FISHERY RESEARCH

IDAHO ANADROMOUS EMIGRANT MONITORING

2019 ANNUAL REPORT

Photo: Lexie Tate, IDFG

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ABBREVIATIONS AND ACRONYMS

Abbreviation	Definition
BY	Brood Year
DPS	Distinct Population Segment
ESA	Endangered Species Act
ESU	Evolutionarily Significant Unit
ICTRT	Interior Columbia (River Basin) Technical Recovery Team
IDFG	Idaho Department of Fish and Game
LGR	Lower Granite Dam
MPG	Major Population Group
PIT	Passive Integrated Transponder
RST	Rotary Screw Trap(s)

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CHAPTER 1

ANADROMOUS EMIGRANT MONITORING IN IDAHO USING ROTARY SCREW TRAPS

ABSTRACT

During 2019, Idaho Department of Fish and Game monitored emigration of wild juvenile Chinook Salmon and steelhead at ten rotary screw traps in the Salmon River basin and five in the Clearwater River basin. Estimated abundance of Chinook Salmon emigrants varied from 8,212 to 128,607 fish in the Salmon basin (n = 9 traps) and was 2,526 fish at Crooked River trap, the only trap in the Clearwater River basin where an estimate for Chinook Salmon was possible. Estimated abundance of Chinook Salmon for the BY2017 cohort (trapped during 2018 and spring 2019) varied from 2,086 to 8,949 fish in the Salmon River basin (n = 9 traps) and was 305 fish at the Crooked River trap. Estimated abundance of steelhead emigrants in 2019 varied from 944 to 18,870 fish in the Salmon River basin (n = 9 traps) and from 283 to 6,864 fish in the Clearwater River basin (n = 4 traps). For both species, emigrant estimates are paired with adult spawner estimates. We present adult-to-juvenile productivity for both species where data were available. Estimated adult-to-juvenile productivity of Chinook Salmon at trapping locations for BY2017 varied from 126 to 2,567 emigrants per female spawner in the Salmon River basin (n = 10 traps) and 306 emigrants per female spawner at Crooked River. Chinook productivity of smolts to Lower Granite Dam for BY2017 varied from 51 to 1,112 smolts per female spawner from the Salmon River basin (n = 10 traps) and 184 smolts per female spawner from Crooked River. Steelhead productivity at trapping locations from BY2014 varied from 0 to 714 emigrants per female in the Salmon River basin (n = 6 traps) and from 0 to 501 emigrants per female in the Clearwater River basin (n = 4 traps). Differences in productivity among populations within major population groups as well as differences among major population groups was observed along with density dependence, with fewer juveniles per female surviving as female abundance increased. The pairing of adult and juvenile abundance data provided insight into the variation in habitat and stock characteristics for Chinook Salmon and steelhead trout populations throughout Idaho. Information gathered helps support recreational fisheries and guides the implementation of future habitat restoration projects.

INTRODUCTION

Chinook Salmon *Oncorhynchus tshawytscha* and steelhead *O. mykiss,* the anadromous form of Rainbow Trout, in the Snake River basin declined substantially 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 started increasing slightly in the early 1980s (Busby et al. 1996), and noticeably increased again starting in 2000 while the returns of naturally produced Chinook Salmon and steelhead remained critically low. Recent years have documented substantial declines in abundance to levels similar to the mid-1990s. 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.

Within the Snake River spring-summer Chinook Salmon evolutionarily significant unit (ESU), there are seven major population groups (MPGs): Lower Snake River, Grande Ronde/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. A total of 28 extant demographically independent populations have been identified in the ESU.

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 (ICTRT 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 to 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 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 (ICTRT 2003).

Idaho Department of Fish and Game (IDFG) 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). However, 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 or traps) have been the primary tool used by IDFG since the early 1990s to address the following objectives: 1) estimation of juvenile 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 and 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 (the draft 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. 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 locations, providing us the opportunity to monitor both supplemented and non-supplemented populations.

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.

We have three 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, and 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). Additionally, we include recently developed methods to estimate survival of juvenile steelhead to LGR with a case study using data from Big Bear Creek, a tributary to the Potlatch River. Due to the complexities of steelhead early life history, this is the first example in which this survival parameter is reported for a steelhead population in the Snake River basin.

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. Eight dams lie between Idaho and the Pacific Ocean including four Snake River dams and four Columbia River dams. 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. In the Clearwater River basin, 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 (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). Traps were located to sample emigration from selected populations for either or both species. Details about trap coverage are given in Appendix A.

METHODS

Rotary Screw Trap Operations and Sampling Process

Methods applied to operate traps, 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. A RST manual is currently in development that will outline these methods in detail and will be used as a reference for future reports (Copeland et al. *in preparation*). We anticipate the manual to be complete prior to the next annual report.

Traps are operated as much of the year as possible and operation is generally discontinued only when conditions jeopardize safety of personnel, fish, or the trap. While some low elevation traps 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. Trap operations in some Clearwater River basin streams are routinely unable to operate past June, limited by low stream flow and high stream temperatures (>17°C). Traps are not operated in the winter due to the lack of fish movement (Bjornn 1978). We positioned RSTs in the thalweg (region of the stream that has most of the flow by volume) to maximize capture efficiency whenever flow conditions allow. Program personnel check traps and process fish at least once daily during daylight hours. High water flows, debris, and ice prevented trap operation on some days. When we anticipated such problems or when unusually high numbers of hatchery juveniles were passing (generally immediately following hatchery releases), we checked the traps several times throughout the day and night as necessary to avoid harm to fish and avoid damage or loss of the RST. We also may have moved traps out of the thalweg or stopped fishing them (i.e., raised the cone) during those times until it was safe for personnel and equipment to resume routine operation. With those exceptions, we deployed traps as early in the spring as possible and operated them continuously until ice-up in the fall.

Fish collected in RSTs were processed using standard protocols (Copeland et al. *in preparation*). 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) bath, 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 30 juvenile fish at one time to reduce exposure time to the anesthetic. All salmonids were measured and weighed prior to release. Subsamples of the target species (Chinook Salmon and steelhead) were marked and sampled for biological data. Chinook Salmon ≥60 mm FL and steelhead ≥80 mm FL were implanted with 12 mm x 2.05 mm PIT tags. At the Hayden Creek and Upper Lemhi River traps, Chinook Salmon and steelhead ≥70 mm FL were implanted with 12 mm PIT tags. The number of fish tagged daily was based on a predetermined percentage of the daily catch designed to distribute PIT tags proportionally over the entire trapping season. All PIT tagging followed established protocols (Kiefer and Forster 1991; PIT Tag Steering Committee 1992; CBFWA 1999). Single-use injectors were used at most traps (Venditti et al. 2013). Chinook Salmon <60 mm FL were generally not tagged; however, in locations where Chinook Salmon <60 mm make up a substantial proportion of the total emigrants, we used Bismarck Brown Y stain to mark subsamples of fish that were 35-59 mm FL for mark-recapture abundance estimates (Venditti et al. 2015a). Steelhead <80 mm FL captured in the Potlatch River were marked with a ventral fin clip and included with PIT-tagged fish in mark-recapture abundance estimates. At the Lower Lemhi River trap, operated by Biomark Applied Biological Services in 2019, steelhead 60-70 mm FL were marked with 9 mm PIT tags, and steelhead 50-59 mm FL were marked with fin clips and included in emigrant estimates. At the Upper Lemhi River and the Hayden Creek RSTs, Chinook Salmon between 60-69 mm FL and steelhead between 65-69 mm FL were implanted with 9 mm PIT tags and included in emigrant estimates. Tagging 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 various life stages as part of Intensively Monitored Watershed studies. We allowed all fish to recover 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.

Incidental catch of other non-target species were enumerated, a subsample were measured for length and weight, and all were then released downstream. 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 ammocoetes or macrophthalmia based on physical characteristics, 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 fin clips by releasing those fish upstream from the trap on a daily basis. Subsequent recaptures of marked fish were used to estimate daily trap efficiency. Efficiencies were based off of Chinook that were generally recaptured ≤7 days after release and steelhead recaptured within the same season (spring and summer/fall). We selected release sites approximately 0.5 km or at least two riffles and a pool upstream of the trap to maximize the probability that marked fish would mix randomly with the general population prior to their recapture. Release locations had adequate holding habitat to reduce immediate predation risk.

Scale samples were collected from steelhead ≥80 mm FL at most traps for ageing. We followed established protocols and methods to collect scales from up to 150 steelhead per season (spring and summer/fall), and subsequently assign ages to sampled fish (Wright et al*.* 2015). At RSTs where fewer than 150 steelhead are captured, scales are collected from all steelhead. In locations with high abundance, scales are collected systematically to evenly sample steelhead, up to a maximum of 150 per season.

Data Management

Data from RST operations are stored in the PTAGIS P4 database locally then uploaded to the PIT Tag Information System (PTAGIS) database (https://www.ptagis.org/home) within three days of collection with P4 software. All PIT-tagged and non-PIT-tagged fish data, along with metadata, are uploaded to the Idaho Fish and Wildlife Information System database (https://fishandgame.idaho.gov/ifwis/portal/page/juvenile-fish-trapping) via the J-Trap application. Data are queried from the Idaho Fish and Wildlife Information System database for analysis. Steelhead age data are archived in the IDFG BioSamples database (https://collaboration.idfg.idaho.gov/qci/default.aspx). Interested parties can access raw data with permission form IFWIS. Data were checked for accuracy and completeness at several stages (e.g., trap tender prior to initial uploading, trap supervisors, IDFG database 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/data/coordinated-assessments/).

Chinook Salmon Emigrant Abundance at RSTs

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

$$N = \sum_{i=1}^{k} c_i (m_i + 1)/(r_i + 1),$$

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 on the shinyapps webpage: https://jmccormick.shinyapps.io/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).

Trap efficiency was monitored to detect changes relative to environmental conditions (e.g., flow and temperature), and efficiency strata were established based on these conditions, within the species-specific seasonal periods described below. This stratification resulted in an improvement in overall efficiency estimation and, therefore, a tighter bound on abundance estimates. To maintain robustness for analysis, we targeted a lower limit of seven recaptures for any strata (Steinhorst et al. 2004). If a stratum did not contain a sufficient number of recaptures, it was included with the previous or subsequent stratum depending on stream and trap conditions and based on the professional judgment of the biologist responsible for the trap. Trap efficiencies were calculated as followed:

$$Trap\ efficiency = R_i/M_i$$

where *R* is the number of recaptured PIT-tagged fish, *i* is a specific time period (dependent upon trap), and *M* is the number of fish that were implanted with a PIT tag during the same time period.

Chinook Salmon Cohort Abundance and Productivity

Age-specific abundances of Chinook Salmon emigrants passing the trap were estimated by season. Body size and overall appearance were used to distinguish cohorts (age-0 from age-1 fish) as two ages could be captured simultaneously, especially in the spring. Season designations for Chinook Salmon followed standard calendar periods (Venditti et al. 2015a). The spring period is defined as trap deployment through June 30, a period of time dominated by catch of age-1 fish that are smolting and will be emigrating past LGR the same year. 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). Emigrants from a given cohort PIT tagged within each time period generally display distinct differences in overall survival rates to LGR (Venditti et al. 2015b). Complete cohort abundance at the trap is calculated by processing all the strata for the seasons together in R statistical software (R Development Core Team 2017). Abundance estimates reported from trap operations in 2018 (Poole et al. 2019) and through spring of 2019 (current report) were used to complete the total estimate for brood year (BY) 2017.

Steelhead Emigrant Abundance and Productivity

Age-specific abundances of steelhead emigrants passing RST were estimated by season. Estimated ages based on scale data were used to distinguish the multiple cohorts captured simultaneously. Season designations followed standard calendar periods and are based on the major periods of fish movement during spring and fall, which is consistent with past reports (e.g., Copeland et al. 2015; Apperson et al. 2017; Belnap et al. 2018). The spring period was the time from trap installation until May 31, a period of time when most steelhead emigrants are smolting. The summer period was from June 1 to August 14, a time period that emigrants generally continued to rear in freshwater for at least one more year. The fall period was from August 15 until trap removal, usually between late October and early December depending on the trap. Emigration past the screw traps generally increases in the fall period compared to the summer period. The summer and fall periods were ultimately combined for analyses because summer often lacked sufficient recaptures or catch to report a reliable estimate. Additionally, the East Fork Potlatch River trap and the Big Bear Creek trap typically do not run during the summer months due to low flow. However, these two traps tend to run during the first week of June so fish captured during June are included in analyses for the spring season.

The adult-to-juvenile productivity of steelhead at RST was estimated by dividing the seasonal sum of estimated cohort abundances by the number of adult female spawners that produced them. The number of adult female spawners was obtained by either PIT-tag arrays or weir counts at locations with both a RST and an array or weir. These adult abundances are reported annually in our adult steelhead report (Stark et al. 2016; Knoth et al. 2018; Dobos et al. 2017 and 2019). Spring emigrant age composition is always 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 2015, with the assumption that age-5 fish comprise a negligible proportion of emigrants at most locations. For locations with few age-4 emigrants, we include information through BY 2016. At this time, productivity at the trap is presented for steelhead and survival of steelhead to LGR is presented for Big Bear Creek RST. The method used to estimate emigrant cohort survival to LGR for Big Bear Creek RST will be replicated for other traps in future analyses.

Estimating Survival and Productivity of Smolts at LGR

We estimated survival rates of PIT-tagged Chinook Salmon emigrants from each RST to LGR, by cohort by season. Cohort abundance of smolts at LGR was calculated by multiplying the seasonal abundance estimates by the survival proportion estimates (RST to LGR) before summation. Main stem detection sites were Lower Granite, Little Goose, Lower Monumental, Ice Harbor, McNary, John Day, and Bonneville dams and the estuary towed array. We assumed that tagged fish represented untagged fish in each group. Detection histories of Chinook Salmon tagged at each trap were used in a Cormack-Jolly-Seber model implemented by the Survival Under Proportional Hazards (SURPH) program (Lady et al. 2001) to estimate survival rate from RSTs to LGR and the probability of detecting a PIT-tagged fish at LGR from each population. Tagging and tag interrogation data were queried from the PTAGIS database (www.ptagis.org).

Adult-to-juvenile productivity was modeled with stock-recruitment analysis for five locations (i.e., Big Creek, Marsh Creek, Pahsimeroi River, upper Salmon River, Lemhi River) and updated through brood year 2017. Estimates of the number of redds (estimated from single or multiple pass surveys) or number of females (estimated from weir passage) above screw traps were taken as a measure of “stock” and estimated number of smolts at LGR were taken as a measure of “recruits.” The stock-recruit relationship was modeled using a $\log_e$ transformed Beverton-Holt (Beverton and Holt 1957) model:

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

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 2017), which executes code in Program JAGS (Plummer 2003) from the R statistical software interface. 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 2017 (Bowersox and Biggs 2014; 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 or PIT array and the number of smolts that survived to Lower Granite Dam.

RESULTS

Rotary Screw Trap Operations

The RSTs were operated in ten locations in the Salmon River basin and five locations in the Clearwater River basin (Appendix A). Of these traps, 13 have operated annually at the same location for a minimum of ten years. Three traps have operated for 28 years (Lemhi, Upper Salmon, and Pahsimeroi rivers), and the Crooked River RST has operated since 1990. Calendar year 2019 represents the fourth complete year of operation for three RSTs included in this report (Lower South Fork Salmon, North Fork Salmon, and Lower Lochsa rivers). All RSTs included here were operated by IDFG, except the Lower Lemhi River RST (LLRTP), which was operated by Biomark Applied Biological Services in 2019.

Most traps were operated during three seasons (spring, summer, and fall). However, streamflow was insufficient to operate the two traps in the Potlatch River (Big Bear Creek and East Fork Potlatch River) during summer. Summer flows typically limit RST operations in the Potlatch River; thus, we assume emigration is negligible during summer in the Potlatch River. These two traps, along with the Fish Creek trap were the only RSTs to not sample Chinook Salmon in 2019. Traps were operated for the majority of the trapping season, and therefore we can report reliable emigrant information for all seasons except winter. Across all RSTs, operations averaged 75% of the trapping season (Appendix B).

Chinook Salmon Emigrant Abundance at RSTs

Chinook Salmon emigrant abundance varied from 8,212 to 128,607 fish in the Salmon basin (n = 9 traps) and 2,526 fish at Crooked River, the sole trap in the Clearwater River basin where an estimate was possible (Table 2).

Chinook Salmon Cohort Abundance and Productivity

Chinook Salmon BY2017 cohort abundance varied from 2,086 to 89,419 fish in the Salmon River basin (n = 9 traps) and 305 fish at Crooked River (Table 3). Estimated adult-to-juvenile productivity of Chinook Salmon at RSTs for BY2017 varied from 126 to 2,567 emigrants per female spawner in the Salmon River basin (n = 10 traps) and 305 emigrants per female spawner at Crooked River (Table 4).

Steelhead Emigrant Abundance and Productivity

Juvenile steelhead emigrant abundances were estimated at 13 of 15 RST locations operated across 11 steelhead populations (Table 5). Abundance of juveniles at lower Marsh Creek and Lochsa River traps was not estimated because of low catch and limited recaptures.

Estimated abundance of steelhead emigrants varied from 944 to 18,870 fish in the Salmon River basin (n = 9 traps) and from 283 to 6,864 fish in the Clearwater River basin (n = 4 traps). Big Creek produced an estimated 18,870 emigrants, more than any other location. Of the traps where an estimate was possible, Crooked River produced the fewest emigrants at 283 fish. The catch of steelhead <80 mm FL, which were generally not marked to estimate trap efficiencies, varied from 0 in Big Bear Creek to 1,230 from the Lower South Fork Salmon River (Appendix C).

Scale samples were collected from juvenile steelhead at all 15 traps, with ages assigned to 3,359 fish (96%; Table 6). 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. Fish were predominately age-2 or age-3 in the spring, and age-1 and age-2 in the fall. The Hayden Creek trap was the only RST that captured age-5 emigrants.

Emigrant abundance, juvenile age proportions, and female spawner abundance data were used to produce adult-to-juvenile productivity estimates for multiple cohorts at six trap locations in the Salmon River MPG and four trap locations in the Clearwater River MPG (Appendix D). Steelhead emigrant/female productivity increased from BY2014 to BY2015 in two out of the six traps in the Salmon River basin and two out of the four traps in the Clearwater River basin. Plots of complete cohort estimates through BY2015 are presented in Figures 3 and 4. Steelhead emigrant/female productivity from BY2014 varied from 0 to 714 recruits per female in the Salmon River basin (n = 6 traps) and from 0 to 501 recruits per female in the Clearwater River basin (n = 4 traps; Appendix D). Zero recruits per female is likely unrealistic and resulted from low steelhead abundance and low screw trap efficiency. The lower South Fork Salmon River array and the Crooked River weir were not efficient at detecting or capturing adult steelhead and thus recruits per female could not be estimated. The greatest productivities for the two MPGs occur in the Upper Salmon River (Salmon River MPG) and in the East Fork Potlatch River (Clearwater MPG). Trend lines indicate that populations in both MPGs generally experience density-dependence, with juvenile productivity declining with increasing spawner escapement (Figures 3 and 4).

Estimating Survival and Productivity of Smolts at LGR

Total survival of emigrants from RSTs to LGR was influenced by both seasonal abundance at a given RST and seasonal survival rate to LGR (Table 3). Survival of smolts from the Hayden Creek RST were estimated to Little Goose Dam since survival to LGR would be biased because emigrants passed over LGR undetected. Survival to LGR increased for each successive seasonal group (from summer age-0 fish to spring age-1) within a brood year across all traps, with the exception of North Fork Salmon River RST, Lemhi River weir RST, and Pahsimeroi River RST (Table 3). Survival of spring age-0 fry was generally not assessed since those fish are too small for PIT tag implantation. Fall age-0 fish generally had higher abundances of emigrants past LGR than summer age-0 or spring age-1 fish. Exceptions to this generality were Marsh Creek RST, Hayden Creek RST, and upper Salmon River RST where abundance of either summer age-0, spring age-0, or both were greater than fall age-0 fish.

Chinook productivity of smolts at LGR for BY2017 varied from 51 to 1,112 smolts at LGR per female spawner in the Salmon River basin (n = 10 traps) and 184 smolts at LGR per female spawner at Crooked River (Table 4).

The Beverton-Holt model suggests a density dependent relationship between spawning Chinook Salmon female abundance and smolts at LGR in the Salmon River basin (Table 7). This relationship has occurred over the observed range of female abundance (Figure 5). However, the strength of the density dependent relationship (β) was variable among the 5 traps evaluated. Insufficient data in the Clearwater River basin prohibited completion for any population in that MPG.

Pacific Lamprey Catch

Pacific Lamprey were captured at the Lower South Fork Salmon River and the Lower Lochsa River RSTs (Table 8). A total of 1,327 Pacific Lamprey were captured at the Lower South Fork Salmon River trap, consisting of 602 ammocoetes and 752 macrophthalmia. The length of lamprey in the Lower South Fork Salmon River ranged from 130 mm to 182 mm. A total of 90 Pacific Lamprey were captured at the Lower Lochsa River trap, all of which were ammocoetes, which ranged from 12 mm to 139 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, in terms of smolts per female, varied widely, both between locations and by brood year, making trends difficult to assess. The number of emigrants is influenced by the habitat quantity and quality upstream from traps, intrinsic productivity unique to each stream, and survival of emigrants from natal reaches to the end of freshwater rearing at LGR. Distinct differences in productivity among populations are evident, as expected with large spatial and temporal variability (Table 5). To better understand the differences in productivity among populations, the amount of habitat available and the quality of habitat necessary for juvenile fish rearing and overwintering should be further assessed for locations upstream of traps. The Intensively Monitored Watershed studies in the Potlatch River basin and the Lemhi River basin provide a unique opportunity to identify life stage specific limiting habitat factors through research, monitoring, and evaluation efforts. Information gathered will help guide habitat restoration actions to increase Chinook and steelhead abundance, survival, and productivity.

The stock-recruit analysis of smolt-to-adult productivity of Chinook Salmon indicated a density-dependent relationship between spawning female abundance and smolts at LGR. 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 may be more variable than previously thought. The specific mechanisms that cause density dependent mortality in juvenile Snake River spring/summer Chinook Salmon are unclear, although we suspect competition among juveniles, spatial clustering, habitat loss, and relatively sterile rearing areas to be likely contributors. Variability in quantity and quality of rearing areas may be responsible for the observed variability among populations. Potential limiting factors associated with density dependence may include clustering of redds, overwinter mortality, and limited resource availability (Walters et al. 2013). Alternatively, a density-dependent relationship was not observed for Marsh Creek and Big Creek, as these two creeks have high quality habitat and showed little evidence of reaching asymptotic smolt production over the observed range of female abundance. This may be due to the insufficient length of data records. Hilborn and Walters (1992) recommend at least 15 years of data are needed for stock-recruitment analyses. In our study, Marsh Creek and Big Creek had eight and eleven years of data respectively.

Variation present in natural populations can make comparison of productivity metrics difficult, and as a result, alternate juvenile life history forms may not be accounted for. For example, the Pahsimeroi and Lemhi populations tend to have age-0 Chinook Salmon reaching sufficient size to undergo smoltification and migrate downstream (Lutch et al. 2003; Copeland and Venditti 2009). In 2019, spring age-0 migrants made up approximately 30% and 12% of the Chinook that passed the Pahsimeroi River and Lemhi River RSTs. While age-0 migrants generally have lower survival than age-1 smolts, spring age-0 Chinook are usually not PIT tagged, and thus their survival and abundance at LGR is unknown. If spring age-0 emigrants make up a substantial proportion of emigrants at LGR, productivity would be underestimated. Additionally, productivity values may not be comparable to other traps where this variant life history form does not exist. Tagging a greater number of spring age-0 emigrants, such that a survival estimate is possible, is one way to account for these fish.

Estimating steelhead survival is problematic because of their complex life history (i.e. emigration at different ages). The Fish Creek trap provides us with a good example of steelhead life history complexity. In some years, there were five age classes of juveniles captured at the Fish Creek RST. A portion of each age class will emigrate to LGR in the same year that they pass the trap, but others remain upstream of LGR for another year or more before emigrating. To better understand the complex life history of steelhead, a tool has been developed by the University of Washington to include cohort survival estimates by accommodating the variation in age at migration of steelhead (Buchanan et al. 2015; Lady et al. 2014). This model has been evaluated using data from the Big Bear Creek RST, with results presented in Chapter 2 of this report. Smolt survival from other RSTs will be presented at a later time, as we develop the appropriate model structures for all IDFG traps.

Juvenile emigration estimates in this report are considered conservative (biased low) because no interpolation is attempted for time periods that traps are not operated. However, bias in emigration estimates is likely minimal since there is little indication of significant winter movements (Bjornn 1978). Also, the majority of fish emigrate during the fall when RSTs are in operation and trapping efficiencies are high. To ensure the most precise estimates, a multiyear hierarchical Bayesian model has been developed to interpolate abundance during periods of sparse and missing trap data (Oldemeyer 2015). The model will need to be applied on a case-by-case basis, and will need to be customized to each trap. Traps with longer data series (e.g., Pahsimeroi River, upper Lemhi River, Marsh Creek, and Upper Salmon River traps) can use historical data to populate the model. Newer traps (e.g. the North Fork Salmon River, Hayden Creek, Lochsa River traps) will need more years of data to fully realize the benefits of the model. The model is currently not used to supplement emigrant estimates, due to the current methods possibly producing erroneous estimates when applied to certain life stages. In particular, fry, which are too small to safely PIT tag, are an issue due to lack of current and historical mark-recapture data (Bruce Barnett, IDFG, personal communication). A possible solution to this issue would be collecting more mark-recapture data on fry by marking them with Bismarck Brown Y stain as demonstrated in the Lemhi River; however, most of our traps generally catch few fry. Thus, it is likely that fry will continue to be excluded from interpolation by the model in the future. Needless to say, the majority of fry likely have very poor survival. The model is currently being validated by populating it with historical data and comparing the results with estimates obtained using traditional methods. As the model is refined, it will be incorporated into future reports.

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.

- Continue to test and implement new models to estimate juvenile emigrant steelhead survival rates to LGR. Develop this model for all sites included in this report.

- Validate the Oldemeyer (2015) model by populating it with historical data and compare those estimates with estimates obtained from Gauss. 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.

- Integrate steelhead survival and smolt abundance at LGR into future reporting for populations where data is robust.

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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 is to present a method for estimating survival of juvenile steelhead from a rotary screw trap (RST) to LGR. Big Bear Creek was used as a case study to examine and present survival of steelhead juveniles from the RST site to LGR and estimate the number of smolts at LGR by brood year (2006–2015). Across brood years (BYs), a mean of 96.5% of Big Bear Creek steelhead juveniles migrated directly out of the Snake River basin the year they were tagged and 3.5% overwintered downstream of the RST. Most juveniles detected in the hydrosystem were tagged as age-2 (mean = 72.6%), followed by age-1 (19.8%) and age-3 (5.6%). Median survival for direct migrating smolts were 23.8% for age-1, 60.6% for age-2, and 49.7% for age-3. Of juveniles that overwintered prior to ocean migration, median survival was 19.9% for age-2 and <0.1% for age-3 fish. No age-1 juvenile steelhead were detected to have overwintered downstream of the RST and survive to LGR. Total abundance by brood year varied from 1,721 to 7,839 smolts (mean = 3,931 smolts).

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INTRODUCTION

Smolt abundance and migration survival through the hydrosystem has been the focus of monitoring efforts for Snake River basin juvenile Chinook Salmon and steelhead. Traditionally, a Cormack-Jolly-Seber (CJS) model is used to estimate survival of juvenile salmonids from rotary screw traps (RST) where they are PIT tagged to Lower Granite Dam (LGR) where they are first detected as smolts in the main stem Snake River. 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 spring/summer Chinook Salmon or hatchery steelhead (Buchanan et al. 2015). Steelhead and Chinook Salmon can emigrate out of natal tributaries at various ages and overwinter downstream of RST. However, 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. The Lowther-Skalski model is a multistate release-recapture model that allows flexibility for delayed migration and having multiple tributary releases (i.e., years tagged at a RST) for a given cohort (i.e., brood year; Buchanan et al. 2015). In this chapter, detection and age data of juvenile steelhead from Big Bear Creek, a tributary to the Potlatch River, were used to test the feasibility of applying the Lowther-Skalski model through the Basin TribPIT program (Lady et al. 2017) to estimate cohort survival of wild juvenile steelhead from RST to LGR. The purpose of this chapter is to present an example of how to estimate survival of juvenile steelhead from a RST to LGR.

METHODS

Cohort Abundance at RST

Seasonal abundances of juvenile steelhead (2006–2015) at the Big Bear Creek RST were estimated using methods outlined by Chapter 1 of this report. Trapping juveniles at Big Bear Creek during the summer and fall are often not feasible due to extreme low flows; therefore, only data during the spring seasons were used. Ages for a subsample of juveniles PIT tagged were pooled across years and used to create an age-length-key for all PIT tagged juveniles using methods by Kimura (1977) through the FSA packages in R developed by Ogle (2016) and available at http://derekogle.com/fishR/. Each unaged PIT-tagged juvenile was then assigned an age. Once an age-length-key was established, age proportions were applied to the overall abundance estimates to determine cohort abundances by age and year tagged and released. Age at tagging and movement were reported only for juveniles that were subsequently detected as a smolt in the hydrosystem. 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) main stem observation history and 2) age data. For the main stem observation history, a list of all known PIT tags implanted in juveniles at Big Bear Creek RST across brood years was generated from the PTAGIS website (www.ptagis.org). The PIT tag list was 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 Big Bear Creek RST. For the age data, all PIT-tagged juvenile steelhead from the Big Bear Creek RST were paired with year they were tagged and 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 Basin TribPIT program.

Model and Output

Detection data were organized in a matrix by year juvenile steelhead were tagged and released, by brood year, and by year they were detected at respective interrogation sites (i.e., hydrosystem dams). Lower Granite Dam was the only site where survival was estimated so all interrogation sites upstream of LGR were excluded. All detections downstream of LGR were pooled to estimate the probability of detecting a PIT-tagged juvenile steelhead at LGR. Models were fitted to each brood year separately.

Model output for each brood year included survival estimates by release group and by year fish were detected at LGR or other main stem dams. The number of PIT-tagged juvenile steelhead detected at LGR by age of release and by year of detection were expanded by the detection probabilities for a given detection year to standardize proportions by group across years. Survival estimates for each group were then multiplied by the brood year abundance by release year and age at the RST to estimate total number of smolts by brood year that survived to LGR. Overall smolt survival was the number of smolts estimated at LGR divided by total juvenile abundance at the RST by brood year.

RESULTS

Steelhead juveniles from a given brood year in Big Bear Creek emigrated over three calendar years and at ages ranging from age-1 to age-3. Based on hydrosystem detections of smolts, two distinct movement patterns were observed: 1) juveniles directly migrated out to the ocean the same year they were tagged at the Big Bear Creek RST, and 2) juveniles overwintered downstream of the RST and emigrated to the ocean the following spring. Of the smolts detected in the hydrosystem across brood years, a median of 19.8% (8.1–39.9%) were tagged as age-1 juveniles, 72.6% (57.2–89.1%) were age-2 juveniles, and 5.6% (2.7–11.5%) were age-3 juveniles (Figure 6). Across all brood years and by age at release of juvenile steelhead, a mean of 96.5% (57.1–100.0%) of juvenile steelhead directly migrated out to the ocean within the same year and a mean of 3.5% (0.0–42.9%) overwintered prior to migration. No age-1 juveniles were detected as overwintering downstream of the RST before migrating as a smolt the following spring.

For direct migrant smolts, median survival to LGR was 23.8% (range = 12.5–68.6%) for age-1 juveniles, 60.6% (32.1–85.6%) for age-2 juveniles, and 49.7% (0.0–100.0%) for age-3 juveniles. For smolts that overwintered prior to migration, median survival was 1.9% for age-2 juveniles (0.0–5.7%) and 0.0% for age-3 juveniles (0.0–2.2%; Figure 7). Mean survival across all ages of direct migrant smolts was 47.3% and mean survival for juveniles that overwintered was 0.9%. Total abundance by brood year varied from 1,721 to 7,839 smolts (mean = 3,931 smolts; Figure 8).

DISCUSSION

The Big Bear Creek steelhead smolt survival is the first example of survival estimated with the Lowther-Skalski model for an Idaho steelhead population. Early life history complexities of juvenile steelhead cause difficulties in producing survival estimates and subsequent smolt abundance estimates to main stem hydrosystem dams. Only recently has the Basin TribPIT program been applied to wild steelhead populations. The model provides the flexibility to analyze a brood year by age at which juveniles emigrate past a RST and movement patterns by which they could overwinter below the RST, which was necessary to accurately report survival to LGR. The survival analysis will be applied to other wild steelhead populations where data is sufficient. 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 measure productivity to and downstream of LGR which will be valuable in assessing overall life cycle survival and hydrosystem effects on steelhead. Future examinations 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 Snake River steelhead distinct population segment (DPS) and spring-summer Chinook Salmon evolutionary significant unit (ESU; 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) [a] 34. Lapwai Creek (extirpated) [a] 35. Lawyer Creek (extirpated) [a] 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]	

[a] Reintroduced fish exist in extirpated areas except the North Fork Clearwater River.

Table 2. Trap catch and emigrant abundance estimates with confidence intervals (CI) 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 2019. Instances where no estimate was made are noted NE.

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	0	NE	NE	NE
RPDTRP	Spring age-0	2	NE	NE	NE
	Summer age-0	25	NE	NE	NE
	Fall age-0	35	NE	NE	NE
	Total	**62**	**NE**	**NE**	**NE**
Lower South Fork Salmon River	Spring age-1	724	9,648	7,276	16,029
SFSRKT	Spring age-0	1,096	NE	NE	NE
	Summer age-0	3,002	45,441	37,745	64,560
	Fall age-0	8,305	58,871	54,071	66,049
	Total	**13,127**	**113,960**	**99,092**	**146,638**
Middle Fork Salmon River					
Big Creek	Spring age-1	443	8,320	5,980	13,669
BIG2CT	Spring age-0	2	NE	NE	NE
	Summer age-0	504	6,558	4,550	11,992
	Fall age-0	4,536	35,903	32,840	40,318
	Total	**5,485**	**50,781**	**43,370**	**65,979**
Lower Marsh Creek	Spring age-1	201	2,591	1,779	5,396
MARTR2	Spring age-0	597	7,774	3,887	23,322
	Summer age-0	4,335	81,886	67,211	122,199
	Fall age-0	2,778	36,356	31,999	43,634
	Total	**7,911**	**128,607**	**104,876**	**194,551**
Upper Salmon River					
North Fork Salmon River	Spring age-1	141	541	401	1,058
NFSTRP	Spring age-0	2	NE	NE	NE
	Summer age-0	33	323	162	646
	Fall age-0	4,368	11,762	11,134	12,628
	Total	**4,544**	**12,626**	**11,697**	**14,332**
Upper Lemhi River	Spring age-1	203	1,386	1,092	2,555
LEMTRP	Spring age-0	670	3,412	2,947	4,964
	Summer age-0	131	545	425	1,184
	Fall age-0	4,605	24,073	22,614	26,775
	Total	**5,609**	**29,416**	**27,078**	**35,478**
Hayden Creek	Spring age-1	93	526	380	1,015
HAYTRP	Spring age-0	228	4,414	2,846	12,228
	Summer age-0	6	NE	NE	NE
	Fall age-0	555	3,272	2,812	4,154
	Total	**882**	**8,212**	**6,038**	**17,397**
Lower Lemhi River	Spring age-1	2,167	6,070	5,612	6,699
LLRTP	Spring age-0	132	1,100	712	2,017
	Summer age-0	65	308	205	616
	Fall age-0	9,035	37,087	33,626	41,571
	Total	**11,399**	**44,565**	**40,155**	**50,903**

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	1,294	12,002	10,302	14,551
SAWTRP	Spring age-0	40	NE	NE	NE
	Summer age-0	274	15,400	7,700	61,600
	Fall age-0	408	2,677	2,195	3,673
	Total	**2,016**	**30,079**	**20,197**	**79,824**
Pahsimeroi River	Spring age-1	159	1,657	1,130	3,103
PAHTRP	Spring age-0	470	5,248	3,908	7,348
	Summer age-0	103	1,181	719	3,003
	Fall age-0	1,038	11,361	9,484	13,970
	Total	**1,770**	**19,447**	**15,241**	**27,424**
Dry Clearwater River					
Crooked River	Spring age-1	81	305	221	457
CROTRP	Spring age-0	0	NE	NE	NE
	Summer age-0	7	NE	NE	NE
	Fall age-0	517	2,221	1,930	2,649
	Total	**605**	**2,526**	**2,151**	**3,106**
Big Bear Creek	Spring age-1	NE	NE	NE	NE
BBCTRP	Spring age-0	NE	NE	NE	NE
	Summer age-0	NE	NE	NE	NE
	Fall age-0	NE	NE	NE	NE
	Total	**NE**	**NE**	**NE**	**NE**
East Fork Potlatch	Spring age-1	NE	NE	NE	NE
EFPTRP	Spring age-0	NE	NE	NE	NE
	Summer age-0	NE	NE	NE	NE
	Fall age-0	NE	NE	NE	NE
	Total	**NE**	**NE**	**NE**	**NE**
Wet Clearwater River					
Fish Creek	Spring age-1	NE	NE	NE	NE
FISTRP	Spring age-0	NE	NE	NE	NE
	Summer age-0	NE	NE	NE	NE
	Fall age-0	NE	NE	NE	NE
	Total	**NE**	**NE**	**NE**	**NE**
Lower Lochsa River	Spring age-1	151	NE	NE	NE
LOCTRP	Spring age-0	6	NE	NE	NE
	Summer age-0	10	NE	NE	NE
	Fall age-0	141	NE	NE	NE
	Total	**308**	**NE**	**NE**	**NE**

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 2017 wild juvenile Chinook Salmon from the Salmon River and Clearwater River basins, Idaho. Instances where no estimate was made are noted NE.

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	NE	0	NE	NE
Salmon River	Summer age-0	23,681	725	0.29 (0.032)	6,903
SFSRKT	Fall age-0	56,090	4,351	0.38 (0.013)	21,415
	Spring age-1	9,648	720	0.63 (0.048)	6,074
	BY Total	**89,419**	**5,796**		**34,393**
Middle Fork Salmon River					
Big Creek	Spring age-0	NE	0	NE	NE
BIG2CT	Summer age-0	5,889	351	0.36 (0.042)	2,104
	Fall age-0	42,267	3,470	0.40 (0.018)	16,750
	Spring age-1	8,320	437	0.67 (0.120)	5,608
	BY Total	**56,476**	**4,258**		**24,462**
Lower Marsh Creek	Spring age-0	8,274	189	0.03 (0.038)	214
MARTR2	Summer age-0	30,171	1,051	0.24 (0.020)	7,262
	Fall age-0	19,134	1,480	0.34 (0.030)	6,423
	Spring age-1	2,591	198	0.56 (0.125)	1,448
	BY Total	**60,170**	**2,918**		**15,348**
Upper Salmon River					
North Fork Salmon River	Spring age-0	NE	NE	NE	NE
NFSTRP	Summer age-0	NE	3	NE	NE
	Fall age-0	1,545	110	0.63 (0.460)	978
	Spring age-1	541	135	0.41 (0.660)	224
	BY Total	**2,086**	**248**		**1,202**
Upper Lemhi River	Spring age-0	2,047	1	NE	NE
LEMTRP	Summer age-0	154	21	0.40 (0.270)	62
	Fall age-0	12,794	1,611	0.37 (0.018)	4,747
	Spring age-1	1,386	202	0.69 (0.150)	949
	BY Total	**16,381**	**1,835**		**5,758**
Hayden Creek	Spring age-0	753	0	NE	NE
HAYTRP	Summer age-0	24	7	NE	NE
	Fall age-0	1,012	134	0.33 (0.072)	592
	Spring age-1	526	93	0.62 (0.310)	326
	BY Total	**2,315**	**234**		**918**
Lower Lemhi River	Spring age-0	51	0	NE	NE
LLRTP	Summer age-0	101	22	0.00 (0)	0
	Fall age-0	14,944	2,531	0.38 (0.014)	5,679
	Spring age-1	6,070	1,444	0.69 (0.043)	4,188
	BY Total	**21,167**	**3,997**		**9,867**
Upper Salmon River	Spring age-0	NE	57	NE	NE
SAWTRP	Summer age-0	25,228	908	0.15 (0.022)	3,661
	Fall age-0	15,071	1,180	0.23 (0.021)	3,445
	Spring age-1	12,002	1,289	0.56 (0.059)	6,703
	BY Total	**52,287**	**3,434**		**13,809**

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	5,219	693	0.54 (0.017)	2,803
PAHTRP	Summer age-0	1,339	119	0.14 (0.060)	180
	Fall age-0	8,441	439	0.31 (0.370)	2,626
	Spring age-1	1,657	159	0.69 (0.110)	1,146
	BY Total	**16,656**	**1,410**		**6,755**
Dry Clearwater River					
Crooked River	Spring age-0	NE	NE	NE	NE
CROTRP	Summer age-0	NE	NE	NE	NE
	Fall age-0	NE	13	0.14 (0.073)	NE
	Spring age-1	305	78	0.61 (0.340)	184
	BY Total	**305**	**91**		**184**

Table 4. Estimated adult-to-juvenile productivity of wild juvenile Chinook Salmon for brood year (BY) 2017, expressed as both emigrants at rotary screw trap (RST) 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	180[a]	89,419	443	34,393	191
Middle Fork Salmon River					
Big Creek BIG2CT	22[a&b]	56,476	2,567	24,462	1,112
Lower Marsh Creek MARTR2	54[b]	60,170	1,114	15,446	281
Upper Salmon River					
North Fork Salmon River NFSTRP	2[a]	2,086	1,043	1,202	601
Lemhi River (upper) LEMTRP	43[b]	16,381	381	6,576	153
Hayden Creek HYDTRP	12[b]	2,315	193	918	77
Lower Lemhi River LLRTP	109[a&b]	21,167	194	9,867	91
Upper Salmon River SAWTRP	178[c]	52,287	294	13,809	78
Pahsimeroi River PAHTRP	132[c]	16,656	126	6,755	51
		Clearwater River Basin			
Dry Clearwater River					
Crooked River CROTRP	1[b]	305	305	184	184

[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.

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Table 5. Rotary screw trap catch and emigrant abundance estimates, with 95% confidence intervals (CI) for wild juvenile steelhead >80 mm FL, by season during 2019. 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	89	528	360	880
RPDTRP	Sum/Fall	54	416	243	972
	Total	143	944	690	1,644
South Fork Salmon River					
Lower South Fork Salmon River	Spring	30	NE	NE	NE
SFSRKT	Sum/Fall	594	11,187	7,905	21,159
	Total	624	11,187	7,905	21,159
Lower Middle Fork Salmon River					
Big Creek	Spring	181	3,845	2,366	10,253
BIG2CT	Sum/Fall	699	15,025	11,131	23,771
	Total	880	18,870	13,497	34,024
Upper Middle Fork Salmon River					
Lower Marsh Creek	Spring	69	NE	NE	NE
MARTR2	Sum/Fall	59	NE	NE	NE
	Total	128	NE	NE	NE
North Fork Salmon River					
North Fork Salmon River	Spring	273	2,129	1,604	3,189
NFSTRP	Sum/Fall	898	6,691	5,723	8,120
	Total	1,171	8,820	7,327	11,309
Lemhi River					
Upper Lemhi River	Spring	95	618	441	1,156
LEMTRP	Sum/Fall	558	6,207	5,221	10,104
	Total	653	6,825	5,662	11,260
Hayden Creek	Spring	270	3,905	3,083	7,873
HYDTRP	Sum/Fall	150	1,727	1,244	3,822
	Total	420	5,632	4,327	11,695
Lower Lemhi River	Spring	991	6,444	5,540	7,940
LLRTP	Sum/Fall	708	7,237	5,818	10,561
	Total	1,699	13,681	12,028	17,396
Upper Salmon River mainstem					
Upper Salmon River	Spring	176	6,549	3,275	19,647
SAWTRP	Sum/Fall	71	972	486	1,944
	Total	247	7,521	3,761	21,591
Pahsimeroi River					
Pahsimeroi River	Spring	85	903	556	2,408
PAHTRP	Sum/Fall	525	5,402	4,228	7,879
	Total	610	6,305	4,784	10,287

Table 5. 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	9	45	23	90
CROTRP	Sum/Fall	34	238	132	595
	Total	43	283	155	685
Lower Clearwater Mainstem					
Big Bear Creek	Spring	1,215	6,149	5,485	7,168
BBCTRP	Sum/Fall	NE	NE	NE	NE
	Total	1,215	6,149	5,485	7,168
East Fork Potlatch River	Spring	251	3,100	2,138	5,166
EFPTRP	Sum/Fall	NE	NE	NE	NE
	Total	251	3,100	2,138	5,166
Lochsa River					
Fish Creek	Spring	11	NE	NE	NE
FISTRP	Sum/Fall	2,364	6,864	6,364	7,373
	Total	2,375	6,864	6,364	7,373
Lower Lochsa River	Spring	287	NE	NE	NE
LOCTRP	Sum/Fall	39	NE	NE	NE
	Total	326	NE	NE	NE

Table 6. Seasonal age composition estimates of juvenile steelhead >80 mm FL in 2019 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	79	0	0	40	361	127	0	528
RPDTRP	Sum/Fall	50	0	100	225	92	0	0	416
South Fork Salmon River									
Lower South Fork Salmon River	Spring	28	NE	NE	NE	NE	NE	NE	NE
SFSRKT	Sum/Fall	197	454	3,918	6,133	511	170	0	11,187
Lower Middle Fork Salmon River									
Big Creek	Spring	57	0	1,012	1,349	1,484	0	0	3,845
BIG2CT	Sum/Fall	146	0	6,689	7,204	1,029	103	0	15,025
Upper Middle Fork Salmon River									
Lower Marsh Creek	Spring	30	NE	NE	NE	NE	NE	NE	NE
MARTR2	Sum/Fall	42	NE	NE	NE	NE	NE	NE	NE
North Fork Salmon River									
North Fork Salmon River	Spring	85	0	156	831	857	286	0	2,129
NFSTRP	Sum/Fall	172	467	2,451	2,490	1,284	0	0	6,691
Lemhi River									
Upper Lemhi River	Spring	95	0	428	177	14	0	0	618
LEMTRP	Sum/Fall	139	179	4,823	1,072	134	0	0	6207
Lower Lemhi River	Spring	320	0	518	3,377	2,404	145	0	6444
LLRTRP	Sum/Fall	300	241	5,259	1,665	72	0	0	7237
Hayden Creek	Spring	164	0	1,741	1,425	0	53	27	3905
HYDTRP	Sum/Fall	27	0	211	1,069	411	23	12	1727
Upper Salmon River mainstem									
Upper Salmon River									
SAWTRP	Spring	74	0	2,921	2,390	1,239	0	0	6549
Pahsimeroi River	Sum/Fall	26	75	785	112	0	0	0	972
Pahsimeroi River									
PAHTRP	Spring	80	0	497	339	68	0	0	903
	Sum/Fall	322	2,550	2,399	386	67	0	0	5402
South Fork Clearwater River									
Crooked River	Spring	0	0	0	28	17	0	0	45
CROTRP	Sum/Fall	25	0	82	116	34	7	0	238

Table 6. 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 EFPTRP	Spring	57	0	1,423	1,372	305	0	0	3100
Big Bear Creek BBCTRP	Spring	127	0	932	4,705	512	0	0	6149
Lochsa River									
Fish Creek FISTRP	Spring	10	NE	NE	NE	NE	NE	NE	NE
	Sum/Fall	411	100	868	5,060	802	33	0	6864
Lochsa River LOCTRP	Spring	262	NE	NE	NE	NE	NE	NE	NE
	Sum/Fall	34	NE	NE	NE	NE	NE	NE	NE

Table 7. 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	2006-2017	373.8	0.001	343,562
Lower Marsh Creek MARTR2	2009-2017	239.1	0.0005	502,586
Upper Salmon River				
Upper Lemhi River LEMTRP	1991-2017	114.1	0.0025	46,238
Pahsimeroi River PAHTRP	1992-2017	183.3	0.0077	23,820
Upper Salmon River SAWTRTP	1992-1994, 1996-2017	225.0	0.0049	45,510

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 2019. 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	564	154	134-182
		Macrophthalmia	723	151	130-168
	Summer*	Ammocoete	37	147	135-161
		Macrophthalmia	0		
	Fall*	Ammocoete	1	183	
		Macrophthalmia	2	150	146-154
	Total		**1,327**		
Wet Clearwater River	Spring*	Ammocoete	85	106	12-139
Lower Lochsa River LOCTRP		Macrophthalmia	NA	NA	NA
	Summer*	Ammocoete	0	NA	NA
		Macrophthalmia	NA	NA	NA
	Fall*	Ammocoete	5	113	100-122
		Macrophthalmia	NA	NA	NA
	Total		**90**		

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

FIGURES

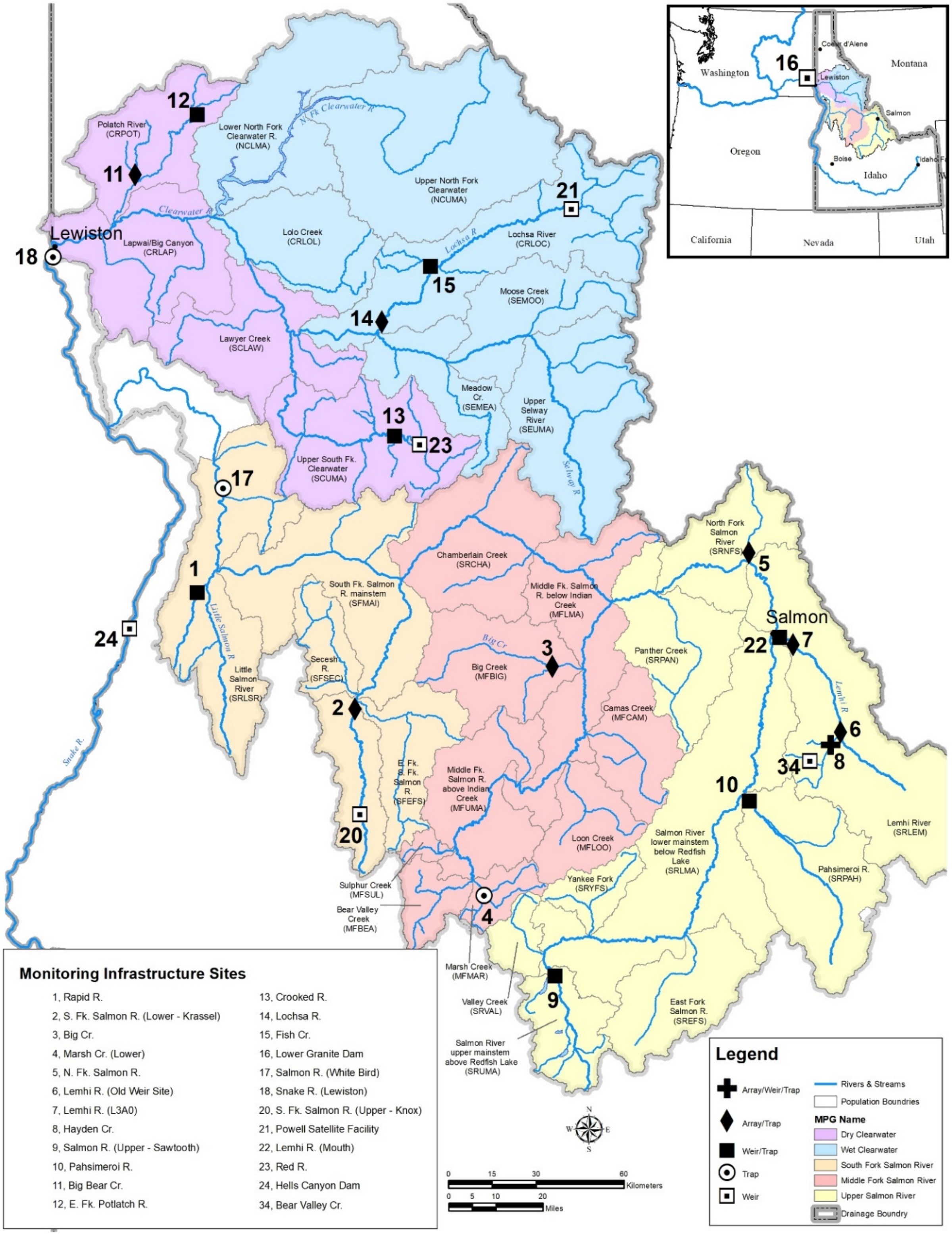

Figure 1. Location of rotary screw traps, weirs, and PIT arrays operated by IDFG in 2019 with reference to spring/summer Chinook Salmon population structure. Numbers correspond to infrastructure sites in the lower left inset. Chinook Salmon major population groups are highlighted and independent populations are delineated.

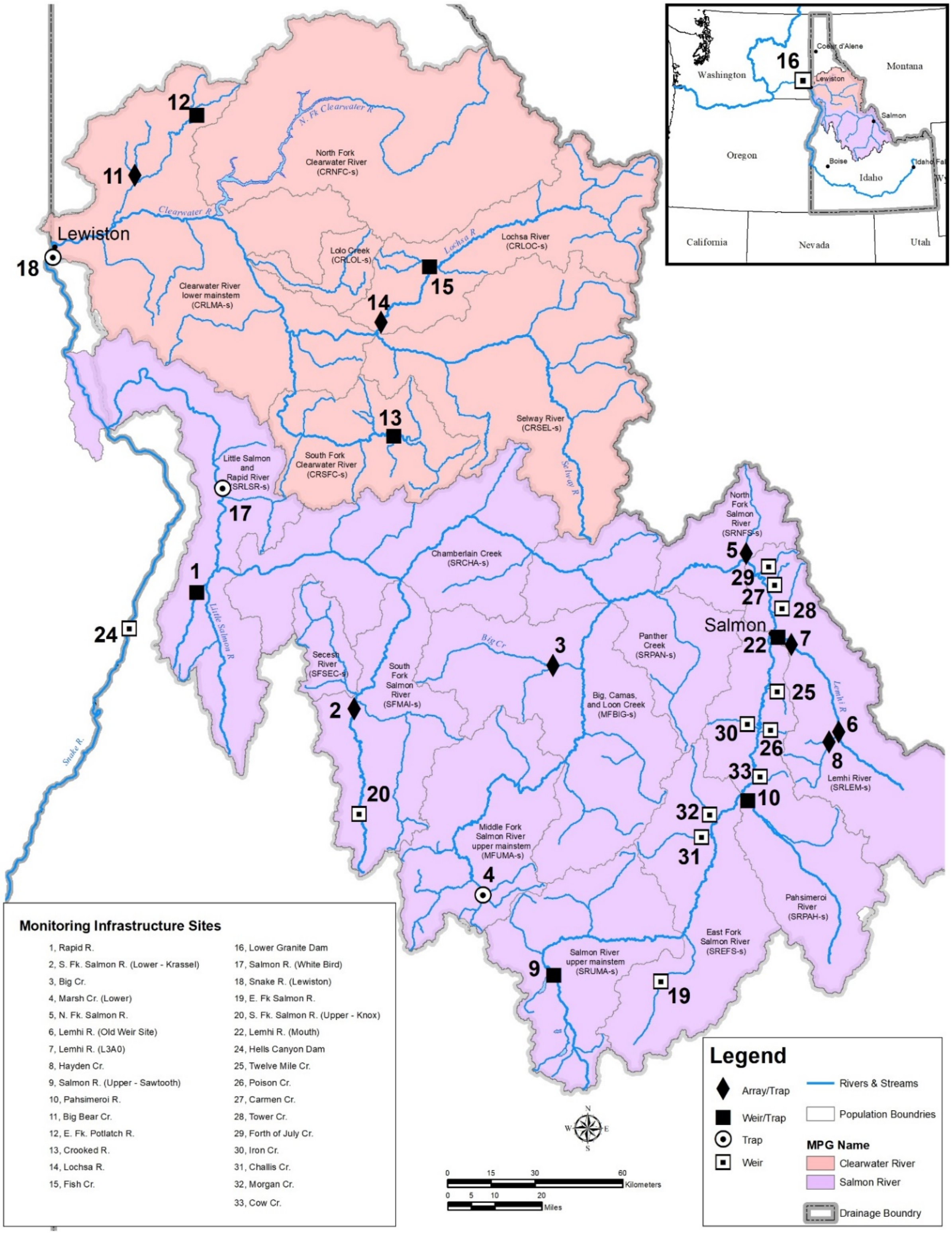

Figure 2. Location of rotary screw traps, weirs, and PIT arrays operated by IDFG in 2019 with reference to steelhead population structure. Numbers correspond to infrastructure sites in the lower left inset. Steelhead major population groups are highlighted and independent populations are delineated.

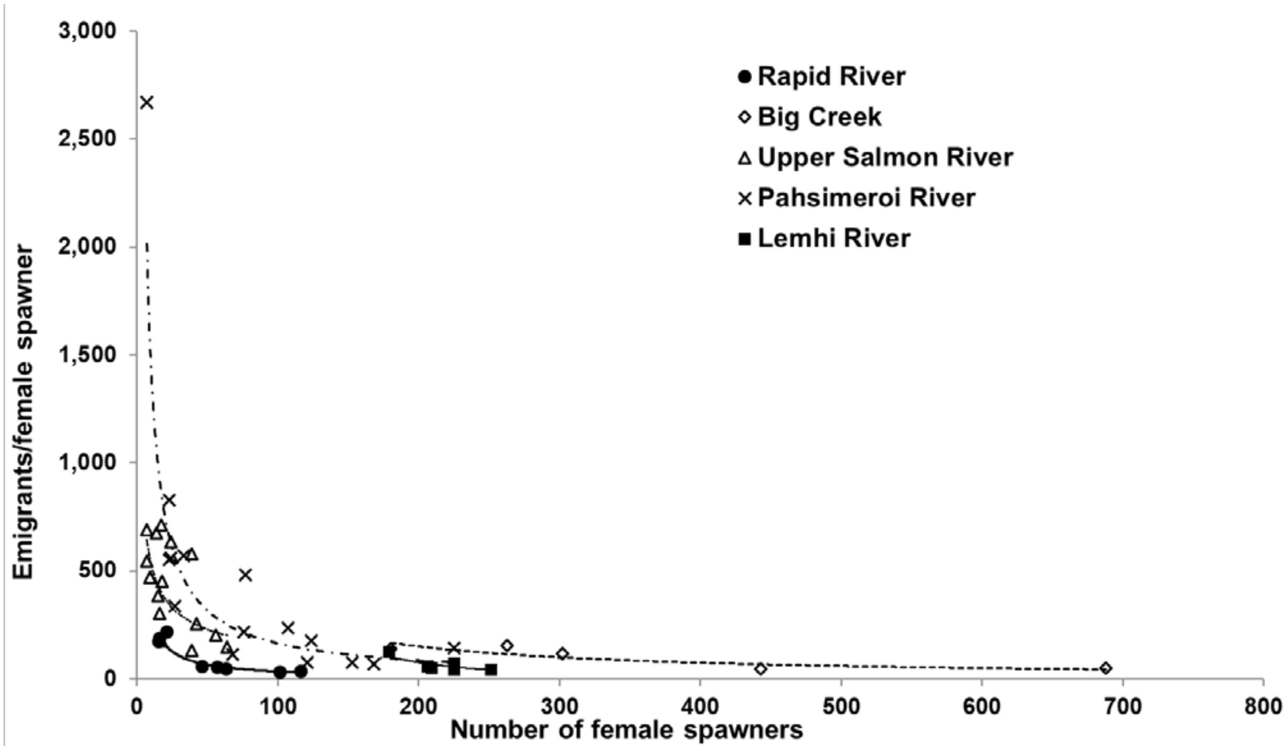

Figure 3. Relationship between wild steelhead emigrant productivity (recruits per spawner expressed as emigrants above the trap/ female spawner above the trap or array) and adult female spawner abundance above the trap or array from Rapid River (brood years 2006-2014), Big Creek (brood years 2010-2014), Upper Salmon River (brood years 2001-2015), Pahsimeroi River (brood years 2001-2015), and Lemhi River (brood years 2010-2015). Trend lines fit with a power function are shown for each data set.

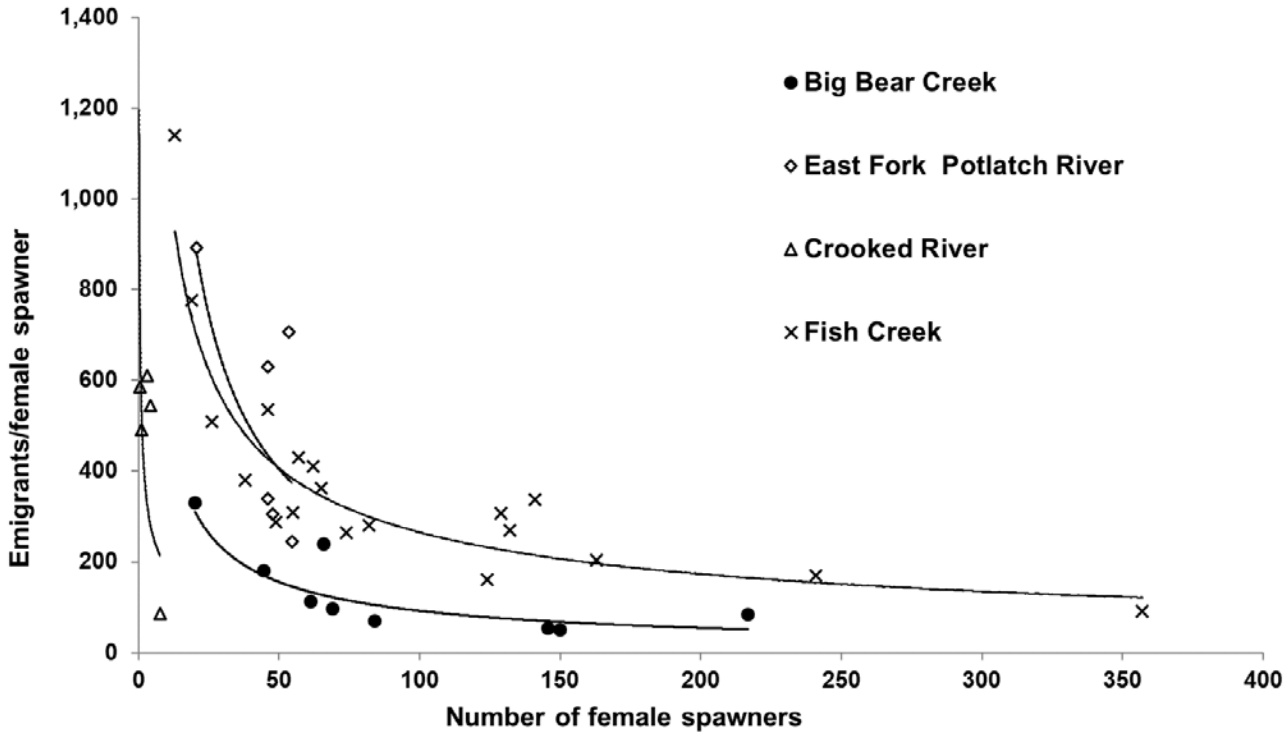

Figure 4. Relationship between wild juvenile steelhead productivity (recruits per spawner expressed as emigrants above the trap/ female spawner) and adult female spawner abundance above the trap or array for steelhead populations from Big Bear Creek (brood years 2005-2015), East Fork Potlatch River (brood years 2008-2015), Crooked River (brood years 2007-2015), Fish Creek (brood years 1996-2014). Trend lines fit with a power function are shown for each data set.

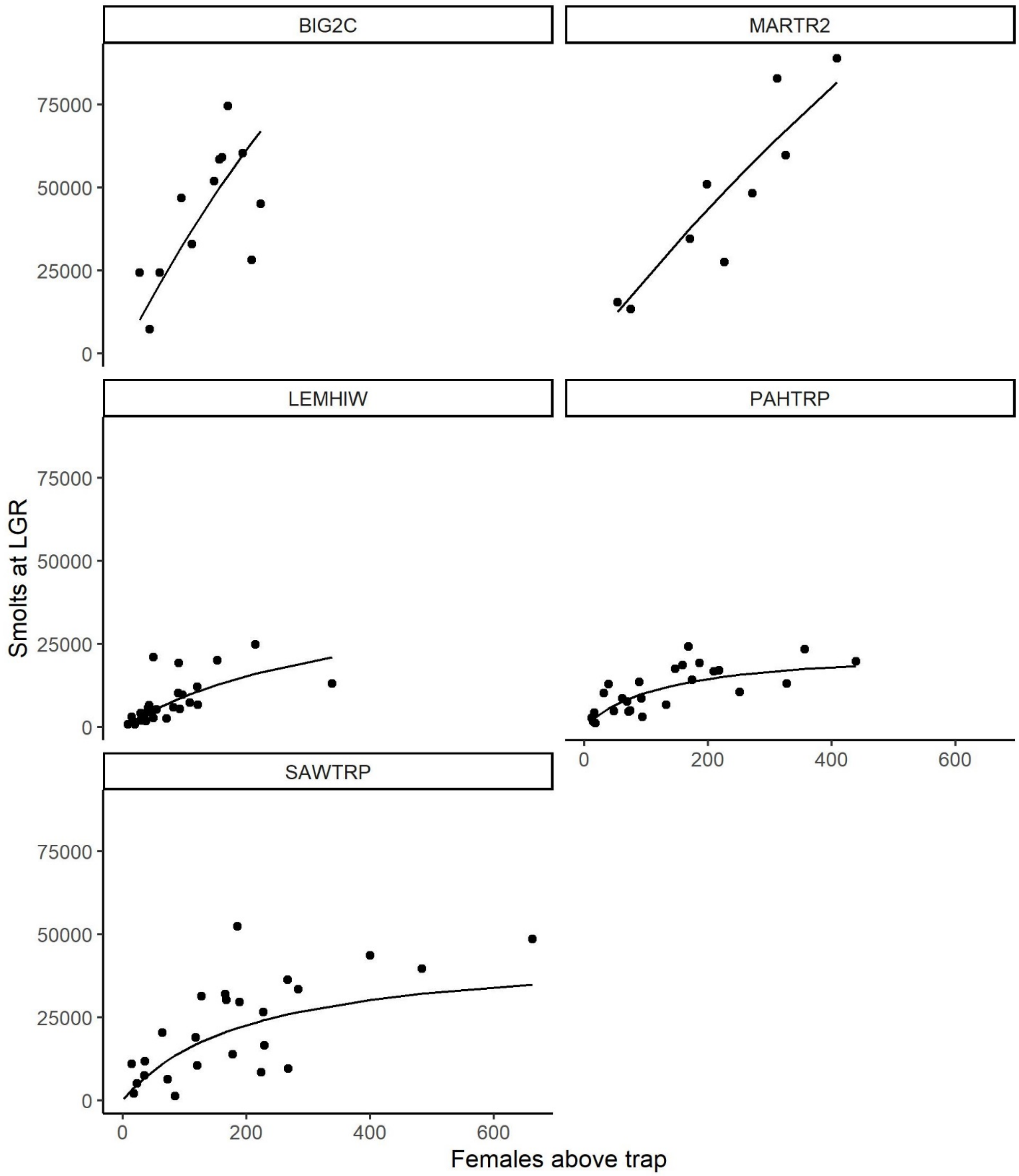

Figure 5. Relationship between wild Chinook Salmon smolts at Lower Granite Dam (LGR) and adult female spawner abundance (all redds above trap) for Chinook Salmon in Big Creek (brood years (BY) 2006-2016) and Marsh Creek (BY 2009-2016) in the Middle Fork Salmon River MPG, Pahsimeroi River, Lemhi River, and the Upper Salmon River (BY 1992-2016).

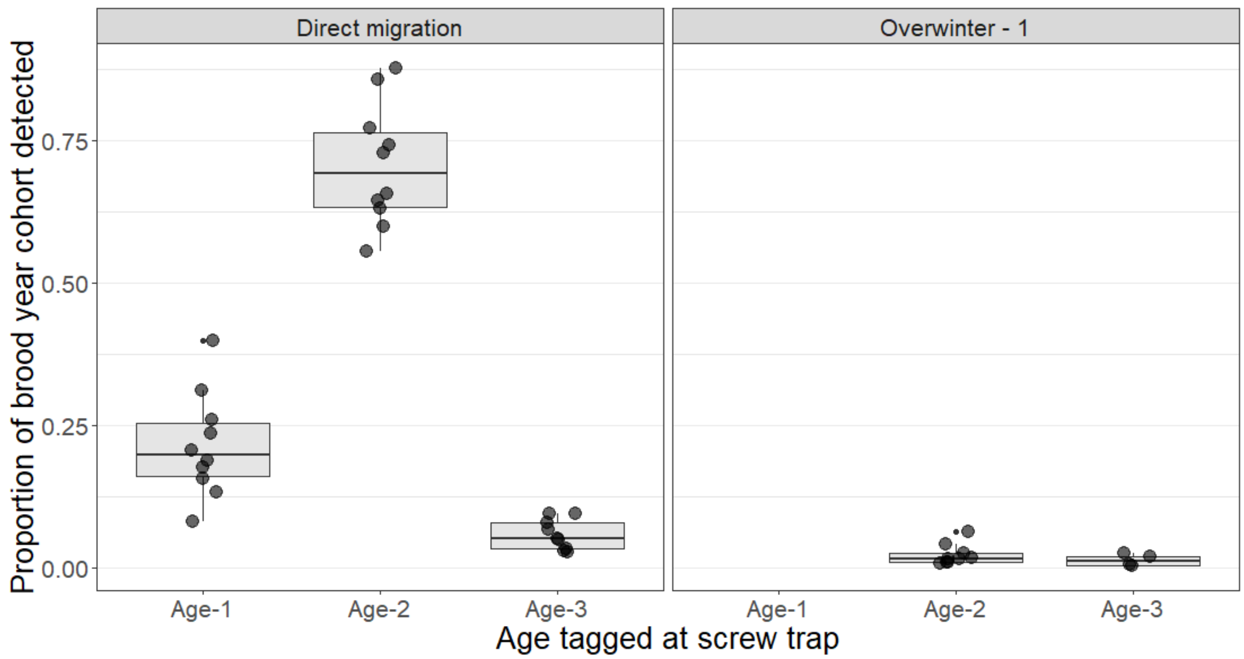

Figure 6. Boxplots of the proportions of two migratory patterns exhibited by Big Bear Creek juvenile steelhead brood year cohorts (2006–2015) by age based on hydrosystem detections. Central line represents the median, boxes represents the 25th and 75th percentiles, and whiskers represents the 5% and 95% confidence levels.

Figure 7. Boxplots of estimated survival of Big Bear Creek juvenile steelhead from rotary screw trap to Lower Granite Dam by tagged age and movement pattern for brood years 2006–2015. Central line represents the median, boxes represents the 25th and 75th percentiles, and whiskers represents the 5% and 95% confidence levels.

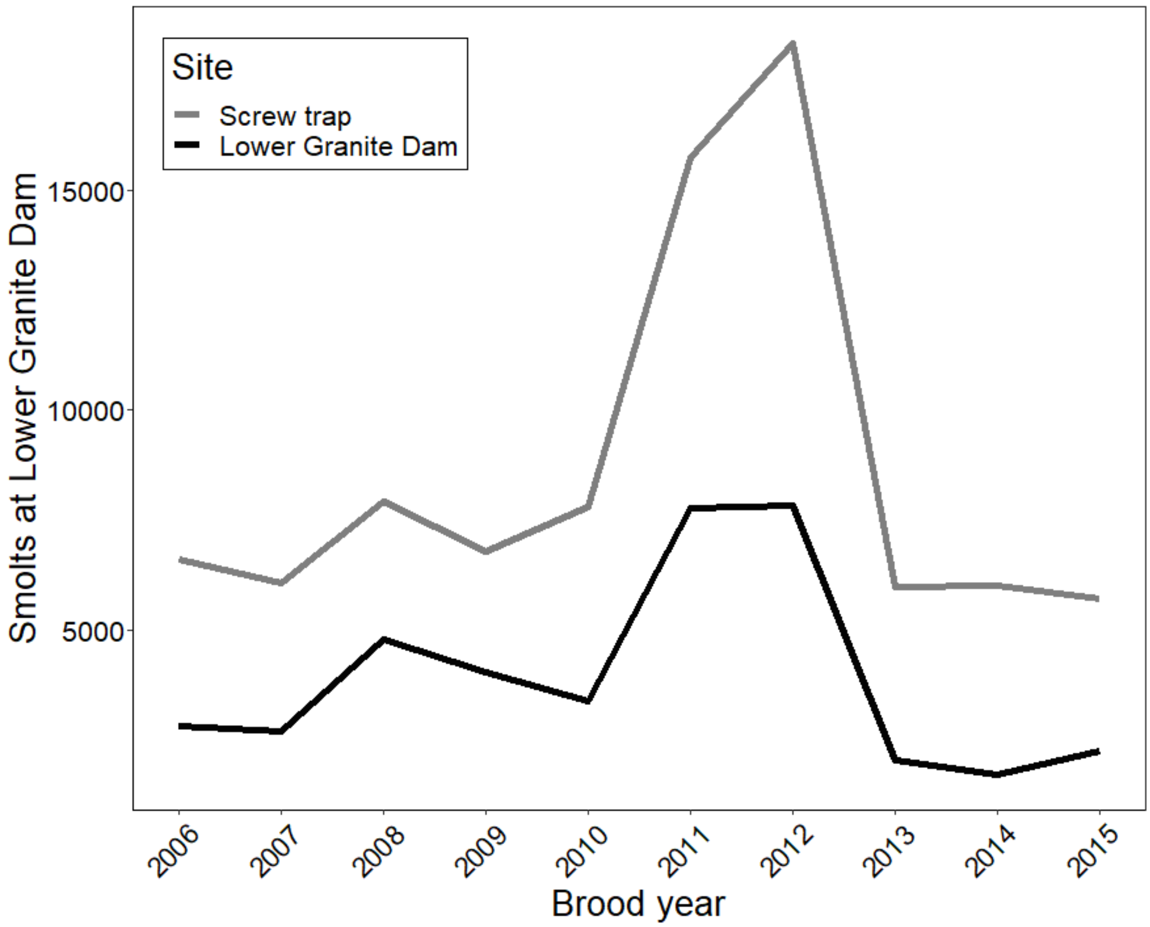

Figure 8. Total estimated juvenile steelhead at the rotary screw trap site on Big Bear Creek and estimated smolts at Lower Granite Dam for brood years 2006–2015.

APPENDICES

Appendix A. Rotary screw traps operated by Idaho Department of Fish and Game in 2019 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 steelhead Monitoring and Evaluation Studies (ISMES), Idaho Natural Production Monitoring and Evaluation Project (INPMEP), Intensively Monitored Watershed (IMW), and Integrated Status and Effectiveness Monitoring Project (ISEMP).

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*	ISMES	2007-2019	Permanent weir
2	Lower South Fork Salmon River (SFSRKT)	**South Fork Salmon River /** *South Fork Salmon River*	**Salmon River** / *South Fork Salmon River*	INPMEP	2015-2019	PIT array
3	Big Creek (BIG2CT)	**Middle Fork Salmon River /** *Big Creek*	**Salmon River** / *Lower Middle Fork Salmon River*	ISMES	2007-2019	PIT array
4	Lower Marsh Creek (MARTR2)	**Middle Fork Salmon River** / *Marsh Creek*	**Salmon River /** *Upper Middle Fork Salmon River*	INPMEP	2009-2019	None
5	North Fork Salmon River (NFSTRP)	**Upper Salmon River /** *North Fork Salmon River*	**Salmon River /** *North Fork Salmon River*	ISMES	2015-2019	PIT array
6	Lemhi River (LEMTRP)	**Upper Salmon River /** *Lemhi River*	**Salmon River /** *Lemhi River*	IMW	1992-2019	PIT array
7	Lower Lemhi River (LLRTP)	**Upper Salmon River /** *Lemhi River*	**Salmon River /** *Lemhi River*	ISEMP	2013-2019	PIT array
8	Hayden Creek (HYDTRP)	**Upper Salmon River /** *Lemhi River*	**Salmon River /** *Lemhi River*	IMW	2006-2019	PIT array
9	Upper Salmon River (SAWTRP)	**Upper Salmon River /** *Upper Salmon River mainstem*	**Salmon River** / *Upper Salmon River mainstem*	INPMEP	1992-2019	Permanent weir
10	Pahsimeroi River (PAHTRP)	**Upper Salmon River** / *Pahsimeroi River*	**Salmon River** */ Pahsimeroi River*	INPMEP	1992-2019	Permanent weir
		Clearwater River Basin				
11	Big Bear Creek (BBCTRP)	**Dry Clearwater River /** *Upper South Fork Clearwater River*	**Clearwater River /** *Lower Clearwater Mainstem*	IMW	2004-2019	PIT array
12	East Fork Potlatch River (EFPTRP)	**Dry Clearwater River /** *Upper South Fork Clearwater River*	**Clearwater River /** *Lower Clearwater Mainstem*	IMW	2007-2019	Seasonal weir
13	Crooked River (CROTRP)	**Dry Clearwater River /** *Upper South Fork Clearwater River*	**Clearwater River /** *South Fork Clearwater River*	ISMES	1990-2019	Seasonal weir
14	Lower Lochsa River (LOCTRP)	**Wet Clearwater River /** *Lochsa River*	**Clearwater River** / *Lochsa River*	ISMES	2015-2019	PIT array
15	Fish Creek (FISTRP)	**Wet Clearwater River /** *Lochsa River*	**Clearwater River** / *Lochsa River*	ISMES	1995-2019	Seasonal weir

Appendix B. Rotary screw trap operations in the Salmon River and Clearwater River basins, Idaho for 2019, 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)	4/26-10/31	142/189	The trap was not operated until after the hatchery smolt release. It was inoperable for 40 days during spring runoff and an additional 5 days because of mechanical issues.
Lower South Fork Salmon River (SFSRKT)	3/18-10/29	142/225	Trap was deployed later than usual due to high snowfall in the spring. The trap did not operate for 6 days during the chinook smolt release and for an additional 73 days during spring runoff. We did not operate the trap for 4 days during the summer due to the river temperature exceeding 18.0°C. Due to an early freeze, the cone was raised 10/29 and monitored for the next 15 days, however, conditions did not improve and the trap was removed for the season.
Big Creek (BIG2CT)	3/31-10/26	147/210	Trap was deployed later than usual due to high snowfall in the spring. The trap did not operate for 59 days in the spring due to spring runoff and 4 days in the summer due to trap mechanical issues. Due to an early freeze, the cone was raised 10/26 and monitored for the next 15 days, however, conditions did not improve and the trap was removed for the season.
Lower Marsh Creek (MARTR2)	3/23-10/27	165.5/219	The trap was inoperable for 46 days during spring runoff and 2 days in July due to fire activity and road closures. The cone was pulled on October 27 because of freezing conditions.
North Fork Salmon River (NFSTRP)	03/18-11/17	192.5/244	The trap was not operated for 4 days in April due to damage form debris floating downstream. From 5/13 – 6/12 the trap was not operated due to high flows. The trap was not operated for 3 days in August due to state-wide training (Spawning Ground Surveys). The trap was not operated from 10/30 – 11/05 due to cold weather that caused ice to form in the river and on the trap. Additionally, on multiple occasions the trap was found to be inoperable due to logs jams, low flows, et cetera.
Upper Lemhi River (LEMTRP)	3/12-11/17	243.5/249	The trap was partially operated for 10 days in the spring due to high flows and debris. The trap was partially operated for 7 days in the fall due to debris and ice buildup from an early freeze.

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
Hayden Creek (HYDTRP)	3/12-11/17	151/249	The trap was inoperable for 34 days and was partially operated for 4 days in the spring due to high flows and debris as well as low flows in June as summer approached. During the summer the trap did not operate for 27 days and was only partially operated for 5 days due to low flows. The trap was inoperable for 31 days and was partially operated for 3 days in the fall due to low flows, leaf litter, and an early freeze.
Upper Salmon River (SAWTRP)	3/22-10/29	193.5/221	SAWTRP was damaged before installation so a replacement trap was used in its place. The trap was inoperable for 4 days during the hatchery smolt release and 22 days during spring runoff. Due to freezing conditions, the cone was pulled on October 29 and the trap was removed three days later.
Pahsimeroi River (PAHTRP)	03/11-11/13	226.5/247	The trap was not operated for 12 days in April due to hatchery release of juvenile Chinook Salmon from 04/16 – 04/29. On two occasions, once in June for 3 days (6/01 – 06/03) and once in August for 3 days (08/05 – 08/07) the trap was not operated due to state-wide training activities (i.e., swift water rescue in June and spawning ground surveys in August). In October, the trap was not operated for two days from 10/12 – 10/13 due to no one being available to operate the trap. Additionally, on several occasions the trap was found to be inoperable due to logs jams, low flows, et cetera.
Big Bear Creek (BBCTRP)	02/21-06/25	51/105	The screw trap was operated for 105 days. It was fully operational for 51 days and partially or not operable for 54 days. Extreme flow conditions and heavy debris was responsible for the majority of the inoperable period.
East Fork Potlatch River (EFPTRP)	03/28-06/5	56/70	The trap operated for 70 days. It was fully operational for 56 days and partially or not operable for 14 days. The trap was installed later than normal due to heavy ice conditions and high spring runoff was responsible for the majority of the inoperable period.
Crooked River (CROTRP)	03/29-11/14	193/230	The screw trap was operated for 230 days. It was fully operational for 193 days and partially or not operable for 36 days. The trap was installed later than normal due to heavy ice conditions during installation.

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**
Fish Creek (FISTRP)	03/24-10/29	128/220	The trap was deployed for 220 days. It operated for 125 full days and 3 partial days. The trap only ran partial days due to high flows and repairs. In April, high flows and unsafe conditions caused the trap to be inoperable May 14 to August 19. The trap broke free from the safety cables on May 14. A backup trap was installed on August 2 after repairs to old trap could not be made. Due to personnel switches the week of August 4, the trap partially operated that week, On October 22, the trap cables needed repair and therefore the trap was inoperable.
Lower Lochsa (LOCTRP)	03/22-10/31	188/223	The trap was deployed for 223 days. It operated for 183 full days and 5 partial days. To avoid the capture of hatchery juvenile Chinook released upstream of the trap, the trap ran for partial days. The trap was inoperable for several days in May and June when the trap needed repairs. The trap was not operated during the month of August due to little to no fish typically captured during this time of the year.

Appendix C. Seasonal catch of juvenile steelhead <80 mm FL from rotary screw traps operated in streams in Idaho in 2019.

Population, location and PTAGIS site code	Season	Catch
Little Salmon River		
Rapid River	Spring	1
RPDTRP	Sum/Fall	1
South Fork Salmon River		
Lower South Fork Salmon River	Spring	1
SFSRKT	Sum/Fall	1,229
Lower Middle Fork Salmon River		
Big Creek	Spring	30
BIG2CT	Sum/Fall	106
Upper Middle Fork Salmon River		
Lower Marsh Creek	Spring	39
MARTR2	Sum/Fall	15
North Fork Salmon River		
North Fork Salmon River	Spring	16
NFSTRP	Sum/Fall	45
Lemhi River		
Lemhi River	Spring	4
LEMTRP	Sum/Fall	18
Hayden Creek	Spring	34
HYDTRP	Sum/Fall	112
Lower Lemhi River	Spring	18
LLRTP	Sum/Fall	28
Upper Salmon River mainstem		
Upper Salmon River	Spring	104
SAWTRP	Sum/Fall	56
Pahsimeroi River		
Pahsimeroi River	Spring	1
PAHTRP	Sum/Fall	315
South Fork Clearwater River		
Crooked River	Spring	0
CROTRP	Sum/Fall	9
Lower Clearwater Mainstem		
East Fork Potlatch River	Spring	9
EFPTRP	Sum/Fall	0
Big Bear Creek	Spring	0
BBCTRP	Sum/Fall	0
Lochsa River		
Fish Creek	Spring	0
FISTRP	Sum/Fall	116
Lower Lochsa River	Spring	1
LOCTRP	Sum/Fall	3

Appendix D. 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) Age-0	Age-1	Age-2	Age-3	Age-4	Age-5	Sum	Female Parents	Productivity
					Salmon River MPG					
Little	2007	112	716	1,865	1,628	259	0	4,580	21	218
Salmon	2008	72	478	885	958	217	65	2,675	46	58
River	2009	17	286	1,327	768	725	19	3,142	63	50
	2010	0	448	1,782	1,698	261	0	4,189	116	36
Rapid River[b]	2011	0	773	1,377	956	94	0	3,200	101	32
RPDTRP	2012	24	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	1,040	677	1,338	127	--	3,253	54	60
	2016	8	416	800	453	--	--	1,677	15	112
	2017	0	162	265	--	--	--	427	6	71
	2018	0	100	--	--	--	--	100	5	20
	2019	0	--	--	--	--	--	0	7	0
South Fork	2012	--	--	--	0	0	0	0	365	--
Salmon River	2013	--	--	277	482	0	0	759	273	--
Lower South	2014	--	5,188	1,386	1,222	0	0	7,796	279	--
Fork Salmon	2015	5,049	34,055	10,954	790	--	--	50,848	486	105
River[a,c]	2016	4,749	22,454	17441	--	--	--	44,644	651	69
SFSRKT	2017	711	4862	--	--	--	--	5,573	411	14
	2018	0	--	--	--	--	--	0		--
	2019	454	--	--	--	--	--	454		
Lower	2010	0	7,605	18,634	6,950	602	0	33,791	688	49
Middle Fork	2011	0	3,314	10,143	5,979	558	0	19,994	443	45
Salmon River	2012	84	14,551	19,330	6,754	243	0	40,962	263	156
	2013	85	13,263	20,762	1,097	211	0	35,418	302	117
Big Creek[a,c]	2014	0	13,431	9,812	1,603	0	0	24,846	180	138
BIGC2T	2015	0	12,826	6,777	666	103	--	20,372	532	38
	2016	442	4,772	14700	2,513	--	--	22,427	216	104
	2017	0	4098	8,553	--	--	--	12,651	42	301
	2018	154	7,701	--	--	--	--	7,855	85	92
	2019	0	--	--	--	--	--	0	56	0

Appendix D Continued.

Population and RST Location	Cohort	Age-0	Age-1	Age-2	Age-3	Age-4	Age-5	Sum	Female Parents	Productivity
		Number of Emigrants by Age (years)								
Upper Salmon	2001	264	9,916	4,318	656	57	0	15,211	24	634
River	2002	32	1,779	2,830	563	0	0	5,204	39	133
Mainstem	2003	16	3,045	1,548	204	13	0	4,826	16	302
	2004	22	988	954	1,842	0	0	3,806	7	544
Upper Salmon	2005	62	1,001	4,734	0	0	0	5,797	15	386
River[b]	2006	0	4,172	0	49	0	0	4,221	9	469
SAWTRP	2007	128	0	2,552	343	0	0	3,023	17	178
	2008	0	1,923	2,817	80	6	0	4,826	7	689
	2009	12	5,055	4,133	237	14	0	9,451	14	675
	2010	12	7,607	3,530	175	0	0	11,324	56	202
	2011	16	5,281	4,092	27	0	0	9,416	64	147
	2012	182	6,278	3,900	334	0	0	10,694	42	255
	2013	0	4,108	3,701	327	0	0	8,136	18	452
	2014	0	8,068	3,997	72	0	0	12,137	17	714
	2015	526	19,546	2,187	377	0	--	22,636	39	580
	2016	1,374	6,540	2776	1,239	--	--	11,929	44	271
	2017	436	856	2,502	--	--	--	3,794	18	211
	2018	51	3,706	--	--	--	--	3,757	9	417
	2019	75	--	--	--	--	--	75	7	11
Pahsimeroi	2001	8,038	22,045	6,773	172	0	0	37,028	77	481
River[b]	2002	12,194	17,211	2,477	337	0	0	32,219	225	143
PAHTRP	2003	7,264	10,010	4,505	155	0	0	21,934	124	177
	2004	6,696	10,049	2,065	0	0	0	18,810	33	570
	2005	2,822	5,897	188	151	0	0	9,058	27	335
	2006	3,146	8,045	1,444	77	0	0	12,712	23	553
	2007	5,766	11,468	903	550	0	0	18,687	7	2670
	2008	5,040	8,138	5,371	453	0	0	19,002	23	826
	2009	2,227	9,879	1,306	0	0	0	13,412	24	559
	2010	1,581	3,410	2,050	664	0	0	7,705	68	113
	2011	202	4,897	6,420	64	0	0	11,583	153	76
	2012	1,224	8,368	2,103	22	0	0	11,717	168	70
	2013	12,086	11,432	1,399	159	0	60	25,136	107	235
	2014	2,533	4,940	1,566	0	0	0	9,039	121	75
	2015	5,525	10,340	680	132	0	--	16,677	76	219
	2016	3,330	6,140	2114	135	--	--	11,719	57	206
	2017	1,436	6339	725	--	--	--	8,500	18	472
	2018	1142	2,896	--	--	--	--	4,038	20	202
	2019	2,550	--	--	--	--	--	2,550	21	121

Appendix D Continued.

Population and RST Location	Cohort	Age-0	Age-1	Age-2	Age-3	Age-4	Age-5	Sum	Female Parents	Productivity
		Number of Emigrants by Age (years)								
Lemhi	2010	388	8,164	1,601	160	20	3	10,336	225	46
River[a,c]	2011	90	9,261	1,482	230	32	0	11,095	209	53
LEMTRP	2012	1,056	8,207	1,871	373	41	0	11,548	251	46
	2013	922	7,352	3,287	806	0	0	12,367	206	60
	2014	705	16,169	5,407	48	0	0	22,329	179	125
	2015	1,734	13,390	1,123	204	0	--	16,451	225	73
	2016	0	11,138	882	148	--	--	12,168	146	83
	2017	725	6852	1,249	--	--	--	8,826	116	76
	2018	611	5,251	--	--	--	--	5,862	67	87
	2019	179	--	--	--	--	--	179		
Clearwater River MPG										
Lower	2006	1	2,450	3,286	903	0	0	6,640	145	55
Clearwater	2007	0	2,109	4,383	205	0	0	6,697	20	332
River	2008	23	1,266	6,621	175	0	0	8,085	69	97
Mainstem	2009	3	3,264	3,452	279	0	0	6,998	44	182
	2010	5	209	6,548	1,049	0	0	7,811	61	114
Big Bear Creek[b]	2011	0	4,224	11,109	516	0	0	15,849	150	52
BBCTRP	2012	4	10,526	6,911	930	0	0	18,371	66	241
	2013	1	928	4,870	193	0	0	5,992	217	85
	2014	0	2,736	3,216	70	0	0	6,022	84	71
	2015	0	2,446	3,127	139	0	--	5,712	125	48
	2016	0	7,730	6788	512	--	--	15,030	48	119
	2017	0	3256	4,705	--	--	--	7,961	173	87
	2018	0	932	--	--	--	--	932	18	450
	2019	0	--	--	--	--	--	0	5	200
East Fork										
Potlatch	2008	140	9,572	7,229	0	0	0	16,941	46	339
River[b]	2009	10	22,017	4,366	666	0	0	27,059	46	629
EFPTRP	2010	550	9,959	2,784	686	0	0	13,979	55	245
	[a]2011	0	9,139	6,192	415	0	0	15,746	21	892
	2012	258	33,473	4,768	1,825	0	0	40,324	53	707
	2013	21	5,942	8,952	378	0	0	15,293	48	306
	2014	0	16,742	3,297	0	0	0	20,039	45	501
	2015	0	5,538	3,057	165	0	--	8,760	59	183
	2016	206	12,153	5456	305	--	--	18,120	54	336
	2017	0	9589	1,372	--	--	--	10,961	8	2,192
	2018	0	1,423	--	--	--	--	1,423	10	129
	2019	0	--	--	--	--	--	0	2	0

Appendix D 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
South Fork										
Clearwater	2007	0	131	827	376	144	0	1,478	8	87
River	2008	0	54	116	291	30	0	491	1	491
	2009	0	0	93	125	9	0	227	0	
Crooked River[b]	2010	0	1,024	1,754	1,026	9	0	3,813	4	545
CROTRP	2011	0	83	1,283	388	0	0	1,754	0	585
	2012	5	992	832	0	0	0	1,829	3	610
	2013	0	0	0	7	0	0	7	1	
	2014	0	0	87	26	0	0	113	0	
	2015	0	1,454	343	0	7	--	1,804	4	451
	2016	0	290	0	51	--	--	341	1	0
	2017	0	0	144	--	--	--	144	0	0
	2018	0	82	--	--	--	--	82	0	
	2019	0	--	--	--	--	--	0	0	
Lochsa River										
	1996	0	5,286	6,869	1,057	20	0	13,232	26	509
Fish Creek[b]	1997	57	4,974	9,087	626	88	0	14,832	13	1141
FISHTRP	1998	0	10,713	10,961	2,934	15	0	24,623	46	535
	1999	99	8,581	15,846	924	39	0	25,489	62	411
	2000	137	8,466	4,679	1,479	0	0	14,761	19	777
	2001	238	7,667	15,612	1,050	0	0	24,567	57	431
	2002	0	13,501	15,288	4,266	0	0	33,055	163	203
	2003	341	14,029	23,948	2,449	116	0	40,883	241	170
	2004	241	23,092	14,091	2,079	70	0	39,573	129	307
	2005	491	9,021	12,149	1,295	0	0	22,956	82	280
	2006	66	9,236	9,227	853	155	0	19,537	74	264
	2007	56	4,553	8,108	1,417	0	0	14,134	49	288
	2008	0	4,883	11,809	286	0	0	16,978	55	309
	2009	47	16,008	29,647	1,740	104	0	47,546	141	337
	2010	0	16,984	16,279	2,425	0	0	35,688	132	270
	2011	0	7,723	23,651	1,147	43	0	32,564	357	91
	2012	70	7,626	10,896	963	435	0	19,990	124	161
	2013	0	3,440	9,764	597	9764	0	23,565	65	363
	2014	0	8,735	5,664	43	0	0	14,442	38	380
	2015	94	70,459	487	70459	487	--	141,986	349	407
	2016	0	25,307	9,259	802	--	--	35,368	142	249
	2017	12,654	2,380	5,060	--	--	--	20,094	58	346
	2018	37	868	--	--	--	--	905	8	113
	2019	100	--	--	--	--	--	100	40	3

[a] Adult estimate from PIT array (John Powell personal communication).
[b] Estimate from weir escapement.
[c] Female parent estimates for years 2019 and prior were re-calculated using the improved DABOM model.

Appendix E. Plan for operation of rotary screw traps by Idaho Department of Fish and Game in 2019.

FINAL 2-25-19

2019 Plan for IDFG Screw Traps and Biosampling Adult Steelhead and Chinook Salmon Released at Weirs

Bill Schrader, Brett Bowersox, Jeff Diluccia, Greg Schoby, Dale Allen, and Tim Copeland, 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 2019. 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 SMP/CSS traps and those covered in the HGMPs) in tributaries of the Clearwater and Salmon 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 9/30/18 and NOAA Section 4(d) permitting applications due 10/6/18.

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 Feeken (Lemhi IMW), and Scott Putnam (Idaho SMP/CSS) as well as Idaho Steelhead Monitoring and Evaluation Studies (ISMES) and Idaho Natural Production Monitoring and Evaluation (INPMEP) 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 2019.

Map #	Trap and PTAGIS Site Code	Subbasin	NOAA Juvenile Permit	Migratory Year 2019 Status	Calendar Year 2019 Contract and Operator	Screw Trap Comments
IDFG Wild Salmon & Steelhead Projects (INPMEP & ISMES)						
9	Sawtooth (SAWTRP)	Upper Salmon	10-2022-#1124-6R	OPERATE	INPMEP-Eli Felts	
10	Pahsimeroi River (PAHTRP)	Upper Salmon	4d-2019-#22513	OPERATE	INPMEP-Conor McClure	
5	North Fork Salmon River (NFSTRP)	Upper Salmon	4d-2019-#22513	OPERATE	ISMES- Conor McClure	
4	Marsh Creek Lower (MARTR2)	MF Salmon	4d-2019-#22513	OPERATE	INPMEP-Eli Felts	
3	Big Creek (BIG2CT)	MF Salmon	4d-2019-#22513	OPERATE	ISMES-Josh Poole	
2	Krassel (SFSRKT)	SF Salmon	4d-2019-#22513	OPERATE	INPMEP-Josh Poole	
1	Rapid River (RPDTRP)	Lower Salmon	4d-2019-#22513	OPERATE	ISMES-Eric Stark	
15	Fish Creek (FISTRP)	Lochsa	4d-2019-#22514	OPERATE	ISMES-Marika Dobos	
14	Lochsa River Lower (LOCTRP)	Lochsa	4d-2019-#22514	OPERATE	ISMES-Marika Dobos	
13	Crooked River (CROTRP)	SF Clearwater	4d-2019-#22514	OPERATE	ISMES-Brian Knoth	Steelhead monitoring, CSS PIT-tagging, habitat evaluation
IDFG Potlatch Project (IMW)						
11	Big Bear Creek (BBCTRP)	Lower Clearwater	4d-2019-#22514	OPERATE	Potlatch IMW-Brian Knoth	
12	East Fork Potlatch River (EFPTRP)	Lower Clearwater	4d-2019-#22514	OPERATE	Potlatch IMW-Brian Knoth	
IDFG Lemhi Projects (IMW)						
6	Lemhi River Upper (LEMTRP)	Upper Salmon	4d-2019-#22643	OPERATE	Lemhi IMW-Stacey Feeken	
8	Hayden Creek (HYDTRP)	Upper Salmon	4d-2019-#22643	OPERATE	Lemhi IMW-Stacey Feeken	
7, 22	Lemhi River Lower (LLRTP)	Upper Salmon	4d-2019-#22643	OPERATE	Biomark-Stacey Feeken	
IDFG Smolt Monitoring Project (SMP/CSS)						
17	White Bird (SALTRP) [a]	Lower Salmon	02-19-FPC47	OPERATE	Idaho SMP/CSS-Scott Putnam	Permitted (LOD) through FPC
18	Lewiston (SNKTRP) [a]	Lower Snake	02-19-FPC47	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 2019. Scale and genetics sampling for steelhead and Chinook salmon are indicated.

IDFG Adult Weir (Map #)	Wild and Integrated Adult Sampling at Hatchery and Research Weirs							
	Steelhead				Spring-Summer Chinook Salmon			
	Collect Scale Sample ?	Collect Genetic Sample ?	NOAA Adult Permit	2019 Contract & Operator	Collect Scale Sample ?	Collect Genetic Sample ?	NOAA Adult Permit	2019 Contract & Operator
Sawtooth (9)	Yes	Yes	HGMP	ISMES-Sawtooth FH	No	Yes	HGMP	INPMEP-Sawtooth FH
EFSR (19)	Yes[a]	Yes	HGMP	ISMES-Sawtooth FH	N/A[b]	N/A[b]	N/A[b]	N/A[b]
Pahsimeroi (10)	Yes	Yes	HGMP	ISMES-Pahsimeroi FH	No	Yes	HGMP	INPMEP-Pahsimeroi FH
Lemhi River (22)	Yes[c]	Yes[c]	10-2020-#19690	Lemhi IMW-Stacey Feeken	No[c]	Yes[c]	10-2020-#19690	Lemhi IMW-Stacey Feeken
Hayden Creek (8)	N/A[c]	N/A[c]	N/A[c]	Lemhi IMW-Stacey Feeken	N/A[c]	N/A[c]	4d-2019-#22643	Lemhi IMW-Stacey Feeken
Bear Valley Creek (34)	N/A[c]	N/A[c]	N/A[c]	Lemhi IMW-Stacey Feeken	N/A[c]	N/A[c]	4d-2019-#22643	Lemhi IMW-Stacey Feeken
Twelve Mile Creek (25)	Yes	Yes	4d-2019-#22513	Region 7-Conor McClure	N/A	N/A	N/A	N/A
Poison Creek (26)	Yes	Yes	4d-2019-#22513	Region 7-Conor McClure	N/A	N/A	N/A	N/A
Carmen Creek (27)	Yes	Yes	4d-2019-#22513	Region 7-Conor McClure	N/A	N/A	N/A	N/A
Tower Creek (28)	Yes	Yes	4d-2019-#22513	Region 7-Conor McClure	N/A	N/A	N/A	N/A
Fourth of July Creek (29)	Yes	Yes	4d-2019-#22513	Region 7-Conor McClure	N/A	N/A	N/A	N/A
Iron Creek (30)	Yes	Yes	4d-2019-#22513	Region 7-Conor McClure	N/A	N/A	N/A	N/A
Cow Creek (33)	Yes	Yes	4d-2019-#22513	Region 7-Conor McClure	N/A	N/A	N/A	N/A
Challis Creek (31)	Yes	Yes	4d-2019-#22513	Region 7-Conor McClure	N/A	N/A	N/A	N/A
Morgan Creek (32)	Yes	Yes	4d-2019-#22513	Region 7-Conor McClure	N/A	N/A	N/A	N/A
McCall SFSR (20)	Yes[d]	Yes[d]	HGMP	ISMES-Josh Poole	No	Yes	HGMP	INPMEP-McCall FH
Rapid River (1)	Yes[d]	Yes[d]	HGMP	ISMES-Eric Stark	No	Yes	HGMP	INPMEP-Rapid River FH
Hells Canyon Oxbow (24)	Yes	Yes	HGMP	ISMES-Oxbow FH	No	Yes	HGMP	INPMEP-Oxbow FH
Powell (21)	N/A[d]	N/A[d]	N/A	N/A	No	Yes	N/A[e]	INPMEP-Clearwater FH
Fish Creek (15)	Yes	Yes	4d-2019-#22514	ISMES-Marika Dobos	No	Yes	N/A[e]	ISMES-Marika Dobos
Red River (23)	N/A[d]	N/A[d]	N/A	N/A	No	Yes	N/A[e]	INPMEP-Clearwater FH
Crooked River (13)	Yes[d]	Yes[d]	4d-2019-#22514	ISMES-Brian Knoth	No	Yes	N/A[e]	INPMEP-Clearwater FH
EF Potlatch River (12)	Yes	Yes	4d-2019-#22514	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 is not a full escapement weir, anticipate capturing 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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