LOWER SNAKE RIVER COMPENSATION PLAN:
Oregon Summer Steelhead Evaluation Studies
2018 Annual Progress Report

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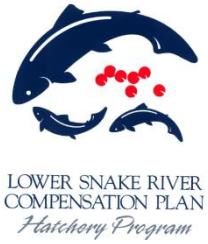

This report is available at: http://www.fws.gov/lsnakecomplan/Reports/ODFWreports.html

Front cover photo: Sampling steelhead smolts for our reciprocal study at Washington Department of Fish and Wildlife's Cottonwood Creek acclimation pond on the lower Grande Ronde River in March 2018.

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PREFACE

The purpose of this progress report is to provide summary information for Lower Snake River Compensation Plan (LSRCP) summer steelhead (*Oncorhynchus mykiss*) programs operated by ODFW in the Grande Ronde and Imnaha river basins during 2018. These ongoing monitoring programs provide technical, logistical, and biological information to managers charged with maintaining viable salmon and steelhead populations and associated fisheries in northeast Oregon. This report is organized into fish culture monitoring for juveniles, adults, experimental group recoveries (coded-wire tags and PBT assignments), and estimates for total escapement. During the period covered in this report, steelhead from the 2013-2015 broods returned to spawn, and steelhead from the 2017 brood were released as smolts. Adult steelhead that returned to spawn were used to create the 2018 brood.

ACKNOWLEDGMENTS

We would like to thank hatchery managers Ron Harrod of Wallowa Fish Hatchery and Terry Blessing of Irrigon Fish Hatchery, as well as Keenan Schmidt, Chad Aschenbrenner, and the many other hatchery personnel who exhibited great dedication and provided essential assistance. Numerous personnel from the Oregon Department of Fish and Wildlife, U.S. Fish and Wildlife Service, the Nez Perce Tribe, and the Confederated Tribes of the Umatilla Indian Reservation provided enthusiastic support. We also thank Chris Starr, Mark Robertson, Julie Collins, and Rod Engle, who provided administrative and technical support. This project was funded by the U.S. Fish and Wildlife Service under the Lower Snake River Compensation Plan, contract number F16AC00030, a cooperative agreement with the Oregon Department of Fish and Wildlife.

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EXECUTIVE SUMMARY

Objectives

1. Document summer steelhead rearing and release activities at all LSRCP facilities.

2. Determine optimum rearing and release strategies that will produce maximum survival to adulthood for hatchery-produced summer steelhead smolts.

3. Document summer steelhead adult returns by stock to each LSRCP broodstock collection facility.

4. Determine if the total production of summer steelhead adults meets mitigation goals, and index annual smolt survival and adult returns to Lower Granite Dam for production groups.

5. Participate in planning activities associated with anadromous fish production and management in the Grande Ronde and Imnaha river basins, and participate in ESA permitting, consultation, and rearing activities.

6. Monitor natural spawning of summer steelhead in selected areas within the Grande Ronde basin.

7. Determine the number of summer steelhead harvested annually and angler effort in recreational fisheries on the Grande Ronde, Wallowa, and Imnaha rivers.

Accomplishments and Findings

We accomplished each of our objectives for 2018. In this report, we present data and results for objectives 1, 2, 3, 4, and 6. To accomplish objective 5, project staff participated in planning and coordination with co-managers to develop and write the annual operation plan (available at: www.fws.gov/lsnakecomplan/Reports/AOPreports.html), and staff consulted with the National Marine Fisheries Service on drafting the Lower Snake River Steelhead Hatchery Program Biological Opinion. Data and results for objective 7 are published in separate annual creel survey reports (*e.g., Flesher et al. 2019a).*

The production goal of 800,000 Wallowa stock smolts was achieved in 2018, with 831,180 smolts released (includes 40,286 smolts from Lyons Ferry Hatchery). The Imnaha stock production goal of 215,000 smolts was also reached with 251,209 smolts released.

In 2018, 1,877 and 733 Wallowa stock hatchery steelhead returned to Wallowa Fish Hatchery and the Big Canyon Facility, respectively. We trapped 24 natural steelhead at Wallowa Fish Hatchery and 35 natural steelhead at the Big Canyon Facility, which were released to spawn naturally. At the Little Sheep Creek Facility, we trapped 946 Imnaha stock hatchery and 37 natural steelhead adults. During spawning in the spring of 2018, we collected 594,800 Wallowa stock production eggs, 613,200 Wallowa fall broodstock eggs, and 349,300 Imnaha stock eggs.

In the 2017-18 run year, compensation area goals were not reached for either the Wallowa stock (9,184 adults) or the Imnaha stock (2,000 adults) above Lower Granite Dam. We have met the Wallowa stock compensation area goal thirteen times in our program history, and the Imnaha stock compensation area goal fifteen times. We estimate that 4,108 Wallowa stock hatchery steelhead (44.7% of goal), and 1,301 Imnaha stock hatchery steelhead (65.1% of goal) returned to the LSRCP compensation area in 2018.

INTRODUCTION

The objectives of this report are to document fish culture practices, describe adult returns, and assess progress toward meeting LSRCP goals for Grande Ronde and Imnaha steelhead *(Oncorhynchus mykiss)*. We report on juvenile steelhead rearing and release activities for the 2017 brood year (BY) released in 2018. Included are collection, spawning, and adult characteristics for the 2018 returns, returns from experimental releases, supplementation in Little Sheep Creek, and success toward achieving compensation goals.

The Grande Ronde and Imnaha river steelhead hatchery programs were initiated in 1976 and 1982 in response to the rapid decline in Snake River steelhead abundance. Annual adult mitigation, brood year specific smolt-to-adult return, total smolt-to-adult survival rates, and annual smolt production goals were established to compensate for the estimated annual loss of 48% of adult production from the Lower Snake River dams (USFWS 2020). Adaptive management has resulted in current interim smolt production goals of 800,000 (ODFW Wallowa stock released into the Grande Ronde) and 215,000 (Imnaha stock) smolts; less than the original goals of 1,350,000 and 330,000 smolts. Based on original smolt production goals it was assumed that 27,552 Wallowa stock and 6,000 Imnaha stock adults would be produced annually. Furthermore, 66.7% of these fish were expected to be harvested below the compensation area, defined as the watershed above Lower Granite Dam, resulting in compensation area adult return goals of 9,184 Wallowa stock and 2,000 Imnaha stock.

In general, the data in this report were derived from hatchery inventories and standard databases (e.g., Pacific States Marine Fisheries Commission Regional Mark Information System (RMIS), ODFW mark recovery) or through standard measuring techniques. As such, specific protocols are usually not described. In cases where expansions of data or unique methodologies were used, protocols are described in more detail. Additional descriptions of protocols can be found in our work statements (Ruzycki et al. 2017, Ruzycki et al. 2018). Coded-wire tag (CWT) data collected from 2018 adult returns were used to evaluate smolt-to-adult survival rates in experimental rearing and release groups. In 2018, two experimental treatments from which fish returned were the third-generation progeny from early returning (fall-collected) broodstock, and our reciprocal hatchery of rearing study with Washington Department of Fish and Wildlife (WDFW). In 2018, smolts were released at Wallowa Hatchery that were fourth generation progeny of early returning (fall-collected) broodstock for an experimental comparison with progeny of standard production broodstock. Methods for the fall broodstock experiment are described in Warren et al. (2011a). Also, 2018 was the fourth and final release year of our Wallowa stock reciprocal study with WDFW where Irrigon Hatchery reared smolts were acclimated and released at WDFW's Cottonwood Acclimation Facility

on the lower Grande Ronde River and Lyons Ferry Hatchery reared smolts were released from acclimation ponds at Wallowa Hatchery. Acclimation at the Cottonwood Facility is at low densities in a semi-natural pond, and these factors could translate to better post-release performance. Final adult returns to hatchery facilities from this study will occur in 2022, with analysis of survival and straying to be completed and presented in separate reports, journal articles, or conference presentations once all datasets are complete. Twibell et al. (2018) reports on results of smolt physiology monitoring during this study. In addition, much of the data that we discuss in this report will be used in separate and specific evaluations of ongoing supplementation programs for steelhead in the Imnaha River basin. We began culture evaluations in 1983 and have dramatically improved many practices. Progress for work completed in previous years is presented in annual progress reports, a United States vs. Oregon production report, a five-year study plan, and journal articles (available at https://www.fws.gov/lsnakecomplan/reports.html).

RESULTS AND DISCUSSION

Juveniles

Wallowa stock egg-to-eyed embryo survival for the 2017 BY was 93.3%, within the range of recent brood years (1993-2016 BY range = 71.8-93.8%), and embryo-to-smolt survival was 91.6%, within the range of recent brood years (1993-2016 BY range = 65.0-98.3%; Table 1). Imnaha stock egg-to-embryo survival for the 2017 BY was 91.1%, within the range of recent brood years (1993-2016 BY range = 76.7-92.9%), and embryo-to-smolt survival was 80.1%, within the range of recent brood years (1993-2016 BY range = 61.0-98.5%; Table 1). We released 831,180 Wallowa stock smolts in 2018, exceeding our production goal of 800,000 smolts. For the Imnaha stock, we released 251,209 Imnaha stock smolts, exceeding our production goal of 215,000 smolts (Table 2). The Little Sheep Creek program release was at 117% of the release target and represented higher in-hatchery survival and fecundity values than was planned; in addition, culling of brood year 2016 steelhead for trout mitigation in Oregon waters was not implemented for the release. Discussions with NOAA-Fisheries, co-managers and the LSRCP program occurred pre-release. Hatchery managers attempt to meet production goals every year; however, variation in mortality at various stages of rearing, from fertilized eggs to acclimated smolts, results in fewer or more fish being released in any given year. Managers periodically adjust the number of eggs collected based on recent hatchery performance.

Beginning with BY 2013 releases, a programmatic decision was made to eliminate ventral fin clipping of steelhead for purposes of identifying the presence of coded-wire tags. Electronic scanning is now used to detect wire in hatchery fish harvested in fisheries and recovered at hatchery traps. However, one raceway of coded-wire tagged Wallowa production stock continue to be left ventral fin clipped (AdLV and CWT) to assess the effect that ventral clips have on smolt-to-adult survival, and Wallowa fall broodstock released at Wallowa Hatchery continue to be right ventral clipped so that returning adults may be visually identified at hatchery weirs and collected for broodstock. Hatchery fish continue to be adipose fin clipped. To evaluate different rearing and release strategies, we tagged and released five groups of Wallowa stock steelhead and one group of Imnaha stock steelhead smolts with adipose clips and coded-wire tags (Ad and CWT), one group of Wallowa stock with adipose-left ventral clips and coded-wire tags (AdLV and CWT), two groups of Wallowa fall broodstock with adipose clips and coded-wire tags (Ad and CWT), and two groups of Wallowa fall broodstock with

adipose-right ventral clips and coded-wire tags (AdRV and CWT; Table 3 and Table 4). For fin clip quality, we marked 99.2% and 97.1% of Wallowa and Imnaha stock smolts with an adipose fin clip, which was within the range of recent brood years for Wallowa stock (1993-2016 BY range = 95.6-99.9%) and the Imnaha stock (1993-2016 BY range = 96.1-100.0%). In addition, 94.7% of Wallowa stock fall broodstock smolts received a right-ventral (RV) fin clip, which was within the range of brood years (2004-2016 BY range = 93.3%-100.0%). Tag retention for release groups averaged 99.5% for Wallowa stock, which was higher than the range of recent years (1993-2016 BY range = 89.1-99.3%) and 99.4% for Imnaha stock, also within the range of recent years (1993-2016 BY range = 84.7-100.0%). Details of releases for the 2017 BY are shown in Figure 1 and the number of fish implanted with passive integrated transponder (PIT) tags are shown in Table 3.

Densities of resident hatchery steelhead averaged 7.6fish/100m^2 at index sites in the Grande Ronde basin in 2018 (Table 5), whereas wild *O. mykiss* averaged 14.9 fish/100m^2. In the Imnaha basin, densities of resident hatchery steelhead and wild *O. mykiss* were 6.2 and 6.4 fish/100m^2, respectively, contradicting historical patterns. We had observed a clear pattern of higher densities of resident hatchery steelhead than wild *O. mykiss* in the Imnaha basin index from the beginning of resident hatchery sampling in 1996 until 2017.

PIT tag monitoring of the month-long volitional smolt release from Little Sheep Creek acclimation pond was discontinued during spring 2017 due to stream flow modifications. The stream level at the facility was raised to provide fish passage upstream during summer low flows, which in turn flooded the outflow pipe from the acclimation pond. The outflow pipe previously supported two PIT-tag antennas used to monitor outmigration timing of juveniles leaving the acclimation pond. Therefore, no data were collected for this task, noted in the 2018 Work Statement (Objective 4, Subobjective 4.1, Task 4.1.2; Ruzycki et. al., 2018).

Adults

Returning PIT-tagged adults from the 2013 to 2015 broods were detected at main-stem dams during the 2017-18 run year. Of the 191 Wallowa stock adults detected at Bonneville Dam on the Columbia River, 149 were detected at Lower Granite Dam on the Snake River. For the Imnaha stock, 124 of the 164 adults detected at Bonneville Dam were detected at Lower Granite Dam (Table 6). Weirs were installed to capture adult steelhead on 29 January at Wallowa Fish Hatchery, 15 February at Big Canyon Facility, and 6 March at Little Sheep Creek Facility (Table 7). Returns to the Little Sheep Creek Facility were predominantly hatchery fish, with 37 (3.8%) natural steelhead. Similar to Little Sheep Creek, most of the adults that returned to the Big Canyon Facility were of hatchery origin, with only 35 (4.6%) natural steelhead. In addition, 24 (1.3%) natural steelhead returned to Wallowa Fish Hatchery. Ninety-one percent of hatchery adults that returned to Wallowa Fish Hatchery, Big Canyon Facility, and Little Sheep Creek Facility spent one year in the ocean (Table 8). Of the natural origin fish, 86% (32 of 37), 63% (22 of 35), and 75% (18 of 24) of the Little Sheep Creek Facility, Big Canyon Facility, and Wallowa Fish Hatchery, respectively, spent one year in saltwater before returning.

The majority of hatchery adults that returned to Wallowa Fish Hatchery in 2018 were spawned or killed (Table 8). In 2018, Big Canyon Facility hatchery returns were not needed for the Grande Ronde steelhead hatchery program due to the large number of adults returning to Wallowa Fish

Hatchery. We outplanted 222 adult hatchery steelhead from Wallowa Fish Hatchery and the Big Canyon Facility to local ponds for harvest opportunities. Fish captured at Big Canyon Facility are no longer returned to the Wallowa River for further angling opportunities due to low harvest success. At Big Canyon Facility, 35 natural adults were passed above the weir site to spawn in Deer Creek. In addition, an unknown number of hatchery and natural fish passed above the weir before it was installed on 15 February. Over the following two months, 141 hatchery adults were recovered as either fallbacks or retrievals from Deer Creek by hatchery personnel. Recovered hatchery adults are included in the Big Canyon Facility returns. Hatchery fish are not intentionally passed into Deer Creek. We usually conduct multiple spawning surveys for steelhead that are passed above Deer Creek weir using protocols described in Gee et al. (2008). In lieu of the normal multi-pass redd surveys and weir counts, we used total discharge at Perry gauge in the Upper Grande Ronde River (station #13318960) from March through May to calculate the fish:redd estimate for 2018. Since Deer Creek's fish:redd ratio in prior years was significantly correlated with total discharge from the Perry gauge, we deemed this regression an appropriate estimator of fish:redd when Deer Creek weir operates below 100% efficiency, as it did in 2018 (Horn et al. 2018; Table 9).

We retained 13.6% of the hatchery fish and 10.8% of the natural fish for spawning at Little Sheep Creek Facility. Natural fish comprised 3% of the broodstock. Adult outplants to Big Sheep Creek were discontinued in 2018 after mangers concluded that monitoring efforts of wild steelhead production in Big Sheep Creek was shown to be adequate and indicated that supplementation of smolts or adult outplants had no benefit. Thirty-three natural and 223 hatchery adults were released above the weir in Little Sheep Creek to spawn naturally. In addition, 3 natural males were spawned and then passed above the weir, resulting in 86.1% of fish above the weir being of hatchery origin. Of the 259 fish passed into Little Sheep Creek, 26 fell back and were recaptured at the weir (Table 10), then were passed above the weir again. Length-at-age data for Wallowa and Imnaha stock adults are presented in Figure 2.

In 2018, we exceeded our egg take goal of 1,155,000 green eggs for the Wallowa stock with 1,208,000 green eggs collected. Of these, 594,800 were for production and 613,200 were for the fall broodstock evaluation. We collected 349,300 green Imnaha stock eggs, thus we exceeded our goal of 317,000 eggs. Mortality from green egg-to-eyed embryo from seven (Wallowa stock) and six (Imnaha stock) weekly spawns ranged from 3.7-9.4% for Wallowa production stock, 3.7-15.9% for fall broodstock, and from 2.0-7.0% for Imnaha stock (Table 11).

Experimental Group Returns

The number of coded-wire tag (CWT) and adipose-clipped adults that were harvested or returned to collection sites is used to estimate various performance parameters. These numbers allow us to monitor our success toward meeting the LSRCP goals, to estimate stray rates, and to determine the contribution to recreational, tribal, and commercial fisheries. They also provide the basis for evaluating the success of experimental rearing and release strategies. Recoveries for each CWT code were summarized from the CWT recovery database maintained by PSMFC, ODFW's mark recovery database, and from data reported by the Washington Department of Fish. Our protocol was to collect and enumerate all fish marked with a CWT when they were spawned, dispatched, or died. A summary of these data is provided in this report. Final analyses, results, and discussion of production

and release strategies will be presented in special reports or conference presentations once all adults have returned from the experimental groups.

Since spawn year 2008, ODFW has collected genetic samples from all steelhead broodstock collected at Wallowa Hatchery (Wallowa stock) and Little Sheep Creek Facility (Imnaha stock). Samples were submitted to Eagle Fish Genetics Laboratory for inclusion in the Snake River Parentage-Based Tagging (PBT) genetic baseline. Beginning with one-ocean returns in return year 2016-17, CWT recoveries are incomplete and have been supplemented with harvest estimates based on PBT samples in certain areas, particularly in the Idaho portion of the Snake River and Idaho tributaries, to account for all recoveries. PBT-based estimates of harvest from the Idaho portion of the Snake River and its tributaries provide total harvest estimates by stock and by age without using CWT recoveries. This is especially important, as BY 2012 was the final brood year in which IDFG applied CWTs to steelhead for the purpose of harvest estimation (Warren et al. 2017), leaving little impetus for IDFG to put significant effort into sampling Idaho fisheries for CWTs beyond return year 2016-17. Therefore, this report we will employ both CWT and PBT methods of estimating adult recoveries, in order to evaluate our success toward meeting LSRCP goals.

Actual harvest recoveries (versus estimates) of genetically sampled hatchery adults assigned to Oregon Wallowa or Imnaha steelhead stocks by PBT can be found in Table 16. Adults were sampled by Washington Department of Fish and Wildlife (WDFW), Idaho Department of Fish and Game (IDFG), and ODFW from fishery areas in the Columbia and Snake rivers for the 2017-18 run year. Results of this sampling represent a comprehensive attempt to categorize stock composition of the steelhead harvest in the Lower Columbia sport fishery, and will aid in monitoring needs for the U.S. v Oregon Management Agreement (Byrne et al. 2018). Results also represent an evaluation of stock composition of the Columbia River tribal (Zone 6) fishery, and in-state Washington and Idaho recreational fisheries, using PBT.

For the Columbia River, out of 1,625 samples collected from select fisheries, 1,145 fish (70.5%) were assigned back to known hatchery stocks and of those, 92 (8.0%) were Oregon Wallowa stock adults and 37 (3.2%) were Imnaha stock adults. For the Snake River and selected tributaries in Idaho, out of 1,305 samples, 519 steelhead (39.8%) were assigned to stock of origin and of those, 47 (9.1%) assigned to Oregon Wallowa stock and 47 (9.1%) assigned to Imnaha stock. There were no Snake River, Washington samples submitted in 2018. Utilization of PBT sampling to provide parental assignments is discussed in Steele et al. (2018).

Adults from BY 2013 to 2015 returned during the 2017-18 run year, including the twelfth year of adult returns from the Wallowa fall broodstock experiment and the second year of adults returning from the Wallowa stock reciprocal experiment with WDFW's Lyons Ferry Hatchery. We had Wallowa stock recoveries from 20 CWT codes (Table 12) and Imnaha stock recoveries from two CWT codes (Table 13). Of approximately 250,000 total coded-wire-tagged fish released for both production and fall broodstock groups, a total of 412 Wallowa fall broodstock, 540 Wallowa production, and 71 Wallowa reciprocal study CWT's were recovered (Table 12). It is important to note that reciprocal study CWTs were only applied to steelhead smolts transferred from Oregon to Lyons Ferry Hatchery. No CWTs were applied to steelhead coming into Oregon from Lyons Ferry Hatchery.

We are still tabulating data from the second and third generations (brood years 2008-2011 and 2011-2015) of the fall brood experiment; however, preliminary results suggest that adult run timing was more similar between the fall broodstock and standard production lines during the second generation than they were in the first generation, as were smolt-to-adult survival, straying and harvest rates. Long-term management of the fall broodstock program includes continuing to spawn and tag fall broodstock and production lines separately to maintain comparisons of performance metrics, return timing, and straying. We will occasionally "refresh" the fall broodstock line with adults collected via angling in the fall Grande Ronde River fishery. We expect that refreshing the fall broodstock line will ameliorate the loss of run timing differences observed in the F1 generation, and diversify the genetic makeup of the broodstock (Clarke et al. 2012).

Compensation Area Goals

The LSRCP project area starts at Ice Harbor Dam extending to Lower Granite Dam and is inclusive of the Walla Walla Basin, a Columbia River Basin tributary in SE Washington adjacent to the Snake River (USFWS 2020). For the State of Oregon, measurement of the LSRCP program returns is upstream of the project area (upstream of Lower Granite Dam) and encompasses 11,184 of the 55,100 goal for steelhead. Goals for smolt-to-adult return (SAR) rates and the number of adults produced to the compensation area are 0.68% and 9,184 for the Grande Ronde basin (Wallowa stock) and 0.61% and 2,000 for the Imnaha basin (Imnaha stock). To provide a cumulative summary of disposition for all adults that returned to the compensation area, we expanded CWT recoveries to account for the non-CWT fish that returned. In addition, we included PBT-based estimates of adult recoveries from the Idaho portion of the Snake River and its tributaries because few CWT estimates were available.

In the 2017-18 run year, we estimate that 4,108 hatchery origin Wallowa stock adults returned to the compensation area, representing 44.7% of the compensation area goal (Table 14). In addition, we estimate that 1,301 Imnaha stock adults returned to the compensation area, representing 65.1% of the compensation area goal. Age composition of returning adults is shown in Table 15. Development of the compensation plan goals assumed that twice as many adult steelhead would be harvested in downriver fisheries as return to the compensation area (USACOE 1975); however, that harvest level was not reached for either stock (Table 14).

There are three principal factors that influence success in meeting the compensation goals: number of smolts released for the brood years that produced the adults; smolt-to-adult survival rates to the mouth of the Columbia River; and capture of fish below the compensation area in fisheries and as out-of-basin strays. Over the history of the LSRCP project, we have reached our adult production compensation goal thirteen times (1997-98, 2001-02, 2003-12, and 2014-16 run years) for the Wallowa program, and fifteen times for the Imnaha program (1992-93, 2001-12, and 2013-16 run years; Figure 3). For both the Grande Ronde and Imnaha programs, we have met our smolt production goals in most years. Returns in the 2017-18 run year represent the final returns of the 2013 BY. For the 2013 BY, smolt-to-adult survival for the Wallowa and Imnaha stocks were above average at 1.63% and 1.89%, respectively (Figure 4). Smolt-to-adult return to the compensation area above Lower Granite Dam has reached our goal in 14 of the last 29 brood years for Wallowa and 15 of the last 29 brood years for Imnaha stocks (Figure 5). This suggests that low smolt-to-adult rates may be the primary factor for only occasionally achieving our adult compensation goals. However,

the smolt-to-adult return compensation area goal has been reached in each of the last 15 years for Imnaha stock and in 13 of the last 15 years for Wallowa stock.

The Imnaha steelhead supplementation program allows us to evaluate and compare productivity (adult progeny produced per parent) of hatchery and naturally spawning fish. Hatchery and natural origin fish are used both for hatchery spawning and they are passed above the weir to spawn naturally; therefore, progeny-per-parent ratios include both hatchery and natural origin parents (Figure 6). Progeny-per-parent ratios for naturally spawning fish were below 1.0 for completed brood years 1987-1994, 1998, and 2001-2012 and above 1.0 for completed brood years 1995-1997, 1999, and 2000 (Figure 6). Progeny-per-parent ratios for fish spawned in the hatchery (weir returns only) have been above 1.0 for all brood years except 1991. Hatchery ratios exceeded natural ratios for all brood years except for the 1991 and 1997 broods. One purpose of the supplementation program is to enhance or stabilize natural fish abundance. Annual abundance of naturally-produced fish has steadily decreased over the past 9 years; however, the long-term pattern suggests a slight increasing trend in natural returns since the program began in 1985 (Figure 7).

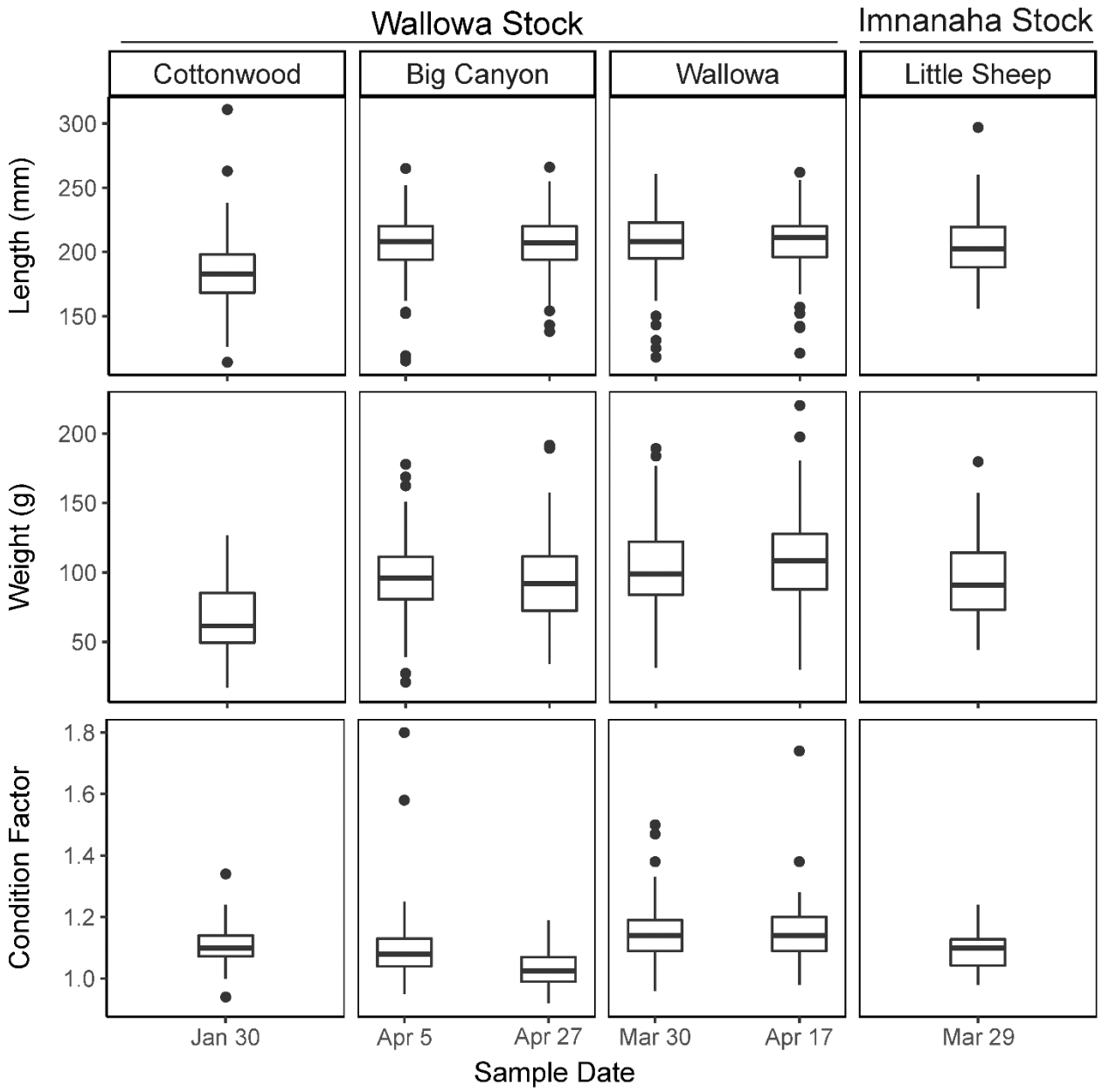

Figure 1. Length, weight, and condition factor of 2017 brood year hatchery steelhead by week of release at Big Canyon Facility, Cottonwood, Little Sheep, and Wallowa Hatchery. Each location was sampled within eight days of release with the exception of Cottonwood that was sampled prior to acclimation on 30 January.

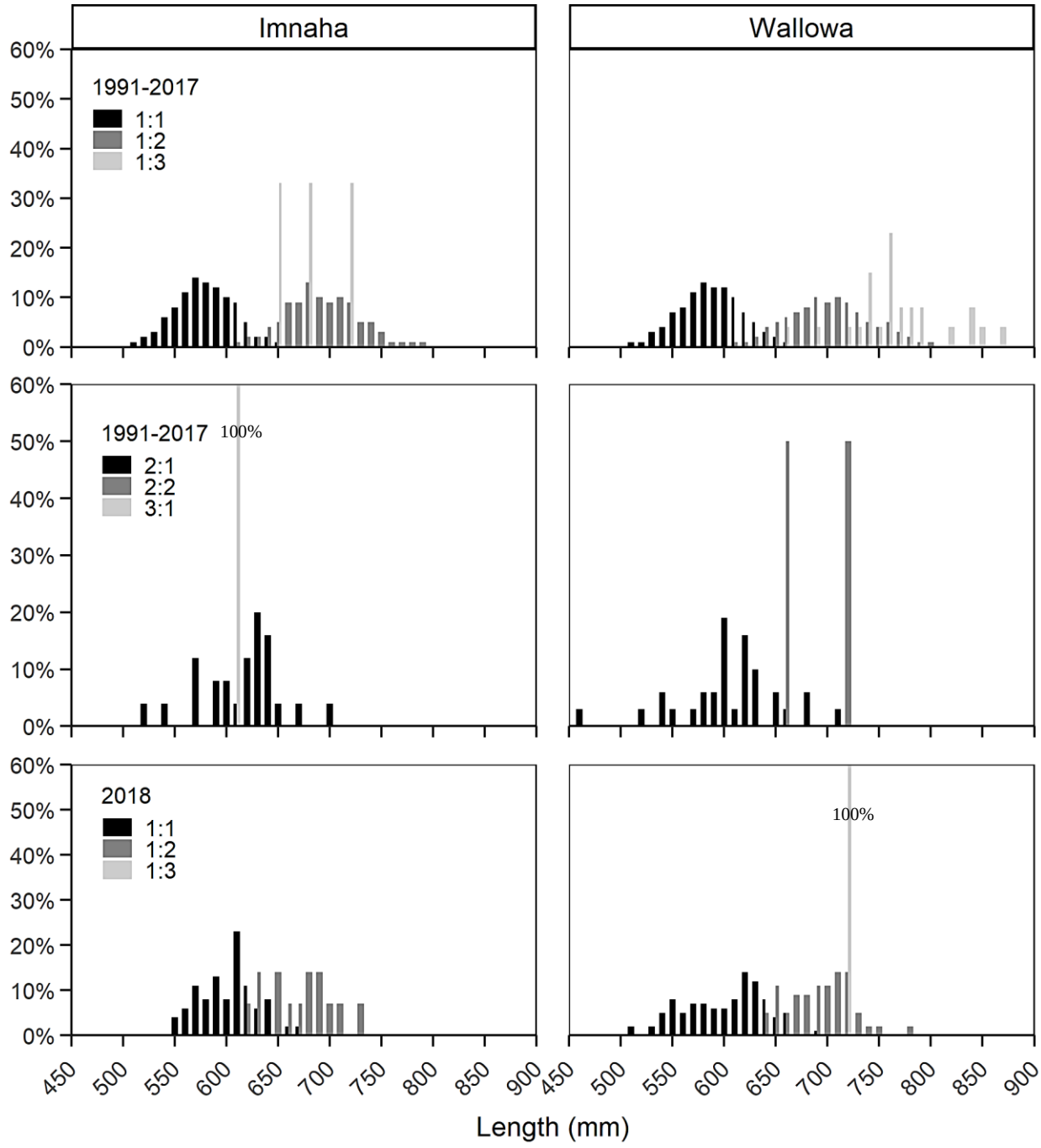

Figure 2. Length-at-age relationships based on scale analysis for hatchery adult returns of one freshwater age (top) and two freshwater age (middle) for Wallowa and Imnaha stock summer steelhead from 1991 to 2017, and in 2018 (bottom).

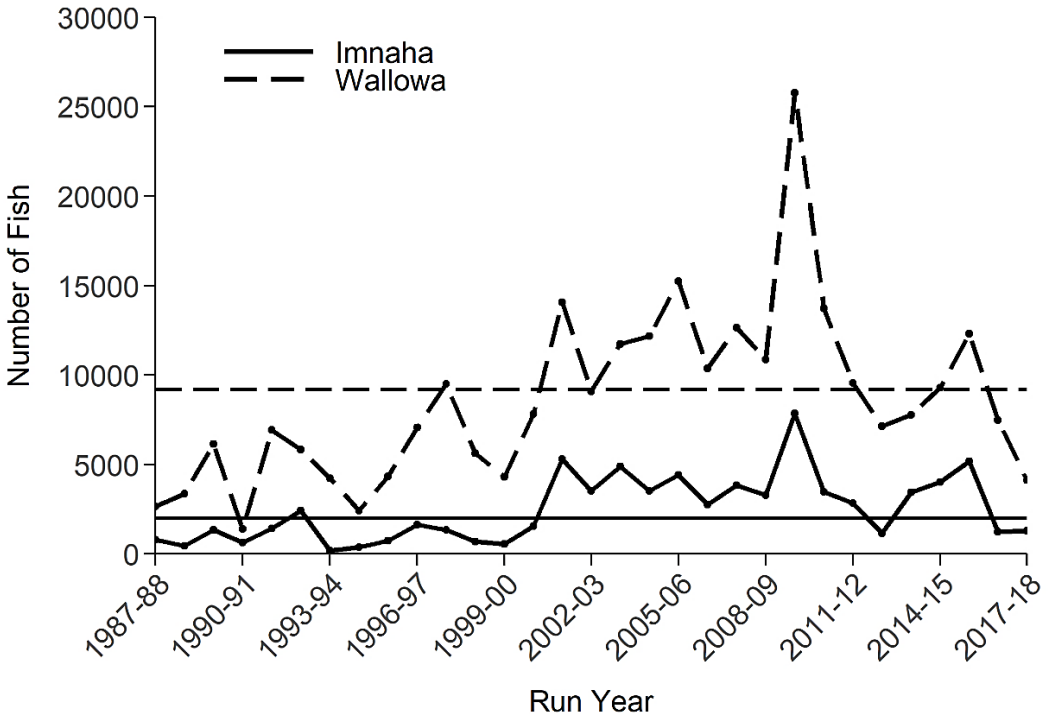

Figure 3. Estimated hatchery returns to the compensation area above Lower Granite Dam for Wallowa and Imnaha stock summer steelhead for the 1987-88 to 2017-18 run years. The compensation goal for Wallowa and Imnaha stocks are 9,184 adults and 2,000 adults, respectively (dashed and solid horizontal lines).

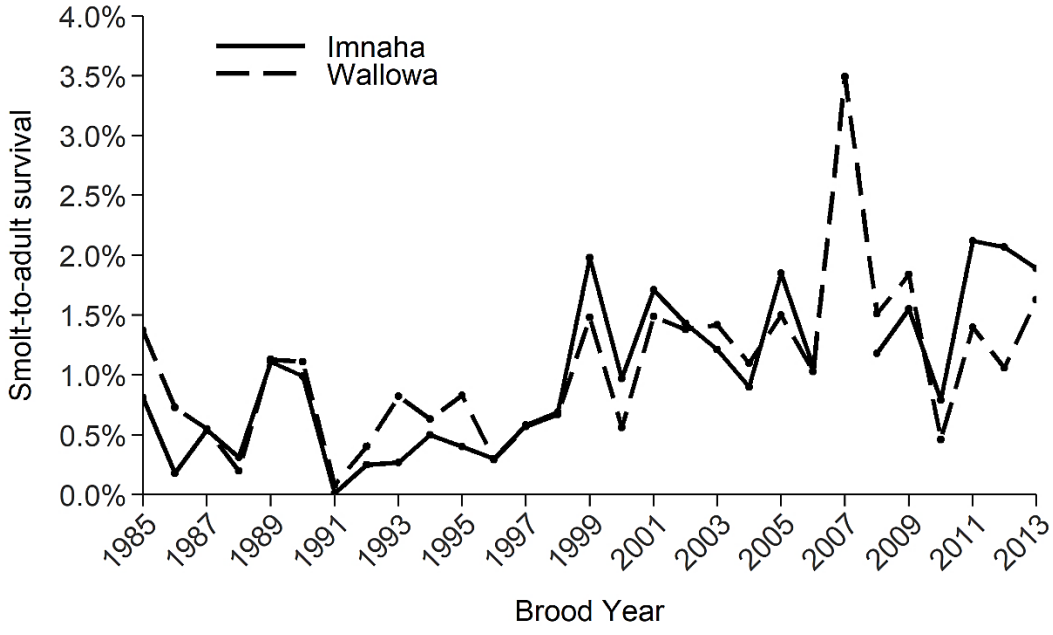

Figure 4. Smolt-to-adult survival (SAS) for Wallowa and Imnaha stock summer steelhead, 1985-2013 brood years. Data is based on CWT recoveries.

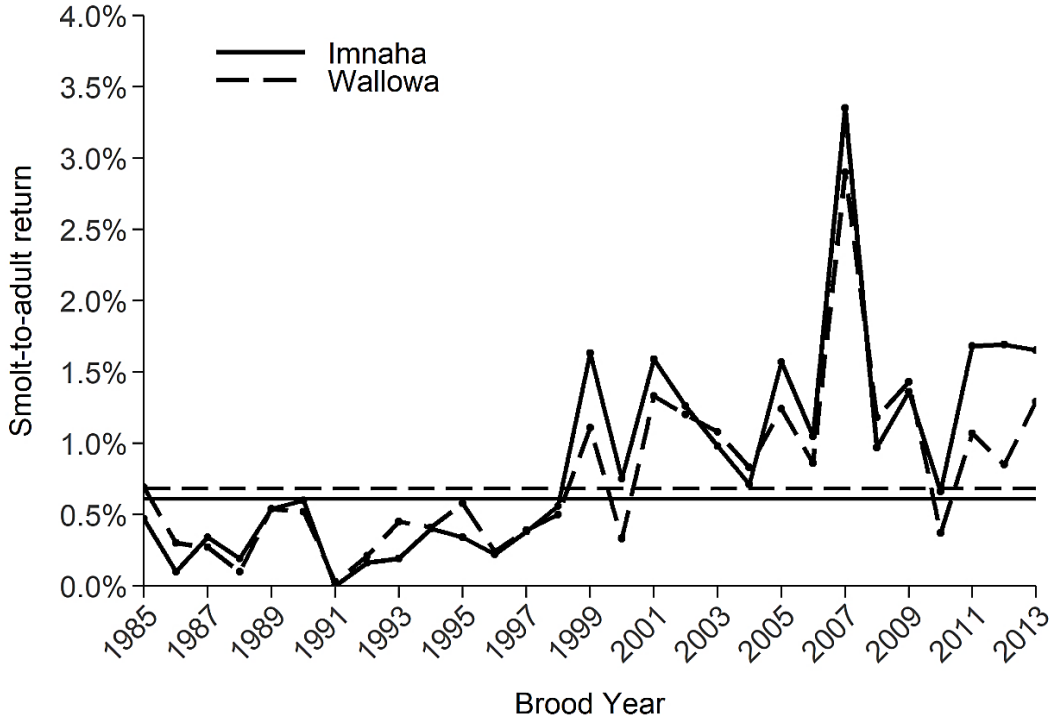

Figure 5. Smolt-to-adult return (SAR) to the compensation area above the Snake River mouth for Wallowa and Imnaha stock summer steelhead, 1985-2013 brood years. The Wallowa and Imnaha stock goals are 0.68% and 0.61% are indicated, respectively. Data is based on CWT recoveries.

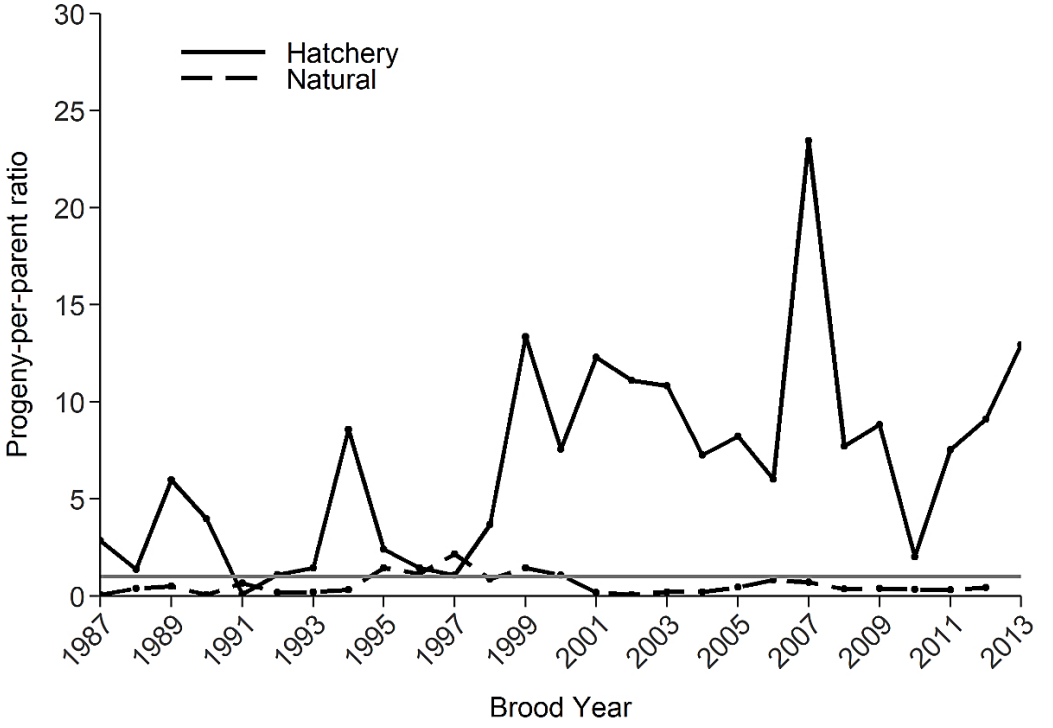

Figure 6. Progeny-per-parent ratios for Little Sheep Creek summer steelhead, 1987-2013 brood years. Natural origin returns are complete through the 2012 brood. Both types of spawning include hatchery and natural origin parents. Grey line represents replacement (P: P ratio = 1.0).

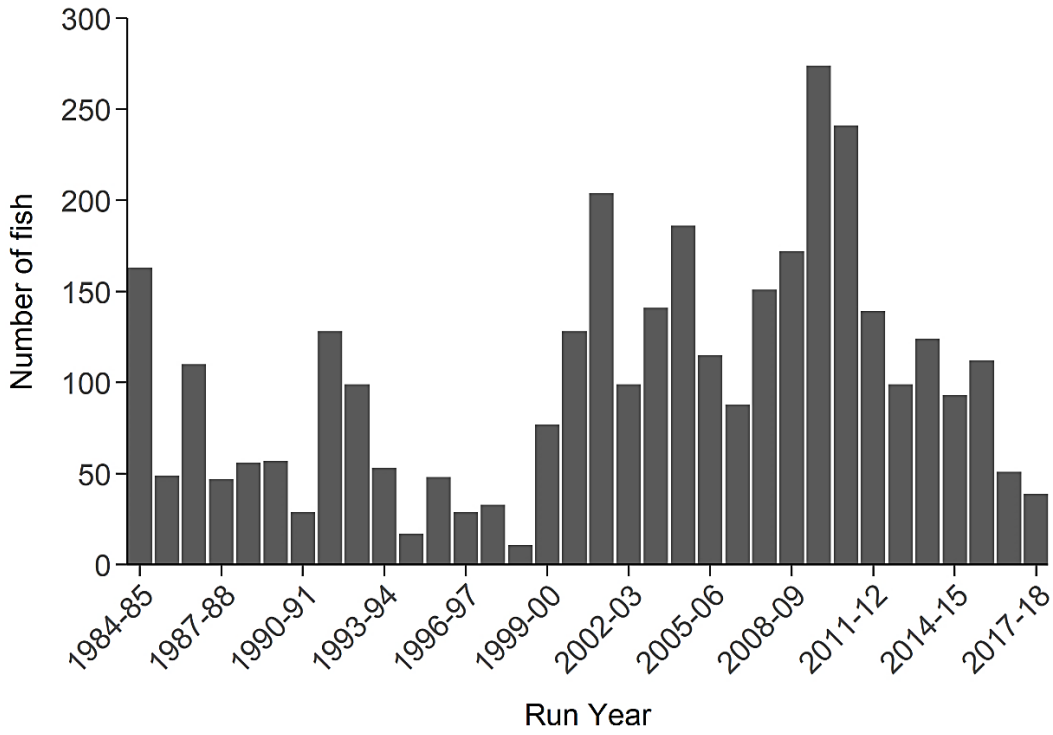

Figure 7. Returns of naturally-produced summer steelhead to Little Sheep Creek weir, run years 1984-85 to 2017-18.

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Table 1. Summary of egg collection and juvenile survival for 2017 brood year summer steelhead released in the Grande Ronde and Imnaha river basins at LSRCP facilities in 2018. This table does not include the 40,286 smolts reared at Lyons Ferry Hatchery in Washington and released into Spring Creek. However, this table does include 42,773 smolts reared in pond 14 at Irrigon Fish Hatchery and transferred to Cottonwood Acclimation Pond, Washington, for subsequent release into Cottonwood Creek.

Stock	Number of eggs taken	Eyed embryos	Total smolts released	Estimated survival rate	
				Egg-to-embryo	Embryo-to-smolt[a]
Wallowa	1,374,900	1,282,600[b]	920,040[c]	93.3	91.4
Imnaha	391,800	357,000[d]	251,209	91.1	80.1

[a] *Embryos that were culled from or not part of production were subtracted from the calculation of embryo-to-smolt survival.*
[b] *Includes 274,900 embryos that were euthanized because they were excess to program needs. Also includes 1,200 embryos that were transferred to the Salmon and Trout Enhancement Program (STEP) Coordinator.*
[c] *Includes a total of 88,860 fish released into Hells Canyon Reservoir as rainbow trout on Oct 12, 2017.*
[d] *Includes 43,200 embryos that were euthanized because they were excess to program needs.*

Table 2. Details of the 2017 brood year summer steelhead released in the Grande Ronde (Wallowa stock) and Imnaha (Imnaha stock) river basins in 2018. LGD indicates Lower Granite Dam; percent migration includes ± 95% confidence intervals and median travel time includes ± standard deviation. This table does not include 40,286 smolts reared at Lyons Ferry Hatchery in Washington and released into Spring Creek on 2-3 April.

Release date	Raceway	Tag code	CWT-marked smolts	Total smolt releases	PIT-tagged smolts	Survival rate to LGD[a]	Median travel time to LGD
			Wallowa Stock				
Wallowa							
Apr 1 - 3	7[b]	091102	26,685	42,117	1,986	79.9 ± 6.2	25 ± 13
Apr 1 - 3	9, 11, 12[b]	—	0	124,487	0	—	—
Apr 2 - 3	8	091104	24,878	41,513	2,088	80.3 ± 5.0	24 ± 14
Apr 2 - 3	10	091105	26,711	41,626	4,635	76.8 ± 4.1	26 ± 17
Apr 2 - 3	16	091106	26,960	43,120	1,689	89.0 ± 7.3	20 ± 14
Apr 18 - 30	19[b]	—	0	41,852	0	—	—
Apr 18 - 30	20	—	0	42,132	0	—	—
Apr 18 - 30	21[b]	091103	27,133	41,847	1,701	81.9 ± 8.9	20 ± 9
Apr 18 - 30	22	091107	26,681	41,925	0	—	—
Big Canyon							
Apr 5 - 13	13[b]	—	0	41,039	0	—	—
Apr 5 - 13	15[b]	091111	26,313	40,384	1,640	76.0 ± 7.0	33 ± 15
Apr 5 - 13	17	—	0	39,768	0	—	—
Apr 5 - 13	18	091109	25,208	41,333	1,654	81.4 ± 6.4	27 ± 15
May 5 - 11	23[b]	091110	26,269	41,861	1,698	79.2 ± 6.0	10 ± 7
May 5 - 11	24	—	0	41,926	1,688	86.8 ± 7.5	8 ± 7
May 5 - 11	25[b]	—	0	41,941	0	—	—
May 5 - 11	26	—	0	42,023	0	—	—
Total			236,838	790,894	18,779		
Cottonwood Creek, WA							
Apr 15 – 24[c]	14	091108	26,918	42,345	4,000	77.6 ± 12.6	15 ± 27
			Imnaha Stock				
Little Sheep							
Apr 1 - 30	28	091101	26,983	42,385	5,886	81.2 ± 3.4	39 ± 14
Apr 1 - 30	30	—	0	41,765	5,988	80.6 ± 3.1	38 ± 15
Apr 1 - 30	32	—	0	41,764	3,092	84.0 ± 4.3	37 ± 13
Apr 1 - 30	27, 29, 31	—	0	125,295	0	—	—
Total			26,983	251,209	14,966		

[a] *Survival estimates were calculated using the Cormack-Jolly-Seber method. This survival estimate does not take into consideration the survival of hatchery resident trout. Not shown in table is the number of PIT tags released and survival rate and median travel time to LGD for the Lyons Ferry release group (N = 3,973, 83.9 ± 4.0, 15 ± 27).*

[b] *Represents raceways included in the fall broodstock program.*

[c] *Actual number of PIT tags released at Cottonwood were likely fewer than 4,000 due to un-scanned mortalities in the acclimation pond*

Table 3. Estimates of coded-wire tag retention for 2017 brood year summer steelhead reared at Irrigon Fish Hatchery and released in 2018. Experimental group indicates treatment and rearing raceway number. Wallowa and Imnaha stocks were intended to be 100% adipose fin-clipped. Wire-tagged standard production (Prod.) groups were Ad+CWT except for pond 8, which remained AdLV+CWT.

Release site, experimental group	Raceway	Tag code	No. checked	Percent			
				CWT+ clip[a]	CWT+ noclip	NoCWT + clip	NoCWT +noclip
			Wallowa Stock				
Spring Creek							
Fall broodstock	07	091102	519	99.8	0.0	0.2	0.0
Production	08	091104	527	99.6	0.2	0.2	0.0
Production	10	091105	520	99.4	0.4	0.0	0.2
Early/Normal Haul Study, Prod.	16	091106	513	99.6	0.2	0.2	0.0
Fall broodstock	21	091103	534	99.4	0.4	0.2	0.0
Production	22	091107	518	99.2	0.6	0.0	0.2
Deer Creek							
Fall broodstock	15	091111	506	99.6	0.2	0.2	0.0
Production	18	091109	514	99.4	0.4	0.0	0.2
Fall broodstock	23	091110	533	99.2	0.2	0.2	0.4
Cottonwood Creek, WA							
Reciprocal Study, Production	14	091108	508	99.6	0.4	0.0	0.0
Average	—	—	519	99.5	0.3	0.1	0.1
			Imnaha Stock				
Little Sheep							
Production	28	091101	502	99.4	0.4	0.0	0.2
Overall Average	—	—	518	99.5	0.3	0.1	0.1

[a] *A programmatic decision to discontinue ventral fin clipping to indicate the presence of a CWT began with brood year 2013. Fish in pond 8 were left ventral fin clipped (CWT+AdLV) to determine the effect of ventral fin clips on post release survival. All other pond percentages are calculated based upon the presence of an adipose fin clip.*

Table 4. Estimates of adipose fin and right-ventral fin clip quality for 2017 brood year summer steelhead reared at Irrigon Fish Hatchery and released in 2018. Release period indicates first (April) and second (late April or May) releases from the upper (UAP) and lower (LAP) acclimation ponds at Wallowa Hatchery and Big Canyon Facility. Little Sheep Creek Facility only has one acclimation and release. Right-ventral fin clip quality checks were completed prior to acclimation.

Acclimation pond or raceway, release	No. checked	Percent[a]	
		Adequate Clip	Inadequate Clip
Wallowa Stock – Adipose fin clip[b]			
Wallowa UAP, April	305	99.3	0.7
Wallowa LAP, April	303	99.3	0.7
Wallowa LAP, late April	303	99.3	0.7
Big Canyon UAP, April	317	99.7	0.3
Big Canyon LAP, April	287	98.6	1.4
Big Canyon UAP, May	310	98.4	1.6
Big Canyon LAP, May	305	99.7	0.3
Average	304	99.2	0.8
Imnaha Stock – Adipose fin clip[b]			
Little Sheep	313	97.1	2.9
Overall Average	305	98.9	1.1
Wallowa Stock – Right-ventral fin clip[c]			
Irrigon raceway 7	519	94.2	5.8
Irrigon raceway 9	508	96.1	3.9
Irrigon raceway 11	515	97.9	2.1
Irrigon raceway 12	531	95.3	4.7
Irrigon raceway 19	532	92.9	7.1
Irrigon raceway 21	512	92.2	7.8
Average	520	94.7	5.3

[a] *An inadequate fin clip is considered to be more than one-third of the fin left intact.*
[b] *Adipose fin clip quality checks were completed during pre-release sampling after the fish had been moved to acclimation ponds.*
[c] *Right ventral fin clip quality checks were completed by raceway at Irrigon Hatchery before transfer to acclimation.*

Table 5. Density (±95% confidence interval) and mean fork length (standard deviation in parentheses) of resident hatchery steelhead, wild rainbow trout/juvenile steelhead, and juvenile Chinook salmon from index sites on Deer (Grande Ronde basin) and Little Sheep (Imnaha basin) creeks in 2018. Hatchery steelhead were classified as residents after 20 June. HSTS indicates resident hatchery steelhead, WSTS indicates wild rainbow trout/juvenile steelhead for ages one and older, and WChS indicates juvenile (age 0+) spring Chinook salmon. "na" indicates no density estimate available.

Location[a]	Date	Species	Area (m^2)	Size of fish (mm)			Density[b] (fish/100m^2)
				N	Fork length	Range	
Grande Ronde basin							
Deer Cr.	24 July	HSTS	377.2	24	167.0 (26.4)	114 – 220	7.6 ± 2.7
Deer Cr.	24 July	WSTS	129.3	19	98.0 (17.0)	69 – 132	14.9 ± 1.1
Deer Cr.	24 July	WChS	377.2	33	85.7 (7.4)	68 – 98	na
Imnaha basin							
Little Sheep Cr.	26 July	HSTS	291.1	16	161.3 (33.4)	106 – 240	6.2 ± 0.9
Little Sheep Cr.	26 July	WSTS	291.1	18	113.3 (18.5)	63 – 150	6.4 ± 0.6

[a] *Index sites located on Deer Creek (Rkm 0.1) at Big Canyon Facility and on Little Sheep Creek (Rkm 8.0) at Little Sheep Creek Facility. Two adjacent sites were sampled at each location and each site typically included both riffle and pool habitat.*

[b] *Density (±95% confidence interval) was determined using a multiple pass removal method (Zippen 1958) with a backpack electrofisher (Smith-Root Model 12) and block seines.*

Table 6. Number of PIT tags released and unique adult PIT tag detections at Bonneville and Lower Granite dams during the 2017-18 run year by stock and brood year.

Brood year	PIT tags released	Age at return	Adult detections	
			Bonneville Dam	Lower Granite Dam
Wallowa Stock				
2013	19,544	5	0	0
2014	26,619	4	23	18
2015	23,937	3	168	131
Total	70,100		191	149
Imnaha Stock				
2013	21,875	5	0	0
2014	14,897	4	13	11
2015	14,878	3	151	113
Total	51,650		164	124

Table 7. Timing of adult steelhead returns to LSRCP facilities in 2018 by location and origin.

Period	Week of the year	Number of fish trapped[a]					
		Wallowa		Big Canyon		Little Sheep	
		Hatchery	Natural	Hatchery	Natural	Hatchery	Natural
Jan 22-28	4	-	-	-	-	-	-
Jan 29-Feb 04	5	78	0	-	-	-	-
Feb 05-11	6	132	0	-	-	-	-
Feb 12-18	7	164	0	81	0	-	-
Feb 19-25[b]	8	0	0	3	0	-	-
Feb 26-Mar 04	9	50	0	3	0	-	-
Mar 05-11	10	117	0	3	0	0	0
Mar 12-18	11	273	1	121	0	8	0
Mar 19-25	12	239	2	117	5	47	2
Mar 26-Ap 01	13	273	7	119	4	92	4
Apr 02-Apr 08	14	236	5	81	4	76	2
Apr 09-15	15	153	6	94	10	251	7
Apr 16-22	16	114	2	66	5	256	12
Apr 23-29	17	25	0	34	4	112	2
Apr 30-May 06	18	17	1	5	1	54	2
May 07-13	19	4	0	5	2	39	6
May 14-20	20	2	0	1	0	11	0
May 21-27	21	0	0	0	0	0	0
May 28-June 03	22	-	-	0	0	0	0
Jun 04-10	23	-	-	-	-	-	-
Total		1,877	24	733	35	946	37

[a] *The ladder was opened on 29 January at Wallowa Fish Hatchery, and weirs were installed 15 February at Big Canyon Facility (Deer Creek) and 6 March at Little Sheep Creek Facility. Adult collections ended 24 May at Wallowa Fish Hatchery and 29 May at both Big Canyon Facility and Little Sheep Creek Facility.*

[b] *The Wallowa trap was not operational at this time due to heavy ice. There was an estimated 40 steelhead in the trap during this period.*

Table 8. Number, disposition, and mean fork length (mm) of adult steelhead that returned to LSRCP facilities in 2018 by stock, origin, estimated age (freshwater:saltwater), and gender. M indicates male and F indicates female.

Facility, stock, disposition	Hatchery[a]									Natural[b]											Grand total
	1:1		1:2		2:1		1:3			2:1		2:2		3:1		3:2		3:3			
	M	F	M	F	M	F	M	F	Total	M	F	M	F	M	F	M	F	M	F	Total	
Wallowa Hatchery (Wallowa Stock-Production)																					
Trapped	623	406	34	77	0	0	0	3	1,143	2	7	1	2	3	6	1	2	0	0	24	1,167
Passed	0	0	0	0	0	0	0	0	0	2	7	1	2	3	6	1	2	0	0	24	24
Outplanted	51	23	2	5	0	0	0	0	81	0	0	0	0	0	0	0	0	0	0	0	81
Kept	572	383	32	72	0	0	0	3	1,062	0	0	0	0	0	0	0	0	0	0	0	1,062
Mortality	4	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	4
Spawned	104	89	14	28	0	0	0	0	235	0	0	0	0	0	0	0	0	0	0	0	235
Killed[c]	464	294	18	44	0	0	0	3	823	0	0	0	0	0	0	0	0	0	0	0	823
Wallowa Hatchery (Wallowa Stock-Fall Broodstock)																					
Trapped	423	264	16	29	0	1	0	1	734	0	0	0	0	0	0	0	0	0	0	0	734
Passed	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Outplanted	64	4	3	0	0	0	0	0	71	0	0	0	0	0	0	0	0	0	0	0	71
Kept	359	260	13	29	0	1	0	1	663	0	0	0	0	0	0	0	0	0	0	0	663
Mortality	3	2	1	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	6
Spawned	125	112	3	16	0	0	0	1	257	0	0	0	0	0	0	0	0	0	0	0	257
Killed[c]	231	146	9	13	0	1	0	0	400	0	0	0	0	0	0	0	0	0	0	0	400
Wallowa Hatchery (Total Returns)																					
Trapped	1,046	670	50	106	0	1	0	4	1,877	2	7	1	2	3	6	1	2	0	0	24	1,901
Fork length (mm)	604	582	703	681	-	-	-	715		-	-	-	-	-	-	-	-	-	-		
Standard deviation	39	33	35	25	-	-	-	-		-	-	-	-	-	-	-	-	-	-		
Sample size	72	50	15	29	-	-	-	1		-	-	-	-	-	-	-	-	-	-		

Table 8. Continued.

Facility, stock, Disposition	Hatchery[a] 1:1 M	1:1 F	1:2 M	1:2 F	2:1 M	2:1 F	1:3 M	1:3 F	Total	Natural[b] 2:1 M	2:1 F	2:2 M	2:2 F	3:1 M	3:1 F	3:2 M	3:2 F	3:3 M	3:3 F	Total	Grand Total
Big Canyon Facility (Wallowa stock)																					
Trapped[d]	336	325	19	50	0	0	0	3	733	7	4	4	5	8	3	1	3	0	0	35	768
Passed[d]	0	0	0	0	0	0	0	0	0	7	4	4	5	8	3	1	3	0	0	35	35
Outplanted	28	33	2	6	0	0	0	1	70	0	0	0	0	0	0	0	0	0	0	0	70
Kept	308	292	17	44	0	0	0	2	663	0	0	0	0	0	0	0	0	0	0	0	663
Mortality	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Spawned	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Killed[c]	308	292	17	44	0	0	0	2	663	0	0	0	0	0	0	0	0	0	0	0	663
Fork length (mm)	-	-	-	-	-	-	-	-		574	620	609	-	-	-	732	-	-	-		
Standard deviation	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-	-	-		
Sample size	-	-	-	-	-	-	-	-		1	1	1	-	-	-	1	-	-	-		
Little Sheep Creek Facility (Imnaha stock)																					
Trapped	385	473	23	65	0	0	0	0	946	14	13	3	1	1	4	0	0	0	1	37	983
Passed	99	101	5	18	0	0	0	0	223	12	13	2	1	1	4	0	0	0	0	33	256
Outplanted	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Kept	286	372	18	47	0	0	0	0	723	2	0	1	0	0	0	0	0	0	1	4	727
Mortality	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Spawned[e]	63	44	1	21	0	0	0	0	129	2	0	1	0	0	0	0	0	0	1	4	133
Killed[c]	223	328	17	26	0	0	0	0	594	0	0	0	0	0	0	0	0	0	0	0	594
Fork length (mm)	603	588	681	666	-	-	-	-		564	537	-	575	601	597	-	-	-	709		
Standard deviation	27	25	-	33	-	-	-	-		44	21	-	-	-	39	-	-	-	-		
Sample size	31	22	1	13	-	-	-	-		9	8	-	1	1	3	-	-	-	1		

[a] *Wallowa and Imnaha stock ages apportioned using CWT data and 167 (Wallowa stock) and 67 (Imnaha stock) scale samples collected in 2018. For Imnaha stock, additional CWT data and 50 scale samples from 2017 were also included to increase sample size. Mean fork lengths were derived from fish with scale samples collected in 2018.*

[b] *Ages of natural steelhead from the Wallowa basin were apportioned using historical data (251 samples) and 2018 data (4 samples); Little Sheep Creek Facility natural steelhead ages apportioned using 2017 data (31 samples) and 2018 data (23 samples). Mean fork lengths are from fish with scale samples collected in 2018.*

[c] *For Wallowa stock steelhead, 760 fish (494 from Wallowa Hatchery and 266 from Big Canyon Facility) were euthanized and donated to local food banks, 90 fish (71 from Wallowa and 19 from Big Canyon) were euthanized and used for educational purposes. An additional 782 fish were used for stream enrichment (494 from Wallowa and 288 from Big Canyon. For Imnaha stock steelhead, 398 fish from Little Sheep Creek Facility were euthanized and donated to local food banks, and 313 fish were used for stream enrichment, including 130 fish that had been spawned prior to use for enrichment.*

[d] *An unknown number of hatchery and wild fish passed above the Deer Creek weir without being trapped in early February2018, although many (N=141 hatchery fish) were netted between the weir and the intake ladder (that was blocked to upstream passage beginning February 15, 2018) and were included in the Big Canyon trapped count.*

[e] *Includes 3 natural males that were live-spawned and passed above the weir.*

Table 9. Summary of summer steelhead spawning surveys in Deer Creek above the Big Canyon Facility weir, 2002-2018. Note that data for 2005 has been updated to reflect an adjusted number of fish passed above the weir. The abbreviation "na" indicates incomplete counts.

	Passed			Redds	Fish per	Females	% Redds	Redds
Year	Females	Males	Total	counted	redd	per redd	counted[a]	per mile[b]
2002	120	89	209	84	2.49	1.43	70	8.4
2003	92	48	140	64	2.19	1.44	70	6.4
2004	47	20	67	46	1.46	1.02	98	4.6
2005	42	35	76	35	2.20	1.20	83	3.5
2006[c]	55	41	96	58	1.66	0.95	105	5.8
2007	27	21	48	41	1.17	0.66	152	4.1
2008	23	38	61	15	4.07	1.53	65	1.5
2009	42	38	80	21	3.81	2.00	50	2.1
2010	85	49	134	84	1.60	1.01	99	8.4
2011	75	58	133	28	4.75	2.68	37	2.8
2012	34	34	69	22	3.09	1.54	65	2.2
2013	41	22	63	33	1.91	1.24	80	3.3
2014[d]	18	30	48	18	2.67	1.00	100	1.8
2015[e]	34	32	66	49	1.35	0.69	144	4.9
2016	53	29	82	63	1.30	0.84	119	6.3
2017[f]	22	14	36	na	3.51[g]	na	na	na
2018[h]	15	20	35	na	1.96[g]	na	na	na

[a] *Calculated as number of redds counted ÷ number of females passed x 100. Assumes each female built one redd.*

[b] *Twelve miles of stream were surveyed in 2002, 2003, 2007-2010, and in 2012-2015. Ten miles of stream were surveyed in 2004-06 and in 2011. Redds per mile are based on the lower ten miles, since redds have not been observed between RM 10-12.*

[c] *Includes an estimated seven additional hatchery steelhead (4 females and 3 males) that escaped above the weir prior to weir installation, based on marked and unmarked fallbacks at weir.*

[d] *Includes an estimated 3 additional hatchery steelhead (1 female and 2 males) that escaped above the weir prior to weir installation. However, the total passed column does not include 3 steelhead passed above the weir after May 16, 2014 because stream surveys were discontinued prior to that date.*

[e] *Estimate includes 9 additional steelhead (5 males, 4 females) that escaped above the weir prior to installation in February, based on marked and unmarked fallbacks recovered at the weir.*

[f] *Deer Creek weir was installed on 17 February, 2017. On March 16, extremely high water necessitated removal of some weir panels. Also on March 16, panels were placed at the intake (~100 meters upstream of the weir) to prevent fish that escaped into Deer Creek from migrating further upstream. Weir panels were reinstalled on March 23. During the six-day breach of the weir an unknown number of hatchery and wild steelhead passed above the weir and likely spawned in Deer Creek.*

[g] *In lieu of the normal multi-pass redd surveys and weir counts, we used total discharge at Perry gauge in the Upper Grande Ronde River (station #13318960) from March through May to calculate the fish:redd estimate for 2017 and 2018. Since Deer Creek's fish:redd ratio in prior years was significantly correlated with total discharge from the Perry gauge, we deemed this regression an appropriate estimator of fish:redd when Deer Creek weir operates below 100% efficiency, as it did in 2017 and 2018.*

[h] *Deer Creek weir was installed on 5 February, 2018. Trapping at Big Canyon began 15 February and an unknown number of hatchery and wild steelhead passed above the weir prior to weir installation. Over the next two months hatchery personnel periodically netted fish out of Deer Creek just above the weir and collected fallbacks on the weir. These hatchery fish (N = 141) were included in the Big Canyon trap returns.*

Table 10. Number of adult summer steelhead trapped at the Little Sheep Creek Facility weir that were either outplanted to Big Sheep Creek or passed above the weir, and were subsequently recaptured, 1999-2018. Adult outplants to Big Sheep Creek were discontinued beginning in 2018. The abbreviation "na" indicates no steelhead were outplanted.

	Big Sheep Creek			Little Sheep Creek		
	Number of fish		%	Number of fish		%
Year	Outplanted	Recaptured[a]	Recaptured[b]	Passed[c]	Recaptured[a]	Recaptured[b]
1999	42	6	14.3	80	1	1.3
2000	138	17	12.3	200	9	4.5
2001	354	48	13.6	784	89	11.4
2002	2,030	907	44.7	1,198	269	22.5
2003	1,403	439	31.3	387	36	9.3
2004	1,719	244	14.2	823	138	16.8
2005	1,555	109	7.0	461	37	8.0
2006	1,934	703	36.3	356	53	14.9
2007	1,315	168	12.8	241	14	5.8
2008	1,365	382	28.0	291	23	7.9
2009	869	394	45.3	281	15	5.3
2010	1,450	166	11.4	346	6	1.7
2011	401	154	38.4	306	2	0.7
2012	350	175	50.0	241	13	5.4
2013	58	5	8.6	245	20	8.2
2014	232	29	12.5	270	1	0.4
2015	362	10	2.8	147	1	0.7
2016	515	21	4.1	260	1	0.4
2017	106	16	15.1	217	11	5.1
2018	na	na	na	259	26	10.0
Mean	-	-	21.2	-	-	7.0

[a] *Total number of recaptures, including multiple recaptures. For 1999-2002, recaptures were opercle punched at the weir and second and third time recaptures recorded.*

[b] *Total recaptured divided by total outplanted.*

[c] *Includes natural males that were live-spawned and passed above the weir.*

Table 11. Spawning summaries for summer steelhead at LSRCP facilities in 2018. The percent mortality is from green egg to eyed embryo after shocking.

Spawn date, lot number	Parental origin[a]	Number of females spawned[b]	Number of eggs[e]	Eyed embryos[c]	% mortality
		Wallowa Hatchery (Wallowa stock)			
2/28/, WA550	Production	0	0	0	—
	Fall Broodstock	28	132,300	111,300	15.9
3/7, WA551	Production	4	22,300	20,300	9.0
	Fall Broodstock	35	165,000	147,100	10.8
3/14, WA552	Production	25	119,500	109,500	8.4
	Fall Broodstock	29	138,700	130,300	6.1
3/21, WA553	Production	23	112,700	105,500	6.4
	Fall Broodstock	26	124,100	119,500	3.7
3/28, WA554	Production	24	126,400	118,700	6.1
	Fall Broodstock	10	53,100	51,000	4.0
4/4, WA555	Production	20	92,900	89,500	3.7
	Fall Broodstock	0	0	0	—
4/11, WA556	Production	22	121,000	109,600	9.4
	Fall Broodstock	0	0	0	—
Subtotal	Production	118	594,800	553,100	7.0
	Fall Broodstock	128	613,200	559,200	8.8
Total		246	1,208,000	1,112,300	7.9
		Little Sheep Creek Facility (Imnaha stock)[d]			
3/27, LI650	Hatchery	7	37,100	34,800	6.2
	Mixed				
4/3, LI651	Hatchery	12	62,000	59,100	4.7
	Mixed				
4/10, LI652	Hatchery	18	88,117	86,800	7.0
	Mixed		5,183		
4/17, LI653	Hatchery	11	43,782	58,200	3.3
	Mixed		16,418		
4/24, LI654	Hatchery	13	71,300	69,800	2.1
	Mixed				
5/1, LI655	Hatchery	5	25,400	24,900	2.0
	Mixed				
Subtotal	Hatchery	66	327,699	333,600	4.5
	Mixed		21,601	0	
Total		66	349,300	333,600	4.5

[a] *In general, family groups were one male x one female for Wallowa stock and were matrix spawned (three males x three females) for Imnaha stock.*

[b] *Number of males spawned equals the number of females spawned in most cases. Imnaha stock numbers of males and females spawned may differ due to the use of matrix spawning.*

[c] *Includes 1,200 Wallowa production stock eyed embryos that were transferred to the Salmon and Trout Enhancement Program (STEP). Also includes 51,900 eyed embryos from Wallowa Production, 59,200 eyed embryos from Wallowa Fall Broodstock, and 51,600 eyed embryos from Little Sheep (Imnaha stock) that were euthanized because they were excess to program needs.*

[d] *Hatchery and Mixed refer to ancestry of viable eggs. "Mixed" eggs include both natural and hatchery parents. Number of females spawned is listed on "Hatchery" row, regardless of origin.*

[e] *The number of hatchery and mixed eggs for the Imnaha stock is an estimate calculated by taking the number of wild spawners divided by the total number of female spawners for the specified lot.*

Table 12. Summary of anadromous adult recoveries of coded-wire tagged (CWT) Wallowa stock summer steelhead for the 2017-18 run year. All CWT fish were of hatchery origin and were released into Deer Creek (at Big Canyon Facility), Spring Creek (at Wallowa Hatchery), or Cottonwood Creek, WA (at the Cottonwood Acclimation Pond) for the reciprocal study with WDFW's Lyons Ferry Hatchery. Beginning with the 2016-17 run year, CWT sampling in many Idaho fisheries was reduced; thus, harvest estimates for Wallowa stock steelhead were based on parentage-based tagging (PBT) samples and Idaho harvest card returns (Alex LeCheminant, personal communication). Data were summarized as available through July 2020.

Brood year, release site	Experimental group[a]	CWT code	Recoveries at weirs[b]	Other in-basin recoveries[c]	Out-of-basin recoveries[d]	Total recoveries
2013						
Spring Cr.	Production, April	090772	1	0	0	1
	Production, late April	090776	1	0	0	1
2014						
Deer Cr.	Fall broodstock, April	090813	4	0	6	10
	Production, April	090814	7	0	0	7
	Fall broodstock, May	090815	1	0	5	6
Spring Cr.	Fall broodstock, April	090806	8	6	13	27
	Fall broodstock, late April	090807	1	0	1	2
	Production, April	090808	4	0	5	9
	Production, April	090809	8	0	4	12
	Production, April	090810	13	0	0	13
	Production, late April	090811	4	0	0	4
2015						
Deer Cr.	Production, April	090971	60	0	16	76
	Fall broodstock, April	090972	73	20	45	138
	Fall broodstock, May	090973	24	0	16	40
Spring Cr.	Fall broodstock, late April	090964	52	6	26	84
	Fall broodstock, April	090965	78	14	13	105
	Production, April	090966	74	2	34	110
	Production, April	090967	93	4	12	109
	Production, late April	090968	59	2	12	73
	Production, April	090969	90	8	27	125
	Total recoveries		655	62	235	952
2014 Cottonwood Cr., WA	Reciprocal, April	090812	4	0	0	4
2015 Cottonwood Cr., WA	Reciprocal, April	090970	36	4	27	67
	Total recoveries		40	4	27	71

[a] *Experimental groups include the release strategy. All releases were targeted for four fish per pound (113 g/fish).) and acclimated. April releases were forced while late April and May releases were volitional unless otherwise noted.*

[b] *Actual number of CWT fish that were released into Spring Creek and recovered at the Wallowa Hatchery weir or released into Deer Creek and recovered at the Big Canyon Facility weir.*

[c] *Estimated number (from creel surveys and harvest card returns) of CWT fish that were harvested in the Grande Ronde River basin fisheries, and in-basin stray recoveries.*

[d] *Estimated number (from PSMFC and ODFW databases) of CWT fish that were recovered in the ocean, mainstem Columbia, Deschutes or Snake river fisheries, or in tributaries outside the Grande Ronde River basin. Unexpanded data were used when CWT expansion factors were 25 or greater due to low sampling rates. Snake River recoveries from Idaho (N = 35) were not included here because harvest estimates were based on PBT samples rather than CWT recoveries.*

Table 13. Summary of anadromous adult recoveries of coded-wire tagged (CWT) Imnaha stock summer steelhead for the 2017-2018 run year. All CWT fish were of hatchery origin and were released into Little Sheep Creek at the Little Sheep Creek Facility. Beginning with the 2016-17 run year, CWT sampling in many Idaho fisheries was reduced; thus, harvest estimates for Imnaha stock steelhead were based on parentage-based tagging (PBT) samples and Idaho harvest card returns (Alex LeCheminant, personal communication). Data were summarized as available through July 2020.

Brood year, release site	Experimental group[a]	CWT code	Recoveries at weirs[b]	Other in-basin recoveries[c]	Out-of-basin recoveries[d]	Total recoveries
2014						
Little Sheep	Production, April	090805	3	0	0	3
2015						
Little Sheep	Production, April	090963	74	0	37	111
	Total recoveries		77	0	37	114

[a] *Experimental groups include the release strategy. All Little Sheep fish were acclimated and volitionally released over a four-week period.*

[b] *Estimated number of CWT fish recovered at the Little Sheep Creek Facility weir based on actual number recovered at the weir and estimated number either passed above the weir to Little Sheep Creek or outplanted to Big Sheep Creek to spawn naturally.*

[c] *Estimated number (from creel surveys and harvest card returns) of CWT fish that were harvested in the Imnaha River basin fishery.*

[d] *Estimated number (from PSMFC and ODFW databases) of CWT fish that were recovered in the ocean, mainstem Columbia, Deschutes or Snake river fisheries, or in tributaries outside the Imnaha River basin. Unexpanded data were used when CWT expansion factors were 25 or greater due to low sampling rates. Snake River recoveries from Idaho (N = 15) were not included here because harvest estimates were based on PBT samples rather than CWT recoveries.*

Table 14. Harvest and escapement distribution of adult summer steelhead by recovery location for the 2017-18 run year using the PSMFC and ODFW mark recovery databases, and parentage-based tagging (PBT) harvest estimates from Idaho fisheries. Beginning with the 2016-17 run year, harvest estimates from Idaho waters were based on Idaho harvest card returns and PBT creel samples rather than CWT recoveries (Alex LeCheminant, personal communication). "C and S" indicates ceremonial and subsistence tribal fisheries. No CWT recoveries were reported from WDFW's portion of the Snake River. Data were summarized as available through July 2020. "-" indicates not sampled or undefined.

	Wallowa Stock			Imnaha Stock		
Location	Estimated CWT recoveries	Total return	Percent of total return	Estimated CWT recoveries	Total return	Percent of total return
Ocean harvest	0	0	0.0	0	0	0.0
Columbia River harvest						
Treaty net	132	439	9.0	23	191	11.9
C and S	0	0	0.0	0	0	0.0
Sport	21	80	1.6	10	83	5.2
Test	0	0	0.0	0	0	0.0
Tributary sport	25	93	1.9	0	0	0.0
Deschutes River harvest						
Sport	21	113	2.3	2	17	1.0
C and S	0	0	0.0	0	0	0.0
Strays						
Outside Snake R. basin	14	51	1.0	2	17	1.0
Within Snake R. basin						
Below Lower Granite Dam	2	5	0.1	0	0	0.0
Above Lower Granite Dam*	2	5	0.1	0	0	0.0
Snake River sport, tribs. harvest*	19	43	0.9	0	0	0.0
Idaho harvest from PBTsamples* [a]	-	347	7.1	-	335	20.8
Oregon tributary harvest* [b]	61	1,103	22.6	0	22	1.4
Hatchery weir* [c]	655	2,610	53.4	77	944	58.7
Total estimated return	952	4,889	100	114	1,609	100
Return to compensation area		4,108			1,301	
Percent of compensation goal		44.7			65.1	

** Indicates areas defining the compensation area. The compensation goal for Wallowa stock is 9,184 adults and the goal for Imnaha stock is 2,000 adults.*

[a] PBT based estimated harvest from Idaho waters include ODFW's reciprocal study adults returning to WDFW's Cottonwood Facility, but do not include WDFW's reciprocal study adults returning to Wallowa Hatchery. Because both experimental groups had similar release numbers, the adult returns should be comparable and can be counted towards each states' return goal without any adjustments.

[b] Harvest in Oregon tributaries are estimates based on angler surveys and harvest card returns.

[c] Total returns to the hatchery weir are actual numbers, except for the Imnaha stock where we estimated the number of CWT fish recovered at the Little Sheep Creek Facility weir. This estimate is based on the actual number of CWT fish recovered at the weir and estimated number passed above the weir to Little Sheep Creek.

Table 15. Harvest and escapement distribution of adult summer steelhead by age and recovery location for the 2017-18 run year using the PSMFC and ODFW mark recovery databases, and parentage-based tagging (PBT) harvest estimates from Idaho fisheries. Beginning with the 2016-17 run year, harvest estimates from Idaho waters were based on Idaho harvest card returns and PBT creel samples rather than CWT recoveries (Alex LeCheminant, personal communication). "C and S" indicates ceremonial and subsistence tribal fisheries. Data were summarized as available through July 2020.

	Total returns by age							
	Wallowa Stock				Imnaha Stock			
Location	Age 3	Age 4	Age 5	Total	Age 3	Age 4	Age 5	Total
Ocean harvest	0	0	0	0	0	0	0	0
Columbia River harvest								
Treaty net	338	101	0	4	191	0	0	191
C and S	0	0	0	0	0	0	0	0
Sport	68	12	0	80	83	0	0	83
Test	0	0	0	0	0	0	0	0
Tributary sport	93	0	0	93	0	0	0	0
Deschutes River harvest								
Sport	81	32	0	113	17	0	0	17
C and S	0	0	0	0	0	0	0	0
Strays								
Outside Snake R. basin	42	9	0	51	17	0	0	17
Within Snake R. basin								
Below Lower Granite Dam	5	0	0	5	0	0	0	0
Above Lower Granite Dam*	5	0	0	5	0	0	0	0
Snake River sport, tribs. harvest*	43	0	0	43	0	0	0	0
Idaho harvest from PBT samples* [a]	347	0	0	347	317	18	0	335
Oregon tributary harvest* [b]	949	154	0	1,103	22	0	0	22
Hatchery weir* [c]	2,377	226	7	2,610	856	88	0	944
Total estimated return	4,348	534	7	4,889	1,503	106	0	1,609

** Indicates areas defining the compensation area. The compensation goal for Wallowa stock is 9,184 adults and the goal for Imnaha stock is 2,000 adults.*

[a] *PBT based estimated harvest from Idaho waters include ODFW's reciprocal study adults returning to WDFW's Cottonwood Facility, but do not include WDFW's reciprocal study adults returning to Wallowa Hatchery. Because both experimental groups had similar release numbers, the adult returns should be comparable and can be counted towards each states' return goal without any adjustments.*

[b] *Harvest in Oregon tributaries are estimates based on angler surveys and harvest card returns.*

[c] *Total returns to the hatchery weir are actual numbers, except for the Imnaha stock where we estimated the number of CWT fish recovered at the Little Sheep Creek Facility weir. This estimate is based on the actual number of CWT fish recovered at the weir and estimated number passed above the weir to Little Sheep Creek.*

Table 16. Distribution of parentage-based tagging (PBT) genetic samples assigned to NE Oregon steelhead during the 2017-18 run year by stock, river, sample collection location, and fishery. Also shown are the total number of samples in pertinent major sample collections, and of these samples, the number that assigned back to any steelhead stock. PBT samples are not expanded in this table. Data provided by Jesse McCane, Eagle Fish Genetics Laboratory, and summarized as available through July 2019. PBT data and anecdotal evidence indicate that WDFW did not recover any PBT samples from NE Oregon steelhead in the Snake or Grande Ronde river sport fisheries for this run year.

	Wallowa Stock[a]		Imnaha Stock		Samples Taken	
River and sample collection location	Fishery	Number	Fishery	Number	Total	Assigned
Columbia River						
Below Bonneville (WN Sec 1-10)	Sport	10	Sport	13	-	-
Bonneville Pool	Sport	0	Sport	1	-	-
Wind River	Sport	2	Sport	0	-	-
Drano Lake/Little White Salmon	Sport	0	Sport	0	-	-
Lake Wallula	Sport	3	Sport	0	-	-
Total Columbia River Sport	Sport	15	Sport	14	298	192
Total Columbia River Tribal (Zone 6)[b]	Tribal	37	Tribal	16	570	343
Total Columbia River Pound Net[c]	Test	40	Test	7	757	610
Total Columbia River, All Fisheries	All	92	All	37	1,625	1,145
Total Mouth of Deschutes Sport[d]	Sport	0	Sport	0		
Snake River, Washington*						
Mouth to ID/WA border*	Sport	0	Sport	0	-	-
Grande Ronde River Sport (WA)*	Sport	0	Sport	0	-	-
ID/WA border to WA/OR border*	Sport	0	Sport	0	-	-
Total Snake River Sport, Washington*	Sport	0	Sport	0	-	-
Snake River, Idaho*						
Clearwater River*	Sport	0	Sport	0	-	-
Salmon River*	Sport	2	Sport	0	377	231
ID/WA border to Hells Canyon*	Sport	45	Sport	47	928	288
Total Snake River Sport, Idaho*	Sport	47	Sport	47	1,305	519
Total samples with NE Oregon origins		139		84	-	-
Samples from Compensation area*		47		47	1,305	519

** Indicates areas defining the compensation area.*

[a] *"Wallowa Stock" as used in this table refers only to Wallowa stock steelhead produced in NE Oregon, and does not include Wallowa stock steelhead from the Lyons Ferry complex, Washington.*

[b] *Zone 6 encompasses the Columbia River from Bonneville to McNary dams.*

[c] *Columbia River Pound Net Test Fishery took place in late summer, 2017, in Cathlamet Channel (Columbia River below Bonneville) and was a collaborative effort between WDFW and the Wild Fish Conservancy. Goal of this fishery was to determine if pound nets could capture hatchery steelhead while allowing for release of natural steelhead, and could be used as an alternative means of commercial harvest. WDFW collected genetic samples from trapped fish.*

[d] *All "Mouth of Deschutes" samples were collected by Oregon samplers; Columbia River samples were collected by Washington samplers and thus, are treated as separate sample collections.*

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