

LOWER SNAKE RIVER COMPENSATION PLAN:
Oregon Spring Chinook Salmon Evaluation Studies
2021-2023 Annual Progress Report



Oregon Department of Fish and Wildlife
Northeast Oregon Research and Monitoring

Joseph H. Dittmer
Joseph W. Feldhaus
Justin D. Fisk
Aidan G. Buch

July 2026



This program receives federal financial assistance from the U.S. Fish and Wildlife Service and prohibits discrimination based on race, color, national origin, age, sex, or disability. If you believe that you have been discriminated against as described above in any program, activity, or facility, or if you desire further information, please contact ADA coordinator, Oregon Department of Fish and Wildlife, 4034 Fairview Industrial Drive, SE, Salem, OR 97302, 503-947-6000, or contact the Office of Diversity and Inclusive Workforce Management, U.S. Fish and Wildlife Service, 5275 Leesburg Pike, Mailstop: ODIWM Falls Church, Virginia 22041-3803 or call (703) 358-1724.

This report is available at:

- <https://www.fws.gov/office/lower-snake-river-compensation-plan/library>
- <https://nrimp.dfw.state.or.us/DataClearinghouse/default.aspx?p=202&XMLname=42799.xml>

Suggested citation: Dittmer, J.H., J.W. Feldhaus, J.D. Fisk, A.G. Buch. 2026a. Lower Snake River Compensation Plan: Oregon spring Chinook Salmon evaluation studies, 2021-2023. Annual Progress Report. Oregon Department of Fish and Wildlife, Salem.

Photo cover: Unspawned female Chinook Salmon recovered from Hurricane Creek, September 2023: Photo by Joseph Feldhaus.

ANNUAL PROGRESS REPORT

FISH RESEARCH PROJECT OREGON

PROJECT TITLE: Lower Snake River Compensation Plan: Oregon Spring Chinook
Salmon Evaluation Studies

CONTRACT NUMBER: F22AC00019 & F23AC00378

PROJECT PERIOD: 1 January 2021 through 31 December 2023

Prepared By: Joseph H. Dittmer
Joseph W. Feldhaus
Justin D. Fisk
Aiden G. Buch

July 2026

Oregon Department of Fish and Wildlife
4034 Fairview Industrial Drive, SE
Salem, OR 97302

This project was financed by the U.S. Fish and Wildlife Service under the Lower Snake River
Compensation Plan.

Preface

This annual progress report provides summary information for the Lower Snake River Compensation Plan (LSRCP) spring Chinook Salmon programs operated by the Oregon Department of Fish and Wildlife (ODFW) in the Imnaha and Grande Ronde River basins for calendar year 2021 through 2023 per data availability. Also included in this report are summaries of data collected at Chinook Salmon broodstock collection facilities operated by co-managers, the Nez Perce Tribe (Lostine River) and the Confederated Tribes of the Umatilla Indian Reservation (Catherine Creek and Upper Grande Ronde River) and funded by the Bonneville Power Administration. These ongoing monitoring and evaluation programs provide technical, logistical, and biological information to managers charged with maintaining viable natural Chinook Salmon populations and managing hatchery programs and recreational and tribal fisheries in northeast Oregon.

Data in this report serves as the basis for assessing the success of meeting management objectives and were derived from hatchery inventories, standard databases, through standard sampling techniques, or provided by other agencies. As such, specific protocols are usually not described. When possible, data obtained from different sources were cross-referenced and verified. In cases where expansions of data or unique methodologies were used, protocols were described in more detail.

Coded-wire tag (CWT) data collected from 2018–2023 returns was used to evaluate smolt-to-adult survival rates, harvest, straying, escapement, and specific information on experimental results. In addition, much of the data discussed in this report will be used in separate and specific evaluations of ongoing supplementation and research programs for Chinook Salmon in the Imnaha and Grande Ronde River basins. Salmon culture evaluations began in 1983 and have improved many practices. Progress for work completed in previous years is presented in annual progress reports available at the [LSRCP library website](#) and the [ODFW Data Clearinghouse](#).

In this report, data are organized into nine priority monitoring and evaluation objectives. Results presented for objective are used to inform the four primary management goals of recovering natural populations, ensuring a high probability of population persistence, restoring sport and tribal fisheries, and minimizing the risk of potential negative effects of artificial production. Additionally, results are used to gauge success in meeting LSRCP hatchery mitigation goals for smolt releases and mature (age 3-6) salmon returns.

Contents

Preface.....	ii
List of Figures	3
List of Tables	4
EXECUTIVE SUMMARY	6
Introduction.....	9
Program Goals	9
Management Goals and Evaluation objectives	11
Sliding scales	12
Methods.....	12
Juvenile Disease Monitoring.....	13
Escapement Monitoring	13
Pre-release sampling	15
Broodstock collection and hatchery spawning	15
Fecundity.....	15
Proportion of Natural Origin broodstock (pNOB).....	15
Proportionate Natural Influence (PNI).....	16
Juvenile survival to Lower Granite Dam	16
Weir operations.....	16
Genetic monitoring	17
Recruits per spawner.....	18
Calculating mitigation goals	18
Terminal Fisheries	19
Results and Discussion	20
Objective 1. Document and assess fish culture and hatchery operation practices and performance.	20
2021-2023 Trapping and spawning	20
3-year average: Fecundity, age structure, and pNOB	26
Genetic monitoring	35
Green egg-to-smolt and marking	39
Objective 2. Determine optimum rearing and release strategies	43
Production tagging and smolt releases.....	43
Objective 3. Determine total catch and escapement, smolt survival, smolt-to-adult survival, and assess if adult production meets mitigation goals.	52
Catch and Escapement	52
Total adult production and compensation area returns	58
Smolt-to-adult survival and return rates	60

Juvenile survival compared to smolt-to-adult return rates.....	61
Objective 4. Compare recruits-per-spawner (R:S) for hatchery and natural origin fish.....	63
Hatchery origin R/S	63
Natural origin R/S	63
Objective 5. Assess response in natural population abundance and productivity to supplementation.	65
2021-2023 Chinook Spawning Ground Surveys	65
Hatchery and Natural Origin Tributary Returns	74
Objective 6. Assess and compare life history characteristics (smolt migration, run timing, age structure, sex ratio, fecundity) of hatchery and natural fish.	78
Hatchery smolt releases vs natural smolt out-migrants	78
Adult run timing to the tributaries	81
Objective 7. Determine the success of maintaining genetic integrity of endemic wild spring Chinook Salmon in the Minam and Wenaha rivers.	86
Objective 8: Assess success in restoring fisheries.	87
Objective 9: Coordinate project activities and disseminate results	89
Acknowledgments.....	91
References.....	92

List of Figures

Figure 1. Mean fecundity (± 1 SD) for age 3-5 Chinook Salmon spawned at Lookingglass Fish Hatchery, brood years 2013 to 2023.	33
Figure 2. Proportion of natural-origin broodstock in the Catherine Creek, Imnaha River, Lookingglass Creek, Lostine River, and Upper Grande Ronde conventional hatchery programs, brood years 2013-2023.	33
Figure 3. Broodstock at Lookingglass Fish Hatchery and the proportion of parentage-based tagging (PBT) stock assignments, spawn year 2021-2023.	39
Figure 4. Green egg-to-smolt survival rates (%) for conventionally produced Chinook Salmon at Lookingglass Fish Hatchery, brood years 2012-2021.	40
Figure 5. Hatchery spring Chinook Salmon smolt releases in the Imnaha River, 1983-2021 brood years.	49
Figure 6. Hatchery spring Chinook Salmon smolts released in Catherine Creek, Lookingglass Creek, the Lostine River, and the Upper Grande Ronde River compared to smolt release goals, 1997-2021 brood years.	49
Figure 7. Release strategies and release dates for hatchery spring Chinook Salmon smolts released into Catherine Creek, the Imnaha River, Lookingglass Creek, the Lostine River, and the Upper Grande Ronde, release years 2013-2023.	50
Figure 8. Mean apparent survival to Lower Granite Dam of PIT-tagged hatchery juvenile Chinook Salmon released into Catherine Creek, the Imnaha River, Lookingglass Creek, the Lostine River, and the Upper Grande Ronde River.	51
Figure 9. First release date compared to estimated juvenile survival rate (%) to Lower Granite Dam.	51
Figure 10. Total age 3-5 Chinook Salmon production from captive and conventional Grande Ronde basin and Imnaha basin hatchery programs, return years 1997-2023.	58
Figure 11. Total age 3-5 production of Chinook Salmon from captive and conventional Grande Ronde and conventional Imnaha River basin hatchery programs returning to the compensation area, run years 1997-2023.	59
Figure 12. Age 3-5 returns to the compensation area of hatchery-origin Chinook Salmon produced by the Catherine Creek, Imnaha River, Lookingglass Creek, Lostine River, and Upper Grande Ronde stocks, run years 1997-2023.	60
Figure 13. Smolt-to-adult survival (SAS) and return (SAR) rates for captive and conventional production programs, complete brood years 1998-2018.	61
Figure 14. Estimated juvenile survival rate to Lower Granite Dam compared to smolt-to-adult return rates for captive and conventional program smolts.	62
Figure 15. Total adult return to river recruits per spawner ratios for conventional hatchery production from Catherine Creek, Imnaha River, Lookingglass Creek, Lostine River, and Upper Grande Ronde, and Imnaha River populations, complete brood years (1985–2018)	63
Figure 16. Total age 3–5 return to river recruits per spawner ratios for naturally produced populations of Catherine Creek, Imnaha River, Lookingglass Creek, Lostine River, and Upper Grande Ronde, Imnaha River, Minam River, and Wenaha River spring- summer Chinook Salmon populations.	64
Figure 17. Total unexpanded Chinook Salmon redds counted in Index and Extensive survey reaches in the Grande Ronde and Imnaha River basins, 1988–2023.	66

Figure 18. Total returns of age 3–6 hatchery and natural origin Chinook Salmon to supplemented populations in Catherine Creek, the Imnaha River, Lookingglass Creek, the Lostine River, and Upper Grande Ronde River, return years 1996-2023.	75
Figure 19. Proportion hatchery origin spawners including jacks in the five supplemented and two wilderness populations, spawning years 2011-2023.	77
Figure 20. Estimated total number of age 3–6 natural origin Chinook Salmon in each of the Independent Populations of Snake River Chinook Salmon, spawning years 1994 to 2023.	77
Figure 21. Proportionate natural influence (PNI) for the Catherine Creek, Imnaha River, Lookingglass Creek, Lostine River, and Upper Grande Ronde River populations, return years 2011 to 2023.	78
Figure 22. Arrival time at Lower Granite Dam of hatchery and natural Chinook Salmon smolts emigrating from the Grande Ronde and Imnaha basins, travel metrics, and the proportion subject to barging for migration years 2021-2023.	80
Figure 23. Annual estimated weir efficiency for streams in the Grande Ronde and Imnaha basins, 1997–2023.	82
Figure 24: Return years 2021–2023 cumulative arrival date of age 3–5 hatchery and natural Chinook Salmon trapped at weirs on Catherine Creek, Imnaha River, Lookingglass Creek, Lostine River, and the Upper Grande Ronde River.	84
Figure 25. Total Chinook Salmon harvested by origin and fishing method (Sport or Tribal) in sport and tribal fisheries in Catherine Creek, the Imnaha River, Lookingglass Creek, the Lostine River, and the Upper Grande Ronde River, return years 2000-2023.	88

List of Tables

Table 1. Lower Snake River Compensation Plan mitigation goals for Oregon’s spring Chinook Salmon in the Grande Ronde and Imnaha River basins.	10
Table 2. Mitigation goals specific to the Grande Ronde and Imnaha River spring/summer Chinook Salmon populations.	11
Table 3. Numbers and dispositions, by origin, age, and sex of age 3-5 spring Chinook Salmon returning to northeast Oregon in 2021-2023.	27
Table 4. Spawning summaries of spring Chinook Salmon from the Conventional Hatchery Programs at Lookingglass Fish Hatchery for the Imnaha and Grande Ronde basins, spawning years 2021 – 2023.	32
Table 5. Numbers of successfully spawned hatchery males (M) and females (F), mean fecundity, and proportion of natural-origin broodstock (pNOB) for conventional production at Lookingglass Fish Hatchery from brood years 2014–2023, by stock: Catherine Creek, Imnaha River, Lookingglass Creek, Lostine River, and Upper Grande Ronde River.	34
Table 6. The genetic stock assignment for hatchery Chinook Salmon used for broodstock at Lookingglass Fish Hatchery, spawn years 2021– 2023. IMNW = Imnaha stock, CTHW = Catherine Creek stock, LKGW = Lookingglass Creek stock.	37
Table 7. Conventional hatchery production summaries for BY 2019-2021 juvenile spring Chinook Salmon released into the Imnaha and Grande Ronde River basins, 2021-2023.	41
Table 8. The number of raceways, the Annual Operating Plan (AOP) coded-wire tag (CWT) marking objectives and estimates of percent adipose (AD) clip and CWT application success, brood years 2019 – 2021.	42

Table 9. Last release date, pre-release sampling date, mean size, total number of coded-wire-tagged smolts and total number of smolts, number PIT-tagged, and survival rate to Lower Granite Dam of BYs 2019-2021 spring Chinook Salmon smolts released into the Imnaha and Grande Ronde River basins, 2021-2023.	45
Table 10. Catch and escapement distribution of Catherine Creek, Upper Grande Ronde, Imnaha River, Lookingglass, and Lostine River spring/summer Chinook Salmon, complete brood years 2016.....	55
Table 11. Catch and escapement distribution of Catherine Creek, Upper Grande Ronde, Imnaha River, Lookingglass, and Lostine River spring/summer Chinook Salmon, complete brood years 2017.....	56
Table 12. Catch and escapement distribution of Catherine Creek, Upper Grande Ronde, Imnaha River, Lookingglass, and Lostine River spring/summer Chinook Salmon, complete brood years 2018.....	57
Table 13. Summary of hatchery and natural origin Chinook Salmon total carcass and redd counts by stream in Index and Extensive survey sections the Imnaha and Grande Ronde River basins, 2021-2023. NS = Not Surveyed.....	67
Table 14. Numbers of female Chinook Salmon carcasses recovered on the spawning grounds that were classified as either a pre-spawn mortality, spawned, or unknown, and the pre-spawn mortality rates, 2021-2023.	70
Table 15. Number of unique coded-wire-tags recovered on spawning ground surveys in 2021-2023.....	72
Table 16. Proportions of hatchery and natural Chinook Salmon smolts emigrating from the Grande Ronde and Imnaha basins detected at Lower Granite Dam after smolt barging begins for migration years 2021-2023.	81
Table 17. Return years 2021-2023 mean and median trap dates of age 3–5 hatchery and natural Chinook Salmon trapped at weirs on Catherine Creek, Imnaha River, Lookingglass Creek, Lostine River, and the Upper Grande Ronde River.....	85
Table 18. Hatchery and natural origin carcasses found in the Minam and Wenaha rivers over the last ten spawning years, 2014–2023.	87
Table 19. Timeline of key production, research, and collaboration activities in a normal calendar year.....	89
Table 20. Key data collection, reporting metrics, and data storage locations.	90

EXECUTIVE SUMMARY

In 2021-2023, weirs were operated in the Grande Ronde and Imnaha River basins from May to mid-September to trap returning spring-summer Chinook Salmon for broodstock and to manage the number of hatchery fish spawning in nature. The Oregon Department of Fish and Wildlife operated weirs in the Imnaha River and Lookingglass Creek. The Confederated Tribes of the Umatilla Indian Reservation operated weirs in Catherine Creek and the Upper Grande Ronde River. The Nez Perce Tribe operated a weir in the Lostine River.

Collectively across all five hatchery programs at Lookingglass Fish Hatchery from 2021 to 2023, between 320 and 371 hatchery females and 64 to 110 natural females were spawned, resulting in estimated collections of 1,532,885 – 1,728,186 green eggs. For the Imnaha program, 107 hatchery and 28 natural females were spawned in 2021, 99 hatchery and 38 natural females in 2022, and 103 hatchery and 32 natural females in 2023. These females yielded 601,187 green eggs in 2021, 514,608 in 2022; and 532,650 in 2023. In Catherine Creek, 47 hatchery and 12 natural females were spawned in 2021, 42 hatchery and 15 natural females in 2022, and 34 hatchery and 13 natural females in 2023. These females produced 209,758 green eggs in 2021; 196,486 in 2022; and 163,148 in 2023. The Upper Grande Ronde River program included 76 hatchery and seven natural females in 2021, 42 hatchery and 15 natural females in 2022, and 67 hatchery and 10 natural females in 2023. Total green egg yield from the Upper Grande Ronde females totaled 299,511 in 2021; 231,147 in 2022; and 235,359 in 2023. In Lookingglass Creek, 78 hatchery and six natural females were spawned in 2021, 74 hatchery and 10 natural females in 2022, and 91 hatchery and three natural females in 2023. Total green egg take for Lookingglass Creek was 298,193 in 2021; 285,016 in 2022; and 324,351 in 2023. In the Lostine River, 63 hatchery and 11 natural females were spawned in 2021, 41 hatchery and 32 natural females in 2022, and 48 hatchery and 25 natural females in 2023. These spawns produced 319,537 green eggs in 2021, 305,628 in 2022, and 287,563 in 2023.

A total of 1,333,129 brood year 2019 smolts were released in 2021, 1,496,194 brood year 2020 smolts in 2022, and 1,491,253 brood year 2021 smolts in 2023. For these brood years, green egg-to-smolt survival rates ranged from 68.5% to 98.0%, and 97.4% to 100% of smolts were identifiable as hatchery origin through either an adipose fin clip (AD clip) or an internal coded-wire tag (CWT). The mean survival rate from release to Lower Granite Dam (LGD) across all smolt groups was 53.9%, with a range of 22.1% to 87.0%. The mean survival rate for Imnaha River smolts was 58.7%. In the Grande Ronde Basin, mean survival rates were 54.9% for Catherine Creek, 47.1% for the Upper Grande Ronde River, 54.7% for Lookingglass Creek, and 51.2% for the Lostine River.

The total return goal for Imnaha hatchery-origin Chinook Salmon to the Columbia Basin is 16,050 returns. In 2021, an estimated 1,587 mature (age 3–5) fish returned to the Columbia River, achieving 9.9% of the goal; in 2022, 1,226 returned (7.6% of the goal); and in 2023, 922 returned (5.7% of the goal). Of the total returns, 1,386 were estimated to have returned above LGD, achieving 43.2% of the compensation area goal of 3,210 adults; in 2022, 982 returned (30.6% of the goal); and in 2023, 905 returned (28.2% of the goal). We estimated that 1,341 hatchery and 282 natural-origin Chinook Salmon returned to the Imnaha River in 2021, 968 hatchery and 376 natural-origin in 2022, and 925 hatchery and 320 natural-origin in 2023. Between 2021 and 2023, one sport fishery was conducted, with anglers harvesting 104 hatchery-origin Chinook. Tribal fisheries harvested 252 hatchery and 2 natural-origin salmon in 2021, 199 hatchery and 18 natural-origin in 2022, and 133 hatchery and 5 natural-origin in 2023.

The total return goal for Grande Ronde Basin hatchery-origin Chinook Salmon to the Columbia Basin is 29,100 adults. In 2021, an estimated 2,374 hatchery-origin Chinook Salmon returned, achieving 8.2% of this goal. Returns increased to 4,284 adults in 2022 (14.7% of the goal) and declined to 2,104 adults in 2023 (7.2% of the goal).

Above Lower Granite Dam (LGD), an estimated 2,119 hatchery-origin Chinook Salmon from the Grande Ronde Basin returned in 2021, achieving 36.4% of the compensation area goal of 5,820 adults. In 2022, 3,602 hatchery fish returned (61.9% of the goal), and in 2023, 1,990 returned (34.2% of the goal).

At the tributary level, estimated returns of Chinook Salmon from 2021 to 2023 varied by location. In Catherine Creek, hatchery-origin returns ranged from 302 to 694 adults, and natural-origin returns from 98 to 183. Lookingglass Creek had 601 to 1,453 hatchery-origin and 53 to 139 natural-origin returns. In the Lostine River, returns ranged from 783 to 1,148 hatchery-origin and 130 to 859 natural-origin fish. Finally, the Upper Grande Ronde River had an estimated 200 to 293 hatchery-origin and 42 to 111 natural-origin returns.

No sport fisheries occurred in the Grande Ronde Basin in 2021. In 2022 and 2023, sport fisheries were open in Lookingglass Creek, resulting in the harvest of 74 and 27 hatchery-origin Chinook Salmon, respectively. Combined tribal harvest by CTUIR and NPT totaled 37 hatchery-origin and six natural-origin Chinook Salmon in 2021, 37 hatchery-origin and six natural-origin fish in 2022, and 214 hatchery-origin and nine natural-origin Chinook in 2023. The CTUIR conducted a tribal fishery on Catherine Creek in 2021, harvesting three hatchery-origin and no natural-origin Chinook Salmon. No tribal fisheries occurred in Catherine Creek during 2022–2023 or in the Upper Grande Ronde River from 2021 through 2023. Tribal fishers in the Lostine River harvested 56 hatchery-origin and two natural origin Chinook Salmon in 2021, 250 hatchery-origin and 55 natural-origin fish in 2022, and 116 hatchery-origin and seven natural-origin Chinook in 2023.

In the Imnaha River, brood years (BY) 2016–2018 recruits-per-spawner (R:S) ratios ranged from 4.2 to 8.2 for the hatchery program and from 0.23 to 1.18 for naturally spawning Chinook Salmon. In the Grande Ronde Basin, R:S ratios for the conventional hatchery program (CHP) component during the same brood years ranged from 2.6 to 7.8 in Catherine Creek, 3.7 to 10.3 in Lookingglass Creek, 5.7 to 7.7 in the Lostine River, and 1.4 to 2.0 in the Upper Grande Ronde River. The natural component R:S values ranged from 0.59 to 1.43 in Catherine Creek, 0.11 to 0.56 in Lookingglass Creek, 0.31 to 1.33 in the Lostine River, and 0.46 to 0.78 in the Upper Grande Ronde River. In the Minam and Wenaha rivers, R:S ratios for BY 2016–2018 ranged from 0.81 to 1.72 and 0.24 to 1.30, respectively.

In the Imnaha River basin, a total of 346 redds and 202 carcasses were recorded in 2021, 188 redds and 18 carcasses in 2022, and 202 redds and 31 carcasses in 2023. The proportion of hatchery-origin spawners in nature, including jacks (pHOSij), ranged from 55.0% to 74.9%, while the proportionate natural influence (PNI) ranged from 26.3% to 41.2%. The estimated pre-spawn mortality in 2021 above the Imnaha River weir was 0% and 3.2% below the weir. Due to insufficient carcass recoveries, we could not reliably estimate pre-spawn mortality in 2022 and 2023.

In the Grande Ronde Basin, 688 redds and 351 carcasses were recorded in 2021, 1,385 redds and 792 carcasses in 2022, and 576 redds and 345 carcasses in 2023. Estimated pHOSij values in hatchery-supplemented populations ranged from 43.5% in the Wallowa–Lostine population to 89.9% in Lookingglass Creek. Grande Ronde Basin PNI values ranged from 2.2% to 48.7%. The percentage of pre-spawn female mortality where ≥ 20 females had egg retention estimates ranged

from 0% to 27.9%. In the Minam River, 103 redds and 13 carcasses were recorded in 2021, 119 redds and five carcasses in 2022, and 65 redds and four carcasses in 2023. In the Wenaha River, 101 redds and two carcasses were recorded in 2021, 239 redds and 14 carcasses in 2022, and 89 redds and six carcasses in 2023. Between 2021 and 2023, one hatchery-origin carcass from an unidentified hatchery program was recovered in the Minam River. In the Wenaha River, four hatchery-origin carcasses were recovered during the same period—one from the Lookingglass Conventional program and three from unidentified hatchery programs.

Introduction

This annual progress report summarizes spring-summer Chinook Salmon monitoring data collected by the Oregon Department of Fish and Wildlife (ODFW) for the Lower Snake River Compensation Plan (LSRCP) in calendar years 2021 – 2023. This report documents and evaluates spring-summer Chinook Salmon culture performance for hatchery programs and achievement of management objectives in the Imnaha and Grande Ronde River basins. Included in this report are summaries of the associated broodstock monitoring data collected at weirs in the Grande Ronde Basin operated by co-managers, the Nez Perce Tribe (NPT; Lostine River) and Confederated Tribes of the Umatilla Indian Reservation (CTUIR; Catherine Creek and Upper Grande Ronde River). The CTUIR and NPT have specific objectives for Chinook returns to Catherine Creek, the Upper Grande Ronde River, Lookingglass Creek, and the Lostine River that are discussed and evaluated in separate reports prepared by each co-management agency. Overall, these data are used to adaptively manage salmon culture practices to optimize egg-to-smolt survival rate, smolt quality, smolt-to-adult survival rate, the recruits-per-spawner (R:S) ratio, and to monitor spawning in nature by hatchery-reared salmon.

This report provides information on rearing and release operations for brood year (BY) 2019 – 2021 of juvenile Chinook Salmon smolts, numbers and characteristics (e.g., age composition) of mature Chinook Salmon in the 2021 – 2023 return years, the collection of eggs and the BY2021-2023 spawning year at Lookingglass Fish Hatchery (LFH) and in nature, and survival information (e.g., SAR, R:S) for BY2016 – 2018. These metrics document the success of these programs in meeting the LSRCP goals and objectives for Chinook Salmon returning to the mitigation area above Lower Granite Dam (LGD) and for harvest below LGD. To avoid confusion around whether jacks (age 3) are included with adult metrics, the convention that “adults” refer to ages 4 and 5 and “total” or “mature salmon” include all sexually mature salmon ages 3–5 is used in this report.

Program Goals

The LSRCP hatchery program consisting of hatcheries in Oregon, Washington, and Idaho was developed to compensate for the salmon and steelhead mortality caused by the construction and operation of the four lower Snake River dams. A total estimated loss of 48% of spring- and summer-run Chinook Salmon smolts was attributed to the four lower Snake River dams by applying a 15% smolt mortality rate at each of the four dams (Corps of Engineers 1975). The assumption was that the remaining 52% of adult production would be achieved by naturally spawning Chinook Salmon populations. The expected production loss contributed to dam construction (i.e., 48%) was multiplied by the estimated average return of 122,200 spring/summer Chinook Salmon adults to the Snake River from 1959-1961 (pre-dam construction) to estimate an annual average loss of 58,677 spring and summer Chinook Salmon. The loss estimate became the annual escapement goal of 58,677 spring- and summer-run Chinook Salmon (50,677 spring-run and 8,000 summer-run) to the project area (Herrig 1990).

For Oregon LSRCP hatchery programs in the Grande Ronde and Imnaha basins, age 3-6 Chinook Salmon production and smolt-to-adult return (SAR) compensation area goals represent the required performance to the area above LGD (USFWS 2020). Based on an assumed SAR rate of 0.65%, the total LSRCP mitigation goal for Oregon is 9,070 returning mature hatchery salmon to the compensation area, with hatchery production expected to consist of 3,210 from the Imnaha River Basin and 5,860 from the Grande Ronde Basin (Table 1). The LSRCP smolt production

release goals are 900,000 and 490,000 in the Grande Ronde and Imnaha River basins, respectively (Table 1). Over time, those smolt release goals have varied (Carmichael et al. 2010 a, b; [Feldhaus et al. 2023](#)). Co-managers for the Grande Ronde and Imnaha programs use a $\pm$ 10% threshold to evaluate success in achieving smolt release goals. In the Grande Ronde Basin, current release goals are 150,000 smolts per year for Catherine Creek and 250,000 smolts per year for each of the Lookingglass Creek, Upper Grande Ronde River, and Lostine River populations (Table 2). The Catherine Creek smolt release goal was originally established at 250,000 and then changed in 2006 when co-managers agreed to reduce the goal to 150,000 and shift production to increase releases into Lookingglass Creek.

The total smolt-to-adult survival (SAS) rate goal, which comprises all age 3-6 returns below and above LGD, is 3.25% (Table 2). Additionally, an assumed 4:1 ratio of catch downstream of LGD (commercial catch 3:1 and sport catch 1:1) in the Columbia River System and the Pacific Ocean to above LGD was used to estimate an additional loss of 234,777 mature salmon in the coastwide commercial, tribal, and recreational fisheries downstream of the project area. These combined catch and escapement estimates resulted in total mitigation of 293,454 adults produced annually for the entire LSRCF program. For facilities operated by ODFW, this equates to 45,350 mature hatchery salmon—12,840 from the Imnaha River Basin and 23,440 from the Grande Ronde Basin.

Table 1. Lower Snake River Compensation Plan mitigation goals for Oregon’s spring Chinook Salmon in the Grande Ronde and Imnaha River basins. Adult and survival goals are expressed for returns to the compensation area and total catch plus escapement goals below Lower Granite Dam.

	Grande Ronde Basin	Imnaha Basin
<i>Compensation Area (i.e., above Lower Granite Dam)</i>		
Annual smolt goal	900,000	490,000
Annual production (Lbs.)	45,000	24,500
Annual adult goal	5,820	3,210
Brood year smolt-to-adult return rate	0.65%	0.65%
<i>Total Catch and Escapement below Lower Granite Dam (4:1 harvest objective)</i>		
Annual adult goal	29,100	16,050
Brood year smolt-to-adult survival	3.25%	3.25%

Table 2. Mitigation goals specific to the Grande Ronde and Imnaha River spring/summer Chinook Salmon populations. Adult and survival goals are stated for returns to the compensation area and total catch plus escapement goals below Lower Granite Dam.

	Smolts	Smolt size (fish/lb)	Compensation Area adult returns	SAR (%)	Coastwide harvest objective (4:1)	Total Adults Produced	SAS (%)
Grande Ronde Basin							
Catherine Creek	150,000	20-25	970	0.65	3,880	4,850	3.25
Upper Grande Ronde	250,000	20-25	1,617	0.65	6,468	8,085	3.25
Lookingglass Creek	250,000	20-25	1,617	0.65	6,468	8,085	3.25
Lostine River	250,000	20-25	1,617	0.65	6,468	8,085	3.25
<i>Sub-total</i>	900,000	--	5,821 ^a	--	23,284 ^b	29,105 ^c	--
Imnaha Basin							
Imnaha River	490,000	20-25	3,210	0.65	12,840	16,050	3.25

^a Calculation rounding errors resulted in 5,821 adults instead of the agreed to mitigation goal of 5,820 returns.

^b Calculation rounding errors resulted in 23,284 returns. To meet LSRCF mitigation goals, returns should be $\geq 23,400$.

^c Calculation rounding errors resulted in 29,105 returns. To meet LSRCF mitigation goals, returns should be $\geq 29,100$.

Management Goals and Evaluation objectives

Management goals for the LSRCF hatchery programs focus on operating in a way that meets both mitigation objectives (e.g., adult returns and harvest) and conservation objectives (e.g., population persistence and enhancement). To operate the Oregon hatchery programs, co-managers in the Grande Ronde and Imnaha basins are guided by four primary management goals: recover natural populations, ensure a high probability of population persistence, restore sport and tribal fisheries, and minimize risk of potential negative effects of artificial production. Nine priority management objectives have guided implementation:

- 1) Prevent extinction of the Grande Ronde and Imnaha basin salmon populations.
- 2) Establish adequate broodstock to meet annual production needs.
- 3) Establish an annual return to the mitigation area of 5,820 Grande Ronde Basin hatchery spring Chinook and 3,210 Imnaha Basin spring-summer Chinook.
- 4) Provide a demographic foundation to rebuild after the key limiting factors and threats are addressed.
- 5) Maintain and enhance natural production while maintaining long term fitness.
- 6) Maintain genetic and life history characteristics of the natural population.
- 7) Operate the hatchery program so that the genetic and life history characteristics of hatchery fish mimic wild fish.
- 8) Re-establish historical tribal and recreational fisheries.
- 9) Maintain endemic wild populations of spring Chinook Salmon in the Minam and Wenaha rivers.

A comprehensive research, monitoring, and evaluation (RM&E) program has been underway since 1984. The RM&E objectives are:

- 1) Document and assess fish culture and hatchery operation practices and performance.
- 2) Determine optimum rearing and release strategies

- 3) Determine total catch and escapement, smolt survival, smolt-to-adult survival, and assess if adult production meets mitigation goals
- 4) Compare recruits-per-spawner (R/S) for hatchery and natural origin fish
- 5) Assess response in natural population abundance and productivity (adult R/S, smolts-per-spawner) to supplementation.
- 6) Assess and compare life history characteristics (age structure, run timing, sex ratio, smolt migration, fecundity) of hatchery and natural fish.
- 7) Determine the success of maintaining genetic integrity of endemic wild spring Chinook Salmon in the Minam and Wenaha rivers.
- 8) Assess success in restoring fisheries.
- 9) Coordinate project activities and disseminate results.

Sliding scales

Variably allocating natural and hatchery fish to broodstock, natural production and harvest via a “sliding scale” manages the levels of integration and interaction between hatchery and natural populations. The sliding scale management framework is based on the theory that at low population levels, the greatest risk to population persistence is demographic. At low population levels, fewer constraints are placed on the genetic risks imposed by hatchery program because the short-term goal is population persistence, and the desire is to rapidly boost population levels. As population levels increase, the demographic risks are of less concern, and more constraints are placed on the hatchery program to control potential genetic risks of artificial propagation. For example, when the Grande Ronde Endemic Supplementation Program (GRESPP) program in the Grande Ronde Basin was developed in the 1990’s (Carmichael et al. 2010a), captive broodstock were viewed as higher risk than conventional broodstock so captive broodstock progeny were not used for broodstock.

Each year, managers monitor stock specific in-season run development using PIT tag derived population estimates at mainstem Columbia and Snake River dams in concert with basin-wide weekly coordination meetings to inform sliding scale management. The sliding scale is not used in the upper Grande Ronde River where a very aggressive level of supplementation is applied. Sliding scales for Catherine Creek, the Lostine River, and Imnaha river programs have varying levels of complexity (for example, ODFW et al. 2020, pages 34-36).

Methods

During 2021-2023, spring Chinook Salmon from BYs 2019-2021 produced from the Conventional Hatchery Program (CHP) were released into the Imnaha River, Catherine Creek, the Upper Grande Ronde River, Lookingglass Creek, and the Lostine River. Chinook Salmon from complete BYs 2016 – 2018, and partial BYs 2019 – 2020 returned to spawn and some of these returns were collected from each population to use as broodstock to create offspring for BYs 2021-2023 CHP production. All Chinook Salmon were reared at LFH. Coded-wire-tag (CWT) recoveries from Chinook Salmon were used to assess the success of achieving mitigation goals and management objectives. Spawning ground surveys were used to assess the number of hatchery and natural Chinook Salmon spawning in nature, to estimate total returns, stray rates of hatchery salmon into wilderness populations, and to evaluate the effectiveness of weirs in managing salmon returns.

Juvenile Disease Monitoring

The ODFW fish health lab routinely monitors disease at LFH. The monitoring plan and disease treatments are outline in Appendix B of the Annual Operating Plan (e.g., [ODFW et al. 2020](#)). Fish health screens each female used in broodstock for *R. salmoninarum* the causative agent for bacterial kidney disease (BKD). To reduce the incidence of BKD in Chinook Salmon offspring, the ODFW Fish Health recommends that eggs from female Chinook Salmon with enzyme-linked immunosorbent assay (ELISA) optical density values ≥ 0.2 should be culled. Significant disease outbreaks and results for egg culling to control for BKD are discussed in subsequent sections of this report.

Escapement Monitoring

Escapement estimation for Catherine Creek, the Imnaha River, Lookingglass Creek, the Lostine River, and the Upper Grande Ronde is comprised of several components. A more complete description of methods used to estimate total escapement is described in [Feldhaus et al. 2017](#) Appendix B. Briefly, weir data is used to enumerate the number and origin (i.e., hatchery or natural) of Chinook removed at each weir or released back into nature. Then, tributary escapement above each weir is derived using the Chapman (1951) modification of the Petersen recapture estimator calculated as:

$$\tilde{N} = \frac{(M + 1)(C + 1)}{R + 1} - 1$$

This estimate is possible because every Chinook passed upstream of a weir is marked in either the left or right opercular plate with a hole punch. On the Chinook spawning ground surveys, surveyors examine each carcass to record the presence or absence of the operculum mark. For each river with a weir, the number of fish passed upstream (M), the number of OP marked carcasses (R) and the number of carcasses found without an OP mark are used to estimate the above weir salmon escapement.

Below weir abundance estimates for each population are determined using an annual spawner/redd estimate multiplied by the total number of redds found below each weir. The above weir spawner/redd estimate is derived from the above weir population estimate adjusted by estimates of pre-spawn survival. The adjusted above weir spawner/redd estimate is then divided by the above weir redd count. Total return to each river is the sum of the above weir estimate, the number of fish removed at each weir (e.g., broodstock, foodbank), the number of fish spawning below each weir, and the estimated number of fish harvested in sport and tribal fisheries. Redds are expanded below the weir by 3.2 fish/red if it is not possible to derive an above weir spanner/redd estimate (note: fish/redd includes jacks).

Spawning Ground Surveys

Spring and Summer Chinook Salmon spawning ground surveys were conducted from early August to mid-September in streams in the Imnaha and Grande Ronde Basin. The spatial extent and temporal timing of Index, Extensive, and Supplemental surveys is structured around methods described in [Tranquilli et al. 2004](#). Surveys were conducted on foot in a downstream direction with one or more surveyors. Stream specific index surveys were scheduled to take place following peak spawning. Extensive area surveys occur on the same day as the index survey and cover nearly all possible Chinook Salmon spawning areas. Supplemental surveys were

completed two or more times at approximately one-week intervals following the index survey in the same locations as the index and extensive areas. Surveys completed prior to the index date are referred to as pre-index surveys.

On each survey, surveyors recorded the number of new redds observed, the number of live Chinook Salmon observed, and the number of Chinook carcasses encountered in each survey section. On each survey, new redds were numbered and marked with colored flagging, and the location of each redd was recorded using a GPS device. Flagging was removed on the last supplemental survey. Data obtained from each carcass encountered included: sex, length, fin marks, degree of spawning (females only), and presence of opercle marks. In addition, approximately 10 scales or the dorsal fin rays were removed from some carcasses for ageing purposes, each carcass is interrogated for a PIT tag code or a CWT. Snouts from each carcass with a CWT are removed from each carcass and individually labeled. To avoid repeat sampling on subsequent surveys, the caudal peduncle of every carcass is severed after sampling.

Pre-spawn Mortalities

Female Chinook Salmon carcasses sampled on the spawning grounds are classified as a pre-spawn mortality (PSM) if $\geq 50\%$ of the eggs were retained and spawned if $< 50\%$ of the eggs were retained. If egg retention for a female carcass was undetermined, it was excluded from PSM calculations. Spawning success for male carcasses is not estimated and assumed that PSM rates for males are the same as females. The PSM rate is calculated by dividing the number of PSM females by the total number of identifiably spawned and unspawned females.

For streams with weirs (i.e., hatchery supplementation programs), PSM rates above and below weirs are estimated separately. If < 20 female are recovered above or below a weir, above and below weir recoveries are combined to calculate a single PSM rate estimate for the stream. For the Wallowa-Lostine populations (i.e., the Lostine River, Bear Creek, Hurricane Creek, and Wallowa River), a combined annual PSM rate estimate was calculated. In the Minam and Wenaha rivers, two wilderness streams in North East Oregon, pre-spawn mortality is assumed to be $\leq 10\%$ due to low female carcass recoveries.

Age composition

All Chinook Salmon (ages 3–5) returning to the Grande Ronde and Imnaha river basins of Northeast Oregon are assigned an age to determine their contribution to each brood year. For a portion of returning salmon, an individual's known age can be determined using CWTs, PIT tags, by determining a genetic age through genetic analysis, or through age analysis of hard structures (e.g., scales, fin rays) to derive an age. Briefly, scales were mounted on gummed cards and acetate impressions were made using a heat press. Scale age was determined by counting the winter annuli and adding one. Dorsal fin rays were dried, cleaned, and placed in an epoxy following methods described by Copeland et al. 2008. After the epoxy is dry, a thin sliver of the fin ray is cut, an image of the cross-section is taken using a digital camera and a microscope, and the number of annuli were counted. Snouts were removed from all adipose fin marked carcasses with a CWT. The recovery and decoding of coded wire tags was conducted by the ODFW CWT Laboratory. After compiling known age data, population specific age-length keys are used to assign individual ages to all fish lacking a known age.

Pre-release sampling

Each year, adipose (AD) fin clip and CWT and mark application success are evaluated by checking 350-550 (depending on mark type) juvenile Chinook Salmon from each raceway at LFH for marking success. Smolts are typically sampled at two different time periods a minimum of 30 days after marking because the ponding plan at LFH resulted in smolts marked with only an Ad clip being mixed with AD CWT-marked smolts. To accurately represent the proportion of smolts marked with an AD CWT, sampling occurs in early October before the AD marked salmon are mixed with the AD CWT-marked salmon. The goal is for each raceway with CWT-marked smolts to receive a unique code, but because of ponding logistics to balance raceway densities, some raceways received multiple CWT codes.

Additionally, length and weight measurements are taken on a random sample of ≥ 150 smolts per raceway prior to release, within approximately one week prior to the final release of each smolt group.

Broodstock collection and hatchery spawning

Adult broodstock collection numbers are determined annually by co-managers during the Annual Operations Plan (AOP) meetings. The ESA section 10 permits numbers which guide broodstock collections are as follows: Upper Grande Ronde River (permit #18033), Catherine Creek (permit #18034), Lookingglass Creek (permit #18035) and Lostine River (permit #18036). Broodstock collection strategies are subject to change in-season depending on run performance. Co-managers use weekly in-season run updates developed between April and July to track return performance of spring and summer Chinook Salmon migrating up the Columbia River, Snake River, and their tributaries using a combination of dam counts, and PIT tag expansions and conversion rates. Ultimately, both pre-season and in-season updates are used to determine fisheries allocations, broodstock collection strategies, and sliding scale management criteria.

The typical spawning practice at LFH is to spawn two males with two females in a 2x2 matrix. At the end of a spawn day other matrices can be used if ripe females are still available. Other common matrices used to spawn Chinook Salmon at LFH are: 3 females x 2 males and 1 female x 2 males. Also, for programs spawned at LFH, males are sometimes live spawned and returned to the holding pond for subsequent spawning events. Occasionally, some live spawned males are returned to their natal river. For all stocks spawned at LFH, the current practice is to use jacks (i.e., age 3 males) the same as adult (i.e., assumed age 4-5) males.

Fecundity

Prior to 2019, a five-year rolling average of fecundity, egg-to-smolt survival, and in-hatchery pre-spawning mortality rates were used to determine the number of females to be collected and spawned to achieve egg collection goals for each stock. Starting in 2019, a three-year rolling average that better reflected the annual variation in size and fecundity of returning females was adopted. The number of males to be collected is paired with the females.

Proportion of Natural Origin broodstock (pNOB)

Across all LSRCP hatchery programs, low productivity in nature has created challenges in collecting natural origin broodstock. Repeated use of individual males during hatchery spawning events can alter the estimated proportion of natural-origin broodstock (pNOB). The pNOB

calculations include spawned age 3 males (i.e., jacks), and account for males used multiple times. The observed origin (i.e., hatchery or natural) is based on the best available information for an individual fish at the time it was handled (e.g., presence of a CWT, adipose fin clip, genetic determination, etc). A fish's final origin is subject to change for several months post-spawning because of processing delays in compiling CWT and genetic PBT data.

Proportionate Natural Influence (PNI)

Proportionate natural influence (PNI) is calculated as $PNI = pNOB / (pNOB + pHOS_{ij})$. pNOB is defined as successful age 3-5 spawners at LFH. To calculate pNOB, unmarked hatchery fish using PBT genotype results are corrected, and age 3-5 males spawned multiple times are accounted for. The $pHOS_{ij}$ is the estimated proportion of hatchery origin spawners in nature including jacks.

Juvenile survival to Lower Granite Dam

Smolt migration success is based on survival from release to LGD for all stocks. Annually, 55,000 hatchery smolts are PIT tagged at LFH in October, 5-6 months prior to release. PIT tag detection data stored in the Pacific States PTAGIS database is used to compile release-recapture and travel time information for PIT-tagged smolts from each raceway. For each release group, Cormack-Jolly-Seber survival probabilities (rates) to LGD are determined by using a single release-recapture model. The PTAGIS release site codes and release dates are used to identify smolt releases from each acclimation facility or direct stream release.

Weir operations

The adult salmon weirs in the Grande Ronde and Imnaha basins are operated collaboratively by co-managers for the purpose of hatchery supplementation and distributing fish according to needs and the sliding scale. Typically, fish handled at weirs are either collected for broodstock, released to spawn naturally, recycled to fisheries, or, in the case of hatchery-origin returns, sacrificed and distributed to tribal and state food banks to help limit the number of hatchery fish spawning in the wild. Additionally, weirs enable managers to capture other data on populations such as run timing, return to river estimates, length and age data, and allow managers to mark fish released above weirs for mark recapture analysis. Specifically, weirs enable managers to better compare hatchery and natural runs

For Chinook trapping, the lead agency for the Imnaha River and Lookingglass Creek weir is ODFW. However, the NPT assist with Imnaha trap operations and CTUIR assists with Lookingglass Creek trap operations. The CTUIR operates the Catherine Creek and Upper Grande Ronde weirs (BPA project # [199800703](#)) and the NPT operate the Lostine River weir (BPA project # [199800702](#)).

Notable changes to weir operations have since 2009 are briefly described below.

1. Upper Grande Ronde: In 2010, managers agreed to remove the Upper Grande Ronde weir when the daily maximum water temperature exceeds 68° F (20° C). This decision has led to the weir being removed before the run is complete. Therefore, missing data limit the ability to accurately represent run timing and total returns to the weir site, which may lead to additional errors in escapement estimates.

2. Lookingglass Creek: the main ladder and trap, referred to as the “upper trap”, is upstream of the main hatchery facility, is adjacent to the water intake facility, and remains open throughout the trapping season.
 - A second trap entrance adjacent to LFH called the “lower trap” relies solely on attraction flow to lure fish into the trap. The lower trap operation began in 2018 and is typically opened when tribal fishing seasons have concluded.
 - A new fish ladder and trap was built and installed in 2005
3. Lostine River: permanent hydraulic weir installed in 2010.
4. Imnaha River: A new bridge style weir was installed by LSRCP in the summer of 2015 and was operational for the 2016 return.

Weir efficiency

For each population, weir efficiency is calculated as the number of Chinook Salmon that were trapped at the weir divided by the total number of Chinook that arrived at the weir location. Trapped fish include those that were removed (e.g., broodstock, sacrificed) or passed above the weir to spawn naturally. The number of Chinook that arrived at the weir location is a composite of fish handled plus an estimate of the number that escaped past the weir without being handled. Weir efficiency calculations are typically limited to adult fish which correspond to ≥ 600 mm fork length (FL) on Catherine Creek, the Upper Grande Ronde, and Lookingglass Creek, and ≥ 630 mm FL on the Lostine and Imnaha rivers. Fish below those size criteria are managed as jacks. Managers purposefully limit the number of jacks spawning in nature.

Genetic monitoring

Both CTUIR and NPT are collaborating on Relative Reproductive Success (RRS) studies. Brief summaries for existing projects are summarized below.

- Lookingglass Creek: The CTUIR partnered with CRITFC project 2009-009-00 to evaluate the re-introduction of spring Chinook into Lookingglass Creek. This is a multi-year study to test the presumption that natural origin adults derived from natural spawning of hatchery adults descended from the Catherine Creek captive broodstock hatchery program would demonstrate improved productivity, estimated by comparison within brood years of average juvenile recruits-per-spawner of natural origin versus hatchery origin adults spawning naturally. Progress to date for the genetic study is detailed in (Nuetzel et al. 2021, Nuetzel et al. 2022).
- Catherine Creek: As part of a multi-year project, CTUIR has partnered with NOAA fisheries on a relative reproductive success (RRS) study that spans the entire reintroduction period (i.e, late 1990’s to present). Relevant results are presented in Berntson et al. 2013.
- Lostine River: The NPT partnered with NOAA fisheries to evaluate the Lostine River hatchery program. The RRS study had some setbacks from 2001-2008 due to data integrity issues and several years of relatively low weir capture efficiency. Therefore, inference from the RRS evaluation is limited because only three complete brood years have sufficient data for analysis (Berntson et al. 2020).
- Parentage-based tagging (PBT). The ODFW, NPT, and CTUIR have been collecting genetics samples for Chinook Salmon spawned at LFH to be used in the PBT baseline since 2008 (Steele et al. 2019).

Recruits per spawner

Recruit per spawner (R:S) ratios, sometimes referred to as progeny to parent ratios, are used to compare productivity of fish spawning in nature and at the hatchery. Ratios >1 represent populations exceeding replacement. R:S ratios are reported to StreamNet for naturally spawning populations three different ways: 1) spawner to spawner; 2) return to river: spawner, and 3) smolts: spawner. The spawner-to-spawner ratios differ from return to river ratios because spawners are first adjusted for population specific annual rates of pre-spawn mortality. Return to river is total escapement of salmon to the population before adjusting for pre-spawn mortality. Return to river estimates include salmon permanently removed from the population via harvest, broodstock collection, out planting and food-banking efforts. The spawner-to-spawner estimates represent salmon remaining in the river to spawn after adjusting for pre-spawn mortality.

Calculating mitigation goals

Coded wire tag recoveries

Hatchery salmon from most raceways at LFH were marked with a CWT to provide basic information on survival, harvest, escapement, and straying, as well as specific information on experimental groups, if any. Recovery information for each CWT group was obtained from the Regional Mark Information System (RMIS) CWT recovery database maintained by the Pacific States Marine Fisheries Commission (PSMFC). The CWT recoveries and estimated recovery rates from RMIS are used to estimate harvest and stray rates above and below LGD.

Observed and estimated numbers of hatchery salmon from each CWT group recovered in ocean and Columbia River fisheries, as well as strays collected in and out of the Snake River Basin were compiled. Estimated CWT recoveries in the RMIS database were expanded from observed recoveries based on sampling efficiencies at some recovery locations, but not for recoveries at weirs in the Imnaha and Grande Ronde River basins. Therefore, total CWT-marked hatchery salmon from each code group (observed from weir collections and spawning ground recoveries) returning to the Imnaha River, Upper Grande Ronde River, Lookingglass Creek, Catherine Creek, and Lostine River were estimated based on total escapement to each stream, sampling rate, and the proportion of each cohort marked with CWTs. For some stocks, excess hatchery Chinook Salmon were outplanted to nearby streams. The CWTs for stocks recovered in outplant streams were not considered strays and were included in escapement calculations for the natal stream. Methods to estimate hatchery and natural escapement to the Imnaha River and Grande Ronde Basin streams are described in [Feldhaus et al. 2017](#) Appendix B.

In both the Imnaha and Grande Ronde basins, the exception to the CWT expansion method is when there were no CWT recoveries for a particular brood year, but weir data indicated salmon from that brood year had returned. In these cases, the total number of returning salmon by age class was estimated. If the returning salmon from the brood year were potentially comprised of more than one tag group, the estimated CWT returns into individual code groups based on the relative proportion of tag group recoveries from the previous year's return was partitioned.

Compensation area returns (SAR)

To assess LSRCP success in achieving mitigation goals and management objectives, total numbers of hatchery salmon from each stock are estimated based on those caught in fisheries, those that escaped to the stream of release, and those that strayed within or outside the Snake River Basin. The return rate to the LSRCP Compensation Area, defined as the Snake River Basin above LGD for programs within the State of Oregon, is determined by summing all estimated escapement above LGD. Estimated returns to the compensation area include the sum of tributary estimates and CWT-derived estimates for salmon recovered above LGD but outside the Grande Ronde and Imnaha basins. For each brood year, the number of age 3–6 returns over LGD is divided by the number of smolts released and multiplied by 100 to calculate a smolt-to-adult return (SAR) rate.

Total catch and escapement (SAS)

Total catch and escapement are the estimated compensation return plus the CWT derived stray and harvest rates below LGD, and ocean harvest. Therefore, the estimated total production for age 3-6 returns is used to define the smolt-to-adult survival (SAS) rate. For each brood year, the total estimated number of age 3-6 salmon divided by the number of smolts released and multiplied by 100 to calculate a smolt-to-adult survival (SAS) rate.

Terminal Fisheries

Planning for fisheries begins with the pre-season run estimates that determine abundance-based sliding scales to set annual fishery impacts. In-season run monitoring of PIT tagged salmon migration upstream over Bonneville and Lower Granite dams and subsequent tributary detection at in-stream interrogation sites allows for stock-specific run-updates.

Overall, sport and recreational fisheries management in the Grande Ronde and Imnaha basins is a collaborative effort between state and tribal co-managers. A complete description of the fisheries management is described in [Bratcher et al. 2016](#). Briefly, co-managers within each basin have a sharing agreement that provides tribal fisheries with a larger portion of the natural origin impacts to reflect the non-selective nature of traditional fishing techniques. Recreational fisheries are provided with a larger portion of the hatchery harvest such that all available impacts (hatchery and natural collectively) are shared equally. Harvest is curtailed when hatchery run size does not exceed the number of adults identified for broodstock and supplementation needs as described by population specific sliding scale management plans for each hatchery program. Surplus is generally defined as the adult hatchery run projection less hatchery adults needed for broodstock.

Results and Discussion

Objective 1. Document and assess fish culture and hatchery operation practices and performance.

2021-2023 Trapping and spawning

Imnaha River

Trap Year 2021

The Imnaha River weir was operated by ODFW Lookingglass Fish Hatchery staff from June 15 to September 9, 2021. After accounting for unmarked hatchery returns, a total of 1,048 hatchery and 197 natural-origin Chinook Salmon were captured (Table 3). Of these, 240 hatchery and 63 natural-origin fish were retained for broodstock. A total of 343 hatchery-origin Chinook Salmon were released below the weir, 50 were outplanted to Big Sheep Creek, and 56 were outplanted to Lick Creek. Eighty-five hatchery-origin fish were killed at the weir for stream enrichment, and 52 were distributed to foodbanks. Six hatchery-origin trap mortalities occurred. The remaining 216 hatchery-origin and 134 natural-origin Chinook Salmon were passed above the weir. The age composition of hatchery-origin Chinook Salmon captured at the weir was 19.2% age-3, 77.1% age-4, and 3.7% age-5 fish (Table 3). Natural-origin returns consisted of 21.8% age-3, 67.5% age-4, and 10.7% age-5 fish.

A total of 107 hatchery and 28 natural-origin females were spawned with 85 unique hatchery and 27 unique natural-origin males (Table 4). After accounting for multiple use males, pNOB was 0.27 (Table 5; Figure 2). The PBT data identified one male spawned as natural-origin was an unmarked hatchery fish. Spawning operations accounted for 601,187 green eggs with a 5.1% mortality rate to shocking resulting in 570,498 eyed eggs with a mean fecundity of 4,453 eggs (Table 4). Zero eggs were culled to control for BKD.

Trap Year 2022

The Imnaha River weir was operated by ODFW Lookingglass Fish Hatchery personnel from June 21 to September 2, 2022. After accounting for unmarked hatchery returns, a total of 752 hatchery and 286 natural-origin Chinook Salmon were captured (Table 3). Of these, 212 hatchery and 90 natural-origin fish were retained for broodstock. A total of 126 hatchery-origin Chinook Salmon were killed at the weir for stream enrichment, and 4 natural-origin salmon were trap mortalities. The remaining 107 hatchery-origin and 192 natural-origin Chinook Salmon were passed above the weir, and 307 hatchery-origin fish were placed below the weir. The age composition of hatchery-origin Chinook Salmon captured at the weir was 40.7% age-3, 57.0% age-4, and 2.3% age-5. Natural origin returns consisted of 4.5% age-3, 90.6% age-4, and 4.9% age-5 (Table 3).

A total of 99 hatchery and 38 natural-origin females were spawned with 55 unique hatchery and 42 unique natural-origin males (Table 4). After accounting for multiple use males, pNOB was 0.38 (Table 5; Figure 2). The PBT derived salmon origins matched observational origins determined during spawning. Spawning operations resulted in 514,608 green eggs with a 6.8% mortality rate to shocking, resulting in 479,529 eyed eggs with a mean fecundity of 3,756 eggs (Table 4). Zero eggs were culled to control for BKD.

Trap Year 2023

The Imnaha River weir was operated by ODFW Lookingglass Fish Hatchery personnel from June 20 to September 15, 2023. After accounting for unmarked hatchery returns, a total of 636 hatchery and 188 natural-origin Chinook Salmon were captured (Table 3). Of these, 235 hatchery and 64 natural-origin fish were retained for broodstock. A total of 46 hatchery-origin Chinook Salmon were released below the weir. Eighty-four hatchery fish were killed at the weir for stream enrichment and there was one natural-origin trap mortality. The remaining 134 hatchery-origin and 123 natural-origin Chinook Salmon were passed above the weir. Age structure of hatchery Chinook Salmon captured at the weir was 32.4% age-3, 59.7% age-4, and 7.8% age-5. Natural origin returns were comprised of 10.1% age-3, 72.4% age-4, and 17.6% age-5 (Table 3).

A total of 103 hatchery and 32 natural females were spawned with 119 unique hatchery and 31 unique natural-origin males (Table 4). After accounting for multiple use males, pNOB was 0.24 (Table 5; Figure 2). The PBT data indicated that four males spawned as natural origin were unmarked hatchery origin Chinook Salmon. Spawning operations resulted in 532,650 green eggs with a 4.4% mortality rate to shocking, resulting in 509,139 eyed eggs with a mean fecundity of 3,975 eggs (Table 4). Zero eggs were culled to control for BKD.

Catherine Creek

Trap Year 2021

The Catherine Creek weir was operated by CTUIR from March 4 through July 29, 2021. After adjusting for unmarked hatchery returns, a total of 503 hatchery and 138 natural-origin Chinook Salmon were captured (Table 3). Of these, 163 hatchery and 24 natural-origin fish were retained for broodstock. Seventy-seven hatchery and 24 natural Chinook Salmon were retained for use in the Catherine Creek broodstock, and 62 of these were allocated to the Lookingglass Creek broodstock. A total of 83 hatchery salmon were sacrificed for tribal distribution, 13 hatchery fish were outplanted to Indian Creek, and one natural-origin fish died in the trap. The remaining 268 hatchery and 113 natural-origin Chinook Salmon were passed above the weir. The age composition of hatchery-origin Chinook Salmon captured at the weir was 16.7% age-3, 82.5% age-4, and 0.8% age-5 (Table 3). Natural origin returns were comprised of 7.2% age-3, 89.8% age-4, and 2.9% age-5.

A total of 47 hatchery and 12 natural females were spawned with 43 unique hatchery and 11 unique natural-origin males (Table 4). After accounting for multiple use males, pNOB was 0.26 (Table 5; Figure 2). The PBT data indicated that observational origins determined at spawning for all Chinook Salmon were correct. Spawning operations resulted in 209,758 green eggs with a 4.0% mortality rate to shocking. This resulted in 194,830 eyed eggs with a mean fecundity of 3,555 eggs (Table 4). To control for BKD; a total of 6,613 eggs were culled from two females.

Trap Year 2022

The CTUIR operated the Catherine Creek weir from March 4 through August 4, 2022. After adjusting for unmarked hatchery returns, a total of 619 hatchery and 164 natural-origin Chinook Salmon were captured (Table 3). Of these, 77 hatchery and 25 natural-origin fish were kept for broodstock. A total of 74 hatchery-origin fish were sacrificed for tribal distribution, 56 were outplanted to Indian Creek, and 100 were outplanted to Lookingglass Creek. There was one hatchery-origin and one natural-origin trap mortality. The remaining 311 hatchery-origin and 138

natural-origin Chinook Salmon were passed above the weir. Age structure of hatchery Chinook Salmon captured at the weir was 13.6% age-3, 84.2% age-4, and 2.3% age-5 (Table 3). Natural origin returns were comprised of 7.9% age-3, 90.8% age-4, and 1.2% age-5

A total of 42 hatchery and 15 natural-origin females were spawned with 31 unique hatchery and 10 unique natural-origin males (Table 4). After accounting for multiple use males, pNOB was 0.36 (Table 5; Figure 2). The PBT data indicated origins determined at spawning for all Chinook Salmon were correct. Spawning operations resulted in 196,486 green eggs with a 7.0% shocking mortality rate. This resulted in 182,669 eyed eggs with a mean fecundity was 3,270 eggs (Table 4). Zero eggs were culled to control for BKD.

Trap Year 2023

The CTUIR operated the Catherine Creek weir from March 17 through August 4, 2023. After adjusting for unmarked hatchery returns, a total of 298 hatchery and 98 natural-origin Chinook Salmon were captured (Table 3). The CTUIR retained 72 hatchery and 29 natural-origin Chinook Salmon for broodstock. A total of 40 hatchery Chinook Salmon were sacrificed for tribal distribution. There were two hatchery and two natural origin trap mortalities. The remaining 184 hatchery and 67 natural origin Chinook Salmon were passed above the weir. Age structure of hatchery Chinook Salmon captured at the weir was 15.1% age-3, 83.9% age-4, and 1.0% age-5 (Table 3). Natural origin returns were comprised of 9.2% age-3, 87.8% age-4, and 3.0% age-5.

A total of 34 hatchery and 13 natural-origin females were spawned with 34 unique hatchery and 14 unique natural-origin males (Table 4). After accounting for multiple use males, pNOB was 0.36 (Table 5; Figure 2). The PBT data indicated origins determined at spawning for all Chinook Salmon were correct. Spawning operations resulted in 163,148 green eggs. The mortality rate to shocking was 3.0%. This resulted in 158,166 eyed eggs with a mean fecundity of 3,471 eggs (Table 4). Zero eggs were culled to control for BKD.

Upper Grande Ronde River

Trap Year 2021

The CTUIR operated the Upper Grande Ronde weir from May 5 through June 15, 2021. After adjusting for unmarked hatchery returns, a total of 121 hatchery and 25 natural-origin Chinook Salmon were captured (Table 3). All the trapped hatchery-origin fish were taken to Lookingglass Fish Hatchery and held in the broodstock pond. Of the trapped natural-origin salmon, 12 were kept for broodstock and 12 were passed above the weir. Age structure of hatchery-origin Chinook Salmon captured at the weir was 18.7% age-3, 95.8% age-4, and 0.0% age-5 (Table 3). Natural-origin age structure was 4.0% age-3, 92.0% age-4, and 4.0% age-5.

Seventy-six hatchery and seven natural females with 54 unique hatchery origin males and five unique natural origin males were spawned (Table 4). After accounting for multiple use males, pNOB was 0.12 (Table 5; Figure 2). The PBT data indicated that 2 males spawned as natural origin were unmarked hatchery origin Chinook Salmon. Spawning operations resulted in 299,511 green eggs with a mortality rate to shocking of 6.4%, resulting in 280,393 eyed eggs with a mean fecundity of 3,609 eggs (Table 4). Zero eggs were culled to control for BKD.

Trap Year 2022

The CTUIR operated the Upper Grande Ronde weir from May 12 through July 7, 2022. After adjusting for unmarked hatchery returns, a total of 217 hatchery and 82 natural-origin Chinook

Salmon were captured (Table 3). Of these, 118 hatchery and 32 natural-origin fish were kept for broodstock. A total of 60 hatchery fish were sacrificed for tribal distribution and there was one natural origin trap mortality. The remaining 39 hatchery and 49 natural-origin Chinook Salmon were passed above the weir. Age structure of hatchery-origin Chinook Salmon captured at the weir was 30.5% age-3, 68.7% age-4, and 0.9% age-5 (Table 3). Natural origin returns consisted of 7.3% age-3, 92.7% age-4, and 0.0% age-5.

A total of 64 hatchery and 15 natural-origin females were spawned with 42 unique hatchery and 14 unique natural-origin males (Table 4). After accounting for multiple use males, pNOB was 0.36 (Table 5; Figure 2). The PBT data indicated origins determined at spawning for all Chinook Salmon were correct. Spawning operations resulted in 231,147 green eggs with a 4.8% mortality rate to shocking. This resulted in 220,124 eyed eggs with a mean fecundity of 2,926 (Table 4). A total of 2,842 eggs from one female were culled to control for BKD.

Trap Year 2023

The CTUIR operated the Upper Grande Ronde weir from May 16 through June 30, 2023. After adjusting for unmarked hatchery returns, a total of 256 hatchery and 42 natural-origin Chinook Salmon were captured (Table 3). Of these, 165 hatchery and 19 natural-origin Chinook Salmon were kept for broodstock. Sixteen hatchery fish were sacrificed for tribal distribution. There were four hatchery and one natural-origin trap mortalities. The remaining 71 hatchery and 22 natural-origin Chinook Salmon were passed above the weir. Age structure of hatchery-origin Chinook Salmon captured at the weir was 11.7% age-3, 88.3% age-4, and 0.0% age-5 (Table 3). Natural origin returns were comprised of 2.4% age-3, 97.6% age-4, and 0.0% age-5.

A total of 67 hatchery and 10 natural-origin females were spawned with 89 unique hatchery 10 unique natural-origin males (Table 4). After accounting for multiple use males, pNOB was 0.14 (Table 5; Figure 2). The PBT data indicated that five males spawned as natural origin were unmarked hatchery origin Chinook Salmon. Spawning operations resulted in 235,359 green eggs with a 5.6% mortality rate to shocking. This resulted in 222,133 eyed eggs with a mean fecundity of 3,097 (Table 4). Zero eggs were culled to control for BKD.

Lookingglass Creek

Trap Year 2021

The Upper Lookingglass Creek weir was operated from March 1 to September 20, 2021. The Lower Trap was operated from June 25 to September 14, 2021. After adjusting for unmarked hatchery returns, a total of 453 hatchery and 80 naturally produced Chinook Salmon were captured between the two traps (Table 3). Of these, 124 hatchery and 14 natural-origin Chinook Salmon were kept for Lookingglass broodstock and 23 Upper Grande Ronde hatchery strays were retained for Upper Grande Ronde broodstock. A total of 174 hatchery-origin salmon were distributed to foodbanks, and 27 hatchery salmon were killed for stream enrichment. A total of 105 hatchery and 66 natural-origin Chinook Salmon were passed above the weir. Age structure of hatchery Chinook Salmon captured at the weir was 47.9% age-3, 51.2% age-4, and 0.9% age-5 (Table 3). Natural origin age structure was 31.3% age-3, 66.3% age-4, and 2.5% age-5.

A total of 78 and 6 natural females were spawned with 73 unique hatchery and eight unique natural-origin males (Table 4). After accounting for multiple use males, pNOB was 0.12 (Table 5; Figure 2). The PBT data indicated origins determined at spawning for all Chinook Salmon were correct. A total of 298,193 green eggs were collected and the mortality rate to shocking was

5.7%. This resulted in 281,082 eyed eggs with a mean fecundity of 3,550 eggs (Table 4). A total of 3,388 eggs from one female were culled to control for BKD.

Trap Year 2022

The Upper Lookingglass Creek weir was operated from March 1 to September 16, 2022. The Lower Trap was operated from July 21 to September 16, 2022. After accounting for unmarked hatchery returns, a total of 901 hatchery- and 110 natural-origin Chinook Salmon were captured (Table 3). Of these, 183 hatchery- and 24 natural-origin fish were retained for Lookingglass broodstock. Sixty-four hatchery-origin Chinook Salmon were distributed to food banks, 65 were killed at the weir for stream enrichment, and one hatchery-origin trap mortality occurred. Ninety-nine hatchery-origin Chinook Salmon were released below the weir, and the remaining 489 hatchery- and 86 natural-origin fish were passed upstream. Age structure of hatchery-origin Chinook Salmon captured at the weir was 19.2% age-3, 80.2% age-4, and 0.6% age-5 fish (Table 3). Natural-origin returns consisted of 3.6% age-3, 96.3% age-4, and 0.0% age-5 fish.

A total of 74 hatchery and 10 natural-origin females were spawned with 82 unique hatchery-origin males and 8 unique natural-origin males (Table 4). After accounting for multiple-use males, the pNOB was 0.16 (Table 5; Figure 2). The PBT data confirmed that origin determinations made during spawning were correct. A total of 285,016 green eggs were collected with a 5% mortality rate to shocking, resulting in 270,839 eyed eggs and a mean fecundity of 3,393 eggs per female (Table 4). To control for BKD, 877 eggs from one female were culled.

Trap Year 2023

The Upper Lookingglass Creek weir was operated from March 1 to September 15, 2023. The Lower Trap was operated from June 22 to September 5, 2023. After adjusting for unmarked hatchery returns, a total of 471 hatchery- and 38 natural-origin Chinook Salmon were captured (Table 3). A total of 208 hatchery and four natural origin Chinook Salmon were retained for Lookingglass broodstock. Additionally, ten assumed Upper Grande Ronde hatchery strays were retained for Upper Grande Ronde broodstock, but two of these fish were later determined to be natural origin. A total of 74 hatchery Chinook Salmon were distributed to foodbanks, and 12 hatchery-origin fish were killed for stream enrichment. The remaining 177 hatchery- and 34 natural-origin Chinook Salmon were passed above the weir. The age structure of hatchery-origin Chinook Salmon captured at the weir was 12.6% age-3, 76.2% age-4, and 2.1% age-5. Natural origin returns were comprised of 18.4% age-3, 81.6% age-4, and 0.0% age-5 (Table 3).

A total of 91 hatchery and three natural-origin females were spawned with 92 unique hatchery origin and zero natural-origin males (Table 4). After accounting for multiple use males, pNOB was 0.02 (Table 5; Figure 2). The PBT data indicated that two males and one female spawned as natural origin were unmarked hatchery origin Chinook Salmon. A total of 324,351 green eggs were collected with a 2.8% mortality rate to shocking, resulting in 315,364 eyed eggs and a mean fecundity of 3,488 eggs per female (Table 4). A total of 9,017 from two females were culled to control for BKD.

Lostine River

Trap Year 2021

The Lostine River Weir was operated by the NPT from March 18 to September 9, 2021. After adjusting for unmarked hatchery returns, a total of 547 hatchery- and 180 natural-origin Chinook Salmon were captured (Table 3). Of these, 139 hatchery and 30 natural-origin fish were kept for broodstock, and one hatchery-origin fish was sacrificed for tribal distribution. Of the adults collected for broodstock, eight hatchery-origin fish were returned to the Lostine River unspawned. A total of 307 hatchery-origin salmon were outplanted to the Wallowa River. The remaining 100 hatchery and 150 natural origin Chinook Salmon were passed above the weir. Age composition of hatchery-origin Chinook Salmon captured at the weir was 19.9% age-3, 77.1% age-4, and 2.9% age-5 (Table 3). Natural origin returns were comprised of 28.9% age-3, 65.6% age-4, and 5.6% age-5.

A total of 63 hatchery and 11 natural-origin females were spawned with 47 unique hatchery and 15 unique natural-origin males (Table 4). After accounting for multiple use males, pNOB was 0.25 (Table 5; Figure 2). The PBT data indicated that one female spawned as natural origin was an unmarked hatchery origin Chinook Salmon. A total of 319,537 green eggs were collected with a 7.5% mortality rate to shocking, resulting in 295,513 eyed eggs and a mean fecundity of 4,318 eggs per female (Table 4). Zero eggs were culled to control for BKD.

Trap Year 2022

The Lostine River Weir was operated by the NPT from March 28 to September 9, 2022. After adjusting for unmarked hatchery returns, a total of 357 hatchery and 384 natural-origin Chinook Salmon were captured (Table 3). Of these, 115 hatchery and 83 natural origin Chinook Salmon were kept for broodstock. A total of 63 hatchery-origin fish were sacrificed for tribal distribution. Thirty-eight hatchery-origin fish were outplanted to the Wallowa River, along with one natural-origin Chinook Salmon. The remaining 144 hatchery- and 300 natural-origin Chinook Salmon were passed above the weir. Age composition of hatchery-origin Chinook Salmon captured at the weir was 25.5% age-3, 73.4% age-4, and 1.1% age-5. Natural origin returns were comprised of 4.7% age-3, 94.8% age-4, and 0.6% age-5 (Table 3).

A total of 41 hatchery and 32 natural-origin females were spawned with 29 unique hatchery and 23 unique natural-origin males (Table 4). After accounting for multiple use males, pNOB was 0.45 (Table 5; Figure 2). The PBT data indicated origins determined at spawning for all Chinook Salmon were correct. A total of 305,628 green eggs were collected with a 12.8% mortality rate to shocking, resulting in 266,622 eyed eggs with a mean fecundity of 4,187 eggs per female (Table 4). Zero eggs were culled to control for BKD.

Trap Year 2023

The Lostine River Weir was operated by the NPT from March 31 to September 9, 2023. After adjusting for unmarked hatchery returns, a total of 413 hatchery and 228 naturally produced Chinook Salmon were captured (Table 3). The NPT retained 122 hatchery and 47 natural origin Chinook Salmon for broodstock. Twenty-five hatchery Chinook Salmon were sacrificed for tribal distribution and 117 were outplanted to the Wallowa River. 25 hatchery origin Chinook Salmon were returned to the Lostine River unspawned. The remaining 149 hatchery and 181 natural origin Chinook Salmon were passed above the weir. Age structure of

hatchery Chinook Salmon captured at the weir was 10.9% age-3, 88.2% age-4, and 0.9% age-5 (Table 3). Natural origin returns were comprised of 7.9% age-3, 89.9% age-4, and 2.2% age-5).

A total of 48 hatchery and 25 natural-origin females were spawned with 40 unique hatchery and 21 unique natural-origin males (Table 4). After accounting for multiple use males, pNOB was 0.35 (Table 5; Figure 2). The PBT data indicated that one male spawned as natural origin was an unmarked hatchery origin Chinook Salmon. A total of 287,563 green eggs were collected with a 5.6% shocking mortality rate, resulting in 271,320 eyed eggs with a mean fecundity of 3,939 eggs per female (Table 4). Zero eggs were culled to control for BKD.

3-year average: Fecundity, age structure, and pNOB

Over the last three spawn years (i.e., 2021 to 2023), an average of 136 Imnaha river females have been spawned with a mean fecundity of 4,061 eggs. In the Grande Ronde Basin, the three-year average for the Catherine Creek program, which has a smolt production goal of 150,000 smolts, was 54 females with an average fecundity of 3,491 eggs. The Upper Grande Ronde, Lookingglass Creek, and Lostine River smolt production goal is 250,000. The three-year average for spawned females was 80 females for the Upper Grande Ronde River, 87 females for Lookingglass Creek, and 73 females for the Lostine River (Table 4). The three-year mean fecundities were 3,211, 3,477, and 4,148 for the Upper Grande Ronde, Lookingglass Creek, and Lostine River programs (Table 4).

The proportion of age-5 females over the last three years have comprised 0.109, 0.026, 0.004, 0.019, 0.032 of the Imnaha River, Catherine Creek, Upper Grande Ronde, Lookingglass Creek, and Lostine River broodstock, respectively. The low percentage of age-5 females present in the broodstock is concerning because Chinook Salmon fecundity is typically a function of size and age. Larger females tend to produce more eggs; hence older females tend to produce more eggs. Therefore, female fecundity directly affects both hatchery broodstock collection strategies and the number of fish produced in nature. Lower fecundities result in a higher number of females collected at weirs for broodstock to meet smolt release goals and can also impact natural production because the number of eggs per female is directly related to the number of potential offspring. This trend is particularly concerning for the Catherine Creek stock where zero age-5 females were spawned in 2021, and only two were spawned in 2022 and 2023. Only one age-5 female was spawned in the Upper Grande Ronde stock between 2021 and 2023.

Over the past 10 years, after adjusting for males used multiple times and correcting for origin using PBT data, Catherine Creek had the highest average proportion of natural-origin broodstock (pNOB) at 0.38, while Lookingglass Creek had the lowest at 0.17 (Table 5). During the most recent three spawn years (2021–2023), average pNOB values were 0.33 for Catherine Creek, 0.30 for the Imnaha River, 0.10 for Lookingglass Creek, 0.35 for the Lostine River, and 0.21 for the Upper Grande Ronde River. These low pNOB values indicate a limited contribution of natural-origin Chinook Salmon to the broodstock.

Table 3. Numbers and dispositions, by origin, age, and sex of age 3-5 spring Chinook Salmon returning to northeast Oregon in 2021-2023. Numbers of Chinook trapped were adjusted to account errors in origin using genetic and coded-wire-tag data from spawning at Lookingglass Fish Hatchery. Due to errors in identifying sex at time of capture, the numbers of male and female salmon kept for broodstock in the weir data may not match the number reported here. UGR = Upper Grande Ronde; LKG = Lookingglass

Stock Trap Year & Disposition		Hatchery							Natural							Grand Total
		Age 3		Age 4		Age 5		Total	Age 3		Age 4		Age 5		Total	
		M	F	M	F	M	F		M	F	M	F	M	F		
<u>Imnaha River</u>																
2021	Trapped	201	0	368	440	15	24	1,048	43	0	74	59	8	13	197	1,245
	Passed above weir	1	0	81	116	9	9	216	36	0	51	39	4	4	134	350
	Released below weir	60	0	128	151	0	4	343	0	0	0	0	0	0	0	343
	Kept for broodstock ^b	8	0	102	116	5	9	240	7	0	23	20	4	9	63	303
	Trap mortality	0	0	3	2	0	0	6	0	0	0	0	0	0	0	6
	Foodbank	50	0	2	0	0	0	52	0	0	0	0	0	0	0	52
	Outplants	1	0	48	55	1	1	106	0	0	0	0	0	0	0	106
	Weir comp. (%)	19.2	0.0	35.1	42.0	1.4	2.3	100	21.8	0.0	37.6	29.9	4.1	6.6	100	
2022	Trapped ^a	306	0	173	256	8	9	752	13	0	136	123	6	8	286	1,038
	Passed above weir	1	0	31	70	2	3	107	8	0	91	84	2	7	192	299
	Kept for broodstock ^b	13	0	91	99	6	3	212	5	0	44	36	4	1	90	302
	Trap mortality	0	0	0	0	0	0	0	0	0	1	3	0	0	4	4
	Foodbank	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Outplant	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Weir comp. (%)	40.7	0.0	23.0	34.0	1.1	1.2	100	4.5	0.0	47.6	43.0	2.1	2.8	100	
	2023	Trapped ^a	205	1	191	189	23	27	636	19	0	77	59	11	22	188
Passed above weir		1	1	54	64	4	10	134	15	0	53	38	6	11	123	257
Kept for broodstock ^b		5	0	107	92	16	15	235	4	0	23	21	5	11	64	299
Trap mortality		0	0	0	0	0	0	0	0	0	0	1	0	0	0	1
Foodbank		113	0	13	10	1	0	137	0	0	0	0	0	0	0	0
Outplants		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Weir comp. (%)		32.2	0.2	30.0	29.7	3.6	4.2	100	10.1	0.0	41.0	31.4	5.9	11.7	100	

		Hatchery							Natural								
Stock		Age 3		Age 4		Age 5			Age 3		Age 4		Age 5			Grand	
Trap Year & Disposition		M	F	M	F	M	F	Total	M	F	M	F	M	F	Total	Total	
<u>Catherine Creek</u>																	
2021	Trapped ^a	84	0	140	275	3	1	503	10	0	49	75	3	1	138	641	
	Passed above weir	10	0	65	190	2	1	268	8	0	40	62	3	0	113	381	
	Kept for broodstock ^b	1	0	39	36	1	0	77	2	0	9	12	0	1	24	101	
	LKG broodstock	0	0	23	39	0	0	62	0	0	0	0	0	0	0	62	
	Trap mortality	0	0	0	0	0	0	0	0	0	0	1	0	0	1	1	
	Foodbank	70	0	8	5	0	0	83	0	0	0	0	0	0	0	83	
	Outplants	3	0	5	5	0	0	13	0	0	0	0	0	0	0	13	
	Weir comp. (%)	16.7	0.0	27.8	54.7	0.6	0.2	100	7.2	0.0	35.5	54.3	2.2	0.7	100		
2022	Trapped ^a	84	0	203	318	8	6	619	13	0	62	87	1	1	164	783	
	Passed above weir	8	0	106	189	6	2	311	13	0	52	71	1	1	138	449	
	Kept for broodstock ^b	2	0	30	41	2	2	77	0	0	10	15	0	0	25	102	
	Trap mortality	0	0	0	1	0	0	1	0	0	0	1	0	0	1	2	
	Foodbank	71	0	3	0	0	0	74	0	0	0	0	0	0	0	74	
	Outplant	3	0	64	87	0	2	156	0	0	0	0	0	0	0	156	
	Weir comp. (%)	13.6	0.0	32.8	51.4	1.3	1.0	100	7.9	0.0	37.8	53.0	0.6	0.6	100		
2023	Trapped ^a	45	0	78	172	2	1	298	8	1	38	48	1	2	98	396	
	Passed above weir	6	0	39	137	2	0	184	5	1	26	34	0	1	67	251	
	Kept for broodstock ^b	3	0	34	34	0	1	72	3	0	12	12	1	1	29	101	
	Trap mortality	0	0	2	0	0	0	2	0	0	0	2	0	0	2	4	
	Foodbank	36	0	3	1	0	0	40	0	0	0	0	0	0	0	40	
	Outplant	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	Weir comp. (%)	15.1	0.0	26.2	57.7	0.7	0.3	100	8.2	1.0	38.8	49.0	1.0	2.0	100		

		Hatchery							Natural								
Stock		Age 3		Age 4		Age 5		Total	Age 3		Age 4		Age 5		Total	Grand Total	
Trap Year & Disposition		M	F	M	F	M	F		M	F	M	F	M	F			
<u>Upper Grande Ronde^c</u>																	
2021	Trapped ^a	5	0	43	73	0	0	121	1	0	9	14	0	1	25	146	
	Passed above weir	0	0	0	0	0	0	0	1	0	4	6	0	1	12	12	
	Kept for broodstock ^b	5	0	43	73	0	0	121	0	0	5	7	0	0	12	133	
	Trap mortality	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	Foodbank	0	0	0	0	0	0	0	0	0	0	1	0	0	1	1	
	Weir composition (%)	4.1	0.0	35.5	60.3	0.0	0.0	100	4.0	0.0	36.0	56.0	0.0	4.0	100		
2022	Trapped ^a	65	1	44	105	0	2	217	6	0	29	47	0	0	82	299	
	Passed above weir	1	0	1	37	0	0	39	6	0	14	29	0	0	49	88	
	Kept for broodstock ^b	7	1	40	68	0	2	118	0	0	15	17	0	0	32	150	
	Trap mortality	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	
	Foodbank	57	0	3	0	0	0	60	0	0	0	0	0	0	0	60	
	Weir composition (%)	30.0	0.5	20.3	48.4	0.0	0.9	100	7.3	0.0	35.4	57.3	0.0	0.0	100		
2023	Trapped ^a	30	0	90	136	0	0	256	1	0	11	30	0	0	42	298	
	Passed above weir	4	0	3	64	0	0	71	1	0	3	18	0	0	22	93	
	Kept for broodstock ^b	8	0	86	71	0	0	165	0	0	8	11	0	0	19	184	
	Trap mortality	2	0	1	1	0	0	4	0	0	0	1	0	0	1	5	
	Foodbank	16	0	0	0	0	0	20	0	0	0	1	0	0	1	21	
	Weir composition (%)	11.7	0.0	35.2	53.1	0.0	0.0	100	2.4	0.0	26.2	71.4	0.0	0.0	100		
<u>Lookingglass Creek</u>																	
2021	Trapped ^a	217	0	86	146	4	0	453	25	0	23	30	2	0	80	533	
	Passed above weir	1	0	35	68	1	0	105	25	0	15	24	2	0	66	171	
	Kept for broodstock ^b	19	0	47	78	3	0	147	0	0	8	6	0	0	14	161	
	UGR Swim-ins ^e	2	0	7	14	0	0	23	0	0	0	0	0	0	0	23	

		Hatchery							Natural								
Stock		Age 3		Age 4		Age 5			Age 3		Age 4		Age 5			Grand	
Trap Year & Disposition		M	F	M	F	M	F	Total	M	F	M	F	M	F	Total	Total	
2022	Foodbank	173	0	1	0	0	0	174	0	0	0	0	0	0	0	174	
	Killed at weir	24	0	3	0	0	0	27	0	0	0	0	0	0	0	27	
	Weir comp. (%)	47.9	0.0	19.0	32.2	0.9		100	31.3	0.0	28.8	37.5	2.5	0.0	100		
	Trapped ^a	167	6	321	402	5	0	901	4	0	60	46	0	0	110	1,011	
	Passed above weir	1	5	191	289	3	0	489	4	0	46	36	0	0	86	575	
	Kept for broodstock ^b	21	1	83	78	2	0	185	0	0	14	10	0	0	24	209	
	Foodbank	54	0	9	1	0	0	64	0	0	0	0	0	0	0	64	
2023	Killed at weir	50	0	15	0	0	0	65	0	0	0	0	0	0	0	65	
	Weir composition (%)	18.5	0.7	35.6	44.6	0.6	0.0	100	3.6	0.0	54.5	41.8	0.0	0.0	100		
	Trapped ^a	100	2	163	196	3	7	471	7	0	12	19	0	0	38	509	
	Passed above weir	1	1	65	106	1	3	177	7	0	11	16	0	0	34	211	
	Kept for broodstock ^b	27	1	88	93	3	4	216	0	0	3	3	0	0	6	21	
	UGR Swim-ins ^e	1	0	3	3	1	0	8	0	0	2	0	0	0	2	10	
	Foodbank	61	0	13	0	0	0	74	0	0	0	0	0	0	0	74	
Lostine River ^d	Killed at weir	12	0	0	0	0	0	12	0	0	0	0	0	0	0	12	
	Weir composition (%)	21.2	0.4	34.6	41.6	0.6	1.5	100	18.4	0.0	31.6	50.0	0.0	0.0	100		
	Trapped ^a	109	0	203	219	10	6	547	52	0	61	57	5	5	180	727	
	Passed above weir	0	0	34	61	2	3	100	52	0	48	46	1	3	150	250	
	Kept for broodstock ^b	4	0	55	69	8	3	139	0	0	13	11	4	2	30	169	
	Foodbank	0	0	0	1	0	0	1	0	0	0	0	0	0	0	1	
	Outplant	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Lostine River ^d	Weir comp. (%)	19.9	0.0	37.1	40.0	1.8	1.1	100	28.9	0.0	33.9	31.7	2.8	2.8	100		

		Hatchery							Natural								
Stock		Age 3		Age 4		Age 5			Age 3		Age 4		Age 5			Grand	
Trap Year & Disposition		M	F	M	F	M	F	Total	M	F	M	F	M	F	Total	Total	
2022	Trapped ^a	89	2	109	153	3	1	357	16	2	165	199	1	1	384	741	
	Passed above weir	0	0	47	97	0	0	144	15	2	137	145	0	1	300	444	
	Kept for broodstock ^b	5	0	51	55	3	1	115	0	0	28	54	1	0	83	198	
	Foodbank	57	0	3	0	0	0	60	0	0	0	0	0	0	0	60	
	Outplant	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	Weir composition (%)	24.9	0.6	30.5	42.9	0.8	0.3	100	4.2	0.5	43.0	51.8	0.3	0.3	100		
2023	Trapped ^a	44	1	215	149	1	3	413	18	0	112	93	4	1	228	641	
	Passed above weir	4	0	82	63	0	0	149	18	0	95	68	0	0	181	330	
	Kept for broodstock ^b	4	0	60	54	1	3	122	0	0	17	25	4	1	47	169	
	Foodbank	19	0	5	1	0	0	25	0	0	0	0	0	0	0	25	
	Outplant	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	Weir comp. (%)	10.7	0.2	52.1	36.1	0.2	0.7	100	7.9	0.0	49.1	40.8	1.8	0.4	100	¹	

^a The number trapped was adjusted to account for final origin, age, and sex structure of Chinook Salmon retained for broodstock.

^b Numbers kept for broodstock were adjusted for origin, age, and sex structure using spawning records from Lookingglass Fish Hatchery.

^c Operated by Confederated Tribes of the Umatilla Indian Reservation (CTUIR). Data provided by Mike McLean (CTUIR).

^d Operated by Nez Perce Tribe (NPT). Data provided by Shane Vatland (NPT). Dispositions represent the final capture event.

^e Lookingglass staff assumes unclipped fish with a wire are from the Upper Grande Ronde stock.

Table 4. Spawning summaries of spring Chinook Salmon from the Conventional Hatchery Programs at Lookingglass Fish Hatchery for the Imnaha and Grande Ronde basins, spawning years 2021 – 2023.

Year, Stock	Number of parents						Number of green eggs collected	Mean fecundity	Number of eyed eggs	Percent mortality to shocking
	Hatchery			Natural						
	Females	Males ^a		Females	Males ^a					
	Unique	Unique	Multiple ^b	Unique	Unique	Multiple ^b				
<u>2021</u>										
Imnaha River	107	85	100	28	27	39	601,187	4,453	570,498	5.1
Catherine Creek	47	43	43	12	11	15	209,758	3,555	201,445	4.0
Upper Grande Ronde River	76	54	55	7	5	9	299,511	3,609	280,393	6.4
Lookingglass Creek	78	73	75	6	8	12	298,193	3,550	281,082	5.7
Lostine River	63	47	52	11	15	22	319,537	4,318	295,513	7.5
<u>2022</u>										
Imnaha River	99	55	76	38	42	62	514,608	3,756	479,529	6.8
Catherine Creek	42	31	35	15	10	23	196,486	3,447	182,669	7.0
Upper Grande Ronde River	64	42	45	15	14	36	231,147	2,926	220,124	4.8
Lookingglass Creek	74	82	86	10	8	17	285,016	3,393	270,839	5.0
Lostine River	41	29	38	32	23	34	305,628	4,187	266,622	12.8
<u>2023</u>										
Imnaha River	103	119	116	32	31	34	532,650	3,975	509,139	4.4
Catherine Creek	34	34	36	13	14	14	163,148	3,471	158,277	3.0
Upper Grande Ronde River	67	89	90	10	10	10	235,359	3,097	222,133	5.6
Lookingglass Creek	91	90	94	3	0	1	324,351	3,488	315,364	2.8
Lostine River	48	40	46	25	21	28	287,563	3,939	271,320	5.6

^a Male counts include jacks.

^b The number of male parents is greater than the number of unique males that were spawned and the number of unique males kept because some males were spawned more than once.

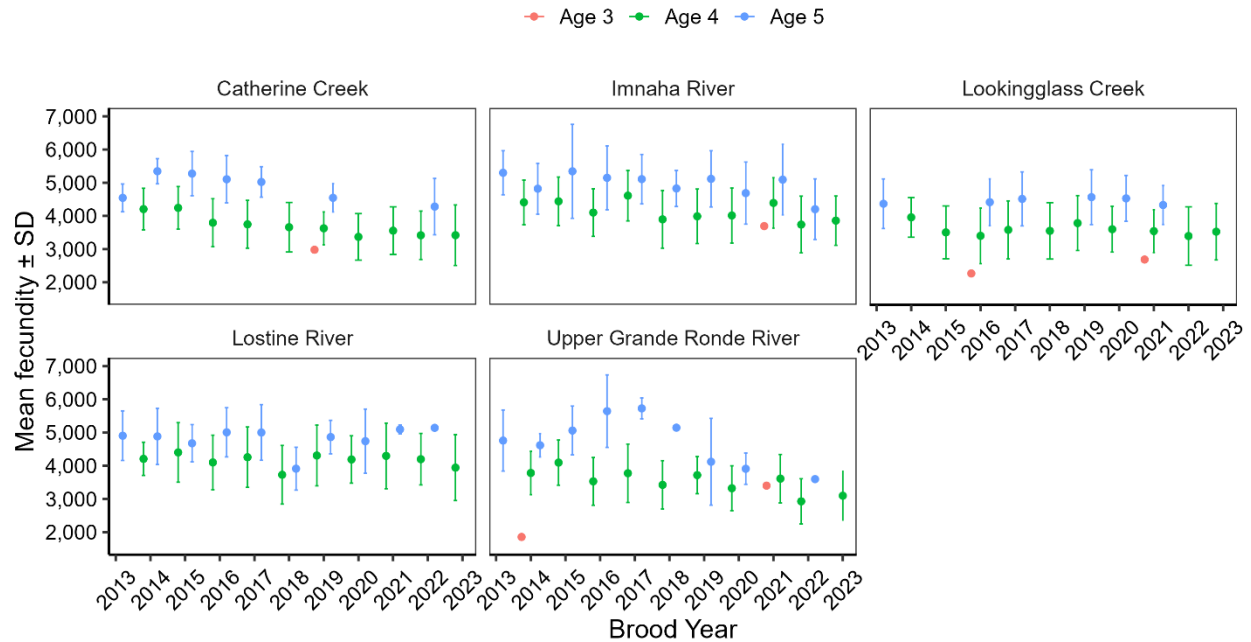


Figure 1. Mean fecundity (± 1 SD) for age 3-5 Chinook Salmon spawned at Lookingglass Fish Hatchery, brood years 2013 to 2023.

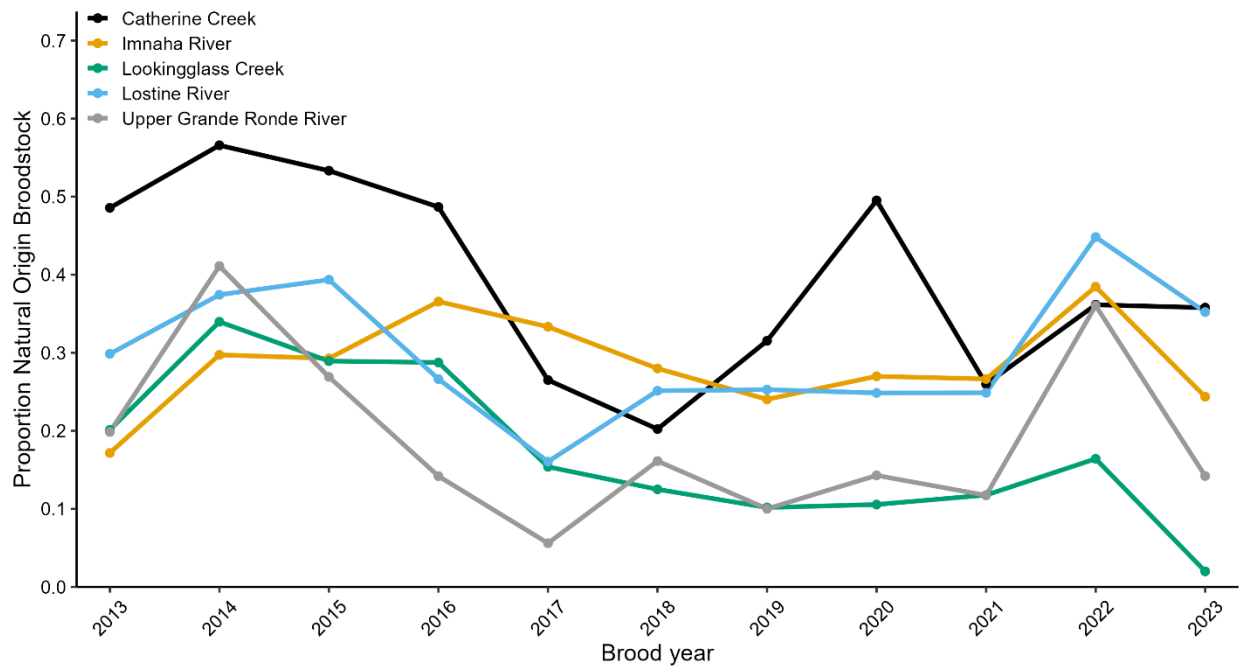


Figure 2. Proportion of natural-origin broodstock in the Catherine Creek, Imnaha River, Lookingglass Creek, Lostine River, and Upper Grande Ronde conventional hatchery programs, brood years 2013-2023.

Table 5. Numbers of successfully spawned hatchery males (M) and females (F), mean fecundity, and proportion of natural-origin broodstock (pNOB) for conventional production at Lookingglass Fish Hatchery from brood years 2014–2023, by stock: Catherine Creek, Imnaha River, Lookingglass Creek, Lostine River, and Upper Grande Ronde River.

Stock	Brood Year	Hatchery			Natural			pNOB
		M ^a	F	Mean Fecundity	M ^a	F	Mean Fecundity	
<u>Catherine Creek</u>	2014	37	19	4,557	48	25	4,074	0.57
	2015	30	33	4,309	52	20	4,545	0.53
	2016	23	16	3,980	15	22	4,075	0.49
	2017	27	34	3,912	11	11	3,698	0.27
	2018	34	37	3,756	9	9	3,260	0.20
	2019	43	33	3,661	24	11	3,629	0.32
	2020	25	28	3,261	25	27	3,480	0.50
	2021	47	47	3,530	21	12	3,656	0.26
	2022	41	42	3,510	32	15	3,270	0.36
	<u>2023</u>	<u>36</u>	<u>34</u>	<u>3,478</u>	<u>26</u>	<u>13</u>	<u>3,453</u>	<u>0.36</u>
Average		34	32	3,796	26	17	3,714	0.38
<u>Imnaha River</u>	2014	160	100	4,423	70	40	4,489	0.30
	<u>2015</u>	<u>143</u>	<u>101</u>	<u>4,471</u>	<u>67</u>	<u>34</u>	<u>4,827</u>	<u>0.29</u>
	<u>2016</u>	<u>107</u>	<u>96</u>	<u>4,196</u>	<u>78</u>	<u>39</u>	<u>4,511</u>	<u>0.37</u>
	<u>2017</u>	<u>112</u>	<u>94</u>	<u>4,786</u>	<u>66</u>	<u>37</u>	<u>4,636</u>	<u>0.33</u>
	<u>2018</u>	<u>126</u>	<u>85</u>	<u>3,958</u>	<u>54</u>	<u>28</u>	<u>4,075</u>	<u>0.28</u>
	2019	181	113	4,089	67	26	4,546	0.24
	2020	119	111	4,047	61	24	4,134	0.27
	2021	127	107	4,417	57	28	4,591	0.27
	2022	101	99	3,772	87	38	3,716	0.38
	<u>2023</u>	<u>136</u>	<u>103</u>	<u>3,909</u>	<u>45</u>	<u>32</u>	<u>4,187</u>	<u>0.24</u>
Average		131	101	4,207	65	33	4,371	0.30
<u>Upper Grande Ronde R</u>	2014	60	46	3,937	52	22	3,504	0.41
	<u>2015</u>	<u>78</u>	<u>66</u>	<u>4,120</u>	<u>34</u>	<u>19</u>	<u>4,567</u>	<u>0.27</u>
	<u>2016</u>	<u>71</u>	<u>62</u>	<u>3,698</u>	<u>15</u>	<u>7</u>	<u>3,850</u>	<u>0.14</u>
	<u>2017</u>	<u>67</u>	<u>68</u>	<u>3,831</u>	<u>4</u>	<u>4</u>	<u>4,263</u>	<u>0.06</u>
	<u>2018</u>	<u>60</u>	<u>70</u>	<u>3,471</u>	<u>18</u>	<u>7</u>	<u>3,201</u>	<u>0.16</u>
	2019	91	71	3,737	15	3	4,046	0.10
	2020	65	73	3,423	14	9	2,828	0.14
	2021	66	77	3,617	12	7	3,515	0.12
	2022	46	64	2,878	47	15	3,129	0.36
	<u>2023</u>	<u>96</u>	<u>67</u>	<u>3,144</u>	<u>17</u>	<u>10</u>	<u>2,743</u>	<u>0.14</u>
Average		70	66	3,586	23	10	3,527	0.19

Stock	Brood Year	Hatchery			Natural			pNOB
		M ^a	F	Mean Fecundity	M ^a	F	Mean Fecundity	
<u>Lookingglass Creek</u>	2014	79	59	3,983	48	23	3,891	0.34
	__2015	92	48	3,450	30	27	3,599	0.29
	__2016	53	56	3,449	23	21	3,794	0.29
	__2017	39	38	3,601	7	7	4,393	0.15
	__2018	69	71	3,570	11	9	3,384	0.13
	2019	90	69	3,914	11	7	3,837	0.10
	2020	87	74	3,641	14	5	3,908	0.11
	2021	87	78	3,540	16	6	3,682	0.12
	2022	89	74	3,335	22	10	3,824	0.16
	<u>2023</u>	<u>106</u>	<u>91</u>	<u>3,523</u>	<u>1</u>	<u>3</u>	<u>2,426</u>	<u>0.02</u>
	Average	79	66	3,601	18	12	3,674	0.17
<u>Lostine River</u>	2014	74	48	4,224	48	26	4,307	0.38
	__2015	67	47	4,499	49	25	4,283	0.39
	__2016	81	54	4,281	29	20	4,426	0.27
	__2017	73	63	4,344	15	11	4,771	0.16
	__2018	81	59	3,796	33	14	3,465	0.25
	2019	78	58	4,468	31	15	4,649	0.25
	2020	72	55	4,437	24	18	3,982	0.25
	2021	79	63	4,323	36	11	4,289	0.25
	2022	55	41	4,091	46	32	4,309	0.45
	<u>2023</u>	<u>55</u>	<u>48</u>	<u>3,893</u>	<u>31</u>	<u>25</u>	<u>4,028</u>	<u>0.35</u>
	Average	72	54	4,236	34	20	4,251	0.30

^a Totals account for age 3-5 live spawned males used multiple times.

Genetic monitoring

During each hatchery spawning event, individual Chinook Salmon are classified as hatchery or natural origin based on fin clips (e.g., adipose clips) or the presence of a CWT. The PBT data provided by the Eagle Fish Genetics Lab was used to verify and correct origin, quantify the number of broodstock that were successfully genotyped, derive genetic ages, and look for hatchery strays that were not identified using CWT data. The term observational origin is used to reference individual Chinook Salmon that were classified as hatchery- or natural-origin using CWT and fin clip information (i.e., origin was not corrected using genetic data). In the classification criteria, local broodstock refers to individuals within a stock that are genetically matched to parents from the same stock. Individuals that do not match parents in the baseline are assumed to be from the same stock or river in which they were collected (i.e., local broodstock).

For uniquely spawned Chinook Salmon at LFH from 2021 to 2023, genotyping rates for fish observationally identified as hatchery-origin varied among stocks and years. Among hatchery-origin Chinook Salmon spawned at LFH, >94% of the Catherine Creek stock, >77% of the Imnaha stock, >93% of the Lookingglass Creek stock, >59% of the Lostine River stock, and >96% of the Upper Grande Ronde River stock were genetically assigned to the weir where their parents were collected (Table 6, Figure 3). For fish observationally identified as natural-origin,

PBT data revealed 31 were actually hatchery origin. Misidentifications by stock included: Catherine Creek (0), Imnaha River (13), Lookingglass Creek (5), Lostine River (2), and Upper Grande Ronde River (11) (Table 6, Figure 3).

Overall, genetic data provided ages and origin for 1,799 individuals, compared to 1,402 ages obtained from CWT codes. PBT results also identified stocks for hatchery fish lacking CWTs (Table 6, Figure 3). PBT data further revealed out-of-stock and out-of-basin strays in several broodstocks (Table 6; Figure 3). In the Catherine Creek broodstock, three Grande Ronde River stock fish and one from the Clearwater River basin (Kooskia National Fish Hatchery, Idaho) were identified. In the Imnaha River broodstock, 16 out-of-basin fish from Idaho's Rapid River stock and one Lostine River fish were detected. The Lookingglass Creek broodstock included 10 Grande Ronde River fish, one Klickitat River fish, one Tucannon River fish (Washington), and three Lostine River fish. In 2021, 62 adults from the Catherine Creek weir (Table 3) were intentionally used in the Lookingglass broodstock, so the identification of 54 Catherine Creek fish in that group (Table 6) was expected. The Lostine River broodstock contained two Catherine Creek stock, and one Imnaha River Chinook adult. The Upper Grande Ronde broodstock included one out of basin stray from the Clearwater River basin (Dworshak National Fish Hatchery) in Idaho and 18 Lookingglass Creek stock salmon.

One explanation for variation in genotyping rates is that some males are used in multiple spawn events (i.e., live-spawned), but a genetic sample is not collected each time. If the original genetic sample for a male is lost or fails to genotype successfully, all male–female cross information for that fish is lost for every spawn event in which it was used. To improve genotyping success, one proposed solution is to collect a genetic sample each time a male is spawned. Another factor affecting our ability to identify stock or origin is that if a fish is natural origin or from an unsampled hatchery parent, PBT data cannot determine its stock or origin. Known PBT origins can only be assigned to fish whose parents were sampled at a hatchery during spawning and whose genetic samples were successfully processed by the genetics lab.

Table 6. The genetic stock assignment for hatchery Chinook Salmon used for broodstock at Lookingglass Fish Hatchery, spawn years 2021– 2023. IMNW = Imnaha stock, CTHW = Catherine Creek stock, LKGW = Lookingglass Creek stock.

Stock	Year	Genetic Stock	Hatchery		Natural	
			Female	Male	Female	Male
<u>Catherine Creek</u>	2021	Local Broodstock	44	41	0	0
		Not assigned	2	5	12	21
		GRUW	1	0	0	0
		Idaho: stray	0	1	0	0
		sub-total	47	47	12	21
	2022	Local Broodstock	38	35	0	0
		No PBT assigned	3	6	15	32
		GRUW	1	0	0	0
		sub-total	42	41	15	32
	2023	Local Broodstock	33	34	0	0
		No PBT Assigned	1	0	13	26
		GRUW	0	1	0	0
		sub-total	34	35	13	26
<u>Imnaha River</u>	2021	Local Broodstock	89	64	0	1
		No PBT Assigned	16	61	28	57
		Idaho: Stray	1	1	0	0
		LSTW	1	0	0	0
		sub-total	107	126	28	58
	2022	Local Broodstock	78	55	1	6
		No PBT assigned	21	43	37	80
		Idaho: stray	0	3	0	1
		sub-total	99	101	38	87
	2023	Local Broodstock	90	86	0	4
		No PBT Assigned	11	38	32	45
		Idaho: Stray	2	8	0	0
		sub-total	103	132	32	49
<u>Lookingglass Creek</u>	2021	Local Broodstock	33	43	0	0
		No PBT assigned	5	19	6	16
		CTHW	34	20	0	0
		GRUW	6	3	0	0
		Lower Columbia	0	1	0	0
		LSTW	0	1	0	0
		sub-total	78	87	6	16

Stock	Year	Genetic Stock	Hatchery		Natural	
			Female	Male	Female	Male
	2022	Local Broodstock	66	80	0	1
		No PBT assigned	5	6	9	21
		CHTW	3	3	0	0
		LSTW	0	0	1	0
	sub-total		74	89	10	22
	2023	Local Broodstock	83	84	1	2
		No PBT Assigned	3	16	3	1
		CTHW	3	2	0	0
		GRUW	0	1	0	0
		LSTW	1	0	0	0
		Tucannon River: Stray	0	1	0	0
	sub-total		90	104	4	3
<u>Lostine River</u>	2021	Local Brood	53	34	1	0
		Not assigned	8	45	11	36
		IMNW	1	0	0	0
	sub-total		62	79	12	36
	2022	Local Broodstock	25	21	0	0
		No PBT assigned	16	34	32	46
	sub-total		41	55	32	46
	2023	Local Broodstock	37	42	0	1
		No PBT Assigned	11	10	25	30
		CTHW	0	2	0	0
<u>Upper Grande Ronde R.</u>	2021	Local Broodstock	71	40	0	2
		No PBT assigned	0	14	7	12
		Idaho Stray	0	1	0	0
		LKGW	5	9	0	0
	sub-total		76	64	7	14
	2022	Local Broodstock	60	43	2	1
		No PBT assigned	2	3	13	46
		LKGW	2	0	0	0
	sub-total		64	46	15	47
	2023	Local Broodstock	64	80	0	6
		No PBT Assigned	1	10	10	17
		LKGW	2	0	0	0
	sub-total		67	90	10	23

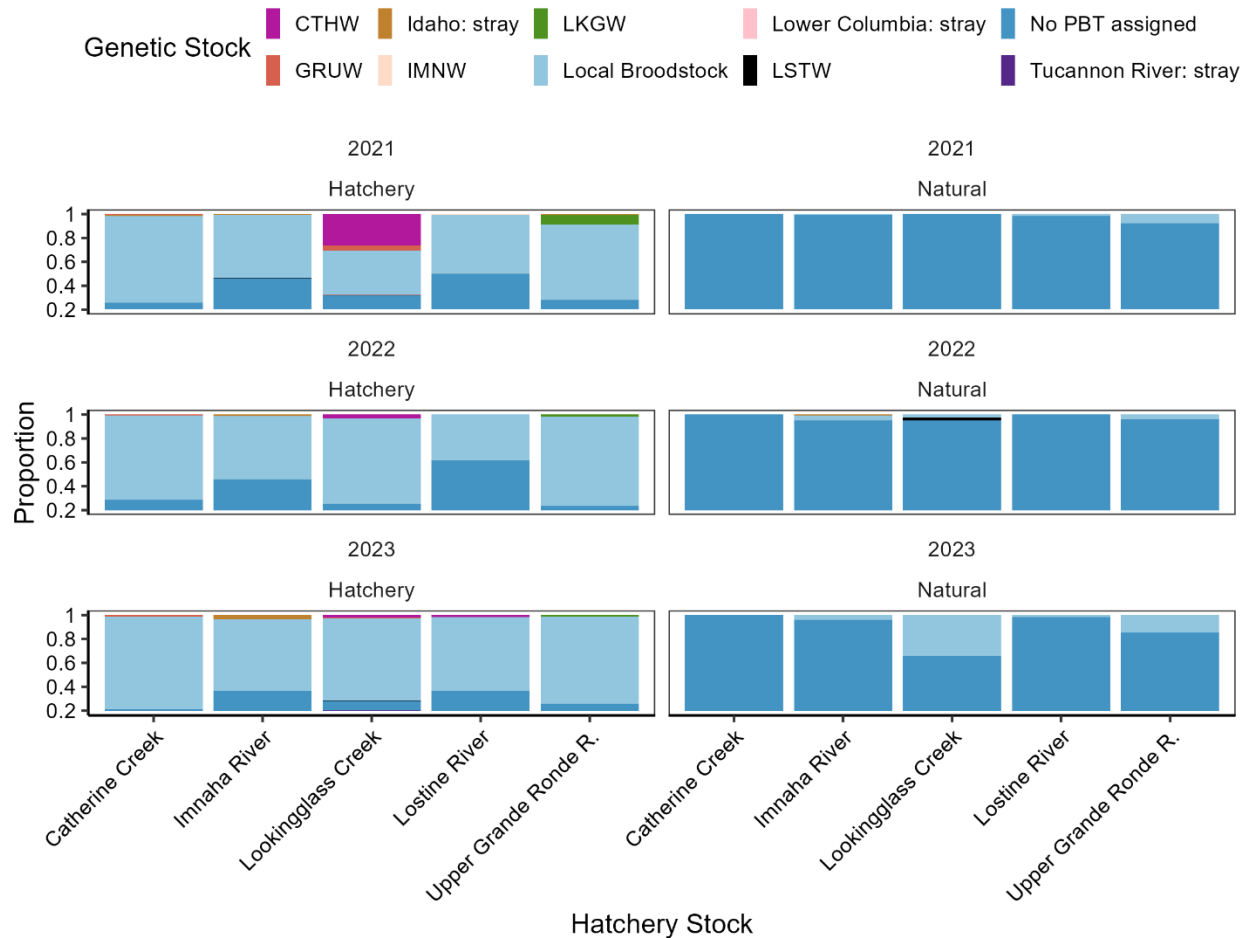


Figure 3. Broodstock at Lookingglass Fish Hatchery and the proportion of parentage-based tagging (PBT) stock assignments, spawn year 2021-2023. Each panel reports observational origin and colors within each stock represent known origins corrected using PBT results. Abbreviations: CTHW = Catherine Creek, GRUW = Upper Grande Ronde River, IMNW = Imnaha River, LKGW = Lookingglass Creek, LSTW = Lostine River.

Green egg-to-smolt and marking

Over the last 10 complete brood years, green egg-to-smolt survival rates for hatchery Chinook Salmon at LFH were generally above 70% (Figure 4). Green egg-to-eyed egg and eyed egg-to-smolt calculations can exceed 100% due to accounting errors in the hatchery.

Brood Year 2019

The green egg-to-smolt survival rate for BY 2019 Imnaha River smolts released in 2021 was 88.1% (97.1% green egg-to-eyed egg; 90.8% eyed egg-to-smolt; Table 7, Figure 4). Green egg-to-smolt survival rate for Catherine Creek was 91.5% (94.8% green egg-to-eyed egg; 91.5% eyed egg-to-smolt). For the Upper Grande Ronde River, the green egg-to-smolt survival rate was 87.0% (97.0% green egg-to-eyed egg; 90.0% eyed egg-to-smolt). For Lookingglass Creek, the green egg-to-smolt survival rate was 68.5% (95.0% green egg-to-eyed egg; 72.1% eyed egg-to-smolt). For Lostine River smolts, the green egg-to-smolt survival rate was 74.4% (90.3% green egg-to-eyed egg; 82.4% eyed egg-to-smolt).

Brood Year 2020

The green egg-to-smolt survival rate for BY 2020 Imnaha River Chinook Salmon released in 2022 was 93.7% (97.7% green egg-to-eyed egg; 95.9% eyed egg-to-smolt; Table 7, Figure 4). The green egg-to-smolt survival rate for Catherine Creek was 96.8% (94.7% green egg-to-eyed egg; 102.2% eyed egg-to-smolt). For the Upper Grande Ronde River, the green egg-to-smolt survival rate was 98.0% (95.5% green egg-to-eyed egg; 102.7% eyed egg-to-smolt). For Lookingglass Creek, the green egg-to-smolt survival rate was 94.6% (96.2% green egg-to-eyed egg; 98.3% eyed egg-to-smolt). For Lostine River smolts, the green egg-to-smolt survival rate was 84.7% (94.9% green egg-to-eyed egg; 89.2% eyed egg-to-smolt).

Brood Year 2021

The green egg-to-smolt survival rate for BY 2021 Imnaha River Chinook Salmon released in 2023 was 87.3% (94.9% green egg-to-eyed egg; 92.0% eyed egg-to-smolt; Table 7, Figure 4). The green egg-to-smolt survival rate for Catherine Creek was 82.4% (96.0% green egg-to-eyed egg; 85.9% eyed egg-to-smolt). For the Upper Grande Ronde River, the green egg-to-smolt survival rate was 91.0% (93.6% green egg-to-eyed egg; 97.2% eyed egg-to-smolt). For Lookingglass Creek, the green egg-to-smolt survival rate was 89.0% (94.3% green egg-to-eyed egg; 94.3% eyed egg-to-smolt). For Lostine River smolts, the green egg-to-smolt survival rate was 81.7% (92.4% green egg-to-eyed egg; 88.3% eyed egg-to-smolt).

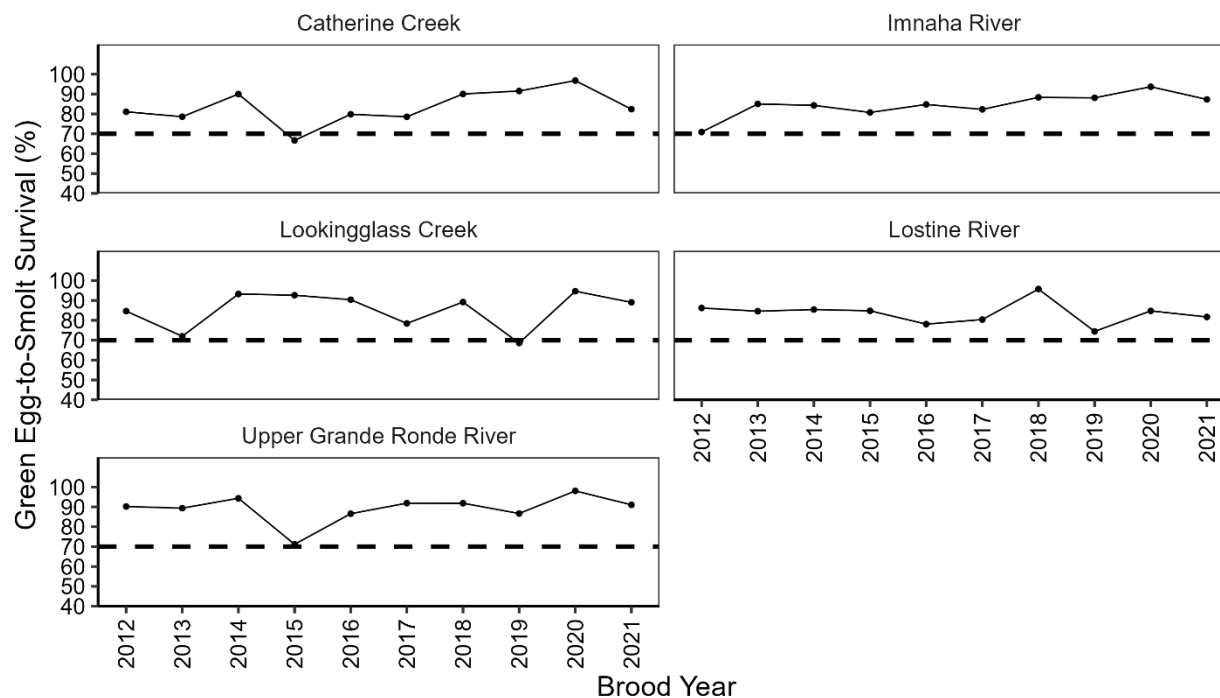


Figure 4. Green egg-to-smolt survival rates (%) for conventionally produced Chinook Salmon at Lookingglass Fish Hatchery, brood years 2012-2021. The dashed line is the green egg-to-smolt survival rate goal of 70%.

Table 7. Conventional hatchery production summaries for BY 2019-2021 juvenile spring Chinook Salmon released into the Imnaha and Grande Ronde River basins, 2021-2023.

Brood Year	Stock	Females spawned	Green eggs taken	Eyed eggs ^a	Eggs culled ^b	Percent Survival			Parr released	Total smolts released
						Green egg-to- eyed egg	Eyed egg-to- smolt ^b	Green egg-to- smolt ^b		
2019	Imnaha River	139	580,264	563,324	0	97.1	90.8	88.1	0	511,261
	Catherine Creek	44	160,750	148,578	4,025	94.8	97.0	91.5	0	143,446
	Upper Grande Ronde R.	74	277,475	260,582	7,874	97.0	90.0	87.0	0	233,643
	Lookingglass Creek	76	296,940	282,280	0	95.0	72.1	68.5	0	203,658
	<u>Lostine River</u>	<u>73</u>	<u>323,943</u>	<u>292,614</u>	<u>0</u>	<u>90.3</u>	<u>82.4</u>	<u>74.4</u>	<u>0</u>	<u>241,121</u>
	Total/Means	406	1,639,372	1,547,388	11,899	94.8	86.5	81.9		1,333,129
2020	Imnaha River	135	548,472	527,738	8,396	97.7	95.9	93.7	0	505,872
	Catherine Creek	55	185,273	175,456	0	94.7	102.2	96.8	0	179,283
	Upper Grande Ronde R.	82	275,298	262,841	0	95.5	102.7	98.0	0	269,890
	Lookingglass Creek	79	288,991	278,226	0	96.2	98.3	94.6	0	273,553
	<u>Lostine River^c</u>	<u>73</u>	<u>315,732</u>	<u>299,697</u>	<u>0</u>	<u>94.9</u>	<u>89.2</u>	<u>84.7</u>	<u>29,933</u>	<u>267,596</u>
	Total/Means	424	1,613,766	1,543,958	8,396	95.8	97.7	93.6	29,933	1,496,194
2021	Imnaha River	135	601,187	570,498	0	94.9	92.0	87.3	0	524,875
	Catherine Creek	59	209,758	194,830	6,613	96.0	85.9	82.4	0	167,354
	Upper Grande Ronde R.	83	299,511	280,393	0	93.6	97.2	91.0	0	272,687
	Lookingglass Creek	84	298,193	281,082	338	94.3	94.3	89.0	18,502	265,237
	<u>Lostine River</u>	<u>74</u>	<u>319,537</u>	<u>295,513</u>	<u>0</u>	<u>92.4</u>	<u>88.3</u>	<u>81.7</u>	<u>0</u>	<u>261,110</u>
	Total/Means	435	1,728,186	1,622,316	6,951	94.2	91.5	86.3	18,502	1,491,263

^a Includes all eggs (embryos) that eyed up, even if culled, released, or transferred later.

^b Eggs were culled if enzyme-linked immunosorbent assay (ELISA) levels of female broodstock were > 0.2. Embryos culled from production, released as eyed eggs, transferred to another facility, and/or parr released or transferred, were not used in calculating green egg-to-smolt and eyed egg-to-smolt survival.

^c 29,848 Parr (Ad Only) were released into the Lostine River on 9/29/2021 due to program excess

Table 8. The number of raceways, the Annual Operating Plan (AOP) coded-wire tag (CWT) marking objectives and estimates of percent adipose (AD) clip and CWT application success, brood years 2019 – 2021.

Brood Year	Stock	Number of Raceways	AOP CWT marking obj.	% AD clip, with CWT	% AD clip, no CWT	% CWT, no AD clip	% no CWT, no AD clip	Total smolts released	Smolt release goal	% of goal
2019	Imnaha River	6	245,000	46.1	53.5	0.3	0.2	511,261	490,000	104.3
	Catherine Creek	2	100,000	67.7	31.9	0.2	0.2	143,446	150,000	95.6
	Upper Grande Ronde R.	4	250,000	47.0	1.0	49.4	2.6	233,643	250,000	93.5
	Lookingglass Creek	6 ^a	120,000	62.8	36.9	0.2	0.1	203,658	250,000	81.5
	<u>Lostine River</u>	<u>4</u>	<u>126,000</u>	<u>48.7</u>	<u>50.9</u>	<u>0.0</u>	<u>0.4</u>	<u>241,121</u>	<u>250,000</u>	<u>96.5</u>
	Total	22 ^a	841,000					1,333,129	1,390,000	95.9
2020	Imnaha River	6	245,000	46.1	52.9	0.0	0.9	505,875	490,000	103.2
	Catherine Creek	2	100,000	54.6	45.1	0.1	0.2	179,283	150,000	119.5
	Upper Grande Ronde R.	4	250,000	43.0	8.3	47.4	1.3	269,890	250,000	108.0
	Lookingglass Creek	6 ^a	120,000	42.3	57.0	0.2	0.4	273,553	250,000	109.4
	<u>Lostine River</u>	<u>4</u>	<u>126,000</u>	<u>40.4</u>	<u>59.5</u>	<u>0.0</u>	<u>0.1</u>	<u>267,596</u>	<u>250,000</u>	<u>107.0</u>
	Total	22 ^a	841,000					1,496,194	1,390,000	107.6
2021	Imnaha River	6	245,000	49.4	50.0	0.0	0.6	524,875	490,000	107.1
	Catherine Creek	2	100,000	59.2	40.8	0.0	0.0	167,354	150,000	111.6
	Upper Grande Ronde R.	4	250,000	36.2	14.3	48.4	1.1	272,687	250,000	109.1
	Lookingglass Creek	6	120,000	44.0	55.8	0.1	0.1	265,237	250,000	106.1
	<u>Lostine River</u>	<u>4</u>	<u>126,000</u>	<u>50.5</u>	<u>49.3</u>	<u>0.0</u>	<u>0.1</u>	<u>231,100</u>	<u>250,000</u>	<u>92.4</u>
	Total	22 ^a	841,000					1,491,253	1,390,000	107.3

^a There are 18 traditional raceways at Lookingglass Fish Hatchery. Lookingglass Creek stock Chinook smolts were reared in two traditional raceway and four of the Adult Holding Ponds which were previously modified for smolt rearing.

Objective 2. Determine optimum rearing and release strategies

Production tagging and smolt releases

Hatchery-origin smolts reared at LFH are marked with an adipose fin clip (AD), a coded-wire tag (CWT), or both (AD CWT). Marking strategies vary by stock: all smolts except those from the Upper Grande Ronde are 100% AD-clipped, while Upper Grande Ronde smolts are 50% AD-clipped but 100% CWT-marked.

Smolts are reared at LFH and transported in late March or early April to acclimation facilities on Catherine Creek, the Upper Grande Ronde, Lostine River, and Imnaha River, where they are released following acclimation periods using volitional or forced release methods. Smolts for Lookingglass Creek are released directly from LFH at rkm 3.7. The target release size for all smolts is 20–25 fish/lb (18–23 g), a standard established after 1990s evaluations found no survival or straying differences between smaller (18–23 g) and larger (30–38 g) Imnaha smolts (Feldhaus et al. 2016).

Catherine Creek

The annual release goal for Catherine Creek is 150,000 smolts ($\pm 10\%$), with all fish AD fin clipped and a goal to mark 67% with a CWT. For brood years 2019–2021, between 143,446 and 179,283 smolts were released, achieving 95.6%–119.5% of the production goal (Table 8; Figure 6). In each brood year, smolts were reared in two raceways at LFH, with each raceway assigned a unique CWT code. The Catherine Creek stock has a single acclimated release date each year. Transfers to the acclimation site occurred between 25 March and 11 April, and releases took place between 23 and 27 April (Table 9).

On average, 60.5% of released smolts were marked with both an AD clip and a CWT, 39.3% were AD-clipped only, 0.1% received a CWT without an AD clip, and 0.1% were unmarked (Table 8). Overall, 99.9% of Catherine Creek smolts were identifiable as hatchery origin. The average travel time to LGD was 21 days, with a median arrival date of 15 May, and the mean smolt survival was 0.55, ranging from 0.42 to 0.59 (Table 9; Figures 8 and 9).

Imnaha River

The annual smolt release goal into the Imnaha River is 490,000 smolts ($\pm 10\%$), with all fish AD fin clipped and a goal to mark 50% with a CWT. For brood years 2019–2021, between 505,872 and 524,875 smolts were released, achieving 100.3% – 107.1% of the smolt production goal (Table 8; Figure 6). In each brood year, smolts were reared in six raceways at LFH, with each of 4 raceways assigned a unique CWT code. For BY's 2010–2020, annual smolt releases consisted of both acclimated and direct stream releases. Beginning BY 2021, managers shifted to using two shorter acclimated releases. For BY's 2019–2020, three raceways within each smolt release were released directly into the Imnaha River from 12 -15 April. The remaining raceways were transferred to acclimation ponds from 18 March – 11 May and released between 11 and 17 May (Table 9).

On average, 47.2% of released smolts were ADCWT-marked, 52.1% were only AD clipped, 0.1% received a CWT but no AD clip, and 0.6% were unmarked (Table 8). Overall, 99.4% of the Imnaha River smolts were identifiable as hatchery origin. Mean smolt survival to LGD was 0.59 and ranged from 0.23 to 0.80, average travel time to LGD was 22 days with a median arrival date of 7 May (Table 9; Figure 8; Figure 9).

Upper Grande Ronde River

The annual smolt release goal for the Upper Grande Ronde River (UGR) program is 250,000 smolts ($\pm 10\%$), with 50% AD fin-clipped and all fish coded-wire-tagged (CWT). For brood years 2019–2021, releases ranged from 233,643 to 272,687 smolts, achieving 93%–109% of the production goal (Table 8; Figure 6). In each brood year, smolts were reared in four raceways at LFH, with each raceway assigned a unique CWT code.

The Upper Grande Ronde stock has two acclimation periods and corresponding release dates. Transfers to acclimation occurred between 24 March and 10 April. The first groups were released between 4 and 12 April, and the second groups between 23 and 27 April. On average, 42.1% of released smolts were marked with both an AD clip and a CWT, 7.9% were AD-clipped only, 48.4% received a CWT without an AD clip, and 1.7% were unmarked. Overall, 98.3% of smolts released into the Upper Grande Ronde River were identifiable as hatchery origin. Mean smolt survival to LGD) was 0.47 and ranged from 0.22 to 0.87, the average travel time to was 30 days with a median arrival date of 15 May (Table 9; Figures 8 and 9).

Lookingglass Creek

The annual smolt release goal into Lookingglass Creek is 250,000 smolts ($\pm 10\%$), with 100% AD fin-clipped and a goal to mark 48% with a CWT. For brood years 2019–2021, between 203,658 and 273,553 smolts were released, achieving 81.46% – 107.12% of the smolt production goal (Table 8; Figure 6). For all three brood years, one standard raceway and the four adult holding ponds were utilized, and two unique CWT codes were used to identify smolts. The Lookingglass Creek stock has one release date each year. Smolts were released from LFH between 4 – 22 April.

On average, 49.7% of the smolts released were ADCWT-marked, 49.9% were AD-clipped only, 0.2% only received a CWT, and 0.2% were released unmarked (Table 8). Overall, 99.8% of the smolts released in Lookingglass Creek were identifiable as hatchery origin. The average travel time to LGD was 24 days, with a median arrival date of 8 May, and the mean smolt survival was 0.55, ranging from 0.41 to 0.68. (Table 9; Figure 8; Figure 9).

Lostine River

The annual smolt release goal for Lostine River is 250,000 smolts ($\pm 10\%$), with 100% AD fin clipped, and a goal to mark 50% of the releases with a CWT. For brood years 2019–2021, between 241,121 and 267,596 smolts were released, achieving 96.5% – 107% of the smolt production goals (Table 8; Figure 6). In each brood year, smolts were raised in four raceways at LFH, with two unique CWT codes used each year.

The Lostine River stock has two acclimation periods and corresponding release dates. Each release group received a unique CWT code (Table 9). Transfers to acclimation occurred between 7 March and 11 April. Release dates for the first transfer occurred between 4 April and 10 April, and release dates for the second group occurred from 20 – 21 April.

On average, 46.5% of released smolts were marked with both an AD clip and a CWT, 53.2% were AD-clipped only, 0.0% received a CWT without an AD clip, and 0.2% were unmarked (Table 8). Overall, 99.8% of Lostine River smolts were identifiable as hatchery origin. The average travel time to LGD was 27 days, with a median arrival date of 11 May, and the mean smolt survival was 0.51, ranging from 0.41 to 0.70 (Table 9; Figure 8; Figure 9).

Table 9. Last release date, pre-release sampling date, mean size, total number of coded-wire-tagged smolts and total number of smolts, number PIT-tagged, and survival rate to Lower Granite Dam of BYs 2019-2021 spring Chinook Salmon smolts released into the Imnaha and Grande Ronde River basins, 2021-2023. NA = Not applicable.

Brood Year	Stock CWT code	Raceway	Last release date	Size sample date	Fork Length (mm)		Weight (SD)		Total CWT smolts released	Total smolts released	Number PIT tagged	Survival Rate to Lower Granite Dam
					Mean	SD	Mean	SD				
2019	Imnaha River											
	091410	09	04/15/2021	04/12/2021	120.42	6.83	20.20	3.57	58,318	73,976	2,909	0.57
	091411	10	04/15/2021	04/12/2021	120.14	8.26	20.36	4.27	58,995	69,397	2,966	0.59
	091412	11	04/17/2021	03/16/2021	115.80	7.03	19.72	3.52	60,625	67,393	2,986	0.77
	091413	12	04/17/2021	03/16/2021	111.48	8.34	17.71	4.09	58,831	77,944	2,990	0.78
	Ad only	06	04/17/2021	03/16/2021	116.70	6.75	19.88	3.52	0	74,396	2,985	0.76
	Ad only	07	04/17/2021	03/16/2021	115.25	6.87	19.09	3.62	0	78,038	2,897	0.76
	<u>Ad only</u>	<u>08</u>	<u>04/15/2021</u>	<u>04/12/2021</u>	<u>121.10</u>	<u>6.06</u>	<u>19.92</u>	<u>3.15</u>	<u>0</u>	<u>69,571</u>	<u>2,968</u>	<u>0.80</u>
	Totals/Means								236,769	511,261	20,701	0.72
2019	Catherine Creek											
	091407	13	04/23/2021	03/23/2021	118.46	6.81	20.27	3.99	49,228	71,573	10,346	0.55
	<u>091406</u>	<u>14</u>	<u>04/23/2021</u>	<u>03/23/2021</u>	<u>116.79</u>	<u>9.38</u>	<u>19.37</u>	<u>4.59</u>	<u>48,242</u>	<u>71,873</u>	<u>10,352</u>	<u>0.50</u>
	Totals/Means								97,470	143,446	20,698	0.53
2019	Upper Grand Ronde R											
	091416	15	04/06/2021	03/23/2021	118.07	6.68	19.75	3.37	54,983	58,062	482	0.39
	091417	16	04/06/2021	03/23/2021	116.99	7.29	19.77	3.80	58,063	59,686	474	0.57
	091418	17	04/23/2021	04/06/2021	123.57	6.59	21.40	3.50	56,858	59,412	482	0.61
	<u>091419</u>	<u>18</u>	<u>04/23/2021</u>	<u>04/06/2021</u>	<u>120.39</u>	<u>7.59</u>	<u>19.72</u>	<u>3.82</u>	<u>55,354</u>	<u>56,483</u>	<u>490</u>	<u>0.48</u>
	Totals/Means								225,258	233,643	1,928	0.51
2019	Lookingglass Creek											
	091415	01	04/22/2021	04/21/2021	125.27	6.97	22.79	4.38	38,404	66,301	1,577	0.58
	091415	AHPD ^b	04/22/2021	04/21/2021	125.40	8.12	22.54	4.53	20,030	34,297	749	0.62

Brood Year	Stock CWT code	Raceway	Last release date	Size sample date	Fork Length (mm)		Weight (SD)		Total CWT smolts released	Total smolts released	Number PIT tagged	Survival Rate to Lower Granite Dam
					Mean	SD	Mean	SD				
	091414	AHPA ^b	04/22/2021	04/21/2021	124.14	6.46	22.12	3.68	23,337	34,364	830	0.55
	091414	AHPB ^b	04/22/2021	04/21/2021	124.65	7.07	23.28	10.59	23,199	34,201	765	0.52
	091414	AHPC ^b	04/22/2021	04/21/2021	126.19	7.00	23.41	4.06	23,395	34,486	854	0.58
	Totals/Means								128,365	203,658	4,775	0.57
2019	Lostine River											
	091409	02	04/05/2021	03/09/2021	111.74	6.31	17.88	3.04	14,566	59,490	1,500	0.46
	091409	03	04/05/2021	03/09/2021	114.82	5.96	18.31	2.95	43,716	59,625	1,491	0.53
	091408	04	04/20/2021	04/06/2021	119.79	6.94	19.36	3.45	15,262	60,818	1,497	0.49
	091408	05	04/20/2021	04/06/2021	120.06	6.24	19.01	3.17	43,929	61,188	1,473	0.49
	Totals/Means								117,473	241,121	5,961	0.49
2020	Imnaha River											
	Ad Only	06	04/15/2022	03/15/2022	113.24	7.66	17.16	3.22	0	66,916	2,986	0.65
	Ad Only	07	04/15/2022	03/15/2022	114.02	6.19	17.25	2.91	0	66,153	2,992	0.67
	Ad Only	08	04/12/2022	04/07/2022	116.80	6.48	19.23	3.21	0	67,667	2,997	0.30
	091692	09	04/12/2022	04/07/2022	118.66	7.50	19.63	3.91	61,022	75,964	2,994	0.26
	091693	10	04/12/2022	04/07/2022	118.04	6.74	20.33	10.38	60,504	79,184	2,997	0.23
	091694	11	04/12/2022	03/15/2022	113.74	7.13	17.33	3.26	62,209	74,160	2,994	0.63
	091695	12	04/12/2022	03/15/2022	115.74	6.60	18.57	3.04	49,905	75,378	2,996	0.63
	Totals/Means								233,640	505,872	20,956	0.48
2020	Catherine Creek											
	091682	13	04/27/2022	03/24/2022	116.46	5.83	18.83	2.99	48,778	89,887	10,416	0.55
	091683	14	04/27/2022	03/24/2022	113.79	8.75	17.57	4.21	49,366	89,396	10,417	0.51
	Totals/Means								98,144	179,283	20,932	0.53
2020	Upper Grande Ronde											
	091686	15	04/12/2022	03/24/2022	115.98	6.10	17.83	3.19	58,190	74,037	496	0.35

Brood Year	Stock CWT code	Raceway	Last release date	Size sample date	Fork Length (mm)		Weight (SD)		Total CWT smolts released	Total smolts released	Number PIT tagged	Survival Rate to Lower Granite Dam
					Mean	SD	Mean	SD				
	091687	16	04/27/2022	04/07/2022	121.20	5.69	20.40	3.16	57,908	64,671	498	0.48
	091684	17	04/27/2022	04/07/2022	118.18	6.87	19.15	3.48	63,922	65,592	500	0.87
	<u>091685</u>	<u>18</u>	<u>04/12/2022</u>	<u>03/24/2022</u>	<u>115.79</u>	<u>6.80</u>	<u>17.98</u>	<u>3.28</u>	<u>63,839</u>	<u>65,590</u>	<u>499</u>	<u>0.42</u>
	Totals/Means								243,859	269,890	1,993	0.53
2020	Lookingglass Creek											
	091690	AHPA ^b	04/22/2022	04/18/2022	123.73	6.81	22.72	4.04	28,626	49,274	898	0.53
	091690	AHPB ^b	04/22/2022	04/18/2022	124.97	7.03	23.00	4.04	28,436	48,999	797	0.59
	091691	AHPC ^b	04/22/2022	04/18/2022	123.71	6.29	22.39	3.98	30,753	49,113	883	0.62
	091691	AHPD ^b	04/22/2022	04/18/2022	121.68	8.04	21.28	4.35	28,559	45,620	797	0.67
	<u>Ad Only</u>	<u>01</u>	<u>04/22/2022</u>	<u>04/18/2022</u>	<u>122.12</u>	<u>6.84</u>	<u>21.15</u>	<u>3.90</u>	<u>0</u>	<u>80,547</u>	<u>1,595</u>	<u>0.68</u>
	Totals/Means								116,374	273,553	4,970	0.62
2020	Lostine River											
	091688	02	04/10/2022	03/03/2022	116.11	7.06	17.83	3.20	19,037	67,114	1,493	0.48
	091688	03	04/10/2022	03/03/2022	112.59	7.29	16.12	3.41	40,720	66,855	1,463	0.52
	091689	04	04/21/2022	04/07/2022	117.70	6.98	19.90	10.76	16,800	66,820	1,478	0.63
	<u>091689</u>	<u>05</u>	<u>04/21/2022</u>	<u>04/07/2022</u>	<u>115.27</u>	<u>7.09</u>	<u>18.91</u>	<u>3.35</u>	<u>31,491</u>	<u>66,807</u>	<u>1,482</u>	<u>0.70</u>
	Totals/Means								108,048	267,596	5,916	0.58
2021	Imnaha River											
	Ad Only	06	04/17/2023	04/04/2023	119.10	6.60	20.40	3.90	0	71,917	2,976	0.53
	Ad Only	07	04/16/2023	04/04/2023	114.90	7.20	20.80	3.80	0	71,444	2,983	0.50
	Ad Only	08	04/11/2023	04/04/2023	115.00	9.20	20.80	5.40	0	71,651	2,977	0.63
	092080	09	04/11/2023	04/04/2023	120.00	7.70	21.00	4.00	67,700	77,523	2,992	0.61
	091881	10	04/11/2023	04/04/2023	116.20	11.90	19.10	5.90	62,945	77,130	2,979	0.56
	091894	11	04/17/2023	04/04/2023	122.20	7.60	21.80	4.30	65,762	77,569	2,995	0.57
	<u>091895</u>	<u>12</u>	<u>04/16/2023</u>	<u>04/04/2023</u>	<u>118.60</u>	<u>9.20</u>	<u>20.00</u>	<u>4.50</u>	<u>62,945</u>	<u>77,641</u>	<u>2,991</u>	<u>0.51</u>
	Total/Means								259,352	524,875	20,893	0.56

Brood Year	Stock CWT code	Raceway	Last release date	Size sample date	Fork Length (mm)		Weight (SD)		Total CWT smolts released	Total smolts released	Number PIT tagged	Survival Rate to Lower Granite Dam
					Mean	SD	Mean	SD				
2021	Catherine Creek											
	092076	13	04/24/2023	03/23/2023	113.50	7.40	16.80	3.30	49,966	83,556	10,341	0.59
	<u>092077</u>	<u>14</u>	<u>04/24/2023</u>	<u>03/23/2023</u>	<u>113.90</u>	<u>8.70</u>	<u>17.50</u>	<u>4.60</u>	<u>49,031</u>	<u>83,798</u>	<u>10,375</u>	<u>0.59</u>
	Total/Means								98,997	167,354	20,716	0.59
2021	Lookingglass Creek											
	091893	AHPA ^b	04/01/2023	03/27/2023	119.30	7.30	20.10	3.90	21,225	47,136	898	0.52
	091893	AHPB ^b	04/01/2023	03/27/2023	118.20	7.40	19.40	3.90	21,228	47,145	798	0.45
	091893	AHPC ^b	04/01/2023	03/27/2023	116.30	7.20	21.00	4.00	21,704	47,084	896	0.45
	091892	AHPD ^b	04/01/2023	03/27/2023	117.20	7.90	21.90	28.80	18,759	48,438	792	0.41
	<u>091892</u>	<u>01</u>	<u>04/01/2023</u>	<u>03/27/2023</u>	<u>115.10</u>	<u>9.60</u>	<u>20.10</u>	<u>4.90</u>	<u>33,980</u>	<u>75,434</u>	<u>1,591</u>	<u>0.44</u>
	Total/Means								116,896	265,237	4,975	0.45
2021	Upper Grande Ronde R,											
	092082	15	04/04/2023	03/23/2023	117.70	8.10	19.30	4.30	49,259	69,928	497	0.22
	092083	16	04/24/2023	04/04/2023	117.60	8.60	19.80	4.50	50,318	70,357	497	0.46
	092079	17	04/24/2023	04/04/2023	118.90	7.10	20.20	3.70	66,193	66,672	498	0.53
	<u>092078</u>	<u>18</u>	<u>04/04/2023</u>	<u>03/23/2023</u>	<u>117.80</u>	<u>6.30</u>	<u>18.90</u>	<u>3.30</u>	<u>64,901</u>	<u>65,730</u>	<u>606</u>	<u>0.27</u>
	Total/Means								230,671	272,687	2,098	0.37
2021	Lostine River											
	092084	02	04/10/2023	03/16/2023	116.80	7.40	19.20	3.80	30,267	67,427	1,500	0.41
	092084	03	04/10/2023	03/16/2023	116.10	8.40	19.10	4.20	35,769	64,356	1,499	0.42
	091891	04	04/20/2023	04/04/2023	116.80	8.60	18.30	4.00	30,247	64,763	1,499	0.50
	<u>091891</u>	<u>05</u>	<u>04/20/2023</u>	<u>04/04/2023</u>	<u>120.30</u>	<u>9.20</u>	<u>20.40</u>	<u>4.50</u>	<u>35,715</u>	<u>64,554</u>	<u>1,499</u>	<u>0.52</u>
	Total/Means								131,998	261,100	5,997	0.46

^a Direct Stream Release

^b Indicates Adult holding pond at Lookingglass Fish Hatchery

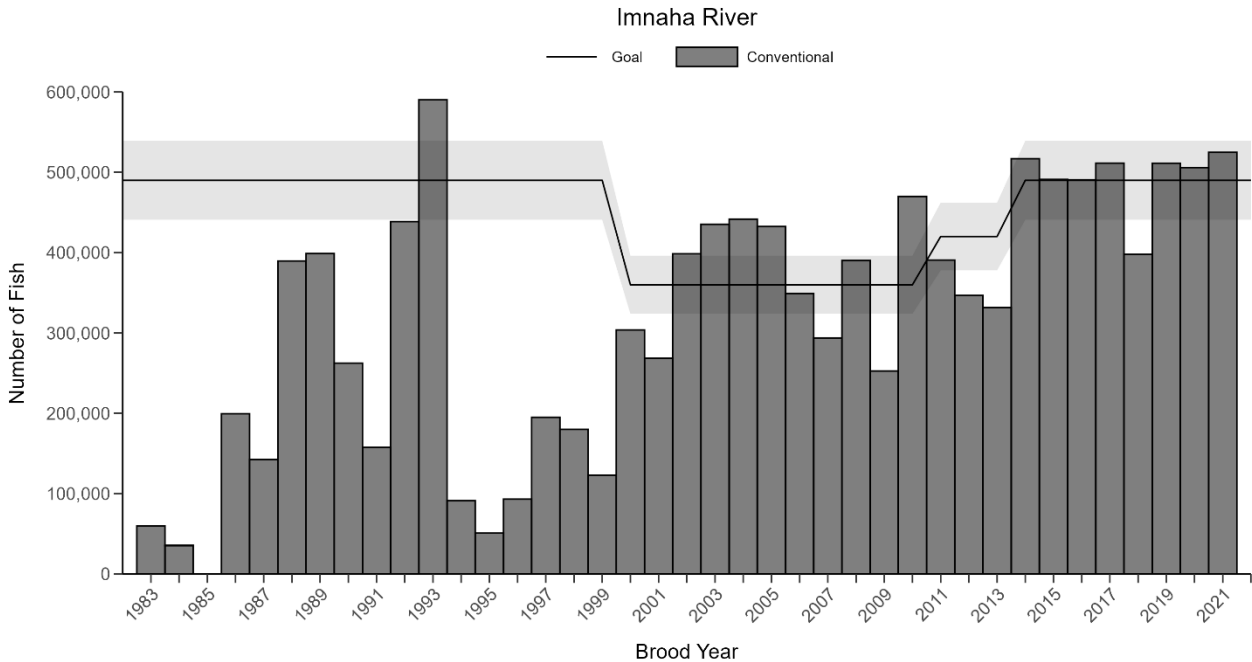


Figure 5. Hatchery spring Chinook Salmon smolt releases in the Imnaha River, 1983-2021 brood years. The shaded region around the smolt goal is $\pm 10\%$. Smolt release goals were 490,000 (BYs 1983-1999 and 2014-present), 360,000 (BYs 2000-2010), and 420,000 (BYs 2011-2013).

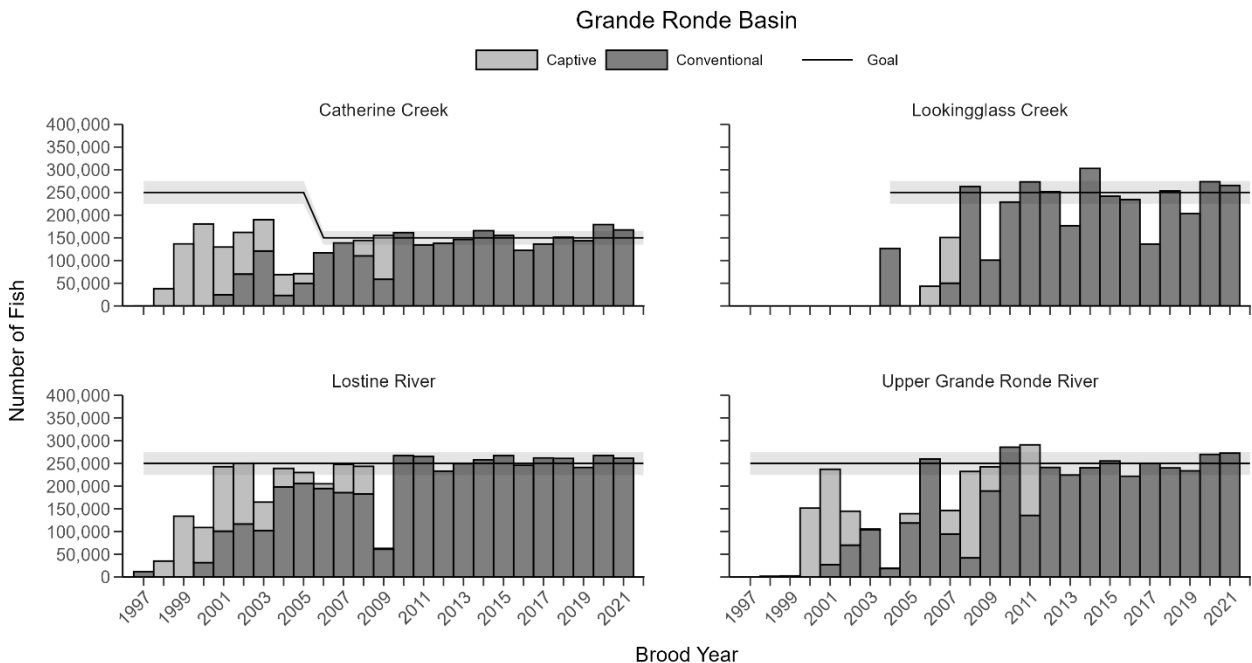


Figure 6. Hatchery spring Chinook Salmon smolts released in Catherine Creek, Lookingglass Creek, the Lostine River, and the Upper Grande Ronde River compared to smolt release goals, 1997-2021 brood years. The shaded region around the smolt goal is $\pm 10\%$.

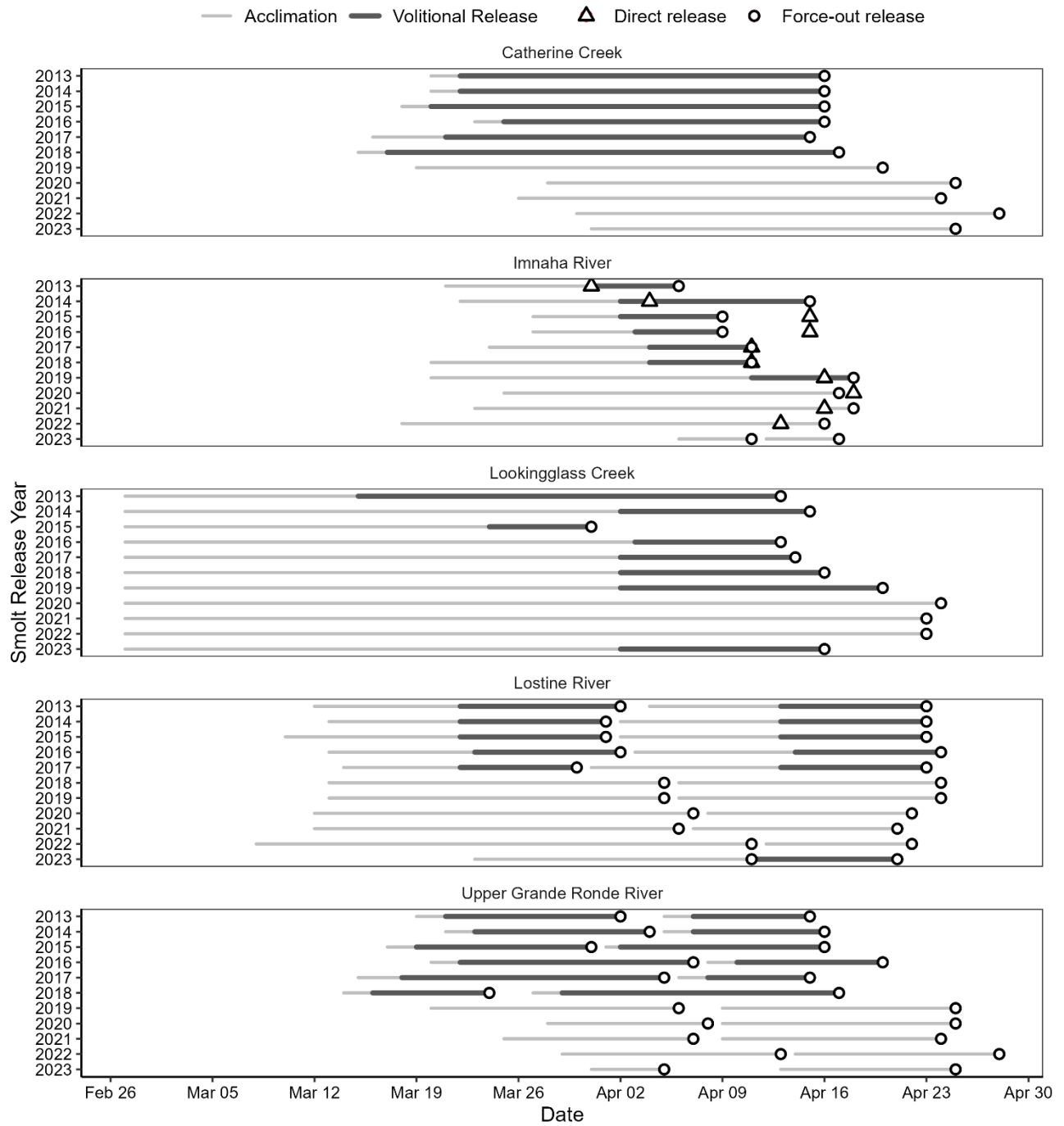


Figure 7. Release strategies and release dates for hatchery spring Chinook Salmon smolts released into Catherine Creek, the Imnaha River, Lookingglass Creek, the Lostine River, and the Upper Grande Ronde, release years 2013-2023.

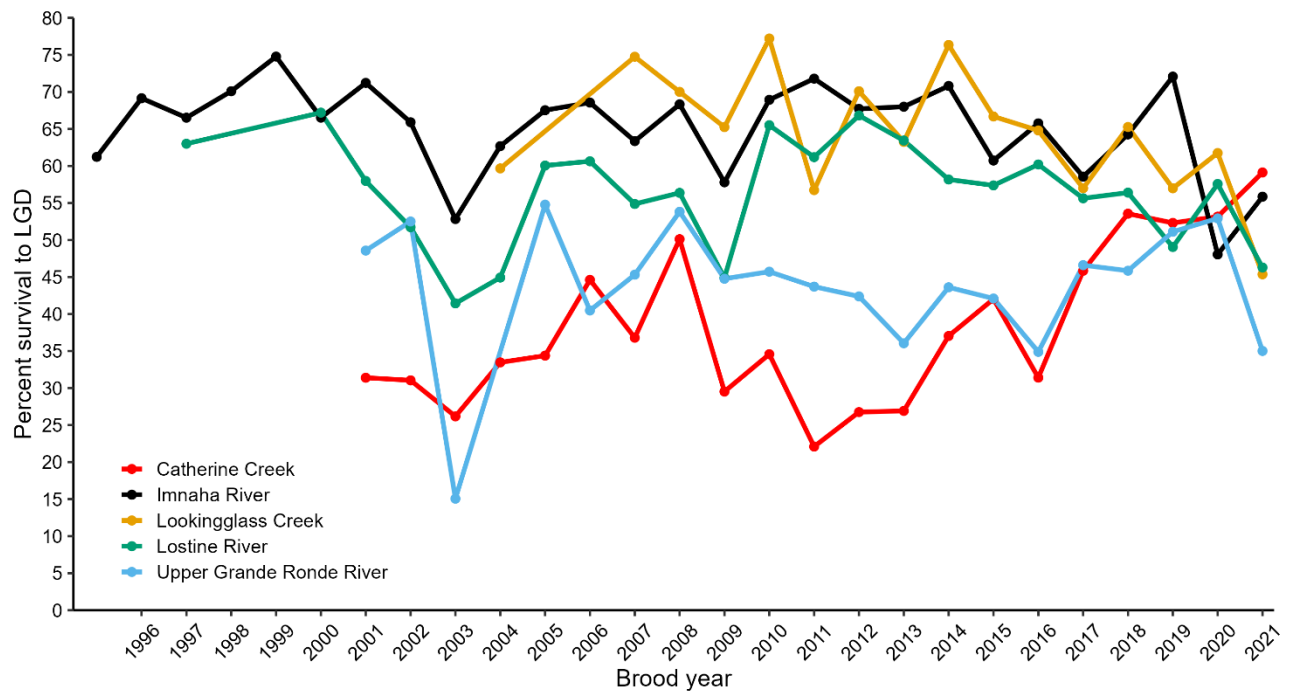


Figure 8. Mean apparent survival to Lower Granite Dam of PIT-tagged hatchery juvenile Chinook Salmon released into Catherine Creek, the Imnaha River, Lookingglass Creek, the Lostine River, and the Upper Grande Ronde River.

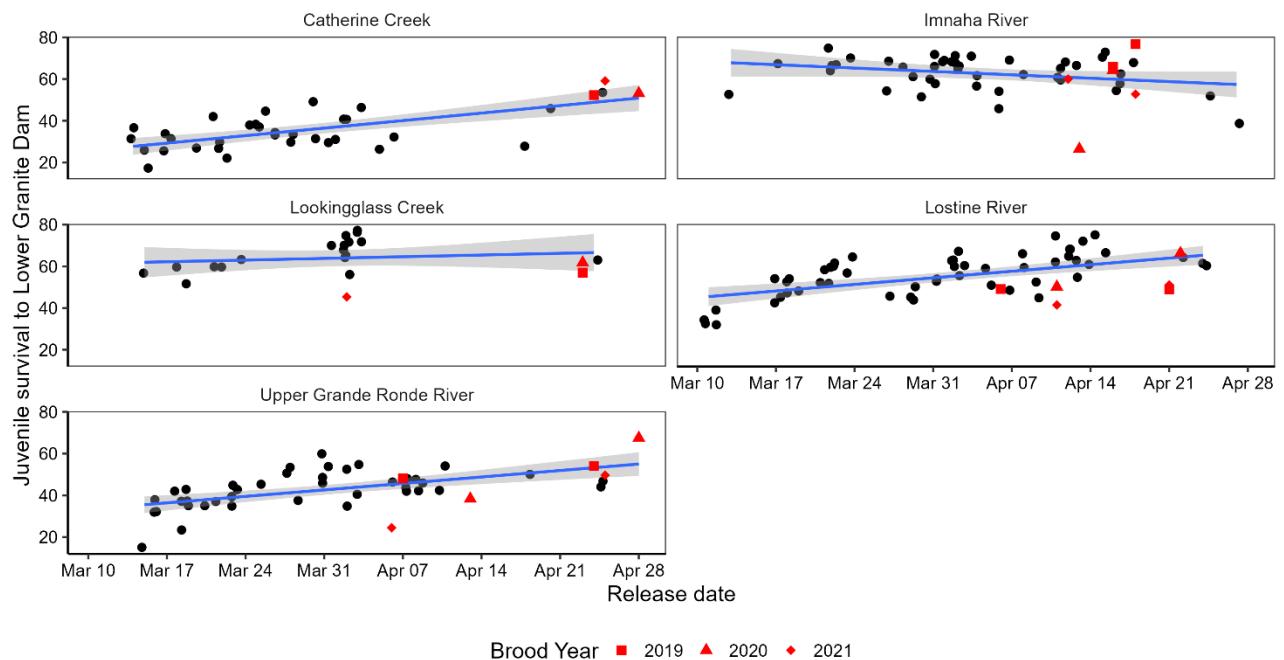


Figure 9. First release date compared to estimated juvenile survival rate (%) to Lower Granite Dam. Smolts were released into Catherine Creek and the Upper Grande Ronde River (BYs 1998-2021), the Imnaha River (BY 1991-2021), the Lostine River (BY 1997-2021), and Lookingglass Creek (BYs 2002-2004, 2006-2021). Red points are for releases from BY 2019-2021. The shaded area around the linear regression line is a 95% confidence interval.

Objective 3. Determine total catch and escapement, smolt survival, smolt-to-adult survival, and assess if adult production meets mitigation goals.

Catch and Escapement

The ODFW relies on CWT data from the Pacific States RMIS database to estimate catch and escapement of hatchery stocks downstream of terminal tributaries in the Grande Ronde and Imnaha basins. The data used to report SAR, SAS, and stray rate metrics was current through 28 January 2025. Estimated hatchery and natural Chinook Salmon escapement to each river is derived through a combination of tributary sport and tribal fishery estimates, weir recoveries, and spawning ground surveys to estimate the numbers of Chinook Salmon above and below weirs. In general, return year data is finalized, and the origin and age-structure estimate for hatchery and natural Chinook Salmon for each tributary are derived within one year of the Chinook Salmon's return to the system. It can take two or three years before the RMIS CWT recovery data is static. The disparate timelines for data availability between tributary escapements and CWT derived RMIS estimates is a consistent data reporting challenge that contributes to delays in finalizing catch distribution summaries as well as SAS and SAR rates.

Brood Year 2016

The age-5-year Chinook Salmon that returned to the Columbia Basin in 2021 completed returns for BY 2016 hatchery production for the five Chinook Salmon stocks reared and released from LFH. The estimated production of 3,756 age 3-5 Chinook Salmon from BY 2016 were comprised of estimated returns of 207 from Catherine Creek, 280 from the Upper Grande Ronde, 538 from Lookingglass Creek, 820 from the Lostine River, and 1,909 from the Imnaha River (Table 10, Figure 10).

In Ocean fisheries, the five hatchery stocks contributed to expanded estimates of five Chinook Salmon (Table 10). For Columbia River fisheries, for these five stocks combined, it was estimated that 62 salmon were harvested, zero in net fisheries, 28 in sport fisheries, and 34 in tribal fisheries.

In the Snake River, estimated total hatchery production from the five stocks reared at LFH contributed to harvest of 20 Chinook Salmon in sport fisheries and zero in tribal fisheries (Table 10). Below LGD, an estimated six Chinook Salmon strayed. These strays were represented by three unique CWT recoveries, one Chinook Salmon from Lookingglass Creek and one from the Lostine River, both recovered at Pelton Dam on the Deschutes River, and one Chinook Salmon from Lookingglass Creek recovered at the Salmon River Hatchery in Oregon.

Above LGD, an estimated 17 Chinook Salmon strayed, represented by 16 unique CWT recoveries (Table 10). None of these recoveries occurred outside the Grande Ronde Basin. Within the basin, CWT-marked Chinook Salmon were recovered at the Lookingglass and Upper Grande Ronde weirs, as well as from the spawning grounds in Lookingglass Creek. Six Catherine Creek strays were recovered at the Lookingglass Creek trap. The four Upper Grande Ronde strays were represented by three unique CWT recoveries—two from the Lookingglass Creek trap and one from the Lookingglass Creek spawning grounds. Five Lookingglass Creek Chinook Salmon were recovered at the Upper Grande Ronde trap. Additionally, two Imnaha River salmon were recovered at the Lookingglass Creek trap.

Overall, an estimated 3,644 Chinook Salmon (i.e., 97% of the total production) from BY 2016 returned to their natal hatchery programs. Within the Grande Ronde Basin, 195 mature Chinook Salmon returned to Catherine Creek, 270 returned to the Upper Grande Ronde River, 516 returned

to Lookingglass Creek, and 791 returned to the Lostine River. An estimated 1,872 mature hatchery Chinook Salmon returned to the Imnaha River from BY 2016 production (Figure 10).

Brood Year 2017

The 2022 return of age-5 Chinook Salmon marked the completion of brood year (BY) 2017 hatchery production for the five stocks reared and released from LFH. For BY 2017, the estimated total production of age-3 to age-5 Chinook Salmon was 3,973 fish, consisting of 498 from Catherine Creek, 286 from the Upper Grande Ronde, 424 from Lookingglass Creek, 929 from the Lostine River, and 1,836 from the Imnaha River (Table 11, Figure 10).

In Ocean fisheries, the five hatchery programs contributed to expanded estimates of 10 Chinook Salmon (Table 11). For Columbia River fisheries, an estimated 373 Chinook Salmon were harvested, 25 in net fisheries, 232 in sport fisheries, and 116 in tribal fisheries.

In the Snake River, an estimated total hatchery production from LFH contributed to harvest of 58 salmon in sport fisheries and zero in tribal fisheries (Table 11). Below LGD, an estimated 24 salmon strayed. These strays were represented by nine unique CWT recoveries: one from Catherine Creek, one from the Lostine River, and four from the Imnaha River—all recovered at Pelton Dam on the Deschutes River. One Catherine Creek Chinook Salmon was recovered at the Round Butte trap on the Deschutes River. One Imnaha River Chinook Salmon was recovered at the Cowlitz Salmon Hatchery in Washington, and one more was recovered in the Umatilla River in Oregon.

Above LGD, an estimated 54 Chinook Salmon strayed, represented by 46 unique CWT recoveries (Table 11). Two of these strays were outside the Grande Ronde Basin, including two Lostine River Chinook Salmon represented by one unique CWT recovery in Idaho at the Rapid River trap. Within the Grande Ronde Basin, CWT-marked Chinook Salmon were recovered at the Lookingglass Creek, Lostine River, Upper Grande Ronde, Imnaha River, and Catherine Creek weirs, as well as from the spawning grounds in Lookingglass Creek, Catherine Creek, and the Wallowa River. The estimated 13 Catherine Creek strays were represented by 13 unique CWT recoveries—11 were recovered at the Lookingglass Creek trap, and two from the Lookingglass Creek spawning grounds. The 14 Upper Grande Ronde CWT-marked Chinook Salmon were represented by 14 unique recoveries: one from the Catherine Creek trap, one from the Catherine Creek spawning grounds, nine from the Lookingglass Creek trap, and three from the Lookingglass Creek spawning grounds. Eight Lookingglass Creek Chinook Salmon were recovered at the Upper Grande Ronde trap. The 16 Lostine River strays were represented by nine unique CWT recoveries—one from the Imnaha River trap, one from the Lookingglass Creek spawning grounds, and seven from the Wallowa River spawning grounds. One Imnaha River CWT-marked Chinook Salmon was recovered at the Lostine River trap.

Overall, an estimated 3,452 Chinook Salmon (i.e., 87% of the total production) from BY 2017 returned to their natal hatchery programs. Within the Grande Ronde Basin, 466 mature Chinook Salmon returned to Catherine Creek, 226 returned to the Upper Grande Ronde River, 396 returned to Lookingglass Creek, and 802 returned to the Lostine River. An estimated 1,562 mature hatchery Chinook Salmon returned to the Imnaha River from BY 2017 production (Figure 10).

Brood Year 2018

The 2022 return of age-5 Chinook Salmon marked the completion of brood year (BY) 2018 hatchery production for the five stocks reared and released from LFH. For BY 2017, the estimated total production of age-3 to age-5 Chinook Salmon was 5,427 fish, consisting of 779 from

Catherine Creek, 272 from the Upper Grande Ronde, 1,804 from Lookingglass Creek, 1,388 from the Lostine River, and 1,184 from the Imnaha River (Table 12, Figure 10).

In Ocean fisheries, the five hatchery programs contributed to expanded estimates of eight Chinook Salmon (Table 12). For Columbia River fisheries, an estimated 845 Chinook Salmon were harvested, 20 in net fisheries, 605 in sport fisheries, and 220 in tribal fisheries.

In the Snake River, an estimated total hatchery production from LFH contributed to harvest of 116 Chinook Salmon in sport fisheries and zero in tribal fisheries (Table 120). Below LGD, an estimated eight Chinook Salmon strayed. These strays were represented by four unique CWT recoveries: one Chinook Salmon from Lookingglass Creek, one from the Imnaha River, and two from the Upper Grande Ronde River, all recovered at Pelton Dam on the Deschutes River.

Above LGD, an estimated 51 Chinook Salmon strayed, represented by 39 unique CWT recoveries (Table 12). None of these recoveries occurred outside the Grande Ronde Basin. CWT-marked Chinook Salmon were recovered at the Lookingglass Creek, Lostine River, Upper Grande Ronde, Imnaha River, and Catherine Creek weirs, as well as from the spawning grounds in Hurricane Creek, Lookingglass Creek, and the Wenaha River. The estimated 11 Catherine Creek strays were represented by eight unique CWT recoveries—three were recovered at the Lookingglass Creek weir, and five on the Lookingglass Creek spawning grounds. The estimated 16 Upper Grande Ronde CWT-marked Chinook Salmon were represented by 11 unique CWT recoveries—four from the Catherine Creek trap, two from the Lookingglass Creek trap, four from the Lookingglass Creek spawning grounds, and one from the Lostine River trap. The estimated 10 Lookingglass Creek strays were represented by eight unique CWT recoveries—one from the Catherine Creek trap, four from the Upper Grande Ronde River trap, one from the Lostine River trap, one from the Imnaha River trap, and one from the Wenaha spawning grounds. The estimated eight Lostine River strays were represented by six unique CWT recoveries—three from the Lookingglass Creek trap, one from the Lookingglass Creek spawning grounds, and two from the Hurricane Creek spawning grounds. Six Imnaha River Chinook Salmon strayed—one was recovered at the Upper Grande Ronde trap, while five were found at the Lostine River trap.

The overall BY 2018 production consisted of 4,399 Chinook Salmon which was 81.2% of the total production. Within the Grande Ronde Basin 679 mature Chinook Salmon returned to Catherine Creek, 207 returned to the Upper Grande Ronde River, 1,534 returned to Lookingglass creek, 1,005 returned to the Lostine River (Table 12). An estimated 974 mature hatchery Chinook Salmon returned to the Imnaha River from BY 2018 production (Figure 10).

Table 10. Catch and escapement distribution of Catherine Creek, Upper Grande Ronde, Imnaha River, Lookingglass, and Lostine River spring/summer Chinook Salmon, complete brood years 2016.

	Catherine Creek.		Upper Grande Ronde River		Lookingglass Creek		Lostine River		Imnaha River	
Total smolts released	122,401		221,814		234,007		245,784		490,510	
% AD + CWT	95.6%		47.9%		63.8%		53.0%		52.3%	
	% of catch	Est. return	% of catch	Est. return	% of catch	Est. return	% of catch	Est. return	% of catch	Est. return
Ocean ^a	0.0	0	0.0	0	0.0	0	0.2	2	0.2	3
Columbia River ^a										
Commercial Net	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0
Sport	0.5	1	0.0	0	1.3	7	1.0	8	0.6	12
Tribal Net	0.0	0	0.0	0	0.0	0	2.1	17	0.9	17
Snake River ^a										
Sport ^b	2.4	5	2.1	6	1.1	6	0.0	0	0.2	3
Tribal ^b	0.0	0	0.0	0	0	0	0.0	0	0.0	0
Stray Below LGD	0.0	0	0.0	0	0.7	4	0.2	2	0.0	0
Stray Above LGD	2.9	6	1.4	4	0.9	5	0.0	0	0.1	2
Recruitment to River ^{b, c}	<u>94.2</u>	<u>195</u>	<u>96.4</u>	<u>270</u>	<u>95.9</u>	<u>516</u>	<u>96.5</u>	<u>791</u>	<u>98.1</u>	<u>1,872</u>
Total returns	100	207	100	280	100	538	100	820	100	1,909

^a Based on expanded CWT recoveries from the PSMFC RMIS database

^b Indicates areas within the LSRCP compensation area

^c Includes estimates of fish removed in tribal and sport fisheries, fish removed at weirs (e.g., broodstock, foodbanks), and estimates of untrapped fish above and below weirs.

Table 11. Catch and escapement distribution of Catherine Creek, Upper Grande Ronde, Imnaha River, Lookingglass, and Lostine River spring/summer Chinook Salmon, complete brood years 2017.

	Catherine Creek.		Upper Grande Ronde River		Lookingglass Creek		Lostine River		Imnaha River	
Total smolts released	136,458		250,095		136,467		262,235		511,337	
% AD + CWT	79.8%		47.6%		93.2%		50.3%		52.0%	
	% of catch	Est. return	% of catch	Est. return	% of catch	Est. return	% of catch	Est. return	% of catch	Est. return
Ocean ^a	0.0	0	0.0	0	0.2	1	0.4	4	0.2	3
Columbia River ^a										
Commercial Net	0.4	2	2.8	8	0.0	0	0.8	7	0.4	8
Sport	2.4	12	5.9	17	2.4	10	6.8	63	7.1	130
Tribal Net	0.0	0	0.0	0	0.0	0	3.4	31	4.6	85
Snake River ^a										
Sport ^b	0.0	0	6.3	18	1.7	7	0.0	0	1.8	33
Tribal ^b	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0
Stray Below LGD	0.6	3	0.0	0	0.0	0	0.2	2	0.7	12
Stray Above LGD	3.0	15	5.9	17	1.9	8	1.4	13	0.1	1
Recruitment to River ^{b, c}	<u>93.6</u>	<u>466</u>	<u>79.0</u>	<u>226</u>	<u>93.8</u>	<u>396</u>	<u>87.0</u>	<u>802</u>	<u>85.1</u>	<u>1,562</u>
Total returns	100	498	100	286	100	422	100	922	100	1,836

^a Based on expanded CWT recoveries from the PSMFC RMIS database

^b Indicates areas within the LSRCP compensation area

^c Includes estimates of fish removed in tribal and sport fisheries, fish removed at weirs (e.g., broodstock, foodbanks), and estimates of untrapped fish above and below weirs.

Table 12. Catch and escapement distribution of Catherine Creek, Upper Grande Ronde, Imnaha River, Lookingglass, and Lostine River spring/summer Chinook Salmon, complete brood years 2018.

	Catherine Creek.		Upper Grande Ronde River		Lookingglass Creek		Lostine River		Imnaha River	
Total smolts released	151,567		240,123		253,309		260,884		397,917	
% AD + CWT	66.6%		47.2%		49.5%		43.7%		60.1%	
	% of catch	Est. return	% of catch	Est. return	% of catch	Est. return	% of catch	Est. return	% of catch	Est. return
Ocean ^a	0.0	0	0.0	0	0.0	0	0.6	8	0.0	0
Columbia River ^a										
Commercial Net	0.3	2	0.0	0	0.3	6	0.9	12	0.0	0
Sport	8.0	62	16.5	45	9.2	166	13.4	186	12.3	146
Tribal Net	0.0	0	0.0	0	0.3	6	12.2	169	3.8	45
Snake River ^a										
Sport ^b	3.2	25	0.0	0	4.4	80	0.0	0	0.9	11
Tribal ^b	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0
Stray Below LGD	0.0	0	1.5	4	0.1	2	0.0	0	0.2	2
Stray Above LGD	1.4	11	5.9	16	0.6	10	0.6	8	0.5	6
Recruitment to River ^{b, c}	<u>87.2</u>	<u>679</u>	<u>76.1</u>	<u>207</u>	<u>85.0</u>	<u>1,534</u>	<u>72.4</u>	<u>1,005</u>	<u>82.3</u>	<u>974</u>
Total returns	100	779	100	272	100	1,804	100	1,388	100	1,184

^a Based on expanded CWT recoveries from the PSMFC RMIS database

^b Indicates areas within the LSRCP compensation area

^c Includes estimates of fish removed in tribal and sport fisheries, fish removed at weirs (e.g., broodstock, foodbanks), and estimates of untrapped fish above and below weirs.

Total adult production and compensation area returns

The escapement goal for the Grande Ronde Basin is 29,100 hatchery spring–summer Chinook Salmon. Estimated age-3 to age-5 hatchery production totaled 2,375 fish in 2021, 4,284 in 2022, and 2,104 in 2023 (Figure 10), representing 8.2%, 14.7%, and 7.2% of the goal, respectively. Above LGD, adult returns were estimated at 2,119 in 2021, 3,602 in 2022, and 1,990 in 2023, achieving 36.4%, 61.9%, and 34.2% of the Grande Ronde Basin target of 5,820 returns.

In the Imnaha Basin, total hatchery production was estimated at 1,587 fish in 2021, 1,226 in 2022, and 922 in 2023 (Figure 10), corresponding to 9.9%, 7.6%, and 5.7% of the 16,050-fish production goal. Above LGD, adult returns were estimated at 1,386 in 2021, 982 in 2022, and 905 in 2023, meeting 43.2%, 30.6%, and 28.2% of the LSRCP mitigation target.

Neither the Grande Ronde nor the Imnaha Basin hatchery programs have achieved their total adult production goals (Figure 10). The Grande Ronde Basin programs have exceeded 5,820 returns only three times, and the Imnaha program has surpassed 3,210 returns seven times. Neither program has met its mitigation target since return year 2014.

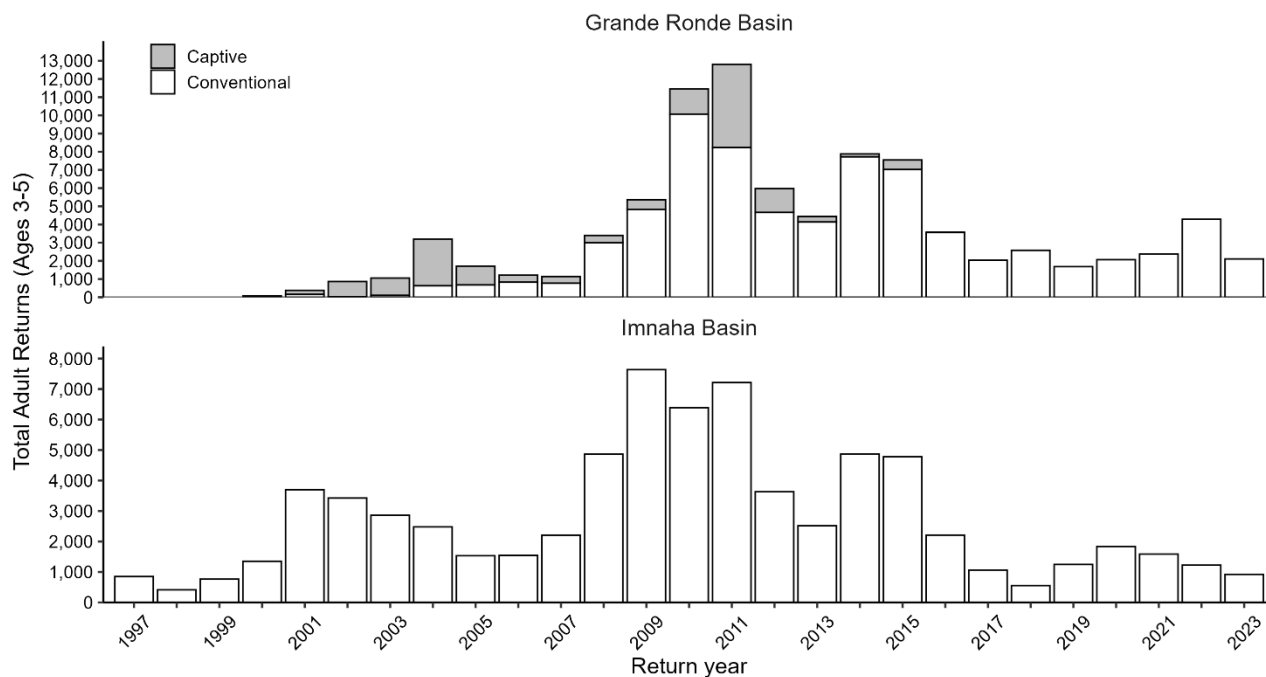


Figure 10. Total age 3-5 Chinook Salmon production from captive and conventional Grande Ronde basin and Imnaha basin hatchery programs, return years 1997-2023 The LSRCP total hatchery production goals are 29,100 Grande Ronde basin and 16,050 Imnaha basin returns.

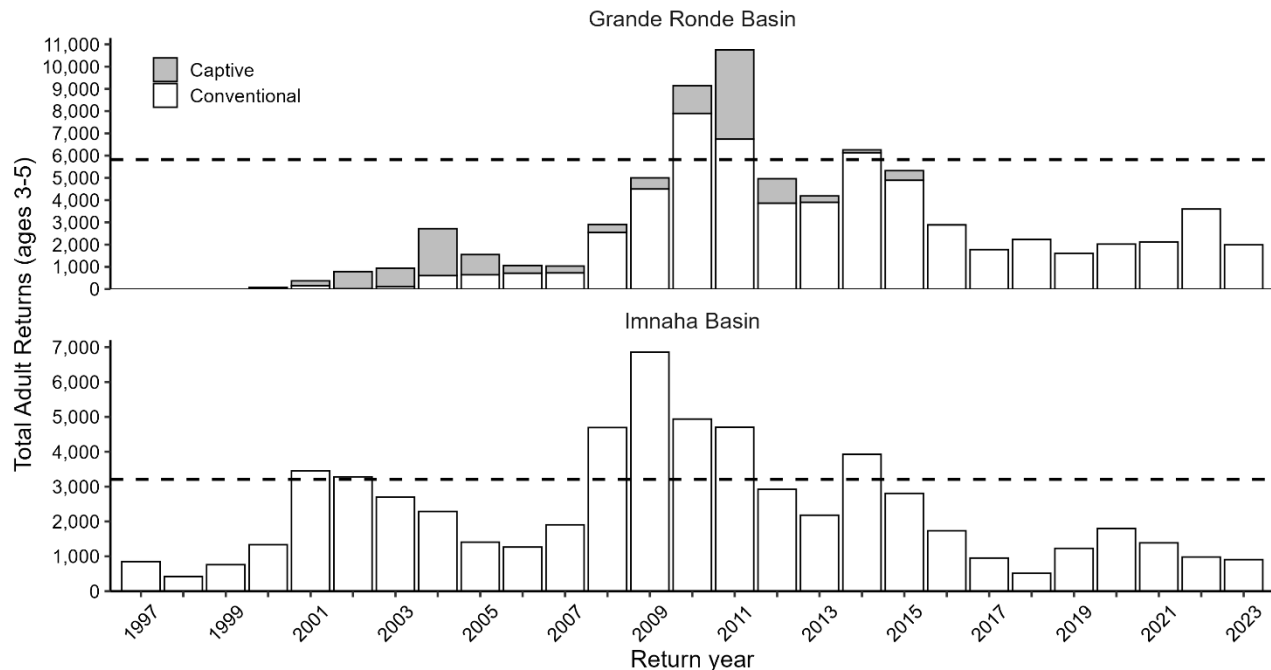


Figure 11. Total age 3-5 production of Chinook Salmon from captive and conventional Grande Ronde and conventional Imnaha River basin hatchery programs returning to the compensation area, run years 1997-2023. The black dashed lines represent mitigation goals of 5,820 and 3,210 mature salmon returns to the Grande Ronde and Imnaha basins, respectively.

Within the Grande Ronde Basin, each hatchery program has specific return goals that contribute to the overall LSRCP compensation goal of 5,820 adult Chinook Salmon. The goals are 970 adult returns for the Catherine Creek program and 1,617 returns each for the Lookingglass Creek, Lostine River, and Upper Grande Ronde River programs. None of the five hatchery stocks met their mitigation return goals during return years 2021–2023 (Figure 12).

In 2021, estimated hatchery returns totaled 466, 665, 752, and 235 Chinook Salmon from the Catherine Creek, Lookingglass Creek, Lostine River, and Upper Grande Ronde programs, respectively. The Imnaha program produced 1,386 Chinook Salmon for the mitigation area in return year 2021. In 2022, estimated hatchery returns increased to 730 from Catherine Creek, 1,412 from Lookingglass Creek, 1,154 from the Lostine River, 307 from the Upper Grande Ronde River, and 1,226 Imnaha program fish. In 2023, returns declined to 254 in Catherine Creek, 742 in Lookingglass Creek, 723 Lostine River, and 263 for the Upper Grande Ronde. Similarly, returns from the Imnaha program also decreased with an estimated return of 657 mature salmon.

Since 1997, the Catherine Creek program has met its mitigation goal of 970 adults twice, and the Imnaha program has exceeded its goal of 3,210 returns seven times. The mitigation goal of 1,617 adults has been reached twice in Lookingglass Creek, five times in the Lostine River, and once in the Upper Grande Ronde.

When comparing LSRCP mitigation estimates above LGD to total estimated returns for each river, the 2021 return estimates accounted for $\geq 93.7\%$ of mitigation returns for the Catherine Creek, Imnaha River, Lookingglass Creek, and Lostine River programs, and 85.1% for the Upper Grande Ronde River. For 2022, returns accounted for $\geq 94.5\%$ of mitigation returns for the Catherine Creek, Imnaha River, Lookingglass Creek, and Lostine River programs, and 93.8% for the Upper Grande Ronde River. For 2023, return estimates accounted for $\geq 72.5\%$ of mitigation returns for the Catherine

Creek, Imnaha River, Lookingglass Creek, and Lostine River programs, and 99.6% for the Upper Grande Ronde River.

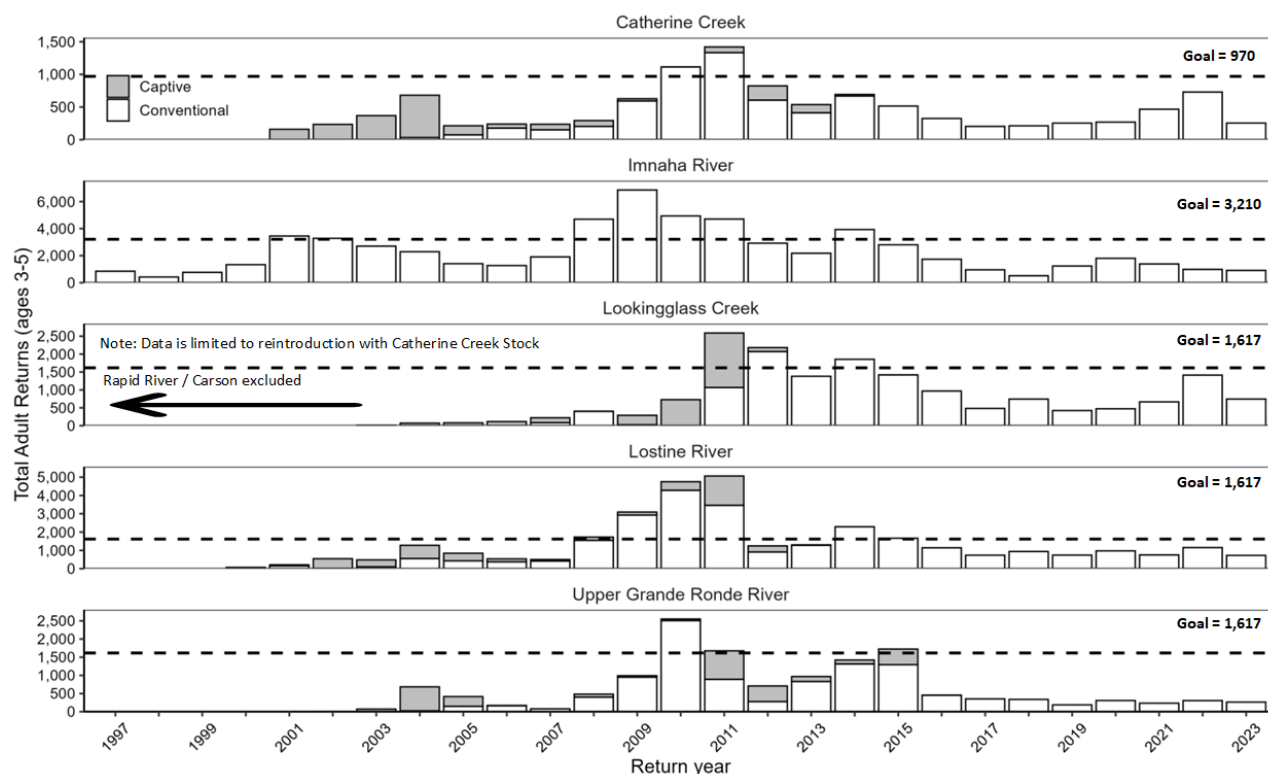


Figure 12. Age 3-5 returns to the compensation area of hatchery-origin Chinook Salmon produced by the Catherine Creek, Imnaha River, Lookingglass Creek, Lostine River, and Upper Grande Ronde stocks, run years 1997-2023. The black dashed line represents population specific mitigation goals for each hatchery stock.

Smolt-to-adult survival and return rates

The smolt-to-adult survival (SAS) rate goal for both the Grande Ronde and Imnaha river hatchery programs is 3.25%, a target that has never been achieved (Figure 13). For complete brood years 2016–2018, SAS rates ranged from 0.17–0.51% for Catherine Creek, 0.30–0.39% for the Imnaha River, 0.23–0.71% for Lookingglass Creek, 0.33–0.53% for the Lostine River, and 0.11–0.13% for the Upper Grande Ronde program.

Across the last five complete brood years (BYs 2014–2018), mean SAS rates were 0.27% for Catherine Creek, 0.27% for the Imnaha River, 0.35% for Lookingglass Creek, 0.38% for the Lostine River, and 0.12% for the Upper Grande Ronde. The highest SAS rates in program history were observed for brood year 2006—3.17% for the Imnaha River and 3.09% for the Lostine River. Between brood years 2006 and 2018, SAS rates for conventional hatchery production exceeded 1.0% only once for Catherine Creek, three times for the Imnaha River, twice for Lookingglass Creek, four times for the Lostine River, and once for the Upper Grande Ronde.

The LSRCP compensation area smolt-to-adult return (SAR) rate goal is 0.65%, and production has consisted of both captive and conventional hatchery programs (Figure 13). For complete returns from BYs 2016 through 2018, the SAR rates ranged from 0.16–0.46% for Catherine Creek, 0.25–0.38% for the Imnaha River, 0.22–0.61% for Lookingglass Creek, 0.31–0.39% for the Lostine

River, and 0.09–0.12% for the Upper Grande Ronde program. Over the last five complete BY's (i.e., 2014 to 2018), the 0.65% SAR rate has not been met for any of the five hatchery stocks.

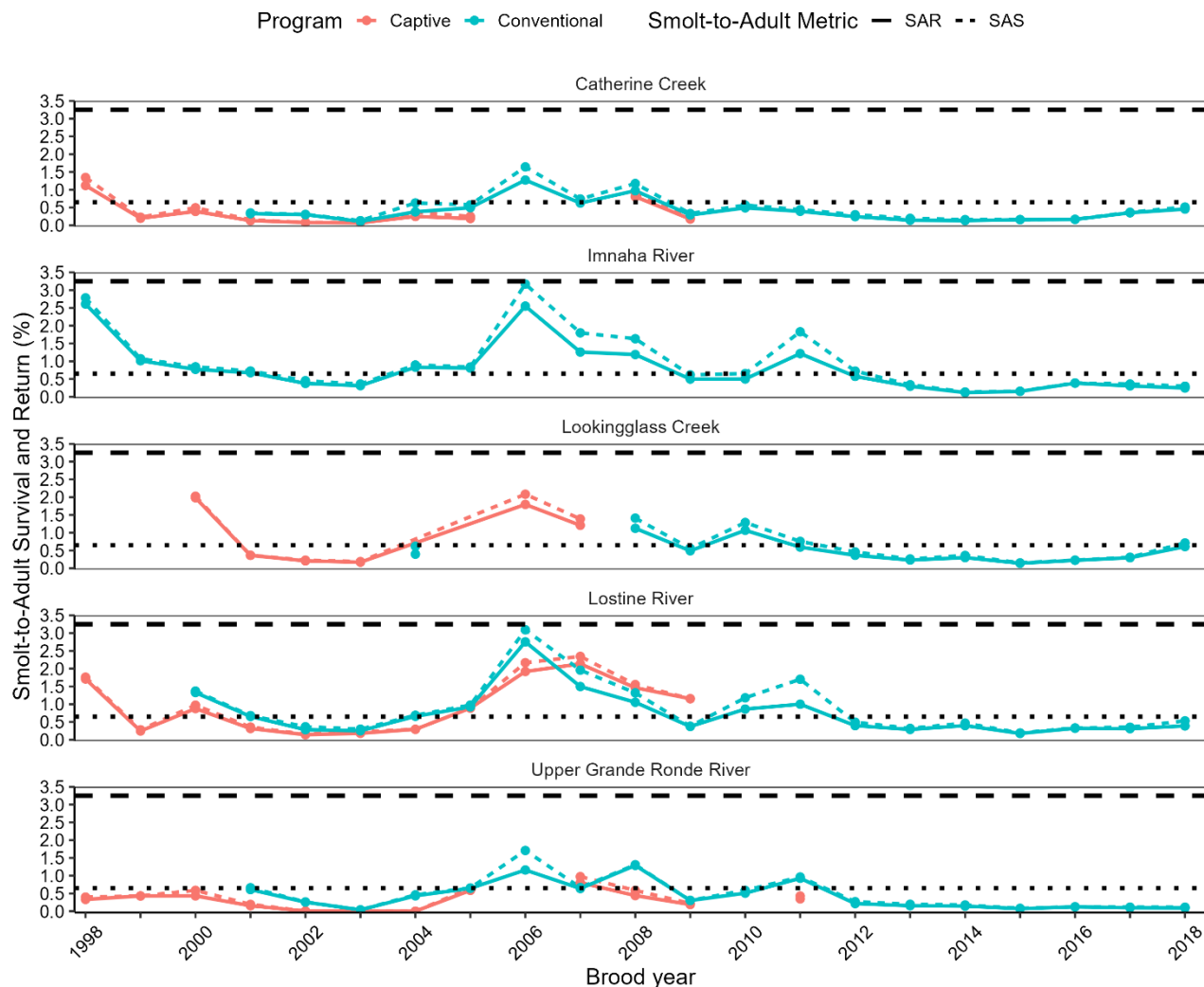


Figure 13. Smolt-to-adult survival (SAS) and return (SAR) rates for captive and conventional production programs, complete brood years 1998-2018. The LSRCP compensation SAS and SAR goal are 3.25% (dashed line) and 0.65% (dotted line), respectively. Note: Captive Broodstock program releases into Lookingglass Creek reflect reintroduction efforts.

Juvenile survival compared to smolt-to-adult return rates

There is a positive correlation between estimated juvenile survival to LGD and SAR rates among all five hatchery stocks (Figure 14). This relationship was significant for smolts released into Catherine Creek, Lookingglass Creek, the Lostine River, and the Upper Grande Ronde ($P < 0.05$), and inconclusive for smolts released into the Imnaha River ($P = 0.08$). For complete returns from BYs 2016-2018, none of the hatchery stocks achieved the LSRCP SAR rates goals of $\geq 0.65\%$. For all captive and conventional smolt releases within populations when juvenile survival rates are $\geq 50\%$, the 0.65% SAR goal was achieved in one of two smolt releases in Catherine Creek, 13 times out of 28 times in the Imnaha River, five out of 16 times in Lookingglass Creek, 15 out of 24 times in the Lostine River, and one out of five times in the Upper Grande Ronde. In contrast,

when juvenile survival rates to LGD are below 50%, the SAR goals were achieved three times in Catherine Creek, once in the Lostine River, three times in the Upper Grande Ronde, and zero times in the Imnaha River and Lookingglass Creek stocks.

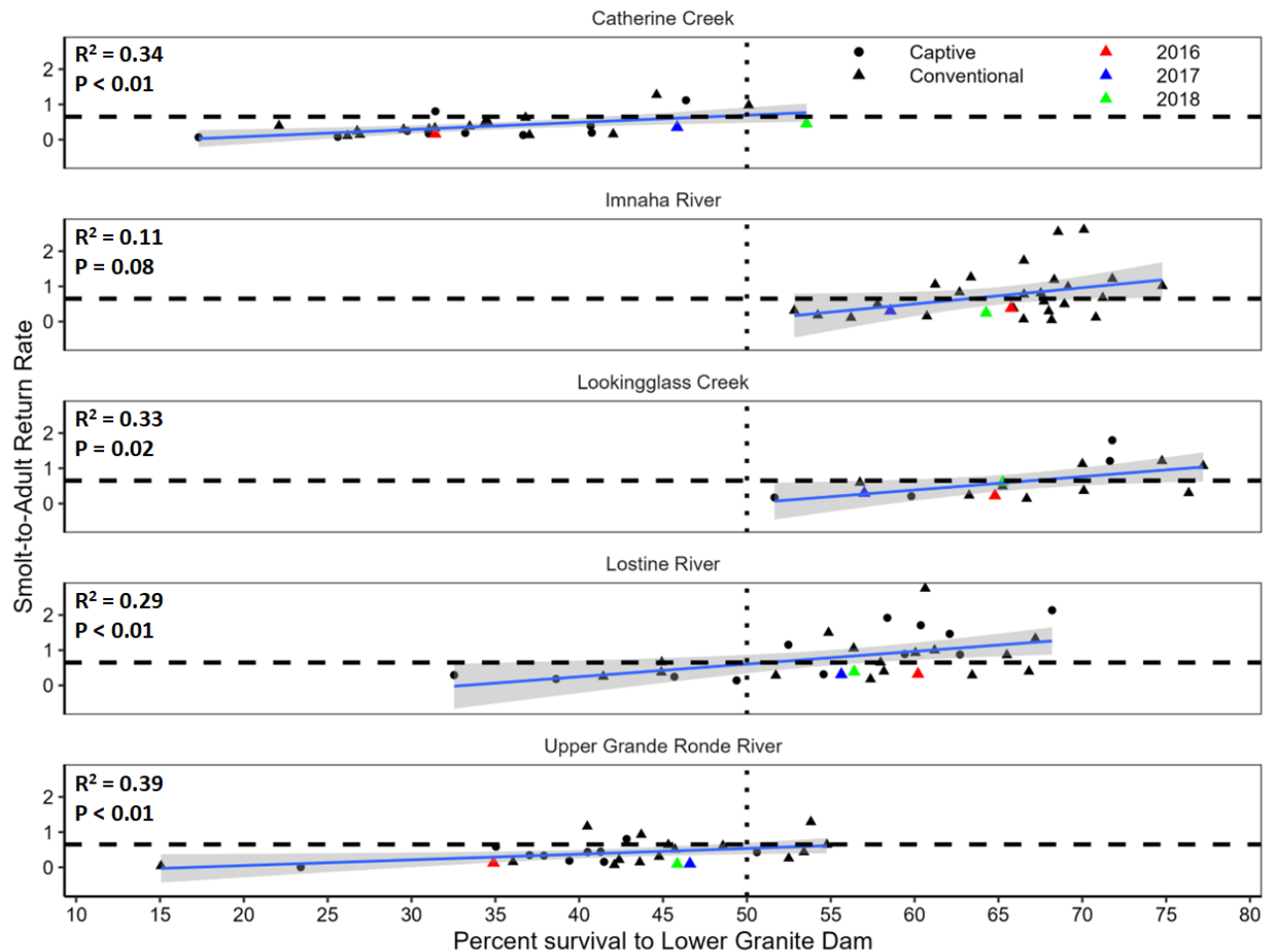


Figure 14. Estimated juvenile survival rate to Lower Granite Dam compared to smolt-to-adult return rates for captive and conventional program smolts. The colored triangles represent comparisons for BY 2016-2018. The shaded area around the linear regression line is a 95% confidence interval. The horizontal dashed lines represent the 0.65% SAR goal and the dotted vertical line is 50% juvenile survival to Lower Granite Dam.

Objective 4. Compare recruits-per-spawner (R:S) for hatchery and natural origin fish.

Hatchery origin R/S

The return of age 5 adults in 2023 completed returns for BY2018. The return to river recruits per spawner (R:S) ratios for BYs 2016–2018 conventional hatchery program production ranged from 2.6–7.8, 4.2–8.2, 3.7–10.3, 5.7–7.7, and 1.4–2 for the Catherine Creek, Imnaha River, Lookingglass Creek, Lostine River, and Upper Grande Ronde River, respectively (Figure 15).

The return to river R:S ratios for spring and summer Chinook Salmon spawned at LFH regularly exceed 1 and show considerable annual synchrony. Over program history, R:S ratios have only been <1 twice in the Imnaha River (BYS 1990 and 1992) and once in the Upper Grande Ronde (BY2003). For BYs 2014–2018, the mean R:S ratios were 4.1, 4.7, 5.2, 5.9, and 1.6 for the Catherine Creek, Imnaha River, Lookingglass Creek, Lostine River, and Upper Grande Ronde River, respectively.

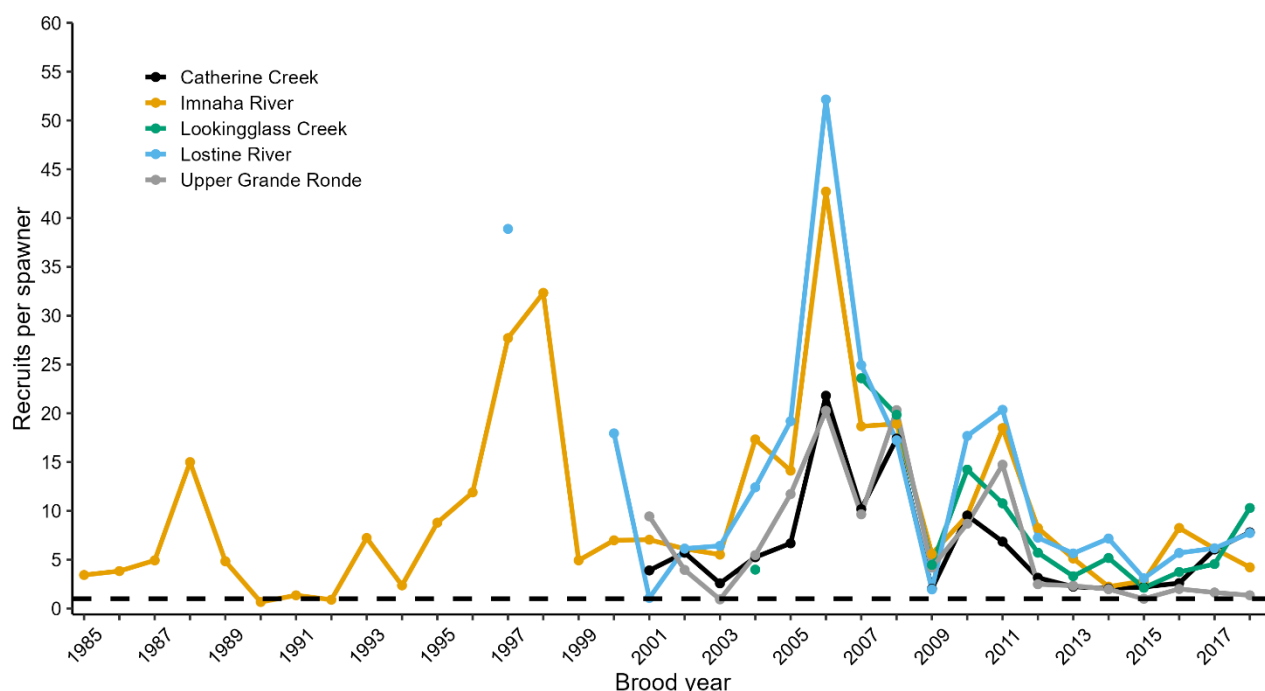


Figure 15. Total adult return to river recruits per spawner ratios for conventional hatchery production from Catherine Creek, Imnaha River, Lookingglass Creek, Lostine River, and Upper Grande Ronde, and Imnaha River populations, complete brood years (1985–2018). The dashed line represents the level necessary for population replacement (1:1). Lookingglass Creek was limited to reintroduction with Catherine Creek stock.

Natural origin R/S

For the supplemented populations, the mean R:S ratios for BYs 2016–2018 ranged from 0.59–1.43 in Catherine Creek, 0.11–0.56 in Lookingglass Creek, 0.23–1.18 in the Imnaha River, 0.31–1.33 in the Lostine River, and 0.46–0.78 in the Upper Grand Ronde River (Figure 16). The BY 2015–2018 R:S ratios in the Minam and Wenaha rivers ranged from 0.80–1.72 and 0.24–1.30, respectively.

For the last five complete BYs 2014–2018, the average R:S values were 0.65 for Catherine Creek, 0.41 for the Imnaha River, 0.24 for Lookingglass Creek, 0.45 for the Lostine River; and 0.41 for the Upper Grande Ronde River. In the two wilderness populations, the R:S values for BYs 2014-2018 were 0.89 and 0.69 in Minam and Wenaha rivers, respectively. The last time BY's for all population were >1 was BY2007. From BY2008-2018, R:S ratios exceeded one in the Imnaha River, Lookingglass Creek, Lostine River, and the Upper Grande Ronde River once, twice in Catherine Creek, and four times in the Minam and Wenaha Rivers.

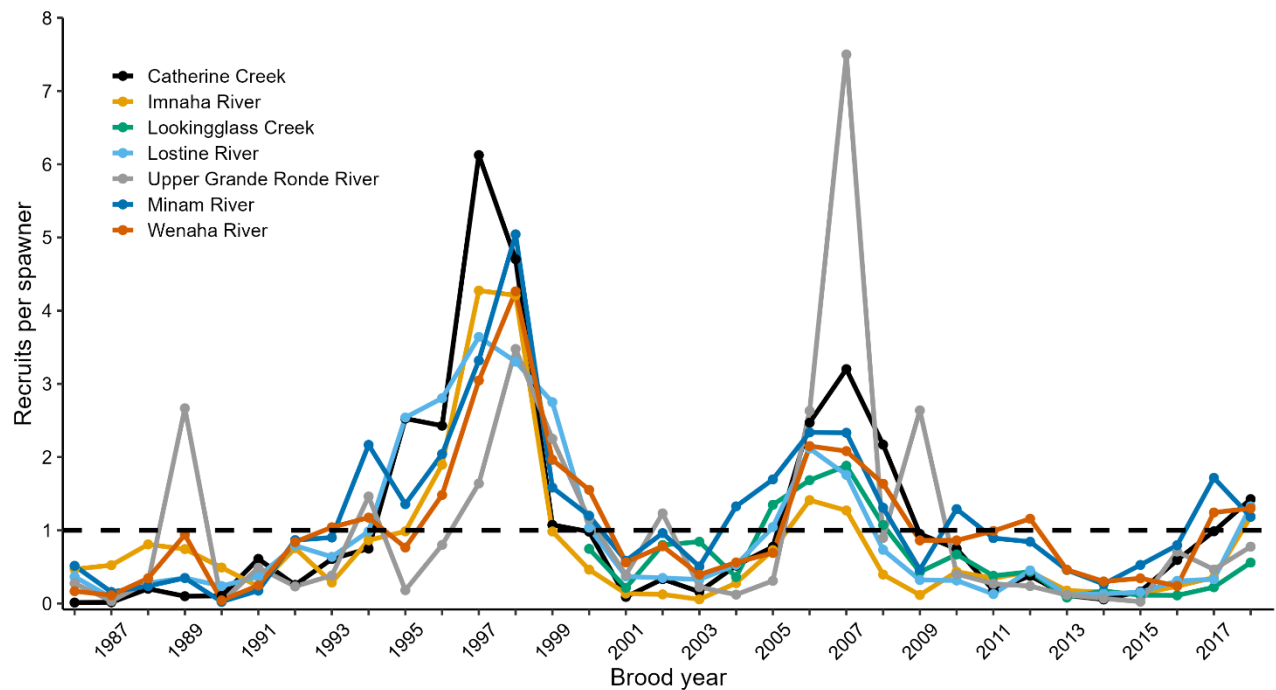


Figure 16. Total age 3–5 return to river recruits per spawner ratios for naturally produced populations of Catherine Creek, Imnaha River, Lookingglass Creek, Lostine River, and Upper Grande Ronde, Imnaha River, Minam River, and Wenaha River spring- summer Chinook Salmon populations. The dashed line represents the level necessary for population replacement (1:1).

Objective 5. Assess response in natural population abundance and productivity to supplementation.

Annual spawning ground surveys in combination with data collected from weirs and hatchery spawning at LFH are used to evaluate the natural population response to supplementation. Data collected at weirs provide information on hatchery and natural return abundance, age structure, and run timing to a specific stream location. Spawning ground surveys inform pHOS estimates, in-basin hatchery straying, natural return estimates, and are used as a basis for determining natural spawner age structure. Results summarized from the 2021–2023 spawning ground surveys were used to calculate natural return estimates, pHOS, and PNI.

2021-2023 Chinook Spawning Ground Surveys

Chinook spawning ground surveys from 2021 to 2023 were conducted on three streams in the Imnaha Basin and 11 Grande Ronde Basin streams. In 2020, we began beta testing the applicability of electronic data collection on spawning ground surveys using smart phones and tablets operating the ESRI [ArcGIS Survey123](#) and the [ArcGIS Field Maps](#) applications. One advantage of these applications is that they are cloud-based platforms which enabled rapid data synchronization across multiple users and devices. For example, georeferenced carcass and redd data collected with Survey123 can be viewed in FieldMaps along with corresponding survey boundaries and synchronized daily across all users using these applications. All spawning ground surveys data from 2021 to 2023 were collected electronically using Survey123 and Field Maps.

Redd counts and Carcass recoveries

In the Imnaha Basin, a total of 346 unique redds were counted in Index and Extensive survey sections in 2021, 188 in 2022, and 202 in 2023 (Table 13; Figure 17). In the Grande Ronde Basin, across 11 streams, 688 redds were observed in Index and Extensive survey section in 2021, 1,385 in 2022, and 576 redds in 2023 (Table 13; Figure 17). The Minam and Wenaha rivers flow through designated Wilderness areas and are not hatchery supplemented. In the Minam River, a total of 103 redds were counted in 2021, 119 in 2022, and 65 in 2023. In the Wenaha River 101, 239, and 89 redds were observed from 2021 to 2023, respectively.

In the Imnaha Basin 202 carcasses were recovered in 2021, and 80.1% were identifiable as hatchery origin (Table 13). In 2022, of the 18 total carcass recoveries, 62.5% were known hatchery fish. In 2023, of the 31 carcass recoveries, 54.8% were identifiable as hatchery origin (Table 13).

From 2021 to 2023, for all streams surveyed in the Grande Ronde Basin, between 60.7% and 73.3% of the carcasses recovered on Index or Extensive surveys, or found on weirs, were determined to be hatchery origin (Table 13). Within the Grande Ronde Basin, 351 carcasses were recovered in 2021, 792 in 2022, and 345 in 2023. For the two Wilderness populations, the Minam and Wenaha Rivers, we had difficulties recovering carcasses. In the Minam River, we recovered 13 total carcasses in 2021, five in 2022, and four in 2023. In the Wenaha River, we recovered two carcasses in 2021, 14 in 2022, and six in 2023.

In the five supplemented streams, from known origin carcasses, the percentage of known hatchery Chinook Salmon carcasses recovered on spawning ground surveys in 2021–2023 were 78.8–82.8% in Catherine Creek, 50–93.3% in the Upper Grande Ronde River, 90.4–93.8% in Lookingglass Creek, 43.0–68.3% in the Lostine River, and 55.2–77.5% in the Imnaha River (Table 13). The composition of hatchery Chinook Salmon carcasses on the Minam River spawning

grounds was 12.5% in 2021 and 0% for 2022 and 2023. The Wenaha River hatchery Chinook Salmon spawning ground carcass composition was 0% in 2021, 21.4% in 2022, and 16.7% in 2023.

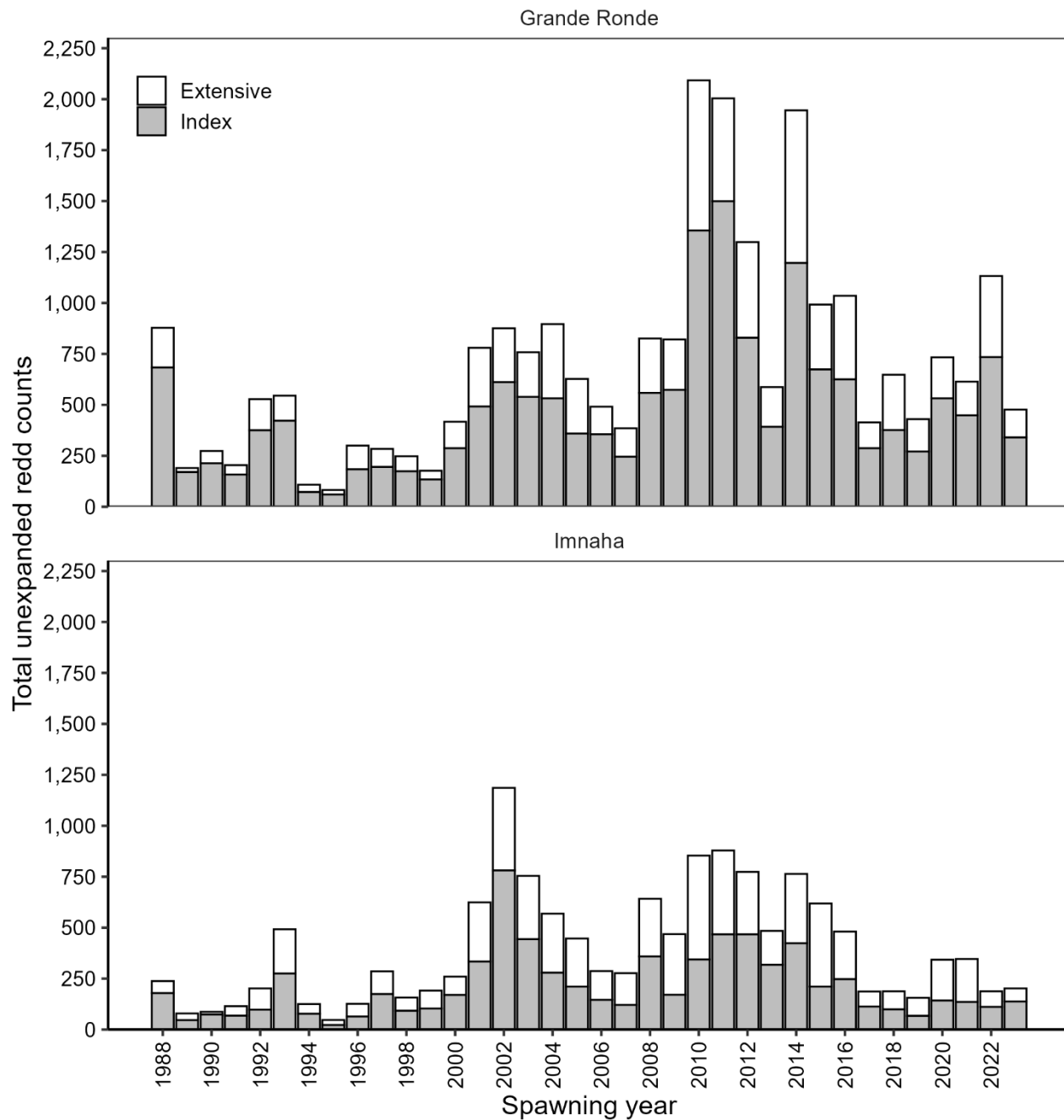


Figure 17. Total unexpanded Chinook Salmon redds counted in Index and Extensive survey reaches in the Grande Ronde and Imnaha River basins, 1988–2023.

Table 13. Summary of hatchery and natural origin Chinook Salmon total carcass and redd counts by stream in Index and Extensive survey sections the Imnaha and Grande Ronde River basins, 2021-2023. NS = Not Surveyed.

Year	Basin, stream	Carcasses			Number of redds
		Hatchery	Natural	Unknown origin	
<u>2021</u>	<u>Imnaha River Basin</u>				
	Big Sheep Creek	12	0	0	13
	Imnaha River	131	38	11	311
	<u>Lick Creek</u>	<u>10</u>	<u>0</u>	<u>0</u>	<u>22</u>
	Total	153	38	11	346
<u>2021</u>	<u>Grande Ronde River Basin</u>				
	Bear Creek	0	3	0	6
	Catherine Creek	82	22	2	186
	Hurricane Creek	51	19	1	29
	Limber Jim Creek	0	0	0	0
	Lookingglass Creek ^{b,c}	30	2	1	67
	Lostine River ^d	56	26	3	134
	Minam & Little Minam R.	1	7	5	103
	Sheep Creek	0	0	0	0
	Upper Grande Ronde R. ^e	17	3	2	51
	Wallowa River	10	6	0	11
	<u>Wenaha River^e</u>	<u>0</u>	<u>2</u>	<u>0</u>	<u>101</u>
	Total	247	90	14	688
<u>2022</u>	<u>Imnaha River Basin</u>				
	Big Sheep Creek	0	0	0	5
	Imnaha River	10	6	2	183
	<u>Lick Creek</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>0</u>
	Total	10	6	2	188
<u>2022</u>	<u>Grande Ronde River Basin</u>				
	Bear Creek	1	2	0	10
	Catherine Creek	142	36	2	182
	Hurricane Creek	6	48	8	106
	Limber Jim Creek	0	0	0	0
	Lookingglass Creek ^{b,c}	188	20	5	246
	Lostine River ^d	113	150	3	362
	Minam & Little Minam R.	0	5	0	119
	Sheep Creek	0	0	0	0
	Upper Grande Ronde R. ^e	14	1	3	47
	Wallowa River	1	30	0	74
	<u>Wenaha River^f</u>	<u>3</u>	<u>11</u>	<u>0</u>	<u>239</u>
	Total	468	303	21	1,385

Year	Basin, stream	Carcasses			Percent hatchery ^a	Number of redds
		Hatchery	Natural	Unknown origin		
<u>2023</u>	<u>Imnaha River Basin</u>					
	Big Sheep Creek	1	0	0	100.0	3
	Imnaha River	16	13	1	55.2	198
	<u>Lick Creek</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>0.0</u>	<u>1</u>
	Total	17	13	1	54.8	202
<u>2023</u>	<u>Grande Ronde River Basin</u>					
	Bear Creek	1	0	0	100.0	7
	Catherine Creek	106	22	15	82.8	107
	Hurricane Creek	23	29	0	44.2	61
	Limber Jim Creek	0	0	0	0.0	0
	Lookingglass Creek ^{b,c}	47	4	1	92.2	93
	Lostine River ^d	43	22	12	66.2	123
	Minam & Little Minam R.	0	4	0	0.0	65
	Sheep Creek	0	0	0	0.0	0
	Upper Grande Ronde R. ^e	1	1	1	50.0	16
	Wallowa River	2	4	1	33.3	15
	<u>Wenaha River^e</u>	<u>1</u>	<u>5</u>	<u>0</u>	<u>16.7</u>	<u>89</u>
	Total	224	91	30	71.1	576

^a Percent of known origin carcasses.

^b Data provided by CTUIR

^c Includes Little Lookingglass Creek.

^d Includes recoveries on the weir

^e Includes redd count data provided by J. Platz (U.S. Forest Service) in a 1.4 mile section of Vey Meadows near Limber Jim Creek.

^f To comply with the National Marine Fisheries Service (NMFS) ESA Section 10(a)(1)(A) Permit Number 18035; the ODFW, NPT, and CTUIR co-managers notified NMFS in a letter dated December 27, 2019 that spring Chinook from Lookingglass Hatchery (LKG) have composed, on a three-year running average, more than 5% of the spawners within the Wenaha River (Kyle Bratcher, ODFW, personnel communication).

Female pre-spawn mortality

Estimated pre-spawn mortality (PSM) rates based on female carcass recoveries from return years 2021–2023 varied by stream (Table 14). During the 2021 Imnaha River surveys, estimated PSM was 0% above the weir and 3.2% below. In 2022, egg retention was assessed for seven females, with one identified as a PSM. In 2023, 11 spawned females were recovered, and zero PSM mortalities were observed. In Catherine Creek, PSM ranged from 3.1% to 14.8%, based on 65–108 females with egg retention data. In Lookingglass Creek, PSM ranged from 0.9% to 11.8%, with 17–108 females examined. In the Lostine River, PSM ranged from 2.8% to 13.9%, with egg retention estimates from 36–149 females. Fewer than 20 carcasses were recovered from other surveyed streams, preventing reliable PSM estimation for those locations.

In-basin and out-of-basin CWT recoveries

On the spawning grounds in the Imnaha Basin, a total of 71 CWTs were recovered in 2021, seven in 2022, and six in 2023 (Table 15). One CWT-marked hatchery stray with agency wire (i.e., 090000) was recovered on the 2023 Big Sheep Creek survey. This fish is likely a stray from the Umatilla River basin because this location uses agency wire to mark Chinook Salmon releases.

In the Grande Ronde Basin, 123 CWT marked salmon were recovered in 2021, 181 in 2022, and 97 in 2023 (Table 15). Zero out-of-basin CWT-marked hatchery Chinook Salmon were recovered between 2021 and 2023.

From 2021 to 2023, nine CWTs from the Catherine Creek program, eight from the Upper Grande Ronde program, and three from the Lostine River program were recovered in Lookingglass Creek, while one Upper Grande Ronde CWT was recovered in Catherine Creek. All the CWT marked Chinook Salmon found in Hurricane Creek in 2021 and 2022, and four of the six salmon found in the Wallowa River in 2021 had a hole punch in the opercle plate. We do not classify recoveries of Lostine River Chinook Salmon with an OP punch recovered in Hurricane Creek or the Wallowa River as strays because the OP punch indicates that they were purposely transplanted into the Wallowa River from the Lostine River weir to reduce hatchery spawner numbers in the Lostine River. However, two Lostine River CWTs recovered in Hurricane Creek in 2022 lacked opercle punches, suggesting they volitionally traveled into the upper Wallowa River.

Because we do not mark 100% of the Lookingglass Creek, Catherine Creek, or Lostine River Chinook Salmon releases with a CWT, it is possible that some of the hatchery salmon recovered without a CWT could be in-basin strays. To identify every hatchery salmon back to its release location, we need to either mark 100% of the releases with a CWT or take genetic samples from every hatchery salmon. If the genetic samples were sent to a genetics lab, it would be possible to take advantage of the PBT baseline to assign non-CWT marked hatchery salmon to their hatchery stock and release location.

Table 14. Numbers of female Chinook Salmon carcasses recovered on the spawning grounds that were classified as either a pre-spawn mortality, spawned, or unknown, and the pre-spawn mortality rates, 2021-2023.

Year	Recovery location	Pre-spawn mortality	Spawned	Unknown	% Pre-spawn females
<u>2021</u>	<u>Imnaha River Basin</u>				
	Big Sheep Creek	0	7	0	0.0
	Imnaha River (above weir)	0	25	7	0.0
	Imnaha River (below weir)	2	61	2	3.2
	<u>Lick Creek</u>	<u>2</u>	<u>7</u>	<u>0</u>	<u>22.2</u>
	Sub-total	4	100	9	3.8
<u>2021</u>	<u>Grande Ronde River Basin</u>				
	Bear Creek	0	1	0	0.0
	Catherine Creek	2	63	0	3.1
	Hurricane Creek	1	22	0	4.3
	Lookingglass Creek ^a	2	15	0	11.8
	Lostine River ^b	1	35	4	2.8
	Minam River	0	6	0	0.0
	Sheep Creek	0	0	0	0.0
	Upper Grande Ronde R.	3	9	3	25.0
	Wallowa River	1	4	0	20.0
	<u>Wenaha River</u>	<u>0</u>	<u>1</u>	<u>0</u>	<u>0.0</u>
	Sub-total	10	156	7	6.0
<u>2022</u>	<u>Imnaha River Basin</u>				
	Big Sheep Creek	0	0	0	0.0
	Imnaha River (above weir)	0	5	1	0.0
	Imnaha River (below weir)	1	1	2	50.0
	<u>Lick Creek</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>0.0</u>
	Sub-total	1	6	3	14.3
<u>2022</u>	<u>Grande Ronde River Basin</u>				
	Bear Creek	0	3	0	0.0
	Catherine Creek	16	92	2	14.8
	Hurricane Creek	2	21	1	8.7
	Lookingglass Creek ^a	1	107	8	0.9
	Lostine River ^b	6	143	3	4.0
	Minam River	0	1	2	0.0
	Sheep Creek	0	0	0	0.0
	Upper Grande Ronde R.	1	3	3	25.0
	Wallowa River	1	18	0	5.3
	<u>Wenaha River</u>	<u>0</u>	<u>12</u>	<u>1</u>	<u>0.0</u>
	Sub-total	27	400	20	6.3

Year	Recovery location	Pre-spawn mortality	Spawned	Unknown	% Pre-spawn females
<u>2023</u>	<u>Imnaha River Basin</u>				
	Big Sheep Creek	0	1	0	0.0
	Imnaha River (above weir)	0	8	4	0.0
	Imnaha River (below weir)	0	3	1	0.0
	<u>Lick Creek</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>0.0</u>
	Sub-total	0	11	5	0.0
 <u>2023</u>	 <u>Grande Ronde River Basin</u>				
	Bear Creek	0	1	0	0.0
	Catherine Creek	4	77	8	4.9
	Hurricane Creek	2	16	2	11.1
	Lookingglass Creek ^a	1	35	2	2.8
	Lostine River ^b	12	31	0	13.9
	Minam River	0	3	1	0.0
	Sheep Creek	0	0	0	0.0
	Upper Grande Ronde R.	1	0	2	100.0
	Wallowa River	0	2	1	0.0
	<u>Wenaha River</u>	<u>0</u>	<u>0</u>	<u>4</u>	<u>0.0</u>
	Sub-total	20	165	20	10.8

^a Data provided by CTUIR. Includes Little Lookingglass Creek.

^b Includes recoveries on the weir.

Table 15. Number of unique coded-wire-tags recovered on spawning ground surveys in 2021-2023. For each stream surveyed, the hatchery program for each CWT recovery is identified.

Year	River	Hatchery Program					Total
		Catherine Creek	Imnaha River.	Lookingglass Creek	Lostine River	Upper Grande Ronde R.	
<u>2021</u>	<u>Imnaha River Basin</u>						
	Big Sheep Cr.	0	5	0	0	0	5
	Imnaha R.	0	61	0	0	0	61
	<u>Lick Cr.</u>	<u>0</u>	<u>5</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>5</u>
	Sub-total	0	71	0	0	0	71
<u>2021</u>	<u>Grande Ronde Basin</u>						
	Catherine Cr.	44	0	0	0	1	45
	Hurricane Cr.	0	0	0	20	0	20
	Lookingglass Cr.	2	0	14	1	3	20
	Lostine R.	0	0	0	18	0	18
	Upper Grande Ronde R.	0	0	0	0	14	14
	<u>Wallowa R.</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>6</u>	<u>0</u>	<u>6</u>
	Subt-total	46	0	14	45	18	123
<u>2022</u>	<u>Imnaha River Basin</u>						
	Big Sheep Cr.	0	0	0	0	0	0
	Imnaha R.	0	7	0	0	0	7
	<u>Lick Cr.</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>0</u>
	Sub-total	0	7	0	0	0	7
<u>2022</u>	<u>Grande Ronde Basin</u>						
	Catherine Cr.	58	0	0	0	0	58
	Hurricane Cr.	0	0	0	4	0	4
	Lookingglass Cr.	7	0	60	1	5	73
	Lostine R.	0	0	0	39	0	39
	Upper Grande Ronde R.	0	0	0	0	6	6
	<u>Wenaha R.</u>	<u>0</u>	<u>0</u>	<u>1</u>	<u>0</u>	<u>0</u>	<u>1</u>
	Sub-total	65	0	61	44	11	181
<u>2023</u>	<u>Imnaha River Basin</u>						
	Big Sheep Cr.	0	0	0	0	0	1
	Imnaha R.	0	5	0	0	0	5
	<u>Lick Cr.</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>0</u>
		0	5	0	0	0	6

		Hatchery Program						
Year	River	Catherine Creek	Imnaha River.	Lookingglass Creek	Lostine River	Upper Grande Ronde R.	Out- of- basin	Total
<u>2023</u>	<u>Grande Ronde Basin</u>							
	Catherine Cr.	61	0	0	0	0	0	61
	Hurricane Cr.	0	0	0	4	0	0	4
	Lookingglass Cr.	0	0	13	1	0	0	14
	Lostine R.	0	0	0	17	0	0	17
	<u>Upper Grande Ronde R.</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>1</u>	<u>0</u>	<u>1</u>
	Sub-total	61	0	13	22	1	0	97

Hatchery and Natural Origin Tributary Returns

Mature Chinook Salmon returns to the supplemented Imnaha and Grande Ronde basin populations have been dominated by hatchery returns (Figure 18). For return years 2021-2023, an estimated total of 1,623, 1,344, and 1,245 mature Chinook Salmon returned to the Imnaha River, 17.4% (282), 28.0% (376), and 25.7% (320) were natural origin, and 82.6% (1,341), 72.0% (968), and 74.3% (925) were hatchery origin. In the Grande Ronde Basin, an estimated total return of 655, 877, and 400 mature Chinook Salmon returned to Catherine Creek, 21.4% (140), 20.9% (183), and 24.5% (98) were natural origin, and 78.6% (515), 79.1% (694), and 75.5% (302) were hatchery origin. An estimated total of 242, 399, and 342 mature Chinook Salmon returned to the Upper Grande Ronde River where 17.4% (42), 27.8% (111), and 14.3% (49) were natural origin, and 82.6% (200), 72.2% (288), and 85.7% (293) were hatchery origin. An estimated total of 916, 2,007, and 1,070 mature Chinook Salmon returned to the Lostine River where 14.2% (130), 42.8% (859), and 26.8% (287) were natural origin, and 85.8% (786), 57.2% (1,148), and 73.2% (783) were hatchery origin. An estimated total of 695, 1,592, and 930 mature Chinook Salmon returned to Lookingglass Creek where 13.5% (94), 8.7% (139), and 5.7% (53) were natural origin, and 86.5% (601), 91.3% (1,453), and 94.3% (877) were hatchery origin.

Adult hatchery Chinook Salmon returns to the Imnaha River have exceeded natural returns for the last 27 consecutive years and 32 of the last 40 return years. In Grande Ronde Basin, hatchery Chinook Salmon have comprised $\geq 50\%$ of the returns in 20 of the last 27 return years in Catherine Creek, 20 of the last 27 return years in the Upper Grande Ronde River, 22 of the last 27 return years in the Lostine River, and 19 of the last 20 years in Lookingglass Creek.

Proportionate Hatchery Origin Spawners

The proportion of mature Chinook Salmon including jacks (pHOSij) has consistently exceeded 0.5 across all five hatchery supplemented populations (Figure 19). Natural- and hatchery-origin return estimates represent total escapement, whereas pHOSij reflects only fish spawning in nature. The stable pHOS patterns across populations and years suggest that weirs effectively limit hatchery fish on the spawning grounds and that sliding-scale management strategies are being applied as intended. However, the lack of variation in pHOS among populations makes it difficult to assess the effects of supplementation. If evaluating supplementation impacts is a priority, adjustments to sliding-scale strategies may be needed in selected population-year combinations.

The low number of natural adult returns is concerning because the program is not meeting NOAA's recovery goals (Figure 20). In the NOAA 2017 Recovery Plan for Northeast Oregon Snake River Spring Chinook Salmon sets minimum adult abundance thresholds of 1,000 fish for the Wallowa-Lostine, Upper Grande Ronde, and Imnaha River populations, and 750 fish for Catherine Creek, the Minam River, and the Wenaha River. Lookingglass Creek is considered functionally extinct and has a management goal of 500 natural adults. Catherine Creek and the Upper Grande Ronde have never met their minimum thresholds, and Lookingglass Creek has never met its goal. Since 1994, the Imnaha River population has exceeded its threshold only four times (2001–2003 and 2011). The Wallowa-Lostine population includes natural spawners from the upper Wallowa River, Hurricane Creek, Bear Creek, and the Lostine River, and has only surpassed 1,000 adults in 2010–2012, 2014, and 2022. The non-supplemented Minam and Wenaha River populations consistently return more natural adults than Catherine Creek, Lookingglass Creek, and the Upper Grande Ronde, yet they also fall short of meeting NOAA's minimum abundance thresholds.

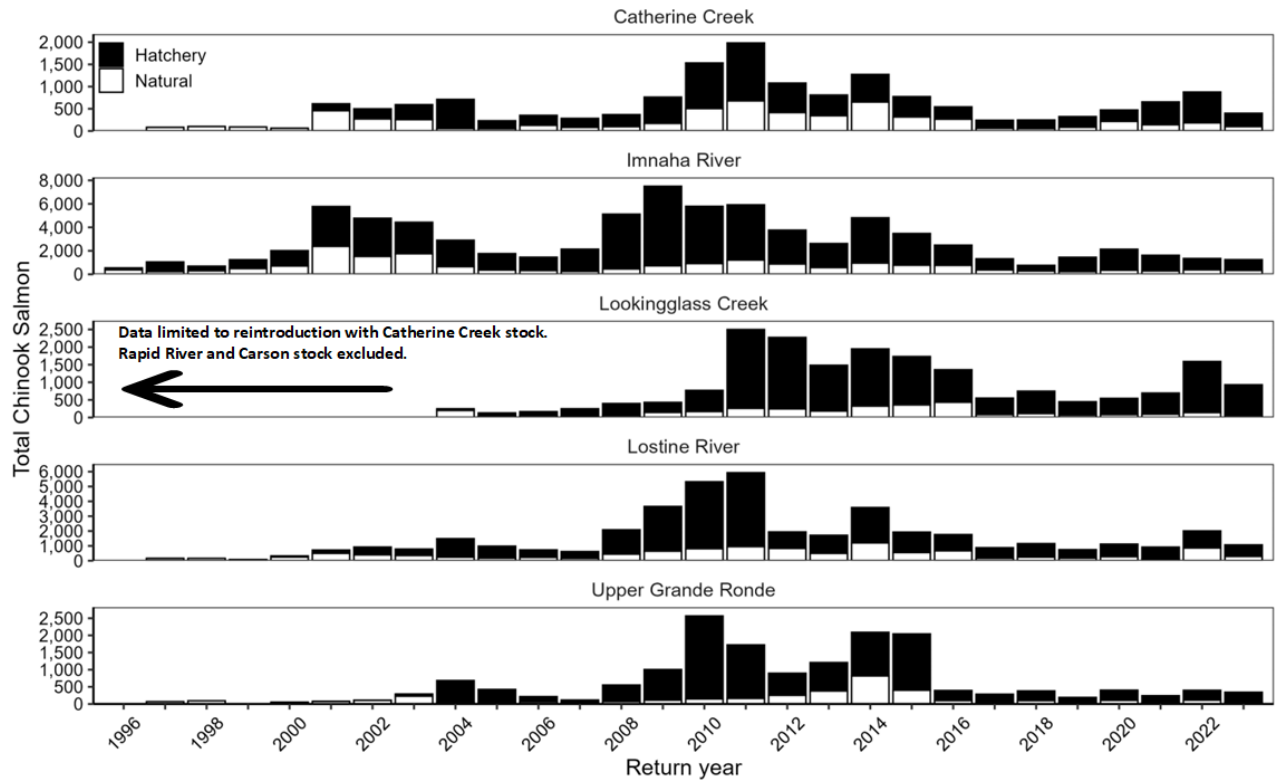
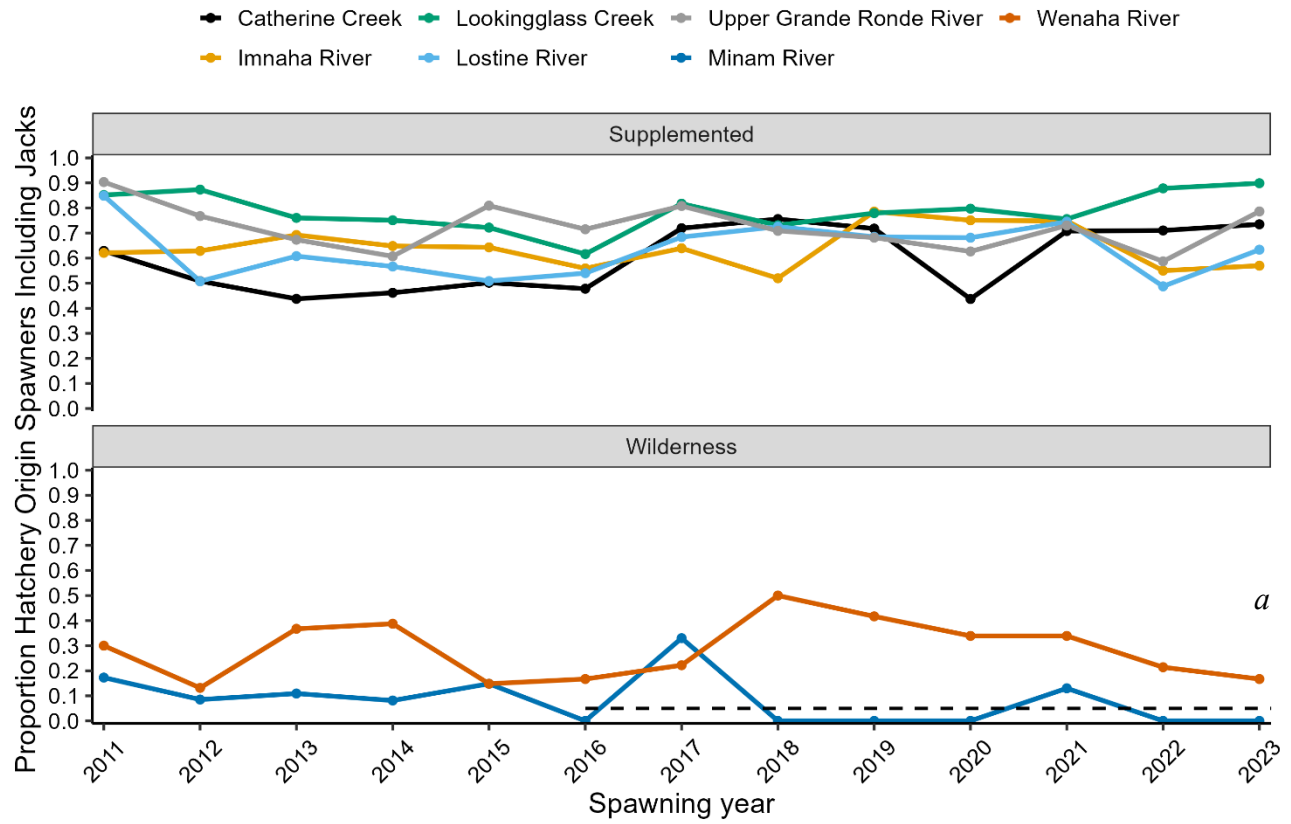


Figure 18. Total returns of age 3–6 hatchery and natural origin Chinook Salmon to supplemented populations in Catherine Creek, the Imnaha River, Lookingglass Creek, the Lostine River, and Upper Grande Ronde River, return years 1996-2023. Data for Lookingglass Creek are limited to the period after the Catherine Creek reintroduction.



^a The 2020 pHOS estimate is based on a five year average (i.e., years 2014, and 2016-2019).

Figure 19. Proportion hatchery origin spawners including jacks in the five supplemented and two wilderness populations, spawning years 2011-2023. The horizontal black dashed line represents ESA Section 10 permit requirements to keep hatchery stray rates into the Minam and Wenaha Rivers $\leq 5\%$ (3-year running average).

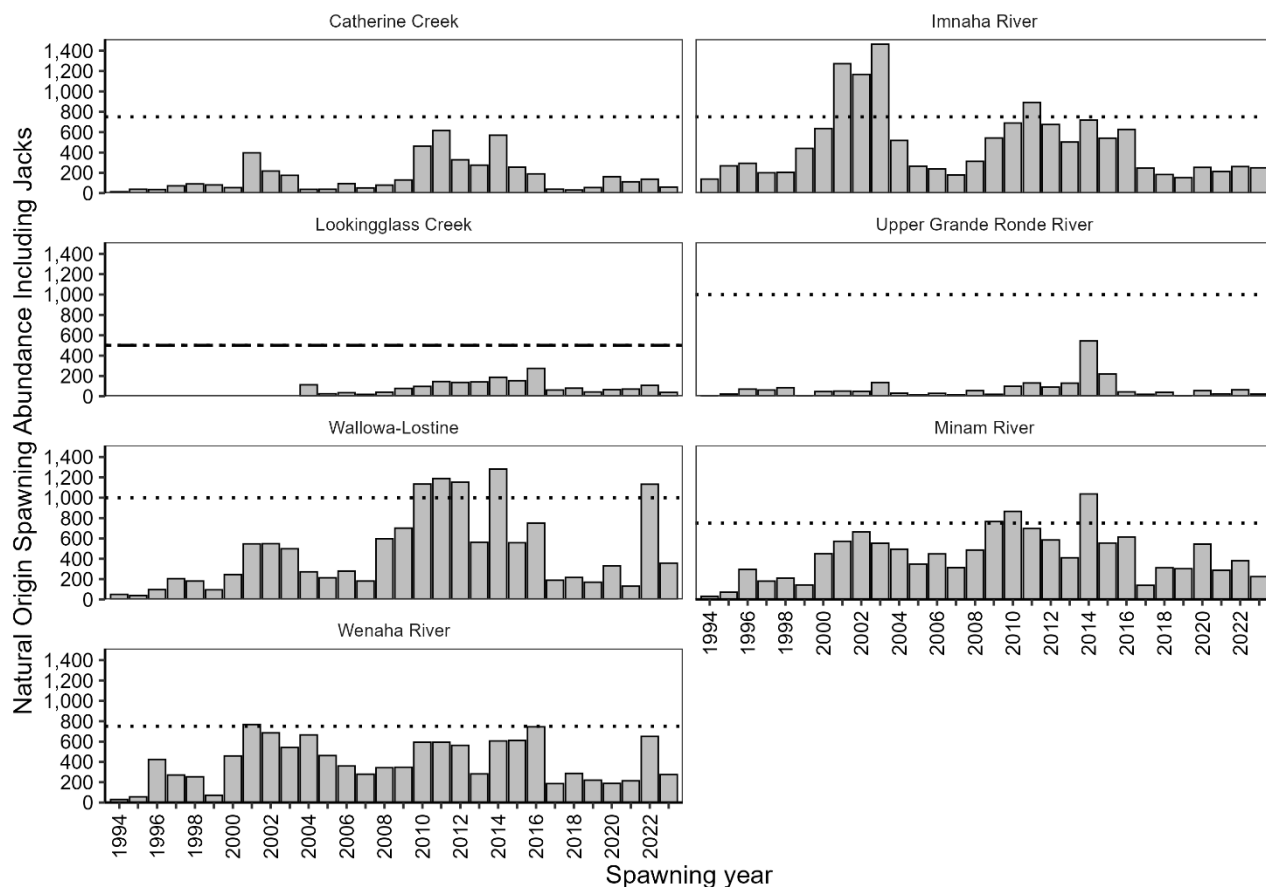


Figure 20. Estimated total number of age 3–6 natural origin Chinook Salmon in each of the Independent Populations of Snake River Chinook Salmon, spawning years 1994 to 2023. Chinook Salmon populations were compared to [NOAA'S 2017 Recovery Plan](#) minimum abundance thresholds (dotted line). Note: returns to Lookingglass Creek are limited to returns after 2003 and the dashed line represents the management goal.

Proportionate Natural Influence

The 2009 Hatchery Scientific Review Group (HSRG) proposed that a key to controlling genetic and ecological risks due to straying and fitness loss is to manage hatchery broodstock and natural spawning escapement in a way that allows the natural habitat, not the hatchery, to drive adaptation and productivity (HSRG 2009). The HSRG recommended designating the Catherine Creek, Imnaha River, and Lostine River programs as primary populations and the Lookingglass Creek and Upper Grande Ronde populations as stabilizing. For integrated populations, the HSRG indicated that pNOB should exceed the proportion of hatchery origin spawners in nature (pHOS) by a factor of two, corresponding to a proportionate natural influence (PNI) of ≥ 0.67 . For contributing populations, the recommendation was to maintain $PNI \geq 0.50$. For both Primary and Contributing

populations, the recommended pHOS in nature was < 0.3 . The HSRG did not develop PNI criteria for stabilizing populations.

For spawn years 2021–2023, PNI values ranged between (0.27–0.34), (0.26–0.39), (0.02–0.16), (0.24–0.50), and (0.14–0.37) for the Catherine Creek, Imnaha River, Lookingglass Creek, Lostine River, and Upper Grande Ronde populations, respectively (Figure 21). Over the last 10 years, the PNI goal of ≥ 0.67 for Primary populations has never been met for the Catherine Creek, Imnaha River, or Lostine River populations. The ten-year (2014–2023) mean PNI (± 1 SD) values were 0.39 (± 0.12), 0.32 (± 0.05), 0.19 (± 0.10), 0.33 (± 0.09), and 0.22 (± 0.10) for the Catherine Creek, Imnaha River, Lookingglass Creek, Lostine River, and Upper Grande Ronde populations, respectively. Low numbers of natural returns used in the broodstock and a high proportion of hatchery spawners in nature hampers efforts to achieve HRSR PNI recommendations.

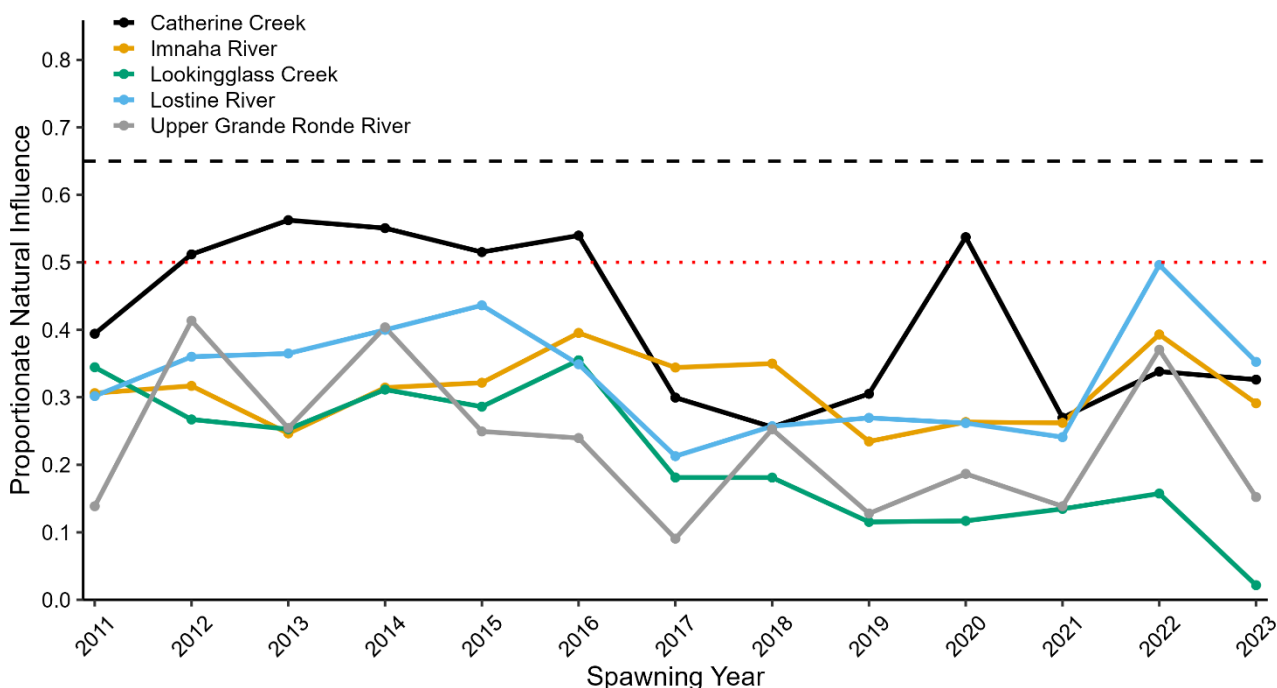


Figure 21. Proportionate natural influence (PNI) for the Catherine Creek, Imnaha River, Lookingglass Creek, Lostine River, and Upper Grande Ronde River populations, return years 2011 to 2023. The HSRG recommended PNI ≥ 0.67 (black dashed line) for Primary populations and >0.5 (red dashed line) for Contributing populations.

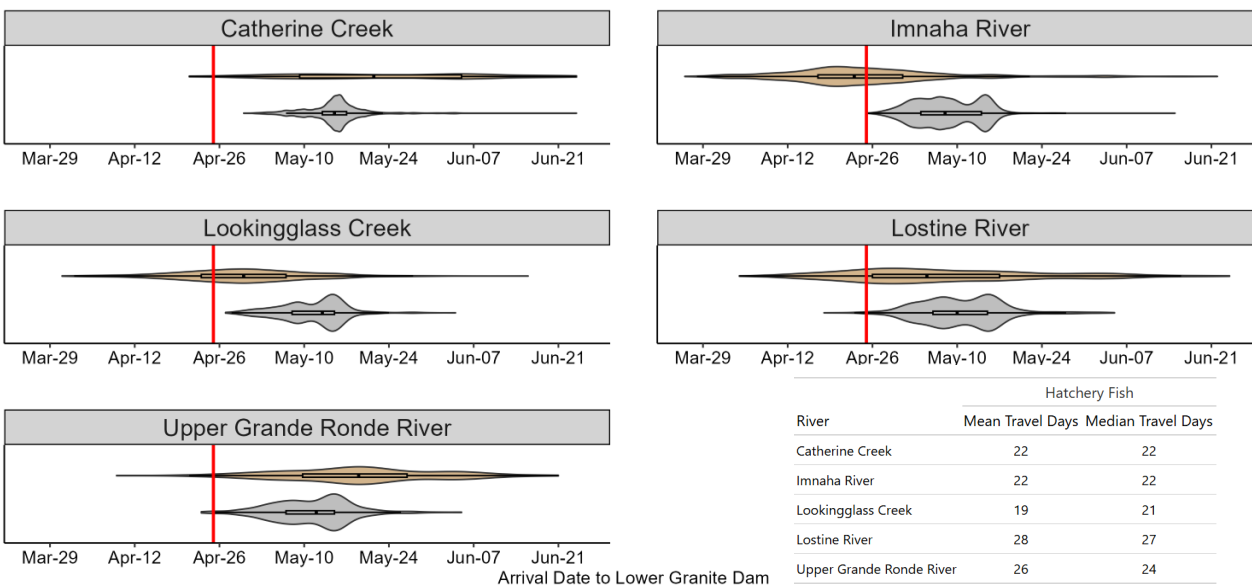
Objective 6. Assess and compare life history characteristics (smolt migration, run timing, age structure, sex ratio, fecundity) of hatchery and natural fish.

Hatchery smolt releases vs natural smolt out-migrants

A trend observed across all hatchery releases, is that when compared to natural spring migrants, the arrival time at LGD for hatchery smolts is more truncated than the arrival time of natural emigrants (Figure 22). Median travel days from release to LGD for hatchery smolts ranged from 16 to 47 days for migration years 2021–2023.

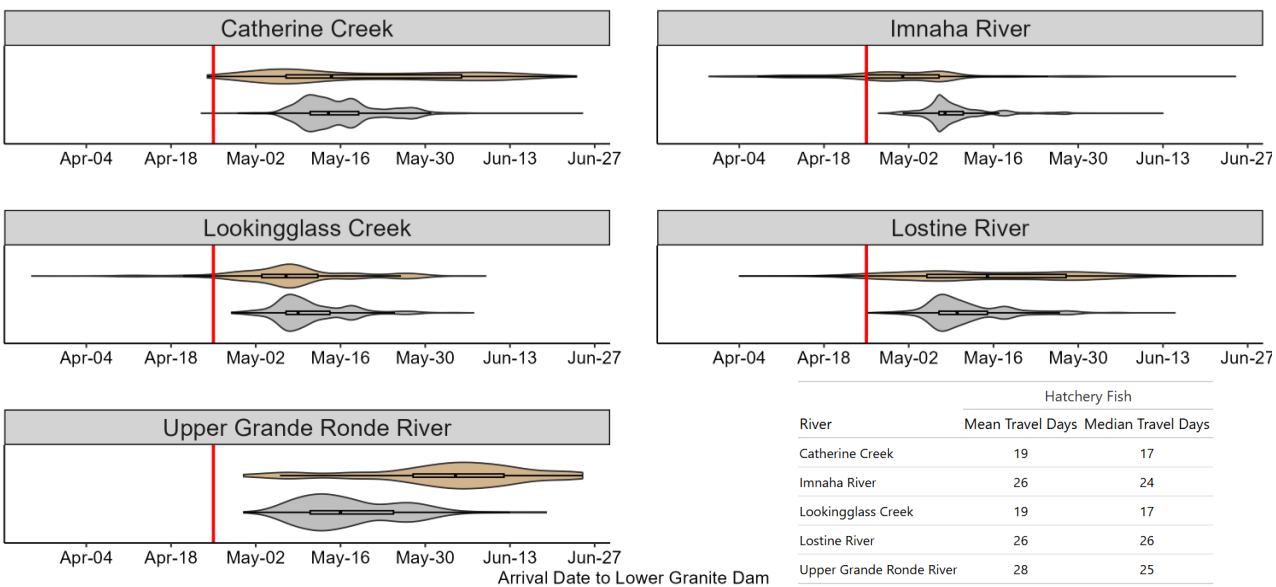
Migration Year 2021

Rear Type Hatchery Natural Start of Barging



Migration Year 2022

Rear Type Hatchery Natural Start of Barging



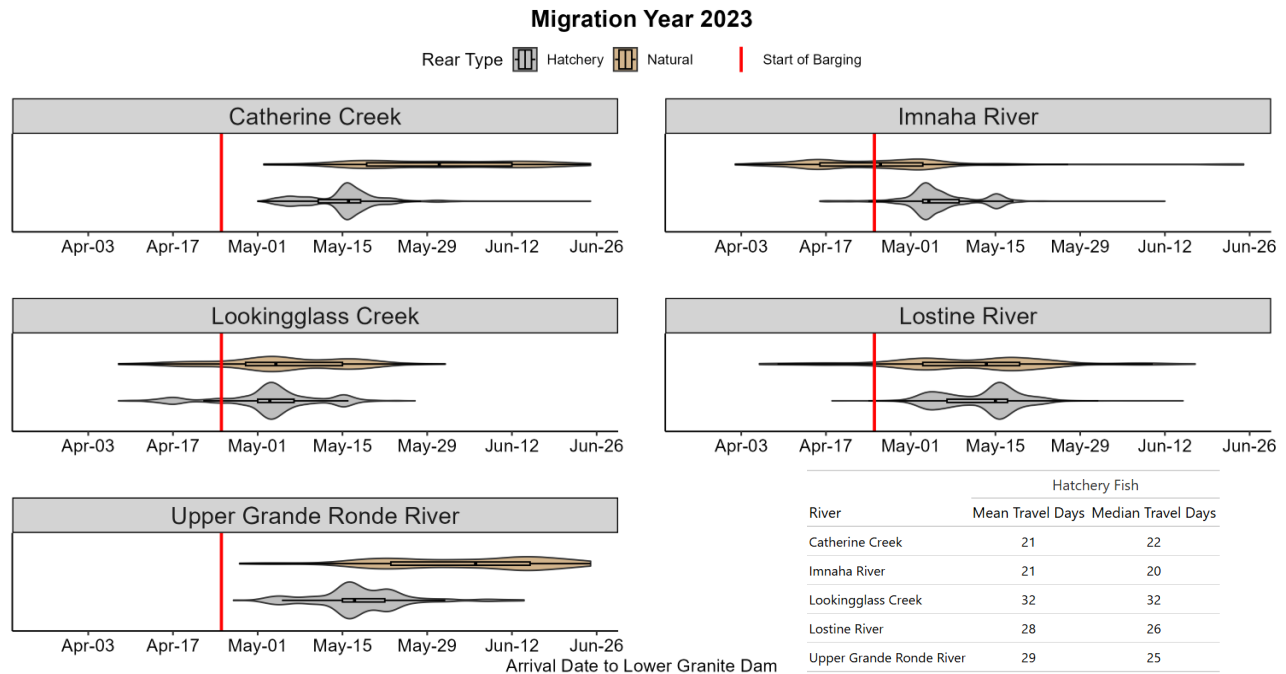


Figure 22. Arrival time at Lower Granite Dam of hatchery and natural Chinook Salmon smolts emigrating from the Grande Ronde and Imnaha basins, travel metrics, and the proportion subject to barging for migration years 2021-2023. Mean and median travel time for hatchery smolts is shown in the lower right corner. The start of barging is assumed to be 21 April.

The disparate arrival times at LGD between hatchery and natural smolts result in a differential proportion of smolts being available to barge (Figure 22, Table 14). If the goal of hatchery smolt releases is to mimic the emigration patterns of natural fish, the data suggests that current management actions are not meeting this objective. Reconsideration of both release dates and release strategies (e.g., volitional vs. forced releases) may be warranted, particularly for stocks such as those from the Imnaha River and Lookingglass Creek, where the greatest disparities in LGD arrival times are observed. Also, the truncated arrival patterns of hatchery smolts could limit the ability of hatchery populations to adapt to climate driven changes in river migration corridors, affect estuarine and ocean arrival time, or limit their ability to capitalize on inter-annual variation in the timing of productive ocean conditions.

Table 16. Proportions of hatchery and natural Chinook Salmon smolts emigrating from the Grande Ronde and Imnaha basins detected at Lower Granite Dam after smolt barging begins for migration years 2021-2023.

Migration Year	Release River	Rear Type	Proportion		
			After Barging	Mean arrival date	Median arrival date
2021	Catherine Creek	Hatchery	1.00	15 May	15 May
2021	Catherine Creek	Natural	0.98	23 May	21 May
2021	Imnaha River	Hatchery	1.00	8 May	8 May
2021	Imnaha River	Natural	0.42	25 Apr	23 Apr
2021	Lookingglass Creek	Hatchery	1.00	11 May	13 May
2021	Lookingglass Creek	Natural	0.67	30 Apr	30 Apr
2021	Lostine River	Hatchery	0.99	10 May	10 May
2021	Lostine River	Natural	0.78	8 May	5 May
2021	Upper Grande Ronde River	Hatchery	0.98	11 May	12 May
2021	Upper Grande Ronde River	Natural	0.97	18 May	19 May
2022	Catherine Creek	Hatchery	1.00	15 May	14 May
2022	Catherine Creek	Natural	0.99	19 May	14 May
2022	Imnaha River	Hatchery	1.00	9 May	8 May
2022	Imnaha River	Natural	0.72	30 Apr	1 May
2022	Lookingglass Creek	Hatchery	1.00	11 May	9 May
2022	Lookingglass Creek	Natural	0.92	8 May	7 May
2022	Lostine River	Hatchery	1.00	11 May	10 May
2022	Lostine River	Natural	0.94	15 May	15 May
2022	Upper Grande Ronde River	Hatchery	1.00	17 May	16 May
2022	Upper Grande Ronde River	Natural	1.00	2 Jun	4 Jun
2023	Catherine Creek	Hatchery	1.00	15 May	16 May
2023	Catherine Creek	Natural	1.00	30 May	31 May
2023	Imnaha River	Hatchery	0.96	5 May	4 May
2023	Imnaha River	Natural	0.51	26 Apr	26 Apr
2023	Lookingglass Creek	Hatchery	0.85	3 May	3 May
2023	Lookingglass Creek	Natural	0.82	5 May	4 May
2023	Lostine River	Hatchery	1.00	12 May	15 May
2023	Lostine River	Natural	0.90	11 May	13 May
2023	Upper Grande Ronde River	Hatchery	1.00	17 May	17 May
2023	Upper Grande Ronde River	Natural	1.00	3 Jun	6 Jun

Adult run timing to the tributaries

For the 2021–2023 return years, estimated weir efficiencies averaged $\geq 92\%$ in Catherine Creek, the Imnaha River, and Lookingglass Creek, 60.5% in the Lostine River, and 78.4% for the Upper Grande Ronde River (Figure 23). A 5-year average return timing (i.e., 2015–2019) was used to compare adult return timing from 2021–2023 to examine patterns of hatchery and natural adults arriving at weirs in the Grande Ronde and Imnaha River basins (Figure 24). In return year 2021–2022, hatchery fish had an earlier median trap date except for Catherine Creek and the Upper

Grande Ronde in 2021, and Catherine Creek, Lookingglass Creek, and the Lostine River in 2022. In return year 2023, across all hatchery supplemented rivers except the Imnaha River, hatchery and natural adults had similar median trap dates (Table 17).

Two important functions of weirs are to collect broodstock for subsequent in-hatchery spawning and to manage the number of hatchery salmon allowed to spawn in nature. Since spawning and migration timing are heritable, variability in capturing broodstock creates potential risk of divergence from the natural population, if the full breadth of phenological characteristics cannot be consistently incorporated into the hatchery population. Consequently, the weir location and the efficiency of that weir in capturing returning salmon throughout the entire return are important considerations in how salmon populations are managed.

Notable factors that have directly influenced weir efficiency over the last ten years were completion of the Imnaha River Bridge Weir in the summer of 2016 and the requirement that the Upper Grande Ronde weir is removed when water temperatures are $\geq 20^{\circ}\text{C}$. In the Imnaha river, the previously operated picket weir could only be safely installed when river discharge was $< 28 \text{ m}^3/\text{s}$ and weir efficiency ranged from 30 to 100%. However, a challenge that is still present in the Imnaha River is that up to 50% of the spawning can occur below the weir (ODFW, unpublished data). The temperature operating limits for the Upper Grande Ronde were implemented in 2010 to prevent mortality of adult salmon trapped below the weir. This was in response to the death of approximately 300 Chinook Salmon documented below the weir in 2009 that was attributed to thermal stress. One result of the early weir removal is the inability to trap a representative proportion of the entire run. By only collecting adults from the beginning of the run, it is possible that we might be selecting for early returning adults which could alter run timing.

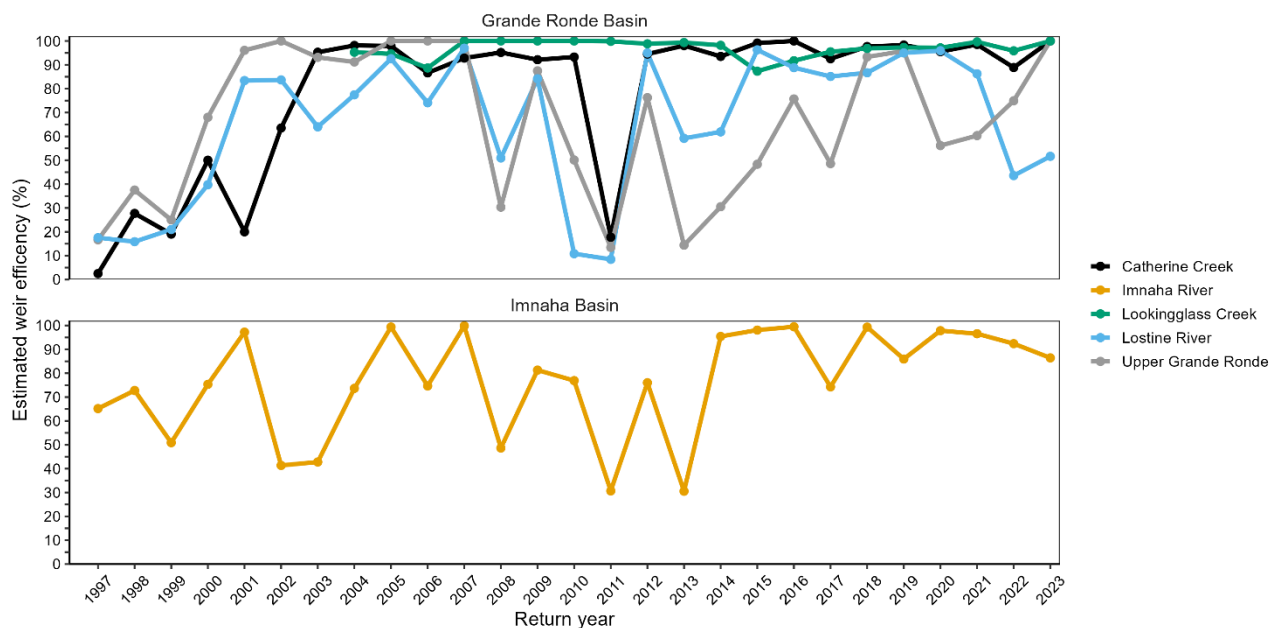
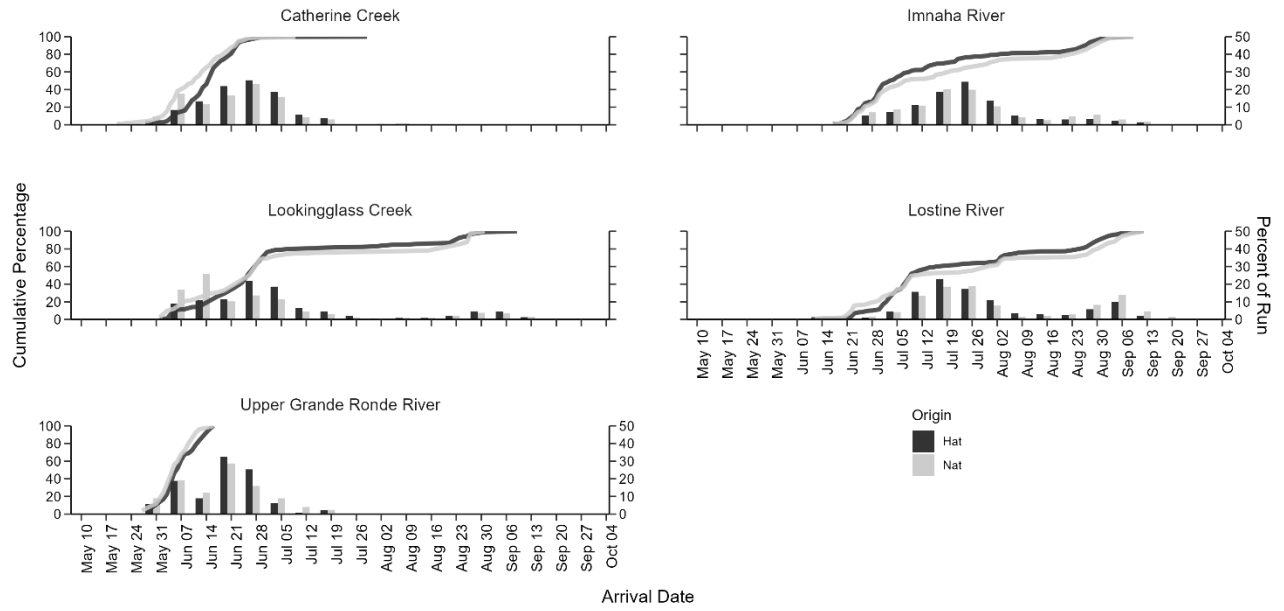
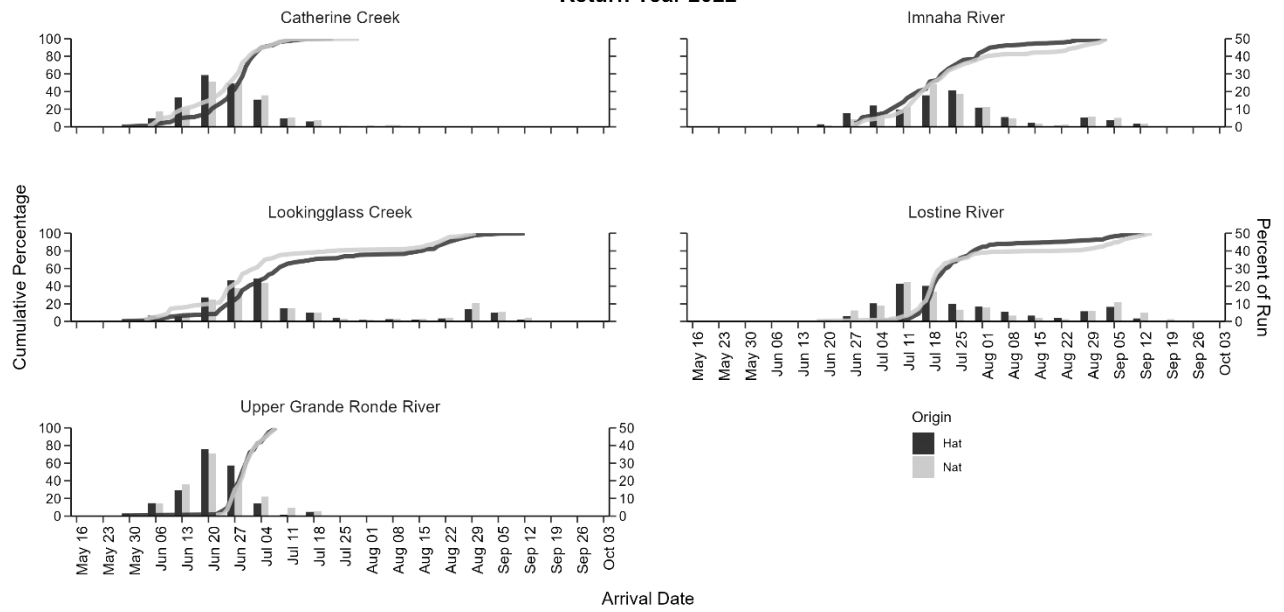


Figure 23. Annual estimated weir efficiency for streams in the Grande Ronde and Imnaha basins, 1997–2023.

Return Year 2021



Return Year 2022



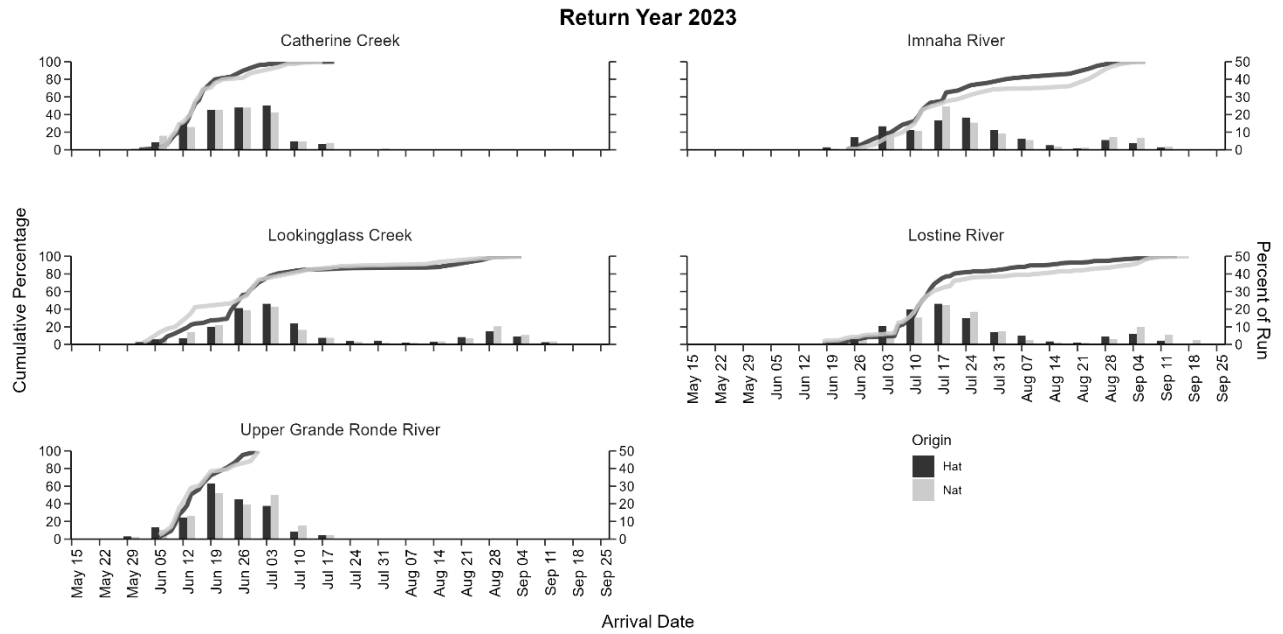


Figure 24: Return years 2021–2023 cumulative arrival date of age 3–5 hatchery and natural Chinook Salmon trapped at weirs on Catherine Creek, Imnaha River, Lookingglass Creek, Lostine River, and the Upper Grande Ronde River. Bars are the five-year average percentage of the run trapped at each adult weir grouped by week of the year.

Table 17. Return years 2021-2023 mean and median trap dates of age 3–5 hatchery and natural Chinook Salmon trapped at weirs on Catherine Creek, Imnaha River, Lookingglass Creek, Lostine River, and the Upper Grande Ronde River.

Return Year	River	Hatchery		Natural	
		Mean Trap Date	Median Trap Date	Mean Trap Date	Median Trap Date
2021	Catherine Creek	13 Jun	14 Jun	10 Jun	10 Jun
2021	Imnaha River	13 Jul	2 Jul	18 Jul	7 Jul
2021	Lookingglass Creek	2 Jul	25 Jun	4 Jul	26 Jun
2021	Lostine River	21 Jul	8 Jul	24 Jul	9 Jul
2021	Upper Grande Ronde River	5 Jun	5 Jun	4 Jun	4 Jun
2022	Catherine Creek	25 Jun	28 Jun	23 Jun	25 Jun
2022	Imnaha River	19 Jul	17 Jul	23 Jul	20 Jul
2022	Lookingglass Creek	13 Jul	5 Jul	5 Jul	28 Jun
2022	Lostine River	25 Jul	20 Jul	28 Jul	19 Jul
2022	Upper Grande Ronde River	28 Jun	28 Jun	29 Jun	29 Jun
2023	Catherine Creek	16 Jun	14 Jun	16 Jun	14 Jun
2023	Imnaha River	20 Jul	14 Jul	25 Jul	17 Jul
2023	Lookingglass Creek	1 Jul	26 Jun	28 Jun	26 Jun
2023	Lostine River	16 Jul	13 Jul	20 Jul	13 Jul
2023	Upper Grande Ronde River	15 Jun	13 Jun	15 Jun	13 Jun

Objective 7. Determine the success of maintaining genetic integrity of endemic wild spring Chinook Salmon in the Minam and Wenaha rivers.

The National Marine Fisheries Service (NMFS) Section 10 permits for the Grande Ronde Basin Hatchery programs require monitoring for hatchery-origin strays into the Minam and Wenaha rivers. Annual spawning ground surveys are conducted to determine whether any hatchery program contributes more than 5% of the total spawners in either river. The stray rate is evaluated using a three-year running average that began in 2016. If this threshold is exceeded, program co-managers must notify NMFS. We use both CWT and genetic samples to determine the hatchery program.

In the Minam River, one hatchery-origin Chinook Salmon carcass was recovered in 2021 and none in 2022 or 2023 (Table 17). The 2021 carcass lacked a coded-wire tag (CWT), and the Eagle Genetics Lab was unable to identify its hatchery program from the genetic sample. In the Wenaha River, hatchery-origin carcass recoveries totaled zero in 2021, three in 2022, and one in 2023—marking the fifth consecutive year with fewer than 20 total carcasses recovered (Table 17). One of the 2022 recoveries was identified via CWT as originating from the Lookingglass Conventional program, while the hatchery programs for the remaining 2022 and 2023 recoveries could not be determined. Overall, carcass recoveries in both the Minam and Wenaha rivers remain low, likely due to the high abundance of scavengers in these wilderness systems.

From 2011–2023, the proportion of hatchery-origin spawners, including jacks ((pHOS_{ij})), in the Minam and Wenaha Rivers ranged from 0%–33% and 0.12%–50%, respectively (Figure 19). Years with zero pHOS are likely due to low carcass recovery probability rather than true inter-annual variation. Testing this hypothesis would require substantially more surveys—and more staff—during July–September in these wilderness streams. The current pHOS estimates rely entirely on carcass recoveries, and low sample sizes create considerable uncertainty. Wildfires have also regularly interfered with surveys. For example, the 2015 Grizzly Ridge Complex Fire burned most of the Wenaha River drainage and destroyed over 80% of the trail system, while the 2019 Granite Gulch Fire curtailed surveys in the upper Minam River. If we are unable to improve our carcass recovery rates, pHOS estimates in these wilderness streams may not yield precise estimates. To complement the existing survey methods (i.e., two ground-based surveys/year), we need to explore alternative approaches, such as observing holding adults—which avoids scavenger-related issues and can occur before fire season—or having a greater reliance on PIT tag detections at in-stream interrogation sites (e.g., WEN, MR1). Another option to consider exploring is genetic sampling of juveniles to determine if one or both grandparents were hatchery- or natural-origin. Implementing alternative monitoring strategies will likely require additional personnel and funding.

As an alternative method to estimating pHOS, we queried the PTAGIS database for adult Chinook Salmon PIT tags detected at the Minam River ([MR1](#)) and the Wenaha River ([WEN](#)) interrogation sites. At MR1, 87 adults were detected in 2021, 87 in 2022, and 71 tags in 2023. Of these, one hatchery fish was detected in 2021, three in 2022, and two in 2023, yielding pHOS estimates of 1.14%, 3.4%, and 2.8% for 2021–2023, respectively, if all detected fish were Minam spawners. At WEN, 28 adults were detected in 2021, 23 in 2022, and eight in 2023; all were natural- or unknown-origin fish, resulting in pHOS estimates of zero for all three years. These results should be interpreted with caution. It is unclear whether all detected adults spawned in these systems or were temporary “dip-ins” seeking thermal refuge. The estimates also assume complete detection at the interrogation sites, but the WEN array often experiences equipment failures. Its antennas frequently break during the spring Chinook migration, making 100% detection efficiency unlikely.

Table 18. Hatchery and natural origin carcasses found in the Minam and Wenaha rivers over the last ten spawning years, 2014–2023. Hatchery and natural origin determinations were based on fin clips, coded-wire tags, or through genetic analysis.

River / Spawning Year	Hatchery population							Natural Origin	Total
	Catherine Cr.	Imnaha R.	Lookingglass Cr	Lostine R.	Upper Grande Ronde R.	Out- of- Basin	Unk Hatchery		
<u>Minam R.</u>									
2014	0	0	1	4	0	0	5	115	125
2015	0	0	2	1	0	0	1	23	27
2016	0	0	0	0	0	0	0	23	23
2017	0	0	0	0	0	0	1	2	3
2018	0	0	0	0	0	0	0	9	9
2019	0	0	0	0	0	0	0	6	6
2020	0	0	0	0	0	0	0	12	12
2021	0	0	0	0	0	0	1	7	8
2022	0	0	0	0	0	0	0	5	5
2023	0	0	0	0	0	0	0	4	4
<u>Wenaha R.</u>									
2014	0	0	17	0	0	1	15	50	83
2015	0	0	1	0	0	0	0	8	9
2016	0	0	1	0	0	1	7	45	54
2017	0	0	1	0	0	0	1	5	7
2018	0	0	5	0	0	0	6	11	22
2019	0	0	2	0	0	0	3	7	12
2020	0	0	0	0	0	0	0	2	2
2021	0	0	0	0	0	0	0	2	2
2022	0	0	1	0	0	0	2	11	14
2023	0	0	0	0	0	0	1	5	6

Objective 8: Assess success in restoring fisheries.

Between 2021 and 2023, three sport fisheries took place: one in the Imnaha River in 2022 and two in Lookingglass Creek in 2022 and 2023 (Figure 25). Sport anglers harvested 104 hatchery-origin Chinook Salmon in the Imnaha River in 2021. In Lookingglass Creek, sport fishermen harvested 74 hatchery-origin Chinook salmon in 2022 and 27 in 2023.

Tribal fisheries also occurred during this period. The NPT tribal harvest data was shared by e-mail communication with ODFW by Jack Yearout and the CTUIR harvest data was shared by Preston Bronson. In the Imnaha River, the estimated tribal harvest of hatchery-origin Chinook Salmon was 252 in 2021, 199 in 2022, and 133 in 2023 (Figure 25). Natural-origin harvest estimates were two in 2021, 18 in 2022, and five in 2023. In Lookingglass Creek, estimated tribal harvest of hatchery-origin Chinook Salmon was 37 in 2021, 282 in 2022, and 214 in 2023. The Lookingglass Creek natural-origin estimates were five in 2021, six in 2022, and nine in 2023. In the Lostine River, the tribal harvest of hatchery-origin Chinook Salmon was 56 in 2021, 250 in 2022, and 116 in 2023. During the same period, the estimated harvest of natural-origin fish was two, 55, and seven, respectively. In Catherine Creek, three hatchery-origin Chinook Salmon and zero natural-origin Chinook were harvested in tribal fisheries in 2021.

Since the 2000 return year, terminal harvest opportunities have been limited (Figure 25). The Imnaha River, Lookingglass Creek, and Lostine River have provided the most consistent opportunities for both tribal and sport fisheries. In contrast, only one sport fishery has occurred in Catherine Creek (2012), which yielded an estimated harvest of 24 hatchery-origin and 7 incidental natural-origin spring Chinook Salmon. No sport fisheries have occurred in the Upper Grande Ronde. Although tribal harvest is authorized most years in Catherine Creek and the Upper Grande Ronde, low adult returns have resulted in minimal reported harvest.

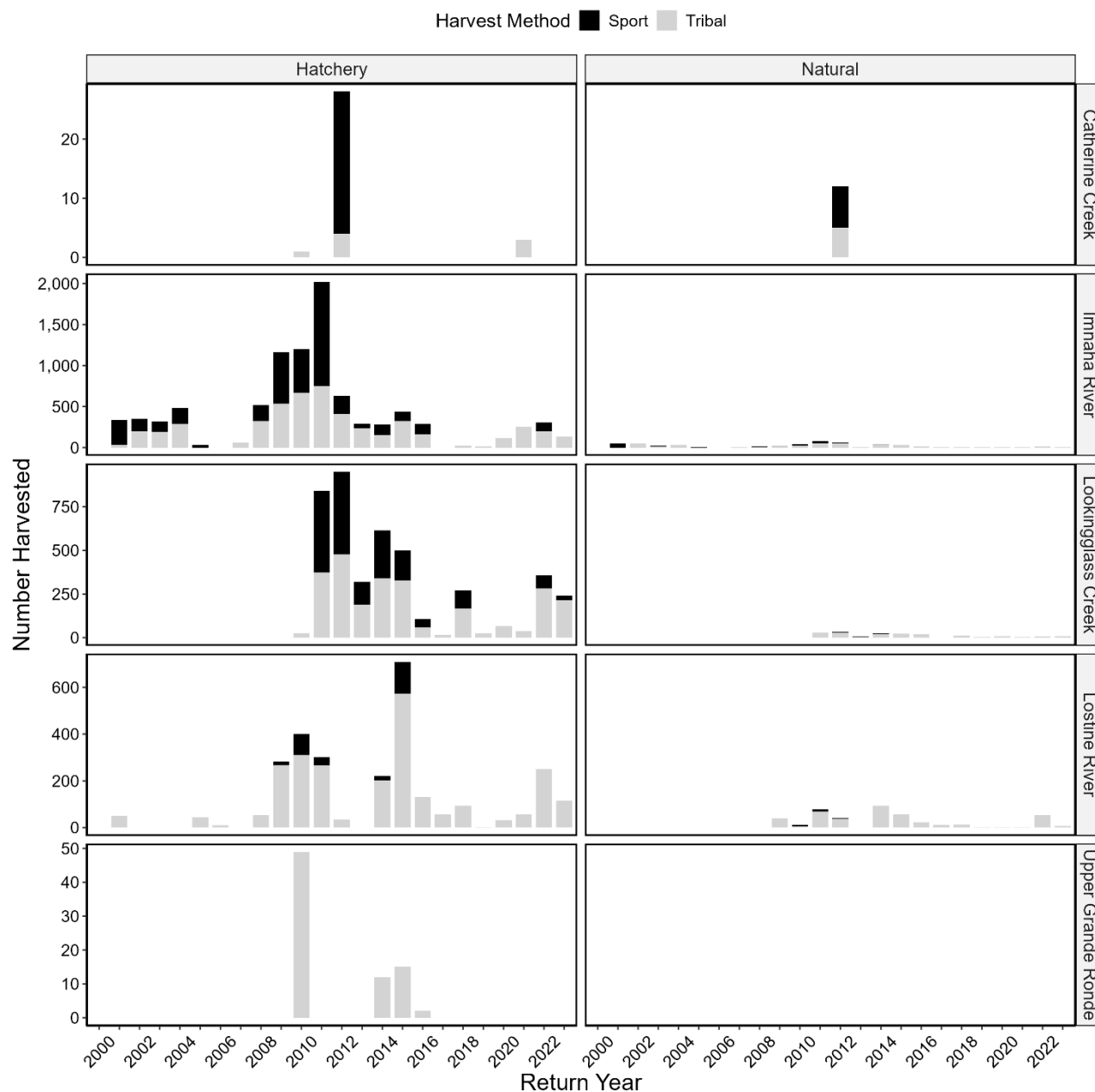


Figure 25. Total Chinook Salmon harvested by origin and fishing method (Sport or Tribal) in sport and tribal fisheries in Catherine Creek, the Imnaha River, Lookingglass Creek, the Lostine River, and the Upper Grande Ronde River, return years 2000-2023.

Objective 9: Coordinate project activities and disseminate results

The Grande Ronde and Imnaha River hatchery programs are complex and require significant collaboration to collect data within the co-management structure and across agencies. Successful project coordination, data management, and reporting of results to fisheries managers occur regularly at various scales and levels of complexity (Table 16). The ODFW, CTUIR, and NPT M&E projects rely on a combination of online databases, in-house access databases, and annual reports provided to BPA and the LSRCP office to archive and report findings. Key data collection and reporting metrics are summarized in Table 20.

Table 19. Timeline of key production, research, and collaboration activities in a normal calendar year.

Project Activities	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Production												
Catherine Creek: Chinook trapping												
Upper Grande Ronde: Chinook trapping												
Lookingglass Creek: Chinook trapping												
Lostine River: Chinook trapping												
Imnaha River: Chinook trapping												
Chinook spawning at LFH												
Fin clipping and CWT marking												
Egg shocking												
Egg hatching												
Acclimate and release juvenile Chinook												
Research												
Trapping QA-QC with co-managers												
Chinook spawning ground surveys												
Adult radio tracking												
Hatchery juvenile PIT tagging												
Pre-release hatchery juvenile sampling												
Fin clip and CWT retention checks												
PIT array operations and maintenance												
Pre-season run projections												
In-season run monitoring												
Upload PIT tag data to PTAGIS												
Submit annual report to the LSRCP office												
Submit statement of work to LSRCP office												
Joint												
Annual Operating Plan development												
Local and regional coordination												
Data sharing among co-managers												
ESA reporting to NOAA & USFWS												
Reporting to Coordinated Assessments												

Table 20. Key data collection, reporting metrics, and data storage locations. Data is reported by the Oregon Department of Fish and Wildlife (ODFW), the Confederated Tribes of the Umatilla Indian Reservation (CTUIR), and the Nez Per Tribe (NPT). HMS = ODFW's Hatchery Management System. CDMS = Central Data Management System.

Key data collection or reporting metric	Where data is stored or reported
Chinook Salmon trapping and broodstock collection	a) CTUIR stores data for the Catherine Creek, Upper Grande Ronde, and Lookingglass Creek in CTUIR's CDMS system. Catherine Creek and Upper Grande Ronde trapping data is also reported to FINS. b) NPT stores Lostine River Chinook trapping data in 1) NPT's CDMS system, and 2) FINS. c) ODFW stores Imnaha and Lookingglass trapping data in FINS. d) The Fish Research Office stores copies of all trapping records in in-house access databases where records are supplement with age data derived from CWTs, scales, PIT tags, and genetic data. e) Chinook trapping data for all traps is reported to the ODFW's HMS. f) ODFW annual reports submitted to LSRCP. g) Individual reports by NPT and CTUIR to BPA.
Egg Collection Numbers	a) ODFW's HMS. b) ODFW Fish Research in-house access database. c) ODFW annual reports submitted to LSRCP. d) Individual reports by NPT and CTUIR to BPA.
Hatchery broodstock spawning records	a) ODFW's HMS b) ODFW Fish Research in-house access database. c) ODFW annual reports submitted to LSRCP. d) CTUIR CDMS system for Lookingglass Creek, Upper Grande Ronde, Catherine Creek.
Chinook spawning ground surveys	a) ODFW in-house access database. b) portions of the data are uploaded to NPT and CTUIR CDMS systems. c) Redd counts and carcass data StreamNet (www.streamnet.org).
Genetic samples	a) Starting in 2008, genetic samples for the parentage-based tagging baseline (BPA # 201003100; Steele et al. 2019) have been collected from all Chinook Salmon spawned at Lookingglass Fish Hatchery for all five hatchery programs. b) Relative reproductive success evaluations on Catherine Creek and Lookingglass Creek (BPA # 198909600). c) Relative reproductive success study in Lookingglass Creek (BPA #200900900).
Juvenile release numbers, number of CWT-marked releases, release locations	a) ODFW's HMS. b) ODFW annual reports submitted to LSRCP. c) Individual reports by NPT and CTUIR to BPA. d) Pacific States Reginal Mark Processing Center (rmcp.org).
Coded-wire-tagged fish recoveries	a) ODFW's HMS. b) ODFW annual reports submitted to LSRCP. c) Pacific States Reginal Mark Processing Center (rmcp.org).
PIT tagged hatchery releases	a) ODFW annual reports submitted to LSRCP. b) PTAGIS.org
PIT tag detections (in-stream or adult ladders and traps).	Both ODFW, NPT, and CTUIR collaborate to operate and maintain PIT tag equipment to monitor streams and fish ladders, and to scan individual adults at Chinook traps in the Grande Ronde and Imnaha basins. All data is submitted to PTAGIS. Efforts support BPA Project #201005700.
Harvest Monitoring	a) In-season harvest sport and tribal harvest information is shared during weekly meetings with co-managers. b) For sport fisheries, data is provided in ODFW annual reports submitted to LSRCP.

Key data collection or reporting metric	Where data is stored or reported
Smolt-to-Adult-Survival (SAS) and Smolt-to-Adult Return (SAR) rates	c) CTUIR and NPT complete independent harvest monitoring efforts. Harvest data is shared via e-mail and in annual reports. a) Hatchery SAR/SAS rates are in ODFW annual reports submitted to LSRCP for all five hatchery programs. b) Hatchery SAR rates: NPT and CTUIR provide in reports to BPA. c) Natural SAR estimates. ODFW reports Catherine Cr, Upper Grande Ronde, Lostine R, Minam R to https://cax.streamnet.org. CTUIR reports natural SAS and SAR to LSRCP and data is stored on the CTUIR CDMS system.
Outmigration juvenile survival rates	a) ODFW annual reports submitted to LSRCP b) Individual reports by NPT and CTUIR to BPA and LSRCP. c) Natural origin Chinook outmigrant estimates: StreamNet Coordinated Assessments https://cax.streamnet.org
Stray-rates (in-basin and out of basin)	a) ODFW annual reports submitted to LSRCP
Recruit:Spawner ratios	
1. Spawner:Spawner	a) ODFW and CTUIR annual reports submitted to LSRCP
2. Return to river: spawner	b) StreamNet Coordinated Assessments https://cax.streamnet.org
3. Smolts:spawner	
Proportion of natural influence (PNI)	a) ODFW annual reports submitted to LSRCP
Percent Hatchery Origin Spawners (PHOS)	a) For Grande Ronde and Imnaha basin populations, including Minam and Wenaha rivers: StreamNet Coordinated Assessments https://cax.streamnet.org
Natural Origin Spawner Abundance (NOSA)	a) For Grande Ronde and Imnaha basin populations, including Minam and Wenaha rivers: StreamNet Coordinated Assessments https://cax.streamnet.org

Acknowledgments

Lookingglass Fish Hatchery personnel exhibited great dedication and provided essential assistance. Numerous employees from the ODFW, U.S. Fish and Wildlife Service, U.S. Forest Service, Nez Perce Tribe (NPT), Confederated Tribes of the Umatilla Indian Reservation (CTUIR), and Grande Ronde Model Watershed were supportive during spawning ground surveys and spawning at Lookingglass Fish Hatchery. The NPT provided Lostine River weir data and CTUIR provided weir data from Catherine Creek and the Upper Grande Ronde River, as well as spawning ground survey data summarized from Lookingglass Creek. This project was funded by the U.S. Fish and Wildlife Service under the Lower Snake River Compensation Plan, contract numbers F16AC00030 & F21AP00136, a cooperative agreement with ODFW.

References

- Bratcher, K.W., J. A. Yanke, T.D. Bailey. 2016. Lower Snake River Compensation Plan: Oregon Spring Chinook Harvest Monitoring. Annual Progress Report. Oregon Department of Fish and Wildlife. [link](#)
- Carmichael, R.W., T. Hoffnagle, J. Feldhaus, D. Eddy and N. Albrecht. 2010a. Grande Ronde Basin spring Chinook Salmon hatchery review: introduction and the early years. 2010 Spring Chinook Hatchery Program Review Symposium, Lower Snake River Compensation. [link](#).
- Carmichael, R.W., T. Hoffnagle, J. Feldhaus, D. Eddy and N. Albrecht. 2010b. Imnaha River spring/summer Chinook Salmon hatchery program review. 2010 Spring Chinook Hatchery Program Review Symposium, Lower Snake River Compensation. [link](#)
- Chapman, D.G. 1951. Some properties of the hypergeometric distribution with applications to zoological sample census. University of California Publications in Statistics 1:131-160.
- Copeland, T, M.W. Hyatt, J. Johnson. 2008. Comparison of methods used to age Spring-Summer Chinook Salmon in Idaho: validation and simulated effects on estimated age composition. North American Journal of Fisheries Management 27: 1393–1401.
- Corps of Engineers. 1975. Special Report, Lower Snake River Fish and Wildlife Compensation Plan, Lower Snake River, Washington and Idaho. U.S. Army Engineer District, Walla Walla, Washington. <http://www.fws.gov/lsnakecomplan/Reports/LSRCPreports.html>
- Feldhaus, J.W., T.L. Hoffnagle, D.L. Eddy, and R.W. Carmichael. 2014. Lower Snake River Compensation Plan: Oregon spring Chinook Salmon evaluation studies, 2011. Annual Progress Report. Oregon Department of Fish and Wildlife, Salem.
- Feldhaus, J.W., T.L. Hoffnagle, and R.W. Carmichael. 2016. The influence of size at release on performance of Imnaha River Chinook Salmon hatchery smolts. North American Journal of Fisheries Management 36:363-374.
- Feldhaus, J.W., T.L. Hoffnagle, D.L. Eddy, and K.N. Ressel. 2017. Lower Snake River Compensation Plan: Oregon spring Chinook Salmon evaluation studies, 2014. Annual Progress Report. Oregon Department of Fish and Wildlife, Salem. [link](#)
- Feldhaus, J, E. Brant, I. Tattam, C. Crump, L. Naylor. 2023. The 2022 Grande Ronde and Imnaha River basin Spring Chinook Salmon Hatchery Review, Lower Snake River Compensation Plan. Oregon Department of Fish and Wildlife, Salem [link](#)
- Hatchery Scientific Review Group (HSRG). 2009. Columbia River Hatchery Reform System-Wide Report. [link](#)
- Herrig, Daniel M. A Review of the Lower Snake River Compensation Plan Hatchery Program. 1990. Lower Snake River Compensation Plan Office, Boise, Idaho. <http://www.fws.gov/lsnakecomplan/Reports/LSRCPreports.html>
- NMFS (National Marine Fisheries Service). 2017. ESA Recovery Plan for Snake River Spring/Summer Chinook Salmon (*Oncorhynchus tshawytscha*) & Snake River basin Steelhead (*Oncorhynchus mykiss*) – November 2017. 282 p. Available: [link](#)

- Nuetzel, H., A. Pierce, L. Koch, L. Medeiros, N. Hoffman, A. Matala, and P. Galbreath. 2021. *Basin Wide Supplementation Evaluation Project 2020 Annual Report*. Annual progress report, Portland, Oregon: Bonneville Power Administration.
- Nuetzel, H., P. Galbreath, B. Staton, C. Crump, L. Naylor, and G. Shippentower. 2022. Improved productivity of naturalized spring Chinook Salmon following reintroduction from a hatchery stock in Lookingglass Creek, Oregon. *Canadian Journal of Fisheries and Aquatic Sciences*. <https://doi.org/10.1139/cjfas-2022-0114>
- Oregon Department of Fish and Wildlife (ODFW), Confederated Tribes of the Umatilla Indian Reservation, Nez Perce Tribe. 2020. Annual Operating Plan for the Lower Snake River Fish and Wildlife Compensation Programs Grande Rond and Imnaha Basins, Oregon. [link](#)
- Steele, Craig A., M. Hess, S. Narum, M. Campbell. Parentage-based tagging: Reviewing the implementation of a new tool for an old problem. *Fisheries* 44.9 (2019): 412-422.
- Tranquilli, J. V, B.C. Jonasson, M. Keefe, R.W. Carmichael. 2004. A Compendium of Grande Ronde River and Imnaha River Basins Spring Chinook Salmon Spawning Ground Surveys Conducted from 1948 through 2003. Report prepared for the Lower Snake River Compensation Plan. Oregon Department of Fish and Wildlife, Salem [link](#)
- U.S. Fish and Wildlife Service. 2020. Lower Snake River Compensation Plan: Fiscal Year 2018 Report. U.S. Fish and Wildlife Service, Lower Snake River Compensation Plan Office. [link](#)