FISHERY RESEARCH

IDAHO ADULT CHINOOK SALMON MONITORING

2015 ANNUAL REPORT

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Idaho Adult Chinook Salmon Monitoring

2015 Annual Report

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ABBREVIATIONS AND ACRONYMS

ASMS	Anadromous Salmonid Monitoring Strategy
BPA	Bonneville Power Administration
BY	Brood Year
CV	Coefficient of Variation
CWT	Coded Wire Tag
DJ	Dingell-Johnson Sport Fish Restoration Program
ESA	Endangered Species Act
ESU	Evolutionarily Significant Unit
FINS	Fish Inventory System Hatchery Database
GSI	Genetic Stock Identification
ICBTRT	Interior Columbia Basin Technical Recovery Team
IFWIS	Idaho Fish and Wildlife Information System
IDFG	Idaho Department of Fish and Game
IPC	Idaho Power Company
LSRCP	Lower Snake River Compensation Program
MPG	Major Population Group
NMFS	U.S. Department of Commerce, National Marine Fisheries Service
NPCC	Northwest Power and Conservation Council
PA	Percent Agreement
PIT	Passive Integrated Transponder
PCSRF	Pacific Coast Salmon Recovery Funds
PSMFC	Pacific States Marine Fisheries Commission
SGS	Spawning Ground Survey
SGSA	Spawning Ground Survey Application
USFS	U.S. Forest Service
VSP	Viable Salmonid Population

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ABSTRACT

The Idaho Department of Fish and Game wild salmon and steelhead program monitors the status of wild Snake River spring-summer Chinook Salmon *Oncorhynchus tshawytscha* populations in the Salmon River and Clearwater River, Idaho. In this report we summarize adult Chinook Salmon monitoring information collected during 2015 including redd counts, carcass data, and weir samples. Surveyors observed 2,650 redds throughout Idaho's historic, single-pass index transects. Of the 2,400 redds counted in the Salmon River transects, 680 were in the South Fork Salmon River major population group (MPG), 825 were in the Middle Fork Salmon River MPG, and 895 were in the Upper Salmon River MPG. Of the 250 redds counted in the Clearwater River transects, 170 were in the Dry Clearwater River MPG and 80 were in the Wet Clearwater River MPG. Index redd count trends in these MPGs have generally been flat over the last five years, and all 2015 counts were down compared to 2014. Surveyors also used a multiple-pass census survey to count 272 redds in Marsh Creek, 315 redds in the Lemhi River, and 342 redds downstream of the Sawtooth Hatchery weir to Redfish Lake Creek. Miscellaneous additional redd surveys were used to assess spawner abundance, spatial distribution, and spawn timing at several locations. For example, we report the third year of Chamberlain Basin additional redd surveys that were conducted in areas outside the standard index transects. From carcass surveys, the fraction of hatchery carcasses ranged from 1% in the non-supplemented Middle Fork Salmon River MPG to 88% in the highly-supplemented Dry Clearwater River MPG. Wild carcass sex ratios were 46% female in the Salmon River subbasin and 48% female in the Clearwater River subbasin. We aged 1,260 carcasses using dorsal fin rays. Age-4 (brood year 2011 or 2-saltwater) adults were the dominant age class in all MPGs and populations. The percentage that were age-4 was 74% in the South Fork Salmon River MPG (n = 257); 77% in the Middle Fork Salmon River MPG (n = 279); 79% in the Upper Salmon River MPG (n = 524); 57% in the Dry Clearwater River MPG (n = 28); 80% in the Wet Clearwater River MPG (n = 25); and 82% from wild fish used for various integrated hatchery programs combined (n = 147). A single age-length key was constructed for Marsh Creek and Bear Valley Creek populations to derive their final age composition. In Marsh Creek, 1% of carcasses were age-3, 67% were age-4, and 32% were age-5. In Bear Valley Creek, 0% of carcasses were age-3, 72% were age-4, and 28% were age-5. Estimating ages of spawning Chinook Salmon using fin rays continues to be the preferred method for population-specific age composition. Percent agreement between reader-determined age and known age was 97.0%; mean coefficient of variation was 0.6% (n = 133). Finally, an accounting of genetics samples collected from wild Chinook Salmon released at adult weirs and traps operated by Idaho Department of Fish and Game is presented.

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INTRODUCTION

Populations of Chinook Salmon *Oncorhynchus tshawytscha* in the Snake River basin declined substantially following the construction of hydroelectric dams in the Snake and Columbia rivers. Raymond (1988) documented a decrease in survival of Chinook Salmon from the Snake River following the construction of dams on the lower Snake River during the late 1960s and early 1970s. Abundance rebounded slightly in the early 1980s, but then escapements over Lower Granite Dam into the Snake River basin declined again (Busby et al. 1996). In recent years, abundance in the Snake River basin has slightly increased; however, the returns of naturally produced (hereafter wild) Chinook Salmon remain critically low compared to historic levels. As a result, Snake River spring-summer Chinook Salmon were classified as threatened in 1992 under the Endangered Species Act (ESA). In 2004, the Interior Columbia Basin Technical Recovery Team (ICBTRT) was formed by the National Marine Fisheries Service (NMFS) to define independent populations within the evolutionary significant unit (ESU) and to develop viability criteria for each population. The ICBTRT defined a hierarchical structure for Snake River spring-summer Chinook Salmon. From spatially largest to smallest they include the ESU, the major population group (MPG), and the population. Within the Snake River spring-summer Chinook Salmon ESU there are seven MPGs in areas currently accessible to salmon, five of which are in Idaho (Figure 1; ICBTRT 2003, 2005; Ford et al. 2011; NMFS 2011, 2016). The Dry Clearwater River and Wet Clearwater River MPGs are considered to have been extirpated but have been mostly refounded with stocks from other Snake River MPGs. A total of 28 extant populations have been identified in the ESU.

A primary goal of Idaho Department of Fish and Game's (IDFG) wild salmon and steelhead monitoring program is to provide information on the status of Idaho's wild Snake River spring-summer Chinook Salmon (hereafter Chinook Salmon) with respect to viable salmonid population (VSP) criteria. The key metrics used to evaluate viability of salmonid populations are abundance, productivity, spatial structure, and diversity (McElhany et al. 2000). This report focuses on the adult life-history stage of these viability metrics with respect to wild Chinook Salmon. We define "wild" fish as those fish whose parents – both parents – spawned naturally in the wild. This is in contrast to "wild" versus "natural" designations traditionally used by IDFG to distinguish lineage or history of hatchery stocking (e.g., Hassemer 1993a).

In Idaho it is difficult to census all wild adult Chinook Salmon returning to each population to spawn due to the large geographic area encompassed, the difficulty accessing remote wilderness areas, and funding constraints. In the 1950s IDFG developed a program to index annual spawning escapement by enumerating Chinook Salmon redds in select areas at time of peak spawning. The intent was to monitor population trends over time. Hence, the core transects that were and are surveyed annually are referred to as index transects. Although sporadic surveys were made as early as 1947, consistent index surveys date back to 1957. The complete time series for these index survey data, 1957-2015, will be presented in a future report. This report summarizes the 2015 index surveys by both MPG and population and presents five-year trends by MPG.

The total area and number of streams surveyed using these index transects represent a large portion of the wild Chinook Salmon spawning habitat in Idaho (Pirtle 1956; Hassemer 1993a). The use of index surveys of spawner abundance continues to be the most efficient, albeit least precise, method to monitor the status and trends of Chinook Salmon populations across the landscape (ASMS 2010; Gallagher et al. 2010). Recent efforts have been undertaken to expand the index survey data to actual spawner abundance for the 2015 ESA status assessment (NMFS 2016; IDFG et al., in preparation). These derived spawner

abundance data can be obtained at the Idaho Fish and Wildlife Information System website (https://fishandgame.idaho.gov/ifwis/portal/), the IDFG Follow Idaho Salmon Home website (http://216.206.157.62/idaho/web/apps/index_main.php), the NMFS Salmonid Population Summary website (https://data.noaa.gov/dataset/sps-abundance-salmon-population-summary-database), and the StreamNet website (http://www.streamnet.org/data/).

In addition to reporting index redd survey information for 2015, we also report four additional types of information that were collected by IDFG as part of monitoring wild adult Chinook Salmon in Idaho. First, census redd surveys are conducted in intensively-monitored populations where complete spawner abundance data are not obtainable through infrastructure such as fish weirs or PIT-tag arrays. The census surveys provide in whole or in part the high precision fish-in information needed for VSP life-cycle monitoring (at least one population per MPG) and habitat effectiveness monitoring (ASMS 2010). The intensively-monitored populations identified in Idaho (and, in parentheses, the high precision fish-in methodology used to enumerate or estimate adult Chinook Salmon population spawner abundance followed by the responsible agency or tribe) include: 1) South Fork Salmon River Mainstem (combination of census redd surveys and PIT-tag arrays by Nez Perce Tribe; McCall Hatchery weir by IDFG); 2) Secesh River (combination of census redd surveys, Didson sonar weir, and PIT-tag array by Nez Perce Tribe); 3) East Fork South Fork Salmon River (combination of census redd surveys, weir, and PIT-tag array by Nez Perce Tribe); 4) Big Creek (PIT-tag array by IDFG); 5) Bear Valley Creek (combination of census redd surveys and video weir by Shoshone-Bannock Tribes); 6) Marsh Creek (census redd surveys by IDFG); 7) Lemhi River (combination of census redd surveys and PIT-tag arrays by IDFG); 8) Pahsimeroi River (Pahsimeroi Hatchery weir by IDFG); 9) Salmon River Upper Mainstem Above Redfish Lake (combination of census redd surveys downstream of the Sawtooth Hatchery weir and the Sawtooth Hatchery weir by IDFG); and 9) Lolo Creek (combination of census redd surveys, weir, and PIT-tag array by Nez Perce Tribe). Chamberlain Creek was dropped from the initial ASMS candidate list. This report will summarize census redd surveys conducted by IDFG in Marsh Creek, Lemhi River, and downstream of the Sawtooth Hatchery weir to Redfish Lake Creek.

Second, additional redd surveys are conducted in various streams for a variety of reasons such as assessing relative spawner abundance, assessing spatial distribution of spawners, or assessing spawn timing. For example, in the Appendix we report the third year of Chamberlain Basin additional redd surveys that were conducted in areas outside the standard index transects. These additional surveys will inform future Chamberlain Creek population spawner abundance estimates that rely on the traditional index surveys.

Third, carcass surveys are generally conducted in tandem with, or in addition to, redd surveys to provide spawning biological assessment information such as origin (wild or hatchery), age composition, length at age, and sex ratio. We combine our data with Nez Perce Tribe and Shoshone-Bannock Tribes data, where acknowledged, to provide a truly comprehensive Idaho summary of this type of information. We do not report genetics results but note that carcass fin tissue samples are archived by IDFG for future reference.

Finally, fish weirs and traps are used by IDFG to capture, enumerate, and manage adult Chinook Salmon returning to several Idaho streams (Figure 2). Many weirs are integral to the high precision life-cycle monitoring as described above, as are screw traps and other monitoring infrastructure such as PIT-tag arrays (ASMS 2010). Most weirs and traps are operated by IDFG hatchery personnel who typically collect hatchery fish for broodstock and release wild or integrated hatchery fish at the weir to spawn naturally. Some additional weirs are operated by IDFG personnel for research or monitoring purposes, but none were specifically operated for

Chinook Salmon in 2015. We refer the reader to IDFG hatchery reports and to the Fish Inventory System Hatchery Database (FINS; http://www.finsnet.org/) to obtain adult Chinook Salmon return and disposition information relative to IDFG hatchery weirs and traps. Wild fish returning to weirs and traps are not able to be aged accurately using scales (Copeland et al. 2007), and fin rays are not collected from live fish that are released. We do not report genetics results but we do summarize the fin tissue samples that were collected by IDFG hatchery personnel and archived for future genetic reference.

METHODS

Redd Surveys

Spawning Ground Survey Training

To maintain consistency among cooperators and crews, all personnel responsible for surveying redds and sampling Chinook Salmon carcasses attended an annual joint spawning ground survey training at the beginning of spawning season. Surveyors were trained in the identification of redds, use of global positioning systems, recording thorough data, and techniques for proper collection of biological information and samples from carcasses. In 2015 IDFG hosted the statewide spawning ground survey workshop in Stanley, Idaho, to provide standardized training for all State, Federal, and Tribal co-managers conducting redd counts and carcass surveys in Idaho.

Index Surveys

Methods used for Chinook Salmon index redd surveys during 2015 were the same as recent years. Standardized redd count protocols are described in Hassemer (1993b), and all surveys were conducted in August and September. Single-pass, peak-count surveys were made in each index transect. Each survey was originally timed to coincide with the period of maximum spawning activity on a particular stream, based on historic observations, and assigned a target survey-time window. The method chosen for each survey was dependent upon a) the best visual technique for each transect, and b) the ability to maximize the number of river miles surveyed. Methods included low-flying helicopter or single-pass ground surveys conducted on foot. Methods have varied within some transects over the years. Currently no redd count index transects are identified for the following populations: Little Salmon River, Middle Fork Salmon River Above and Including Indian Creek, Potlatch River, Lapwai Creek, Lawyer Creek, or Meadow Creek.

Census Surveys

Streams in some intensively-monitored populations, or in portions of intensively-monitored populations like downstream of the Sawtooth Hatchery weir, are typically surveyed three or more times to provide a census of all redds. Objectives of intensively-monitored populations and their associated high precision life-cycle monitoring are described in the Anadromous Salmonid Monitoring Strategy (ASMS 2010). Standardized redd count protocols are described in Hassemer (1993b). In contrast to the index surveys, timing of these census surveys is population-specific and designed to begin and end with spawning activity. Census surveys are designed to be intensive, and they use multiple-pass ground counts that generally include all probable spawning habitat. Heavily used spawning reaches also benefit from multi-

pass census surveys to accurately count redds in areas that are subject to redd superimposition.

Multiple-pass ground counts allow observation either during redd construction or shortly thereafter and aid in redd identification. Redds observed during ground counts are flagged, assigned a unique number, and waypoints recorded using a global positioning system; flags are removed during the last count. Surveyors also record the presence of any live adult fish observed to help ascertain if spawning is complete. For streams that are counted multiple times on the ground, the final redd count is the sum of all new redds observed during each pass. Multiple-pass counts also increase the number of adult Chinook Salmon carcasses recovered over what would have been collected in a single-pass design.

Additional Surveys

Additional redd surveys are conducted in various streams. In general, all additional redd surveys follow standardized redd count protocols described in Hassemer (1993b). However, specific methods used in Chamberlain Basin during 2015 are described in detail in the Appendix.

Carcass Surveys

Chinook Salmon carcasses were sampled from spawning areas throughout the Idaho portion of the study area consistent with methods in Copeland et al. (2004). The 2015 carcass survey locations were chosen to include: 1) all redd count index transects that were surveyed from the ground; 2) index transects or portions of transects that were aerially surveyed and required revisiting from the ground to collect carcasses; 3) index transects or portions of transects that were surveyed from the ground but additional carcass data from revisits was desired; 4) areas outside index transects where additional carcass data was desired; or 5) hatchery weirs located in the Pahsimeroi River, the upper Salmon River (Sawtooth Hatchery), South Fork Salmon River (McCall Hatchery), and Johnson Creek where wild fish are collected and used for integrated broodstock programs.

For each carcass encountered during the surveys, we recorded its location, origin (wild or hatchery), any marks or tags, length, sex, and whether the fish succumbed to prespawn mortality. All carcasses were measured for length (fork and middle of eye-to-hypural). Lengths were measured using a tape measure. If any carcasses, male or female, were found washed up on weirs or during early surveys before the construction of any redds, they were considered prespawn mortalities if their gonads were fully intact. After the construction of redds had begun only females with fully intact skeins were considered prespawn mortalities as it could not be determined if males had spawned or not. Visceral cavities were inspected to determine sex and whether the fish succumbed to prespawn mortality, both of which are used to calculate females per redd and associated productivity metrics. During examination, female carcasses were given a percent spawned value that ranged from zero (skeins fully intact) to 100% (no or few eggs remaining) in 25% increments.

We used marks and tags to identify origin for all carcasses encountered. Two types of hatchery Chinook Salmon broodstock are present: segregated and integrated. Smolts from both types of stocks are marked to distinguish them from each other and from natural-origin fish. All segregated fish are marked with an adipose fin clip; a subset is additionally marked with an internal coded wire tag (CWT) or an internal passive integrated transponder (PIT) tag. Integrated fish are all marked with a CWT only with the adipose fin left intact and some have a

PIT-tag inserted. Hence, hatchery origin carcasses were determined by the visual presence of any external mark, such as an adipose fin clip, or by scanning for the presence of an internal CWT tag. Since PIT tags are not immediately diagnostic of hatchery origin, because some wild fish are also PIT tagged, all adipose fin intact PIT-tagged carcasses not otherwise marked or tagged were assumed wild in the field for data recording and sample collection purposes.

For carcasses encountered during the surveys, dorsal fin ray samples for age analysis and tissue samples for genetic analysis were collected from a designated target number of carcasses per survey location. If a carcass was extremely decomposed or missing its dorsal fin, fin rays or tissue samples may not have been collected. Four to five fin rays from each fish were removed, placed in a coin envelope, and dried. A tissue sample was 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 located in Nampa, Idaho. Tissue samples are also archived in Nampa for future processing by the IDFG Eagle Fish Genetics Laboratory located in Eagle, Idaho. In support of Russ Thurow, our USFS cooperator (BPA project 1999-020-00, Analyze Persistence and Dynamics in Chinook Redds), otoliths were collected in Middle Fork Salmon River tributaries and delivered to the Rocky Mountain Research Station laboratory in Boise, Idaho, for future ageing.

Fin ray sample size goals for 2015 varied by population size with a maximum of n = 150. The target for each population was determined using power analysis combined with a preseason forecast to predict abundance of wild spawners. The power analysis consisted of using a simulation program in R (R Development Core Team 2010) to evaluate accuracy and precision of age proportion estimates across varying sample sizes and spawner abundances. This unpublished analysis showed that the increase in accuracy and precision for age-3, age-4, and age-5 age proportions diminished when sample sizes exceeded 30% of total spawners. Further, there was little benefit to increasing fin ray sample sizes beyond n = 150 regardless of population size. Finally, accurate and precise estimates of age-6 proportions could not be achieved in any population with a reasonable amount of effort due to the extremely low incidence of this age class.

Carcass Age Composition

Laboratory Processing of Dorsal Fin Rays

Chinook Salmon are assigned ages based on dorsal fin ray samples. Fin rays were processed and assigned a saltwater age. Freshwater age was assumed to be one year for all fin rays. Summing saltwater age with freshwater age, plus 1, yields total age (hereafter age). Fin rays were dried, set in epoxy resin, cut into crosssections with a bone saw, and mounted on microscope slides. All samples were aged independently by two technicians. Personnel were trained with reference fin rays and were required to demonstrate 90% accuracy in an ageing test before they were allowed to begin ageing new samples. If there was disagreement in age determination or the age did not match what was expected for fish length, then fins were aged again in a referee session. A referee session requires that three personnel observe the fin together and arrive at a consensus age. In some cases, a consensus could not be achieved and the sample was removed from analysis.

Dorsal Fin Ray Age Validation

For age validation purposes, we rely on fish of known age from two sources. Hatchery personnel collect dorsal fin rays from tagged hatchery adults returning to Rapid River, McCall,

Pahsimeroi, Sawtooth, and Clearwater hatchery facilities. Hatchery fish PIT tags and CWTs are recorded during spawning operations and provide a known-age mark for total age validation (Campana 2001). PIT tags encountered on the spawning grounds from wild fish could also be used but they provide only saltwater age validation and not total age validation. For simplification, only known total age samples are presented in this report.

Metrics used to assess accuracy of our age assignments were percent agreement and percent bias expressed as mean coefficient of variation; both assess accuracy because assigned age is compared to known age. Percent agreement (PA) is calculated as the percentage of assigned ages that agreed with the known age based on tag information. The following equation was used:

$$PA = 100 \times \frac{A}{N}$$

where *A* is the number of correctly assigned ages and *N* is the total number of fish aged. A PA that is ≥90% is desired to prevent bias (Buckmeier 2002). An age bias plot was constructed to illustrate pairwise comparisons between assigned fin ray age and known age based on tags.

The coefficient of variation (CV; Chang 1982, Campana 2001) is the ratio of the standard deviation to the mean when two readers assign ages to each fish, or when an assigned age is compared to the validated age. These values are then averaged over the samples to obtain the mean coefficient of variation. The following equation was used:

$$CV_j = 100 \times \frac{\sqrt{\sum_{i=1}^{R} \frac{(X_{ij} - X_j)^2}{R-1}}}{X_j}$$

where CV_j is the ageing precision estimate for the *j*th fish, X_{ij} is assigned age, X_j is the validated known age, and R is the number of times each fish was aged. Using the assigned age and known age in this CV formula gives an estimate of percent bias (Copeland et al. 2007). A CV that is ≤10% is desired.

An age bias plot was used to graphically compare known age to reader assigned age. A bias is apparent if the paired estimations (95% confidence intervals) depart from the 1:1 line.

Genetics Samples at Weirs and Traps

All adult Chinook Salmon captured at IDFG weirs or traps had the following data recorded: origin (wild or hatchery), any marks or tags, fork length, and sex. We refer the reader to IDFG hatchery reports and to the Fish Inventory System Hatchery Database (FINS; http://www.finsnet.org/) to obtain more specific information. Tissue samples for genetics analysis were collected from all wild and integrated hatchery 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.

Survey Data and Biological Data Management

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 devices. Waypoints are captured for new redds, carcasses, and survey boundaries using

standardized naming conventions. IDFG and the Shoshone-Bannock Tribes enter survey data into a local Microsoft Access Spawning Ground Survey application (SGSA), and the global positioning systems 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 and USFS transfer their index redd survey data to IDFG biologists who then enter it into their 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.

Index transects are assigned their transect code (WS-1, NS-1, etc.) based upon the criteria described in Hassemer 1993a (location, timing, redds, live fish, and carcasses). Index count assignments are reviewed by the biologists who compiled the survey data. The data from all compilers are accessible in read only views from the Idaho Fish and Wildlife Information System (IFWIS) web reports (https://fishandgame.idaho.gov/ifwis/portal/).

Carcass sample data such as fin ray, genetics, 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 BioSamples database to assist in joining the two databases.

Carcasses 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 Estimated Total Age field in the SGS database.

For this report, all index and census redd survey data were downloaded from the SGS database on 4/27/16; data were downloaded on 5/13/16 for the additional redd surveys. Carcass survey data were downloaded from the SGS database on 4/27/16. Fin ray ageing data were downloaded from the BioSamples database on 4/20/16. Length-at-age data were downloaded from the BioSamples database on 4/18/16. Adult weir and trap data are stored in and accessed from the Fish Inventory System Hatchery Database (FINS; http://www.finsnet.org/). These data include all adult Chinook Salmon that are trapped, spawned, or released to spawn naturally. Weir and trap genetics sample data were downloaded from the IDFG Eagle Fish Genetics Laboratory Progeny database on 7/21/16 (Jesse McCane, IDFG, personal communication).

Summaries of some of the data collected in this report are available at the IDFG Follow Idaho Salmon Home website (http://216.206.157.62/idaho/web/apps/index_main.php).

RESULTS

Redd Surveys

Index Surveys

Staff from IDFG and cooperating agencies surveyed 93 of the 100 current index transects and observed 2,650 Chinook Salmon index redds in 2015 (Table 1). The Colt Killed Creek (Lochsa River) transect (NC-13) and one of the Moose Creek (Selway River) transects (WC-3a) were not surveyed due to fire. The Newsome Creek (South Fork Clearwater River) transect (NC-8), the other Moose Creek transect (WC-3b), and one of the mainstem Selway River transects (WC-5) were partially surveyed. Six index transects in the Upper Selway River population are no longer surveyed due to discontinued helicopter use (White Cap Creek, WC-1; Running Creek, WC-4a and WC-4b; and mainstem Selway River, WC-6, WC-8, and WC-9).

A total of 2,400 redds were observed in Salmon River subbasin index transects (Table 1). Of these, 680 redds were counted in the South Fork Salmon MPG with most, or 370 redds, in the South Fork Salmon River Mainstem population. The Middle Fork Salmon River MPG had 825 redds with most, or 314 redds, in the Bear Valley Creek population. There were 895 redds in the Upper Salmon River MPG with most, or 270 redds, in the Salmon River Upper Mainstem Above Redfish Lake population.

A total of 250 redds were observed in Clearwater River subbasin index transects (Table 1). Of these, 170 redds were counted in the Dry Clearwater River MPG and 80 redds in the Wet Clearwater River MPG. All of the Dry Clearwater River MPG redds counted were in the Upper South Fork Clearwater River population.

Index redd counts in all Idaho MPGs have generally trended flat over the last five years but with large year-to-year swings in the Salmon River subbasin that were sometimes over 100% (Figure 3). Counts in all MPGs were down in 2015 compared to 2014.

Census Surveys

For the 2015 census surveys, multiple-pass ground counts were conducted in the Marsh Creek and Lemhi River populations and in that portion of the Salmon River Upper Mainstem Above Redfish Lake population downstream of the Sawtooth Hatchery weir (Table 2). The Marsh Creek population spawned from the last week of July to the first week of September and constructed 272 redds; timing peaked in the third week of August. The Lemhi River population was surveyed from the Lemhi Store to the headwaters and produced 315 redds; an additional 11 redds were produced downstream of the store and were counted during the aerial index surveys. Hayden Creek spawn timing was from the second week of August to the first week of September whereas the rest of the Lemhi population spawned one to two weeks later. The Salmon River Upper Mainstem Above Redfish Lake population was surveyed from the Sawtooth Hatchery weir downstream to Redfish Lake Creek; 342 redds were counted between August 20 and September 18 with the peak in the first week of September.

Additional Surveys

For the 2015 additional redd surveys, ground counts were conducted in the South Fork Salmon River Mainstem, Chamberlain Creek, Panther Creek, Pahsimeroi River, East Fork Salmon River, Upper South Fork Clearwater River, Moose Creek, and Upper Selway River

populations (Table 3). Chamberlain Creek is summarized separately but 65 redds were counted outside the index transects (Appendix). A total of 186 redds were counted in the Pahsimeroi River population including 14 from a transect (PBSC1 to PBSC3 on Patterson Creek) that was flown on September 24 due to lack of property access (Table 3). Eighty-two of 186 redds counted in the population were in Patterson Creek; spawn timing ranged from the first week of September to the last week of September. In the East Fork Salmon River population, 270 redds were counted in the mainstem upstream of Herd Creek and 70 redds were counted from the mainstem mouth up to and including Herd Creek.

Carcass Surveys

During 2015, staff from IDFG and cooperating agencies and tribes sampled 3,153 Chinook Salmon carcasses in 23 populations (Table 4). Of these, 205 carcasses or 7% were of unknown origin. Of the remaining 2,948 carcasses where origin could be determined, 1,721 carcasses or 58% were wild. In the Salmon River subbasin 1,602 carcasses or 68% were wild, whereas in the Clearwater River subbasin 119 carcasses or 20% were wild.

In the Salmon River subbasin, 46% of 1,533 wild carcasses where gender could be determined were female, whereas 37% of 747 hatchery carcasses were female (Table 4). In the Clearwater River subbasin, 48% of 118 wild carcasses where gender could be determined were female, whereas 51% of 450 hatchery carcasses were female.

In the South Fork Salmon River populations, the percentage of hatchery carcasses observed, or hatchery fraction, ranged from 4% in the Secesh River (n = 173) to 76% in the South Fork Salmon River Mainstem downstream of the McCall Hatchery weir (n = 161; Table 4). The hatchery fraction upstream of the weir was 50% (n = 149), but note that hatchery adults are deliberately released upstream of this weir to achieve IDFG integrated hatchery program goals. The hatchery fraction in the East Fork South Fork Salmon River was 48% (n = 23), but note that hatchery smolts and adults are deliberately released to achieve the Nez Perce Tribe Johnson Creek supplementation program goals.

In the Middle Fork Salmon River populations – generally considered the gold standard for Columbia Basin wild spring-summer Chinook Salmon production – hatchery fraction was less than or equal to 5% over all populations surveyed (Table 4). Hatchery fraction was 3% in Chamberlain Creek (n = 36); 0% in Big Creek (n = 9); 0% in Camas Creek (n = 27); 5% in Loon Creek (n = 19); 1% in Sulphur Creek (n = 85); 1% in Bear Valley Creek (n = 145); and 1% in Marsh Creek (n = 217).

In the Upper Salmon River populations, hatchery fraction was 0% in four populations – Panther Creek (n = 94), North Fork Salmon River (n = 28), Lemhi River (n = 140), and sparsely sampled Valley Creek (n = 7; Table 4). Similarly, hatchery fraction in the East Fork Salmon River population was 1% (n = 113). Hatchery fraction was highest at 62% in that part of the Salmon River Upper Mainstem Above Redfish Lake population downstream of the Sawtooth Hatchery weir (n = 707). Next highest was upstream of the weir at 56% (n = 135), but note that hatchery adults are deliberately released upstream of this weir to achieve IDFG integrated hatchery program goals. In the Pahsimeroi River population, hatchery fraction was 38% upstream of the Pahsimeroi Hatchery weir (n = 60) and 33% downstream of the weir where sampling was sparse (n = 3), but note that hatchery adults are deliberately released upstream of this weir to achieve IDFG integrated hatchery program goals. Hatchery fraction was 33% in the sparsely sampled Salmon River Lower Mainstem Below Redfish Lake population (n = 3). In the

Yankee Fork Salmon River population, where the Shoshone-Bannock Tribes operate a hatchery supplementation program, hatchery fraction was 11% (n = 28).

In the Dry Clearwater River populations, hatchery fraction was 88% in the Upper South Fork Clearwater River (n = 478; Table 4). In the Wet Clearwater River populations, hatchery fraction was 60% in the Lochsa River (n = 45), 54% in Lolo Creek (n = 26), and 11% in the Upper Selway River (n = 37).

Carcass Age Composition

Dorsal fin ray samples were collected from 1,297 wild carcasses from the spawning grounds and 158 wild carcasses that were used for integrated hatchery broodstock programs for a total of 1,455 samples (Table 5). Ages were assigned to 1,260 of these samples or 87%.

Age-4 (brood year 2011 or 2-saltwater) adults were the dominant age class in all MPGs and populations (Table 5). In the Salmon River subbasin, 74% were age-4 in the South Fork Salmon River MPG (n = 257), 77% in the Middle Fork Salmon River MPG (n = 279), and 79% in the Upper Salmon River MPG (n = 524). In the Clearwater River subbasin, the percentage was 57% in the Dry Clearwater River MPG (n = 28) and 80% in the Wet Clearwater River MPG (n = 25). For various integrated hatchery programs including Pahsimeroi, Sawtooth, McCall, and Johnson Creek, the overall percentage was 82% (n = 147). Of the assigned ages in the Salmon River subbasin, 5% were brood year (BY) 2012, 78% were BY 2011, and 17% were BY 2010. In the Clearwater River subbasin, 5% were BY 2012, 79% were BY 2011, and 16% were BY 2010. Note that our South Fork Salmon River MPG ageing data will be used by the Nez Perce Tribe to develop age-length keys to derive their final age composition.

We did not age any of the Bear Valley Creek samples because a single age-length key for Marsh Creek and Bear Valley Creek was used to derive their final age compositions. Auxiliary analysis showed that there was not a statistically significant difference between Marsh Creek and Bear Valley Creek age-length keys, in total or by year, over multiple years (Schrader et al. 2016). Hence, Marsh Creek age-length data were used to construct the 2015 age-length key. In Marsh Creek, 1% of carcasses were age-3, 67% were age-4, and 32% were age-5 (Table 6). In Bear Valley Creek, 0% of carcasses were age-3, 72% were age-4, and 28% were age-5 (Table 7).

Age-4 fish between 68 and 84 cm fork length dominated the relative length frequency distributions and comprised 68% of the spawning cohort (n = 1,110; Figure 4). There was substantial overlap between age-4 and age-5 in the 80 to 90 cm length categories, as well as some overlap between age-3 and age-4 fish between 60 and 70 cm. No fish were assigned an age-6. Mean length-at-age for age-3 fish ranged from 53.4 cm in the Middle Fork Salmon River MPG (n = 12) to 60.4 cm in the South Fork Salmon River MPG (n = 13), disregarding the Dry Clearwater River MPG due to small sample size (n = 1; Table 8). The means for age-4 fish were predominately 75-76 cm with the exception of the Wet Clearwater River MPG which was 72.2 cm (n = 19). The means of age-5 fish ranged from 88.0 cm in the Dry Clearwater River MPG (n = 11) to 91.7 cm in the Middle Fork Salmon River MPG (n = 51). The Middle Fork Salmon River MPG had the highest mean length-at-age for age-5 fish (91.7 cm, n = 51) and the lowest mean for age-3 fish (53.4 cm, n = 12).

Fin ray ages from 2015 are accurate (Figure 5). Of the 133 known-age fin rays, percent agreement between assigned age and known age was 97.0%, well within our desired goal of $\geq$90% (Buckmeier 2002). Our estimated mean coefficient of variation or percent bias was 0.6%,

well within our desired goal of ≤10%. Assigned age assumed that freshwater age was one year. Overall, there were 53 known-age samples from BY 2012, 69 samples from BY 2011, and 11 samples from BY 2010. There were no BY 2009 fish in the known-age samples or in the general collection of samples (Table 5).

Genetics Samples at Weirs and Traps

A total of 1,865 tissue samples were collected from wild and integrated hatchery adult Chinook Salmon released at IDFG hatchery weirs, hatchery traps, and research weirs during 2015 (Figure 6). Most samples (n = 696) 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 2015 and no samples were collected. Chinook Salmon are incidental catch at the Fish Creek research weir, which is operated for steelhead *O. mykiss*.

DISCUSSION

For monitoring wild Chinook Salmon abundance, redd surveys cover a large proportion of each population's available spawning habitat in Idaho. In contrast to the redd surveys, the spatial distribution of carcass surveys could be improved to include more populations. Increased effort or spatially balanced sampling would benefit the analysis and interpretation of the biological data used to monitor these wild populations. However, the importance and utility of maintaining the long-term redd index survey dataset is a higher priority than restructuring our current carcass survey design. Because most spring-summer Chinook Salmon spawn during such a narrow time period, we have very little flexibility in altering our carcass survey design.

Spring-summer Chinook Salmon index redd counts in all Idaho MPGs have generally trended flat over the last five years but with large year-to-year swings in the Salmon River subbasin that were sometimes over 100% (Figure 3). Counts in all MPGs were down in 2015 compared to 2014. Despite the generally flat five-year trend, the estimated abundance of wild adult spawners in Idaho has been extremely low compared to historical estimates, and no population currently meets viability criteria; hence all populations continue to be listed under the ESA as threatened (Ford et al. 2011; NMFS 2016). Negative trends in spatial distribution have also resulted from declining trends in abundance. Since adult spawner abundance is low compared to the vast area of spawning habitat that is available, the poor dispersion of spawning fish – a direct result of patchy and disjunct spatial structure over this habitat – is not unexpected.

Population diversity can be monitored using genetics, spawn timing, age distributions, fecundity, and sex ratios (Crawford and Rumsey 2011). Genetic diversity is estimated by the genotyping for genetic stock identification at Lower Granite Dam (BPA project #2010-026-00; see Ackerman et al. 2012, Table 2). For the shorter-term trends, however, little information is available on spawn timing and fecundity. Estimating spawn timing is not possible using single-pass redd surveys. However, multiple-pass surveys conducted in certain locations can estimate and track annual changes in spawn timing. Currently, fecundity is measured for wild fish spawned in the hatchery to create the integrated supplementation release groups. Population-specific sex ratios and age distributions are monitored on the spawning grounds annually.

Spawning ground survey data management and quality control of sample collections continue to be refined. In 2015, a fin ray removal training video was created to aid in training collection personnel virtually. In 2016, we will have new data cards for carcass collections limiting the duplication of data collection in the field. All data will continue to be collected on

standardized paper data sheets. A tablet application for use on the spawning grounds is being produced but is not expected to be ready until 2017.

Biological data from carcass surveys provide many population metrics including age composition, sex composition, length-at-age, and hatchery fraction. These metrics are essential to estimate population productivity and for ESU status assessments. Overlapping length-at-age between age-4 and age-5 fish show that ages based on length alone are not accurate. Ages provided by fin ray analysis continue to provide unbiased estimates (Figure 5). Tissue samples obtained from carcasses were archived for future use.

The process by which we identified Chinook Salmon fin ray sample size targets is specific to Idaho populations and is better suited than targets identified in previous publications. These targets for 2015 were n = 150 for larger populations or 30% of forecasted spawner abundance for smaller populations. Our collection targets fall between the 40 samples recommended by Gerritsen and McGrath (2007) and 500+ recommended by Thompson (1987). While these publications provided a one target solution, they do not take into account how population abundance influences the accuracy and precision estimating multinomial proportions. Population abundance is an important consideration as small populations represent a finite scenario and proportions can be accurately measured with a relatively small sample size. Conversely, large populations represent an infinite scenario that requires a larger sample size to accurately measure proportions. Given the spectrum of population sizes in Idaho, from Camas Creek population (small; less than 100 spawners) to South Fork Salmon River Mainstem population (large; over 900 spawners), we suggest our population-specific targets are more appropriate for the populations we monitor as they provide a level of accuracy and precision that guide management decisions and are logistically achievable. Several population fin ray sample target goals were not met in 2015. Additional research is needed to determine population specific fin ray sample sizes.

Fin ray processing is a time-intensive process and collecting only needed samples will allow for more efficient use of resources. A length-at-age comparison was completed between Marsh Creek and Bear Valley Creek to determine if an age-length key could be used in lieu of collecting samples at both locations (Schrader et al. 2016). We found that a fixed stratified sample of 100 fin rays collected in Marsh Creek can be used interchangeably for Bear Valley Creek, and vice versa, to build a generalized age-length key. Additional sampling in and analyses of other tributaries, e.g. Sulphur Creek, might reflect that age-length keys from major population groups could be used as surrogates for these smaller populations as well, further reducing fin ray sampling and processing time.

In general, the frequency of hatchery carcasses encountered on the spawning grounds varied among MPGs and populations. Ratio of wild and hatchery carcasses in this report should be indicative of the hatchery fraction for most Idaho populations. Most carcass surveys conducted by IDFG were within areas of controlled escapement such as wild production areas upstream of hatchery weirs, or areas designed to monitor supplementation. For some supplemented populations (e.g., South Fork Salmon River Mainstem) estimates of hatchery fraction may be biased high or low depending on the transect. For example, surveys immediately downstream from a hatchery weir will have a greater proportion of hatchery spawners due to fallout. For other populations with no history of hatchery supplementation (e.g., those in the Middle Fork Salmon River MPG), we assume this bias does not exist. Thus, frequencies of fish encountered by origin provide an accurate estimate of hatchery fraction on these spawning grounds.

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 (e.g., evaluate change and/or annual fluctuations in peak spawn timing).

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. Publish current protocols for redd surveys and carcass surveys to ensure standardized methods are used. This publication would be an update of Hassemer (1993b).

4. Evaluate the peak spawn timing and accuracy of the target survey dates for the index surveys in at least one population per year.

5. Further review fin ray sample size targets to determine how they influence productivity estimates, i.e. adult recruits per adult spawner.

6. Increase monitoring of wild adult spawners in the Clearwater River drainages to better understand those populations.

7. Update previously reported length-at-age (Copeland et al. 2004) analyses through current years.

8. A new transect area should be defined for Patterson Creek. Patterson Creek has been surveyed by air since the reconnect to the Pahsimeroi River in 2009, and one-half of all recently counted redds in the drainage have been in Patterson Creek. Further, the established Pahsimeroi River index transect (NS-33a) is currently surveyed around September 22 rather than historically around September 6; surveys conducted since 2010 are not directly comparable to the pre-2010 surveys.

9. Establish new index transects to be surveyed on the ground in the Upper Selway River population as several current transects are no longer or now partially surveyed due to discontinued helicopter use.

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TABLES

Table 1. Single-pass redd count index surveys that were conducted for spring-summer Chinook Salmon in Idaho during 2015. Surveys are organized by major population group (MPG).

Population	Transect name	Target survey date	Actual survey date[a]	Method[a]	Redds[a]
	South Fork Salmon River MPG				
Little Salmon River	n/t[b]	n/t	n/t	n/t	n/t
South Fork Salmon River Mainstem	NS-26	9/5	9/14	Ground	121
	NS-27[c]	9/5	9/1	Ground	145
	NS-28[c]	9/5	9/8	Ground	91
	NS-29	9/5	9/8	Ground	13
Subtotal					370
Secesh River	WS-16	8/25-9/1	8/26	Ground	30
	WS-17	8/25-9/1	8/26	Ground	20
	WS-18	8/25	8/27	Ground	18
	WS-19	8/25	8/31	Ground	32
	WS-20[d]	8/25	8/27	Ground	0
Subtotal					100
East Fork South Fork Salmon River	NS-30[d]	9/1-9/5	9/2	Ground	210
	NS-31[d]	9/1-9/5	9/17	Ground	0
Subtotal					210
Total MPG					680
	Middle Fork Salmon River MPG				
Chamberlain Creek	WS-1	8/25	8/26	Ground	12
	WS-1a	8/25	8/26	Ground	45
Subtotal					57
Middle Fork Salmon River Below Indian Creek	WS-15[e]	9/8	9/8-9/11	Aerial	2
Subtotal					2
Big Creek	WS-13	9/5	8/31	Ground	52
	WS-14a[d]	9/5	8/28	Ground	16
	WS-14b[e]	9/5	9/8-9/11	Aerial	23
	WS-14c[e]	9/5	9/8-9/11	Aerial	16
	WS-14d[e]	9/5	9/8-9/11	Aerial	1
Subtotal					108
Camas Creek	WS-8[e]	8/25-9/5	9/8-9/11	Aerial	26
Subtotal					26
Loon Creek	WS-6[e]	8/25-9/5	9/8-9/11	Aerial	6
	WS-7[e]	8/25-9/5	9/8-9/11	Aerial	32
Subtotal					38
Middle Fork Salmon River Above and Including Indian Creek	n/t[b]	n/t	n/t	n/t	n/t

Table 1. Continued.

Population	Transect name	Target survey date	Actual survey date[a]	Method[a]	Redds[a]
	Middle Fork Salmon River MPG, continued				
Sulphur Creek	OS-4	8/21	8/24	Ground	9
	WS-12	8/21	8/24	Ground	46
Subtotal					*55*
Bear Valley Creek	WS-9a[e]	8/27	8/26	Ground	0
	WS-9b[e]	8/27	8/26	Ground	5
	WS-9c	8/27	8/26	Ground	25
	WS-9d[e]	8/27	8/26	Ground	54
	WS-10a	8/27	8/26	Ground	86
	WS-10b	8/27	8/27	Ground	8
	WS-11a	8/27	8/25	Ground	65
	WS-11b	8/27	8/25	Ground	59
	WS-11c	8/27	8/25	Ground	12
Subtotal					314
Marsh Creek	WS-2a	8/15-8/20	8/22	Ground	1
	WS-2b	8/15-8/20	8/22	Ground	138
	WS-3	8/15-8/20	8/24	Ground	35
	WS-4	8/15-8/20	8/21	Ground	5
	WS-5	8/15-8/20	8/23	Ground	46
Subtotal					225
Total MPG					825
	Upper Salmon River MPG				
Panther Creek	NS-11a	9/8	9/5	Aerial	7
	NS-11b	9/8	9/5	Aerial	20
Subtotal					27
North Fork Salmon River	NS-25a	9/8	9/3	Ground	8
	NS-25b	9/8	9/2-9/3	Ground	45
	NS-25c	9/8	9/2-9/3	Ground	17
Subtotal					70
Lemhi River	NS-9	9/8	9/5	Aerial	93
	NS-10	9/8	9/5	Aerial	23
Subtotal					116
Salmon River Lower Mainstem Below Redfish Lake	NS-17	9/8	9/4	Aerial	13
	NS-18	9/8	9/4	Aerial	4
	NS-19	9/8	9/4	Aerial	3
	NS-20	9/8	9/4	Aerial	10
	NS-21	9/8	9/4	Aerial	0
	NS-22	9/8	9/4	Aerial	0
	NS-23	9/8	9/4	Aerial	0
	NS-24	9/8	9/4	Aerial	0
Subtotal					30

Table 1. Continued.

Population	Transect name	Target survey date	Actual survey date[a]	Method[a]	Redds[a]
	Upper Salmon River MPG, continued				
Pahsimeroi River	NS-33a	9/8	9/24	Aerial	86
Subtotal					86
East Fork Salmon River	NS-1a	9/8	9/4	Aerial	46
	NS-1b	9/8	9/4	Aerial	36
	NS-2a	9/8	9/4	Aerial	39
	NS-2b	9/8	9/4	Aerial	54
	NS-2c[f]	9/8	9/10-9/17	Ground	31
Subtotal					206
Yankee Fork Salmon River	NS-5[f]	9/8	8/20-9/2	Ground	2
	NS-6[f]	9/8	8/13-9/1	Ground	4
	NS-7[f]	9/8	8/19	Ground	2
	NS-8[f]	9/8	8/13-8/26	Ground	8
Subtotal					16
Valley Creek	NS-3a	9/8	9/4	Aerial	0
	NS-3b	9/8	9/4	Aerial	45
	NS-4	9/8	9/4	Aerial	29
Subtotal					74
Salmon River Upper Mainstem Above Redfish Lake	NS-12	8/31-9/5	9/4	Aerial	1
	NS-13a	9/8	9/4	Aerial	1
	NS-13b	9/8	9/4	Aerial	0
	NS-15a	9/8	9/4	Aerial	56
	NS-15b	9/8	9/4	Aerial	4
	NS-15c	9/8	9/4	Aerial	6
	NS-16	9/8	9/4	Aerial	201
	OS-1	8/31-9/5	9/5	Ground	0
	OS-2	8/31-9/5	9/5	Ground	1
	OS-3	8/31-9/5	9/5	Ground	0
	OS-5	9/8	9/4	Aerial	0
	OS-6	9/8	9/6	Ground	0
Subtotal					270
Total MPG					895
Grand Total Salmon River					2,400
	Dry Clearwater River MPG				
Potlatch River	n/t[b]	n/t	n/t	n/t	n/t
Lapwai Creek	n/t[b]	n/t	n/t	n/t	n/t
Lawyer Creek	n/t[b]	n/t	n/t	n/t	n/t

Table 1. Continued.

Population	Transect name	Target survey date	Actual survey date[a]	Method[a]	Redds[a]
	Dry Clearwater River MPG, continued				
Upper South Fork Clearwater River	NC-1	9/3	9/8-9/9	Ground	115
	NC-2a	9/3	9/10	Ground	11
	NC-2b	9/3	9/9	Ground	3
	NC-3	9/3	9/13	Ground	0
	NC-4	9/1-9/5	9/9	Ground	23
	NC-6	9/3	9/23	Ground	15
	NC-8[d,g]	9/3	9/8	Ground	3
Subtotal					170
Total MPG					170
	Wet Clearwater River MPG				
Lolo Creek	NC-14[d]	9/3	9/14	Ground	15
Subtotal					15
Lochsa River	NC-10	9/3	9/9	Ground	23
	NC-11	9/3	9/9	Ground	4
	NC-13[h]	9/3	n/c	n/c	n/c
Subtotal					27
Meadow Creek	n/t[b]	n/t	n/t	n/t	n/t
Moose Creek	WC-3a[h]	9/8	n/c	n/c	n/c
	WC-3b[g]	9/8	9/14	Ground	0
Subtotal					0
Upper Selway River	WC-1[i]	9/8	n/c	n/c	n/c
	WC-2	9/8	9/14-9/15	Ground	10
	WC-4a[i]	9/8	n/c	n/c	n/c
	WC-4b[i]	9/8	n/c	n/c	n/c
	WC-5[g]	9/8	9/3	Ground	3
	WC-6[i]	9/8	n/c	n/c	n/c
	WC-7	9/8	9/4	Ground	25
	WC-8[i]	9/8	n/c	n/c	n/c
	WC-9[i]	9/8	n/c	n/c	n/c
Subtotal					38
Total MPG					80
Grand Total Clearwater River					250

[a] Downloaded from the SGS database on 4/27/16.
[b] Index transects for trend monitoring have not been established (n/t = no transect).
[c] Surveyed by both Idaho Department of Fish and Game and Nez Perce Tribe; counts are combined.
[d] Surveyed by Nez Perce Tribe.
[e] Surveyed by U.S. Forest Service.
[f] Surveyed by Shoshone-Bannock Tribes.
[g] Partial survey.
[h] Survey not conducted in 2015 due to fire (n/c = no count).
[i] Transect is no longer surveyed due to discontinued helicopter use (n/c = no count).

Table 2. Multiple-pass redd count census surveys that were conducted for spring-summer Chinook Salmon in Idaho during 2015. 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	n/c[b]	n/c	8/12	30	8/23	40	9/3	0	n/c	n/c	70
	Banner Creek	n/c	n/c	8/9	0	8/24	3	9/1	1	n/c	n/c	4
	Cape Horn Creek	8/3	2	8/9	7	8/24	26	9/1	3	n/c	n/c	38
	Knapp Creek	n/c	n/c	8/13	4	8/21	1	9/4	0	n/c	n/c	5
	Marsh Creek	8/2	8	8/10	45	8/22	91	9/2	11	9/9	0	155
Total			10		86		161		15		0	272
					Upper Salmon River MPG							
Lemhi River	Bear Valley Creek	8/17	4	8/24	2	8/31	2	9/9	0	n/c	n/c	8
	Big Springs Creek	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	9/28	5	5
	Big Timber Creek	8/19	0	8/26	0	9/2	0	n/c	n/c	n/c	n/c	0
	Canyon Creek	8/19	0	8/26	0	n/c	n/c	n/c	n/c	n/c	n/c	0
	Hayden Creek	8/17-8/18	42	8/24-8/25	53	8/30-9/1	43	9/8-9/9	11	n/c	n/c	149
	Lemhi River[c]	n/c	n/c	8/24	13	8/31-9/1	95	9/8-9/9	38	9/14-9/15	7	153
	Little Springs Creek	8/19	0	8/26	0	9/2	0	n/c	n/c	n/c	n/c	0
Total			46		68		140		49		12	315
Salmon River Upper Mainstem Above Redfish Lake	Redfish Lake Creek upstream to Sawtooth Weir	8/20	0	8/31	151	9/8	172	9/18	19	n/a	n/a	342
Total			0		151		172		19		n/a	342

[a] Downloaded from the SGS database on 4/27/16.
[b] Not completed = n/c.
[c] Surveys were from the Lemhi store upstream; an additional 11 redds were recorded on 9/5 in the aerial index from the Lemhi store downstream to the Lemhi River mouth.

Table 3. Additional redd count surveys that were conducted for spring-summer Chinook Salmon in Idaho during 2015. Surveys are organized by major population group (MPG). Chamberlain Creek is reported separately in the Appendix.

Population	Waterbody	Transect	Date	New redds[a]	Date	New redds[a]	Date	New redds[a]	Total	Purpose[b]
			South Fork Salmon River MPG							
South Fork Salmon River Mainstem	South Fork Salmon River	SF Weir upstream to Rice Creek	8/31	102	n/c[c]	n/c	n/c	n/c	102	C
Total				102		n/c		n/c	102	
			Upper Salmon River MPG							
Panther Creek	Panther Creek	Mouth upstream to Blackbird Creek	9/5	2	n/c	n/c	n/c	n/c	2	A,B,C
Total				2		n/c		n/c	2	
Pahsimeroi River	Pahsimeroi River	Mouth upstream to Hooper	9/10-9/11	60	9/16-9/18	29	9/23-9/25	15	104	B
	Patterson Creek	Mouth to Hooper	9/10	35	9/18	17	9/23-9/24	30	82	B
Total				95		46		45	186	
East Fork Salmon River	East Fork Salmon River	Herd Creek upstream to Bowery Guard Station	8/20-8/21	76	8/26-8/27	112	9/10-9/11	82	270	A,B,C
Total				76		112		82	270	
			Dry Clearwater River MPG							
Upper South Fork Clearwater River	American River	Mouth upstream to Kirks Fork	9/9	19	9/23-9/24	2	n/c	n/c	21	A
	American River	Kirks Fork upstream to Lick Creek	n/c	n/c	9/23-9/25	1	n/c	n/c	1	A
	American River	Lick Cr upstream to Limber Luke Creek	9/9	2	9/23-9/24	1	n/c	n/c	3	A
	Subtotal			21		4		n/c	25	

Table 3. Continued.

Population	Waterbody	Transect	Date	New redds[a]	Date	New redds[a]	Date	New redds[a]	Total	Purpose[b]
			Dry Clearwater MPG, continued							
Upper South Fork Clearwater River	Red River	Campground upstream to Shissler Bridge	8/25	2	n/c	n/c	n/c	n/c	2	A
	Red River	Gibler upstream to Dawson	8/26	1	n/c	n/c	n/c	n/c	1	A
	Red River	Mouth upstream to Shissler Bridge	9/11-9/12	2	9/21-9/23	54	n/c	n/c	56	A
	Subtotal			5		54		n/c	59	
	South Fork Red River	Mouth upstream to Headwaters	9/13	0	n/c	n/c	n/c	n/c	0	A
	Subtotal			0		n/c		n/c	0	
	Upper South Fork Clearwater River	Crooked River upstream to Red River	9/10	5	n/c	n/c	n/c	n/c	5	B
	Subtotal			5		n/c		n/c	5	
	Elk Creek	Mouth upstream to Headwaters	9/14	0	n/c	n/c	n/c	n/c	0	B
	Subtotal			0		n/c		n/c	0	
Total				31		58		n/c	89	
			Wet Clearwater MPG							
Moose Creek	North Fork Moose Creek	Mouth upstream to NFMCEND	9/14	2	n/c	n/c	n/c	n/c	2	A,B,C
Upper Selway River	Selway River	Little Clearwater upstream to Magruder Crossing	8/29	16	9/18	1	n/c	n/c	17	A,B,C
Total				18		1		n/c	19	

[a] Downloaded from the SGS database on 5/13/16.
[b] A = assessment of spawner abundance; B = assessment of spatial distribution; C = assessment of spawn timing.
[c] Not completed = n/c.

Table 4. Carcasses observed on spring-summer Chinook Salmon spawning grounds in Idaho by origin and sex during 2015. Surveys are organized by major population group (MPG). F = female; M = male; U = unknown sex. Hatchery fraction is sum of segregated hatchery and integrated hatchery divided by the sum of segregated hatchery, integrated hatchery, and wild carcasses.

	Segregated hatchery[a]			Integrated hatchery[a]			Wild[a]			Unknown origin[a]			Total	Hatchery
Population	**F**	**M**	**U**	**F**	**M**	**U**	**F**	**M**	**U**	**F**	**M**	**U**	**carcasses**	**fraction**
South Fork Salmon River MPG														
South Fork Salmon River Mainstem downstream of weir[b]	45	29	2	23	24	0	17	19	2	3	1	5	170	76%
South Fork Salmon River Mainstem upstream of weir[c]	0	0	0	27	45	2	21	49	5	1	3	5	158	50%
Secesh River[b]	2	2	0	1	2	0	86	72	8	5	4	5	187	4%
East Fork South Fork Salmon River[b]	3	2	0	4	2	0	9	2	1	0	0	0	23	48%
Total MPG	50	33	2	55	73	2	133	142	16	9	8	15	538	42%
Middle Fork Salmon River MPG														
Chamberlain Creek	1	0	0	0	0	0	17	16	2	0	0	0	36	3%
Big Creek[b]	0	0	0	0	0	0	0	8	1	0	0	0	9	0%
Camas Creek	0	0	0	0	0	0	11	14	2	0	1	0	28	0%
Loon Creek	1	0	0	0	0	0	7	11	0	0	0	0	19	5%
Sulphur Creek	0	1	0	0	0	0	44	35	5	0	0	0	85	1%
Bear Valley Creek[d,e]	0	1	0	0	0	0	66	78	0	0	0	0	145	1%
Marsh Creek	2	0	0	0	0	0	107	82	26	0	0	0	217	1%
Total MPG	4	2	0	0	0	0	252	244	36	0	1	0	539	1%
Upper Salmon River MPG														
Panther Creek[f]	0	0	0	0	0	0	33	58	3	0	0	3	97	0%
North Fork Salmon River	0	0	0	0	0	0	16	12	0	0	0	0	28	0%
Lemhi River	0	0	0	0	0	0	74	59	7	0	0	0	140	0%
Salmon River Lower Mainstem Below Redfish Lake	1	0	0	0	0	0	2	0	0	0	0	0	3	33%

Table 4. Continued.

Population	Segregated hatchery[a]			Integrated hatchery[a]			Wild[a]			Unknown origin[a]			Total carcasses	Hatchery fraction
	F	M	U	F	M	U	F	M	U	F	M	U		
Upper Salmon River MPG, continued														
Pahsimeroi River downstream of weir	1	0	0	0	0	0	1	1	0	0	0	0	3	33%
Pahsimeroi River upstream of weir	1	0	0	5	17	0	9	28	0	0	0	0	60	38%
East Fork Salmon River	0	0	0	1	0	0	55	54	3	0	0	0	113	1%
Yankee Fork Salmon River[f]	0	2	0	0	1	0	6	19	0	0	2	1	31	11%
Valley Creek[f]	0	0	0	0	0	0	4	3	0	0	0	0	7	0%
Salmon River Upper Mainstem Above Redfish Lake downstream of weir	125	257	9	27	17	0	110	158	4	0	1	0	708	62%
Salmon River Upper Mainstem Above Redfish Lake upstream of weir	2	10	0	7	56	0	6	54	0	0	0	0	135	56%
Total MPG	130	269	9	40	91	0	316	446	17	0	3	4	1,325	41%
Dry Clearwater River MPG														
Upper South Fork Clearwater River[c]	204	199	16	1	2	0	27	28	1	10	6	141	635	88%
Total MPG	204	199	16	1	2	0	27	28	1	10	6	141	635	88%
Wet Clearwater River MPG														
Lochsa River[c]	15	10	1	0	1	0	5	13	0	0	0	6	51	60%
Lolo Creek[b]	3	0	0	6	5	0	5	7	0	0	0	0	26	54%
Upper Selway River[c]	2	2	0	0	0	0	20	13	0	0	0	2	39	11%
Total MPG	20	12	1	6	6	0	30	33	0	0	0	8	116	42%

[a] Downloaded from the SGS database on 4/27/16 except if provided otherwise.
[b] Staff from the Nez Perce Tribe collected and provided information.
[c] Staff from the Nez Perce Tribe and IDFG collected and provided information.
[d] Staff from the Shoshone-Bannock Tribes and IDFG collected and provided information.
[e] Staff from U.S. Forest Service and IDFG collected and provided information.
[f] Staff from the Shoshone-Bannock Tribes collected and provided information.

Table 5. Brood year and age class frequencies of spring-summer Chinook Salmon carcasses sampled from Idaho spawning grounds during 2015. Samples are organized by major population group (MPG). Saltwater ages were derived from fin rays and freshwater ages (X) were assumed to be one year.

Population	Fin ray sample target for 2015	Fin ray samples taken[a]	Total aged[a]	Brood year and saltwater age[a] 2012 X.1	2011 X.2	2010 X.3
South Fork Salmon River MPG						
Little Salmon River	50	0	0	0	0	0
South Fork Salmon River Mainstem[b]	150	36	35	5	19	11
Secesh River[b]	150	154	154	7	119	28
East Fork South Fork Salmon River[b]	150	68	68	2	53	13
Total MPG	500	258	257	14	191	52
Middle Fork Salmon River MPG						
Chamberlain Creek	150	34	34	3	29	2
Middle Fork Salmon River Below Indian Creek	0	0	0	0	0	0
Big Creek	150	9	9	0	8	1
Camas Creek	150	27	27	6	19	2
Loon Creek	150	18	17	2	12	3
Middle Fork Salmon River Above and Including Indian Creek	0	0	0	0	0	0
Sulphur Creek	115	84	77	0	70	7
Bear Valley Creek	150	144	0	n/a[c]	n/a	n/a
Marsh Creek	150	126	115	1	78	36
Total MPG	1,015	442	279	12	216	51
Upper Salmon River MPG						
Panther Creek[d]	0	86	81	2	67	12
North Fork Salmon River	100	28	28	3	23	2
Lemhi River	150	125	123	4	108	11
Salmon River Lower Mainstem Below Redfish Lake	150	2	2	0	2	0
Pahsimeroi River	100	39	30	2	24	4
East Fork Salmon River	150	102	102	5	73	24
Yankee Fork Salmon River[d]	150	25	24	9	14	1
Valley Creek	150	7	7	0	5	2
Salmon River Upper Mainstem Above Redfish Lake	150	129	127	4	99	24
Total MPG	1,100	543	524	29	415	80
Dry Clearwater River MPG						
Potlatch River	0	0	0	0	0	0
Lapwai Creek	0	0	0	0	0	0
Lawyer Creek	0	0	0	0	0	0
Upper South Fork Clearwater River[e]	150	29	28	1	16	11
Total MPG	150	29	28	1	16	11
Wet Clearwater River MPG						
Lolo Creek	75	0	0	0	0	0
Lochsa River	150	6	6	0	5	1
Meadow Creek	0	0	0	0	0	0
Moose Creek	0	0	0	0	0	0
Upper Selway River	0	19	19	0	15	4
Total MPG	225	25	25	0	20	5

Table 5. Continued.

Population	Fin ray sample target for 2015	Fin ray samples taken[a]	Total aged[a]	Brood year and saltwater age[a] 2012 X.1	2011 X.2	2010 X.3
Idaho Hatcheries						
Pahsimeroi[f]	0	29	27	0	26	1
Sawtooth[f]	0	12	12	1	9	2
McCall[f]	0	49	40	8	28	4
Johnson Creek[e,f]	0	68	68	0	58	10
Total Idaho Hatcheries	0	158	147	9	121	17

[a] Downloaded from the BioSamples database on 4/20/16.
[b] Staff from the Nez Perce Tribe collects most or all of the samples and will analyze age composition using an age-length key derived from IDFG ageing data.
[c] Staff from the Shoshone-Bannock Tribes collects most or all of the samples and we analyze age composition using the Marsh Creek age-length key derived from IDFG ageing data; Bear Valley Creek samples were not aged (n/a).
[d] Staff from the Shoshone-Bannock Tribes collects most or all of the samples.
[e] Staff from the Nez Perce Tribe collects most or all of the samples.
[f] Collected from wild fish used for integrated hatchery broodstock.

Table 6. Marsh Creek spring-summer Chinook Salmon age-frequency distribution for 2015. An age-length key based on Marsh Creek fin ray age subsamples (n = 116) was applied to all Marsh Creek carcass length information (n = 215) to derive age composition (Schrader et al. 2016).

Length group (cm)	Number in length sample	Number (age) in fin ray subsample	Sample allocation per age-group		
			Age-3	Age-4	Age-5
<60	2	1(3)	2		
60-64	2	1(4)		2	
65-69	5	1(4)		5	
70-74	37	24(4)		37	
75-79	69	39(4)		69	
80-84	32	10(4), 2(5)		27	5
85-89	23	3(4), 10(5)		5	18
90-94	28	13(5)			28
95-99	11	9(5)			11
≥100	6	3(5)			6
All	215		2	145	68

Table 7. Bear Valley Creek spring-summer Chinook Salmon age-frequency distribution for 2015. An age-length key based on Marsh Creek fin ray age subsamples (n = 116) was applied to all Bear Valley Creek carcass length information (n = 145) to derive age composition (Schrader et al. 2016).

Length group (cm)	Number in length sample	Number (age) in fin ray subsample	Sample allocation per age-group		
			Age-3	Age-4	Age-5
<60	0	1(3)	0		
60-64	3	1(4)		3	
65-69	9	1(4)		9	
70-74	31	24(4)		31	
75-79	37	39(4)		37	
80-84	24	10(4), 2(5)		20	4
85-89	16	3(4), 10(5)		4	12
90-94	11	13(5)			11
95-99	4	9(5)			4
≥100	10	3(5)			10
All	145		0	104	41

Table 8. Mean fork length (cm) at age (fin ray derived) for spring-summer Chinook Salmon in Idaho during 2015. Samples are organized by major population group (MPG). Range of lengths is given in parentheses.

Major population group (MPG)	Sample size[a]	Mean fork length (cm) at age[a]		
		Age-3	Age-4	Age-5
South Fork Salmon River	255	60.4	75.9	88.8
		(51-74)	(64-92)	(76-106)
Middle Fork Salmon River	279	53.4	75.4	91.7
		(49-67)	(62-93)	(78-111)
Upper Salmon River	524	59.4	75.2	90.6
		(49-77)	(59-94)	(78-112)
Dry Clearwater River	28	69[b]	74.5	88.0
		--	(63-97)	(78-97)
Wet Clearwater River	24	n/a[c]	72.2	89.6[d]
		--	(64-81)	(80-97)

[a] Downloaded from the BioSamples database on 4/18/16.
[b] Only one sample.
[c] No samples available (n/a) to estimate an average.
[d] Fewer than ten samples available to estimate average.

FIGURES

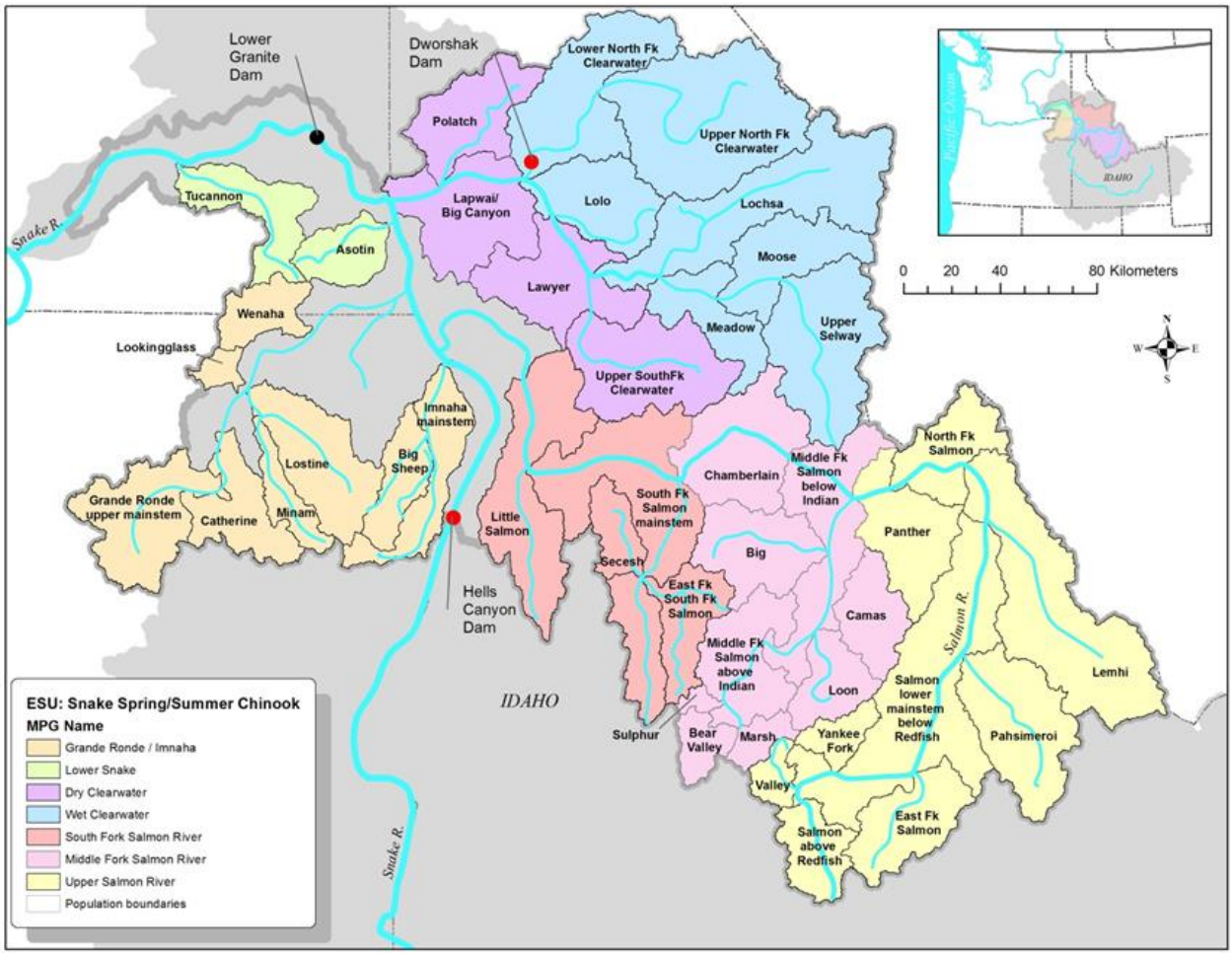


Figure 1. Spring-summer Chinook Salmon populations and major population groups (MPGs) in the Snake River evolutionary significant unit (ESU). Red dots represent impassable dams.

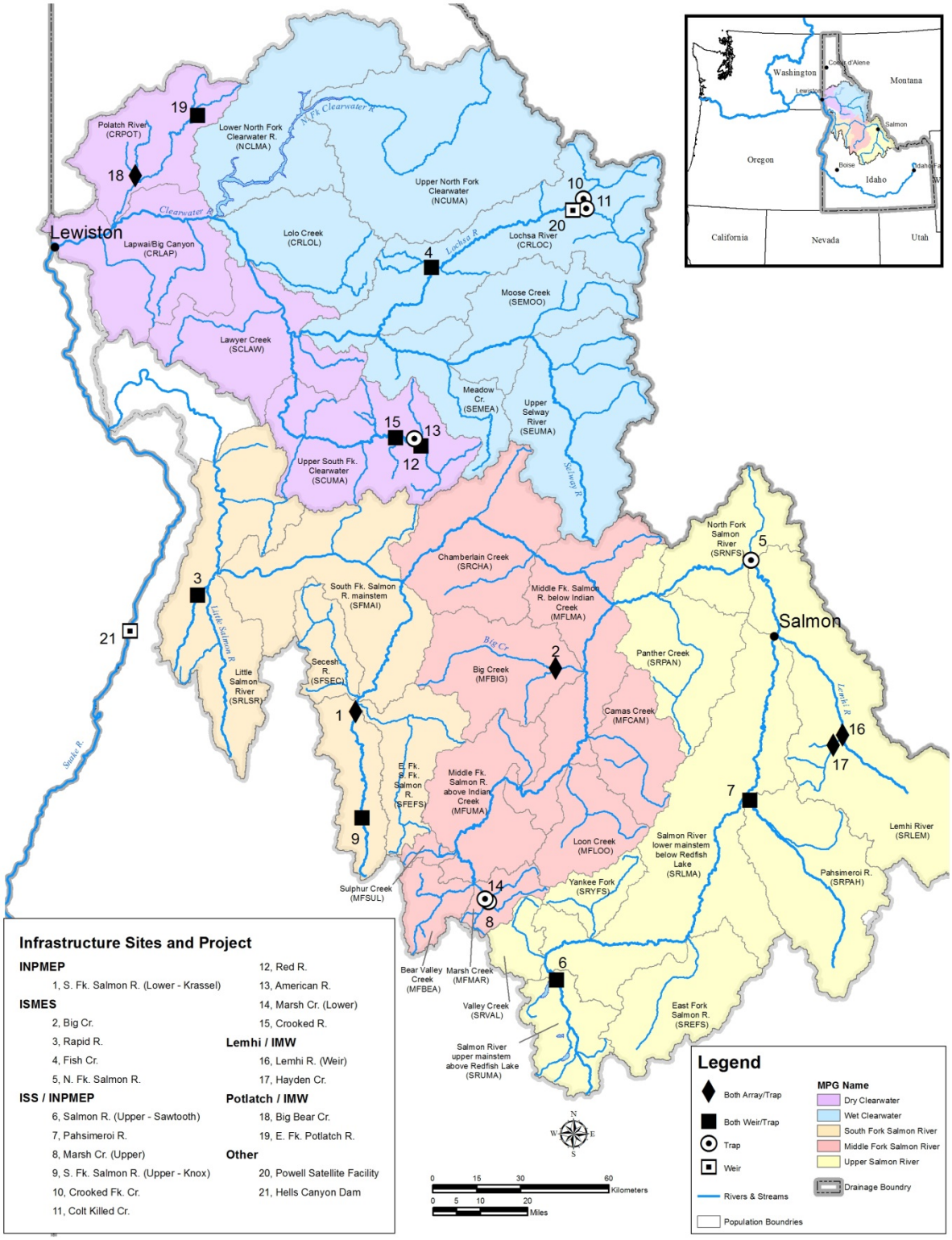


Figure 2. Location of spring-summer Chinook Salmon monitoring infrastructure used in Idaho during 2014-2015. Numbers correspond to IDFG infrastructure sites in the lower left inset. Major population groups are highlighted and independent populations are delineated.

Figure 3. Spring-summer Chinook Salmon index redd count trends in Idaho major population groups (MPG), 2011-2015. Numbers shown are raw counts downloaded from the SGS database on 4/27/16. Missing index counts from population (year) include East Fork South Fork Salmon River (2011-2012), Yankee Fork Salmon River (2012-2013), Lolo Creek (2011-2012), and Moose Creek (2011-2012).

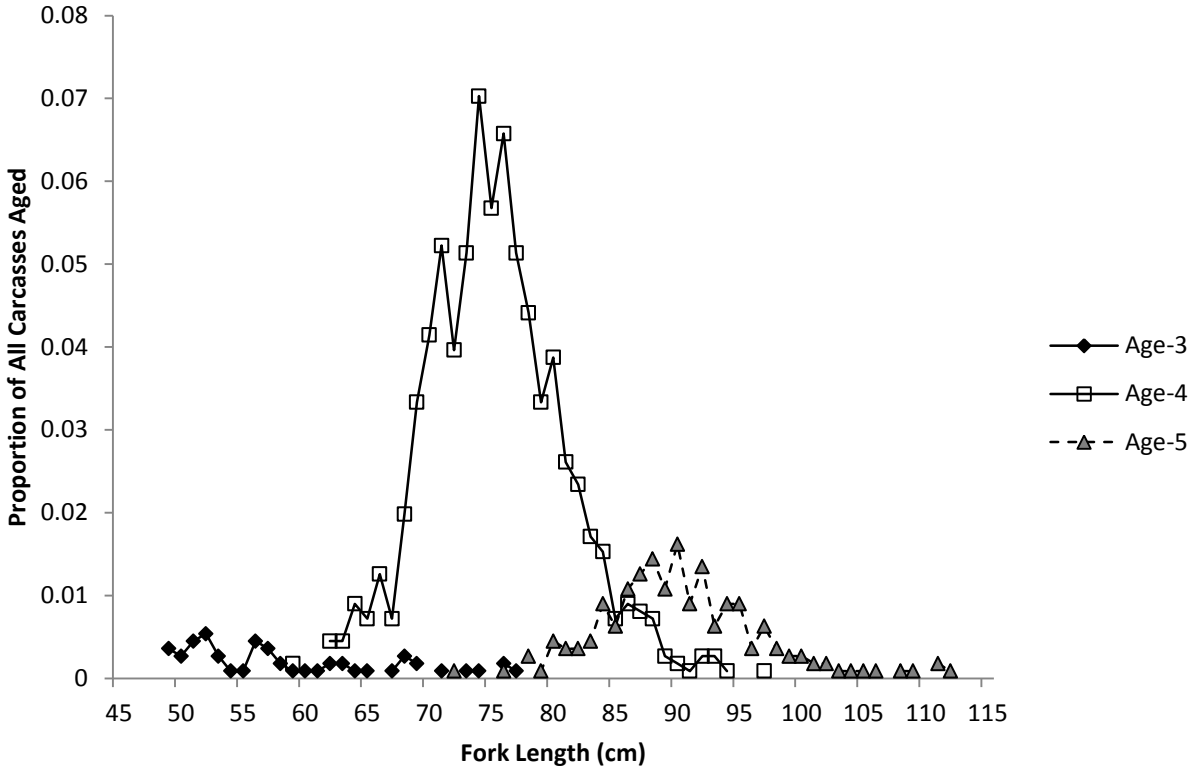


Figure 4. Relative length frequency distributions of the entire wild spring-summer Chinook Salmon spawning cohort in Idaho during 2015. The summation of all proportions irrespective of age is equal to 1. Carcasses were collected on the spawning grounds and ages were determined from fin ray analysis (n = 1,110).

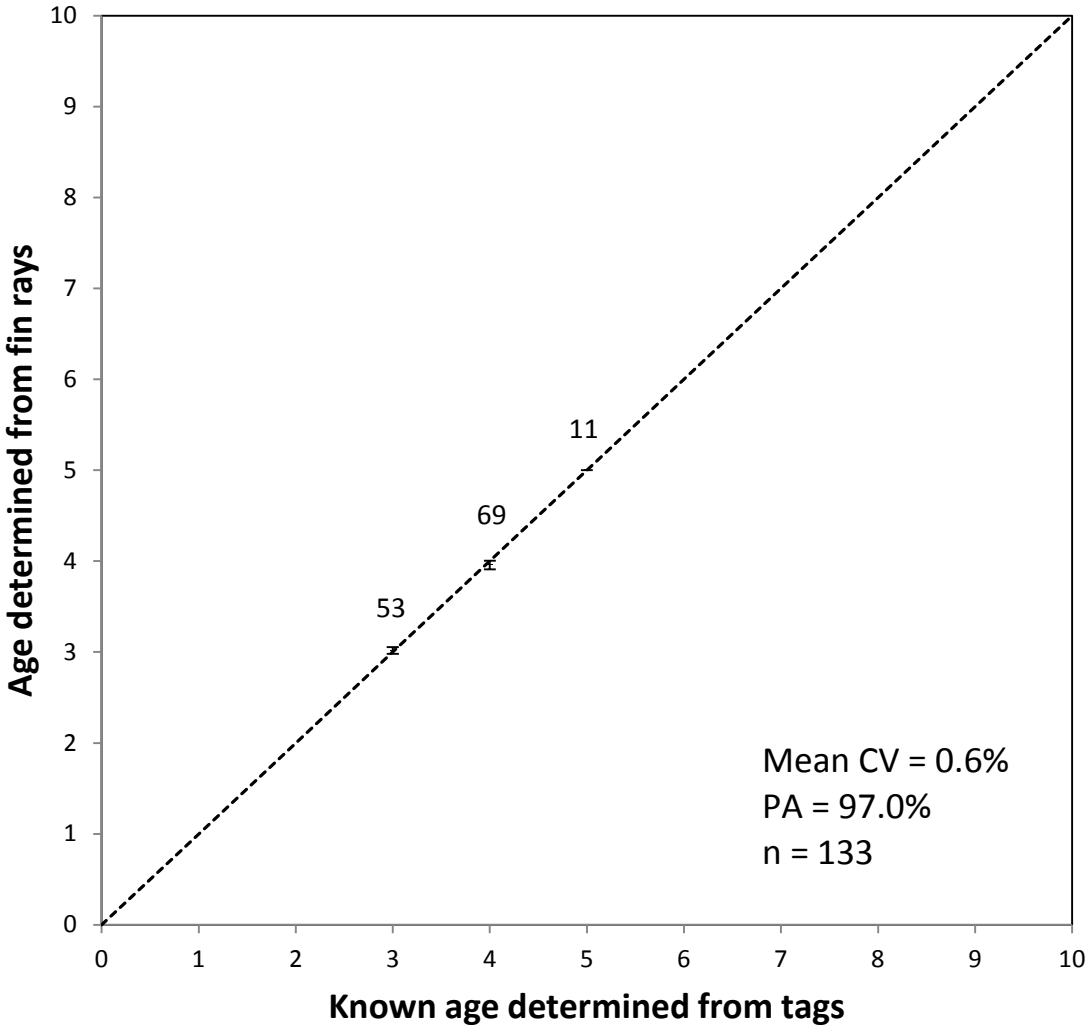
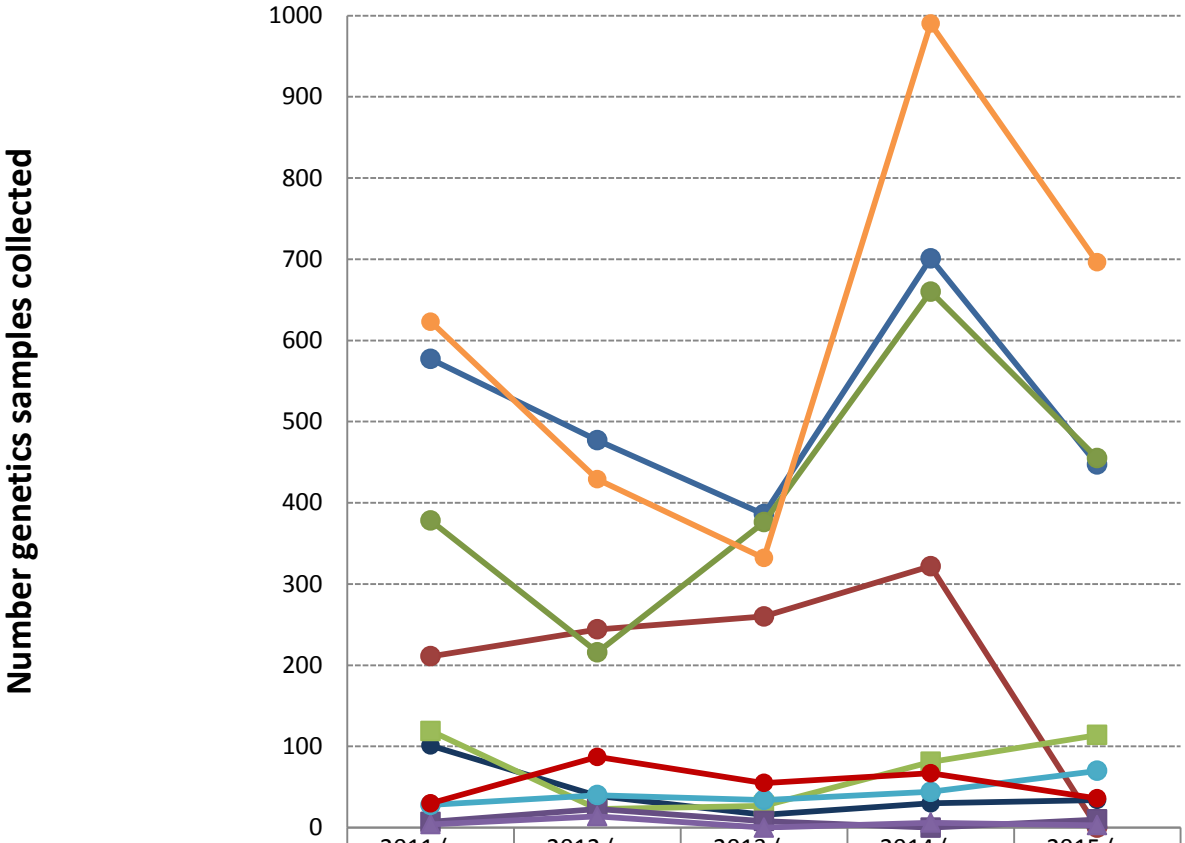


Figure 5. Age bias plot illustrating pairwise comparisons of fin ray determined age with known age for spring-summer Chinook Salmon in Idaho, 2015 (BioSamples database, fin ray data; PTAGIS database, PIT-tag data; RMIS database, CWT data). Dashed line represents the 1:1 relationship. Error bars represent 95% confidence intervals around the mean fin ray assigned age for all fish of a given tag-assigned age. Mean coefficient of variation (CV) is over all individual CVs (n = 133). PA = percent agreement. Fin ray freshwater ages were assumed to be 1 year.



	2011 (n = 2,078)	2012 (n = 1,592)	2013 (n = 1,494)	2014 (n = 2,901)	2015 (n = 1,865)
Salmon River (Sawtooth)	577	477	386	701	447
E. F. Salmon River	211	244	260	322	0
Pahsimeroi River	378	216	376	660	455
S. F. Salmon River	623	429	332	990	696
Rapid River	101	39	16	30	34
Hells Canyon Dam	119	23	27	81	114
Lochsa River (Powell)	7	23	8	0	10
Fish Creek	4	14	0	6	3
Crooked River	28	40	34	44	70
Red River	30	87	55	67	36

Figure 6. Number of genetics samples collected from wild and integrated hatchery adult Chinook Salmon released at IDFG hatchery weirs (dots), hatchery traps (squares), and research weirs (triangles), 2011-2015. Crooked River samples for 2014 (n = 44) have not been located.

APPENDIX

Appendix. Extended Spawning Ground Surveys Conducted for Spring-Summer Chinook Salmon in the Chamberlain Creek Population, Idaho, during 2015

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INTRODUCTION

Snake River spring-summer Chinook Salmon (hereafter Chinook Salmon) were classified as threatened in 1992 under the Endangered Species Act (ESA). However, data on some specific Snake River Steelhead and Chinook Salmon populations are lacking, particularly key parameters such as abundance, age composition, genetic diversity, recruits per spawner, and survival rates (ICBTRT 2003). The key metrics to assessing viability of salmonid populations are abundance, productivity, spatial structure, and diversity (McElhany et al. 2000). In the 1950s, IDFG developed a program to index annual spawning escapement by enumerating Chinook Salmon redds in selected areas. Currently, the total area and number of streams surveyed represents a large portion of wild Chinook Salmon spawning habitat (Hassemer 1993a). The number of redds counted in these areas provide an index of the annual wild adult Chinook Salmon spawner abundance at the independent population scale (see ICBTRT 2003 for population delineations).

Chamberlain Creek supports Chinook Salmon within the Chamberlain Creek population (Appendix Figure 1) which is part of the larger Middle Fork Salmon River major population group (MPG). The population is located entirely within the Frank Church River of No Return Wilderness area which is remote and rugged. The Chamberlain Creek population is apparently the most robust population in the Middle Fork Salmon MPG (see Table 3.4-1 in Ford et al. 2011). Recent work has also found that the population is genetically distinct (Ackerman et al. 2012), and estimates of population abundance based on extrapolation of genetic stock identification of samples at Lower Granite Dam have exceeded 500 adults in 2010 and 2011 (Schrader et al. in preparation). Recovery planning objectives for the Middle Fork Salmon MPG include the Chamberlain Creek population as being viable due to its location at the downstream extent of the MPG (NMFS 2016).

Past assessments of the status of this population have been hampered by several data gaps (Ford et al. 2011). For example, the current index transects that are surveyed compose only 9% of the total weighted spawning habitat within Chamberlain Creek. This is the smallest percentage of spawning habitat surveyed of any population in the Salmon River subbasin. This means that the index count is expanded much more than any other for the spawner abundance estimate. Further, the index transects and the extensive transects combined account for approximately 19% of the total weighted spawning habitat in the Chamberlain Creek population (spatial query of Intrinsic Potential layer). Finally, many carcass surveys on which age structure and hatchery influence metrics depend have yielded few recoveries. Hence, past assessments were based on smaller than desired sample sizes with extrapolations of data from within the MPG.

Given these data gaps, in 2013 IDFG initiated additional spawning ground survey data collection efforts in the Chamberlain Creek population in order to validate the current redd count expansion and to obtain additional carcass data (Stiefel et al. 2014). That effort was continued

in 2014 (Stiefel et al. 2015). Here we report the third year of extended spawning ground surveys conducted in August 2015. The goals of the extended surveys were to:

1) Detail the extent of spawning in Chamberlain Creek outside of the current index transects.

2) Collect additional carcasses throughout the area to estimate hatchery fraction, age composition and sex ratios.

3) Compare and contrast redd counts from the current index transects to the other areas surveyed.

METHODS

Survey Section

The Chamberlain Creek Chinook Salmon population is composed of several drainages (Appendix Figure 1). The areas surveyed in 2015 included the upper sections of Chamberlain Creek and the West Fork Chamberlain, as well as the lower end of Game Creek. These areas correspond with many of the areas identified as having high intrinsic potential in the NMFS habitat assessment (Ford et al. 2011). The other tributaries adjacent to the survey area (e.g., Flossie Creek, Moose Creek, and McCalla Creek) proved to be too small to contain usable salmon spawning habitat. In 2015, the section between No Name Creek and Moose Creek (section three) was not surveyed. As noted in Stiefel et al. (2015), this area is dominated by large substrate and contained only minor areas suitable for spawning. Many bank to bank logjams are caught by the large substrate, and are very hazardous. This provided justification for not surveying section three in 2015.

Stonebraker Ranch was used as a base camp to conduct the extended surveys. Generally, the trails around the ranch, the nearby U.S. Forest Service Guard Station, and the USFS backcountry airstrip are in good condition. Upper sections were accessed by a well-maintained trail adjacent to Chamberlain Creek. The farthest upstream sections require a 20 mile round trip from the basecamp. In 2015 a spike camp was made a short distance upstream of Moose Creek. This allowed for the uppermost sections to be split between two groups of two surveyors without the need for an additional hike from the base camp. Furthermore, the two groups also split two sections downstream of Moose Creek the next day before heading back to the base camp at Stonebraker Ranch.

Though much of the off-trail area contains large sections of fallen and burned trees, there was relatively easy access to the creek in several areas where the trail is in close proximity to the creek. Survey time was extended in certain sections due to excessive log jams. The West Fork Chamberlain is in close proximity to Stonebraker Ranch making it easily accessible with day trips (Appendix Figures 2 and 3). However, it has numerous beaver ponds and wet meadows which increase survey time in some areas. The West Fork Chamberlain Creek from Game Creek to the mouth survey sections were done in a day by one team of two surveyors.

Redds and live adult salmon were enumerated, and carcasses were sampled during both survey weeks in 2015.

Spawning Ground Surveys

Surveys were conducted August 18-19 and August 25-26, 2015 (Appendix Table 1). Redd survey methods used standardized procedures described in Hassemer (1993b). Index transect boundaries (Appendix Figure 2) were described in Hassemer (1993a): in Chamberlain Creek from the mouth of the West Fork upstream to Flossie Creek (transect WS-1a), and in West Fork Chamberlain Creek from the mouth upstream to Game Creek (transect WS-1). Trained observers walked the transect, visually observing the stream channel using polarized sunglasses for the presence of redds. Single-pass, peak-count surveys were timed to coincide with the period of maximum spawning activity, based on historic observations (August 25). Redds observed during ground counts were assigned a unique number and location recorded using a global positioning system. Surveyors noted the presence of any live Chinook Salmon observed.

Chinook Salmon carcasses were sampled to determine their origin (wild or hatchery), age, spawn status, and sex. Measurements collected included fork length and mid-eye to hypural plate length (nearest cm). Carcasses were checked for fin clips, marks, tags, radio transmitters, and/or coded-wire tags (CWT). Dorsal fin rays were collected for age determination as well as fin tissue for DNA analysis.

Data Analysis

The long-term index transects in Chamberlain Creek (WS-1a) and West Fork Chamberlain Creek (WS-1) were surveyed as well as three additional sections (one, two, and four) to assess spawning activity in these areas (Appendix Table 1 and Appendix Figure 2). These sections were different in 2015 compared to 2013 and 2014 based on the previous years' information to more effectively survey the basin.

Total spawner abundance estimates were generated using two methods so that they could be compared for all years. The first method (index survey expansions) expanded the sum of the new and previous redds observed in the two index transects during only the index count surveys by the intrinsic habitat potential (for these index sections). The expanded redds estimate was multiplied by a fish per redd ratio of 1.8 to estimate the total adult spawners.

The second method, (extended survey expansions) expanded the sum of the new redds observed in all sections and all surveys (i.e. total distinct redds) by an intrinsic habitat potential (for all surveyed sections) and a fish per redd ratio of 1.8. An age composition summary was generated using a simple proportion of fin ray ages.

RESULTS

Index counts were conducted in WS-1 on August 25 (12 redds), and WS-1A (45 redds) was surveyed on August 26.

A total of 19.4 km was surveyed for redds, taking 27 hours for each of the two passes (Appendix Table 1). A total of 188 redds were observed. There were 93 redds observed the first week, and there were 95 redds observed the second week. Within the index transects, WS-1 and WS-1a, redd densities were 7.2 redds/km and 20.9 redds/km, respectively. There was a total of 162 redds observed in Chamberlain Creek, and 26 redds in West Fork Chamberlain

Creek. In the two uppermost sections from Moose Creek to Rim Creek, extended section one and extended section two redd densities were 2.2 redds/km, and 10.0 redds/km. Redds were observed through all of the areas surveyed, although there were some short sections within survey sections without suitable habitat and no redds (Appendix Figure 3). Extended section five was not surveyed in 2015 due to a lack of redds in previous years. Extended section six was not surveyed for redds and carcasses because of time limitations. A quick survey of extended section six from the trail in 2015 indicated very little suitable Chinook Salmon spawning habitat. A survey of McCalla Creek from Moose Jaw Creek to Whimstick Creek indicated little suitable spawning habitat and no redds or adult salmon observed (Chris Harrington, IDFG, personal communication). Little suitable spawning habitat and no redds or live adult salmon were observed in extended section six (Chris Harrington, IDFG, personal communication).

Adult abundance estimates using index survey and extended survey expansion estimates were dissimilar to one another in 2015 (Appendix Table 2). Estimates based upon extended survey expansion (920) were approximately 30% greater than the index survey expansion (647). The two estimates were within 4% of each other in 2014. The abundance estimate based upon Genetic Stock Identification at Lower Granite Dam was 430 in 2015. That is 33.5% lower than the index survey expansion, and 53.3% less than the extended survey expansion.

In total, 36 carcasses were collected and fin rays were collected from 35 of these fish. Eighty-six percent (31) of the carcasses were recovered in the WS-1a section. Half of the carcasses (18) were encountered during the first week of surveys, and half the second week (Appendix Table 1). There were 108 live adult salmon observed the first week, and 23 the second week. Bear activity was evident (tracks and scat), so it is likely fish were removed from the stream either before they died or shortly thereafter. The majority (58%) of fish were age-4. However, age-3 and age-5 fish also contributed to 11 and 5% of the returns, respectively. No age-6 fish were observed.

DISCUSSION

With the exception of extended section three, spawning ground surveys upstream of the current transects could be completed safely and efficiently. Upstream areas of Chamberlain Creek (upstream of West Fork Chamberlain Creek) had good spawning and rearing habitat with minimal human influence. A large number of redds were counted and many carcasses were collected in the extended survey areas. The index transect sections accounted for 61.7% of the observed redds, which is over 20 percentage points greater than the 40.8% observed in 2013 (Stiefel et al. 2014) or the 41.4% observed in 2014 (Stiefel et al. 2015). This is probably due to the decreased number of redds observed in extended sections one and two upstream of the index transects. This could be due to spawning activity being concentrated in prime spawning areas further downstream, i.e. greater stream flows downstream during a below average water year.

The primary objective of the extended redd surveys was to understand how the index survey sections trend with respect to the population as a whole. Additionally we were comparing abundance estimates generated from the index surveys and the expanded surveys as well as comparisons with the GSI population estimate at Lower Granite (Appendix Table 2).

In 2013 the index (681) and extended (667) survey estimates tracked well with the GSI estimate (812; Stiefel et al. 2014). The estimate over Lower Granite Dam was 16.1% and 17.9% greater than the index and extended estimates respectively. These results are reasonable if all the fish that passed Lower Granite Dam did not make it to within the Chamberlain Creek population boundary spawning grounds or, if they did, spawned in other streams like Bargamin Creek.

In 2014 the index (1,681) and extended (1,763) estimates were approximately double the GSI estimate (841; Stiefel et al. 2015). Further, the GSI estimates were very similar both years. These differences are counter to the relationship exhibited in 2013.

In 2015 the GSI estimate (430) was roughly half of the 2013 and 2014 GSI estimates. And like 2014, the 2015 GSI estimate was less than the index (647) or extended (920) estimates. This may indicate too great of an expansion factor from the intrinsic potential habitat for the spawning both within and outside of the index and extended surveys. For example, the intrinsic potential for McCalla Creek shows expansive high and low quality spawning habitat from Moose Jaw Creek to Whimstick Creek, but no adult salmon or redds were observed in that habitat in 2015. Additionally, the spatial distribution redds observed in the index and extended areas were similar in 2013 and 2015, and their abundance estimates were similar. However, the GSI estimate for 2015 was roughly half of the 2013 estimate. This discordance in estimates will be evaluated and reported in our next annual report.

With only three years of data to compare, it is premature to draw any conclusions about the relationships between the index, extended, and GSI estimates of abundance. An additional year of comparison in this population is recommended. The following observations should be taken into consideration when planning future surveys. 1) Suitable spawning substrate was found from Moose Creek upstream to Rim Creek. No suitable habitat was found in Game Creek. The most upstream redd on Chamberlain Creek in 2015 was found approximately 1,800 meters downstream of Rim Creek, near the upper end of the Upper Red Top Meadows area, where the valley floor narrows and the stream habitat changes. In 2013 and 2014, the uppermost redds were less than 500 meters downstream of Rim Creek. 2) If additional carcass data are needed, a survey should be made the week before the index surveys because of spawn timing and predator activity. 3) The hike to the upstream camp site took between 2 and 3 hours, depending on amount of gear (i.e. overnight gear vs. day hiking). 4) Additional transects in McCalla Creek downstream of Whimstick Creek, the upper portion of Bargamin Creek, lower Lodgepole Creek, and the upper portion of Sabe Creek (per Intrinsic Potential data) should be surveyed in a relatively high escapement and average water year (e.g. 2014 with 360 redds). These observations will help tailor surveys to program objectives.

ACKNOWLEDGEMENTS

Chris Harrington, Pam Bond, Kevin Meyer, Brent Thomas, and Emanuel Ziolkowski assisted with fieldwork. Emanuel Ziolkowski also provided the intrinsic potential map and the expansion values for intrinsic habitat potential for the areas surveyed.

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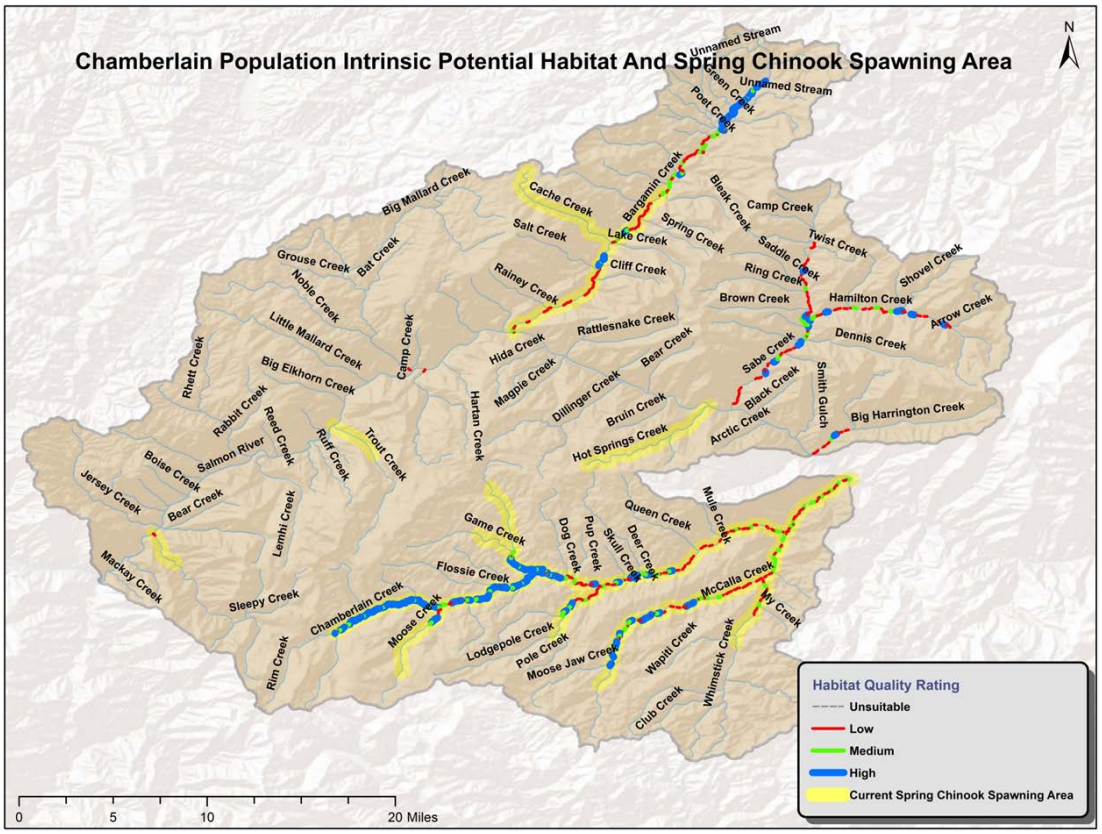
Appendix Table 1. Summary of redds and carcasses observed in each section of Chamberlain Basin surveyed in 2015. NS indicates the section was not surveyed.

Section ID	Length (km)	Redds	Redds/ km	Carcasses
1	5.1	11	2.2	0
2	4.3	45	10.5	3
3	1.6	NS	NS	NS
4	2.1	16	7.6	1
5	1.5	NS	NS	NS
6	1.6	NS	NS	NS
WS-1	3.6	26	7.2	1
WS-1a	4.3	90	20.9	31
Total*	**19.4**	**188**	**9.3**	**36**

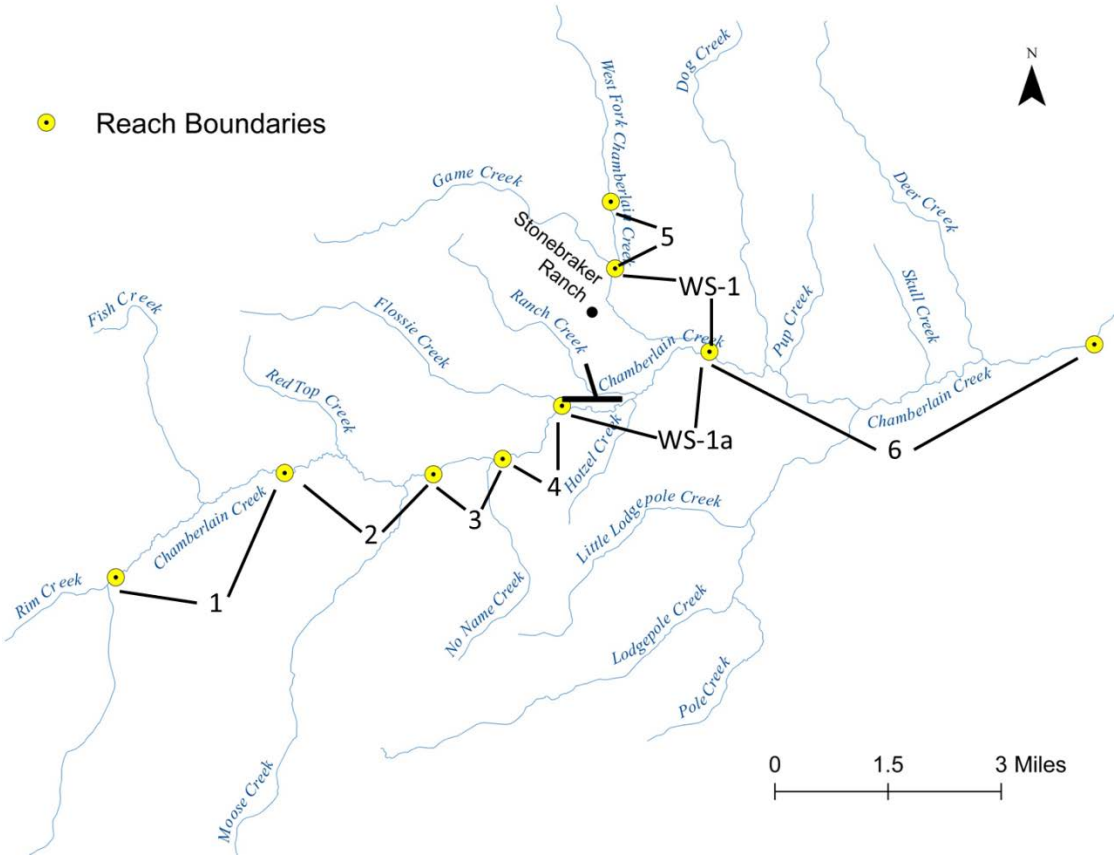
*Only surveyed sections were included in the total.

Appendix Table 2. Comparison of Chamberlain Basin spring-summer Chinook Salmon total estimated spawner abundance based on index survey expansions (WS-1 and WS-1a) versus extended survey expansions (all surveyed reaches within Chamberlain Basin), 2013-2015. Estimates of abundance at Lower Granite Dam are based on genetic stock identification (GSI; Mike Ackerman, IDFG, personal communication).

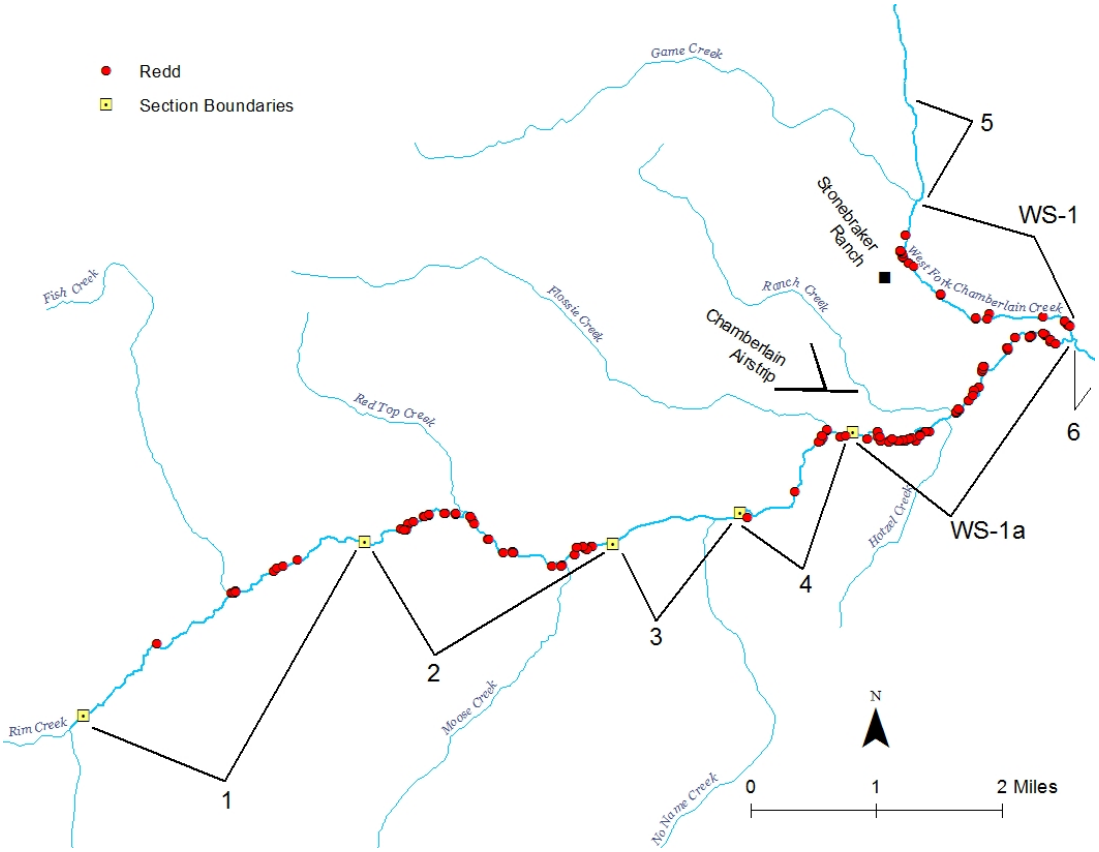
	Index Survey Expansions			**Extended Survey Expansions**			
Year	**Redds**	**Intrinsic Potential Expansion**	**Spawner Abundance**	**Redds**	**Intrinsic Potential Expansion**	**Spawner Abundance**	**GSI Estimate at Lower Granite Dam (90% CI)**
2013	60	6.24	681	147	2.52	667	812 (683-942)
2014	147	6.24	1,681	360	2.72	1,763	841 (703-984)
2015	57	6.24	647	188	2.72	920	430 (317-551)



Appendix Figure 1. Chamberlain population intrinsic potential for spring-summer Chinook Salmon spawning habitat.



Appendix Figure 2. Map of the Chamberlain Creek drainage and spawning ground survey section boundaries used in 2015.



Appendix Figure 3. Distribution of Chinook Salmon redds (n = 188) observed in Chamberlain Creek and West Fork Chamberlain Creek in 2015. Sections three, five, and six were not surveyed.

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