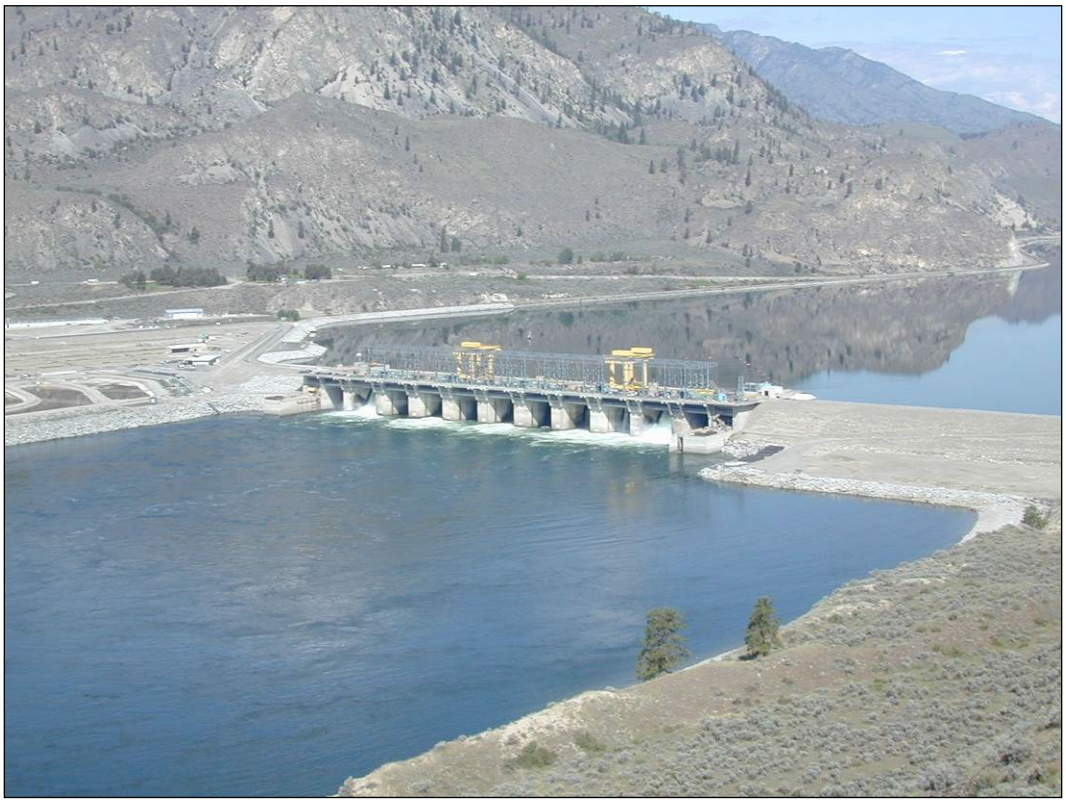
FINAL 2024 COMPREHENSIVE PROGRESS REPORT: STATUS OF ACHIEVING NNI UNDER THE ANADROMOUS FISH AGREEMENT AND HABITAT CONSERVATION PLAN

WELLS HYDROELECTRIC PROJECT



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1.0 INTRODUCTION

The Wells Hydroelectric Project (Wells Project), owned and operated by the Public Utility District No. 1 of Douglas County (Douglas PUD), operates under license by the Federal Energy Regulatory Commission (FERC). During the early 1990s, with impending Endangered Species Act (ESA) listings of spring Chinook and summer steelhead in the Upper Columbia, Douglas PUD and the National Marine Fisheries Service (NMFS) sought a new avenue other than the recently signed 1990 Wells Settlement Agreement through which they could obtain the measures that each deemed necessary for achieving their respective management responsibilities or organizational missions. Douglas PUD and the purchasers of power produced by the Wells Project (collectively, "Power Purchasers") desired ESA permit-coverage for continued operation of the Wells Project, and predictable and achievable measures for species protection and recovery that would allow long-term fiscal planning and project operation without the continued threat of litigation. They also sought support from relevant stakeholders for such measures in the pending relicensing of the Wells Project. Tribes and fish-management agencies desired minimization of negative effects of the Wells Project on anadromous fish species such that continued operation would not jeopardize the continued existence of those species, would contribute to and support the recovery of all five Wells HCP plan species, and achieve other related objectives such as predictable hatchery and habitat mitigation measures. Douglas PUD shared these desires with the respective tribes and management agencies, which provided the basis for agreement, but sorting through and agreeing upon the most efficacious and practical measures for achieving these shared objectives required substantial time and effort for all parties.

In 1993, Douglas PUD commenced what would turn into years of collaborative work with the NMFS and various tribal, state, and federal fisheries agencies, including the U.S. Fish and Wildlife Service (USFWS), Washington Department of Fish and Wildlife (WDFW), the Confederated Tribes of the Colville Reservation (CTCR), the Confederated Tribes and Bands of the Yakama Nation (YN), the Confederated Tribes of the Umatilla Indian Reservation, and American Rivers, to develop a Habitat Conservation Plan (HCP) for anadromous salmon and steelhead affected by the Wells Project. The resulting Wells HCP committed Douglas PUD to a 50-year program (2004 – 2054) to ensure that its operation of the Wells Project would have "no net impact" (NNI) on five "Plan Species" of anadromous salmonids. Plan Species include ESA-listed Upper Columbia River (UCR) spring Chinook Salmon and UCR summer steelhead, as well as summer/fall Chinook, Sockeye, and Coho salmon, which are not ESA listed. Approval of the Wells HCP allowed the NMFS to issue to Douglas PUD Incidental Take Permits (ITPs) for the "Permit Species" impacted by the operation of the Wells Project under Section 10 of the ESA. In addition to the ESA, the Wells HCP supported the relicensing of the Wells Project and satisfies the Project's obligations under the Federal Power Act, the Fish and Wildlife Coordination Act, the Essential Fish Habitat provisions of the Magnuson-Stevens Fishery Conservation and Management Act, the Pacific Northwest Electric Power Planning and Conservation Act, and Title 77 Revised Code of Washington.

For all signatory parties ("Parties," comprising CTCR, YN, NMFS, USFWS, WDFW, Douglas PUD, and Power Purchasers) to the Wells HCP, the Agreement provides the objectives originally

sought during the multi-year negotiations: ESA coverage and operational and program predictability administered through an orderly and collaborative process unencumbered by the looming threat of litigation. Since implementation of the Wells HCP commenced with its approval by the FERC in 2004, the steadfast participation and contribution of the Parties has resulted in the achievement of NNI for the Wells Project by 2007 and the maintenance of NNI in all subsequent years.

NNI forms the fundamental basis of the Wells HCP, and NMFS approval of the Wells HCP as an ESA-compliance vehicle hinges on the continued achievement of NNI. The mechanics of NNI are simple: NNI consists of two components including, (1) a 91 percent combined adult and juvenile Wells Project survival standard achieved by Wells Project improvement measures implemented within the geographic area of the Wells Project, and (2) up to 9 percent compensation for unavoidable Wells Project-related mortalities. Compensation to meet NNI is provided through a hatchery program and a tributary program under which 7-percent compensation is provided through hatchery production and 2-percent compensation is provided through the funding of protection or enhancements to tributary habitats that support Plan Species. With its basis in NNI as defined above, the Wells HCP provides substantial incentive for Douglas PUD to maximize survival through the Wells Project, for in doing so Douglas PUD can also minimize its obligations for hatchery and habitat compensation. It is precisely this relationship—the inverse proportionality between Project survival rates and compensation obligations—that ideally suits the Wells HCP as an ESA-compliance vehicle, for, with an NNI foundation, the Wells HCP is indeed a plan for minimizing ESA "take" of Plan Species.

This report is the second Comprehensive No-Net Impact Progress Report for the Wells HCP, with the first report published in 2013. Through the remainder of this document, Douglas PUD will review the various components of the Wells HCP as they relate to the achievement and maintenance of NNI during the first twenty years of implementation, including phase designations. In addition, the report includes as an appendix a status update for all five Plan Species.

2.0 PASSAGE SURVIVAL PLAN

In the Wells HCP, determining whether Douglas PUD has achieved NNI requires measuring or calculating the survival rates of adult and juvenile Plan Species passing the Wells Project. The Passage Survival Plan (Section 4) of the Wells HCP defines the survival standards for adult and juvenile Plan Species and describes the testing protocols necessary for determining survival rates and the timelines during which testing will occur.

2.1 Survival Standards

Achievement of NNI requires the attainment of survival standards for both adult and juvenile Plan Species migrating through the Wells Project. The Wells HCP establishes a tiered compliance process through which Douglas PUD attained Phase Designations, denoting the degree to which Douglas PUD has met the survival standards necessary to satisfy the NNI benchmark. Phase Designations are described in Wells HCP Section 4.2 (Phased Implementation Plans), which defines the conditions for the achievement of each of the three Phases (and of the three sub-phases

of Phase III). Ultimately, attaining Phase III for each Plan Species is a prerequisite for achieving NNI.

The definitive survival standard under Phase III of the Phased Implementation Plan (and thus, NNI) is the Combined Adult and Juvenile Project Survival of at least 91 percent. That is, at least 91 percent of each Plan Species, juvenile and adult combined, survive project effects. If technology limitations prevent the measurement of Adult Project Survival, Douglas PUD must measure and achieve an alternative standard of 93-percent Juvenile Project Survival. Further, if Douglas PUD is unable to measure the 93-percent Juvenile Project Survival Standard, it must measure and achieve 95-percent Measured Juvenile Dam Passage Survival. Finally, should limitations prevent measurement of either Juvenile Project Survival or Juvenile Dam Passage Survival, Douglas PUD must demonstrate, through a Wells HCP Coordinating Committee-approved calculation methodology, that the Wells Project provides at least 95-percent Juvenile Calculated Dam Passage Survival. The decision-making process for implementation of the survival standards explained above is graphically depicted in Figure 1.

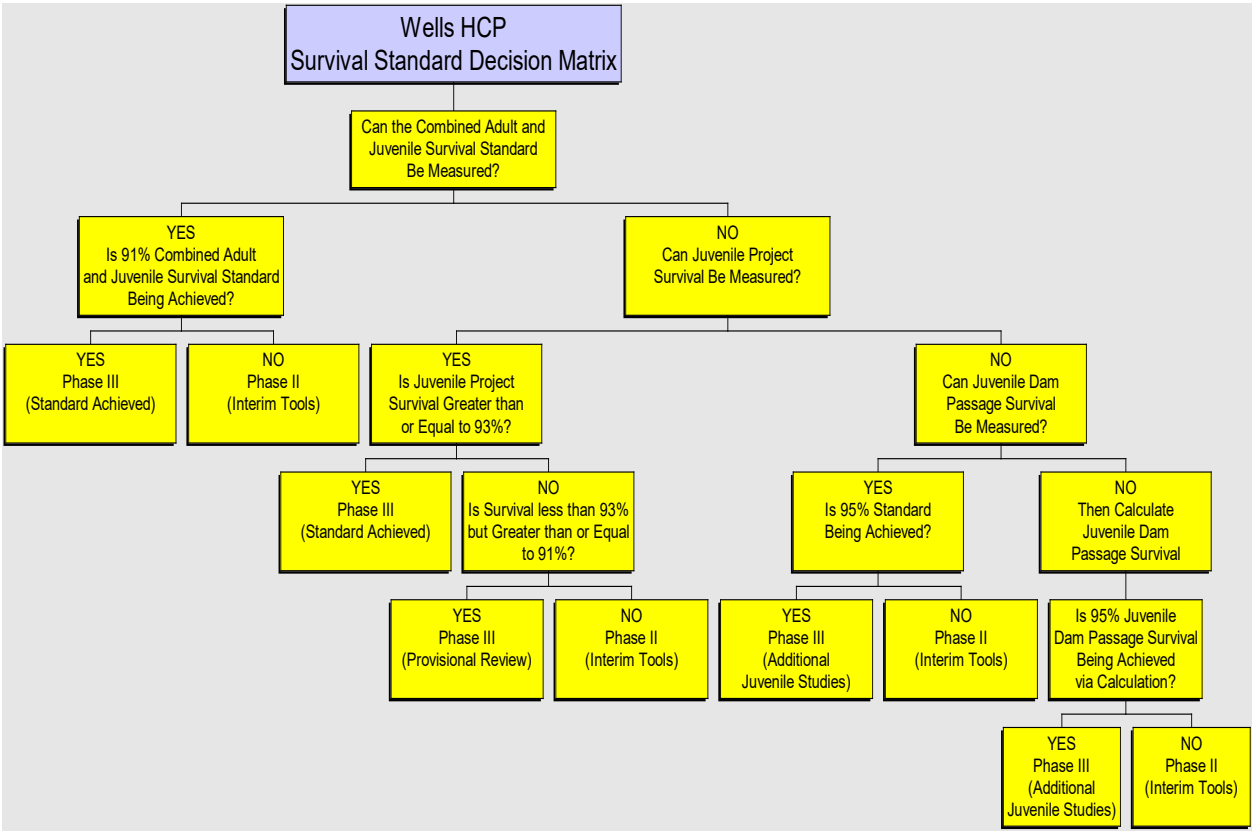

Figure 1. Wells HCP Survival Standard Decision Matrix

From the Passage Survival Plan (as illustrated in Figure 1) the first step in determining Phase Designation for each Plan Species is to determine whether Douglas PUD has achieved the Adult Project Survival standard of 98 percent.

2.2 Adult survival

For adult Plan Species passing through the Wells Project, the Wells HCP sets the survival standard at 98 percent based on estimates from regional studies. When the Wells HCP was completed in 2002, the signatories acknowledged that no scientific methodology currently existed by which the Wells HCP Coordinating Committee could definitively assess Adult Project Survival for Plan Species through the Wells Project. This was because available methods were unable to differentiate between mortality caused by the Wells Project versus other sources of non-detection. Such sources might include mortality from natural causes or fisheries; delayed mortality from injuries resulting from passage at downstream projects, or injuries sustained by marine mammals or harvest activities; or fish not detected for other reasons, such as spawning in locations downstream from Wells Dam or loss of body-cavity passive integrated transponder (PIT) tags due to gonadal maturation during migration. Regardless of tagging method, this limitation remains—technology still does not allow a determination of the fates of tagged fish detected passing a dam but not detected elsewhere (e.g., at the next dam upstream), nor is it possible to attribute those fates to their causes. However, in the Biological Opinion for the Wells HCP, NMFS (2003) concluded that calculation of total unaccounted-for, between-projects losses of known-origin PIT-tagged fish from upstream populations provides a means for evaluating compliance with the Wells HCP standards for adult passage.

Sequential detections of known-origin PIT-tagged adult salmonids through PIT-tag-detection systems in the fishways of each dam provide data for calculating conversion rates through the hydrosystem. Calculated per-project conversion rates furnish sufficient evidence for the achievement of the Adult Project Survival standard, in that Project-related mortality must be below 2 percent when per-project conversion rates exceed 98 percent (i.e., less than 2% of fish missing from all sources including Project-related mortality).

The PIT-tag conversion-rate method utilized by NMFS in the Biological Opinion relies on the use of known-origin fish tagged above Wells Dam with the assumption "that all returning adults will attempt to return to locations at or upstream of the release location (in this instance, above Wells Dam)" (NMFS 2003). Table 1 details, for return-years 2013-2023, PIT-tag detections at Rocky Reach Dam of known-origin adult Plan Species, the number of those adults redetected at Wells Dam, and the calculated conversion rate (Rocky Reach Dam to Wells Dam). The Rocky Reach-to-Wells conversion rate was 99.0 percent for spring Chinook Salmon. In other words, only 1% of the spring Chinook Salmon PIT tagged above Wells Dam and detected at Rocky Reach as adults from 2013 to 2023 were not also detected at Wells Dam. Similarly, the Rocky Reach-to-Wells conversion rates for the other Plan Species were 98.9 percent for steelhead, 97.6 percent for summer Chinook Salmon, 98.3 percent for Sockeye Salmon, and 94.4 percent for Coho Salmon. The rates for steelhead, summer Chinook Salmon, Sockeye Salmon, and Coho Salmon include any losses due to the popular recreational fisheries downstream of Wells Dam. Additionally, summer Chinook Salmon spawn in the Wells Dam tailrace, and Coho Salmon routinely spawn in locations between Rocky Reach and Wells dams, including the Entiat River, Chelan River, Beebe Springs, and the Wells Hatchery outfall. Spring Chinook used in the conversion-rate calculations were not subjected to a fishery in the mainstem Columbia upstream of Rocky Reach Dam, unless arriving after the summer Chinook Fishery opens below Wells Dam. These late arrivals (<5% of the run distribution) are likely released if captured in a fishery, but their survival post release is unknown.

In the Kenai River, Alaska, researchers examined catch-and-release mortality from hook-and-line angling on spring migrating Chinook Salmon, showing that mortality rates averaged 7.6 percent and ranged from 4.1 to 10.6 percent on 446 radio tagged fish that were captured and released, with hooking location being the proximate cause among recorded variables (Bendock and Alexandersdottir 1993).

Table 1. Adult Rocky Reach Dam-to-Wells Dam conversion rates for PIT-tagged Wells HCP Plan Species[1]

Stock Species	Rocky Reach	Wells	Rocky Reach-to-Wells Conversion Rate
Summer Steelhead[2] Return Years (RY) 2013-2023	2,039	2,017	98.9%
Spring Chinook[3] RY 2013-2023	1,766	1,748	99.0%
Summer Chinook[4] RY 2013-2023	1,397	1,363	97.6%
Sockeye[5] RY 2013-2023	658	647	98.3%
Coho Salmon[6] RY 2013-2023	2,480	2,341	94.4%

1 Calculated at Columbia Basin Research Columbia River DART (Data Access in Real Time) PIT Tag Adult Returns Conversion Rate (https://www.cbr.washington.edu/dart/query/pitadult_conrate) for each Plan Species as "Conversion Rate"; Conversion Reach "Rocky Reach to Wells"; Rear Type "All"; Release Location "Columbia River and Tributaries WEL and above (Columbia Upper)"; Month Range, Start "January," End "December"; Detections Upstream of Upper Project "Include"; Chinook Minijacks "Exclude"; Release Sites below Upper Project "Exclude"; Transported Fish "Include (in-river and transport)"; Set Summary Sort Order "Observation Year." Because the DART Conversion Rate query sometimes misses final detections for observation, recapture, and recovery events above and below the upper project, as well as detections in spawning locations downstream of Wells, "Complete Tag History" queries were run in PTAGIS (https://www.ptagis.org/) for each fish identified by DART as detected at Rocky Reach (PTAGIS site RRF) but not at Wells (PTAGIS site WEA). Of those fish, those with confirmed detections above WEA were included in the "Wells" column, and those with a confirmed final detection below WEA other than the RRF detection, were excluded from the "Rocky Reach" column. Additionally, confirmed juvenile detections at RRF were excluded from the calculations.

2 Includes summer steelhead released above Wells Dam at the following PTAGIS sites: ANTOIC, BEAV2C, CHERBT, CHEWUR, LBRIC, METH, METHR, METTRP, OKANR, OMAKC, SALMOC, SIMILP, SIMILR, STMARP, TWISPP, TWISPR, TWISPW, and WINT.

3 Includes spring Chinook salmon released at the following PTAGIS sites: 1890SC, BIDDLP, CHEWUP, CHEWUR, CHJO, GOATWP, MDVAP, METH, METHR, METTRP, RIVERP, SPRNGC, TWISPP, TWISPR, WINT, WINTBC, and WOLFC.

4 Includes summer Chinook salmon released above Wells Dam at the following PTAGIS sites: CARP, CHJO, COLR8, MCITAL, OMAKP, and SIMILR.

5 Includes Sockeye Salmon originating from the Canadian Okanagan Basin released from the following PTAGIS sites: OKANR, OSOYBR, OSOYHA, OSOYOL, SKA, SKAHAL, SKATAL.

6 Includes Coho Salmon released above Wells Dam at the following PTAGIS sites: 1890SC, BIDDLP, CHEWUP, EARLWP, EIGHTP, GOLD2C, MDVAP, METHR, SPRNGC, TWIS2P, TWISPR, WINT, WINTBC

For those populations of fish represented by the PIT tags, conversion rates of PIT-tagged fish provide a surrogate survival estimate. While conversion rates do encompass mortalities from all sources and include non-detected fish (as described above), adult conversion rates as a substitute for adult project survival do not entirely meet the intent of the adult survival metric: As stated in

section 13.3 of the Wells HCP, "Combined Adult and Juvenile Project Survival' means that 91% of each Plan Species [survives] Project effects when migrating through the Project's reservoir, Forebay, Dam and Tailrace including direct, indirect, and delayed mortality whenever it may occur and can be measured (as it relates to the Project) given available mark recapture technology". The variable and relatively low detection probability of PIT-tag-detection systems upstream of Wells Dam precludes calculation of adult conversion rates that include both Wells Dam and reservoir. Therefore, the rates reported in Table 1 do not include any direct, indirect, or delayed mortality (regardless of cause) that might occur upstream of Wells Dam (the redetection site). However, Douglas PUD has no reason to expect that the Project-related conditions facing adult fish in the Wells Reservoir would differ substantially from those experienced in the Rocky Reach Reservoir, which is included in the reported conversion rates. As noted above, conversion rates reflect a combination of mortality attributable to both non-project related causes (e.g., recreational harvest, predation, and disease) and dam passage, as well as non-detections resulting from straying and spawning below Wells Dam, but do not include estimates of delayed, or indirect mortally, or survival rates of fish from downriver populations which overshoot their natal stream and must fall back to return. Additionally, though the 2013-2023 conversion rate for summer Chinook Salmon was four-tenths of a percent less than 98 percent (97.6%), a reasonable assumption was that losses from the popular fishery below Wells Dam affected that rate. Indeed, applying WDFW's reported annual harvest rates for River Section 543 (Rocky Reach to Wells) to the PIT-tagged summer Chinook Salmon annually detected at Rocky Reach Dam for this conversion-rate analysis readily accounts for nearly all missing fish. Nevertheless, the Wells HCP states that "given the present inability to differentiate between the sources of adult mortality, initial compliance with the Combined Adult and Juvenile Survival standard will be based upon the measurement of juvenile survival…." Thus, Douglas PUD's current Phase Designation for each Plan Species was established based upon the juvenile survival standards.

Finally, though volitional passage of Wells Dam by adult fish originating below Wells Dam demonstrates the effectiveness of adult-passage facilities at successfully passing upstream migrants, such events constitute "overshooting," an unpredictable behavior confounding estimation of passage success rates. Involuntary and voluntary fallback of adult migrants sometimes occurs following successful passage of Wells Dam, and is not encompassed within the Rocky Reach-to-Wells conversion rates. This conversion rate does not account for downstream passage or associated survival rates. Discussions concerning overshoot steelhead (both out-of-basin and UCR DPS') have occurred in the Wells HCP Coordinating Committee over the last two years but consensus on the magnitude of the problem, application and interpretation of the HCP, and subsequent resolution, has not been reached.

Section 4.4 of the Passage Survival Plan requires Douglas PUD to operate the ladders, turbines, and spillways at Wells Dam under criteria determined to be best suited for the passage of adult plan species, to conduct adult passage studies, address any identified sources of delay within the fishways, to identify rates of fallback, and implement corrective measures to reduce rates of fallback if necessary. In December 2004, Douglas PUD provided the Wells HCP Coordinating Committee with a summary of all the adult passage studies conducted at Wells Dam. In February 2005, Douglas PUD provided the Wells HCP Coordinating Committee with an evaluation of the fallback rates for all the adult fish passage studies conducted at Wells Dam. These studies included multiple years of telemetry monitoring for adult spring and summer/fall Chinook Salmon, Sockeye

Salmon, steelhead, and Coho Salmon. The studies documented the rate of passage through the tailrace, fishways, and reservoir above Wells Dam, and documented the fish-passage efficiency under various fishway entrance configurations and the impact of broodstock collection on rates of fish passage. The studies also demonstrated the rate of fallback for Sockeye Salmon; steelhead; and spring, summer, and fall Chinook Salmon (Table 2).

Table 2. Summary of results from radio-telemetry studies used to estimate fallback rates for Wells HCP Permit Species. Total numbers of fish that fell back over Wells Dam are categorized based on observed final detections, where applicable. Fates of "unknown" Chinook Salmon and Sockeye Salmon could not be determined from the studies as designed or implemented; thus, the numbers in the other categories of fallback are minimum estimates, as evidenced from the steelhead studies that determined fates for all fish.

Species	Number Passing Wells	Number in each Fallback Category			
		Voluntary[5]	Involuntary[6]	Re-ascend[7]	Unknown[8]
Sockeye[1]	298	1 (<1%)	0	13 (4%)	3 (1%)
Steelhead[2]	414	23 (6%)	4 (1%)	14 (3%)	0
Spring Chinook	56	2 (4%)	0	0	0
Summer Chinook[3]	157	9 (6%)	0	8 (5%)	6 (4%)
Fall Chinook[4]	52	3 (6%)	0	1 (2%)	6 (12%)

1. Combined results from 1992 and 1997 studies.
2. Combined results from 1999 and 2001 studies.
3. Combined results from 1993 and 1997 studies.
4. The 6 "unknown" fish remained in the tailrace where substantial numbers of spawners have been observed. An additional fish fell back and was harvested in the tailrace; thus, we categorized it as an "unknown."
5. "Voluntary fallback" = detected entering a downstream tributary (or spawning location) or Wells Hatchery, or was otherwise collected for broodstock.
6. "Involuntary fallback" = not detected spawning downstream, nor entering Wells Hatchery, nor collected for brood stock, nor re-ascending the dam, or a fish whose life history is not conducive to utilizing the mainstem Columbia River for spawning (i.e., only summer/fall Chinook have been observed spawning in the tailraces of Columbia River dams).
7. "Re-ascend" = fish has either been detected exiting the ladder or otherwise observed upstream of Wells Dam.
8. "Unknown" = final fate not determined after fallback event during 1992-1998 studies when the detection array and/or monitoring efforts were insufficient to determine the final fate of fish that fell back.

In February 2005, the Wells HCP Coordinating Committee approved the adult passage study summary and the fallback-rate documents when it designated the Wells Project as successfully achieving the Phase III Phase Designation for spring and summer/fall Chinook Salmon, steelhead, and Sockeye Salmon at the Wells Project. Douglas PUD did not conduct any passage studies for adult Plan Species between 2013 and 2023, because they made no structural or operational modifications to Wells Dam during that time interval such as would warrant additional studies.

2.3 Juvenile Survival

As described above, the Passage Survival Plan included in the Wells HCP is structured with a Phased Implementation Plan with three phases (Wells HCP Section 4.2). Phase I of the Wells HCP (1998 through 2002) required the implementation of juvenile and adult operating plans and criteria toward meeting the survival standards, and the implementation of the studies necessary for determining compliance with those standards.

During Phase I of the Wells HCP, Douglas PUD conducted three years of valid Juvenile Project Survival Studies with steelhead and yearling Chinook Salmon migrating from the mouth of the Methow River. Results from those studies consistently exceeded the 93 percent Juvenile Project Survival standard, the precision and accuracy requirements of the Wells HCP, and were determined to reflect Representative Environmental Conditions and Representative Operating Conditions at the Wells Project. The average Juvenile Project Survival for yearling Chinook and steelhead over the three years of study was 96.2 percent. The results from the Phase I Juvenile Project Survival studies provided the necessary information for the Wells HCP Coordinating Committee to designate the Wells Project as in Phase III (Standard Achieved) for yearling Chinook Salmon and steelhead.

The Wells HCP Passage Survival Plan requires periodic monitoring of the survival rates of Plan Species designated as in Phase III (Standard Achieved), to ensure the maintenance of those survival rates throughout the term of the Wells HCP. Douglas PUD must monitor survival rates by conducting at least one year of survival verification studies every 10 years following the initial achievement of the Phase III (Standard Achieved) designation. The results from the one-year survival verification study must be included in the pertinent average for the subject Plan Species. If the survival standard is verified, Douglas PUD remains in Phase III. Otherwise, additional testing must occur, followed by Phase II (Interim or Additional Tools) if the standard cannot be achieved within three years of reevaluation (Wells HCP section 4.2). Finally, the Wells HCP (Section 4.2.1) stipulates that future studies, including verification studies, would include releases representing migrants originating from the Okanogan River.

In 2010 and 2020 Douglas PUD implemented Survival Verification Studies (SVS) designed to estimate the pooled survival of yearling Chinook Salmon migrating from the mouths of the Okanogan and Methow rivers, through the reservoir, dam, and tailrace of the Wells Project, and to consider direct, indirect, and delayed mortality wherever it may occur and can be measured (as it relates to the Project) given available mark-recapture technology (Figure 2).

2.3.1 2010 Survival Verification Study

Prior to approving the first survival verification study scheduled for spring 2010, the Wells HCP Coordinating Committee evaluated the available smolt-trap and hatchery-release data to determine that the proportional rate of contribution for yearling Chinook Salmon and steelhead from the Okanogan and Methow rivers was 25 percent and 75 percent, respectively, over the previous decade. With this information, the Wells Coordinating Committee approved a study design that included 15 replicated releases of treatment study fish at a ratio of three Methow fish to one Okanogan fish that, combined, matched the total number of control fish released into the Wells Dam tailrace for each of the 15 replicates. The Wells HCP Coordinating Committee selected hatchery-origin yearling summer Chinook Salmon as the study fish to represent yearling Chinook Salmon and steelhead, because summer Chinook Salmon were readily available at Wells Hatchery, were not ESA listed as were spring Chinook Salmon and steelhead, and releasing them above Wells Dam did not pose the same management challenges as would releases of spring Chinook Salmon or steelhead.

Figure 2. Tanks of study fish on a barge being towed into position to begin the tailrace release for the 8th replicate of the 2020 Survival Verification Study on April 28, 2020.

The results of the 2010 SVS confirmed that the Wells Project continued to achieve a high rate of survival for yearling spring-migrating Chinook Salmon. The point estimate of Juvenile Project Survival for the 2010 SVS was 96.4 percent (Bickford et al. 2011). The 4-year-average estimate of Juvenile Project Survival used to determine the NNI hatchery compensation levels of yearling spring migrants increased as a result of this study. The 3-year-average mitigation goal was 3.8 percent based upon the 3-year-average survival of 96.2 percent (Bickford et al. 2001). The 4-year-average survival used for determining the NNI calculation moved to 96.3 percent following the 2010 SVS, with an associated hatchery compensation goal of 3.7 percent for yearling Chinook Salmon and steelhead per Section 8.4.4 of the Wells HCP and as approved by the Wells HCP Coordinating Committee in a Statement of Agreement (SOA) on November 16, 2010.

2.3.2 2020 Survival Verification Study

Leading up to the 2020 SVS, the Wells HCP Coordinating Committee selected yearling summer Chinook Salmon for the 2020 study to represent spring-migrating Plan Species currently in Phase III (Standard Achieved). The primary goal of the 2020 SVS was to precisely estimate the Juvenile Project Survival of PIT-tagged yearling Chinook Salmon migrating through the Wells Project, as was accomplished in 2010. Similar to the 2010 SVS, fish were released at three locations: above

Wells Dam at the mouths of the Okanogan (Rkm 870) and Methow (Rkm 843) rivers, and below Wells Dam into the tailrace (Rkm 829.6); however, a larger share of the fish were released at the mouth of the Okanogan 33.3 percent instead of the 25-percent share in 2010. Chinook released at the mouths of the Okanogan and Methow rivers were pooled into one "treatment" release group for statistical analyses, with release numbers mimicking the proportional contribution of the two rivers to the overall spring migration of yearling Chinook and Coho salmon and steelhead passing through the Wells Project in the previous decade.

Nearly 106,000 PIT-tagged Chinook Salmon were released during the 2020 SVS. Fish were released during the months of April and May with release timing closely matching the run of spring migrating Plan Species through the Wells Project. Fish were released during sixteen replicate releases at each of the three specified release locations for a total of 48 releases. Each replicate release group at each of the three release sites was provided nearly identical rearing, collection, tagging, recovery, interrogations, and transportation exposures, to prevent unnecessary covariates in experimental methods and analyses.

Passive interrogation of study fish occurred at the PIT-tag detection systems installed at Rocky Reach, McNary, John Day, and Bonneville dams. Additional study fish were detected below Bonneville Dam by the National Oceanic and Atmospheric Administration (NOAA) PIT-tag barge. Fish detected at the barge were pooled with detections at Bonneville Dam for statistical purposes.

Survival through the Wells Project (reservoir, forebay, dam, and tailrace) in 2020 was estimated based upon the relative survival of treatment (Okanogan and Methow) and control (tailrace) release groups. The weighted average survival from the 2020 SVS was 95.17 percent (SE 0.0142) (Gingerich et al. 2020). As summarized above and prior to the 2020 SVS, the historical juvenile project survival estimates were 99.7 percent (0.015), 94.3 percent (0.016), 94.6 percent (0.015), and 96.4 percent (0.013) for years 1998, 1999, 2000, and 2010, respectively. The historical arithmetic average was 96.25 percent. A *Z*-test of the difference between the historical average (1998–2000, 2010) and the 2020 survival estimate was not significantly different and as such, including the 2020 SVS data, the new five-year average estimate of Wells Project passage survival was 96.04 percent (0.0098). The Wells HCP Coordinating Committee approved the 2020 SVS by SOA on December 15, 2020.

The results of the 2020 SVS confirmed that the Wells Project continued to achieve a high rate of Juvenile Project Survival. The resultant new NNI hatchery compensation rate became 3.96-percent for NNI hatchery compensation production, applying to all Plan Species in Phase III (Standard Achieved), including yearling Chinook and Coho salmon, and steelhead. This 3.96-percent compensation value was used by the Wells HCP Hatchery Committee in the recalculation of hatchery-production obligations in 2022.

2.3.3 Methow River Coho Salmon

Coho Salmon were extirpated from the upper Columbia Basin early in the 20th Century, and therefore, were not included in the Wells HCP as a Permit Species. However, at the signing of the Wells HCP, Coho Salmon in the Wenatchee and Methow basins were the subject of a reintroduction feasibility study by the YN, and thus the Wells HCP included Methow River Coho

Salmon as a Plan Species. Actions by the Wells HCP Coordinating and Hatchery committees in 2006 and 2007 culminated in the designation of Methow River Coho Salmon as in Phase III (Additional Juvenile Studies). At that time, limited broodstock availability and other considerations rendered Coho Salmon survival studies impractical, and the 2008 Coho Mitigation Agreement between the YN and Douglas PUD deferred survival studies through 2017. In 2014, Douglas PUD and the YN began discussing a new agreement for Coho Salmon mitigation for implementation in 2018. Development of a new agreement necessitated the establishment of an NNI hatchery compensation rate. The rate established for Coho Salmon in the Wells HCP, Section 8.4.5.1, was based on the estimated Juvenile Project Survival of yearling spring migrants that had been documented prior to the signing of the Wells HCP and was subsequently modified with the inclusion of the results from the 2010 Wells Project SVS. In 2015, to determine whether this assumption of similar survival rates among Coho Salmon and other spring migrants was valid, Drs. John Skalski and Richard Townsend (University of Washington, Columbia Basin Research) analyzed hydrosystem survival of juvenile spring Chinook Salmon, Coho Salmon, and steelhead from Winthrop National Fish Hatchery (WNFH) over multiple migration years. The analysis found that, in general, spring Chinook Salmon survival exceeded Coho Salmon survival; however, when compared to steelhead, Coho Salmon survival was higher in three out of five years and significantly higher in one out of five years (Skalski and Townsend 2015). Therefore, on October 27, 2015 the Wells HCP Coordinating Committee approved an SOA designating Coho Salmon as a Plan Species meeting the Phase III (Standard Achieved) Phase Designation for passage at Wells Dam, based on those findings of survival similar to other yearling spring migrants studied (intermediate between yearling Chinook Salmon and steelhead).

2.3.4 Sockeye Salmon

When the Wells HCP was signed in 2002 the Parties agreed that the measurement of Juvenile Project or Dam Passage Survival at the Wells Project for subyearling Chinook and Sockeye salmon was not then possible. Limitations to conducting survival studies for sockeye included inadequacies in tag technology, challenges to obtaining an adequate sample size, lack of facilities for in-river fish collection, and concerns over tag effects. Because of these limitations, the Parties accepted a Calculated Juvenile Dam Passage Survival estimate of greater than 95 percent for Sockeye Salmon based upon studies of bypass efficiency (95.3% for Sockeye Salmon) and balloon-tag studies that documented no measurable injuries or mortality for fish passing Wells Dam via the Wells Bypass System.

2.3.5 Subyearling Chinook Salmon

The same limitations that precluded studies of Sockeye Salmon also apply to studies involving subyearling Chinook Salmon, with the additional impediment that they failed several assumptions of the paired-release survival-study model because of their complicated life history, protracted migration, and smaller body size. As with Sockeye Salmon, the Parties also accepted a Calculated Juvenile Dam Passage Survival estimate of greater than 95 percent for subyearling Chinook Salmon, based upon studies of bypass efficiency (96.2% for subyearling Chinook Salmon) and balloon-tag studies that documented no measurable injuries or mortality for fish passing Wells Dam via the Wells Bypass System. At the conclusion of Phase I in February 2005, the Wells HCP Coordinating Committee formalized the acceptance of those Calculated Dam Passage Survival estimates and designated the Wells Project as in Phase III (Additional Juvenile Studies) for

Sockeye Salmon and subyearling Chinook Salmon. Table 3 summarizes current Wells Project phase designations for all Plan Species.

Table 3. Phase designations for the Wells Project

Plan Species	Phase Designation	Date
UCR Steelhead	Phase III (Standard Achieved)	February 22, 2005[1]; verified November 16, 2010,[2] and December 15, 2020[3]
UCR Yearling Chinook Salmon	Phase III (Standard Achieved)	February 22, 2005[1]; verified November 16, 2010,[2] and December 15, 2020[3]
UCR Subyearling Summer/Fall Chinook Salmon	Phase III (Additional Juvenile Studies)	February 22, 2005[1]
Okanogan River Sockeye Salmon	Phase III (Additional Juvenile Studies)	February 22, 2005[1]
Methow River Coho Salmon	Phase III (Standard Achieved)	October 27, 2015,[4] and December 15, 2020[3]

Notes:

1. Approved in an SOA on February 22, 2005, by the Wells HCP Coordinating Committee and based upon the Wells HCP Survival Standard Decision Matrix per Section 4.1.2 of the Wells HCP.
2. Verified in an SOA on November 16, 2010, by the Wells HCP Coordinating Committee. Verification study included Okanogan Basin yearling Chinook Salmon per Sections 4.2.1 and 8.4.5.2 of the Wells HCP.
3. Verified in an SOA on December 15, 2020, by the Wells HCP Coordinating Committee.
4. Approved in an SOA on October 27, 2015, by the Wells HCP Coordinating Committee.

As specified in the Wells HCP, the HCP Coordinating Committee continues to monitor developments in survival-study technology for emerging opportunities to measure Juvenile Project Survival for Sockeye and subyearling Chinook salmon. Improvements in both tag and detection technology led the combined HCP Coordinating Committees (the Coordinating Committees for the Wells, Rocky Reach, Rock Island HCPs that meet collectively) to convene a "Subyearling Workshop" in November 2009 to determine whether limitations identified during Wells HCP development continued to represent valid impediments to study implementation. The Subyearling Workshop convened experts from the NMFS and USFWS to provide to the HCP Coordinating Committees presentations on the state of the science for subyearling Chinook Salmon life-history variation and behavior, survival-study experimental design and model assumptions, tag technology and study logistics, and tagging and tag effects. Grant PUD also presented on the lessons learned from their pilot studies on subyearling Chinook Salmon, and Douglas and Chelan PUDs presented on the current, limited understanding of the life-history variations exhibited by mid-Columbia subyearling Chinook Salmon. Following the Subyearling Workshop, the HCP Coordinating Committees concluded that active-tag technology remained unsuitable for studies of subyearling Chinook Salmon and that the complicated life-history expression in the regional subyearling Chinook Salmon population precluded survival studies because of the violation of several assumptions of survival-study models. The Coordinating Committees directed the PUDs to continue pursuing measures for evaluating passage-survival rates of subyearling Chinook Salmon, including obtaining data to inform understanding of the behavior and life history of subyearling Chinook Salmon in the mid-Columbia.

To more precisely address the limitations discussed at the 2009 Subyearling Workshop, Douglas PUD voluntarily initiated a pilot effort of a multi-year life-history study of subyearling Chinook Salmon in the spring of 2011. Following the success of the pilot effort, Douglas PUD expanded the study in 2012 and 2013 (Figure 3). The intent of the study was to describe the behavior, distribution, size, and life-history strategies of subyearling Chinook Salmon in the Wells Reservoir, with the specific objectives of comparing observed behaviors with survival-study assumptions. From these studies, Douglas PUD worked to identify the extent to which subyearling Chinook Salmon conform to each of the assumptions of the survival-study models, and to determine whether adaptation of technical or statistical methods could provide acceptable study approaches for measuring either Project or Dam Passage Survival.

Figure 3. Douglas PUD crews beach-seining in 2013 at "Gebber's Landing," a highly productive collection location upstream of Brewster, WA, identified in the 2011 pilot effort, during the 2011-2013 study of the behavior and life-history variation of subyearling Chinook Salmon in the Wells Reservoir.

Study results indicated that subyearling Chinook Salmon in the Wells Project were available in high numbers in late-April and May but few were large enough to tag with a standard 12-mm PIT tag until late-May when they reached 60 mm FL. Not until mid-June did the average length of fish captured with beach seines reach 60 mm, and not until mid-July did the length for all fish captured equal or exceed 60 mm. Travel times for tagged fish from release to Rocky Reach Dam (PTAGIS

site code RRJ) ranged widely from 2 days to over 65 days, with most fish falling into two general migration strategies: fish of the entire size distribution that migrated to RRJ within 20 days; and fish comprising individuals that fell into the smaller two-thirds of the size distribution of tagged individuals with travel times to RRJ exceeding 20 days (up to 66 days). In addition, tagged fish were often recaptured days or weeks later in similar or upstream locations suggesting many of the study fish were using the reservoir for rearing and foraging rather than migrating through the Wells Project. Finally, as fish increased in size, their availability to beach seining diminished as they apparently shifted to offshore foraging.

Study conclusions were that the tag technology then available was incapable of tagging a representative sample of individuals from the entire size distribution, and would not provide a long enough tag life to encompass the protracted migration that was observed in tagged fish. Larger fish that were observed in the reservoir appeared to be more offshore and more consistent with the size distribution of fish captured during fyke net collection that occurred in the 1980's at Wells Dam. As such, beach seining may not be an appropriate approach to capture, tag, and study a representative sample of available or migrating fish within the Wells Project.

Douglas PUD presented results of their study at the second Subyearling Workshop convened by the HCP Coordinating Committees and Priest Rapids Coordinating Committee (PRCC) in June 2016. Douglas PUD also presented a comparison of the historical data from fyke-netting at Wells Dam with the beach seining data from 2011-2014, showing that, historically, subyearling Chinook Salmon passed Wells Dam from mid-April through late-August, and that the size distributions of fyke-netted individuals included a greater size range than those captured by beach seining. Beach seining substantially under-represented the largest individuals. Other presentations at the 2016 workshop described advances in active-tag technology, updates on subyearling Chinook Salmon life history from the Entiat and Snake rivers, and the analytical challenges to studying a population with complex migratory behavior. Conclusions from the 2016 workshop include, 1) current tag technology available in 2016 did not allow the tagging of a representative sample of the population using the reservoir because the fish are either too small or do not migrate within the life of the battery; 2) available capture methods cannot obtain a representative sample of the size distribution present because of shifting migratory and/or foraging behavior with increasing size; 3) fish length was not a reliable predictor of migratory behavior; 4) variability in migratory behavior leads to multiple violations of study-model assumptions; 5) no analytical solutions can overcome the inability to distinguish between mortality and protracted residency.

On June 11, 2024, the HCP Coordinating Committees and PRCC convened the third Subyearling Workshop. Douglas PUD again presented findings from the 2011-2013 subyearling Chinook Salmon study extended by analysis of data through 2023 from continued annual beach seining and PIT-tagging efforts by the CTCR at locations originally sampled by Douglas PUD. Combined, these efforts provided 13 years of data on natural-origin subyearling Chinook Salmon PIT-tagged in the Wells Reservoir, with over 200,000 tagged individuals. Analysis of the 13-year dataset confirmed findings from Douglas PUDs original study, but also provided thousands of recaptured individuals to improve insights into growth and residency, and to bolster findings regarding adult returns. In-reservoir and downstream recaptures indicate that fish grow rapidly, such that the anticipated average length at the time of Wells or Rocky Reach dam passage of those fish with protracted reservoir residency is nearly 20 mm longer than the average length at tagging, and

exceeds the length of most individuals readily available to beach-seine capture. Additional data on adult returns corroborates the original finding that larger individuals (at tagging) are more likely to survive to adult return. Finally, differences in the representation on the spawning grounds of PIT-tagged and non-PIT-tagged individuals from a brood year indicate that the PIT tagging effort is poorly representing the run at-large and/or the process of tagging or the experience of carrying a PIT tag results in decreased survival relative to untagged individuals.

Other presentations at the 2024 Subyearling Workshop included findings from Chelan PUD's studies of subyearling behavior within the Rock Island Project; migratory behavior of PIT-tagged summer Chinook Salmon from the Entiat and Methow rivers; size and emigration timing of captured summer Chinook Salmon from the Methow, Entiat, and Wenatchee rivers; current and future tag technology and tag effects; available survival-study models and their suitability for studies of subyearling Chinook Salmon; and novel modeling approaches incorporating both temporal and spatial mark-recapture data. Despite promising advances in tag technology, tagging a representative sample of the population remains impossible because of the size distribution of the population above Wells Dam and their availability to practical capture methods. Additionally, complex fish behavior prevents traditional study approaches because of multiple violations of model assumptions. No available analytical methods can rectify our inability to distinguish a fish that failed to migrate during the study period from a fish that died.

The HCP Coordinating Committees discussed the information presented at the 2024 Subyearling Workshop at their June 25, 2024 meeting at Wells Dam, identifying the need for continued and regular discussions to process multiple unresolved questions and to discuss the path forward towards implementing a subyearling Chinook survival study. Primary questions for continued discussion include: 1) representative sampling, both in space and time, which is a function of fish availability given practical collection methods/locations and fish sizes present during the course of a representative study; 2) fish behavior while within the respective projects, which affects study timing, duration, and methods; 3) tag technologies and the intersection of those technologies with the representative-sampling and fish-behavior questions described above; 4) HCP requirements and specified approaches and how to meet those or whether to accept alternate approaches and requirements for subyearling Chinook Salmon; and 5) analytical limitations and advances, and whether alternate models and/or study designs could resolve current limitations and provide estimates necessary for a determination of mitigation obligation. Douglas PUD's ultimate goal is to achieve Phase III (Standard Achieved) for subyearling Chinook Salmon. Therefore, any future study designs must produce a viable estimate of Measured Juvenile Project Survival that the Wells HCP Coordinating Committee will approve. The HCP Coordinating Committee continues to discuss both the need for additional studies and how to measure project survival following the 2024 subyearling workshop.

3.0 TRIBUTARY CONSERVATION PLAN

The Wells HCP established a Tributary Conservation Plan (Section 7) as a component of NNI compensation. The Tributary Conservation Plan was intended to provide up to two percent of the combined unavoidable project mortality (assumed 9% combined total) by funding actions to benefit the freshwater habitat of Plan Species above Wells Dam.

3.1 Wells Plan Species Account

The Wells HCP specifies that Douglas PUD's funding of a Plan Species Account would fully and completely compensate for adult mortality (assumed 2%) associated with the Wells Project. The Wells HCP describes the purpose of the Plan Species Account as to fund projects for the protection and restoration of Plan Species in the Columbia River and tributaries upstream of Wells Dam. Douglas PUD established the Wells Plan Species Account in September 2004 with an initial five-year lump-sum contribution of $2,272,740, as specified in the Wells HCP. Following the first five years, Douglas PUD began annual contributions of $176,178 (in 1998 dollars adjusted annually for inflation) in January 2010, with the most recent annual contribution of $358,876 in January 2024. Annual payments will continue for the duration of the Wells HCP, but payment amounts will be adjusted per Section 7.4.3 of the Wells HCP if Douglas PUD measures an adult survival rate greater than 98 percent and a juvenile survival rate greater than 93 percent.

The Wells HCP established a Tributary Committee tasked primarily with selecting habitat restoration and protection projects for funding via the Wells Plan Species Account. The Wells HCP Tributary Committee accepts project proposals from regional project sponsors at any time, and annually in coordination with the annual funding cycle of the Washington State Salmon Recovery Funding Board (SRFB). Project sponsors often use the Plan Species Account as matching funds for projects funded by the SRFB or other sources. The Wells HCP Tributary Committee meets concurrently with the Rocky Reach and Rock Island HCPs Tributary Committees to facilitate coordinated project reviews and maximize funding potential. For the same reasons, these committees also hold joint meetings with the Priest Rapids Coordinating Committee-Habitat Subcommittee when shared agenda items require coordination.

Project approval by the Tributary Committees requires unanimous consent by the representatives of all HCP Parties present for the vote. Criteria for making funding decisions are outlined in Section 5 of the HCP Tributary Committees Policies and Procedures document. In general, these policies include evaluation of projects based on the project scoring criteria used by the Upper Columbia Regional Technical Team (RTT) for review of SRFB projects. However, unlike the RTT, which focuses primarily on the biological benefit of projects under evaluation and only considers cost-effectiveness as a minor component of evaluation, the Tributary Committees consider project cost-effectiveness as a major component of project evaluation. In addition to approved project-funding policies, in 2019 at the request of the Tributary Committees and Coordinating Committees, the HCP Policy Committees provided the following guidance specific to the HCP Tributary Committees:

- HCP Tributary Committees will base funding decisions on technical merit, biological benefit, durability, feasibility, and cost effectiveness (using the specific evaluation criteria in Section 5 of the Policies and Procedures document) and will notify respective HCP Coordinating and Policy Committees' representatives of any potential policy issues needing to be addressed in those forums.
- Representatives of the HCP Tributary Committees should consider abstention in lieu of disapproval to preserve respective policy positions.

3.2 Projects Funded by the Wells Plans Species Account

Since the first annual funding round in 2005, Douglas PUD's Wells HCP Tributary Committee has awarded over $6.6 million from the Wells Plan Species Account to either support or fund entirely 60 projects with total cost exceeding $30 million (Table 4). Actual expenditures on projects to date total over $5 million, differing from the total allocated due to cost savings by project sponsors during implementation; project cancellation; and projects newly awarded funding, delayed for technical reasons, or still in progress. Administrative costs since September of 2004 have totaled $106,472, or approximately 2 percent of total expenditures.

Projects funded by the Wells HCP Tributary Committee include habitat assessments, channel restoration, restoring fish passage, improving instream flows, creating or restoring access to off-channel habitat, protecting high-quality or restorable habitat, and riparian plantings and fencing (Figures 4 through 6). Initial emphasis by the Wells HCP Tributary Committee on funding habitat-protection projects in the Methow Subbasin shifted toward restoration projects as property prices increased and the Tributary Committee encountered limitations on restoration actions and public access on parcels protected by the Tributary Committee via conservation easement. More recent funding decisions have included protection projects that facilitated desired restoration actions, and fee-title purchases rather than conservation easements.

Table 4. Projects approved by the Wells HCP Tributary Committee for funding via the Wells Plan Species Account, 2005-2024

Year	Project Name	Project Sponsor	Project Type	Estimated Total Cost	Amount Allocated by TC	Amount Contributed (actual to date)	Year Complete
2005	05 Okanagan River Restoration – Phase III	Okanagan Nation Alliance	Instream Structures	$219,121	$219,121	$197,681	2007
2005	05 Methow Riparian Protection (Heath)	Methow Conservancy	Protection	$2,684,500	$1,177,500	$812,700	2006
2005	05 Methow Riparian Protection (Prentice)	Methow Conservancy	Protection			$1,749	2008
2005	05 Methow Riparian Protection (MacDonald)	Methow Conservancy	Protection			$345,400	2008
2007	07 Lower Beaver Creek Livestock Exclusion	Okanogan Conservation District	Riparian Habitat	$24,670	$18,559	$16,561	2008
2007	07 Heath Floodplain Restoration	Methow Salmon Recovery Found	Off-Channel Habitat	$48,695	$48,695	$43,915	2008
2007	07 Okanogan River Restoration – Phase IV	Okanagan Nation Alliance	Instream Structures	$1,022,000	$411,000	$411,000	2010
2008	08 Riparian Regeneration & Restoration Initiative	Methow Conservancy	Riparian Habitat	$22,737	$15,537	$15,537	2010
2008	08 Fort Thurlow Pump Project	Methow Salmon Recovery Found	Instream Flows	$48,150	$7,000	$7,009	2008
2008	08 Goodman Livestock Exclusion Project	Okanogan Conservation District	Riparian Habitat	$8,080	$7,980	$6,829	2008
2008	08 Poorman Creek Barrier Removal	Methow Salmon Recovery Found	Fish Passage	$191,579	$53,748	$53,748	2009
2008	08 Twisp River Riparian Protection (Pampanin)	Methow Conservancy	Protection	$119,720	$48,649	$48,649	2010
2008	08 Twisp River Riparian Protection (Neighbor)	Methow Conservancy	Protection	$260,000	$55,000	$55,000	2009
2008	08 Twisp River Riparian Protection (Speir)	Methow Conservancy	Protection	$79,976	$23,993	$23,993	2009
2010	10 Prevent Fish Entrainment on Inkaneep Cr.	Okanagan Nation Alliance	Instream Flows	$24,000	$0	$0	Cancelled
2010	11 Methow River Acquisition MR 39.5 (Hoffman)	Methow Salmon Recovery Found	Protection	$195,048	$74,415	$74,415	2012

Year	Project Name	Project Sponsor	Project Type	Estimated Total Cost	Amount Allocated by TC	Amount Contributed (actual to date)	Year Complete
2010	11 Methow River Acquisition MR 48.7 (Bird)	Methow Salmon Recovery Found	Protection	$292,140	$111,680	$109,786	2013
2010	11 Methow River Acquisition MR 41.5 (Risley)	Methow Salmon Recovery Found	Protection	$148,210	$31,854	$26,518	2012
2011	12 Twisp River Acquisition 2011 (Hovee)	Methow Salmon Recovery Found	Protection	$140,700	$29,000	$1,074	Cancelled
2011	12 Silver Protection	WA Dept. of Fish & Wildlife	Protection	$660,000	$250,000	$0	Cancelled
2012	12 Twisp River Well Conversion	Trout Unlimited	Instream Flows	$87,739	$68,023	$68,023	2013
2012	13 Twisp River Poorman Cr. Wetland Acquisition	Methow Salmon Recovery Found	Protection	$423,000	$63,450	$338	Cancelled
2012	13 Fish Passage at Shingle Creek Dam	Okanagan Nation Alliance	Fish Passage	$180,950	$59,225	$59,224	2014
2012	13 Upper Beaver Habitat Improvement Channel Restoration	Methow Salmon Recovery Found	Channel Restoration	$674,600	$102,613	$68,982	2015
2012	13 Lower Chewuch Beaver Restoration	Methow Conservancy	Off-Channel Habitat	$247,985	$27,000	$27,000	2013
2013	13 Methow/Chewuch Groundwater Monitoring	Cascade Columbia Fisheries Enhancement	Instream Flows	$34,180	$30,580	$29,962	2014
2013	13 MVID Instream Flow Improvement Project	Trout Unlimited	Instream Flows	$9,747,000	$400,000	$395,679	2017
2014	14 Remove Collapsed Bridge from Shingle Cr.	Okanagan Nation Alliance	Channel Restoration	$8,193	$6,693	$6,689	2014
2014	15 Methow Watershed Beaver Reintroduction	Methow Salmon Recovery Found	Channel Restoration	$216,000	$33,500	$33,500	2017
2015	15 M2 Sugar Acquisition	Methow Salmon Recovery Found	Protection	$119,652	$15,185	$15,185	2016
2015	17 M2 Right Sugar Acquisition	Methow Salmon Recovery Found	Protection	$291,268	$43,690	$43,690	2018
2016	16 Silver Side Channel Acquisition	Methow Salmon Recovery Found	Protection	$801,470	$236,406	$0	Cancelled

Year	Project Name	Project Sponsor	Project Type	Estimated Total Cost	Amount Allocated by TC	Amount Contributed (actual to date)	Year Complete
2017	17 M2 WDFW Flow Connection Project	Methow Salmon Recovery Found	Off-Channel Habitat	$78,828	$11,824	$0	Cancelled
2017	18 Methow Basin Barrier Diversion Assessment	Cascade Columbia Fisheries Enhancement	Fish Passage	$206,650	$40,000	$40,000	2019
2018	19 Twisp R. Floodplain Left Bank Spring-fed Alcove	Methow Salmon Recovery Found	Riparian Habitat	$41,822	$12,084	$12,084	2020
2018	18 Burns-Garrity Perennial Side Channel	CC Fisheries Enhancement Group	Off-Channel Habitat	$735,000	$316,000	$0	Cancelled
2019	19 Johnson Creek Habitat Restoration	Trout Unlimited	Fish Passage	$1,562,455	$267,547	$267,547	2024
2019	19 Sugar Levee Groundwater Evaluation	Methow Salmon Recovery Found	Assessment	$5,404	$2,940	$2,940	2020
2020	20 Sugar Reach Habitat Enhancement Early Implementation	Methow Salmon Recovery Found	Channel Restoration	$19,932	$15,621	$14,405	2021
2020	20 Enloe Dam Removal Concept Plan	Interfluve (on behalf of CCT)	Fish Passage	$464,075	$117,612	$104,933	2021
2020	20 Vandervort Appraisal	Methow Salmon Recovery Found	Channel Restoration	$9,250	$9,250	$432	2020
2020	20 Upper Beaver Cr Final Design & Restoration	Methow Salmon Recovery Found	Fish Passage	$395,342	$59,307	$57,585	2021
2020	20 Alder Creek Floodplain Restoration	Yakama Nation Fisheries	Channel Restoration	$691,700	$149,967	$149,967	2022
2020	21 Chewuch RM 4.2 Fish Enhancement	Yakama Nation Fisheries	Channel Restoration	$659,351	$137,866	$119,431	2021
2021	21 Methow Thermal Refugia Restoration Assessment	Methow Salmon Recovery Found	Assessment	$40,467	$40,467	$39,777	2022
2021	21 Methow 3R Floodplain Restoration Feasibility	Methow Salmon Recovery Found	Assessment	$59,238	$54,238	$53,798	2022
2021	21 Mission Wood Amendment	Cascade Fisheries	Instream Structures	$56,525	$41,525	$37,584	2023
2021	21 Eagle Rocks Groundwater Flow Productivity Test	Methow Salmon Recovery Found	Channel Restoration	$7,500	$4,500	$4,500	2021

Year	Project Name	Project Sponsor	Project Type	Estimated Total Cost	Amount Allocated by TC	Amount Contributed (actual to date)	Year Complete
2021	21 Twisp Horseshoe Habitat Enhancement	Yakama Nation Fisheries	Off-Channel Habitat	$441,970	$144,470	$144,470	2022
2021	21 Lower Little Bridge Creek Restoration	Yakama Nation Fisheries	Channel Restoration	$360,175	$122,500	$119,523	2022
2021	21 Mystery and War Creek Reach Aquatic Restoration	Yakama Nation Fisheries	Channel Restoration	$984,970	$288,000	$288,000	2022
2022	22 Salmon Creek Channel Realignment	City of Okanogan	Channel Restoration	$91,529	$60,579	$94,047	2023
2022	22 M2@3R Proposal to Advance Preferred Concepts	Methow Salmon Recovery Found	Instream Structures	$204,444	$184,444	$184,444	2024
2023	23 Twisp to Carlton Reach Side Channel	Cascade Fisheries	Assessment	$96,546	$62,816	$56,080	In Progress
2023	23 Chewuch Acquisition RM 2.8-3.1	Methow Salmon Recovery Found	Protection	$449,996	$69,045	$56,506	2024
2023	23 Goat Creek Fan Restoration Final Design	Cascade Fisheries	Channel Restoration	$100,186	$50,093	$25,541	In Progress
2024	24 Salmon Cr. Fish Screen Survey and Design	Okanogan Irrigation District	Fish Passage	$24,455	$24,455	$24,455	2024
2024	24 Larsen Road Culvert Removal/Bridge Installation	Okanagan Conservation District	Fish Passage	$353,766	$341,266	$162,508	In Progress
2024	24 Habitat Connectivity Improvement at Twisp Ponds	Methow Salmon Recovery Foundation	Instream Flows	$128,698	$19,949	$0	Newly awarded
2024	24 Okanagan Lake Dam East Salmon Passage	Okanagan Nation Alliance	Fish Passage	$3,598,252	$300,000	$0	Newly awarded
			Total	$30,889,889	$6,618,462	$5,060,394	

Figure 4. Three of the 35 helicopter-constructed large-wood structures installed by the YN in the upper Twisp River in 2022. The Mystery and War Creek Fish Habitat Restoration Project was one of three restoration projects completed by the YN in the Twisp Basin in 2022 that collectively installed 89 total large-wood structures comprising nearly 1,200 large-wood pieces over approximately five river miles. All three projects were partially funded by the Wells HCP Plan Species Account (photo from Inter-Fluve, Inc. 2022).

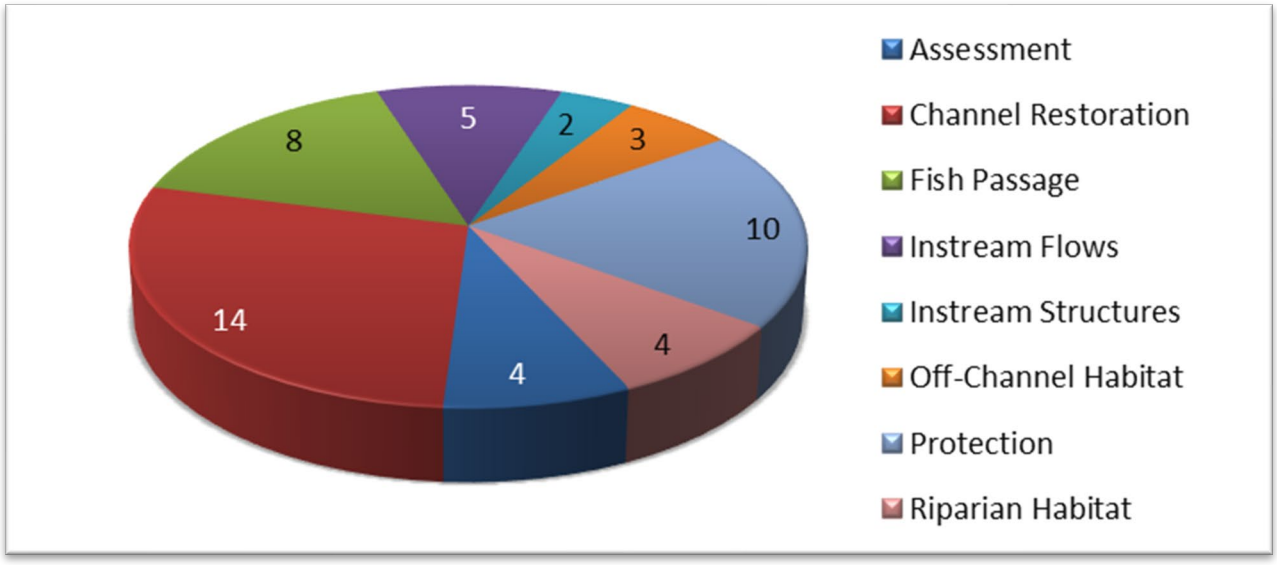

Figure 5. The number of projects funded by the Wells HCP Plan Species Account by project type (excludes cancelled projects).

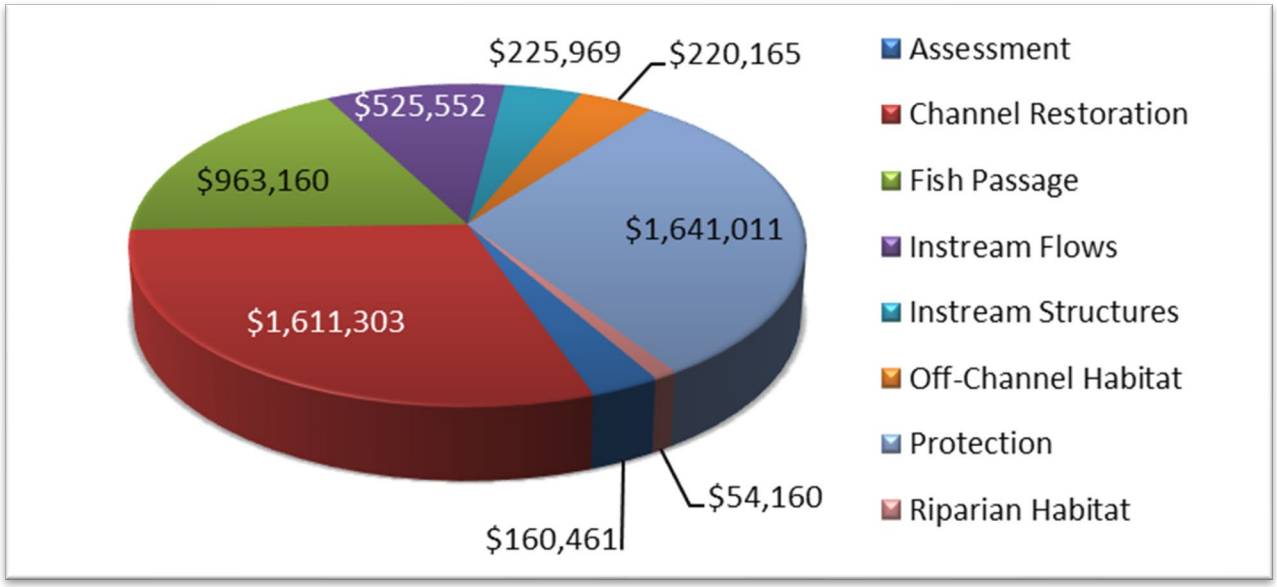

Figure 6. Wells HCP Plan Species Account expenditures by project type (excludes cancelled projects).

3.3 Tributary Assessment Program

In addition to establishing the Wells Plan Species Account, the Wells HCP also required Douglas PUD to separately fund a Tributary Assessment Program intended to evaluate the relative performance of projects funded by the initial contribution (a five-year lump sum) to the Wells HCP Plan Species Account. The Tributary Assessment Program committed Douglas PUD to invest up to $200,000 to monitor and evaluate relative project performance. The underlying concept behind

the Tributary Assessment Program was that because not all project types would yield the desired outcome or benefit species in a cost-effective manner, Douglas PUD should evaluate the relative merits of individual projects or suites of projects to inform the Wells HCP Tributary Committee in their selection of future habitat projects. The Rock Island and Rocky Reach HCPs also have identical requirements for Tributary Assessment Programs, with the collective monitoring commitments of the three HCPs totaling $600,000.

Beginning in 2008, the Wells HCP Tributary Committee elected to partially fund the monitoring of a multi-phased levee-setback project that they had funded on the Okanagan River in Canada. That monitoring by the Okanagan Nation Alliance (ONA) included pre-construction and post-construction monitoring of the first ONA Okanagan River Restoration Initiative (ORRI) project (Figure 7) that moved levees away from the channel and reconnected two relict oxbows on a channelized portion of the Okanagan River near Oliver, BC. Subsequently, the Wells HCP Tributary Committee funded two additional monitoring efforts by the ONA from the Tributary Assessment Program, including Phase II of the ORRI project in 2014, and the installation of a permanent PIT-tag interrogation system near the mouth of Shingle Creek in 2015 to monitor recolonization of the stream by steelhead and spring Chinook Salmon following removal of a diversion dam. The ONA completed their monitoring of the Phase II of the ORRI project in December 2018. Results of the monitoring indicated that the ORRI restoration effort succeeded in creating substrate and flow characteristics ideal for spawning Sockeye Salmon, and conditions for spawners have continued to improve as the river further adjusts within the set-back levees. Since completion of both phases of levee setback and reconnection with historical channel and floodplain features, the restored reach now supports a high percentage of spawners disproportionate to reach length, and in some years the highest density of spawners between Okanagan and Osoyoos lakes. Prior to project implementation, few spawners utilized the subject reach.

After funding the three monitoring projects described above, the Wells HCP Tributary Assessment Program had a remaining balance of just under $13,000, an amount too small to fund monitoring proposals considered by the Tributary Committees from 2019 through 2023. However, in early 2024, the Tributary Committees approved a monitoring project titled “Floodplain Restoration: Monitoring Fish Response at Site, Reach, and Population Scales.” This project is the second year of a three-year project by Hinchinbrook, Inc., the first year of which the Tributary Committees funded as a pilot investigation. The Tributary Committees directed Douglas and Chelan PUDs to apply the remaining balances of their respective Tributary Assessment Programs to funding this project, with the Rock Island HCP Plan Species Account covering the difference in the total project costs. With this funding, Hinchinbrook, Inc. has continued monitoring fish use of floodplain restoration projects and control sites in the Methow, Entiat, and Wenatchee subbasins, which will ultimately inform the Tributary Committees regarding appropriate designs for projects that activate floodplain habitat. The Wells HCP Tributary Assessment Program funds allocated to this monitoring effort only apply to monitoring in the Methow subbasin.

Figure 7. October 26, 2022 drone imagery of spawning patches in the ORRI Phases I (left) and II (right) reaches. Shaded polygons show areas utilized by spawners. Images from Carlile 2023, used by permission.

4.0 HATCHERY COMPENSATION PLAN

The Wells HCP specifies that to achieve NNI, hatchery production could provide compensation for up to seven percent of the assumed nine-percent Unavoidable Project Mortality of Plan Species at the Wells Project. The Hatchery Compensation Plan of the Wells HCP (Section 8) describes the overall objectives of the hatchery-compensation programs as to achieve NNI and rebuild natural populations. Latitude provided to the Joint Fisheries Parties (JFP) in the Wells HCP allowed the development of species-specific hatchery objectives that included those overall objectives but added the objective of supporting harvest. Another provision of the Wells HCP, intended to benefit Sockeye Salmon, allowed measures to increase the off-site survival of naturally spawning fish or their progeny in lieu of hatchery production.

4.1 Overview of NNI Production

Douglas PUD's NNI hatchery production was intended to compensate for Unavoidable Project Mortality experienced by juvenile Plan Species when passing the Wells Project, but could also compensate for adult Unavoidable Project Mortality if such losses exceeded two percent but the combined adult and juvenile survival did not exceed nine percent. However, in no case could

hatchery compensation exceed seven percent of the total Unavoidable Project Mortality at the Wells Project. This provision and the proportional relationship between reductions in Project Mortality and reductions in hatchery compensation reward Douglas PUD for maximizing survival of both adult and juvenile Plan Species passing through the Wells Project. Indeed, Douglas PUD and NMFS designed the Wells HCP according to the philosophy of minimizing ESA "take" by maximizing Wells Project survival, thereby minimizing hatchery-production obligations.

The Wells HCP established NNI hatchery-compensation production commitments based upon an assumed seven-percent Unavoidable Project Mortality for both hatchery- and natural-origin juvenile Plan Species emigrating through the Wells Project. The number of smolts of each Plan Species entering the Wells Project was multiplied by the assumed rate of Unavoidable Project Mortality to determine the number of smolts that Douglas PUD would produce as hatchery compensation during Phase I of the Phased Implementation Plan. For estimating compensation for hatchery-origin fish, the equation used the actual numbers of hatchery fish released above the Wells Project (e.g., WNFH production).

The Wells HCP requires adjustment of the initial NNI hatchery compensation based upon the results of survival studies. Since Douglas PUD completed three years of valid survival studies on yearling Chinook Salmon and steelhead (three-year average mortality estimated at 3.8%) prior to the signing of the Wells HCP, the signed HCP incorporated the survival-study-adjusted production commitments for those Plan Species. With completion of the first SVS in 2010, the mortality estimate for yearling spring migrants (excepting Sockeye and Coho salmon) dropped further to 3.7 percent, resulting in a further reduction of the hatchery-production commitment for yearling Chinook Salmon and steelhead. Production obligations were again adjusted—this time upward to 3.96 percent—for yearling Chinook and Coho salmon (see Section 2.3.3 regarding Coho Salmon) and steelhead following the Wells HCP Coordinating Committee approval of the second SVS in 2020.

In addition to adjustments resulting from survival studies, the Wells HCP (Section 8.4.5) specifies that NNI hatchery-compensation obligations are to be adjusted in 2013, and every ten years thereafter, based on changes in population dynamics including the adult-to-smolt survival rate and for changes to the smolt-to-adult survival rate from the hatchery production facilities. The HCP Hatchery Committee approved recalculated NNI production values in December 2011 that applied to brood years 2012 (2013 release year for steelhead, and 2014 release year for yearling Chinook) through release year 2023. In 2022, the HCP Hatchery Committee approved the second recalculation of NNI compensation program mitigation production for release years 2024 through 2033. Doulgas PUD began producing these recalculated production obligations starting with BY 2022 for yearling Chinook and Coho salmon and brood year 2023 for steelhead. Table 5 lists Douglas PUD's hatchery-compensation obligations beginning with the initial production obligations in 2002, through the obligations updated by SVS in 2010 and 2020, and recalculations of NNI production obligations in 2011 and 2022.

For brood years 2012-2021 (release years 2014-2023), Douglas PUD exceeded the spring Chinook Salmon production goal at Methow Hatchery in 9 of 10 years, with the average production of 107 percent of the goal. Likewise, for brood years 2012-2022 (release years 2013-2023), Douglas PUD exceeded the steelhead combined NNI and Inundation Compensation (see Section 4.2) production

goals at Wells Hatchery in 10 of 11 years, and averaged 110 percent of the combined production goals. Douglas PUD began NNI production of Coho Salmon at Wells Hatchery in brood year 2018 (for release year 2020), with varying production goals over those years as described in Table 5 (see footnote 5). For release years 2020-2024, Coho Salmon NNI production has met or exceeded the production goals in three of five years, and averaged 102 percent of the production goals. For the two years when the Coho Salmon production goals were not achieved, Douglas PUD received fewer eyed eggs from WNFH than the respective production goals.

4.2 Inundation Compensation Production

Besides NNI hatchery-compensation production, the Wells HCP requires Douglas PUD to produce hatchery fish as compensation for original inundation of habitat resulting from the construction of Wells Dam. This production, referred to in the Wells HCP as "fixed hatchery compensation – inundation" (inundation) applies only to summer Chinook Salmon yearlings and subyearlings and steelhead, all of which are produced at Wells Hatchery. The term "fixed" denotes that the inundation production numbers are not subject to adjustment to account for survival-study results or population dynamics. The intended goals of the inundation-compensation programs are mixed, with the summer Chinook compensation intended to replace the loss of mainstem Chinook spawning habitat inundated by the filling of the Wells Reservoir. The steelhead inundation compensation was not associated with the loss of steelhead spawning habitat but instead was intended to replace the loss of recreational opportunity to fish for resident fish within the Wells Project. Douglas PUD's production for inundation compensation is included in Table 5.

For brood years 2012-2022 (release years 2013-2023) subyearling Chinook Salmon production at Wells Hatchery averaged 98 percent of the production target. Likewise, for brood years 2012-2021 (release years 2014-2023) yearling Chinook Salmon production at Wells Hatchery averaged 106 percent of the production target. Though total inundation compensation production for steelhead is difficult to disentangle from NNI production because of combined releases to the Twisp River, combined NNI and inundation compensation production for steelhead averaged 110 percent for brood years 2012-2022, as described above in Section 4.1

Table 5. Douglas PUD's hatchery-compensation fish production under the Wells HCP from 2002 through 2024.

Plan Species	Facility	Release Location	2002 Obligation	2010-SVS Obligation	2011 Recalc Obligation	2020-SVS Obligation	2022 Recalc Obligation	Purpose
Spring Chinook Salmon	Methow Hatchery	Methow Basin	67,071[1.]	59,464	29,123	31,169	24,728	NNI
	Chief Joseph Hatchery[2]	Upper Columbia/Okanogan	NA	NA	33,300	35,640	35,640	NNI
Summer Chinook Salmon	Wells Hatchery Yearlings	Direct to Columbia River	320,000	320,000	320,000	320,000	320,000	Inundation
	Wells Hatchery Subyearlings	Direct to Columbia River	484,000	484,000	484,000	484,000	484,000	Inundation
	Wells Hatchery Yearlings	Methow Basin	108,000	105,714	NA	NA	35,437	NNI
	Chief Joseph Hatchery Yearlings[2,3.]	Upper Columbia/Okanogan	NA	NA	54,575	58,410	58,410	NNI
Steelhead	Wells Hatchery	Methow Basin	48,858	47,571	8,000	8,562	17,111	NNI
	Wells Hatchery	Columbia River/Methow Basin	300,000	300,000	300,000	300,000	300,000	Inundation
Methow Coho Salmon	Wells Hatchery	Twisp River	NA	NA[4.]	37,000[5.]	27,720	27,909	NNI

1. For brood years 2002 and 2003, Douglas PUD produced 225,000 additional spring Chinook Salmon smolts at Methow Hatchery as compensation for Okanagan Sockeye Salmon. Beginning in 2004, the Sockeye Salmon obligation was achieved via funding the Okanagan Fish-Water Management Tool.
2. Douglas PUD provides NNI mitigation for summer Chinook above Wells Dam (in part) and for Okanogan spring Chinook by cost-share for operation, maintenance, and monitoring and evaluation of the Chief Joseph Hatchery (CJH) programs. Due to delays in construction at CJH, releases of spring Chinook Salmon began in 2015, and summer Chinook Salmon in 2014 with juveniles produced at Wells Hatchery and transferred to CJH in October 2013 for overwinter acclimation.
3. Numbers shown for CJH summer Chinook Salmon are in "yearling equivalents," per the 2011 agreement between Douglas PUD, BPA, and CTCR, where mitigation for 700,000 subyearlings produced at CJH is converted to 175,000 yearlings to simplify the calculation and representation of the production obligation.
4. Douglas PUD satisfied production obligations for Methow River Coho Salmon from 2008-2017 by monitory contributions to the YN reintroduction program.
5. Douglas PUD's production of Methow River Coho Salmon is based on the YN Methow Basin Release Goal for each brood year and began with brood year 2018. Obligations were as follows: BY2019 = 37,000, BY 2020 = 25,900, BY 2021 = 27,720, BY's 2022-2023 = 27,909.

4.3 Hatchery Production Facilities

Douglas PUD owns and operates Methow Hatchery on the Methow River near Winthrop, Washington for NNI production of Methow Basin spring Chinook Salmon and acclimation of Methow Basin summer Chinook Salmon; and Wells Hatchery at Wells Dam for NNI production of Methow River Coho Salmon, NNI production of Methow River summer Chinook Salmon, NNI and inundation production of steelhead, and inundation production of summer Chinook Salmon (Figure 8). Methow Hatchery includes satellite acclimation facilities on the Twisp and Chewuch rivers, where spring Chinook and Coho salmon are acclimated. Methow Hatchery also has a broodstock-collection weir on the Twisp River, and a broodstock-collection trap in the Methow Hatchery outfall channel. A broodstock-collection trap on the Methow River at Foghorn Dam just upstream of Methow Hatchery is not used because the dam (owned by the USFWS) is no longer a fish barrier. Broodstock-collection traps in the fishways at Wells Dam also provide broodstock for both Methow and Wells hatcheries, and the trapping facilities at Wells Hatchery likewise provide broodstock for multiple programs. Major modernization of Wells Hatchery between 2015 and 2019 substantially expanded incubation and rearing capacity, replaced inadequate adult handling and adult holding facilities, replaced the degraded water-distribution system, provided water-to-water transfer between incubation and rearing vessels, and divided and relined outdoor rearing ponds and enclosed them with netting.

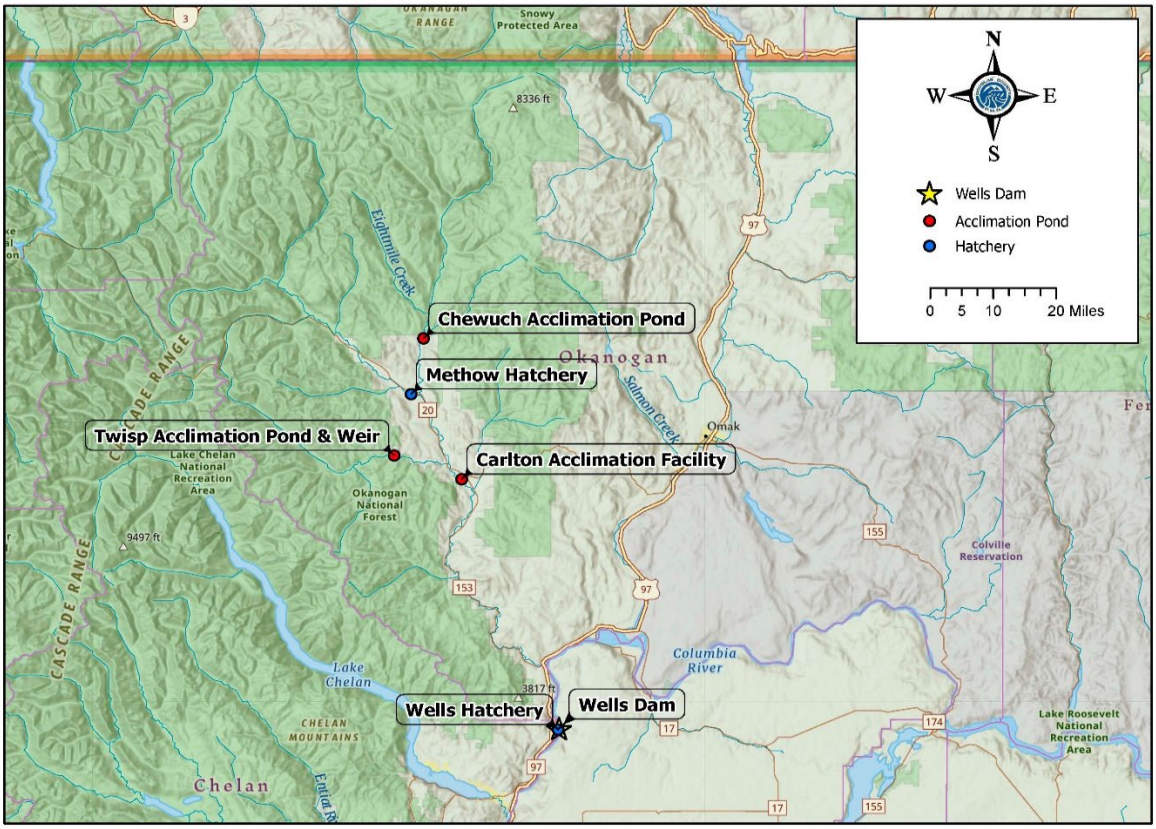

Figure 8. Map of hatchery and acclimation facilities owned by Douglas PUD, plus the Carlton Acclimation Facility, which is owned by Grant PUD, but operated for Grant PUD by Douglas PUD.

Interlocal agreements between Douglas and Grant PUDs give Grant PUD production capacity at both Methow and Wells hatcheries for Methow spring Chinook Salmon and Okanogan steelhead, respectively. Douglas PUD hatchery staff produce those fish on behalf of Grant PUD. Additionally, Douglas PUD produces spring Chinook Salmon at Methow Hatchery for Chelan PUD for their Chewuch River program. Chelan PUD acclimates those spring Chinook at Douglas PUD's Chewuch Acclimation Pond, along with Coho Salmon for the YN. Douglas PUD also acclimates the YN's Coho Salmon along with their own mitigation production of Coho and spring Chinook salmon at the Twisp Acclimation Pond. Finally, Douglas PUD also operates the Carlton Acclimation Facility for acclimation of Grant PUD's Methow River summer Chinook program.

4.4 Hatchery Monitoring and Evaluation

Section 8.5 of the Wells HCP specifies the requirements for monitoring and evaluation of Douglas PUD's passage-loss and inundation-compensation hatchery programs, and directs Douglas PUD to fund a comprehensive hatchery evaluation program. Douglas PUD funded monitoring and evaluation (M&E) of its passage-loss and inundation-compensation hatchery programs prior to the signing of the Wells HCP, but adjusted their M&E efforts to conform with the Wells HCP Hatchery Committee-approved M&E Plan (Hays et al. 2006; Hays et al. 2007) beginning with the calendar-year 2006 monitoring contract. Implementation of the M&E Plan occurs annually as directed by annual M&E Implementation Plans approved by the Wells HCP Hatchery Committee. The Wells HCP Hatchery Committee has modified the M&E Plan repeatedly since 2006, and the current 2024 M&E Implementation Plan is based upon the M&E Plan update completed in 2019 (Hillman et al. 2019). The Wells HCP Hatchery Committees are currently in the process of another update to the M&E Plan (see below).

Monitoring is intended to determine whether the hatchery programs are meeting the management objectives of conservation, safety-net, or harvest augmentation programs. The M&E Plan groups objectives for hatchery programs into three categories of performance indicators:

1. In-Hatchery: Is the program meeting the hatchery production objectives?
2. In-Nature: How do fish from the program perform after release?
    a. Conservation Program:
        - How does the program affect target population abundance and productivity?
        - How does the program affect target population long-term fitness?
    b. Safety-Net Program:
        - How does the program affect target population long-term fitness?
    c. Harvest Augmentation Program:
        - Does the program provide harvest opportunities?
3. Risk Assessment: Does the program pose risks to other populations?

WDFW's Supplementation Research Team has implemented Douglas PUD's M&E Plan since 2003, with data collection performed by field crews from the Methow Field Office in Twisp, Washington. WDFW's field crews performed spawner surveys for spring Chinook and steelhead in the Methow River Basin; operated rotary-screw traps for enumeration of juvenile outmigrants in the Twisp and Methow rivers; collected and tagged wild juvenile spring Chinook and steelhead prior to and during emigration; performed stock-assessment sampling during broodstock collection

at Wells Dam, Methow Hatchery and the Twisp Weir; collected morphometric and stock-assessment data during spawning at Wells and Methow hatcheries; monitored hatchery releases from the acclimation facilities in the Twisp, Methow, and Chewuch rivers; maintained instream PIT-tag detection arrays in the Methow Basin; uploaded tag files for PIT-tagged hatchery- and natural-origin fish released in the Methow Basin or recovered on the spawning grounds; submitted scale samples to the WDFW scale lab, and genetic samples to the WDFW genetics lab for analysis; and provided annual reporting of M&E activities to Douglas PUD. WDFW has also conducted a multi-year, relative-reproductive-success study on Twisp River steelhead for Douglas PUD in fulfillment of Section 8.5 of the Wells HCP, but has yet to complete the data analysis.

Other contracts supporting M&E Plan implementation included those for tagging of hatchery fish to monitor survival, travel time, run timing, spawner distribution, straying, contribution to harvest, smolt-to-adult returns, and other metrics. Douglas PUD contracted BioAnalysts, Inc. to PIT-tag returning adult steelhead at Priest Rapids Dam for determination of spawner distribution and escapement. WDFW ad-clipped and/or coded-wire tagged juvenile salmon and steelhead at Wells and Methow hatcheries. Finally, Douglas PUD contracted Biomark, Inc. to PIT tag salmon and steelhead at those facilities.

Besides annual reports of M&E activities, the Wells HCP Hatchery Committee developed a reporting timeline that included statistical analysis of M&E data at 5-year intervals, and comprehensive reporting at 10-year intervals, intended to encompass the hatchery program review of Section 8.8 of the Wells HCP. Data analysis for the most recent 10-year comprehensive reporting cycle was completed in early 2023 by Douglas, Chelan, and Grant PUDs, with substantial contributions from WDFW, BioAnalysts, Inc., and Buchanan Statistical Consulting, LLC. The combined Hatchery Committees (Wells, Rocky Reach, Rock Island, and PRCC-Hatchery Subcommittee) utilized those data-analysis products to develop the *Monitoring and Evaluation of the Chelan, Douglas, and Grant County PUDs Hatchery Programs: Ten-Year Comprehensive Technical and Management Report Summary* (Summary Report), which is still in progress, to be completed in November 2024.

A key finding of that summary report is that Douglas PUD consistently met release-number targets for all NNI and inundation hatchery programs, in conformance with mitigation and license requirements. The hatchery programs produced returning adults generally similar to natural-origin adults phenotypically and in run- and spawn-timing, though hatchery-origin spring Chinook tended to return at earlier ages than their natural-origin counterparts, particularly for males. Fish spawned in the hatcheries produced more recruits than did spawners in the wild, indicating a abundance benefit to the hatchery programs. Other analyses of productivity metrics for spring Chinook populations were possibly confounded by lack of in-basin references and by management actions that modulated hatchery influence on the spawning grounds. Similarly for steelhead, the lack of pre-supplementation data hampered analyses regarding the influence of the hatchery programs on productivity. The Hatchery Committees continue to evaluate the implications of the analyses conducted under the 10-year reporting effort on the management of the hatchery programs and on the future of the M&E Plan.

The Hatchery Committees are currently in the process of updating the M&E Plan per Section 8.5 of the Wells HCP concurrently with completion of the summary report. Modifications to the plan

are intended to address any shortcomings in the monitoring and analytical approaches identified by the 10-year reporting effort, including data needs. The Hatchery Committees anticipate completion of updates to the M&E Plan in 2025, with the updated plan guiding M&E implementation beginning in calendar-year 2026.

4.5 Sockeye Salmon Mitigation

Survival studies on yearling spring migrants implemented by Douglas PUD prior to the signing of the Wells HCP did not include sockeye salmon for the reasons described above in Section 2.3. Thus, Phase I production commitments for sockeye were based on an assumed seven-percent mortality per the HCP, despite higher bypass guidance efficiency for Sockeye than for other juvenile spring migrants (see Section 2.3.4). Initially (1998-2005), Douglas PUD's Wells HCP hatchery-production commitment for sockeye was met by producing 225,000 spring Chinook smolts. During that same period, Douglas PUD also worked with Canadian collaborators to develop and implement the Okanagan Fish and Water Management Tool (FWMT). The FWMT is an internet-accessible, real-time, multi-user, environmental decision-support system used by water and fish managers in the Okanagan Basin to facilitate water release decisions at Okanagan Lake dam that are "fish-friendly" while avoiding increases in property damage (flooding) or disruptions to irrigation and recreational opportunities associated with water supply variations (Figure 9). Use of the FWMT by Canadian fish and water managers increases the productivity of naturally spawning sockeye on the spawning grounds in the Canadian Okanagan River Basin by minimizing or eliminating density-independent mortality events from poorly timed water-management actions that historically caused redd desiccation or scour. In October 2004, the Wells HCP Hatchery and Coordinating committees approved the FWMT as meeting Douglas PUD's sockeye mitigation responsibility. Thus, since brood year 2004, Douglas PUD's NNI hatchery obligation for sockeye has been entirely satisfied by continuous implementation of the FWMT in Canada.

Figure 9. Screen shot from the Okanagan FWMT showing the modeled outcomes of a user-submitted water-release scenario for the Okanagan River at Oliver, BC, where green = desirable, yellow = risk of undesirable, and red = undesirable. The black lines indicate discharge volumes that have already occurred, and blue lines the forecast discharge. The modeled outcomes indicate

that the runoff and fry-emergence forecast present some scour risk (indicated by yellow) to pre-emergent Sockeye Salmon alevins at the end of the forecasted emergence period in early May, and some risk to domestic and agricultural water-withdrawal intakes in August.

Douglas PUD funds the Okanagan Nation Alliance to implement the FWMT with substantial assistance from subcontractors and in-kind contributors, including the Department of Fisheries and Oceans Canada (DFO), ESSA Technologies, and the British Columbia Ministry of Water, Land, and Resource Stewardship. Annual implementation includes the maintenance and managed hosting of the web-based FWMT model, the maintenance and operation of real-time data-collection infrastructure (e.g., stream gages, lake-level gages, snow-survey sites, etc.), collection of biological data (e.g., spawner surveys, emergence timing, hydroacoustic and trawl surveys, etc.), data input to and maintenance and hosting of the supporting database, and the personnel time to run model scenarios with input data and the resultant decision-making collaboration between users. Continuous deployment of the FWMT since brood-year 2004 has facilitated informed fish-friendly water-management decisions that have minimized density-independent mortality events in the Canadian Okanagan Basin, substantially improving the consistency of annual fry and smolt production over pre-FWMT management, translating into record returns of adult sockeye.

In late-2014, Douglas PUD began a three-phased renewal and modernization of the FWMT to secure the original investment in model development and coding that had performed beyond expectations for 12 years, ensuring continued performance, improved capabilities, and enhanced security. The renewal and modernization effort moved the FWMT from obsolete, unsupported software on a vulnerable in-house server with desktop interface, to cloud-based modernized applications and multidevice user-interfacing with industry-standard security. All six submodels were updated to reflect advanced knowledge and enhanced data availability, while preserving time-validated logic. Improvements to the hydrology submodel increased prediction intervals, updated tributary inflow forecasting, added user-specified custom forecasting periods and override capabilities, and added a lake-level/storage volume rating curve, among other advances. Modernization included full documentation of the design process (record of design) and updated apprentice guidebook for training water managers on the modernized decision-support system. The renewal/modernization process occurred while maintaining the fully functional legacy FWMT system until a beta modernized version could be tested side-by-side with the legacy system through at least one water-year. Modernization was completed in December 2018, with documentation completed by February 2019 and bug-fixes continuing through 2020.

In 2024, the ONA and DFO completed a multiyear project to quantify the estimated contribution of the FWMT to the production of Okanagan Sockeye. This project, started in 2011 by the late Dr. Kim Hyatt (DFO), mastermind of the FWMT, relied on a weight-of-evidence (WOE) approach to distill the relative contribution of the FWMT from the multiple factors contributing to the increased productivity of Okanagan Sockeye. In 2005, Hyatt and Alexander performed a retrospective analysis to estimate the potential for FWMT implementation to improve smolt production, and they estimated an average 55-percent increase in smolt production. That analysis relied on naïve water managers to virtually "operate" the Okanagan Lakes Regulatory System (OLRS) using FWMT on the previous 25 water years to determine the FWMT-mediated smolt-production outcomes from each of those years relative to the actual smolt production from those years. Ideally, the most robust evaluation of the contribution of FWMT to smolt production from

the last 21 years of FWMT implementation would apply a similar approach in which naïve water managers would virtually operate the OLRS without FWMT to contrast actual smolt production with what it would have been without FWMT implementation. However, there are no naïve water managers who know how to operate the OLRS the way it was operated in the pre-FWMT era. Thus, the current analysis must rely on other means for disentangling the FWMT contribution from all contributing factors, including ocean conditions, concurrent reintroduction and supplementation efforts by Chelan and Grant PUDs, and substantial restoration of habitat and access to historical habitat funded by the three PUDs and others.

The WOE analysis of the contribution of annual FWMT implementation to production of Okanagan Sockeye Salmon first compared pre-FWMT water management to determine whether FWMT implementation had improved compliance with fish-protection objectives in the Okanagan Basin Implementation Agreement (OBIA). Before FWMT development, an evaluation by Bull (1999) identified routine failures by water managers to achieve compliance with OBIA flow objectives for Sockeye Salmon adult migration and spawning, and for egg incubation and alevins through fry emergence. Of those objectives, Canadian fish managers acknowledge that those associated with the egg-to-fry-emergence stage had the greatest potential to influence fry production due to the catastrophic losses that can occur with redd desiccation/freezing or scour. Thus, the WOE analysis focused on performance of FWMT implementation in protecting Osoyoos Sockeye Salmon during the egg-to-fry-emergence phase.

Compliance with the OBIA in the FWMT era dramatically improved over the pre-FWMT era (Figure 10). Using FWMT, fish and water managers nearly eliminated redd-desiccation events, and substantially minimized scour events. Only in extreme flood years (e.g., 2017, 2019), in which runoff conditions substantially limited decision space, were fish and water managers unable to prevent major scour events. Even in those extreme years, fish and water managers were able to avoid catastrophic loss to brood-year production by modulating flows to restrict scour damage. Therefore, with FWMT, fish and water managers were able to maximize fry production from each brood year within the constraints of given hydrologic conditions.

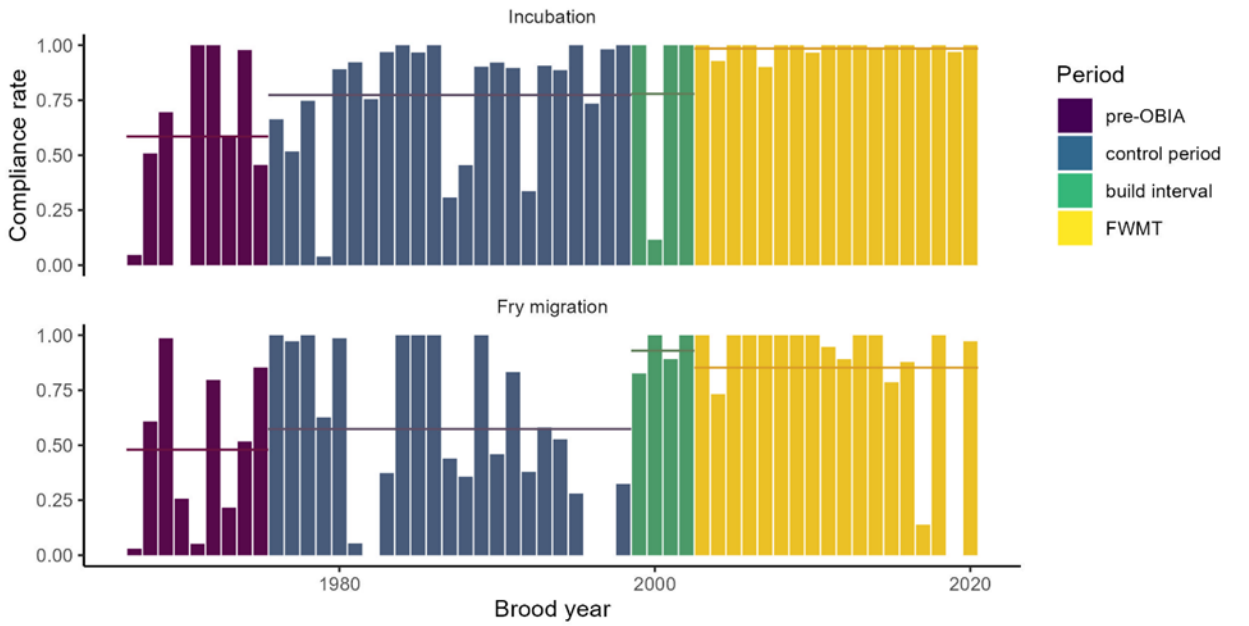

Figure 10. Annual (brood years 1967-2020) rates of compliance with OBIA objectives, in percentage of days compliant for each life stage, for phases of FWMT implementation, with phases from Hyatt et al. (2015). "Pre-OBIA" is the period before the OBIA codified flow objectives for fish management (1967-1975). "Control period" is the period of OBIA implementation before the decision to develop the FWMT (1976-1998). "Build interval" is 1999-2002, the period between initiation of the development of the FWMT and implementation, where the collaboration between fish and water managers and the partial implementation of FWMT yielded improvements. "FWMT" is 2003-2020, the period of test (2003) and full implementation (2004-2020) of FWMT for operation of the OLRS. From, Ng et al. in review.

Because water-management decisions supported by FWMT only affect the availability of spawning habitat and the suitability of that habitat to support incubation and development of progeny through fry emergence, the ability of the FWMT to influence Sockeye Salmon production is limited to the spawning, incubation, and emergence phases of the Sockeye Salmon lifecycle. Once fry emerge and migrate to Osoyoos Lake, water managers have very limited or no influence on smolt production. Therefore, the true measure of FWMT contribution to sockeye production is fry production. However, biological sampling of fry emergence timing has not been conducted using methods capable of fry enumeration. Therefore, the first opportunity for managers to measure fry production from a given brood year is during the early summer acoustic and trawl surveys (ATS) in Osoyoos Lake, at which point the population has already experienced losses beyond the control of FWMT implementation (e.g., predation). Indeed, the ONA conducts two to three ATS events for each brood year, and reports primarily on pre-smolt numbers from the late-winter (typically late-February or early-March) survey by which time the cohort has been subjected to at least 10 months of in-lake mortality. This has been the practice because HCP mitigation is in the currency of smolts, rather than fry or parr. Regardless, ATS numbers provide our best estimate of brood-year performance from egg to juvenile (parr or pre-smolt), and thus our best estimate of FWMT contribution to production of Okanagan Sockeye Salmon.

Because of large variability in juveniles-per Osoyoos Lake spawner in the pre-FWMT era, no relationship existed between female spawner and pre-smolt abundance (Alexander et al. 2024; Figure 11). However, annual implementation of the FWMT substantially dampened that variability in juvenile production per spawner (Alameddine et al. 2024; Figure 12), resulting in a strong relationship between female spawners and pre-smolts and extended the upper range of juveniles per spawner beyond what the population had previously produced (note clustering of post-FWMT data points in upper right quadrant of Figure 11, in contrast with pre-FWMT data points clustered in the lower left quadrant).

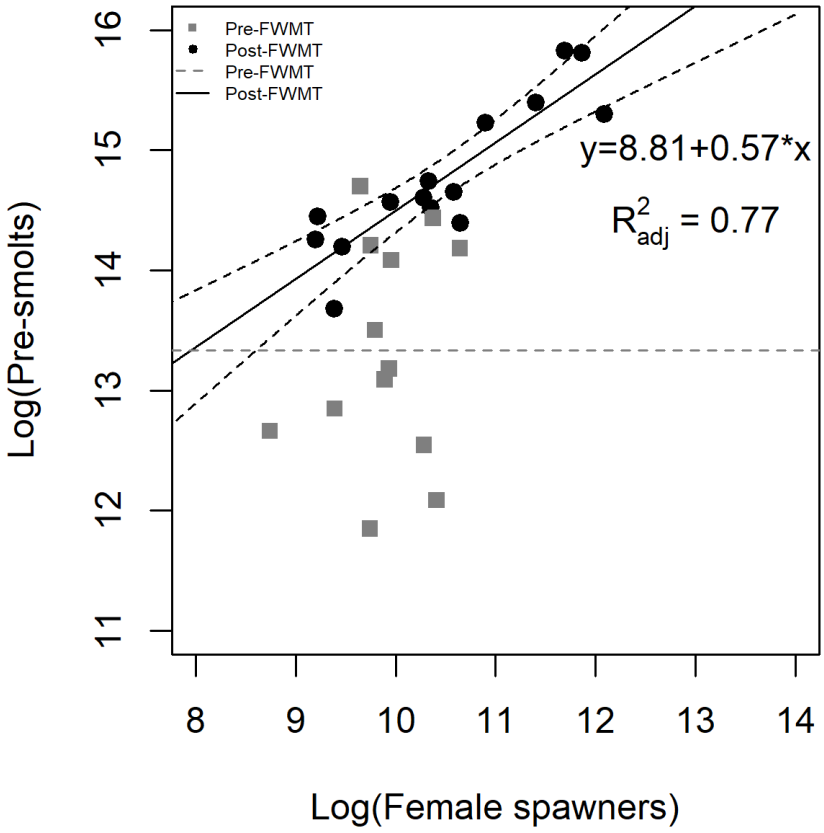

Figure 11. Figure from Alexander et al. (2024): Relationship between the number of Osoyoos Lake Sockeye Salmon pre-smolts produced in a brood year as a function of the number of female spawners. Black solid line represents the relationship post-FWMT. Dashed black line represents the 95% confidence interval. The grey dotted line represents the mean log pre-smolts in the pre-FWMT period.

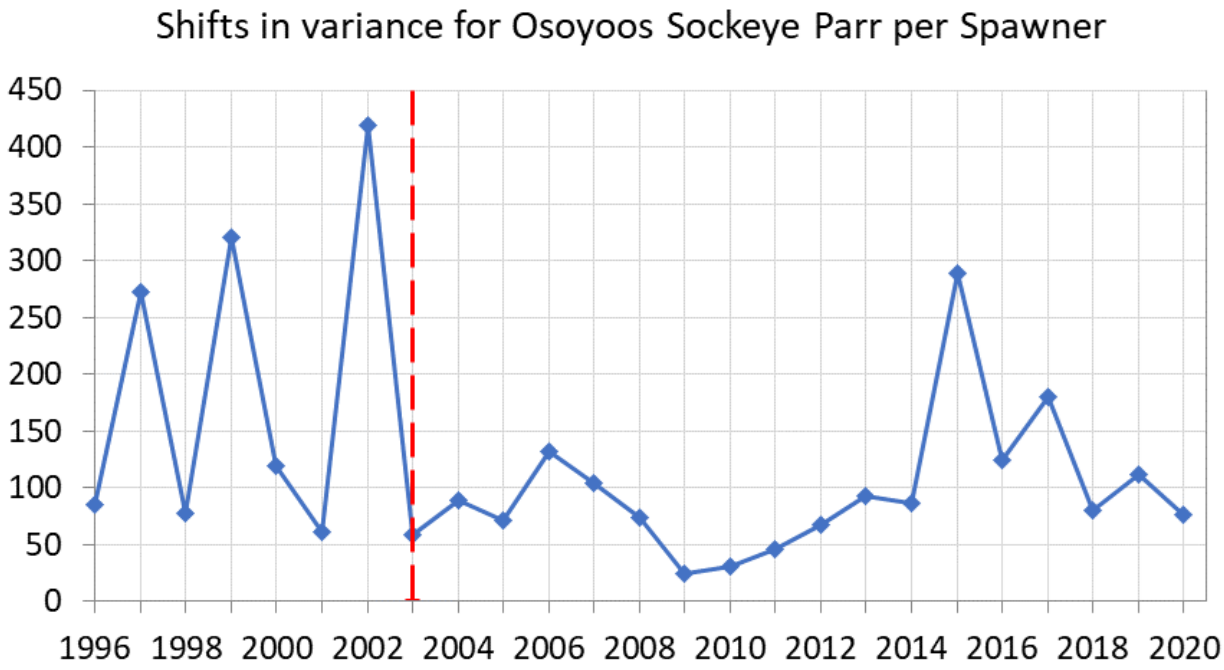

Figure 12. Figure from Alameddine et al. (2024): Changepoint detection for a shift in the magnitude of variance in the ratio of Osoyoos Lake Sockeye Salmon parr per spawner was detected as of brood year 2003 (red dashed line), which was the first year that a beta version of the FWMT was tested in real-time operation of the OLRS.

Maximized smolt production translated into relative increases in adult returns (given other factors affecting SARs), which compounded smolt increases from subsequent brood years. Estimated increases in Osoyoos Lake Sockeye Salmon smolt production (measured as pre-smolts in the late-winter ATS) in the FWMT era relative to the pre-FWMT era were 107 percent for the multiyear mean, 142 percent for the multiyear maximum, and 189 percent for the multiyear minimum (Alameddine et al. 2024). These increases greatly exceed the required 7-percent NNI production level specified in the Wells HCP. These values also exceed the 55-percent mean increase from the retrospective analysis (Hyatt and Alexander 2005), but that analysis applied the approach to single years independent of each other. Therefore, they did not account for any benefit that would accrue from sequential years of FWMT implementation in which improved smolt production would compound by increasing adult returns from a given brood year (Figure 13).

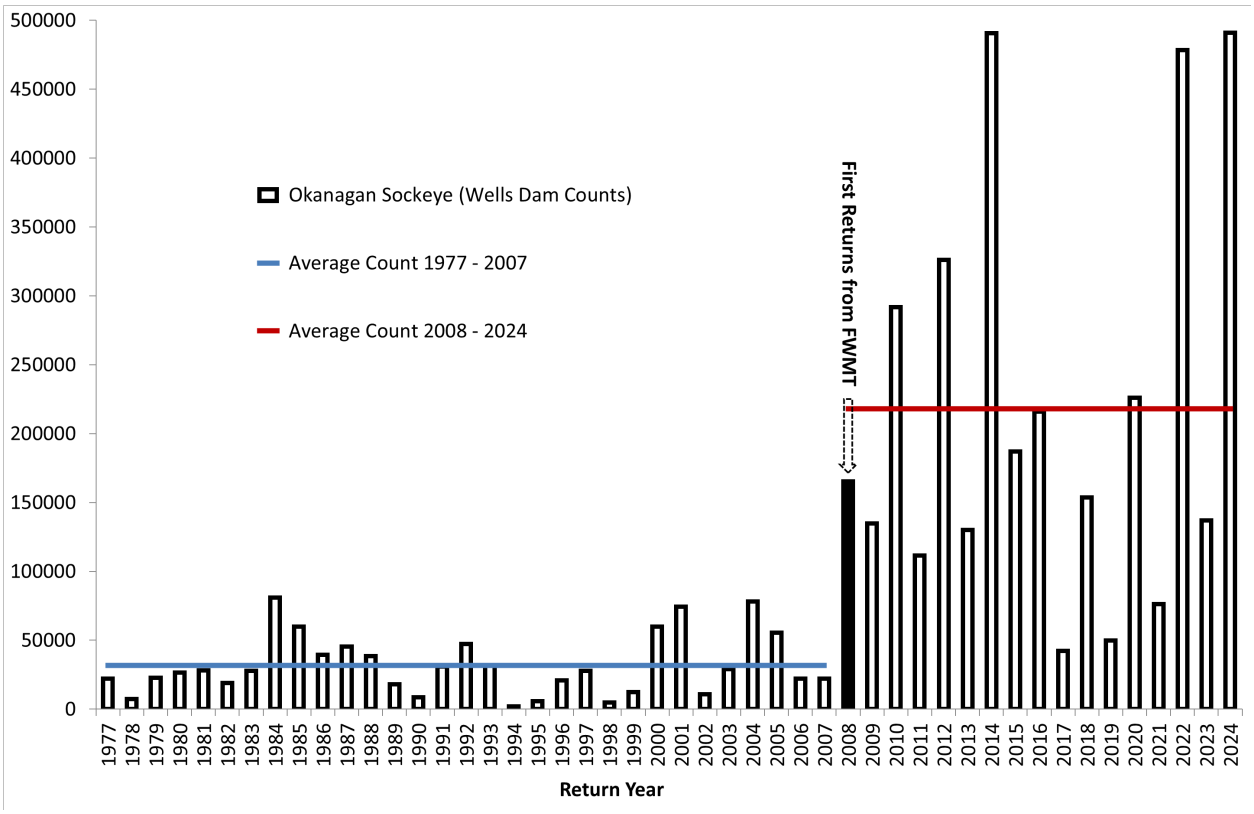

Figure 13. Counts of Sockeye Salmon at Wells Dam from 1977-2024, showing the cumulative benefits of multiple years of maximizing production of fry per female spawner. The 2008 count included the first adult returns from the first brood year (2004) to benefit from full implementation of the FWMT by Canadian fish and water managers.

The full realized benefit from the long-term implementation of the FWMT for operation of the OLRS is difficult to describe and transcends the reported benefits to Osoyoos Lake Sockeye Salmon. The reintroduction efforts of the ONA funded by the Chelan and Grant PUDs would not have been possible—at least at the scale experienced—without the production improvements to the Osoyoos Lake population from the FWMT implementation. The successful reintroduction effort has relied and continues to rely on Osoyoos Lake spawners collected for broodstock for the reintroduction hatcheries from the Osoyoos Lake spawning grounds on the Okanagan River near Oliver, BC. The Canadian managers insist on using Osoyoos returns for broodstock, to avoid the incorporation of hatchery returns into the brood for the reintroduction hatchery. The reliance on the Osoyoos Lake spawners for reintroduction broodstock necessitates that the Osoyoos Lake population has sufficient surplus spawners. The improbability of that surplus is unknown, but expected to have varied consistent with historical patterns that, had those patterns persisted, would have substantially impeded achievement of hatchery production objectives in many brood years (Figure 14).

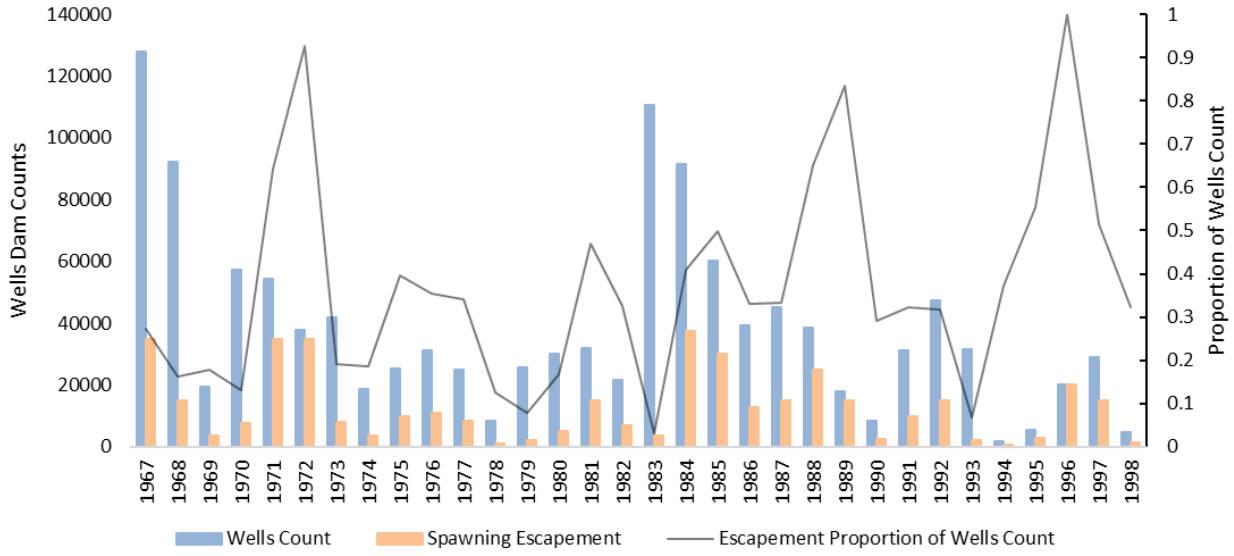

Figure 14. Wells Dam Sockeye Salmon counts (blue) and Osoyoos spawning escapement (orange) by return year, with the escapement as a proportion of the Wells Dam count (black line, and secondary y-axis). Note that the pre-FWMT escapement objective for Osoyoos Lake Sockeye Salmon (From Hyatt and Rankin 1999) was achieved in only 5 of 32 years.

Besides the direct benefit of broodstock for the reintroduction program, the FWMT also protects Skaha Lake spawners from density-independent mortality. Managers modulate flows in the Okanagan River by releasing water from Okanagan Lake, and they rely on the FWMT to guide those release decisions. Those releases are managed to protect Sockeye Salmon redds in the Okanagan River between McIntyre Dam and Osoyoos Lake from desiccation or scour, but Skaha Lake spawners in the Penticton Channel immediately downstream of Okanagan Lake are provided with the same modulated flows. Additionally, the Kokanee Submodel of the FWMT allows managers to protect redds of beach-spawning kokanee in Okanagan Lake by maintaining lake levels that prevent redd desiccation. Should reintroduced Sockeye Salmon also spawn on the beaches of Okanagan Lake as anticipated, the FWMT will provide protection for them, too. Finally, the benefits to Okanagan Sockeye Salmon accrued from multiple years of FWMT implementation have not come at the cost of lakeshore and floodplain flood damage and lost irrigation and municipal water withdrawals. The use of the FWMT has allowed fish and water managers to protect all uses of the OLRS while maximizing juvenile production of Sockeye Salmon.

5.0 STATUS OF PLAN SPECIES

Section 6.9 of the Wells Habitat Conservation Plan (HCP) includes the requirement for the Public Utility District No. 1 of Douglas County (Douglas PUD) to prepare, at 10-year intervals beginning in 2013, comprehensive progress reports that assess the overall status of achieving "no net impact (NNI, this report). It also describes an associated analysis directed by the Wells HCP Coordinating Committee to determine whether each Plan Species is rebuilding. The lack of detail in that latter requirement left the Wells HCP Coordinating Committee to conclude in 2013 that it was neither Douglas PUD's obligation nor authority to determine whether the Plan Species were rebuilding,

and that the Wells HCP Coordinating Committee would defer to National Marine Fisheries Service (NMFS) for such determination. NMFS produces 5-year status reviews of listed species, and the timing of every other of those reviews generally coincides with the 10-year comprehensive report cycle of the HCP.

In discussions with the HCP Coordinating Committees prior to the preparation of this second comprehensive report, the HCP Coordinating Committees reconsidered the requirement for an analysis of whether each Plan Species was rebuilding. The committees asked Chelan and Douglas PUDs to include such an analysis in the NNI reports, relying on the most recent NMFS 5-Year Status Review, with additional local data as warranted. Thus, this appendix fulfills that request by providing excerpts from the most recent NMFS 5-Year Status Review (NMFS 2022) for ESA-listed species, as well as relevant data from other sources for both ESA-listed and non-listed Plan Species.

5.1 Upper Columbia River Spring Chinook Salmon

Figure 15 shows the adjusted count of Upper Columbia River (UCR) spring Chinook Salmon that passed and remained above Wells Dam in return-years 2006 through 2023 (data from Snow et al. 2024). Chinook Salmon counted at Wells Dam were parsed into spring and summer runs by analyzing video footage (through 2020) or PIT-tag data (2021-2023). Counts were further adjusted by subtracting fish that fell back over Wells Dam and were later detected downstream, and accounting for double-counted fish (fallback and re-ascension). Total counts of spring Chinook Salmon at Wells Dam have been substantially bolstered by hatchery-origin returns from multiple hatchery programs above Wells Dam, including PUD mitigation production at Methow and Chief Joseph hatcheries. Variability in hatchery-origin returns generally mirrors that of natural-origin returns, but is relatively exaggerated in comparison with the more stable natural-origin pattern.

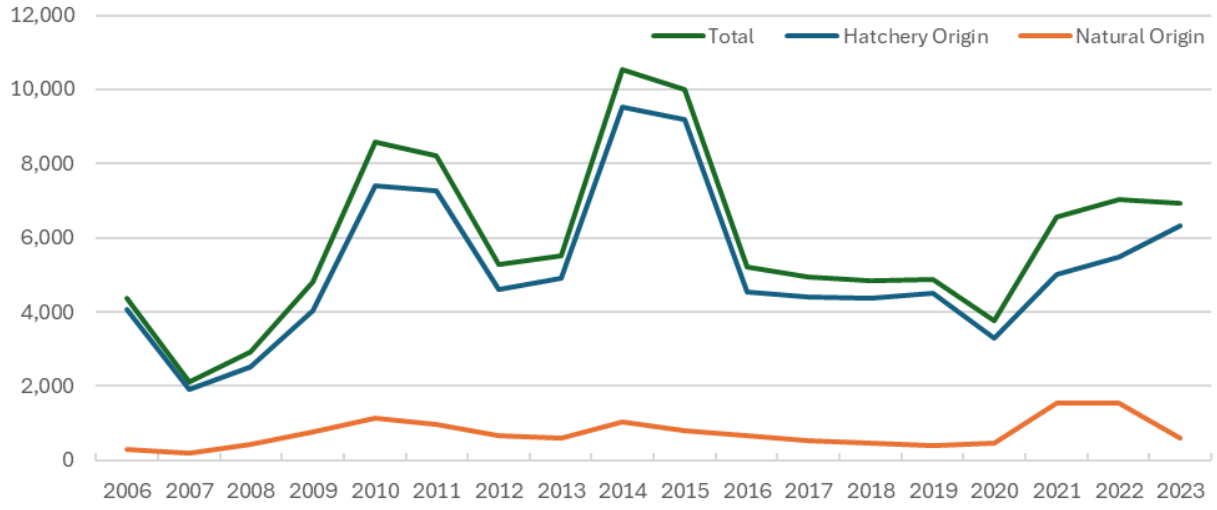

Figure 15. Total, hatchery-origin, and natural-origin UCR spring Chinook Salmon passing and remaining above Wells Dam in return-years 2006-2023 (data from Snow et a. 2024). See the explanation of enumeration methodology provided in text.

From the 2022 5-year status review (NMFS 2022):

> UCR Spring-run Chinook Salmon ESU Updated Biological Risk Summary All three populations in the UCR spring-run Chinook salmon ESU remain at high overall risk. Natural origin abundance has decreased over the levels reported in the prior review for all populations in this ESU, in many cases sharply. The abundance data for the entire ESU show a downward trend over the last 5 years, with the recent 5-year abundance levels for all three populations declining by an average of 48 percent. The consistent and sharp declines for all populations in the ESU are concerning. Relatively low ocean survivals in recent years were a major factor in recent abundance patterns. Spatial structure and diversity ratings remain unchanged from the prior review and continue to be rated at low to moderate risk for spatial structure but at high risk for diversity criteria. Largescale supplementation efforts in the Methow and Wenatchee Rivers are ongoing, intended to counter short-term demographic risks given current survival levels. Under the current recovery plan, habitat protection and restoration actions are being implemented that are directed at key limiting factors. Given the high degree of year-to-year variability in life stage survivals and the time lags resulting from the 5-year life cycle of the populations, it is not possible to detect incremental gains from habitat actions implemented to date in population-level measures of adult abundance or productivity. Efforts are underway to develop life-stage-specific estimates of performance (survival and capacities) and to use a life-cycle model framework to evaluate progress (Zabel and Jordan 2020). Based on the information available for this review, the risk category for the UCR spring-run Chinook ESU remains unchanged from the prior review (NWFSC 2015). Although the recent decline of population abundances is concerning, each population remains well above the abundance levels of when they were listed.

5.2 Upper Columbia River Summer Steelhead

Figure 16 shows the adjusted count of UCR Summer Steelhead that passed and remained above Wells Dam in return-years 1998 through 2023 (data from Snow et al. 2024). Steelhead counted at Wells Dam were adjusted by subtracting fish that fell back over Wells Dam and were later detected downstream, and by accounting for double-counted fish (fallback and re-ascension). Total counts at Wells Dam are driven by hatchery-origin returns, which show high variability and a multiyear decline (since 2010), while natural-origin returns remain stable, exceeding returns from when listed as Endangered in the late-1990s.

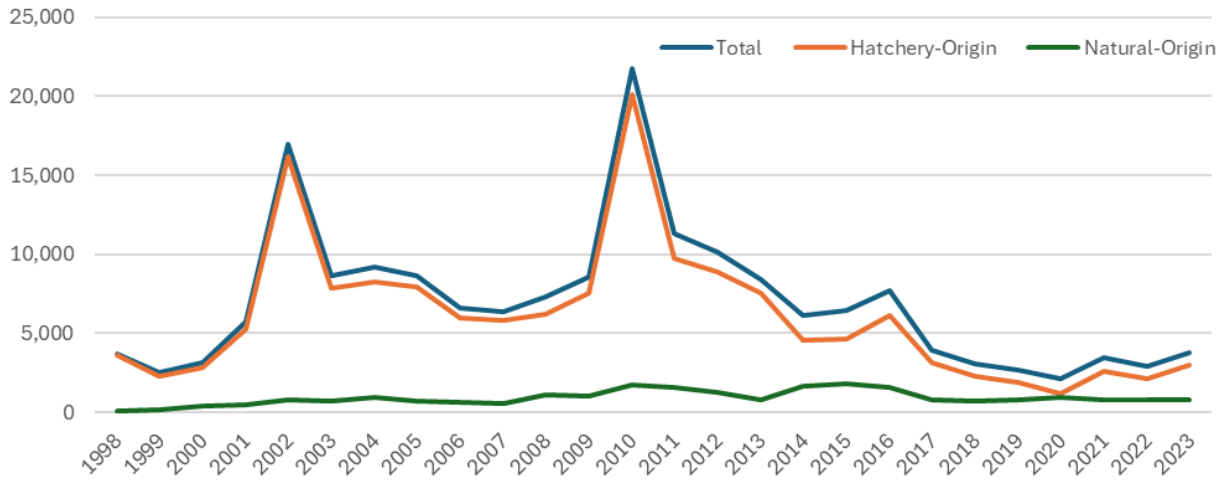

Figure 16. Total, hatchery-origin, and natural-origin UCR steelhead passing and remaining above Wells Dam in return-years 1998-2023 (data from Snow et a. 2024). See the explanation of enumeration methodology provided in the text.

From the 2022 5-year status review (NMFS 2022):

> All four populations in the UCR steelhead DPS remain at high overall risk. Natural origin abundance has decreased over the levels reported in the prior review for all populations in this DPS, in many cases sharply. The abundance data for the entire DPS show a downward trend over the last 5 years, with the recent 5-year abundance levels for all four populations declining by an average of 48 percent. The consistent and sharp declines for all populations in the DPS are concerning. Relatively low ocean survivals in recent years were a major factor in recent abundance patterns. Spatial structure ratings remain unchanged from the prior review and continue to be rated at low risk for the Wenatchee and Methow populations, moderate risk for the Entiat population, and high risk for the Okanogan population. The overall diversity ratings remain unchanged at high risk. The high risk ratings for diversity are largely driven by high levels of hatchery spawners within natural spawning areas and lack of genetic diversity among the populations. Under the current recovery plan, habitat protection and restoration actions are being implemented that are directed at key limiting factors. Given the high degree of year-to-year variability in life stage survivals and the time lags resulting from the 5-year life cycle of the populations, it is not possible to detect incremental gains from habitat actions implemented to date in population level measures of adult abundance or productivity. Based on the information available for this review, the risk category for the UCR steelhead remains unchanged from the prior review (NWFSC 2015). Although the recent decline of population abundances is concerning, each population remains well above the abundance levels of when they were listed.

5.3 Upper Columbia River Summer/Fall Chinook Salmon

In the 1990s, the NMFS evaluated the status of UCR summer/fall Chinook Salmon and concluded that the Evolutionarily Significant Unit (ESU) was not at risk of extinction nor at risk of becoming

endangered in the foreseeable future (Myers et al. 1998). Counts of summer/fall Chinook Salmon at Wells Dam (Figure 17) show dramatically increased abundance of summer/fall Chinook since those NMFS status reviews. The proportion of natural-origin returns in the Wells Dam counts for the years reported (2001-2023) averaged 0.43, and ranged from 0.23 to 0.68. For spawners in the Methow River, pHOS has been equal to or greater than 0.67 in each of the last five return years, and pHOS exceeded 0.5 in the Okanogan/Similkameen in three of last five years.

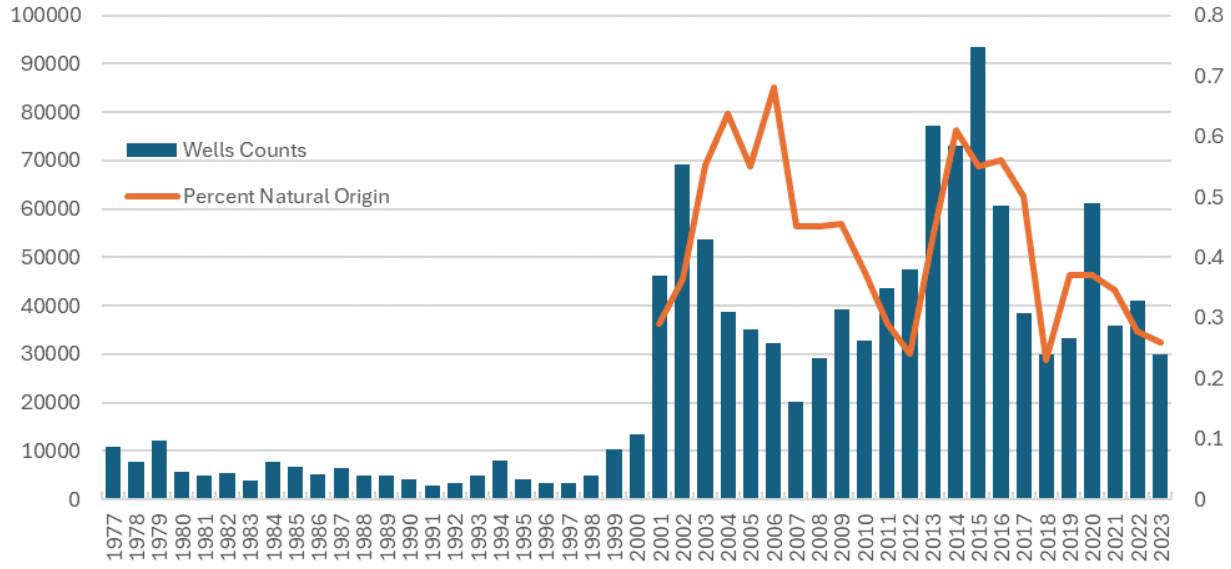

Figure 17. Counts of summer/fall Chinook Salmon adults and jacks at Wells Dam from 1977 through 2023, with percent natural-origin fish in those counts from 2001-2023.

5.4 Okanagan Sockeye Salmon

The 1997 NMFS status review (Gustafson et al. 1997) concluded that the Okanagan Sockeye ESU was not in danger of extinction or becoming endangered, despite record low returns in the 1990s. Nevertheless, NMFS recommended "close monitoring" of the ESU because of those years of low abundance. Since then, the ESU has experienced spectacular increases in abundance as measured at Wells Dam (Figure 18), coinciding with the full implementation of the Okanagan FWMT in 2004 (first adult returns in 2008), and more recent contributions from the concurrent reintroduction efforts and restoration of habitat and access to Skaha and Okanagan lakes funded largely by the mid-Columbia PUDs (Figure 19).

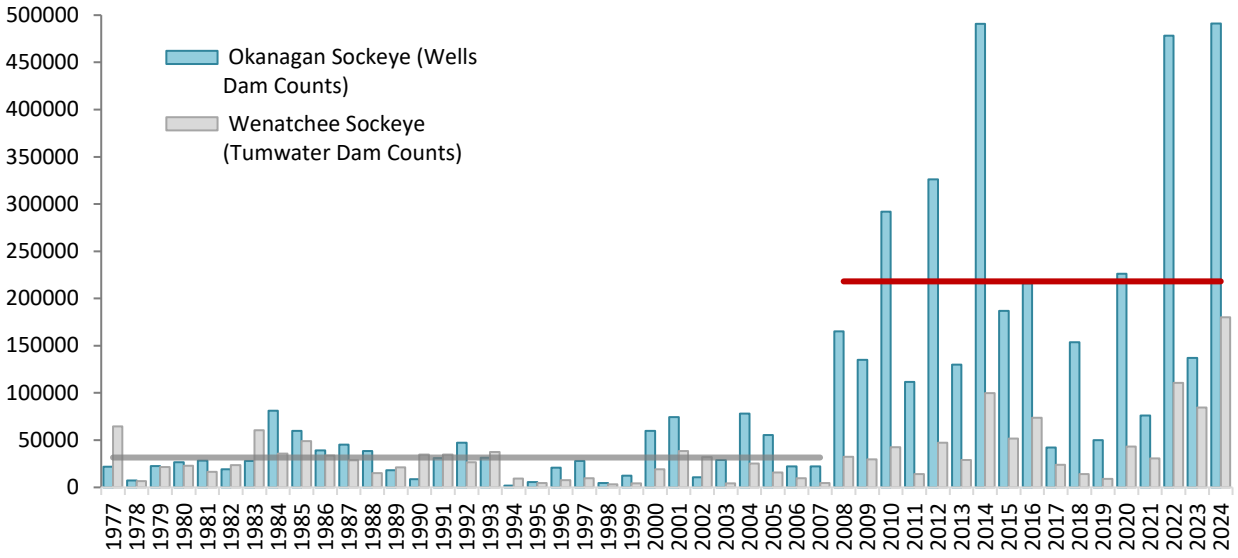

Figure 18. Returns of Okanagan (blue) and Lake Wenatchee (gray) Sockeye Salmon as counted at Wells and Tumwater dams, respectively, from 1977-2024, with mean returns of Okanagan Sockeye Salmon for the pre-FWMT era (1977-2007), and FWMT era (2008-2024).

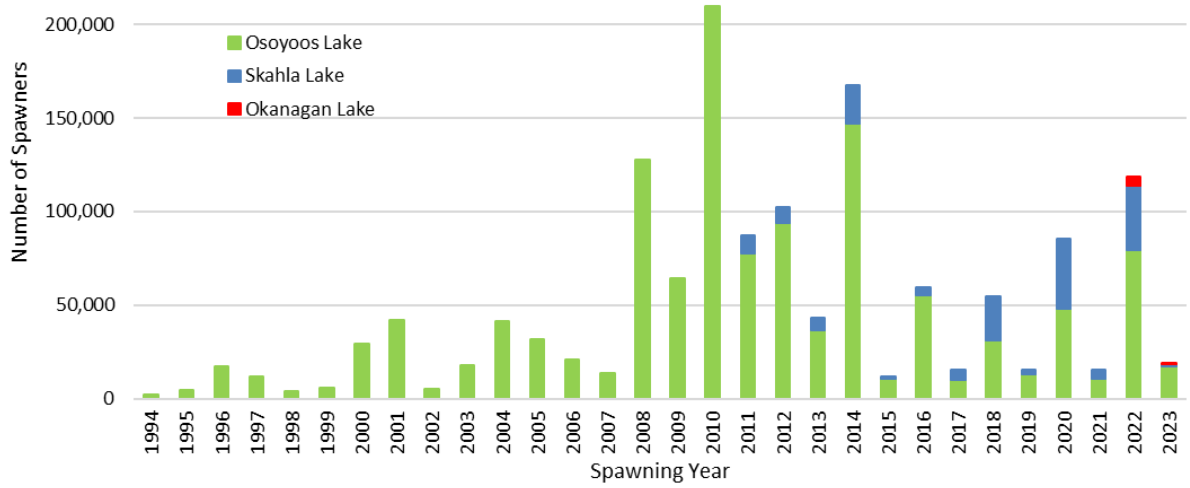

Figure 19. Spawner escapement to the Canadian Okanagan for Osoyoos, Skaha, and Okanagan lakes 1994-2023. Although Skaha Lake numbers include returns from both natural- and hatchery-origin spawners in the Penticton Channel (Skaha Lake rearing), origins were not differentiated in the escapement dataset from which this graph was generated. Unpublished data from carcass sampling indicate that Skaha Lake spawners are predominately natural-origin.

From Figures 18 and 19, one can readily observe that large returns to Wells Dam do not necessarily translate into large escapement to the Canadian spawning grounds. Since 2012, spawner escapement has shifted from an average 61 percent (1999-2011) to an average of 28 percent (2012-2023) of the Wells count. At the same time, the proportion of "missing fish" (those lost between Wells Dam passage and spawning, and not accounted for in estimates of fisheries removals) shifted

from 37 percent from 1999-2011, to 48 percent from 2012-2023 (Figure 20). Multiple factors contribute to this phenomenon, and synergistic relationships between two or more of these factors may compound losses between Wells Dam and the spawning grounds.

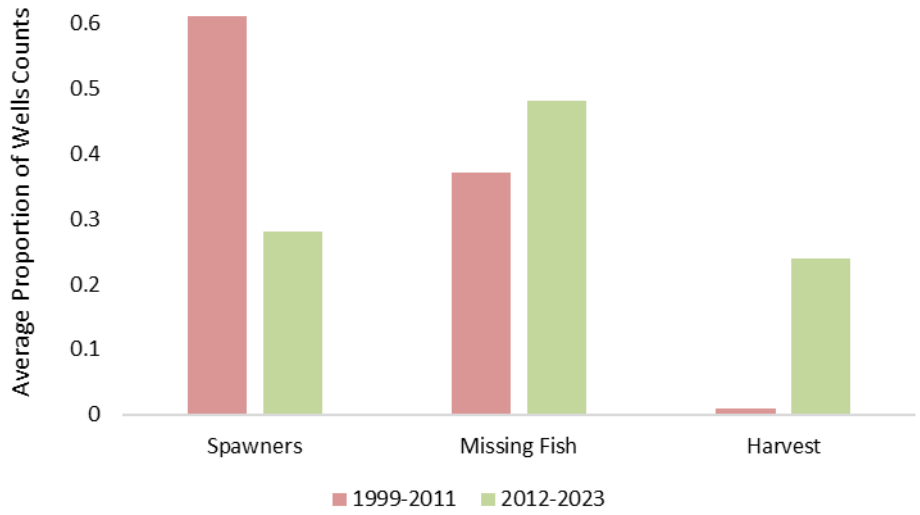

Figure 20. Spawning escapement (left columns), missing fish (middle columns), and harvest (right columns) as proportions of Wells Counts of Okanagan Sockeye in two periods representing differential fishery pressure above Wells Dam: 1999-2011 as none or developing fishery effort; and 2012-2023, as annual fishery exposure in Wells Reservoir and Canada, with removals ranging from 7.5-39 percent (see Figure 25).

A natural thermal barrier to migration in the US Okanogan River prevents an annually variable portion of returns from reaching the spawning grounds. Major and Mighell (1967) were first to investigate this thermal barrier, demonstrating that rising or stable water temperatures at or above 22°C block migration. In the presence of climate change, salmon managers fear an earlier onset and prolonged persistence of the thermal barrier in the future. Hyatt et al. (2020) reported that approximately 80 percent of the dates during July and August exceeded 20°C in the Okanogan River since the 1990s, in contrast with 50 percent of the days between the 1950s and 1990s. While thermal conditions in the Columbia River above Wells Dam remain cooler (seldom exceeding 20°C) than in the Okanogan River, lengthy holding in the Columbia near the Okanogan River mouth because of a persistent thermal barrier may subject Sockeye Salmon to protracted exposure (up to over 6 weeks; Hyatt et al. 2020) to stressful temperatures and to fisheries. Lengthy exposure to temperatures over 18°C predicts increased pre-spawn mortality (Martins et al. 2012). Though differences in thermal tolerance related to aerobic, cardiac, and heart-rate scope have been documented in Fraser River populations as a function of migration distance, effort, and rate, those local adaptations are to the historical temperature regimes that exerted selective pressures on those populations, and not future warmer temperatures (Eliason et al. 2011). It is unknown whether the Okanagan Sockeye Salmon population is nearing the upper limit of the thermal maxima to which the population has adapted.

Thermal conditions in the migration corridor between the Columbia River and the adult-holding habitat in the deep North Basin of Osoyoos Lake present formidable obstacles to surviving migration, and that adult holding habitat is limited by physical and chemical conditions (Figure 21). Even when a thermal barrier has not set up near the mouth of the Okanogan River, one may exist in the Okanogan River above the confluence of the seasonally cooler Similkameen River, and in Osoyoos Lake (Figure 22). Migrants successfully reaching that confluence must select between holding in the warming Similkameen where most will not survive (Fryer et al. 2017), or attempt pushing through the lethal temperatures of the shallow south and middle basins of Osoyoos Lake. Most Sockeye Salmon complete the approximately 140-kilometer migration from the Columbia River to suitable holding habitation in the North Basin of Osoyoos Lake in two to five days (Figure 23). This leads to further complications to the thermal delay near the mouth of the Okanogan River, as the thermal barrier can break temporarily only to reset hours or days later. Waiting Sockeye Salmon that resume migration in such events but that do not make it to a thermally acceptable location before the barrier resets, or do so but find a location that is only temporarily thermally tolerable, may not survive. The breaking of the thermal barrier and re-establishment a short time later occurs multiple times in some years (Figure 24), and can result in high mortality and very low escapement as in 2015 when only 8 percent of the Wells count reached the spawning grounds. These natural thermal conditions routinely reduce adult escapement to a fraction of counts at Wells Dam. Historically (1967-1998), the portion of the Wells Dam count that reached the spawning grounds averaged 37 percent (range 3% to nearly 100%), leading Hyatt and Rankin (1999) to describe the Canadian pre-FWMT escapement objective for Osoyoos Sockeye Salmon in terms of both Wells Dam counts (58,730) and spawner escapement (29,365 peak visual count) numbers (Figure 25).

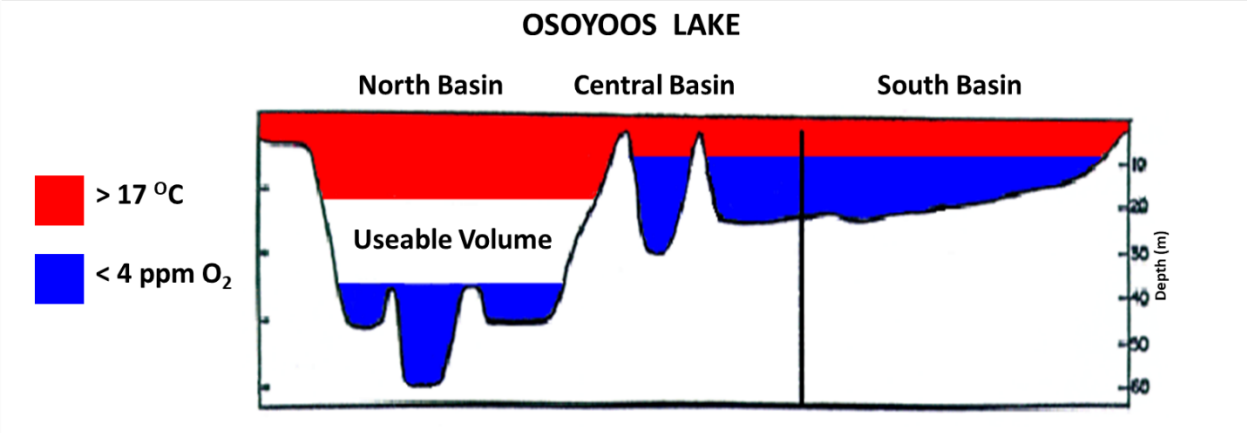

Figure 21. Osoyoos Lake bathymetric profile showing the inhospitable conditions for Sockeye Salmon juvenile rearing and adult holding in the Central and South basins due to stratification and eutrophication, and the squeeze between the thermally inhospitable epilimnion and hypoxic hypolimnion in the North Basin. The "useable volume" represents the habitable zone with sufficient oxygen and tolerable temperature for rearing and holding, which shrinks throughout the summer.

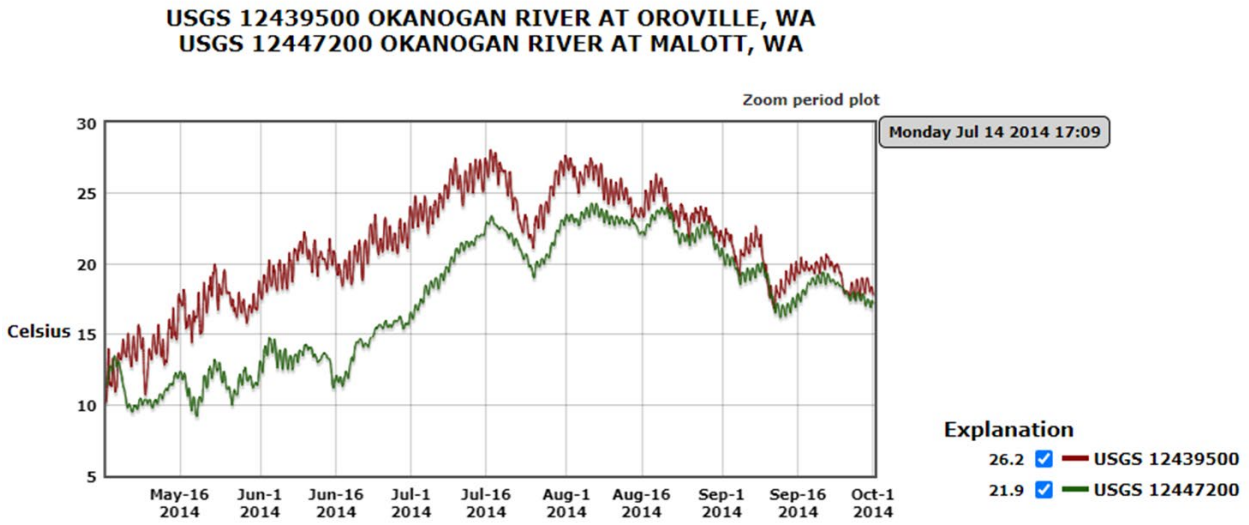

Figure 22. Water-temperature profiles for USGS gages near the mouth of the Okanogan River (Malott) and below the outlet of Osoyoos Lake but above the confluence with the Similkameen River (Oroville) approximately 116 river kilometers upstream, showing the difference in timing of the onset of the 22°C thermal barrier above and below the Similkameen River.

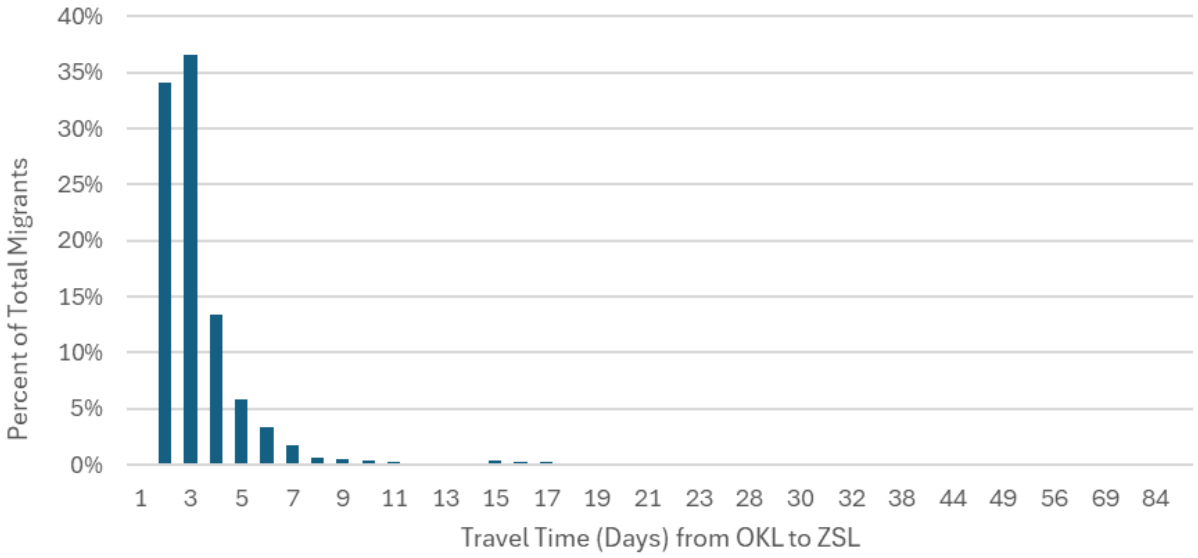

Figure 23. Travel time between PIT-tag-detection sites OKL (lower Okanogan) and ZSL (Zosel Dam) for 3,674 PIT-tagged Sockeye Salmon from 2014-2024, as a proxy for travel time from the mouth of the Okanogan River to the North Basin of Osoyoos Lake (approximately 140 kilometers). Note that the actual distance between OKL and ZSL is only 116 kilometers.

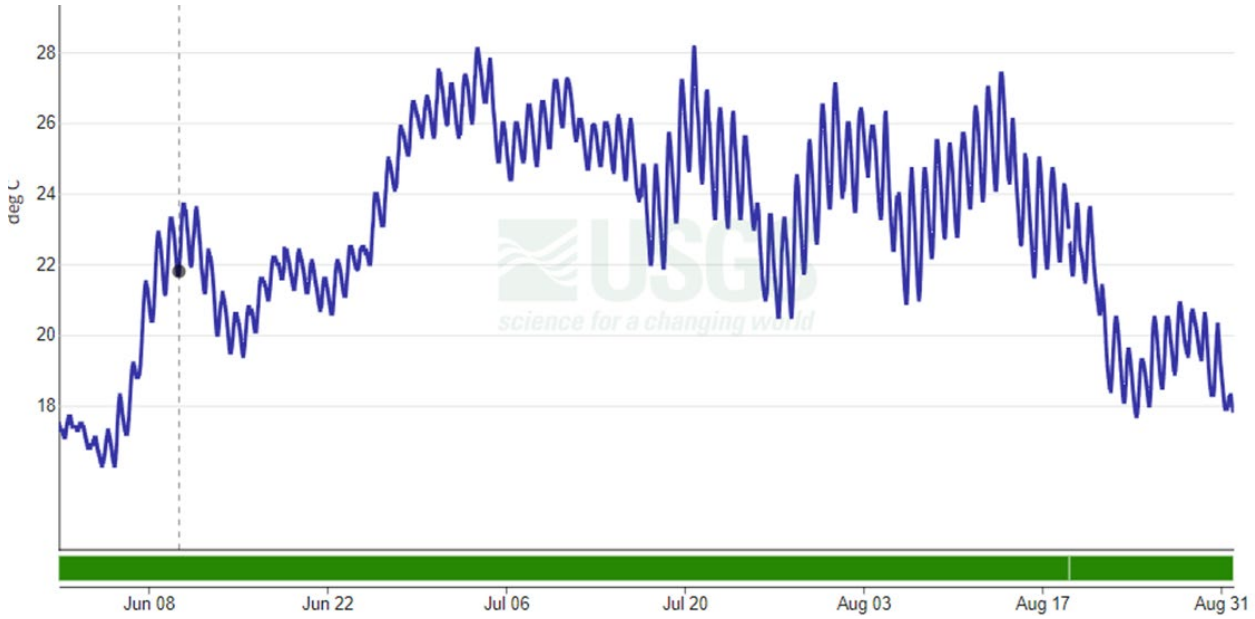

Figure 24. Okanogan River water temperature at the USGS Malott gage (12447200) showing the multiple breaks in the 22°C thermal barrier in 2015.

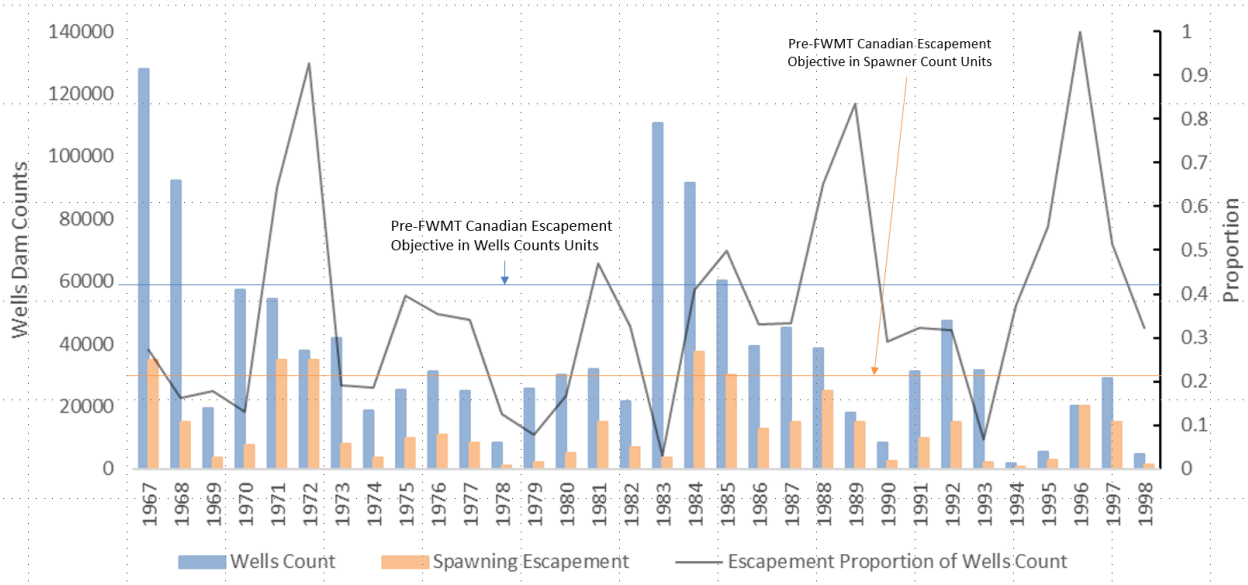

Figure 25. Historical (1967-1998) Wells Dam and spawning-escapement counts for Osoyoos Sockeye Salmon, with Canadian spawning escapement objectives for Osoyoos spawners expressed in both Wells Dam counts and spawning-escapement counts (per Hyatt and Rankin 1999) because of the anticipated loss of approximately 30 percent of the returns between Wells Dam and the Okanagan River spawning grounds.

In the last 50 years, no major fisheries for Okanagan Sockeye Salmon occurred above Wells Dam prior to 2010. Beginning in 2010, both US and Canadian harvest managers implemented non-tribal fisheries above Wells Dam. First Nations/tribal fisheries began in 2010 (Canada) and 2012 (US) above Wells Dam. The combined fisheries first removed greater than 10 percent of the

annual Wells Dam counts of Okanagan Sockeye Salmon beginning in 2012, and averaged 24 percent from 2012-2023 (range 7.5% to 39%; Figure 26, see Figure 20). It is unclear to what extent fisheries impact the ratio of missing fish or those that make it to the spawning grounds relative to counts at Wells Dam. However, the authors acknowledge the need to investigate the mechanisms that impact spawning escapement, especially in a warming climate. Moreover, the trends in missing fish and spawner escapement since 2012 are concerning given that thermal stressors are not expected to decline in the future. Errors in estimation of spawning escapement in Canada, counts at Wells Dam, and harvest in both the US and Canada could contribute to the missing fish proportion, and despite robust methods, those errors may increase for each of those metrics in years with very large runs. Sockeye hooked in a fishery that shake the hook loose before the angler can land them (referred to as "drop off") represent another potential source of error in estimates of recreational harvest. The degree to which such events result in delayed mortality depends upon many factors, including fish condition, how long the fish fights before dropping off, hooking location (e.g., gill raker or mouth), number of drop-offs a fish experiences, and cumulative thermal experience up to the time of hooking, and post-hooking water temperature (Patterson et al. 2017). No empirical data on the actual drop-off rates exists for the local Sockeye Salmon fishery.

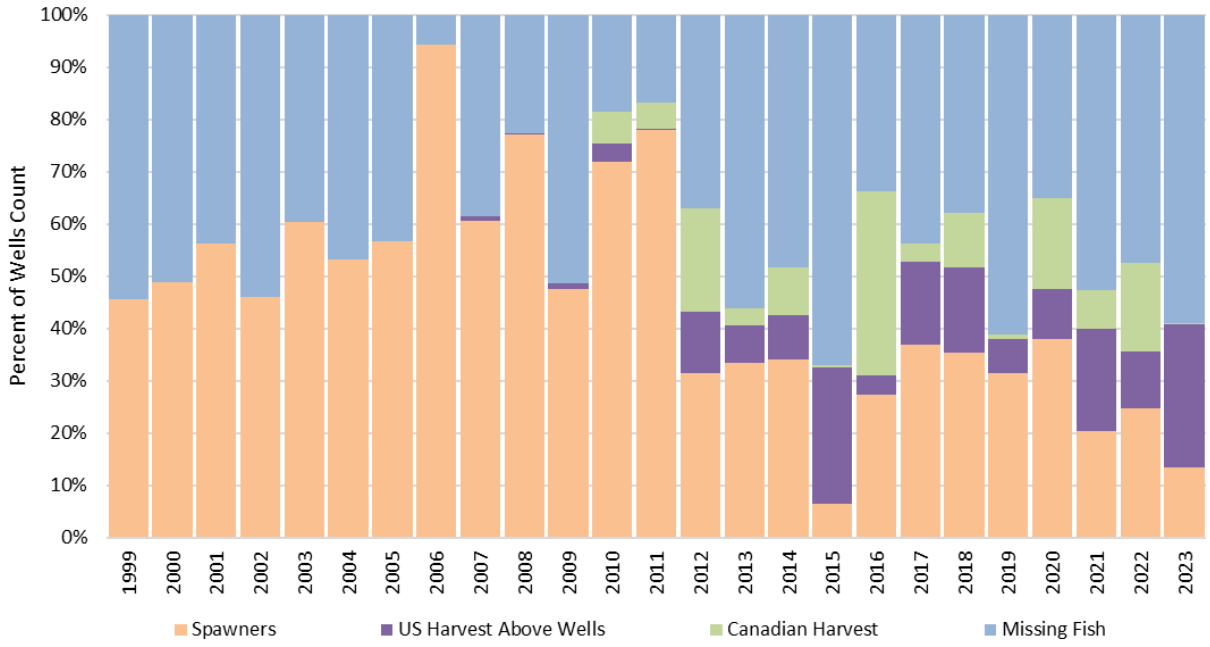

Figure 26. Annual Sockeye Salmon counts at Wells Dam from 1999-2023 apportioned by fates, with "Missing Fish" comprising those individuals lost between Wells Dam passage and spawning, and not accounted for in estimates of fisheries removals.

The persistence of the Okanagan Sockeye Salmon population in a warming climate depends upon continued juvenile survival in the mainstem Columbia River migration corridor, improved juvenile survival in the tributary and nursery lake habitats, improved adult survival to the spawning grounds, and seeding of the newly accessible historical spawning and rearing habitat. O'Sullivan and Alex (2024) estimated the escapement necessary for maximum seeding of spawning habitat

(in its current condition) for Osoyoos and Skaha lakes at approximately 148,000, and Department of Fisheries and Oceans Canada (DFO; 2024) estimated escapement ranging from 192,000-231,000 for maximum seeding for all three lakes. Those numbers do not account for any shore spawning in Okanagan Lake that might occur and is likely to occur given the shore-spawning kokanee population and the observed behavior of translocated Okanagan Sockeye Salmon in Cle Elum Lake. Since 2008, total Okanagan spawning escapement has averaged less than 65,000 and exceeded 200,000 once and 148,000 twice, both in the last 15 years. The current US escapement target of 65,000 adults at Priest Rapids Dam precludes the achievement of necessary escapement objectives for Okanagan Sockeye Salmon (and certainly for both Lake Wenatchee and Okanagan), and thus is substantially constraining smolt production from the Okanagan to well below capacity.

5.5 Methow River Coho Salmon

As described in the NNI Report above in Section 2.3.3, Coho Salmon had been effectively extirpated from the upper Columbia River prior to the construction of Wells Dam. However, in 1996, during HCP negotiations, the Confederated Tribes and Bands of the Yakama Nation (YN) initiated a reintroduction feasibility study in the Wenatchee and Methow subbasins. Anticipating a successful reintroduction program, Coho Salmon were included as a Plan Species in the Wells HCP. Reintroduction hatchery production for the Methow Subbasin began with brood year 1998, with smolts released in 2000 and annually since then (Figure 27). Redds have been counted since 2001, and natural-origin smolts enumerated since 2005 (see Figure 27). Wells Dam counts varied dramatically between 2006 and 2016, but have consistently exceeded 3,000 since 2017, and averaged 9,300 during that period (Figure 28).

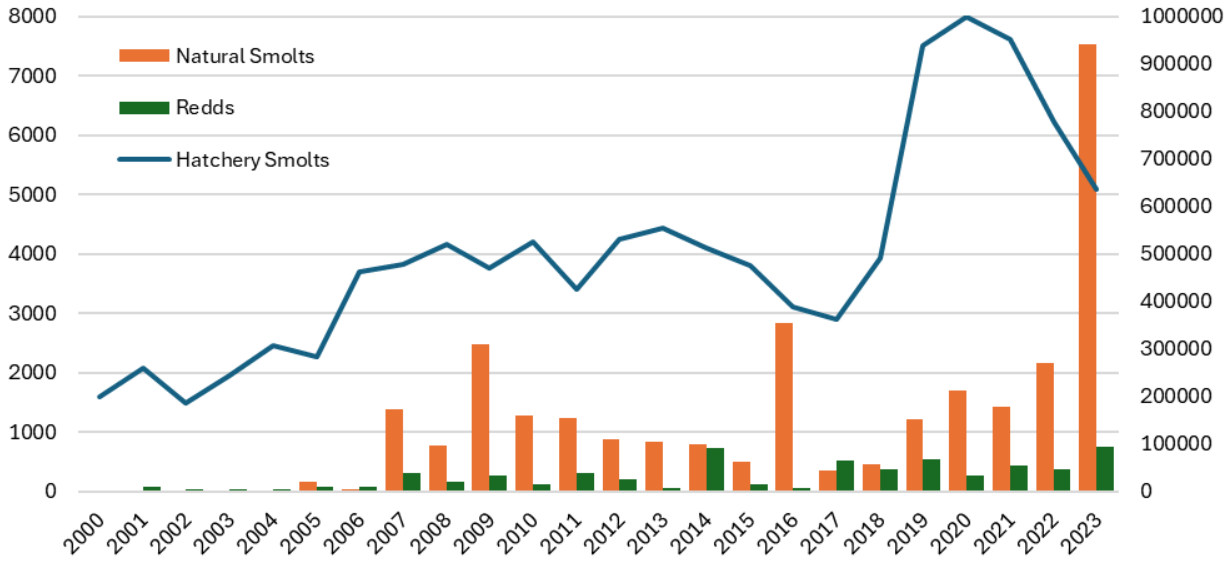

Figure 27. Releases to the Methow Subbasin of hatchery-origin Coho Salmon smolts (blue line, right y-axis) for release years 2000-2023; estimates of natural-origin Coho Salmon smolts produced in the Methow Subbasin derived from captures at smolt traps, 2005-2023 (orange bars, left y-axis); and, redd counts from the Methow Subbasin, 2001-2023 (green bars, left y-axis). Data from Caisman et al. 2024.

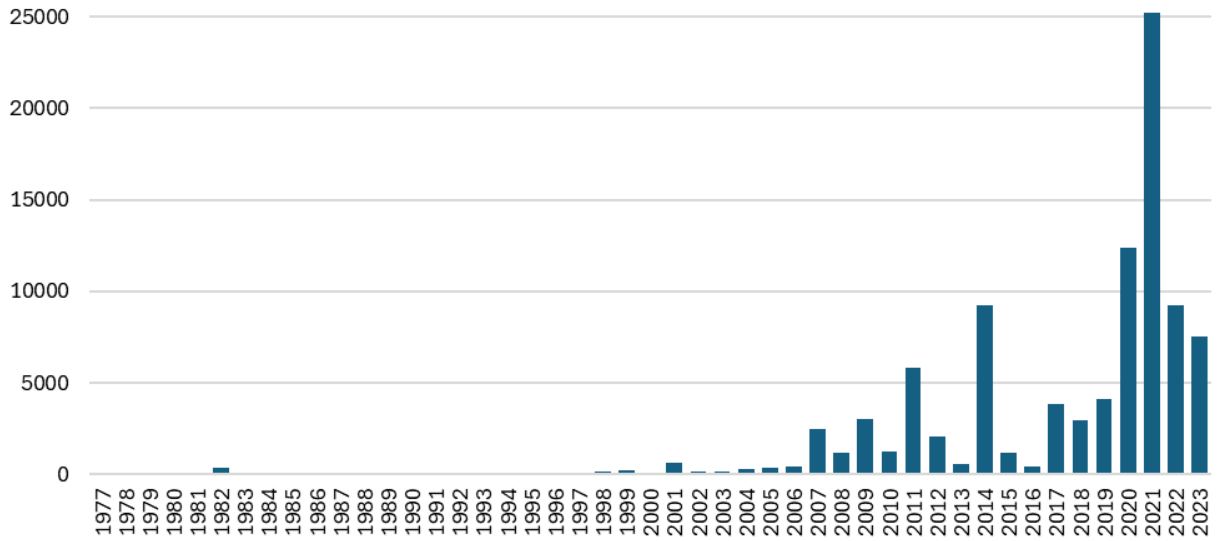

Figure 28. Counts of Coho Salmon adults and jacks at Wells Dam from 1977-2023. Numbers do not include broodstock collected from Wells Dam ladder traps below the count windows.

6.0 CONCLUSIONS

Douglas PUD has achieved and maintained No Net Impact for the Wells Project through the implementation of adult and juvenile passage plans and survival studies; the implementation of passage-loss and inundation-compensation hatchery production; through the strategic funding of tributary enhancement projects via the Wells Plan Species Account; and funding the development, modernization, and annual implementation of the Okanagan Fish and Water Management Tool. The next NNI progress report is due in 2033. Douglas PUD intends to maintain NNI during the intervening years by continuing the implementation of those measures through which NNI has already been achieved and maintained. Besides the implementation of routine measures, over the next ten years Douglas PUD will also conduct another survival verification study at Wells Dam (2030) and recalculate hatchery obligations (process begins in 2031 for 2032 broodstock collection). Douglas PUD also commits to continued investigation into means by which to measure Juvenile Project Survival for subyearling Chinook Salmon through the Wells Project, and to evaluate Project interactions with overshooting steelhead. Additional measures already underway include improvement in infrastructure at Wells Dam for detection of PIT-tagged juvenile Plan Species to clarify arrival timing and refine bypass operations. Finally, the 2012 issuance of a new FERC license for the Wells Hydroelectric Project in November 2012 provided for uninterrupted implementation of the Wells HCP through at least 2052, and offers certainty to all HCP signatories regarding the relationship of the HCP with other license requirements. Douglas PUD anticipates no impediments to the continued maintenance of NNI at the Wells Project for the foreseeable future.

7.0 ACKNOWLEDGMENTS

The success of the Wells HCP in achieving and maintaining NNI for the Wells Project is directly attributed to the collaborative nature of the Wells HCP committees and the committee representatives of each signatory party that have served over the course of Wells HCP implementation, including:

Wells HCP Coordinating Committee: Mark Miller, Brian Cates, Jim Craig, Bill Gale, and Jason Romine (USFWS); Ritchie Graves, Bryan Nordlund, and Scott Carlon (NMFS); Steve Parker, Bob Rose, Keely Murdoch, and Brandon Rogers (YN); Rod Woodin, Bill Tweit, Carmen Andonaegui, Theresa Scott, Jeff Korth, Chad Jackson, and Andrew Murdoch (WDFW); Bill Towey, Jerry Marco, and Kirk Truscott (CTCR); and Shane Bickford, Rick Klinge, Andrew Gingerich, and Tom Kahler (Douglas PUD).

Wells HCP Hatchery Committee: Jerry Marco and Kirk Truscott (CTCR); Kristine Petersen, Craig Busack, Lynn Hatcher, Justin Yeager, Brett Farman, and Emi Melton (NMFS); Brian Cates, Dave Carie, Bill Gale, Mathew Cooper, and Mathew Maxey (USFWS); Tom Scribner, Keely Murdoch, and Cory Kamphaus (YN); Kirk Truscott, Jeff Korth, Mike Tonseth, and Chad Jackson (WDFW); and Shane Bickford, Rick Klinge, Greg Mackey, Tom Kahler, and John Rohrback (Douglas PUD).

Wells HCP Tributary Committee: Bob Rose. Lee Carlson, Brandon Rogers, and Hans Smith (YN); Chris Fisher (CTCR); Dale Bambrick, Dennis Carlson, Justin Yeager (NMFS); Dennis Beich, Chris Parsons, Casey Baldwin, Carmen Andonaegui, Jeremy Cram, and Amanda Barg (WDFW); David Morgan, Kate Terrell, and Patrick (Shelby) Fowler (USFWS); and Rick Klinge, Shane Bickford, Tom Kahler, and Chas Kyger (Douglas PUD).

Wells HCP Policy Committee: Joe Peone, Kirk Truscott, and Cody Desautel (CTCR); Keith Kirkendall and Ritchie Graves (NMFS); Mark Miller, Brian Cates, Jessica Gonzales, Jim Craig, and Bill Gale (USFWS); Jeff Koenings, Bill Tweit, Jim Brown, Chad Jackson, Michael Livingston, and Brock Hoenes (WDFW); Steve Parker and David Blodgett, III, (YN); and Bob Clubb and Shane Bickford (Douglas PUD).

The late Mike Schiewe chaired the HCP Policy, Coordinating, and Hatchery committees from 2004 through early 2015, and John Ferguson has chaired the Policy and Coordinating committees from 2015 to the present. Both have provided outstanding leadership and led the Anchor QEA team in establishing and maintaining the administrative record of HCP implementation. Bob Bugert chaired the HCP Tributary Committees from 2004 through mid-2007, overseeing the establishment of operating procedures and funding policies, and otherwise setting the committees on a productive trajectory. Tracy Hillman (BioAnalysts, Inc.) took over as chair of the Tributary Committees in 2007 and continues to the present, and has led in the refinement of funding policies and project scoring criteria. Likewise, he has chaired the HCP Hatchery Committees since early-2015, guiding the committees through several complicated technical processes. Julie Pyper and Becky Sadler (current) of Chelan PUD served as Project Coordinators and logistical orchestrators for the Tributary Committee.

Several Anchor QEA staff members have provided indispensable support to the chairs of the HCP Policy, Coordinating, and Hatchery committees: Ali Wick, Carmen Andonaegui, Kristi Geris, Sarah Montgomery, Larissa Rohrbach, and Natasha Winnacott. Their contribution to the day-to-day functions of the respective committees has carried the Wells HCP implementation process through the 20 years since the FERC approval, including a robust administrative record of that process.

Finally, Keely Murdoch (current Yakama Nation representative to the Wells HCP Coordinating Committee and alternate representative to the Wells HCP Hatchery Committee), Krik Truscott (current Colville Confederated Tribes representative to the Wells HCP Coordinating Committee and Wells HCP Hatchery Committee), and Chad Jackson (current Washington Department of Fish and Wildlife representative to the Wells HCP Coordinating Committee) provided thoughtful, helpful comments and edits on drafts of this report. Three drafts were provided to the Wells HCP Coordinating Committee in advance of report approval and finalization.

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Appendix A

Douglas PUD's Responses to Comments Received from the Wells HCP Coordinating Committee on the *Draft 2024 Comprehensive Progress Report: Status of Achieving NNI under the Anadromous Fish Agreement and Habitat Conservation Plan – Wells Hydroelectric Project*

December 2024

Douglas PUD's Responses to Comments Received from the Wells HCP Coordinating Committee

Douglas PUD presented the first draft version of this report to the Wells HCP Coordinating Committee on October 25, 2024, and received edits and comments from Wells HCP signatory representatives to the Wells HCP Coordinating Committee during the 30-day comment period that ended on November 25, 2024. Those edits and comments were provided in tracked changes to the MS Word file, and a red-line file showing those edits and comments and Douglas PUD responses to them was provided to the Wells HCP Coordinating Committee along with a "clean" draft for approval on November 26, 2024. The following section lists the comments provided by Wells HCP Coordinating Committee members by reviewer, along with Douglas PUD's specific responses to those comments. References to sections, paragraphs, and pages refer to the draft document.

Douglas PUD received edits and the following comments from Keely Murdoch, Yakama Nation representative to the Wells HCP Coordinating Committee, on November 21, 2024, and further discussed those edits and comments via a telephone conversation with Tom Kahler (Douglas PUD) on November 25, 2024.

Comment 1 (In reference to Section 2.2, page 4, paragraph 2): Although it should be noted that conversion rates from only fish known to [originate] from areas upstream of Wells Dam would [sic] don't include fish from downstream population[s] which may overshoot into the Wells Project area and may realize higher mortality rates when trying to return downstream. Conversion rates do not represent the survival of all adult fish using the Project area. This should be briefly acknowledged in this discussion.

Response 1: Douglas PUD agrees and confirmed via telephone call that her edits to the paragraphs beginning at the bottom of page 5 and continuing through the first full paragraph on page 6 sufficiently address Comment 1.

Comment 2 (In reference to Section 2.2, page 4, paragraph 3): The Rocky Reach to Wells conversion rate says more about survival through the Rocky Reach Project Area than about Wells Dam and the Wells Project Area survival. Limitations of a Rocky Reach- Wells Conversion rate should also be acknowledged.

Response 2: Douglas PUD acknowledges on page 6 that the conversion rates do not include the Wells Reservoir, and discusses the limitations of the method for the Wells Project. Douglas PUD confirmed via telephone call that original text on page 6 regarding this issue, and her edits to the paragraphs beginning at the bottom of page 5 and continuing through the first full paragraph on page 6 sufficiently address comments 2 and 3 (see below).

Comment 3 (In reference to Section 2.2, page 5, Table 1): Doesn't this say more about survival through the Rocky Reach Project Area than Wells Dam and the Wells Project Area? The limitations of this method should be acknowledged.

Response 3: See Response 2, above.

Comment 4 (In reference to Section 2.2, page 5, paragraph 1): Do not agree with stating that a conversion rate is a 'minimum' since the whole project area is not measured, nor are a representative sample of all fish using the project area included in the conversion rate. I have suggested language similar to which the Committee recently approved in a CPUD conversion rate SOA.

Response 4: This comment accompanied and explained corrective edits that Douglas PUD accepted (with minor edits to grammar).

Comment 5 (In reference to Section 2.2, page 6, paragraph 0 [i.e., paragraph begins on page 5]): I don't think we can say "the actual survival rate" since we cannot measure indirect and delayed mortality and we are not including fish from downriver populations in the estimate.

Response 5: This comment accompanied and explained corrective edits that Douglas PUD accepted as provided.

Comment 6 (In reference to Section 2.2, page 6, paragraph 1): Navigating upstream by overshoot fish is not the issue. Whether overshoot fish make it successfully back is the real issue. Do overshoot fish suffer mortality or injury passing through the Wells Dam Powerhouse upon return? The adult survival metric is not simply one-way; it is a measure of how a dam impacts adult fish.

Response 6: This comment accompanied and explained corrective edits that Douglas PUD accepted as provided.

Comment 7 (In reference to Section 2.2, page 8, footnotes 1 through 3 of Table 2): These studies are 25-30 years old. It's possible these values change over time, especially if there is a connection between warming river temps downstream and overshoot behavior for thermal refuge. Do we have a pathway to update these evaluations or are we supposed to rely on the same values for the 50 -year lifespan of the HCP?

Response 7: Douglas PUD confirmed via telephone call that this comment does not necessitate edits or revisions to the report, but was simply a question for future consideration by the Wells HCP Coordinating Committee.

Comment 8 (In reference to Section 4.4, page 31, paragraph 2): I understand this plan was new in 2006, it is no longer 'new' so this terminology is confusing as we are about to have another 'new' version.

Response 8: This comment accompanied and explained corrective edits that Douglas PUD accepted as provided.

Comment 9 (In reference to Section 4.4, page 32, paragraph 3): If the migratory survival is limiting natural production, hatchery production will not fix the issue, but may buy us time to fix the issue. In this scenario an in-basin reference stream will not provide further information because

natural origin fish in the reference stream would be subject to the same limiting life stage as natural origin fish produced in the treatment stream. An in-basin reference stream may lead to the conclusion the hatchery program is "not working" because there is no change in the abundance and productivity of natural origin fish. I think this is [a] very real scenario of what we are working with in the Upper Columbia.

Response 9: This comment accompanied and explained corrective edits that Douglas PUD accepted as provided.

Comment 10 (In reference to the title page for Appendix A, page 45): Section 6.9 of the Wells HCP is very specific about including an analysis to determine if each plan species [is] rebuilding. Because this is specifically called out, I am confused why this section is an appendix rather than in the main body of the report. I would recommend including this information [in] a section within the report.

Response 10: Douglas PUD moved the Status of Plan Species from Appendix A to the body of the report above the Conclusions section, and moved this comment and response section to Appendix A.

Douglas PUD received edits and the following comments from Kirk Truscott, Confederated Tribes of the Colville Reservation representative to the Wells HCP Coordinating Committee, on November 27, 2024, and further discussed those edits and comments via several (separate) telephone conversations with Andrew Gingerich (Douglas PUD) and Tom Kahler (Douglas PUD) on November 27, December 11, and December 13, 2024.

Comment 1 (In reference to Section 5.4, page 43): General comment: This section goes to great length to discuss and in my opinion lead the reader to a conclusion that harvest and [FRIM] are the primary contributors (cause) for reduced escapement and increase in the proportion of "missing Fish" passing Wells Dam and is a major threat to the continuation of the population.

Response 1: The intent is not to lead the reader to that conclusion, since harvest is already a reported contributor to reduced escapement recognized by all PST parties. Rather, the intent is to describe an additional factor capable of explaining an unquantified portion of the "missing fish," the magnitude of which has changed since 2012, while other factors remain within the range of historical variation. The inclusion of this information regarding FIRM is not based upon a tangential reference to an obscure publication. Canadian researchers have a long history of investigation into the causes of declines of Fraser River stocks. That investigation includes much research on the physiology of migrating adults and the interactions of disease burden, environmental conditions in the migration corridor, and additional stressors (e.g., fishery encounters) with the physiological condition of the returning adults as a predictor of migration (and ultimately, spawning) success. These investigations have yielded dozens of peer- reviewed publications in primary journals and Secretariat-level reports informing Canadian fisheries management decisions. The cited reference [Patterson et al. 2017] for the discussion on FRIM is a Canadian Science Advisory Secretariat review commissioned specifically to serve as the basis for updating the FRIM estimation used by DFO in fisheries management, and a companion publication by [a] subset of those authors provides guidance for that update. Based upon these two reports and

other more-recent publications, Canadian fisheries managers currently apply in Fraser River management a model that includes both water temperature and river discharge as variables affecting FRIM. [reference: Patterson, D.A., Robinson, K.A., Lennox, R.J., Nettles, T.L., Donaldson, L.A., Eliason, E.J., Raby, G.D., Chapman, J.M., Cook, K.V., Donaldson, M.R., Bass, A.L., Drenner, S.M., Reid, A.J., Cooke, S.J., and Hinch, S.G. 2017. Review and Evaluation of Fishing-Related Incidental Mortality for Pacific Salmon. DFO Can. Sci. Advis. Sec. Res. Doc. 2017/010. ix + 155 p.]

Comment 2 (In reference to the caption for Figure 19, page 44): If Skaha spawners in the Penticton Channel are not differentiated for hatchery and natural-origin spawners and Skaha spawners are relatively abundant such as in 2018, 2020 and 2022, how can we state that "Skaha and Okanagan lakes spawners are primarily hatchery-origin returns from reintroduction efforts.?

Response 2: I [Tom Kahler] confirmed that carcass surveys are indeed conducted (though results were not reported in the dataset from which this graph was generated), and it turns out that spawners in the Penticton Channel are NOT primarily HO returns. See edits.

Comment 3 (In reference to Section 5.4, paragraph 2, page 44): There are no Figures titled A-4 and A-5.

Response 3: Corrected throughout. Legacy issue from KM [Keely Murdoch] request to move this appendix section into the main body. Keely's comment was a good one. We moved it but missed the in-text references to figures. This has been corrected throughout.

Comment 4 (In reference to Section 5.4, paragraph 3, page 48): What is the definition of "substantial"? Yes, sockeye harvest increased beginning in 2012; however, there is a fair amount of variability (spit balling the graph, harvest estimates appear to range from 8-10% to 35-40%). I suggest that this language indicate that harvest has increased since 2012 ranging between x-y% and let the reader determine if the harvest removal is "substantial."

Response 4: Removed. Agree. No quantity given. Reworded to remove subjective language.

Comment 5 (In reference to Section 5.4, paragraph 3, page 48): [I] Don't see a Figure A-7. I see Figure 21 that appears to be related to the "fate" of sockeye passing Wells Dam. This apparent mislabeling of tables in this sockeye section is repeated throughout.

Response 5: Yes, good catch. When I [Tom Kahler] moved this section from the appendix to the report main body, I neglected to update the figure captions.

Comment 6 (In reference to Section 5.4, paragraph 3, page 48): In my opinion, this statement, while technically true, it also leads the reader to [the] conclusion that the reduced average spawn escapement from 61% to 28% is a result of harvest implementation. The causation is likely attributable to many different factors and not simply the result of harvest actions. To suggest that the reduction in escapement is due primarily to harvest actions suggests that harvest impacts ae 100% additive mortality and that there is no compensatory mortality consideration and no other mortality factors are in play. I would disagree. Factors such as additive thermal stress before fish

ever pass wells dam, periodic thermal breakdown and re-establishment of the Okanogan thermal barrier and the O^2/temp squeeze in the north basin of Osoyoos Lake could all impart mortality regardless of whether or not there were harvest actions.

Response 6: We agree that multiple factors contribute to migratory and spawning success of those individuals that pass Wells. Those factors operated in both periods that we compared in the accompanying figures, and have done so throughout the historical record. Therefore, the harvest activity is in addition to the other factors that operated in both periods, and if the harvest activity had no effect beyond the reported catches, we would expect those other factors to result in levels of "missing fish" consistent with the prior period. Since those levels are not consistent, we sought answers for the observed differences. Canadian researchers have found that they have been underestimating FRIM because studies of FRIM had generally reported only short-term (24-hour or sometimes 48-hour) mortality and have not consistently included water temperature. FRIM studies holding fish from 96 hours to up to four weeks have identified temperature effects on FRIM at temperatures above 16 degrees. Those effects are dose-dependent (increasing probability of mortality with increasing temperature), which is a strong indicator of causation in correlative statistical analyses. We are certain that FRIM is not the only factor contributing to increased "missing fish," because we would expect increasing pre-spawn mortality with increasing temperature even without a fishery. However, the reported synergy between FRIM and temperature should warrant our mention and concern given warming temperatures and the level of fisheries effort coinciding with annual thermal maxima. What we have observed is that in years where the sockeye face a persistent thermal barrier and high temperatures, the "missing fish" proportion is higher than in years where the thermal barrier is late, or short-lived, and temperatures are lower during the period of reservoir residence. The comparison of 2016 and 2023 is just the two years I selected to highlight because I already had the data. We also observed this to a lesser extent below Wells, but we expect that it would manifest most readily in and above Wells Reservoir because the fish spend the most time in those locations and have the longest exposure to fisheries at high temperatures. Only 39.9% of the Sockeye PIT-tagged at Wells Dam in 2023 were detected at OKL—a rate lower even than in 2015. In contrast, 95.3% of the sockeye tagged at Wells were detected at OKL in 2016. Because the Wells-to-OKL detection rate is an indicator of losses downstream of OKL rather than in the Okanogan River above OKL or holding habitat in Osoyoos Lake, we cannot attribute the missing fish in 2023 solely to mortality factors operating upstream of Wells Reservoir.

Comment 7 (In reference to Section 5.4, paragraph 3, page 48): I'm not saying that harvest has no impact, but there needs to be consideration of other factors contributing to mortality (see above comment). Also, if I remember correctly, the spawn escapement estimate methods were variable between 1999 and 2023. I don't recall when the escapement methodology shifted to the AUC method, but it should be reviewed to determine if the methodology change coincided with the general reduction in escapement estimates post 2011, to rule out potential bias of escapement estimates due to different methods.

Response 7: We agree about the need for identifying any bias from a methodological change. In investigating methods we confirmed that the escapement methods changed in 2002, leaving 10 years of pre-2012 data collected using the same methods as used from 2012-2023 (AUC). The methods used prior to 2002 relied on peak counts in index areas, and only one or two surveys per

year. Therefore, the spawner escapement in those years was likely biased low. However, leaving out 1999-2001 from the "before" period (i.e., using only 2002-2011) results in a higher average escapement (65%, rather than 61% with 1999-2001 included), and thus the comparison with 1999-2001 included is conservative.

Comment 8 (In reference to Section 5.4, paragraph 4, page 50): This is conjecture. Mortality from additive thermal stress, periodic breakdown and re-establishment of the Okanogan river thermal barrier and pre-spawn holding mortality in the north basin of Osoyoos Lake and changes in escapement methodologies may have an effect on the "increase in missing fish."

Response 8: We moderated the language, but see the response above to your [sixth] comment. The Canadian studies mentioned specifically identified underestimation of FRIM due to the lack of studies holding fish beyond 48 hours or accounting for a realistic range of holding temperatures. Again, the studies holding fish for 96 or more hours and with a range of real-world temperatures identified mortality not observed in studies with shorter post-harvest/handling periods. If the current assumptions used by local fisheries managers are based only on 24-hour or 48-hour hold times, then they are likely to underestimate FRIM. We used the words in the original text "possibly due to inappropriate assumptions" to allow for alternative explanations, but suspect that the relatively new science has not been incorporated into current creel methods. Nevertheless, we have moderated the language further in response to this comment.

Comment 9 (In reference to Section 5.4, paragraph 3, page 48): Conjecture. Until there is data to establish the hook-and-landed ratio, we don't have data to assert that "many" fish are subjected to FRIM. In addition, there is likely a difference in [FRIM] between fish that are hooked and lost and those that are hooked, landed and then released, with the latter resulting in a greater [FRIM].

Response 9: Edited and softened. While studies have not provided a defensible estimate for our local fisheries, plenty of anecdotal evidence supports the statement that during the typical angler outing fish are hooked but not successfully landed. Many fishers collectively experiencing such lost opportunities results in many fish subjected to conditions known to contribute to FRIM. Nevertheless, we agree that "many" is a subjective term and the rate is unknown. We recommend investigating the rate for our local fisheries to close this data gap.

Comment 10 (In reference to Section 5.4, paragraph 3, page 48): If I was confident that we have appropriately accounted for all forms of mortality contributing to "missing fish" and that changes in escapement estimate methodologies have not imparted a bias relative to the comparison of pre and post 2012 escapement estimates, I wouldn't be so concerned with this statement. Since we don't, I have concerns that this leads the reader to conclude that FRIM is the primary contributor [to] the increase of "missing fish". Yes, it is a contributor, but to what extent is unknown.

Response 10: Revised to point out the need to investigate what appears to be corollary at this point. As described above, we addressed the question of bias related to methodological differences in the time series—that's not an issue. We have modified this to emphasize the need to evaluate what emerging science has identified as an important and underappreciated contributor to fishery- and temperature-dependent pre-spawn mortality in a generally analogous system.

Comment 11 (In reference to Section 5.4, paragraph 3, page 48): Again, how do we know that harvest mortality was strictly additive and no compensatory mortality is at some level in play? I don't think that simply comparing these two years supports that harvest is the primary culprit for the missing fish. In [2023], did the thermal barrier breakdown and re-establish multiple times and if so when? What were the adult holding conditions in Osoyoos Lake in [2023]? Same questions for 2016.

Response 11: As described in a response to an above comment, these are only two years of several that show differences in missing fish with differences in temperature and fishery exposure time. The differences were stark in those two years in the proportions of the runs exposed to both high temperatures and a fishery, so they seemed like the best example. To the point about compensatory versus additive mortality, we don't know to what extent the harvest and FRIM are compensatory or simply additive in any given year. However, the 2016 escapement to Osoyoos was very high, but the Canadians harvested over half of those fish. I'm not aware of any environmental conditions that would have prevented the 2016 run from a spawner escapement approaching 200,000 had there not been fisheries.

Douglas PUD received edits and the following comments from Chad Jackson, Washington Department of Fish and Wildlife representative to the Wells HCP Coordinating Committee, on December 17, 2024, and further discussed those edits and comments via MS Teams Meeting with Tom Kahler (Douglas PUD) on December 17, 2024.

Comment 1 (In reference to Section 5.4, paragraphs 3 and 4, pages 46 and 47): So, for the thermal barrier I think there's three main issues. First, it forces sockeye to stage in the reservoir for 2-3 months under different water quality conditions (e.g., temps, flow, etc.) that may vary annually and cause [mortality]. Second, water temps in the Okanogan can temporarily break, sockeye enter, and then get trapped causing mortality. Third, (as you mentioned) there can be a thermal barrier coming out of Osoyoos. All of these cause some level of mortality contributing to missing fish.

Response 1: I [Tom Kahler] added some text and references to elaborate on these points, and split the paragraph.

Comment 2 (in reference to Section 5.4, paragraph 5, pages 48 and 49): So, for harvest it's (obviously) a known removal of sockeye. What might contribute to missing fish is errors in harvest estimates (i.e., sometimes wide error bounds) and sockeye "drop off". Drop off refers to sockeye that shake off an angler's line sometime between being hooked and before being handled/netted and released. Mortality associated with drop off depends upon at which point during the fight they drop off, water temperatures, conditions ("fresh" vs "stale"), how often it occurs (more when it was barbless hooks required vs barbed hooks allowed).

Response 2: I updated this to include discussion of this topic to cover these points and to replace some of what was deleted below in a more general context.

Comment 3 (In reference to Section 5.4, paragraph 6, pages 50 and 51): For this paragraph I recommend addressing other factors that contribute to missing fish including, but not necessarily limited to:

1. Natural pre-spawn mortality in the reservoir waiting for the thermal barrier to break.
2. Sockeye condition upon arrival in the reservoir ("fresh" versus "stale").
3. Run size above Wells (i.e., less problems if 100K in reservoir versus 500K; space/crowding issue).
4. Errors in counts at Wells Dam.
5. Error in spawner escapement estimates

Response 3: I abandoned this deleted material because I addressed the agreed upon points from it in the preceding paragraph.