302	34.4%	2.2%

[1]Detailed information for all release groups can be found Appendix C, table C6.
[2]Estimated by expanding known recoveries by Upper Columbia Creel Report totals.
[3]Natural spawner and stray estimates were determined by expanded PIT recoveries and likely spawning location after removal of sport harvest above Wells Dam and local broodstock collection. Pre-spawn mortality was assumed to be 10%.

Steelhead carcass recoveries are rare, so PIT tag detections (expanded by tag rate) are used to estimate stray rates. Generally, final detection location is used to interpret presumed spawning location. However, several assumptions and interpretations are made to assign stray status. This method assumes interrogation sites across the region have similar detection efficiencies and interrogation coverage is similar in all areas where WNFH adults can potentially stray. In general, both timing and location indicative of straying and professional judgement are needed to assign stray status. Some fish have been detected in tributaries downstream of Wells Dam without subsequent detections. As these detections were near the mouth of each tributary (e.g., Deschutes and Wenatchee rivers), and during the fall prior to spawn, their ultimate fate remains uncertain and are not considered strays. Over 10 years of WNFH steelhead releases, the only known stray fish have been detected in the Okanogan Subbasin, apart from one fish in Foster Creek and two fish intercepted at the Chief Joseph Hatchery trap. Many fish show a last detection at Wells Dam and it is unknown whether they eventually entered the Methow Subbasin; their status remains somewhat in limbo though they are not considered strays.

The program target stray rate is <5% for total brood return. The estimated stray rate for BY17 production S2 steelhead was 0.0% though there were only seven adult returns (Table 21). Though total brood stray rate exceeded 5% in two of the ten years reported (BY11 and BY14), the long-term mean is well below the target (2.2%, Table 21). While brood year stray rates have met the program target over time, WNFH steelhead (combined with DPUD programs) should not comprise >5% of any recipient population within spawn years (NOAA 2017). In 2021, the estimated stray composition from WNFH steelhead in the Okanogan Subbasin was only 0.70% yet the combined stray composition was 5.49% (Table 22). The long-term average for WNFH strays in the Okanogan Subbasin is 2.42%, well below the 5% target and

only once has the target been exceeded (2018, 10.15%; Table 22). However, the total stray composition, which includes DPUD adult returns has averaged 5.99% with two years above 12% (Table 22).

Table 22. Winthrop NFH and Douglas PUD PIT-based stray contribution to the Okanogan Subbasin steelhead spawner escapement.

Spawn Year	Estimated WNFH Strays[1]	Estimated DPUD Strays[2]	Okanogan Subbasin Spawner Escapement[3]	WNFH Stray Composition	DPUD Stray Composition	Total Stray Composition
2012	4	5	2,802	0.14%	0.18%	0.32%
2013	5	111	1,937	0.26%	5.73%	5.99%
2014	5	45	1,356	0.37%	3.32%	3.69%
2015	29	86	1,461	1.98%	5.89%	7.87%
2016	75	117	1,566	4.79%	7.47%	12.26%
2017	27	0	1,044	2.59%	0.00%	2.59%
2018	46	22	453	10.15%	4.86%	15.01%
2019	7	16	473	1.48%	3.38%	4.86%
2020	0	5	374	0.00%	1.34%	1.34%
2021	5	34	710	0.70%	4.79%	5.49%
12-20 mean	22	45	1,274	2.42%	3.57%	5.99%

[1]All WNFH release groups combined.
[2]Includes releases in the Methow Subbasin and at Wells Hatchery.
[3]Total subbasin escapement estimate from OBMEP 2022.

2021 Natural Environment Monitoring

Escapement Estimate/Summary

Returning adult steelhead are inherently difficult to count and agencies are currently refining methods to apportion above-Wells Dam counts using multiple methods. WDFW staff in Wenatchee utilize a PIT-based escapement tool to estimate Upper Columbia DPS populations above Priest Rapids Dam (based on Waterhouse et al. 2020). In-season removals (PSM, harvest, broodstock/adult management) are accounted for in M&E reports for Wells Hatchery programs to DPUD (e.g., Snow et al. 2023).

Natural Spawner Composition and Gene Flow Metrics

Run-at-large PIT-tagging at Priest Rapids Dam and subsequent PIT-based escapement estimates have occurred since the 2010/2011. Escapement can be categorized into sub-components (conservation program, safety-net programs, and natural-origin returns) distributed across a zone-based spatial scale described in the BiOp (NOAA 2017), including upper tributary conservation and mainstem management zones (Appendix C). PIT-based values are then adjusted by fishery and adult management removals, including broodstock collections. The recent BiOp stipulates that by spawn year 2022, programs will have shared goals of basin-wide PNI of ≥0.67 with pHOS in the tributary conservation zone of ≤0.25, of which

0.20 (80% of allowable pHOS) can be combined conservation program spawners (WNFH and DUD Twisp).

In 2021, Methow Subbasin PNI was estimated at 0.49 (multi-population PNI model; Busack 2015), falling below the 2022 BiOp target and HSRG (2009) guideline of ≥0.67 for integrated programs, but exceeding the interim target of ≥0.45 in the BiOp (Table 23; Snow et al 2023). Total pHOS in the conservation zone was 0.56, exceeding the maximum allowable value of ≤0.25 in 2022; however, combined conservation program partial pHOS was 0.18, within the allowable level for conservation program returns. Conservation program partial pHOS has remained within allowable limits in all eight years measured though partial pHOS of Safety Net program fish in the conservation zone remain higher than desired.

Table 8. Methow Subbasin steelhead program gene-flow metrics for Winthrop NFH and Wells Hatchery programs (data courtesy of Snow et al. 2023).

Spawn year	Conservation Zone[1]				Management Zone[1]				Subbasin PNI
	NOR	ppHOS^{C}	ppHOS^{SN}	pHOS	NOR	ppHOS^{C}	ppHOS^{SN}	pHOS	
2014	0.61	0.13	0.26	0.39	0.29	0.34	0.36	0.71	0.50
2015	0.54	0.14	0.32	0.46	0.17	0.11	0.71	0.83	0.46
2016	0.64	0.14	0.22	0.36	0.35	0.15	0.50	0.65	0.53
2017	0.39	0.18	0.44	0.61	0.25	0.19	0.56	0.75	0.43
2018	0.62	0.14	0.24	0.38	0.49	0.46	0.06	0.51	0.59
2019	0.60	0.15	0.25	0.40	0.12	0.30	0.58	0.88	0.55
2020	0.64	0.11	0.25	0.36	0.06	0.57	0.37	0.94	0.59
2021	0.44	0.18	0.38	0.56	0.26	0.12	0.62	0.74	0.49
14-20 mean	0.58	0.14	0.28	0.42	0.25	0.30	0.45	0.75	0.52

[1]ppHOS^{C} = partial program pHOS for combined Conservation programs; ppHOS^{SN} = partial program pHOS for Safety-Net programs.

Non-target Taxa Monitoring

Non-target Taxa Encounters, by Activity

The primary activity associated with the WNFH steelhead program during which non-target fish taxa (NTT) are encountered is angling-based broodstock collection. WDFW-maintained fish exclusion screens restrict entrance by NTT into WNFH ponds, so all phases of fish production in the hatchery are isolated from NTT. The NTT of greatest concern are Bull Trout (*Salvelinus confluentus*), which are ESA-listed and subject to take limits and reporting requirements (allowance of up to 40 non-lethal captures). Bull Trout allowances have never been exceeded; however, in 2016, captures were trending towards the allowable 40 adults captured (Table 24). Crews adopted a policy requiring them to leave a site if two Bull Trout were caught and, since adopting this strategy, incidental capture has declined.

Table 9. Non-target fish taxa incidental captures during inter-agency angling-based steelhead broodstock collection efforts.

Year	Bull Trout	Westslope Cutthroat Trout	Mountain Whitefish	Residual hatchery-origin *O. mykiss*	Wild Rainbow Trout[1]
2014	8	2	11	- -	0
2015	16	2	12	- -	0
2016	31	3	22	- -	0
2017	18	3	13	2	0
2018	11	9	3	3	1
2019	13	12	9	10	0
2020	28	18	15	21	1
2021	12	19	7	16	2
14-20 mean	18	7	12	9	0

[1]Field identified by coloration, spotting, morphology, and size. Not always scale-sampled.

Discussion of Performance Relative to Program Targets

Broodstock Collection Objectives

Broodstock collection goals center on the collection of locally-sourced, high pNOB broodstock. WNFH has successfully met its local broodstock goal for the seven previous brood years through 100% local collection of high pNOB broodstock (Tables 14 and Table 19). Program partners were able to fully implement the pNOB/production sliding scale at the full production level (200K) while maximizing pNOB (1.0). Brood year 2020 pNOB results were verified through scale analysis.

Juvenile Rearing/Fish Culture Objectives

Steelhead egg take goals have varied for previous brood years during the development of a finalized Biological Opinion and associated permit. US v OR obligations considered the uncertainty of tributary broodstock collection and allowed flexibility for smolt releases between 100-200K during the experimental shift from Wells-based to locally-based broodstock collection. The finalized BiOp, based on several years' experience, formalized these sliding pNOB/production targets. Table 25 reflects estimated green egg take for recent brood years relative to specific brood year smolt release and associated green egg take targets.

Table 10. Winthrop NFH steelhead program green egg take totals and program goals.

Brood year	Smolt release goal & associated management	Green eggtake[1]		
		Target[1]	Actual	Variance from target
2014	100K-200K (*draft* HMGP)	117K – 233K	150,903	N/A
2015	100K-200K (*draft* HMGP)	117K – 233K	277,787	N/A
2016	200K (*draft* HMGP)	233K[2]	226,540	-2.8%
2017	200K (*draft* HMGP) + 48K DPUD[3]	289K[2]	303,879	+5.1%
2018	200K (final BiOp) + 48K DPUD[3]	289K[2]	321,305	+11.2%
2019	200K (final BiOp pNOB sliding scale) + 48K DPUD[3]	289K[2]	313,877	+8.6%
2020	200K (final BiOp pNOB sliding scale) + 48K DPUD[3]	289K[2]	314,514	+8.8%
2021	200K (final BiOp pNOB sliding scale) + 48K DPUD[3]	289K[2]	315,103	+9.0%

[1]Green egg take estimates account for post-tagging and other various adjustments
[2]Eggtake goals are adjusted up to full production target (200K) based on strength of natural-origin run, and cooperative broodstock collection with DPUD Twisp Program.
[3]Interim management strategy including partial incorporation of DPUD Twisp and alternative release strategies.

Green egg take has exceeded the HGMP target each year by an average of about 6.7% for the six years since formalization of the HGMP target. Brood year 2018 is the only year to have exceeded the +/-10% allowable bounds during this time after recalculation due to an uncalibrated scale. However, egg take for brood years 2019-2021 were close to the 10% overage. To mitigate risk of over-collection of natural origin spawners, managers and evaluation biologists have analyzed the run composition (balance of 1- and 2-salt returns to improve fecundity estimates) and made in-season reductions to adult collection targets. Eye-up rate for BY19 was 96.5%, exceeding the target of >95%. Eye-up rates have averaged 96.2% since 2008, when the program began spawning on site (Table 1). Rearing survival (fry to smolt) was 88.8%, below the 95% goal. Most of the mortality occurred immediately after initial ponding into nursery tanks.

Juvenile Release Objectives

Steelhead releases since 2014 have consistently met release number targets and fish have been >96% adipose-marked with CWT-tag rates generally in the mid-to-high 90-percent range, in compliance with US v OR mitigation obligations (Table 4). Release totals in recent years have increased towards maximum sliding-scale production level (200K smolt release target), with a range of 150k to 216k in the last five years (Table 4). These have all been compliant with the HGMP goals and BiOp allowances since being formalized and the hatchery deserves credit for achieving these goals while simultaneously accommodating numerous experimental release groups all aimed at improving hatchery performance and reducing ecological risk.

While the population of BY19 production S2 steelhead was estimated to have 19.1% fish likely to residualize in spring 2021, WNFH conducted a successful volitional release, which reduced the estimated non-migrant proportion of the final release group to 16.6%. This value exceeds the 10% maximum identified in the BiOp and we will continue to monitor future releases tin hopes of reducing this number.

Fishery Contribution and Harvest Objectives

There are no identified fishery contribution and/or harvest targets and much of these would be beyond the direct control of Winthrop NFH or Mid-Columbia FWCO staff. Fishery contribution values are summarized in the Harvest Contributions and straying section. After an extensive review of Upper Columbia sport harvest for this report, recent harvest contributions through the latest complete cohort of returning adults (BY17) has averaged 35.3%; the reliability of Upper Columbia creel estimates make these data somewhat uncertain. Harvest rates for Methow River steelhead are highly dependent upon implementation of conservation fisheries above Priest Rapids Dam and in the Methow River.

Adult Management Objectives

A total of 176 hatchery-origin steelhead, 118 of which were presumed Wells Safety-net HORs, were removed from the spawner escapement during activities directly related to conservation program operations in 2021. Since no tributary conservation fisheries have occurred above Priest Rapids Dam during the last several runs, fish removed by program cooperators (e.g., removals during broodstock collection and at Wells Dam) have remained the only hatchery-origin fish removed for gene flow purposes.

Collective efforts to reduce pHOS and increase PNI have affected slow, steady progress marking an increase since 2014. In 2021, some gene flow targets were achieved. Subbasin PNI was estimated at 0.49, meeting the interim target of >0.45 but still insufficient to meet the >0.67 target that will be required from 2022 and beyond. Conservation program (WNFH and Twisp) pHOS goals have been met in the conservation zone since 2014, though conservation zone and subbasin pHOS rates have remained sufficiently high to preclude attainment of 2022 PNI goals at the subbasin scale. However, it appears most gene flow metrics have stabilized and any gains from the Stepping-stone management paradigm have largely been realized.

Even though significant progress has been made in the last decade, all pHOS and PNI targets have not been fully achieved (compared to the 2022 target) and long-term adult management objectives are not being fully met (Table 23). Selective pressures may likely continue to favor the hatchery environment. Improvement in adult and broodstock/gamete management may benefit long-term subbasin PNI, but challenges remain with broodstock collection and production constraints resulting from poor overall NOR returns.

Stepping-Stone Implementation and Inter-agency Coordination Objectives

Coordinated broodstock collection and adult management efforts have modestly improved gene flow metrics on the spawning grounds and in the conservation and safety-net programs through inter-hatchery management. With respect to 2022 targets, much depends on the size and composition of future return cohorts, particularly natural-origin run strength. Following are recommendations for maximizing the ability to achieve gene flow goals in future years:

1) As feasible, within allowance of the BiOp and details of the US v OR agreement, maximize pNOB in the Conservation Program broodstock, erring towards lower production/maximum pNOB vs. maximum production/compromised pNOB.
2) As feasible, within allowance of the BiOp and details of the US v OR agreement, maximize proportion of conservation program adults in the safety-net broodstock ($pHOB_c$).
3) Maximize removal of Wells Safety-net adults via conservation fisheries and aggressive adult management during broodstock collection and via hatchery infrastructure. Support inter-agency

efforts to remove excess HORs possibly beyond attainment of NOR broodstock targets if feasible within ESA take constraints.

4) Under some run scenarios, proceed with caution when removing Conservation Program returns - removal of more Conservation Program adults than necessary could hinder the ability to attain safety-net partial pHOS targets, even in situations where PNI targets are theoretically attained or approached.
5) Continue collaborative inter-agency coordination, planning, and implementation of Methow Subbasin programs. Improve holistic reporting of performance and risk metrics since none of the conservation programs or safety-net programs function independently.
6) Support efforts for comprehensive DPS-wide escapement analyses to include all subbasins above PRD.

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.

Berejikian, B., C. Tatara, D. Van Doornik, M. Humling, M. Cooper, C. Pasley, and J. Atkins. 2020. Duration in captivity affects competitive ability and breeding success of male but not female steelhead trout (Oncorhynchus mykiss). Can. J. Fish. Aquat. Sci. 77(6): 1000-1009.

Box, J., M. Humling, B. Gerwig, and C. Pasley. 2017. 2016 Winthrop NFH smolt release and analysis memo. Mid-Columbia Fish and Wildlife Conservation Office, Winthrop, WA.

Box, J. and M. Humling. 2019. 2018 Winthrop NFH smolt release summary and analysis memo. Mid-Columbia Fish and Wildlife Conservation Office, Winthrop, WA.

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.

Christie, M.R., M.L. Marine, and M.S. Blouin. 2011. Who are the missing parents? Grandparentage analysis identifies multiple sources of gene flow into a wild population. Molecular Ecology 20:1263-1276.

Columbia River DART, Columbia Basin Research, University of Washington. (2021). PIT Tag File Selection for Generating Survival and Travel Time Estimates. Accessed June 2021. 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.

Courter, I.I., D.B. Child, J. A. Hobbs, T.M. Garrison, J.G. Glessner, and S. Duery. 2013. Resident rainbow trout produce anadromous offspring in a large interior watershed. Can. J. Fish. Aquat. Sci. 70(5):701-710.

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

Fuchs, N. and C.C. Caudill. 2018. Evaluation of the migration behaviors of radio-tagged adult summer steelhead in the Upper Columbia River, 2015-2016 and 2016-2017. Technical Report 2018-1 to Washington Department of Fish & Wildlife. University of Idaho, Moscow, ID.

Goodman, Ben. Fish & Wildlife Biologist, Washington Department of Fish & Wildlife, Methow Research Team, Twisp, WA. Personal communication, June, 2020.

Gorbman, A. W.W. Dickhoff, J.L. Mighell, E.F. Prentice, and F.W. Waknitz. 1982. Morphological indices of developmental progress in the parr-smolt Coho salmon, Oncorhynchus kisutch. Aquaculture 28:1-19.

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.

Humling, M., J. Box, B. Gerwig, and C. Palsey. 2018. 2017 Winthrop NFH smolt release summary and analysis memo. Mid-Columbia Fish and Wildlife Conservation Office, USFWS. Winthrop, WA.

Humling, M., S. Reese, C. Pasley, T. Bundy, C. Parker-Graham, and M. Cooper. 2021. Winthrop National Fish Hatchery summer steelhead annual report – 2019. U.S. Fish and Wildlife Service, Mid-Columbia Fish and Wildlife Conservation Office, Winthrop, WA.

Humling, M., C. Smith, C. Frady, S. Reese, C. Pasley, T. Bundy, C. Parker-Graham, and M. Cooper. 2023. Monitoring and evaluation of the Winthrop National Fish Hatchery summer steelhead program – 2020. U.S. Fish and Wildlife Service, Mid-Columbia Fish and Wildlife Conservation Office, Winthrop, WA.

MSSSWG. 2018. Management alternatives for Methow Basin conservation steelhead programs. Memo to the Wells HCP Hatchery Committee. Authored by the Methow Subbasin Steelhead Small Working Group. USFWS, WDFW, DPUD.

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.

NOAA. 2017. Endangered Species Act (ESA) Section 7(a)(2) Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat (EFH) Consultation for two steelhead hatchery programs in the Methow River. NMFS Consultation Number WCR-2017-6986. West Coast Region. Portland.

NOAA 2019a. Endangered Species Act Section 10(a) Permit for Takes of Endangered/Threatened Species, Scientific Research/Enhancement Permit #23163 for the Wells Complex Summer Steelhead Program. National Marine Fisheries Service West Coast Region, Portland, OR.

NOAA 2019b. Endangered Species Act Section 4(d) Limit 5 approval of the Hatchery and Genetics Management Plan for the Winthrop National Fish Hatchery steelhead program. National Marine Fisheries Service West Coast Region, Portland, OR.

OBMEP. 2022. Okanogan Basin Monitoring and Evaluation Program, 2021 Annual Progress Report. Colville Confederated Tribes Fish and Wildlife Department, Nespelem, WA. Report submitted to the Bonneville Power Administration, Project No. 2003-022-00.

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

Peven, C.M., R.R. Whitney, and K.R. Williams. 1994. Age and length of steelhead smolts from the Mid-Columbia River Basin, Washington. North American Journal of Fisheries Management. 14:77-86.

Piper, R., I. McElwain, L. Orme, J. McCraren, L. Fowler, and J. Leonard. 1982. Fish Hatchery Management. Washington, DC: U. S. Department of the Interior, Fish and Wildlife Service.

See, K. Unpublished steelhead escapement model data. Provided April 2024. Washington Department of Fish & Wildlife, Wenatchee, WA.

Smith, C. and K. Hansch. 2024. 2021 Winthrop NFH smolt release summary and analysis memo. Mid-Columbia Fish and Wildlife Conservation Office, USFWS. Winthrop, WA.

Snow, C. D. Grundy, B. Goodman, A. Haukenes, and Tom Kahler. 2023. Monitoring and evaluation of the Wells Hatchery and Methow Hatchery Programs: 2022 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, East Wenatchee, WA.

Snow, C. and M. Humling. 2017. Compositing the Twisp and Winthrop NFH steelhead broodstocks in 2017. Memo to Methow Subbasin steelhead managers (WDFW, WDFW Methow Hatchery, USFWS MCFWCO, USFWS Winthrop NFH, Douglas PUD). WDFW Twisp office and USFWS MCFWCO Winthrop office.

Tatara, C., D. Larsen, M. Cooper, P. Swanson, M. Middleton, J. Dickey, D. Harstad, M. Humling, C. Palsey, and B. Berejikian. 2019. Age at release, size, and maturation status influence residualism in hatchery steelhead. North American Journal of Fisheries Management. 39: 468-484.

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

USFWS. 2012. (revised) Hatchery and Genetic Management Plan (HGMP) for the Winthrop National Fish Hatchery summer steelhead program, Winthrop National Fish Hatchery, Leavenworth Fisheries Complex. Winthrop, WA.

USFWS. 2014. Biological Assessment for the operation and maintenance of Winthrop National Fish Hatchery. Leavenworth Fisheries 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.

USFWS. 2017. (revised) Hatchery and Genetic Management Plan (HGMP) for the Winthrop National Fish Hatchery summer steelhead program, Winthrop National Fish Hatchery, Leavenworth Fisheries Complex. Winthrop, WA.

USFWS. 2019. (revised) Hatchery and Genetic Management Plan (HGMP) for the Winthrop National Fish Hatchery summer steelhead program, Winthrop National Fish Hatchery, Leavenworth Fisheries Complex. Winthrop, WA.

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

Waterhouse, L., J. White, K. See, A. Murdoch, and B. X. Semmens. 2020. A Bayesian nested patch occupancy model to estimate steelhead movement and abundance. Ecological Applications 30(8): e02202.

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

Appendix A. WNFH Steelhead Program Monitoring Goals & Objectives.

Stage	Monitoring Attribute	Operational Criteria/Target	Source of Criterion/Target
Broodstock Collection & Management	*Stock & DPS*	Methow Subbasin, Upper Columbia Summer DPS	HGMP
	Strategy	Integrated Conservation, supports Stepping-Stone	HGMP
	Collection locations	Primarily angling, Methow Subbasin	HGMP
	Ladder operation	N/A, angling collection throughout run	HGMP, BiOp
	Broodstock collection target	Up to NOR[1] 62 pairs, including DPUD Methow/Twisp.	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	>99%	Facility-specific operational detail
	Adult sampling	Generally 100%, representative sub-sample in high escape.	HEP
	Adult monitoring	Origin/sex/age/length/external mark/Tag ID	HEP
Spawning	*Spawner M:F ratio*	2 x 2 factorial	HGMP
	Fish Health Monitoring	100% ovarian virology females; bacteriology/virology males	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	N/A	HGMP
Eggtake, incubation, & Gamete Management	*Green egg target*	289,000 (includes DPUD portion)	HGMP
	Prophylaxis	Disinfect, water harden	WA 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
	Culling	N/A unless virology concerns (e.g. IPN)	HGMP
	Post-cull egg total	N/A	Facility-specific operational detail
	Shocking	Eggs kept at 1 female per tray	Facility-specific operational detail
	% green-to-eyed egg	≥95%/216,000 + 48,000 to Twisp/Alt. program	HGMP
	% eyed-to-fry	≥95% /205,000 fry	Facility-specific operational detail

[1]NOR pairs are maximized. Some HOR adults from Conservation programs can be included on sliding scale.

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)	1.0-2.5%	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*	8 x 80 raceways	Facility-specific operational detail
	Water source	Well/infiltration gallery, river (winter)	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, Bio Clarks Fry	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	1-3x per week	Washington State Co-managers Disease Control Policy
	Mass marking	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*	8 x 80 raceways	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	Bio Clark, BioSupreme	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
	Feed application	Hand	Facility-specific operational detail
	Cleaning frequency	Brushed 1-2x/wk	WA Co-managers Disease Control Policy
	Monthly monitoring	Monthly fish health & biometrics	WA 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	≤ 0.20	Facility-specific operational detail
	Flow Index	≤ 1.0	Facility-specific operational detail
Smolt Release	*Condition factor (K)*	1	Facility-specific operational detail
	Size (FPP)	5-10	HGMP
	Early maturation (% males)	<10%	BiOp (pending)
	Release type	Volitional	HGMP
	Release time	3rd week of April	HGMP
	Release Goal	100,000 - 200,000, pNOB/Production sliding scale	US v OR and BiOp (sliding scale)
Survival and Escapement Metrics	*Green egg to smolt survival*	85%	Facility-specific operational detail
	Green egg to fry survival	90%	IHOT, HGMP
	Fry to smolt survival	95%	IHOT, HGMP
	Smolt to adult survival	0.50%-2.0%	Facility-specific operational detail
	Hatchery return rate (HRR)	>2, see BiOp: dependent on pNOB/pHOS/PNI	BiOp
	Partial pHOS on spawn. grnd.	0.2, cons. prog. total w/sliding scale in mgmt. zones	BiOp
	Subbasin PNI	≥0.45 (through 2021); ≥0.67 (starting in 2022)	BiOp
	Stray rate to other subbasins	<5% of total escapement (HSRG *guideline*)	BiOp (in Permit 18927)

Appendix B. Section 4(d) Limit 5 Reporting Requirement Summary.

NMFS's Section 4(d) Limit 5 authorization (NOAA 2019b) for the Winthrop NFH steelhead program includes authorization/provision of direct and incidental take as well as reasonable and prudent measures (RPMs), implementation terms and conditions (T&Cs), and conservation recommendations (CRs).

Direct and indirect take associated with Methow steelhead programs are assessed through indirect surrogates discussed throughout this report. This summary appendix accompanies the WNFH annual report to directly address the RPMs, implementation T&Cs, and CRs, and is consistent with activities through completion of the BY17 steelhead release period, summer 2019.

RPM 1. The USFWS implement the hatchery program and operate the WNFH facility as described in the Proposed Action (Section 1.3) and in the submitted HGMP.

RPM 1 was maintained for this operational period. The only major modification to the HGMP, as proposed, was incorporation of Winthrop NFH and Twisp conservation programs and associated release locations, which began in 2018. These resulted in no net change across combined Methow Subbasin programs. Modification of the programs was discussed and vetted in the Wells HPC Hatchery Committee and notification/consultation included NOAA Fisheries representatives.

RPM 2. The applicant provides reports to Sustainable Fisheries Division (SFD) annually for the WNFH program, and associated RM&E.

Through the submission of this annual report (the third published), RPM 2 is satisfied.

T&C 1.a. Provide advance notice to NMFS of any change in hatchery program operation (including early releases) that potentially increases the amount or extent of take, or results in an effect of take not previously considered

No major changes in operation requiring notification except that noted for RPM 1 occurred during the operational period.

T&C 1.a. Provide notice if monitoring reveals an increase in the amount or extent of take, or discovers an effect of the Proposed Action not considered in this opinion

No major observations during monitoring suggest substantial increases in the amount/extent of take occurred. We are actively continuing to monitor the incidence of residualism on juvenile release groups, are actively pursuing research in this area, and are in discussion with NOAA, as 5y average rates begin to materialize. While 2020 residualism rates (Figure 4) were out of 10% exceedance, we remain optimistic that ongoing S1/S2 research will continue to mitigate excess take concerns via release of non-migrant O. mykiss.

T&C 1.c. Allow NMFS to accompany any employee or representative field personnel while they conduct activities covered by their biological opinion

NOAA/NMFS representatives are encouraged to join USFWS in any field activity at any time.

T&C 1.d. Develop a marking scheme, in coordination with the HCP Hatchery Committee and US v Oregon processes, to be implemented before fish are marked for the 2019 release, with the goal of facilitating adult management, broodstock collection, and assessment of hatchery escapement into the wild

No changes to the marking scheme for WNFH conservation program steelhead have been implemented as of 2021. The current mark combination is 100% adipose-clip and 100% CWT along with a high PIT-tag mark rate (avg. 20K/year). These allow for adequate M&E activities to be implemented. The disadvantage of this mark strategy is lack of ability to implement a mark-selective fishery on differentially-marked conservation and safety-net adults by anglers. The HCP Hatchery Committee has discussed this issue. Program managers have been reluctant to impose a ventral fin clip due to added cost, concern of regeneration, and conflicting findings in the literature about survival – USFWS is of the opinion this mark should not be used for any WxW conservation program steelhead, particularly when alternative removal methods can be used.

Appendix C. Long-term data sets.

Table C1. Marking and release summary for all WNFH release groups, brood years 2007-2019.

Brood Year	Release Year	Group	Release Start Date	Release End Date	Days of Release	CWT code(s)	# CWT	% CWT	# Ad-clip	% Ad-clip	# PIT Released	Total Released
2007	2008	Prod. S1	5/7/2008	5/7/2008	0	054638,4810, 4811,4812,4813	115,845	99.1%	114,559	98.0%	4,915	116,897
2008	2009	Prod. S1	4/21/2009	4/21/2009	0	054819,4820, 4821,4822	89,280	87.2%	100,370	98.0%	4,997	102,418
2008	2010	Prod. S2	4/19/2010	4/19/2010	0	053574	26,230	89.9%	28,645	98.2%	14,756	29,170
2009	2010	Prod. S1	4/19/2010	4/19/2010	0	054823,4824, 4825	69,689	97.9%	69,570	97.7%	14,841	71,208
2009	2011	Prod. S2	4/19/2011	4/19/2011	0	053175	41,765	96.7%	42,687	98.8%	14,881	43,205
2010	2011	Prod. S1	4/19/2011	4/19/2011	0	054730,4731, 4828	62,569	97.9%	62,402	97.6%	14,698	63,936
2010	2012	Prod. S2	4/19/2012	5/22/2012	33	053564,3565	29,469	49.7%	58,343	98.3%	14,892	59,352
2011	2012	Prod. S1	4/19/2012	5/24/2012	35	054138	56,389	97.5%	57,337	99.1%	14,917	57,858
2011	2013	Prod. S2	4/15/2013	5/13/2013	28	053567,3792	55,816	96.4%	57,240	98.9%	14,475	57,894
2012	2013	Prod. S1	4/15/2013	5/13/2013	28	055421	47,283	87.8%	53,405	99.2%	14,543	53,827
2012	2014	Prod. S2	4/15/2014	5/21/2014	36	055425	86,060	95.0%	90,424	99.8%	14,630	90,599
2013	2014	Prod. S1	4/15/2014	5/21/2014	36	055489	47,356	95.1%	48,443	97.3%	14,689	49,799
2013	2015	Prod. S2	4/15/2015	5/22/2015	37	055684	71,253	94.8%	73,908	98.3%	13,887	75,165
2014	2015	Prod. S1	4/15/2015	5/22/2015	37	054666	15,749	81.2%	19,020	98.0%	13,920	19,405
2014	2016	Prod. S2	4/15/2016	4/16/2016	31	055422,5658	128,071	99.6%	127,416	99.1%	19,562	128,585
2015	2017	Twisp S2	4/21/2017	4/25/2017	N/A	054648	10,865	96.9%	10,930	97.5%		11,214
2015	2017	Prod. S2	4/27/2017	4/27/2017	0	055756	27,020	98.2%	27,405	99.6%	19,831	27,515
2015	2017	Prod. S2	4/25/2017	5/18/2017	23	055756	169,780	98.2%	172,200	99.6%		172,892
2016	2018	Twisp S2	4/24/2018	4/26/2018	N/A	055646	23,531	97.7%	23,531	97.7%	4,729	24,093
2016	2018	Prod. S2	4/23/2018	5/14/2018	21	054968,5645	125,547	99.4%	125,008	99.0%	13,392	126,299
2017	2019	Twisp S2	4/15/2019	4/15/2019	N/A	053080	23,432	96.4%	24,113	99.2%	4,531	24,307
2017	2019	Prod. S2	4/22/2019	5/14/2019	22	056232	160,789	99.0%	175,120	100.0%	14,183	175,120
2018	2019	Split Study S1	4/22/2019	5/14/2019	22	053793	13,505	98.0%	13,394	97.2%	5,854	13,780
2018	2020	Twisp S2	4/8/2020	4/9/2020	N/A	054279	25,838	96.4%	26,749	99.8%	3,977	26,803
2018	2020	Split Study S2	4/16/2020	5/15/2020	29	056196	11,542	94.0%	12,254	99.8%	5,769	12,279
2018	2020	Prod. S2	4/16/2020	5/15/2020	29	056325	151,346	97.6%	164,229	99.8%	15,352	164,539
2019	2020	Split Study S1	4/16/2020	4/28/2020	12	056227	12,111	98.5%	11,922	96.9%	5,920	12,299
2019	2021	Twisp S2	4/21/2021	4/21/2021	N/A	054280	23,985	98.6%	24,083	99.0%	4,444	24,326
2019	2021	Split Study S2	4/19/2021	5/17/2021	28	056365	12,776	97.8%	12,828	98.2%	5,656	13,063
2019	2021	Prod. S2	4/19/2021	5/17/2021	28	056326	148,814	94.2%	152,447	96.5%	14,489	157,976

*Prod. S1 = Production S1 (from Wells); Prod. S2 = Production S2 (collected in the Methow Subbasin)

Table C2. Pre-release summary for all Winthrop NFH release groups, brood years 2008-2019.

Brood Year	Group	Fork length (mm)		Weight (g)		N	K
		Mean	CV	Mean	Fish/lb.		
2008	Production S2	202.3	7.9	90.4	5.0	259	1.07
2009	Production S2	187.1	13.7	72.3	6.3	543	1.05
2009	Prod. S1 (W)	185.5	11.4	71.2	6.4	310	1.07
2010	Production S2	186.7	11.8	70.6	6.4	619	1.05
2010	Prod. S1 (W)	152.5	23.8	55.8	10.6	592	1.02
2011	Production S2	197.1	11.4	87.5	5.2	642	1.10
2011	Prod. S1 (W)	172.0	16.7	59.2	7.7	607	1.08
2012	Production S2	187.7	11.3	74.4	6.1	587	1.09
2012	Prod. S1 (W)	194.8	10.8	81.6	5.6	624	1.07
2013	Production S2	204.2	9.6	94.3	4.8	606	1.08
2013	Prod. S1 (W)	173.6	14.3	60.0	7.6	590	1.08
2014	Production S2	197.3	9.0	82.1	5.5	275	1.05
2014	Prod. S1 (W)	172.5	16.4	60.1	7.6	597	1.08
2015	Production S2	204.9	10.8	93.4	4.9	300	1.07
2016	Production S2	201.4	11.8	89.4	5.1	302	1.07
2017	Production S2	189.3	12.6	74.5	6.1	300	1.05
2018	Production S2	197.4	9.4	77.6	5.9	303	0.99
2018	Split Study S1	178.3	10.0	62.8	7.2	298	1.08
2018	Split Study S2	190.5	8.8	66.9	6.8	301	0.95
2019	Production S2	197.0	13.0	83.0	5.5	299	1.05
2019	Split Study S1	172.7	11.5	54.7	8.3	300	1.02
2019	Split Study S2	197.2	9.9	81.2	5.6	303	1.03
08-19 mean	Prod. S2	196.0	11.0	82.5	5.6	420	1.06
09-14 mean	Prod. S1 (W)	175.2	15.6	64.7	7.6	553	1.07
18-19 mean	Split Study S1	175.5	10.8	58.8	7.8	299	1.05
18-19 mean	Split Study S2	193.9	9.4	74.1	6.2	302	0.99

*Prod. S1 (W) = Production S1 (from Wells)

Table C3. Winthrop NFH PIT-based juvenile survival rates and travel times to Rocky Reach (RRJ) and Bonneville dams (BON) for steelhead release groups from brood years 2008-2019.

Brood Year	Group	Mean speed to RRJ (km/day)	Mean Travel Time to RRJ			Survival to RRJ		Mean Travel Time to BON			Survival to BON	
			Days	SE	N	%	SE	Days	SE	N	%	SE
2008	Prod. S2	23.2	7.0	0.12	2,382	77.7	1.3	23.0	0.16	939	45.2	3.9
2008	Prod. S1 (W)	N/A	N/A	N/A	N/A	N/A	N/A	27.0	1.10	56	N/A	N/A
2009	Prod. S2	11.6	14.0	0.11	1,810	64.1	1.3	22.0	0.33	148	33.5	9.1
2009	Prod. S1 (W)	18.1	9.0	0.15	3,364	71.7	1.2	25.0	0.24	892	31.0	2.7
2010	Prod. S2	46.4	3.5	0.11	1,060	62.1	2.3	14.0	0.41	164	29.0	8.2
2010	Prod. S1 (W)	9.6	17.0	0.25	804	47.2	1.4	24.0	0.77	63	24.7	9.6
2011	Prod. S2	32.5	5.0	0.06	3,174	59.1	1.7	14.0	0.15	627	34.1	5.1
2011	Prod. S1 (W)	40.6	4.0	0.14	1,132	64.6	2.1	20.0	0.62	130	38.7	11.1
2012	Prod. S2	40.6	4.0	0.05	4,244	67.0	1.8	14.0	0.16	652	38.6	7.9
2012	Prod. S1 (W)	20.3	8.0	0.11	3,255	70.0	2.2	20.0	0.26	597	50.1	10.2
2013	Prod. S2	27.1	6.0	0.08	4,586	58.8	1.1	21.0	0.16	989	18.7	1.7
2013	Prod. S1 (W)	27.1	6.0	0.12	3,115	59.1	1.8	19.0	0.35	440	28.3	7.0
2014	Prod. S2	32.5	5.0	0.06	5,117	65.0	1.2	16.0	0.13	1,353	30.7	4.1
2014	Prod. S1 (W)	18.1	9.0	0.14	4,659	59.1	1.1	25.0	0.24	970	20.3	1.8
2015	Prod. S2	32.5	5.0	0.06	4,873	67.3	1.5	14.0	0.21	601	43.1	13.0
2016	Prod. S2	40.6	4.0	0.05	3,457	68.1	1.9	13.0	0.14	720	49.1	13.8
2016	Twisp S2	40.6	4.0	0.13	432	76.5	3.8	13.0	0.40	77	N/A	N/A
2017	Prod. S2	20.3	8.0	0.11	2,897	63.6	1.6	19.0	0.24	551	18.9	2.5
2017	Twisp S2	23.2	7.0	0.28	529	55.1	2.4	20.0	0.53	88	30.0	13.5
2018	Prod. S2	20.3	8.0	0.09	4,108	62.4	1.5	19.0	0.56	67	24.4	21.1
2018	Twisp S2	8.1	20.0	0.27	1,021	45.3	2.5	28.0	0.94	17	N/A	N/A
2018	Split S1	10.2	16.0	0.35	1,156	66.2	3.0	29.0	0.78	150	23.2	7.2
2018	Split S2	20.3	8.0	0.16	1,451	61.5	2.5	20.0	1.11	24	N/A	N/A
2018	Wells S1	20.3	8.0	0.57	813	58.3	2.9	23.0	1.15	129	14.9	5.0
2019	Prod. S2	27.1	6.0	0.09	3,745	59.6	2.2	18.0	0.17	888	26.0	9.7
2019	Twisp S2	13.5	12.0	0.21	1,311	48.3	2.3	24.0	0.42	242	14.9	5.9
2019	Split S1	6.5	25.0	0.45	905	56.4	2.3	36.0	2.52	12	N/A	N/A
2019	Split S2	27.1	6.0	0.14	1,393	61.5	1.3	18.0	0.32	291	30.0	1.8
2019	Wells S1	6.8	24.0	0.82	641	61.8	3.2	37.5	4.44	8	N/A	N/A
08-19 mean	Prod. S2	29.6	6.3	0.1	3,454	64.8	1.5	17.3	0.24	642	32.1	7.8
08-14 mean	Prod. S1 (W)	22.3	8.8	0.2	2,722	62.0	1.6	22.9	0.51	450	32.2	7.1
16-19 mean	Twisp S2	21.4	10.8	0.2	823	56.3	2.8	21.3	0.57	106	22.5	9.7
18-19 mean	Split S1	8.4	20.5	0.4	1,031	61.3	2.7	32.5	1.65	81	23.2	7.2
18-19 mean	Split S2	23.7	7.0	0.2	1,422	51.5	3.9	19.0	0.72	158	26.0	9.7
18-19 mean	Wells S1	13.6	16.0	0.7	727	60.1	3.1	30.3	2.80	69	14.9	5.0

*Prod. S1 (W) = Production S1 (from Wells); Prod. S2 = Production S2 (collected in the Methow Subbasin)

Table C4. Parental crosses and pNOB for Winthrop NFH, brood years 2014-2021.

Brood year	Parental Crosses				pNOB
	HxH	WxH	WxW	Total	
2014	0	8	29	37	0.892
2015	5	28	20	53	0.642
2016	0	21	32	53	0.802
2017	0	42	65	107	0.804
2018	0	2	128	130	0.992
2019	0	2	118	120	0.992
2020	0	0	114	114	1.000
2021	0	0	109	109	1.000
14-20 mean	1	15	72	88	0.875

Table C5. PIT tag-based smolt-to-adult return (SAR) and Hatchery Replacement Rate (HRR) for all Winthrop NFH steelhead release groups. Returns are based on adult detection at Bonneville Dam (BON). NRR = Natural Replacement Rate in the Methow Subbasin (Snow et al. 2023).[1]

Brood Year	Release Year	Group	Brood Used	Smolts Released	# PITs Released	Fish/PIT tag	Adult PITs at BON	Exp'd Adults	Smolt-to-Adult (SAR)	HRR	NRR
2008	2009	Prod. S1 (W)	43	102,418	4,997	20.5	15	307	0.30%	7.15	0.26
2008	2010	Prod. S2	14	29,170	14,756	2.0	161	318	1.09%	22.73	
2009	2010	Prod. S1 (W)	33	71,208	14,841	4.8	146	701	0.98%	21.23	0.30
2009	2011	Prod. S2	14	43,205	14,881	2.9	88	255	0.59%	18.25	
2010	2011	Prod. S1 (W)	28	63,936	14,698	4.3	39	170	0.27%	6.06	0.25
2010	2012	Prod. S2	27	59,352	14,892	4.0	102	407	0.68%	15.06	
2011	2012	Prod. S1 (W)	25	57,858	14,917	3.9	112	434	0.75%	17.38	0.31
2011	2013	Prod. S2	34	57,894	14,475	4.0	47	188	0.32%	5.53	
2012	2013	Prod. S1 (W)	21	53,827	14,543	3.7	118	437	0.81%	20.80	0.33
2012	2014	Prod. S2	44	90,599	14,630	6.2	65	403	0.44%	9.15	
2013	2014	Prod. S1 (W)	15	49,799	14,689	3.4	78	264	0.53%	17.63	0.09
2013	2015	Prod. S2	30	75,165	13,887	5.4	3	16	0.02%	0.54	
2014	2015	Prod. S1 (W)	11	19,405	13,920	1.4	12	17	0.09%	1.52	0.30
2014	2016	Prod. S2	69	128,585	19,562	6.6	95	624	0.49%	9.05	
2015	2017	Prod. S2	81	212,570	19,831	10.7	35	375	0.18%	4.63	0.31
2016	2018	Prod. S2	90	126,299	13,392	9.4	19	179	0.14%	1.99	0.37
2016	2018	Twisp S2	18	24,093	4,729	5.1	7	36	0.15%	1.98	
2017	2019	Prod. S2	76	175,120	14,183	12.3	1	12	0.01%	0.16	--
2017	2019	Twisp S2	11	24,307	4,531	5.4	0	0	0.00%	0.00	
2018	2019	Split Study S1	7	13,780	5,854	2.4	1	2	0.02%	0.34	--
08-14 mean		Prod. S1s (W)	25	59,779	13,229	6.0	74	333	0.53%	13.11	0.26
08-17 mean		Prod. S2s	48	99,796	15,449	6.4	62	278	0.40%	8.71	0.34
16-17 mean		Twisp S2s	15	24,200	4,630	5.2	4	18	0.07%	0.99	0.37

*Prod. S1 (W) = Production S1 (from Wells); Prod. S2 = Production S2 (collected in the Methow Subbasin)

Table C6. Winthrop NFH harvest and stray rates for all steelhead groups.

Brood Year	Group	Expanded Recoveries							Harvest Rate (%)	Stray Rate (%)
		Tribal (All)	Sport – Col. R.	Sport – Trib.[1]	Hatchery (All)	Methow Subbasin Spawners[2]	Stray Spawners	Total		
2008	Prod. S1 (W)	17	85	93	20	115	0	330	59.1%	0.0%
2008	Prod. S2	16	23	107	47	102	4	299	48.8%	1.3%
2009	Prod. S1 (W)	22	85	164	27	336	10	644	42.1%	1.6%
2009	Prod. S2	11	40	123	17	53	3	247	70.4%	1.2%
2010	Prod. S1 (W)	7	0	25	23	68	4	127	25.2%	3.1%
2010	Prod. S2	4	82	292	82	46	4	510	74.1%	0.8%
2011	Prod. S1 (W)	28	44	90	40	165	20	387	41.9%	5.2%
2011	Prod. S2	9	5	73	32	66	12	197	44.2%	6.1%
2012	Prod. S1 (W)	26	6	61	42	195	22	352	26.4%	6.3%
2012	Prod. S2	25	0	38	133	125	12	333	18.9%	3.6%
2013	Prod. S1 (W)	36	10	41	123	42	17	269	32.3%	6.3%
2013	Prod. S2	5	0	0	12	6	0	23	21.7%	0.0%
2014	Prod. S1 (W)	0	0	0	7	6	0	13	0.0%	0.0%
2014	Prod. S2	23	26	4	260	270	40	623	8.5%	6.4%
2015	Prod. S2[1]	16	28	0	123	175	0	342	12.9%	0.0%
2016	Twisp S2	0	0	0	4	15	5	24	0.0%	20.8%
2016	Prod. S2	15	0	0	52	75	0	142	10.6%	0.0%
2017	Twisp S2	0	0	0	1	0	0	1	0.0%	0.0%
2017	Prod. S2	3	0	0	4	0	0	7	42.9%	0.0%
08-14 mean	Prod. S1s (W)	19	33	68	40	132	10	303	32.4%	3.2%
08-17 mean	Prod. S2s[1]	13	20	64	76	92	8	272	35.3%	1.9%
16-17 mean	Twisp S2s	0	0	0	3	8	3	13	0.0%	10.4%

*Prod. S1 (W) = Production S1 (from Wells); Prod. S2 = Production S2 (collected in the Methow Subbasin)