FISHERY RESEARCH

IDAHO ADULT CHINOOK SALMON MONITORING

2022 ANNUAL REPORT

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Idaho Adult Chinook Salmon Monitoring

2022 Annual Report

By

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ABBREVIATIONS AND ACRONYMS

BIG	Big Creek
BPA	Bonneville Power Administration
BVC	Bear Valley Creek
BY	Brood Year
CAM	Camas Creek
CHC	Chamberlain Creek
CWT	Coded Wire Tag
DPS	Distinct Population Segment
EFSR	East Fork Salmon River
EFSFSR	East Fork South Fork Salmon River
ESA	Endangered Species Act
ESU	Evolutionarily Significant Unit
FCRPS	Federal Columbia River Power System
FINS	Fish Inventory System Hatchery Database
GPS	Global Positioning System
ICBTRT	Interior Columbia Basin Technical Recovery Team
IFWIS	Idaho Fish and Wildlife Information System
IDFG	Idaho Department of Fish and Game
LAP	Lapwai/Big Canyon creeks
LEM	Lemhi River
LSR	Little Salmon River
LOC	Lochsa River
LOLO	Lolo Creek
LOON	Loon Creek
LNFC	Lower North Fork Clearwater River
MAR	Marsh Creek
MED	Meadow Creek
MPG	Major Population Group
MFSRU	Middle Fork Salmon River above and including Indian Creek
MFSRL	Middle Fork Salmon River below Indian Creek
MOO	Moose Creek
NFSR	North Fork Salmon River
NMFS	U.S. Department of Commerce, National Marine Fisheries Service

NOAA	National Oceanic and Atmospheric Administration
NPCC	Northwest Power and Conservation Council
NPT	Nez Perce Tribe
NRAAL	Nampa Research Anadromous Ageing Laboratory
NWFSC	Northwest Fisheries Science Center
PA	Percent Agreement
PAH	Pahsimeroi River
PAN	Panther Creek
PCSRF	Pacific Coast Salmon Recovery Funds
PDO	Pacific Decadal Oscillation
PIT	Passive Integrated Transponder
POT	Potlatch River
PSMFC	Pacific States Marine Fisheries Commission
PTAGIS	PIT Tag Information System
RMSE	Root Mean Squared Error
SAR	Smolt-to-adult Return Rate
SBT	Shoshone-Bannock Tribes
SEC	Secesh River
SEL	Upper Selway River
SFSR	South Fork Salmon River mainstem
SGS	Spawning Ground Survey
SGSA	Spawning Ground Survey Application
SUL	Sulphur Creek
UAS	Unmanned Aircraft System
USFS	U.S. Forest Service
UNFC	Upper North Fork Clearwater River
USFC	Upper South Fork Clearwater River
USRL	Salmon River Lower Mainstem (below Redfish Lake Creek)
USRU	Salmon River Upper Mainstem (above Redfish Lake Creek)
VAL	Valley Creek
YFK	Yankee Fork Salmon River

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FOREWORD

INTRODUCTION

Historically, Idaho waters supported abundant, naturally reproducing Chinook Salmon *Oncorhynchus tshawytscha* runs, which represented an important cultural, economic, and recreational resource within the state (Fulton 1968; Chapman 1986). Adult spring-run, summer-run, and fall-run Chinook Salmon migrate through the Columbia River and enter Idaho via the Snake River. Fall-run Chinook Salmon are currently monitored in Idaho by Idaho Power Company and the Nez Perce Tribe. As such, this report is exclusively focused on spring-summer Chinook Salmon.

Snake River spring-summer Chinook Salmon runs were historically supported by populations that spawned in the Salmon River and Clearwater River basins of Idaho. The Salmon River basin has long been recognized as the most productive spawning area for spring-summer Chinook Salmon in the entire Columbia River basin (Fulton 1968). During the late 1950s, an estimated 44 percent of the spring and summer runs in the Columbia River, and 83 percent in the Snake River, were destined for the Salmon River basin (Fulton 1968). The Clearwater River basin represented an important spawning area for spring-summer Chinook Salmon until 1927, when the construction of Lewiston Dam prevented passage and functionally extirpated all populations in this basin (Fulton 1968). Lewiston Dam was removed in 1973 to accommodate other projects taking place as part of the Federal Columbia River Power System (FCRPS). The Clearwater Reintroduction Program was active from the early 1960s into the 1980s to restore salmon to the Clearwater River basin with some success, as measured by redd counts (e.g., Lindland and Bowler 1989). Dworshak Dam, located on the North Fork Clearwater River 5 km upstream of the confluence with the Clearwater River, was completed in 1973 and currently prevents spring-summer Chinook Salmon passage into previously productive spawning grounds (Fulton 1968). Hence, population abundance in the Salmon and Clearwater basins has declined from historic levels but their history and current status are quite different.

Populations of spring-summer Chinook Salmon in the Snake River basin declined substantially following the construction of hydroelectric dams in the Snake and Columbia rivers in the late 1960s and early 1970s. Survival of all Chinook Salmon runs emigrating from the Snake River basin decreased following the construction of these dams (Raymond 1988). Shifts in ocean climatic regime also contributed to an unfavorable state for all Columbia River salmonid stocks in the 1980s and early 1990s (Mantua et al. 1997). Declines in abundance from the late 1960s until the early 1990s resulted in listing of Snake River spring-summer Chinook Salmon as threatened under the Endangered Species Act (ESA) in 1992 (Federal Register notice 57FR14653). Abundance has been variable since the initial 1992 listing but observed increases have not been sufficient for delisting (NMFS 2022).

Current monitoring for Snake River spring-summer Chinook Salmon recovery is framed by population boundaries established by the Interior Columbia Basin Technical Recovery Team following ESA guidance (ICBTRT 2003, 2005; Figure 1). The ESA defines species to include subspecies and distinct population segments (DPS) of vertebrate species. Policy guiding identification of DPS for salmon species directs the National Marine Fisheries Service (NMFS) to identify population groups that are evolutionarily significant units (ESU) within their species (NMFS 2022). NMFS considers a group of populations an ESU “if it is substantially reproductively isolated from other populations and represents an important component in the evolutionary legacy of the biological species” (NMFS 2022). Evolutionarily Significant Units are divided into hierarchical levels including Major Population Groups (MPGs), which are further divided into

demographically independent populations (McElhany et al. 2000; ICBTRT 2005). The Snake River spring-summer Chinook Salmon ESU is organized into seven MPGs, five of which are in Idaho (ICBTRT 2005). A total of 33 independent populations have been identified in Idaho, of which 12 have been extirpated. However, 6 previously extirpated populations have been re-established in Clearwater MPGs with stocks from extant Snake River populations. The Panther Creek population in the Upper Salmon MPG was also extirpated and re-established. Currently there are 27 extant or re-established populations across all 5 Idaho MPGs.

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 in the basin – and recovery planning and implementation efforts aimed at recovering ESA-listed wild salmon and steelhead stocks. The Idaho Department of Fish and Game's anadromous fish program long-range goals, consistent with basinwide mitigation recovery programs, are to preserve Idaho's 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 salmon populations function (McElhany et al. 2000) as well as regular status assessments.

The Idaho Salmon and Steelhead Monitoring and Evaluation Studies are designed to collect information necessary to assess the status of Idaho's spring-summer Chinook Salmon (hereafter Chinook Salmon) populations relative to IDFG and ESA goals. These data are used in fishery planning and management in accordance with goals for wild- and natural-origin Chinook Salmon stated in the current IDFG fisheries management plan (IDFG 2019). Additionally, status of Pacific salmonids listed under the ESA is assessed by NMFS using population viability criteria which are related to trends and status in abundance, productivity, spatial structure, and diversity (McElhany et al. 2000; Ford 2022).

Natural-origin fish were those produced in the natural stream habitat, whereas hatchery-origin fish were those produced in a hatchery. For the purposes of this report, wild-origin fish, defined as without history or evidence of hatchery introgression (IDFG 2019), were considered to be a subset of natural-origin fish. Hatchery fish were further distinguished by either segregated or integrated production type. Segregated hatchery-origin Chinook Salmon were those produced from crosses of hatchery fish only, whereas integrated hatchery-origin fish were produced from crosses of either two natural-origin parents or crosses of one natural- and one hatchery-origin parent. Carcasses with an adipose fin clip were considered segregated hatchery-origin. Carcasses with an intact adipose fin and a coded wire tag were considered integrated hatchery-origin.

REPORT CHAPTERS AND TOPICS

This report documents status and trends in spawner abundance and productivity of Chinook Salmon using data collected on Idaho's spawning grounds. Abundance of spawning salmon can fluctuate greatly and should be related to historic observations for proper interpretation. Chapter 1 reports annual redd counts at index reaches surveyed during the historical peak spawning period and compares current observations to select long-term data collected since the 1950s. In addition to a metric of relative spawner abundance such as redd counts, the adult-to-adult productivity of the population is essential to evaluate population status. Chapter 1 also reports spawner composition metrics necessary to quantify productivity (i.e., age composition, hatchery fraction), and uses that information to quantify adult-to-adult productivity through the most recently completed brood year.

Chapter 2 focuses on a unique MPG by analyzing the persistence and spatial dynamics of Chinook Salmon in Idaho's pristine Middle Fork Salmon River basin. A long-term plan for annual spawning ground surveys in the Middle Fork Salmon River wilderness was developed for this basin in 2018 and was provided in a previous version of this report (Felts et al. 2019, Appendix A).

Additional data not related to specific chapter objectives are often collected during spawning ground surveys and hatchery weir operations. This annual report also serves to document those collection efforts or any changes to our standard efforts. Appendix A documents data collected at hatchery weirs and during multiple pass redd counts.

DATA MANAGEMENT AND ACCESS

Throughout this report we refer to populations designated by the Interior Columbia Basin Technical Recovery Team (ICBTRT 2003, 2005). Because some of these names are quite long, we use our own abbreviations (see Abbreviations and Acronyms page) to describe populations in tables and figures.

Data management follows protocols detailed in Copeland et al. (2019). Spawning ground survey (SGS) data, including redd count and carcass survey data, are recorded in the field on standardized paper data sheets and with global positioning systems (GPS) devices. Waypoints are captured for new redds, carcasses, and survey boundaries using standardized naming conventions. Personnel from IDFG and the Shoshone-Bannock Tribes enter index and non-index survey data into a local Spawning Ground Survey application (SGSA), and the GPS data are imported into their respective surveys in the SGSA. The data are quality checked by the compilers against the paper survey forms. The waypoint data are visually inspected by the compilers to ensure accuracy in the SGSA. Upon verification of complete and correct surveys, the data are uploaded to the centralized, Microsoft SQL Server SGS database. Other organizations such as the Nez Perce Tribe send index count data to IDFG biologists who then enter it into a local SGSA. The transferred index data are checked for completeness and correctness by data managers, and corrections are uploaded from their SGSA to the SGS database if necessary. Non-index data collected by other organizations are housed and maintained in their separate databases. The data from all compilers are accessible with permission from Idaho Department of Fish and Game (IDFG) in read-only views from the Idaho Fish and Wildlife Information System (IFWIS) web reports, which query the SGS database: https://fishandgame.idaho.gov/ifwis/portal.

Carcass sample data - such as fin ray, genetic, and otolith data - that are recorded on the spawning grounds are entered into SGSA, uploaded to the SGS database, and then transferred from the SGS database to the BioSamples database, which is located on a Microsoft SQL Server. The transfer is performed by the aging laboratory coordinator who uses a data template in Microsoft Excel to reformat data from the SGS database for entry into the BioSamples database. A unique fish identification code from the SGS database is entered into the BioSamples database to assist in joining the two databases. Carcass records in the SGS database with fin ray samples are joined to the aging data in the BioSamples database using the unique fish identification code and the sample number. When the fin rays are analyzed, the estimated age from the BioSamples database populates the Estimate Total Age field in the SGS database.

For the purposes of this report, all index and census redd survey data were entered into pre-formatted tables by biologists responsible for their collection. Length and fin ray age data were downloaded from the BioSamples database on 16 February 2023. Adult weir and trap data are stored in and accessed from the Fish Inventory System Hatchery Database

https://www.finsnet.org/#. These data include all adult Chinook Salmon that are trapped, spawned, or released to spawn naturally. Weir and trap genetics sample data were downloaded from the IDFG Eagle Fish Genetics Laboratory Progeny database on 9 March 2023.

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FIGURES

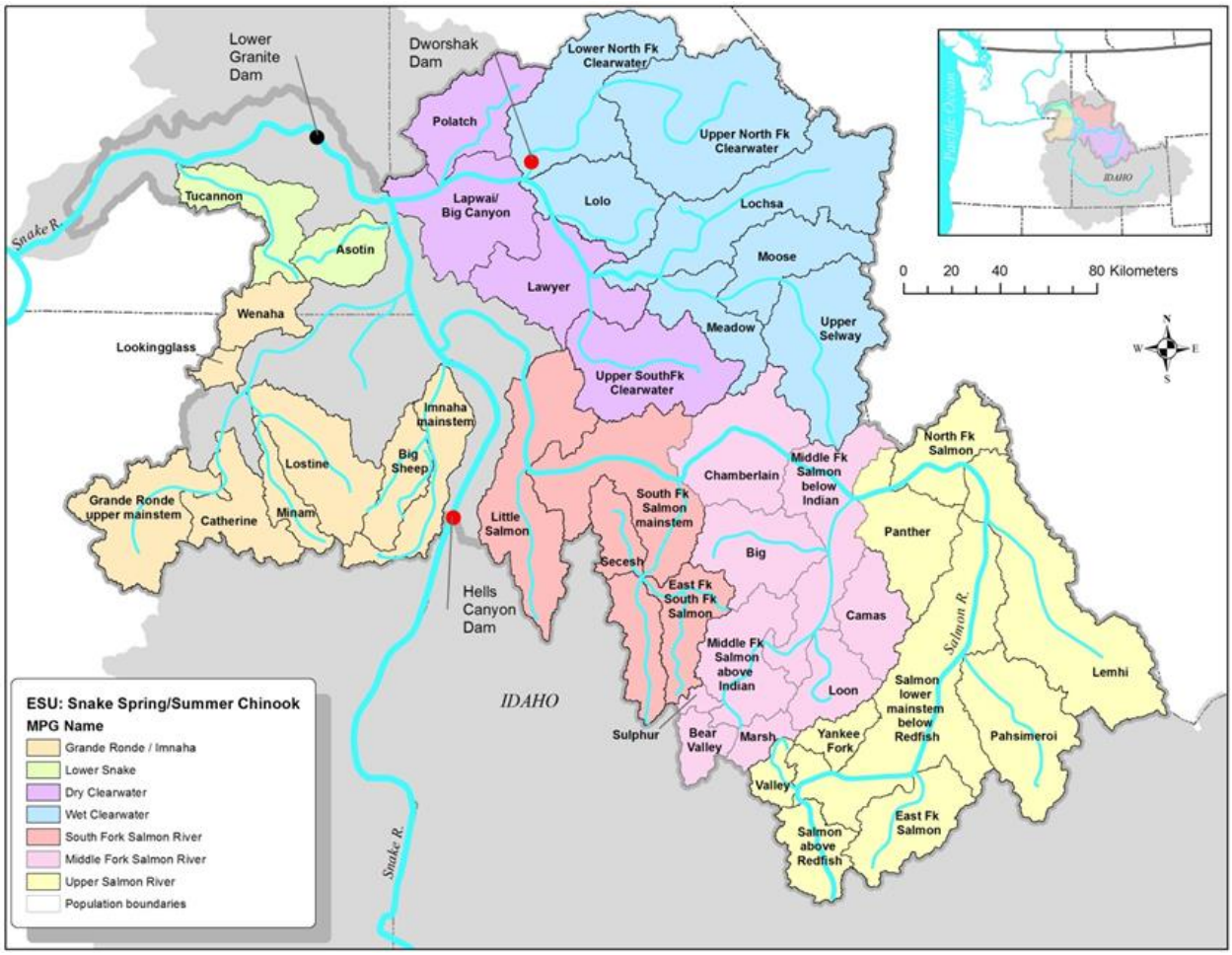

Figure 1. Spring-summer Chinook Salmon independent populations and major population groups (MPGs) in the Snake River evolutionary significant unit (ESU). Red dots represent impassable dams.

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CHAPTER 1. RELATIVE ABUNDANCE AND PRODUCTIVITY IN IDAHO POPULATIONS OF SPRING-SUMMER CHINOOK SALMON

ABSTRACT

The Idaho Salmon and Steelhead Monitoring and Evaluation Studies project monitors the status of Snake River spring-summer Chinook Salmon *Oncorhynchus tshawytscha* populations in the Salmon River and Clearwater River basins. Annual single-pass redd counts and carcass surveys are conducted at index river reaches and provide estimates and temporal trends of relative abundance and productivity. In 2022, a total of 2,713 redds were counted across 1,129.1 km of spawning habitat, covering 27 populations and five major population groups. Relative abundance in 2022 was higher than in 2021 in the Salmon River basin and lower in the Clearwater River basin. In most Idaho populations relative abundance fluctuates annually but remains well below the pre-1970 era range for all populations. The brood year 2018 cohort, represented by age-4 fish on the spawning grounds in 2022, was the most common among all age classes observed. Adult-to-adult productivities were estimated for 19 populations for the brood year 2017 cohort. Eleven of these were greater than one recruit per spawner (i.e., replacement).

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INTRODUCTION

Abundance is an essential metric in monitoring fish populations as it represents the end product of the interplay between three processes considered to be the pillars of fisheries management: recruitment, growth, and mortality (Ricker 1975; Allen and Hightower 2010). Population status is often assessed by using current abundance estimates to predict extinction risk and future trends (McElhany et al. 2000). The direct link between population processes and abundance has led to the latter being designated as a critical metric in assessing viability of salmonid populations (ICBTRT 2005).

Understanding the relationship between spawner abundance and recruitment of a new generation of spawners is important when managing fish populations. In semelparous fishes such as Chinook Salmon *Oncorhynchus tshawytscha*, estimation of adult-to-adult productivity is straightforward if abundance and age composition of spawners is quantified annually (Myers et al. 1999). This metric represents the integrated effects of factors such as population density, environmental conditions, and ecological conditions throughout the entire life cycle (McElhany et al. 2000). Adult-to-adult productivity offers an indication of population trends that is robust to annual fluctuations in spawner abundance. If population abundance is below a desired threshold, as is the case for all spring-summer Chinook Salmon populations in Idaho (NMFS 2016), productivity must, on average, exceed replacement for abundance to increase. As such, adult-to-adult productivity and abundance are given the highest priority in assessing viability of salmonid populations (McElhany et al. 2000, ICBTRT 2005).

In this chapter, relative abundance of Snake River spring-summer Chinook Salmon (hereafter Chinook Salmon) spawners in Idaho in 2022 is summarized using single-pass redd counts. Redd counts are commonly used as a *relative* index of population abundance across space and time. Nonetheless, redd counts were the basis for the decision to list Snake River spring-summer Chinook Salmon as threatened under the ESA (Matthews and Waples 1991). Hence, continuous standardized redd count data were used to compare 2022 relative abundance to the most recent 5-year period, to the 1957-1969 era, and across the Idaho landscape. Specific objectives were to:

1) Quantify redd spawner abundance for 27 Idaho populations of Chinook Salmon that were surveyed in 2022.

2) Quantify adult-to-adult productivity using completed brood years for 19 Idaho populations of Chinook Salmon where sufficient data were available.

METHODS

Study Design

Stream reaches targeted for redd counts in 2022 were selected based on long-term monitoring conducted by Idaho Department of Fish and Game (IDFG) and collaborators (Table 1-1). Standardized sampling of trend reaches began as early as 1957 (Hassemer 1993; Copeland et al. 2019). Trend reaches were selected to represent important production areas containing a large portion of available spawning habitat (Copeland et al. 2019). Reaches have been added or dropped periodically over the course of the program's history, so the amount of habitat surveyed has changed over time (Copeland et al. 2019). Reach distances were refined in 2020, reflecting the use of updated GIS layers (Felts et al. 2020, Appendix C). Trend surveys were timed to

coincide with the period of peak spawning activity on a particular stream as estimated from historical observations (Copeland et al. 2019). The timing of trend surveys ranges from mid-August to late September (Table 1-1).

Data Collection

Observers conducting surveys in Idaho are trained annually to accurately determine and record redds, as well as sample carcasses during surveys in a standardized manner. Redd counts were conducted by trained observers who attended a training workshop hosted by the Idaho Department of Fish and Game near Stanley, Idaho, on August 15, 2022. Workshop attendees were trained to identify redds by the presence of two features: 1) a “pit” resulting from excavation of the redd and covering of the eggs, and 2) tailspill, which is defined by the presence of loose substrate immediately downstream of the excavated pit (Burner 1951; Hassemer 1993). Training emphasizes the “four D’s” (disturbance, digging, definition, and deposition) as criteria indicating a completed redd.

Surveys were conducted by walking or flying a single pass along the designated reach and examining the streambed for redds (Table 1). Redds were identified by the presence of two features: 1) a “pit” resulting from excavation of the redd and covering of the eggs, and 2) tailspill, which is defined by the presence of loose substrate immediately downstream of the excavated pit (Burner 1951; Copeland et al. 2019). Aerial surveys were conducted in a few instances with either a low-flying helicopter or unmanned aircraft systems (UAS). Surveys by UAS in the Upper Salmon River Lower Mainstem population involved subsampling five reaches as described in Nau et al. (2021), Appendix C. All redds were enumerated and georeferenced using GPS units.

Chinook Salmon carcasses encountered during ground surveys were sampled to determine origin, estimate age composition, and to collect tissue for genetic analysis. Supplemental surveys were also conducted for the sole purpose of collecting biological information from carcasses. Carcasses were first identified as either natural- or hatchery-origin based on where they were produced and as indicated by marks and tags. All carcasses encountered were visually inspected for an adipose or other fin clip and scanned for a coded wire tag (CWT) and passive integrated transponder (PIT) tag. Carcasses with an adipose fin clip were considered segregated hatchery-origin. Carcasses with a CWT and an intact adipose fin were considered integrated hatchery-origin. All other carcasses with an intact adipose fin were considered natural- or wild-origin. Some hatchery release groups from the Clearwater basin did not receive an adipose fin clip or a CWT.

Each carcass was inspected for any other marks and tags, measured for fork length (mm), and examined internally to determine sex. Dorsal fin ray and tissue samples were taken from all natural carcasses when feasible. Four to five fin rays were collected, placed in a coin envelope, and frozen. Tissue samples were collected from the least decayed fin and stored on a piece of paper inside separate coin envelopes. Fin ray and tissue samples were delivered to IDFG’s Nampa Research Anadromous Ageing Laboratory (NRAAL) located in Nampa, Idaho.

Once delivered to NRAAL, dorsal fin rays were processed and assigned a saltwater age. Fin rays were dried, set in epoxy resin, cut into cross sections with a TechCut 5™ Precision High Speed Saw, and mounted on microscope slides using Shandon-Mount™. Mounted fin rays were digitally imaged using a Leica DFC 450 microscope camera attached to a Leica DM1000 LED microscope. Imaged fin rays were read independently by two trained readers and discrepancies were re-examined in a referee session until both readers and a third party came to a consensus. If a consensus could not be reached, the sample was removed from analysis. Total age (hereafter

age unless otherwise denoted) was assigned by adding assumed freshwater age to assigned saltwater age; all freshwater ages were assumed to be 2-years-old. This step allows us to assign fish to the correct brood year. To assess the accuracy of our age assignments, fin ray samples from known-age fish were mixed into the overall sample. Smolts implanted with PIT tags or CWTs and recovered during hatchery spawning or carcass surveys were considered known age.

In addition to ages obtained from fin ray samples, age composition data is also obtained from in-stream array detections of PIT-tagged individuals previously sampled at Lower Granite Dam. These additional samples bolster sample size, particularly in remote populations where few carcasses are encountered during spawning ground surveys. Final detections of PIT-tagged adults at sites with in-stream arrays, weirs, or hatchery traps which could be assigned to independent populations were queried to obtain age composition data from the IDFG BioSamples database; these data are accessible to collaborators upon request (Table 1-2). Scale samples are taken from adipose-intact adults sampled at Lower Granite Dam (Camacho et al. 2018). Technicians at NRAAL process scale samples and assign ages according to protocols detailed in Wright et al. (2015). When PIT-tagged fish were also recovered from carcass surveys and assigned an age from a fin ray sample, the fin ray age assignment was used in further analysis.

Data Analysis

The number of redds counted in index reaches in 2022 was summed by population and plotted alongside observations from the recent era (previous five years, 2017-2021) and from the pre-1970 era (13 years, 1957-1969), a historical baseline time period prior to most large dam construction when populations were generally considered healthy and harvestable (Petrosky et al. 2020). Geometric mean, minimum, and maximum number of redds were calculated for the pre-1970 era comparison.

Hatchery fraction was estimated as the proportion of carcasses which were hatchery-origin within populations. For populations with hatchery weirs, hatchery fraction was estimated at the population level, and separately above and below the weir. In populations where no carcasses were recovered, hatchery fraction was assumed to be 0 if there were no hatchery releases within the population. Carcasses were recovered in all populations with intended hatchery releases in 2022 so no assumptions were necessary for these populations.

Performance of NRAAL age assignment from fin rays was evaluated using a combination of metrics and graphical assessment. Accuracy was assessed using root mean squared error (RMSE), percent agreement (PA) between assigned and known age, and age bias plots. The RMSE was calculated as the square root of the mean squared difference between the assigned age (A_e) and the known age (A_k):

$$RMSE = \sqrt{(A_e - A_k)^2}$$

Percent agreement was calculated as the number of samples for which assigned age was equal to known age divided by the total number of known-age samples, then multiplied by 100. An age bias plot was constructed to depict the relationship between known age and assigned age for a group of samples. Accuracy metrics and age bias plots were computed using the base and “ggplot2” (Wickham 2009) packages in Program R (R Core Team 2017).

Population-specific age composition for 2022 was estimated directly using the age class proportions of sampled fish observed in each population, or from age class proportions in the MPG aggregate, depending on sample size. If at least 20 samples in a population were assigned

an age from fin rays or scales, then age composition was estimated directly (Felts et al. 2019). If at least 20 samples in a population were assigned an age, but additional carcasses were measured for fork length and not assigned an age, then an age-length key was constructed for natural-origin fish using methods described by Isley and Grabowski (2007). In this scenario, the combined sample of assigned ages and indirect ages from the age-length key was used to estimate population-specific age composition. If fewer than 20 samples in a population were assigned an age, then the aggregate age composition for the MPG was taken to represent population-specific age composition. Age composition at the MPG level was calculated using the same methods described for populations. If less than 20 samples in an MPG were assigned an age, then the aggregate age composition for the ESU was taken to represent population-specific age composition within that MPG. In addition to overall age composition, adult age composition was estimated by excluding age-3 fish. This metric was calculated because age-3 fish are almost exclusively males, whereas our index of abundance is derived from redds which are constructed by the female population.

Adult-to-adult productivity was updated through brood year 2017 for this report. The number of redds counted during a given brood year was taken as a measure of "stock." Adult returns ("recruits"), which excluded jacks, were calculated by estimating the number of natural-origin redds produced from a brood year at age 4, 5, and 6:

$$R_j = \left(age4prop_{j+4} * wr_{j+4}\right) + \left(age5prop_{j+5} * wr_{j+5}\right) + \left(age6prop_{j+6} * wr_{j+6}\right)$$

where R_j is recruits (natural-origin redds) from brood year j, *ageXprop* is the proportion of adults which were age *X*, and *wr* is the estimated number of natural-origin redds. Natural-origin redds was estimated by multiplying wild fraction (1 minus hatchery fraction) by the total number of redds counted in index reaches within populations. Adult age composition was applied because age-3 fish, which were primarily males, were assumed to have no effect on redd abundance (Quinn 2018). Age composition dating back to brood year 2002 was calculated using the methods described above for the current year's age composition. This time series was selected to characterize productivity over the three most recent brood cycles. The estimated number of natural-origin redds was used for returning redds because we were primarily interested in how many returning redds were produced by natural-origin Chinook Salmon. Clearwater River basin populations were omitted from productivity analysis because of inconsistency in reach boundaries and uncertainty associated with estimates of hatchery fraction. Panther Creek and Yankee Fork Salmon River were omitted for the same reasons, and the Little Salmon River did not have sufficient data because index reaches were not established until 2017.

RESULTS

During August and September 2022, 1,129.1 km of streams in Idaho were surveyed for Chinook Salmon redds (Table 1-3). A total of 2,713 redds were counted in index reaches across five MPGs and 27 populations in the Salmon River and Clearwater River basins. Ninety percent of redds were counted in the Salmon River basin (Table 1-3; Figure 1-1; Figure 1-2). Redd numbers were highest in the South Fork Salmon River mainstem, the Lemhi River, the Upper South Fork Clearwater, and the Secesh River. (Table 1-3). Hatchery fraction was highest (58%) in the Upper South Fork Clearwater River. Only natural-origin carcasses were recovered in Bear Valley Creek, Big Creek, and the East Fork Salmon River, among others.

All index reaches in the South Fork Salmon River MPG were surveyed, which included 113 km of current spawning habitat. The total number of redds counted ranged from two redds in

the Little Salmon River to 398 redds in the South Fork Salmon River mainstem (Table 1-3; Figure 1-2). Redd abundance within this MPG in 2022 was below the pre-1970 era range for the South Fork Salmon River mainstem. Hatchery-origin fish composed 14% of carcasses in the East Fork South Fork Salmon River, 22% in the South Fork Salmon River downstream of the weir, 15% in the South Fork Salmon River upstream of the weir, and 1% in the Secesh River (Table 1-4).

Most index reaches in the Middle Fork Salmon River MPG were surveyed, which included 448.2 km of current spawning habitat. Part of the index reach on the Middle Fork Salmon River below Indian Creek was not surveyed due to limited flight time and lack of fuel. Sections not surveyed were between the mouth of Loon and Camas creeks, and from the mouth of Big Creek downstream to Goat Creek. The total number of redds counted ranged from 33 redds in the Loon Creek to 196 redds in the Bear Valley Creek population (Table 1-3; Figure 1-3). Redd abundance within this MPG in 2022 was below the pre-1970 era range for all populations. All carcasses collected during 2022 in the Middle Fork Salmon River MPG were natural-origin with the exception of one hatchery-origin fish recovered in Marsh Creek, and two hatchery-origin fish in Chamberlain Creek (Table 1-4). No carcasses were recovered in the mainstem Middle Fork Salmon River.

All index reaches in the Upper Salmon River MPG were surveyed, which totaled 486 km of current spawning habitat. The total number of redds counted ranged from 17 in the Upper Salmon River lower mainstem to 345 in the Lemhi River (Table 1-3; Figure 1-4). Redd abundance within this MPG in 2022 was below the pre-1970 era range for all populations except Panther Creek and the Pahsimeroi River. The highest hatchery proportion in this MPG was 71% in the Yankee Fork (Table 1-4). Hatchery proportion was next highest at 62% in the Upper Salmon River upstream of the weir and was comprised of fish from integrated and segregated brood stocks. Fewer than five hatchery-origin carcasses were encountered in each of Panther Creek, the Lemhi River, and the Pahsimeroi River upstream of the weir. No carcasses were recovered in the Pahsimeroi River below the weir.

Most index reaches in the Dry Clearwater MPG were surveyed, though wildfires prevented access to three of seven survey reaches. In total, 64.3 km of current spawning habitat was surveyed which is less than the 85.5 km surveyed in 2021 (Table 1-3). Only one population in the Dry Clearwater MPG was sampled, the Upper South Fork Clearwater River, because there is no evidence of substantial spawning by spring-summer Chinook Salmon in other populations. In 2022, 283 redds were counted for this population. The 2022 count was lower than the 440 redds observed in 2021 (Figure 1-5). Fifty-eight percent of the carcasses collected in the Upper South Fork Clearwater population were hatchery-origin (Table 1-4). Some hatchery release groups from the Dry Clearwater MPG did not receive an adipose fin clip or a CWT, so hatchery-origin fish were likely underestimated for this population.

Index redd surveys in the Wet Clearwater MPG were also limited due to wildfires; 17.6 km of current spawning habitat was surveyed in 2022, a decrease from the 34.9 km surveyed in 2021. Total number of index redds counted in the Wet Clearwater MPG was one redd in Lolo Creek (Table 1-3; Figure 1-5). Five known-origin carcasses were recovered in the Wet Clearwater MPG, all of which were natural-origin (Table 1-4). Some hatchery release groups from the Wet Clearwater MPG did not receive an adipose fin clip or a CWT, so hatchery-origin fish were likely underestimated for this MPG.

In total, 2,524 natural-origin samples were assigned an age using fin rays or scales in 2022 (Table 1-5). Fin ray samples from carcasses accounted for 1,423, or about 56%, of the age assignments. Age assignments matched their known ages for 97.7% of the known-age fin ray samples (n =133), and the most common error was for known age-4 fish to be over-estimated by

one year (n = 2; Figure 1-6). The brood year 2018 cohort, represented by age-4 fish on the spawning grounds in 2022, was the most common among all age classes observed within MPGs (Table 1-5) and across all samples (Figure 1-7). Age-3 and age-5 fish were also observed.

Adult-to-adult productivity over brood years 2003-2017 was estimated for 19 populations within the South Fork Salmon River, Middle Fork Salmon River, and Upper Salmon River MPGs. Temporal trends in productivity (returned redds per spawned redd) tracked similarly among populations over brood years 2003-2017 (Figure 1-8). Productivity in nearly all populations was below replacement for brood year 2003, and above replacement for brood years 2006 and 2007. Productivity has generally been below replacement in nearly all populations for the last five completed brood years, 2013-2017, though some populations showed evidence of replacement for brood year 2017 (Table 1-6). Time series of productivity by population for brood years 2003-2017 are provided (Figures 1-9–1-11).

DISCUSSION

Idaho Chinook Salmon redd abundance in 2022, measured by our standard index redd counts, increased relative to the past five years across Salmon River basin populations and decreased compared to the past five years across Clearwater River basin populations.

For Salmon River basin populations, the five-year range of recent observations has been below or near the low end of the pre-1970 era range, indicating that even more abundant recent runs, such as that in 2022, are well below historical levels. We assume that low relative redd abundance indicates low absolute spawner abundance. Relative abundance within supplemented populations, including the South Fork Salmon River mainstem, the East Fork South Fork Salmon River, Pahsimeroi River, and Salmon River mainstem above Redfish Lake, have been within the pre-1970 era range and near the geometric mean over recent years, but hatchery-origin fish comprised a large portion of the redds in these populations. Thus, relative abundance in these populations as indicated by redd counts is augmented by hatchery production and should not be taken as an indication of better performance.

The Clearwater River basin had reduced counts primarily due to wildifres which prevented successful surveys in most of the index reaches. Furthermore, in 2021 redd counts in the South Fork Clearwater River were inflated because the NPT outplanted adult hatchery fish (Poole et al. 2022). The Lower North Fork Clearwater River and Upper North Fork Clearwater River populations are inaccessible to Chinook because Dworshak Dam prevents passage, so no index reaches exist. The Nez Perce Tribe stocks spring Chinook Salmon parr into the Meadow Creek population but surveys formerly conducted by Tribal staff, which documented natural production (e.g., Backman et al. 2007), have apparently lapsed and IDFG has never surveyed the stream.

In addition to the index redd counts, samples from carcasses collected during surveys are used to produce productivity estimates which are used to assess population status and viability. The accuracy of these estimates relies on accurate aging of the samples. The Nampa Research Anadromous Ageing Lab (NRAAL) has an accuracy goal of >90% for total and saltwater age determination using fin rays (Wright et al. 2015). This standard is met or exceeded in the vast majority of years in which accuracy has been assessed. In spawn year 2022, the accuracy of total age assignments exceeded this standard at 97.7% and represents the percent agreement (PA) between known age samples and a multiple reader consensus. In this report, the most common error was over-aging, which accounted for two of three disagreements between known total age and consensus age.

Productivity of brood year 2017 was above replacement in several of the 19 populations examined, with the exception of the East Fork Salmon River, the South Fork Salmon River, the Pahsimeroi River, and the mainstem Middle Fork Salmon River. Productivity has been below replacement for four of the last five completed brood years (2013-2016) across nearly all populations. Age-3 fish were mistakenly included in the 2021 version of this report. We corrected that issue for this report and productivity estimates therefore represent only age 4-6 adults. Density-independent factors affecting survival through the hydrosystem and ocean have driven recent productivity trends for Snake River spring-summer Chinook Salmon (McCann et al. 2018). Ocean climatic conditions since 2013 have been especially abnormal and are suspected to have had a large negative impact on productivity of Pacific Northwest salmon (Peterson et al. 2018). A large area of abnormally warm water nicknamed the "Blob" stretched from the coast of Alaska to Baja California in the northeastern Pacific from late 2013 until late 2015 (Cavole et al. 2016). The elevated sea surface temperatures associated with the Blob reduced phytoplankton availability and caused several food web changes thought to reduce prey quality for Chinook Salmon (Cavole et al. 2016). Changes in forage fish abundance, distribution and spawning time have also been observed due to increased surface temperatures (Auth et al. 2017; Brodeur et al. 2019), contributing to changes in Chinook Salmon distribution in the Pacific Ocean as well (Shelton et al. 2020). The 2017 brood year cohort was the second cohort in several years to not have had any members migrate to the ocean into the Blob; increases in productivity reflected that. High temperature events have since reoccurred and will likely continue to occur periodically in the future (Scannell et al. 2020). The increased productivity of brood year 2017 is likely due to changes in those conditions, because prior brood years which were exposed to the Blob or other high temperature events for part, or all, of their ocean phase showed reduced productivity.

Redd counts from 2022 indicate the majority of Idaho populations of Chinook Salmon remain at low spawner abundance relative to pre-1970 era observations and NMFS recovery goals. The most recent status review for the Snake River spring-summer Chinook Salmon ESU concluded the majority of populations in the ESU continue to be at moderate-to-high risk and recommended no change in status (Ford 2022). Despite an increase in productivity for brood year 2017, overall status has not improved drastically since the previous status review. Low productivity has been observed since the 2015 status assessment, resulting in decreased abundance throughout the ESU. NOAA annually assesses climatic, atmospheric, physical, and biological variables related to juvenile salmon survival and ranks them (https://www.fisheries.noaa.gov/content/ocean-conditions-indicators-trends). Most of the returning adult Chinook Salmon in 2022 emigrated as juveniles in 2020, a year in which ocean conditions were generally classified as poor (mean rank 13.9). However, 2020 northern copepod biomass was classified as good, which may have contributed to increased 2022 returns. Conditions in 2021 improved considerably (mean rank 6.6) and may bode well for 2023 returns. The majority of the ocean conditions in 2022 ranked substantially lower than 2021 conditions (11.2 vs. 6.6, respectively), thus abundance is unlikely to increase to desired levels without sustained favorable ocean conditions. Chinook Salmon have a high maximum annual reproductive rate (Myers et al. 1999), meaning populations can quickly increase in abundance when exposed to favorable conditions. These declining ocean conditions will negatively affect the returns in coming years.

Lastly, we continued surveying designated reaches in the Upper Salmon MPG using an Unmanned Aerial System (UAS or drone). In 2022, approximately 211 km were surveyed with a UAS. This effort was reduced from approximately 500 km in 2018-2019 and took approximately two weeks less time. An estimated 366 personnel hours were used for UAS surveys (i.e., driving and flying time). When surveys were completed, it took 6 personnel hours to import, upload, and

safely store individual images in the database. Further image post processing was conducted by one biologist and one technician. This portion of the process took 32 hours. In 2022, we again collaborated with researchers from Washington State University to investigate factors affecting redd detection by UAS. Selected reaches were flown in the Yankee Fork Salmon River to examine image quality as influenced by UAS specifications and the physical environment. This work was summarized by Auerbach et al. (2023) and provided background information for UAS flights to conduct safe, effective, and efficient redd surveys. They also recommended that training and image interpretation protocols should be developed as quality assurance and quality control measures.

RECOMMENDATIONS

1. Maintain the IDFG redd count index surveys.

2. Continue to evaluate potential spatial or temporal changes to index surveys relative to maintaining our ability to track long- and short-term abundance trends in Chinook Salmon spawning in Idaho.

3. Continue to refine spawning ground survey data management, from quality assurance in the field to quality control of the Spawning Ground Survey database and its output to ensure timely and accurate summaries.

4. Develop quality assurance and quality control measures for UAS surveys.

5. Analyze the sensitivity of age estimation errors on productivity metrics such as adult-to-adult productivity and smolt-to-adult return ratios.

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TABLES

Table 1-1. List of Idaho Chinook Salmon redd count index reaches and 2022 sampling information. NS = Not Surveyed, NA = Not Applicable, NT= No index transects identified, NPT = Nez Perce Tribe, SBT = Shoshone-Bannock Tribes, UAS = Unmanned Aircraft System. See Abbreviations and Acronyms pages for population abbreviations.

Population	Transect ID	Target survey date	Actual survey date	Method	Agencies
		South Fork Salmon River MPG			
LSR	NS-34	9/5-9/10	9/9	Ground	IDFG
SFSR	NS-26	9/5	9/8-9/9	Ground	IDFG
	NS-27	9/5	9/2-9/6	Ground	NPT, IDFG
	NS-28	9/5	9/2,9/7	Ground	NPT, IDFG
	NS-29	9/6	9/3	Ground	IDFG
SEC	WS-16	8/25-9/1	9/9	Ground	NPT, IDFG
	WS-17	8/25-9/1	9/1	Ground	NPT, IDFG
	WS-18	8/25	8/30	Ground	NPT, IDFG
	WS-19	8/25	8/31	Ground	NPT, IDFG
	WS-20	8/25	8/30	Ground	NPT, IDFG
EFSFSR	NS-30	9/1-9/5	8/30	Ground	NPT, IDFG
	NS-31	9/1-9/5	8/30	Ground	NPT, IDFG
		Middle Fork Salmon River MPG			
CHC	WS-1	8/25	8/24	Ground	IDFG
	WS-1a	8/25	8/25	Ground	IDFG
MFSRL	WS-15c	9/5-9/12	9/10	Helicopter	USFS,IDFG
	WS-15d	9/5-9/12	9/12	Helicopter	USFS,IDFG
	WS-15e	9/5-9/12	NS	NA	USFS,IDFG
BIG	WS-13	9/5	9/8	Ground	NPT, IDFG
	WS-14a	9/5	9/8	Ground	NPT, IDFG
	WS-14b	9/5	9/11	Helicopter	IDFG
	WS-14c	9/5	9/11	Helicopter	IDFG
	WS-14d	9/5	9/12	Helicopter	IDFG
CAM	WS-8	8/25-9/5	9/11	Helicopter	IDFG
LOON	WS-6	8/25-9/5	9/9	Helicopter	IDFG
	WS-7	8/25-9/5	9/9	Helicopter	IDFG
MFSRU	WS-15a	9/5-9/12	9/7	Helicopter	IDFG
	WS-15b	9/5-9/12	9/7	Helicopter	IDFG
	WS-21	9/5-9/12	9/8	Helicopter	IDFG
	WS-22a	9/5-9/12	9/7	Helicopter	IDFG
	WS-22b	9/5-9/12	9/7	Helicopter	IDFG
	WS-23	9/5-9/12	9/8	Helicopter	IDFG
	WS-24	9/5-9/12	9/9	Helicopter	IDFG
SUL	OS-4	8/21	9/6	Helicopter	IDFG
	WS-12	8/21	9/5	Helicopter	IDFG
BVC	WS-9a	8/27	8/31	Ground	IDFG

Table 1-1. Continued.

Population	Transect ID	Target survey date	Actual survey date	Method	Agencies
		Middle Fork Salmon River MPG (continued)			
BVC, continued	WS-9b	8/27	8/31	Ground	IDFG
	WS-9c	8/27	8/31	Ground	IDFG
	WS-9d	8/27	8/31	Ground	IDFG
	WS-10a	8/27	8/31	Ground	IDFG
	WS-10b	8/27	8/30	Ground	IDFG
	WS-11a	8/27	8/30	Ground	IDFG/SBT
	WS-11b	8/27	8/30	Ground	SBT
	WS-11c	8/27	8/30	Ground	SBT
MAR	WS-2a	8/18	8/21	Ground	IDFG
	WS-2b	8/18	8/21	Ground	IDFG
	WS-3	8/17	8/22	Ground	IDFG
	WS-4	8/19	8/20	Ground	IDFG
	WS-5	8/16	8/19	Ground	IDFG
		Upper Salmon River MPG			
PAN	NS-11a	9/8	9/1	UAS	IDFG
	NS-11b	9/8	9/1	UAS	IDFG
	NS-11c	9/8	9/1	UAS	IDFG
	NS-11d	9/8	9/1	UAS	IDFG
NFSR	NS-25a	9/8	9/6	Ground	IDFG
	NS-25b	9/8	9/5-9/6	Ground	IDFG
	NS-25c	9/8	9/5-9/6	Ground	IDFG
LEM	NS-9	9/8	9/7-9/8	Ground	IDFG
	NS-10	9/8	9/10	Ground/UAS	IDFG
	NS-35a	9/8	9/6	Ground	IDFG
	NS-35b	9/8	9/6	Ground	IDFG
USRL	NS-17	9/8	9/6	UAS	IDFG
	NS-18	9/8	9/7	UAS/Estimate	IDFG
	NS-19	9/8	9/6	UAS	IDFG
	NS-20	9/8	9/22	UAS/Estimate	IDFG
	NS-21	9/8	9/19	UAS/Estimate	IDFG
	NS-22	9/8	9/21	UAS/Estimate	IDFG
	NS-23	9/8	9/19	UAS/Estimate	IDFG
PAH	NS-33a	9/20	9/16-9/19	Ground/Boat	IDFG
	NS-33b	9/20	9/19	Ground	IDFG
EFSR	NS-1a	9/8	9/12	Ground	IDFG
	NS-1b	9/8	9/12	Ground	IDFG
	NS-2a	9/8	9/12	UAS	IDFG
	NS-2b	9/8	9/13	Ground	IDFG
	NS-2c	9/8	9/12	UAS	IDFG

Table 1-1. Continued.

Population	Transect ID	Target survey date	Actual survey date	Method	Agencies
		Upper Salmon River MPG (Continued)			
YFK	NS-5	9/8	9/8	UAS	IDFG
	NS-6	9/8	9/8	UAS	IDFG
	NS-7	9/8	9/9	Ground	IDFG
	NS-8	9/8	9/9	Ground	IDFG
VAL	NS-3a	9/8	9/8	Ground	IDFG
	NS-3b	9/8	9/8	Ground	IDFG
	NS-4	9/8	9/8	Ground	IDFG
USRU	NS-12	8/31-9/5	9/15	Ground	IDFG
	NS-13a	9/8	9/14	UAS	IDFG
	NS-13b	9/8	9/14	UAS	IDFG
	NS-15a	9/8	9/5	Boat	IDFG
	NS-15b	9/8	9/5	Boat	IDFG
	NS-15c	9/8	9/15	UAS	IDFG
	NS-16	9/8	9/7	Ground	IDFG
	OS-1	8/31-9/5	9/18	Ground	IDFG
	OS-2	8/31-9/5	NS	Ground	IDFG
	OS-3	8/31-9/5	NS	Ground	IDFG
	OS-5	9/8	NS	UAS	IDFG
	OS-6	9/8	NS	Ground	IDFG
		Dry Clearwater MPG			
LAP	NT	NA	NA	NA	NA
LAW	NT	NA	NA	NA	NA
POT	NT	NA	NA	NA	NA
USFC	NC-1	9/3	9/7	Ground	IDFG
	NC-2a	9/3	NS	Ground	IDFG
	NC-2b	9/3	NS	Ground	IDFG
	NC-3	9/3	NS	Ground	IDFG
	NC-4	9/1-9/5	8/31	Ground	IDFG
	NC-6	9/3	8/31	Ground	IDFG
	NC-8	9/3	9/12	Ground	NPT, IDFG
		Wet Clearwater MPG			
LNFC	NT	NA	NA	NA	NA
LOLO	NC-14	9/3	9/6	Ground	NPT, IDFG
LOC	NC-10	9/3	NS	Ground	IDFG
	NC-11	9/3	NS	Ground	IDFG
	NC-13a	9/3	NS	Ground	IDFG
	NC-13b	9/3	NS	Ground	IDFG
	NC-13c	9/3	NS	Ground	IDFG
MED	NT	NA	NA	NA	NA

Table 1-1. Continued.

Population	Transect ID	Target survey date	Actual survey date	Method	Agencies
		Wet Clearwater MPG (Continued)			
MOO	WC-3c	9/8	NS	Ground	IDFG
	WC-3d	9/8	NS	Ground	IDFG
SEL	WC-2	9/8	NS	Ground	IDFG
	WC-5	9/8	NS	NA	NA
	WC-7	9/8	NS	Ground	IDFG
UNFC	NT	NA	NA	NA	NA

Table 1-2. List of PTAGIS sites queried for PIT-tagged Chinook Salmon adults to obtain scale age assignments in 2022. See Abbreviations and Acronyms pages for population abbreviations.

Population	PTAGIS site code	Type
	South Fork Salmon River MPG	
LSR	RAPH	Hatchery Trap
SFSR	KRS	In-stream Array
	SALSFW	Hatchery Trap
	SFG	In-stream Array
SEC	ZEN	In-stream Array
EFSFSR	ESS	In-stream Array
	Middle Fork Salmon River MPG	
BIG	TAY	In-stream Array
BVC	BRC	Weir
	Upper Salmon River MPG	
NFSR	NFS	In-stream Array
LEM	HYC	In-stream Array
	LLR	In-stream Array
	LRW	In-stream Array
PAH	PAHH	Hatchery Trap
YFK	YFK	In-stream Array
VAL	VC1	In-stream Array
USRU	SAWT	Hatchery Trap
	Dry Clearwater MPG	
USFC	SC1	In-stream Array
	SC2	In-stream Array
	Wet Clearwater MPG	
LOLO	LC1	In-stream Array
	LC2	In-stream Array
LOC	LRL	In-stream Array
	LRU	In-stream Array
MOO/SEL	SW1	In-stream Array
	SW2	In-stream Array

Table 1-3. Chinook Salmon redds counted in Idaho index reaches in 2022. Hatchery fraction based on carcass information in Table 1-4 is also indicated. NT = No index reaches identified, NA = Not Applicable. See Abbreviations and Acronyms pages for population abbreviations.

Population	Length (km)	Redds	Hatchery fraction
South Fork Salmon River MPG			
LSR	3.8	2	0.50
SFSR	70.1	398	0.19
SEC	28.3	243	0.01
EFSFSR	10.8	194	0.14
MPG Total	113.0	837	0.13
Middle Fork Salmon River MPG			
CHC	8.0	58	0.15
MFSRL	64.3	0	0
BIG	63.7	65	0
CAM	9.8	34	0
LOON	24.4	33	0
MFSRU	179.9	35	0
SUL	8.0	53	0
BVC	63.3	196	0
MAR	26.8	191	0.01
MPG Total	448.2	665	0.01
Upper Salmon River MPG			
PAN	46.9	49	0.04
NFSR	29.5	38	0.15
LEM	48.9	345	0.01
USRL	139.1	17	0.40
PAH	37.7	136	0.19
EFSR	62.7	87	0
YFK	41.3	23	0.71
VAL	28.2	62	0.10
USRU	51.7	170	0.62
MPG Total	486.0	927	0.36
Salmon River Basin Total	1,047.2	2,429	0.14

Table 1-3. Continued.

Population	Length (km)	Redds	Hatchery fraction
Dry Clearwater MPG			
LAP	NT	NA	NA
LAW	NT	NA	NA
POT	NT	NA	NA
USFC	64.3	283	0.58
MPG Total	64.3	283	0.58
Wet Clearwater MPG			
LNFC	NT	NA	NA
LOLO	17.6	1	0
LOC	0	NA	NA
MED	NT	NA	NA
MOO	0	NA	NA
SEL	0	NA	NA
UNFC	NT	NA	NA
MPG Total	17.6	1	0
Clearwater River Basin Total	81.9	284	0.19
Idaho Total	1,129.1	2,713	0.16

Table 1-4. Chinook Salmon carcasses collected during spawning ground surveys in Idaho during 2022. Surveys are organized by major population group (MPG). F = female, M = male, U = unknown sex. Hatchery fraction is the number of hatchery-origin carcasses divided by the number of known-origin carcasses. Downloaded from SGS database on 3/4/23. See Abbreviations and Acronyms pages for population abbreviations.

	Integrated hatchery			Segregated hatchery			Natural			Unknown			Total			
Population	**F**	**M**	**U**	**F**	**M**	**U**	**F**	**M**	**U**	**F**	**M**	**U**	**All**	**Known-origin**	**Hatchery**	**Hatchery fraction**
South Fork Salmon River MPG																
LSR	0	0	0	1	0	0	1	0	0	0	0	0	2	2	1	0.50
SFSR downstream of weir[(e)]	7	0	0	18	6	0	59	47	1	1	0	0	139	138	31	0.22
SFSR upstream of weir	9	6	0	2	1	0	30	74	0	0	3	7	132	122	18	0.15
SEC[(a)]	0	0	0	0	2	0	59	72	0	0	2	0	135	133	2	0.01
EFSFS [(e)]	5	4	0	1	2	0	29	42	0	0	1	0	84	83	12	0.14
MPG Total	21	10	0	22	11	0	178	235	1	1	6	7	492	479	64	0.13
Middle Fork Salmon River MPG																
CHC	0	0	0	2	0	0	7	4	0	0	0	42	55	13	2	0.15
MFSRU	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MFSRL	0	0	0	0	0	0	0	1	0	0	0	0	1	1	0	0
BIG	0	0	0	0	0	0	11	17	0	1	1	0	30	28	0	0
CAM	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0
LOON	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0
SUL	0	0	0	0	0	0	1	0	1	0	0	9	11	2	0	0
BVC[(c)]	0	0	0	0	0	0	43	29	0	0	2	0	74	72	0	0
MAR	0	0	0	0	1	0	30	33	1	0	0	1	65	64	1	0.01
MPG Total	0	0	0	2	1	0	149	119	13	3	7	77	371	284	3	0.01
Upper Salmon River MPG																
PAN[(c)]	0	0	0	1	3	0	38	43	2	0	0	2	89	87	4	0.04
NFSR	0	0	0	1	1	0	4	5	2	0	0	0	13	13	2	0.15
LEM	0	0	0	1	0	0	77	34	8	0	0	0	120	120	1	0.01
USRL	0	0	0	0	2	0	1	2	0	0	0	0	5	5	2	0.40

Table 1-4. Continued.

Population	Integrated hatchery			Segregated hatchery			Natural			Unknown			Total			Hatchery fraction
	F	M	U	F	M	U	F	M	U	F	M	U	All	Known-origin	Hatchery	
Upper Salmon River MPG (Continued)																
PAH downstream of weir	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PAH upstream of weir	2	1	0	0	0	0	8	5	0	0	0	0	16	16	3	0.19
EFSR[c]	0	0	0	0	0	0	13	7	2	0	0	0	22	22	0	0
YFK	0	1	1	5	31	1	5	11	0	1	1	0	57	55	39	0.71
VAL	1	1	0	0	3	0	24	21	2	0	2	5	59	52	5	0.10
USRU downstream of weir	1	3	0	36	43	3	48	39	0	1	0	2	176	173	86	0.50
USRU upstream of weir	4	12	0	29	89	5	13	74	2	0	2	5	232	225	139	0.62
MPG Total	8	18	1	73	172	9	231	241	18	3	4	11	789	771	281	0.36
Dry Clearwater MPG																
USFC	4	2	0	30	46	2	18	33	9	0	1	0	145	144	84	0.58
MPG Total	4	2	0	30	46	2	18	33	9	0	1	0	145	144	84	0.58
Wet Clearwater MPG																
LOC[e]	0	0	0	0	0	0	1	1	0	0	0	0	2	2	0	0
LOLO[f]	0	0	0	0	0	0	2	0	1	0	0	0	3	3	0	0
MOO	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SEL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MPG Total	0	0	0	0	0	0	3	1	1	0	0	0	5	5	0	0

[a] Staff from the Nez Perce Tribe and Idaho Department of Fish and Game collected and provided information.
[b] Staff from U.S. Forest Service collected and provided information.
[c] Staff from the Shoshone-Bannock Tribes and Idaho Department of Fish and Game collected and provided information.
[d] Staff from the Shoshone-Bannock Tribes collected and provided information.
[e] This survey was attempted and halted due to wildfires, though some carcasses were observed and sampled.
[f] Staff from the Nez Perce Tribe collected and provided information.

Table 1-5. Age composition of natural-origin Chinook Salmon estimated from carcasses collected during spawning ground surveys, natural-origin brood stock removed at weirs, and from PIT array detections in Idaho during 2022. NA = Not Applicable. See Abbreviations and Acronyms pages for population abbreviations.

					Freshwater.saltwater age (total age)			
Population	**# Carcass fin ray samples**	**# PIT array scale samples**	**Length samples**	**# Total age samples**	**2.1 (3)**	**2.2 (4)**	**2.3 (5)**	**2.4 (6)**
South Fork Salmon River MPG								
LSR	2	0	0	2	0	2	0	0
SFSR[a]	172	252	77	501	11	453	37	0
SEC[a]	367	110	7	484	9	452	23	0
EFSFSR[a]	225	31	2	258	11	236	11	0
MPG Total	766	393	86	1,245	31	1,143	71	0
Middle Fork Salmon River MPG								
CHC	11	0	0	11	0	9	2	0
MFSRL	27	0	0	27	1	23	3	0
BIG[a]	3	103	0	106	14	84	8	0
CAM	1	0	0	1	0	1	0	0
LOON	2	0	0	2	0	2	0	0
MFSRU	0	0	0	0	0	0	0	0
SUL	2	0	0	2	0	2	0	0
BVC[b]	72	31	1	104	1	91	12	0
MAR	112	0	52	164	2	148	14	0
MPG Total	230	134	53	417	18	360	39	0
Upper Salmon River MPG								
PAN	41	0	0	41	0	41	0	0
NFSR	10	15	1	26	0	24	2	0
LEM	51	89	63	203	1	192	10	0
USRL	3	0	0	3	0	3	0	0
PAH	14	31	1	46	2	41	3	0
EFSR	21	0	1	22	0	19	3	0
YFK	32	5	0	37	12	21	4	0
VAL	34	0	13	47	0	39	8	0
USRU	181	12	24	217	21	168	28	0
MPG Total	387	152	103	642	36	548	58	0
Salmon River Basin Total	1,383	679	242	2,304	85	2,051	168	0

Table 1-5. Continued.

Population	# Carcass fin ray samples	# PIT array scale samples	Length samples	# Total age samples	Freshwater.saltwater age (Total Age) 2.1 (3)	2.2 (4)	2.3 (5)	2.4 (6)
			Dry Clearwater MPG					
LAP	NA	NA	NA	NA	NA	NA	NA	NA
LAW	NA	NA	NA	NA	NA	NA	NA	NA
POT	NA	NA	NA	NA	NA	NA	NA	NA
USFC	37	18	7	62	1	58	3	0
MPG Total	37	18	7	62	1	58	3	0
			Wet Clearwater MPG					
LNFC	NA	NA	NA	NA	NA	NA	NA	NA
LOLO	1	15	2	18	1	14	3	0
LOC	2	44	2	48	1	44	3	0
MED	NA	NA	NA	NA	NA	NA	NA	NA
MOO[C]	0	0	0	0	0	0	0	0
SEL[C]	0	92	0	92	1	86	5	0
UNFC	NA	NA	NA	NA	NA	NA	NA	NA
MPG total	3	151	4	158	3	144	11	0
Clearwater River Basin Total	40	169	11	220	4	202	14	0
Idaho Total	1,423	848	253	2,524	89	2,253	182	0

[a] Staff from the Nez Perce Tribe and Idaho Department of Fish and Game collected and provided information.
[b] Staff from the Shoshone-Bannock Tribes and Idaho Department of Fish and Game collected and provided information.
[c] PIT array scale samples detected in the Selway River could potentially spawn in the SEL or MOO populations.

Table 1-6. Productivity estimates for 25 Chinook Salmon populations in five Major Population Groups in Idaho for brood years 2003-2017. NA indicates incomplete data. Also omitted due to incomplete data are the Little Salmon River, East Fork South Fork Salmon River populations.

Major Population Group	Population	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Dry Clearwater River	USFC	0.18	NA	NA	NA	0.25	0.23	0.27	0.49	0.07	0.07	0.03	0.04	0.03	0.21	1.13
Middle Fork Salmon River	BVC	0.18	1.00	1.58	5.99	3.82	1.60	0.55	1.43	0.90	0.29	0.18	0.25	0.12	0.57	1.11
	BIG	0.18	0.51	1.61	1.39	2.30	1.65	0.38	0.93	1.28	0.39	0.19	0.42	0.10	0.32	1.05
	CAM	0.06	0.31	0.60	1.15	1.18	2.03	0.93	1.63	10.55	0.88	0.44	0.60	0.14	0.24	0.88
	CHC	0.26	0.56	1.56	2.78	3.71	1.38	0.86	1.96	0.65	NA	NA	NA	0.04	0.34	NA
	LOON	0.06	0.28	0.81	1.76	1.17	1.22	0.31	1.52	3.52	0.65	0.23	0.51	0.09	0.36	2.15
	MAR	0.07	0.63	3.74	9.29	13.94	3.46	1.16	1.56	0.95	0.53	0.18	0.22	0.08	0.90	1.92
	MFSRU	0.13	0.31	0.50	4.86	2.54	1.68	0.75	1.05	1.20	0.42	0.47	0.54	0.14	0.36	0.41
	MFSRL	0.08	0.19	NA	2.11	NA	0.29	0.11	1.21	10.01	4.02	NA	1.76	0.04	0.62	0.23
	SUL	0.21	3.01	1.95	3.18	1.75	0.78	1.03	2.27	0.76	0.55	0.07	0.38	0.09	0.54	2.79
South Fork Salmon River	EFSFSR	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	SEC	0.17	1.02	1.58	5.53	0.77	0.84	0.25	1.31	0.53	0.61	0.20	0.28	0.26	0.68	1.18
	SFSR	0.15	1.04	0.93	2.49	3.21	0.64	0.30	1.39	0.23	0.17	0.10	0.09	0.05	0.16	0.40
Upper Salmon River	EFSR	0.35	0.79	1.75	9.25	3.04	0.62	1.15	NA	NA	NA	0.32	0.13	0.08	0.24	0.65
	LEM	0.30	1.06	1.09	4.07	5.27	1.75	0.95	2.59	1.48	1.02	0.34	0.57	0.44	1.00	1.84
	NFSR	0.32	0.52	1.10	4.68	3.82	1.26	0.56	0.91	1.25	0.51	0.08	0.31	0.17	0.77	2.35
	PAH	0.29	0.15	0.30	0.98	0.99	5.52	1.65	2.86	2.17	0.97	0.16	0.15	0.14	0.25	0.58
	PAN	NA	NA	NA	NA	NA	NA	NA	8.43	NA	2.34	0.35	1.16	0.16	0.08	NA
	USRL	0.36	0.37	0.96	1.85	1.95	1.13	0.49	NA	NA	NA	0.09	0.06	0.21	0.37	1.52
	USRU	0.20	0.77	0.91	2.25	1.49	0.94	0.39	0.65	0.66	0.30	0.14	0.14	0.15	0.42	0.51
	VAL	0.38	1.48	1.87	2.88	2.34	1.27	0.89	1.66	2.41	0.43	0.30	0.24	0.11	1.33	1.25
	YFK	NA	NA	NA	2.48	NA	NA	NA	NA	6.06	NA	NA	0.75	NA	NA	NA
Wet Clearwater River	LOC	0.29	0.64	1.13	0.93	1.57	0.38	0.28	0.47	0.27	0.53	0.09	0.34	0.30	0.39	NA
	LOLO	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.21	0.14	0.02	0.04	0.84
	MOO	0.66	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	14.00	NA
	SEL	NA	1.07	0.37	1.18	0.29	0.09	0.81	1.09	2.28	3.78	0.27	0.58	0.10	0.18	NA

FIGURES

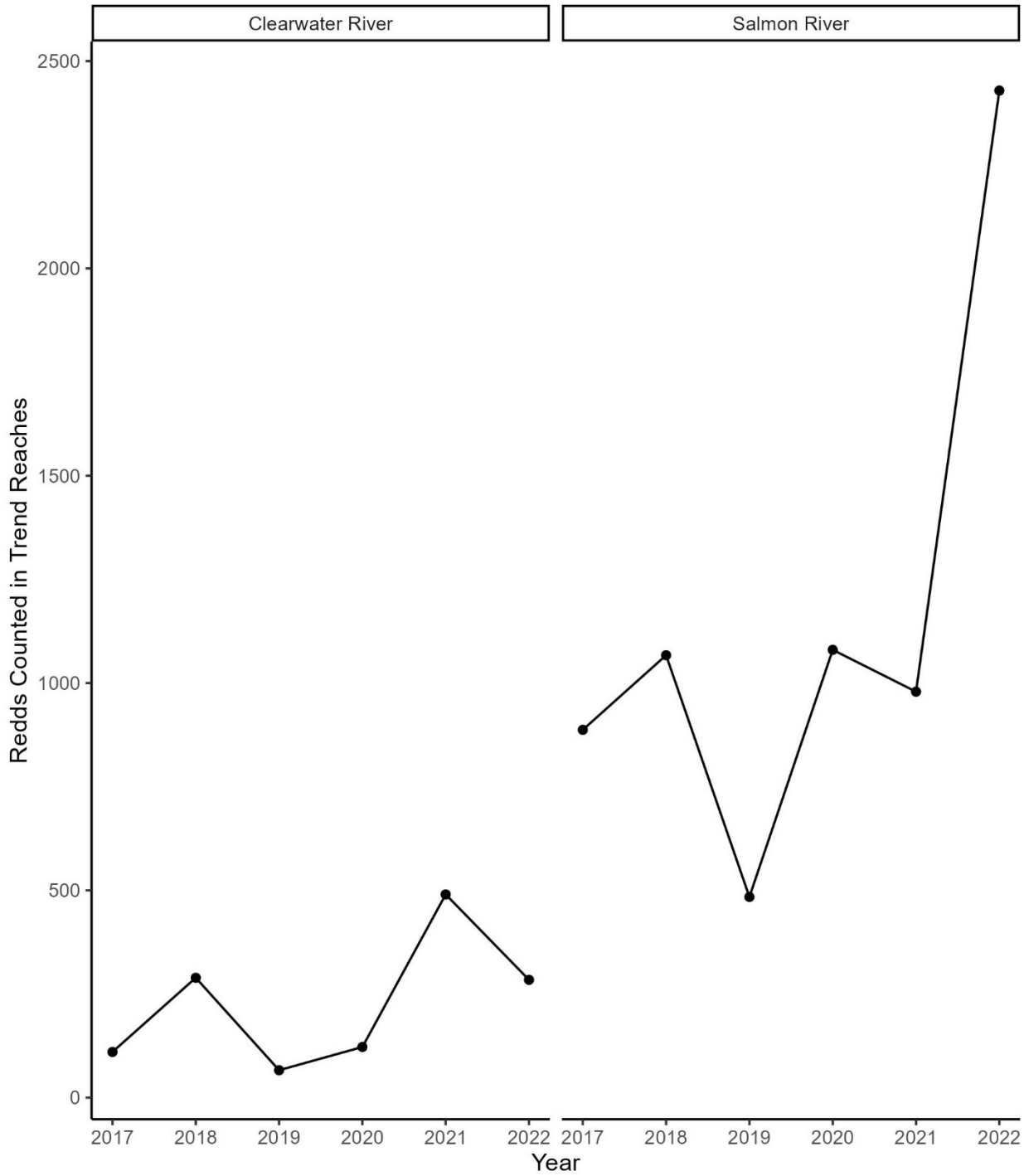

Figure 1-1. Number of Chinook Salmon redds counted in index reaches of the Clearwater River (left panel) and Salmon River (right panel) basins from 2017 through 2022.

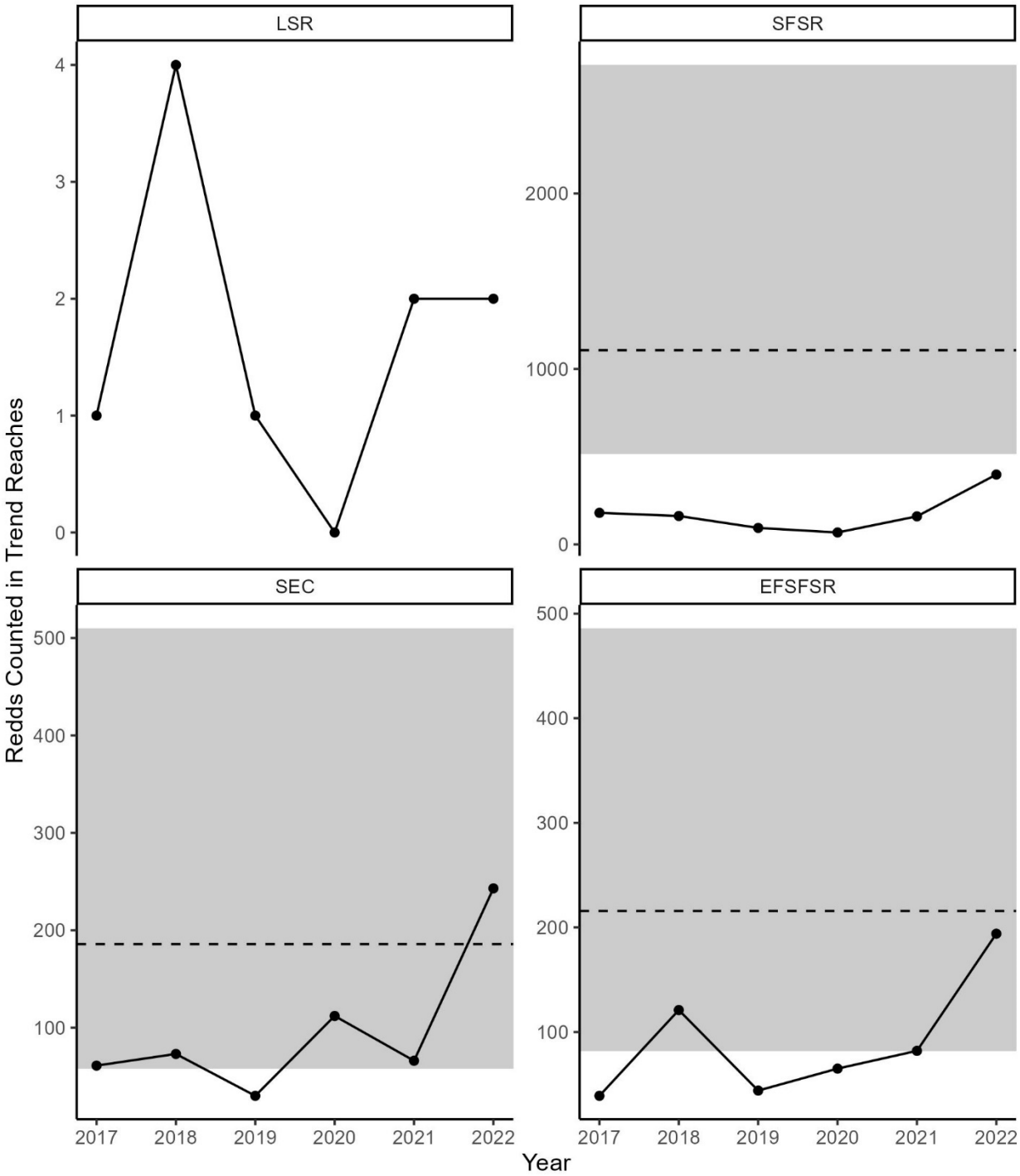

Figure 1-2. Number of Chinook Salmon redds counted in index reaches of the South Fork Salmon River populations during the recent era, 2017-2022. Shaded area represents the pre-1970 era range, and dashed reference line represents the pre-1970 era geometric mean. No shading or dashed line represents lack of pre-1970 era data. Note different y-axis scales.

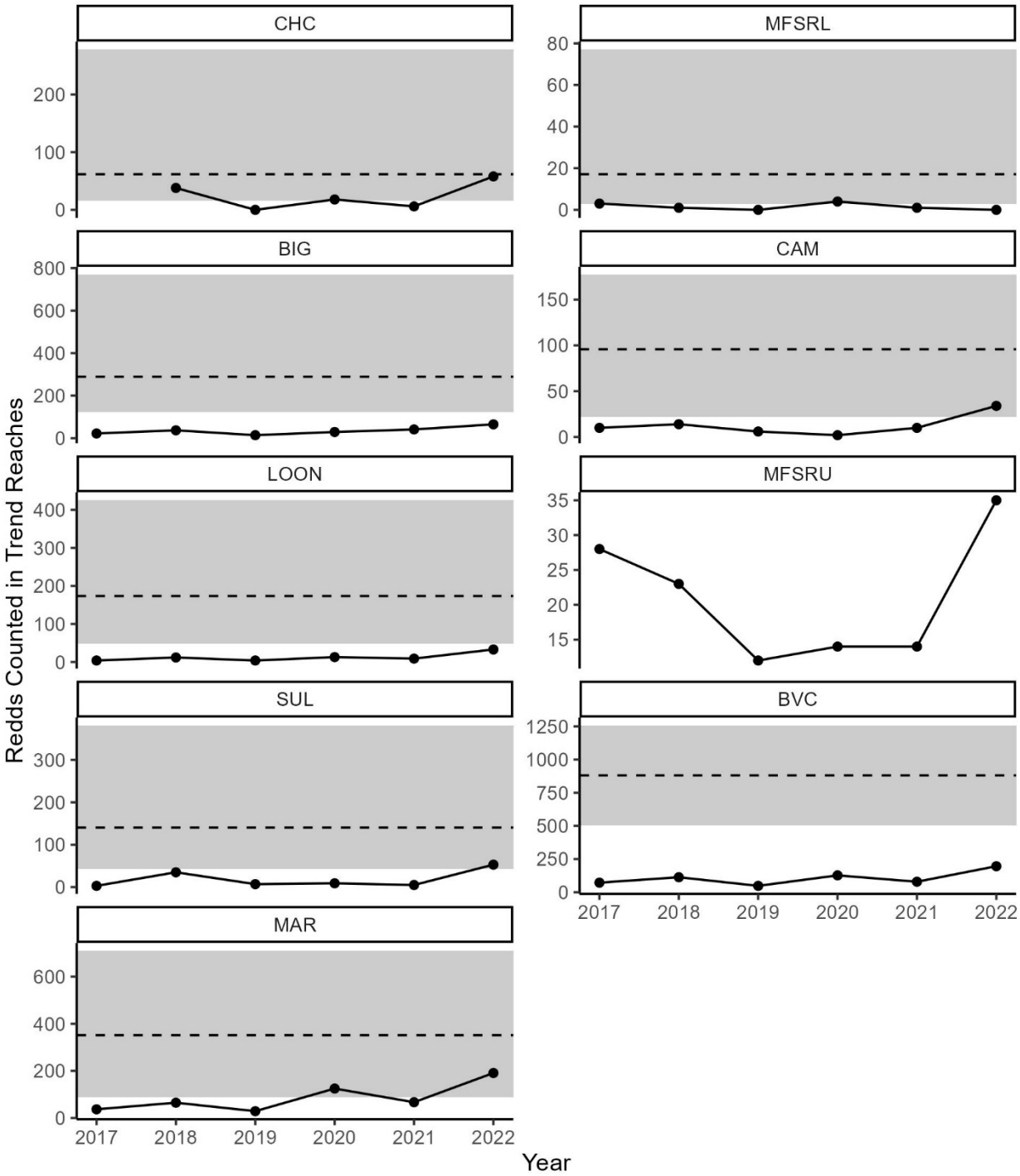

Figure 1-3. Number of Chinook Salmon redds counted in index reaches of the Middle Fork Salmon River populations during the recent era, 2017-2022. Shaded area represents the pre-1970 era range, and dashed reference line represents the pre-1970 era geometric mean. No shading or dashed line represents lack of pre-1970 era data. Note different y-axis scales.

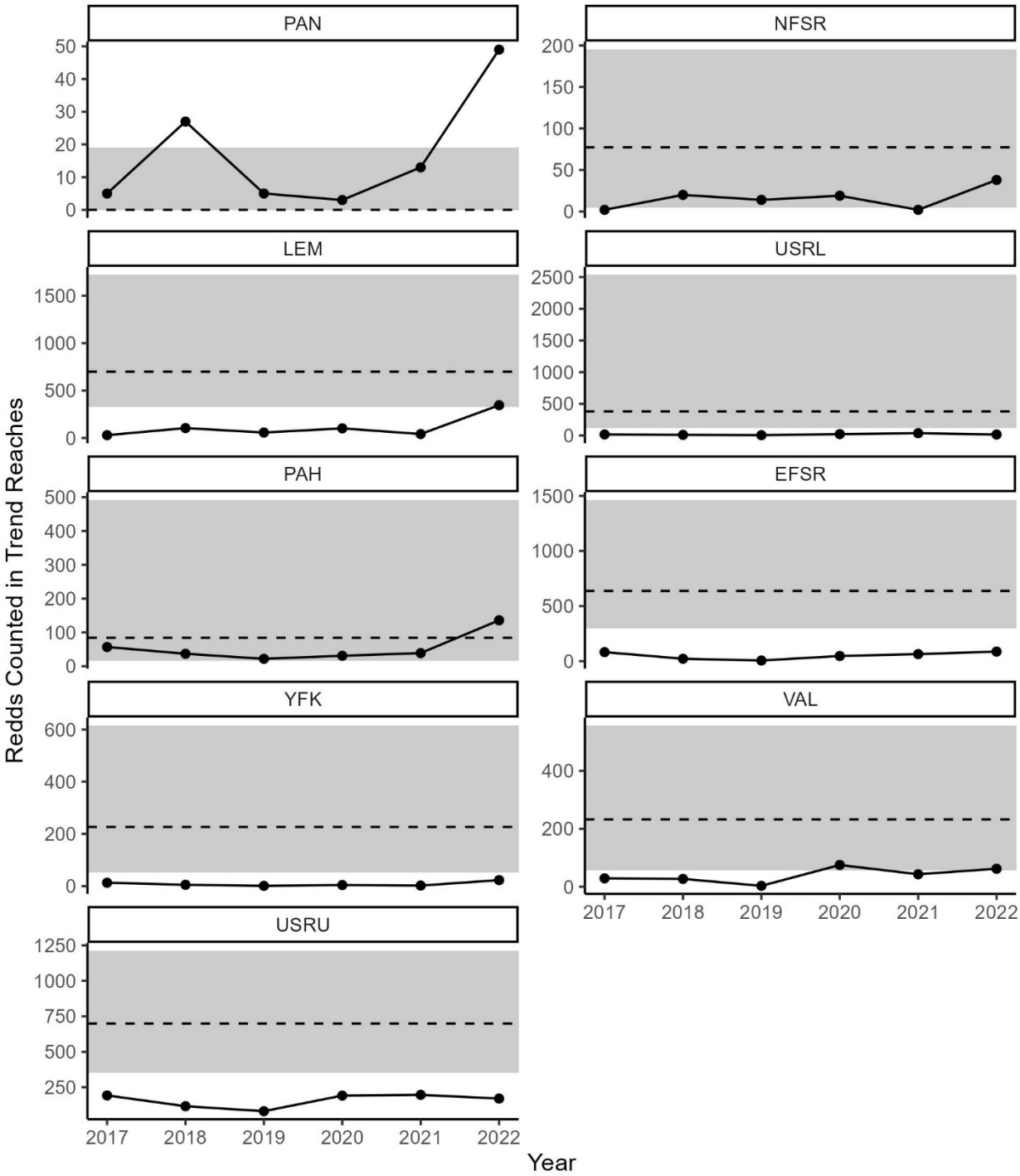

Figure 1-4. Number of Chinook Salmon redds counted in index reaches of the Upper Salmon River populations during the recent era, 2017-2022. Shaded area represents the pre-1970 era range, and dashed reference line represents the pre-1970 era geometric mean. No shading or dashed line represents lack of pre-1970 era data. Note different y-axis scales.

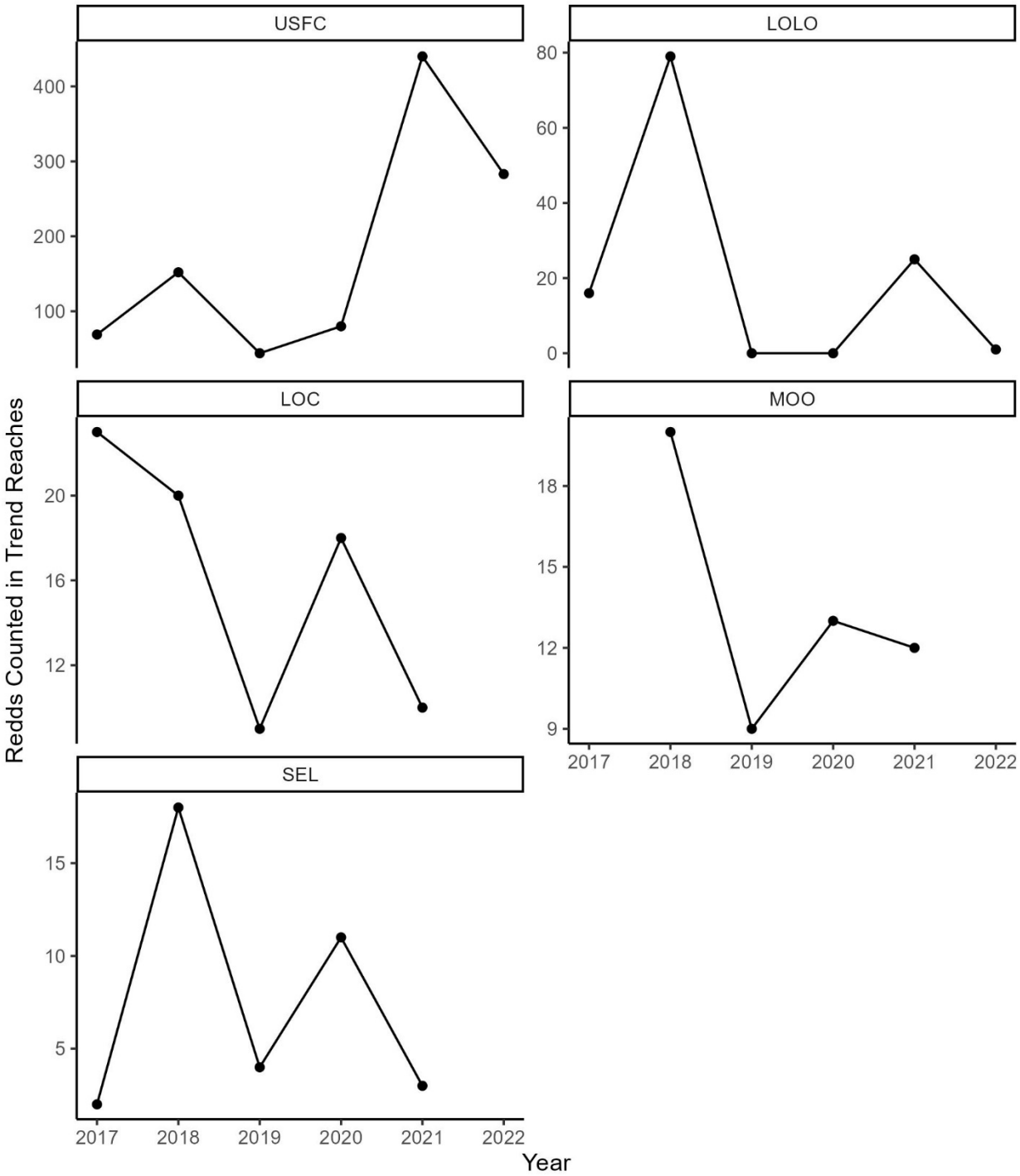

Figure 1-5. Number of Chinook Salmon redds counted in index reaches of the Clearwater River basin populations during the recent era, 2017-2022.

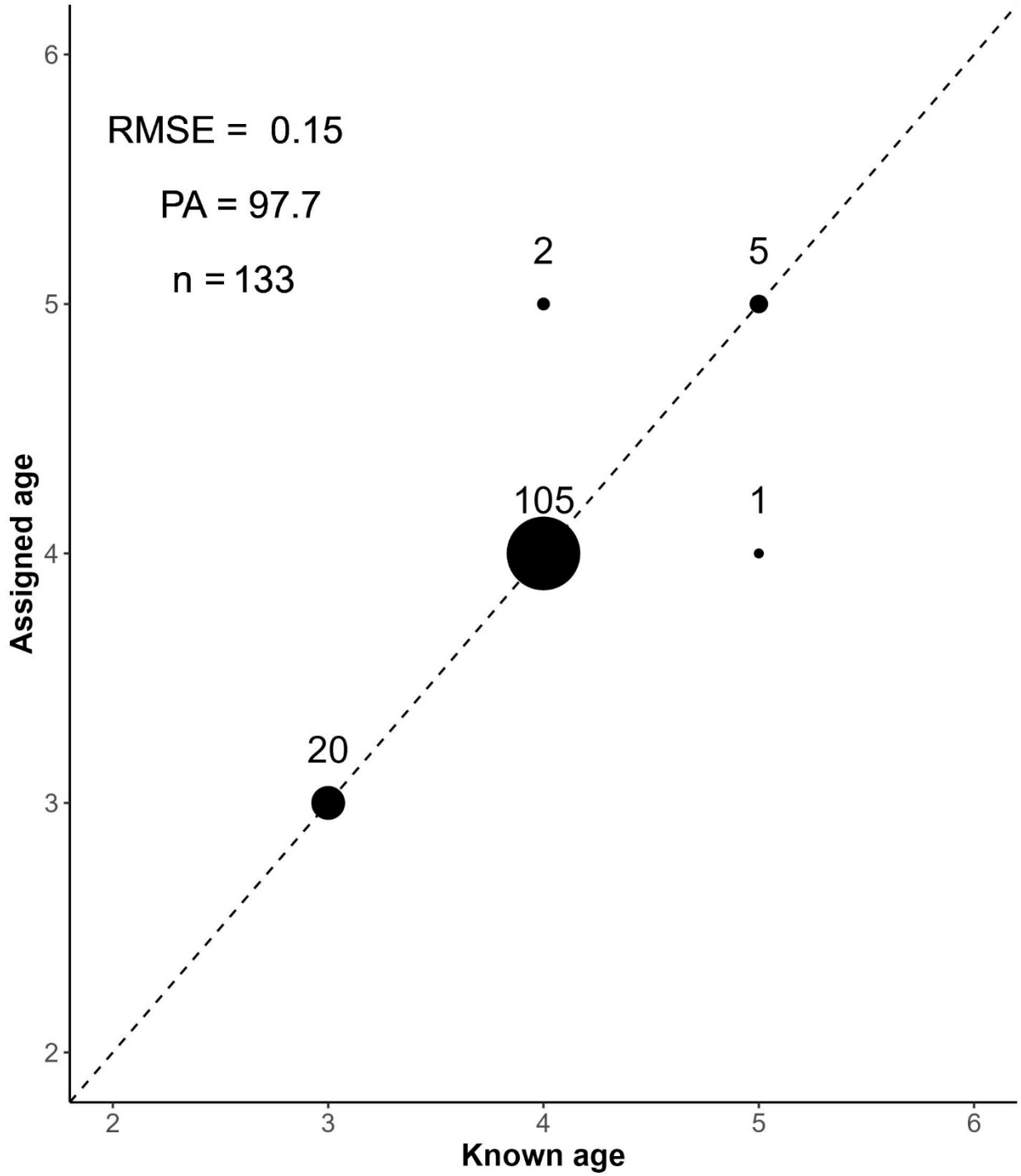

Figure 1-6. Age bias plot depicting the relationship between ages assigned to Chinook Salmon using fin rays and their corresponding known ages as determined by PIT tags and CWTs. All samples were collected in 2022. RMSE = root mean squared error, PA = percent agreement, and n = the number of known-age fish.

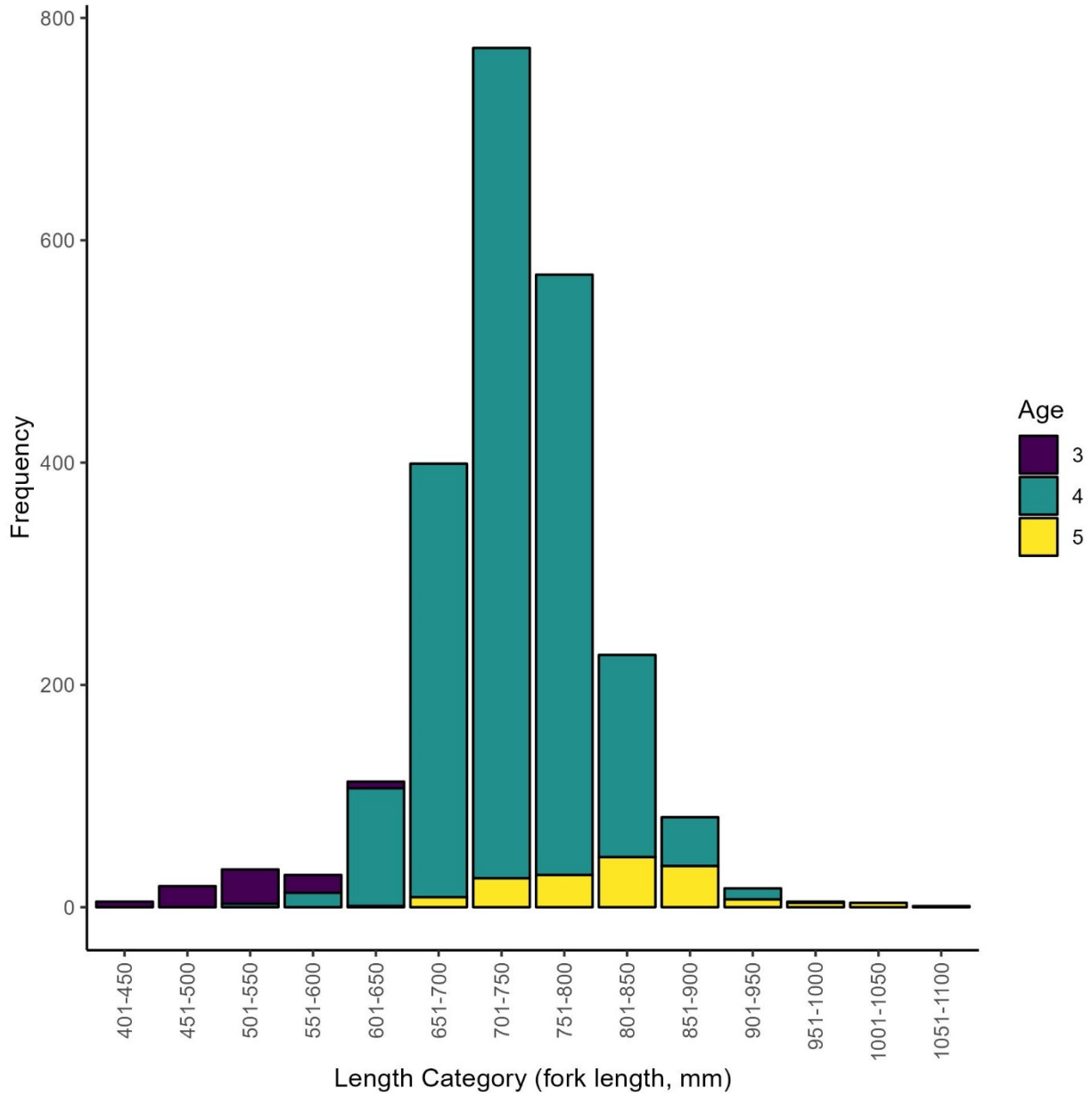

Figure 1-7. Length frequency distribution stacked by age class for natural-origin Chinook Salmon carcasses collected in Idaho during 2022 (n = 2,524).

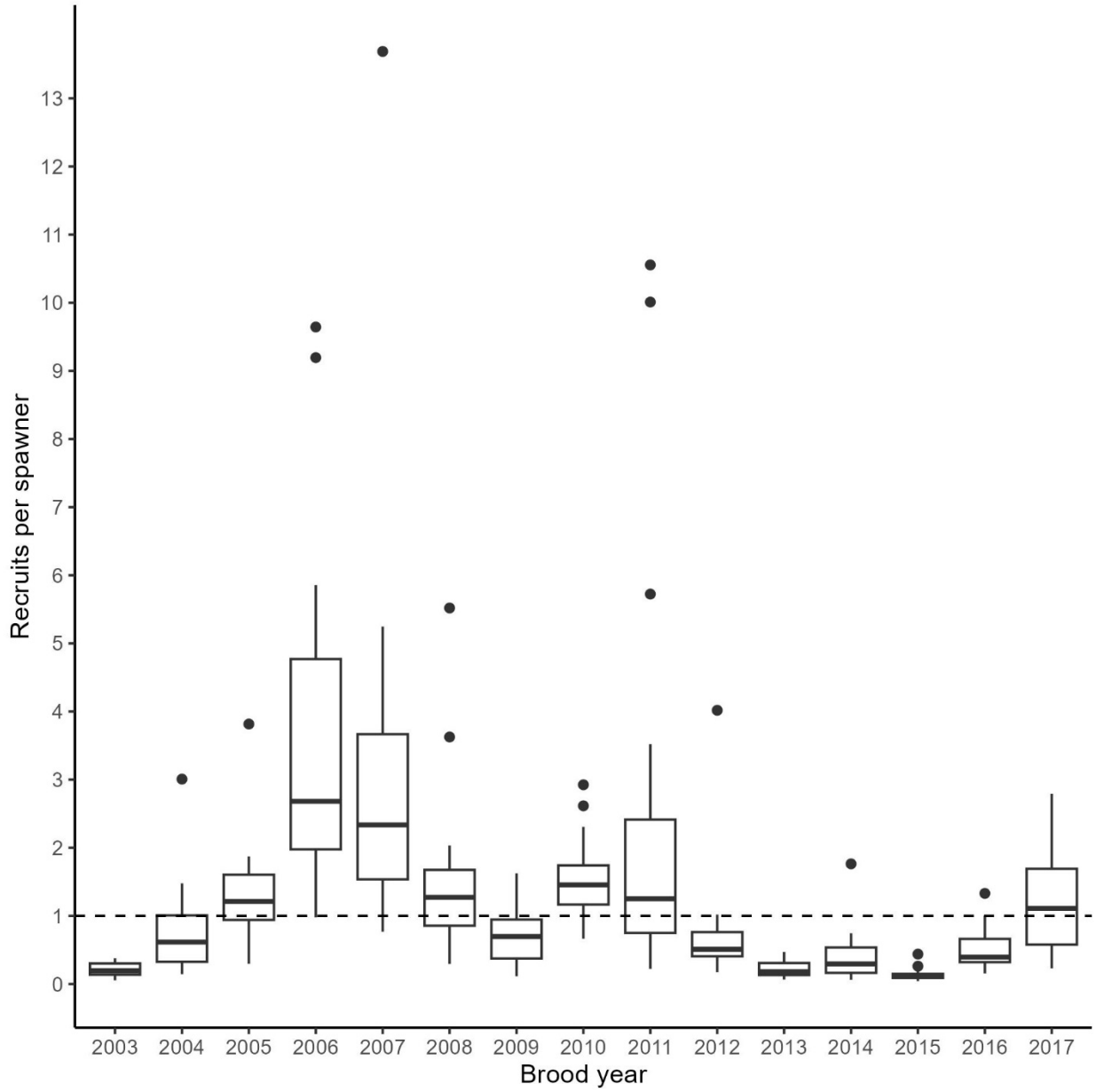

Figure 1-8. Box and whisker plot of productivity (natural-origin returned redds per spawned redd) estimates for 19 Chinook Salmon populations sampled in Idaho over brood years 2003-2017. Select populations in some years were omitted due to incomplete data (see Figures 1-11 to 1-13). Dashed line represents 1:1 replacement.

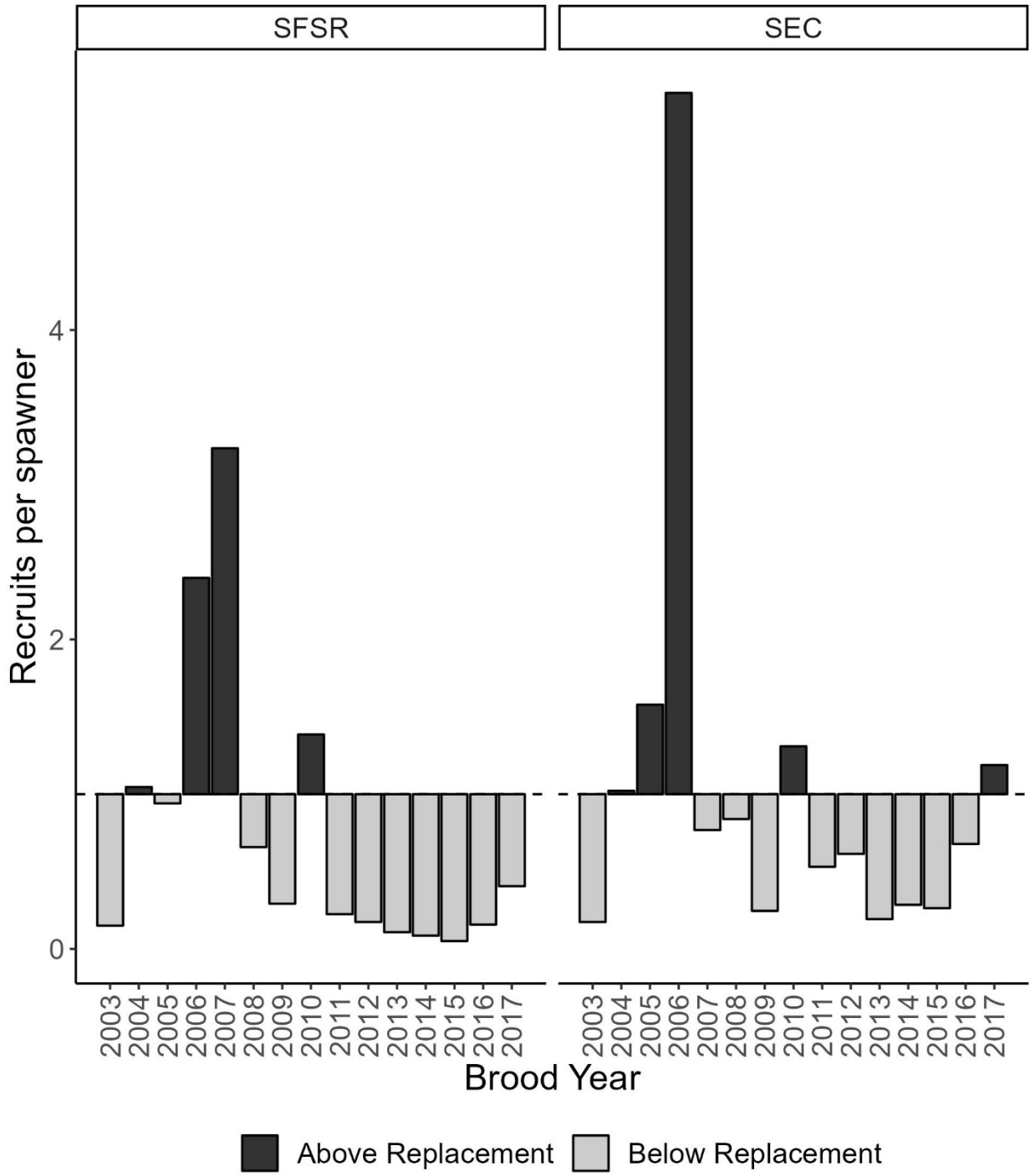

Figure 1-9. Productivity (natural-origin returned redds per spawned redd) of South Fork Salmon River Chinook Salmon populations, except Little Salmon River and East Fork South Fork Salmon River, over brood years 2003-2017. Dashed line represents 1:1 replacement.

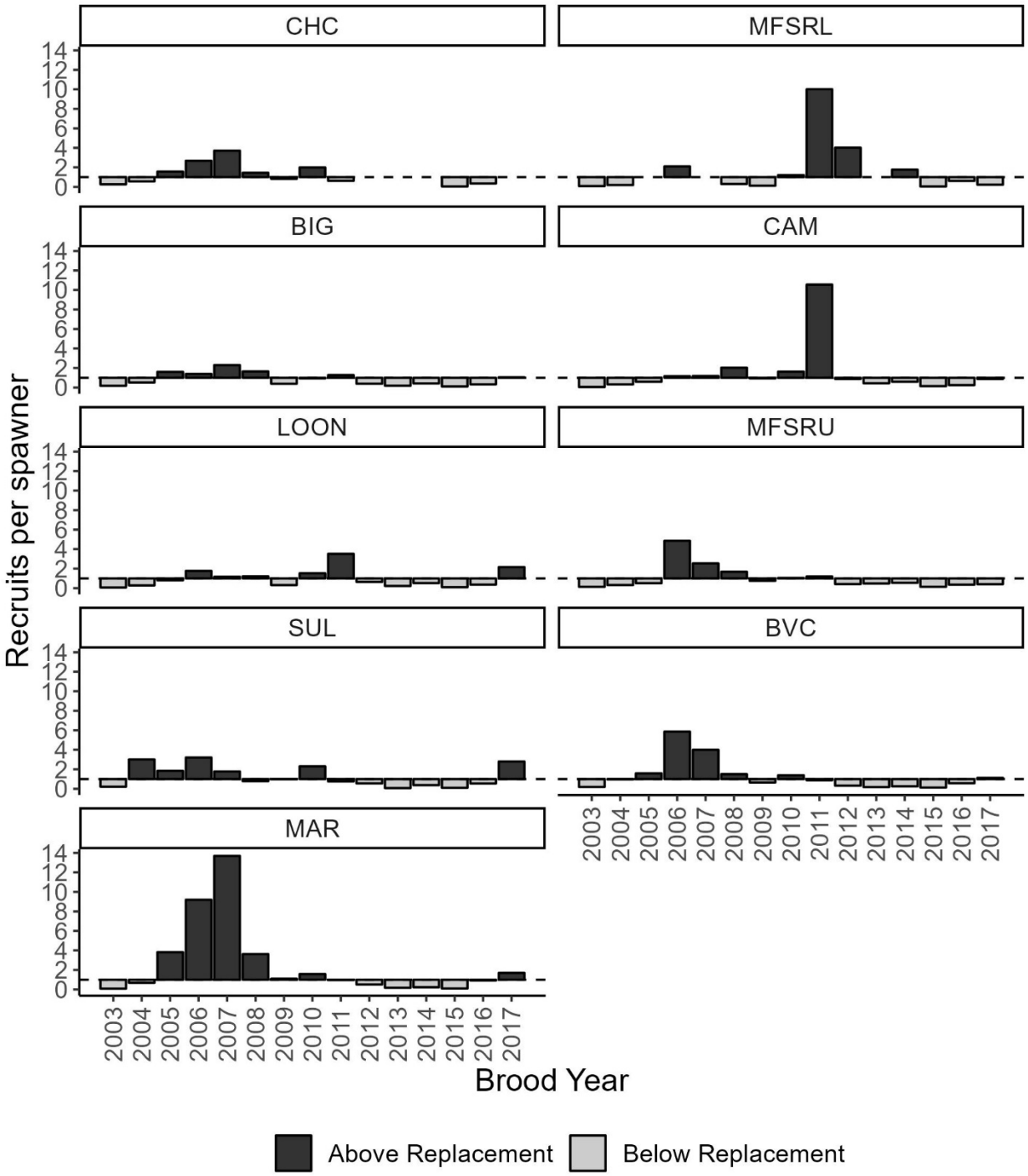

Figure 1-10. Productivity (natural-origin returned redds per spawned redd) of all Middle Fork Salmon River Chinook Salmon populations over brood years 2003-2017. Select brood years were omitted due to incomplete data. Dashed line represents 1:1 replacement.

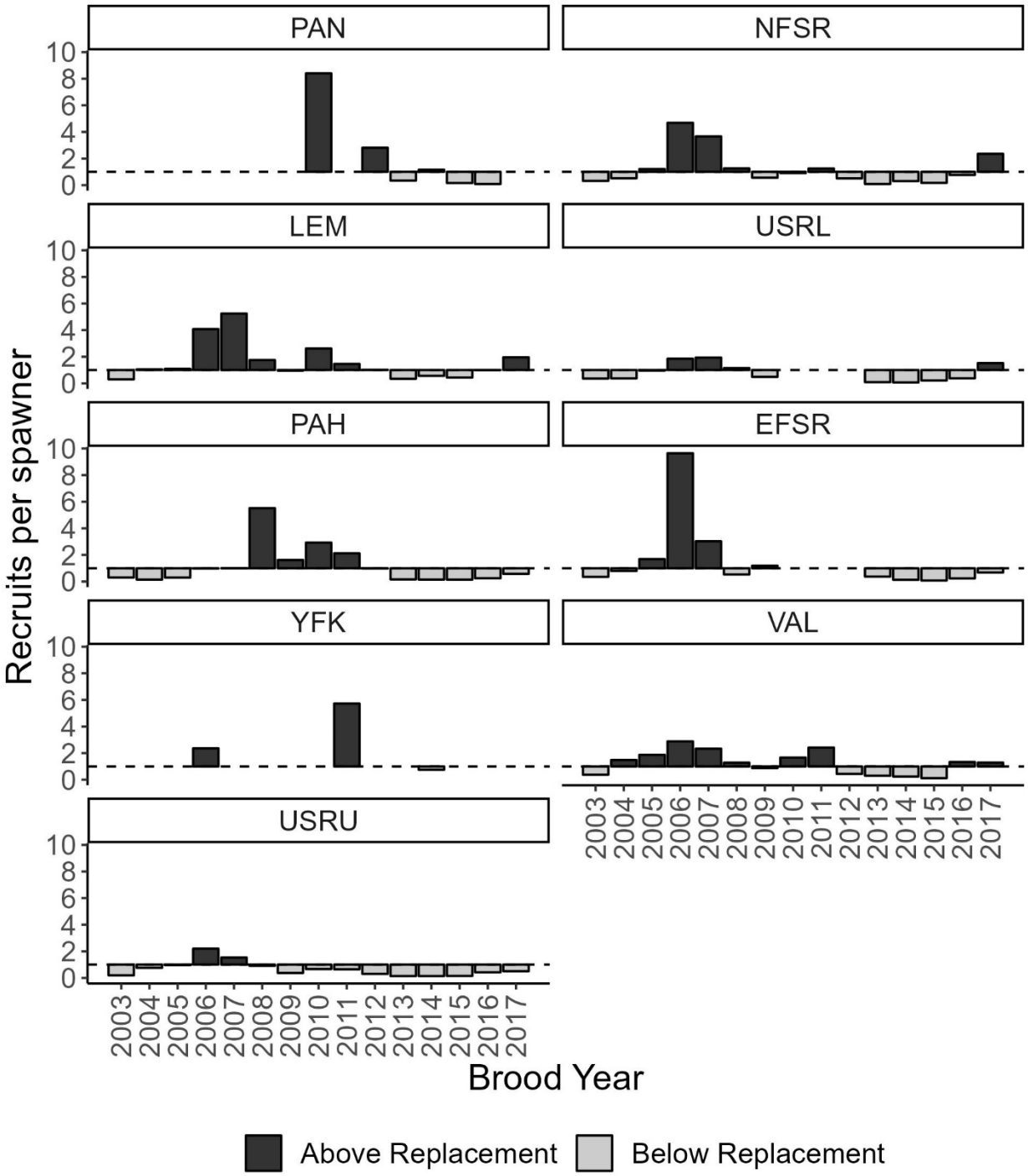

Figure 1-11. Productivity (natural-origin returned redds per spawned redd) of all Upper Salmon River Chinook Salmon populations over brood years 2003-2017. Select brood years were omitted due to incomplete data. Dashed line represents 1:1 replacement.

CHAPTER 2. PERSISTENCE AND SPATIAL DYNAMICS OF CHINOOK SALMON REDDS IN THE MIDDLE FORK SALMON RIVER BASIN, IDAHO, USA

ABSTRACT

Intensive monitoring of redd distribution has been conducted in the Middle Fork Salmon River basin since 1995 to better understand spawning distribution of Chinook Salmon *Oncorhynchus tshawytscha*. In 2022, approximately 693km of Chinook Salmon spawning habitat was surveyed for redds by air and ground, and a total of 842 redds were identified. These surveys cover approximately 260km of Chinook Salmon Spawning habitat that is not included in Idaho Department of Fish and Game index transects. Basin-wide redd counts increased from 2021 and were slightly higher than the 1995-2022 average.

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INTRODUCTION

Snake River spring-summer Chinook Salmon *Oncorhynchus tshawytscha* have been listed as threatened under the Endangered Species Act (ESA) since 1992 (Federal Register notice 57FR14653). Monitoring strategies have been designed to document trends in abundance, productivity, spatial structure, and diversity, and relate those metrics to viability criteria (ICBTRT 2007). Viability is assessed at the population scale but must also be considered at a broader spatial scale. The long-term viability of Chinook Salmon on a broad scale such as an ESU is thought to be dependent on large-scale interactions among individual populations.

The Middle Fork Salmon River (MFSR) basin is an ideal area to study the persistence and spatial dynamics of Snake River spring-summer Chinook Salmon (hereafter Chinook Salmon) for several reasons. First, no hatchery releases have occurred in the MFSR, meaning Chinook Salmon stocks are wild and indigenous (IDFG 2019). Additionally, most of the basin is located within the Frank Church River of No Return Wilderness, which has limited anthropogenic habitat degradation (Thurow 2000). Finally, the MFSR basin consists of approximately 800 km of Chinook Salmon spawning habitat spread across the mainstem and ten tributary basins that have consistently supported spawning in recent decades. Thus, the MFSR basin represents a large, complex network of relatively unaltered Chinook Salmon spawning habitat occupied by wild, indigenous stocks.

Intensive monitoring in the MFSR has been conducted since 1995 to better understand persistence and spatial dynamics of Chinook Salmon (Thurow 2017). This monitoring effort was designed to investigate the influence of habitat area, quality, and configuration on the distribution, pattern, and persistence of Chinook Salmon. In the late 1990s and early 2000s Chinook Salmon abundance in the MFSR increased and spawners expanded into previously unoccupied portions of the basin, but the majority of redds remained clustered in a limited area of the basin (Isaak and Thurow 2006).

The objective of this chapter is to summarize the 2022 surveys designed to monitor wild-Chinook Salmon distribution and abundance by mapping the annual distribution of redds in the Middle Fork Salmon River Basin. Survey methods and study sites were consistent with those first implemented by the Rocky Mountain Research Station in 1995.

METHODS

Study Design

All tributaries that were known to historically support Chinook Salmon spawning were selected to be surveyed. Determination of historical and current occurrence was made by reviewing past redd surveys and anecdotal accounts of spawning activities, interviewing biologists familiar with the MFSR, and reviewing records of juvenile Chinook Salmon occurrence (Isaak and Thurow 2006). Three tributaries (Sheep Creek, Wilson Creek, and Little Loon Creek) that had previously been surveyed as part of basinwide redd counts in the MFSR, have not been surveyed since 2020. Zero redds have been observed in Sheep and Wilson creeks since basinwide redd counts began in 1995 (Thurow 2018). Little Loon Creek was added to basinwide redd counts in 2016, and zero redds were observed in 2 years of surveys (Thurow 2017). We are unaware of any historical records of Chinook Salmon redds in Little Loon Creek. These three streams are assumed to not currently support Chinook Salmon spawning but may be surveyed when adult

escapements above Lower Granite Dam exceed 30,000 natural-origin fish to monitor for recolonization.

Data Collection

Surveys were conducted by flying or walking along designated stream sections and examining the streambed for redds. Rafts are typically used to survey the mainstem MFSR, but debris flows and weather prevented those surveys in 2022. Instead, the mainstem MFSR was surveyed by helicopter; the sections from Loon Creek to Camas Creek, and from Big Creek downstream to Goat Creek were not surveyed due to limited flight time and lack of available fuel. Aerial (helicopter) surveys occurred between September 7-13, which coincides with the end of the spawning period while redds are still visible (Thurow 2010). Surveys were conducted between 0930 and 1800 hours to increase the likelihood of direct overhead sunlight (Copeland et al. 2019). Airspeeds ranged from approximately 10-20 knots and surveys were suspended if the pilot was unable to maintain these airspeeds. Altitudes ranged 15-50 m above ground level. Two trained observers examined the streambed for redds simultaneously. All redds were georeferenced using GPS. The primary observer, located in the front seat, marked locations using a Garmin GPSMAP 66i handheld GPS unit, and the secondary observer, located in the back seat, marked locations using the same model of GPS as a backup.

Ground surveys consisted of either multiple pass surveys or single pass surveys targeted to occur from September 5-12, which coincides with the end of the spawning period while redds are still visible (Thurow 2010). Multiple pass surveys were used for reaches where IDFG index counts occur during the peak of spawning and in populations that are intensively surveyed for fish-in, fish-out monitoring. For these reaches, additional passes were made after the peak count such that a final pass occurred at the end of the spawning period (Copeland et al. 2019). During ground surveys, observers examined the streambed and marked redds using handheld GPS (GPSMAP 66i). On each pass of multiple pass surveys, newly observed redds were flagged and assigned a unique number to avoid double counting. Flagging was removed on the final pass.

RESULTS

In 2022, a total of 842 Chinook Salmon redds were identified across 692.7 km of stream surveyed in the MFSR basin (Table 2-1, Figure 2-1). Aerial surveys encompassed 54% of the surveyed area. Multiple pass ground counts occurred in all IDFG index reaches in the Bear Valley Creek population and covered all potential spawning habitat upstream of the rotary screw trap in Marsh Creek. All other aerial and ground counts consisted of a single pass at the end of the spawning period.

Redds were observed for most surveyed streams within the Middle Fork Salmon River basin, though redd counts were highly variable among streams. Surveys ranged from zero redds observed in the Middle Fork Salmon River below Indian Creek to 296 redds in the Marsh Creek population. The 2022 basinwide redd count was above the 1995-2022 average (Figure 2-2). The majority of redds (63.5%) were in two high elevation populations (Bear Valley and Marsh Creek) at the upper extent of the MFSR drainage (Figure 2-3).

DISCUSSION

The number of redds counted in 2022 across the MFSR basin increased from 2021. Additionally, the number of redds counted increased over the 1995-2022 average of 726 redds. However, spawner abundance was still well below pre-1970 levels. Spawner abundance, along with patch size and connectivity of spawning habitat, influences the distribution of Chinook Salmon redds in the MFSR (Isaak and Thurow 2006; Isaak et al. 2007). When spawner abundance is low, most redds are found in areas with large patches of spawning habitat and high connectivity among those patches (Isaak and Thurow 2006). The distribution of redds in 2022 was consistent with this observation, as 63.5% of redds were found in the upper Middle Fork basin, where large, connected patches of spawning habitat occur within the Bear Valley Creek and Marsh Creek drainages.

The data collected in this study add another year to a rich data set which has been used in studies of temporal change in population synchrony (Isaak et al. 2003), sampling design for monitoring Chinook Salmon populations (Courbois et al. 2008), temporal variation in redd distribution (Isaak and Thurow 2006), factors affecting natal homing (Neville et al. 2006), genetic structure of Chinook Salmon (Neville et al. 2006), factors affecting use of spawning patches (Isaak et al. 2007), and effects of climate change and fire regime on redd distribution (Jacobs et al. 2021). Analysis of the spatial and temporal variability of Chinook Salmon in the MFSR basin will continue as this data set continues to grow.

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TABLES

Table 2-1. Stream length surveyed and Chinook Salmon total redd counts in the Middle Fork Salmon River, Idaho, 2022. See Abbreviations and Acronyms pages for population abbreviations.

Population	Length (km)	Redds
MFSRL	64.3	0
BIG[a]	120.6	119
CAM	74.8	49
LOON	85.8	51
MFSRU	172.8	35
SUL	23.5	53
BVC[b]	96.9	239
MAR	53.8	296
Total	**692.7**	**842**

[a] Staff from Nez Perce Tribe, U.S. Forest Service, and Idaho Department of Fish and Game collected and provided information.

[b] Staff from the Shoshone-Bannock Tribes, U.S. Forest Service, and Idaho Department of Fish and Game collected and provided information.

FIGURES

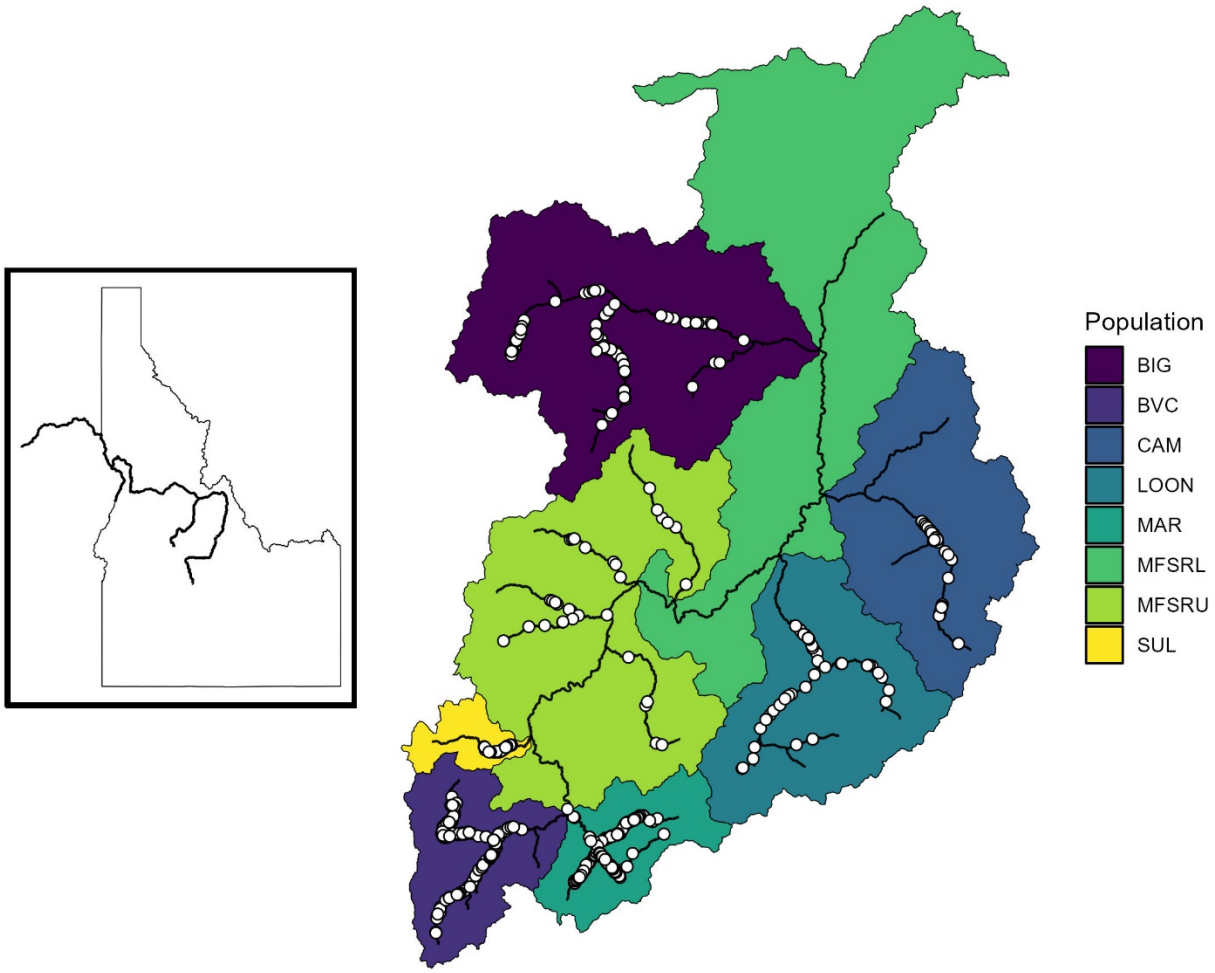

Figure 2-1. Chinook Salmon redds (white circles; N = 842) observed in independent populations of the Middle Fork Salmon River basin, Idaho, 2022.

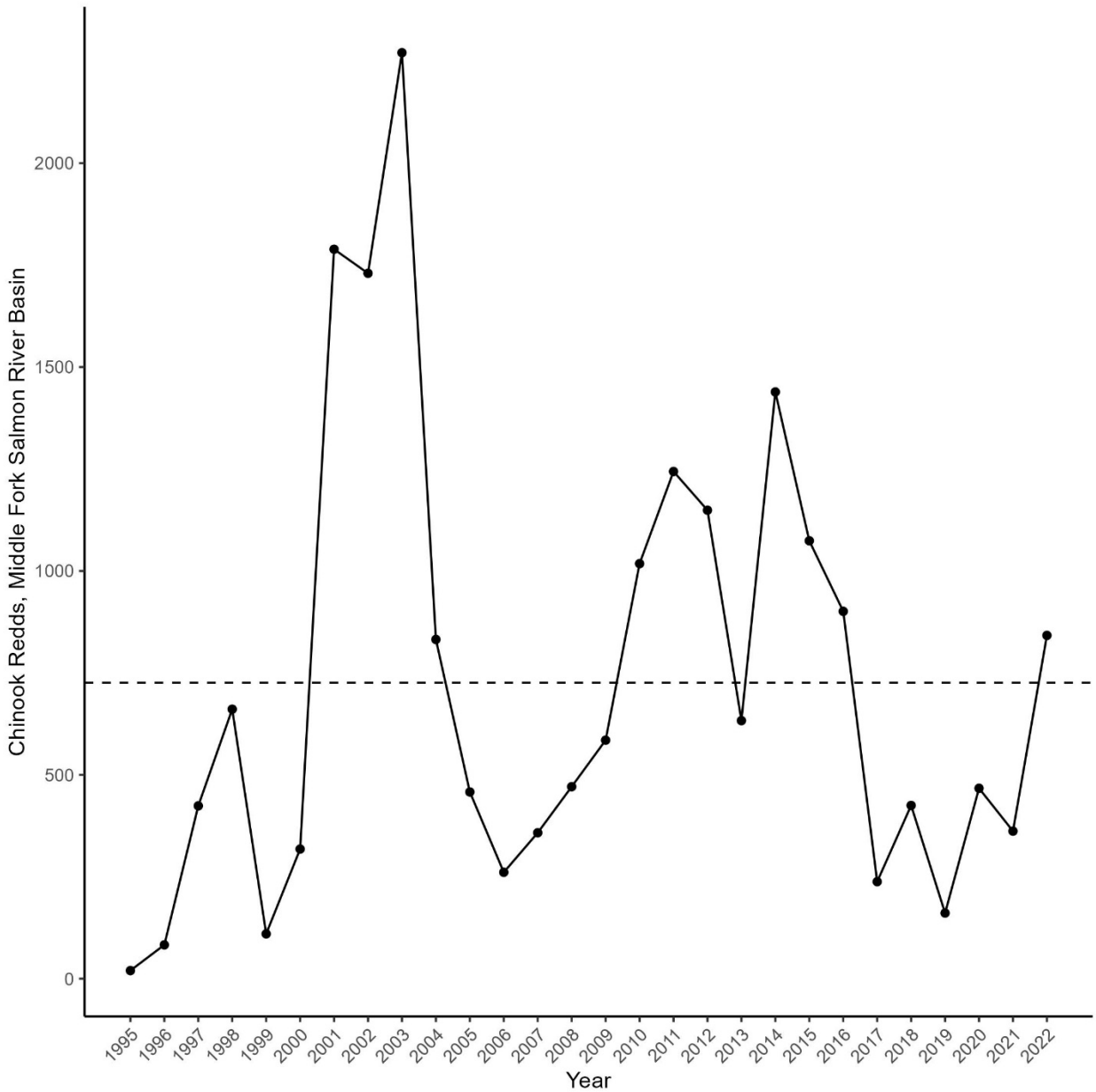

Figure 2-2. Total redd counts in the Middle Fork Salmon River basin, Idaho, 1995-2022. Dashed line represents the average redd abundance for 1995-2022.

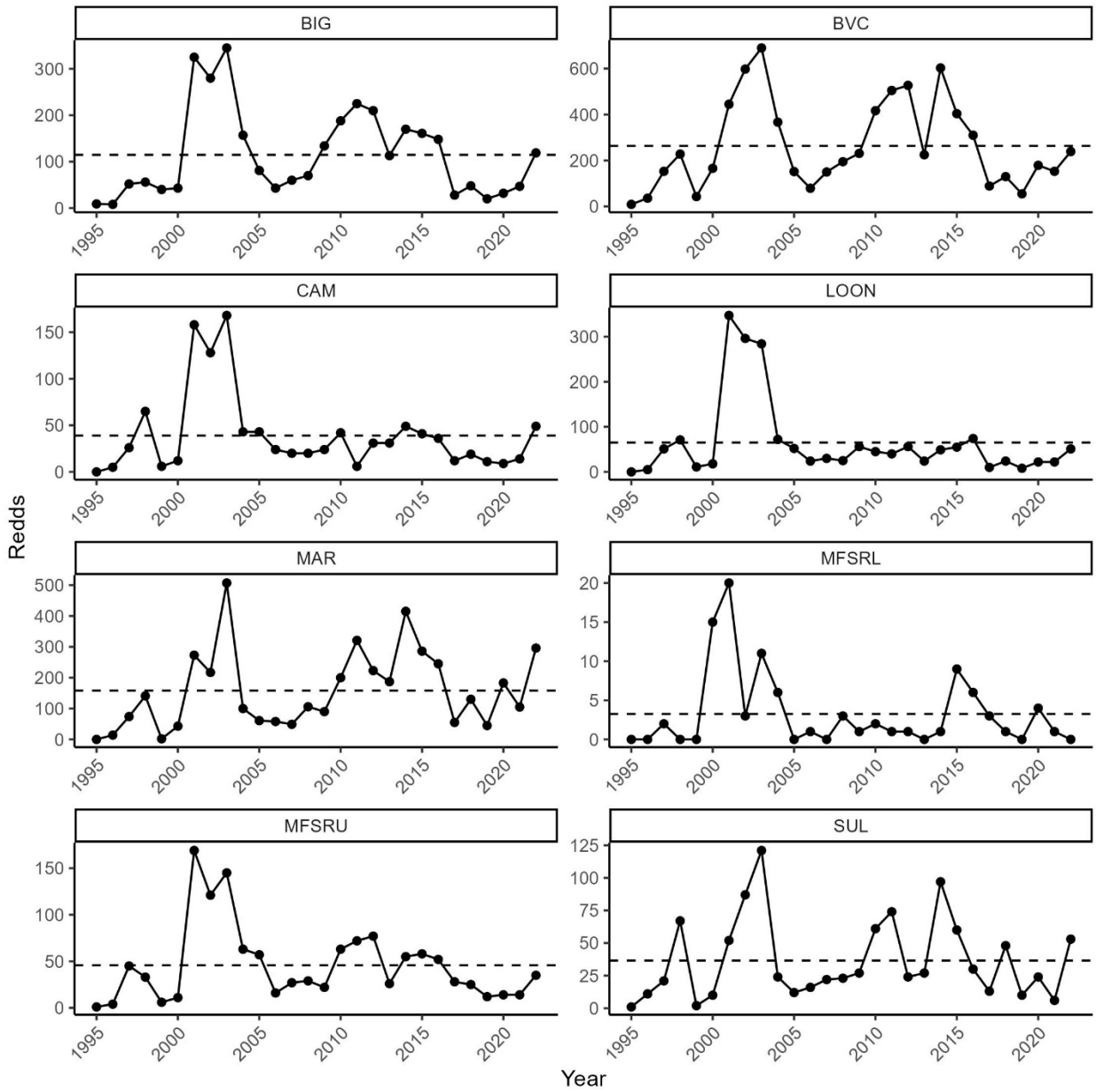

Figure 2-3. Total redd counts in independent populations of the Middle Fork Salmon River basin, Idaho, 1995-2022. Dashed line represents the average for 1995-2022. Note differing scales on y-axes.

APPENDICES

Appendix A. Additional information collected on spawning ground surveys and at hatchery weirs in 2022.

Jacob S. Ruthven, Fisheries Biologist

INTRODUCTION

Chinook Salmon spawning ground surveys are primarily designed to monitor status and trends in abundance and productivity within and among Idaho populations. However, additional data are collected in order to monitor more intensively at smaller scales and to address ancillary objectives. These data are not comparable on the broad scale that is the main focus of this report. In most cases, these data will eventually be used in completion reports on projects such as habitat effectiveness monitoring and genetic diversity monitoring or to help improve monitoring methods. The purpose of this appendix is to report the annual collection methods for these data.

METHODS

Multiple Pass Surveys

Multiple pass redd counts were used to estimate total redds within three populations, Marsh Creek, Valley Creek, and Lemhi River, and in the Salmon River upper mainstem from Redfish Lake Creek to Sawtooth weir. Multiple pass surveys were designed to begin with the start of spawning activity, with subsequent surveys conducted weekly until the end of spawning activity (Copeland et al. 2019). Each survey followed data collection methods described in Chapter 2 of this report. On each pass, newly observed redds were flagged, assigned a unique number, and georeferenced using GPS units. Flags were removed on the last pass. In the Clearwater River basin, prior years surveys included redds counted beyond the index sites in various streams. However, these redds were excluded from the index counts reported in Chapter 1 for 2022. Multiple pass redd survey data was downloaded from the SGS database on 16 February 2023.

Weir Passage

Adult Chinook Salmon passage is recorded at IDFG weirs at the Pahsimeroi, Sawtooth, and South Fork Salmon River hatcheries. All fish released above weirs were marked with an opercle punch. Carcass surveys were conducted above weirs. Abundance above the Sawtooth and South Fork Salmon river weirs was estimated using the Chapman modification of the Lincoln-Petersen method (Chapman 1951, Seber 1982):

$$\widehat{N} = \frac{(M+1)(C+1)}{(R+1)} - 1,$$

where M was the number of fish marked at the weir, C was the number of carcasses recovered above the weir, and R was the number of marked carcasses recovered above the weir. Prespawn mortality was assessed by examining the spawning stage of carcasses collected on spawning grounds, and escapement was estimated by directly subtracting observed prespawn mortalities from estimated abundance. Recapture probability was estimated separately for differentially marked fish (i.e., hatchery-origin or natural origin) to inform the Integrated Broodstock Program (Venditti et al. 2020).

Genetics Samples at Weirs and Traps

All adult Chinook Salmon captured at IDFG weirs or traps had the following data recorded: origin (natural or hatchery), any marks or tags, fork length (mm), and sex. We refer the reader to hatchery reports and to the Fish Inventory System Hatchery Database (FINS; http://www.fishnet.org/) to obtain more specific information. Tissue samples for genetics analysis were collected from all fish released upstream of the weir for natural spawning. Tissue samples were stored on Whatman sheets and delivered to the IDFG Eagle Fish Genetics Laboratory located in Eagle, Idaho.

RESULTS

Multiple Pass Surveys

Surveys in the Marsh Creek population went from the first week of August until the second week of September and documented 285 redds (Appendix Table A-1). Surveys in the Lemhi River population went from the third week of August until the third week of September and documented 420 redds (Appendix Table A-1). Valley Creek was also surveyed three times from the last week of August to the third week of September; 63 redds were observed (Appendix Table A-1). Surveys in the upper mainstem Salmon River went from the first week of September to the third week of September and documented 115 redds.

Weir Passage

We estimated abundances of 317 natural- and 64 hatchery-origin Chinook Salmon that passed above the Pahsimeroi weir. At the Sawtooth weir, we estimated 211 natural- and 254 hatchery-origin Chinook Salmon. Estimated abundance at the South Fork Salmon weir was 504 natural- and 193 hatchery-origin Chinook Salmon. Recapture probabilities of fish passed above the Sawtooth weir were lower than normal in 2022 because the weir was installed later due to high water. As a result, many unmarked fish passed upstream.

Genetic Samples at Weirs and Traps

A total of 1,314 tissue samples were collected from Chinook Salmon released at IDFG hatchery and research weirs during 2022 (Appendix Table A-3). Most samples (n = 661) were collected from the South Fork Salmon River. Genetic samples from the South Fork Salmon River, the Pahsimeroi River and reaches of the Salmon River near the Sawtooth weir are used to evaluate performance of the Integrated Broodstock Program in those rivers (e.g., Venditti et al. 2020). The East Fork Salmon River weir was not operated for Chinook Salmon in 2022 and no samples were collected. Chinook Salmon are incidental catch at the Fish Creek research weir, which is operated for steelhead *Oncorhynchus mykiss*.

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Appendix Table A-1. Multiple-pass redd count census surveys that were conducted for Chinook Salmon in Idaho during 2022. Surveys are organized by major population group (MPG). Data was downloaded from the SGS database on 2/25/23.

Population	Waterbody	Date	New redds[a]	Date	New redds[a]	Date	New redds[a]	Date	New redds[a]	Date	New redds[a]	Date	New Redds[a]	Total
						Middle Fork Salmon River MPG								
Marsh Creek	Beaver Creek	8/5	11	8/12	42	8/19	49	8/29	11	9/2	3	9/9	0	116
	Banner Creek			8/13	4	8/22	0	8/28	0					4
	Cape Horn Creek			8/13	18	8/22	14	8/28	7	9/3	0			39
	Knapp Creek					8/20	9	8/26	1	9/3	1			11
	Marsh Creek	8/6	17	8/14	27	8/21	51	8/27	17	9/4	3	9/10	0	115
Total			**28**		**91**		**123**		**36**		**7**		**0**	**285**
						Upper Salmon River MPG								
Lemhi River	Bear Valley Creek					8/24	0					9/9	0	0
	Big Springs Creek									9/2	1	9/9	2	3
	Big Timber Creek							8/30	0					0
	Hayden Creek			8/22	11			8/29	22	9/6	14			47
	Lemhi River							8/31	103	9/7	216	9/20	51	370
	Little Springs Creek			8/24	0			8/31	0	9/9	0			0
Total					**11**				**125**		**232**		**52**	**420**
Valley Creek	Valley Creek							8/30	35	9/8	27	9/17	1	63
Salmon River Upper Mainstem Above Redfish Lake	Redfish Lake Creek upstream to Sawtooth Weir					9/1	47	9/7	56	9/16	10	9/24	2	115

Appendix Table A-2. Data collected for estimating Chinook Salmon abundance above IDFG weirs in 2022. M = Number of fish marked and passed above weirs, C = number of carcasses recovered above weirs, R = number of marked carcasses recovered above weirs, and N = estimated abundance, and recapture probability of fish passed above the weir (not including fish taken into the hatchery for spawning).

Weir	Origin	M	C	R	N	Recapture probability
Pahsimeroi	Natural	299	10	9	317	0.90
	Integrated	56	3	2	64	0.67
	Segregated	0	0	0	0	NA
Sawtooth	Natural	162	87	67	211	0.77
	Integrated	46	16	12	60	0.75
	Segregated	55	117	31	194	0.27
South Fork Salmon	Natural	476	104	98	504	0.94
	Integrated	193	15	15	193	1.00
	Segregated	0	0	0	0	NA

Appendix Table A-3. Number of genetic samples collected from Chinook Salmon released upstream of IDFG hatchery and research weirs, 2017-2022.

Weir	2017	2018	2019	2020	2021	2022
Salmon River (Sawtooth)	305	152	78	191	251	260
Pahsimeroi River	277	320	92	161	105	357
South Fork Salmon River	389	455	291	110	338	661
Rapid River	30	30	19	22	27	36
Hells Canyon Dam	0	3	1	17	11	0
Lochsa River (Powell)	24	27	0	0	0	0
Fish Creek	3	0	0	1	0	0
Red River	22	15	0	0	0	0
Crooked River	8	13	0	0	0	0
Total	1,058	1,015	462	502	721	1,314

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