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IDAHO ANADROMOUS EMIGRANT MONITORING

2022 ANNUAL REPORT

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ABBREVIATIONS AND ACRONYMS

Abbreviation	Definition
BY	Brood Year
CSS	Comparative Survival Study
DPS	Distinct Population Segment
ESA	Endangered Species Act
ESU	Evolutionarily Significant Unit
HGMP	Hatchery and Genetic Management Plans
ICTRT	Interior Columbia (River Basin) Technical Recovery Team
IDFG	Idaho Department of Fish and Game
IFWIS	Idaho Fish and Wildlife Information System
LGR	Lower Granite Dam
MPG	Major Population Group
PIT	Passive Integrated Transponder
RST	Rotary Screw Trap(s)
SMP	Smolt Monitoring Project

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CHAPTER 1

ANADROMOUS EMIGRANT MONITORING IN IDAHO USING ROTARY SCREW TRAPS

ABSTRACT

During 2022, Idaho Department of Fish and Game monitored emigration of wild juvenile Chinook Salmon *Oncorhynchus tshawytscha* and steelhead *O. mykiss* at ten rotary screw traps (RST) in the Salmon River basin and five in the Clearwater River basin. In the Salmon basin, with the exception of Rapid River where abundance could not be estimated, total estimated abundance of Chinook Salmon emigrants varied from 2,606 to 137,104 fish (n = 9). In the Clearwater River basin, abundance of Chinook Salmon emigrants could only be estimated for spring age-1 fish at the Crooked River RST (663 fish) and for spring age-1 and fall age-0 fish at the Lochsa River RST (4,530 fish). Abundance of juvenile steelhead emigrants were estimated for at least one trapping period for all RSTs that operated in 2022. Total abundance estimates of juvenile steelhead varied from 1,493 to 26,573 fish in the Salmon River basin and from 823 to 30,554 fish in the Clearwater River basin. Productivity of juvenile Chinook Salmon emigrants at RSTs and of smolts that survived to Lower Granite Dam (LGR) were estimated at all RSTs except the Rapid River site in the Salmon River basin and could not be estimated at any RST sites in the Clearwater River basin. Productivity of Chinook juveniles in the Salmon River basin at RSTs for brood year (BY) 2020 varied from 201 emigrants per female spawner in the Lemhi River to 1,736 emigrants per female spawner in Big Creek. Productivity of smolts from the Salmon River basin at LGR for BY2020 varied from 13 smolts per female spawner from Hayden Creek to 835 smolts per female spawner from Big Creek. Juvenile steelhead productivity for BY2017 at trapping sites in the Salmon River basin varied from 76 emigrants per female spawner in the lower Lemhi River to 554 emigrants per female spawner in the upper Lemhi River. Juvenile steelhead productivity for BY2017 in the Clearwater River basin varied from 138 emigrants per female spawner in Fish Creek to 959 emigrants per female spawner in East Fork Potlatch River. Productivity of juvenile steelhead from Crooked River could not be estimated for BY 2017. The pairing of adult and juvenile abundance data provided insight into the variation in habitat and stock characteristics for Chinook Salmon and steelhead populations throughout Idaho.

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INTRODUCTION

Chinook Salmon *Oncorhynchus tshawytscha* and steelhead *O. mykiss,* the anadromous form of Rainbow Trout, declined substantially in the Snake River basin following the construction of hydroelectric dams in the Snake and Columbia rivers. Raymond (1988) documented a decrease in survival of emigrating spring-summer Chinook Salmon (hereafter Chinook Salmon) and steelhead from the Snake River following the construction of dams on the lower Snake River during the late 1960s and early 1970s. Adult Chinook Salmon and steelhead abundances over Lower Granite Dam (LGR) into the Snake River increased slightly in the early 1980s (Busby et al. 1996), declined in the 1990s, and noticeably increased again starting in 2000. As a result of critically low adult abundances in the 1990s, Snake River spring-summer Chinook Salmon were classified as threatened in 1992 and Snake River steelhead were classified as threatened under the Endangered Species Act (ESA) in 1997. Since 2015, abundance declined to levels similar to the mid-1990s.

Within the Snake River spring-summer Chinook Salmon evolutionarily significant unit (ESU), there are seven major population groups (MPGs): Lower Snake River, Grande Ronde and Imnaha rivers, South Fork Salmon River, Middle Fork Salmon River, Upper Salmon River, Dry Clearwater River, and the Wet Clearwater River (Table 1). The Dry Clearwater River and the Wet Clearwater River MPGs are considered to be extirpated but have been reestablished with stocks from other MPGs. The Panther Creek population in the Upper Salmon MPG was also extirpated and re-established. Currently there are 28 extant or re-established populations across all five Idaho MPGs.

Within the Snake River steelhead distinct population segment (DPS), there are six MPGs: Lower Snake River, Grande Ronde River, Imnaha River, Clearwater River, Salmon River, and Hells Canyon Tributaries (ICBTRT 2003, 2005; NMFS 2011). However, the Hells Canyon MPG is considered to be extirpated. A total of 24 extant demographically independent populations have been identified.

Anadromous fish management programs in the Snake River basin include large-scale hatchery programs (intended to mitigate for the impacts of hydroelectric dam construction and operation on fisheries in the basin) and recovery planning and implementation (aimed at recovering ESA-listed wild salmon and steelhead stocks). The Idaho Department of Fish and Game (IDFG) anadromous fish program's long-range goal, consistent with basin-wide mitigation and recovery programs, is to preserve Idaho's Chinook Salmon and steelhead runs and recover them to provide benefit to all users (IDFG 2019). Management to achieve these goals requires an understanding of how salmonid populations function as well as periodic status assessments (McElhany et al. 2000). Specific data necessary to achieve these goals on some Snake River steelhead and Chinook Salmon populations were lacking in the past, particularly key parameters such as abundance, age composition, genetic diversity, recruits per spawner, and survival rates (ICBTRT 2003).

Idaho Department of Fish and Game provides long-term continuous research, monitoring, and evaluation of the status of the state's populations of anadromous salmon and steelhead. Recommendations for monitoring to address population status assessments across the Columbia River basin include: 1) annual estimation of juvenile emigrant abundance across major populations, and 2) estimation of the adult-to-juvenile productivity of both tributary emigrants and smolts through the Columbia River basin hydrosystem (Crawford and Rumsey 2011), which provides insight into survival throughout the life cycle. These are two of several critical metrics necessary to assess overall trends in abundance and productivity.

Freshwater rearing of anadromous salmonids in Idaho is spatially extensive and emigration is protracted, especially for steelhead. Chinook Salmon and steelhead may rear from headwater spawning areas to the lower Snake River throughout the year, with spatial distribution of multiple cohorts often overlapping temporally. Cohorts of Chinook Salmon are relatively easy to distinguish, with a few exceptions (e.g., Pahsimeroi River, where a significant proportion of age-0 emigrants smolt; Copeland and Venditti 2009). Extensive ageing of steelhead emigrants is necessary to estimate population productivity because several cohorts emigrate together and overlap in size. Ideal locations to estimate abundance of juvenile emigrants at the population scale are downstream from most spawning and early-rearing habitat, yet upstream enough in the drainage to allow efficient population-specific sampling. If traps are located appropriately downstream of important spawning and rearing habitats, standardized sampling through time and across locations can allow long-term evaluations and comparisons of population trends. Rotary screw traps (hereafter RSTs) have been the primary tool used by IDFG since the early 1990s to address the following objectives for juvenile anadromous fishes: 1) estimation of emigrant abundance for select populations, and 2) implanting passive integrated transponder (PIT) tags in emigrants to evaluate hydrosystem passage (Venditti et al. 2015a; Copeland et al. 2015; Bowersox and Biggs 2012; Apperson et al. 2016, 2017; Uthe et al. 2017; McCann et al. 2015).

A collaborative effort across the Columbia River basin offered guidance to standardize monitoring of juvenile emigrants and to coordinate and prioritize monitoring work (i.e., Anadromous Salmonid Monitoring Strategy, http://www.nwcouncil.org/fw/am/monitoring/monitoring-strategies). Since that collaborative process began, IDFG has continued some previous RST operations and strategically implemented new RST operations to contribute to the monitoring of the Major Population Groups (MPGs) and populations most important to overall recovery goals. Most monitoring restructuring was delayed until the completion of Idaho Supplementation Studies (Venditti et al. 2015b). However, monitoring in Marsh Creek downstream of the Beaver Creek confluence was implemented in 2010. The current monitoring configuration began in 2015. Our goal with this report is to consolidate all information generated by means of RSTs operated by IDFG to assess trends in abundance and productivity of juvenile Chinook Salmon and steelhead populations. Additionally, juvenile Pacific Lamprey *Entosphenus tridentatus*, a species of greatest conservation need in Idaho (IDFG 2017), are captured at some RSTs, providing us the opportunity to monitor both supplemented and non-supplemented lamprey populations.

We have four objectives for this report: 1) report estimates of emigrant abundance at RSTs by season and cohort for Chinook Salmon and steelhead, 2) estimate emigrant survival rate to Lower Granite Dam (LGR) by season and cohort for Chinook Salmon, 3) present current estimates of adult-to-juvenile freshwater productivity for Chinook Salmon using the Beverton-Holt stock-recruit relationship and for steelhead using brood tables (Beverton and Holt 1957), and 4) develop methods and a series of survival estimates to LGR for steelhead cohorts, thus allowing adult to smolt productivity for that species.

STUDY AREA

The Salmon River and Clearwater River basins include portions of the Idaho Batholith, the Middle Rockies, and the Northern Rockies ecoregions (McGrath et al. 2002; Kohler et al. 2013). Most study streams drain in areas with sterile granitic parent material associated with the Idaho Batholith, resulting in relatively low-nutrient systems (McGrath et al. 2002; Sanderson et al. 2009). Three exceptions are the Potlatch River in the Clearwater River basin and the Lemhi and

Pahsimeroi rivers in the Salmon River basin, all of which flow through predominately fertile basaltic geologies. In both the Clearwater and the Salmon river basins, water quality is good and substrates range from sand and small gravels to cobbles and large boulders. Winters are harsh and growing seasons are short (45-100 d). This area is also relatively dry with annual precipitation (primarily snowfall during spring, fall, and winter) ranging from 31 cm to 203 cm. Snowmelt influences most flow regimes with peak spring flows occurring during May and June and base flows occurring for the remainder of the year. Groundwater recharge heavily influences base flows in the Lemhi River and Pahsimeroi River. All waterbodies discussed in this report are inhabited by anadromous fishes.

Idaho Chinook Salmon and steelhead migrate long distances during their life cycle. They travel 1,451 km from the Pacific Ocean to the highest reaches of their spawning grounds in the Sawtooth National Recreation Area and climb from sea level to elevations over 2,000 m. Juvenile salmon and steelhead encounter eight dams, four along the Snake River and four along the Columbia River before they reach the ocean. The first dam Idaho Chinook Salmon and steelhead encounter during emigration is LGR on the Snake River, 695 km from the Pacific Ocean. In the Salmon River basin, juveniles migrate between 283 km and 747 km from their respective RST before encountering LGR. At Clearwater River basin RSTs, juveniles migrate between 98 km and 324 km before encountering LGR. Juvenile Chinook Salmon and steelhead rear in a variety of locations ranging from natal tributaries to downstream mainstem rivers (Dobos et al. 2020; Copeland et al. 2014).

Rotary screw traps operated by IDFG to sample wild juvenile Chinook Salmon and steelhead are distributed throughout the Salmon River and Clearwater River basins, Idaho (Figures 1 and 2). Rotary screw traps were located to sample emigration from selected populations for both species if present. Details about RSTs coverage are given in Appendix A.

METHODS

Rotary Screw Trap Operations and Sampling Process

Methods applied to operate RSTs, handle and tag fish, manage data, and estimate emigrant abundance and smolt survival were primarily adapted from Venditti et al. (2015a). Volkhardt et al. (2007) provides much detail regarding RST design/construction and recommendations regarding river placement and general trap operations in a wide range of stream sizes. Biologists with IDFG spent a great deal of time since the early 1990s refining all protocols associated with operating RSTs in Idaho rivers to ensure 1) consistent information was collected and archived, 2) fish were handled appropriately to minimize stress, and 3) personnel safety. These protocols were collated and formalized by Copeland et al. (2021).

We continuously strive to sample populations efficiently and minimize potential harm to individual fish. Tagging and information derived from sampling is coordinated with and used among multiple projects (e.g., Copeland et al. 2015; Venditti et al. 2015b; McCann et al. 2015; Uthe et al. 2017). Take associated with trapping ESA-listed species is permitted under a State of Idaho 4d research permit issued by NMFS. A detailed take report is submitted to NMFS at the end of each year, which also outlines the measures we take to minimize stress or harm to fish.

Rotary screw traps were operated throughout much of the year and operation was generally discontinued only when conditions jeopardize safety of personnel, fish, or the trap. While some low elevation RSTs are operated from late February into December, most traps are higher in elevation and are operated from the middle of March into the middle of November. Rotary screw trap operations in some Clearwater River basin streams (Potlatch and Big Bear Creek) are routinely unable to operate past June, limited by low stream flow and high stream temperatures (>17°C). Additionally, RST operation in Hayden Creek can be limited due to irrigation withdrawals. Rotary screw traps are not operated in the winter due to icing and the lack of fish movement (Bjornn 1978). When flow conditions allow, traps were positioned in the thalweg (region of the stream that has most of the flow by volume) to maximize capture efficiency. Program personnel checked RSTs and processed fish at least once daily during daylight hours and more frequently when conditions were problematic. High water flows, debris, and ice can inhibit RST operations and render them inoperable for short periods of time (Appendix B). Juvenile hatchery fish releases can overwhelm RSTs and cause risk to fish health. During high flows and after hatchery fish were released upstream of RSTs, personnel checked the RSTs several times throughout the day and night, and occasionally moved RSTs out of the thalweg, or ceased trapping to avoid harm to fish and damage to the RST. Once conditions were improved and it was safe for personnel, normal trapping operations resumed.

Fish collected in RSTs were processed using standard protocols (Copeland et al. 2021). All fish were removed from the trap box and placed in aerated holding containers. Chinook Salmon and steelhead were anesthetized in buffered Tricaine Methanesulfonate (MS-222) solution, scanned for PIT tags, weighed to the nearest 0.1 g, and measured to the nearest 1 mm fork length (FL). We anesthetized no more than 20 juvenile fish at one time to reduce exposure time to the anesthetic. Lengths and weights were recorded for all age-1 Chinook Salmon captured in the spring while age-0 emigrants were subsampled, depending on the number captured in the RST and time/temperature constraints. Lengths and weights were recorded on all steelhead unless high abundances forced crews to subsample. Target species (Chinook Salmon and steelhead) were marked (e.g., PIT tags) and sampled for biological data (e.g., scales).

For Chinook Salmon ≥60 mm FL and steelhead ≥80 mm FL, PIT tagging was the primary mark used. Fish were implanted with 12 mm x 2.05 mm PIT tags. All PIT tagging followed established protocols (Kiefer and Forster 1991; PIT Tag Steering Committee 1992; CBFWA 1999). Single-use PIT tag injectors were used at most RSTs (Venditti et al. 2013). Effort was made to tag all steelhead and all age-1 Chinook Salmon smolts. Young of the year Chinook Salmon were subsampled based on the minimum number of tags needed to obtain abundance, survival, and smolt-to-adult survival rates (SARs; LGR to LGR) while not exceeding permitted take limits (Copeland et al. 2021). The number of tags placed to estimate trap efficiency was controlled by the number needed for statistical estimation of abundance with desired precision and the concurrent efficiency of the RST (Copeland et al. 2021). Tagging and marking of Chinook Salmon and steelhead at the Potlatch River, Lemhi River, and Hayden Creek traps differed from other traps because of the need for monitoring fish at younger life stages as part of Intensively Monitored Watershed studies (Uthe et al. 2017). At the Hayden Creek, the upper Lemhi River, and the lower Lemhi River RSTs, steelhead 60-79 mm FL were implanted with 9-mm PIT tags. Chinook Salmon <60 mm FL were not tagged unless smaller PIT tags were used; however, in locations where smaller Chinook Salmon (<60 mm) make up a substantial proportion of the total emigrants, Bismarck Brown Y stain was used to mark subsamples of fish that were 35-59 mm FL for mark-recapture abundance estimates (Venditti et al. 2015a). Fish recovered from handling in large, lidded perforated plastic containers placed in the stream with sufficient free flow of water or in buckets of water with aeration and temperature control prior to release into the stream.

Incidental catches of other non-target species were enumerated, a subsample of each species was measured for length and weight depending on catch, and all were then released downstream of RSTs. All ESA-listed species were processed first to minimize duration of stress.

Juvenile Pacific Lamprey were anesthetized with MS-222, counted, measured to the nearest 1-mm total length (TL), identified as either an ammocoete or macrophthalmia based on the presence or absence of visible eyes, and subsampled for genetic tissue with a fin clip. Protocols for collecting data and samples from Pacific Lamprey were adapted from the Nez Perce Tribe (Mike Kosinski, Nez Perce Tribe, personal communication).

Trap efficiency was estimated using fish that were newly marked with either PIT tags, stain, or ventral fin clips by releasing those fish upstream from the RST on a daily basis. Subsequent recaptures of marked fish were used to estimate trap efficiency. Efficiencies were based on marked salmonids that were recaptured after the release. To meet an assumption of a single capture-recapture method for a closed population, we selected release sites approximately 0.5 km or at least two riffles and a pool upstream of the RST to maximize the probability that marked fish would mix randomly with the general population prior to their recapture (Volkhardt et al. 2007). Release locations had adequate holding habitat to reduce immediate predation risk.

Scale samples were collected from steelhead ≥80 mm FL at most RSTs for ageing. We followed established protocols using either a systematic random sampling method for large abundances (>150 fish in a given season; spring, summer/fall) or sampling all individuals for small abundances (<150 fish in a given season) to collect scales. We attempted to sample up to 150 steelhead at each RST site for each season, and subsequently assign ages to those fish using methods by Wright et al*.* (2015) and Reinhardt et al. (2022). Fish that were aged were used to estimate proportional age composition of the emigrating cohort by respective season.

Data Management

Tagging data from RST operations are stored in the PIT Tag Information System (PTAGIS) P4 data entry and management tool locally, then uploaded to the PTAGIS database (https://www.ptagis.org). All PIT-tagged and non-PIT-tagged fish data, along with metadata, are uploaded to the Idaho Fish and Wildlife Information System (IFWIS) database (https://fishandgame.idaho.gov/ifwis/portal/page/juvenile-fish-trapping) via the J-Trap application. Data were queried from the IFWIS database for analysis. Steelhead age data were archived in the IDFG BioSamples database (https://collaboration.idfg.idaho.gov/qci/default.aspx). Interested parties can access raw data with permission from IFWIS. Data were checked for accuracy and completeness at several stages (e.g., trap tender prior to initial uploading, trap supervisors, IDFG data coordinators, PTAGIS database managers). After analysis, juvenile abundance and productivity estimates are publicly available via the Coordinated Assessments data exchange website (https://www.streamnet.org/home/data-maps/fish-hlis).

Chinook Salmon Cohort Abundance and Productivity

Abundance at RSTs

Age-specific abundances of Chinook Salmon emigrants passing the RSTs were estimated by season/life stage. Body size and date were used to distinguish cohorts (age-0 from age-1 fish) as two ages could be captured simultaneously, especially in the spring. There are four distinct life stages designated for juvenile Chinook Salmon at RSTs based on age and standard calendar periods that are described in Copeland et al. (2021). The spring period is defined as trap deployment through June 30, a period of time dominated by catch of age-1 fish (i.e., smolts) that will be emigrating past LGR that same spring. Smaller age-0 fish are also captured in the spring, depending on the trap site, but are often too small to mark for evaluation. The summer period is July 1 through August 31, a period of time when age-0 fish grow large enough to be marked with

PIT tags. The fall period is September 1 through the end of the trapping year, a period of time when age-0 fish appear to actively emigrate out of upper tributary rearing reaches (Chapman 1966; Venditti et al. 2015b). Seasonal life stage abundances are calculated by stratifying fish by seasons, summing by complete BY, and processing the strata in R statistical software (R Development Core Team 2021). Abundance estimates of age-0 fish captured in 2021 and age-1 smolts captured in the spring of 2022 were used to complete the total estimate for brood year (BY) 2020.

We calculated emigrant abundance estimates from RST operations with the stratified Lincoln-Petersen estimator with Bailey's modification:

$$N = m_i(c_i + 1) \,/\, (r_i + 1)$$

where *N* is abundance of juveniles emigrating in a given season or year, *i* is season (defined below for each species), c_i is the number of all unique fish captured in season *i*, m_i is the number of tagged fish released in season *i*, and r_i is number of recaptures in season *i*. (Bailey 1951). The estimator is computed using an iterative maximization of the log likelihood (Steinhorst et al. 2004), using R statistical software (R Development Core Team 2021) and is located at the following webpage location: http://ifwisshiny.idfg.state.id.us:3838/JLM/IDFGStatApps/. The method assumes that fish are captured independently with probability *p* (equivalent to trap efficiency) and tagged fish mix thoroughly with untagged fish. We computed 95% confidence intervals with the bootstrap option (10,000 iterations).

Survival and Abundance at LGR

We estimated survival rates of PIT-tagged Chinook Salmon emigrants from each RST to LGR by life stage, BY, and season and used the survival rates to calculate the abundance of smolts at LGR. Estimates were made separately for each life stage described in the "Abundance at RST" methods because of their inherent differences in survival (Copeland et al. 2021). Survival of juvenile Chinook Salmon was estimated using PIT tag detections at juvenile bypass systems on main stem Snake and Columbia and river hydrosystem dams (Lower Granite, Little Goose, Lower Monumental, Ice Harbor, McNary, John Day, and Bonneville) and the estuary towed PIT tag array. The Lower Granite Spillway PIT tag detection site was included in the analysis and is the only hydrosystem site in the Columbia River basin to detect juvenile fish passing over a main stem a spillway. We assumed that tagged fish represented untagged fish in each life stage group. The data used to calculate survival were queried from the PTAGIS database in Advanced Reporting (https://www.ptagis.org/). Tagging detail data (i.e., the tagged fish from the RSTs) and Interrogation data (i.e., the PIT tag detections at the dams on the Snake and Columbia rivers) were used. The software program PitPro (Westhagen and Skalski 2009) was used to translate raw PTAGIS PIT-tag data into usable capture histories. This program implements a Cormack-Jolly-Seber model to output the basic point estimates of survival (RST to LGR) and detection probabilities at the dams. Cohort abundance of smolts at LGR was calculated by multiplying the seasonal abundance estimates by the survival proportion estimates before summation.

Productivity

Productivity was estimated at the watershed scale where RSTs operated (i.e., juveniles), and at the larger Snake River basin scale at LGR (i.e., smolts). It is important to examine whether productivity is more limited in the tributary watershed versus the migration to LGR to better understand limiting factors and where they occur. In addition to the results of stock-recruit analysis, this report presents the relationship between Chinook Salmon juvenile productivity and adult spawner abundance at ten locations for brood year 2020 (Bowersox and Biggs 2012; Venditti et al. 2015b; Apperson et al. 2016; Uthe et al. 2017). This metric was estimated using either redd counts or the escapement estimate above a weir and the number of smolts that survived to Lower Granite Dam.

Adult-to-smolt productivity was also modeled with stock-recruitment analysis at five RST locations with sufficient completed BYs (i.e., BIG2C, MARTR2, LEMTRP, PAHTRP, SAWTRP) and updated through brood year 2020. Additionally, this analysis was conducted in the 2021 Idaho Anadromous Emigrant Monitoring report for selected RSTs that are no longer in operation (i.e., KNOXB, MARTRP, REDTRP, AMERR, CFCTRP, COLTKC). Estimates of the number of redds (estimated from single or multiple pass surveys) or number of females (estimated from weir passage) above RSTs were taken as a measure of “stock” and estimated number of smolts at LGR were taken as a measure of “recruits” (Heller et al. 2023; Ruthven et al. 2023). The stock-recruit relationship was modeled using a $\log_e$ transformed Beverton-Holt (Beverton and Holt 1957) model:

$$log_e[R] = log_e\left(\frac{(\alpha * S)}{(1 + \beta * S)}\right),$$

where recruits (R) is a function of stock (S), α is the maximum recruitment rate at low spawner abundance, β is the level of density dependence, and alpha/beta provides an estimate of the asymptote. A Bayesian hierarchical approach was used to estimate global and trap-level parameter estimates. This framework assumes parameters for groups (e.g., populations) are distributed around global or shared parameters (Gelman and Hill 2007). Analysis was conducted using the R2jags package (Su and Yajima 2015) in R statistical software (R Development Core Team 2021), which executes code in Program JAGS (Plummer 2003) from the R statistical software interface.

Steelhead Emigrant Abundance and Productivity

Abundance at RSTs

Age-specific abundances of steelhead emigrants passing RST were estimated by season. Estimated ages based on scale data were used to distinguish the multiple BY cohorts captured simultaneously. Season designations followed standard calendar periods and are based on the major periods of fish movement, which is consistent with past reports (e.g., Copeland et al. 2015; Apperson et al. 2017; Belnap et al. 2018). Peak migration varies among populations but generally, juveniles either emigrate out of natal systems primarily in the spring or in the fall. The spring period is defined as the time when RSTs were installed in late winter or early spring through May 31. The summer period is June 1 through August 14, and the fall period was August 15 through trap removal, usually between late October and early December depending on site conditions. Emigration past the RSTs generally increases in the fall period compared to the summer period. The summer and fall periods are pooled when there are not sufficient recaptures or catch to report a reliable estimate. If recaptures and catch numbers are sufficient, abundance is stratified and summed across summer and fall periods. Mark recapture analyses for steelhead at RSTs are similar to protocols for Chinook (see above) but use different seasonal strata.

Productivity

The adult-to-juvenile productivity of steelhead at RSTs was estimated by dividing the sum of estimated juvenile abundances by brood year cohort across seasons and years by the number of adult female spawners that produced them. The number of adult female spawners was obtained from either PIT tag array or weir counts or estimates at sites with both a RST and an array or weir. These adult abundances and the methods used to estimate them are reported annually in our adult steelhead report (Smith et al. 2021). In general, spring emigrant age composition is older than summer and fall emigrant age composition and summer and fall are typically similar. Therefore, age composition for spring samples was calculated separately from combined summer and fall age compositions. Scale sample age proportions were directly applied to the seasonal emigrant abundance estimates. Brood tables were constructed by summing emigrant abundances by cohort, then dividing by the number of female spawners upstream of the RST to calculate brood year productivity. This report provides complete productivity estimates through BY 2017.

RESULTS

Rotary Screw Trap Operations

Rotary screw traps were operated at 10 sites in the Salmon River basin and five sites in the Clearwater River basin (Appendix A). Of these traps, 10 have operated annually at the same sites for a minimum of 14 years. Rotary screw traps have operated in Fish Creek for 27 years since 1994, the Lemhi, Upper Salmon, and Pahsimeroi rivers for 30 years since 1992, and Crooked River for 32 years since 1990. Calendar year 2022 represents the seventh complete year of operation for two RSTs included in this report (Lower South Fork Salmon, North Fork Salmon, and Lower Lochsa rivers). All RSTs included here were operated by IDFG.

Most RSTs were operated during three seasons (spring, summer, and fall). However, streamflow was insufficient during the summer and fall to operate two traps in the Potlatch River basin (Big Bear Creek and East Fork Potlatch River) and one trap in the Salmon River basin (Hayden Creek). Summer flows typically limit RST operations in the Potlatch River; thus, we assumed emigration was negligible during the summer. However, at Hayden Creek a log jam diverted flows preventing operation of RSTs during late summer and fall. The Moose Fire also prevented the operation of the North Fork Salmon River RST for 10 days and the Lower Lochsa and South Fork Salmon River RSTs were inoperable for a few days in the summer due to increased water temperatures. Hatchery smolt releases also prevented the Rapid River, South Fork Salmon River, Upper Salmon River, Pahsimeroi, and Lower Lochsa RSTs from operating between 2-23 days. In general, the majority of the RSTs were operated for most of the trapping season, and therefore, we can report reliable emigrant information for all seasons except winter (Appendix B).

Annual Chinook Salmon Emigrant Abundance at RSTs

Rotary screw trap catches of Chinook Salmon varied greatly among traps, but tended to be higher in the Salmon River basin (Table 2). Chinook Salmon emigrant abundance varied across nine RSTs in the Salmon basin from 2,606 fish at the Hayden Creek site to 137,104 fish at the Lower South Fork Salmon River site. No estimate was made in Rapid River due to low numbers of fish captured. In the Clearwater River basin, no estimates for Chinook Salmon were made at Big Bear Creek, East Fork Potlatch, and Fish Creek due to low numbers of fish captured. Chinook Salmon emigrant abundance was 663 fish at Crooked River and 4,530 at the Lower Lochsa River RST. Almost all of the emigrants captured at the Lochsa and Crooked River RST were spring emigrants migrating directly toward the ocean.

Cohort Chinook Salmon Emigrant Abundance at RSTs

Operations in spring 2022 completed sampling for BY 2020. Rotary screw trap catches for BY2020 Chinook Salmon were variable across traps. Chinook Salmon abundances in the Salmon River basin ranged from 16,918 fish at the Upper Salmon River to 156,847 fish at the Lower Marsh Creek RST (Table 3). In the Clearwater River basin abundance of juvenile Chinook Salmon were not estimated for Big Bear Creek, East Fork Potlatch, Fish Creek, and Lower Lochsa River RSTs due to low numbers of tagged fish and a lack of recaptured fish. For Crooked River, the Chinook Salmon abundance estimate was 983 fish. The complete time series of abundance and productivity estimates are presented in Appendix D.

Chinook Salmon Survival and Productivity

In general, survival of emigrants from RSTs to LGR by BY was influenced by life stage and varied from 0.085 to 0.775 (Table 3). Survival to LGR increased for each successive life stage within a brood year across all RSTs except for the South Fork Salmon River and the Pahsimeroi River. The summer age-0 emigrants from the South Fork Salmon River had higher survival (0.428) than the emigrating fall age-0 (0.338). Emigrating spring age-0 from the Pahsimeroi River also had higher survival (0.338) than the summer age-0 (0.261) and fall age-0 fish (0.253).

Productivity of Chinook Salmon BY2020 juveniles at RST sites varied from 201 juveniles per female spawner in the Lemhi River to 1,736 juveniles per female spawner in Big Creek in the Salmon River basin. The RST at Crooked River caught very few juvenile Chinook Salmon in the trap so productivity could not be estimated (Table 4).

Productivity of Chinook Salmon BY2020 smolts at LGR varied from 13 smolts per female spawner from Hayden Creek to 835 smolts per female spawner from Big Creek in the Salmon River basin. The RST at Crooked River caught very few juveniles in the trap so productivity could not be estimated (Table 4).

Beverton-Holt models have been conducted in past reports showing the relationship between smolts at LGR and adult female spawner abundance in places where rotary screw traps currently operate. The Beverton-Holt models suggest that density-dependent mechanisms are influencing production of smolts that survive to LGR more in the Upper Salmon River MPG, than in the Middle Fork Salmon MPG (Figure 3; Table 5).

Steelhead Emigrant Abundance and Productivity

Juvenile steelhead emigrant abundances were estimated at all RST sites that operated across ten steelhead populations in the Salmon River basin and five in the Clearwater River basin (Table 6). Estimated abundance of steelhead emigrants >80 mm varied from 1,493 fish in Marsh Creek to 26,573 fish in Big Creek for Salmon River basin populations. In the Clearwater River basin, abundances varied from 823 fish in Crooked River to 30,554 fish in the Lochsa River.

The catch of steelhead <80 mm FL, which were generally not marked to estimate trap efficiencies, varied across RST within the Salmon River and Clearwater River basins. In the Salmon River Basin, catch of steelhead <80mm FL ranged from five fish in the Lower Lemhi River to 1,976 fish in the South Fork Salmon River. Steelhead catches <80 mm FL for the Clearwater River basin ranged from 2 fish in Big Bear Creek to 29 fish in Crooked River. There were no steelhead <80 mm FL reported for the East Fork Potlatch River (Appendix C).

Scale samples were collected from juvenile steelhead at 13 RSTs, with ages assigned to 3,798 fish (Table 7). Juvenile steelhead ages varied from 0 to 5 years, and in general an older age distribution was observed in the spring than the summer/fall period at most RSTs.

Emigrant abundance, juvenile age proportions, and female spawner abundance data were used to produce adult-to-juvenile productivity estimates for BY cohorts at seven RST locations in the Salmon River MPG and four RST locations in the Clearwater River MPG (Appendix E). Productivity for steelhead BY2017 in the Salmon River basin ranged from 76 emigrants per female spawner in Lower Lemhi River to 554 emigrants per female spawner in the Upper Lemhi River. Productivity in the Clearwater River basin varied from 138 emigrants per female spawner in Fish Creek to 959 emigrants per female spawner in the East Fork Potlatch River. Compared to the mean of previous years, steelhead productivity in the Salmon River basin was low in the Upper Salmon, Pahsimeroi, and Lower Lemhi rivers, and high in Rapid and Lower Lemhi rivers. Steelhead productivity in the Clearwater River basin was low in the East Fork Potlach River, Crooked River, Fish Creek, and high in Big Bear Creek.

Plots of complete cohort estimates through BY2017 were presented in Figures 4 and 5. Even though age five emigrants are only complete through BY2017, BY2018 data are included in the plots because so few age-5 emigrants are aged and there is a high likelihood some of these could be resident Rainbow Trout (Appendix E). This adds another data point to each stream's time series and will be adjusted next year if there are any age five emigrants for BY2018. Trend lines indicate that populations in both MPGs generally experience density dependence, with juvenile productivity declining with increasing spawner escapement, with the exception of Crooked River which had an inverse relationship. The weir that operates at Crooked River is ineffective at capturing adult steelhead during spring conditions. However, juvenile fish are still caught in the RST occasionally. No females were estimated to return in BY2018 so there was no productivity measure for this year in Crooked River.

<u>Pacific Lamprey Catch</u>

Pacific Lamprey were captured at the South Fork Salmon River and the Lochsa River RSTs (Table 8). A total of 3,116 Pacific Lamprey were captured at the South Fork Salmon River trap, consisting of 2,130 ammocoetes and 986 macrophthalmia. The total length of lamprey in the South Fork Salmon River varied from 120 mm to 170 mm. A total of 131 Pacific Lamprey were captured at the Lower Lochsa River trap, of those 129 were ammocoetes and two were macrophthalmia. Total lengths for lamprey from the Lower Lochsa River RST varied from 68 mm to 140 mm.

DISCUSSION

Adult-to-juvenile productivity estimates provide insight to the quality and quantity of habitat available in Idaho. Adult-to-juvenile productivity estimates for Chinook Salmon at both the watershed scale (i.e., juveniles at RSTs) and at a larger basin scale (i.e., smolts at LGR) varied widely in 2022. However, productivity estimates were higher in the Upper Salmon River and Middle Fork Salmon River major population groups. The number of emigrants passing each trap was influenced by the habitat quantity and quality upstream from RSTs and the intrinsic productivity unique to each stream. Distinct differences in productivity among populations were evident, as expected with large spatial and temporal variability (Table 4). To better understand the differences in productivity among populations, factors affecting success of rearing and overwintering of juvenile fish should be further assessed in natal reaches upstream of RSTs. The

Intensively Monitored Watershed (IMW) studies monitor and evaluate potential limiting factors specific to juveniles rearing in natal tributary habitat and response to habitat restoration actions in the Potlatch and Lemhi River watersheds. Information on fish response to habitat restoration actions will help guide future projects to improve Chinook and steelhead abundance, survival, and productivity in natal tributary habitat. Not only is this information valuable in these IMW watersheds, but this information is useful for other systems that have received habitat restoration efforts but may not be monitored to the same extent.

The stock-recruit analysis of smolt-to-adult productivity of Chinook Salmon indicated a density-dependent relationship between spawning female abundance and smolts that were estimated to survive to LGR (Figure 3). Density-dependent smolt production has been shown for Snake River spring/summer Chinook Salmon (Walters et al. 2013; Camacho et al. 2019), but the extent to which density dependence regulates smolt production across all populations is variable. Adult-to-juvenile productivity estimates for Chinook Salmon in the Upper Salmon River MPG appear to be more limited by density dependence than the Middle Fork Salmon MPG. The Lower Marsh Creek and Big Creek RSTs showed little evidence of reaching asymptotic smolt production over the observed range of female abundance. The specific mechanisms that cause density dependent mortality in juvenile Snake River spring/summer Chinook Salmon are unclear, although we suspect competition among juveniles due to habitat loss from anthropogenic disturbances and/or hatchery influence to be likely contributors.

Steelhead exhibit two characteristics that complicate survival estimation. First, juvenile Idaho steelhead may spend more than one winter rearing downstream of the RST before becoming a smolt. Second, steelhead smolts can vary in age from age-1 up to age-7 (Peven et al. 1994) with overlapping length ranges by age making a CJS model not feasible for estimating survival. A model framework has been created using the Basin TribPIT program (see Chapter 2) that allows flexibility for delayed migration and multiple tributary releases (i.e., years tagged at an RST) for a given brood year. The model structure needs to be customized based on the unique characteristics of each steelhead population. Because of time constraints in 2022, evaluating steelhead survival for all RSTs was not feasible but was implemented for four RSTs in the Clearwater River basin and one RST on Hayden Creek (Chapter 2).

Consideration of mark-recapture assumptions should be a regular part of RST operation and data analysis (Copeland et al. 2021; Roper and Scarnecchia 2000). Some assumptions may need annual checking but all should be re-visited at regular intervals. Prior to 2021 (see Chapter 2 of Heller et al. 2022), no assumptions had been tested for steelhead at IDFG's RSTs and it had been many years since assumptions had been checked for Chinook Salmon. Distance of releases upstream of the RST location should be evaluated, especially for newer traps. The number of days for efficiency recaptures at each trap should also be evaluated. For example, Pahsimeroi recapture efficiencies were changed from 5 to 10 days because of distance and habitat between release site and RST. However, for the South Fork Salmon River RST there were no significant differences in recapture efficiencies between release sites (see Chapter 2 of Heller et al. 2022). If mark-recapture assumptions are being violated, then operations and analysis should be adjusted to produce valid estimates.

RECOMMENDATIONS

The following recommendations would improve our understanding of population status and trends in the juvenile freshwater life stage of Chinook Salmon and steelhead, and would improve reporting efficiency and effectiveness.

- Integrate the juvenile emigrant steelhead survival into the annual emigrant report and use the Basin TribPIT model to estimate juvenile emigrant steelhead survival rates to LGR for all other RST sites where data is sufficient.

- Validate the Oldemeyer (2015) model by populating it with historical data and compare those estimates with estimates obtained from Program R. Refine the model and implement where warranted.

- Continue to add annual information to the historical adult-to-juvenile productivity data series for both Chinook Salmon and steelhead populations presented in this report. Refine historical information as existing datasets are verified and estimation methods are improved.

- Incorporate testing of mark-recapture assumptions as a regular part of RST operations and data analyses.

- Periodically revisit tagging methodology strategy for each trap and across the fleet of RSTs.

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CHAPTER 2

ESTIMATING SURVIVAL AND ABUNDANCE OF WILD STEELHEAD SMOLTS TO LOWER GRANITE DAM

ABSTRACT

Anadromous parr survival and subsequent smolt abundance estimates are important for monitoring productivity and population success and can be used to compare performance across populations. The purpose of this chapter was to build upon the previous work estimating survival of juvenile steelhead *Oncorhynchus mykiss* from multiple rotary screw traps (RSTs) in the Clearwater and Salmon River basins. Big Bear Creek, East Fork Potlatch River, Fish Creek, and Hayden Creek were used to examine survival of steelhead juveniles from the RSTs to Lower Granite Dam (LGR) and estimate the number of smolts at LGR by brood year (2005–2019). Patterns in BY survival were quite different among traps, corresponding to differences in life histories expressed at each location. Steelhead smolt abundance at LGR varied an order of magnitude across BYs. Several issues must be addressed to implement these procedures at other locations. Decisions about applications will need to be strategic and balance data availability with the goal of estimating population smolt production. These estimates will be valuable in assessing overall life cycle survival and hydrosystem effects on steelhead. Future investigations using this method will help identify population-specific characteristics in juvenile movement and rearing, which are useful in assessing and guiding large restoration programs focused on large basin-scale improvements.

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INTRODUCTION

Migration survival and subsequent smolt abundance of juvenile salmonids are critical metrics that are used to evaluate population viability. Apparent survival of wild juvenile Snake River basin salmonids are typically estimated using a Cormack-Jolly-Seber (CJS) model (Cormack 1964; Jolly 1965; Seber 1982). Survival of smolts is estimated to Lower Granite Dam (LGR) using fish that are PIT tagged at rotary screw traps (RST) and their subsequent detections at hydrosystem facilities as they migrate downstream to the ocean. The CJS model is sufficient when all fish of a given cohort are migrating within the same year or season, as is often the case with juvenile spring/summer Chinook Salmon *Oncorhynchus tshawytscha* or hatchery-reared juvenile salmon and steelhead *O. mykiss* (Buchanan et al. 2015).

Wild steelhead exhibit complex early life history movements and rearing strategies that do not meet the assumptions of the CJS model needed for estimating survival. Wild juvenile steelhead may overwinter and even spend several years rearing downstream of the RST in mainstem rivers before migrating to the ocean (Figure 6). The number of years juvenile steelhead can rear in freshwater can vary from one to seven years (Peven et al. 1994; Dobos et al. 2020) and lengths overlap among ages. Accurate ages need to be associated for each PIT-tagged fish to track brood year cohort success, but logistics limit the portion of PIT-tagged fish that are aged through scale samples.

In this chapter, wild juvenile steelhead captured, PIT tagged, and released at RSTs in Big Bear Creek, East Fork Potlatch River, and Fish Creek from the Clearwater River basin and Hayden Creek from the Salmon River basin were used to estimate brood year survival to Lower Granite Dam (LGR) using the Lowther-Skalski model through the Basin TribPIT program (Lady et al. 2017). Steelhead survival and abundance were estimated for Big Bear Creek in the 2019 report (see Feeken et al. 2020 Chapter 2) and the purpose of this chapter was to examine feasibility to apply methods to other existing datasets and evaluate survival at other RSTs where data was sufficient. Specifically, we present analyses for steelhead emigrants from East Fork Potlatch, Fish Creek, and Hayden Creek as well as updating the previous work done for emigrants from Big Bear Creek. We examined methods to assign ages to PIT-tagged fish and estimate survival to LGR based on age, migration pathway, and brood year. Age-length keys were used to assign ages to unaged, PIT-tagged juvenile steelhead (Dobos et al. 2023). The Lowther-Skalski model is a multi-state release-recapture model that allows flexibility for delayed migration and multiple tributary releases (i.e., years tagged at a RST) for a given cohort (i.e., brood year) and was used to estimate survival of smolts to LGR (Buchanan et al. 2015).

METHODS

<u>Cohort abundance at RST</u>

Seasonal abundances of juvenile steelhead at Big Bear Creek, East Fork Potlatch River, Fish Creek, and Hayden Creek RSTs were estimated using methods outlined by Chapter 1 of this report. Trapping juveniles at Big Bear Creek and the East Fork Potlatch River during the summer and fall is often not feasible due to extreme low flows; therefore, only data during the spring seasons were used. Summer and fall seasons for Hayden Creek were pooled together. A subsample of PIT-tagged juvenile steelhead were aged and all PIT-tagged fish were designated into 10-mm length intervals for each year and season. Unaged fish were then assigned ages based on the proportions of aged fish in each bin for a given season and trapping year (Dobos et al. 2023). Age proportions from aged and age-assigned fish were then multiplied by the seasonal abundance estimates to calculate total estimates of juvenile steelhead for each age group (i.e., brood year). Juveniles from a given brood year were then summed across trapping years for a total brood year cohort estimate that emigrated at each RST site. Detailed demographic data of all juveniles trapped at the RST were reported in Chapter 1 of this report.

Estimating Survival to LGR

Program and Uploading Files

The Basin TribPIT program and instructions manual can be downloaded from the Columbia Basin Research website at http://www.cbr.washington.edu/analysis/apps/BasinTribPit. Two inputs were needed for the model: 1) mainstem river observation history, and 2) age data for individual PIT-tagged fish. For the mainstem river observation history, a list of all known PIT tags implanted in juveniles at the RSTs across brood years was generated from the PTAGIS website (www.ptagis.org). The PIT tag lists were uploaded at http://www.cbr.washington.edu/dart/query/pit_tagids using the Basin TribPIT "Observation File" option to generate the observation history for all juveniles PIT tagged at the RSTs. For the age data, all PIT tagged juvenile steelhead from each trap were paired with their assigned brood year based on age determined either from scales or assigned from the age-length key method if scales were not sampled. The observation and age data files were loaded into the Basin TribPIT program.

Model and Output

Detection data were organized in a matrix three ways: by the year juvenile steelhead were tagged and released, by brood year, and by year they were detected at respective interrogation sites (e.g., hydrosystem dams). Lower Granite Dam was the only site where survival was estimated so all interrogation sites upstream of LGR were excluded. All juvenile detections downstream of LGR were pooled to estimate the probability of detecting a PIT-tagged juvenile steelhead at LGR, given that it passed the dam. Models were fitted to each brood year separately and across all release year's juveniles from a given brood year emigrated at RST sites.

Each brood year cohort had groups of fish that were PIT tagged and released as exiting their natal tributary system in a given year (i.e., release groups). Each release group could exhibit one of four potential pathways to the ocean; 1) directly migrate the same year released, 2) overwinter and migrate the following spring, 3) overwinter twice and migrate that following spring, and 3) overwinter three times and migrate that following spring (Figure 6). The multi-state capture-recapture model estimates a joint probability of migrating to the ocean in a certain year and surviving that migration (i.e., survival parameter).

Models were run for each brood year cohort separately, and survival to LGR was estimated for each migration pathway of each release group where there was a sufficient number of PIT tags detected. Estimated abundance of each release group for a given brood year was multiplied by the survival estimated for each pathway those fish exhibited. For example, the 2002 release group from brood year 2002 was estimated at 2,000. A portion of those fish directly migrated to the ocean the same year and a portion overwintered and migrated out the following spring. Survival for direct migrants was 60% and those that overwintered had a survival of 30%. There were 1,200 direct migrant smolts and 600 overwintering smolts that survived to LGR. Total brood year production of smolts at LGR was the sum of fish that survived to LGR across all migration pathways for each release group. Overall brood year survival was the total number of smolts estimated to have survived to LGR divided by estimated total abundance of juveniles at the RST.

RESULTS

Cohort Steelhead Emigrant Movement Patterns

Wild juvenile steelhead exhibited a variety of movement patterns that varied across trapping sites (Figure 7). Juveniles at RSTs that emigrated from tributary watersheds ranged in age from zero to four years old. The most common movement pattern overall was fish that emigrated in the spring as an age-2 fish and directly migrated to LGR (Figure 7). However, the most common movement pattern for juveniles in Fish Creek was to emigrate as age-2 fish in the fall and overwinter for one winter period before migrating to the ocean. The highest diversity in age and movement patterns was observed in Fish Creek where juveniles ranged in age from zero to four years old and held in freshwater habitat up to three winters downstream of their natal tributary watershed before being detected moving downstream to the ocean.

Steelhead Survival, Abundance, and Productivity

Survival of juvenile steelhead varied across BYs and watersheds (Figure 8). Mean survival was related to age at which fish emigrated from their natal tributary watersheds and their movement pattern to LGR. Mean survival was the highest for direct migrants across all ages of juvenile emigrants in Big Bear Creek and age-2 and -3 emigrants in the East Fork Potlatch River. Mean survival was highest for fish that overwintered for one winter across all ages of juvenile emigrants in Fish Creek and age-2 and -3 emigrants in Hayden Creek. In Hayden Creek, age-0 fish had the highest mean survival when they overwintered for two winters and highest mean survival for age 1 fish were those that overwintered for one winter.

Rotary screw trap abundance and age composition of juvenile steelhead across BYs were variable among traps (Figure 9; Appendix F). In the Clearwater River basin, juvenile steelhead abundance by BY varied from 3,994 to 21,356 fish in Big Bear Creek, 1,587 to 38,611 fish in the East Fork Potlatch River, and 2,933 to 90,224 fish in Fish Creek. In the Salmon River basin, juvenile steelhead abundance by BY varied from 2,084 to 20,798 fish in Hayden Creek. Juvenile abundances included age-1 through age-3 fish across most BYs in Big Bear Creek and the East Fork Potlatch River (Figure 9). Juvenile abundances included age-0 fish through age-4 fish across most BYs in Fish Creek and Hayden Creek.

Lower Granite Dam abundance and age composition of smolts across BYs were variable among traps (Figure 9; Appendix F). In the Clearwater River basin, smolt abundance by BY varied from 1,909 to 7,398 fish in Big Bear Creek, 805 to 7,744 fish in the East Fork Potlatch River, and 1,372 to 21,184 fish in Fish Creek. In the Salmon River basin, smolt abundance by BY varied from 792 to 9,001 fish in Hayden Creek. Smolt abundances included age-1 through age-3 fish across most BYs in Big Bear Creek and the East Fork Potlatch River (Figure 9). Smolt abundances included age-2 fish through age-5 fish across most BYs in Fish Creek and age-1 through age-4 fish in Hayden Creek. Age composition at LGR was older than that observed at RSTs.

Overall survival of steelhead emigrant BY cohorts from RSTs to LGR fluctuated among watersheds with no apparent synchronous pattern (Figure 10). The highest mean survival of BY cohorts was observed in Big Bear Creek (0.469) and varied from 0.312−0.601. Mean survival of

BY cohorts was 0.226 (0.071−0.455) for the East Fork Potlatch, 0.438 (0.225−0.576) for Fish Creek, and 0.285 (0.116−0.491) in Hayden Creek.

Productivity of steelhead smolts at LGR varied across brood years and RSTs (Appendix F). In the Clearwater River basin, productivity of steelhead smolts at LGR from Big Bear Creek varied from 12 to 641 smolts per female spawner (BY2007−2020). Productivity varied from 15 to 3,872 smolts per female spawner in the East Fork Potlatch River (BY2007−2020), and varied from 55 to 191 in Fish Creek (BY2005−2019). In the Salmon River basin, productivity of steelhead smolts at LGR from Hayden Creek varied from 29 to 202 (BY2009−2019).

DISCUSSION

The purpose of this chapter was to build upon the work done by Feeken et al. (2019) by estimating survival of juvenile steelhead from selected RSTs. The series for Big Bear Creek was updated through BY2020 and series for three other traps were added. Patterns in BY survival were quite different among traps, corresponding to differences in life histories expressed at each location. The end product of this work is smolt productivity at LGR for steelhead similar to what is done for Chinook Salmon. Available data from the other RSTs mentioned in Chapter 1 must be assessed to guide steps needed to model steelhead survival.

Several issues must be addressed to implement these procedures at other locations. Assigning ages to all PIT-tagged steelhead takes a significant amount of time but the methods were recently worked out by Dobos et al. (2023). Another important decision is the number of age and movement pattern combinations to be modeled. The more complex the population portfolio is for juvenile ages and movements, the more PIT-tag observations are needed as they get partitioned among the different groups. Some combinations may have negligible contributions to population smolt production and can be ignored in order for the model to converge and provide estimates for all combinations for a given brood year. However, excluding groups of fish due to lack of data will affect assessing the full life history portfolio of wild steelhead populations and how that might change over time. The interface to run the model has not been widely used and needs to be updated with flexibilities and functions to improve efficiencies. Decisions about applications will need to be strategic and balance data availability with the goal of estimating population smolt production.

Another challenge is determining which format for reporting survival data is most appropriate for this document. Life history strategies for spring-summer Chinook Salmon are simpler and tracking trends in survival and abundance generally only involves two life history strategies, 1) age-1 fish that leave natal tributary watersheds, directly migrating to the ocean, and age-0 fish that emigrate out and overwinter before migrating to the ocean the following spring. For wild steelhead, age and PIT tag data allow for description of age composition at a screw trap and at Lower Granite Dam, tracking of movement patterns, and estimating abundance or contribution of the different life history strategies. Shifts in these metrics can indicate density dependence, stochastic events, or other environmental conditions that affects diversity traits. Shifts can also indicate population response to habitat or management actions aimed at improving populations. Identifying these processes and tracking these metrics are necessary for evaluating population viability (McElhany et al. 2000). The flexible life history of steelhead makes it challenging to present specific data in a coherent manner.

As this model gets applied to other wild steelhead populations, the process of refining methods and reporting results will evolve. Survival and smolt abundances of wild steelhead were data gaps in this report and by adding these parameters, we can account for and measure productivity to LGR. These estimates will be valuable in assessing overall life cycle survival and hydrosystem effects on steelhead. Future investigations using this method will help identify population-specific characteristics in juvenile movement and rearing, which are useful in assessing and guiding large restoration programs focused on large basin-scale improvements (e.g., Uthe et al. 2017).

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TABLES

Table 1. Major population groups and independent populations within the spring-summer Chinook Salmon evolutionary significant unit (ESU) and Snake River steelhead distinct population segment (DPS; ICTRT 2003, 2005; NMFS 2011).

Snake River spring-summer Chinook Salmon ESU	
Major population group	**Population name**
Lower Snake River	1. Tucannon River 2. Asotin Creek (extirpated) [a]
Grande Ronde/Imnaha Rivers	3. Wenaha River 4. Lostine River 5. Minam River 6. Catherine Creek 7. Upper Grande Ronde River 8. Imnaha River 9. Big Sheep Creek (extirpated) [a] 10. Lookinglass Creek (extirpated) [a]
South Fork Salmon River	11. Little Salmon River 12. South Fork Salmon River Mainstem 13. Secesh River 14. East Fork South Fork Salmon River
Middle Fork Salmon River	15. Chamberlain Creek 16. Middle Fork Salmon River below Indian Creek 17. Big Creek 18. Camas Creek 19. Loon Creek 20. Middle Fork Salmon River above and including Indian Creek 21. Sulphur Creek 22. Bear Valley Creek 23. Marsh Creek
Upper Salmon River	24. Panther Creek (extirpated) [a] 25. North Fork Salmon River 26. Lemhi River 27. Salmon River Lower Mainstem below Redfish Lake 28. Pahsimeroi River 29. East Fork Salmon River 30. Yankee Fork Salmon River 31. Valley Creek 32. Salmon River Upper Mainstem above Redfish Lake
Dry Clearwater River (extirpated) [a]	33. Potlatch River (extirpated) 34. Lapwai Creek (extirpated) 35. Lawyer Creek (extirpated) 36. Upper South Fork Clearwater River (extirpated) [a]
Wet Clearwater River (extirpated) [a]	37. Lower North Fork Clearwater River (extirpated) 38. Upper North Fork Clearwater River (extirpated) 39. Lolo Creek (extirpated) [a] 40. Lochsa River (extirpated) [a] 41. Meadow Creek (extirpated) [a] 42. Moose Creek (extirpated) [a] 43. Upper Selway River (extirpated) [a]

Table 1. Continued.

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) [a]	NA

[a] Reintroduced fish exist in extirpated areas.

Table 2. Trap catch and emigrant abundance estimates for juvenile Chinook Salmon by season and age from rotary screw traps (RST) operated in the Salmon River and Clearwater River basins, Idaho during calendar year 2022. Instances where no estimate was made are noted NA.

Major Population Group, RST location and PTAGIS code	Season and age	Trap catch	Point estimate	Lower 95% CI	Upper 95% CI
South Fork Salmon River					
Rapid River	Spring age-1	2	NA	NA	NA
RPDTRP	Spring age-0	0	NA	NA	NA
	Summer age-0	17	NA	NA	NA
	Fall age-0	97	NA	NA	NA
	Total	**116**	**NA**	**NA**	**NA**
Lower South Fork Salmon River	Spring age-1	1,419	10,854	9,135	13,369
SFSRKT	Spring age-0	27	NA	NA	NA
	Summer age-0	2,184	33,152	26,340	43,700
	Fall age-0	11,732	93,099	83,972	104,452
	Total	**15,362**	**137,104**		
Middle Fork Salmon River					
Big Creek	Spring age-1	749	13,339	10,186	18,675
BIG2CT	Spring age-0	2	NA	NA	NA
	Summer age-0	373	5,787	3,927	9,996
	Fall age-0	3,187	30,186	27,063	33,855
	Total	**4,311**	**49,312**		
Lower Marsh Creek	Spring age-1	353	2,655	2,106	3,592
MARTR2	Spring age-0	111	NA	NA	NA
	Summer age-0	5,471	80,434	70,413	95,759
	Fall age-0	3,756	23,530	21,642	26,839
	Total	**9,691**	**106,619**		
Upper Salmon River					
North Fork Salmon River	Spring age-1	281	2,492	1,874	4,970
NFSTRP	Spring age-0	36	NA	NA	NA
	Summer age-0	5	10	5	20
	Fall age-0	779	4,607	3,953	6,489
	Total	**1,101**	**7,109**		
Upper Lemhi River	Spring age-1	1,080	5,447	4,858	6,199
LEMTRP	Spring age-0	383	4,992	3,256	9,360
	Summer age-0	19	127	63	380
	Fall age-0	4,611	13,137	12,580	13,716
	Total	**6,093**	**23,703**		
Hayden Creek	Spring age-1	50	127	94	196
HAYTRP	Spring age-0	333	2,479	1,907	3,420
	Summer age-0	1	NA	NA	NA
	Fall age-0	NA	NA	NA	NA
	Total	**384**	**2,606**		
Lower Lemhi River	Spring age-1	1,120	18,641	15,009	24,091
LLRTP	Spring age-0	2	NA	NA	NA
	Summer age-0	1	NA	NA	NA
	Fall age-0	770	12,750	9,533	22,809
	Total	**1,893**	**31,391**		

Table 2. Continued.

Major Population Group, RST location and PTAGIS code	Season and age	Trap catch	Point estimate	Lower 95% CI	Upper 95% CI
Upper Salmon River	Spring age-1	726	4,186	3,588	5,141
SAWTRP	Spring age-0	850	4,255	2,128	8,510
	Summer age-0	2,020	23,023	20,095	27,451
	Fall age-0	796	5,897	4,936	7,816
	Total	**4,392**	**37,362**		
Pahsimeroi River	Spring age-1	155	2,164	1,404	5,668
PAHTRP	Spring age-0	225	5,928	4,966	9,991
	Summer age-0	38	NA	NA	NA
	Fall age-0	452	4,812	4,006	8,919
	Total	**870**	**12,903**		
Dry Clearwater River					
Crooked River	Spring age-1	84	663	414	1,326
CROTRP	Spring age-0	0	NA	NA	NA
	Summer age-0	549	NA	NA	NA
	Fall age-0	27	NA	NA	NA
	Total	**660**	**663**		
Big Bear Creek	Spring age-1	0	NA	NA	NA
BBCTRP	Spring age-0	0	NA	NA	NA
	Summer age-0	0	NA	NA	NA
	Fall age-0	0	NA	NA	NA
	Total	**0**	**NA**	**NA**	**NA**
East Fork Potlatch	Spring age-1	0	NA	NA	NA
EFPTRP	Spring age-0	0	NA	NA	NA
	Summer age-0	0	NA	NA	NA
	Fall age-0	0	NA	NA	NA
	Total	**0**	**NA**	**NA**	**NA**
Wet Clearwater River					
Fish Creek	Spring age-1	0	NA	NA	NA
FISTRP	Spring age-0	0	NA	NA	NA
	Summer age-0	0	NA	NA	NA
	Fall age-0	0	NA	NA	NA
	Total	**0**	**NA**	**NA**	**NA**
Lower Lochsa River	Spring age-1	115	4,331	2,165	12,992
LOCTRP	Spring age-0	0	NA	NA	NA
	Summer age-0	9	NA	NA	NA
	Fall age-0	21	199	100	399
	Total	**145**	**4,530**		

Table 3. Estimated abundance of emigrants at each rotary screw trap (RST), survival to Lower Granite Dam (LGR), and estimated smolt abundance at LGR for brood year 2020 wild juvenile Chinook Salmon from the Salmon River and Clearwater River basins, Idaho. Instances where no estimate was made are noted NA.

Major Population Group, RST location and PTAGIS code	Season and age	Emigrant abundance at RST	Number PIT tagged at RST	Survival rate to LGR (SE)	Smolt abundance to LGR
South Fork Salmon River					
Lower South Fork	Spring age-0	9,419	326	0.276 (0.070)	2,600
Salmon River	Summer age-0	9,611	453	0.428 (0.138)	4,115
SFSRKT	Fall age-0	40,480	3,430	0.338 (0.023)	13,682
	Spring age-1	10,854	1,211	0.609 (0.044)	6,610
	BY Total	**70,364**	**5,420**	**0.384**	**27,007**
Middle Fork Salmon River					
Big Creek	Spring age-0	NA	5	NA	NA
BIGC2T	Summer age-0	4,588	213	0.381 (0.077)	1,749
	Fall age-0	37,618	1,637	0.432 (0.037)	16,232
	Spring age-1	13,339	747	0.655 (0.073)	8,737
	BY Total	**55,545**	**2,602**	**0.481**	**26,718**
Lower Marsh Creek	Spring age-0	24,634	15	NA	NA
MARTR2	Summer age-0	70,382	1,049	0.288 (0.043)	20,270
	Fall age-0	59,176	6,633	0.349 (0.019)	20,652
	Spring age-1	2,655	345	0.506 (0.068)	1,343
	BY Total	**156,847**	**8,042**	**0.320**	**42,266**
Upper Salmon River					
North Fork Salmon River	Spring age-0	NA	NA	NA	NA
NFSTRP	Summer age-0	1,657	149	0.085 (0.024)	141
	Fall age-0	22,216	1,344	0.417 (0.050)	9,264
	Spring age-1	2,492	301	0.540 (0.135)	1,346
	BY Total	**26,365**	**1,794**	**0.408**	**10,751**
Lemhi River weir	Spring age-0	1,325	2	NA	NA
LEMTRP	Summer age-0	224	36	0.111 (0.076)	25
	Fall age-0	10,676	2,440	0.322 (0.025)	3,438
	Spring age-1	5,447	1,079	0.636 (0.066)	3,464
	BY Total	**17,672**	**3,557**	**0.424**	**6,927**
Hayden Creek	Spring age-0	20,902	2	NA	NA
HAYTRP	Summer age-0	638	140	0.293 (0.238)	187
	Fall age-0	548	173	0.435 (0.131)	238
	Spring age-1	127	49	NA	NA
	BY Total	**22,215**	**364**	**0.324**	**425**
Lower Lemhi River	Spring age-0	345	2	NA	NA
LLRTP	Summer age-0	62	28	NA	NA
	Fall age-0	13,401	1,182	0.392 (0.039)	5,253
	Spring age-1	18,641	1,043	0.775 (0.076)	14,447
	BY Total	**32,448**	**2,255**	**0.614**	**19,700**
Upper Salmon River	Spring age-0	4,195	50	NA	NA
SAWTRP	Summer age-0	4,740	310	0.119 (0.095)	564
	Fall age-0	3,797	607	0.257 (0.060)	974
	Spring age-1	4,186	717	0.421 (0.049)	1,762
	BY Total	**16,918**	**1,684**	**0.259**	**3,300**

Table 3. Continued.

Major Population Group, RST location and PTAGIS code	Season and age	Emigrant abundance at RST	Number PIT tagged at RST	Survival rate to LGR (SE)	Smolt abundance to LGR
Pahsimeroi River	Spring age-0	5,213	814	0.338 (0.055)	1,762
PAHTRP	Summer age-0	3,759	309	0.261 (0.146)	981
	Fall age-0	15,700	2,053	0.253 (0.028)	3,972
	Spring age-1	2,164	153	0.747 (0.147)	1,616
	BY Total	**24,672**	**3,329**	**0.338**	**8,332**
Dry Clearwater River					
Crooked River	Spring age-0	NA	NA	NA	NA
CROTRP	Summer age-0	NA	NA	NA	NA
	Fall age-0	320	87	NA	NA
	Spring age-1	663	78	NA	NA
	BY Total	**983**	**165**	**NA**	**NA**

Table 4. Estimated adult-to-juvenile productivity of wild juvenile Chinook Salmon for brood year 2020, expressed as both emigrants at rotary screw trap per female spawner and smolts at Lower Granite Dam (LGR) per female spawner. Instances where no estimates were made are noted NE.

Major Population Group and trap location, and PTAGIS site code	**Female adults**	**Emigrants at trap**	**Emigrants /female**	**Smolts to LGR**	**Smolts at LGR / female**
		Salmon River Basin			
South Fork Salmon River					
Rapid River RPDTRP	NE	NE	NE	NE	NE
Lower South Fork Salmon River SFSRKT	72[a][c]	70,364	977	27,007	375
Middle Fork Salmon River					
Big Creek BIG2CT	32[a]	55,545	1,736	26,718	835
Lower Marsh Creek MARTR2	177[b]	156,847	747	42,266	239
Upper Salmon River					
North Fork Salmon River NFSTRP	19[a]	26,365	1,388	10,751	576
Lemhi River (upper) LEMTRP	88[b]	17,672	201	6,927	79
Hayden Creek HYDTRP	33[a]	22,215	673	425	13
Lower Lemhi River LLRTP	121[a][b]	32,448	268	19,700	163
Upper Salmon River SAWTRP	31[c]	16,918	546	3,300	106
Pahsimeroi River PAHTRP	61[c]	26,836	440	8,332	137
		Clearwater River Basin			
Dry Clearwater River					
Crooked River CROTRP	0	NE	NE	NE	NE

[a] Data source: IDFG index (single pass) redd survey.
[b] Data source: Census (multi-pass) redd surveys.
[c] Data source: Females passed upstream from weir.

Table 5. Parameter estimates for wild Chinook Salmon Beverton-Holt stock recruit curves. “Recruits” are represented by smolts at Lower Granite Dam, and “stock” are wild redds above traps or female spawners above traps estimated using mark-recapture techniques. Alpha/beta is the estimated asymptote.

Major population group, trap location, and PTAGIS code	Brood years in analysis	α	β	α/β
Middle Fork Salmon River				
Big Creek BIG2CT	2006-2020	572.1	0.005	114,637
Lower Marsh Creek MARTR2	2009-2020	277.6	0.001	292,815
Upper Salmon River				
Upper Lemhi River LEMTRP	1991-2020	114.9	0.002	52,928
Pahsimeroi River PAHTRP	1992-2020	169.7	0.006	27,417
Upper Salmon River SAWTRTP	1992-1994, 1996-2020	177.3	0.003	59,971
Lower Lemhi Trap LLTRP	2017-2020	274.6	0.003	100,335

Table 6. Rotary screw trap catch and emigrant abundance estimates, with 95% confidence intervals (CI) for wild juvenile steelhead >80 mm FL, by season during 2022. Instances where no estimate was made are noted NE.

Population, trap location and PTAGIS site code	Season	Catch	Emigration estimate	Lower 95% CI	Upper 95% CI
	Salmon River Basin				
Little Salmon River					
Rapid River	Spring	222	2,063	1,500	3,300
RPDTRP	Sum/Fall	165	1,141	830	1,712
	Total	**387**	**3,204**	**2,330**	**5,012**
South Fork Salmon River					
Lower South Fork Salmon River	Spring	212	1,038	773	1,510
SFSRKT	Sum/Fall	1,028	14,192	11,227	18,805
	Total	**1,240**	**15,231**	**12,000**	**20,315**
Lower Middle Fork Salmon River					
Big Creek	Spring	50	NA	NA	NA
BIG2CT	Sum/Fall	632	26,573	16,676	66,739
	Total	**682**	**26,573**	**16,676**	**66,739**
Upper Middle Fork Salmon River					
Lower Marsh Creek	Spring	13	91	46	182
MARTR2	Sum/Fall	135	1,402	911	2,603
	Total	**148**	**1,493**	**957**	**2,785**
North Fork Salmon River					
North Fork Salmon River	Spring	210	2,606	1,772	4,430
NFSTRP	Sum/Fall	402	15,996	9,998	31,993
	Total	**612**	**18,603**	**11,770**	**36,423**
Lemhi River					
Upper Lemhi River	Spring	302	1,082	918	1,317
LEMTRP	Sum/Fall	1,702	14,299	12,503	16,587
	Total	**2,004**	**15,381**	**13,421**	**17,905**
Hayden Creek	Spring	301	1,596	1,296	2,079
HYDTRP	Sum/Fall	16	127	63	255
	Total	**317**	**1,723**	**1,359**	**2,334**
Lower Lemhi River	Spring	374	7,677	5,220	13,050
LLRTP	Sum/Fall	83	3,234	1,617	6,468
	Total	**457**	**10,911**	**6,837**	**19,518**
Upper Salmon River mainstem					
Upper Salmon River	Spring	1,018	10,147	8,456	12,519
SAWTRP	Sum/Fall	167	4,620	2,520	13,860
	Total	**1,185**	**14,767**	**10,976**	**26,379**
Pahsimeroi River					
Pahsimeroi River	Spring	131	2,809	1,686	6,321
PAHTRP	Sum/Fall	944	11,756	9,734	14,840
	Total	**1,075**	**14,566**	**11,419**	**21,161**

Table 6. Continued

Population, trap location and PTAGIS site code	Season	Catch	Emigration estimate	Lower 95% CI	Upper 95% CI
		Clearwater River Basin			
South Fork Clearwater River					
Crooked River	Spring	11	NA	NA	NA
CROTRP	Sum/Fall	125	823	559	1,399
	Total	**136**	**823**	**559**	**1,399**
Lower Clearwater Mainstem					
Big Bear Creek	Spring	545	3,169	2,674	4,392
BBCTRP	Sum/Fall	NA	NA	NA	NA
	Total	**545**	**3,169**	**2,674**	**4,392**
East Fork Potlatch River	Spring	101	1,065	639	2,397
EFPTRP	Sum/Fall	NA	NA	NA	NA
	Total	**101**	**1,065**	**639**	**2,397**
Lochsa River					
Fish Creek	Spring	0	NA	NA	NA
FISTRP	Sum/Fall	1,815	10,827	9,674	12,232
	Total	**1,815**	**10,827**	**9,674**	**12,232**
Lower Lochsa River	Spring	361	29,594	14,797	118,374
LOCTRP	Sum/Fall	63	960	480	3,840
	Total	**424**	**30,554**	**15,277**	**122,214**

Table 7. Seasonal age composition estimates of juvenile steelhead >80 mm FL in 2022 from rotary screw traps (RST) operated in the Salmon River and Clearwater River basins, Idaho.

Population, RST location and PTAGIS site code	Season	Total aged	Estimated emigrant abundance by age						Total est
			Age 0	Age 1	Age 2	Age 3	Age 4	Age 5	
Little Salmon River									
Rapid River	Spring	215	0	38	499	1,190	317	19	2,063
RPDTRP	Sum/Fall	159	0	345	689	100	7	0	1,141
South Fork Salmon River									
Lower South Fork Salmon River	Spring	134	0	790	217	31	0	0	1,038
SFSRKT	Sum/Fall	218	0	10,482	3,385	326	0	0	14,192
Lower Middle Fork Salmon River									
Big Creek	Spring[b]	47	NA	NA	NA	NA	NA	NA	NA
BIG2CT	Sum/Fall	240	0	10,961	14,837	775	0	0	26,573
Upper Middle Fork Salmon River									
Lower Marsh Creek	Spring[a]	12	0	9	60	24	4	0	91
MARTR2	Sum/Fall	120	0	1,192	199	12	0	0	1,402
North Fork Salmon River									
North Fork Salmon River	Spring[b]	144	0	1,303	796	507	0	0	2,606
NFSTRP	Sum/Fall	239	201	10,776	4,217	803	0	0	15,996
Lemhi River									
Upper Lemhi River	Spring	123	0	783	273	26	0	0	1,082
LEMTRP	Sum/Fall	219	0	13,516	718	65	0	0	14,299
Lower Lemhi River	Spring	158	0	340	5,150	1,992	194	0	7,677
LLRTRP	Sum/Fall	44	0	2,058	956	221	0	0	3,234
Hayden Creek	Spring[a]	0	0	366	806	403	12	5	1,596
HYDTRP	Sum/Fall[a]	0	27	65	26	7	1	0	127
Upper Salmon River mainstem									
Upper Salmon River									
SAWTRP	Spring	239	0	6,156	3,439	552	0	0	10,147
Pahsimeroi River	Sum/Fall	156	267	3,998	355	0	0	0	4,620
Pahsimeroi River									
PAHTRP	Spring	128	0	1,997	702	88	22	0	2,809
	Sum/Fall	264	3,874	6,323	1,336	223	0	0	11,756
South Fork Clearwater River									
Crooked River	Spring[a][b]	0	NA	NA	NA	NA	NA	NA	NA
CROTRP	Sum/Fall[a]	0	0	592	197	26	3	0	823

Table 7. Continued.

Population, RST location and PTAGIS site code	Season	Total aged	Estimated emigrant abundance by age						Total est
			Age 0	Age 1	Age 2	Age 3	Age 4	Age 5	
Lower Clearwater River Mainstem									
East Fork Potlatch River	Spring	91	0	35	866	164	0	0	1,065
EFPTRP	Sum/Fall[(a,b)]	7	NA	NA	NA	NA	NA	NA	NA
Big Bear Creek	Spring	166	0	57	3,093	19	0	0	3,169
BBCTRP	Sum/Fall[(a,b)]	18	NA	NA	NA	NA	NA	NA	NA
Lochsa River									
Fish Creek	Spring[(a)(b)]	0	NA	NA	NA	NA	NA	NA	NA
FISTRP	Sum/Fall	314	34	6,517	4,172	103	0	0	10,827
Lochsa River	Spring	301	0	393	8,750	18,877	1,573	0	29,594
LOCTRP	Sum/Fall	42	23	754	114	46	23	0	960

[a] Age was determined for fewer than 30 fish, thus age proportions are based off average of prior years with greater than 30 fish aged.

[b] No abundance estimate due to low catch or recaptures.

Table 8. Season and life stage of Pacific Lamprey captured in rotary screw traps (RST) operated in the Salmon River and Clearwater River basins, Idaho during calendar year 2022. Only RST that captured Pacific Lamprey are included.

Major Population Group, RST location and PTAGIS code	Season	Life stage	Trap catch	Mean length (mm)	Length range (mm)
South Fork Salmon River					
Lower South Fork Salmon River SFSRKT	Spring*	Ammocoete	2107	137	120-170
		Macrophthalmia	984	146	129-170
	Summer*	Ammocoete	17	135	114-145
		Macrophthalmia	0	NA	NA
	Fall*	Ammocoete	6	140	124-152
		Macrophthalmia	2	142	135-148
	Total				
Wet Clearwater River	Spring*	Ammocoete	101	108	68-140
Lower Lochsa River		Macrophthalmia	2	138	135-140
LOCTRP	Summer*	Ammocoete	28	101	74-132
		Macrophthalmia	0	NA	NA
	Fall*	Ammocoete	0	NA	NA
		Macrophthalmia	0	NA	NA
	Total				

*Spring = start of trapping-6/30; Summer = 7/1-8/31; Fall = 9/1-end of trapping.

FIGURES

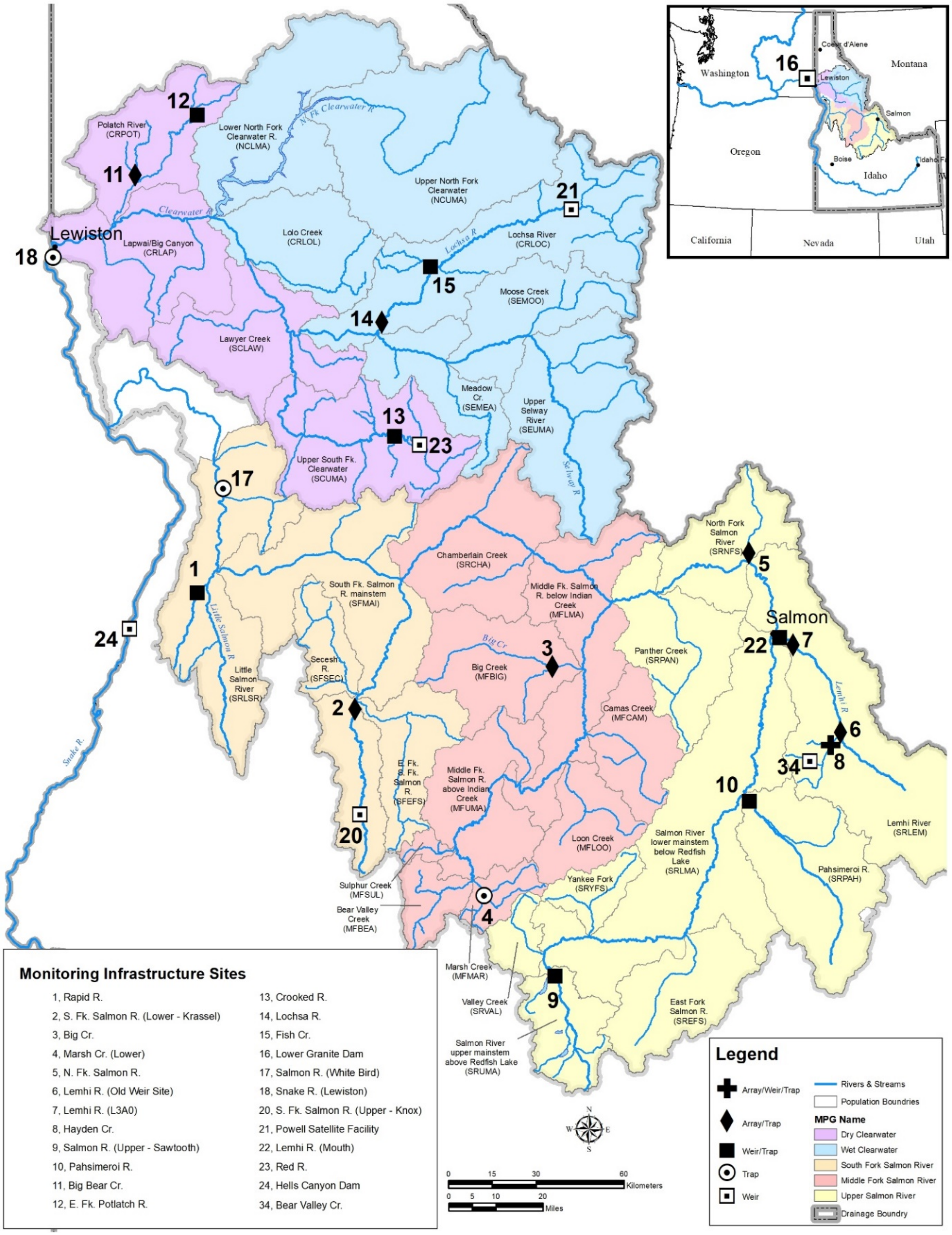

Figure 1. Location of rotary screw traps, weirs, and PIT arrays operated by IDFG in 2022 with reference to spring/summer Chinook Salmon population structure. Numbers correspond to infrastructure sites in the lower left inset. Chinook Salmon major population groups are highlighted and independent populations are delineated.

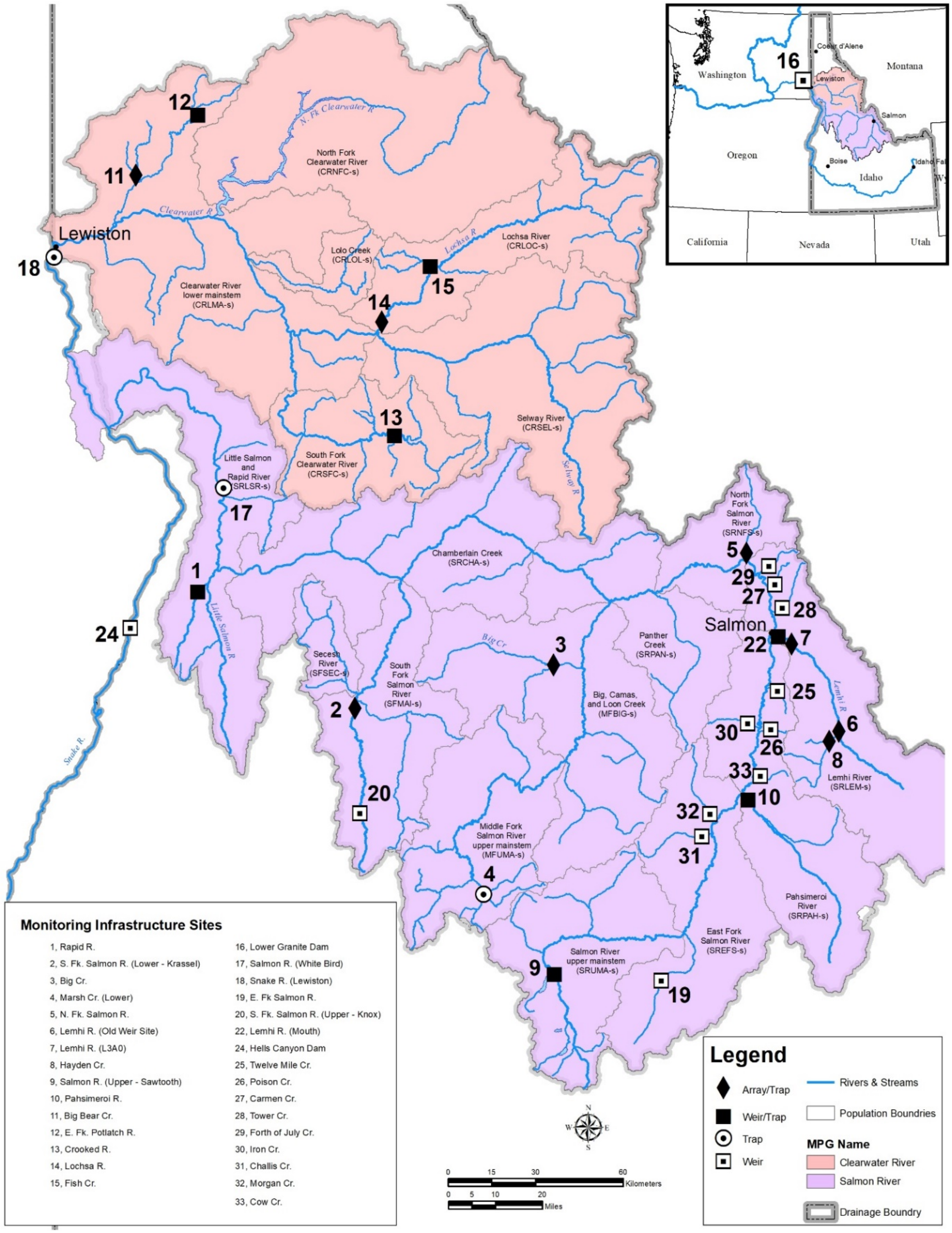

Figure 2. Location of rotary screw traps, weirs, and PIT arrays operated by IDFG in 2022 with reference to steelhead population structure. Numbers correspond to infrastructure sites in the lower left inset. Steelhead major population groups are highlighted and independent populations are delineated.

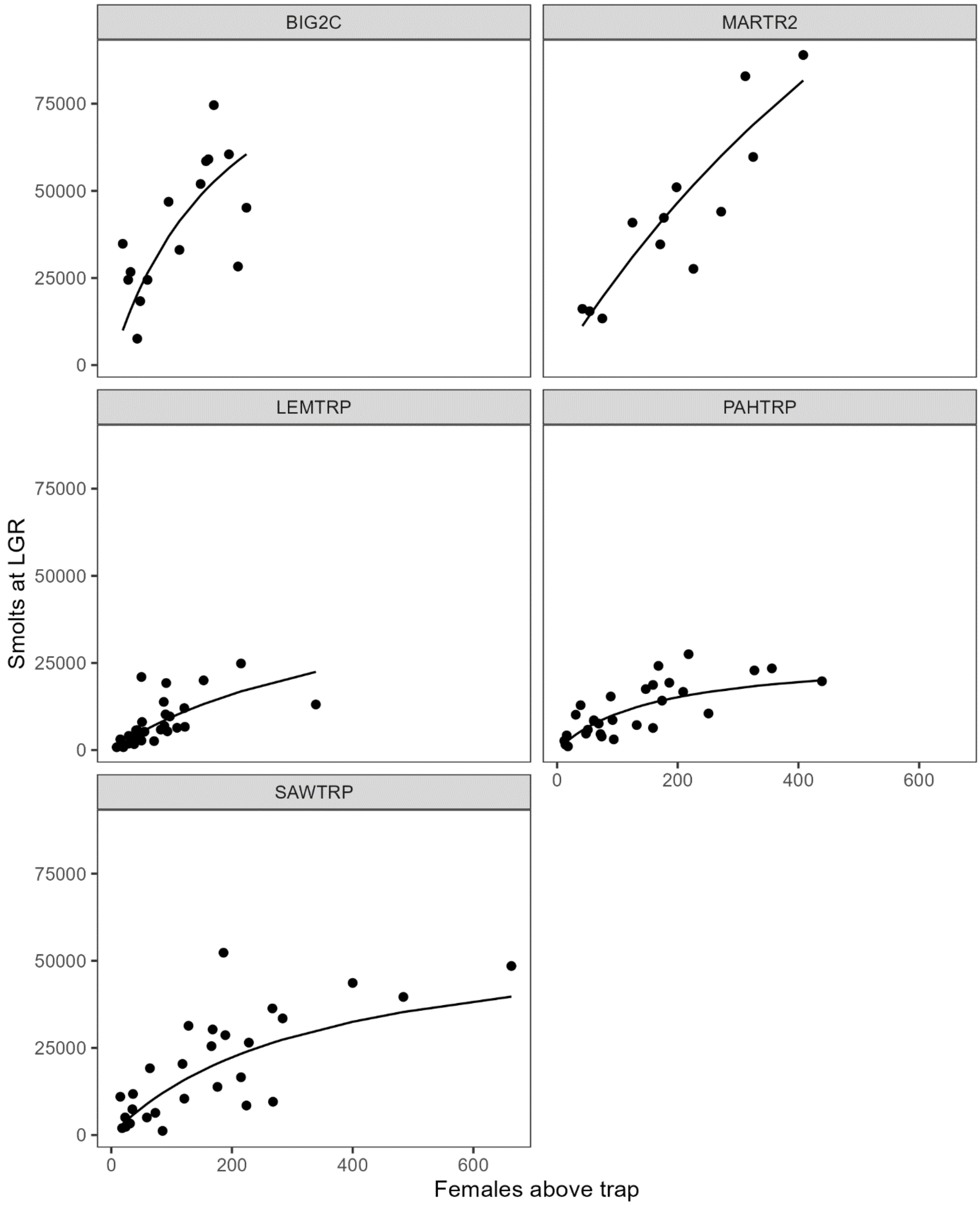

Figure 3. Relationship between wild Chinook Salmon smolts at Lower Granite Dam (LGR) and adult female spawner abundance (all redds above trap) for Chinook Salmon in Big Creek (Brood Years (BY) 2006-2020), and Lower Marsh Creek (BY 2009-2020) in the Middle Fork Salmon major population group (mpg). The Lemhi River (BY 1991-2020), Pahsimeroi and Upper Salmon river (BY 1992-2020) in the Upper Salmon River mpg.

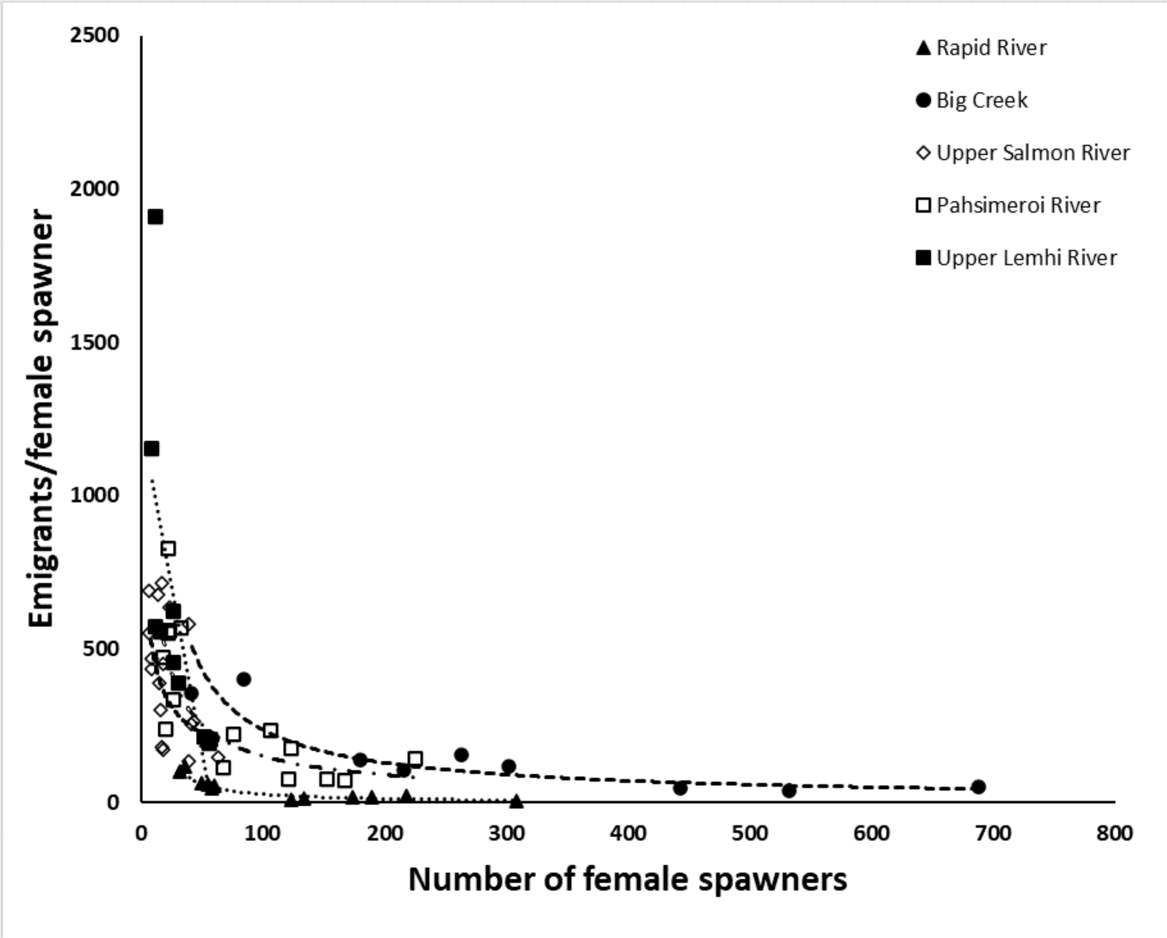

Figure 4. Relationship between wild steelhead emigrant productivity (recruits per spawner expressed as emigrants above the trap/ female spawner above the trap or array) and adult female spawner abundance above the trap or array from Rapid River (Brood Years (BY) 2006-2018), Big Creek (BY 2010-2018), Upper Salmon River (BY 2001-2018), Pahsimeroi River (BY 2001-2018), and Lemhi River (BY 2010-2018). Trend lines fit with a power function are shown for each data set.

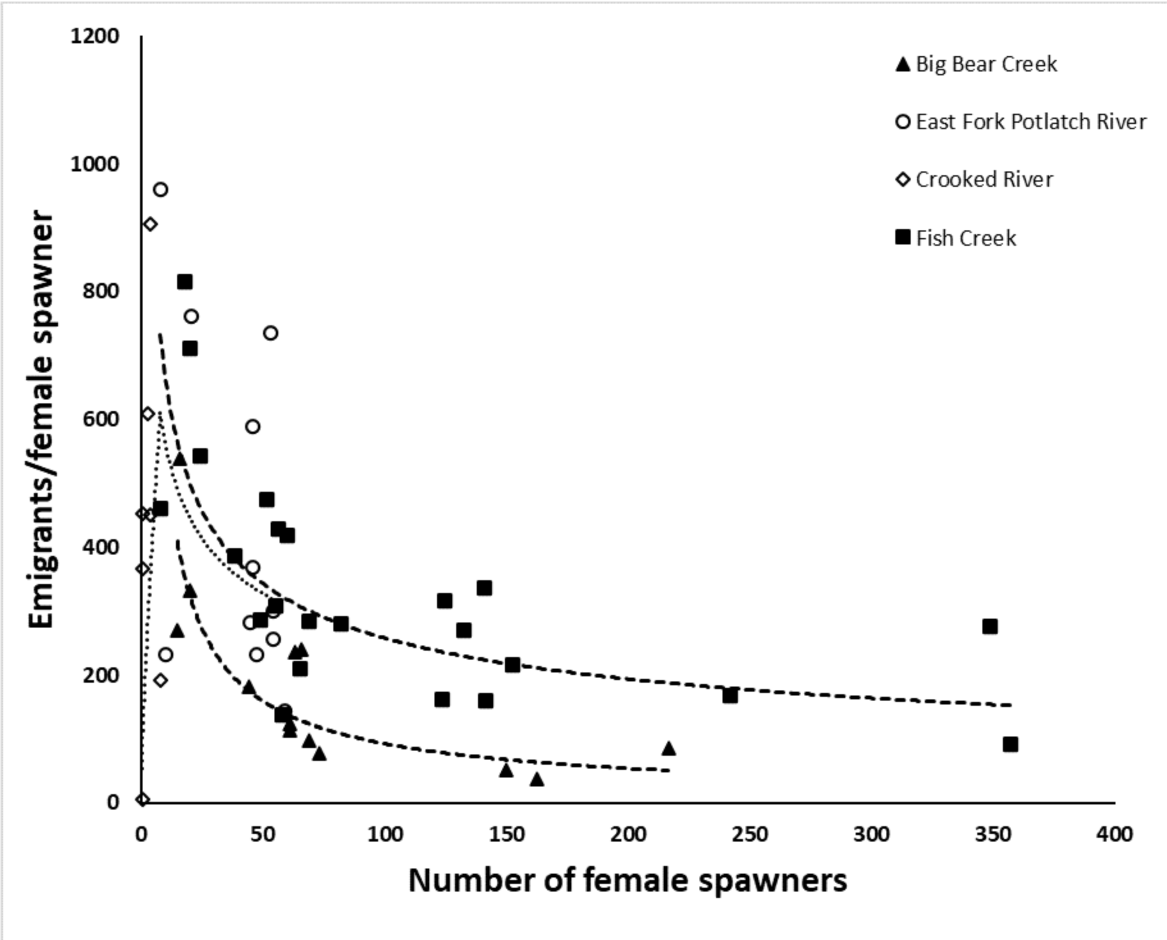

Figure 5. Relationship between wild juvenile steelhead productivity (recruits per spawner expressed as emigrants above the trap/ female spawner) and adult female spawner abundance above the trap or array for steelhead populations from Big Bear Creek (Brood Years (BY) 2005-2018), East Fork Potlatch River (BY 2008-2018), Crooked River (BY 2007-2016), Fish Creek (BY 1996-2018). Trend lines fit with a power function are shown for each data set.

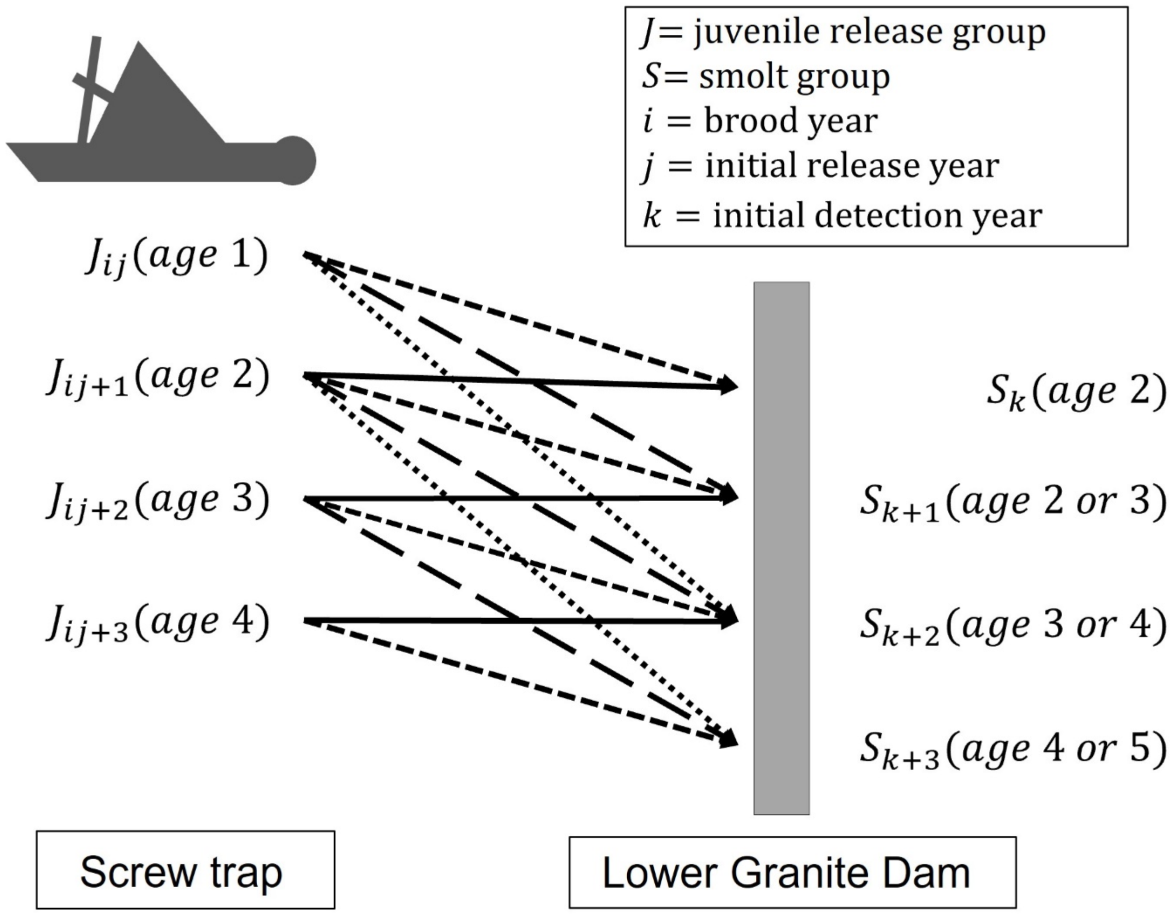

Figure 6. Schematic of migratory pathway possibilities of an example wild juvenile steelhead brood year cohort. Juveniles are tagged and released at rotary screw traps leaving tributary watersheds at a range of ages. Possible pathways to Lower Granite Dam (LGR) include direct migration with no delay (solid lines), overwintering and migrating the following spring (short dashed lines), holding for two winters before ocean migration (long dashed lines), and holding for three winters prior to ocean migration (dotted lines). Total brood year smolt production is the sum of smolt groups that survive to LGR.

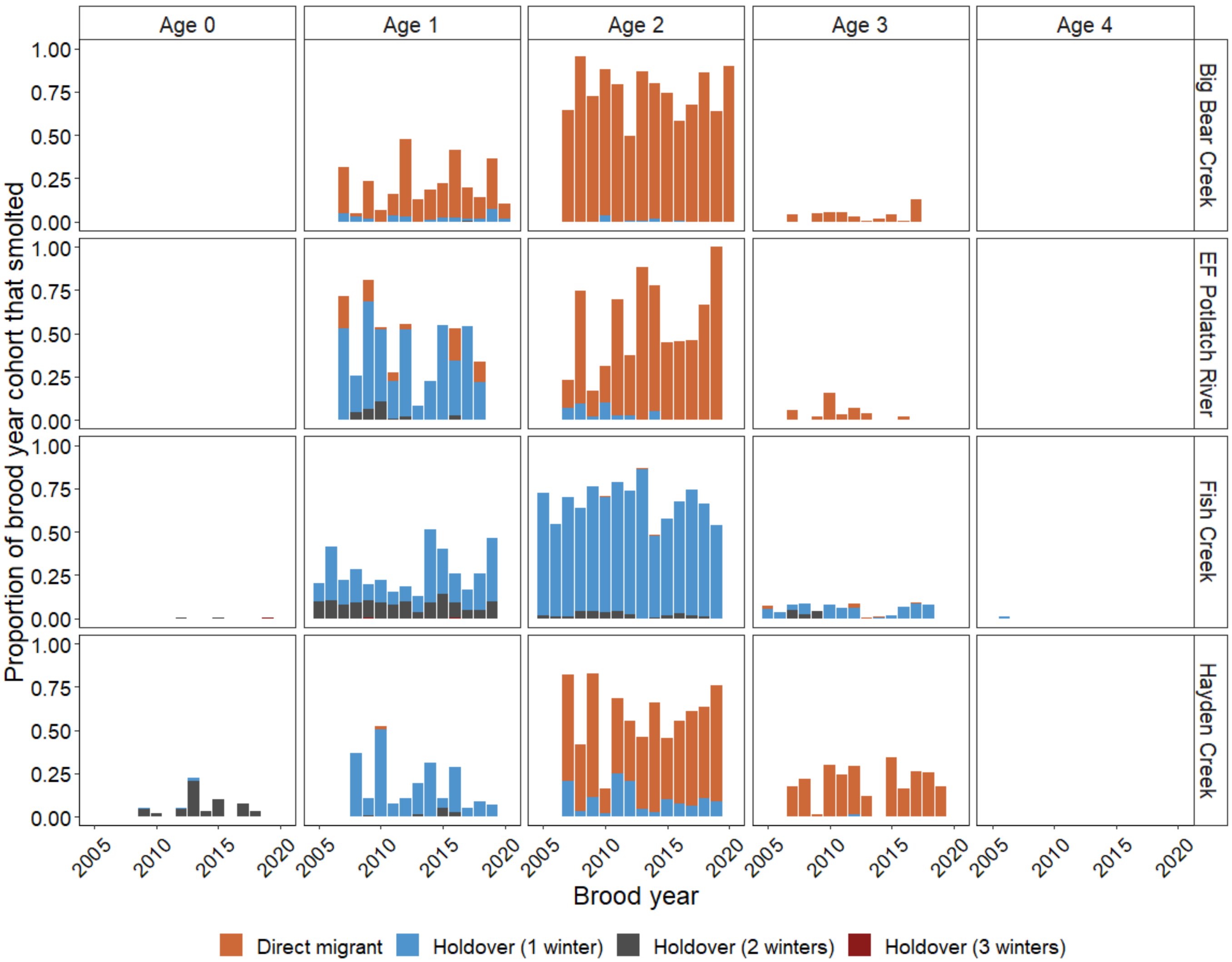

Figure 7. Proportions of brood year cohorts of juvenile steelhead from Big Bear Creek (BY 2007−2020), the East Fork Potlatch River (BY 2007−2019), Fish Creek (BY 2005−2017), and Hayden Creek (BY 2007−2017) that smolted and survived to Lower Granite Dam, partitioned by movement pattern and by age tagged at four rotary screw trap sites.

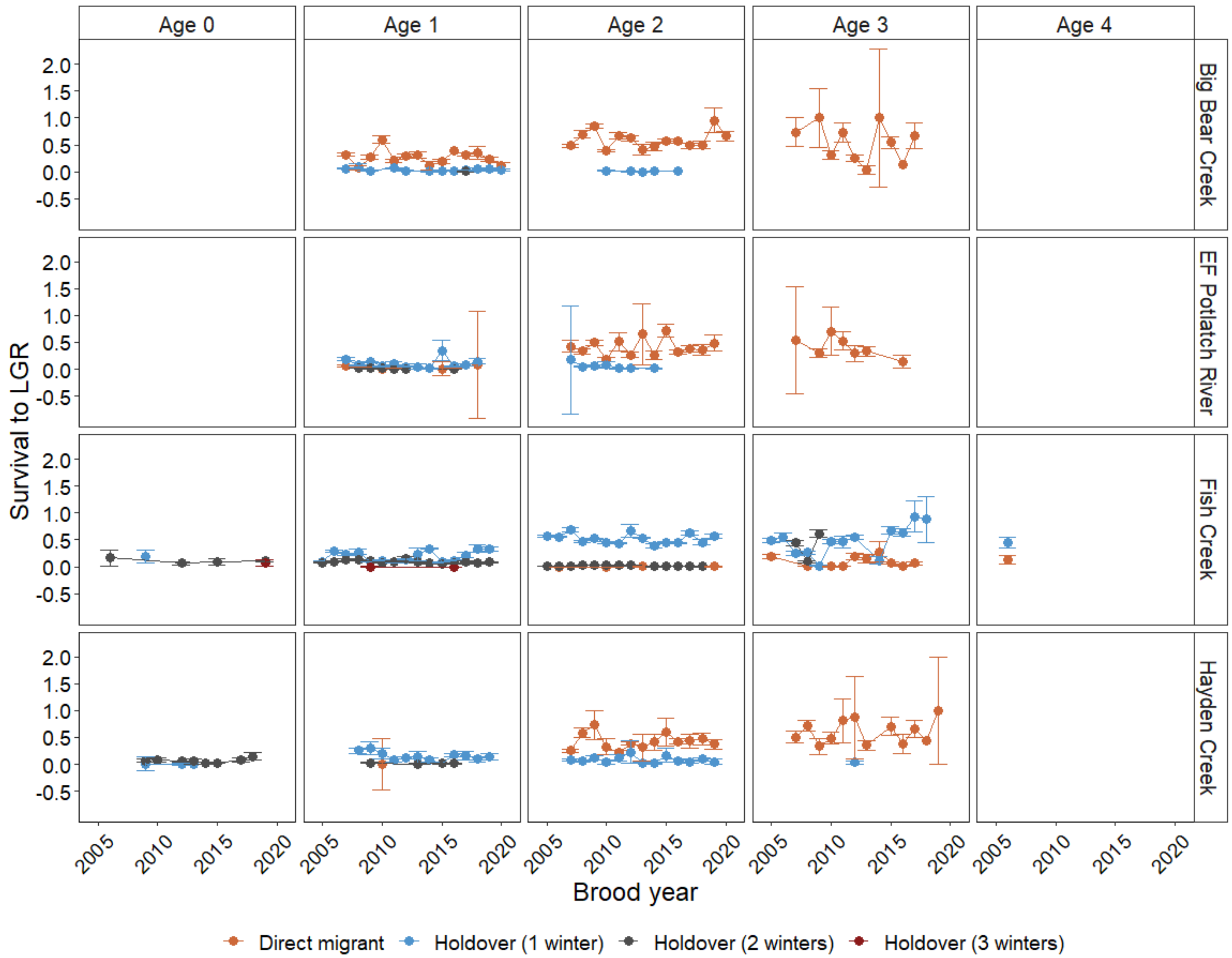

Figure 8. Brood year cohort trends in estimated survival of juvenile steelhead with standard error bars to Lower Granite Dam by movement pattern and by age tagged at four rotary screw trap sites. Estimates span brood years 2007−2020 for Big Bear Creek, 2007−2019 for the East Fork Potlatch River, 2005−2019 for Fish Creek, and 2007−2019 for Hayden Creek.

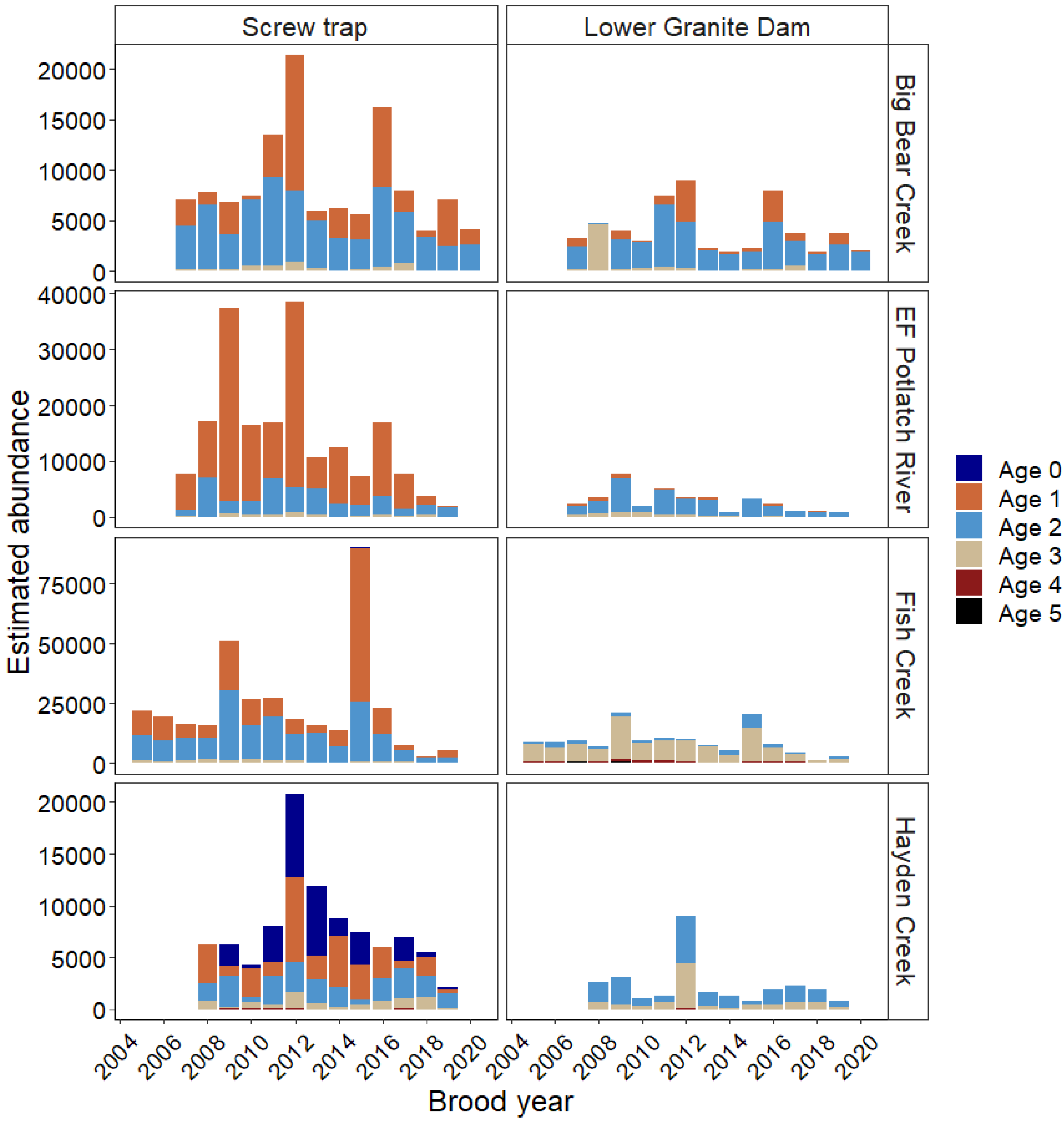

Figure 9. Stacked bars of estimated total brood year cohort abundance of juvenile steelhead by age group at the rotary screw trap of the respective natal tributary watershed and subsequently at Lower Granite Dam. Estimates are presented for fish from Big Bear Creek, EF Potlatch River, Fish Creek, and Hayden Creek.

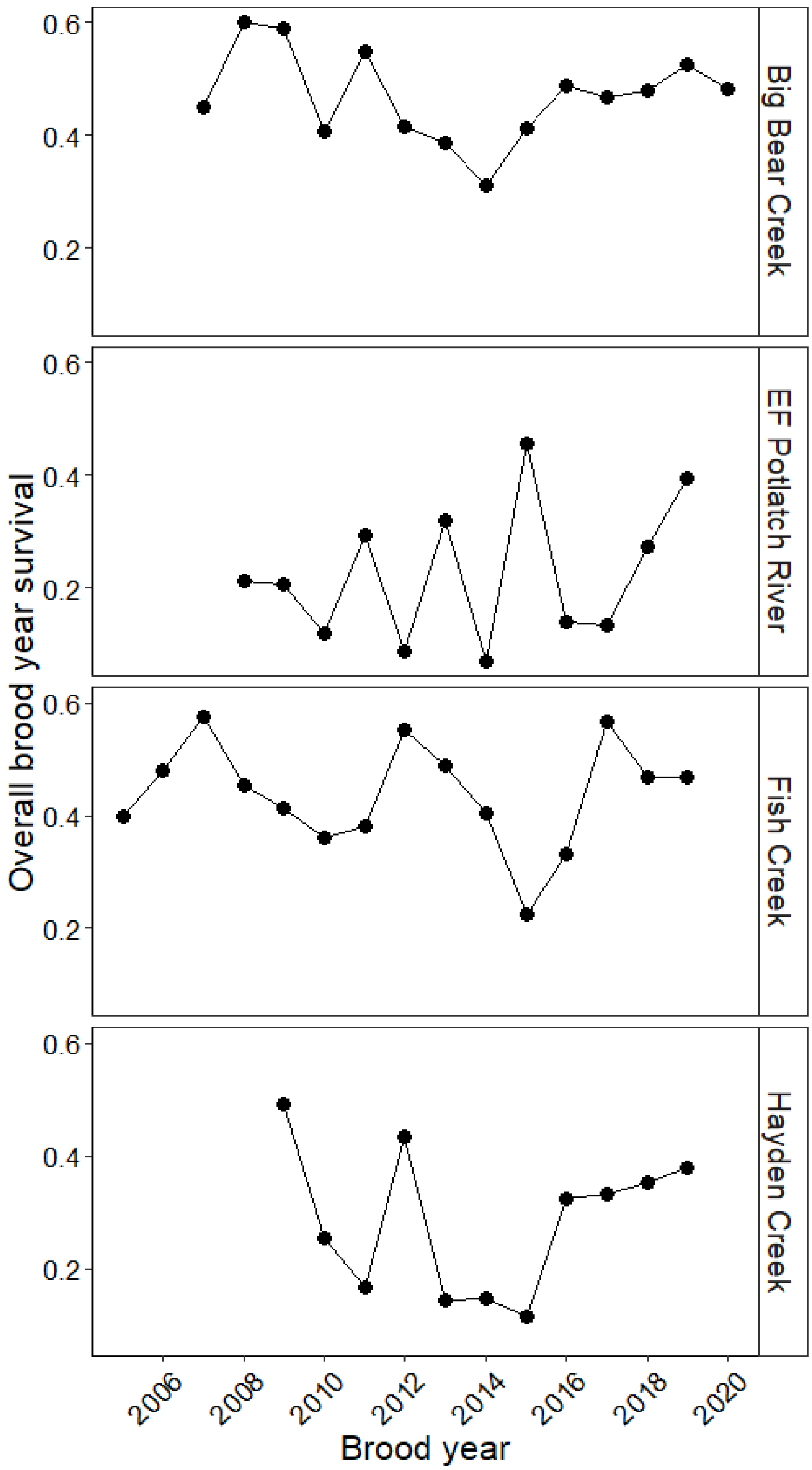

Figure 10. Overall brood year cohort survival of juvenile steelhead from Big Bear Creek, EF Potlatch River, Fish Creek, and Hayden Creek.

APPENDICES

Appendix A. Rotary screw traps operated by Idaho Department of Fish and Game in 2022 to monitor Chinook Salmon and steelhead juvenile emigrants in Idaho. Major population group (MPG) and population for each species are identified. Funding projects include Idaho Salmon and Steelhead Monitoring and Evaluation Studies (ISSMES), and Intensively Monitored Watershed (IMW).

Map reference number	**Trap location (PTAGIS code)**	**Chinook Salmon MPG / *population***	**Steelhead Trout MPG / *population***	**Funding project**	**Years of operation**	**Adult escapement infrastructure**
		Salmon River Basin				
1	Rapid River (RPDTRP)	**South Fork Salmon River /** *Little Salmon River*	**Salmon River /** *Little Salmon River*	ISSMES	2007-2022	Permanent weir
2	Lower South Fork Salmon River (SFSRKT)	**South Fork Salmon River /** *South Fork Salmon River*	**Salmon River** / *South Fork Salmon River*	ISSMES	2015-2022	PIT array
3	Big Creek (BIG2CT)	**Middle Fork Salmon River /** *Big Creek*	**Salmon River** / *Lower Middle Fork Salmon River*	ISMES	2007-2022	PIT array
4	Lower Marsh Creek (MARTR2)	**Middle Fork Salmon River** / *Marsh Creek*	**Salmon River /** *Upper Middle Fork Salmon River*	ISSMESS	2009-2022	None
5	North Fork Salmon River (NFSTRP)	**Upper Salmon River /** *North Fork Salmon River*	**Salmon River /** *North Fork Salmon River*	ISMES	2015-2022	PIT array
6	Lemhi River (LEMTRP)	**Upper Salmon River /** *Lemhi River*	**Salmon River /** *Lemhi River*	IMW	1992-2022	PIT array
7	Lower Lemhi River (LLRTP)	**Upper Salmon River /** *Lemhi River*	**Salmon River /** *Lemhi River*	ISSMES	2013-2022	PIT array
8	Hayden Creek (HYDTRP)	**Upper Salmon River /** *Lemhi River*	**Salmon River /** *Lemhi River*	IMW	2006-2022	PIT array
9	Upper Salmon River (SAWTRP)	**Upper Salmon River /** *Upper Salmon River mainstem*	**Salmon River** / *Upper Salmon River mainstem*	ISSMESS	1992-2022	Permanent weir
10	Pahsimeroi River (PAHTRP)	**Upper Salmon River** / *Pahsimeroi River*	**Salmon River** */ Pahsimeroi River*	ISSMESS	1992-2022	Permanent weir
		Clearwater River Basin				
11	Big Bear Creek (BBCTRP)	**Dry Clearwater River /** *Upper South Fork Clearwater River*	**Clearwater River /** *Lower Clearwater Mainstem*	IMW	2004-2022	PIT array
12	East Fork Potlatch River (EFPTRP)	**Dry Clearwater River /** *Upper South Fork Clearwater River*	**Clearwater River /** *Lower Clearwater Mainstem*	IMW	2007-2022	Seasonal weir
13	Crooked River (CROTRP)	**Dry Clearwater River /** *Upper South Fork Clearwater River*	**Clearwater River /** *South Fork Clearwater River*	ISMES	1990-2022	Seasonal weir
14	Lower Lochsa River (LOCTRP)	**Wet Clearwater River /** *Lochsa River*	**Clearwater River** / *Lochsa River*	ISMES	2015-2022	PIT array
15	Fish Creek (FISTRP)	**Wet Clearwater River /** *Lochsa River*	**Clearwater River** / *Lochsa River*	ISMES	1995-2022	Seasonal weir

Appendix B. Rotary screw trap operations in the Salmon River and Clearwater River basins, Idaho for 2022, with a brief summary of operations and logistical issues that possibly affected estimation of juvenile Chinook Salmon and steelhead emigrants.

Trap Operation			
Location (PTAGIS site code)	**Date range (mm/dd)**	**Total days operated / total days in date range**	**Operation summary and logistical issues**
Salmon River basin			
Rapid River (RPDTRP)	4/24 – 11/3	151.5/193	The trap was installed on 4/13/22 but was not in operation until after the hatchery smolt release in late April. The cone was stopped by large debris on five occasions during high flows and was not operating for 38 days during spring runoff. The trap was removed on 11/3/22.
Lower South Fork Salmon River (SFSRKT)	3/11 – 11/9	115/234	The trap was installed on 3/11/22 but cone was not lowered until 3/13/22 due to ice upstream. Trap was pulled from 3/28/22-4/5/22 due to debris. The trap was shut down for smolt hatchery release 4/11/22-4/20/22. The trap was shut down for spring runoff 4/21/22-7/7/22. Additionally, because personnel were needed for the Chinook fishery, the trap was shut down for 9 days. The trap was nonoperational 7/29/22-8/5/22 and 8/13/22-8/15/22 due to high water temperatures. The cone was pulled on the trap on 11/3/22 due to unsafe weather conditions and officially removed on 11/9/22.
Big Creek (BIG2CT)	3/18-11/7	150.5/235	The trap nonoperational on 3/28, 3/30, and 3/31 due to high water conditions. The trap was shut down for spring runoff 4/25/22-7/13/22. The trap was shut down for 2 days due to high level of debris. The trap was pulled on 11/7/22 for the winter season.
Lower Marsh Creek (MARTR2)	3/20 – 10/28	151.5/223	The trap was installed on 3/19. Freezing conditions made the trap inoperable on four occasions in early spring as well as three occasions in late fall. High flows during spring runoff prevented operation for 64 days. In August, the cone was pulled for 3 days because of personnel scheduling. The trap was removed 10/29/22
North Fork Salmon River (NFSTRP)	03/23-11/14	199/238	The trap was installed on 3/23. The trap was in the water for 238 days. During this time, it was not operational for 25 days in the spring due to high water. Additionally, the trap did not run for 10 days in July due to the Moose Fire and 3 days in November due to ice. The trap was removed on 11/14.

Appendix B. Continued

Trap Operation

Location (PTAGIS site code)	Date range (mm/dd)	Total days operated / total days in date range	Operation summary and logistical issues
Lemhi River Weir (LEMTRP)	03/22 – 11/19	224.5/243	The Upper Lemhi trap was inoperable for 13 day and partially operated for 11 days. The trap did not operate due to high flows requiring maintenance. Partial operations were a result of debris.
Hayden Creek (HYDTRP)	03/22 – 11/3	36/227	The Hayden Trap was inoperable for 185 days and partially operated for 12 days. Partial operations were a result of both debris and high flows. Inoperable periods were the result of extremely low flows in Hayden Creek, leaving the trap to sit on rocks from July to November.
Lower Lemhi River (LLRTP)	03/25 – 11/15	183/236	The Lower Lemhi River trap was inoperable for 39 days and partially operated for 28 days. A majority of those days were during high flows, beaching our trap and resulting in trap maintenance. Low flows occurred in the summer and as a result, the cone was not able to spin for a few days.
Upper Salmon River (SAWTRP)	3/17 – 10/29	199.5/227	The trap was installed on 3/16/22. The cone was pulled for 4 days in April due to the hatchery release of integrated Chinook smolts. The trap fished intermittently for 22 days during spring runoff. In August, the trap was not operated for 2 days due to personnel scheduling. In September, a mink was observed on or near the trap. There was a 2-week period where obvious signs of predation on Chinook parr were observed in the trap box. After several attempts, the mink was trapped and relocated. The trap was removed on 10/29.
Pahsimeroi River (PAHTRP)	03/15-11/29	231/259	The trap was installed on 3/15. The trap was in the water for 259 days. Of this time, the trap was not operated for 23 days in April due to hatchery releases. The trap was found inoperable due to tire damage on 8/26. The trap was also found inoperable for 3 days in October due to a log and had to be replaced with a backup trap. Additionally, the cone was pulled after trap was checked on 11/22 to allow staff to take Thanksgiving Day off, so the trap was not operable 11/23. The trap was removed 11/29.

Appendix B. Continued

Trap Operation

Location (PTAGIS site code)	Date range (mm/dd)	Total days operated / total days in date range	Operation summary and logistical issues
Big Bear Creek (BBCTRP)	3/14-6/9	79/88	The BBCTRP was installed on 3/14/2022 and operated for 79 days. The trap was inoperable for 6 days and partially operated for 3 days in the spring due to low water conditions and available personnel. Trapping operations ceased on 6/9/2022 and no trapping was conducted during the summer and fall.
East Fork Potlatch River (EFPTRP)	3/14-6/5	80/84	The EFPRTRP was installed on 3/14/2022 and operated for 80 days. The trap was inoperable for 1 day and was partially operable for 3 days in the spring due to low water conditions and mechanical failure. Trapping ceased on 6/5/2022 and no trapping was conducted during the summer and fall.
Crooked River (CROTRP)	3/17-11/8	222/237	The CROTRP was installed on 3/17/2022 and operated for 222 days. The trap was inoperable for 15 days and partially operated for 31 days due to high flows/debris loads in the spring and low water conditions in the summer. Trapping ceased on 11/8/2022.
Fish Creek (FISTRP)	03/23-11/04	224/227	The FISTRP was installed on 3/23/2022 and operated for 224 days. The trap did not operate from 5/6/2022 to 5/9/2022 due to high flows/debris loads. Trapping ceased on 11/4/2022.
Lower Lochsa (LOCTRP)	03/15-11/05	188/236	The LOCTRP was installed on 3/15/2023 and operated for 188 days. The trap did not operate for 48 and operated partially for 11 days due to a combination of hatchery releases and high flows/debris loads in the spring, and high temperatures and low flows in the summer.

Appendix C. Seasonal catch of juvenile steelhead <80 mm FL from rotary screw traps operated in streams in Idaho in 2022.

Population, location and PTAGIS site code	Season	Catch
Little Salmon River		
Rapid River	Spring	8
RPDTRP	Sum/Fall	5
South Fork Salmon River		
Lower South Fork Salmon River	Spring	259
SFSRKT	Sum/Fall	1,717
Lower Middle Fork Salmon River		
Big Creek	Spring	49
BIG2CT	Sum/Fall	83
Upper Middle Fork Salmon River		
Lower Marsh Creek	Spring	42
MARTR2	Sum/Fall	52
North Fork Salmon River		
North Fork Salmon River	Spring	120
NFSTRP	Sum/Fall	61
Lemhi River		
Lemhi River	Spring	27
LEMTRP	Sum/Fall	9
Hayden Creek	Spring	90
HYDTRP	Sum/Fall	3
Lower Lemhi River	Spring	4
LLRTP	Sum/Fall	1
Upper Salmon River mainstem		
Upper Salmon River	Spring	158
SAWTRP	Sum/Fall	58
Pahsimeroi River		
Pahsimeroi River	Spring	4
PAHTRP	Sum/Fall	67
South Fork Clearwater River		
Crooked River	Spring	24
CROTRP	Sum/Fall	5
Lower Clearwater Mainstem		
East Fork Potlatch River	Spring	0
EFPTRP	Sum/Fall	NA
Big Bear Creek	Spring	2
BBCTRP	Sum/Fall	NA
Lochsa River		
Fish Creek	Spring	1
FISTRP	Sum/Fall	17
Lower Lochsa River	Spring	11
LOCTRP	Sum/Fall	1

Appendix D. Chinook Salmon abundance and productivity estimates by location and cohort.

Location	Brood year	Abundance at RST	Emigrants per redd/female	Abundance at LGR	Smolts at LGR per redd/female
			Salmon River Basin		
South Fork Salmon	2014	102,681	210	27,314	56
	2015	90,453	245	24,109	65
	2016	178,845	391	48,198	105
	2017	89,419	497	34,393	191
	2018	128,901	448	51,578	179
	2019	146,374	774	57,073	302
	2020	70,364	977	27,007	375
Big Creek	2006	63,442	1,475	7,573	176
	2007	55,885	931	24,469	408
	2008	131,740	1,387	46,867	493
	2009	183,268	1,167	58,509	373
	2010	247,912	1,271	60,485	310
	2011	211,204	943	45,161	202
	2012	129,134	615	28,287	135
	2013	127,661	1,130	33,051	292
	2014	323,649	1,904	74,589	435
	2015	205,194	1,274	59,057	367
	2016	215,345	1,455	51,981	351
	2017	56,476	2,017	24,462	874
	2018	42,461	885	18,346	382
	2019	67,327	3,544	34,817	1,832
	2020	55,545	1,736	26,718	835
Marsh Creek	2010	366,082	1,126	59,733	184
	2011	499,303	1,600	82,888	266
	2012	323,548	1,634	51,029	258
	2013	224,927	1,315	34,638	203
	2014	587,266	1,439	88,978	218
	2015	315,545	1,160	44,014	162
	2016	151,505	670	27,625	121
	2017	60,170	1,114	15,446	281
	2018	128,716	1,030	40,874	327
	2019	46,337	1,103	16,141	384
	2020	156,847	747	42,266	239
North Fork Salmon River	2014	16,199	228	6,002	85
	2015	17,812	262	5,565	82
	2016	27,377	1,141	7,941	331
	2017	2,086	1,043	1,202	601
	2018	15,746	787	5,391	270
	2019	8,362	597	3,026	216
	2020	26,365	1,388	10,751	576
Upper Lemhi River[a]	1991	17,479	318	5,269	96
	1992	11,132	742	3,073	205
	1993	10,428	282	3,983	108

Appendix D. Continued.

Location	Brood year	Abundance at RST	Emigrants per redd/female	Abundance at LGR	Smolts at LGR per redd/female
Lemhi River cont.	1994	1,789	89	814	41
	1995	1,706	190	802	89
	1996	6,790	234	4,071	140
	1997	46,950	939	20,970	419
	1998	12,755	311	5,673	138
	1999	13,654	284	4,573	95
	2000	14,743	159	5,384	58
	2001	46,696	138	13,082	39
	2002	19,424	159	6,667	55
	2003	8,570	121	2,566	36
	2004	10,216	341	3,859	129
	2005	7,743	155	2,730	55
	2006	4,843	127	1,706	45
	2007	4,376	151	1,842	64
	2008	7,035	213	2,224	67
	2009	47,560	523	19,238	211
	2010	23,018	256	10,231	114
	2011	33,951	281	12,047	100
	2012	11,721	143	5,873	72
	2013	20,877	215	9,644	99
	2014	80,386	374	24,842	116
	2015	55,177	361	19,994	131
	2016	34,065	313	6,387	59
	2017	16,381	381	5,758	134
	2018	35,462	394	13,808	153
	2019	20,132	395	8,049	158
	2020	17,672	201	6,927	79
Hayden Creek	2005	3,369	241	1,037	74
	2006	9,110	701	2,650	204
	2007	55,223	1,781	7,026	227
	2008	11,777	1,309	4,617	513
	2009	18,430	1,084	2,847	167
	2010	32,961	891	5,733	155
	2011	20,013	294	5,490	81
	2012	28,039	1,078	3,703	142
	2013	7,860	231	2,172	64
	2014	77,221	1,058	3,895	53
	2015	63,389	409	12,452	80
	2016	43,792	796	6,068	110
	2017	2,315	193	661	55
	2018	8,094	99	1,661	45
	2019	9,802	350	4,057	145
	2020	22,215	673	425	13
Pahsimeroi River[a]	1992[b]	3,227	179	1,053	59
	1993	27,566	452	8,546	140
	1994	8,936	559	4,219	264
	1995	4,270	356	2,641	220
	1996	3,180	227	1,552	111

Appendix D. Continued.

Location	Brood year	Abundance at RST	Emigrants per redd/female	Abundance at LGR	Smolts at LGR per redd/female
Pahsimeroi River cont.	1997	17,793	574	10,131	327
	1998	26,240	673	12,867	330
	1999	19,954	289	7,595	110
	2000	17,288	360	4,715	98
	2001	62,567	372	24,148	144
	2002	42,508	244	14,182	82
	2003	72,724	166	19,754	45
	2004	36,989	147	10,495	42
	2005	79,159	222	23,439	66
	2006	13,255	141	3,063	33
	2007	14,133	196	4,600	64
	2008	22,341	243	8,607	94
	2009	50,896	320	18,696	118
	2010	44,247	301	17,491	119
	2011	51,713	247	16,706	80
	2012	62,148	679	15,368	173
	2013	16,525	223	3,879	52
	2014	70,596	200	22,856	70
	2015	44,166	237	19,323	104
	2016	79,501	365	27,511	126
	2017	16,656	126	7,166	54
	2018	19,109	120	6,346	40
	2019	11,343	222	5,840	115
	2020	26,836	440	8,332	137
Upper Salmon River[a]	1992[b]	3,744	44	1,185	14
	1993	22,705	101	8,470	38
	1994	17,644	504	7,394	211
	1995	NE	NE	NE	NE
	1996	3,804	211	1,976	110
	1997	22,703	631	11,781	327
	1998	35,618	2,375	10,982	732
	1999	17,015	740	5,047	219
	2000	106,597	635	30,291	180
	2001	351,651	727	39,624	82
	2002	441,082	665	48,503	73
	2003	235,254	588	43,650	109
	2004	236,914	887	36,336	136
	2005	295,396	1,588	52,317	281
	2006	135,547	1,059	31,342	245
	2007	80,711	1,261	19,161	299
	2008	94,687	802	20,405	173
	2009	150,729	908	25,506	154
	2010	144,768	766	28,665	152
	2011	153,147	672	26,519	116
	2012	135,031	475	33,463	118
	2013	30,354	416	6,361	87
	2014	57,039	213	9,546	36

Appendix D. Continued.

Location	Brood year	Abundance at RST	Emigrants per redd/female	Abundance at LGR	Smolts at LGR per redd/female
Upper Salmon River cont.	2015	80,286	664	10,441	86
	2016	99,055	461	16,582	77
	2017	52,301	297	13,809	78
	2018	22,829	387	5,028	85
	2019	12,757	395	2,358	98
	2020	16,918	546	3,300	106
	1992	9,922	220	3,382	75
Crooked River[a]	1993	33,448	697	8,648	180
	1994	836	209	262	66
	1995	NE	NE	NE	NE
	1996	6,422	1,284	3,730	746
	1997	12,132	221	4,203	76
	1998	10,887	1,089	2,141	214
	1999	611	611	271	271
	2000	6,470	70	2,503	27
	2001	5,819	67	1,228	14
	2002	6,640	226	1,481	82
	2003	19,955	499	4,886	122
	2004	10,149	597	3,419	201
	2005	2,008	502	703	176
	2006	698	698	218	218
	2007	455	114	255	64
	2008	4,388	169	1,631	63
	2009	3,608	241	2,021	135
	2010	1,944	194	810	81
	2011	2,318	166	816	58
	2012	7,868	NE	1,705	NE
	2013	622	207	NE	NE
	2014	1,857	98	421	22
	2015	11,911	851	2,793	200
	2016	1,704	170	263	26
	2017	305	305	184	184
	2018	2,221	NE	590	NE
	2019	NE	NE	NE	NE
	2020	4,331	NE	2,564	NE

a From 1991 to 1996 smolt traps were not operated during summer periods (June, July, August). Estimates for these years are on the conservative side.

b Smolts only.

Appendix E. Estimated productivity for juvenile steelhead emigrants by cohort, expressed as emigrants at rotary screw trap (RST) per female spawner, for populations with estimates of female spawner abundance in the Salmon River and Clearwater River basins, Idaho. Accounting is incomplete for cohorts with dashes in any age column.

Population and RST location	Cohort	Number of emigrants by age (years)						Sum	Female parents	Productivity
		Age-0	Age-1	Age-2	Age-3	Age-4	Age-5			
				Salmon River MPG						
Little	2007	112	716	1,864	1,628	260	0	4,580	21	218
Salmon	2008	72	478	885	958	216	65	2,675	46	58
River	2009	17	286	1,327	768	725	19	3,142	63	50
	2010	0	448	1,783	1,699	261	0	4,189	116	36
[b]Rapid River	2011	0	774	1,378	955	94	0	3,200	101	32
RPDTRP	2012	23	405	1,561	1,084	60	0	3,134	57	55
	2013	0	579	1,530	478	28	0	2,615	15	174
	2014	9	1,175	1,155	565	132	0	3,036	16	190
	2015	71	1,039	677	1,338	127	0	3,252	54	60
	2016	8	416	800	453	63	6	1,746	13	134
	2017	0	162	265	396	180	19	1,022	8	124
	2018	0	100	362	756	324	--	1,542	5	308
	2019	0	111	646	1,290	--	--	--	8	--
	2020	0	341	1,188	--	--	--	--	8	--
	2021	0	383	--	--	--	--	--	9	--
	2022	0	--	--	--	--	--	--	8	--
South Fork	2012	--	--	--	0	0	0	0	369	--
Salmon River	2013	--	--	277	437	0	0	759	301	--
	2014	--	5,188	1,179	1,221	0	0	7,796	275	--
[a]Lower South	2015	5,049	28,262	10,954	429	170	0	44,864	550	**82**
Fork Salmon	2016	3,919	22,455	6,785	511	175	0	33,845	239	142
River	2017	711	15,202	6,133	2,260	148	0	24,454	163	150
SFSRKT	2018	859	3,918	4,124	488	0	--	9,389	55	170
	2019	454	11,761	3,341	357	--	--	--	45	--
	2020	502	7,457	3,602	--	--	--	--	39	--
	2021	464	11,272	--	--	--	--	--	147	--
	2022	0	--	--	--	--	--	--	132	--
Lower	2010	0	7,604	18,632	6,950	603	0	33,791	688	49
Middle Fork	2011	0	3,316	10,142	5,980	558	0	19,994	443	45
Salmon River	2012	84	14,552	19,328	6,754	244	0	40,962	263	156
	2013	85	13,263	20,761	1,097	211	0	35,418	302	117
[a]Big Creek	2014	0	13,432	9,812	1,603	0	0	24,847	180	138
BIGC2T	2015	0	12,824	6,777	666	98	0	20,365	532	38
	2016	443	4,772	14,701	2,557	0	0	22,473	216	104

Appendix E. Continued

Population and RST location	Cohort	Number of emigrants by age (years)						Sum	Female parents	Productivity
		Age-0	Age-1	Age-2	Age-3	Age-4	Age-5			
	2017	0	4,098	8,179	2,450	120	0	14,847	42	354
	2018	154	7,841	24,258	1,698	0	--	33,951	85	399
Big Creek	2019	195	4,737	5,117	775	--	--	--	56	--
Cont.	2020	0	2,754	14,837	--	--	--	--	62	--
	2021	260	10,961	--	--	--	--	--	85	--
	2022	0	--	--	--	--	--	--	135	--
Upper Salmon River Mainstem	2001	264	9,916	4,316	581	57	0	15,211	24	634
	2002	32	1,780	2,798	563	0	0	5,173	39	133
	2003	17	3,158	1,548	205	13	NE	4,941	16	309
	2004	22	989	955	1,842	NE	0	3,808	7	544
	2005	62	1,000	4,734	NE	0	0	5,796	15	386
[b]Upper Salmon River	2006	0	4,172	NE	48	0	0	4,220	9	469
	2007	128	NE	2,553	344	0	0	3,025	17	178
	2008	NE	1,923	2,817	80	8	0	4,828	7	690
SAWTRP	2009	12	5,054	4,133	304	14	0	9,517	14	680
	2010	13	7,607	3,907	175	0	0	11,703	56	209
	2011	15	4,978	4,092	27	0	0	9,112	64	142
	2012	39	6,278	3,901	333	0	0	10,551	42	251
	2013	0	4,107	3,701	328	0	0	8,137	18	452
	2014	0	8,069	3,997	72	0	0	12,138	17	714
	2015	526	19,544	2,187	377	0	0	22,634	39	580
	2016	1,374	6,540	2,776	807	18	0	11,515	44	262
	2017	436	856	1,631	124	18	0	3,065	18	170
	2018	51	2,175	1,485	183	0	--	3,894	9	433
	2019	46	1,523	1,516	552	--	--	--	8	--
	2020	192	5,120	3,794	--	--	--	--	21	--
	2021	1,803	10,154	--	--	--	--	--	59	--
	2022	267	--	--	--	--	--	--	18	--
[b]Pahsimeroi	2001		23,396	5,188	148	0	0	28,732	77	
River	2002	12,194	17,705	2,429	281	0	0	32,609	225	145
PAHTRP	2003	8,447	8,993	3,448	124	0	0	21,012	124	169
	2004	7,786	10,702	1,584	0	0	0	20,072	33	608
	2005	3,282	5,897	189	151	0	0	9,518	27	353
	2006	3,658	8,044	1,445	77	0	0	13,223	23	575
	2007	5,766	11,467	903	550	0	0	18,686	7	2,669
	2008	5,040	8,139	5,371	453	0	0	19,004	23	826
	2009	2,227	9,879	1,305	0	0	0	13,412	24	559
	2010	1,580	3,410	2,050	666	0	0	7,707	68	113
	2011	202	4,897	6,418	64	0	0	11,581	153	76

Appendix E. Continued

Population and RST location	Cohort	Number of emigrants by age (years) Age-0	Age-1	Age-2	Age-3	Age-4	Age-5	Sum	Female parents	Productivity
	2012	1,224	8,369	2,104	22	0	0	11,719	168	70
	2013	12,085	11,431	1,399	159	0	60	25,135	107	235
	2014	2,533	4,941	1,566	0	0	0	9,040	121	75
	2015	5,524	10,340	680	132	0	0	16,676	76	219
	2016	3,330	6,140	2,114	127	0	8	11,719	57	206
PAHTRP	2017	1,436	6,339	679	73	0	0	8,527	18	474
	2018	1,142	2,614	934	25	22	--	4,737	20	237
	2019	2,281	3,725	686	310	--	--	--	21	--
	2020	1,798	6,512	2,038	--	--	--	--	26	--
	2021	5,543	8,320	--	--	--	--	--	14	--
	2022	3,874	--	--	--	--	--	--	9	--
[a]Lower	2010	0	6,023	NE	218	0	0	6,241	278	22
Lemhi River	2011	0	NE	682	314	0	0	996	228	4
LLRTP	2012	NE	682	2,666	1,176	7	1	4,531	249	18
	2013	0	610	4,819	93	15	22	5,558	226	25
	2014	0	11,181	4,904	209	33	0	16,327	181	90
	2015	1,884	7,600	1,798	929	141	0	12,352	249	50
	2016	260	4,219	3,705	2,407	73	--	10,664	190	56
	2017	246	3,799	4,925	202	175	0	9,347	123	76
	2018	99	5,898	1,785	2,261	194	--	10,237	74	138
	2019	309	4,960	6,719	2,213	--	--	--	48	--
	2020	0	4,591	6,106	--	--	--	--	86	--
	2021	0	2,398	--	--	--	--	--	77	--
	2022	0	--	--	--	--	--	--	38	--
[a]Upper	2010	388	8,600	1,732	125	47	0	10,892	9	1,155
Lemhi River	2011	89	9,202	1,270	198	21	0	10,780	56	192
LEMTRP	2012	782	8,689	2,200	213	41	0	11,925	26	453
	2013	683	7,199	2,401	807	0	0	11,090	52	215
	2014	522	17,677	5,407	51	0	0	23,657	12	1,916
	2015	1,284	13,390	1,138	204	0	0	16,015	26	**607**
	2016	0	11,119	882	142	12	0	12,155	31	388
	2017	725	6,852	1,204	76	0	0	8,857	16	554
	2018	611	5,091	717	185	0	--	6,604	12	573
	2019	388	6,675	1,415	92	--	--	--	6	--
	2020	0	21,045	991	--	--	--	--	6	--
	2021	304	14,299	--	--	--	--	--	7	--
	2022	0	--	--	--	--	--	--	0	--

Appendix E. Continued

Population and RST location	Cohort	Number of emigrants by age (years)							Female	
		Age-0	Age-1	Age-2	Age-3	Age-4	Age-5	Sum	parents	Productivity
				Clearwater River MPG						
Lower	2006	1	2,450	3,286	903	0	0	6,640	20	332
Clearwater	2007	0	2,109	4,383	205	0	0	6,697	69	97
River	2008	23	1,266	6,621	175	0	0	8,085	44	182
Mainstem	2009	3	3,264	3,452	279	0	0	6,998	61	114
[b]Big Bear	2010	5	209	6,548	1,049	0	0	7,811	150	52
Creek	2011	0	4,224	11,109	338	0	0	15,671	66	238
	2012	4	10,526	4,530	932	0	0	15,992	217	74
BBCTRP	2013	1	608	4,880	213	0	0	5,702	73	78
Cont.	2014	0	2,742	3,388	73	0	0	6,203	163	38
	2015	0	4,224	3,242	139	0	0	7,605	61	124
	2016	61	7,613	6,788	533	42	0	15,037	64	237
	2017	0	3,256	4,890	625	23	0	8,794	16	538
	2018(c)	0	726	3,377	45	0	--	4,148	15	271
	2019(c)	0	4,544	2,325	19	--	--	--	5	--
	2020(c)	0	1,512	3,093	--	--	--	--	8	--
	2021(c)	0	57	--	--	--	--	--	8	--
	2022(c)	0	--	--	--	--	--	--	135	--
[b]East Fork	2008	140	9,525	7,230	0	0	0	16,895	46	368
Potlatch	2009	0	22,018	4,366	666	0	0	27,050	46	588
River	2010	550	9,959	2,785	694	0	0	13,987	55	257
EFPTRP	2011(a)	0	9,138	6,242	393	0	0	15,773	21	765
	2012	258	33,289	4,515	1,020	0	0	39,082	53	732
	2013	0	5,628	5,006	379	0	0	11,013	48	231
	2014	0	9,456	3,296	0	0	0	12,752	45	282
	2015	0	5,538	2,937	107	0	0	8,583	59	145
	2016	206	12,273	3,547	326	0	0	16,353	54	301
	2017	0	6,127	1,468	62	17	0	7,674	8	959
	2018	0	1,305	570	428	0	--	2,303	10	233
	2019	0	1,552	1,626	164	--	--	--	2	--
	2020	0	684	866	--	--	--	--	10	--
	2021	0	35	--	--	--	--	--	13	--
	2022	0	--	--	--	--	--	--	2	--
South Fork	2007	0	131	827	376	144	0	1,479	8	193
Clearwater	2008	0	54	115	291	30	0	490	1	454
River	2009	0	0	93	125	9	0	226	0	--
[b]Crooked	2010	0	1,024	1,751	1,026	9	0	3,810	4	906
River	2011	0	82	1,283	387	0	0	1,753	0	--
CROTRP	2012	5	993	832	0	0	0	1,829	3	610

Appendix E. Continued

Population and RST location	Cohort	Number of emigrants by age (years) Age-0	Age-1	Age-2	Age-3	Age-4	Age-5	Sum	Female parents	Productivity
	2013	0	0	0	7	0	0	7	1	6
CROTRP	2014	0	0	87	26	0	0	112	0	--
Cont.	2015	0	1,455	343	0	8	0	1,806	4	452
	2016	0	290	0	48	0	0	338	1	372
	2017	0	0	144	30	1	0	175	0	--
	2018	0	82	427	10	3	--	522	0	--
	2019	0	213	20	26	--	--		0	--
	2020[d]	0	1	197	--	--	--	--	0	--
	2021	0	592	--	--	--	--	--	0	--
	2022	0	--	--	--	--	--	--	2	--
Lochsa	1996	0	5,286	6,869	843	20	0	13,019	24	534
River	1997	57	4,974	8,928	624	88	0	14,672	18	819
	1998	0	10,713	10,962	2,932	0	0	24,607	52	474
[b]Fish Creek	1999	99	8,582	15,847	600	0	0	25,128	60	418
FISTRP	2000	137	8,466	4,484	1,189	0	0	14,275	20	711
	2001	239	7,661	15,114	1,050	0	0	24,064	56	428
	2002	0	13,501	15,288	4,265	0	0	33,054	153	217
	2003	340	14,030	23,945	2,449	116	0	40,879	242	169
	2004	241	23,094	14,091	2,080	70	0	39,576	125	317
	2005	492	9,022	12,148	1,295	0	0	22,957	82	280
	2006	65	9,236	9,227	853	156	0	19,539	69	283
	2007	57	4,553	8,107	1,418	0	0	14,135	49	287
	2008	0	4,883	11,808	288	0	0	16,979	55	308
	2009	47	16,006	29,647	1,739	104	0	47,544	141	336
	2010	0	16,982	16,280	2,426	0	0	35,688	132	269
	2011	0	7,723	23,653	1,147	43	0	32,565	357	91
	2012	70	7,624	10,895	962	435	0	19,986	124	162
	2013	0	3,441	9,765	597	0	0	13,803	65	211
	2014	0	8,735	5,661	487	0	0	14,884	38	387
	2015	93	70,461	25,307	260	33	0	96,155	349	**276**
	2016	0	12,654	9,259	802	39	0	22,753	142	161
	2017	122	2,380	5,060	401	0	0	7,962	58	138
	2018	37	868	2,567	204	0	--	3,677	8	460
	2019	100	2,414	2,852	103	--	--	--	40	--
	2020	0	1,846	4,172	--	--	--	--	10	--
	2021	25	6,517	--	--	--	--	--	74	--
	2022	34	--	--	--	--	--	--		--

[a] Adult estimate from PIT array using DABOM model.
[b] Estimate from weir escapement.
[c] Low abundance so DABOM was not used. Minimum expanded estimate based on detections at Lower Granite.
[d] Weir was not in for most of the season.

Appendix F. Steelhead abundance and productivity estimates by cohort at rotary screw traps and LGR for the Salmon River and Clearwater River drainages, Idaho.

Major Population Group	Site location and PTAGIS code of RST	Brood year	Emigrant abundance at RST	Emigrants per female spawner	Survival rate to LGR (SE)	Smolt abundance at LGR	Smolts per female spawner
Clearwater River							
	Big Bear Creek	2007	7,033	102	0.450	3,164	46
	BBCTRP	2008	7,809	176	0.601	4,697	106
		2009	6,820	111	0.589	4,018	66
		2010	7,380	49	0.405	2,991	20
		2011	13,454	204	0.550	7,398	112
		2012	21,356	99	0.415	8,863	41
		2013	5,879	80	0.385	2,263	31
		2014	6,147	38	0.312	1,917	12
		2015	5,513	90	0.413	2,277	37
		2016	16,249	256	0.489	7,950	125
		2017	7,962	487	0.466	3,711	227
		2018	3,994	315	0.478	1,909	151
		2019	7,022	1,221	0.525	3,686	641
		2020	4,086	564	0.482	1,968	271
	East Fork Potlatch River	2007	7,715	NA	0.307	2,370	NA
	EFPTRP	2008	17,086	372	0.211	3,605	78
		2009	37,506	18,753	0.206	7,744	3,872
		2010	16,510	365	0.120	1,989	44
		2011	16,872	367	0.295	4,971	108
		2012	38,611	723	0.089	3,439	64
		2013	10,699	1,081	0.319	3,413	345
		2014	12,468	210	0.071	887	15
		2015	7,325	154	0.455	3,336	70
		2016	16,810	309	0.141	2,378	44
		2017	7,792	378	0.135	1,053	51
		2018	3,635	454	0.274	997	125
		2019	2,042	37	0.394	805	15
		2020	1,587	167	NA	NA	NA
	Fish Creek	2005	21,960	268	0.398	8,733	107
	FISTRP	2006	19,220	279	0.481	9,240	134
		2007	16,334	332	0.576	9,416	191
		2008	15,545	282	0.455	7,077	128
		2009	51,132	362	0.414	21,184	150
		2010	26,803	202	0.362	9,703	73
		2011	27,387	77	0.381	10,422	29
		2012	18,624	151	0.552	10,280	83
		2013	15,631	239	0.488	7,625	116
		2014	13,648	355	0.404	5,510	143
		2015	90,224	259	0.225	20,275	58
		2016	23,268	164	0.333	7,739	55

Appendix F Continued.

Major Population Group	Site location and PTAGIS code of RST	Brood year	Emigrant abundance at RST	Emigrants per female spawner	Survival rate to LGR (SE)	Smolt abundance at LGR	Smolts per female spawner
		2017	7,468	132	0.567	4,235	74
		2018	2,933	367	0.468	1,372	172
		2019	5,254	132	0.469	2,464	62
Salmon River							
	Hayden Creek	2009	6,252	NA	0.491	3,067	NA
	HYDTRP	2010	4,259	122	0.253	1,078	31
		2011	7,986	587	0.168	1,341	99
		2012	20,798	466	0.433	9,001	202
		2013	11,926	268	0.144	1,713	39
		2014	8,746	297	0.147	1,285	44
		2015	7,390	246	0.116	861	29
		2016	5,975	137	0.324	1,935	44
		2017	6,896	222	0.332	2,292	74
		2018	5,454	485	0.352	1,922	171
		2019	2,084	379	0.380	792	144

Appendix G. Plan for operation of rotary screw traps by Idaho Department of Fish and Game (IDFG) in 2022.

2022 Plan for IDFG Screw Traps and Biosampling Adult Steelhead and Chinook Salmon Released at Weirs

Brett Bowersox, Luciano Chiaramonte, Tim Copeland, Jeff DiLuccia, Jordan Messner, and Greg Schoby IDFG

The following plan was initially drafted in 2014 to facilitate the ISS project closeout, transfer equipment to other projects, prepare 2015 budgets for Bonneville Power Administration, and complete NOAA 4(d) Research Permit applications. Here it is updated for 2022. The plan describes IDFG screw trapping and biosampling of adult steelhead and Chinook Salmon released at hatchery and research weirs. Operation of screw traps and weirs forms the basis for “Fish-in and Fish-out” population monitoring designed to track population level abundance and productivity and fish response to habitat improvement projects. Starting in 2018, all hatchery weirs have been permitted under Hatchery and Genetic Management Plans (HGMPs). Sampling at IDFG research weirs and screw traps (outside the Smolt Monitoring Project (SMP) /Comparative Survival Study (CSS) traps and those covered in the HGMPs) in tributaries of the Clearwater River and Salmon River basins will be conducted under separate 4(d) permits. The Sawtooth screw trap (SAWTRP) and Lemhi River weir will operate under separate Section 10 permits. General contracting and permitting deadlines are as follows: BPA contracting due 9/30/20 and NOAA Section 4(d) permitting applications due 10/6/20.

The contracts and operations plan for IDFG screw traps is part of the closeout of ISS and transfer of most traps to other BPA projects that started in 2015 (Table 1; Figures 1 and 2 in report). Additional screw traps are operated by the Potlatch and Lemhi IMW projects. IDFG trap operators include Brian Knoth (Potlatch IMW), Stacey Meyer (Lemhi IMW), and Scott Putnam (Idaho SMP/CSS) as well as Idaho Salmon and Steelhead Monitoring and Evaluation Studies (ISSMES) staff from Nampa Research and Regions 2, 3M, and 7 as indicated. Outside the SMP/CSS traps, sampling at screw traps will include collecting scales for ageing wild steelhead; tissue samples for genetics will not be collected from any species. Outside the SMP/CSS traps, trap operators will be responsible to provide estimates of abundance and survival to Lower Granite Dam for each species at each screw trap.

The IDFG weir biosampling plan refers to sampling wild or integrated hatchery steelhead and Chinook Salmon adults trapped and released at hatchery or research weirs (Table 2; Figures 1 and 2). Sampling adults released at weirs will include collecting scales from wild steelhead for aging but not from Chinook Salmon. Tissue samples for genetics will be collected from all anadromous fish released at the weir. A comprehensive sampling checklist is provided for all Chinook Salmon trapped at IDFG hatchery weirs (Table 3).

Table 1. IDFG plan for rotary screw trap operations during 2022.

Map #	Trap and PTAGIS site code	Subbasin	NOAA juvenile permit	Migratory year 2022 status	Calendar year 2022 contract and operator	Screw trap comments
IDFG Wild Salmon & Steelhead Projects (ISSMES)						
9	Sawtooth (SAWTRP)	Upper Salmon	10-2022-#1124-6R	OPERATE	ISSMES-Jake Ruthven	
10	Pahsimeroi River (PAHTRP)	Upper Salmon	4d-2022-#26047	OPERATE	ISSMES-Megan Heller	
5	North Fork Salmon River (NFSTRP)	Upper Salmon	4d-2022-#26047	OPERATE	ISSMES- Megan Heller	
4	Marsh Creek Lower (MARTR2)	MF Salmon	4d-2022-#26047	OPERATE	ISSMES-Eli Felts	
3	Big Creek (BIG2CT)	MF Salmon	4d-2022-#26047	OPERATE	ISSMES-Amber Young	
2	Krassel (SFSRKT)	SF Salmon	4d-2022-#26047	OPERATE	ISSMES-Amber Young	
1	Rapid River (RPDTRP)	Lower Salmon	4d-2022-#26047	OPERATE	ISSMES-Alexa Ballinger	
15	Fish Creek (FISTRP)	Lochsa	4d-2022-#26112	OPERATE	ISSMES-Nolan Smith	
14	Lochsa River Lower (LOCTRP)	Lochsa	4d-2022-#26112	OPERATE	ISSMES-Nolan Smith	
13	Crooked River (CROTRP)	SF Clearwater	4d-2022-#26112	OPERATE	ISSMES-Brian Knoth	Steelhead monitoring, CSS PIT-tagging, habitat evaluation
IDFG Potlatch Project (IMW)						
11	Big Bear Creek (BBCTRP)	Lower Clearwater	4d-2022-#26112	OPERATE	Potlatch IMW-Brian Knoth	
12	East Fork Potlatch River (EFPTRP)	Lower Clearwater	4d-2022-#26112	OPERATE	Potlatch IMW-Brian Knoth	
IDFG Lemhi Projects (IMW)						
6	Lemhi River Upper (LEMTRP)	Upper Salmon	4d-2022-#26122	OPERATE	Lemhi IMW-Stacey Meyer	
8	Hayden Creek (HYDTRP)	Upper Salmon	4d-2022-#26122	OPERATE	Lemhi IMW-Stacey Meyer	
7, 22	Lemhi River Lower (LLRTP)	Upper Salmon	4d-2022-#26122	OPERATE	Lemhi IMW-Stacey Meyer	
IDFG Smolt Monitoring Project (SMP/CSS)						
17	White Bird (SALTRP) [a]	Lower Salmon	03-23-FPC-47	OPERATE	Idaho SMP/CSS-Scott Putnam	Permitted (LOD) through FPC
18	Lewiston (SNKTRP) [a]	Lower Snake	03-23-FPC-47	OPERATE	Idaho SMP/CSS-Scott Putnam	Permitted (LOD) through FPC

[a] White Bird and Lewiston are scoop and dipper traps, respectively, and not rotary screw traps.

Table 2. Plan for contracts and operations of IDFG adult weirs relative to sampling wild and integrated fish released at each weir in 2022. Scale and genetics sampling for steelhead and Chinook Salmon are indicated.

	Wild and Integrated Adult Sampling at Hatchery and Research Weirs							
	Steelhead				**Spring-Summer Chinook Salmon**			
IDFG adult weir (map #)	**Collect scale sample**	**Collect genetic sample**	**NOAA adult permit**	**2022 Contract & operator**	**Collect scale sample**	**Collect genetic sample**	**NOAA adult permit**	**2022 Contract & operator**
Sawtooth (9)	Yes	Yes	HGMP	ISSMES-Sawtooth FH	No	Yes	HGMP	INPMEP-Sawtooth FH
EFSR (19)	Yes[a]	Yes	HGMP	Shoshone-Bannock Tribes	N/A[b]	N/A[b]	N/A[b]	N/A[b]
Pahsimeroi (10)	Yes	Yes	HGMP	ISSMES-Pahsimeroi FH	No	Yes	HGMP	INPMEP-Pahsimeroi FH
Lemhi River (22)	N/A[c]	N/A[c]	N/A[c]	Lemhi IMW-Stacey Meyer	No[c]	Yes[c]	N/A	Lemhi IMW-Stacey Meyer
Hayden Creek (8)	N/A[c]	N/A[c]	N/A[c]	Lemhi IMW-Stacey Meyer	N/A[c]	N/A[c]	4d-2022-#26122	Lemhi IMW-Stacey Meyer
Bear Valley Creek (34)	N/A[c]	N/A[c]	N/A[c]	Lemhi IMW-Stacey Meyer	N/A[c]	N/A[c]	4d-2022-#26122	Lemhi IMW-Stacey Meyer
Twelve Mile Creek (25)	Yes	Yes	4d-2022-#26047	Region 7-Megan Heller	N/A	N/A	N/A	N/A
Poison Creek (26)	Yes	Yes	4d-2022-#26047	Region 7-Megan Heller	N/A	N/A	N/A	N/A
Carmen Creek (27)	Yes	Yes	4d-2022-#26047	Region 7-Megan Heller	N/A	N/A	N/A	N/A
Tower Creek (28)	Yes	Yes	4d-2022-#26047	Region 7-Megan Heller	N/A	N/A	N/A	N/A
Fourth of July Creek (29)	Yes	Yes	4d-2022-#26047	Region 7-Megan Heller	N/A	N/A	N/A	N/A
Iron Creek (30)	Yes	Yes	4d-2022-#26047	Region 7-Megan Heller	N/A	N/A	N/A	N/A
Cow Creek (33)	Yes	Yes	4d-2022-#26047	Region 7-Megan Heller	N/A	N/A	N/A	Not operated
Challis Creek (31)	Yes	Yes	4d-2022-#26047	Region 7-Megan Heller	N/A	N/A	N/A	Not operated
Morgan Creek (32)	Yes	Yes	4d-2022-#26047	Region 7-Megan Heller	N/A	N/A	N/A	Not operated
McCall SFSR (20)	Yes[d]	Yes[d]	HGMP	ISMES-Josh Poole	No	Yes	HGMP	ISSMES-McCall FH
Rapid River (1)	Yes[d]	Yes[d]	HGMP	ISSMES-Vacant	No	Yes	HGMP	ISSMES-Rapid River FH
Hells Canyon Oxbow (24)	Yes	Yes	HGMP	ISSMES-Oxbow FH	No	Yes	HGMP	ISSMES-Oxbow FH
Powell (21)	N/A[d]	N/A[d]	N/A	N/A	No	Yes	N/A[e]	ISSMES-Clearwater FH
Fish Creek (15)	Yes	Yes	4d-2022-#26112	ISSMES-Nolan Smith	No	Yes	N/A[e]	ISSMES-Marika Dobos
Red River (23)	N/A[d]	N/A[d]	N/A	N/A	No	Yes	N/A[e]	ISSMES-Clearwater FH
Crooked River (13)	Yes[d]	Yes[d]	4d-2022-#26112	ISSMES-Brian Knoth	No	Yes	N/A[e]	ISSMES-Clearwater FH
EF Potlatch River (12)	Yes	Yes	4d-2022-#26112	Potlatch IMW-Brian Knoth	No	Yes	N/A[e]	Potlatch IMW-Brian Knoth

[a] EFSR steelhead scales should be collected from all wild fish trapped; scales not needed from hatchery fish.
[b] EFSR hatchery rack not generally operated for Chinook broodstock collection; 2014 last year of biosampling for Captive Chinook project.
[c] Lemhi River weir has not been ran since 2017. The weir was not a full escapement weir, anticipated capture was roughly half of the total return; Hayden and Bear Valley Creek weirs are operated for bull trout in September, anticipate Chinook incidental catch.
[d] Hatchery rack not generally operated for steelhead broodstock collection; opportunistic biosamples at McCall SFSR.
[e] Spring/summer Chinook are not listed in the Clearwater drainage and sampling them does not require a NOAA permit.

Table 3. Checklist for Chinook Salmon at IDFG hatchery weirs.

	CHINOOK SALMON AT IDFG HATCHERY WEIRS					
To Do: (see footnotes below for why)	**TRAPPED - Record length, sex, marks and tags from all fish trapped**	**POND MORTS, GIVEAWAYS, OUTPLANTS - Record data according to weir protocols**	**SPAWNED MORTS**			
	RELEASED ABOVE WEIR Ad Intact (UNM), with or without CWT		BROOD Ad Intact (UNM), without CWT	BROOD Ad Intact (UNM), with CWT	BROOD Ad Clip, with CWT	BROOD Ad Clip, without CWT
(1) Opercle punch (OP)	ALL	Recycled (different OP than released above weir)				
(2) Collect tissue sample	ALL	UNM (and IBS at Sawtooth, Pahsimeroi, and SF Salmon/McCall)	ALL	ALL	ALL	ALL
(3) Collect dorsal fin ray sample			ALL			
(4) Collect snout		20 JACKS (CWT lab request)				
(5) Collect snout AND dorsal fin ray sample				30 KNOWN AGE - 10 FROM EACH AGE GROUP TO BE PAIRED WITH CWT SAMPLE (based on standard length cut-offs, hatchery defined). Can also be collected from pond morts or giveaways to achieve desired sample size.		
(6) Collect scale sample						

(1) Opercle punches are needed for any fish released above the weir to enable mark/recapture estimates of weir efficiency and total spawner abundance. Recycled fish are punched on the opposite opercle to distinguish them from newly arrived fish returning to the weir.

(2) Fin clip tissue samples are used to establish parentage based tagging (PBT) genetic baselines for hatchery fish. They are also used to age and assign returning fish to their appropriate parents and to their hatchery stock of origin or release group. Tissue samples from wild fish are used to derive genetic diversity information.

(3) Dorsal fin ray samples are used to assign age to returning fish. They should not be collected from live fish, only morts or carcasses. Both wild and hatchery Chinook can be aged using these samples. Fin rays are not commonly used to age steelhead or sockeye.

(4) Snouts are collected from a sample of fish that have a coded wire tag (CWT). These tags are used to assign hatchery stock of origin, release group, and age. These can be collected from spawned broodstock, pond morts, or giveaways.

(5) Snouts are collected from a sample of fish that have a coded wire tag (CWT). These tags are used to assign hatchery stock of origin, release group, and age. When paired with a fin ray sample, these tagged fish are used for fin ray age validation since their absolute age is known from the CWT. These can be collected from spawned broodstock, pond morts, or giveaways.

(6) Scale samples are used to assign age to returning fish. They should not be collected from Chinook at hatchery weirs or on the spawning grounds due to their degraded condition. Scale samples should be collected from wild steelhead returning to and passed above the weir. In general throughout Idaho, only wild and not hatchery steelhead can be accurately aged using scales.

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