FISHERY RESEARCH

IDAHO ADULT CHINOOK SALMON MONITORING

2019 ANNUAL REPORT

Photo: Eli Felts

Prepared by:

Eli A. Felts, Fisheries Biologist
Bruce Barnett, Fisheries Data Coordinator
Micah Davison, Supervisory Fisheries Biologist
Katherine M. Lawry, Fisheries Biologist
Conor McClure, Fisheries Biologist
Joshua R. Poole, Fisheries Biologist
Robert Hand, Fisheries Biologist
Mike Peterson, Fisheries Biologist
Evan Brown, Sr. Fisheries Data Coordinator

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Eli A. Felts
Bruce Barnett
Micah Davison
Katherine M. Lawry
Conor McClure
Joshua R. Poole
Robert Hand
Mike Peterson
Evan Brown

Idaho Department of Fish and Game
600 South Walnut Street
P.O. Box 25
Boise, ID 83707

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Report Authors:

Eli A. Felts
Joshua R. Poole
Bruce Barnett
Robert Hand
Micah Davison
Mike Peterson
Katherine M. Lawry
Evan Brown
Conor McClure

Report Contributors: Data and Field Work (*alphabetical*)

IDFG Southwest Region (Nampa)

- John Cassinelli
- Isaiah Porteous

IDFG Southwest Region (McCall)

- Jordan Messner
- Dale Allen
- Kaitlyn Wauhkonen
- Dale Brown
- Steven Hughes
- Laurie Janssen
- Dave Rhinehart
- Kert Wuestenhagen

IDFG Salmon Region

- Stacey Feeken
- Jonah Keith
- Taylor Whitson
- A. Tate
- Quinn Richard
- S. Zabronsky
- V. Luzanau
- J. Bryan
- J. Markham
- Eric Geisthardt
- Demitra Blythe
- Jessica Buelow
- Amber Young
- Taylor Pruyne
- Courtnie Ghere
- Catherine Berrick
- Brent Beller

IDFG Clearwater Region

- Brett Bowersox
- Marika Dobos
- Patrick Vrablik
- Jason Fortier
- Brian Knoth
- Scott Putnam

IDFG Nampa Research

- Jeremy Facer
- Ethan Gardner
- Joseph Hirsch
- Brooke Morgan
- Ron Roberts
- Eric Stark
- Dave Venditti

IDFG Headquarters

- Tim Copeland
- Chris Harrington

IDFG Eagle Fish Genetics Lab

- Brian Ayers

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Report Contributors: Data and Field Work (*alphabetical, continued*)

Nez Perce Tribe

- Craig Rabe
- Doug Nelson
- Jay Oatman
- Sherman Sprague
- Devayne Lewis
- Tyler Williamson

U.S. Forest Service

- Scott Brandt
- Ed Fochtner
- Christine Stewart
- Russ Thurow
- Caleb Zurstadt

Shoshone-Bannock Tribes

- Lytle Denny
- Melissa Evans
- Rebecca Croy
- Kurt Tardy
- Angelo Teton
- Josh Jackson
- Kermit Bacon
- Joseph Snapp
- Joshua Taryole
- Kameryn Farmer
- Triston Losh
- Josh Gable
- Peyton Sequints
- M. Miro
- C. Cannon
- Aaron Colter
- Kurrie Adakia
- Riley Ariwite
- Sterling Starlight
- Cerissa Honena
- Ethen Tendore
- Jordan Plentyhawk
- Linden Reyes
- Ron Diaz
- Scott Casier
- Kendra Eaton
- Rob Trahant

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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
INPMEP	Idaho Natural Production Monitoring and Evaluation Project
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
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 Upper 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 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 Snake River 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). 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 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 Chinook Salmon 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 2016).

Current monitoring of Chinook Salmon recovery is framed by population boundaries established by the Interior Columbia Basin Technical Recovery Team (ICBTRT 2003, 2005) following ESA guidance. 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 2016). 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 2016). Evolutionarily Significant Units are divided into hierarchical levels including Major Population Groups (MPGs), which are further divided into independent populations (McElhany et al. 2000; ICBTRT 2005). The 1992 ESA listing organized the Snake River spring-summer Chinook Salmon ESU 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 with stocks from extant Snake River populations. 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 basin-wide 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 Natural Production Monitoring and Evaluation Project (INPMEP) is designed to collect information necessary to assess the status of Idaho's 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 spring-summer 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 viability criteria which are related to trends and status in abundance, productivity, spatial structure, and diversity (McElhany et al. 2000). Data collected from this project are provided to NMFS for status review of extant MPGs of the Snake River spring-summer Chinook Salmon ESU (hereafter Chinook Salmon).

REPORT CHAPTERS AND TOPICS

The primary objective of this annual report is to document 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 transects 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. The chapter incorporates the continuation of a long-running U.S. Forest Service Project (1999-020-00) that started in 1995 and was led by Russ Thurow until being transferred to IDFG in 2018. A long-term plan for annual spawning ground surveys was developed for this basin in 2018 and was provided in a previous version of this report (Felts et al. 2019, Appendix A).

Chapter 3 describes data provided to NMFS for the 2020 status review, and we provide our interpretation of those data.

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 changes to the redd count index transect methodology in the lower mainstem Salmon River.

Appendix B documents data collected at hatchery weirs and during multiple pass redd counts, and Appendix C documents proposed changes to the redd count index transect methodology in East Fork Moose Creek and Colt Killed Creek in the Clearwater drainage.

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 Sequel 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 Sequel Server. The transfer is performed by the ageing 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 ageing 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 preformatted tables by biologists responsible for their collection. Length and fin ray age data were downloaded from the BioSamples database on 18 March 2020. Adult weir and trap data are stored in and accessed from the Fish Inventory System Hatchery Database (FINS; https://www.fishnet.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 18 March 2020.

Authors:

Eli A. Felts
Fisheries Biologist

Evan Brown
Sr. Fisheries Data Coordinator

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

ABSTRACT

The Idaho Natural Production Monitoring and Evaluation 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 transects and provide estimates of relative abundance and productivity of Chinook Salmon. These surveys are conducted annually to document temporal trends in relative abundance and productivity. In 2019, a total of 535 redds were counted at 104 transects covering 1,250 km, 27 populations, and 5 major population groups. With few exceptions, relative abundance in 2019 was lower than in 2018 and the lowest in the most recent 5-year era. Relative abundance has decreased in many Idaho populations since 2014. The brood year 2015 cohort, represented by age-4 fish on the spawning grounds in 2019, was the most common among all age classes observed. Adult-to-adult productivity estimates for the brood year 2014 cohort are now complete, and were less than 1 recruit per spawner for every population.

Authors:

Eli A. Felts
Fisheries Biologist

Bruce Barnett
Fisheries Data Coordinator

Micah Davison
Supervisory Fisheries Biologist

Katherine M. Lawry
Fisheries Biologist

Conor McClure
Fisheries Biologist

Joshua R. Poole
Fisheries Biologist

Robert Hand
Fisheries Biologist

Mike Peterson
Fisheries Biologist

Evan Brown
Sr. Fisheries Data Coordinator

INTRODUCTION

Abundance is an essential metric in monitoring fish populations as it represents the end product of the interplay between three processes (recruitment, growth, and mortality) considered to be the pillars of fisheries management (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 have 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) escaping to Idaho in 2019 is summarized using single-pass redd counts. Redd counts are commonly used as a *relative* index of population abundance across space and time. Hence, continuous standardized redd count data were used to compare 2019 relative abundance to the most recent 5-year era, to the 1957-1969 pre-dam era, and across the Idaho landscape. Specific objectives were to:

1) Quantify spawner relative abundance for 27 Idaho populations of Chinook Salmon that were surveyed in 2019.

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 transects targeted for redd counts in 2019 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 transects began as early as 1957 (Hassemer 1993; Copeland et al. 2019). Trend transects were selected to represent important production areas containing a large portion of available spawning habitat (Copeland et al. 2019). Transects 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). Changes in transects surveyed in 2019 are described in Appendix A of this report, and proposals for changes in 2020 are described in 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).

Data Collection

Redd counts were conducted by trained observers who attended an interagency training workshop hosted by IDFG in Stanley, Idaho on August 7, 2019. Training occurs annually to standardize the criteria by which Chinook Salmon redds are identified across Idaho. 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; Copeland et al. 2019). 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 transect and examining the streambed for redds. Aerial surveys were conducted with either low-flying helicopter or unmanned aircraft systems (UAS). All redds were enumerated and georeferenced using GPS units.

Chinook Salmon carcasses encountered during ground surveys were sampled to determine origin, to estimate age composition, and to collect tissue for genetic analysis. Supplemental surveys were conducted for the sole purpose of collecting biological information from carcasses. Each carcass was inspected for marks and tags, measured for fork length (mm), and examined to determine sex. Dorsal fin ray and tissue samples were taken from all carcasses. 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 the IDFG Nampa Research Anadromous Ageing Laboratory (NRAAL) located in Nampa, Idaho.

Carcasses were identified as either natural- or hatchery-origin based on where they were produced as indicated by marks and tags. Natural-origin fish are those produced outside of a hatchery, whereas hatchery-origin fish are those produced in a hatchery. For the purposes of this chapter, wild-origin fish, as determined by genetic lineage (IDFG 2019), are considered to be a subset of natural-origin fish. Hatchery fish were further distinguished by production type, which was either segregated or integrated. Segregated hatchery-origin Chinook Salmon are those produced from crosses of hatchery fish only, whereas integrated hatchery-origin fish are produced from crosses of either two natural-origin parents or crosses of one natural- and one hatchery-origin parent. All carcasses encountered were visually inspected for an adipose fin clip, scanned for a coded wire tag (CWT), and scanned for an internal passive integrated transponder (PIT) tag. Carcasses with an adipose fin clip were considered segregated hatchery-origin. Carcasses with CWT and an intact adipose fin were considered integrated hatchery-origin. All other carcasses with an intact adipose fin were considered natural. Some hatchery release groups from the Clearwater basin do not receive an adipose fin clip, so hatchery origin is underestimated for these populations. Carcasses which were too decomposed to inspect for fin clips and tags were considered unknown origin.

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 bone saw, and mounted on microscope slides. Mounted 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. To assess the accuracy of our age assignments, fin ray samples from known-age fish were mixed into the overall sample. Smolts marked with PIT tags and CWTs and recovered during hatchery spawning or carcass surveys were considered known-age.

Additional age composition data were obtained from in-stream arrays. These additional samples bolstered 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 (Table 1-2) were queried to obtain age composition data. Scale samples were taken from adults marked with PIT tags at Lower Granite Dam (Camacho et al. 2018). Technicians at NRAAL processed scale samples and assigned 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 transects in 2019 was summed by population and plotted alongside observations from the recent era (previous 5 years, 2014-2018) and from the pre-dam era (13 years, 1957-1969). Geometric mean, minimum, and maximum number of redds were calculated for the pre-dam era comparison. This period also corresponds to the “pre-dam era” described in the Comparative Survival Studies (McCann et al. 2018). The spatial distribution of redds among populations was graphically displayed by constructing a heat map with population polygons shaded in proportion to relative abundance. Spatial data were analyzed using the dplyr (Wickham et al. 2017), rgdal (Bivand et al. 2017), and sp (Pebesma and Bivand 2005) packages in program R (R Core team 2017). Maps were constructed using the ggplot2 (Wickham 2009) and viridis (Garnier 2017) packages in program R (R Core Team 2017).

Population-specific age composition for 2019 was estimated directly using the age class proportions 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. 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 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 less 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.

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 hatchery influence in 2019 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. 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).

Adult-to-adult productivity was updated through brood year 2014 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 transects 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 2005). Age composition dating back to brood year 2001 was calculated using the methods described above for the current year’s age composition. This time series was selected to characterize productivity over the 3 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 transect 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 transects were not established until 2017.

RESULTS

During August and September 2019, 104 transects covering 1,250 km of streams in Idaho were surveyed for Chinook Salmon redds (Table 1-3). A total of 535 redds were counted in index transects across 5 MPGs and 27 populations in the Salmon River and Clearwater River basins. Eighty-eight percent of redds were counted in the Salmon River basin (Table 1-3; Figure 1-1; Figure 1-2). Number of redds was highest in the Upper Salmon River above Redfish Lake Creek, South Fork Salmon River mainstem, Bear Valley Creek, and Upper South Fork Clearwater populations (Table 1-3). However, hatchery fraction was 0.72 in the Upper Salmon River above Redfish Lake Creek, 0.79 in the South Fork Salmon River, and 0.91 in the Upper South Fork Clearwater populations.

All index transects in the South Fork Salmon River MPG were surveyed, which included 123.8 km of current spawning habitat. The total number of redds counted ranged from 1 redd in the Little Salmon River to 94 redds in the South Fork Salmon River mainstem (Table 1-3; Figure 1-3). Hatchery-origin fish composed all carcasses collected in the Little Salmon River, 79% of carcasses in the South Fork Salmon River mainstem, 34% in the East Fork South Fork Salmon River, and 0% in the Secesh River (Table 1-4).

All index transects in the Middle Fork Salmon River MPG were surveyed, which included 487.6 km of current spawning habitat. The total number of redds counted ranged from 0 redds in the Chamberlain Creek and Middle Fork Salmon River below Indian Creek populations to 48 redds in the Bear Valley Creek population (Table 1-3; Figure 1-4). All carcasses collected during 2019 in the Middle Fork Salmon River MPG were natural-origin (Table 1-4).

All except for two index transects in the Upper Salmon River MPG were surveyed, which included 463.1 km of current spawning habitat. The total number of redds counted ranged from 1 in the Yankee Fork Salmon River to 81 in the Upper Salmon River mainstem above Redfish Lake population (Table 1-3; Figure 1-5). Hatchery-origin fish composed 57% of carcasses collected in the Upper Salmon River mainstem above Redfish Lake, and 7% in the Lemhi River (Table 1-4). No hatchery carcasses were encountered in the other populations of the Upper Salmon River MPG.

All index transects in the Dry Clearwater MPG were surveyed, covering 85.4 km of current spawning habitat (Table 1-3). Only one population in the Dry Clearwater MPG was sampled, because there is no evidence of substantial spawning by spring Chinook in other populations. In 2019, 44 redds were counted in the Upper South Fork Clearwater. The 2019 count was a decrease of 108 redds from 2018 (Figure 1-6). Ninety-one percent of the carcasses collected in the Upper South Fork Clearwater population were hatchery-origin (Table 1-4).

All index transects in the Wet Clearwater MPG except WC-5 were surveyed, which included 89.9 km of current spawning habitat. Total number of index redds counted ranged from 0 redds in Lolo Creek to 9 redds in the Lochsa River (Table 1-3; Figure 1-6). Meadow Creek was not sampled. Only seven carcasses were recovered in the Wet Clearwater MPG, and 4 of those were hatchery-origin (Table 1-4).

In total, 661 natural-origin samples were assigned an age using fin rays or scales in 2018 (Table 1-5). Fin ray samples from carcasses accounted for 320, or just under half, of the age assignments. Fewer than 20 samples were assigned an age in 17 surveyed populations. Age assignments matched their known ages for 86% of the known-age fin ray samples (n = 141), and the most common error was for known total age-3 fish to be overestimated by one year (Figure 1-7). Age assignments matched their known ages for 96% of the known-age scale samples (n = 26), and there were no apparent biases among age-classes, indicating scale age assignments were accurate (Figure 1-8). The brood year 2015 cohort, represented by age-4 fish on the spawning grounds in 2019, was the most common among all age classes observed within MPGs (Table 1-5) and across all samples (Figure 1-9). Age-3 and age-5 fish were also observed.

Adult-to-adult productivity over brood years 2000-2014 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 2000-2014 (Figure 1-10). Productivity in nearly all populations was below replacement for brood years 2001-2003, and above replacement for brood years 2006 and 2007. Productivity has been below replacement in nearly all populations for the last 3 completed brood years, 2012-2014. Time series of productivity by population for brood years 2000-2014 are provided (Figures 1-11 – 1-13).

DISCUSSION

Idaho spring-summer Chinook Salmon redd abundance in 2019, measured by our standard index redd counts, was low compared to the past 5 years across all Idaho populations. We presume low relative redd abundance indicates low absolute spawner abundance. The 2019 run stands out even among the relatively poor runs over recent years. Index redd counts within many populations were among the lowest observed in the 63-year history of this data set. The range of recent era observations has been below or near the low end of the pre-dam era range, indicating that even "good" runs in recent years were well below their potential. Relative abundance within supplemented populations, including the East Fork South Fork Salmon River, Pahsimeroi River, and Salmon River mainstem above Redfish Lake, has been within the pre-dam era range and near the geometric mean over recent years, but carcass collections indicate that hatchery-origin fish constructed most 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.

No redds or live fish were observed during the index redd count on Chamberlain Creek or the West Fork Chamberlain Creek in 2019. A second survey was conducted two weeks later to assess if redds were created after the initial count; no redds or live fish were observed on that survey either. In the previous ten years, index counts have ranged from 32 to 55 on Chamberlain Creek and 11 to 69 on the West Fork Chamberlain Creek. Since IDFG began standardized redd surveys in the Chamberlain Creek population in 1957, a count of zero has never been recorded. However, there is evidence that Chamberlain Creek was inaccessible in the past Hauck (1951) reported that in spring 1951 high flows removed debris that had previously blocked salmon, and that redds were observed in 1951 near the Chamberlain Creek guard station in previously inaccessible areas. Genetic stock samples collected at Lower Granite Dam in 2019 yielded an estimate of 72 (90% CI = 44 to 102; 14 female; 58 male) Chinook from the Chamberlain genetic stock (Lawry et al. 2020), so blockage of upstream migration is a potential reason no redds were observed. However, on the second survey observers flew over the downstream portion of Chamberlain Creek in a fixed-wing aircraft and did not observe any obvious passage barriers. It is also possible that the few fish bound for Chamberlain Creek suffered prespawn mortality prior to constructing redds, or that fish spawned in areas outside of the index transects. Regardless, IDFG will continue to conduct redd surveys and monitor the Chamberlain Creek population in 2020.

A major change to IDFG methodology occurred in 2018 with the widespread implementation of UAS for redd counts in the Upper Salmon River MPG. In total, 552.2 km were surveyed in areas which were surveyed by low-flying helicopter in recent years. The use of UAS is desirable as they provide a safe alternative to helicopter surveys in areas where ground access is infeasible. In 2019 IDFG transitioned from manual UAS surveys to predominately autonomous UAS surveys. This change reduced the number of drone crashes due to operator error from three in 2018 to zero in 2019. However, the time it took to complete all the necessary surveys doubled from 2 ½ weeks in 2018 to 5 weeks in 2019. Additionally, a number of transects surveyed by UAS in 2018 and 2019 were also surveyed from the ground, allowing for comparison. Initial analysis suggested that accuracy is variable and depends predominately on the stream surveyed. Generally, UAS counts tended to underestimate redd counts when compared to ground surveys, which is also likely the case with helicopter surveys. Probability of redd detection using UAS aerial images is likely to be influenced by a number of factors including image quality, stream-specific characteristics (e.g., riparian vegetation), and observer experience. Additional work to reduce survey time, increase accuracy, improve precision, and identify other factors affecting detection probability when using UAS for redd counts is planned for 2020. Specifically, in 2020, we plan to change the software program used to fly the drones from DroneDeploy (2019) to DJI Ground Station Pro (2020). DJI Ground Station Pro will permit us to continue with the autonomous UAS surveys, but will use linear flight plans as opposed to polygon flight plans, reducing the number of images required to produce orthomosaic photos. Furthermore, with DJI Ground Station Pro we will be able to temporarily hover the drone in a stationary position to capture images as well as change the angle at which the camera is set to improve image and orthomosaic photo quality. Additionally, we will evaluate alternatives to current sampling design, such as stratified random sampling, which may help reduce survey time while maintaining accuracy and precision (Liermann et al. 2014). These planned changes should help to reduce survey time and cost, maintain safe operations, and improve our ability to identify redds from UAS surveys.

The Nampa Research Anadromous Ageing Lab (NRAAL) has an accuracy goal of >90% for total and saltwater age determination using fin rays. This standard is based on historical accuracy assessments of NRAAL age determination, and is met or exceeded in the vast majority of years in which accuracy has been assessed. In spawn year 2019, the accuracy of total age assignments fell below this standard at 86%. Individual reader accuracy ranged from 83% - 90% and 86% accuracy reflects the percent agreement (PA) between known age samples and a multiple reader consensus read. Overall inaccuracies were biased toward over-aging, which accounted for 17/20 disagreements between known total age and consensus age. This source off error was more apparent with known-age jacks which observers tended to overestimate by 1 year. NRAAL age readers noted a marked increase in the frequency and/or light intensity of false annuli in the known age samples in spawn year 2019. These marks are one of the primary sources of overestimating age in fin rays and manifest as bright narrow bands (checks) or less bright thicker bands close to annuli (shadows) when compared to true annuli (Figure 1-14). Fin ray annuli are defined as bright bands arcing around the fin ray that occur during spring and summer months when food is readily available. True annuli are relatively even in thickness and spacing (Figure 1-14). There are many factors that can cause false annuli, and no post-hoc correlation analysis on growth vs environmental factors, such as ocean conditions, was done for the known-age samples described here. As such, we do not suggest any causation for the perceived increase in false annuli. One potential explanation is age reader bias (Beamish and McFarlane 1995), where readers are biased towards likely age classes when factors make age assignments more difficult. In the majority of errors made (12/20) in which interpretation was made difficult by false annuli, the age was overestimated to age 4, the most dominant age class observed in returning Idaho Snake River Spring/Summer Chinook. This type of error would ultimately lead to an overestimate of productivity of brood year 2015.

Productivity of brood year 2014 was below replacement in all populations, and has been below replacement for each of the last 3 completed brood years (2012-2014) across nearly all populations. 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). Observations indicate the Blob has since dissipated (Peterson et al. 2018), but the low productivity of recent brood years is likely due to those conditions because those brood years would have been exposed to the Blob for part or all of their ocean phase.

Results from 2019 monitoring efforts indicate Idaho populations of spring-summer Chinook Salmon are functioning at low spawner abundance relative to recent era and pre-dam 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 were at high overall risk and recommended no change in status (NMFS 2016). A current status review is in progress (see Chapter 3), and will likely reach the same conclusions as the previous status assessment. Low productivity has been observed since the 2015 status assessment, resulting in decreased abundance throughout the ESU. Poor ocean conditions have likely been a major driver of recent trends, and abundance is unlikely to increase to desired levels without 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. If poor ocean conditions continue, Idaho populations of spring-summer Chinook Salmon will remain at low abundance, and ESA-listed populations will continue to be considered at high overall risk. However, changes in density independent factors which affect productivity could quickly reverse recent trends.

RECOMMENDATIONS

1. Maintain the IDFG redd count index surveys. Potential spatial or temporal changes to these surveys should be thoroughly documented and vetted at the policy level.

2. 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.

3. Investigate factors affecting redd detection probability by UAS, and compare accuracy between ground, helicopter, and UAS survey methods.

4. 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 spring-summer Chinook Salmon redd count index transects and 2019 sampling information. NS = Not Surveyed, NA = Not Applicable, NT= No index transects identified, NPT = Nez-Perce Tribe, SBT = Shoshone-Bannock Tribe, UAS = Unmanned Aircraft System. See Abbreviations and Acronyms pages for population abbreviations.

Population	Transect ID	Target Survey Date	2019 Survey Date	Method	Agencies
		South Fork Salmon River MPG			
LSR	NS-34	9/5-9/10	9/10	Ground	IDFG
SFSR	NS-26	9/5	8/29-8/30	Ground	IDFG
	NS-27	9/5	9/3-9/5	Ground	NPT, IDFG
	NS-28	9/5	9/3-9/5	Ground	NPT, IDFG
	NS-29	9/6	9/6-9/7	Ground	IDFG
SEC	WS-16	8/25-9/1	8/21	Ground	IDFG
	WS-17	8/25-9/1	8/21	Ground	IDFG
	WS-18	8/25	8/20	Ground	IDFG
	WS-19	8/25	8/20	Ground	IDFG
	WS-20	8/25	8/20	Ground	IDFG
EFSFSR	NS-30	9/1-9/5	8/29	Ground	NPT
	NS-31	9/1-9/5	9/16	Ground	NPT
		Middle Fork Salmon River MPG			
CHC	WS-1	8/25	8/25	Ground	IDFG
	WS-1a	8/25	8/26	Ground	IDFG
MFSRL	WS-15c	9/5-9/12	9/11	Raft	USFS,IDFG
	WS-15d	9/5-9/12	9/12	Raft	USFS,IDFG
	WS-15e	9/5-9/12	9/12	Raft	USFS,IDFG
BIG	WS-13	9/5	9/2	Ground	IDFG
	WS-14a	9/5	9/2	Ground	NPT, IDFG
	WS-14b	9/5	9/11	Helicopter	IDFG
	WS-14c	9/5	9/11	Helicopter	IDFG
	WS-14d	9/5	9/11	Helicopter	IDFG
CAM	WS-8	8/25-9/5	9/11	Helicopter	IDFG
LOON	WS-6	8/25-9/5	9/10	Helicopter	IDFG
	WS-7	8/25-9/5	9/10	Helicopter	IDFG
MFSRU	WS-15a	9/5-9/12	9/7	Helicopter	IDFG
	WS-15b	9/5-9/12	9/11	Raft	USFS,IDFG
	WS-21	9/5-9/12	9/9	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	9/10	Helicopter	IDFG
	WS-24	9/5-9/12	9/9	Helicopter	IDFG
SUL	OS-4	8/21	8/21	Ground	IDFG
	WS-12	8/21	8/21	Ground	IDFG
BVC	WS-9a	8/27	8/26	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	8/26	Ground	IDFG
	WS-9c	8/27	8/26	Ground	IDFG
	WS-9d	8/27	8/27	Ground	IDFG
	WS-10a	8/27	8/27	Ground	IDFG
	WS-10b	8/27	8/27	Ground	IDFG
	WS-11a	8/27	8/28	Ground	IDFG
	WS-11b	8/27	8/28	Ground	IDFG
	WS-11c	8/27	8/28	Ground	IDFG
MAR	WS-2a	8/18	8/22	Ground	IDFG
	WS-2b	8/18	8/22	Ground	IDFG
	WS-3	8/17	8/24	Ground	IDFG
	WS-4	8/19	8/25	Ground	IDFG
	WS-5	8/16	8/23	Ground	IDFG
		Upper Salmon River MPG			
PAN	NS-11a	9/8	8/28	UAS	IDFG
	NS-11b	9/8	8/28	UAS	IDFG
	NS-11c	9/8	8/28	UAS	IDFG
	NS-11d	9/8	8/28	UAS	IDFG
NFSR	NS-25a	9/8	9/2	Ground	IDFG
	NS-25b	9/8	9/2-9/3	Ground	IDFG
	NS-25c	9/8	9/3	Ground	IDFG
LEM	NS-9	9/8	9/4-9/5	UAS	IDFG
	NS-10	9/8	9/4-9/5	UAS	IDFG
	NS-35a	9/8	9/10	Ground	IDFG
	NS-35b	9/8	9/10	Ground	IDFG
USRL	NS-17	9/8	9/3	UAS	IDFG
	NS-18	9/8	9/2	UAS	IDFG
	NS-19	9/8	9/12	UAS	IDFG
	NS-20	9/8	9/17	UAS	IDFG
	NS-21	9/8	9/16-9/19	UAS	IDFG
	NS-22	9/8	9/27	UAS	IDFG
	NS-23	9/8	9/20	UAS	IDFG
PAH	NS-33a	9/20	9/24-9/25	UAS	IDFG
	NS-33b	9/20	NS	UAS	IDFG
EFSR	NS-1a	9/8	9/9-9/10	UAS	IDFG
	NS-1b	9/8	9/9-9/10	UAS	IDFG
	NS-2a	9/8	9/9-9/10	UAS	IDFG
	NS-2b	9/8	9/9	UAS	IDFG
	NS-2c	9/8	9/26	UAS	IDFG

Table 1-1. Continued.

Population	Transect ID	Target Survey Date	Actual Survey Date	Method	Agencies
		Upper Salmon River MPG (Continued)			
YFK, continued	NS-5	9/8	9/23	UAS	IDFG
	NS-6	9/8	9/23	UAS	IDFG
	NS-7	9/8	NS	Ground	IDFG
	NS-8	9/8	9/23	Ground	IDFG
VAL	NS-3a	9/8	9/11	UAS	IDFG
	NS-3b	9/8	9/11	UAS	IDFG
	NS-4	9/8	9/10	UAS	IDFG
USRU	NS-12	8/31-9/5	9/11	UAS	IDFG
	NS-13a	9/8	9/7-9/11	UAS	IDFG
	NS-13b	9/8	9/3	UAS	IDFG
	NS-15a	9/8	9/13	UAS	IDFG
	NS-15b	9/8	9/12	UAS	IDFG
	NS-15c	9/8	9/11	UAS	IDFG
	NS-16	9/8	9/11	Ground	IDFG
	OS-1	8/31-9/5	9/8	Ground	IDFG
	OS-2	8/31-9/5	9/8	Ground	IDFG
	OS-3	8/31-9/5	9/9	Ground	IDFG
	OS-5	9/8	9/7	UAS	IDFG
	OS-6	9/8	9/10	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	9/1-9/4	Ground	IDFG
	NC-2a	9/3	9/4	Ground	IDFG
	NC-2b	9/3	9/3-9/4	Ground	IDFG
	NC-3	9/3	9/5	Ground	IDFG
	NC-4	9/1-9/5	9/4	Ground	IDFG
	NC-6	9/3	9/18-9/20	Ground	IDFG
	NC-8	9/3	9/5	Ground	NPT, IDFG
		Wet Clearwater MPG			
LNFC	NT	NA	NA	NA	NA
LOLO	NC-14	9/3	9/3	Ground	NPT, IDFG
LOC	NC-10	9/3	9/3	Ground	IDFG
	NC-11	9/3	9/3	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	9/12	Ground	IDFG
	WC-3d	9/8	9/10	Ground	IDFG
SEL	WC-2	9/8	9/11	Ground	IDFG
	WC-5	9/8	NS	NA	NA
	WC-7	9/8	9/11	Ground	IDFG
UNFC	NT	NA	NA	NA	NA

Table 1-2. List of PTAGIS sites queried for PIT-tagged spring-summer Chinook Salmon adults to obtain scale age assignments in 2019.

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	
	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. Spring-summer Chinook Salmon redds counted in Idaho index transects in 2019. Hatchery fraction based on carcass information in Table 2-4 is also indicated. See Abbreviations and Acronyms pages for population abbreviations. NT= No index transects identified, NA = Not Applicable. Asterisks denote assumed values where no carcasses were recovered.

Population		Length (km)	Redds	Hatchery Fraction
	South Fork Salmon River MPG			
LSR		15.0	1	1.00
SFSR		70.2	94	0.79
SEC		28.1	30	0
EFSFSR		10.5	41	0.34
	MPG Total	123.8	166	
	Middle Fork Salmon River MPG			
CHC		7.9	0	0.00
MFSRL		107.9	0	0.00*
BIG		63.7	14	0.00
CAM		9.9	6	0.00*
LOON		24.4	4	0.00*
MFSRU		174.2	12	0.00*
SUL		9.2	7	0.00
BVC		63.0	48	0.00
MAR		27.4	29	0.00
	MPG Total	487.6	120	0.00
	Upper Salmon River MPG			
PAN		20.3	5	0.00
NFSR		29.3	14	0.00
LEM		48.9	57	0.07
USRL		139.0	6	0.00
PAH		27.9	10	0.00
EFSR		62.5	6	0.00
YFK		37.9	1	0.00
VAL		28.3	3	0.00
USRU		69.0	81	0.45
	MPG Total	463.1	183	
	Salmon River Basin Total	1,074.4	469	
	Dry Clearwater MPG			
LAP		NT	NA	NA
LAW		NT	NA	NA
POT		NT	NA	NA
USFC		85.4	44	0.91

Table 1-3. Continued.

Population	**Length (km)**	**Redds**	**Hatchery Fraction**
Dry Clearwater MPG (Continued)			
MPG Total	85.4	44	0.91
Wet Clearwater MPG			
LNFC	NT	NA	NA
LOLO	17.6	0	1.00
LOC	32.2	9	0.00*
MED	NT	NA	NA
MOO	29.0	9	0.00
SEL	11.1	4	0.00
UNFC	NT	NA	NA
MPG Total	89.9	22	0.57
Clearwater River Basin Total	175.3	66	0.87
Idaho Total	1,249.7	535	

Table 1-4. Spring/summer Chinook Salmon carcasses collected during spawning ground surveys in Idaho during 2019. 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 14 Feb 2020.

	Segregated Hatchery			Integrated 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	2	11	0	0	0	0	0	0	0	0	0	0	13	13	13	1.00
SFSR downstream of weir[a]	10	6	1	2	0	0	2	3	0	0	1	1	26	24	19	0.79
SFSR upstream of weir[a]	0	0	0	8	18	0	2	6	0	1	2	1	39	38	30	0.79
SEC[e]	0	0	0	0	0	0	27	37	2	0	0	0	66	66	0	0
EFSFS [e]	0	0	0	12	3	0	17	12	0	0	0	0	44	44	15	0.34
Total MPG	12	17	1	22	21	0	48	58	2	1	3	2	188	188	77	0.41
Middle Fork Salmon River MPG																
CHC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
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	0	0	0	0	0	0	0	0	0
BIG[a]	0	0	0	0	0	0	0	1	0	0	0	0	1	1	0	0
CAM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LOON	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SUL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BVC[c]	0	0	0	0	0	0	5	1	0	0	0	0	6	6	0	0
MAR	0	0	0	0	0	0	13	6	0	0	0	0	19	19	0	0
Total MPG	0	0	0	0	0	0	18	8	0	0	0	0	26	26	0	0
Upper Salmon River MPG																
PAN[d]	0	0	0	0	0	0	5	20	2	0	0	0	27	27	0	0
NFSR	0	0	0	0	0	0	1	0	0	0	0	0	1	1	0	0

Table 1-4. Continued.

Population	Segregated Hatchery F	Segregated Hatchery M	Segregated Hatchery U	Integrated Hatchery F	Integrated Hatchery M	Integrated Hatchery U	Natural F	Natural M	Natural U	Unknown F	Unknown M	Unknown U	Total All	Total Known-origin	Total Hatchery	Hatchery Fraction
Upper Salmon River MPG, Continued																
LEM	1	0	0	1	0	0	15	11	1	0	0	0	29	29	2	0.07
USRL	0	0	0	0	0	0	1	2	0	0	0	0	3	3	0	0
PAH downstream of weir	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PAH upstream of weir	0	0	0	0	0	0	2	2	0	0	0	0	4	4	0	0
EFSR	0	0	0	0	0	0	3	1	1	0	0	0	5	5	0	0
YFK[d]	0	0	0	0	0	0	1	1	0	0	0	0	2	2	0	0
VAL[c]	0	0	0	0	0	0	2	0	0	0	0	0	2	2	0	0
USRU downstream of weir	33	11	0	3	2	0	12	8	0	0	0	0	68	68	48	0.71
USRU upstream of weir	0	1	0	0	1	0	18	23	0	0	0	0	43	43	2	0.05
Total MPG	34	12	0	3	3	0	60	68	4	0	0	0	184	184	52	0.33
Dry Clearwater MPG																
USFC[a]	62	52	0	0	0	0	3	4	4	0	2	1	128	125	114	0.91
Total MPG	62	52	0	0	0	0	3	4	4	0	2	1	128	125	114	
Wet Clearwater MPG																
LOC[a]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LOLO[e]	3	0	0	1	0	0	0	0	0	0	0	0	4	4	4	1.00
MOO	0	0	0	0	0	0	0	1	0	0	0	0	1	1	0	0
SEL[a]	0	0	0	0	0	0	0	2	0	0	0	0	2	2	0	0
Total MPG	3	0	0	1	0	0	0	3	0	0	0	0	7	7	4	

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 Staff from the Nez Perce Tribe collected and provided information.

Table 1-5. Age composition of natural-origin spring-summer Chinook Salmon estimated from carcasses collected during spawning ground surveys and from PIT array detections in Idaho during 2019. See Abbreviations and Acronyms pages for population abbreviations. NA = Not Applicable.

Population	Carcass Fin Ray Samples	PIT Array Scale Samples	Total Age Samples	Freshwater.Saltwater Age (Total Age)			
				2.1 (3)	2.2 (4)	2.3 (5)	2.4 (6)
South Fork Salmon River MPG							
LSR	0	1	1	0	1	0	0
SFSR[(a)]	20	36	56	5	46	5	0
SEC	63	40	103	26	63	13	0
EFSFSR	82	42	124	8	78	38	0
MPG Total	165	119	284	39	188	56	0
Middle Fork Salmon River MPG							
CHC	0	0	0	0	0	0	0
MFSRL	0	0	0	0	0	0	0
BIG	6	32	38	6	24	8	0
CAM	0	0	0	0	0	0	0
LOON	0	0	0	0	0	0	0
MFSRU	0	0	0	0	0	0	0
SUL	0	0	0	0	0	0	0
BVC[(b)]	6	30	36	16	12	8	0
MAR	18	0	18	1	12	5	0
MPG Total	30	62	92	23	48	21	0
Upper Salmon River MPG							
PAN	27	0	27	5	19	3	0
NFSR	1	6	7	1	5	1	0
LEM	26	37	63	2	48	13	0
USRL	3	0	3	0	3	0	0
PAH	1	15	16	2	12	2	0
EFSR	4	0	4	0	1	3	0
YFK	3	5	8	1	3	4	0
VAL	2	13	15	4	8	3	0

Table 1-5. Continued.

Population	Carcass Fin Ray Samples	PIT Array Scale Samples	Total Samples	Freshwater.Saltwater Age (Total Age) 2.1 (3)	2.2 (4)	2.3 (5)	2.4 (6)
Upper Salmon River MPG (Continued.)							
USRU	58	6	64	8	43	13	0
MPG Total	125	82	207	23	142	42	0
Salmon River Basin Total	320	263	583	85	378	119	0
Dry Clearwater MPG							
LAP	NA	NA	NA	NA	NA	NA	NA
LAW	NA	NA	NA	NA	NA	NA	NA
POT	NA	NA	NA	NA	NA	NA	NA
USFC	0	18	18	3	13	2	0
MPG Total	0	18	18	3	13	2	0
Wet Clearwater MPG							
LNFC	NA	NA	NA	NA	NA	NA	NA
LOLO	0	8	8	3	5	0	0
LOC	0	26	26	2	18	6	0
MED	NA	NA	NA	NA	NA	NA	NA
MOO	0	0 [(c)]	0	0	0	0	0
SEL[(c)]	0	26 [(c)]	26	2	19	5	0
UNFC	NA	NA	NA	NA	NA	NA	NA
MPG Total	0	60	60	7	42	11	0
Clearwater River Basin Total	0	78	78	10	55	13	0
Idaho Total	320	341	661	95	433	132	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.

FIGURES

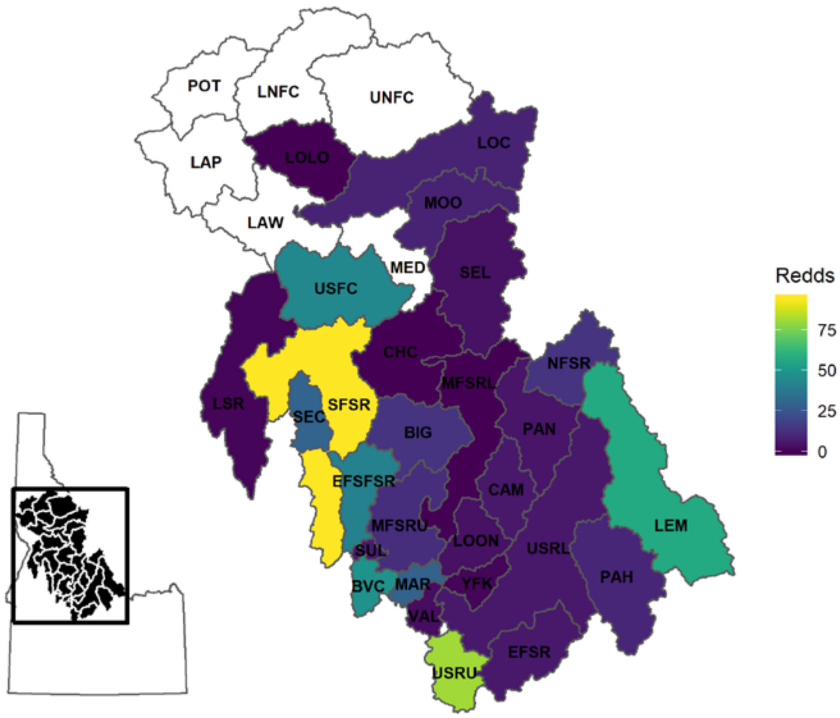


Figure 1-1. Idaho heat map representing the number of spring-summer Chinook Salmon redds counted in index transects by population during 2019. Populations shaded white were not surveyed.

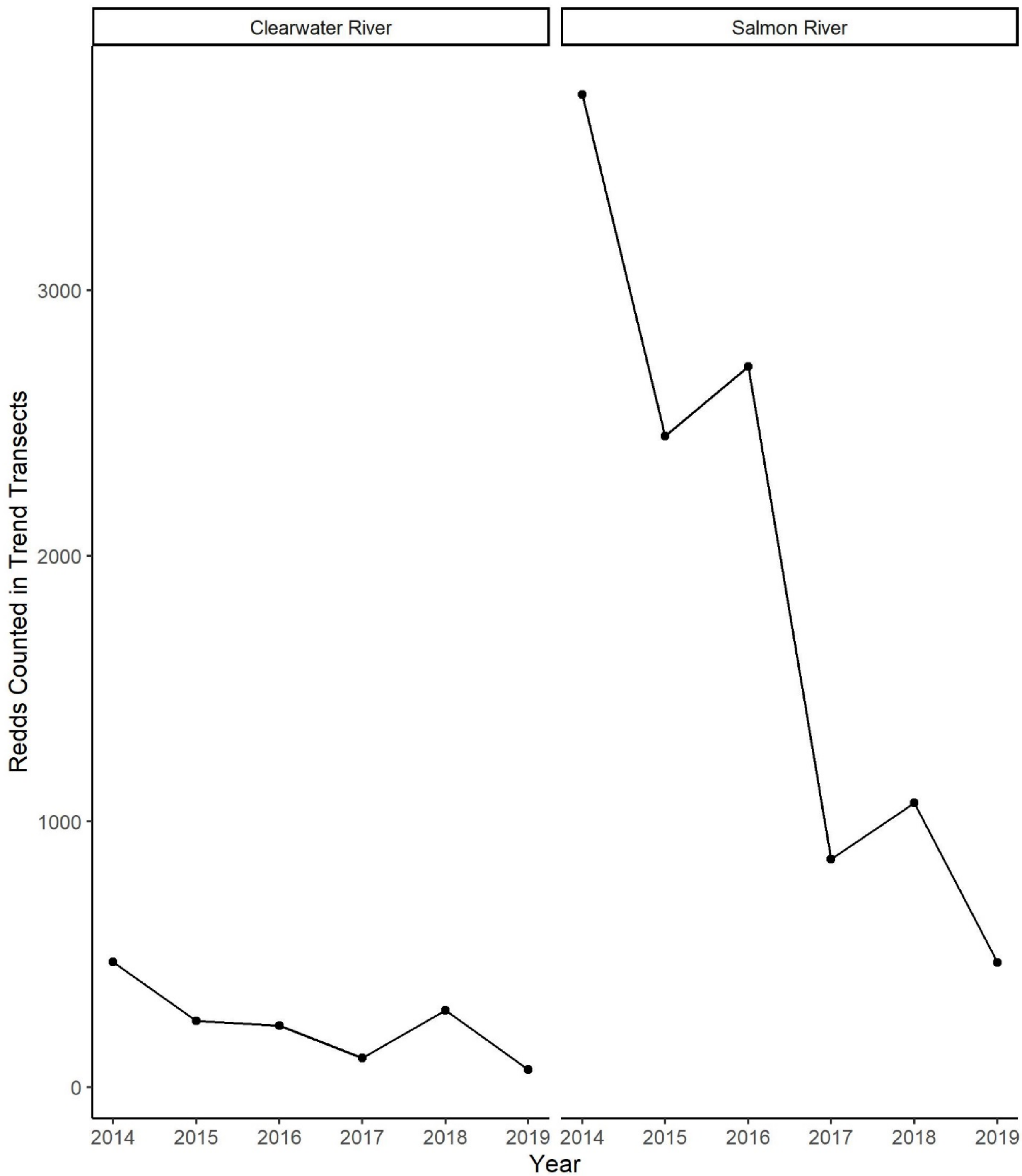


Figure 1-2. Number of spring-summer Chinook Salmon redds counted in index transects of the Clearwater River and Salmon River basins during the recent era, 2014-2019.

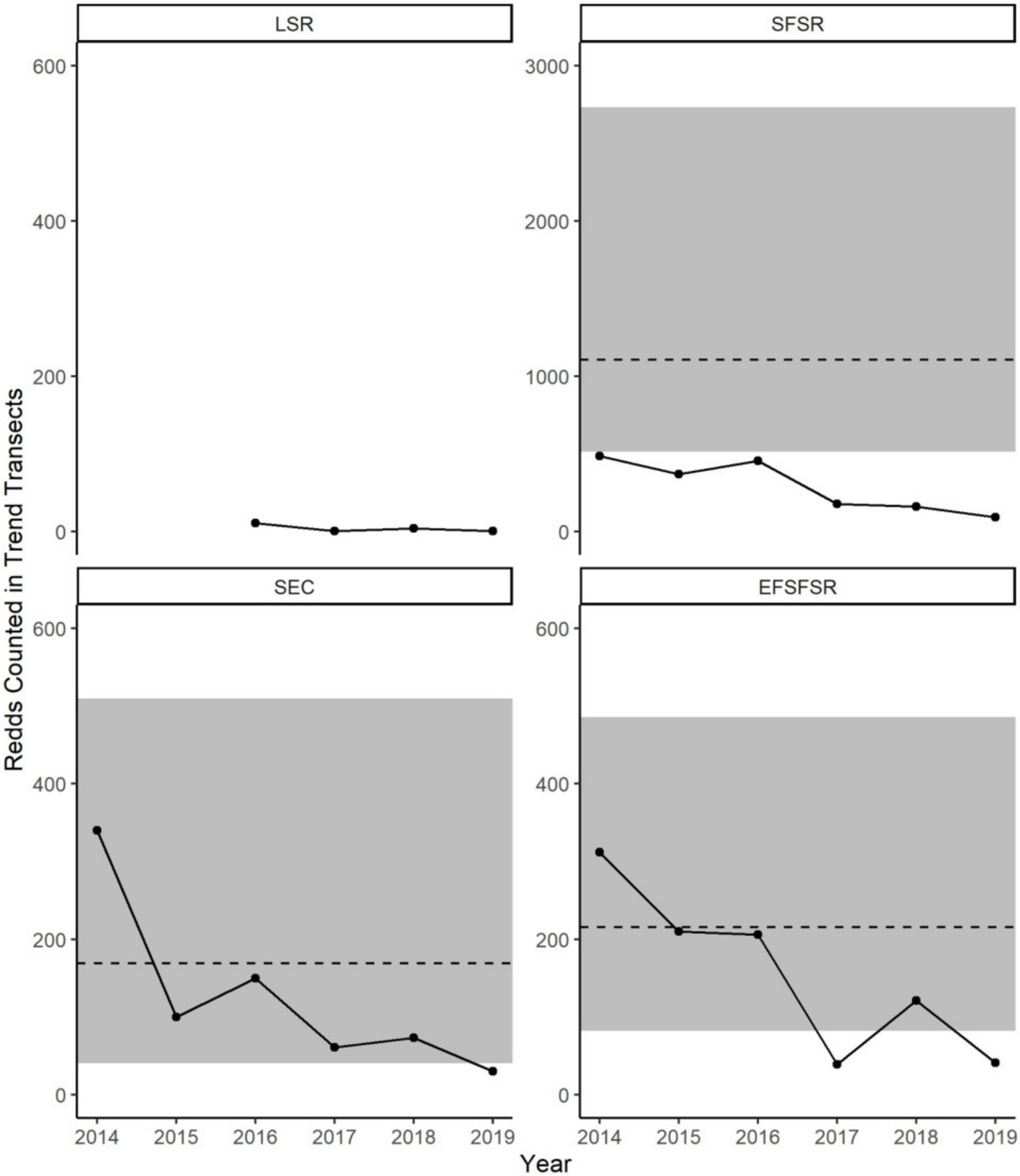


Figure 1-3. Number of spring-summer Chinook Salmon redds counted in index transects of the South Fork Salmon River populations during the recent era, 2014-2019. Shaded area represents the pre-dam era range, and dashed reference line represents the pre-dam era geometric mean. No shading or dashed line represents lack of pre-dam era data. Note different y-axis scales.

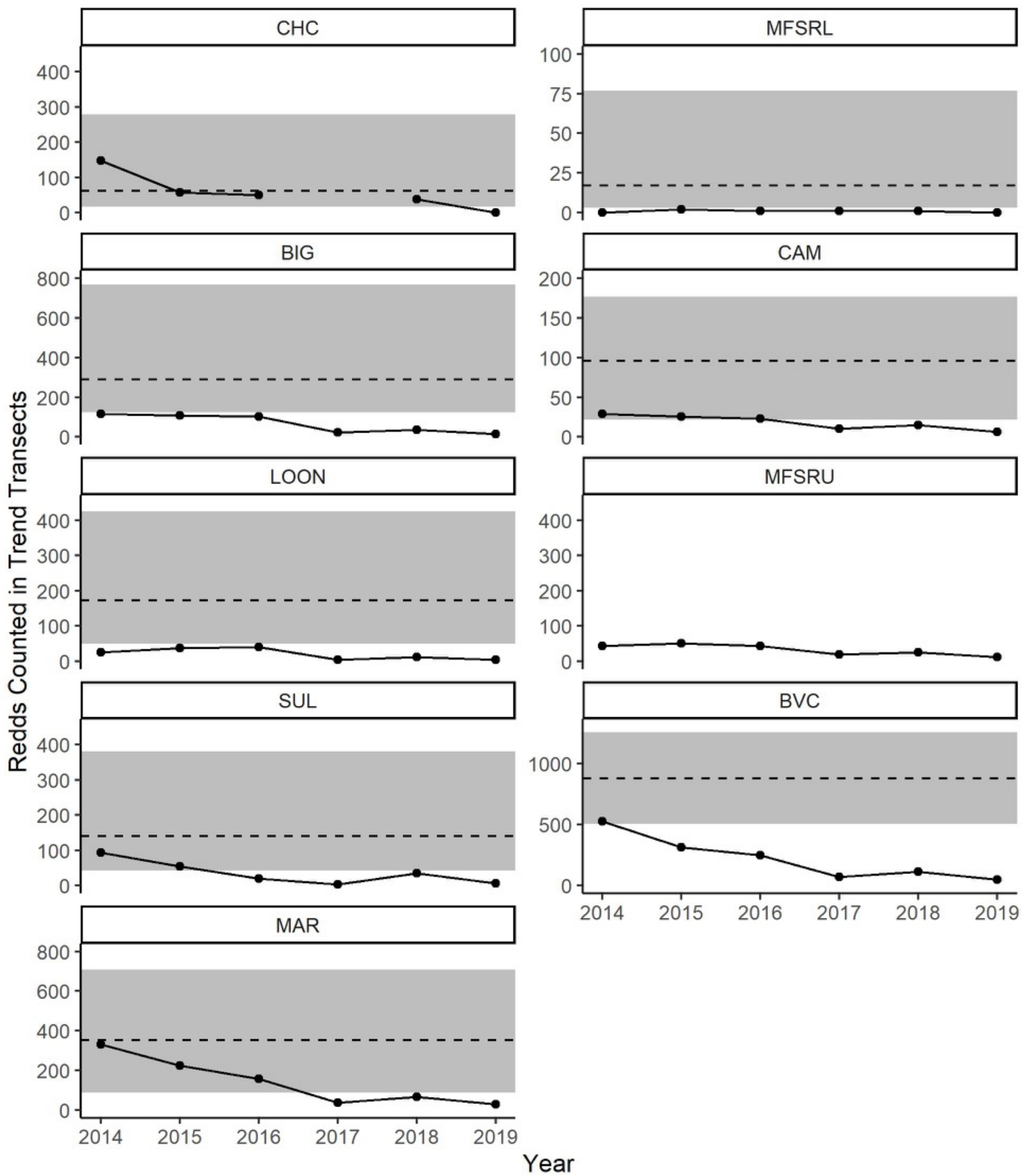


Figure 1-4. Number of spring-summer Chinook Salmon redds counted in index transects of the Middle Fork Salmon River populations during the recent era, 2014-2019. Shaded area represents the pre-dam era range, and dashed reference line represents the pre-dam era geometric mean. No shading or dashed line represents lack of pre-dam era data. Note different y-axis scales.

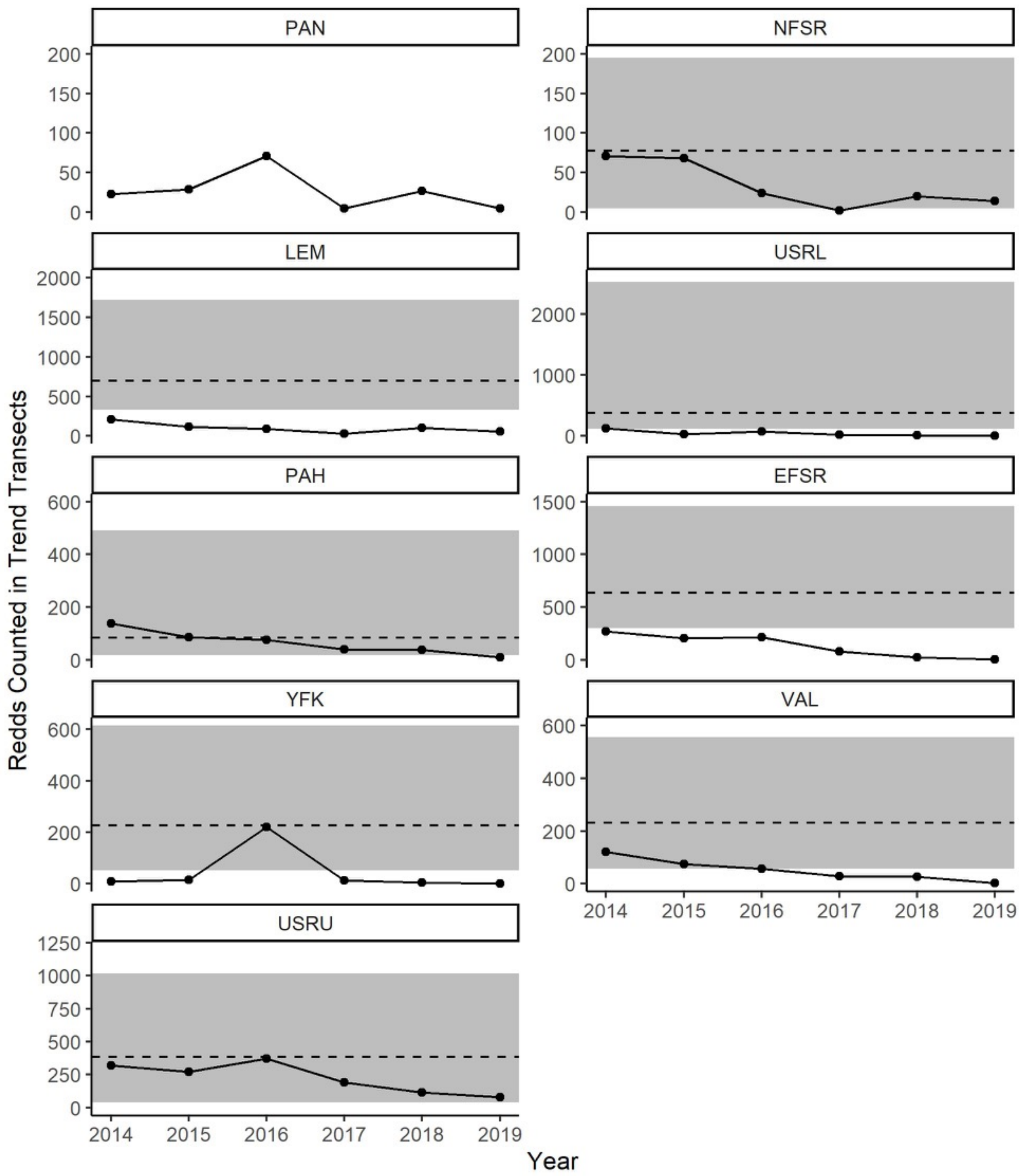


Figure 1-5. Number of spring-summer Chinook Salmon redds counted in index transects of the Upper Salmon River populations during the recent era, 2014-2019. Shaded area represents the pre-dam era range, and dashed reference line represents the pre-dam era geometric mean. No shading or dashed line represents lack of pre-dam era data. Note different y-axis scales.

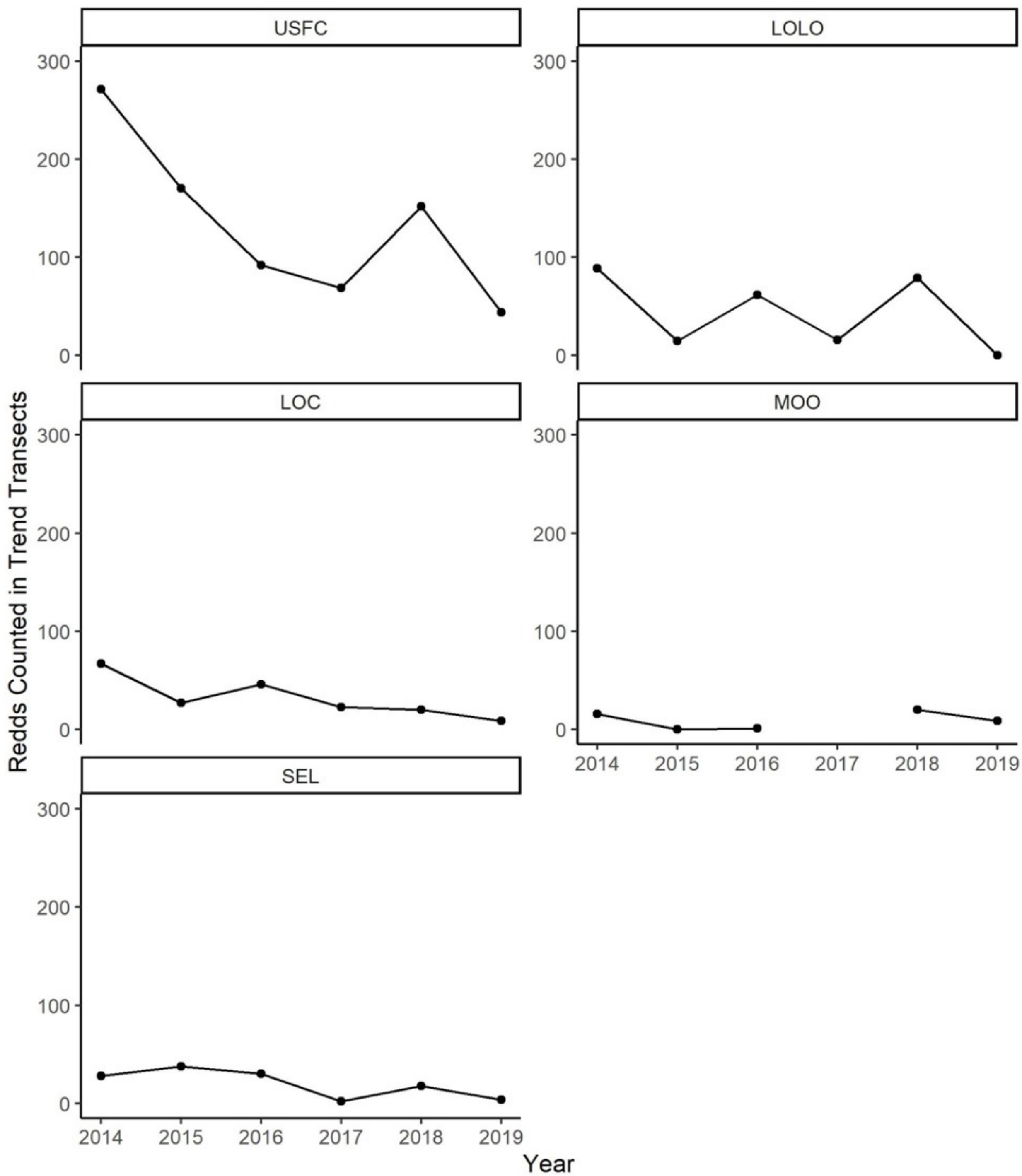


Figure 1-6. Number of spring-summer Chinook Salmon redds counted in index transects of the Clearwater River basin populations during the recent era, 2014-2019.

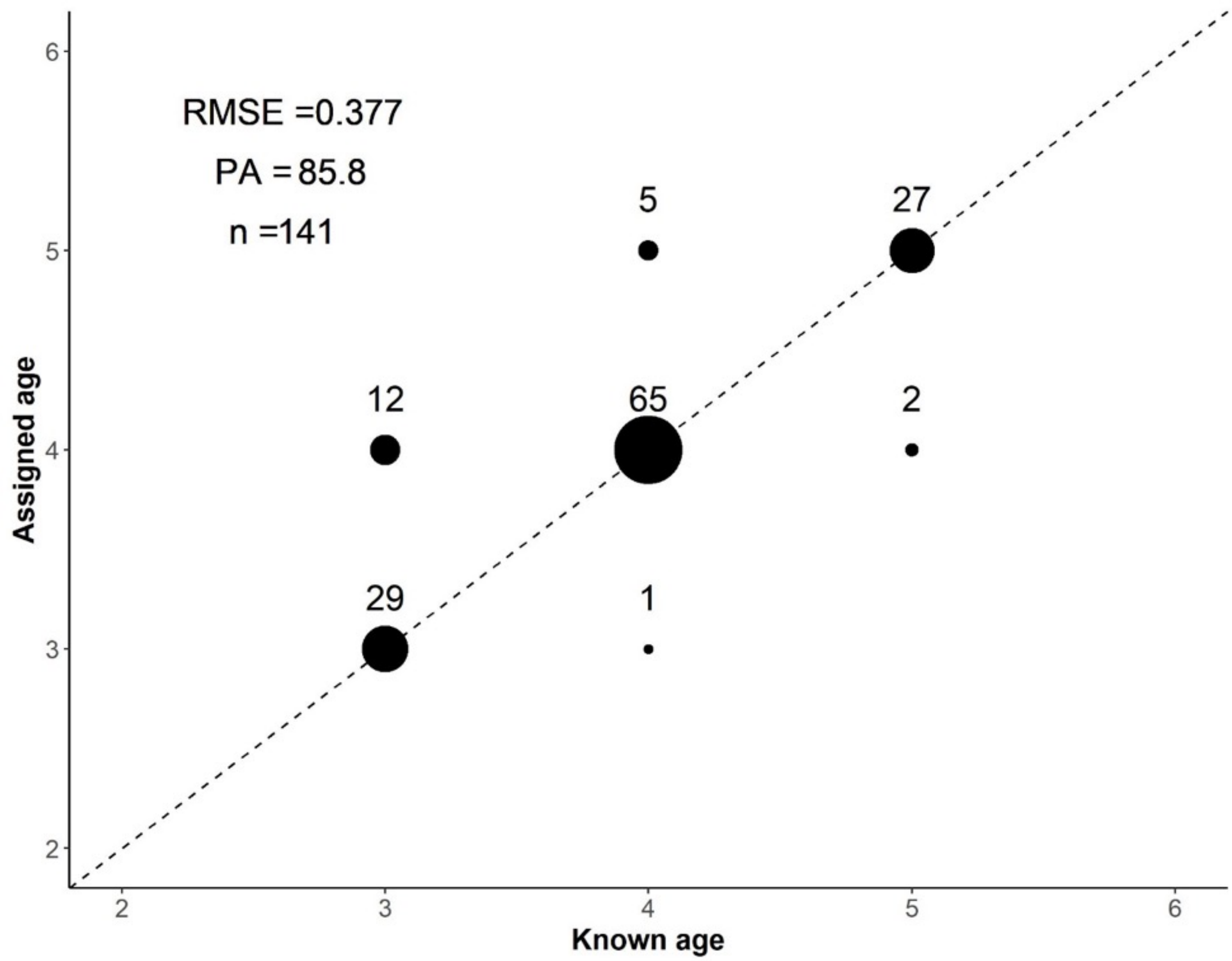


Figure 1-7. Age bias plot depicting the relationship between ages assigned to spring-summer Chinook Salmon using fin rays and their corresponding known ages as determined by PIT tags and CWTs. All samples were collected in 2019. RMSE = root mean squared error, PA = percent agreement, and n = the number of known-age fish.

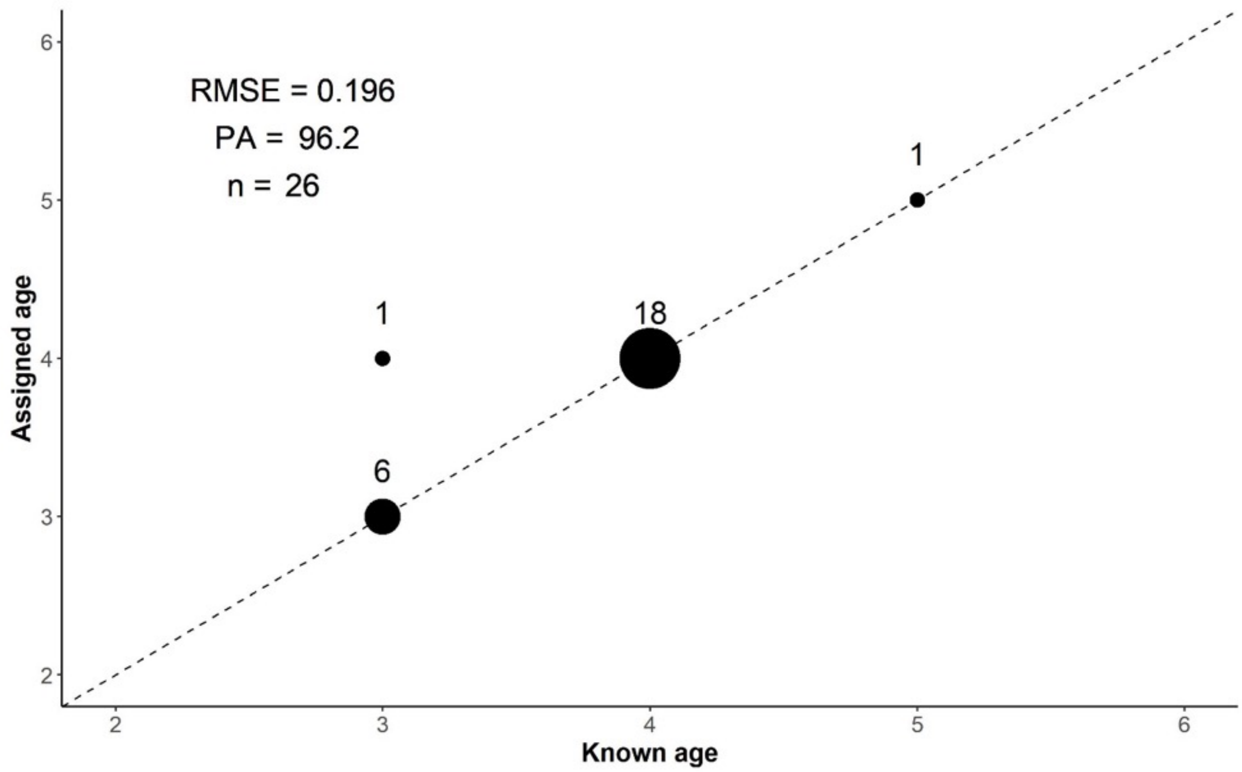


Figure 1-8. Age bias plot depicting the relationship between ages assigned to spring-summer Chinook Salmon using scales and their corresponding known ages as determined by PIT tags and CWTs. All samples were collected in 2019. RMSE = root mean squared error, PA = percent agreement, and n = the number of known-age fish.

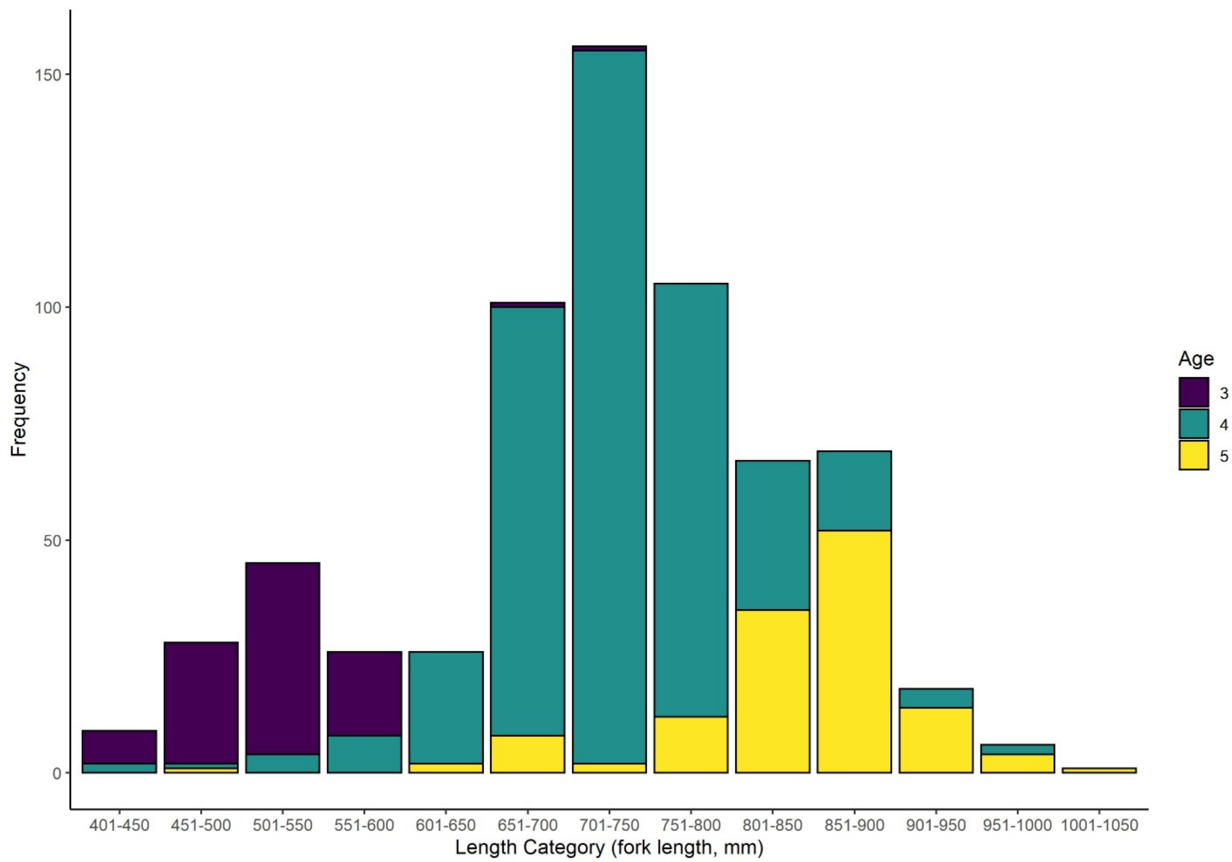


Figure 1-9. Length frequency distribution stacked by age class for natural-origin spring-summer Chinook Salmon carcasses collected in Idaho during 2019 (n = 661).

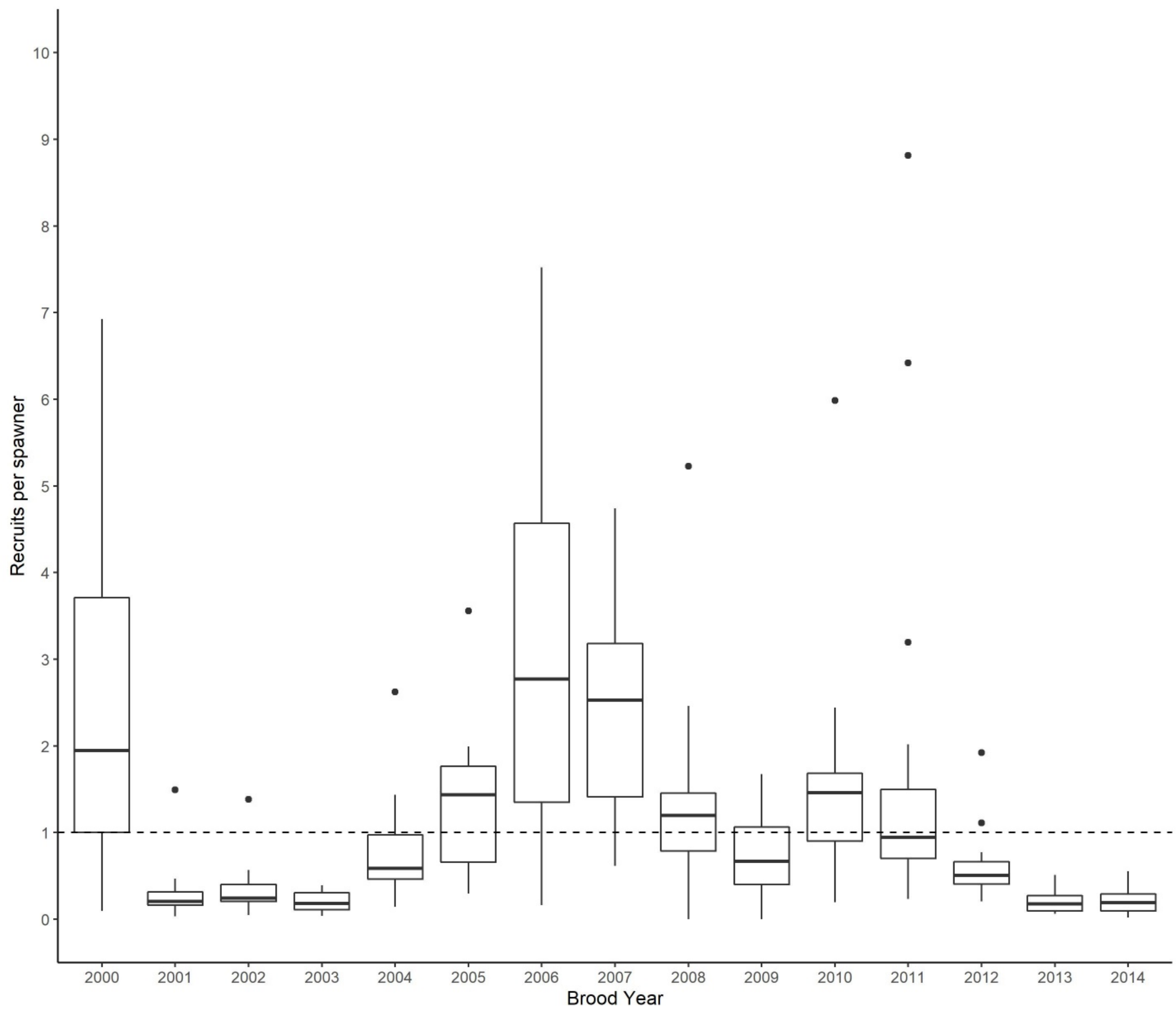


Figure 1-10. Box and whisker plot of productivity (natural-origin returned redds per spawned redd) estimates for 19 spring-summer Chinook Salmon populations sampled in Idaho over brood years 2000-2014. Select populations in some years were omitted due to incomplete data (see Figures 1-11 to 1-13). Dashed line represents 1:1 replacement.

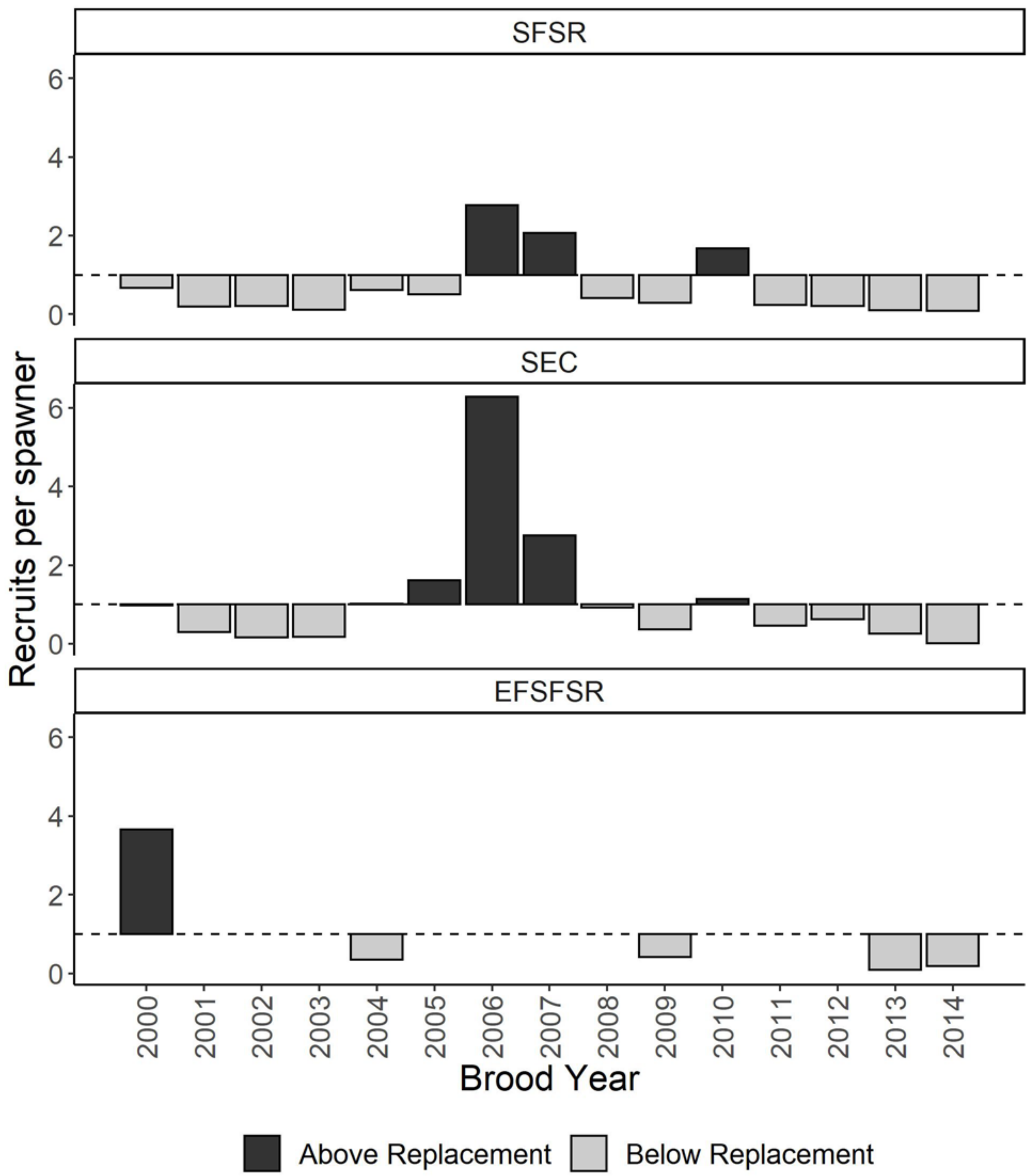


Figure 1-11. Productivity (natural-origin returned redds per spawned redd) of all South Fork Salmon River spring-summer Chinook Salmon populations, except Little Salmon River, over brood years 2000-2014. Select brood years omitted due to incomplete data. Dashed line represents 1:1 replacement.

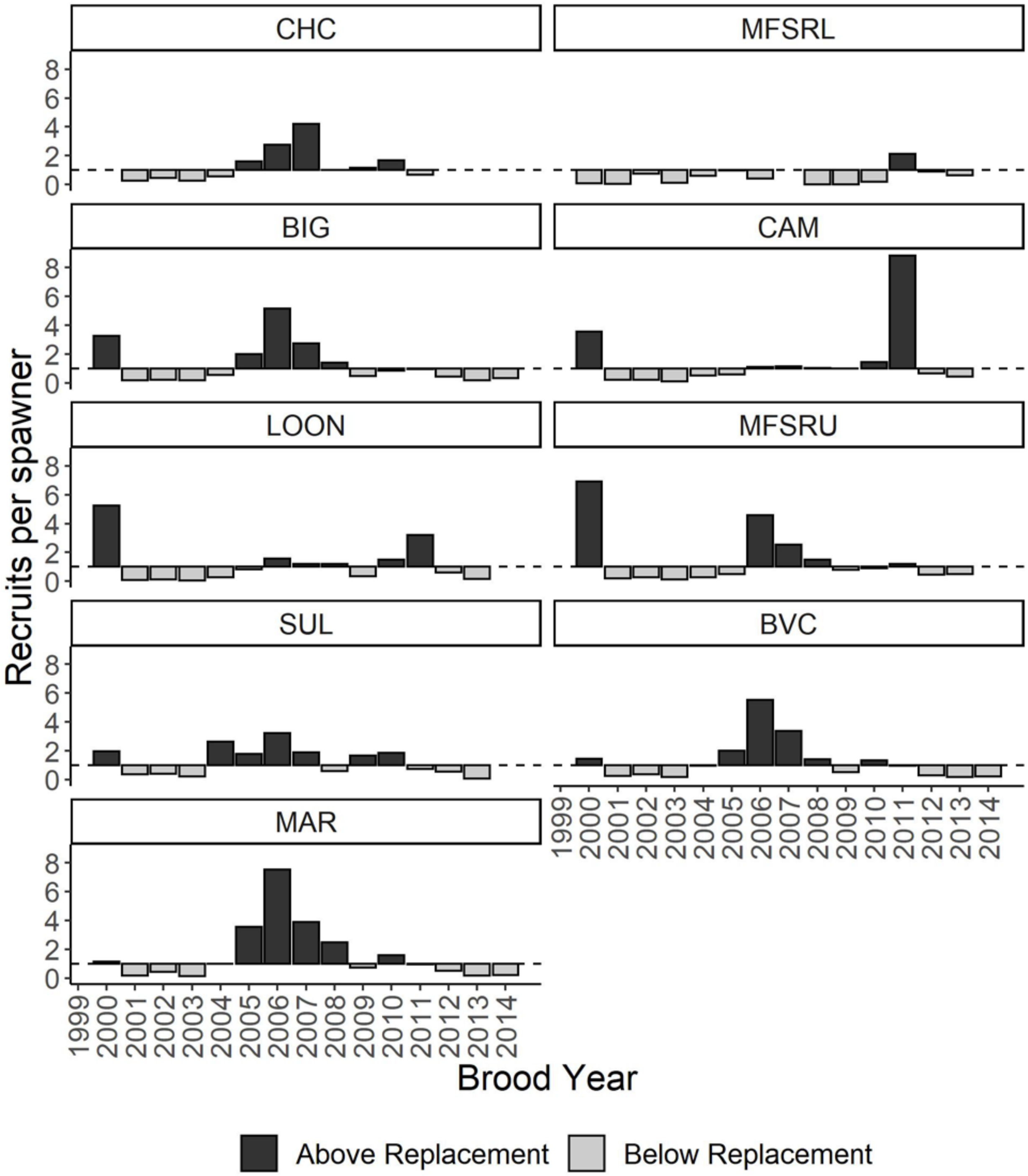


Figure 1-12. Productivity (natural-origin returned redds per spawned redd) of all Middle Fork Salmon River spring-summer Chinook Salmon populations over brood years 2000-2014. Select brood years were omitted due to incomplete data. Dashed line represents 1:1 replacement.

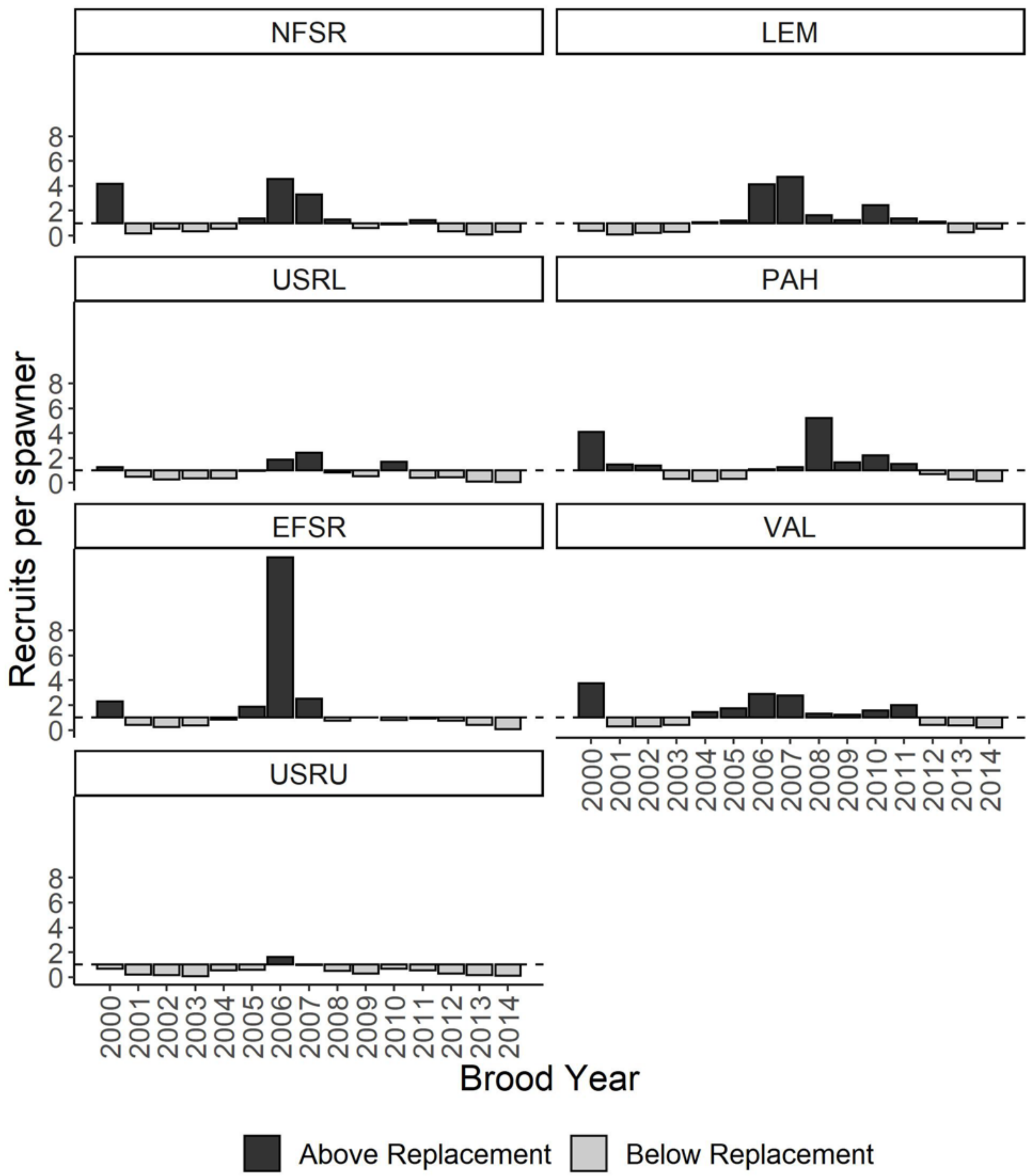
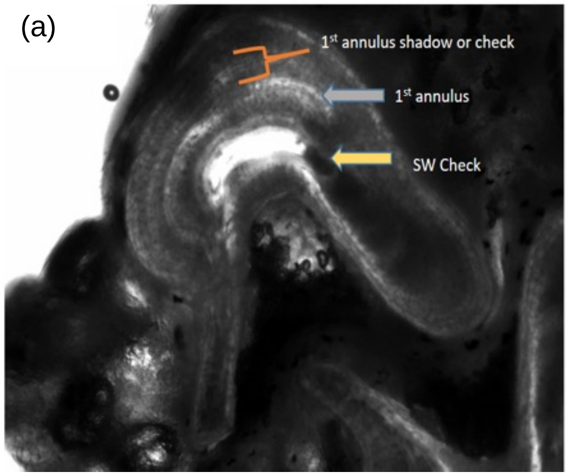


Figure 1-13. Productivity (natural-origin returned redds per spawned redd) of all Upper Salmon River spring-summer Chinook Salmon populations, except Panther Creek and Yankee Fork Salmon River, over brood years 2000-2014. Select brood years were omitted due to incomplete data. Dashed line represents 1:1 replacement.



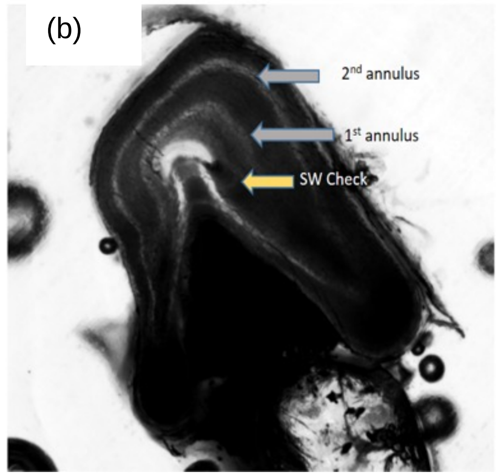


Figure 1-14. Side-by-side comparison of fin ray cross-sections from known age Chinook Salmon, Spawn Year 2019. The estimated age in (a) disagrees with the known age, and likely source of reader error is depicted with a bracket. An example of a correctly assigned agree and representation of annuli on age 4 Chinook is given in (b).

CHAPTER 2—ANALYZING THE PERSISTENCE AND SPATIAL DYNAMICS OF CHINOOK SALMON IN THE MIDDLE FORK SALMON RIVER BASIN, IDAHO

ABSTRACT

Intensive monitoring of redd distribution has been conducted in the Middle Fork Salmon River basin since 1995 to better understand persistence and spatial dynamics of Chinook Salmon *Oncorhynchus tshawytscha*. In 2019, approximately 740 km of Chinook Salmon spawning habitat was surveyed for redds by air and ground, and a total of 161 redds were identified. These surveys cover approximately 260 km of Chinook Salmon Spawning that is not included in IDFG index transects. Basinwide redd counts decreased from 2018 and were lower than all but 3 of the last 25 years.

Authors:

Eli A. Felts
Fisheries Biologist

Bruce Barnett
Fisheries Data Coordinator

Katherine M. Lawry
Fisheries Biologist

Conor McClure
Fisheries Biologist

Mike Peterson
Fisheries Biologist

INTRODUCTION

Snake River spring-summer Chinook Salmon *Oncorhynchus tshawytscha* have been listed as threatened under the ESA since 1992 (Federal Register notice 57FR14653). Monitoring strategies have been designed to document trends in abundance, productivity, spatial structure, and diversity, and relating 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 Chinook Salmon for several reasons. No hatchery releases have occurred in the MFSR, meaning Chinook Salmon stocks are wild and indigenous (IDFG 2019). Most of the basin is located within the Frank Church River of No Return Wilderness, which has limited anthropogenic habitat degradation (Thurow 2017). Finally, the MFSR basin consists of approximately 800 km of Chinook Salmon spawning habitat spread across the main stem and 10 tributary basins which have consistently supported spawning in recent decades (Thurow 2017). 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 (Thurow 2017). 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 2019 surveys in the MFSR designed to describe factors influencing the spatial distribution and persistence of wild-origin Chinook Salmon. Survey methods and study sites were consistent with those implemented by the Rocky Mountain Research Station since 1995. The specific objectives of this study are to: 1) monitor Chinook Salmon distribution and abundance by mapping the annual distribution of Chinook Salmon redds across the entire Middle Fork Salmon River basin, 2) assess spatial and temporal colonization dynamics of Chinook Salmon, 3) describe both individual and population level Chinook Salmon genetic variation, and 4) evaluate methods for measuring Chinook Salmon dispersal for describing salmon life history patterns. This work includes 260 km of Chinook Salmon spawning habitat beyond what is sampled for index surveys.

METHODS

Study Design

All tributaries that historically supported Chinook Salmon spawning were selected to be surveyed. Determination of historical and current occurrence was made by reviewing past redd surveys, 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, were not surveyed in 2019. 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 have been 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 will be surveyed when adult escapements above Lower Granite Dam exceed 30,000 natural-origin fish to monitor for recolonization. Surveys were targeted to occur between September 5-12, which coincides with the end of the spawning period while redds are still visible (Thurow 2010).

Data Collection

Surveys were conducted by walking, flying, or rafting along designated stream sections and examining the streambed for redds. Aerial surveys were conducted from a helicopter 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. Altitude ranged from 15 to 50 m above ground level. Two trained observers examined the streambed for redds. All redds were georeferenced using GPS. The primary observer, located in the front seat, marked locations using a Garmin Rino 750 handheld GPS unit, and the secondary observer, located in the back seat, marked locations using the same model of GPS as a backup.

Raft surveys were conducted by USFS personnel on the main stem Middle Fork Salmon River every other week from early August until late September. An IDFG biologist accompanied USFS personnel during the second-to-last survey which took place on September 11-19. Two rafts floated the river in tandem, one on river right and one on river left. The bow of each raft was outfitted with an elevated observation platform, and the platform on each raft was occupied by a trained observer for the duration of the float. Whenever observers spotted likely spawning habitat they instructed the oarsman to approach it and float by as slowly as possible so it could be examined for redds. When a redd was spotted, the oarsman landed the raft at the nearest safe point. Once landed, the observer waded back to the redd and marked it using handheld GPS (Garmin Rino 750 or Garmin Rino 650). Signs and flagging were then installed to protect the redd from disturbance by other rafters. When side channels or other river morphology features made the raft survey method impractical both trained observers got off the rafts and walked those areas.

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 and raft surveys, observers examined the streambed and marked redds using handheld GPS (Garmin Rino 750 or Garmin Rino 650). 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 2019 a total of 161 Chinook Salmon redds were identified across 740.3 km of stream surveyed in the MFSR basin (Table 2-1, Figure 2-1). Aerial surveys encompassed 50% of the surveyed area. Multiple pass ground counts occurred at all IDFG index transects in the Bear Valley Creek and Sulphur Creek populations, and covered all potential spawning habitat upstream of the rotary screw trap in the Marsh Creek population. All other aerial, raft, and ground counts consisted of a single pass at the end of the spawning period.

Redds were observed in all populations except for the Middle Fork Salmon River below Indian Creek. In the populations where redds were observed, counts ranged from a low of 8 in the Loon Creek population to a high of 55 in the Bear Valley Creek population. The 2019 basinwide count was below the 1995-2018 average (Figure 2-2). Redd counts within populations were below the 1995-2018 average (Figure 2-3). The majority of redds (68%) were in three high elevation populations (Bear Valley, Marsh, and Sulphur) at the upper extent of the MFSR drainage (Figure 2-1).

DISCUSSION

The number of redds counted in 2019 across the MFSR basin was the lowest since 1999, and the 4th lowest in the 25-year history of basinwide counts. Spawner abundance, along with patch size and connectivity of spawning habitat influence 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 2019 was consistent with this observation, as 68% of redds were found in the upper Middle Fork basin, where large connected patches of spawning habitat occur within the Bear Valley Creek, Marsh Creek, and Sulphur 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), and factors affecting use of spawning patches (Isaak et al. 2007). 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, 2019

Population	Length (km)	Redds
MFSRL	107.7	0
BIG[a]	114.2	20
CAM	74.7	11
LOON	87.8	8
MFSRU	181.3	12
SUL	23.6	10
BVC[b]	89.9	55
MAR	61.1	45
Total	**740.3**	**161**

[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

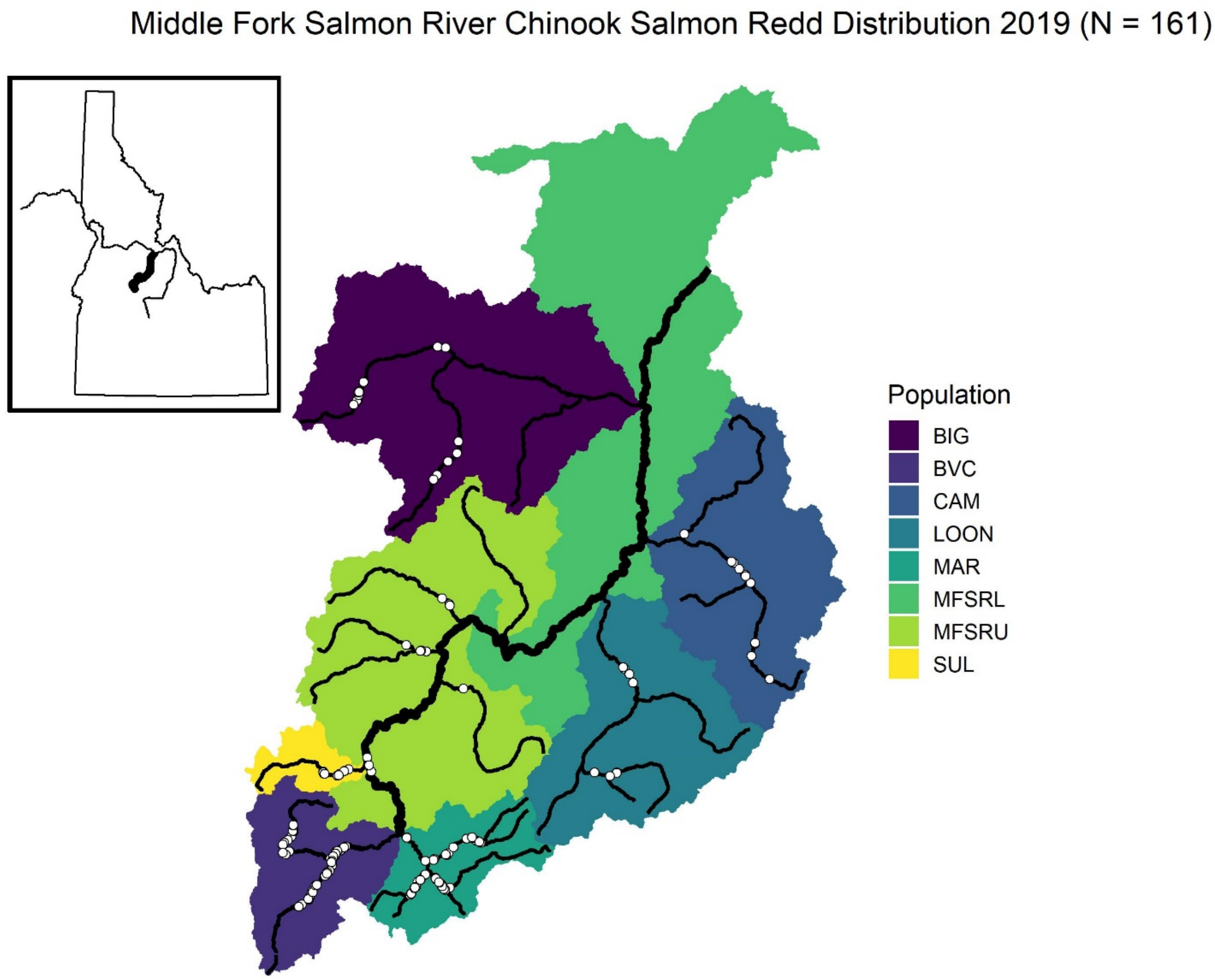

Figure 2-1. Chinook Salmon redds (white circles) observed in independent populations of the Middle Fork Salmon River basin, Idaho, 2019. Bold line indicates main stem Middle Fork Salmon River.

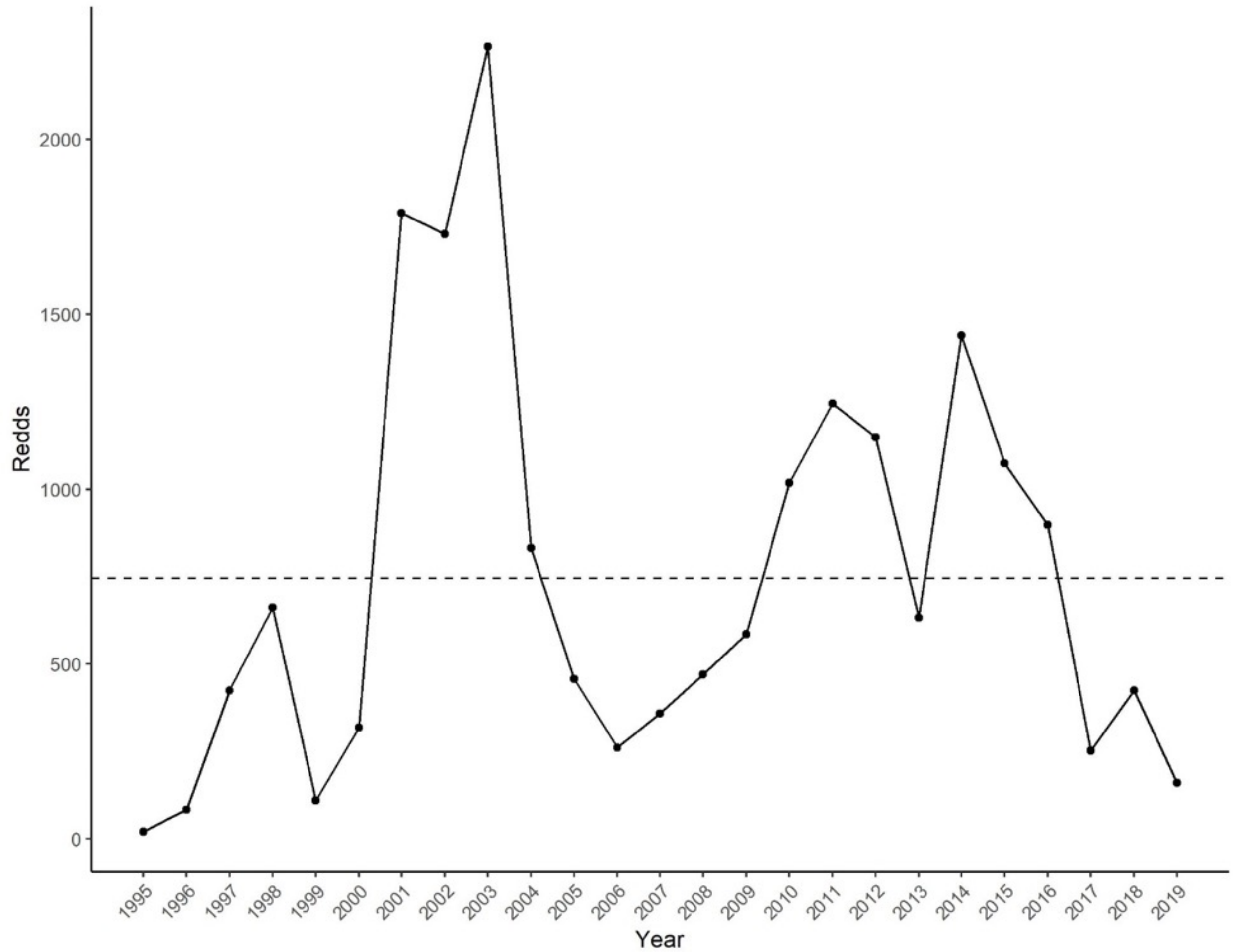

Figure 2-2. Total redd counts in the Middle Fork Salmon River basin, Idaho, 1995-2019 Dashed line represents the average for 1995-2019.

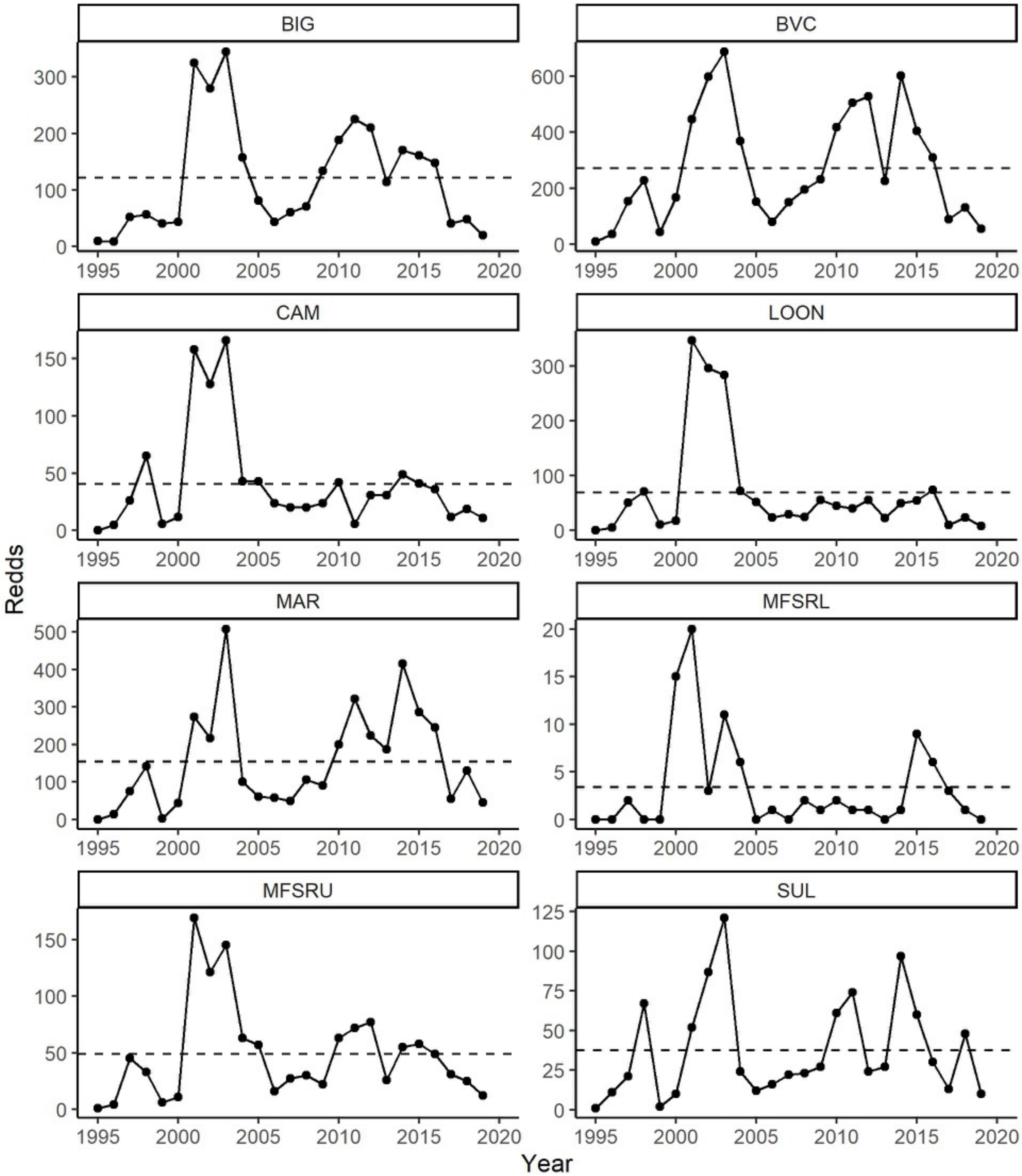

Figure 2-3. Total redd counts in independent populations of the Middle Fork Salmon River basin, Idaho, 1995-2019. Dashed line represents the average for 1995-2019. Note differing scales on y-axes.

CHAPTER 3—DATA PROVIDED FOR 5-YEAR STATUS REVIEW OF ESA LISTED SNAKE RIVER SPRING-SUMMER CHINOOK SALMON

ABSTRACT

Status of Pacific salmonids listed under the Endangered Species Act is assessed by analyzing trends in abundance, productivity, and spatial structure. The Snake River spring-summer Chinook Salmon ESU is due for status review in 2020, and Idaho Department of Fish and Game has provided raw data and a variety of estimates to the National Marine Fisheries Service for their review. In this chapter we describe methods used to collect those data and produce necessary estimates for assessment of abundance, productivity, and spatial structure. Additionally, we provide interpretation of trends observed during 2015-2019.

Author:

Eli A. Felts
Fisheries Biologist

INTRODUCTION

The Snake River spring-summer Chinook Salmon *Oncorhynchus tshawytscha* ESU is due for status review in 2020 (Federal Register notice 84FR53117), and IDFG has provided raw data and a variety of estimates to NMFS for this review. The 2020 status review considers trends during the most recent five-year period (2015-2019) as compared to historical data and performance measures, such as minimum abundance thresholds, recommended by the ICBTRT (2007) and adopted by the ESA recovery plan for spring-summer Chinook Salmon (NMFS 2017). Status of Pacific salmonids is assessed using viability criteria which are related to trends in abundance, productivity, spatial structure, and diversity (McElhany et al. 2000). The raw data and metrics used to assess these criteria are primarily collected and estimated by state and tribal fisheries agencies. In this chapter we describe methods used to collect those data and produce necessary estimates for assessment of abundance, productivity, and spatial structure. Additionally, we provide interpretation of trends observed during 2015-2019.

METHODS

Abundance and Productivity

Data used to estimate total spawner abundance including jacks were collected using three general survey methods: redd counts, passage counts at weirs, and closed population mark-recapture surveys above weirs. IDFG has conducted statewide index redd counts since 1957 and they form the bulk of the survey data (e.g. Chapter 1 of this report). Redd counts were expanded to abundance as detailed by Felts et al. (2019a). Estimates of natural-origin spawner abundance were obtained by using estimates of wild fraction to adjust total spawner abundance (Table 3-1). Populations where no hatchery releases occur were assumed to be 100% wild. In populations where hatchery releases occur hatchery fraction was estimated from carcass surveys or weir passage information. Details of all spawner abundance methods can be found in Felts et al. (2019a) with the exception of modification for the Chamberlain Creek population, which is detailed in Appendix D of Felts et al. (2019b).

Age composition data were also provided for the purposes of estimating adult-to-adult productivity. Carcasses encountered during spawning ground surveys were aged directly using dorsal fin rays. Population-level age composition was estimated directly if sample size of carcasses was sufficient, otherwise age composition was assumed from a higher level such as Major Population Group. Details of these sample size criteria are also found in Chapter 1 of this report and Felts et al. (2019a).

Redd count and carcass data are accessible with permission from IDFG in read-only views from the Idaho Fish and Wildlife Information System (IFWIS) web reports, which query the spawning ground survey (SGS) database: https://fishandgame.idaho.gove/ifwis/portal. Expanded estimates, such as total spawner abundance including jacks, are uploaded annually and are available at the Coordinated Assessments website: https://www.streamnet.org/data/coordinated-assessments/.

Spatial Structure

Redd locations were used to determine occupancy status of Major and Minor Spawning Areas within Idaho populations. Occupancy status was based on criteria established by the Interior Columbia Basin Technical Recovery Team (ICBTRT 2007). For a Major Spawning Area to be considered occupied, it must have two or more redds in both the upper and lower half of the weighted spawning area for each of the last five years, and have two or more redds in both the upper and lower half of the weighted spawning area for at least eight of the last fifteen years. For a Minor Spawning Area to be considered occupied it must have two or more redds for each of the last five years and have two or more redds for at least eight of the last fifteen years.

To evaluate these criteria, we compiled redd waypoints and tallied the number of redds in each year from 2005-2019 within the upper and lower half of each Major Spawning Area, and within each Minor Spawning Area. The upper and lower halves of a Major Spawning Area were determined by finding the midpoint of weighted spawning area and splitting polygons at those midpoints. Redd waypoints consisted of our most complete collection of unique redds. In many cases, this extended beyond IDFG index redd counts to include multiple pass and extensive surveys. Many waypoints were collected by collaborating agencies including Nez Perce Tribe, Shoshone-Bannock Tribes, and United States Forest Service (Table 3-2). We used the sp package (Pebesma and Bivand 2005) in Program R (R Core Team 2019) to perform a spatial intersect between redd waypoints and spawning area polygons, after which we could tally the number of redds by year within each spawning area, including the upper and lower halves of Major Spawning Areas. Waypoints and polygons used in our analysis can be viewed at https://efelts.shinyapps.io/Spatial_Structure/.

Analysis of occupancy status was limited to spawning areas that were considered potentially occupied. We considered spawning areas potentially occupied if they were known to be accessible to Chinook and if they were surveyed frequently enough to evaluate the occupancy criteria. There are 36 Major Spawning Areas in Idaho, and we considered 29 of those potentially occupied in this analysis (Table 3-2). We considered seven Major Spawning Areas not potentially occupied; four (Eighteenmile, Goldberg, Texas, and Upper Pahsimeroi) were excluded because they are currently inaccessible, one (Middle Pahsimeroi) was excluded because only the lower half is accessible, and two (Upper Johnson and Lower Johnson) were excluded from this report because the Nez Perce Tribe conducts the majority of the monitoring in those areas. There are 23 Minor Spawning Areas in Idaho, and we considered eight of those potentially occupied (Table 3-2). We excluded 15 Minor Spawning Areas because they are not sampled frequently enough to evaluate occupancy criteria.

RESULTS AND DISCUSSION

Abundance and Productivity

Natural-origin spawner abundance in the most recent five-year period (2015-2019) declined from the previous five-year period across all populations (Figure 3-1). Abundance was relatively high in 2015 and 2016 before declining substantially in 2017-2019. All populations were well below minimum abundance thresholds in all years from 2015-2019 except for Marsh Creek in 2015. The levels of abundance observed in 2017-2019 were the lowest observed since the late 1990s. In 2019, Chamberlain Creek, Middle Fork Salmon River below Indian Creek, and Salmon River Lower Mainstem populations exhibited their lowest abundance in the 63 years (1957-2019) for which estimates have been generated.

We note that abundance estimates for the Chamberlain Creek population have been altered since the previous status assessment. The methods used to expand redd counts were changed for this population following a number of years of extensive surveys. These surveys occurred in the major spawning area and minor spawning areas, and suggested the minor spawning areas are unoccupied. Based on conclusions from this work we decreased the spatial expansion factor, and the updated abundance estimates are less than half of what they were previously. Details of extensive surveys and the conclusions we reached are detailed in Appendix D of Felts et al. (2019b).

Adult-to-adult productivity was low for brood years which returned to spawn during 2015-2019 (Figure 3-2). Ocean conditions were likely the leading cause of low productivity over this period. A large area of abnormally warm water stretched from the coast of Alaska to Baja California in the northeastern Pacific Ocean from late 2013 until late 2015 (Cavole et al. 2016). The elevated sea surface temperatures reduced phytoplankton availability and caused several food web changes thought to reduce prey quality for Chinook Salmon (Cavole et al. 2016). The low productivity resulting from poor ocean conditions has driven the recent decline in natural-origin spawner abundance, and abundance will likely remain low until the ocean returns to a more favorable state.

Spatial Structure

Consistent monitoring occurred in 29 Major Spawning Areas, and based on the ICBTRT (2007) criteria 13 of those were rated as occupied for the 2020 status assessment (Table 3-3). Consistent monitoring occurred in 8 Minor Spawning Areas and one was rated as occupied for the 2020 status assessment. We suspect the relatively low number of Major Spawning Areas rated as occupied is primarily a result of considerable declines in spawner abundance, which caused spawning distribution to be limited to a small number of core areas. The low number of Minor Spawning Areas rated as occupied is also not surprising at low spawner abundance because these areas typically represent small patches of marginal habitat which are more likely to be utilized at high densities.

The areas currently considered occupied were nearly always occupied over the last 15 years; 11 of the 13 Major Spawning Areas were occupied for either 14 or 15 of those 15 years (Table 3-3, Figure 3-3). Chinook Salmon exhibit clustered spawning distributions with the majority of redds occurring in a limited number of areas. When spawner abundance decreases, as occurred from 2015 through 2019, the spatial distribution of redds tends to contract into a small number of spawning areas (Isaak and Thurow 2006). The areas which met the criteria for occupancy in the 2020 status assessment represent some of the most important spawning areas for spring-summer Chinook in the Snake River basin.

The observation that spawner distribution tends to contract when abundance decreases should be considered when evaluating spatial structure. Given the substantial decrease in abundance from 2015 through 2019, it should be expected that spawner distribution would become diminished. The criteria established for occupancy are sensitive to reduced spawning distribution in years of low spawner abundance. For example, 7 of the 16 Major Spawning Areas rated as unoccupied were occupied for 4 of the last 5 years, meaning that they were assigned an overall rating of unoccupied based on a single year of being rated unoccupied when spawner abundance was extremely low (Table 3-3). We hypothesize those spawning areas that were occupied for 4 of the last 5 years are viable in the sense that if smolt-to-adult return rates improved they would continue to support spawning aggregates.

Four major spawning areas were unoccupied for each of the last 5 years. All of these are parts of the main Salmon River which supported at least moderate spawner abundance in the 1950s and 1960s (Metsker 1958). None of these areas were rated occupied more than 4 of the last 15 years, indicating that declines occurred long before the current assessment period. The trends in these areas indicate a loss of spatial and possibly life history diversity from observations in the 1950s, and we are not confident that they would support abundant spawning aggregates if smolt-to-adult return rates improved. No habitat disturbances that would explain this decline have occurred in these areas.

The location of spawning area boundaries affected the occupancy rating in many of the areas considered. Major Spawning Areas were divided into upper and lower halves of weighted spawning habitat, but in many of these spawning areas Chinook Salmon use one of these halves much more than the other (Figure 3-3). The scale of clustering in Chinook Salmon spawning distribution warrants further research, but our data suggest that spawning areas or “aggregates” may occur at a finer scale than what have been defined as Major Spawning Areas. For example, in the Lower Bear Valley Major Spawning Area there is an abundant spawning aggregate in the upper half but not in the lower half (Figure 3-4). Clearly the upper half of this Major Spawning Area contains an important spawning aggregate but given the construction of its boundaries it is regularly rated unoccupied due to low numbers of redds in the lower half (Table 3-3).

The spatial distribution of Chinook redds in Idaho was less extensive in the 2015-2019 period than the 2010-2014 period examined for the previous status review (NWFSC 2015). However, this change is primarily a result of considerable declines in spawner abundance. The quality of spawning habitat available to Spring/Summer Chinook Salmon in Idaho remains high and, if anything, has improved over the last five years. Many of these populations spawn within National Forest or federally designated wilderness areas where natural processes maintain high quality Chinook spawning and rearing habitat. Human impacts are greater where spawning occurs on or near privately owned lands, primarily in the Upper Salmon River MPG, but even in those areas the quality of Chinook spawning habitat has been maintained or improved in recent years. For example, intensive habitat work aimed at improving or reconnecting Chinook spawning and rearing habitat has occurred and continues to occur in the North Fork Salmon, Lemhi River, Upper Salmon and Pahsimeroi River populations (Uthe et al. 2017). Overall, Chinook spawning habitat quality and connectivity among patches of spawning habitat has been maintained or improved over the current assessment period and we conclude that increased returns of spawners would quickly result in expansion of spawning distribution.

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TABLES

Table 3-1. Data provided for abundance and productivity metrics in 2020 status update. TSAIJ = Total spawner abundance including jacks, NOSAIJ = Natural-origin spawner abundance including jacks.

Population	Year	TSAIJ	Wild Fraction	NOSAIJ	Age Composition Proportions			
					Age 3	Age4	Age 5	Age 6
				South Fork Salmon River MPG				
	2015	854	0.39	329	0.17	0.63	0.20	0.00
	2016	1055	0.33	351	0.00	0.56	0.44	0.00
SFSR	2017	415	0.31	127	0.22	0.52	0.27	0.00
	2018	374	0.29	108	0.00	0.94	0.06	0.00
	2019	217	0.29	64	0.09	0.82	0.09	0.00
				Middle Fork Salmon River MPG				
	2015	273	1	273	0.09	0.85	0.06	0.00
	2016	240	1	240	0.01	0.48	0.51	0.01
CHC	2017	NA	1	NA	0.09	0.53	0.37	0.00
	2018	182	1	182	0.00	0.96	0.04	0.00
	2019	0	1	0	0.25	0.52	0.23	0.00
	2015	28	1	28	0.04	0.77	0.18	0.00
	2016	3	1	3	0.01	0.48	0.51	0.01
MFSR	2017	3	1	3	0.09	0.53	0.37	0.00
	2018	3	1	3	0.00	0.96	0.04	0.00
	2019	0	1	0	0.25	0.52	0.23	0.00
	2015	253	1	253	0.04	0.77	0.18	0.00
	2016	214	1	214	0.05	0.57	0.38	0.00
BIG	2017	48	1	48	0.09	0.53	0.37	0.00
	2018	68	1	68	0.00	0.96	0.04	0.00
	2019	53	1	53	0.16	0.63	0.21	0.00
	2015	81	1	81	0.22	0.70	0.07	0.00
	2016	71	1	71	0.01	0.48	0.51	0.01
CAM	2017	31	1	31	0.09	0.53	0.37	0.00
	2018	43	1	43	0.00	0.96	0.04	0.00
	2019	18	1	18	0.25	0.52	0.23	0.00
	2015	97	1	97	0.04	0.77	0.18	0.00
	2016	102	1	102	0.01	0.48	0.51	0.01
LOON	2017	10	1	10	0.09	0.53	0.37	0.00
	2018	30	1	30	0.00	0.96	0.04	0.00
	2019	10	1	10	0.25	0.52	0.23	0.00

Table 3-1. Continued.

Population	Year	TSAIJ	Wild Fraction	NOSAIJ	Age Composition Parameters			
					Age 3	Age 4	Age 5	Age 6
				Middle Fork Salmon River MPG, Continued				
MFSRU	2015	110	1	110	0.04	0.77	0.18	0.00
	2016	108	1	108	0.01	0.48	0.51	0.01
	2017	57	1	57	0.09	0.53	0.37	0.00
	2018	43	1	43	0.00	0.96	0.04	0.00
	2019	22	1	22	0.25	0.52	0.23	0.00
SUL	2015	119	1	119	0.00	0.91	0.09	0.00
	2016	43	1	43	0.01	0.48	0.51	0.01
	2017	6	1	6	0.09	0.53	0.37	0.00
	2018	75	1	75	0.00	0.96	0.04	0.00
	2019	15	1	15	0.25	0.52	0.23	0.00
BVC	2015	594	1	594	0.00	0.72	0.28	0.00
	2016	469	1	469	0.00	0.51	0.49	0.00
	2017	136	1	136	0.09	0.53	0.37	0.00
	2018	213	1	213	0.00	0.96	0.04	0.00
	2019	90	1	90	0.44	0.33	0.22	0.00
MAR	2015	586	1	586	0.01	0.68	0.31	0.00
	2016	411	1	411	0.00	0.48	0.52	0.00
	2017	96	1	96	0.09	0.59	0.32	0.00
	2018	169	1	169	0.00	0.98	0.02	0.00
	2019	75	1	75	0.25	0.52	0.23	0.00
				Upper Salmon River MPG				
NFSR	2015	183	1	183	0.11	0.82	0.07	0.00
	2016	64	1	64	0.01	0.57	0.42	0.00
	2017	5	1	5	0.16	0.46	0.38	0.00
	2018	54	1	54	0.01	0.93	0.06	0.00
	2019	37	1	37	0.11	0.69	0.20	0.00
LEM	2015	454	1	454	0.03	0.88	0.09	0.00
	2016	512	1	512	0.00	0.63	0.37	0.00
	2017	76	1	76	0.16	0.46	0.38	0.00
	2018	208	1	208	0.00	1.00	0.00	0.00
	2019	206	1	206	0.03	0.76	0.21	0.00

Table 3-1. Continued

Population	Year	TSAIJ	Wild Fraction	NOSAIJ	Age Composition Parameters			
					Age 3	Age 4	Age 5	Age 6
Upper Salmon River MPG, Continued								
	2015	57	1	57	0.05	0.80	0.15	0.00
	2016	148	1	148	0.00	0.58	0.42	0.00
USRL	2017	34	1	34	0.16	0.46	0.38	0.00
	2018	21	1	21	0.01	0.93	0.06	0.00
	2019	11	1	11	0.11	0.69	0.20	0.00
	2015	459	0.80	368	0.04	0.88	0.09	0.00
	2016	417	0.83	347	0.02	0.59	0.39	0.00
PAH	2017	290	0.28	80	0.16	0.46	0.38	0.00
	2018	335	0.21	71	0.04	0.91	0.04	0.00
	2019	98	0.56	55	0.11	0.69	0.20	0.00
	2015	527	1	527	0.05	0.72	0.24	0.00
	2016	551	1	551	0.01	0.57	0.42	0.00
EFSR	2017	210	1	210	0.16	0.46	0.38	0.00
	2018	55	1	55	0.01	0.93	0.06	0.00
	2019	15	1	15	0.11	0.69	0.20	0.00
	2015	34	1	34	0.38	0.58	0.04	0.00
	2016	439	0.80	351	0.13	0.63	0.25	0.00
YFK	2017	27	0.88	24	0.16	0.46	0.38	0.00
	2018	10	0.96	10	0.01	0.93	0.06	0.00
	2019	2	1	2	0.11	0.69	0.20	0.00
	2015	199	1	199	0.05	0.80	0.15	0.00
	2016	153	1	153	0.01	0.57	0.42	0.00
VAL	2017	77	1	77	0.16	0.46	0.38	0.00
	2018	72	1	72	0.01	0.93	0.06	0.00
	2019	8	1	8	0.11	0.69	0.20	0.00
	2015	764	0.37	284	0.04	0.78	0.19	0.00
	2016	887	0.37	326	0.00	0.60	0.40	0.00
USRU	2017	715	0.18	128	0.19	0.48	0.33	0.00
	2018	334	0.30	100	0.01	0.88	0.10	0.00
	2019	212	0.56	118	0.13	0.67	0.20	0.00

Table 3-2. Sampling history and occupancy potential of spring-summer Chinook Salmon Major and Minor Spawning Areas in Idaho, 2005-2019; IDFG = Idaho Department of Fish and Game, NPT = Nez Perce Tribe, SBT = Shoshone-Bannock Tribes, USFS = United States Forest Service, NS = Not Sampled, NA = Not Applicable.

Population	Spawning Area	Type	Potentially Occupied	Years Sampled	Agencies
Little Salmon River	Little Salmon	Minor	No	2017-2019	IDFG
	Yellowbird	Minor	No	NS	NA
	Slate	Minor	No	2007-2009, 2011-2013	NPT
South Fork Salmon River Mainstem	Upper South Fork Salmon	Major	Yes	2005-2019	NPT,IDFG
	Middle South Fork Salmon	Major	Yes	2011-2019	NPT,IDFG
	Warren	Minor	No	NS	NA
	Crooked	Minor	No	NS	NA
Secesh River	Upper Secesh	Major	Yes	2005-2019	NPT, IDFG
	Lower Secesh	Minor	No	NS	NA
East Fork South Fork Salmon River	Upper Johnson	Major	No	2005-2019	NPT
	Lower Johnson	Major	No	2005-2019	NPT
Chamberlain Creek	Chamberlain	Major	Yes	2005-2016, 2018-2019	IDFG
	Bargamin	Minor	No	2016	IDFG
	McCalla	Minor	No	2015	IDFG
	Sabe	Minor	No	NS	NA
Middle Fork Salmon River below Indian Creek	Horse	Minor	No	NS	NA
Big Creek	Upper Big	Major	Yes	2005-2019	USFS,NPT,IDFG
	Lower Big	Major	Yes	2005-2019	USFS,IDFG
	Monumental	Major	Yes	2005-2019	USFS,IDFG
Camas	Camas	Major	Yes	2005-2019	USFS,IDFG
	Yellowjacket	Minor	Yes	2005-2019	USFS,IDFG
Loon	Loon	Major	Yes	2005-2019	USFS,IDFG
Middle Fork Salmon River above Indian Creek	Middle Fork Salmon	Major	Yes	2005-2019	USFS,IDFG
	Marble	Minor	Yes	2005-2019	USFS,IDFG
	Upper Middle Fork Salmon	Minor	Yes	2005-2019	USFS,IDFG
Sulphur Creek	Sulphur	Major	Yes	2005-2019	USFS,IDFG
Bear Valley Creek	Upper Bear Valley	Major	Yes	2005-2019	USFS,SBT,IDFG
	Elk	Major	Yes	2005-2019	USFS,SBT,IDFG
	Lower Bear Valley	Major	Yes	2005-2019	USFS,SBT,IDFG
Marsh Creek	Marsh	Major	Yes	2005-2019	USFS,SBT,IDFG
Panther Creek	Upper Panther	Major	Yes	2010-2019	SBT,IDFG
	Lower Panther	Minor	No	2015-2019	SBT,IDFG
	Big Deer	Minor	No	NS	NA
North Fork Salmon River	North Fork Salmon	Major	Yes	2005-2019	IDFG
Lemhi River	Upper Lemhi	Major	Yes	2005-2019	IDFG

Table 3-2. Continued.

Population	Spawning Area	Type	Potentially Occupied	Years Sampled	Agencies
Lemhi River, continued.	Eighteenmile	Major	No	NS	NA
	Texas	Major	No	NS	NA
	Carmen	Minor	No	NS	NA
	Lower Lemhi	Minor	No	NS	NA
Salmon River Lower Mainstem	Basin	Major	Yes	2005-2019	IDFG
	Lower Salmon	Major	Yes	2005-2019	IDFG
	Bradshaw	Minor	Yes	2005-2019	IDFG
	Bayhorse	Minor	Yes	2005-2019	IDFG
	Challis	Major	Yes	2005-2019	IDFG
	Ellis	Minor	Yes	2005-2019	IDFG
	Hat	Minor	Yes	2005-2019	IDFG
	Iron	Minor	Yes	NS	NA
Pahsimeroi River	Lower Pahsimeroi	Major	Yes	2005-2019	IDFG
	Patterson	Major	Yes	2005-2019	IDFG
	Middle Pahsimeroi	Major	No	2005-2019 (lower only)	IDFG
	Upper Pahsimeroi	Major	No	NS	NA
	Goldberg	Major	No	NS	NA
East Fork Salmon River	East Fork Salmon	Major	Yes	2005-2019	SBT,IDFG
Yankee Fork Salmon River	Yankee Fork	Major	Yes	2005-2019	SBT,IDFG
Valley Creek	Valley	Major	Yes	2005-2019	SBT,IDFG
Salmon River Upper Mainstem	Middle Salmon	Major	Yes	2005-2019	IDFG
	Alturas	Major	Yes	2005-2019	IDFG
	Upper Salmon	Major	Yes	2005-2019	IDFG

Table 3-3. Occupancy ratings of spring-summer Chinook Salmon Major and Minor spawning areas in Idaho, 2005-2019. A rating of Occupied means 2 or more redds were observed in each year from 2015-2019, and in at least 8 years from 2005-2019. Major Spawning Areas must meet these criteria in both the upper and lower half.

Population	Spawning Area	Type	Years Occupied, 2015-2019	Years Occupied, 2005-2019	Rating
South Fork Salmon River Mainstem	Upper South Fork Salmon	Major	5	15	Occupied
	Middle South Fork Salmon	Major	4	8	Unoccupied
Secesh River	Upper Secesh	Major	5	14	Occupied
East Fork South Fork Salmon River	Upper Johnson	Major	-	-	-
	Lower Johnson	Major	-	-	-
Chamberlain Creek	Chamberlain	Major	1	7	Unoccupied
Big Creek	Upper Big	Major	5	15	Occupied
	Lower Big	Major	2	12	Unoccupied
	Monumental	Major	3	11	Unoccupied
Camas	Camas	Major	5	14	Occupied
	Yellowjacket	Minor	0	0	Unoccupied
Loon	Loon	Major	4	13	Unoccupied
Middle Fork Salmon River above Indian Creek	Middle Fork Salmon	Major	5	15	Occupied
	Marble	Minor	3	11	Unoccupied
	Upper Middle Fork Salmon	Minor	5	12	Occupied
Sulphur Creek	Sulphur	Major	5	15	Occupied
Bear Valley Creek	Upper Bear Valley	Major	5	15	Occupied
	Elk	Major	5	15	Occupied
	Lower Bear Valley	Major	2	10	Unoccupied
Marsh Creek	Marsh	Major	5	15	Occupied
Panther Creek	Upper Panther	Major	5	9	Occupied
North Fork Salmon River	North Fork Salmon	Major	2	8	Unoccupied
Lemhi River	Upper Lemhi	Major	5	14	Occupied
Salmon River Lower Mainstem	Basin	Major	4	13	Unoccupied
	Lower Salmon	Major	0	2	Unoccupied
	Bradshaw	Minor	0	2	Unoccupied
	Bayhorse	Minor	0	0	Unoccupied
	Challis	Major	0	1	Unoccupied
	Ellis	Minor	0	3	Unoccupied
	Hat	Minor	0	0	Unoccupied
Pahsimeroi River	Lower Pahsimeroi	Major	4	14	Unoccupied
	Patterson	Major	5	10	Occupied
East Fork Salmon River	East Fork Salmon	Major	4	14	Unoccupied
Yankee Fork Salmon River	Yankee Fork	Major	4	10	Unoccupied

Table 3-3. Continued.

Population	Spawning Area	Type	Years Occupied, 2015-2019	Years Occupied, 2005-2019	Rating
Valley Creek	Valley	Major	5	14	Occupied
Salmon River Upper Mainstem	Middle Salmon	Major	4	14	Unoccupied
	Alturas	Major	0	4	Unoccupied
	Upper Salmon	Major	0	4	Unoccupied

FIGURES

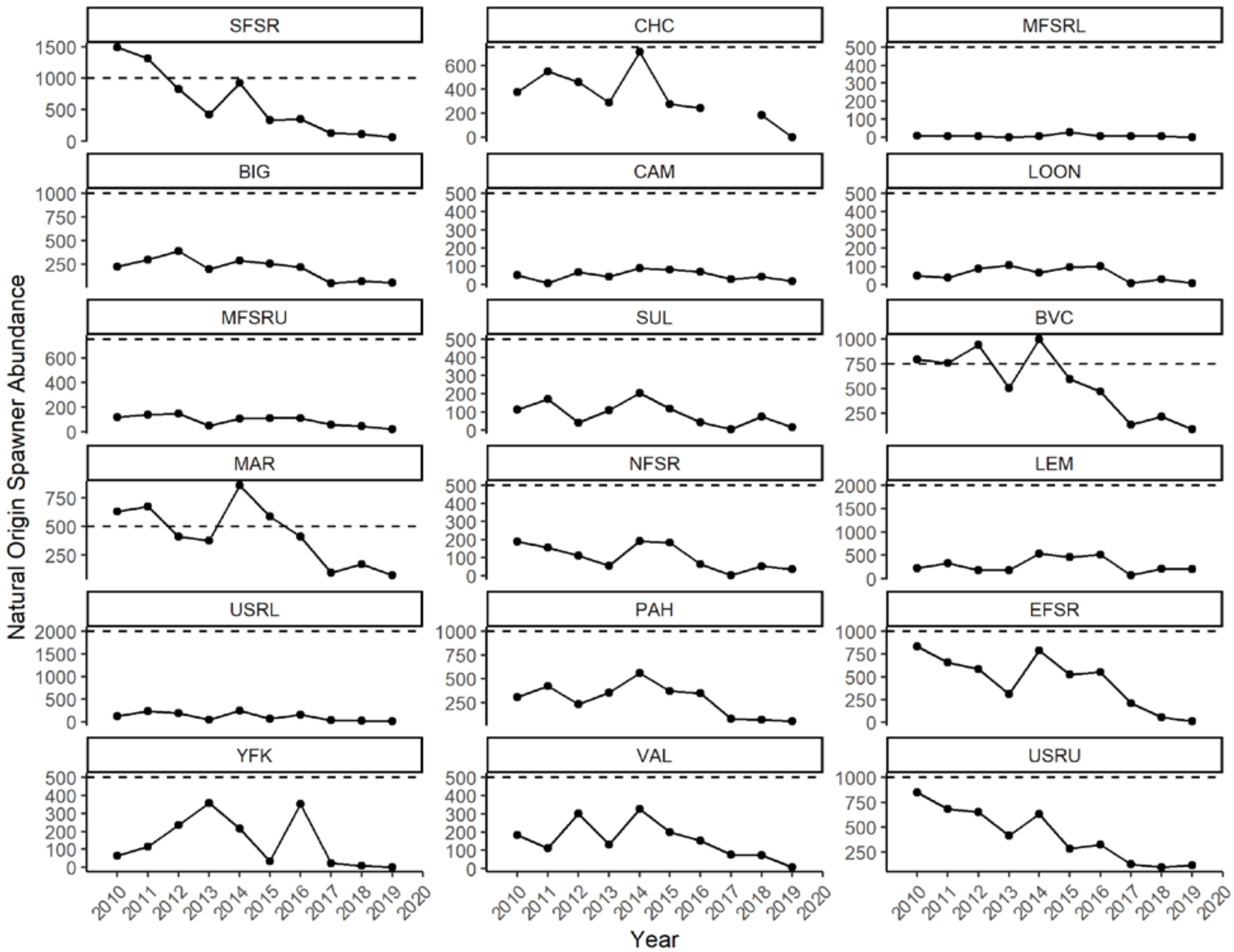


Figure 3-1. Chinook Salmon natural-origin spawner abundance trends in Idaho populations, 2010-2019. Dashed line indicates minimum abundance threshold. Note variable y-axis scale.

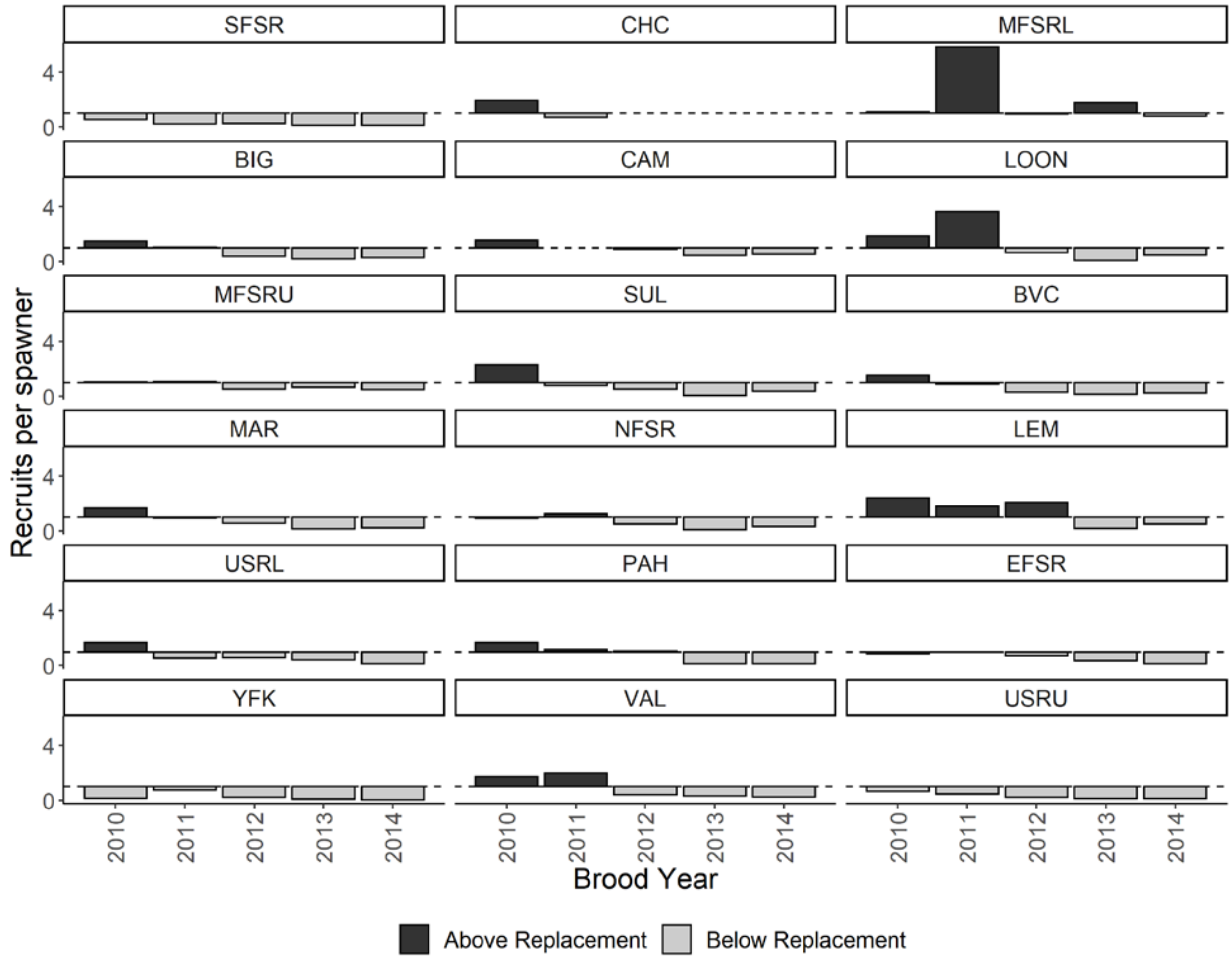


Figure 3-2. Chinook Salmon adult-to-adult productivity trends in Idaho populations, brood years 2010-2014.

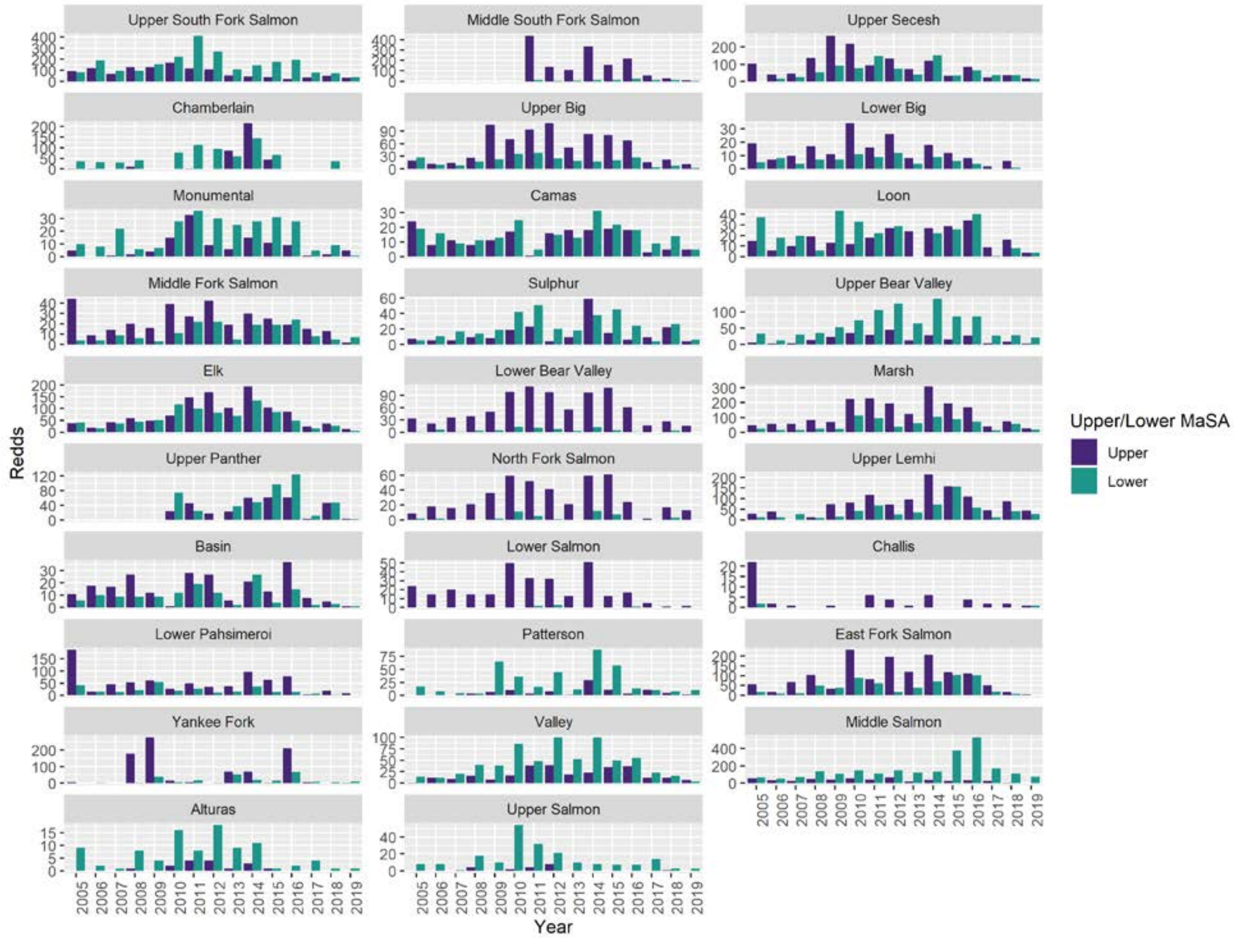


Figure 3-3. Number of redds counted in upper and lower half of Chinook major spawning areas (MaSA) in Idaho, 2005-2019.

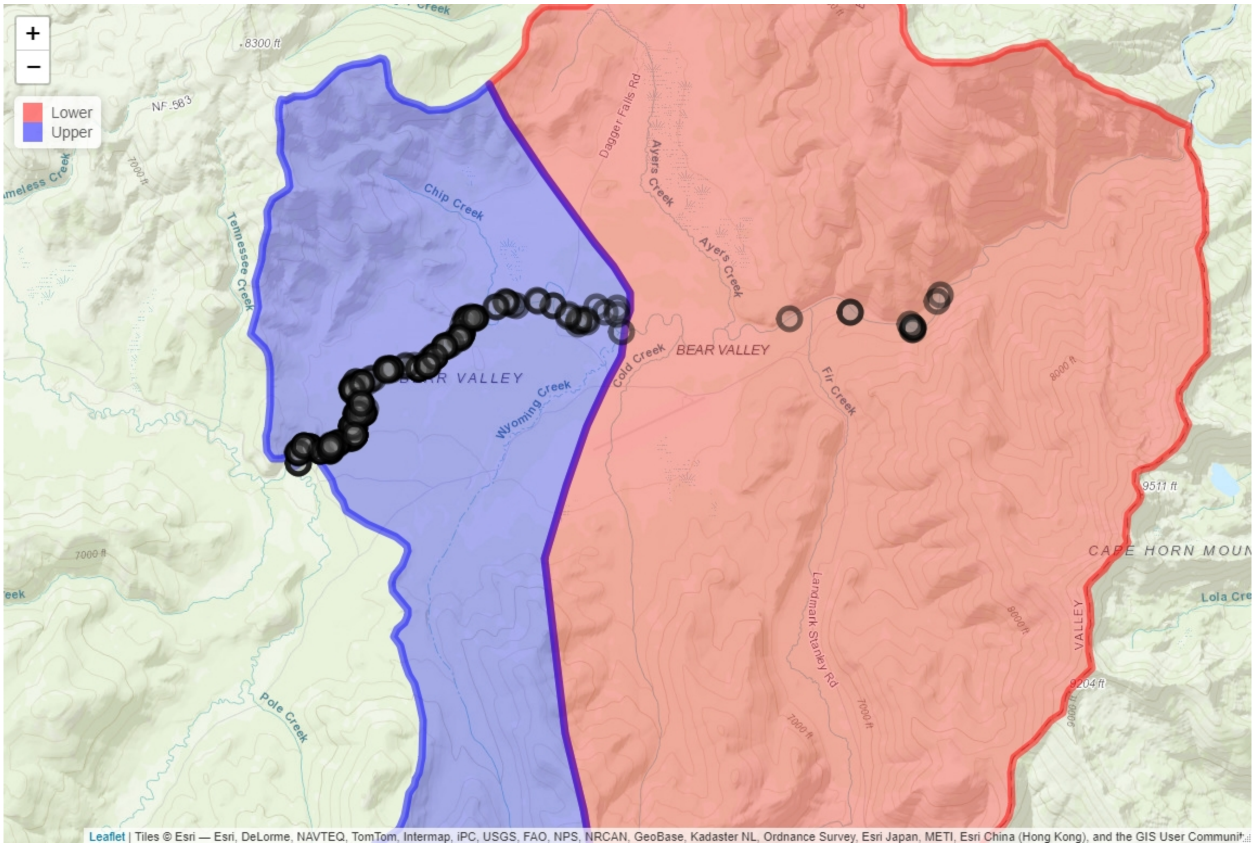


Figure 3-4. Map of redds (black circles) in the upper and lower half of the Lower Bear Valley spawning area, 2015-2019.

APPENDICES

Appendix A. Redd Count index surveys in the Lower Mainstem Salmon River

Eli A. Felts, IDFG, Nampa Fisheries Research

FINAL July 22, 2019

Chinook Salmon redd count index surveys in the Lower Mainstem Salmon River (USRL) population were previously conducted from helicopter but switched to unmanned aircraft systems (UAS) in 2018. While safer than helicopter, UAS is more time consuming and biologists noted that long stretches of unoccupied habitat were being surveyed in the USRL population. Thus, there was a desire to reduce the amount of habitat to be surveyed. Here I have pulled together background information to inform decisions regarding future surveys in index transects of this population.

Index survey transects in the USRL were established by IDFG in 1957. These transects are all on the main stem Salmon River and extend from the confluence with Redfish Lake Creek downstream to the confluence with the Lemhi River (Appendix Figure A-1). This section of river is approximately 214 km (133 miles) in length. Current sampling defines 8 transects (Appendix Table A-1). The transects are numbered consecutively from upstream to downstream, beginning with NS-17 and concluding with NS-24. Transects have been reported as combined units at various points throughout the data series. For example, during 1974 a single count was reported for transects NS-17 and NS-18. At least some portion of the USRL population has been surveyed every year since 1957 except in 1979 when no aircraft were available.

The area surveyed has been relatively consistent from 1957-2018 with few exceptions. In the Salmon River drainage, several survey reaches were dropped in the 1970s and 1980s as runs declined following construction of hydroelectric dams on the Snake River. No counts occurred in transects NS-21, NS-22, NS-23, and NS-24 in 1978, 1980, and 1984. No counts occurred in transects NS-22, NS-23, and NS-24 in 1981-1983. The most downstream transect, NS-24, which extends 75 km from the Pahsimeroi River to the Lemhi River was not surveyed from 1978-1986, 1995-1998, 2000-2006, 2008-2010, and 2013. Surveys were limited to transects NS-18, NS-19, and NS-20 in 2010.

Index counts in the USRL have declined dramatically over the period covered by our data set (Appendix Figure A-2). In the 1960s, annual counts averaged just over 350 redds, whereas annual counts have only exceeded 350 redds once since the 1960s when 359 redds were counted in 1978. Since that relatively high count in 1978, annual counts have averaged 68 redds with a maximum of 233 in 2002. Index redd counts have declined in all transects over this time period although counts in transect NS-17 have increased since the late 1990s (Appendix Figure A-3).

Issues and options

Surveying all transects of the USRL is time consuming and expensive. Ground counts are infeasible due to the size of river and area to be covered. Surveys of this population were conducted from either fixed-wing aircraft or low-flying helicopter from 1957-2017 with the exception of ground surveys in transects NS-18, NS-19, and NS-20 in 2010 when all aerial surveys were grounded due to a helicopter crash. In 2018 unmanned aircraft systems (UAS) were used for all index counts of the USRL.

Although safer than low-flying helicopter, surveying with UAS still presents risks to staff safety. During these surveys, current Federal Aviation Administration regulations require pilots to maintain visual line-of-sight with the aircraft; this is typically achieved by having a technician drive the pilot in a vehicle at relatively slow speeds along a road adjacent to the stream being surveyed. In the USRL the road adjacent to the stream is Highway 75, which is a busy, curvy road on which traveling at such a low rate of speed is a safety concern. Additionally, the UAS batteries currently used by IDFG last approximately 30 minutes so when the USRL is being surveyed observer teams must land the UAS and stop along the road to swap out batteries many times to cover the entire survey area.

In addition to safety concerns, UAS surveys are more time consuming than helicopter surveys. Survey time using UAS is generally longer than helicopter surveys but shorter than ground counts. However, UAS surveys require a significant amount of time for processing images after the flight is completed. The cost of implementing UAS was comparable to helicopter surveys in 2018, although this partially reflects the high initial cost of purchasing the actual UAS unit. Biologists expect that costs other than initial capital will be less than helicopter surveys but more than ground surveys due to the cost of manpower and maintenance and replacement of capital.

The large area to be covered and the low numbers of redds counted in much of the population has raised questions about the need to survey certain parts of the USRL annually. In particular, four transects from the East Fork Salmon River downstream to the Lemhi River (NS-21, NS-22, NS-23, and NS-24) encompass 142.5 km, or nearly two-thirds of the surveyed area in the USRL, but have displayed very low index counts for most of our data set. From 1974-2018, an average of 2 and a maximum of 12 combined redds have been counted in these transects (Appendix Figure A-4). Below I present options for continued sampling in the USRL:

1. **Status Quo**. Continue surveying all transects in the USRL. The advantage is the maintenance of a mostly continuous data set which dates back to 1957. Any potential recolonization of the Salmon River downstream of the East Fork Salmon River will be documented immediately. The disadvantage is that this population's transects require substantial effort and present logistic challenges. The 214 km sampled represents nearly 40% of the stream length covered in the entire Upper Salmon River MPG.

2. **Drop transects NS-21, NS-22, NS-23, and NS-24.** As mentioned above, very few redds have been observed in these areas for several decades. The relationship between counts in these transects and in the rest of the population has been fairly consistent and could be used to estimate redd abundance (Appendix Figure A-6).

3. **Drop transect NS-24 and continue sampling all other transects.** At 75 km, dropping this single transect would offer a substantial reduction in effort required in the USRL. This transect has been dropped from sampling in the past, and has only been surveyed 9 out of the last 20 years. Only a single redd has been counted in this transect since 1988, and it seems to have not been a historically large spawning aggregate with index counts ranging from 0-72, and displaying a mean of 11 during the 1957-1969 pre-dam era.

4. **Only sample transects NS-21, NS-22, NS-23, and NS-24 at high escapement**. In-season escapement estimates are available at the scale of genetic stocks, which roughly correspond to MPGs. The estimates for the Upper Salmon genetic stock (at Lower Granite Dam) could be used to decide whether or not to survey these transects with sampling occurring above a given threshold. This would reduce sampling effort in years of low escapement while continuing to monitor downstream transects. This design assumes that abundance and/or recolonization dynamics in this section of river is related to abundance of the Upper Salmon genetic stock as a whole.

5. Option 4, except drop NS-24

6. Sample transects NS-21, NS-22, NS-23, and NS-24 on a rotation. Rotating among these transects (i.e. surveying one of the 4 each year) would ensure that these areas are sampled within each brood cycle. This option does not make any assumptions about the relationship between abundance of the Upper Salmon genetic stock and abundance in these specific transects.

7. Option 6, except drop NS-24

Recommendation

I recommended dropping transect NS-24 from IDFG annual index redd counts, leaving Options 2, 3, 5, and 7 from the list above. Our data clearly demonstrate that the life history which may have occupied this section of river historically is now functionally extirpated. Of these options, I recommended choosing either option 2 or 7. I prefer a rotating design (Options 6 and 7) to an escapement-based design (Options 4 and 5) because I don't like assuming a relationship between escapement of the genetic stock at Lower Granite Dam and dynamics in these specific areas. The available data suggest there is little relationship between those two numbers (Appendix Figure A-5).

The choice between options 2 and 7 comes down to the objectives of monitoring. The primary objective of index redd counts is to index abundance. It is clear that the area downstream of the East Fork Salmon River contributes little to overall abundance in the USRL so dropping those transects would not stop us from achieving that objective. A second objective of index redd counts is to document spatial structure. Option 7 would substantially reduce effort while doing a better job than option 2 of keeping our understanding of spatial structure in the USRL current.

Consensus Decision

The options put forth in this brief were reviewed and discussed by IDFG staff on June 20, 2019[a]. We agreed that there was little benefit to surveying NS-24. This transect was included historically because aircraft used to conduct surveys were already heading that direction to refuel in Challis and return to Salmon. This convenience is not realized when using UAS, and there has been only 1 redd observed in this transect since 1988. Thus, we reached a consensus decision to drop NS-24 from IDFG annual index redd counts.

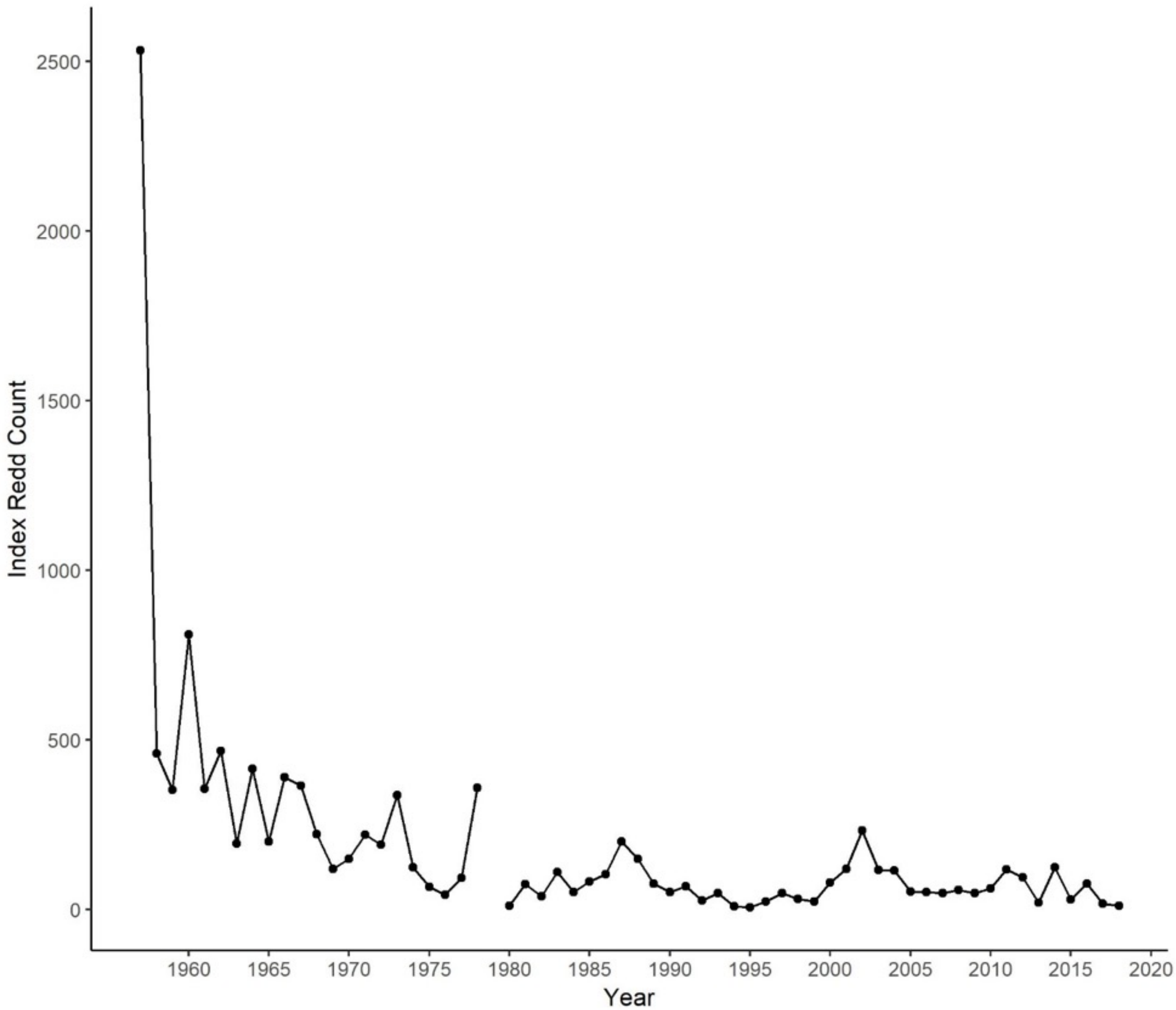
We also discussed potential alterations to NS-21, NS-22, and NS-23 survey design that would reduce the amount of effort required annually. During our discussion, Region 7 staff reported that they expected UAS surveys to become less time demanding as they implement new software and gain experience, meaning that these three transects are anticipated to be completed efficiently. As such, Region 7 expressed a desire to continue sampling each of these transects annually. The rest of us agreed, so our consensus decision was to continue annual redd counts using UAS in transects NS-21, NS-22, and NS-23 (Option 3).The remaining four transects (NS-17, NS-18, NS-19, and NS-20) will also continue to be surveyed using UAS.

[a] Conference call attended by Eli Felts, Katie Lawry, Conor McClure, Greg Schoby, Josh Poole, Jordan Messner, Brett Bowersox, Tim Copeland, and Bill Schrader.

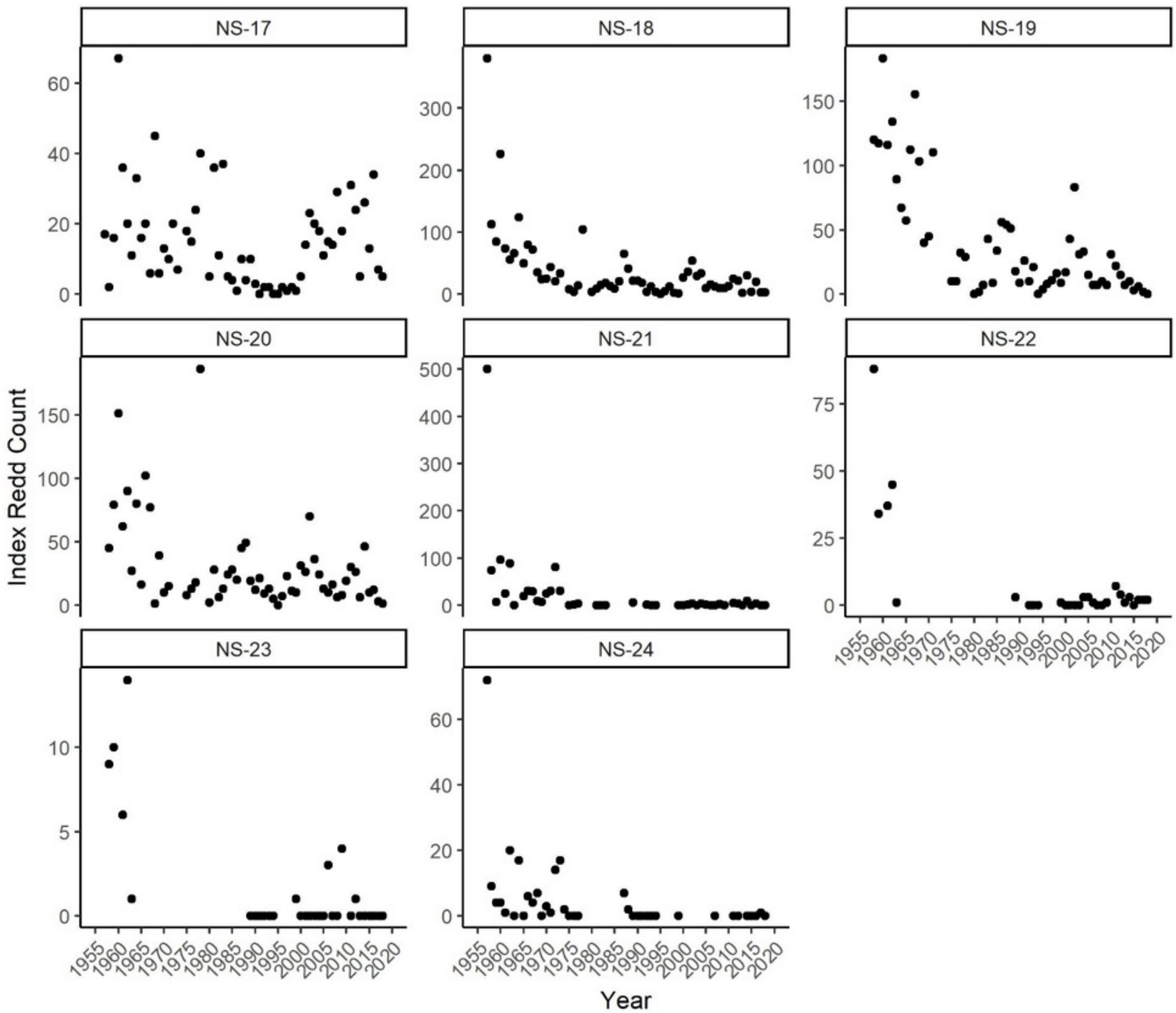
Appendix Table A-1. Summary of IDFG redd count index transects in the Lower Mainstem Salmon River population.

Transect	Upper Boundary	Lower Boundary	Length (km)
NS-17	Redfish Lake Creek	Valley Creek	8.6
NS-18	Valley Creek	Yankee Fork Salmon River	20.4
NS-19	Yankee Fork Salmon River	Warm Springs Creek	6.0
NS-20	Warm Springs Creek	East Fork Salmon River	36.4
NS-21	East Fork Salmon River	HWY 93 Bridge	30.8
NS-22	HWY 93 Bridge	Morgan Creek	21.0
NS-23	Morgan Creek	Pahsimeroi River	15.7
NS-24	Pahsimeroi River	Lemhi River	75.0

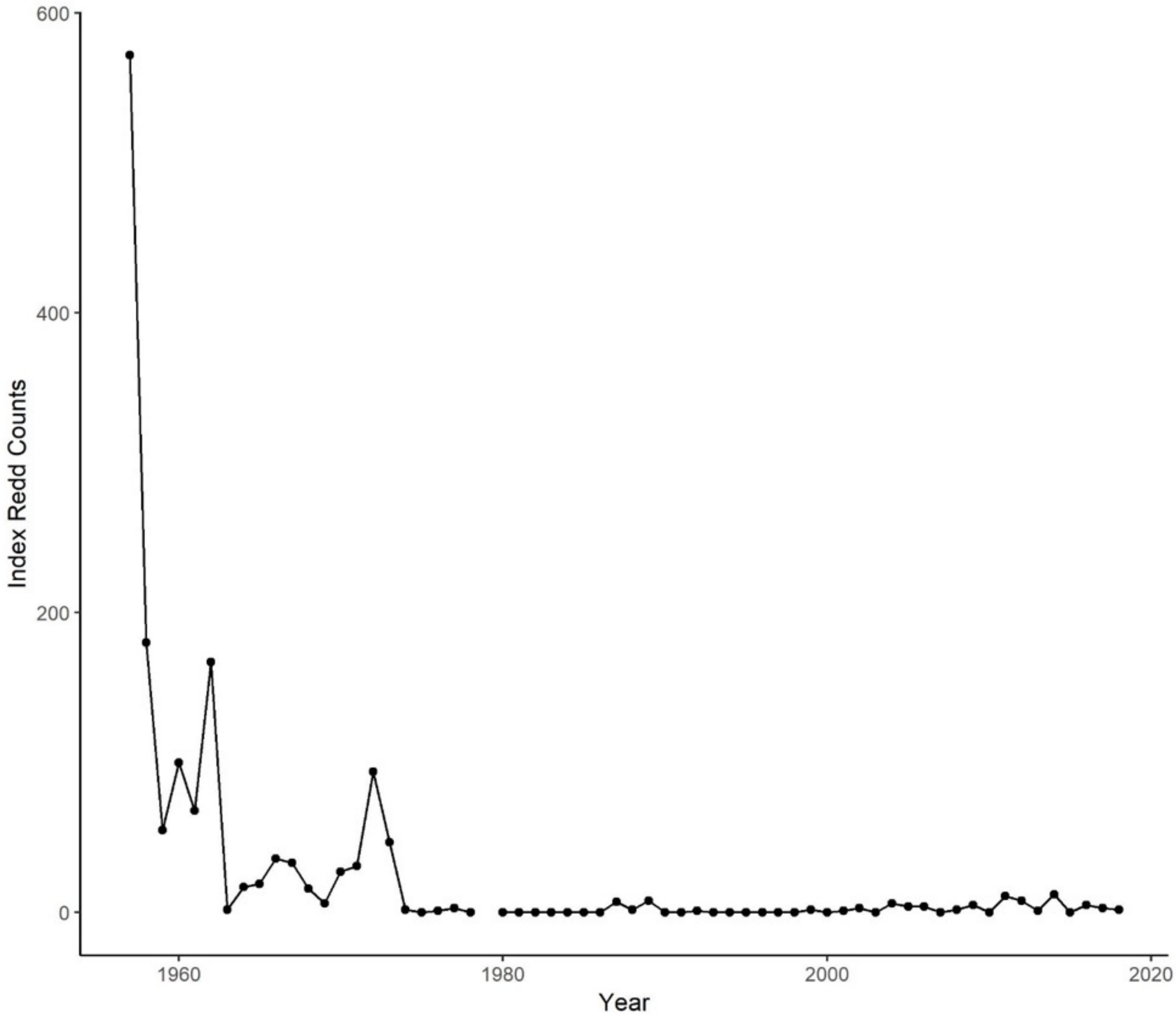
Appendix Figure A-1. Map of IDFG redd count index transects in the Lower Mainstem Salmon River population.



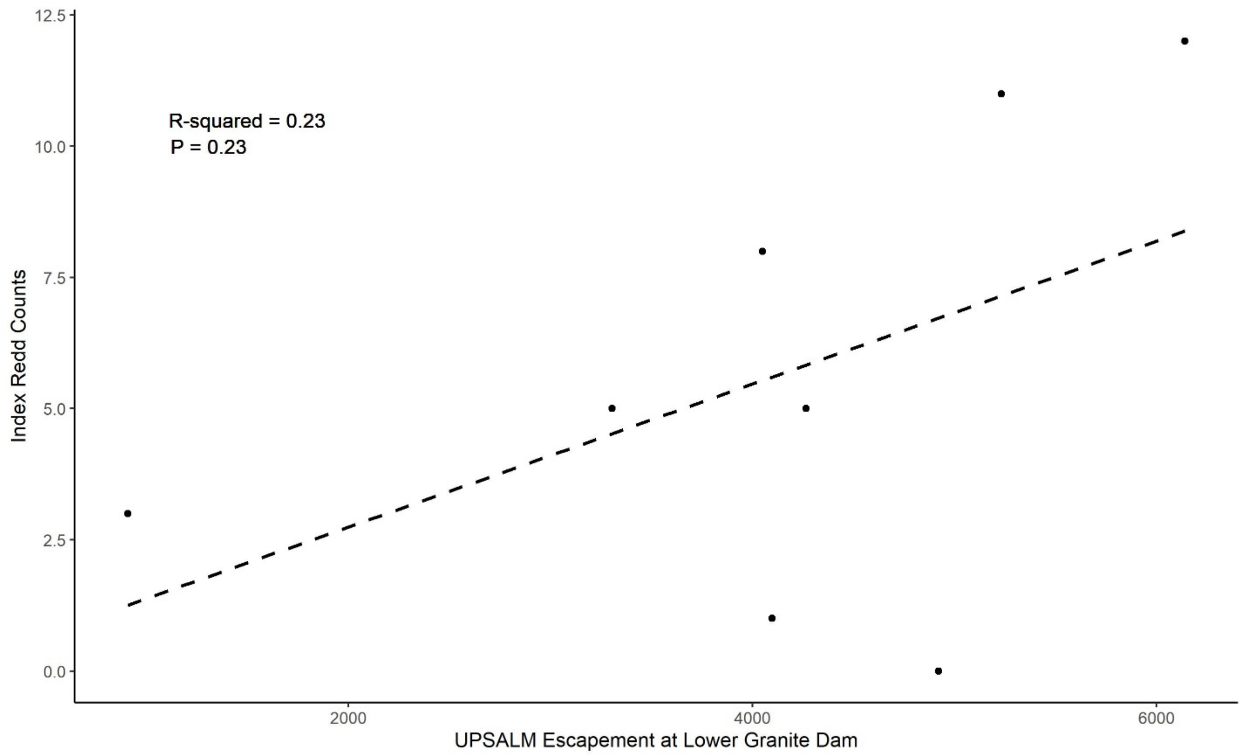
Appendix Figure A-2. Chinook Salmon index redd count in the Lower Mainstem Salmon River population, 1957-2018.



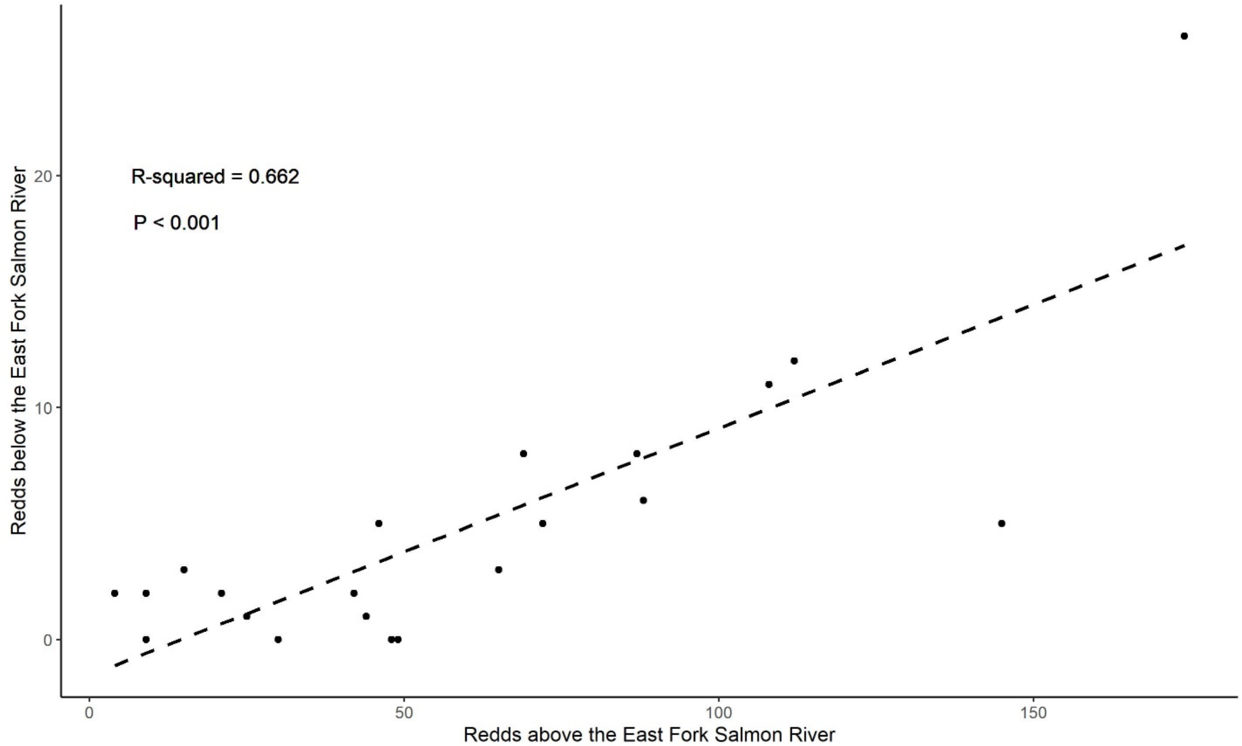
Appendix Figure A-3. Chinook Salmon index redd counts in transects of the Lower Mainstem Salmon River population, 1957-2018. Note variable y-axis scale.



Appendix Figure A-4. Chinook Salmon index redd count from East Fork Salmon River downstream to Lemhi River (transects NS-21, NS-22, NS-23, and NS-24) in the Lower Mainstem Salmon River population, 1957-2018.



Appendix Figure A-5. Chinook Salmon index redd count from East Fork Salmon River downstream to Lemhi River (transects NS-21, NS-22, NS-23, and NS-24) in relation to UPSALM genetic stock escapement at Lower Granite Dam, 2009-2017.



Appendix Figure A-6. Comparison of redds counted above the East Fork Salmon River (NS-17, NS-18, NS-19, NS-20) to redds counted below the East Fork Salmon River (NS-21, NS-22, NS-23, NS-24), 1975-2018. Only includes years when all transects were counted.

Appendix B. Additional information collected on spawning ground surveys and at hatchery weirs in 2019.

Eli A. Felts, Nampa Fisheries Research

INTRODUCTION

Chinook Salmon spawning ground surveys are primarily designed to monitor status and trends in abundance and productivity within and among Idaho populations. However, some 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 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 help to 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 two populations, Marsh Creek and Lemhi River, and one specific transect, NS-16, in the Salmon River upper mainstem above Redfish Lake population. Multiple pass surveys were designed to begin with the start of spawning activity, with subsequent surveys conducted weekly until the end of spawning activity. Each survey followed data collection methods described in chapter 2. On each pass, newly observed redds were flagged, assigned a unique number, and georeferenced using GPS units. Flags were removed on the last pass.

Additional Redd Count Surveys

Additional redd surveys were conducted in various streams of the Clearwater River basin to address specific questions regarding spawner abundance, spatial distribution, and spawn timing. Two passes, separated by one to two weeks, were made at each transect. One of the passes corresponded with the target date for a peak count and was considered to be the index count for trend-monitoring purposes. Survey methods for all passes were identical to those described for multiple pass surveys in chapter 3 of this report.

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 are marked with an opercle punch. Carcass surveys are 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):

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

Where M is the number of fish marked at the weir, C is the number of carcasses recovered above the weir, and R is the number of marked carcasses recovered above the weir. Prespawn survival 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.

Abundance above the Pahsimeroi River weir was estimated by multiplying the number of fish passed above the weir by a value of weir efficiency, then directly subtracting prespawn mortalities observed above the weir. Mark-recapture methods were not used for 2019 because early arriving fish were not marked. Weir efficiency at Pahsimeroi was assumed to be 95% based on the median of estimates in years (N = 6) when abundance was estimated using the Chapman modification of the Lincoln-Peterson method. During these years, weir efficiency ranged from 89% to 97%.

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, 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 at the weir. 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 first or second week of September and documented 42 redds (Appendix Table B-1). Surveys in the Lemhi River population went from the last week of August until the last week of September and documented 79 redds (Appendix Table B-1). Surveys in transect NS-16 went from the last week of August until the last week of September and documented 73 redds.

Additional Redd Count Surveys

In 2019, additional redd count surveys were conducted in American River and Red River of the Upper South Fork Clearwater River Population. Two passes were conducted at each transect. Staff counted a total of 14 redds in American River and 51 redds in Red River (Appendix Table B-2).

Weir Passage

We estimated 98 spawners above the Pahsimeroi weir, 55 of which were natural origin (Appendix Table B-3). We estimated 79 spawners above the Sawtooth weir, all of which were natural origin. We estimated 278 spawners above the South Fork Salmon river weir, 69 of which were natural origin.

Genetics Samples at Weirs and Traps

A total of 462 tissue samples were collected from Chinook Salmon released at IDFG hatchery weirs, hatchery traps, and research weirs during 2019 (Appendix Figure B-1). Most samples (n = 291) were collected at the McCall Hatchery weir in the South Fork Salmon River. The East Fork Salmon River weir was not operated for Chinook Salmon in 2019 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 B-1. Multiple-pass redd count census surveys that were conducted for spring-summer Chinook Salmon in Idaho during 2019. Surveys are organized by major population group (MPG).

Population	Waterbody	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	8/9	5	8/16	8	8/23	0	8/30	1	9/6	1	15
	Banner Creek	8/10	0	8/17	0			8/31	0	9/7	0	0
	Cape Horn Creek	8/10	3	8/17	8	8/24	1	8/31	0	9/7	0	12
	Knapp Creek	8/11	1	8/18	0	8/25	0	9/1	0			1
	Marsh Creek	8/8	2	8/15	3	8/22	8	8/29	1	9/5	0	14
Total			11		19		9		2		1	42
					Upper Salmon River MPG							
Lemhi River	Bear Valley Creek	8/20	2	8/27	1	9/4	0	9/10	0	9/18	0	3
	Big Springs Creek	8/23	0	8/30	0							0
	Big Timber Creek			8/28	0							0
	Hayden Creek	8/19-21	10	8/26-28	5	9/3-4	6	9/9-10	3	9/23-24	1	25
	Lemhi River					9/4-6	43			9/23-27	8	51
	Little Springs Creek	8/22	0	8/28	0	9/5	0					0
Total			12		6		49		3		9	79
Salmon River Upper Mainstem Above Redfish Lake	Redfish Lake Creek upstream to Sawtooth Weir	8/28	23	9/4	40	9/11	10	9/18	0	NC	NC	73

[a] Downloaded from the SGS database on 3/16/20.
[b] Not completed = n/c.

Appendix Table B-2. Additional redd count surveys that were conducted for spring-summer Chinook Salmon in Idaho during 2019.

Population	Waterbody	Transect	Date	New Redds	Date	New Redds	Total
			Dry Clearwater MPG				
USFC	American River	Mouth upstream to Limber Luke Creek	9/4	5	9/17	9	14
	Red River	Mouth upstream to Shissler Bridge	9/1-4	41	9/15-17	10	51
Total				46		19	65

Appendix Table B-3. Data collected for estimating abundance above IDFG weirs in 2019. M = Number of fish marked and passed above weirs, C = number of carcasses recovered above weirs, R = number of carcasses marked and recovered above weirs, and N = estimated abundance. Asterisk indicates value estimated from earlier years.

	Natural-Origin						Hatchery-Origin					
Weir	**M**	**C**	**R**	**Prespawn Mortalities**	**Weir Efficiency**	**N**	**M**	**C**	**R**	**Prespawn Mortalities**	**Weir Efficiency**	**N**
Pahsimeroi	41	4	0	0	0.95[a]	55	26[b]	0	0	0	0.95[a]	43
Sawtooth	78	41	40	0	0.98	79	0	2	2	0	1.00	NE
South Fork Salmon	69	8	8	2	1.00	69	209	25	25	0	1.00	209

[a] Median weir efficiency from previous years.
[b] A total of 41 hatchery fish were passed above the weir, but only 26 of those fish were marked.

Appendix Table B-4. Number of genetic samples collected from adult Chinook Salmon released at IDFG hatchery and research weirs, 2014-2019. Crooked River samples for 2014 have not been located. NA = not applicable, weir not operated for Chinook Salmon.

Weir	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
Salmon River (Sawtooth)	701	447	421	305	152	78
E. F. Salmon River	322	NA	NA	NA	NA	NA
Pahsimeroi River	660	455	399	277	320	92
S. F. Salmon River	990	696	709	389	455	291
Rapid River	30	34	23	30	30	0
Hells Canyon Dam	81	114	29	0	3	1
Lochsa River (Powell)	0	10	23	24	27	0
Fish Creek	6	3	3	3	0	0
Red River	67	36	31	22	15	0
Crooked River	44	70	30	8	13	0
Total	2,901	1,865	1,668	1,058	1,015	462

Appendix C. Region 2 modifications to annual Spawning Ground Survey transects

Robert Hand, IDFG, Region 2

Spawning ground surveys (SGS) are conducted annually to provide important information regarding relative abundance and productivity of Idaho's wild Snake River spring-summer Chinook Salmon in the Clearwater River and Salmon River basins. These surveys also provide information on distribution, spawn timing, wild/hatchery origin, age composition, length/growth, and sex ratios. The data collected from these surveys are used to evaluate the viability of these populations. With the difficulty of surveying these populations across large, remote areas, the Idaho Department of Fish and Game developed a program to index spawning escapement by surveying selected transects at peak spawning times. These standardized transects have been surveyed annually since the 1960s in the Clearwater River basin.

Due to the value of the data collected and maintenance of long-term data sets, it is important to evaluate and document changes to historic transects. A number of significant changes have occurred to Clearwater River basin SGS surveys in the past decade. Historically, Selway River transects were surveyed through aerial (helicopter) surveys; however, this method was discontinued in the Clearwater Region beginning in 2011 due to safety concerns. Some transects previously surveyed by helicopter were dropped and others were modified so they could be completed from the ground. In addition, SGS surveys conducted in the Lochsa River drainage were transferred to the Clearwater Region from Nampa Research staff in 2014, which increased the overall personnel and logistical demands on the regional program. This document contains an evaluation of two SGS transects within the Selway and Lochsa river drainages and the justification for changes to transects within those drainages. The two transects are as follows:

1. East Fork Moose Creek (WC-3b) – mouth to Cedar Creek, 13.8 miles.
2. Colt Killed Creek (White Sands Creek, NC-13) – Mouth to Big Flat Creek, 15.7 miles.

East Fork Moose Creek (WC-3b)

This transect consisted of 13.8 miles of stream from the mouth of the East Fork Moose Creek (EFMC) upstream to Cedar Creek (Appendix Figure C-1). It was surveyed from 1972 - 2008 using aerial methods. During this timeframe, individual redd locations were not marked, with only a total redd count generated. Therefore, we were unable to assign historic redd distribution to the transect. We developed a strategy to prioritize ground survey locations in high quality spawning habitat areas based on the Intrinsic Habitat Potential (IP) model developed by NOAA to address this limitation and prioritize initial ground surveys for this evaluation (Ford et al. 2010). Based on the model, potential high quality habitat areas were located in lower reaches from Fitting Creek downstream, and in upper reaches from Monument Creek to the fish barrier near Dolph Creek (Appendix Figure C-1).

Initial surveys for the evaluation occurred in 2013. On the EFMC, this survey occurred from approximately one half mile upstream of Fitting Creek downstream to the mouth of Moose Creek. Personnel conducting these surveys indicated that the vast majority of these reaches consisted of substrate from large cobble to boulder in size (Appendix Figure C-2), and had minimal suitable spawning habitat (Appendix Figure C-3). In addition, anecdotal information gathered as part of the evaluation suggested there was spawning habitat upstream of Cedar Creek (upper transect boundary). Because of this and the IP model showing high rated habitat in this section, an exploratory ground survey was conducted in 2014 from Dolph Creek downstream to Cedar

Creek. This survey confirmed that most of the substrate in EFMC consisted of imbedded cobble and larger size rocks (Appendix Figure C-2). It also revealed that much of the high-rated spawning habitat in EFMC was in a small section of stream located upstream of the historic transect, between Cedar Creek and Dolph Creek (Appendix Figure C-1).

Since ground surveys began in 2013, redds within the original transect boundaries were exclusively found just upstream of Fitting Creek downstream to the mouth (Appendix Figure C-4). Ground surveys conducted since 2014 have documented 90% of the redds observed in EFMC occurring in the section of stream between Cedar Creek and the fish barrier downstream of Dolph Creek (Appendix Figure C-4). Results of the evaluation have provided a logistically feasible and biologically meaningful transect to maintain within the Moose Creek drainage. As such we recommend the following modifications to the historic trend survey boundary:

a. WC-3c = mouth of EFMC - ½ mile above Fitting Creek.
b. WC-3d = Cedar Creek - fish barrier downstream of Dolph Creek.

Transect boundary coordinates are shown in Appendix Table C-1, and maps of the transects are shown in Appendix Figure C-4. We conducted surveys on these two transects in 2018 and 2019, and verified this can be completed by a 2-3 person crew in five days.

Colt Killed Creek (White Sands Creek; NC-13)

This transect consists of 15.7 miles of stream from the mouth of Colt Killed Creek (CKC) upstream to its confluence with Big Flat Creek. It has been surveyed since 1972 using ground methods. This transect was evaluated for potential modification based on low historic redd abundance and high effort.

We began this evaluation by utilizing the Intrinsic Habitat Potential (IP) map to determine what areas of the transect might have suitable habitat (Appendix Figure C-5) (Ford et al. 2010). Potential high quality habitat areas within the transect are limited to the mouth of Storm Creek and Big Flat Creek. The only other high potential habitat in CKC is located upstream of Big Flat Creek, outside of the current transect (Appendix Figure C-5). Historic surveys corroborated the IP map, indicating that the majority of this transect has little suitable spawning habitat, with most substrate ranging from large cobble to boulder in size (Appendix Figure C-6). Based on this information, we conducted an exploratory survey in 2018 from Storm Creek downstream to the mouth to further evaluate the habitat available in this transect and verify the validity of the IP map. This survey revealed only one small (<5 m^2) patch of spawning habitat, confirming the lack of suitable habitat in this transect.

Even with limited suitable spawning habitat, if redds are concentrated in consistent locations, annual surveys of smaller index reaches within CKC could be warranted. To assess if transect length could be reduced to focused areas, we evaluated the distribution of recent redds to determine if they were located within consistent reaches. Individual redd location data has been collected in CKC since 2008, and indicated that 86% (103/120) of redds observed from 2008 - 2018 were located in the canyon reach (Appendix Figure C-7). However, these redds were distributed throughout the reach. Portions of the transect above Storm Creek and below Beaver Creek had very few (if any) redds present. Based on this analysis, we did not observe a concentration of activity anywhere within the transect, and it appears adults use lower quality habitat within this stretch during higher run years when there are more adults attempting to spawn.

Low adult returns during recent run years have likely contributed to the lack of redds within this transect. To assess this, adult Chinook Salmon counts at Lower Granite Dam (LGD) were compared to the number of redds observed within this transect. Since 1990, <4 redds have been observed in this transect when LGD adult counts are <30,000 (Appendix Figure C-8). In fact, during the 14 years where adult counts were <75,000, only two years had redd counts >5. This confirmed that few redds are observed during lower run years. The issue of low numbers of natural redd counts is exacerbated by the hatchery fraction within this transect. On average since 1997, hatchery origin fish comprise 68% of carcasses recovered in this transect. Estimating the number of natural redds present in this transect (by correcting total redds by the average hatchery fraction of 68%) showed that in approximately 50% of years, no natural redds occurred in the transect and it wasn't until natural/wild adult counts are >10,000 at LGD that we consistently estimated >2 wild redds to be present (Appendix Figure C-9).

The lack of suitable habitat, the low number of redds in low run years, and the low proportion of natural fish found in this transect provides justification for discontinuing annual surveys, especially during low run years. Sampling when fish numbers are higher should provide redds and carcasses in sufficient numbers to make sampling warranted. Additionally, since redds are observed throughout the transect during high run years, surveying the entire transect would be more appropriate than only sampling a portion of the transect. Thus, we have made the following modifications to the historic trend survey frequency:

- Continue surveying the entire NC-13 transect; however, only conduct the survey during years with LGD counts >75,000 total adults.

During low run years, we recommend focusing personnel time on conducting additional walks for redds and carcasses on Brushy Creek and Crooked Fork Creek, which are areas that generally contain more fish and redds than the CKC transect. During the last few years, very few carcasses were available for collection during the initial surveys of Brushy Creek and Crooked Fork Creek, as most of the fish were still alive. We have conducted additional carcass surveys of these transects in order to collect carcasses. Reducing the time spent on CKC will increase redd survey and carcass collections in higher priority areas within the Lochsa River drainage.

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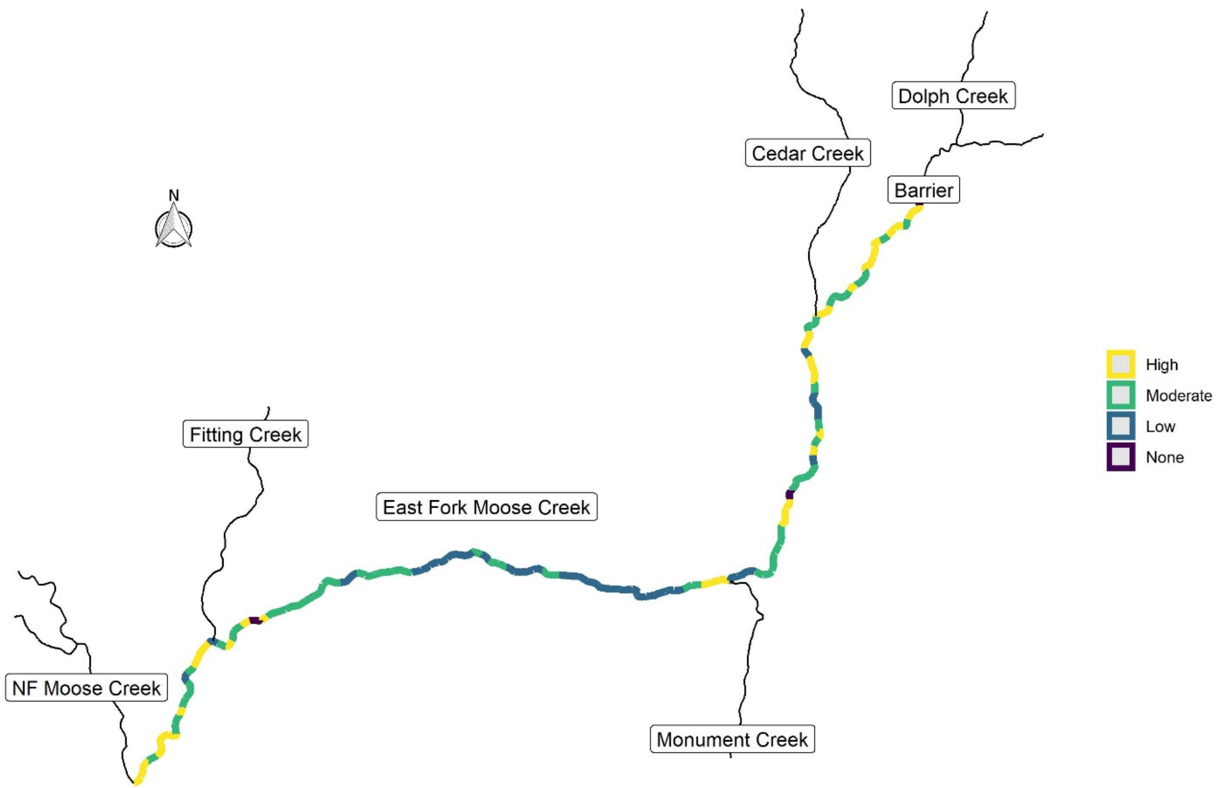
Appendix Table C-1. Boundary locations for proposed new spawning ground survey transects on the East Fork Moose Creek, Idaho.

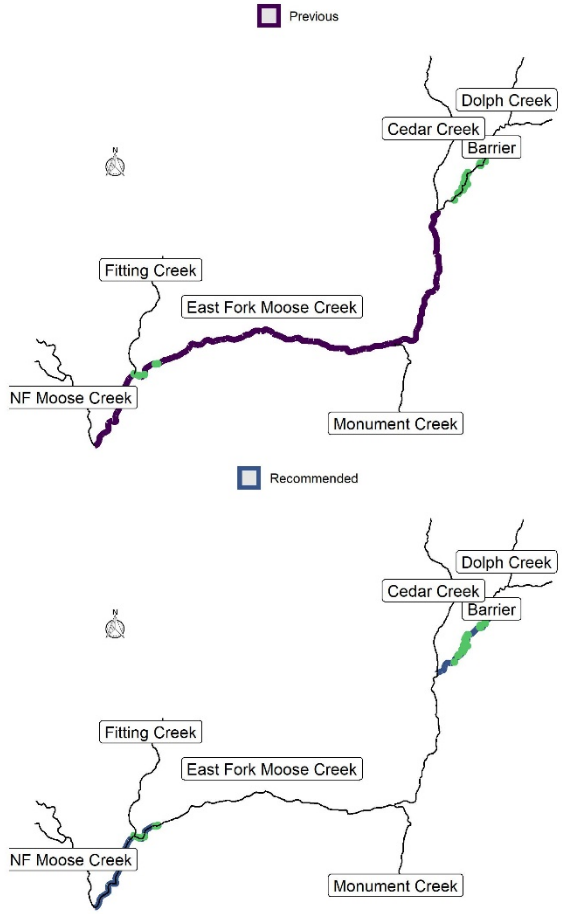
	Upper Boundary		Lower Boundary	
New Transect Name	**Latitude**	**Longitude**	**Latitude**	**Longitude**
WC-3c	46.195015	-114.860928	46.173839	-114.886332
WC-3d	46.272459	-114.67883	46.248907	-114.709282



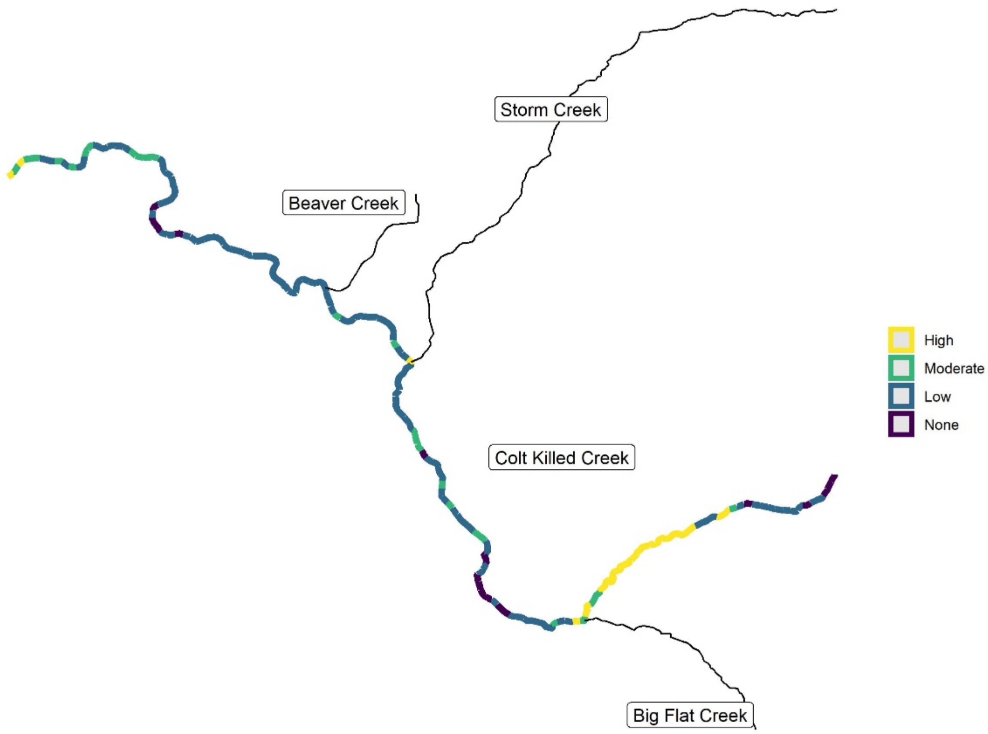
Appendix Figure C-1. Intrinsic Habitat Potential map for East Fork Moose Creek, Idaho.

Appendix Figure C-2. Photos showing typical substrate present in transect WC-3b in the East Fork Moose Creek, Idaho.

Appendix Figure C- 3. Photo showing lack of suitable spawning habitat even in reaches with large woody debris. Spawning size gravels are located above low flow water levels as shown downstream of large log on far shore.

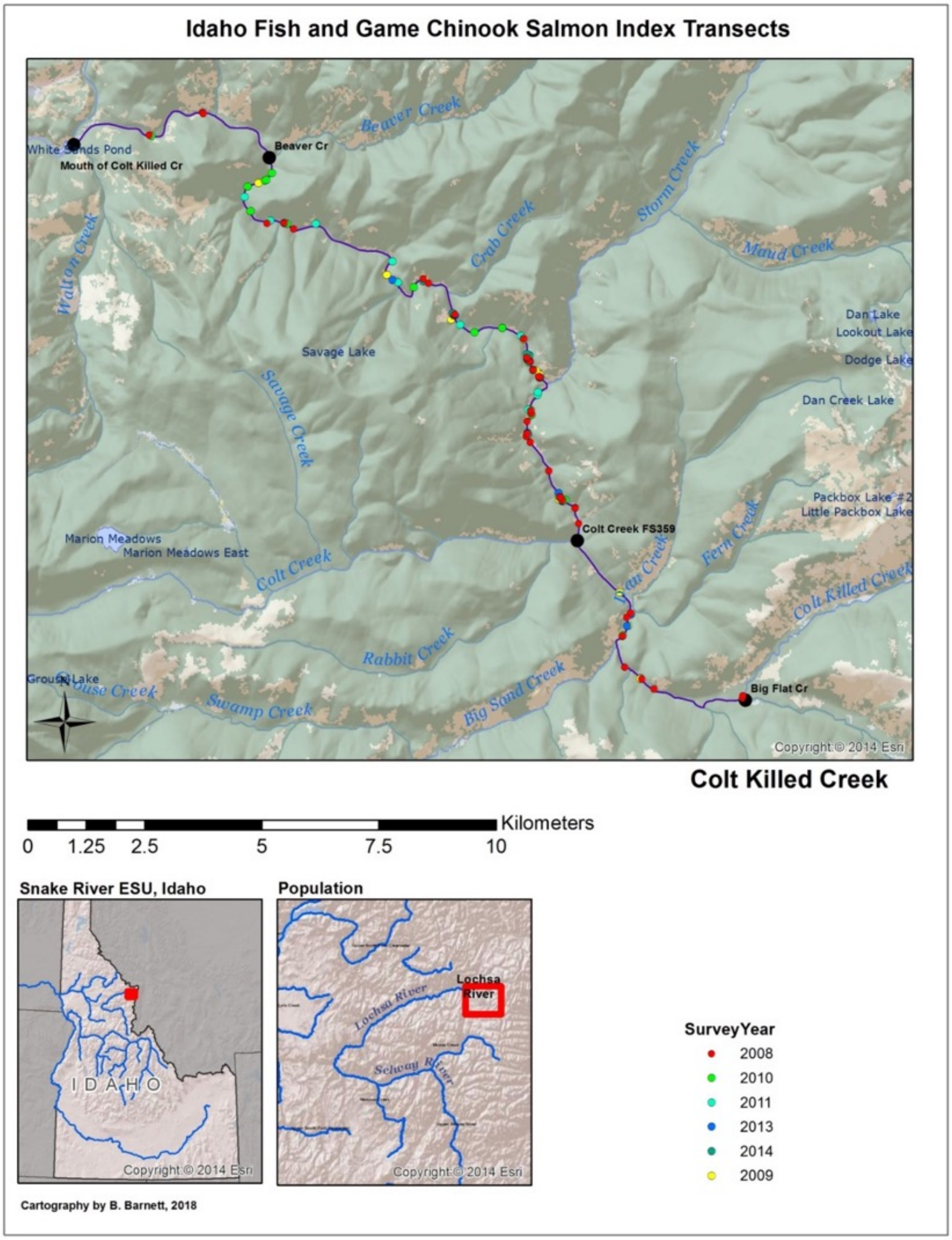


Appendix Figure C-4. Locations of redds (green circles) in East Fork Moose Creek, Idaho, 2014-2016, 2018-2019. Surveys were not conducted in 2017, and abbreviated in 2015-2016 due to wildfire. Previous survey transect (WC-3b) shown in the top panel, highlighted in purple. Recommended transect boundaries shown in bottom panel, highlighted in blue.

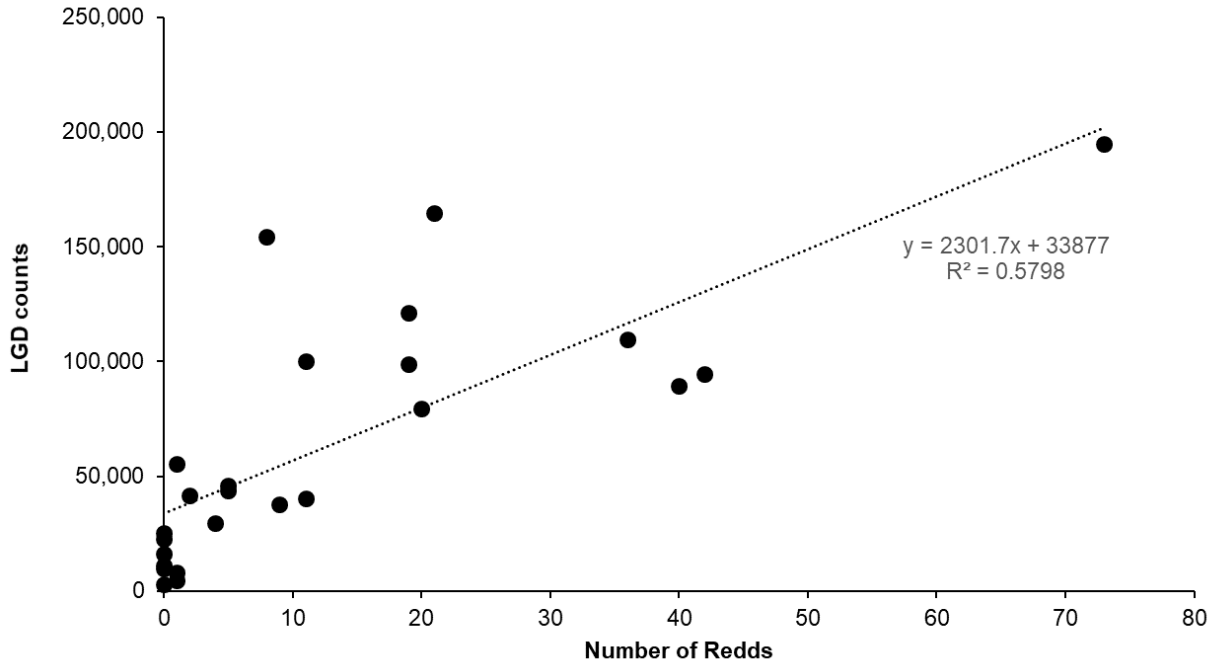


Appendix Figure C-5. Intrinsic Habitat Potential map of White Sand Creek (Colt Killed Creek), Idaho.

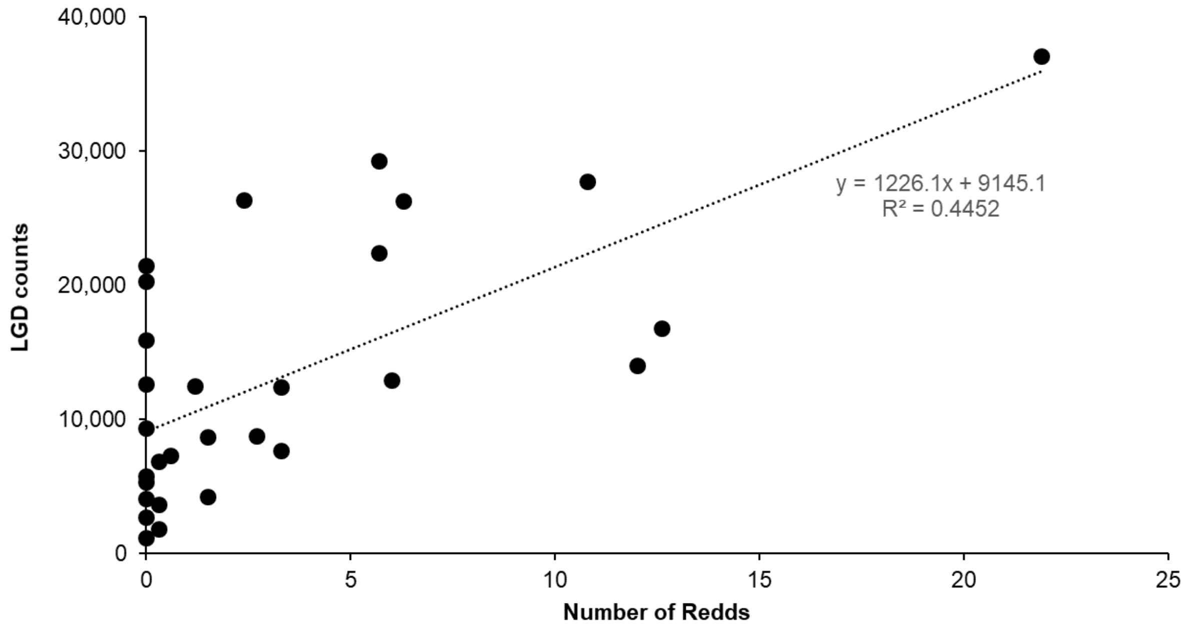
Appendix Figure C-6. Photos of typical substrate present in transect NC-13 in Colt Killed Creek, Idaho.



Appendix Figure C-7. Locations of spring Chinook redds in Colt Killed Creek, Idaho, from 2008 - 2014.



Appendix Figure C-8. Comparison of all Chinook Salmon redds observed in Colt Killed Creek vs. adult Chinook Salmon window counts at Lower Granite Dam (LGD), 1990 - 2018.



Appendix Figure C-9. Comparison of the estimated number of natural Chinook Salmon redds in Colt Killed Creek vs. the estimated number of wild/natural adult Chinook Salmon at Lower Granite Dam (LGD), 1990 - 2018. Wild/natural redds were estimated by taking all redds observed and correcting for the average 0.68 hatchery fraction of carcasses observed in the transect.

Prepared by:

Eli A. Felts
Fisheries Biologist

Bruce Barnett
Fisheries Data Coordinator

Micah Davison
Supervisory Fisheries Biologist

Katherine M. Lawry
Fisheries Biologist

Conor McClure
Fisheries Biologist

Joshua R. Poole
Fisheries Biologist

Robert Hand
Fisheries Biologist

Mike Peterson
Fisheries Biologist

Evan Brown
Sr. Fisheries Data Coordinator

Approved by:

IDAHO DEPARTMENT OF FISH AND GAME

____
J. Lance Hebdon
Anadromous Fisheries Manager

____
James P. Fredericks, Chief
Bureau of Fisheries