FISHERY RESEARCH

IDAHO ADULT STEELHEAD MONITORING

2022 ANNUAL REPORT

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2022 Annual Report

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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
ICBTRT	Interior Columbia Basin 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 2022, Idaho Department of Fish and Game personnel used weirs (temporary picket, floating board resistance, and hatchery traps) and select passive integrated transponder (PIT) tag detector arrays to monitor wild adult steelhead *Oncorhynchus mykiss* in Idaho. Three weirs and three PIT tag detector array sites were in the Clearwater River basin, whereas four weirs and seven PIT tag detector 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 zero fish in the Upper Lemhi River to 475 (95% CI 409–546) fish in the Lochsa River. Across all sites, 47.9% of returning adults were 1-ocean, 48.6% were 2-ocean, 1.2% were 3-ocean, and 1.2% were repeat spawners. Sex ratios varied from 33.0% females in the upper Salmon River to 100.0% females in the lower Lemhi River. Adult-to-adult productivity estimates for brood year (BY) 2015 are now complete with the last of that cohort returning in 2022. Productivity estimates for BY 2015 (n = 9 locations) varied from 0.03 recruits per spawner in the East Fork Salmon River to 0.39 recruits per spawner in Pahsimeroi 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 2015. Productivity increased from BY 2014 to BY 2015 at Big Bear Creek, East Fork Potlatch River, Pahsimeroi River, and upper Salmon River and decreased in all other locations. Including BY 2016, productivity has been below replacement for the last 5 to 9 BYs, except for the upper Salmon River which is above replacement at 1.49 recruits per spawner. At all locations except for Big Creek and the Lemhi River, the trend in spawner abundance decreased as the number of recruits per spawner 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 0.7%, 1.5%, 1.0%, and 0.16%, respectively. All SARs 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 2015, total steelhead abundance estimates have been far below objectives outlined in the draft recovery plan (Ford 2022). Returns of wild 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 (ICBTRT 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 (ICBTRT 2007). Nonetheless, there are 17 demographically independent and extant steelhead populations identified within the Clearwater River and Salmon River MPGs (ICBTRT 2007; 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 Goal for wild steelhead within 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 steelhead from 2008–2017 was 30,452 (IDFG 2019). By first understanding the processes that govern salmonid population viability through trend monitoring and status assessments, we can then work toward achieving 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. (2020). 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 for spawn year 2022, will be reported by Baum et al. (in review). 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.

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 detector arrays (hereafter arrays) were used to monitor wild adult steelhead populations during their spawning migrations. 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 escapement above weirs. Lastly, 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 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 an array were assumed to have a negligible impact on productivity and abundance, and therefore excluded from analyses in this report.

Temporary Weirs—During 2022, 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. The Fish Creek weir was breached on May 6th due to high water and was out of operation until its repair on June 26th. The weir then partially operated for another 24 days until the end of the adult steelhead migration period. The East Fork Potlatch River weir was installed and began operating on March 13th, 2022. The weir was either partially operable or inoperable for 10 days during high flow period and was fully operable through the remaining adult steelhead migration period.

At temporary weirs, adult steelhead moving upstream entered a holding box that was checked at least once 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, visualimplanted 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, saltwater, and total ages. A small portion of fin tissue (for genetic analysis) was sampled from each unique fish at Fish Creek and East Fork Potlatch River. 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/; R Development Core Team, 2023) 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).

Due to a significant and sustained breaching event at the Fish Creek weir on May 6th, 2022, there were not enough kelts captured to produce a reliable mark-recapture escapement estimate. To produce an accurate spawn year (SY) 2022 escapement estimate at Fish Creek, we leveraged the 30-year dataset to build a logistic regression model where the dependent variable was the proportion of the total run that had been passed upstream of the weir prior to the breaching event. The number of prespawn steelhead trapped and passed above the weir prior to May 6th were expanded using this proportion to produce our SY 2022 escapement estimate (Appendix I).

Permanent Weirs—During 2022, 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 Detector Arrays—Instream 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., arrays and weirs). Hatchery-origin adult steelhead strays were excluded.

We reported abundance estimates of SY 2022 adult steelhead from the DABOM analysis (Ryan Kinzer, Nez Perce Tribe, personal communication) for array sites that operated in the Lochsa River, Crooked River, Big Bear Creek, South Fork Salmon River, Big Creek, Marsh Creek, North Fork Salmon River, lower Lemhi River, upper Lemhi River, and Hayden Creek. The DABOM model was not able to produce an estimate of SY 2022 adult steelhead escapement at Big Bear Creek due to small sample sizes and frequent outages of a second array span. However, 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, North Fork Salmon River, and the upper Salmon River. Productivity results were reported for the most recently completed brood year (BY 2015), with preliminary information for BY 2016. The entire range of adult productivity estimates for each location are presented in Appendices C and D. Comparisons across populations were limited to BYs 2003–2016, 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 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 multiplying 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 2016 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 except for the East Fork Salmon River. On occasion, hatchery strays with PIT tags migrate upstream of 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 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 wild 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 Detector Arrays—We developed adult-to-adult productivity series for Big Bear Creek, Big Creek, North Fork Salmon River, and the Lemhi River array sites. The array estimates at the South Fork Salmon River, Crooked River, and Marsh Creek 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 in 2026, the South Fork Salmon River and Marsh Creek populations in 2028. Methods for annual abundance estimates for these locations are outlined in the Sampling and Abundance section. Age and sex composition of returning adults to 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, helped ensure that enough adults were detected to generate reliable estimates for groups with low returns. Other weir and array sites lacked 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 for scale removal 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 Detector Arrays—Adult steelhead were not physically handled at array sites (Big Bear Creek, Crooked River, 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 July 1, 2021 and June 30, 2022, which were subsequently detected at these array sites during 2022. We also queried adult steelhead sampled at LGR, which had been previously PIT tagged as juveniles upstream of arrays through rotary screw 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. 2022) and freshwater and saltwater ages were determined from scale samples (Wright et al. 2015). For a given 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, 2021 and June 30, 2022 at Bonneville, McNary, and Lower Granite dams. Detections of kelts moving downstream were excluded. The first, last, and median timing of detections for 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 wild steelhead in the Snake River basin (Ackerman et al. 2016; Hargrove et al. 2022). During this report period, tissue samples were taken and archived for future analyses.

RESULTS

<u>Adult Abundance</u>

Big Bear Creek PIT Tag Detector Array

The Big Bear Creek Array (BBA) began operating on January 27, 2022 and operated for most of the migration period. There were two temporary outages due to electronics failure resulting in little to no ability to detect tags from February 22 through March 3 and March 4 through March 10. Three PIT-tagged adult wild steelhead were detected on the Big Bear Creek array, of which all were tagged as adults at LGR. All detections occurred on a single span of the Big Bear Creek Array. Because all detections occurred on a single span of the array, a detection efficiency could not be estimated for SY 2022. A minimum abundance estimate of 11 adults was derived by expanding the number of detected adult steelhead PIT-tagged and sampled at LGR by the mean weekly LGR SY 2022 trap rate (Baum et al. in review; Figure 2; Appendix A).

East Fork Potlatch River Weir

The East Fork Potlatch River weir was installed and began operating on March 13, 2022. The weir was either partially operable or inoperable for 10 days during the high flow period and was fully operable through the remaining adult steelhead migration period. Three upstream migrating adult steelhead were captured at the site though only two went above the weir because one fish was a prespawn mortality (Table 3). In addition, 1 downstream migrating kelt was captured at the weir, which was previously handled as a prespawn adult. The total steelhead abundance estimated via mark-recapture was 2 adults (Figure 2; Appendix A).

Crooked River Weir and PIT Tag Detector Array

The Crooked River weir was operational from April 9, 2022 until May 10, 2022 when large amounts of sediments in the trap box resulted in the need to shut the adult trap down for the remainder of the steelhead trapping season. During that time span, the weir was fully operational for 29 days and partially operational for four days. High flows and debris resulted in partial operations. The weir captured six adult steelhead at the weir, five wild and one hatchery steelhead that was released downstream of the weir (Table 3). There were no downstream migrating kelts captured, resulting in a minimum abundance estimate of five wild adult steelhead (Figure 2; Appendix A). The Crooked River Array was fully operational for the entirety of the spring adult migration period. All six steelhead that were captured at the Crooked River weir were also detected at the array. Of the six adult steelhead detected on the array, five were wild and one was of hatchery origin. Of the wild steelhead, one was tagged as an adult at Lower Granite Dam, one was tagged as a juvenile and barged from Lower Granite Dam, and three were PIT tagged as adults upstream of the array at the Crooked River adult steelhead weir. The DABOM model estimated an escapement of 67 adult steelhead to Crooked River (95% CI 3-160; Figure 3, Appendix B; Ryan Kinzer, Nez Perce Tribe, personal communication).

Lochsa River PIT Tag Detector Array

The Lochsa River array operated continuously through the adult steelhead migration period. One hundred ten PIT-tagged adult wild steelhead were detected on the Lochsa River array, of which 87 were tagged as adults at LGR, six were tagged as adults at Bonneville Dam, 11 were tagged as juveniles in the Lochsa River basin, and six were tagged as juveniles at LGR. The DABOM model estimated an escapement of 475 adult steelhead returning to the Lochsa River (95% CI 409–546; Figure 2; Appendix A; Ryan Kinzer, Nez Perce Tribe, personal communication).

Fish Creek Weir

The Fish Creek weir was installed and began operating on March 25 and operated until it was breached on May 6. The weir was repaired on June 26 and operated partially for 24 days through the remaining adult steelhead migration period. Twenty-five wild adult steelhead were trapped, marked, and released upstream of the weir (Table 3). No hatchery steelhead were captured at the weir. One unique wild kelt was captured, which was unmarked and not handled as a prespawn adult (Table 3). The total steelhead abundance estimated via mark-recapture was 48 adults (95% CI 35–79; Figure 2; Appendix A).

Rapid River Weir

The Rapid River weir began operating on March 14 and ran continuously through the remaining adult steelhead migration period. Eighteen wild adult steelhead were trapped and released upstream of the weir for natural spawning, one of which was tagged as an adult at LGD. (Table 3; Figure 3; Appendix B).

South Fork Salmon River PIT Tag Detector Array

The South Fork Salmon River array at Krassel Creek operated continuously during the adult steelhead migration period. Forty PIT-tagged adult wild steelhead were detected on the South Fork Salmon River array, of which 33 were tagged as adults at LGR, two were tagged as adults at BON, and five were tagged as a juvenile in the South Fork Salmon River. The DABOM model estimated an escapement of 175 adult steelhead to the South Fork Salmon River (95% CI 129–218; Figure 3, Appendix B; Ryan Kinzer, Nez Perce Tribe, personal communication).

Big Creek PIT Tag Detector Array

The Big Creek array operated continuously during the adult steelhead migration period. Forty PIT-tagged adult wild steelhead were detected on the Big Creek array, 33 of which were tagged as adults at LGR, two were tagged as adults at BON, two were tagged as juveniles at LGR, and three were tagged as juveniles in Big Creek. The DABOM model estimated an escapement of 160 adult steelhead to Big Creek (95% CI 128–194; Figure 3, Appendix B; Ryan Kinzer, Nez Perce Tribe, personal communication).

Marsh Creek PIT Tag Detector Array

The Marsh Creek array operated continuously during the adult steelhead migration period. Four PIT-tagged adult wild steelhead were detected on the Marsh Creek array. All four-were tagged as adults at LGR. The DABOM model estimated an escapement of 26 adult steelhead to Marsh Creek (95% CI 17–35; Figure 3, Appendix B; Ryan Kinzer, Nez Perce Tribe, personal communication).

North Fork Salmon River PIT Tag Detector Array

The North Fork Salmon River array operated continuously during the adult steelhead migration period. Seven PIT-tagged adult wild steelhead were detected on the North Fork Salmon River array, five of which were tagged as adults at LGR and two were tagged as juveniles at the North Fork Salmon River screw trap (Figure 3, Appendix B). The DABOM model estimated an escapement of 29 adult steelhead for the North Fork Salmon River (95% CI 20–39; Figure 3, Appendix B; Ryan Kinzer, Nez Perce Tribe, personal communication).

Lower Lemhi River PIT Tag Detector Array

The lower Lemhi River array operated continuously during the adult steelhead migration period. Eleven PIT-tagged adult wild steelhead were detected on the lower Lemhi River array, of which one was tagged as a juvenile in Hayden Creek, seven were tagged as adults at Lower Granite Dam, and three were tagged as juveniles at the lower Lemhi River screw trap. The DABOM model estimated an escapement of 38 adult steelhead to the Lemhi River (95% CI 28–50; Figure 3, Appendix B; Ryan Kinzer, Nez Perce Tribe, personal communication).

Hayden Creek PIT Tag Detector Array

The Hayden Creek array operated continuously during the adult steelhead migration period. Four PIT-tagged adult wild steelhead were detected on the Hayden Creek array, of which two were tagged as juveniles at the lower Lemhi River screw trap, and two were tagged as adults at Lower Granite Dam. The DABOM model estimated an escapement of eight adult steelhead to Hayden Creek (95% CI 2–19; Figure 3, Appendix B; Ryan Kinzer, Nez Perce Tribe, personal communication).

Upper Lemhi River PIT Tag Detector Array

The Upper Lemhi River array operated continuously during the adult steelhead migration period. Two PIT-tagged adult wild steelhead were detected on the upper Lemhi River array, of which one was tagged as a juvenile in Hayden Creek, and one was tagged as a juvenile at the lower Lemhi River screw trap. The DABOM model estimated an escapement of no adult steelhead to Upper Lemhi River (95% CI 0–0; Figure 3, Appendix B; Ryan Kinzer, Nez Perce Tribe, personal communication).

Pahsimeroi River Weir

The Pahsimeroi River hatchery weir began operating on February 18 and ran continuously through May 10. Eighteen wild adult steelhead were trapped and released upstream of the Pahsimeroi Fish Hatchery for natural spawning (Table 3; Figure 3, Appendix B). One adult steelhead was tagged as a juvenile at the Pahsimeroi trap and one as an adult at Lower Granite Dam.

East Fork Salmon River Weir

The Shoshone-Bannock Tribes began operating the East Fork Salmon River hatchery weir on March 22 and operations continued through May 28. Thirteen (six females; seven males) wild adult steelhead were trapped at the East Fork Salmon River and ten (five females; five males) were removed and used for hatchery broodstock. Three wild adult steelhead (one female; two males) and nine hatchery adult steelhead (one female; eight males) were passed upstream of the weir for natural spawning purposes (Lytle Denny, personal communication).

Upper Salmon River Weir

The upper Salmon River weir at Sawtooth Fish Hatchery began operating on March 21 and ran continuously through May 9. Fifty-five wild adult steelhead were trapped, marked, and released upstream of the weir. All wild adult steelhead were passed upstream of the weir for natural spawning. No hatchery fish were passed upstream of the weir (Table 3; Figure 3; Appendix B).

Adult-to-Adult Productivity

Big Bear Creek PIT Tag Detector Array

Brood year 2015 spawning steelhead returned 25 adult progeny, which resulted in an adult-to-adult productivity estimate of 0.23 recruits per spawner, and the preliminary adult-to-adult productivity estimate for BY 2016 was 0.13 recruits per spawner (Figure 4; Appendix C). During BYs 2005–2015, Big Bear Creek steelhead recruited an average of 140 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 five brood years, including BY 2016 (2012-2016; 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 2015 spawning steelhead returned 18 adult progeny, which resulted in an adult-to-adult productivity estimate of 0.17 recruits per spawner, and the preliminary adult-to-adult productivity estimate for BY 2016 was 0.27 recruits per spawner (Figure 4; Appendix C). During BYs 2008–2015, East Fork Potlatch River steelhead recruited an average of 56 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 (50.2%) 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 five brood years, including BY 2016 (2012-2016; 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 2015 spawning steelhead returned 83 adult progeny, which resulted in an adult-to-adult productivity estimate of 0.18 recruits per spawner, and the preliminary adult-to-adult productivity estimate for BY 2016 was 0.32 recruits per spawner (Figure 4; Appendix C). During BYs 1992-2015, Fish Creek recruited an average of 154 adult progeny (range = 26-465 adult progeny) per year. Across all completed BYs, adult-to-adult productivity estimates ranged from 0.18 recruits per spawner (BY 2015) to 10.25 recruits per spawner (BY 1997). On average, Fish Creek steelhead spawned mostly as age-5 (45.4%) and age-6 (45.5%), and to a lesser extent, age-3 (0.3%), age-4 (6.7%), and age-7 (0.2%) 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 six brood years, including BY 2016 (2011–2016; 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 2015 spawning steelhead returned 17 adult progeny, which resulted in an adult-to-adult productivity estimate of 0.21 recruits per spawner, and the preliminary BY 2016 productivity estimate was 0.30 recruits per spawner (Figure 4; Appendix D). During BYs 2005–2015, Rapid River steelhead recruited an average 52 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 (BYs 2012 and 2015) to 2.13 recruits per spawner (BY 2007). On average, Rapid River steelhead spawned mostly as age-5 (48.3%), and age-4 (26.8%), and to a lesser extent, age-3 (1.1%), age-6 (20.7%), and age-7 (1.4%) 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 nine brood years, including BY 2016 (2008-2016; Figure 4; Appendix D).

Across BYs 2004-2016, Rapid River productivity estimates were flat or decreased as spawner escapement increased (Figure 6).

North Fork Salmon River PIT Tag Detector Array

The North Fork Salmon River array is relatively new and productivity estimates are unavailable prior to BY 2016. More data will become available in future spawn years. Preliminary BY 2016 productivity estimate is 0.15 recruits per spawner Appendix D). On average (SY 2019-2022), North Fork Salmon River steelhead spawned mostly as age-6 (40.0%), and age-5 (39.0%), and to a lesser extent age-4 (21.1%), and age-7 (0.0%) adults. The North Fork Salmon River adult-to-adult productivity estimate is below the replacement threshold of 1.0 adult recruits per adult spawner for 2016 (Appendix D).

Big Creek PIT Tag Detector Array

Brood year 2015 spawning steelhead returned 109 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 2016 was 0.32 recruits per spawner (Figure 4; Appendix D). During BY 2010–2015, Big Creek steelhead recruited an average 221 adult progeny (range = 73–720 adult progeny) per year. Across all completed BYs, adult-to-adult productivity estimates ranged from 0.15 recruits per spawner (BY 2015) to 0.78 recruits per spawner (BY 2010). On average, Big Creek steelhead spawned mostly as age-5 (43.7%), and age-6 (42.2%), and to a lesser extent age-4 (6.2%), and age-7 (7.4%) 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 2016 (2010–2016; Figure 4; Appendix D). Across BYs 2010–2016, Big Creek productivity estimates were flat or increased slightly as spawner escapement increased (Figure 6).

Lower Lemhi River PIT Tag Detector Array

Brood year 2015 spawning steelhead returned 109 adult progeny, which resulted in an adult-to-adult productivity estimate of 0.29 recruits per spawner, and the preliminary adult-to-adult productivity estimate for BY 2016 was 0.26 recruits per spawner (Figure 4; Appendix D). During BY 2010–2015, lower Lemhi River steelhead recruited an average 197 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 (44.2%), and age-5 (41.7%), and to a lesser extent age-3 (6.5%), age-6 (6.5%), 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 2016 (2010–2016; Figure 4; Appendix D). Across BYs 2010–2016, Lemhi River productivity estimates were flat or increased slightly as spawner escapement increased (Figure 6).

Pahsimeroi River Weir

Brood year 2015 spawning steelhead returned 50 adult progeny, which resulted in an adult-to-adult productivity estimate of 0.39 recruits per spawner, and the preliminary adult-to-adult productivity estimate for BY 2016 was 0.32 recruits per spawner (Figure 4; Appendix D). During BY 2005–2015, 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 (62.5%), and age-5 (23.2%), 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 six brood years, including BY 2016 (2011-2016; 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 2015 spawning steelhead returned 26 adult progeny, which resulted in an adult-to-adult productivity estimate of 0.03 recruits per spawner, and the preliminary adult-to-adult productivity estimate for BY 2016 was 0.15 recruits per spawner (Figure 4; Appendix D). During BY 2006–2015, East Fork Salmon River steelhead recruited an average 46 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 (58.4%), and age-4 (25.6%), and to a lesser extent age-3 (0.4%) and age-6 (14.7%) 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 nine brood years, including BY 2016 (2008–2015; Figure 4; Appendix D). East Fork Salmon River productivity estimates decreased or remained flat as spawner escapement increased across completed BYs (2007–2015; Figure 6)

Upper Salmon River Weir

Brood year 2015 spawning steelhead returned 36 adult progeny, which resulted in an adult-to-adult productivity estimate of 0.49 recruits per spawner, and the preliminary adult-to-adult productivity estimate for BY 2016 was 1.50 recruits per spawner (Figure 4; Appendix D). During BY 2005–2015, upper Salmon River steelhead recruited an average 54 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 (39.7%), and age-4 (38.1%), and to a lesser extent age-3 (1.5%) and age-6 (6.6%) 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, but preliminary estimates for BY 2016 are above the replacement threshold (2009-2016; 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 2019 was the most recently completed estimate and had an SAR of 0.7% (95% CI 0.19–2.3%). For MY 2005–2019, the median SAR was 3.9% and ranged from 0.7% (MYs 2015 and 2019) to 6.0% (MY 2013; Figure 7). Ten of the 15 completed SAR estimates (67%) 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-six 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 2005–2019, 326 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 2018 was the most recently completed estimate and had an SAR of 1.5% (95% CI 1.0–2.0%). 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 23 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 4,975 (MY 2012). Ninety-one adults were detected that were not previously detected as emigrating smolts and were excluded from further analysis. From MYs 1996–2018, 826 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 2018 was the most recently completed estimate and had an SAR of 1.00% (95% CI 0.37–2.5%). 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). Ten of the 16 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-four 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 2019 was the most recently completed estimate and had an SAR of 0.16% (95% CI 0.0–1.0%). For MYs 2003–2019, the median SAR was 1.5% and ranged from 0.0% (MY 2004, 2005) to 5.0% (MY 2008; Figure 7). Eleven of the 17 completed SAR estimates (64.7%) 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 2003–2019, 195 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 PIT Tag Detector Array—Age composition of SY 2022 Big Bear Creek steelhead was determined from adult fish sampled at LGR, because no fish were physically handled at the array site. Age data was collected from three adult steelhead detected at the array in Big Bear Creek that were sampled at LGR and were assigned a complete age (Table 4). Two (66.7%) adult steelhead were assigned as a 2-ocean adult and one (33.3%) was assigned as a 1-ocean adult. All three (100%) adult steelhead smolted after two years in freshwater.

Sex and size composition data were collected from the three adult steelhead sampled at LGR for age composition (Table 3). All three adult steelhead were female and mean fork length was 71 cm (range = 54-85 cm; Table 4).

East Fork Potlatch River Weir—Age composition of SY 2022 East Fork Potlatch River steelhead was determined from data collected at the weir. Age data was collected from three unique wild, adult steelhead (prespawn and kelts) captured at the weir. One of these adult steelhead was a prespawn mortality. All three wild steelhead sampled were assigned complete ages (Table 4). One (33.3%) was 1-ocean, one (33.3%) was 2-ocean, and one (33.3%) was a repeat spawner (Figure 8). All three adults (100.0%) smolted after two years in freshwater. Total ages ranged from four to six years at spawning, with three different freshwater-saltwater age class combinations (Table 4).

Sex and size composition data were collected from the three unique adult steelhead sampled for age composition (Table 3). Females comprised 66.7% (n = 2), and males comprised 33.3% (n = 1). Mean fork length for females was 66.5 cm (range = 60.0–73.0 cm) and the fork length for the male was 70.0.

Crooked River Weir—Age composition of SY 2022 Crooked River steelhead was determined from data collected at the weir. Age data was collected from six unique wild, adult steelhead captured at the weir; five were assigned complete ages, and one had an unknown freshwater age (Table 4). Of those assigned ocean ages, one fish (16.7%) was a 1-ocean adult, four (66.7%) were 2-ocean adults, and one (16.7%) was a 3-ocean adult (Figure 8). Four adults (66.7%) 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 four different freshwater-saltwater age class combinations (Table 4). Of these six adult steelhead collected at the weir, one fish also had samples taken at LGR and was subsequently detected at the Crooked River array.

Sex and size composition data were collected from the six unique wild, adult steelhead sampled for age composition (Table 3). Females comprised 50.0% (n = 3), and males comprised 50.0% (n = 3). Mean fork length for females was 72.5 (range = 67.0–78.0 cm) and mean fork length for males was 81.0 cm (range = 80.0–83.0 cm).

Lochsa River PIT Tag Detector Array—Age composition of SY 2022 Lochsa River steelhead was determined from adult fish sampled at LGR, because no fish were physically handled at the array site. Age data was collected from 95 unique adult steelhead detected at the array in the Lochsa River that were sampled at LGR; 76 were assigned complete ages, 17 had unknown freshwater ages and two were not assigned an age (Table 4). Of those assigned ocean ages, 25 fish (26.8%) were 1-ocean adults, 67 (72.0%) were 2-ocean adults, and one (1.1%) was a 3-ocean adult (Figure 8). Three adults (4.0%) smolted after one year in freshwater, 33 (43.4%) smolted after two years, 38 (50.0%) smolted after three years, and two (2.6%) smolted after four years. Total ages ranged from four to eight years at spawning, with eight different freshwater-saltwater age class combinations (Table 4).

Sex and size composition data were collected from 95 unique adult steelhead detected at the array in the Lochsa River that were sampled at LGR (Table 3). Females comprised 66.3% (n = 63) and males comprised 31.5% (n = 30) of the adults sampled at LGR, in addition to 2.2% (n = 2) of the adults that were unable to be assigned a sex. Mean fork length for females was 76.3 cm (range = 58.0–86.0 cm) and mean fork length for males was 73.0 cm (range = 58.0–89.0 cm).

Fish Creek Weir—Age composition of SY 2022 Fish Creek steelhead was determined solely from data collected at the weir. Age data was collected from 26 unique wild, adult steelhead captured at the weir. Of the 26 adults sampled, 24 were assigned complete ages, and two had unknown freshwater ages (Table 4). Of those assigned ocean ages, three (11.5%) were 1-ocean adults, 21 (80.7%) were 2-ocean adults, and two (7.7%) were 3-ocean adults (Figure 8). Five fish (20.8%) smolted after two years in freshwater and 19 (79.1%) smolted after three years. Total ages ranged from four to six years, with five different freshwater-saltwater age class combinations (Table 4).

Sex and size composition data were collected from the 26 unique adult steelhead sampled for age composition (Table 3). Females comprised 65.4% (n = 17) and males comprised 34.6% (n = 9) of the adults sampled at the weir (Table 3). Mean fork length for females was 77.6 cm (range = 62.8–86.0 cm) and males was 77.6 cm (range = 63.8–85.0 cm).

Rapid River Weir—Age composition of SY 2022 Rapid River steelhead was determined from data collected at the weir. Age data was collected from 18 unique wild, adult steelhead captured at the weir. Of the 18 adults sampled, 14 were assigned complete ages, and four fish had an unknown freshwater age (Table 4). Of those assigned ocean ages, 13 (72.2%) were a 1-ocean adult, and five (27.7%) were 2-ocean adults (Figure 9). Eight fish (57.1%) smolted after two years in freshwater, and six (42.8%) smolted after three years. Total ages ranged from four to six years at spawning, with four different freshwater-saltwater age class combinations (Table 4).

Sex and size composition data were collected from the 18 prespawn adult steelhead sampled for age composition (Table 3). Females comprised 50.0% (n = 9) and males comprised 50.0% (n = 9) of the adults sampled at the weir (Table 3). Mean fork length for females was 65.8 cm (range = 55.0–77.0 cm) and males was 58.8 cm (range = 53.0–70.0 cm).

South Fork Salmon River PIT Tag Detector Array—Age composition of SY 2022 South Fork Salmon River steelhead was determined from adult fish sampled at LGR, because no fish were physically handled at the array site. Age data was collected from 37 unique adult steelhead detected at the array in the South Fork Salmon River that were sampled at LGR; 32 were assigned complete ages, and five had unknown freshwater age (Table 4). Of those assigned ocean ages, 11 fish (29.7%) were 1-ocean adults, and 26 (70.3%) were 2-ocean adults (Figure 9). Five adults (15.6%) smolted after two years in freshwater, 26 (81.3%) smolted after three years, and one adult (3.1%) smolted after four years. Total ages ranged from five to seven years at spawning, with four different freshwater-saltwater age class combinations (Table 4).

Sex and size composition data were collected from the 35 prespawn adult steelhead sampled at LGR for age composition (Table 3). Females comprised 75.7% (n = 28) and males comprised 24.3% (n = 9) of the adults sampled at LGR (Table 3). Mean fork length for females was 76.8 cm (range = 61.0–87.0 cm) and mean fork length for males was 69.2 cm (range = 60.0–86.0 cm).

Big Creek PIT Tag Detector Array—Age composition of SY 2022 Big Creek steelhead was determined from adult fish sampled at LGR because no fish were physically handled at the array site. Age data was collected from 32 unique adult steelhead detected at the array in Big Creek that were sampled at LGR; 26 were assigned complete ages, five had unknown freshwater ages, and one fish was not assigned an age (Table 4). Of those assigned ocean ages, 20 fish (64.5%) were 1-ocean adults, and 11 (35.4%) were 2-ocean adults (Figure 9). Three adults (9.4%) smolted after two years in freshwater, 21 (65.6%) smolted after three years, and two (6.3%) adults smolted after four years. Total ages ranged from four to seven years at spawning, with six different freshwater-saltwater age class combinations (Table 4).

Sex and size composition data were collected from the 32 prespawn adult steelhead sampled at LGR for age composition (Table 3). Females comprised 84.4% (n = 27) and males comprised 15.6% (n = 5) of the adults sampled at LGR (Table 3). Mean fork length for females was 64.9 cm (range = 52.0–85.0 cm) and mean fork length for males was 71.2 cm (range = 62.0–84.0 cm).

Marsh Creek PIT Tag Detector Array—Age composition of SY 2022 Marsh Creek steelhead was determined from adult fish sampled at LGR, because no fish were physically handled at the array site. Age data was collected from five unique adult steelhead detected at the array in Marsh Creek that were sampled at LGR; all five were assigned complete ages (Table 4). Two fish were 1-ocean adults (40.0%) and three fish (60.0%) were 2-ocean adults (Figure 9). One adult (20.0%) smolted after two years in freshwater, two fish (40.0%) smolted after three years in freshwater, and two fish (40.0%) smolted after four years. Total ages ranged from four to seven years at spawning, with four different freshwater-saltwater age class combinations (Table 4).

Sex and size composition data were collected from the five prespawn adult steelhead sampled at LGR for age composition (Table 3). Females comprised 60.0% (n = 3) and males comprised 40.0% (n = 2) of the adults sampled at LGR (Table 3). Mean fork length for females was 73.7 cm (range = 64.0–78.0 cm) and mean fork length for males was 62.5 cm (range = 61.0–64.0 cm).

North Fork Salmon River PIT Tag Detector Array—Age composition of SY 2022 North Fork Salmon River steelhead was determined from adult fish sampled at LGR, because no fish were physically handled at the array site. Age data was collected from seven adult steelhead detected at the array in the North Fork Salmon River that were sampled at LGR, and all were assigned a complete age (Table 4). Five fish were 1-ocean adults (71.4%), and two fish (28.6%) were 2-ocean adults (Figure 9). Two adults (28.5%) smolted after two years in freshwater, four fish (57.1%) smolted after three years in freshwater, and one fish (14.3%) smolted after four years. Total ages ranged from four to seven years at spawning, with four different freshwater-saltwater age class combinations (Table 4).

Sex and size composition data were collected from the seven prespawn adult steelhead sampled at LGR for age composition (Table 3). Females comprised 85.7% (n = 6) and males comprised 14.3% (n = 1) of the adults sampled at LGR (Table 3). Mean fork length for females was 60.3 cm (range = 52.0–69.0 cm) and the male fork length was 52.0 cm.

Lower Lemhi River PIT Tag Detector Array—Age composition of SY 2022 Lemhi River steelhead was determined from adult fish sampled at LGR because no fish were physically handled at the array site. Age data was collected from eight unique adult (prespawn and kelts) steelhead detected at the array in the lower Lemhi River that were sampled at LGR; six were assigned complete ages, one had unknown freshwater age, and one was a repeat spawner (Table 4). Of those assigned ocean ages, five fish (62.5%) were 1-ocean adults, and two (25.0%) were 2-ocean adults (Figure 9). Three adults (42.8%) smolted after two years in freshwater and four (57.1%) smolted after three years. Total ages ranged from four to six years at spawning, with four different freshwater-saltwater age class combinations (Table 4).

Sex and size composition data were collected from six of the eight prespawn adult steelhead sampled at LGR for age composition (Table 3). Females comprised 100.0% (n = 6) of the adults sampled at LGR (Table 3). Mean fork length for females was 61.3 cm (range = 53.0–73.0 cm).

Hayden Creek PIT Tag Detector Array—Age composition of SY 2022 Hayden Creek steelhead was determined from adult fish sampled at LGR because no fish were physically handled at the array site. Age data was collected from two unique adult steelhead detected at the array in Hayden Creek that were sampled at LGR; of which all were assigned complete ages (Table 4). Both fish (100.0%) were 1-ocean adults and both (100.0%) smolted after three years in freshwater (Table 4).

Sex and size composition data were collected from the two prespawn adult steelhead sampled at LGR for age composition (Table 3). Females comprised 100.0% (n = 2) of the adults sampled at LGR (Table 3). Mean fork length for females was 61.5 cm (range = 57.0–66.0 cm).

Upper Lemhi River PIT Tag Detector Array—No SY 2022 adult steelhead were detected at the Upper Lemhi River array that were sampled at LGR (Table 3).

Pahsimeroi River Weir—Age composition of SY 2022 Pahsimeroi River steelhead was determined from data collected at the weir. Age data was collected from 17 unique, wild steelhead. Of the 17 unique adults sampled, 13 were assigned complete ages, and four had unknown freshwater ages (Table 4). Of those assigned ocean ages, 15 (88.2%) were 1-ocean adults and two (11.7%) were 2-ocean adults (Figure 9). Thirteen fish (100.0%) smolted after two years in freshwater. Total ages ranged from four to five years, with two different freshwater-saltwater age class combinations (Table 4).

Sex and size composition data were collected from the 17 prespawn adult steelhead sampled for age composition (Table 3). Females comprised 47.1% (n = 8) and males comprised 53% (n = 9) of the adults sampled at the weir (Table 3). Mean fork length for females was 57.4 cm (range = 53.0–69.0 cm) and males was 59.3 cm (range = 50.0–71.0 cm).

East Fork Salmon River Weir—Age composition of SY 2022 East Fork Salmon River steelhead was determined from data collected at the weir. Nine unique wild adult steelhead were captured at the weir. Of the nine adults sampled, eight were assigned complete ages, and one had an unknown freshwater age (Table 4). Of those assigned ocean ages, five (55.6%) were 1-ocean adults and four (44.4%) were 2-ocean adults (Figure 9). Four fish (50.0%) smolted after two years in freshwater, and four (50.0%) smolted after three years. Total ages ranged from four to six years, with four different freshwater-saltwater age class combinations (Table 4).

Sex and size composition data were collected from eight of the nine prespawn adult steelhead captured at the weir (Table 3). Females comprised 25.0% (n = 2) and males comprised 75.0% (n = 6) of the adults sampled at the weir (Table 3). Mean fork length for females was 71.5 cm (range = 71.0–72.5 cm) and males was 63.4 cm (range = 55.0–76.0 cm).

Upper Salmon River Weir—Age composition of SY 2022 upper Salmon River steelhead was determined from data collected at the weir. Age data was collected from 56 unique wild, adult steelhead captured at the weir. Of the 56 unique adults sampled, 46 were assigned complete ages, seven had unknown freshwater age, and three were repeat spawners (Table 4). Of those assigned ocean ages, 45 (80.0%) were 1-ocean adults and eight (14.2%) were 2-ocean adults (Figure 9). Fourteen (30.4%) fish smolted after two years in freshwater, 24 (52.1%) smolted after three years, and eight fish (17.3%) smolted after four years. Total ages ranged from four to seven years, with seven different freshwater-saltwater age class combinations (Table 4).

Sex and size composition data were collected from the 56 prespawn adult steelhead sampled for age composition (Table 3). Females comprised 32.1% (n = 18), and males comprised 67.9% (n = 38) of the adults sampled at the weir (Table 3). Mean fork length for females was 58.1 cm (range = 50.0–71.0 cm), and males was 56.6 cm (range = 39.0–73.0 cm).

Adult Migration Timing and Conversion Rates

Big Bear Creek PIT Tag Detector Array—Five adult steelhead were detected in the hydrosystem during the SY 2022 adult migration that were PIT-tagged as juveniles in Big Bear Creek. All five individuals were detected at Bonneville Dam upon their return migration (Figure 10). The median date of passage over Bonneville Dam was August 11, 2021 (range = June 20–November 3). The conversion rate from Bonneville Dam to McNary Dam was 60.0% and from Bonneville Dam to LGR was 60.0% (Appendix E). All three PIT-tagged adult steelhead detected at LGR were detected during fall 2021. The median date of passage at LGR was September 22, 2021 (range = September 13–September 29). None of the PIT-tagged adults that entered the hydrosystem were detected at the Big Bear Creek array.

East Fork Potlatch River Weir—One adult steelhead was detected in the hydrosystem during the SY 2022 adult migration that was PIT tagged as a juvenile in the East Fork Potlatch River. The individual was detected at Bonneville Dam on August 25, 2021. The conversion rate from Bonneville Dam to McNary Dam was 0.0% and from Bonneville to LGR was 0.0%.

Prespawn adult steelhead were captured at the weir between March 14–July 9, 2022 and a kelt was captured between March 26–June 1, 2022 (Figure 11). The median date of capture for prespawn adults and kelts was April 26 and April 25, 2022, respectively.

Lochsa River PIT Tag Detector Array—Fifteen adult steelhead were detected in the hydrosystem during the SY 2022 adult migration that were PIT tagged as juveniles in Lochsa River main stem and tributaries. All individuals were detected at Bonneville Dam upon their return migration (Figure 10). Thirteen 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 7, 2021 (range = August 14–September 29). The conversion rate from Bonneville Dam to McNary Dam was 73.3% and from Bonneville Dam to LGR was 73.3%. All 15 PIT-tagged adult steelhead (100.0%) 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 October 7, 2021 (range = September 21–October 30). Of the initial 15 PIT-tagged adults that entered the hydrosystem, 11 (73.3%) were subsequently detected on the Lochsa River array.

The median date for prespawn wild adult steelhead detected at the Lochsa River PIT tag array was March 24, 2022 (March 13–June 27; Figure 11).

Fish Creek Weir—Thirteen adult steelhead were detected in the hydrosystem during the SY 2022 adult migration that were PIT tagged as juveniles in Fish Creek. All thirteen individuals were detected at Bonneville Dam upon their return migration (Figure 10). The median date of passage over Bonneville Dam was September 7, 2021 (range = August 14–September 29). The conversion rate from Bonneville Dam to McNary Dam was 84.6% and from Bonneville Dam to LGR was 84.6% (Appendix E). Twelve of the 13 PIT-tagged adult steelhead (90.9%) detected at LGR were detected during the fall and the remaining fish was detected the following spring. The median date of passage over LGR was October 7, 2021 (range = September 21–March 22). Of the initial 13 PIT-tagged adults that entered the hydrosystem, 6 (46.1%) were subsequently captured at the Fish Creek weir, all of which were handled as prespawn migrants.

Prespawn adult steelhead were captured at the weir between April 19–June 5, 2022 and one kelt was captured on July 9, 2022 (Figure 11). The median date of capture for prespawn adults and kelts was April 29 and July 9, 2022, respectively.

Rapid River Weir—No adult steelhead were detected in the hydrosystem during the SY 2022 adult migration that were PIT tagged as juveniles in Rapid River (Figure 10). There was one adult steelhead PIT tagged as an adult at LGR that was subsequently captured at the Rapid River weir. The date of passage for this fish sampled at LGR was April 12, 2022.

The median date for prespawn adult steelhead captured at the weir was May 7, 2022 (range = April 13–June 17; Figure 11).

South Fork Salmon River PIT Tag Detector Array—Six adult steelhead were detected in the hydrosystem during the SY 2022 adult migration that were PIT tagged as juveniles in the South Fork Salmon River (Figure 10). The median date of passage over Bonneville Dam was September 5, 2021 (range = August 14–October 20). The conversion rate from Bonneville Dam to McNary Dam was 66.7% and from Bonneville to LGR was 83.3%. All 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 29, 2021 (range = September 12–October 20). Of the initial six PIT-tagged adults that entered the hydrosystem, five (83.3%) were subsequently detected on the South Fork Salmon River array.

The median date for prespawn wild adult steelhead detected at the South Fork Salmon River array was April 23, 2022 (March 22–June 24; Figure 11).

Big Creek PIT Tag Detector Array—Six adult steelhead were detected in the hydrosystem during the SY 2022 adult migration that were PIT tagged as juveniles in Big Creek (Figure 10). The median date of passage over Bonneville Dam was August 31, 2021 (range = July 9–October 2). The conversion rate from Bonneville Dam to McNary Dam and LGR was 83.0% (Appendix F). All five 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 20, 2021 (range = August 19–October 13). Of the initial six PIT-tagged adults that entered the hydrosystem, three (50.0%) were subsequently detected on the Big Creek array.

The median date for prespawn wild adult steelhead detected at the Big Creek array was May 4, 2022 (March 26–June 2; Figure 11).

Marsh Creek PIT Tag Detector Array—No adult steelhead were detected in the hydrosystem during the SY 2022 adult migration that were PIT tagged as juveniles in Marsh Creek. There were four adult steelhead PIT tagged as adults at LGR that were subsequently detected at the Marsh Creek array. The median date of passage for these fish sampled at LGR was September 16, 2021 (range = September 1–October 17).

The median date for prespawn adult steelhead detected at the Marsh Creek array was May 4, 2022 (April 27–June 9).

North Fork Salmon River PIT Tag Detector Array—Two adult steelhead were detected in the hydrosystem during the SY 2022 adult migration that were PIT tagged as juveniles in the

North Fork Salmon River (Figure 10). The date of passage over Bonneville Dam was August 2 and 28, 2021. The conversion rate from Bonneville Dam to McNary Dam was 100.0% and from Bonneville to LGR was 100.0%. Both PIT-tagged adult steelhead (100.0%) detected at LGR were detected in the fall, on August 28 and November 7, 2021. Both adult steelhead that were PIT tagged as juveniles in the North Fork Salmon River were detected at the array, one on May 2 and one on May 4, 2022 (Figure 11).

Lower Lemhi River PIT Tag Detector Array—Seven adult steelhead were detected in the hydrosystem during the SY 2022 adult migration that were PIT tagged as juveniles in the Lemhi River basin (Figure 10). Six of those were tagged in the Lemhi River, and one was tagged in Hayden Creek. The median date of passage over Bonneville Dam was August 14, 2021 (range = July 6–September 17). The conversion rate from Bonneville Dam to McNary Dam was 85.7% and from Bonneville Dam to LGR was 85.7% (Appendix F). All adults detected at LGR were during the fall. The median date of passage for migrants over LGR was September 22, 2021 (range = September 6–October 4). Four of the seven PIT-tagged adults (57.1%) were detected at the lower Lemhi River array.

The median date for prespawn adult steelhead detected at the lower Lemhi River array was May 8, 2022 (April 8–June 8; Figure 11).

Pahsimeroi River Weir—No adult steelhead were detected in the hydrosystem during the SY 2022 adult migration that was PIT tagged as juveniles in the Pahsimeroi River (Figure 10). There were two adult steelhead PIT tagged as adults at LGR that were subsequently captured at the Pahsimeroi River weir. The median date of passage for these fish sampled at LGR was September 5, 2021 (range = August 24–September 17).

The median date for prespawn adult steelhead captured at the Pahsimeroi River weir was March 30, 2022 (March 4–April 25; Figure 11).

East Fork Salmon River Weir—No adult steelhead were detected in the hydrosystem during the SY 2022 adult migration that were PIT tagged as juveniles in the East Fork Salmon River. There were no adult steelhead PIT tagged as adults at LGR that were subsequently captured at the East Fork Salmon River weir.

The median date for prespawn adult steelhead captured at the East Fork Salmon River weir was April 26, 2022 (April 4–May 18; Figure 11).

Upper Salmon River Weir—One adult steelhead was detected in the hydrosystem during the SY 2022 adult migration that was PIT tagged as a juvenile in the Upper Salmon River (Figure 10). The date of passage over Bonneville Dam was August 12, 2021. The conversion rate from Bonneville Dam to McNary Dam was 100.0% and from Bonneville Dam to LGR was 100.0% (Appendix F). The adult steelhead was detected at LGR on October 1, 2021.

The median date for prespawn adult steelhead captured at the Upper Salmon River weir was April 25, 2022 (range = March 31–May 9).

Genetic Sampling

During 2022, we collected genetic samples from wild adult steelhead captured in the course of other project activities. A total of 129 genetic samples were collected across six 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 (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 to evaluate these populations at the proper scale to assess recovery objectives (Copeland et al. 2017).

Adult steelhead abundance estimates for the past six years have been relatively low across all populations, with the exception of the Lochsa River population where abundance has increased in SY 2021 and SY 2022. From SY 2021 to SY 2022 abundance decreased slightly or stayed the same in all other monitored populations, including Big Bear Creek, East Fork Potlatch River, Fish Creek, East Fork Salmon River, Hayden Creek, lower Lemhi River, Marsh Creek, Pahsimeroi River, South Fork Salmon River, upper Lemhi River, and the upper Salmon River.

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). Four reconditioned kelts were observed in monitored tributary systems in 2022; two were detected at the Upper Salmon River weir; one was detected on the lower Lemhi River array, and one was detected at the East Fork Potlatch River weir.

Occurrences of hatchery strays above 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., 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 5-9 BYs, with the except of the Upper Salmon BY 2016 (Figure 4). Mean productivity for BY 2015 across all populations monitored was 0.23 (range = 0.04–0.62), well below replacement. Mean productivity for BY 2015 decreased by 16.7% from BY 2014 across all populations monitored. Fish Creek (Clearwater River MPG) contains the longest productivity time series (24 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 (37.5%) meeting replacement. Fluctuations in productivity are expected in wild populations and were 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 population in 2026, and Marsh Creek and South Fork Salmon River populations in 2028.

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 (Knoth et al. 2021), 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 part 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 five MYs reported, with the exception of Big Bear Creek in 2018 (2016-2019; 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 Salmon. 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). In spawn year 2022, 49.0% of adult steelhead were 2-ocean, 48.4% were 1-ocean, 1.3% were 3-ocean, and 1.3% were repeat spawners. 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. Spawn year 2021 was dominated by 2-ocean adults, with 92.7% of ocean-aged steelhead spending two years in the saltwater. Spawn year 2022 was more balanced across 1-ocean and 2-ocean fish, and likely shows there haven’t been improvements in cohort strength. 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. Drought conditions may also explain the differences in year class strength across SY 2021 and SY 2022. 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 fish are generally older, in both time spent in freshwater and in saltwater. Returning adults from these populations were mostly comprised of freshwater age-3 fish (51.8%); whereas, the freshwater age-3 comprised a mean of 40.3% in all other populations in this study. In general, these three populations display an older ocean age and in SY 2022 the mean proportion of 2-ocean adults in the Lochsa River, South Fork Salmon River, and Big Creek was higher (54.5%) than the mean proportion of 2-ocean adults all other populations (24.8%). 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., in review).

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 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 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 array sites helps improve the accuracy of other sites in the state space model. In 2019, a newer version of the model was able to re-run escapement estimates for all previous years (IPTDSW 2020). The Bayesian framework allows older data (prior to installation of some new 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 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 decided annually 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. A sample size of at least 20 individual fish per site would likely provide us with a more accurate estimate of sex and ocean age composition. In SY 2022, Fish Creek, Big Creek, and the Upper Salmon River were the only populations with 20 or more samples. Small sample sizes will also limit the capabilities of the DABOM model to estimate escapement to array sites. A power analysis for 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 weir structures at Crooked River and Fish Creek are ineffective during high spring flows when adult steelhead are migrating, and Crooked River has not had enough individuals trapped to consistently estimate an expanded abundance of spawners in recent years. Additionally, Crooked River weir is not designed to capture kelts, thus we cannot generate estimates using mark recapture methodology. Therefore, an array site was installed on Crooked River in the fall of 2021.

The array effectively captured enough adult steelhead 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 continue to improve our array infrastructure and are examining alternative methods using Bayesian framework to fill these data gaps where expanded estimates could not be generated.

RECOMMENDATIONS

1. 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 Marsh Creek.

2. 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.

3. 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; ICBTRT 2007; 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/Array)	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 detector arrays, spawn year 2022. 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	Female	NA	3	54.0	71.0	85.0	NA	NA
	Male	NA	NA	NA	NA	NA	NA	NA
	All	NA	3	NA	NA	NA	NA	NA
East Fork Potlatch River	Female	2	NA	60.0	76.5	73.0	0	1
	Male	1	NA	70.0	70.0	70.0	0	0
	All	3	NA	70.0	71.5	73.0	0	1
Crooked River	Female	3	NA	67.0	72.5	78.0	0	0
	Male	3	NA	80.0	81.0	83.0	0	0
	All	5	NA	67.0	76.7	83.0	0	0
Lochsa River	Female	NA	65	58.0	76.3	86.0	NA	NA
	Male	NA	30	58.0	73.0	89.0	NA	NA
	All	NA	95	58.0	74.7	87.5	NA	NA
Fish Creek	Female	16	NA	62.8	77.9	86.0	1	0
	Male	9	NA	63.8	77.6	85.0	0	0
	All	25	NA	62.8	77.8	86.0	1	0
Salmon River MPG								
Rapid River	Female	9	NA	55.0	65.8	77.0	NA	NA
	Male	9	NA	53.0	58.8	70.0	NA	NA
	All	18	NA	53.0	62.3	77.0	NA	NA
South Fork Salmon River	Female	NA	28	61.0	76.8	87.0	NA	NA
	Male	NA	9	60.0	69.2	86.0	NA	NA
	All	NA	37	61.0	73.0	87.0	NA	NA
Big Creek	Female	NA	27	52.0	64.9	85.0	NA	NA
	Male	NA	5	62.0	71.2	84.0	NA	NA
	All	NA	32	61.0	68.1	84.0	NA	NA
Marsh Creek	Female	NA	3	64.0	73.7	78.0	NA	NA
	Male	NA	2	61.0	62.5	64.0	NA	NA
	All	NA	5	61.0	68.1	78.0	NA	NA
North Fork Salmon River	Female	NA	NA	NA	NA	NA	NA	NA
	Male	NA	1	52.0	52.0	52.0	NA	NA
	All	NA	1	52.0	52.0	52.0	NA	NA
Lower Lemhi River	Female	NA	6	53.0	61.1	73.0	NA	1
	Male	NA	NA	NA	NA	NA	NA	NA
	All	NA	6	53.0	61.1	73.0	NA	NA
Hayden Creek	Female	NA	2	57.0	61.5	66.0	NA	NA
	Male	NA	NA	NA	NA	NA	NA	NA
	All	NA	2	57.0	61.5	76.0	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	Female	NA	NA	NA	NA	NA	NA	NA
	Male	NA	NA	NA	NA	NA	NA	NA
	All	NA	NA	NA	NA	NA	NA	NA
Pahsimeroi River	Female	8	NA	53.0	57.4	69.0	NA	NA
	Male	9	NA	50.0	59.3	71.0	NA	NA
	All	17	NA	50.0	58.4	71.0	NA	NA
East Fork Salmon River	Female	6	NA	71.0	71.5	72.5	NA	NA
	Male	7	NA	55.0	63.4	76.0	NA	NA
	All	13	NA	55.0	71.0	78.0	NA	NA
Upper Salmon River	Female	18	NA	50.0	58.1	71.0	NA	NA
	Male	38	NA	39.0	56.6	73.0	NA	NA
	All	56	NA	69.0	57.4	73.0	NA	NA

Table 4. Age frequencies of wild adult steelhead captured at weirs or sampled at Lower Granite Dam that were subsequently detected at PIT tag detector arrays, spawn year 2022. 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	0	0	1	2	0	0	0	0	0	0	0	0	0	0	0	3
East Fork Potlatch River	0	0	1	1	0	0	0	0	0	0	1	0	0	0	0	3
Crooked River (Weir)	0	0	1	2	1	0	1	0	0	0	0	0	1	0	0	6
Crooked River (Array)	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1
Lochsa River	1	2	12	21	0	11	27	0	1	1	0	0	16	1	2	95
Fish Creek	0	0	1	3	1	2	16	0	0	0	0	0	1	1	0	25
Salmon River MPG																
Rapid River	0	0	6	2	0	4	2	0	0	0	0	3	1	0	0	18
South Fork Salmon River	0	0	0	5	0	10	16	0	0	1	0	1	4	0	0	37
Big Creek	0	0	2	1	0	15	6	0	1	1	0	2	3	0	1	32
Marsh Creek	0	0	1	0	0	0	2	0	1	1	0	0	0	0	0	5
North Fork Salmon River	0	0	1	1	0	3	1	0	1	0	0	0	0	0	0	7
Lower Lemhi River	0	0	3	0	0	2	1	0	0	0	1	0	1	0	0	8
Hayden Creek	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	2
Upper Lemhi River	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pahsimeroi River	0	0	11	2	0	0	0	0	0	0	0	4	0	0	0	17
East Fork Salmon River	0	0	1	3	0	3	1	0	0	0	0	1	0	0	0	9
Upper Salmon River	0	0	13	1	0	20	4	0	5	3	2	7	0	0	0	55
Total	1	2	54	44	2	73	77	0	9	7	4	18	27	2	3	323

FIGURES

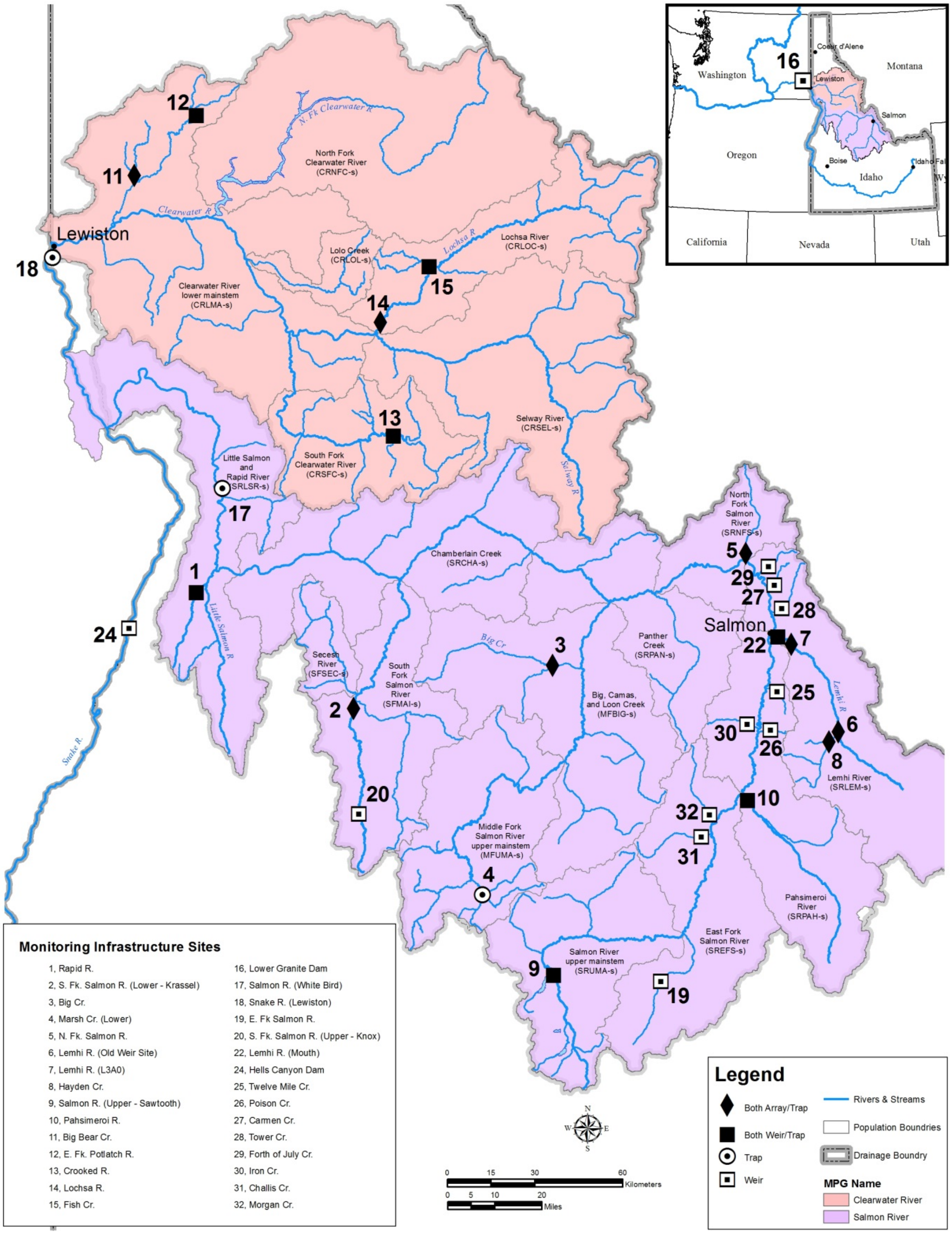


Figure 1. Location of wild steelhead monitoring infrastructure operated by IDFG in Idaho. The Clearwater River Major Population Group is in pink; the Salmon River Major Population Group is in purple. Population boundaries are shown as light gray lines.

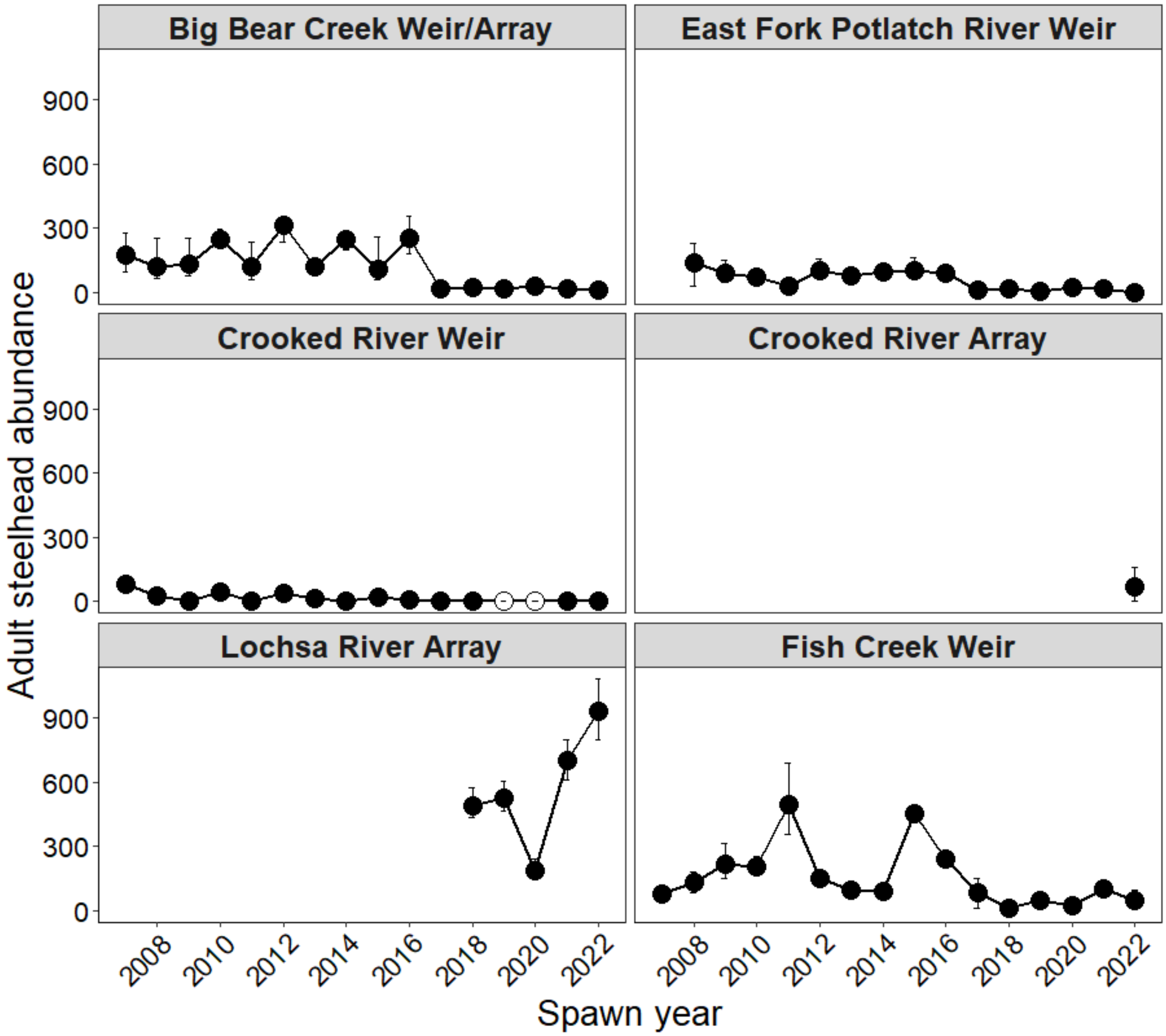


Figure 2. Abundance trends of wild adult steelhead at weirs or PIT tag detector arrays in the Clearwater River basin, spawn years 2007–2022. Confidence intervals are at 95%. Points without confidence intervals are unique adults trapped or detected. Hollow points indicate an abundance of zero.

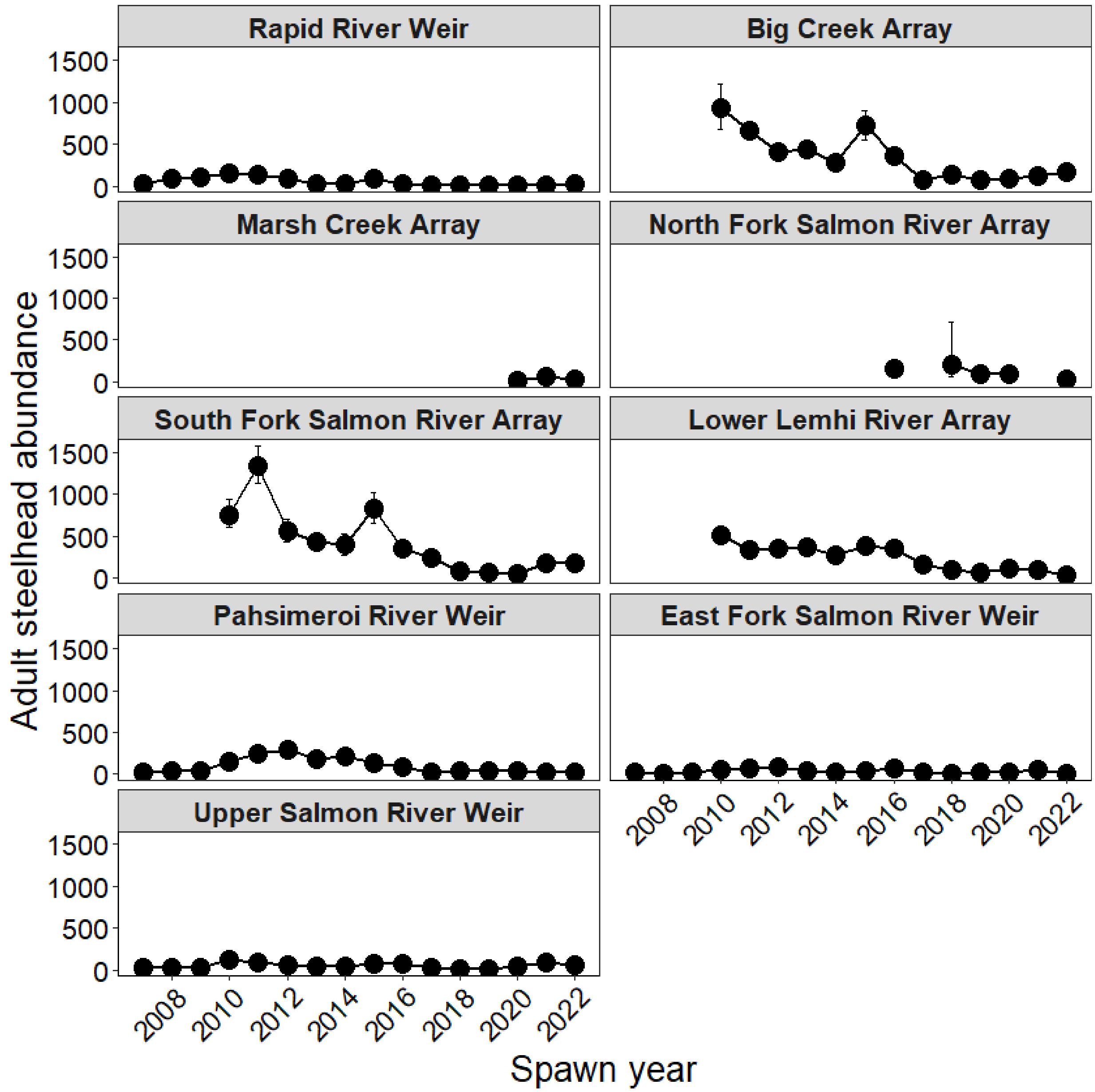


Figure 3. Abundance trends of wild adult steelhead at weirs or PIT tag detector arrays in the Salmon River basin, spawn years 2007–2022. Confidence intervals are at 95%. Points without confidence intervals are unique adults trapped or detected.

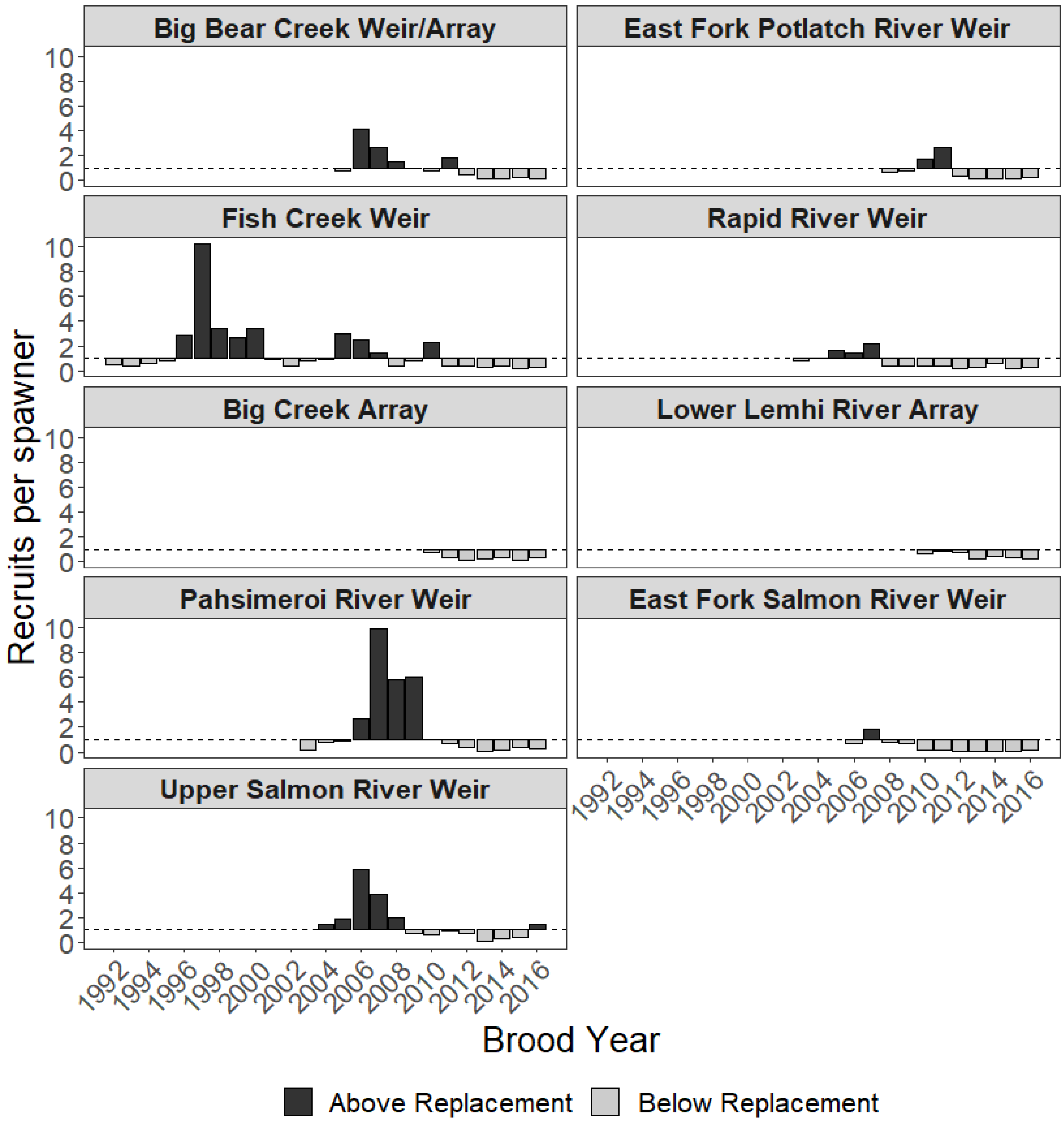


Figure 4. Productivity (wild adult recruits per spawner) of steelhead at select Idaho weirs or PIT tag detector arrays, brood years 1992–2016. Select brood years were omitted due to incomplete data. Dashed line represents 1:1 replacement.

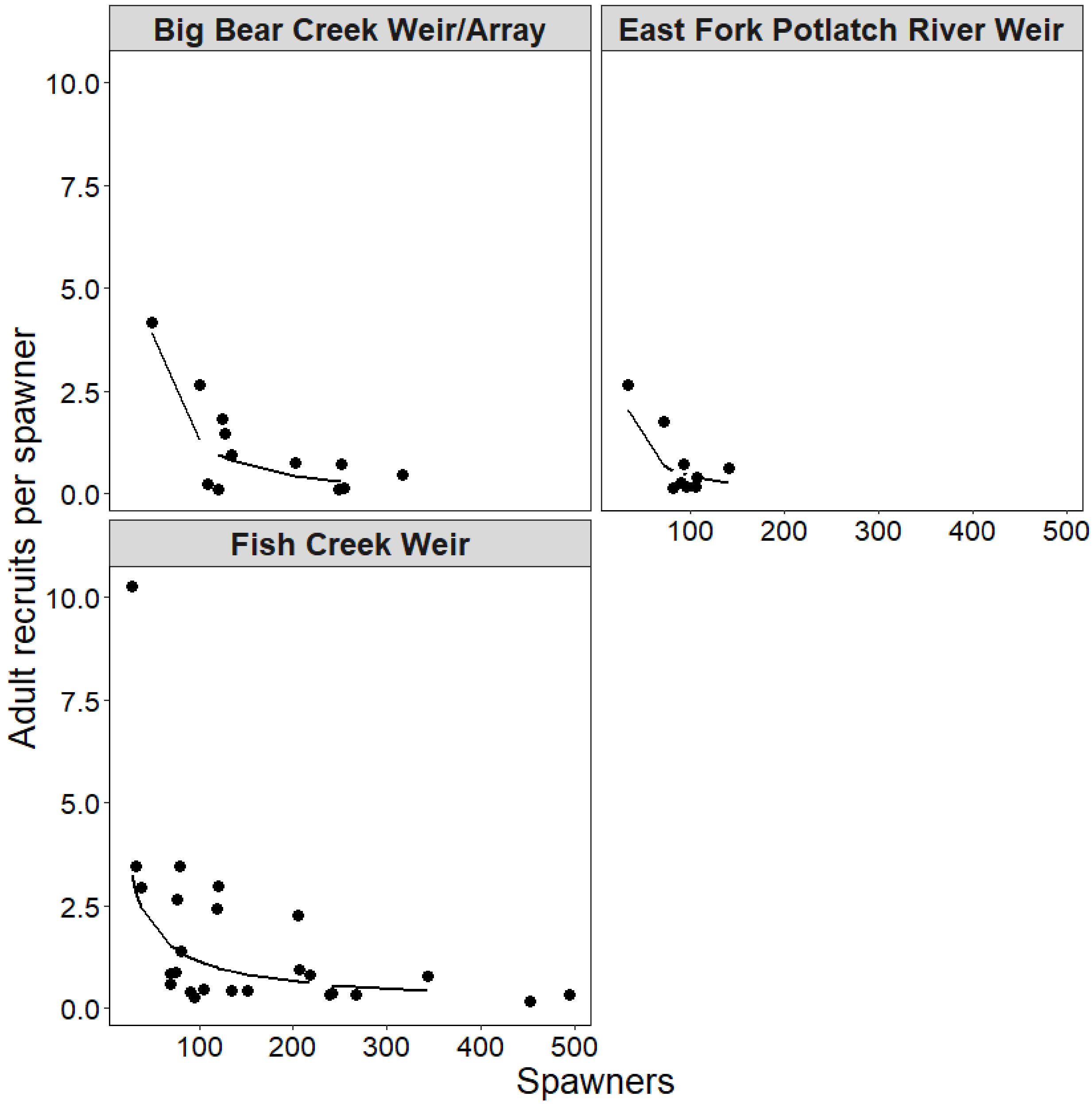


Figure 5. Relationship of steelhead productivity (wild adult recruits per spawner) to spawner abundance at select weirs or PIT tag detector arrays in the Clearwater River basin, brood years 1992–2016. Select brood years were omitted due to incomplete data. Trend lines for each data set were fit with a power function.

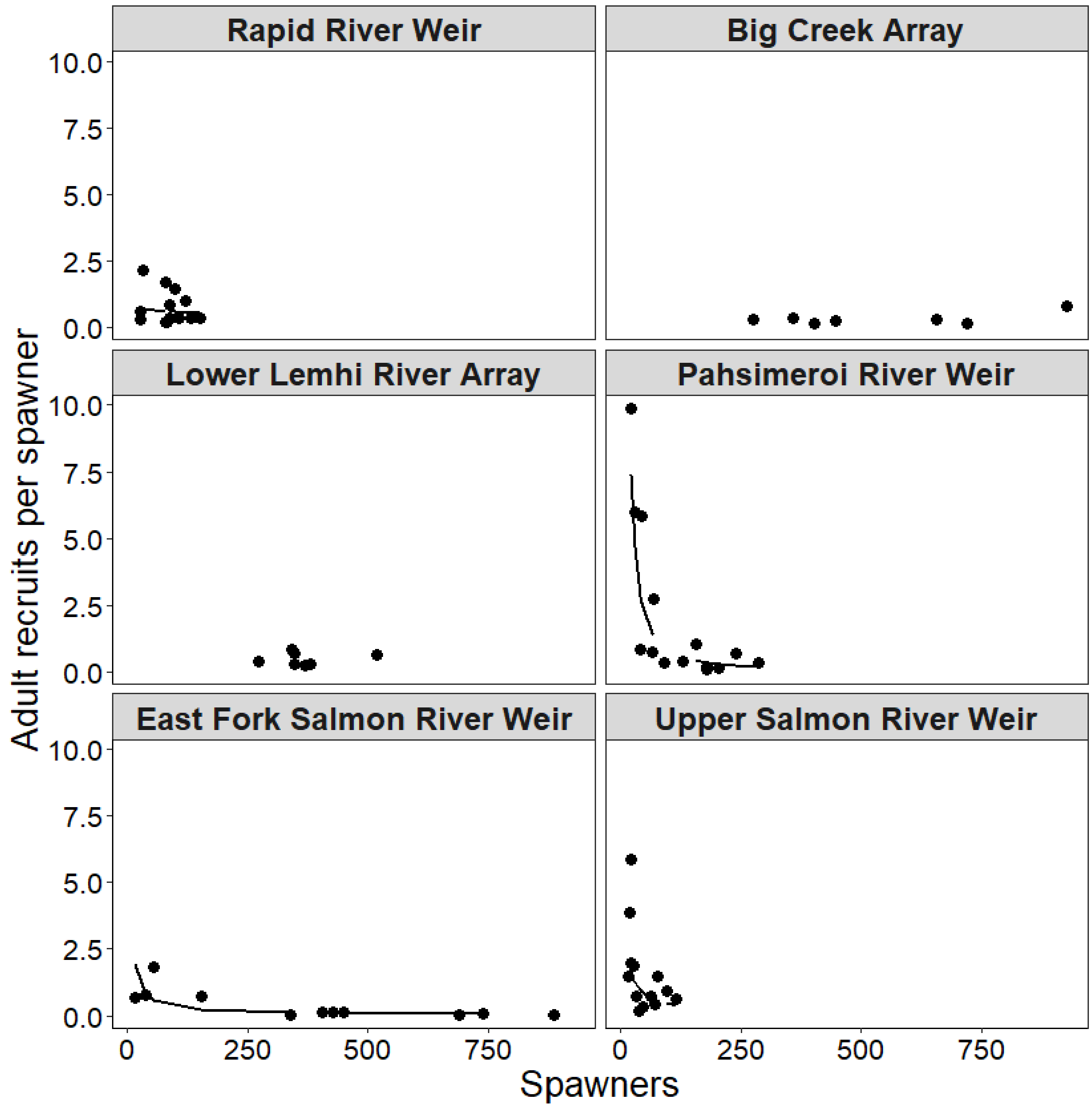


Figure 6. Relationship of steelhead productivity (wild adult recruits per spawner) to spawner abundance at select weirs or PIT tag detector arrays in the Salmon River basin, brood years 1992–2016. Select brood years were omitted due to incomplete data. Trend lines for each data set were fit with a power function where applicable.

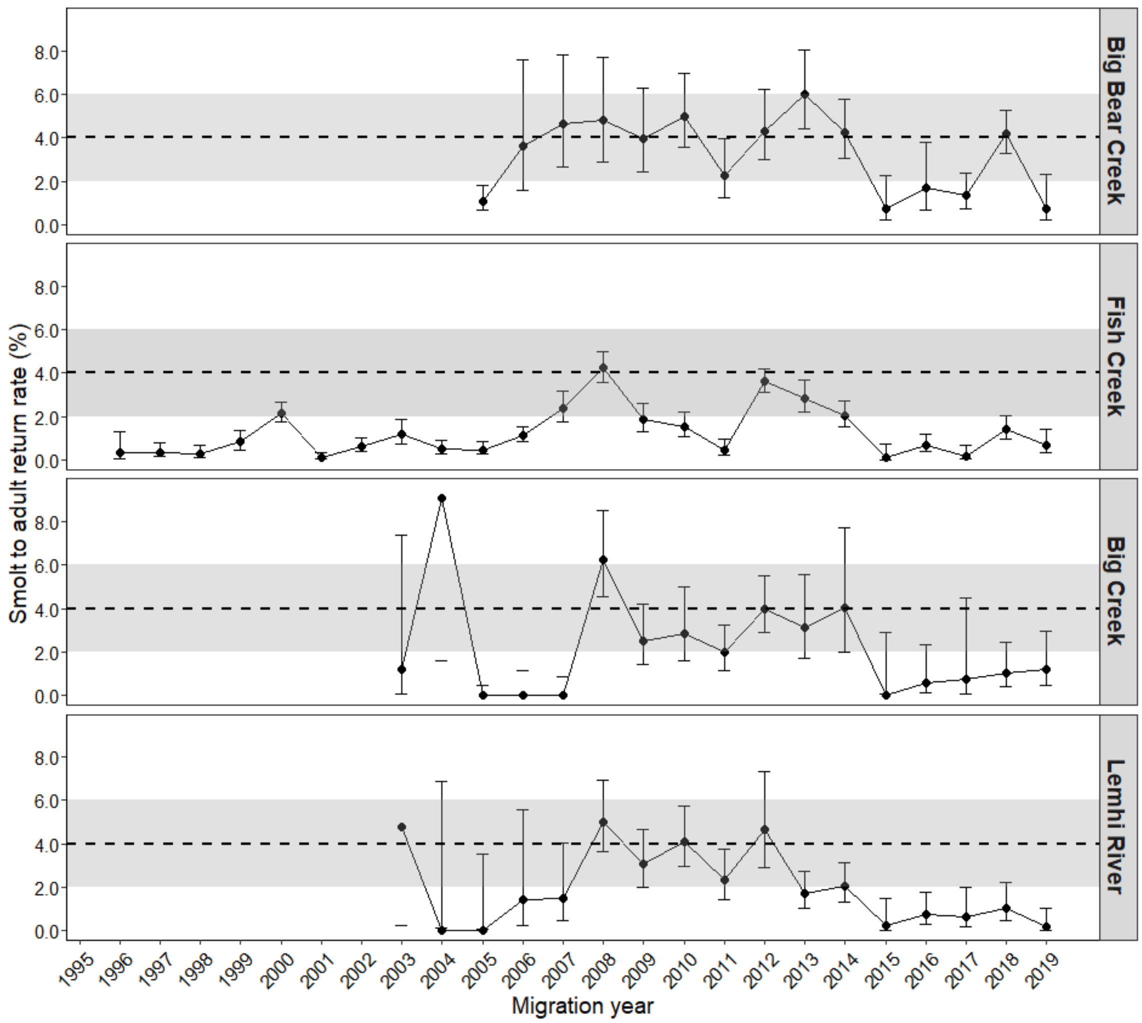


Figure 7. Wild steelhead smolt-to-adult return rate (SAR, %) from select Idaho weirs or PIT tag detector arrays to Bonneville Dam, migratory years 1996–2020. Confidence intervals are at 95%. Hollow points indicate an SAR of zero. Select confidence intervals were omitted due to small number of smolts 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).

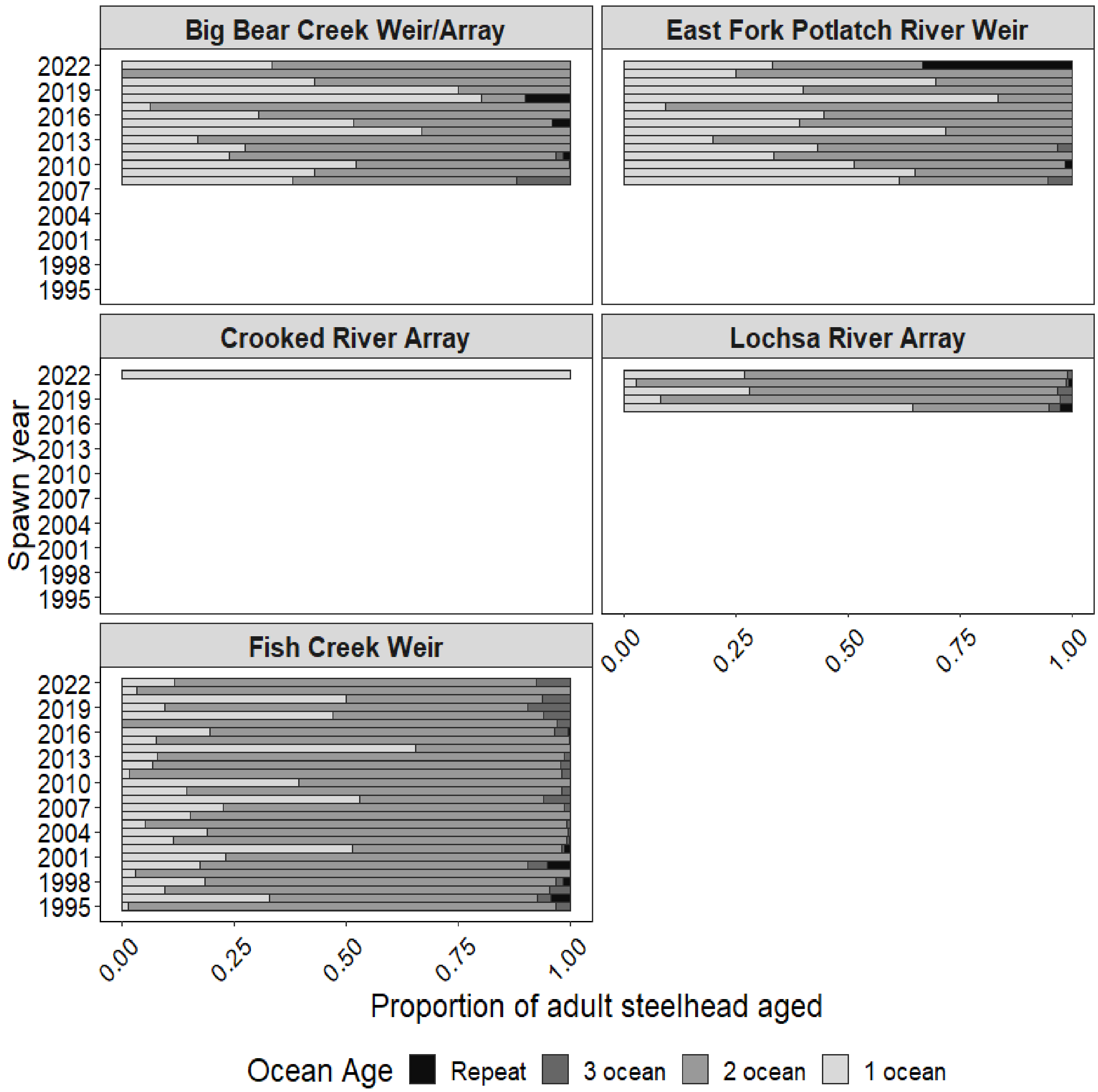


Figure 8. Ocean age composition of wild adult steelhead at select Idaho weirs or PIT tag detector arrays in the Clearwater River basin, spawn years 1995–2022. Select spawn years were omitted due to incomplete data.

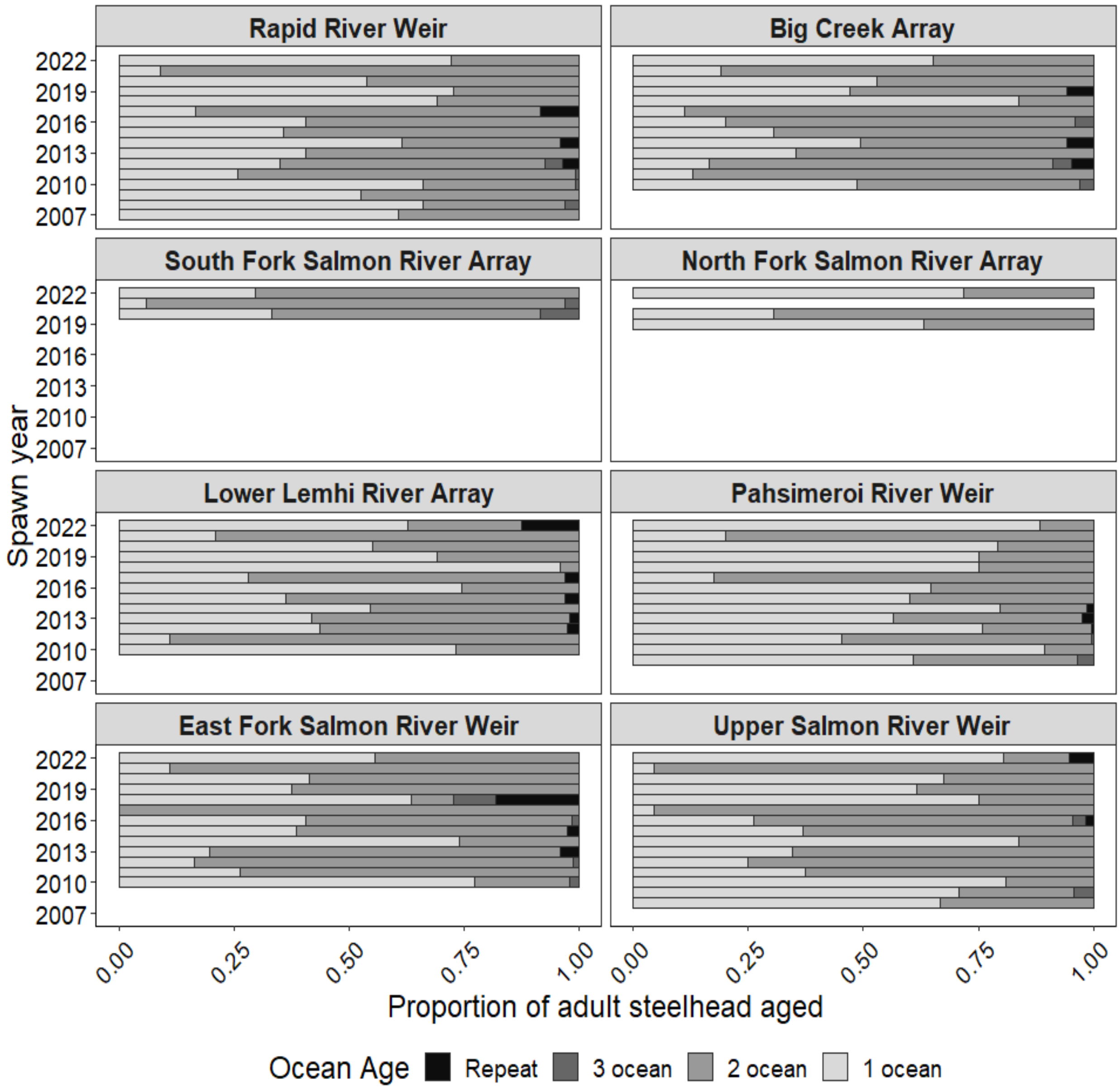


Figure 9. Ocean age composition of wild adult steelhead at select Idaho weirs or PIT tag detector arrays in the Salmon River basin, spawn years 2007–2022. Select spawn years were omitted due to incomplete data.

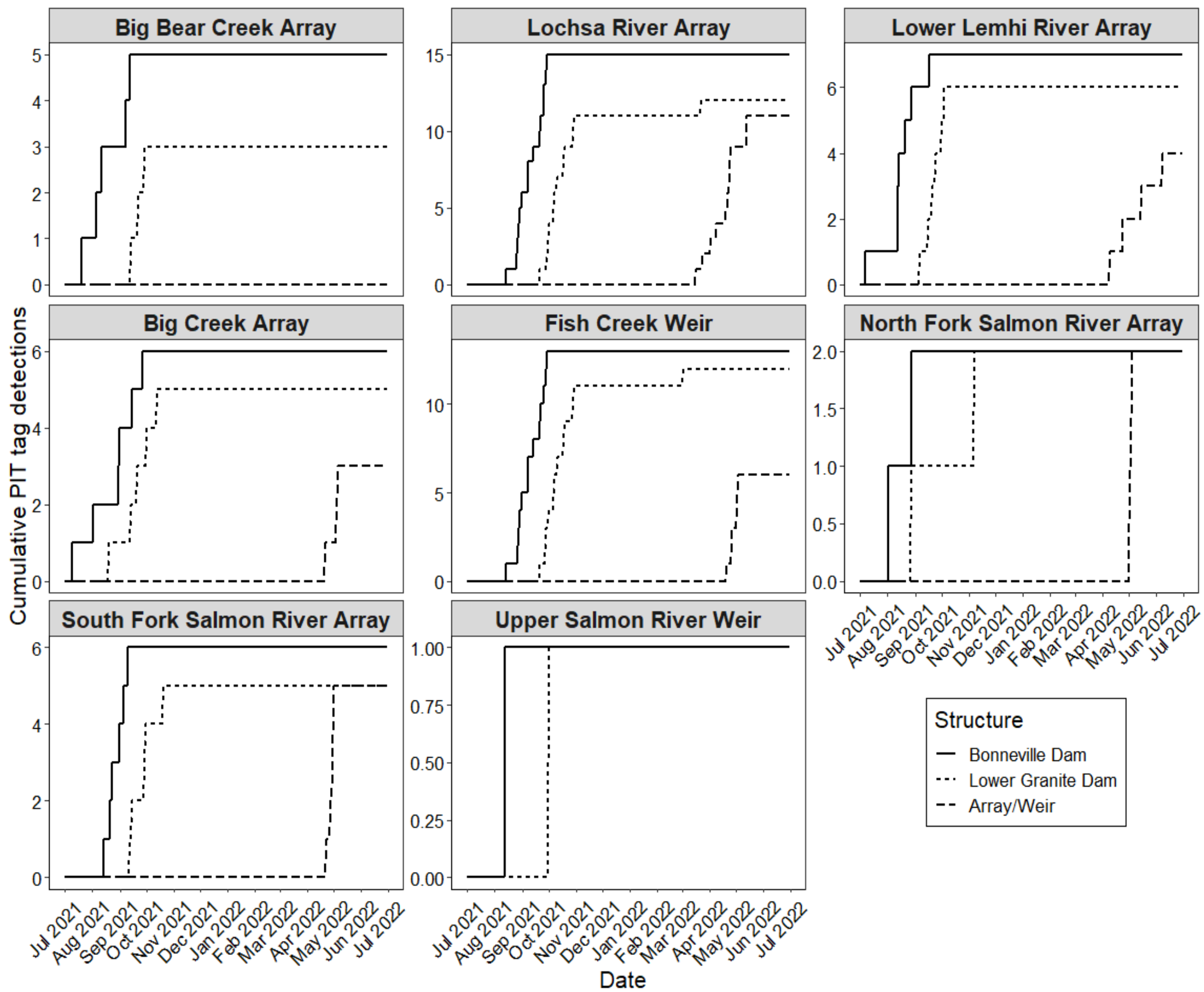


Figure 10. Cumulative wild steelhead run-timing curves at Bonneville Dam, Lower Granite Dam, and select Idaho PIT tag detector arrays and weirs, spawn year 2022. Steelhead were PIT-tagged as juveniles is in their natal tributaries.

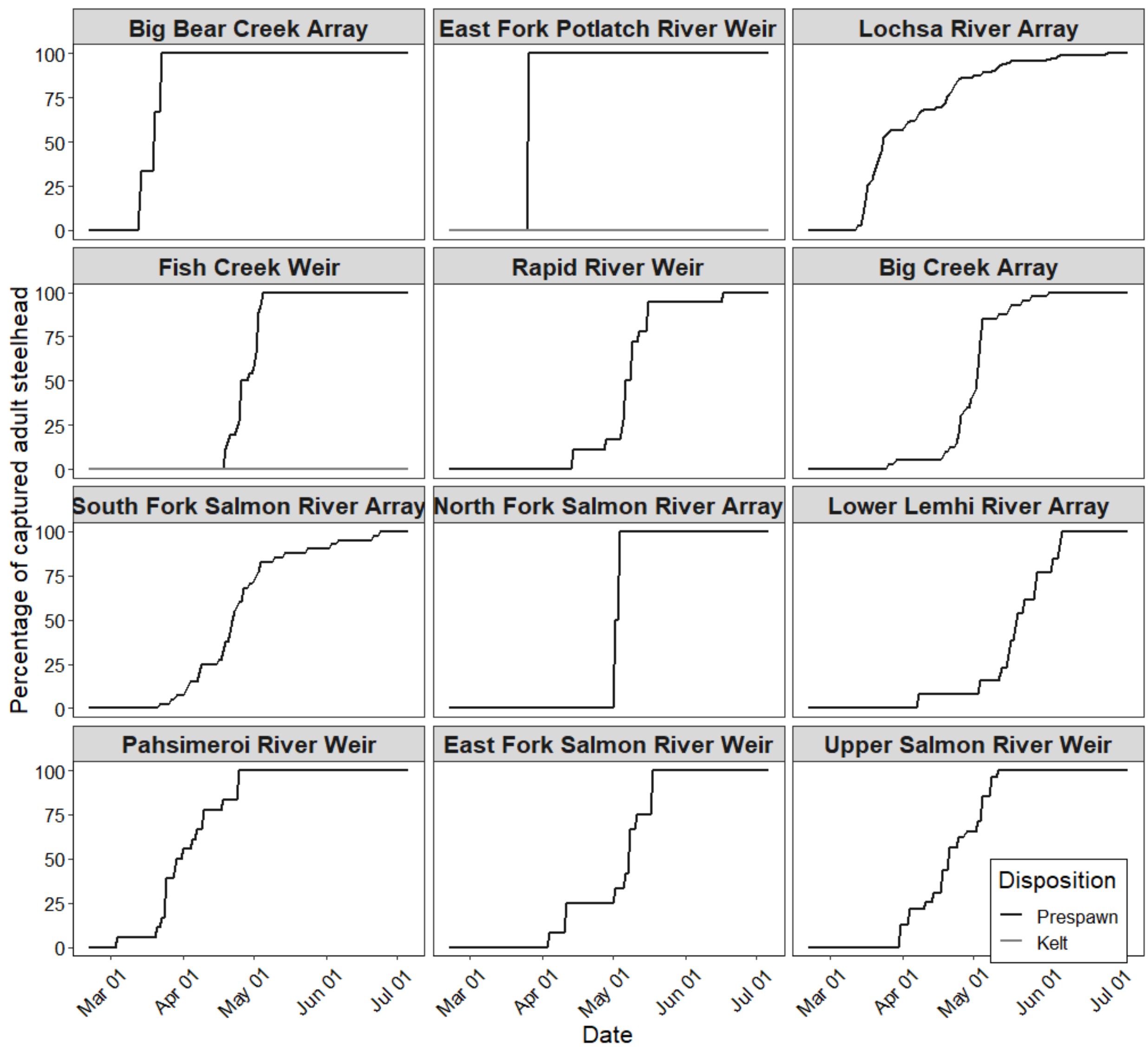


Figure 11. Cumulative wild prespawn and kelt steelhead run-timing curves at select Idaho weirs and PIT tag detector arrays, spawn year 2022. Kelt data were mostly unavailable.

APPENDICES

Appendix A. Wild adult steelhead abundance estimate time series for Clearwater River weirs and PIT tag detector 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
		2022	0	0	0
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
		2022	2	NA	NA
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
		2022	5	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
		2022	933	800	1080
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
		2022[f]	48	35	79

[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 wild fish returning to hatchery weirs were obtained via Chuck Warren (IDFG steelhead hatchery evaluation biologist, personal communication) for years prior to 2015.
[f] Methods for estimating escapement at Fish Creek used a logistic regression model due to the weir being breached.

Appendix B. Wild adult steelhead abundance estimate time series for Salmon River weirs and PIT tag detector 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
		2022	18	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
		2022	175	129	218
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
		2022	160	128	194
Marsh Creek	Array	2020	17	11	44
		2021	63	46	81
		2022	26	17	35

Appendix B. Continued

Population	Structure	Spawn year	Abundance	LCI	UCI
North Fork Salmon River[a]	Array	2016	157	123	191
		2017	NA	NA	NA
		2018	209	69	713
		2019	91	67	122
		2020	93	76	116
		2021[d]	NA	NA	NA
		2022	29	20	39
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
		2022	38	28	50
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
		2022	0	0	0
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
		2022	8	2	19

Appendix B. Continued.

Population	Structure	Spawn year	Abundance	LCI	UCI
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
		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
		2022	18	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	13	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
Upper Salmon River	Weir	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
		2022	55	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).

Appendix B. Continued.

[b] Minimum estimate due to having a single spanning array. The model assumed detection probability was 1.00. Estimates generated from the latest version of the DABOM model.

[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 wild 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	0	25	109	0.23
	2016	0	14	20	0	--	34	254	0.13
	2017	4	0	0	--	--	4	21	0.19
	2018	0	0	--	--	--	0	23	0.00
	2019	0	--	--	--	--	0	19	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	0	18	105	0.17
	2016	0	13	11	0	--	24	89	0.27
	2017	0	0	0	--	--	0	11	0.00
	2018	0	0	--	--	--	0	18	0.00
	2019	0	--	--	--	--	0	19	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

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	1998	0	38	166	72	0	276	80	3.45
	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	0	83	452	0.18
	2016	0	4	38	35	--	77	239	0.32
	2017	0	0	11	--	--	11	83	0.00
	2018	0	2	--	--	--	0	13	0.00
	2019	0	--	--	--	--	0	51	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	0	17	82	0.21
	2016	0	3	3	2	--	8	27	0.30
	2017	0	0	8	--	--	8	11	0.00
	2018	0	8	--	--	--	8	14	0.00
	2019	0	--	--	--	--	0	10	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	6	110	721	0.15
	2016	0	0	73	43	--	116	360	0.32
	2017	0	0	99	--	--	99	67	0.00
	2018	0	12	--	--	--	12	138	0.00
	2019	0	--	--	--	--	0	80	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	0	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	6	--	92	348	0.26
	2017	0	25	11	--	--	36	158	0.23
	2018	0	16	--	--	--	16	102	0.16
	2019	0	--	--	--	--	0	62	0.00
North Fork Salmon River	2016	0	15	0	8	--	23	157	0.15
	2017	0	0	17	--	--	17	--	--
	2018	0	4	--	--	--	4	209	0.02
	2019	0	--	--	--	--	0	91	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	0	50	130	0.39
	2016	0	25	4	0	--	29	92	0.32
	2017	0	12	15	--	--	27	24	1.13
	2018	0	3	--	--	--	3	30	0.10
	2019	0	--	--	--	--	0	35	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

Appendix D. Continued

Stream	Brood year	Number of adult recruits Age-3	Age-4	Age-5	Age-6	Age-7	Total	Parents	Productivity
	2016	0	10	44	5	--	59	405	0.15
	2017	0	2	3	--	--	5	135	0.04
	2018	0	5	--	--	--	5	42	0.12
	2019	0	--	--	--	--	0	33	0.00
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	4	36	73	0.37
	2016	0	24	80	11	--	115	77	1.49
	2017	0	2	25	--	--	27	22	1.23
	2018	0	15	--	--	--	0	17	0.88
	2019	0	--	--	--	--	0	12	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%
	2022	5	3	3	60.0%	60.0%
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%
	2022	13	11	12	75.0%	87.5%

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%
	2022	6	5	5	83.3%	83.3%
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%
	2022	7	6	6	85.7%	85.7%

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	2022
					Clearwater River MPG									
Potlatch River														
Big Bear Creek	Weir	51	18	38	0	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	0
WF Potlatch River	Weir	50	0	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	0
SF Clearwater River														
Crooked River	Weir	0	5	41	17	2	22	10	1	1	0	0	1	0
Lochsa River														
Fish Creek	Weir	200	224	135	91	90	450	204	53	11	22	20	96	26
					Salmon River MPG									
Snake River														
Snake River	Hells Canyon Dam Adult Ladder	0	164	114	161	150	186	38	21	14	52	39	50	27
Little Salmon River														
Rapid River	Weir	149	133	82	27	26	82	27	12	14	10	13	11	18
SF Salmon River														
SF Salmon River	Weir	12	0	0	5	0	2	0	0	0	0	0	0	NR
Pahsimeroi River														
Pahsimeroi River	Weir	157	239	285	177	205	130	94	24	31	35	41	20	18

Appendix G. Continued

Population Location	Structure	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
					Salmon River MPG									
EF Salmon River														
EF Salmon River	Weir	425	442	721	690	339	885	410	132	7	5	29	56	34
Upper Salmon River														
Fourth of July Creek	Weir	0	0	0	0	27	0	10	5	2	4	0	0	0
Tower Creek	Weir	0	0	0	0	29	0	18	19	5	0	0	0	0
Carmen Creek	Weir	0	0	0	0	79	0	16	3	2	1	0	0	0
Iron Creek	Weir	6	0	0	0	0	7	5	1	1	0	1	2	0
Salmon River	Weir	114	96	82	39	46	74	77	22	17	14	44	86	56
Total		1,447	1,400	1,751	1,289	1,080	1,976	1,060	302	123	143	210	339	179

Appendix H. Archived monitoring structure (i.e. PIT tag detector 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 – 2022)* Rapid River (2007 – 2022)* Pahsimeroi River (2007 – 2022)* EF Salmon River (2007 – 2022)* Upper Salmon River (2007 – 2022)* EF Potlatch River (2022)
	Cumulative curve estimation	Fish Creek (1992 – 1997)
	Linear mixed regression model	Fish Creek (2022)
Array	DABOM	Lochsa River (2020 – 2022) SF Salmon River (2020 – 2022) Big Creek (2010 – 2022) Marsh Creek (2022) NF Salmon River (2016 – 2022) Lower Lemhi River (2010 – 2022) Upper Lemhi River (2010 – 2022) Hayden Creek (2010 – 2022) Crooked River (2022)
	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 wild fish returning to hatchery weirs were obtained via Chuck Warren (IDFG steelhead hatchery evaluation biologist, personal communication) for years prior to 2015.

Appendix I. Developing and evaluating an alternative escapement estimate methodology to be used at the Fish Creek weir following severe and significant breaching in 2022.

Adult summer steelhead escapement estimates have been produced annually at Fish Creek, a tributary to the Lochsa River, since 1992 by using an A-frame picket weir to trap upstream-migrating (prespawn) and downstream-migrating (kelts) adults throughout the entirety of the steelhead run. However, due to dynamic flow conditions, it is not uncommon for the weir to breach for days or weeks throughout the run, preventing a complete census. To account for gaps in data due to breaching events, adult escapement at Fish Creek is typically estimated using a Lincoln-Peterson estimator with a Bailey's modification (hereafter *traditional mark-recapture* estimator) (see methods above). However, during the 2022 adult migration period there was a severe and sustained breaching event that kept us from capturing enough kelts to confidently use the traditional mark-recapture estimator. Given the importance of accurate abundance estimates to evaluate wild steelhead status and trends (McElhany et al. 2000), we aimed to find an alternative method for estimating SY 2022 escapement into Fish Creek.

Over the 30-year Fish Creek monitoring dataset, the severity and duration of breaching events is variable. Between 1992 and 2021 there were 13 years where significant breaching did not occur, and the weir was considered fully intact for the duration of the adult migration period (Table 1). Conversely, from 1995 to 2008 there were five years where the weir sustained severe enough breaching to reduce kelt captures to the point that traditional mark-recapture estimator was insufficient. Additionally, from 1992 to 1994, only unmarked kelts were captured, limiting use of the traditional mark-recapture estimator.

Two different methods have previously been used to estimate escapement into Fish Creek when kelt recapture data was insufficient. First, a post hoc cumulative curve was developed using prespawn arrival timing from years the weir was fully functional, or "intact" (hereafter *cumulative curve*). This method averages the proportion of the prespawn run that has passed the weir on all Julian dates throughout the typical migration period:

$$\bar{P}_i = \frac{P_{1i} + \cdots + P_{ni}}{n} \tag{1}$$

where $\bar{P}_i$ is the average proportion of prespawn passage that has occurred on the ith Julian date; P_{1i} is the proportion of prespawn passage that has occurred on the ith Julian date of the first intact year; P_{ni} is the proportion of prespawn passage that has occurred on the ith Julian date of the nth intact year; and n is the number of intact years used to develop the average proportion of prespawn passage. Using the calculated average proportion that had passed the weir on the Julian date that breaching occurred, the number of prespawn fish trapped was expanded to produce an abundance estimate:

$$\hat{N} = \frac{n}{\bar{P}_i} \tag{2}$$

where $\hat{N}$ is the estimated adult abundance; n is the number of unique prespawn adults trapped prior to the breaching event; and $\bar{P}_i$ is the calculated average proportion of prespawn adults that had passed the weir on the Julian date the weir breached. The cumulative curve method was used to produce estimates for 1992-1997 and again in 1999.

Second, a linear regression of the number of fish PIT-tagged at the Fish Creek rotary screw trap that were detected as returning adults in the hydrosystem versus estimated escapement at the Fish Creek weir (hereafter *hydrosystem regression*):

$$\widehat{N_i} = \beta_0 + \beta(Detections_i) \tag{3}$$

where $\widehat{N_i}$ is the estimated adult abundance at the Fish Creek weir for spawn year *i*; β_0 is the intercept; and Detections$_i$ is the predictor variable with a model coefficient β. The hydrosystem regression method was developed using data from 1998-2007, and was used to produce an estimate in 2008.

Although these previous alternative escapement methods have been beneficial by adding continuity to the dataset, we have identified issues that could be improved upon. For instance, by averaging the prespawn run timing proportions across spawn years, the cumulative curve method loses the ability to explain a lot of variability in an estimate. Characterizing variance is always important, especially for years that have large portions of incomplete trapping effort due to severe breaching. The hydrosystem regression model addresses the issue of averaging across spawn years, and leverages advancements made in PIT tag detector technology, but makes a significant assumption: tagging rate at the Fish Creek screw trap is constant among years. Although the screw trap on Fish Creek is one of the most effective and consistent places to implant PIT tags in juvenile steelhead across Idaho (Heller et al. 2022), there is indeed consistent variation in trap efficiency and tagging rate across trap years.

After reconsidering the constraints and opportunities available within the Fish Creek data set and local available infrastructure, we developed two new model frameworks that attempt to improve escapement estimates for years where the traditional mark recapture estimator cannot be implemented. First, we used a similar conceptual framework to the traditional cumulative curve model, but addressed the issue of poor variance characterization by implementing a logistic regression model that treats the proportion of unique prespawn fish passed above the weir as the dependent variable, and Julian date as the independent variable (hereafter *run-timing regression model)*:

$$P_i = \frac{e^{\beta_0 + \beta(Julian\ Date_i)}}{1 + e^{\beta_0 + \beta(Julian\ Date_i)}} \tag{4}$$

where P_i is the proportion of prespawn passage that has occurred on the ith Julian date; e is the base natural logarithm; β_0 is the intercept; and $Julian\ Date_i$ is the predictor variable with a model coefficient β. The calculated proportion of prespawn passage on the breach date was used to expand the number of prespawn fish trapped prior to the breach date (e.g., equation 2). The assumptions of this model are similar to the cumulative curve model, including that the weir is tight prior to the breaching event and that run timing during the years with breaching events mimics the run timing during the intact years used to build the model. However, by not simply averaging the proportion of passage on a given Julian date, the run-timing regression model is able to characterize variance.

The second new model utilizes our existing mark-recapture framework but leverages array infrastructure within the basin to produce estimates. The new approach uses different variables while also using a Lincoln-Peterson estimator with a Bailey's modification:

$$\widehat{N} = \frac{c(m+1)}{(r+1)} \tag{5}$$

where $\widehat{N}$ was the estimated adult abundance; *c* was the total number of unique prespawn adults trapped and passed above the weir; *m* was the number of adults PIT tagged as juveniles in Fish Creek that were detected at the downstream Lochsa River array complex (LRL and LRU; rkm 1 and 3, respectively); and *r* was the number of previously detected adults trapped and passed above the weir (hereafter *array mark-recapture*). The array mark recapture method has standard mark-recapture assumptions, including retention of mark, survival between capture events, and no immigration (straying) between events.

We compared previously used and newly established methods to use the most defensible escapement estimate at the Fish Creek weir for spawn year 2022. We were unable to use evaluators of relative model quality, such as AIC, because our suite of models draw from different data sets (Burnham and Anderson 2002). We first looked at our spawn year 2022 estimates to determine if there was any convergence (Table 2). The cumulative curve, array mark-recapture and run-timing regression models all produced point estimates between 37 and 48, indicating a convergence in this range. The hydrosystem regression model was the outlier at 84. However, convergence doesn't tell the entire story and could be a result of similar assumptions, so our next step was to compare the various assumptions for similarity. All major assumptions are noted in Table 2 and, apart from the cumulative curve and run-timing regression models, have unique assumptions. Ultimately, we chose to use the run-timing regression model to estimate SY 2022 escapement above the Fish Creek weir. The run timing regression model allows for better characterization of variance as compared with the cumulative curve model. The array mark-recapture method was not selected because of concerns about small sample sizes of marks (detections on the Lochsa array), and an incomplete recapture effort that ended roughly halfway through the run when the weir breached. With respect to the hydrosystem regression model, we are wary of the assumption that the proportion of tagged and untagged adults bound for Fish Creek is consistent from year to year.

Due to the importance of producing consistent and reliable abundance estimates, and the difficulty operating steelhead weirs during spring freshet, we developed a robust alternative model that can be used when weir breaching is significant enough to limit the use of our traditional mark-recapture methodology. Abundance is an extremely important parameter for developing population status assessments that is used to guide largescale steelhead recovery goals and efforts. Additionally, abundance estimates at various life stages are foundational data used to estimate productivities that allow assessments of population. As such, consistent and reliable abundance estimates are crucial to sound population monitoring. However, using steelhead weirs to estimate escapement can be a difficult task given the dynamic flow conditions that occur during the adult migration season. Therefore, it is important that the methodology used to estimate escapement can withstand periodic trap outages. Our traditional mark-recapture methodology does a good job handling the outages experienced in most years; however, there are now six seasons over the course of the 31-year Fish Creek data set where weir breaching was severe and sustained enough to reduce kelt captures to the point that an alternative method was required. By utilizing the long data set at Fish Creek, we were able to develop the run-timing regression model which allows for a viable and defensible alternative to the traditional mark-recapture estimator. Additionally, this model should become more accurate as continued "intact" trap years are added to the data set. Our work here in model development and comparison add to the efforts of many that have dealt with missing Pacific salmonid escapement data (Hilborn et al. 1999; Millar et al. 2012; Sethi and Bradley 2016; Jasper et al. 2017). To add consistency in our adult dataset at Fish Creek, consideration should be given to identifying a single model that can be used regardless of the availability of kelt recapture data and how long and sustained breaching events may be.

Table I-2. Trapping years at the Fish Creek steelhead weir, with significant outages, escapement methodology used, and the number of kelts captured and recorded, 1992—2021.

Year	Outages	Estimate methodology used	Kelt captures
1992		Cumulative Curve	54 unmarked
1993*		Cumulative Curve	14 unmarked
1994*		Cumulative Curve	4 unmarked
1995	Breached on May 2nd - End of season	Cumulative Curve	N/A
1996	Breached on May 19th - End of season	Cumulative Curve	N/A
1997	Breached on May 11th - End of season	Cumulative Curve	N/A
1998*		Census	N/A
1999	Breached May 24th - End of season	Cumulative Curve	14 marked
2000	Unknown	Traditional Mark-Recapture	10 marked, 3 unmarked
2001*		Census	42 marked
2002	Breached April 15 - 17, and May 22 - 23	Traditional Mark-Recapture	42 marked, 40 unmarked
2003*		Traditional Mark-Recapture	254 marked, 10 unmarked
2004*+		Traditional Mark-Recapture	147 marked, 10 unmarked
2005*		Census	80 marked
2006	Breached May 17 - 22	Traditional Mark-Recapture	35 marked, 26 unmarked
2007*		Traditional Mark-Recapture	57 marked, 4 unmarked
2008	Breached May 15 - End of season	Hydrosystem Regression	3 marked
2009	Breached May 18 - June 13	Traditional Mark-Recapture	21 marked, 30 unmarked
2010*+	Breached June 6 - 11	Traditional Mark-Recapture	88 marked, 5 unmarked
2011	Breached April 1 - 3, and May 15 - June 20	Traditional Mark-Recapture	36 marked, 82 unmarked
2012	Breached April 23 - May 9	Traditional Mark-Recapture	68 marked, 29 unmarked
2013*+	Partial operations May 11 - 13	Traditional Mark-Recapture	59 marked, 15 unmarked
2014*+	Breached May 5 - 6, and May 21 - 23	Census	75 marked
2015*+		Traditional Mark-Recapture	349 marked, 9 unmarked
2016	Partial operations April 24 - 29	Traditional Mark-Recapture	95 marked, 62 unmarked
2017	Partial operations March 15 - June 13	Traditional Mark-Recapture	2 marked, 3 unmarked
2018	Partial operations April 28 - May 4, and breached May 5 - May 30	Traditional Mark-Recapture	3 marked, 2 unmarked
2019	Partial operations for 26 days	Traditional Mark-Recapture	2 marked, 14 unmarked
2020	Partial operations May 1 - May 25	Traditional Mark-Recapture	5 marked, 6 unmarked
2021*+		Traditional Mark-Recapture	38 marked, 6 unmarked

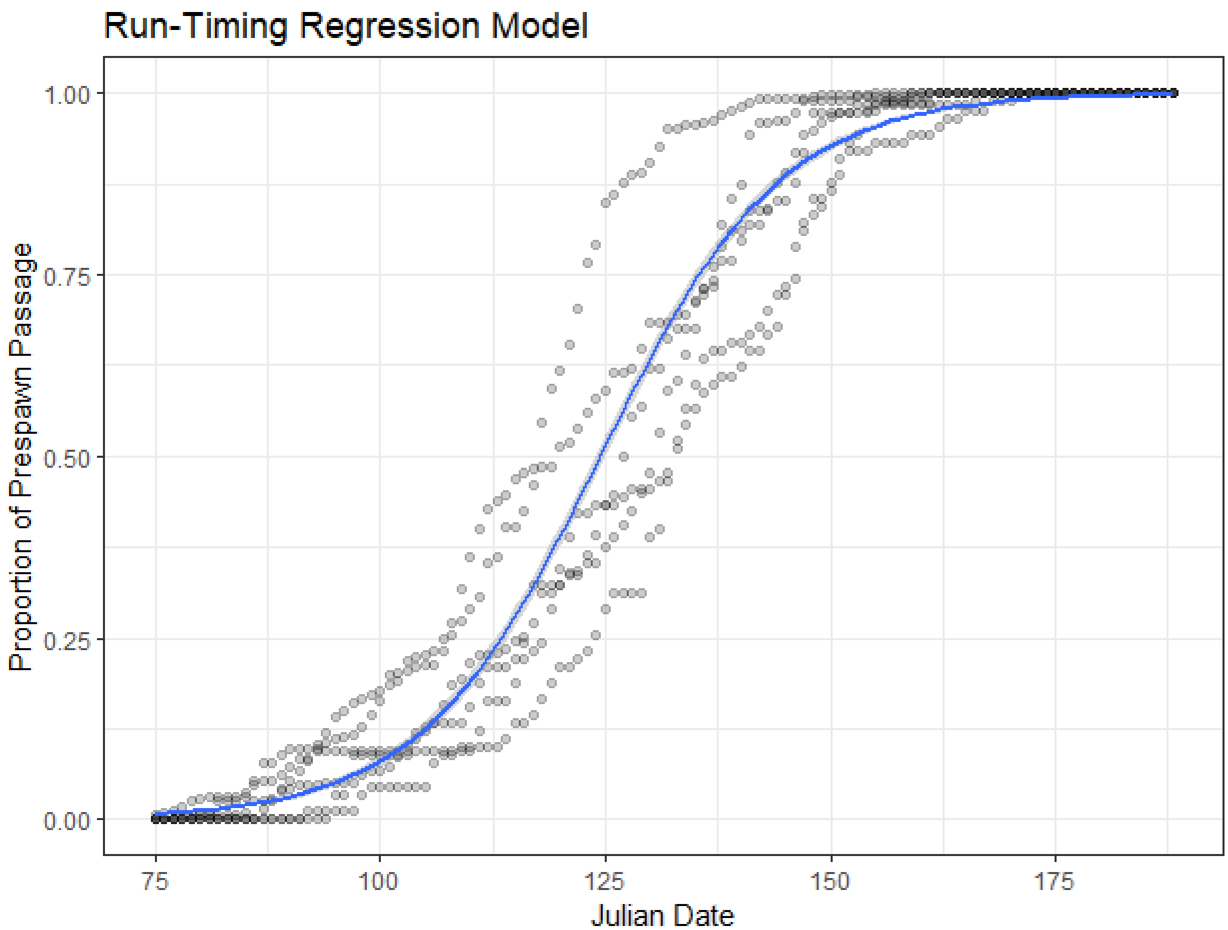
*Weir was considered 'intact' and data from this trap year was used to build cumulative curve model based on the length of outages, and the proportion of marked vs. unmarked kelt captures.

+Weir was considered 'intact' and data from this trap year was used to build run timing regression model based on the length of outages, and the proportion of marked vs. unmarked kelt captures.

Table I-3. Models evaluated for use at the Fish Creek steelhead weir, spawn year 2022.

Model	SY 2022 estimate (95% CI)	Notable assumptions
Array Mark-Recapture	37 (24 - 87)	Traditional mark-recapture, including equal survival between capture events, retention of marks, and lack of emigration (straying).
Cumulative Curve	44 (37 - 51)	Weir is tight prior to breaching event, and run timing in breached years is the same as run timing in intact years
Hydrosystem Regression	84 (41 - 128)	Proportion of tagged and untagged adults returning to Fish Creek is constant from year to year; adult detection efficiency in the hydrosystem is consistent from year to year
Run-Timing Regression	48 (35 - 79)	Weir is tight prior to breaching event, and run timing in breached years is the same as run timing in intact years

Figure I-1. Relationship of the proportion of prespawn steelhead passage to Julian date at Fish Creek weir. Only data from “intact” years were used to build the run-timing regression model (2004, 2010, 2013-2015, and 2021).



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