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IDAHO ADULT STEELHEAD MONITORING

2021 ANNUAL REPORT

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By

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ABBREVIATIONS AND ACRONYMS

BY	Brood Year
CI	Confidence Interval
DPS	Distinct Population Segment
ESA	Endangered Species Act
GSI	Genetic Stock Identification
ICTRT	Interior Columbia Technical Recovery Team
IDFG	Idaho Department of Fish and Game
ISEMP	Integrated Status and Effectiveness Monitoring Program
LGR	Lower Granite Dam
MPG	Major Population Group
MY	Migration Year cohort
PIT	Passive Integrated Transponder
PTAGIS	PIT Tag Information System
SY	Spawn Year
VSP	Viable Salmonid Population

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ABSTRACT

During 2021, Idaho Department of Fish and Game personnel used weirs (temporary picket, floating board resistance, and hatchery traps) and select passive integrated transponder (PIT) tag arrays to monitor wild adult steelhead in Idaho. Three weirs and two PIT tag array sites were in the Clearwater River basin, whereas four weirs and seven PIT tag array sites were in the Salmon River basin. Some of these monitoring structures had small sample sizes, resulting in unreliable abundance and diversity estimates. Steelhead escapement ranged from one fish in Crooked River to 699 (95% CI 611–798) fish in the Lochsa River. Across all sites, 6.6% of return adults were 1-ocean, 92.7% were 2-ocean, 0.6% were 3-ocean, and 0.2% were repeat spawners. Sex ratios varied from 40.0% females in Big Bear Creek to 84.2% females in the lower Lemhi River. Adult-to-adult productivity estimates for brood year (BY) 2014 are now complete with the last of that cohort returning in 2021. Productivity estimates for BY 2014 (n = 9 locations) varied from 0.04 recruits per spawner in the East Fork Salmon River to 0.62 recruits per spawner in Rapid River. Steelhead were below replacement at all monitored locations (Big Bear Creek, East Fork Potlatch River, Fish Creek, Rapid River, Big Creek, Lemhi River, Pahsimeroi River, East Fork Salmon River, and the upper Salmon River) for BY 2014. Productivity increased slightly from BY 2013 to BY 2014 at all locations except Big Bear Creek, where it did not change. Including BY 2015, productivity has been below replacement for the last 4 to 8 BYs, depending on location. At all locations except for Big Creek and the Lemhi River, the trend in recruits per spawner decreased as spawner abundance increased, suggesting density dependent mechanisms are occurring. The productivity data series at Big Creek and the Lemhi River are the two shortest data series considered in this report, and additional years may reveal density-dependent mechanisms. The smolt-to-adult return (SAR) rates for fish from Big Bear Creek, Fish Creek, Big Creek, and the Lemhi River were 1.3%, 0.2%, 0.7%, and 0.6%, respectively, for migration year 2017. These SARs all fell below the range of the Northwest Power and Conservation Council Fish and Wildlife goal (2.0–6.0%).

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INTRODUCTION

Snake River basin steelhead trout *Oncorhynchus mykiss* (hereafter steelhead) populations have declined substantially following the construction of hydroelectric dams in the Snake and Columbia rivers. Survival of juvenile steelhead and Chinook Salmon *O. tshawytscha* emigrating from the Snake River basin decreased following the construction of dams on the lower Snake River during the late 1960s and early 1970s (Raymond 1988). Degradation of freshwater spawning and rearing habitats have also reduced wild steelhead abundance (Nehlsen et al. 1991; Gregory and Bisson 1997; Williams et al. 1999). The abundance of wild steelhead in Idaho streams has fluctuated at low levels since the completion of Lower Granite Dam (LGR) in 1975 (Busby et al. 1996). Consequently, Snake River steelhead were classified as threatened under the Endangered Species Act (ESA) in 1997. The total adult steelhead abundance in the Snake River basin increased slightly during 2002–2010 (Schrader et al. 2014), though the increase was dominated by hatchery-origin returning adults. Since 2010, total steelhead abundance again declined. Presently, returns of naturally produced steelhead remain critically low, especially for populations with later run timing and older age structure (Busby et al. 1996).

There are six major population groups (MPGs) within the Snake River steelhead Distinct Population Segment (DPS). Three MPGs are located in Idaho that include the Clearwater River, Salmon River, and Hells Canyon tributaries (ICTRT 2007; Figure 1). Only a small number of tributaries in the Hells Canyon MPG support spawning, and these streams are geographically separated from historical major spawning areas now considered to be extirpated. Thus, it was determined none of these tributaries were large enough to support an independent population (ICTRT 2007). Nonetheless, there are 17 demographically independent and extant steelhead populations identified within the Clearwater River and Salmon River MPGs (ICTRT 2007; NWFSC 2015; Table 1).

The Idaho Department of Fish and Game (IDFG) anadromous fish program's long-term goals to preserve Idaho's wild salmon and steelhead runs and recover them to provide benefit to all users (IDFG 2019) are consistent with basinwide mitigation and recovery programs. Snake River basin anadromous fish management programs include: 1) large-scale hatchery programs intended to mitigate for the impacts of hydroelectric dam construction and operation in the basin, 2) recovery planning and implementation efforts aimed at recovering ESA-listed wild salmon and steelhead stocks, and 3) management of sport and tribal fisheries. The IDFG Management Goals for wild- and natural-origin steelhead for the Snake River basin including populations in Oregon and Washington is 104,500 with a goal of 72,000 for the Idaho component (IDFG 2019). The mean return of wild- and natural-origin steelhead from 2008–2017 was 30,452 (IDFG 2019). An understanding of how salmonid populations function (McElhany et al. 2000), as well as long-term trend monitoring for status assessments, is required to achieve these management goals.

Wild steelhead population status in Idaho are evaluated by IDFG based upon the viable salmonid population (VSP) criteria (McElhany et al. 2000). Hence, this report was organized in the VSP framework with the following subsections: abundance and productivity, diversity, and spatial structure. To assess steelhead spatial structure, IDFG uses parr distribution as a surrogate, and a full accounting was reported in Poole et al. 2021. The diversity subsection includes information on population demographic metrics including sex ratio, length and age composition, migration timing, and genetic sampling at weirs. A full accounting of steelhead genetic stock composition at LGR, covering the entire Snake River basin, will be reported by Baum et al. (2022) and Hargrove et al. (2021). The four objectives of this report are:

Objective 1: Summarize IDFG's intensive, high-precision monitoring of wild adult steelhead in selected locations within the Clearwater River and Salmon River MPGs (Table 2).

Objective 2: Estimate steelhead adult abundance and productivity at selected locations.

Objective 3: Estimate steelhead smolt-to-adult return (SAR) rates at selected locations.

Objective 4: Estimate steelhead population demographic and diversity metrics including sex ratio, length and age composition, and run timing at selected locations. Enumerate genetic samples collected.

METHODS

Adult Abundance and Productivity

Sampling and Abundance

Weirs and passive integrated transponder (PIT) tag arrays were used to monitor wild adult steelhead populations. Temporary weirs were constructed and removed annually in the East Fork Potlatch River and Fish Creek. Permanent hatchery weirs were operated at hatchery facilities on Rapid River, Pahsimeroi River, East Fork Salmon River, Crooked River, and the upper Salmon River. Temporary and permanent weirs were used to monitor adult steelhead that spawned upstream of the structures. Lastly, PIT tag arrays installed perpendicularly to the stream channel were used to passively detect fish implanted with PIT tags that migrated into spawning tributaries.

Natural repeat spawners, reconditioned kelts, and hatchery steelhead were also encountered at weirs and PIT tag arrays. A reconditioned kelt was defined as a natural kelt that was opportunistically trapped at LGR, reconditioned at a hatchery, and released in the Snake River for natural repeat spawning (Hatch et al. 2017). All repeat spawners were released above weirs to naturally spawn and were incorporated as spawners in productivity analyses. Adults identified as hatchery-origin at weirs were not released upstream for natural spawning purposes except on the East Fork Salmon River, which has an integrated broodstock program for steelhead. Any hatchery-origin fish that made it upstream of a weir unintentionally or were detected at a PIT tag array were assumed to have a negligible impact on productivity and abundance, and therefore excluded from analyses in this report.

Temporary Weirs—During 2021, a temporary picket weir was operated on Fish Creek and a floating resistance board weir was operated on the East Fork Potlatch River to estimate wild adult steelhead escapement.

At temporary weirs, adult steelhead moving upstream entered a holding box that was checked several times daily. Trapped fish were removed with a net and placed in a large holding container for processing. Fork length (cm) and sex were recorded for all prespawn fish. Each fish was examined for marks (e.g., fin clips), injuries, and external tags (e.g., Floy tags, visual-implanted elastomer [VIE] tags) and scanned for the presence of internal tags (e.g., PIT tag, coded-wire tag [CWT], radio tag). Scales were sampled from each unique fish to determine freshwater, ocean, and complete ages. A small portion of fin tissue (for genetic analysis) was sampled from each unique fish at Fish Creek. All prespawn wild steelhead were marked with a right operculum punch and released upstream of the weir. All hatchery steelhead were marked with a left operculum punch and transported downstream of the weir for release.

Steelhead kelts were captured on the upstream side of weirs and processed similarly to prespawn adult fish. Fork length (cm) and sex were recorded for all kelts. Kelts were examined for any previous marks (e.g., operculum punches, fin clips) and tags (e.g., PIT tags, CWT, radio tags). Scales and fin tissue were collected from all unmarked kelts. Live kelts were marked with a left operculum punch and released downstream of the weir.

Total adult escapement above temporary weirs was estimated using a Lincoln-Peterson estimator with a Bailey's modification:

$$\widehat{N} = \frac{c(m+1)}{(r+1)}$$

where $\widehat{N}$ was estimated adult abundance; *c* was the total number of marked and unmarked kelts captured; *m* was the number of unique adults marked and passed upstream; and *r* was the number of marked adults recaptured as kelts. The estimate was computed with R statistical software (http://ifwisshiny.idfg.state.id.us:3838/JLM/IDFGStatApps/) using an iterative maximization of the log likelihood, assuming fish were captured independently with probability *p* (equivalent to weir efficiency) and marked fish mix thoroughly with unmarked fish (Steinhorst et al. 2004). The 95% confidence intervals were computed with a bootstrap option (10,000 iterations).

Permanent Weirs—During 2021, hatchery weir structures were operated at Crooked River, Rapid River, Pahsimeroi River, East Fork Salmon River, and the upper Salmon River to enumerate wild adult steelhead escapement. Panel weirs were operated on Crooked River, Pahsimeroi River, and the upper Salmon River, whereas velocity barriers were used at East Fork Salmon River and Rapid River. Methods for processing adult steelhead at the hatchery weirs were the same as at the temporary weirs described above.

Permanent hatchery weirs are designed to be complete barriers such that all upstream migrating fish are captured. Although kelts can be caught on the weir panels at some hatchery locations, they are currently not sampled to estimate weir efficiency. Weir panels are occasionally removed during high water to protect the trap structure at these locations, with the exception of Rapid River. As a result, some individuals may pass the weir without being sampled. Therefore, adult steelhead escapement to areas upstream of hatchery structures (i.e., fish released for natural spawning) are considered a minimum count of the spawning population without variance.

PIT Tag Arrays—Instream PIT tag arrays were used to estimate wild adult steelhead escapement into spawning tributaries in areas where stream flows and logistics do not allow weir operations: Big Bear Creek, Lochsa River, Big Creek, North Fork Salmon River, lower Lemhi River, upper Lemhi River, Hayden Creek, Marsh Creek, and the South Fork Salmon River.

In order to estimate escapement at each array site, wild adult steelhead were systematically PIT tagged at LGR throughout the migration period (Lawry et al. 2020). A State-Space Adult Dam Escapement Model (STADEM; See et al. 2021) was then used to estimate total abundance of wild adult steelhead at LGR. Total escapement of wild adult steelhead at LGR was then partitioned to branches of the lower Snake River basin stream network using the Lower Granite Dam Adult Branch Occupancy Model (DABOM; Waterhouse et al. 2020). The DABOM model estimated movement probabilities and site-specific detection probabilities of fish traveling throughout the lower Snake River basin stream network upstream of LGR using PIT tag detections extracted from the Columbia Basin PIT Tag Information System (PTAGIS) database (https://www.ptagis.org/) at locations where they could be detected (i.e., PIT tag arrays and weirs). Hatchery-origin adult steelhead strays were excluded.

We reported abundance estimates of SY 2021 adult steelhead from the DABOM analysis reported by Simmons et al. (2022) for PIT tag array sites that operated in the Lochsa River, South Fork Salmon River, Big Creek, Marsh Creek, lower Lemhi River, upper Lemhi River, and Hayden Creek. The DABOM model was not able to produce an estimate of SY 2021 adult steelhead escapement at the North Fork Salmon River due to a technical outage throughout the entirety of the adult migration period, or Big Bear Creek due to small sample sizes and frequent outages of a second array span. Due to the complete outage at the North Fork Salmon River arrays, and complete lack of detections, we were unable to assess escapement in the drainage. However, at Big Bear Creek we produced a minimum abundance estimate, where we expanded the number of unique prespawn adults that were PIT tagged or recaptured at LGR and detected at the array site by the mean weekly trapping rate of unclipped adult steelhead at LGR for a given spawn year, and assumed detection efficiency at the array was 100%.

Adult-to-Adult Productivity

Adult-to-adult productivity time series were constructed for Big Bear Creek, East Fork Potlatch River, Fish Creek, Rapid River, Big Creek, Lemhi River, Pahsimeroi River, East Fork Salmon River, and the upper Salmon River. Productivity results were reported for the most recently completed brood year (BY 2014), with preliminary information for BY 2015. The entire range of adult productivity estimates for each location are presented in Appendices C and D. Comparisons across populations were limited to BYs 2003–2015, in which most populations had estimates available. Productivity was not determined for Crooked River because the dataset does not have adequate adult age structure information available to construct brood tables and accurate adult abundance estimates were lacking. Productivity analyses were not conducted at the upper Lemhi and Hayden Creek PIT tag array sites due to concerns discerning which tributary a fish actually spawns in because of the close proximity of the arrays to each other and the spawning grounds. Additionally, the lower Lemhi River array site provides coverage for analyzing adult-to-adult productivity at the Lemhi River DPS level.

Productivity was calculated by combining adult abundances with age composition determined from scale samples. Interpreting patterns in steelhead scales provides an accurate and unbiased method for producing age compositions when scales are collected in a statistically random design (Reinhardt et al. 2022). Only scale samples in which total age could be determined were used in assigning age proportions. Age composition for returning adult recruits was applied to the escapement estimate to determine the total number of fish of specific ages for a given SY. Age categories (total age was the sum of freshwater age, ocean age, and adult river overwintering) were combined into BYs to determine the number of adult returns by total age. Brood years were summed across return years and divided by parental escapement to get adult-to-adult productivity rates (adult recruits per spawner). Brood years were considered complete when progeny from all possible total age categories returned as spawning adults. Since few age-7 adult spawners have been observed, BY 2015 comprising age-3 through age-6 returning adults were considered mostly complete. Repeat spawners (including reconditioned kelts) were included as recruits (numerator) in the productivity analysis only during their first spawn year; however, they were included as spawners (denominator) in the analysis for every year they returned. Hatchery strays were excluded from productivity analysis at all temporary and permanent weirs because they were not passed upstream for natural spawning with the exception of the East Fork Salmon River. On occasion, hatchery strays with PIT tags migrate upstream of PIT tag arrays but are generally either too low in numbers to be statistically expanded or nonexistent. Therefore, hatchery strays are not included in productivity analysis for sites with PIT tag arrays. Replacement rate of a population was determined to be 1.0 adult recruits per adult spawner assuming an even sex ratio.

Temporary and Permanent Weirs—Adult trapping data was extracted from the Fish Inventory System (FINS) hatchery database (https://www.finsnet.org/). In the East Fork Salmon River, hatchery fish were commonly passed above the weir as part of a supplementation program. Therefore, all steelhead passed upstream for natural spawning were counted as parents, whereas only natural-origin fish returning to the weir were counted as progeny. Although some wild adult steelhead were removed from the East Fork Salmon River weir for broodstock as part of an integrated broodstock management program, they were considered wild returning recruits for productivity analysis.

PIT Tag Arrays—We developed adult-to-adult productivity series for Big Bear Creek, Big Creek, and the Lemhi River PIT tag array sites. The PIT tag array estimates at the Lochsa River, South Fork Salmon River, Marsh Creek, and the North Fork Salmon River were only recently incorporated; therefore, productivity analyses are currently incomplete, but will be developed as brood years are completed. Brood years will be complete for the Lochsa River and North Fork Salmon River populations in 2023, and South Fork Salmon River and Marsh Creek populations will be completed in 2025. Methods for annual abundance estimates for these locations are outlined in the Sampling and Abundance section. Age and sex composition of returning adults to PIT tag array sites was estimated from genetic and scale samples of adult steelhead handled at LGR (see Age, Sex, and Size Composition section below).

Smolt-to-Adult Return (SAR) Rates

Smolt-to-adult return (SAR) rate is a commonly used metric that measures survival of anadromous salmonids from the time they emigrate as smolts out of freshwater rearing habitat to their return migration as mature adults (Nemeth and Kiefer 1999). Performances of anadromous salmonid populations are commonly characterized by SAR rates and are used to assess management strategies and progress towards recovery. We report SAR rates for Big Bear Creek, Fish Creek, Big Creek, and Lemhi River steelhead as smolts that were detected emigrating past LGR and their rate of return as an adult to Bonneville Dam. Using Bonneville Dam as the adult detection location, as opposed to LGR, allowed for a metric more focused on ocean conditions and helped ensure that enough adults were detected to generate reliable estimates for groups with low returns. Other weir and PIT tag array sites lacked large enough returns of PIT-tagged adults across years to estimate SAR from LGR to Bonneville Dam.

Although steelhead smolts from the same brood year emigrate at different ages, SARs were measured on the basis of a smolt cohort or migration year (MY). Queries of hydrosystem detections in the PTAGIS database were used to compile the number of emigrating smolts that were tagged in the four watersheds of interest. Smolts detected in the hydrosystem were assigned to a MY based on the year they emigrated. The sum of all unique PIT-tagged emigrating smolts detected at any interrogation site at dams from LGR to the Columbia River estuary comprised the cohort for a given MY. We then used detections of returning adults PIT tagged as juveniles in a given watershed (i.e., Big Bear Creek, Fish Creek, Big Creek, Lemhi River) as they ascended the adult ladder at Bonneville Dam. Adult status was confirmed either through upstream movement between dams or in the adult ladder at Bonneville Dam and were assigned to a MY based on the date of their first detection as an emigrating smolt. Adults that were not detected emigrating as a smolt were omitted from SAR calculations since they could not be assigned to a MY with certainty. The SAR was calculated by dividing the number of adults detected returning from a given migratory cohort by the number of total migrating smolts detected for that given cohort. We used formulas from Fleiss (1981) to determine 95% confidence intervals on SAR estimates.

Diversity

Age, Sex, and Size Composition

Weirs—We determined age composition of adult fish returning to temporary and permanent weirs from scale samples. Scale samples were collected from all unique adults sampled at weirs, including both prespawn fish and kelts. The target area to remove scales from was the second and third rows of scales above the lateral line and between the posterior fin ray of the dorsal fin and the anterior fin ray of the anal fin (Wright et al. 2015). At least ten scales per fish were collected from this target area. Scales were sent to the IDFG Nampa Research Anadromous Ageing Laboratory for processing using methods established by Wright et al. (2015). Scale ageing data are stored and accessed through the BioSamples database (available at https://collaboration.idfg.idaho.gov/qci/default.aspx). The reader should contact the author for information on how to access these data.

We determined the sex and size composition of all unique adult steelhead (prespawn fish and kelts) handled at weirs. For each fish, sex was determined based on phenotypic characteristics (e.g., protruding vent and short snout for females, developed kype for males) and fork length was measured to the nearest centimeter.

PIT Tag Arrays—Adult steelhead were not physically handled at PIT tag array sites (Big Bear Creek, Lochsa River, South Fork Salmon River, Big Creek, Marsh Creek, North Fork Salmon River, lower Lemhi River, upper Lemhi River, Hayden Creek, and South Fork Salmon River); therefore, diversity information was collected from samples of wild adult steelhead sampled at LGR with known tributary destinations. Lower Granite Dam adult trapping data are stored and accessed through the LGR trapping database (available at https://collaboration.idfg.idaho.gov/qci/default.aspx). The LGR trapping database was queried for adult steelhead sampled at the dam between June 30, 2020 and July 1, 2021, which were subsequently detected at these PIT tag array sites during 2021. We also queried adult steelhead sampled at LGR, which had been previously PIT tagged as juveniles upstream of PIT tag arrays through rotary traps or roving efforts (e.g., electrofishing, hook and line). Adult steelhead were processed at LGR using similar methods as was done at weirs (Lawry et al. 2020). Sex was determined from genetic samples (Hargrove et al. 2021) and freshwater and saltwater ages were determined from scale samples (Wright et al. 2015). For a given PIT tag array, we assumed all fish included in the analysis had an equal probability of conversion from LGR to their upstream interrogation site.

Adult Migration Timing and Conversion Rates

We depicted migration timing of PIT-tagged adult steelhead returning to all of the streams where adult abundances were estimated. Queries of the PTAGIS database were used to obtain detection dates of adult fish that were PIT tagged as juveniles at rotary screw traps or through roving tagging efforts in select streams. We examined migration timing of those adults through the hydrosystem using detections between July 1, 2020 and June 30, 2021 at Bonneville, McNary, and Lower Granite dams. Detections of kelts moving downstream were excluded. The median and range of timing of adult steelhead over each dam were reported. We also examined the proportion of total unique PIT-tagged fish detected at Bonneville Dam that were sequentially detected at McNary and LGR dams moving upstream (i.e., conversion rates). Fish that were not detected at Bonneville, but were detected at upstream hydrosystem facilities were included as having passed over Bonneville Dam for calculating conversion rates. Conversion rates from Bonneville Dam to weirs and arrays were examined at sites that had a sufficient number of PIT-tagged fish returns.

The timing of wild adult steelhead captured at weirs and detected on arrays was also examined. Distribution curves of total unique prespawn adults captured or detected at structures were constructed to compare timing of adult arrival to tributary streams. At weirs where kelts were captured (East Fork Potlatch River and Fish Creek) kelt distribution curves were also constructed to estimate spawn timing.

Genetic Sampling

Since 2000, we have collected tissue samples for genetic analysis from populations that span the range of geographic, temporal, and phenotypic variability observed in the Clearwater and Salmon river basins (Nielsen et al. 2009). Baseline data from past collections were used to conduct genetic stock identification (GSI) at LGR and to monitor genetic diversity of natural origin steelhead in the Snake River basin (Ackerman et al. 2016; Hargrove et al. 2021). The genetic diversity and structure of populations surveyed were evaluated and reported with other Snake River steelhead populations by Hargrove et al. (2021). During this report period, tissue samples were taken and archived for future analyses.

RESULTS

<u>Adult Abundance and Productivity</u>

Sampling and Abundance

During SY 2021 unclipped adult steelhead (both wild and unclipped hatchery fish) were trapped and PIT tagged at LGR from July 2, 2020 through November 12, 2020, and continued from March 1, 2021 through June 30, 2021 (Baum et al. 2022). While the trap was operational, the mean weekly trap and PIT tagging rate for unclipped adult steelhead during the SY 2021 run at LGR was 0.26 (SE = 0.04). The cumulative mean trap and PIT tagging rate for unclipped adult steelhead during the entire SY 2021 migration was 0.21. The trap rate was elevated from August 18 – September 1 in order to reach fall Chinook broodstock collection goals, resulting in an overall trap rate above the target rate of 0.20.

<u>Big Bear Creek Array</u>—The Big Bear Creek PIT tag array site was partially operational throughout the migration period. The upper span became operational on February 3, 2021 and operated through the entire migration year. However, the lower antenna span was damaged by a high flow event on January 26 and was out of operation until April 8, 2021. Nine PIT-tagged adult wild steelhead were detected on the Big Bear Creek PIT tag arrays, of which five were tagged as adults at LGR, three were tagged as juveniles in Big Bear Creek, and one was tagged as an adult at Bonneville Dam. All detections occurred on the upper span of the Big Bear Creek array, with no detections on the lower span array due to issues maintaining operation during the migration period. Because all detections occurred on a single span array, a detection efficiency could not be estimated for SY 2021. A minimum abundance estimate of 20 adults was derived by expanding the number of detected adult steelhead PIT tagged and sampled at LGR by the mean weekly LGR SY 2021 trap rate (Figure 2; Appendix A).

East Fork Potlatch River Weir—The East Fork Potlatch River weir was installed and began operating on March 8. The weir was either partially operable or inoperable for ten days during high flow periods and was fully operating through the remaining adult steelhead migration period. Seventeen upstream migrating adult steelhead were captured at the site (Table 3). In addition, three downstream migrating kelts were captured at the weir, all were previously handled as prespawn adults. The total steelhead abundance estimated via mark-recapture was 17 adults (95% CI 18; Figure 2; Appendix A).

Crooked River Weir—The Crooked River weir was installed and began operating on March 31 and operated continuously through the remaining adult steelhead migration period. The weir was partially operable for ten days during high flow periods. One wild adult steelhead was trapped, marked, and released upstream of the weir (Table 3). Five hatchery adult steelhead were trapped, four of which were released back into the downstream fishery and one was passed above the weir for natural spawning. There were no downstream migrating kelts captured, resulting in a minimum abundance estimate of one wild adult steelhead (Figure 2; Appendix A).

Lochsa River Array—The Lochsa River PIT tag arrays operated continuously through the adult steelhead migration period. One hundred ninety PIT-tagged adult wild steelhead were detected on the Lochsa River PIT tag arrays, of which 142 were tagged as adults at LGR, 11 were tagged as adults at Bonneville Dam, 17 were tagged as juveniles in the Lochsa River basin, 16 were tagged as juveniles at LGR, three were tagged remotely in the Clearwater River as adults, and one was tagged as a kelt at LGR. The DABOM model estimated an escapement of 699 adult steelhead returning to the Lochsa River (95% CI 611–798; Figure 2; Appendix A; Simmons et al. 2022).

Fish Creek Weir—The Fish Creek weir was installed and began operating on March 14 and operated continuously through the remaining adult steelhead migration period. Ninety wild adult steelhead were trapped, marked, and released upstream of the weir (Table 3). No hatchery fish were captured at the weir. Forty-four unique wild kelts were captured, 38 of which were previously marked (Table 3). The total steelhead abundance estimated via mark-recapture was 104 adults (95% CI 94–119; Figure 2; Appendix A).

Rapid River Weir—The Rapid River weir began operating on March 15 and ran continuously through the remaining adult steelhead migration period. Eleven wild adult steelhead were trapped and released upstream of the weir for natural spawning (Table 3; Figure 3; Appendix B).

South Fork Salmon River Array—The South Fork Salmon River PIT tag array at Krassel Creek operated continuously during the adult steelhead migration period. Forty-two PIT-tagged wild adult steelhead were detected on the South Fork Salmon River PIT tag array. Thirty-three were tagged as adults at LGR, three were tagged as juveniles at LGR, three were tagged as juveniles in the South Fork Salmon River basin, two were tagged as adults at Bonneville Dam, and one was tagged as an adult in the Snake River. The DABOM model estimated an escapement of 184 adult steelhead for the South Fork Salmon River (95% CI 132–249; Figure 3, Appendix B; Simmons et al. 2022).

Big Creek Array—The Big Creek PIT tag array operated continuously during the adult steelhead migration period. Twenty-eight PIT-tagged wild adult steelhead were detected on the Big Creek PIT tag array. Twenty-one were tagged as adults at LGR, four were tagged as juveniles at LGR, and three were tagged as juveniles in the Big Creek basin. The DABOM model estimated an escapement of 114 adult steelhead returning to Big Creek (95% CI 88–143; Figure 3, Appendix B; Simmons et al. 2022).

Marsh Creek Array—The Marsh Creek PIT tag array operated continuously during the adult steelhead migration period. Sixteen PIT-tagged wild adult steelhead were detected on the Marsh Creek PIT tag array, of which 12 were tagged as adults at LGR, one was tagged as an adult at Bonneville Dam, one was tagged as an adult at Priest Rapids Dam, and two were tagged as juveniles at LGR. The DABOM model estimated an escapement of 63 adult steelhead returning to Marsh Creek (95% CI 46–81; Figure 3, Appendix B; Simmons et al. 2022).

North Fork Salmon River Array—The North Fork Salmon River PIT tag array was not operational during the majority of the SY 2021 adult steelhead migration period due to technical difficulties. No adult wild steelhead were detected on the North Fork Salmon River array, and therefore an estimated escapement could not be produced (Figure 3, Appendix B).

Lower Lemhi River Array—The lower Lemhi River PIT tag array operated continuously during the adult steelhead migration period. Twenty-seven PIT-tagged wild adult steelhead were detected on the Lemhi River PIT tag array, of which 17 were tagged as adults at LGR, two were tagged as adults at Bonneville Dam, two were tagged as juveniles at LGR, three were tagged as juveniles in the Snake River, and three were tagged as juveniles in the Lemhi River basin. The DABOM model estimated an escapement of 92 adult steelhead for the Lemhi River (95% CI 71–116; Figure 3, Appendix B; Simmons et al. 2022).

Hayden Creek Array—The Hayden Creek PIT tag array operated continuously during the adult steelhead migration period. Fourteen PIT-tagged wild adult steelhead were detected on the Hayden Creek PIT tag array, of which seven were tagged as adults at LGR, two were tagged as adults at Bonneville Dam, two were tagged as juveniles in the Snake River, and three were tagged as juveniles in Hayden Creek. The DABOM model estimated an escapement of 29 adult steelhead for Hayden Creek (95% CI 12–50; Appendix B; Simmons et al. 2022).

Upper Lemhi River Array—The Upper Lemhi River PIT tag array operated continuously during the adult steelhead migration period. Three PIT-tagged wild adult steelhead were detected on the Upper Lemhi River PIT tag array, of which two were tagged as adults at LGR, and one was tagged as an adult at Bonneville Dam. The DABOM model estimated an escapement of ten adult steelhead for the upper Lemhi River (95% CI 1–21; Appendix B; Simmons et al. 2022).

Pahsimeroi River Weir—The Pahsimeroi River hatchery weir began operating on February 22 and ran continuously through May 3. Twenty wild adult steelhead were trapped and released upstream of the Pahsimeroi Fish Hatchery for natural spawning (Table 3; Figure 3, Appendix B).

East Fork Salmon River Weir—The East Fork Salmon River hatchery weir began operating on March 23 and ran continuously through May 13. Fifty-six wild adult steelhead were trapped at the East Fork Salmon River hatchery weir (Table 3; Figure 3, Appendix B). Forty-four wild adult steelhead (28 females; 16 males) were removed and used for hatchery broodstock.

Twelve wild adult steelhead (11 females; one male) and fifty-eight hatchery adult steelhead (41 females; 17 males) were passed upstream of the weir for natural spawning purposes.

Upper Salmon River Weir—The upper Salmon River weir at Sawtooth Fish Hatchery began operating on March 17 and ran continuously through May 12. Eighty-seven wild adult steelhead were trapped, marked, and released upstream of the weir (Table 3; Figure 3, Appendix B). All wild adult steelhead were passed upstream of the weir for natural spawning. No hatchery fish were passed upstream of the weir.

Adult-to-Adult Productivity

Big Bear Creek Array—Brood year 2014 spawning steelhead returned 25 adult progeny, which resulted in an adult-to-adult productivity estimate of 0.10 recruits per spawner, and the preliminary adult-to-adult productivity estimate for BY 2015 was 0.23 recruits per spawner (Figure 4; Appendix C). During BYs 2005–2014, Big Bear Creek steelhead recruited an average of 152 adult progeny (range = 12–265 adult progeny) per year. Across all completed BYs, adult-to-adult productivity estimates ranged from 0.10 recruits per spawner (BY 2013 and 2014) to 4.16 recruits per spawner (BY 2006). On average, Big Bear Creek steelhead spawned mostly as age-4 (43.9%) and age-5 (47.3%), and to a lesser extent, age-3 (4.8%) and age-6 (3.5%) adults. Big Bear Creek adult-to-adult productivity estimates have been below the replacement threshold of 1.0 adult recruits per adult spawner for the last four brood years, including BY 2015 (2012-2015; Figure 4; Appendix C). Across BYs 2005–2015, Big Bear Creek productivity (adult recruits per spawner) decreased as spawner escapement increased (Figure 5).

East Fork Potlatch River Weir—Brood year 2014 spawning steelhead returned 15 adult progeny, which resulted in an adult-to-adult productivity estimate of 0.16 recruits per spawner, and the preliminary adult-to-adult productivity estimate for BY 2015 was 0.17 recruits per spawner (Figure 4; Appendix C). During BYs 2008–2014, East Fork Potlatch River steelhead recruited an average of 61 adult progeny (range = 11–124 adult progeny) per year. Across all completed BYs, adult-to-adult productivity estimates ranged from 0.14 recruits per spawner (BY 2013) to 2.64 recruits per spawner (BY 2011). On average, East Fork Potlatch River steelhead spawned mostly as age-5 (50.3%) and age-4 (38.5%), and to a lesser extent age-3 (1.8%), age-6 (9.0%), and age-7 (0.3%) adults. East Fork Potlatch River adult-to-adult productivity estimates have been below the replacement threshold of 1.0 adult recruits per adult spawner for the last four brood years, including BY 2015 (2012–2015; Figure 4; Appendix C). East Fork Potlatch River productivity estimates decreased as spawner abundance increased during BYs 2008–2015 (Figure 5).

Fish Creek Weir—Brood year 2014 spawning steelhead returned 36 adult progeny, which resulted in an adult-to-adult productivity estimate of 0.40 recruits per spawner, and the preliminary adult-to-adult productivity estimate for BY 2015 was 0.18 recruits per spawner (Figure 4; Appendix C). During BYs 1992–2014, Fish Creek recruited an average of 157 adult progeny (range = 26–465 adult progeny) per year. Across all completed BYs, adult-to-adult productivity estimates ranged from 0.27 recruits per spawner (BY 2013) to 10.25 recruits per spawner (BY 1997). On average, Fish Creek steelhead spawned mostly as age-5 (46.0%) and age-6 (45.1%), and to a lesser extent, age-3 (0.3%), age-4 (6.8%), and age-7 (0.7%) adults. Fish Creek adult-to-adult productivity estimates have been below the replacement threshold of 1.0 adult recruits per adult spawner for the last five brood years, including BY 2015 (2011–2015; Figure 4; Appendix C). Fish Creek productivity estimates decreased as spawner escapement increased across completed BYs (1992–2015; Figure 5).

Rapid River Weir—Brood year 2014 spawning steelhead returned 16 adult progeny, which resulted in an adult-to-adult productivity estimate of 0.62 recruits per spawner, and the preliminary BY 2015 productivity estimate was 0.21 recruits per spawner (Figure 4; Appendix D). During BYs 2004–2014, Rapid River steelhead recruited an average 61 adult progeny (range = 8–145 adult progeny) per year. Across all completed BYs, adult-to-adult productivity estimates ranged from 0.21 recruits per spawner (BY 2012) to 2.13 recruits per spawner (BY 2007). On average, Rapid River steelhead spawned mostly as age-5 (49.7%), and age-4 (26.5%), and to a lesser extent, age-3 (1.1%), age-6 (20.9%), and age-7 (1.5%) adults. Rapid River adult-to-adult productivity estimates have been below the replacement threshold of 1.0 adult recruits per adult spawner for the last eight brood years, including BY 2015 (2008-2015; Figure 4; Appendix D). Across BYs 2004–2015, Rapid River productivity estimates decreased as spawner escapement increased (Figure 6).

Big Creek Array—Brood year 2014 spawning steelhead returned 86 adult progeny, which resulted in an adult-to-adult productivity estimate of 0.31 recruits per spawner, and the preliminary adult-to-adult productivity estimate for BY 2015 was 0.14 recruits per spawner (Figure 4; Appendix D). During BY 2010–2014, Big Creek steelhead recruited an average 243 adult progeny (range = 73–720 adult progeny) per year. Across all completed BYs, adult-to-adult productivity estimates ranged from 0.18 recruits per spawner (BY 2012) to 0.78 recruits per spawner (BY 2010). On average, Big Creek steelhead spawned mostly as age-5 (43.1%), and age-6 (42.7%), and to a lesser extent age-4 (6.2%), and age-7 (7.5%) adults. Big Creek adult-to-adult productivity estimates have been below the replacement threshold of 1.0 adult recruits per adult spawner for all brood years available in this data series, including BY 2015 (2010–2015; Figure 4; Appendix D). Across BYs 2010–2015, Big Creek productivity estimates were flat or increased slightly as spawner escapement increased (Figure 6).

Lower Lemhi River Array—Brood year 2014 spawning steelhead returned 110 adult progeny, which resulted in an adult-to-adult productivity estimate of 0.40 recruits per spawner, and the preliminary adult-to-adult productivity estimate for BY 2015 was 0.29 recruits per spawner (Figure 4; Appendix D). During BY 2010–2014, lower Lemhi River steelhead recruited an average 214 adult progeny (range = 96–342 adult progeny) per year. Across all completed BYs, adult-to-adult productivity estimates ranged from 0.26 recruits per spawner (BY 2013) to 0.83 recruits per spawner (BY 2011). On average, lower Lemhi River steelhead spawned mostly as age-4 (44.3%), and age-5 (41.8%), and to a lesser extent age-3 (6.6%), age-6 (6.4%), and age-7 (0.2%) adults. Lemhi River adult-to-adult productivity estimates have been below the replacement threshold of 1.0 adult recruits per adult spawner for all brood years available in this data series, including BY 2015 (2010–2015; Figure 4; Appendix D). Across BYs 2010–2015, Lemhi River productivity estimates were flat or increased slightly as spawner escapement increased (Figure 6).

Pahsimeroi River Weir—Brood year 2014 spawning steelhead returned 30 adult progeny, which resulted in an adult-to-adult productivity estimate of 0.15 recruits per spawner, and the preliminary adult-to-adult productivity estimate for BY 2015 was 0.39 recruits per spawner (Figure 4; Appendix D). During BY 2004–2014, Pahsimeroi River steelhead recruited an average 127 adult progeny (range = 12–262 adult progeny) per year. Across all completed BYs, adult-to-adult productivity estimates ranged from 0.07 recruits per spawner (BY 2013) to 9.86 recruits per spawner (BY 2007). On average, Pahsimeroi River steelhead spawned mostly as age-4 (63.1%), and age-5 (22.5%), and to a lesser extent age-3 (12.0%), age-6 (1.9%), and age-7 (0.1%) adults. Pahsimeroi River adult-to-adult productivity estimates have been below the replacement threshold of 1.0 adult recruits per adult spawner for the last five brood years, including BY 2015 (2011-2015; Figure 4; Appendix D). Pahsimeroi River productivity estimates decreased as spawner escapement increased across completed BYs (2004–2015; Figure 6)

East Fork Salmon River Weir—Brood year 2014 spawning steelhead returned 13 adult progeny, which resulted in an adult-to-adult productivity estimate of 0.04 recruits per spawner, and the preliminary adult-to-adult productivity estimate for BY 2015 was 0.03 recruits per spawner (Figure 4; Appendix D). During BY 2007–2014, East Fork Salmon River steelhead recruited an average 40 adult progeny (range = 10–100 adult progeny) per year. Across all completed BYs, adult-to-adult productivity estimates ranged from 0.02 recruits per spawner (BY 2013) to 1.82 recruits per spawner (BY 2007). On average, East Fork Salmon River steelhead spawned mostly at age-5 (59.2%), and age-4 (25.4%), and to a lesser extent age-3 (0.5%) and age-6 (14.1%) adults. East Fork Salmon River adult-to-adult productivity estimates have been below the replacement threshold of 1.0 adult recruits per adult spawner for the last eight brood years, including BY 2015 (2008–2015; Figure 4; Appendix D). East Fork Salmon River productivity estimates decreased as spawner escapement increased across completed BYs (2007–2015; Figure 6)

Upper Salmon River Weir—Brood year 2014 spawning steelhead returned 14 adult progeny, which resulted in an adult-to-adult productivity estimate of 0.30 recruits per spawner, and the preliminary adult-to-adult productivity estimate for BY 2015 was 0.44 recruits per spawner (Figure 4; Appendix D). During BY 2005–2014, upper Salmon River steelhead recruited an average 56 adult progeny (range = 6–129 adult progeny) per year. Across all completed BYs, adult-to-adult productivity estimates ranged from 0.15 recruits per spawner (BY 2013) to 5.86 recruits per spawner (BY 2006). On average, upper Salmon River steelhead spawned mostly at age-5 (53.3%), and age-4 (38.9%), and to a lesser extent age-3 (1.6%) and age-6 (5.7%) adults. Upper Salmon River adult-to-adult productivity estimates have been below the replacement threshold of 1.0 adult recruits per adult spawner for the last seven brood years, including BY 2015 (2009-2015; Figure 4; Appendix D). Upper Salmon River productivity estimates decreased as spawner escapement increased across completed BYs (2005–2015; Figure 6)

Smolt-to-Adult Return Rates

Big Bear Creek

Migration year 2018 was the most recently completed estimate and had an SAR of 4.2% (95% CI 3.3–5.3%). For MY 2005–2018, the median SAR was 4.1% and ranged from 0.7% (MY 2015) to 6.0% (MY 2013; Figure 7). Ten of the 14 completed SAR estimates (71.4%) were ≥2.0%. Beginning in 2005, the number of PIT-tagged smolts from Big Bear Creek that were subsequently detected in the hydrosystem ranged from 165 (MY 2021) to 1,727 (MY 2018). Sixty-four adults were detected that were not previously detected as emigrating smolts and were excluded from further analysis. No 3-ocean adults tagged as juveniles in Big Bear Creek have yet been detected in the hydrosystem; therefore, we consider a MY cohort complete after 2-ocean adults return. From MYs 2005–2018, 323 adults were used to calculate SARs to Bonneville Dam. The number of adults detected ranged from three fish (MY 2015) to 72 fish (MY 2018).

Fish Creek

Migration year 2017 was the most recently completed estimate and had an SAR of 0.2% (95% CI 0.0–0.7%). Migration year 2018 is mostly complete, missing only 3-ocean adults returning in 2022 (SAR = 1.4%). For MYs 1996–2018, the median SAR was 0.8% and ranged from 0.1% (MY 2015) to 4.2% (MY 2008; Figure 7). Six of the 22 completed SAR estimates

(27.3%) were ≥2.0%. Beginning in 1994, the number of PIT-tagged smolts from Fish Creek that were subsequently detected in the hydrosystem ranged from 128 (MY 1994) to 4,979 (MY 2012). Eighty-eight adults were detected that were not previously detected as emigrating smolts and were excluded from further analysis. From MYs 1996–2018, 825 adults were used to calculate SARs. The number of adults detected ranged from two fish (MY 1996) to 180 fish (MY 2012).

Big Creek

Migration year 2017 was the most recently completed estimate and had an SAR of 0.7% (95% CI 0.0–4.5%). Migration year 2018 is mostly complete, missing only 3-ocean adults returning in 2022 (SAR = 1.0%). For MYs 2003–2018, the median SAR was 1.6% and ranged from 0.0% (MY 2005–2007, 2015) to 9.1% (MY 2004; Figure 7). Eight of the 15 completed SAR estimates (53.3%) were ≥2.0%. Beginning in 2003, the number of PIT-tagged smolts from Big Creek that were subsequently detected in the hydrosystem ranged from eight (MY 2006) to 951 (MY 2012). Fifty-one adults were detected that were not previously detected as emigrating smolts and were excluded from further analysis. From MYs 2003–2018, 153 adults were used to calculate SARs to Bonneville Dam. The number of adults detected ranged from zero fish (MY 2005–2007, 2015) to 40 fish (MY 2008).

Lemhi River

Migration year 2018 was the most recently completed estimate and had an SAR of 1.9% (95% CI 1.1–3.3%). For MYs 2003–2018, the median SAR was 1.8% and ranged from 0.0% (MY 2004, 2005) to 5.0% (MY 2008; Figure 7). Seven of the 16 completed SAR estimates (43.8%) were ≥2.0%. Beginning in 2003, the number of PIT-tagged smolts from Lemhi River that were subsequently detected in the hydrosystem ranged from 21 (MY 2003) to 1,077 (MY 2014). Seventy adults were detected that were not previously detected as emigrating smolts and were excluded from further analysis. No 3-ocean adults tagged as juveniles in the Lemhi River basin have yet been detected in the hydrosystem; therefore, we consider a MY cohort complete after 2-ocean adults return. From MYs 2003–2018, 200 adults were used to calculate SARs to Bonneville Dam. The number of adults detected ranged from zero fish (MY 2004, 2005) to 38 fish (MY 2008).

Diversity

Age, Sex, and Size Composition

Big Bear Creek Array—Age composition of SY 2021 Big Bear Creek steelhead was determined from adult fish sampled at LGR because no fish were physically handled at the PIT tag array site. Age data was collected from five unique adult steelhead detected at the Big Bear Creek array that were sampled at LGR; three were assigned complete ages, and two had unknown freshwater ages (Table 3). All five fish (100%) were 2-ocean adults (Figure 8). Three adults (100%) smolted after two years in freshwater. Total age was five years at spawning, with one freshwater-saltwater age class combination (Table 3).

Sex and size composition data were collected from the five prespawn adult steelhead sampled at LGR for age composition (Table 3). Females comprised 40.0% (n = 2) and males comprised 60.0% (n = 3) of the adults sampled at LGR (Table 3). Mean fork length for females was 74.5 cm (range = 73.0–76.0 cm) and mean fork length for males was 80.7 cm (range = 73.0–86.0 cm).

East Fork Potlatch River Weir—Age composition of SY 2021 East Fork Potlatch River steelhead was determined from data collected at the weir. Age data was collected from 17 unique wild, adult steelhead (prespawn and kelts) captured at the weir. Of the 17 unique wild steelhead sampled, 14 were assigned complete ages, two were not assigned a freshwater age, and one was not assigned an age (Table 3). Of those assigned ocean ages, four fish (25.0%) were 1-ocean and the other 12 (75.0%) were 2-ocean fish (Figure 8). Seven adults (50.0%) smolted after two years in freshwater, six (42.9%) smolted after three years, and one (7.1%) smolted after four years. Total ages ranged from five to six years at spawning, with four different freshwater-saltwater age class combinations (Table 3).

Sex and size composition data were collected from the 17 unique adult steelhead sampled for age composition (Table 3). Females comprised 70.6% (n = 12), and males comprised 29.4% (n = 5). Mean fork length for females was 69.9 cm (range = 41.2–77.1 cm) and mean fork length for males was 64.0 cm (range = 41.0–78.3 cm).

Crooked River Weir—Age composition of SY 2021 Crooked River steelhead was determined from data collected at the weir. Age data was collected from one unique wild, adult steelhead captured at the weir. The one unique wild steelhead sampled was a 3-ocean fish that was not assigned a freshwater age (Table 3).

Sex and size composition data were collected from the one unique wild, adult steelhead sampled for age composition (Table 3). The one unique wild, adult steelhead captured and sampled was a male with a fork length of 86.0 cm.

Lochsa River Array—Age composition of SY 2021 Lochsa River steelhead was determined from adult fish sampled at LGR because no fish were physically handled at the PIT tag array site. Age data was collected from 145 unique adult steelhead detected at the PIT tag arrays in the Lochsa River that were sampled at LGR; 96 were assigned complete ages, 47 had unknown freshwater ages, including one repeat spawner, and two were not assigned an age (Table 3). Of those assigned ocean ages, four fish (2.8%) were 1-ocean adults, 137 (95.8%) were 2-ocean adults, one (0.7%) was a 3-ocean adult, and one (0.7%) was a repeat spawner (Figure 8). Two adults (2.1%) smolted after one year in freshwater, 48 (50.0%) smolted after two years, 44 (45.8%) smolted after three years, and two (2.1%) smolted after four years. Total ages ranged from four to seven years at spawning, with seven different freshwater-saltwater age class combinations (Table 3).

Sex and size composition data were collected from 145 unique adult steelhead detected at the PIT tag arrays in the Lochsa River that were sampled at LGR (Table 3). Females comprised 78.6% (n = 114) and males comprised 20.7% (n = 30) of the adults sampled at LGR, in addition to 0.7% (n = 1) of the adults that were unable to be assigned a sex. Mean fork length for females was 80.4 cm (range = 70.0–90.0 cm) and mean fork length for males was 80.9 cm (range = 53.0–93.0 cm).

Fish Creek Weir—Age composition of SY 2021 Fish Creek steelhead was determined solely from data collected at the weir. Age data was collected from 96 unique wild, adult steelhead (90 prespawn; 6 kelts) captured at the weir. Of the 96 unique adults sampled, 72 were assigned complete ages, and 24 had unknown freshwater ages (Table 3). Of those assigned ocean ages, three (3.1%) were 1-ocean adults, and 93 (96.9%) were 2-ocean adults (Figure 8). Twenty-four fish (33.3%) smolted after two years in freshwater and 48 (66.7%) smolted after three years. Total ages ranged from five to six years, with three different freshwater-saltwater age class combinations (Table 3).

Sex and size composition data were collected from the 96 unique adult steelhead sampled for age composition (Table 3). Females comprised 70.8% (n = 68) and males comprised 29.2% (n = 28) of the adults sampled at the weir (Table 3). Mean fork length for females was 78.6 cm (range = 72.0–84.0 cm) and males was 79.1 cm (range = 55.5–89.0 cm).

Rapid River Weir—Age composition of SY 2021 Rapid River steelhead was determined from data collected at the weir. Age data was collected from 11 unique wild, adult steelhead captured at the weir. Of the 11 unique adults sampled, eight were assigned complete ages, and three fish had an unknown freshwater age (Table 3). Of those assigned ocean ages, one (9.1%) was a 1-ocean adult and ten (90.9%) were 2-ocean adults (Figure 9). Two fish (25.0%) smolted after two years in freshwater, and six (75.0%) smolted after three years. Total ages ranged from five to six years at spawning, with two different freshwater-saltwater age class combinations (Table 3).

Sex and size composition data were collected from the 11 prespawn adult steelhead sampled for age composition (Table 3). Females comprised 81.8% (n = 9) and males comprised 18.2% (n = 2) of the adults sampled at the weir (Table 3). Mean fork length for females was 77.1 cm (range = 68.0–83.0 cm) and males was 82.0 cm (range = 82.0–82.0 cm).

South Fork Salmon River Array—Age composition of SY 2021 South Fork Salmon River steelhead was determined from adult fish sampled at LGR because no fish were physically handled at the PIT tag array site. Age data was collected from 35 unique adult steelhead detected at the PIT tag array in the South Fork Salmon River that were sampled at LGR; 21 were assigned complete ages, 13 had unknown freshwater age, and one was unable to be aged (Table 3). Of those assigned ocean ages, two fish (5.9%) were 1-ocean adults, 31 (91.2%) were 2-ocean adults, and one (2.9%) was a 3-ocean adult (Figure 9). One adult (4.8%) smolted after one year in freshwater, nine adults (42.9%) smolted after two years in freshwater, and 11 (52.4%) smolted after three years. Total ages ranged from four to six years at spawning, with four different freshwater-saltwater age class combinations (Table 3).

Sex and size composition data were collected from the 35 prespawn adult steelhead sampled at LGR for age composition (Table 3). Females comprised 80.0% (n = 28) and males comprised 20.0% (n = 7) of the adults sampled at LGR (Table 3). Mean fork length for females was 77.3 cm (range = 61.0–83.0 cm) and mean fork length for males was 83.3 cm (range = 65.0–93.0 cm).

Big Creek Array—Age composition of SY 2021 Big Creek steelhead was determined from adult fish sampled at LGR because no fish were physically handled at the PIT tag array site. Age data was collected from 21 unique adult steelhead detected at the PIT tag array in Big Creek that were sampled at LGR; 11 were assigned complete ages, and 10 had unknown freshwater age (Table 3). Of those assigned ocean ages, four fish (19.0%) were 1-ocean adults, and 17 (81.0%) were 2-ocean adults (Figure 9). Five adults (45.5%) smolted after two years in freshwater, and 11 (54.5%) smolted after three years. Total ages ranged from five to six years at spawning, with three different freshwater-saltwater age class combinations (Table 3).

Sex and size composition data were collected from the 21 prespawn adult steelhead sampled at LGR for age composition (Table 3). Females comprised 71.4% (n = 15) and males comprised 23.8% (n = 5) of the adults sampled at LGR, in addition to 4.8% (n = 1) of the adults that were unable to be assigned a sex (Table 3). Mean fork length for females was 75.1 cm (range = 62.0–83.0 cm) and mean fork length for males was 66.6 cm (range = 61.0–79.0 cm).

Marsh Creek Array—Age composition of SY 2021 Marsh Creek steelhead was determined from adult fish sampled at LGR because no fish were physically handled at the PIT tag array site. Age data was collected from 13 unique adult steelhead detected at the PIT tag array in Marsh Creek that were sampled at LGR; nine were assigned complete ages, and four had unknown freshwater age (Table 3). All 13 fish (100%) were 2-ocean adults (Figure 9). Two adults (22.2%) smolted after two years in freshwater, and seven (77.8%) smolted after three years. Total ages ranged from five to six years at spawning, with two different freshwater-saltwater age class combinations (Table 3).

Sex and size composition data were collected from the 13 prespawn adult steelhead sampled at LGR for age composition (Table 3). Females comprised 69.2% (n = 9) and males comprised 30.8% (n = 4) of the adults sampled at LGR (Table 3). Mean fork length for females was 74.4 cm (range = 66.0–82.0 cm) and mean fork length for males was 82.5 cm (range = 74.0–86.0 cm).

North Fork Salmon River Array—Age composition for SY 2021 North Fork Salmon River steelhead was not able to be determined due to technical difficulties that left the PIT tag array out of operation during the majority of the migration period (Table 3; Figure 9). Sex and size composition data were also not analyzed on SY 2021 North Fork Salmon River adult steelhead (Table 3).

Lower Lemhi River Array—Age composition of SY 2021 Lemhi River steelhead was determined from adult fish sampled at LGR because no fish were physically handled at the PIT tag array site. Age data was collected from 19 unique adult steelhead detected at the PIT tag arrays in the lower Lemhi River that were sampled at LGR; 15 were assigned complete ages and four had unknown freshwater ages (Table 3). Of those assigned ocean ages, four fish (21.1%) were 1-ocean adults, and 15 (78.9%) were 2-ocean adults (Figure 9). Two adults (13.3%) smolted after one year in the freshwater, nine adults (60.0%) smolted after two years in freshwater, and four (26.7%) smolted after three years. Total ages ranged from four to six years at spawning, with five different freshwater-saltwater age class combinations (Table 3).

Sex and size composition data were collected from the 19 prespawn adult steelhead sampled at LGR for age composition (Table 3). Females comprised 84.2% (n = 16) and males comprised 15.8% (n = 3) of the adults sampled at LGR (Table 3). Mean fork length for females was 66.3 cm (range = 54.0–73.0 cm) and mean fork length for males was 61.0 cm (range = 53.0–73.0 cm).

Hayden Creek Array—Age composition of SY 2021 Hayden Creek steelhead was determined from adult fish sampled at LGR because no fish were physically handled at the PIT tag array site. Age data was collected from nine unique adult steelhead detected at the PIT tag array in Hayden Creek that were sampled at LGR; six were assigned complete ages, and three had unknown freshwater age (Table 3). Of those assigned ocean ages, one fish (11.1%) was a 1-ocean adult, and eight (88.9%) were 2-ocean adults. Five adults (83.3%) smolted after two years in freshwater, and one (16.7%) smolted after three years. Total ages ranged from four to six years at spawning, with three different freshwater-saltwater age class combinations (Table 3).

Sex and size composition data were collected from the nine prespawn adult steelhead sampled at LGR for age composition (Table 3). Females comprised 77.8% (n = 7) and males comprised 22.2% (n = 2) of the adults sampled at LGR (Table 3). Mean fork length for females was 65.1 cm (range = 57.0–69.0 cm) and mean fork length for males was 70.5 cm (range = 68.0–73.0 cm).

Upper Lemhi River Array—Age composition of SY 2021 upper Lemhi River steelhead was determined from adult fish sampled at LGR because no fish were physically handled at the PIT tag array site. Age data was collected from three unique adult steelhead detected at the PIT tag array in the upper Lemhi River that were sampled at LGR; all three were assigned complete ages (Table 3). All three fish (100.0%) were 2-ocean adults. Two adults (66.7%) smolted after two years in freshwater, and one (33.3%) smolted after three years. Total ages ranged from five to six years at spawning, with two different freshwater-saltwater age class combinations (Table 3).

Sex and size composition data were collected from the three prespawn adult steelhead sampled at LGR for age composition (Table 3). Females comprised 66.7% (n = 2) and males comprised 33.3% (n = 1) of the adults sampled at LGR (Table 3). Mean fork length for females was 65.0 cm (range = 62.0–68.0 cm) and mean fork length for males was 73.0 cm (range = 73.0–73.0 cm).

Pahsimeroi River Weir—Age composition of SY 2021 Pahsimeroi River steelhead was determined from data collected at the weir. Twenty unique wild adult steelhead were captured at the weir, but age data was only collected from 11 adults. Of the 11 unique adults sampled, five were assigned complete ages, five had unknown freshwater ages, and one was not assigned an age (Table 3). Of those assigned ocean ages, two (20.0%) were 1-ocean adults and eight (80.0%) were 2-ocean adults (Figure 9). Three fish (60.0%) smolted after one year in freshwater, one (20.0%) smolted after two years in freshwater, and one (20.0%) smolted after three years in freshwater. Total ages ranged from four to six years, with three different freshwater-saltwater age class combinations (Table 3).

Sex and size composition data were collected from the 20 prespawn adult steelhead sampled for age composition (Table 3). Females comprised 70.0% (n = 14) and males comprised 30.0% (n = 6) of the adults sampled at the weir (Table 3). Mean fork length for females was 66.6 cm (range = 55.0–78.0 cm) and males was 70.8 cm (range = 59.0–87.0 cm).

East Fork Salmon River Weir—Age composition of SY 2021 East Fork Salmon River steelhead was determined from data collected at the weir. Fifty-six unique wild adult steelhead were captured at the weir, but age data was only collected from 55 adults. Of the 55 unique adults sampled, 50 were assigned complete ages, four had unknown freshwater ages, and one was unable to be aged (Table 3). Of those assigned ocean ages, six (11.1%) were 1-ocean adults and 48 (88.9%) were 2-ocean adults (Figure 9). Thirty-seven fish (74.0%) smolted after two years in freshwater, and 13 (26.0%) smolted after three years. Total ages ranged from four to six years, with four different freshwater-saltwater age class combinations (Table 3).

Sex and size composition data were collected from the 56 prespawn adult steelhead captured at the weir (Table 3). Females comprised 69.6% (n = 39) and males comprised 30.4% (n = 17) of the adults sampled at the weir (Table 3). Mean fork length for females was 70.5 cm (range = 53.0–78.0 cm) and males was 70.5 cm (range = 55.0–82.0 cm).

Upper Salmon River Weir—Age composition of SY 2021 upper Salmon River steelhead was determined from data collected at the weir. Age data was collected from 87 unique wild, adult steelhead captured at the weir. Of the 87 unique adults sampled, 79 were assigned complete ages, and eight had unknown freshwater age (Table 3). Of those assigned ocean ages, four (4.6%) were 1-ocean adults and 83 (95.4%) were 2-ocean adults (Figure 9). Seventy-three

(92.4%) fish smolted after two years in freshwater, and six (7.6%) smolted after three years. Total ages ranged from four to six years, with four different freshwater-saltwater age class combinations (Table 3).

Sex and size composition data were collected from the 87 prespawn adult steelhead sampled for age composition (Table 3). Females comprised 67.8% (n = 59) and males comprised 32.2% (n = 28) of the adults sampled at the weir (Table 3). Mean fork length for females was 69.2 cm (range = 53.0–79.0 cm) and males was 722.5 cm (range = 60.0–85.0 cm).

Adult Migration Timing and Conversion Rates

Big Bear Creek Array—Sixty-four adult steelhead were detected in the hydrosystem during the SY 2021 adult migration that were PIT-tagged as juveniles in Big Bear Creek. Sixty-two individuals were detected at Bonneville Dam upon their return migration (Figure 10). The median date of passage over Bonneville Dam was August 4, 2020 (range = June 21–September 23). The conversion rate from Bonneville Dam to McNary Dam was 82.8% and from Bonneville Dam to LGR was 78.1% (Appendix E). Forty-nine of the 50 PIT-tagged adult steelhead detected at LGR were detected during fall 2020, and the other adult was detected during spring 2021. The median date of passage at LGR was October 7 (range = July 5–April 21). Three of the 64 PIT-tagged adults that entered the hydrosystem were detected at the Big Bear Creek PIT tag array.

The median date for prespawn wild adult steelhead detected at the Big Bear Creek PIT tag array was March 13 (Feb 20–April 23; Figure 11).

East Fork Potlatch River Weir—Two adult steelhead were detected in the hydrosystem during the SY 2021 adult migration that were PIT tagged as juveniles in the East Fork Potlatch River. Both individuals were first detected at Bonneville Dam (Figure 10). The median date of passage over Bonneville Dam was July 23, 2020 (range = July 19–July 26). The conversion rate from Bonneville Dam to McNary Dam was 50.0% and from Bonneville to LGR was 50.0%. The only PIT-tagged adult steelhead detected at LGR was detected on September 23. None of the PIT-tagged adults that entered the hydrosystem were captured at the East Fork Potlatch weir.

Prespawn adult steelhead were captured at the weir between April 1–May 13 and kelts were captured between May 1–June 3 (Figure 11). The median date of capture for prespawn adults and kelts was April 17 and May 16, respectively.

Lochsa River Array—Thirty-one adult steelhead were detected in the hydrosystem during the SY 2021 adult migration that were PIT tagged as juveniles in Lochsa River main stem and tributaries. Thirty individuals were detected at Bonneville Dam upon their return migration (Figure 10). Twenty-nine of those were tagged in Fish Creek, and two were tagged in the Lochsa River. The median date of passage over Bonneville Dam was September 4, 2020 (range = July 28–October 2). The conversion rate from Bonneville Dam to McNary Dam was 77.4% and from Bonneville Dam to LGR was 71.0%. Sixteen of the 22 PIT-tagged adult steelhead (72.7%) detected at LGR were detected during the fall and the remaining six fish were detected the following spring. The median date of passage over LGR was December 6 (range = September 22–April 25). Of the initial 31 PIT-tagged adults that entered the hydrosystem, 17 (54.8%) were subsequently detected on the Lochsa River PIT tag arrays.

The median date for prespawn wild adult steelhead detected at the Lochsa River PIT tag arrays was April 4 (October 9–June 1; Figure 11).

Fish Creek Weir—Twenty-nine adult steelhead were detected in the hydrosystem during the SY 2021 adult migration that were PIT tagged as juveniles in Fish Creek. Twenty-eight individuals were detected at Bonneville Dam upon their return migration (Figure 10). The median date of passage over Bonneville Dam was September 5, 2020 (range = August 7–October 2). The conversion rate from Bonneville Dam to McNary Dam was 75.9% and from Bonneville Dam to LGR was 72.4% (Appendix E). Fifteen of the 21 PIT-tagged adult steelhead (71.4%) detected at LGR were detected during the fall and the remaining six fish were detected the following spring. The median date of passage over LGR was December 9 (range = September 28–April 25). Of the initial 29 PIT-tagged adults that entered the hydrosystem, 14 (48.3%) were subsequently captured at the Fish Creek weir, 12 of which were handled as prespawn migrants.

Prespawn adult steelhead were captured at the weir between April 5–June 8 and kelts were captured between May 19–June 24 (Figure 11). The median date of capture for prespawn adults and kelts was May 13 and June 8, respectively.

Rapid River Weir—Six adult steelhead were detected in the hydrosystem during the SY 2021 adult migration that were PIT tagged as juveniles in Rapid River (Figure 10). The median date of passage over Bonneville Dam was August 23, 2020 (range = July 24–September 17). The conversion rate from Bonneville Dam to McNary Dam was 83.3% and from Bonneville to LGR was 83.3%. Four of the five PIT-tagged adult steelhead (80.0%) detected at LGR were detected during the fall, and the other adult steelhead was detected the following spring. The median date of passage at LGR was November 14 (range = September 11–April 29). Of the initial six PIT-tagged adults that entered the hydrosystem, 0 (0.0%) were subsequently captured at the Rapid River weir.

Prespawn adult steelhead were captured at the weir between April 19–May 26 (Figure 11). The median date of capture for prespawn adults was May 7.

South Fork Salmon River Array—Four adult steelhead were detected in the hydrosystem during the SY 2021 adult migration that was PIT tagged as juveniles in the South Fork Salmon River (Figure 10). The median date of passage over Bonneville Dam was September 11, 2020 (range = August 30–September 20). The conversion rate from Bonneville Dam to McNary Dam was 75.0% and from Bonneville to LGR was 50.0%. Both of the PIT-tagged adult steelhead (100.0%) detected at LGR were detected during the fall. The median date of passage over LGR was September 30 (range = September 29–October 2). Of the initial four PIT-tagged adults that entered the hydrosystem, two (50.0%) were subsequently detected on the South Fork Salmon River PIT tag arrays.

The median date for prespawn wild adult steelhead detected at the South Fork Salmon River PIT tag array was April 14 (March 28–May 11; Figure 11).

Big Creek Array—Eight adult steelhead were detected in the hydrosystem during the SY 2021 adult migration that were PIT tagged as juveniles in Big Creek (Figure 10). The median date of passage over Bonneville Dam was August 31, 2020 (range = July 22–September 23). The conversion rate from Bonneville Dam to McNary Dam was 75.0% and from Bonneville to LGR was 75.0% (Appendix F). All six of the PIT-tagged adult steelhead (100.0%) detected at LGR were detected during the fall. The median date of passage over LGR was October 4 (range = August 7–November 23). Of the initial eight PIT-tagged adults that entered the hydrosystem, three (37.5%) were subsequently detected on the Big Creek PIT tag arrays.

The median date for prespawn wild adult steelhead detected at the Big Creek array was April 16 (September 20–May 5; Figure 11).

<u>Marsh Creek Array</u>—No adult steelhead were detected in the hydrosystem during the SY 2021 adult migration that were PIT tagged as juveniles in Marsh Creek. There were 12 adult steelhead PIT tagged as adults at LGR that were subsequently detected at the Marsh Creek arrays. The median date of passage for these fish sampled at LGR was September 14, 2020 (range = August 20–October 7).

The median date for prespawn adult steelhead detected at the Marsh Creek array was April 25 (April 19–May 11; Figure 11).

<u>North Fork Salmon River Array</u>—Three adult steelhead were detected in the hydrosystem during the SY 2021 adult migration that were PIT tagged as juveniles in the North Fork Salmon River (Figure 10). The median date of passage over Bonneville Dam was August 6, 2020 (range = August 5–August 17). The conversion rate from Bonneville Dam to McNary Dam was 33.3% and from Bonneville to LGR was 33.3%. The only PIT-tagged adult steelhead (100.0%) detected at LGR was detected in the fall, on September 4. Because the arrays weren't operating during adult migration period, none of the adults in the hydrosystem that were PIT tagged as juveniles in the North Fork Salmon River were detected at the PIT tag arrays.

<u>Lower Lemhi River Array</u>—Nine adult steelhead were detected in the hydrosystem during the SY 2021 adult migration that were PIT tagged as juveniles in the Lemhi River basin (Figure 10). Five of those were tagged in the Lemhi River, three were tagged in Hayden Creek, and one was tagged in Bohannon Creek. The median date of passage over Bonneville Dam was July 29, 2020 (range = July 3–September 15). The conversion rate from Bonneville Dam to McNary Dam was 77.8% and from Bonneville Dam to LGR was 55.6% (Appendix F). All adults were detected at LGR during the fall. The median date of passage for migrants over LGR was September 16 (range = September 3–October 4). Three of the nine PIT-tagged adults (33.3%) were detected at the lower Lemhi River PIT tag arrays.

The median date for prespawn adult steelhead detected at the lower Lemhi River PIT tag array was April 15 (March 21–May 14; Figure 11).

<u>Pahsimeroi River Weir</u>—Two adult steelhead were detected in the hydrosystem during the SY 2021 adult migration that were PIT tagged as juveniles in the Pahsimeroi River (Figure 10). The median date of passage over Bonneville Dam was August 2, 2020 (range = July 11–August 24). The conversion rate from Bonneville Dam to McNary Dam was 100.0% and from Bonneville to LGR was 50.0%. One adult was detected at LGR on September 2. Of the initial two PIT-tagged adults that entered the hydrosystem, one (50.0%) was captured at the Pahsimeroi weir.

The median date for prespawn adult steelhead captured at the weir was April 8 (March 8–May 3; Figure 11).

<u>East Fork Salmon River Weir</u>—No adult steelhead were detected in the hydrosystem during the SY 2021 adult migration that were PIT tagged as juveniles in the East Fork Salmon River. There were seven adult steelhead PIT tagged as adults at LGR that were subsequently captured at the East Fork Salmon River weir. The median date of passage for these fish sampled at LGR was August 31, 2020 (range = July 9–October 1).

The median date for prespawn adult steelhead captured at the weir was April 28 (April 7–May 8; Figure 11).

Upper Salmon River Weir—Two adult steelhead were detected in the hydrosystem during the SY 2021 adult migration that were PIT tagged as juveniles in the upper Salmon River (Figure 10). The median date of passage over Bonneville Dam was July 15, 2020 (range = July 11–July 19). The conversion rate from Bonneville Dam to McNary Dam was 100.0% and from Bonneville to LGR was 100.0%. The median date of passage for migrants over LGR was October 4 (range = September 2–November 6). Neither of the PIT-tagged adults that entered the hydrosystem was captured at the Upper Salmon River weir.

The median date for prespawn adult steelhead captured at the weir was April 16 (March 29–May 12; Figure 11).

Genetic Sampling

During 2021, we collected genetic samples from wild adult steelhead captured in the course of other project activities. Three hundred and thirty-nine genetic samples were collected across nine IDFG research and hatchery weir locations. All samples were archived for later analysis (Appendix G).

DISCUSSION

The purpose of this report is to collate and summarize population-level information to evaluate the status of selected wild steelhead populations in Idaho. Population abundance, productivity, and life history information are key data needed to inform DPS viability and management. The reporting process continually evolves as data collection infrastructure (arrays and weirs) expands and shifts. This requires an adaptive approach of how to best combine, analyze, and visualize information from various projects. The collation of these data can be used for future tools such as population or life cycle models to increase our knowledge of life-stage specific survival, population dynamics, and predictive powers in assessing long-term viability. Such work has already been completed using data from Fish Creek (McCormick et al. 2020).

Adult Abundance and Productivity

Population-specific abundance and productivity data are key criteria in ESA status assessments of Pacific salmonids (McElhany et al. 2000). Idaho's wild steelhead populations are considered to have a high risk of extinction within 100 years (probability >25%) based on current abundance and productivity estimates (NWFSC 2015; Ford 2022). Idaho Department of Fish and Game conducts population-specific monitoring of adult steelhead abundance and productivity across a diverse assemblage of populations in Idaho. This annual monitoring also provides valuable demographic data (length and age structure) critical to the management of wild steelhead populations. Population-specific monitoring is a key component of the management framework needed in order to evaluate these populations at the proper scale to assess recovery objectives (Copeland et al. 2017).

Adult steelhead abundance estimates for the past five years have been low across all populations compared to years preceding them. However, from SY 2020 to SY 2021 abundance increased in a majority of monitored populations, including the Lochsa River, Fish Creek, South Fork Salmon River, Big Creek, Marsh Creek, East Fork Salmon River, and the upper Salmon

River. The degree of increases in adult abundances across both the Clearwater and Salmon River basins were variable in SY 2021, with increases in some populations (Lochsa River, Fish Creek, and South Fork Salmon River) and moderate changes in other populations.

Natural repeat spawners and reconditioned kelts make up a small percentage (<5%) of annual adult returns to wild steelhead spawning areas. Reconditioned kelts were wild adults that have spawned naturally and were captured as kelts at LGR, which were then artificially reconditioned in a hatchery and released in the Snake River to naturally spawn a second time (Jenkins et al. 2018). Natural repeat spawners and reconditioned kelts were counted as parents for every year that they returned to spawn and were assumed to have the same probability of producing the same number of progeny with each spawning event as all other adult returners. Contributions from repeat spawners diversify steelhead life history and can buffer anthropogenic effects (Moore et al. 2014; Copeland et al. 2019). The overall effect of reconditioned kelts on natural productivity is largely unknown, although reconditioned kelts were found to have a much higher return rate to spawning tributaries than an in-river migration control group in the Yakima River basin (Trammell et al. 2016). Five reconditioned kelts were observed in monitored tributary systems in 2021; three were detected at the lower Lemhi River arrays, one was detected on the Lochsa River arrays, and one was detected on the South Fork Salmon River arrays. One natural repeat spawner was identified on the Lochsa River arrays; this was the only repeat spawner identified at the locations summarized in this report.

Occurrences of hatchery strays above PIT tag array sites are also relatively low based on PIT tag detections, but total contributions to the population are unknown. This is partially due to the reduced tag rate of hatchery-origin steelhead within the Snake River basin relative to wild-origin steelhead. Current productivity analyses have not incorporated hatchery-origin steelhead, and future iterations of this report would benefit from examining the influence of hatchery spawners on the productivity of wild steelhead populations where they cannot be regulated (i.e., PIT tag array sites). Monitoring trends in abundance of hatchery-origin strays in areas managed for wild steelhead populations is important for understanding the long-term effects of hatchery-reared fish and wild fish interactions as they have been associated with decreasing natural production over time in some systems (Chilcote 2003).

Idaho wild steelhead are not consistently meeting replacement based on adult-to-adult productivity. All populations reported here were below replacement for the last 4-8 BYs (Figure 4). Mean productivity for BY 2014 across all populations monitored was 0.28 (range = 0.04–0.62), well below replacement. However, mean productivity for BY 2014 increased by 56.0% from BY 2013 across all populations monitored. Fish Creek (Clearwater River MPG) contains the longest productivity time series (23 complete BYs) and highlights the variability in steelhead productivity. Adult-to-adult productivity in Fish Creek varied from 0.3 to 10.3 recruits per spawner with nine years (39.1%) meeting replacement. Fluctuations in productivity are expected in wild populations and was illustrated in existing data. However, the complex life history diversity of Idaho steelhead likely lends to their ability to rebound from previous low productivity years (Dobos et al. 2020a). Small populations are more easily influenced by random processes such as environmental variation and stochasticity, making them more vulnerable to extinction compared to large populations (McElhany et al. 2000). Identifying the extent of these processes will help determine extinction risks and the resiliency of the population. In order to increase our understanding of the status of Idaho steelhead populations, we will expand our population productivity baseline data sets to include the Lochsa River and North Fork Salmon River populations in 2023, and Marsh Creek and South Fork Salmon River populations in 2025.

Habitat restoration efforts can increase juvenile rearing capacity in systems where density dependence has been observed. In Idaho, density dependence in juvenile steelhead production has been observed in populations in Fish Creek (Dobos et al. 2020a*;* Dobos et al. 2020b) and the Potlatch River (Bowersox et al. 2012; Uthe et al. 2017), and in spring/summer Chinook Salmon production (Walters et al. 2013). Although our dataset is limited, density-dependent patterns are starting to emerge in other study populations, specifically Pahsimeroi River and upper Salmon River populations (Figure 6). Improving freshwater rearing habitat is one of the suite of actions being taken to reduce density-dependent effects on salmonid populations (Copeland et al. 2021). Efforts by IDFG focus on evaluating fish population response to habitat restoration in four monitored watersheds: the Potlatch River, North Fork Salmon River, Lemhi River, and Pahsimeroi River (IDFG 2019). Restoration and monitoring programs have been underway in these watersheds for more than a decade and have provided increased habitat quality and quantity for spawning and rearing (Uthe et al. 2017). Further monitoring of adult productivity should highlight the population-level benefits from these efforts and allow for more adequate evaluation of potential density dependence in additional populations in Idaho.

Smolt-to-Adult Return Rates

Smolt-to-adult return rates remain an important parameter for monitoring population performance and influences of ocean conditions for anadromous fish in Idaho. Smolt-to-adult return rates have been below objective in all four monitored populations for the last four MYs reported, with the exception of Big Bear Creek in 2018 (2015-2018; Figure 7). This trend closely mirrors the poor BY replacement observed in recent years among monitored populations (Figure 4), highlighting the influence of ocean conditions on Idaho steelhead (Petrosky and Schaller 2010). Ocean condition indicators are available through the Northwest Fisheries Science Center (Peterson et al. 2020), and some of the poorest “stoplight” rankings are broadly congruent with the recent trend of poor SARs. However, these indicators were established to understand factors affecting coho and Chinook. Few studies have looked at how these rankings relate to steelhead populations with diverse life history strategies and overlapping cohorts. In 2019, new standard methods were established and SARs (to Bonneville Dam) for Big Bear Creek, Big Creek, Fish Creek, and the Lemhi River were reported (Dobos et al. 2020b). Changing the adult detection location from LGR to Bonneville Dam, allowed for a metric focused more on ocean survival, and free of influence from downstream harvest management actions. Using Bonneville as the adult detection location also helped ensure that enough adults were detected to generate reliable estimates for groups with low returns.

Our population-level SARs complement the large-scale analyses being reported at the MPG-level for the Comparative Survival Study (McCann et al. 2018), and can guide management by examining population-specific performance within MPGs. However, low or no returns of PIT-tagged adults limits the expansion of calculating SARs in the other monitored populations included in this report. We recommend considering combining watersheds (e.g. all juvenile marking sites in the upper Salmon River basin) for systems that have too few PIT-tagged returning adults to calculate SARs.

Diversity

Steelhead have the most diverse portfolio of life history strategies of Pacific salmonids (Quinn 2018) and as a result, they display a tremendous amount of variation in age and size at maturity. Understanding this diversity within and among populations is important to the management and recovery of wild populations (McElhany et al. 2000). Spawn year 2021 was dominated by 2-ocean adults, with 92.7% of ocean-aged steelhead spending two years in the saltwater. Dramatic shifts in age composition have been common in recent years. Spawn year 2017 was dominated by 2-ocean fish (89.7%), which shifted dramatically to predominantly 1-ocean adults in SY 2018 (73.5%), while SYs 2019 and 2020 were comprised of 59.0% and 46.2% 2-ocean fish, respectively. The observed shifts in age composition likely reflect fluctuations in ocean productivity, which can heavily influence year class strength. Additionally, the large age composition shifts observed between SY 2017 and SY 2018 were also compounded by drought conditions in 2015 and poor performance by the MY 2015 cohort. These data highlight the benefits of having a diverse range of ages at maturity for steelhead to buffer against the possibility of a single brood year or ocean year failure.

Further evidence of diversity among steelhead populations, even within MPGs, was reflected in their freshwater and saltwater ages. The Lochsa River, South Fork Salmon River, and Big Creek are generally older fish in both time spent in freshwater and in saltwater. Returning adults from these populations were mostly comprised of freshwater age-3 fish (50.9%); whereas, the freshwater age-3 comprised a mean of 34.5% in all other populations in this study. These three populations normally display an older ocean age as well; however, in SY 2021 the mean proportion of 2-ocean adults in the Lochsa River, South Fork Salmon River, and Big Creek was only slightly higher (89.5%) than the mean proportion of 2-ocean adults all other populations (88.6%). We recommend that future iterations of this report examine if the age and sex diversity findings that are annually reported here align with IDFG's efforts at LGR to monitor steelhead viability at the tributary level (Baum et al. 2022).

Diversity of steelhead populations was also observed in their run timing through the hydrosystem. Across years, Big Bear Creek and Lemhi River steelhead populations, comprised of relatively younger and smaller fish, had an earlier arrival date to Bonneville Dam compared to older, larger fish generally found in the Lochsa River basin. Run timing differences associated with the age and size structure of summer-run steelhead populations has been previously documented (Robards and Quinn 2002; Copeland et al. 2017) and were historically used to differentiate and manage A-run and B-run type stocks in the Columbia River basin (WDFW and ODFW 2002). Adult steelhead returning to the Lochsa River basin usually have a small proportion of fish that do not migrate above LGR until the spring season. Earlier timing at LGR for upper Salmon River basin populations is likely also related to the longer distance to travel to spawning grounds.

Challenges

Abundance estimates derived from PIT tag array data provide a valuable tool for fishery managers. However, potential limitations of the current models need to be addressed prior to including additional array sites in this report. IPTDSW (2020) describes potential issues with the DABOM model that include model maintenance. As additions of new PIT tag array sites and better modeling capabilities are developed, the model estimating abundances will evolve. Versions of the DABOM model have been modified multiple times since results were first published (See et al. 2016). The addition of new PIT tag array sites helps improve the accuracy of other sites in the branch model. In 2019, a newer version of the model was able to re-run escapement estimates for all previous years. The Bayesian framework allows older data (prior to installation of some new PIT tag arrays) to be informed by data collected from all new infrastructure in recent years. Increased precision in abundance estimates lends to higher precision in estimating productivity; however, this analysis influences other analyses reported under other IDFG reports (e.g., Feeken et al. 2020). Another potential issue with using PIT tag arrays to monitor escapement is the limitation of the number of PIT-tagged adult steelhead available for diversity and productivity analysis. The number of adults handled and tagged at

LGR is annually decided through a cooperative agreement of multiple agencies. In low return years, sample sizes might not provide accurate sex and age information for population demographic inference at all sites. Small sample sizes will also limit the capabilities of the DABOM model to estimate escapement to PIT tag array sites. A power analysis for PIT tag array sites would aid in deciding rules on whether to include certain escapement estimates for productivity analysis. Monitoring infrastructure and analytical methods have evolved through time. In order to understand these changes and better grasp the trend data reported here, please see Appendix H.

Infrastructure deficiencies at certain sites, compounded by low numbers of returning adult steelhead over the past five years, continue to hamper our ability to accurately estimate spawners and generate adult-to-adult and adult-to-juvenile productivity analyses. For example, the permanent weir structure at Crooked River is ineffective during high spring flows when adult steelhead are migrating, and has not had enough individuals trapped to consistently estimate an expanded abundance of spawners in recent years. Therefore, a PIT tag array site was installed on Crooked River in the fall of 2021, and will be used to generate an abundance estimate for SY 2022. Additionally, we continue to struggle generating expanded estimates of adult spawners at Big Bear Creek due to a low number of detections resulting from difficulties physically maintaining a dual span array. We have improved the PIT tag array infrastructure and are examining alternative methods using Bayesian framework to fill these data gaps where expanded estimates could not be generated.

RECOMMENDATIONS

1. Identify the influence of hatchery spawners on the productivity of wild steelhead populations where they cannot be regulated (i.e., PIT tag array sites). Examine the inclusion of hatchery spawners into productivity analyses.

2. Expand population productivity baseline data sets to include other monitoring locations. Potential locations where sufficient juvenile tagging at rotary screw traps coincides with sufficient adult collections at weirs or detections at tributary arrays include the Lochsa, the South Fork Salmon, and the North Fork Salmon rivers and Marsh Creek.

3. Estimate SARs for additional populations in the Clearwater River and Salmon River MPGs using methods developed for Big Bear Creek, Fish Creek, Big Creek, and the Lemhi River. For systems that have too few PIT-tagged returning adults to calculate SARs, consider combining watersheds such as all marked sites in the upper Salmon River basin.

4. Compare age structure and sex composition between GSI populations sampled at LGR to index tributaries to determine if metrics estimated at LGR dam are sufficient for viability monitoring at the tributary level.

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TABLES

Table 1. Major population groups and independent populations within the Snake River steelhead distinct population segment (DPS; ICTRT 2007; NWFSC 2015; NMFS 2016).

Snake River steelhead DPS	
Major population group	**Population name**
Lower Snake River	1. Tucannon River 2. Asotin Creek
Grande Ronde River	3. Lower Grande Ronde River 4. Joseph Creek 5. Wallowa River 6. Upper Grande Ronde River
Imnaha River	7. Imnaha River
Clearwater River	8. Lower Clearwater River 9. North Fork Clearwater River (extirpated) 10. Lolo Creek 11. Lochsa River 12. Selway River 13. South Fork Clearwater River
Salmon River	14. Little Salmon River 15. Chamberlain Creek 16. South Fork Salmon River 17. Secesh River 18. Panther Creek 19. Lower Middle Fork Salmon River 20. Upper Middle Fork Salmon River 21. North Fork Salmon River 22. Lemhi River 23. Pahsimeroi River 24. East Fork Salmon River 25. Upper Salmon River
Hells Canyon Tributaries (extirpated)	

Table 2. Selected intensive, high-precision adult steelhead monitoring locations within the Clearwater River and Salmon River MPGs.

MPG	**Site location**	**Population**
Clearwater River	Big Bear Creek (Weir/Array)	Lower Clearwater River
	East Fork Potlatch River (Weir)	Lower Clearwater River
	Crooked River (Weir)	South Fork Clearwater River
	Lochsa River (Array)	Lochsa River
	Fish Creek (Weir)	Lochsa River
Salmon River	Rapid River (Weir)	Little Salmon River
	South Fork Salmon River (Array)	South Fork Salmon River
	Big Creek (Array)	Lower Middle Fork Salmon River
	Marsh Creek (Array)	Upper Middle Fork Salmon River
	North Fork Salmon River (Array)	North Fork Salmon River
	Lower Lemhi River (Array)	Lemhi River
	Hayden Creek (Array)	Lemhi River
	Upper Lemhi River (Array)	Lemhi River
	Pahsimeroi River (Weir)	Pahsimeroi River
	East Fork Salmon River (Weir)	East Fork Salmon River
	Upper Salmon River (Weir)	Upper Salmon River

Table 3. Number of wild adult steelhead (prespawn and kelts) captured at weirs or sampled at Lower Granite Dam (LGR) that were subsequently detected at PIT tag arrays, spawn year 2021. Numbers by sex and size were also given. NA = not applicable.

Site Location	Sex	Unique prespawn adults trapped at weirs	Unique adults sampled at LGR	Fork length (cm)			Kelts recovered	
				Minimum	Mean	Maximum	Unmarked	Marked
Clearwater River MPG								
Big Bear Creek (Array)	Female	NA	2	73.0	74.5	76.0	NA	NA
	Male	NA	3	73.0	80.7	86.0	NA	NA
	All	NA	5	73.0	78.2	86.0	NA	NA
East Fork Potlatch River (Weir)	Female	12	NA	41.2	69.9	77.1	0	1
	Male	5	NA	41.0	64.0	78.3	0	2
	All	17	NA	41.0	68.2	78.3	0	3
Crooked River (Weir)	Female	0	NA	NA	NA	NA	0	0
	Male	1	NA	860	860	860	0	0
	All	0	NA	NA	NA	NA	0	0
Lochsa River (Array)	Female	NA	114	70.0	80.4	90.0	NA	NA
	Male	NA	30	53.0	80.9	93.0	NA	NA
	Unknown	NA	1	79.0	79.0	79.0	NA	NA
	All	NA	145	53.0	80.4	93.0	NA	NA
Fish Creek (Weir)	Female	64	NA	72.0	78.6	84.0	4	31
	Male	26	NA	55.5	79.1	89.0	2	7
	All	90	NA	55.5	78.8	89.0	6	38
Salmon River MPG								
Rapid River (Weir)	Female	9	NA	68.0	77.1	83.0	NA	NA
	Male	2	NA	82.0	82.0	82.0	NA	NA
	All	11	NA	68.0	78.0	83.0	NA	NA
South Fork Salmon River (Array)	Female	NA	28	61.0	77.3	83.0	NA	NA
	Male	NA	7	65.0	83.3	93.0	NA	NA
	All	NA	35	61.0	78.5	93.0	NA	NA
Big Creek (Array)	Female	NA	15	62.0	75.1	83.0	NA	NA
	Male	NA	5	61.0	66.6	79.0	NA	NA
	Unknown	NA	1	81.0	81.0	81.0	NA	NA
	All	NA	21	61.0	73.3	83.0	NA	NA
Marsh Creek (Array)	Female	NA	9	66.0	74.4	82.0	NA	NA
	Male	NA	4	74.0	82.5	86.0	NA	NA
	All	NA	13	66.0	76.9	86.0	NA	NA
North Fork Salmon River (Array)	Female	NA	NA	NA	NA	NA	NA	NA
	Male	NA	NA	NA	NA	NA	NA	NA
	All	NA	NA	NA	NA	NA	NA	NA
Lower Lemhi River (Array)	Female	NA	16	54.0	66.3	73.0	NA	NA
	Male	NA	3	53.0	61.0	73.0	NA	NA
	All	NA	19	53.0	65.5	73.0	NA	NA
Hayden Creek (Array)	Female	NA	7	57.0	65.1	69.0	NA	NA
	Male	NA	2	68.0	70.5	73.0	NA	NA
	All	NA	9	57.0	66.3	73.0	NA	NA

Table 3. Continued.

Site Location	Sex	Unique prespawn adults trapped at weirs	Unique adults sampled at LGR	Fork length (cm) Minimum	Mean	Maximum	Kelts recovered Unmarked	Marked
Salmon River MPG								
Upper Lemhi River (Array)	Female	NA	2	62.0	65.0	68.0	NA	NA
	Male	NA	1	73.0	73.0	73.0	NA	NA
	All	NA	3	62.0	67.7	73.0	NA	NA
Pahsimeroi River (Weir)	Female	14	NA	55.0	66.6	78.0	NA	NA
	Male	6	NA	59.0	70.8	87.0	NA	NA
	All	20	NA	55.0	67.9	87.0	NA	NA
East Fork Salmon River (Weir)	Female	39	NA	53.0	70.5	78.0	NA	NA
	Male	17	NA	55.0	70.5	82.0	NA	NA
	All	56	NA	53.0	70.5	82.0	NA	NA
Upper Salmon River (Weir)	Female	59	NA	53.0	69.2	79.0	NA	NA
	Male	28	NA	60.0	72.3	85.0	NA	NA
	All	87	NA	53.0	70.2	85.0	NA	NA

Table 4. Age frequencies of wild adult steelhead captured at weirs or sampled at Lower Granite Dam (LGR) that were subsequently detected at PIT tag arrays, spawn year 2021. Freshwater age that could not be determined was signified by x, any age that could not be determined was signified by NA, and natural repeat spawners were signified by R.

	Adult Steelhead Age (FW.SW)															
Site location	**1.1**	**1.2**	**2.1**	**2.2**	**2.3**	**3.1**	**3.2**	**3.3**	**4.1**	**4.2**	**R**	**x.1**	**x.2**	**x.3**	**NA**	**Total**
Clearwater River MPG																
Big Bear Creek (Array)	0	0	0	3	0	0	0	0	0	0	0	0	2	0	0	5
East Fork Potlatch River (Weir)	0	0	0	7	0	2	4	0	1	0	0	1	1	0	1	17
Crooked River (Weir)	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1
Lochsa River (Array)	0	2	0	47	1	2	42	0	1	1	1	1	45	0	2	145
Fish Creek (Weir)	0	0	0	24	0	2	46	0	0	0	0	1	23	0	0	96
Salmon River MPG																
Rapid River (Weir)	0	0	0	2	0	0	6	0	0	0	0	1	2	0	0	11
South Fork Salmon River (Array)	0	1	0	8	1	0	11	0	0	0	0	2	11	0	1	35
Big Creek (Array)	0	0	0	5	0	2	4	0	0	0	0	2	8	0	0	21
Marsh Creek (Array)	0	0	0	2	0	0	7	0	0	0	0	0	4	0	0	13
North Fork Salmon River (Array)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lower Lemhi River (Array)	0	2	2	7	0	2	2	0	0	0	0	0	4	0	0	19
Hayden Creek (Array)	0	0	1	4	0	0	1	0	0	0	0	0	3	0	0	9
Upper Lemhi River (Array)	0	0	0	2	0	0	1	0	0	0	0	0	0	0	0	3
Pahsimeroi River (Weir)	0	3	0	1	0	0	1	0	0	0	0	2	3	0	1	11
East Fork Salmon River (Weir)	0	0	2	35	0	4	9	0	0	0	0	0	4	0	1	55
Upper Salmon River (Weir)	0	0	2	71	0	2	4	0	0	0	0	0	8	0	0	87
Total	0	8	7	218	2	16	138	0	2	1	1	10	118	1	6	528

FIGURES

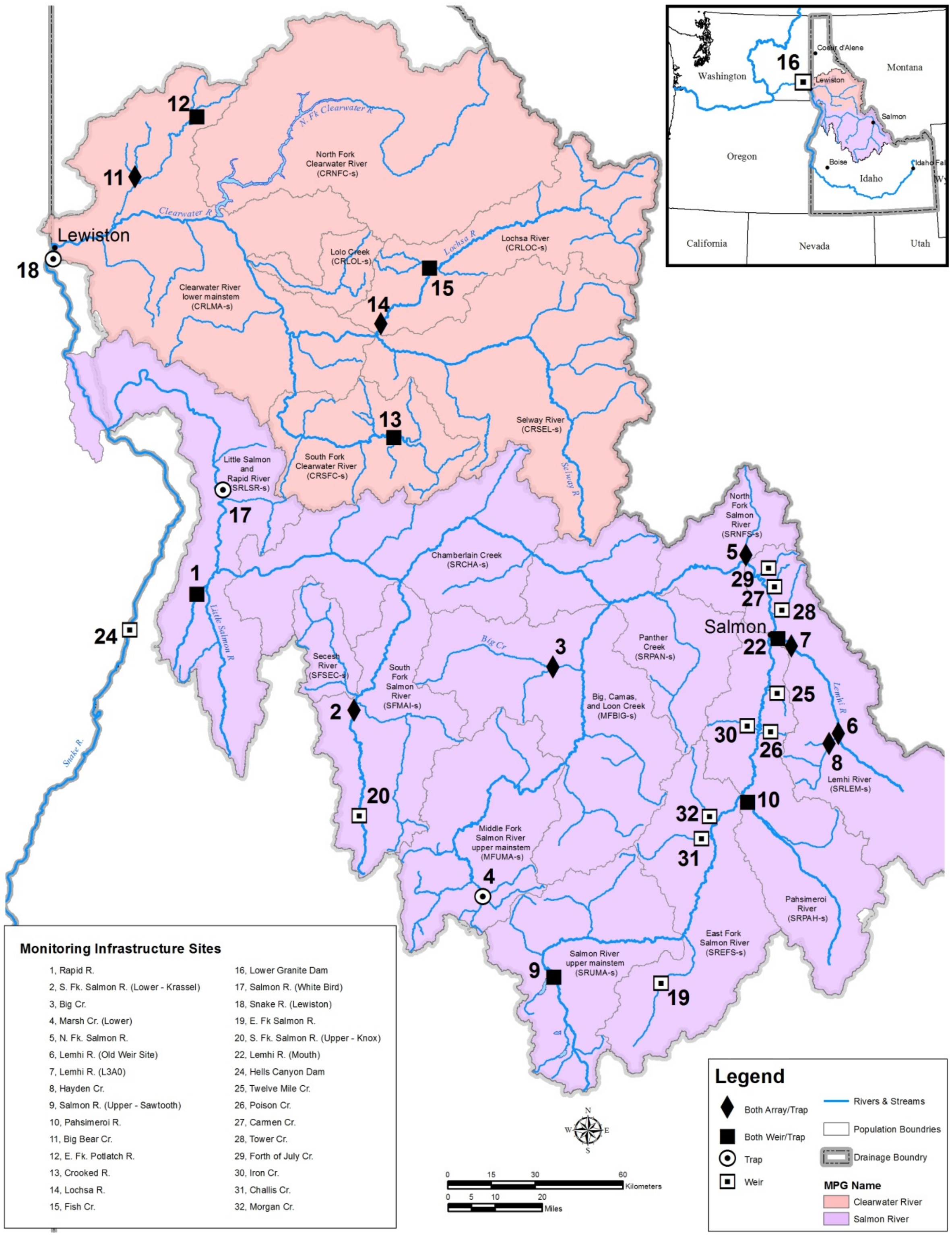

Figure 1. Location of wild steelhead monitoring infrastructure operated by IDFG in Idaho. The Clearwater River Major Population Group is in pink; the Salmon River Major Population Group is in purple. Population boundaries are shown as light gray lines.

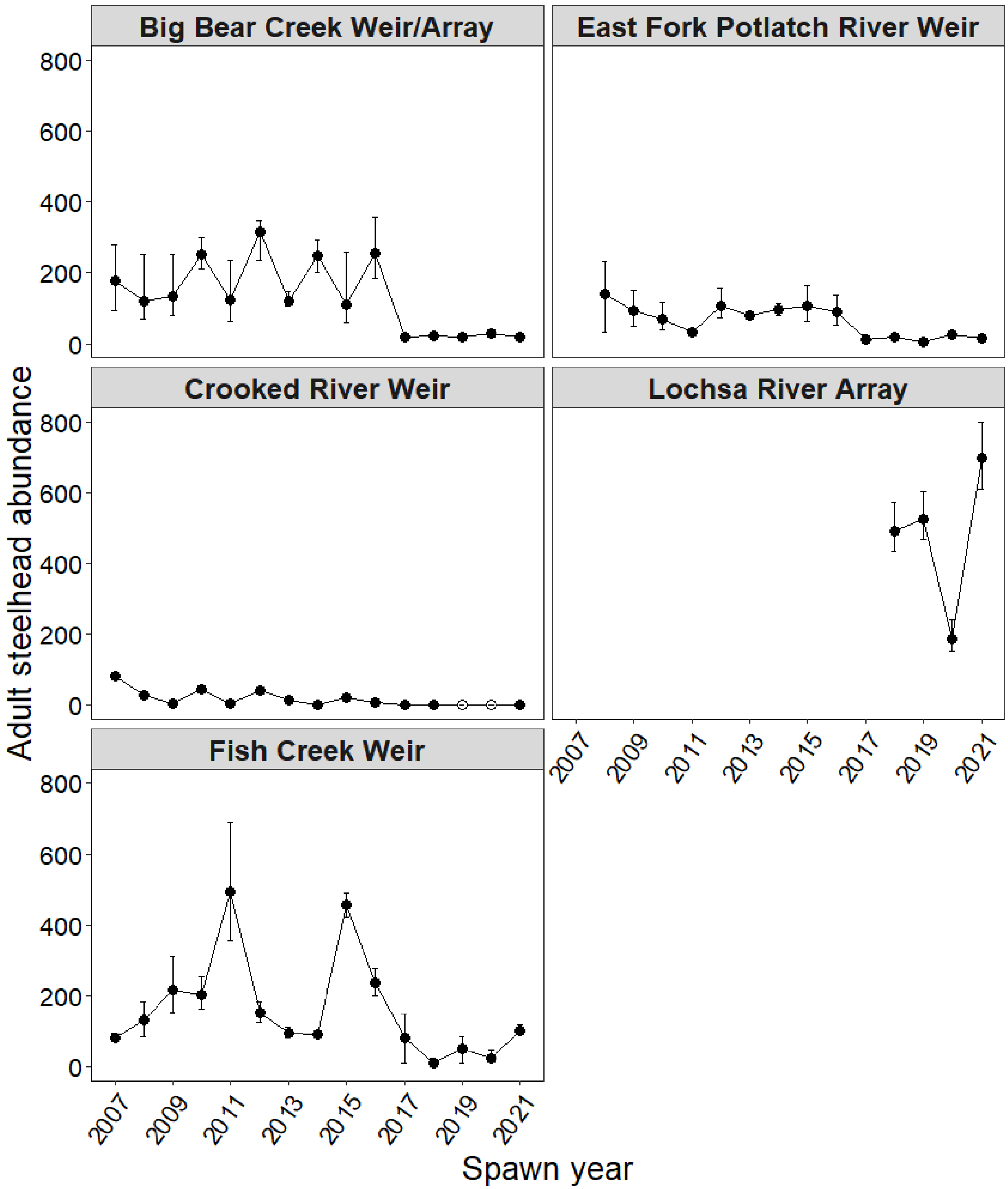

Figure 2. Abundance trends of wild adult steelhead at weirs or PIT tag arrays in the Clearwater River basin, spawn years 2007–2021. Confidence intervals are at 95%. Points without confidence intervals are unique adults trapped or detected. Hollow points indicate an abundance of zero.

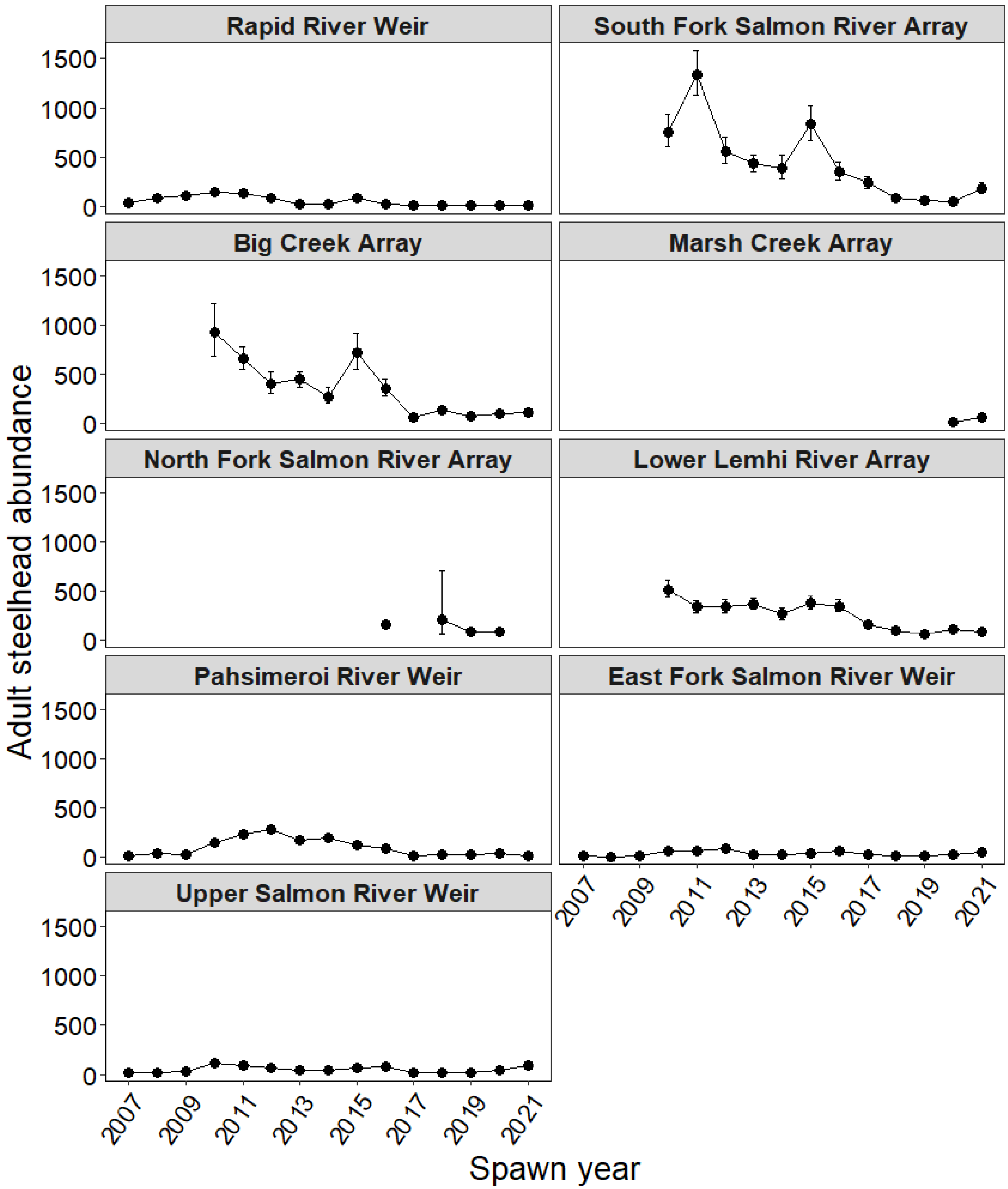

Figure 3. Abundance trends of wild adult steelhead at weirs or PIT tag arrays in the Salmon River basin, spawn years 2007–2021. Confidence intervals are at 95%. Points without confidence intervals are unique adults trapped or detected.

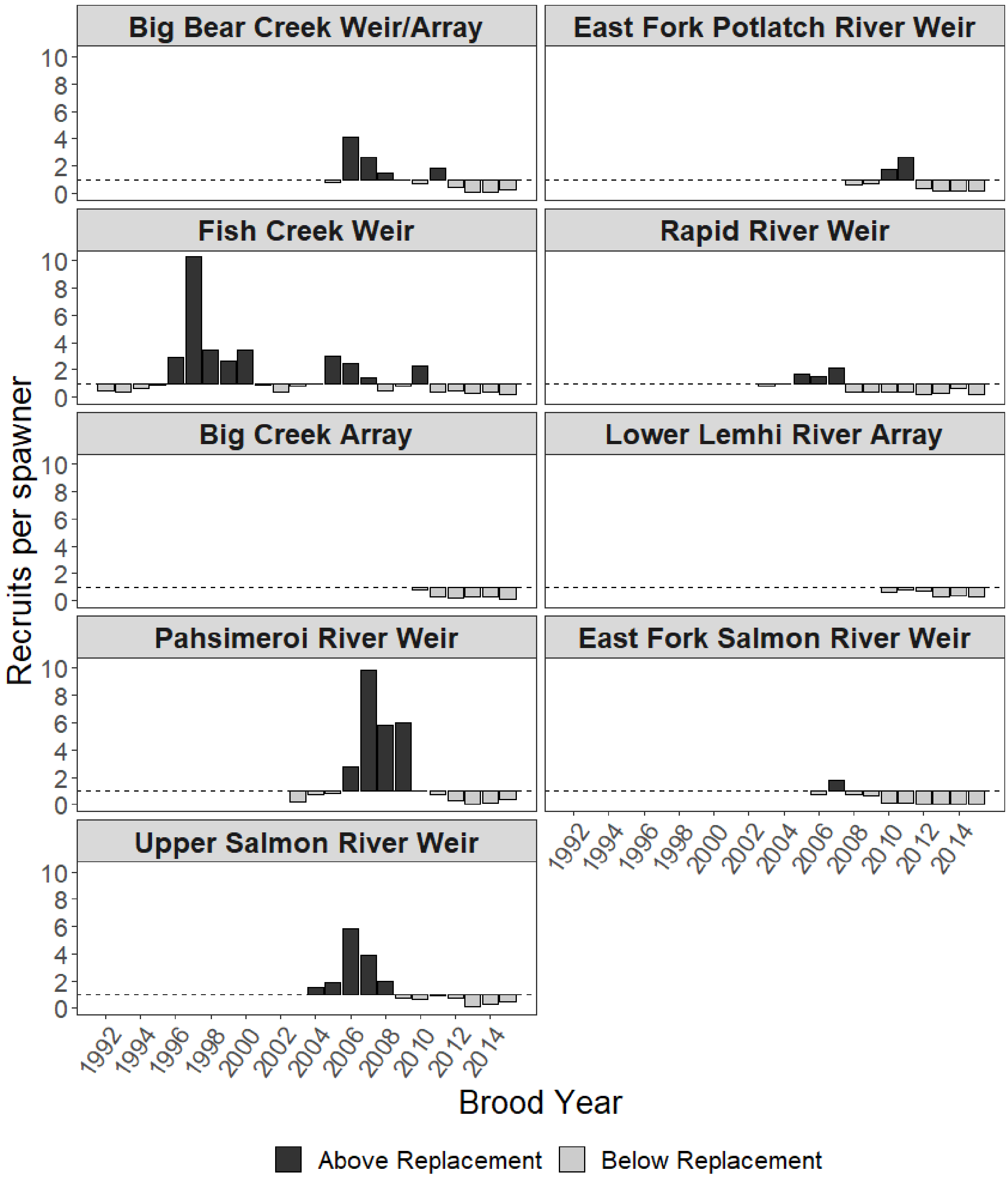

Figure 4. Productivity (wild adult recruits per spawner) of steelhead at select Idaho weirs or PIT tag arrays, brood years 1992–2015. Select brood years were omitted due to incomplete data. Dashed line represents 1:1 replacement.

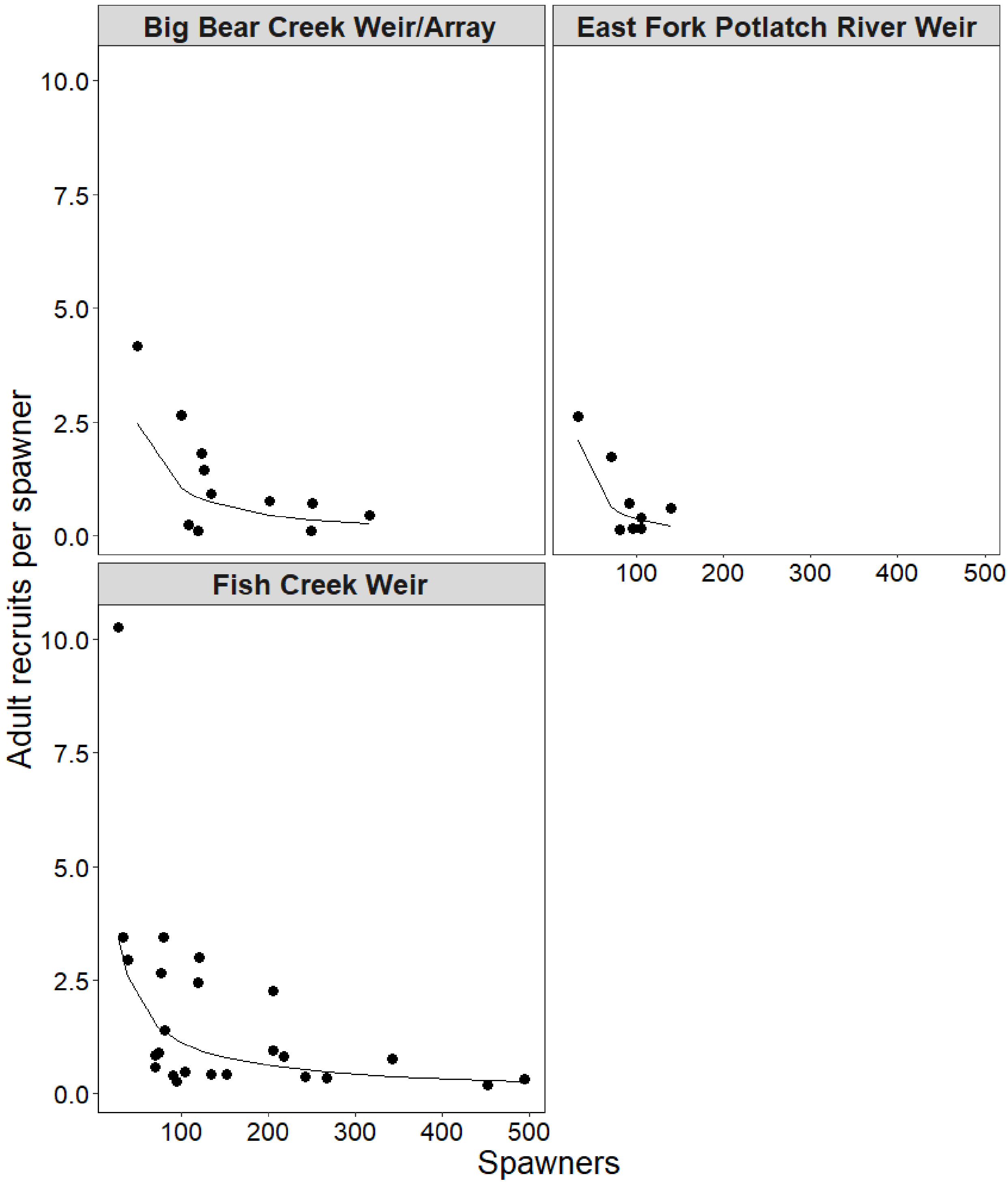

Figure 5. Relationship of steelhead productivity (wild adult recruits per spawner) to spawner abundance at select weirs or PIT tag arrays in the Clearwater River basin, brood years 1992–2015. Select brood years were omitted due to incomplete data. Trend lines for each data set were fit with a power function.

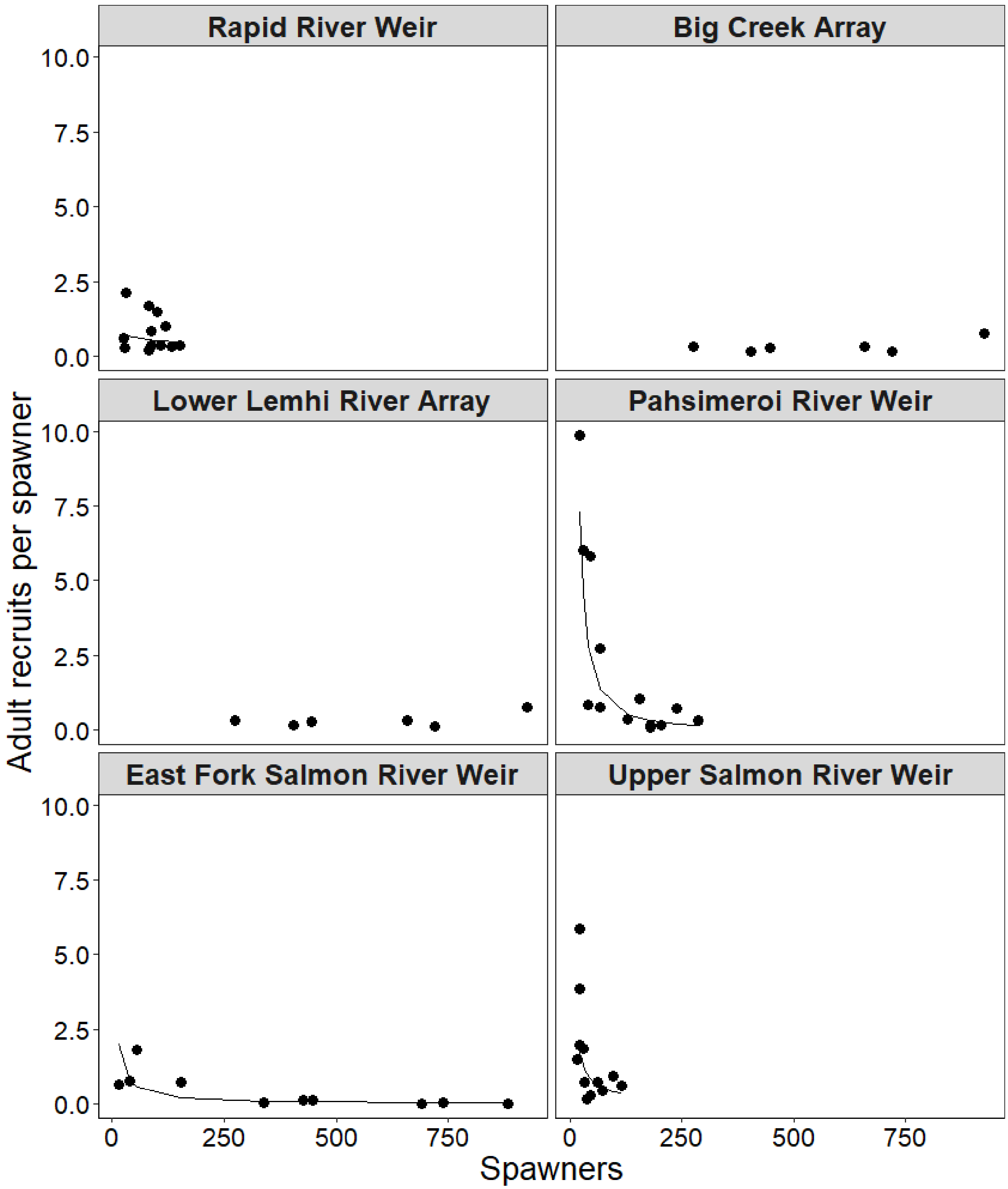

Figure 6. Relationship of steelhead productivity (wild adult recruits per spawner) to spawner abundance at select weirs or PIT tag arrays in the Salmon River basin, brood years 1992–2015. Select brood years were omitted due to incomplete data. Trend lines for each data set were fit with a power function where applicable.

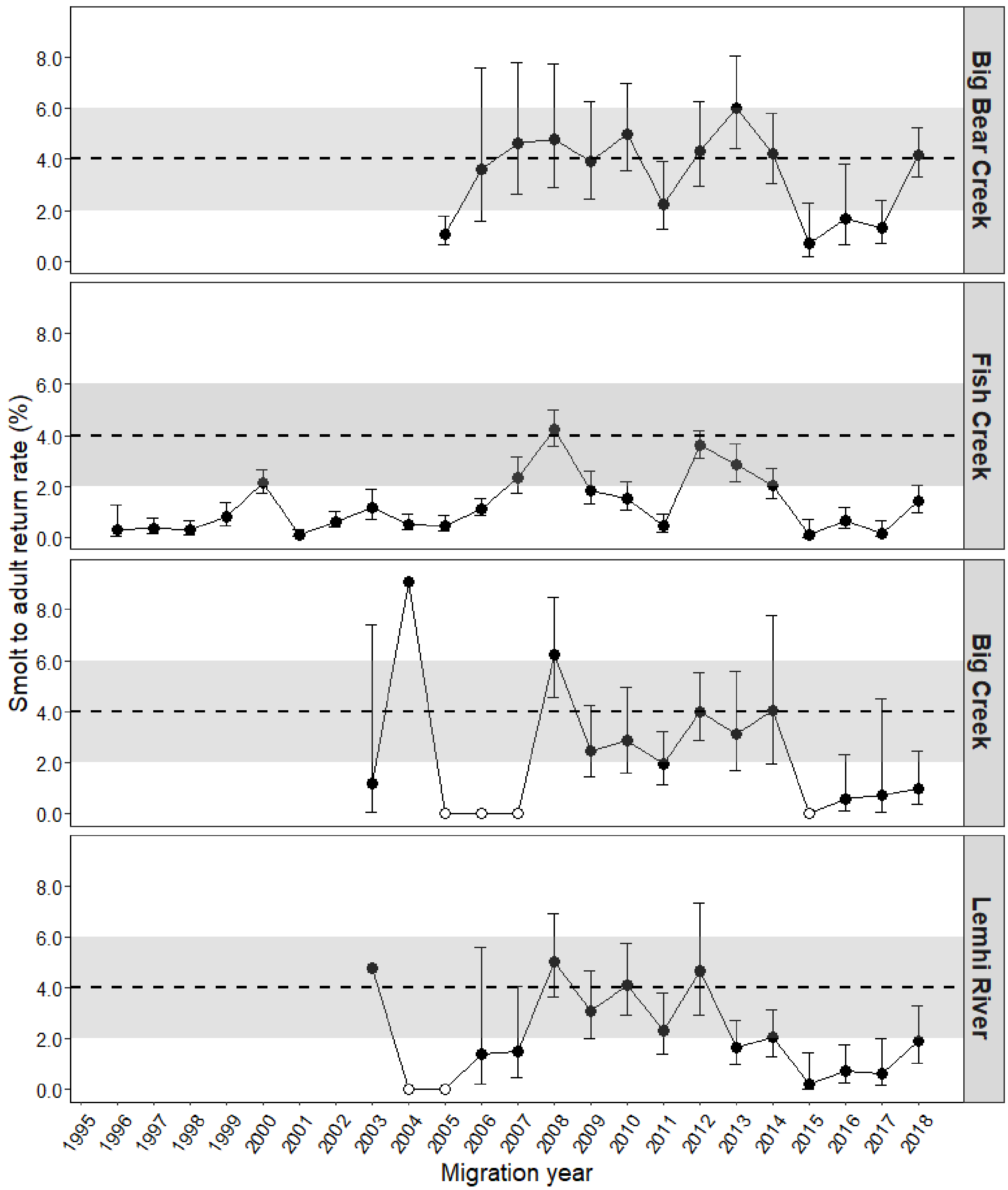

Figure 7. Wild steelhead smolt-to-adult return rate (SAR, %) from select Idaho weirs or PIT tag arrays to Bonneville Dam, migratory years 1996–2018. Confidence intervals are at 95%. Hollow points indicate an SAR of zero. Select confidence intervals were omitted due to small number of smolts used for analyses and extreme interval values. Median SAR objective (dashed lines) with upper and lower range (shaded areas) were established by the Northwest Power and Conservation Council (NPCC 2014).

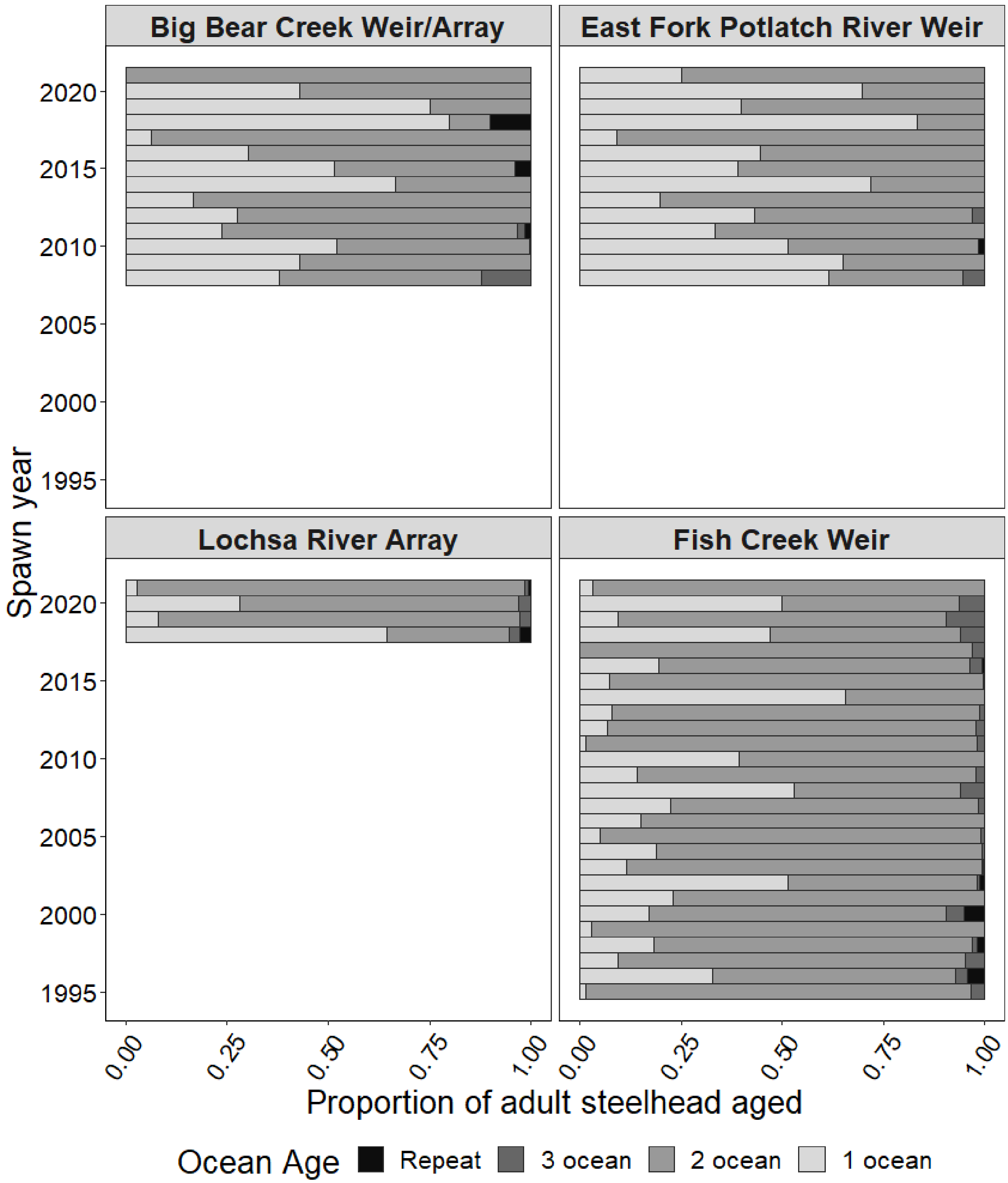

Figure 8. Ocean age composition of wild adult steelhead at select Idaho weirs or PIT tag arrays in the Clearwater River basin, spawn years 1995–2021. Select spawn years were omitted due to incomplete data.

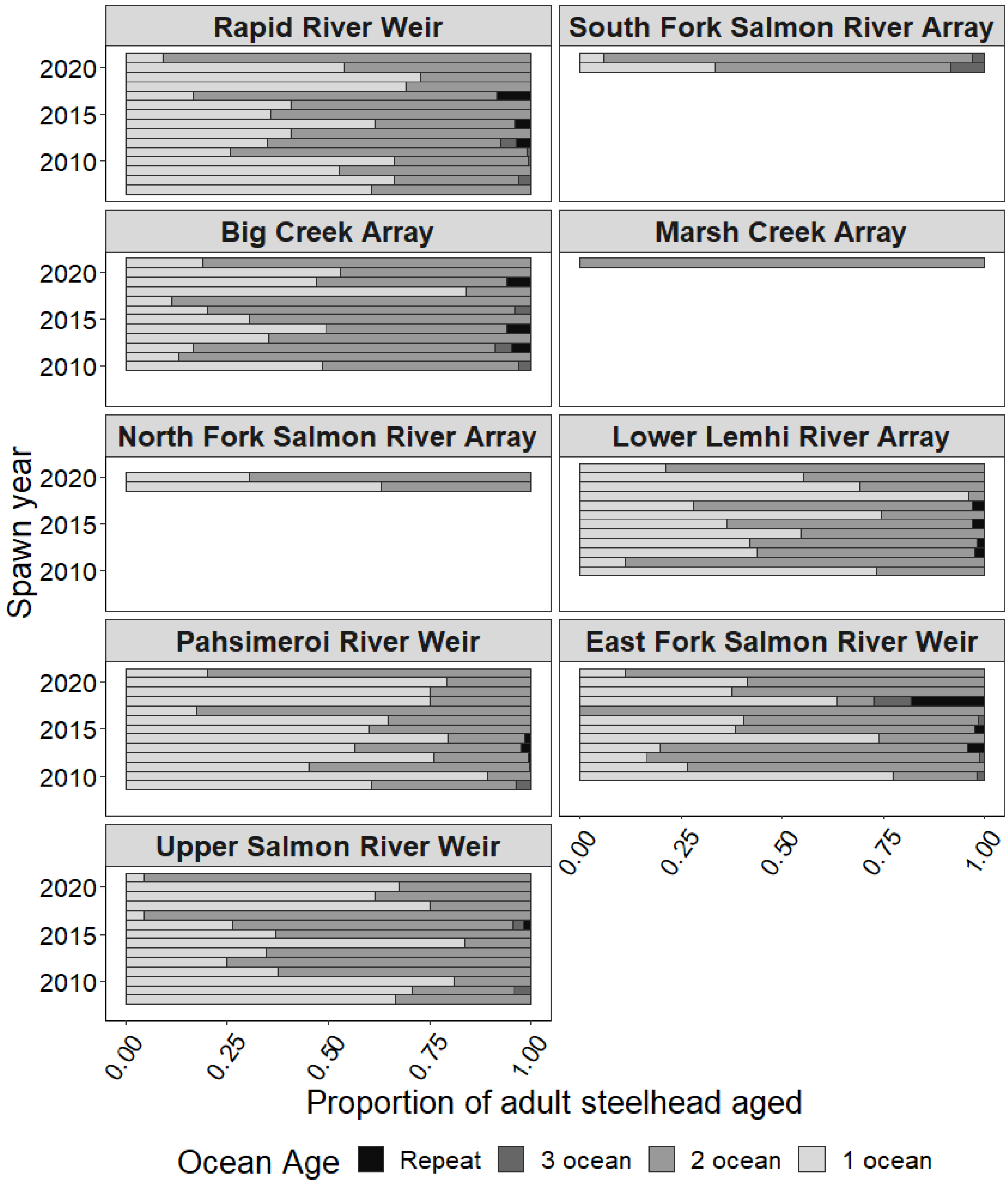

Figure 9. Ocean age composition of wild adult steelhead at select Idaho weirs or PIT tag arrays in the Salmon River basin, spawn years 2007–2021. Select spawn years were omitted due to incomplete data.

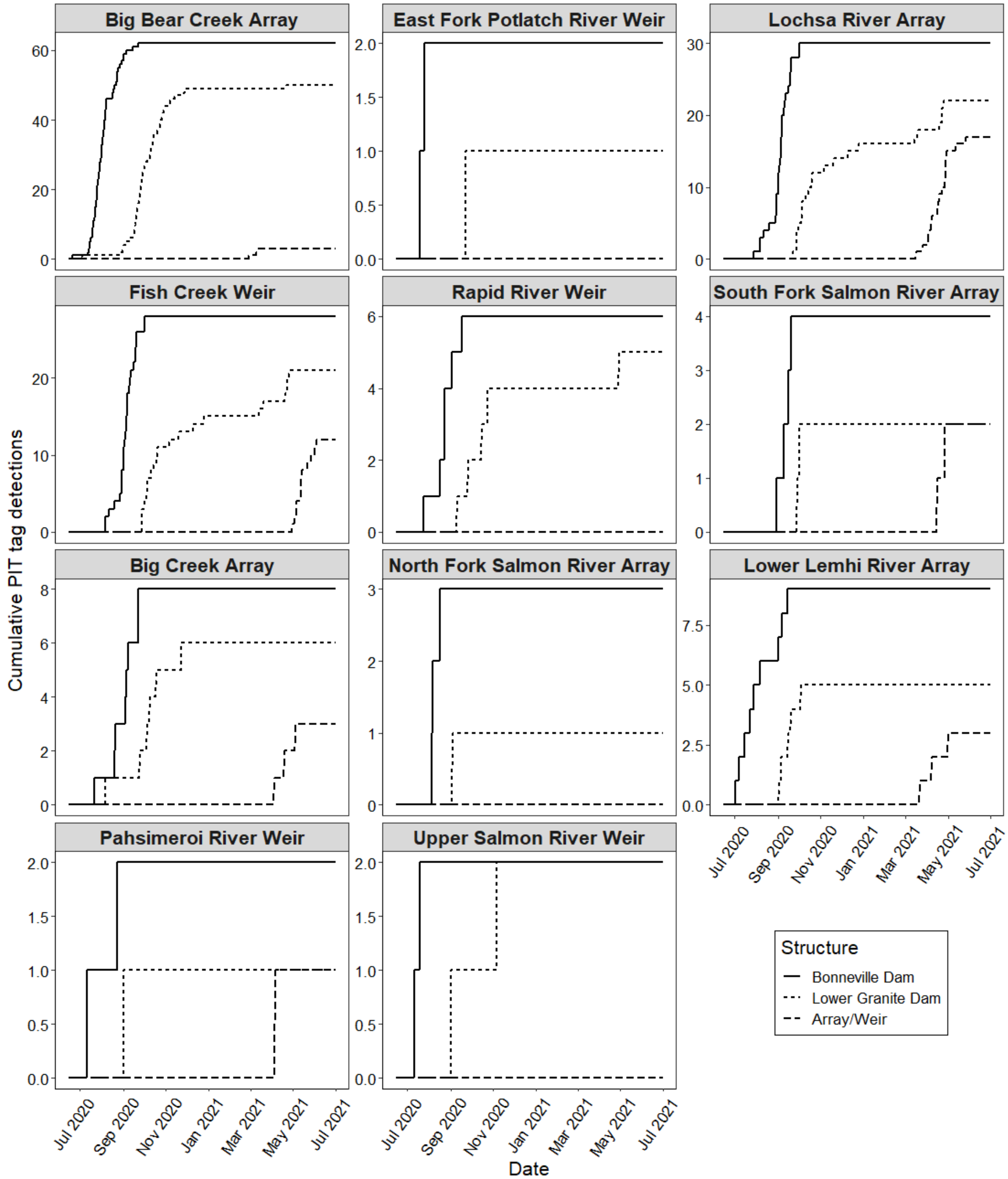

Figure 10. Cumulative wild steelhead run-timing curves at Bonneville Dam, Lower Granite Dam, and select Idaho PIT tag arrays and weirs, spawn year 2021. Steelhead were PIT-tagged as juveniles is in their natal tributaries.

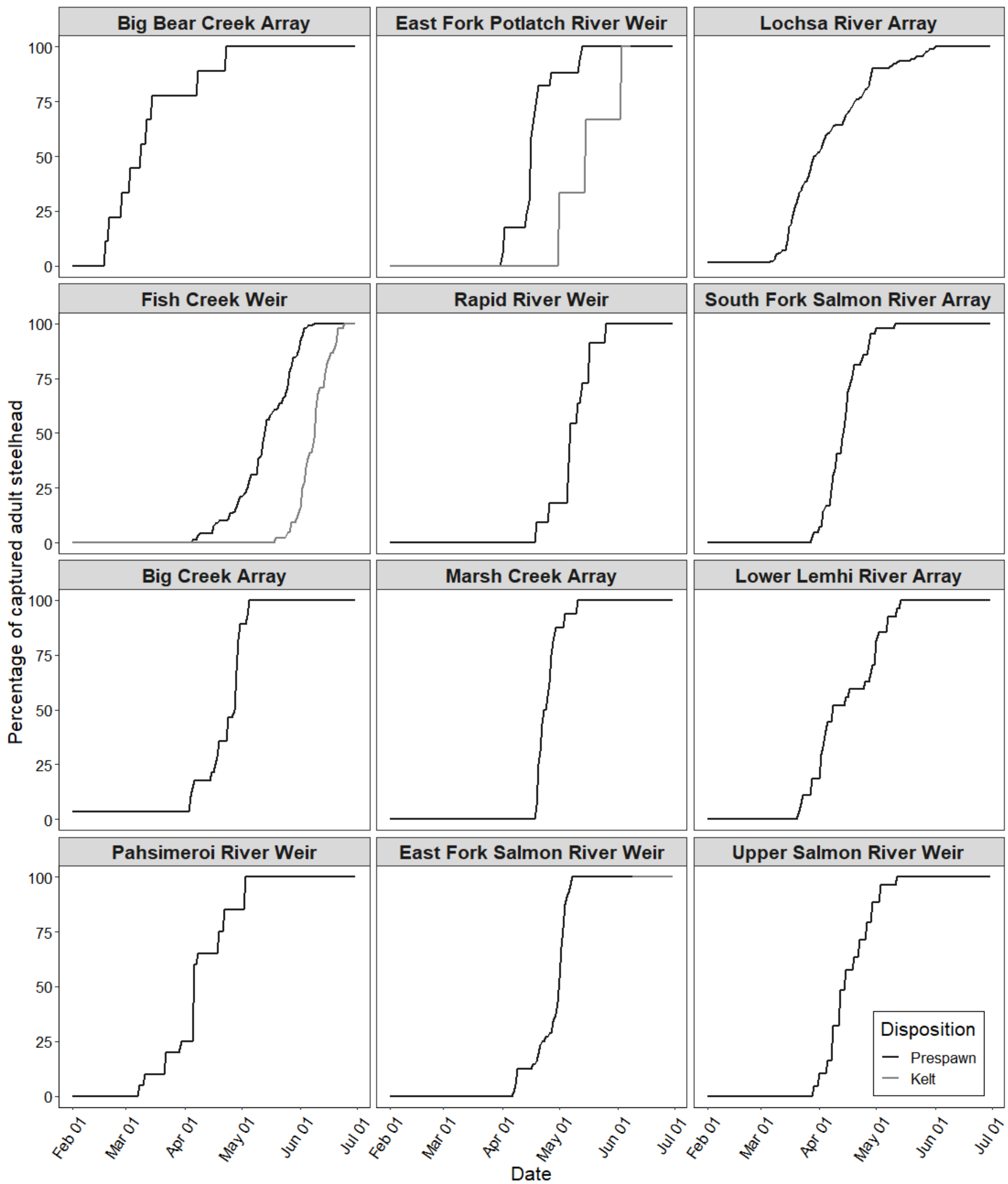

Figure 11. Cumulative wild prespawn and kelt steelhead run-timing curves at select Idaho weirs and PIT tag arrays, spawn year 2021. Kelt data were mostly unavailable.

APPENDICES

Appendix A. Wild adult steelhead abundance estimate time series for Clearwater River weirs and PIT tag arrays. LCI and UCI are lower and upper 95% confidence intervals, respectively. NA = not available.

Population	Structure	Spawn year	Abundance	LCI	UCI
Big Bear Creek	Weir	2005	202	107	372
		2006	50	19	94
		2007	100	66	158
		2008	127	69	253
		2009	135	79	252
		2010	251	200	310
		2011	124	55	242
		2012	317	220	363
	Array	2013	120	112	157
		2014	249	206	825
		2015	109	75	NA
		2016	254	127	507
		2017[a]	21	9	31
		2018[b]	23	NA	NA
		2019[b]	19	NA	NA
		2020[b]	29	NA	NA
		2021[b]	20	NA	NA
East Fork Potlatch River	Weir	2008	140	33	232
		2009	92	50	152
		2010	72	41	113
		2011[a]	33	33	33
		2012	101	67	151
		2013[c]	81	81	81
		2014	96	78	115
		2015	105	64	167
		2016	89	53	136
		2017[a]	11	2	24
		2018	18	NA	NA
		2019	6	NA	NA
		2020	25	21	36
		2021[c]	17	17	17
Crooked River	Weir	2007[e]	84	NA	NA
		2008[e]	27	NA	NA
		2009[e]	4	NA	NA
		2010[e]	46	NA	NA
		2011[e]	5	NA	NA
		2012[e]	41	NA	NA
		2013[e]	15	NA	NA
		2014[e]	2	NA	NA
		2015	22	NA	NA
		2016	10	NA	NA
		2017	1	NA	NA
		2018	1	NA	NA
		2019	0	NA	NA
		2020	0	NA	NA
		2021	1	NA	NA

Appendix A. Continued.

Population	Structure	Spawn year	Abundance	LCI	UCI
Lochsa River	Array	2018	490	433	572
		2019	526	469	615
		2020	189	152	243
		2021	699	611	798
Fish Creek	Weir	1992[d]	105	NA	NA
		1993[d]	267	NA	NA
		1994[d]	70	NA	NA
		1995[d]	70	NA	NA
		1996[d]	39	NA	NA
		1997[d]	28	NA	NA
		1998	80	NA	NA
		1999[c]	77	NA	NA
		2000	33	7	35
		2001[c]	75	NA	NA
		2002	242	181	333
		2003	343	315	371
		2004	206	185	230
		2005[c]	121	NA	NA
		2006	119	82	156
		2007	81	79	96
		2008	134	84	184
		2009	218	152	312
		2010	205	164	255
		2011	494	355	689
		2012	152	126	183
		2013	95	81	111
		2014[c]	91	91	91
		2015	452	420	485
		2016	239	201	277
		2017	83	13	150
		2018	16	10	43
		2019	51	10	85
		2020	24	16	48
		2021	104	94	119

[a] Indicates the weir/array was compromised and only operated for a period of the entire migration; therefore, abundance was considered a minimum estimate.

[b] Detection efficiency unable to be estimated; abundance is a minimum. This differs from SY 2018 and SY 2019 reports.

[c] Signifies years in which all recovered kelts were marked; therefore, the estimate was considered a census of the adult population.

[d] Methods for estimating escapement at Fish Creek used a cumulative curve due to the weir being breached or information on kelt recaptures was unreliable.

[e] Numbers of natural fish returning to hatchery weirs were obtained via Chuck Warren (IDFG steelhead hatchery evaluation biologist, personal communication) for years prior to 2015.

Appendix B. Wild adult steelhead abundance estimate time series for Salmon River weirs and PIT tag arrays. LCI and UCI are lower and upper 95% confidence intervals, respectively. NA = not available.

Population	Structure	Spawn year	Abundance	LCI	UCI
Rapid River	Weir	2007[e]	32	NA	NA
		2008[e]	88	NA	NA
		2009[e]	108	NA	NA
		2010[e]	150	NA	NA
		2011[e]	133	NA	NA
		2012[e]	81	NA	NA
		2013[e]	27	NA	NA
		2014[e]	26	NA	NA
		2015	82	NA	NA
		2016	27	NA	NA
		2017	11	NA	NA
		2018	14	NA	NA
		2019	11	NA	NA
		2020	13	NA	NA
		2021	11	NA	NA
South Fork Salmon River	Array	2010[b]	754	605	934
		2011[b]	1340	1131	1578
		2012[b]	558	432	706
		2013[b]	435	348	526
		2014[b]	394	276	522
		2015[b]	836	662	1021
		2016[b]	356	270	448
		2017[b]	243	188	309
		2018[b]	82	54	115
		2019[b]	67	36	102
		2020	52	28	74
		2021	184	132	249
Big Creek[a]	Array	2010	926	676	1221
		2011	658	544	773
		2012	404	306	520
		2013	446	371	520
		2014	275	206	362
		2015	721	552	907
		2016	360	283	446
		2017	67	47	92
		2018	138	109	167
		2019	80	58	110
		2020	96	76	120
		2021	114	88	143
Marsh Creek	Array	2020	17	11	44
		2021	63	46	81
North Fork Salmon River[a]	Array	2016	157	123	191
		2017	NA	NA	NA
		2018	209	69	713

Appendix B. Continued

Population	Structure	Spawn year	Abundance	LCI	UCI
North Fork Salmon River[a]	Array	2019	91	67	122
		2020	93	76	116
		2021[d]	NA	NA	NA
Lower Lemhi River[a]	Array	2010	518	435	613
		2011	342	287	406
		2012	347	280	419
		2013	368	317	434
		2014	272	214	335
		2015	379	315	453
		2016	348	292	414
		2017	158	129	188
		2018	102	81	126
		2019	62	44	91
		2020	109	87	131
		2021	92	71	116
Upper Lemhi River[a]	Array	2010	18	1	54
		2011	80	33	128
		2012	39	9	75
		2013	84	41	128
		2014	19	2	44
		2015	39	11	79
		2016	49	19	88
		2017	25	9	46
		2018	18	6	34
		2019	9	2	23
		2020	6	0	16
		2021	10	1	21
Hayden Creek[a]	Array	2010	105	49	170
		2011	34	10	72
		2012	67	26	116
		2013	79	45	127
		2014	49	21	87
		2015	30	3	75
		2016	87	49	132
		2017	31	12	56
		2018	15	4	32
		2019	11	1	24
		2020	27	12	45
		2021	29	12	50
Pahsimeroi River	Weir	2007[e]	22	NA	NA
		2008[e]	45	NA	NA
		2009[e]	30	NA	NA
		2010[e]	157	NA	NA
		2011[e]	239	NA	NA
		2012[e]	288	NA	NA
		2013[e]	179	NA	NA

Appendix B. Continued

Population	Structure	Spawn year	Abundance	LCI	UCI
Pahsimeroi River	Weir	2014[e]	205	NA	NA
		2015	130	NA	NA
		2016	92	NA	NA
		2017	24	NA	NA
		2018	30	NA	NA
		2019	35	NA	NA
		2020	41	NA	NA
		2021	20	NA	NA
East Fork Salmon River[c]	Weir	2007[e]	16	NA	NA
		2008[e]	11	NA	NA
		2009[e]	17	NA	NA
		2010[e]	61	NA	NA
		2011[e]	72	NA	NA
		2012[e]	92	NA	NA
		2013[e]	33	NA	NA
		2014[e]	25	NA	NA
		2015	43	NA	NA
		2016	71	NA	NA
		2017	26	NA	NA
		2018	12	NA	NA
		2019	16	NA	NA
		2020	29	NA	NA
		2021	56	NA	NA
Upper Salmon River	Weir	2007[e]	21	NA	NA
		2008[e]	23	NA	NA
		2009[e]	34	NA	NA
		2010[e]	115	NA	NA
		2011[e]	96	NA	NA
		2012[e]	63	NA	NA
		2013[e]	39	NA	NA
		2014[e]	46	NA	NA
		2015	73	NA	NA
		2016	77	NA	NA
		2017	22	NA	NA
		2018	17	NA	NA
		2019	14	NA	NA
		2020	44	NA	NA
		2021	87	NA	NA

[a] Abundance estimates analyzed with the latest version of the DABOM model (Simmons et al. 2022). Results will vary from SY 2018 report and prior (Dobos et al. 2019).

[b] Minimum estimate due to having a single spanning PIT tag array. The model assumed detection probability was 1.00. Estimates generated from the latest version of the DABOM model (See et al. 2019).

[c] Abundance represents all wild adult steelhead trapped at the weir, including those collected for broodstock. Hatchery adult steelhead passed upstream for natural spawning were not included.

[d] Indicates the weir/array was compromised and did not operate during the migration period; therefore, an estimated abundance was not developed.

[e] Numbers of natural fish returning to hatchery weirs were obtained via Chuck Warren (IDFG steelhead hatchery evaluation biologist, personal communication) for years prior to 2015.

Appendix C. Age composition of adult recruits by brood year, number of parent spawners, and adult-to-adult productivity estimates (recruits per spawner) for select Clearwater River wild steelhead populations, Idaho. Accounting is incomplete for brood years with dashes in any age column. Grey, hatched cells indicate years where adult abundance represented a minimum estimate.

		Number of adult recruits							
Stream	**Brood year**	**Age-3**	**Age-4**	**Age-5**	**Age-6**	**Age-7**	**Total**	**Parents**	**Productivity**
Big Bear Creek	2005	3	52	96	2	0	153	202	0.76
	2006	2	137	66	3	0	208	50	4.16
	2007	8	46	211	0	0	265	100	2.65
	2008	9	93	69	14	0	185	127	1.46
	2009	10	46	69	0	0	125	135	0.93
	2010	7	138	35	0	0	180	251	0.72
	2011	28	64	131	3	0	226	124	1.82
	2012	9	115	14	3	0	141	317	0.44
	2013	8	4	0	0	0	12	120	0.10
	2014	0	20	5	0	0	25	249	0.10
	2015	0	14	11	0	--	25	109	0.23
	2016	0	14	20	--	--	34	254	0.13
	2017	4	0	--	--	--	4	21	0.19
	2018	0	--	--	--	--	0	23	0.00
EF Potlatch River	2008	1	28	57	0	0	86	140	0.61
	2009	4	15	32	15	0	66	92	0.72
	2010	0	54	60	10	0	124	71	1.75
	2011*	10	30	46	1	0	87	33	2.64
	2012	0	32	9	0	0	41	106	0.39
	2013	1	1	8	1	0	11	81	0.14
	2014	0	10	4	1	0	15	96	0.16
	2015	0	1	11	6	--	18	105	0.17
	2016	0	13	11	--	--	24	89	0.27
	2017	0	0	--	--	--	0	11	0.00
	2018	0	--	--	--	--	0	18	0.00
Fish Creek	1992	0	0	9	38	3	50	105	0.48
	1993	0	2	39	51	0	92	267	0.34
	1994	0	1	22	17	1	41	70	0.59
	1995	0	1	14	42	3	60	70	0.86
	1996	0	2	31	82	0	115	39	2.95
	1997	0	1	119	167	0	287	28	10.25
	1998	0	38	166	72	0	276	80	3.45

Appendix C. Continued

Stream	Brood year	Number of adult recruits Age-3	Age-4	Age-5	Age-6	Age-7	Total	Parents	Productivity
Fish Creek	1999	0	9	124	71	0	204	77	2.65
	2000	0	10	46	58	0	114	33	3.45
	2001	0	4	59	4	0	67	75	0.89
	2002	0	2	45	34	8	89	242	0.37
	2003	0	29	67	170	2	268	343	0.78
	2004	3	33	40	98	20	194	206	0.94
	2005	0	0	89	271	2	362	121	2.99
	2006	0	16	194	79	0	289	119	2.43
	2007	0	6	64	44	0	114	81	1.41
	2008	3	7	40	7	1	58	134	0.43
	2009	0	11	40	121	5	177	218	0.81
	2010	0	39	307	116	3	465	205	2.27
	2011	5	23	100	37	3	168	494	0.34
	2012	0	18	43	5	0	66	152	0.43
	2013	0	0	5	19	2	28	95	0.27
	2014	0	3	29	4	0	36	91	0.40
	2015	0	3	14	66	--	83	452	0.18
	2016	0	4	38	--	--	42	239	0.18
	2017	0	0	--	--	--	0	83	0.00
	2018	0	--	--	--	--	0	13	0.00

[a] The number of East Fork Potlatch River parents in 2011 is a minimum estimate, thus brood year productivity may be biased high.

Appendix D. Age composition of adult recruits by brood year, number of parent spawners, and adult-to-adult productivity estimates (recruits per spawner) for select Salmon River wild steelhead populations, Idaho. Accounting is incomplete for brood years with dashes in any age column.

		Number of adult recruits							
Stream	**Brood year**	**Age-3**	**Age-4**	**Age-5**	**Age-6**	**Age-7**	**Total**	**Parents**	**Productivity**
Rapid River	2001	--	--	--	2	4	6	31	0.19
	2002	--	--	10	20	2	32	106	0.30
	2003	--	17	38	18	0	73	87	0.84
	2004	3	26	67	22	1	119	120	0.99
	2005	0	21	72	40	4	137	81	1.69
	2006	0	53	70	22	0	145	99	1.46
	2007	3	21	35	9	0	68	32	2.13
	2008	1	18	9	2	0	30	88	0.34
	2009	0	9	14	15	0	38	108	0.35
	2010	0	8	41	4	0	53	150	0.35
	2011	1	26	16	2	0	45	133	0.34
	2012	0	7	9	1	0	17	81	0.21
	2013	0	0	5	3	0	8	27	0.30
	2014	0	8	7	1	0	16	26	0.62
	2015	0	0	9	8	--	17	82	0.21
	2016	0	3	3	--	--	6	27	0.11
	2017	0	0	--	--	--	0	11	0.00
	2018	0	--	--	--	--	0	14	0.00
Big Creek	2010	0	65	417	223	15	720	926	0.78
	2011	0	76	103	30	0	209	658	0.32
	2012	0	17	22	29	0	68	404	0.17
	2013	0	0	86	32	9	127	446	0.28
	2014	0	24	32	30	0	86	275	0.31
	2015	0	5	57	42	--	104	721	0.14
	2016	0	0	72	--	--	72	360	0.20
	2017	0	0	--	--	--	0	67	0.00
	2018	0	--	--	--	--	0	138	0.00
Lower Lemhi River	2010	24	111	189	13	5	342	518	0.66
	2011	55	118	74	36	0	283	342	0.83
	2012	24	141	76	0	0	241	347	0.69
	2013	40	31	20	5	0	96	368	0.26
	2014	0	72	21	17	0	110	272	0.40
	2015	0	36	61	12	--	109	379	0.29

Appendix D. Continued.

Stream	Brood year	Number of adult recruits Age-3	Age-4	Age-5	Age-6	Age-7	Total	Parents	Productivity
Lower Lemhi River	2016	0	31	55	--	--	86	348	0.25
	2017	0	25	--	--	--	25	158	0.16
	2018	0	--	--	--	--	0	102	0.00
Pahsimeroi River	2002	--	--	5	0	0	5	378	0.01
	2003	--	15	17	1	0	33	180	0.18
	2004	2	28	17	3	1	51	67	0.76
	2005	0	11	18	7	0	36	42	0.86
	2006	1	116	68	0	0	185	68	2.72
	2007	20	147	44	6	0	217	22	9.86
	2008	16	192	51	3	0	262	45	5.82
	2009	51	104	25	0	0	180	30	6.00
	2010	15	114	32	1	0	162	157	1.03
	2011	60	83	24	3	0	170	239	0.71
	2012	15	63	17	1	0	96	288	0.33
	2013	4	4	4	0	0	12	179	0.07
	2014	0	25	5	0	0	30	205	0.15
	2015	0	30	16	4	--	50	130	0.39
	2016	0	25	4	--	--	29	92	0.32
	2017	0	12	--	--	--	12	24	0.50
	2018	0	--	--	--	--	0	30	0.00
East Fork Salmon River	2004	--	--	--	10	0	10	7	1.43
	2005	--	--	9	0	0	9	63	0.14
	2006	--	42	61	8	0	111	153	0.73
	2007	0	11	74	15	0	100	55	1.82
	2008	0	11	15	3	0	29	38	0.76
	2009	0	3	4	3	0	10	15	0.67
	2010	0	17	29	6	0	52	426	0.12
	2011	1	9	41	7	0	58	448	0.13
	2012	1	24	17	1	0	43	738	0.06
	2013	0	2	7	7	0	16	690	0.02
	2014	0	1	5	7	0	13	339	0.04
	2015	0	4	12	10	--	26	884	0.03
	2016	0	10	44	--	--	54	405	0.13
	2017	0	2	--	--	--	2	135	0.02
	2018	0	--	--	--	--	0	42	0.00

Appendix D. Continued.

Stream	Brood year	Number of adult recruits					Total	Parents	Productivity
		Age-3	Age-4	Age-5	Age-6	Age-7			
Upper Salmon River	2003	--	--	12	9	0	21	30	0.70
	2004	--	11	13	3	0	27	18	1.50
	2005	0	11	37	6	0	54	29	1.86
	2006	0	75	52	2	0	129	22	5.86
	2007	0	36	42	3	0	81	21	3.86
	2008	2	19	24	0	0	45	23	1.96
	2009	0	12	11	2	0	25	34	0.74
	2010	0	31	34	7	0	72	115	0.63
	2011	4	31	47	6	0	88	96	0.92
	2012	6	23	16	2	0	47	63	0.75
	2013	0	0	6	0	0	6	39	0.15
	2014	0	9	5	0	0	14	46	0.30
	2015	0	7	20	5	--	32	73	0.37
	2016	0	24	80	--	--	104	77	0.31
	2017	0	2	--	--	--	2	22	0.00
	2018	0	--	--	--	--	0	17	0.00

Appendix E. Number of PIT-tagged adults from selected populations in the Clearwater River MPG detected at three hydrosystem dams and their conversion rates to McNary and Lower Granite dams from Bonneville Dam across spawn years where data is available.

Population	Spawn year	Bonneville Dam count	McNary Dam count	Lower Granite Dam count	Conversion to McNary Dam	Conversion to Lower Granite Dam
Big Bear Creek	2007	5	4	2	80.0%	40.0%
	2008	17	17	16	100.0%	94.1%
	2009	7	6	6	85.7%	85.7%
	2010	19	15	15	78.9%	78.9%
	2011	18	14	14	77.8%	77.8%
	2012	33	29	27	87.9%	81.8%
	2013	35	29	27	82.9%	77.1%
	2014	21	18	18	85.7%	85.7%
	2015	43	37	33	86.0%	76.7%
	2016	61	57	56	93.4%	91.8%
	2017	25	20	19	80.0%	76.0%
	2018	8	5	5	62.5%	62.5%
	2019	8	5	5	62.5%	62.5%
	2020	25	21	21	80.1%	80.1%
	2021	64	53	50	82.8%	78.1%
Fish Creek	1998	1	1	1	100.0%	100.0%
	1999	4	4	4	100.0%	100.0%
	2000	6	5	5	83.3%	83.3%
	2001	8	8	8	100.0%	100.0%
	2002	47	45	45	95.7%	95.7%
	2003	64	55	52	85.9%	81.3%
	2004	16	14	14	87.5%	87.5%
	2005	11	10	10	90.9%	90.9%
	2006	23	18	18	78.3%	78.3%
	2007	11	10	9	90.9%	81.8%
	2008	19	18	18	94.7%	94.7%
	2009	50	39	34	78.0%	68.0%
	2010	78	66	60	84.6%	76.9%
	2011	112	94	83	83.9%	74.1%
	2012	49	37	31	75.5%	63.3%
	2013	32	27	22	84.4%	68.8%
	2014	36	30	30	83.3%	83.3%
	2015	189	151	144	79.9%	76.2%
	2016	70	63	61	90.0%	87.1%
	2017	36	29	25	80.6%	69.4%

Appendix E. Continued.

Population	Spawn year	Bonneville Dam count	McNary Dam count	Lower Granite Dam count	Conversion to McNary Dam	Conversion to Lower Granite Dam
Fish Creek	2018	11	9	8	81.8%	72.7%
	2019	7	6	5	85.7%	71.4%
	2020	5	4	4	80.0%	80.0%
	2021	29	22	21	75.9%	72.4%

Appendix F. Number of PIT-tagged adults from selected populations in the Salmon River MPG detected at three hydrosystem dams and their conversion rates to McNary and Lower Granite dams from Bonneville Dam across spawn years where data is available.

Population	Spawn year	Bonneville Dam count	McNary Dam count	Lower Granite Dam count	Conversion to McNary Dam	Conversion to Lower Granite Dam
Big Creek	2006	1	1	1	100.0%	100.0%
	2007	2	2	2	100.0%	100.0%
	2008	0	0	0	NA	NA
	2009	0	0	0	NA	NA
	2010	42	37	36	88.1%	85.7%
	2011	19	14	14	73.7%	73.7%
	2012	23	17	16	73.9%	69.6%
	2013	20	13	13	65.0%	65.0%
	2014	40	29	29	72.5%	72.5%
	2015	29	21	20	72.4%	69.0%
	2016	17	14	14	82.4%	82.4%
	2017	0	0	0	NA	NA
	2018	3	3	3	100.0%	100.0%
	2019	1	1	1	100.0%	100.0%
	2020	2	2	2	100.0%	100.0%
	2021	8	6	6	75.0%	75.0%
Lemhi River	2006	1	1	1	100.0%	100.0%
	2007	0	0	0	NA	NA
	2008	2	2	2	100.0%	100.0%
	2009	4	4	4	100.0%	100.0%
	2010	41	35	32	85.4%	78.0%
	2011	25	21	20	84.0%	80.0%
	2012	49	39	34	79.6%	69.4%
	2013	25	22	20	88.0%	80.0%
	2014	29	17	16	58.6%	55.2%
	2015	26	19	18	73.1%	69.2%
	2016	29	28	26	96.6%	89.7%
	2017	13	9	9	69.2%	69.2%
	2018	5	4	4	80.0%	80.0%
	2019	2	2	2	100.0%	100.0%
	2020	12	10	10	83.3%	83.3%
	2021	9	7	5	77.8%	55.6%

Appendix G. Number of genetic samples collected from wild adult steelhead captured at select IDFG weirs, 2010–2021.

Population Location	Structure	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Clearwater River MPG													
Potlatch River													
Big Bear Creek	Weir	51	18	38	0	0	0	0	0	0	0	0	0
Little Bear Creek	Weir	212	46	180	0	0	0	0	0	0	0	0	0
WF Potlatch River	Weir	50	0	0	0	0	0	0	0	0	0	0	0
EF Potlatch River	Weir	71	33	73	82	87	90	97	9	18	0	23	17
SF Clearwater River													
Crooked River	Weir	0	5	41	17	2	22	10	1	1	0	0	1
Lochsa River													
Fish Creek	Weir	200	224	135	91	90	450	204	53	11	22	20	96
Salmon River MPG													
Snake River													
Snake River	Hells Canyon Dam Adult Ladder	0	164	114	161	150	186	38	21	14	52	39	50
Little Salmon River													
Rapid River	Weir	149	133	82	27	26	82	27	12	14	10	13	11
SF Salmon River													
SF Salmon River	Weir	12	0	0	5	0	2	0	0	0	0	0	0
Pahsimeroi River													
Pahsimeroi River	Weir	157	239	285	177	205	130	94	24	31	35	41	20

Appendix G. Continued

Population Location	Structure	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
					Salmon River MPG								
EF Salmon River													
EF Salmon River	Weir	425	442	721	690	339	885	410	132	7	5	29	56
Upper Salmon River													
Fourth of July Creek	Weir	0	0	0	0	27	0	10	5	2	4	0	0
Tower Creek	Weir	0	0	0	0	29	0	18	19	5	0	0	0
Carmen Creek	Weir	0	0	0	0	79	0	16	3	2	1	0	0
Iron Creek	Weir	6	0	0	0	0	7	5	1	1	0	1	2
Salmon River	Weir	114	96	82	39	46	74	77	22	17	14	44	86
Total		1,447	1,400	1,751	1,289	1,080	1,976	1,060	302	123	143	210	339

Appendix H. Archived monitoring structure (i.e. PIT tag array or weir), and associated abundance analyses for selected Idaho adult steelhead monitoring locations.

Structure	Analysis	Monitoring Locations
Weir	Lincoln-Peterson estimator, with Bailey's modification	Big Bear Creek (2005 – 2012) EF Potlatch River (2008 – 2021) Fish Creek (1998 – 2021)
	Minimum count of fish passed above weir structure	Crooked River (2007 – 2021)* Rapid River (2007 – 2021)* Pahsimeroi River (2007 – 2021)* EF Salmon River (2007 – 2021)* Upper Salmon River (2007 – 2021)*
	Cumulative curve estimation	Fish Creek (1992 – 1997)
PIT Array	DABOM	Lochsa River (2020 – 2021) SF Salmon River (2020 – 2021) Big Creek (2010 – 2021) Marsh Creek (2021) NF Salmon River (2016 – 2021) Lower Lemhi River (2010 – 2021) Upper Lemhi River (2010 – 2021) Hayden Creek (2010 – 2021)
	DABOM minimum	SF Salmon River (2010 – 2019)
	Connolly et al. (2005); Lady et al. (2009)	Big Bear Creek (2013 – 2017) Lochsa River (2018 – 2019) Marsh Creek (2020)
	Connolly et al. (2005); Lady et al. (2009) minimum	Big Bear Creek (2018 – 2021)

* Numbers of natural fish returning to hatchery weirs were obtained via Chuck Warren (IDFG steelhead hatchery evaluation biologist, personal communication) for years prior to 2015.

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