# A Compendium of Viable Salmonid Population Abundance and Productivity Field and Analysis Methods for Natural Origin Steelhead Populations in the Snake River Basin DPS of Northeast Oregon from 1967 to 2015

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This report is available at: https://nrimp.dfw.state.or.us/DataClearinghouse/default.aspx?p=202&XMLname=1101.xml

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# Acronyms and Abbreviations

**BACI:** Before-After-Control-Impact
**BiOp:** Biological Opinion
**BPA:** Bonneville Power Administration
**CBFWA:** Columbia Basin Fish and Wildlife Authority
**CHaMP:** Columbia Habitat Monitoring Program
**CRITFC:** Columbia River Inter-Tribal Fish Commission
**CTUIR:** Confederated Tribes of the Umatilla Indian Reservation
**CTWSRO:** Confederated Tribes of the Warms Springs Reservation of Oregon
**CWT:** **C**oded-Wire-Tagging
**DES:** Data Exchange Standard
**DPS:** Distinct population segment
**EDT:** Ecosystem Diagnosis and Treatment
**EMAP:** Environmental Monitoring and Assessment Protocol.
**EPA:** Environmental Protection Agency
**ESA:** Endangered Species Act
**ESU:** Ecologically Significant Unit
**GIS:** Geographic Information System
**GRTS:** Generalized Random Tesselation Stratified
**ICTRT:** Interior Columbia Technical Recovery Team
**IMW:** Intensively Monitored Watershed
**ISEMP:** Integrated Status and Effectiveness Program
**MaSA:** Major Spawning Area
**MiSA:** Minor Spawning Area
**MPG:** Major Population Group
**NOAA:** National Oceanic and Atmospheric Administration-Fisheries
**NOSA:** Natural Origin Spawner Abundance
**ODFW:** Oregon Department of Fish and Wildlife
**PIT:** Passive Integrated Transponders
**PITAGIS**: PIT Tag Information System
**PNAMP:** Pacific Northwest Aquatic Monitoring Partnership
**pHOS:** proportion Hatchery Origin Spawners
**rkm:** river kilometer
**RperS:** Recruits per Spawner
**RST:** Rotary screw trap
**SAR:** Smolt to Adult Ratio
**TMFD**: Three Mile Falls Dam
**TSA:** Total Spawner Abundance
**VSP:** Viable Salmonid Population
**WDFW:** Washington Department of Fish and Wildlife
**WSNFH:** Warm Springs National Fish Hatchery

# Glossary

**Abundance:** The number of natural-origin spawners in a defined unit. The ICTRT abundance criteria use a geometric mean over the most recent ten years as a consistent measure of current population abundance.

**Biological Opinion (BiOp):** A BiOP is a position document written by a regulatory agency to ensure that a proposed action will not reduce the likelihood of survival and recovery of an ESA-listed species. A BiOp usually also includes conservation recommendations that further the recovery of the specific species. Status reviews of the BiOP for steelhead are reviewed every five years by NOAA.

**Before-After-Control-Impact (BACI)**: The evaluation of an impact involving comparative methods before and after an action.

**Brood year:** The calendar year that a brood of eggs were fertilized.

**Confidence Interval (C.I.):** The confidence interval (C.I.) is an interval that is calculated from the data that describes the reliability of an estimate. It gives an estimated range of values which is likely to include the true value of an unknown population parameter. The confidence level describes how frequently we could expect the estimate to fall within the interval. So, for a 95% confidence interval we could expect the interval to contain the estimate 95% of the time, and that in 5% of the cases the true value would fall outside of the interval.

**Coordinated Assessments (CA):** The Coordinated Assessments (CA) Project is an effort to develop efficient, consistent, and transparent data-sharing among the co-managers (fish and wildlife agencies and Tribes) and regulatory/funding agencies (BPA & NOAA) of the Columbia River Basin (CRB) for anadromous fish related data http://www.pnamp.org/project/3129.

**Data Exchange Standard (DES):** A Data Exchange Standard is used for Viable Salmonid Population (VSP) indicator and metric data that support and feed ODFW's Recovery Planning and Federal BiOP reporting needs. These data are summarized and compiled into a standard format (Coordinated Assessments Data Exchange Standard; DES) at the population level and stored in a central server location.

**Distinct Population Segment (DPS):** A listable entity under the ESA that meets tests of discreteness and significance according to USFWS and NOAA Fisheries policy. A population is considered distinct (and hence a "species" for purposes of conservation under the ESA) if it is discrete from and significant to the remainder of its species based on factors such as physical, behavioral, or genetic characteristics, it occupies an unusual or unique ecological setting, or its loss would represent a significant gap in the species' range. For the purposes of this report, the DPS designation is applied to steelhead.

**Escapement**: Escapement can be defined by the returning of fish at any life stage or any location. (e.g. spawners to natal spawning grounds or fish returning to a specific location such as a dam or weir).

**Ecologically Significant Unit (ESU):** A group of Pacific salmon that is: 1) substantially reproductively isolated from other conspecific units, and 2) represents an important component of the evolutionary legacy of the species. For the purposes of this report, the ESU designation is applied to salmon. ESUs for salmon north of California are listed at http://www.westcoast.fisheries.noaa.gov/publications/protected_species/salmon_steelhead/status_of_esa_salmon_listings_and_ch_designations_map.pdf.

**Extant:** In existence or still existing.

**Extinct:** The end of a population, species or group of taxa. The moment of extinction is generally considered to be the death of the last individual of that species (although the capacity to breed and recover may have been lost before this point and the species or population is considered functionally extinct).

**Extirpated:** Locally extinct. Other populations of this species exist elsewhere. The ICTRT considers extirpated populations to be those that are entirely cut off from anadromy. Functionally extirpated populations are those of which there are so few remaining numbers that there are not enough fish or habitat in suitable condition to support a fully functional population.

**Generalized Random Tesselation Stratified (GRTS):** Spatially-balanced probabilistic sampling.

**Hatchery origin fish:** Parents were spawned in an artificial production program.

**Intensively Monitored Watershed (IMW):** For this study, the Middle Fork John Day River is an IMW and is a coordinated monitoring project aimed at documenting how fish populations respond to habitat restoration projects at the watershed spatial scale.

**Indicator**: A value that characterizes the quality, condition, status, or trend of an environmental resource or ecological process. Also known as a derived variable or a performance measure.

**Intrinsic potential**: The estimated relative suitability of a habitat for spawning and rearing of anadromous salmonid species under historical conditions inferred from stream characteristics including channel size, gradient and valley width.

**Kelts:** Steelhead that are returning to the ocean after spawning and have the potential to spawn again in subsequent years (unlike most salmon, steelhead can be iteroparous and therefore do not necessarily die shortly after spawning).

**Major Spawning Area (MaSA):** A system of one or more branches that contain sufficient spawning and rearing habitat to support 500 spawners. For Interior Columbia salmonid populations: defined using results from intrinsic potential analysis.

**Metric:** A value calculated or derived from observed attributes that inform an indicator. A metric may be known as a variable, and a metric may also be an indicator.

**Minor Spawning Area (MiSA):** A system of one or more branches that contains sufficient spawning and rearing habitat to support 50 – 500 spawners. For Interior Columbia salmonid populations: defined using intrinsic potential analysis.

**Metadata:** A set of data that describes and gives information about other data.

**Major Population Group (MPG):** Groups of populations within an ESU/DPS that are more similar to each other than they are to other populations. They are based on similarities in genetic characteristics, demographic patterns and habitat types and on geographic structure.

**Natural origin fish:** Fish that were spawned and reared in the wild, regardless of their parental origin.

**Natural origin recruits (or returns):** Adult fish returning to spawn that spawned and reared in the wild, regardless of parental origin.

**Natural Origin Spawner Abundance (NOSA):** Number of natural origin fish that actually spawn, not necessarily the number of fish returning to a spawning area.

**Natural Origin Broodstock Removed (NO Broodstock Removed):** The number of natural origin fish removed from the potential spawning population, to be used as hatchery broodstock.

**Pacific Northwest Aquatic Monitoring Partnership (PNAMP):** A forum to facilitate collaboration around aquatic monitoring topics of interest, promote best practices for monitoring, and encourage coordination and integration of monitoring activities as appropriate. The forum's activities are conducted by participant working groups and teams as endorsed by the partner-based steering committee. The coordinating staff serves to enhance and support PNAMP collaboration on topics of importance (http://www.pnamp.org/about).

**proportion Hatchery Origin Spawners (pHOS):** Point estimate for the proportion of fish spawning naturally that are hatchery origin fish. Expressed as a percent.

**Population:** A group of fish of the same species that spawn in a particular locality at a particular season and do not interbreed substantially with fish from any other group.

**Productivity:** The measurement of production expressed as offspring (recruits) per adult spawner (i.e., ratio of recruits from the designated brood year divided by the number of parent spawners responsible for that brood year).

**Proportion at age:** Proportions by age for natural origin fish of a particular brood year. Annual estimates of age structure are based on scales, age-at-length relationships, passive integrative transponder (PIT) tags, or other methods of acquiring known age. Age proportion is a key element of estimating population-specific productivity.

**Pacific States Marine Fisheries Commission (PSMFC):** Pacific States Marine Fisheries Commission's primary goal is to promote and support policies and actions to conserve, develop, and manage our fishery resources in California, Oregon, Washington, Idaho and Alaska. This is accomplished through coordinating research activities, monitoring fishing activities, and facilitating a wide variety of projects. The PSMFC strives to collect data and maintain databases on salmon, steelhead, and other marine fish for fishery managers and the fishing industry. See more at: http://www.psmfc.org/psmfc-info/overview.

**Recovery Domain:** An administrative unit for recovery planning defined by NOAA Fisheries based on species boundaries, ecosystem boundaries, and existing local planning processes. Recovery domains may contain one or more listed species. Five recovery domains have been defined by NMFS in Washington, Oregon, and Idaho and are listed and mapped at http://www.westcoast.fisheries.noaa.gov/maps_data/species_population_boundaries.html. Further information about recovery domains can be found at http://www.nwfsc.noaa.gov/trt/domains.cfm.

**Recruits:** The total numbers of fish of a specific stock available at a particular stage of their life history.

**Redd:** A nest of fish eggs constructed by female salmonids formed by digging in streambed gravels.

**Resident:** An individual fish with a life history that does not include a migration to marine habitats.

**Recruits per Spawner (RperS):** The point estimate for the ratio of recruits from the designated brood year and RperS 'type', divided by the number of parent spawners responsible for that brood year. Recruit per spawner ratios are specific to the locations and seasons described in each record of data. The number of "recruits" can be defined at any life stage (type). These can be in the form of adult recruits per spawner natural origin, juvenile recruits per spawner natural origin, adult recruits per spawner hatchery origin, juvenile recruits per spawner hatchery origin.

**Run (of fish):** A group of fish of the same species that migrate together up a stream to spawn, usually associated with the seasons, e.g., fall, spring, summer, and winter runs. Members of a run interbreed, and may be genetically distinguishable from other individuals of the same species.

**Smolt to adult ratio hatchery origin (SAR hatchery):** Smolt to Adult return ratio is a measure of the survival from a beginning point as a smolt to an ending point as an adult. The point estimate of SAR hatchery is calculated as 100 multiplied by the point estimate of the number of returning hatchery origin adults, divided by the point estimate of the number of smolts that produced those returning adults.

**Smolt to adult ratio natural origin (SAR natural):** Smolt to Adult return ratio is a measure of the survival from a beginning point as a smolt to an ending point as an adult. The point estimate of SAR natural is calculated as 100 multiplied by the point estimate of the number of returning natural origin adults, divided by the point estimate of the number of smolts that produced those returning adults.

**Smolt:** A juvenile salmonid that is undergoing physiological and behavioral changes to adapt from fresh water to salt water as it migrates toward the ocean.

**Spatial structure:** Characteristics of a population's geographic distribution, including its configuration, spatial extent and habitat quality. Current spatial structure is dependent upon the presence of fish, not merely the potential for fish to occupy an area.

**Spawners:** Male and female fish that are actively involved in reproduction.

**Spawning Year:** The four-digit year in which spawning of this species (and run where appropriate) began.

**Species:** Pacific salmon groups of interest in recovery planning.

**StreamNet Project:** provides access to fish and fisheries related data and reference documents in the Columbia River basin and the Pacific Northwest. (http://www.streamnet.org/).

**Total Spawners:** All spawners, natural and hatchery origin, male and female, and all ages.

**Total Spawner Abundance (TSA)**: Total spawner abundance. Estimated total number of fish contributing to spawning in a particular year. Includes both natural origin and hatchery origin returns, and age classes (adult and jack).

**Viable Salmonid Population (VSP):** A population having a negligible risk of extinction due to threats from demographic variability, local environmental variation, and genetic diversity changes over a 100-year time frame.

**VSP parameters:** Abundance, productivity, spatial structure, and diversity. These describe characteristics of salmonid populations that are useful in evaluating population viability. Reported data for these VSP parameters consist of indicator and metric data that support and feed ODFW's Recovery Planning and BiOP reporting needs for NOAA.

# INTRODUCTION

## North-East Central Oregon Fish Research and Monitoring Program

The North-East Central Oregon Fish Research and Monitoring Program (NECORM) is a fish research and monitoring program within the Oregon Department of Fish and Wildlife (ODFW). NECORM's main office is located on the campus of Eastern Oregon University in La Grande, OR, with field offices located throughout central and eastern Oregon. The mission of NECORM is to provide, through field investigations, laboratory experimentation and literature review, biological knowledge necessary for effective management of Oregon's fish and wildlife resources. The information provided is essential for accomplishing ODFW's mission to protect and enhance Oregon's fish and wildlife and their habitats for the use and enjoyment of present and future generations. Research projects are designed to produce new knowledge and techniques to solve problems that will ultimately result in recovery and enhancement of Oregon's fish resources and their habitats.

The NECORM staff (Appendix C) are responsible for collecting, analyzing and reporting population-level data for 25 Endangered Species Act (ESA), listed salmon and steelhead populations in the Interior Columbia domain. A compendium exists for each of the three ESU/DPS's within NECORM staff's responsibility (Snake River spring/summer Chinook Salmon ESU, Snake River steelhead Distinct Population Segment (DPS), and Middle-Columbia Steelhead DPS. This document encompasses the Snake River steelhead DPS (Figure 1).

Status of ESA-listed salmon and steelhead species are evaluated every 5 years by NOAA Fisheries, and status review and viability assessments reports are generated during five and ten year reviews by NOAA and can be found here, http://www.westcoast.fisheries.noaa.gov/publications/status_reviews/salmon_steelhead/2011_status_reviews_of_listed_salmon_steelhead.html.

Data requirements for status reviews are intensive and often time consuming to produce, and, up until recently, population-level estimates were created, maintained, and shared by NECORM project leaders (Appendix C) with little collaboration or standardization of the datasets. In addition, methods documents for these important and widely used datasets were scattered among numerous documents, incomplete, and updated infrequently. For the current status reviews, the synthesis and evaluation of relevant information was accomplished through a cooperative effort involving regional experts from fisheries agencies (state, tribal and federal). In most cases, generating synthesized annual estimates used in the assessments requires considerable staff effort. Compiling that information in an efficient manner in support of future assessments will require continued dedicated staff support for the entities responsible for collecting and assembling key information. The information used and the procedures for synthesizing information are documented in each population assessment section provided below. At present, there is no dedicated staff assigned or any specific plans to assemble the key information for updating the status reviews for many of the interior Columbia River populations.

In early 2010, the Columbia Basin Fish and Wildlife Authority (CBFWA), NOAA Fisheries (NOAA), Bonneville Power Administration (BPA), Pacific Northwest Aquatic Monitoring Partnership (PNAMP), and StreamNet created the Coordinated Assessments Project (CA). The CA Project was developed in an effort to develop efficient, consistent, and transparent data-sharing among the co-managers (fish and wildlife agencies and Tribes) and regulatory/funding agencies (BPA & NOAA) of the Columbia River Basin for anadromous fish related data. The long term goal of the CA Project is to develop a basin-wide approach to data management that allows efficient and reliable calculation and sharing of a broad range of data including abundance, productivity, habitat, and hatchery influence (CA Workgroup 2011, http://www.pnamp.org/project/3129). An initial focus of the CA was the development of the CA Data Exchange Standard (DES) for adult abundance and productivity indicators that were determined essential for use by regulatory agencies in their status reviews of ESA-listed salmon and steelhead. The DES defines the names, purposes and properties of agreed upon indicator, metric and metadata meant to characterize the status of naturally-spawning fish populations (http://www.streamnet.org/data/coordinated-assessments/). The DES provides a standard format for which these indicator and metric data will be shared among collaborating agencies and Tribes.

## Compendium Format and Goals

Goals of this report are to provide a thorough explanation of methods and changes to the methods included in the natural origin spawner abundance (NOSA) and recruits per spawner (RperS) datasets Viable Salmonid Population (VSP) indicators and metrics. The VSP indicators are used to assess the current status of the populations in terms of extinction risk (ICTRT 2010). These abundance and productivity VSP indicators are in the DES, along with brief methods and changes to methods for those indicators and metrics. Full DES records can be quite large tables and are not presented in this compendium. Full DES datasets are available for each population by download on the ODFW Salmon and Steelhead Recovery Tracker website (http://odfwrecoverytracker.org). In addition, the DES data is provided to NOAA Fisheries for status reviews and are available for download on their Salmon Population Summary database and on the StreamNet database (website links below under Data Management Plan Outline). Measurement level data is available by contacting project leaders (Appendix C).

One final goal of this report is to provide a citable reference for co-managers and interested parties when referencing ODFW abundance and productivity data in their own reports and analyses.

This is a working document that will receive annual updates.

## Data Management Procedures

Management of VSP data at the scale and scope needed to inform status assessments from multiple sources spread across eastern and central Oregon is a daunting task. Therefore, concurrent with the writing of this compendium, a detailed Data Management plan is also in development. The full data management plan is available upon request from NECORM's project leader (Appendix C).

**Commented [NC1]:** A brief outline of the data management steps follows, and a flow diagram can viewed in Appendix XX. Put this back in when we get a DMFD

## Data Management Plan Outline

The VSP indicator and metric data that support and feed ODFW's Recovery Planning and BiOP reporting needs are summarized and compiled into DES format at the population level and stored in a central server location. All VSP data in DES format is quality checked, reviewed and approved for sharing by a data steward and the primary VSP data contact for each population. Upon reviewer approval, data in DES format is made available to the public and interested parties through upload on ODFW's Salmon and Steelhead Recovery Tracker (http://odfwrecoverytracker.org/), NOAA's Salmon Population Summary database (https://www.webapps.nwfsc.noaa.gov/apex/f?p=261:home:0) and StreamNet (http://www.streamnet.org/).

## Organization

Recovery planning efforts recognize a biologically based hierarchy that spans the ESU/DPS, major population groups (MPGs), and independent populations. The Snake River Basin Steelhead DPS in northeast Oregon contain five independent populations (Figure 1). These independent populations form larger population groups, referred to here as (MPGs) that share similar genetic, geographic, and/or habitat characteristics separate from other populations in the ESU or DPS (ICTRT 2010). Therefore, this compendium is organized following the established biological hierarchy of *ESU/DPS – MPG – Independent Population*. In instances where population level data is not available, the population will still be mentioned, and a brief description of why the data is unavailable is provided. Every effort has been made to ensure the descriptions provided are accurate and consistent with other sources, and as such, a reference section can be found at the end of the compendium. Where applicable, links have been provided to ease in navigation when viewing this document electronically.

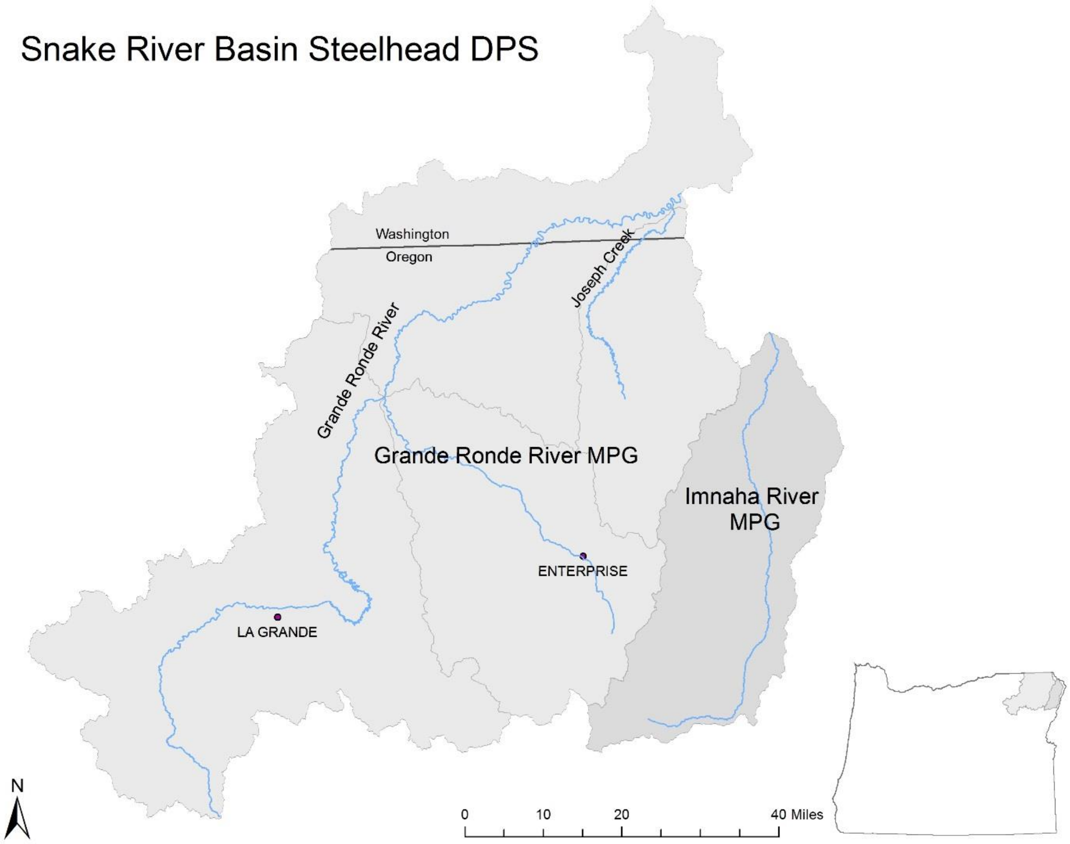


**Figure 1. Grande Ronde River and Imnaha River MPG boundaries within the Snake River Basin Steelhead DPS**

# Data use policy, contacts and citation

**Data and text described in this compendium may be used within the following guidelines and with the proper citation as follows:** Carmichael, R. W., K. L. Bliesner, L. R. Clarke, N. M. Craft, D. G Kurtz, J. R. Ruzycki, and E. R. Sedell. 2015. A Compendium of Viable Salmonid Population Abundance and Productivity Field and Analysis Methods for Natural Origin Steelhead Populations in the Snake River Basin DPS of Northeast Oregon from 1967 to 2015. ODFW, Northeast-Central Oregon Research and Monitoring, La Grande, OR. https://nrimp.dfw.state.or.us/web%20stores/data%20libraries/files/ODFW/ODFW_1101_2_StS_SNAKE_DPS_VSP_Rpt_Methods_20150601.pdf

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There are no warranties, expressed or implied, including the warranty of merchantability or fitness for a particular purpose, accompanying any of these products. Any omissions or errors are unintentional, and the authors would appreciate it brought to their attention.

**Please contact Kasey Bliesner (Kasey.Bliesner@state.or.us) for additional data requests and before documents are published with new analysis using the data in this report.**

# METHODS

## Snake River Steelhead DPS

This inland steelhead Distinct Population Segment (DPS) occupies the Snake River Basin in Washington, Oregon, and Idaho and includes all naturally spawned populations of A-run and B-run steelhead in the Snake River and its tributaries (U.S. Office of the Federal Register 1997). The Snake River steelhead DPS was originally listed as threatened on August 18, 1997 (U.S. Office of the Federal Register 1997) and was reaffirmed on January 5, 2006 (U.S. Office of the Federal Register 2006). A draft Recovery Plan is being developed for the Snake River steelhead DPS to guide recovery of these populations. The Snake River basin encompasses an area of approximately 107,000 square miles, of which the northeast Oregon region comprises 4,880 square miles. Three major rivers in Oregon flow into the Snake River drainage: the Grande Ronde, Imnaha, and Wallowa Rivers (Figure 1). The Interior Columbia Technical Recovery Team (ICTRT) identified 29 populations in the Snake River Steelhead DPS (ICTRT 2010). The populations were grouped into six Major Population Groups (MPGs) distributed across the DPS from southeastern Washington, through northeastern Oregon, and central Idaho. Two MPGs, the Grande Ronde River and Imnaha River are located in northeast Oregon (ICTRT 2010) (Figure 1). Recovery status and methods used to generate the current status review of the Snake River steelhead DPS are described in the ICTRT Viability Criteria Report (ICTRT 2007).

### Grande Ronde River Summer Steelhead MPG

The Grande Ronde River Summer Steelhead MPG includes four extant (existing) summer steelhead populations; the Grande Ronde River Lower Mainstem Tributaries, Grande Ronde River Upper Mainstem, Joseph Creek and Wallowa River populations (Figure 2). Populations in the Grande Ronde MPG form a relatively coherent group genetically and the habitats they occupy are diverse (ICTRT 2010). Populations in the Grande Ronde River summer steelhead MPG were listed as ‘threatened’ under the Endangered Species Act (ESA) in 1997 (U.S. Office of the Federal Register 1997). Past hatchery practices resulted in Wallowa stock hatchery fish comprising a significant proportion of natural spawners in both the upper Grande Ronde River and Wallowa River populations in the past (ICTRT 2010). Although Wallowa stock hatchery fish are still released into portions of the Grande Ronde River subbasin, there have been a significant number of hatchery management changes which have reduced the number of hatchery fish spawning in nature (ODFW 2015b). The total smolt production (Oregon and Washington) has been reduced to 60% of the original level and all smolts are released into the Wallowa River in Oregon (Bumgarner and Schuck 2012; Carmichael et al. 2012) and Cottonwood Creek on the lower Grande Ronde River in Washington (R, Ruzycki, ODFW, personal communication). These management actions have resulted in much lower hatchery fractions in recent years.

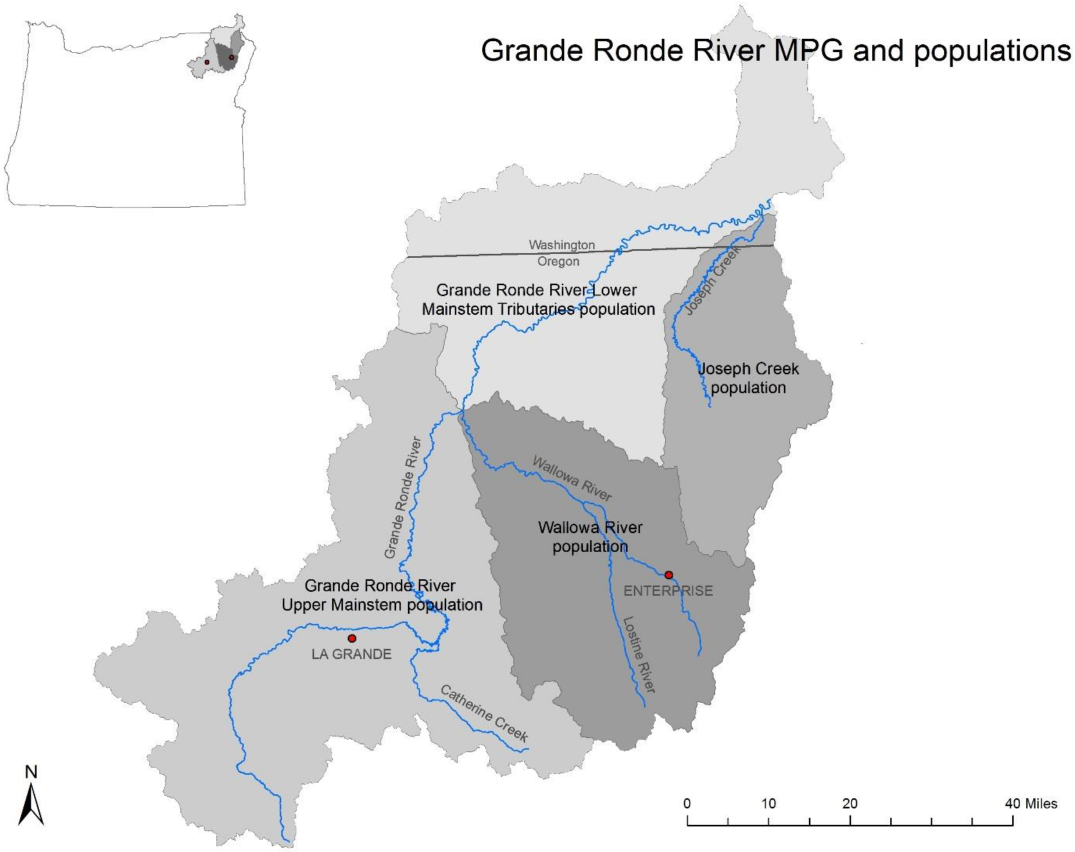


**Figure 2. Individual population boundaries within the Grande Ronde River MPG**

### *Grande Ronde River Lower Mainstem Tributaries Summer Steelhead Population*

*Date Modified: 12/15/2014*

## Population Description

The Grande Ronde River Lower Mainstem Tributaries (GRLM) population is 3,119 km$^2$ in size and consists of two Major Spawning Areas (MaSAs) and five Minor Spawning Areas (MiSAs) (ICTRT 2010). A hatchery-only fishery exists in the GRLM for returning fish that are released at the Wallowa Hatchery facility on the Wallowa River and the Big Canyon facility near the junction of Deer Creek and the Wallowa River (ODFW 2015b). Any natural origin fish caught in the lower Grande Ronde River fishery must be released. No data currently exists to estimate abundance for the population.

### *Grande Ronde River Upper Mainstem Summer Steelhead Population*

Date Modified: 3/3/2015

## Population Description

The Grande Ronde River Upper Mainstem summer steelhead population (GRUM) area is 4,239 km$^2$ in size and consists of six MaSAs and seven MiSAs (ICTRT 2010). Steelhead are widely distributed throughout the population area and occupy all six of the MaSAs and five of the seven MiSAs. Steelhead spawners are predominantly natural origin, although from 1999-2002, a portion of spawners were comprised of Wallowa Hatchery stock, which were directly released into Catherine Creek and the upper Grande Ronde River (ICTRT 2010). Although Wallowa stock hatchery fish are still released into portions of the Grande Ronde River subbasin, there have been a significant number of hatchery management changes which have reduced the number of hatchery fish spawning in nature (ICTRT 2010). The ODFW currently manages the GRUM for natural origin steelhead where hatchery influence is considered negligible.

Index spawning ground surveys began in 1967, and redd counts from annual index spawning ground surveys and intrinsic potential of spawning habitat were used to estimate abundance of adult summer steelhead (ICTRT 2010). In 2008, index site surveys were maintained for historical continuity, but the protocol was adjusted, and abundance is now based on a Generalized Random Tessellation Stratified (GRTS) design to achieve a statistically based dataset (Ruzycki et al. 2008). Data used for calculating age proportion and proportion hatchery origin spawners are collected by the Confederated Tribes of the Umatilla Indian Reservation (CTUIR) at three weirs in the GRUM population area.

## Field methods (spatial and temporal design)

*Index spawning ground surveys (1967-2007):* Index surveys are performed by walking a predefined section of creek once per year and counting redds. Index spawning ground surveys began in 1967 and continue to the present day at five index sites covering approximately 32.9 km of tributaries to the upper mainstem Grande Ronde River. Index survey sites are located on Meadow, Five Points, McCoy, Phillips, and Spring creeks. Fly Creek was part of the original index survey but was replaced with Spring Creek due to lack of access in the mid-1990s. Surveys are conducted annually by ODFW La Grande District and NECORM staff. Each index site is surveyed once, to capture all potential spawning, between April and June. Index spawning ground surveys are conducted with standard ODFW methods (Ruzycki 2012; Susac and Jacobs 1999). Generally, surveyors walk upstream from the bottom of each survey reach and count all redds. Index redds were geographically referenced beginning in 2010.

*GRTS spawning ground surveys (2008-present):* In 2008, the protocol was adjusted to maintain index site surveys for historical continuity, but a GRTS design was implemented to achieve a statistically useful dataset (Dobos et al. 2012). The GRTS design achieves a spatially balanced distribution of sites selected at random from the available spawning habitat to extrapolate an estimate of spawner abundance (Jacobs et al. 2009). GRTS utilizes a probabilistic sampling approach that incorporates a survey-site selection procedure created for the Environmental Protection Agency's Environmental Monitoring and Assessment Program (EMAP). This method follows the Oregon Plan for Salmon and Basins Monitoring Program approach (Stevens 2002).

Survey sites were limited to the current steelhead spawning distribution, which was defined by redd and fish counts from previous index spawning ground surveys and barriers identified during habitat surveys for summer steelhead. This information is annually updated to include newly identified barriers as well as new reaches of spawning habitat. All reaches upstream of known barriers to anadromous fish passage are eliminated from the potential sampling area. Beginning in 2012, a new survey design implementing sites selected from the Columbia Habitat and Monitoring Program (CHaMP) was integrated into the legacy design that includes the following components for the GRUM:

- 10 sites repeated annually
- 10 sites repeated once every 3 years on a staggered basis
- 5 sites from UGRR CHaMP frame to be repeated once every 3 years.
- 5 sites new every year (once-only)

Incorporating a 1:100,000 digital stream network, GIS was used to insure an unbiased and spatially balanced selection of survey sites. The GIS site selection process generated geographic coordinates (i.e. latitude and longitude) for each candidate site. A two-kilometer reach was established encompassing each candidate site. Topographic maps were produced showing the downstream and upstream ends of each survey reach along with the included GRTS point. In the field, crews used a handheld Global Positioning System (GPS) to locate the established survey reaches. Some candidate sites were not sampled due to denial of permission from private landowners or because sites were located upstream of previously unknown fish passage barriers. In such events, replacement sites were drawn from a pre-selected list of 'over-sample' sites (Fitzgerald et al. 2013). Because the GRTS procedure orders samples so that any consecutively numbered sample set is a randomly chosen, spatially-balanced sample, it has the ability to substitute consecutive samples when needed (Adams et al. 2011). This offers several major advantages. First, if any segment is unusable, the next segment in the GRTS draw can be substituted and the sample design will remain spatially balanced and randomized.

Spawning ground surveys are conducted with standard ODFW methods (Ruzycki 2012; Susac and Jacobs 1999). To reduce bias of surveyor observations, surveyors are rotated through sites and partners if logistics allow. Surveyors record the number of new redds as well as previously identified flagged redds, and mark each with a handheld GPS unit. Visibility codes of C1 to C5 indicating clear (C1) or moderate (C2) visibility; visible only due to presence of a flag (C3), not visible due to water clarity (C4), and unidentifiable despite adequate water clarity (C5) are assigned to each flagged redd. If steelhead carcasses are encountered, they are examined to obtain population and life history information by recording fork length (mm), MEPS (middle of the eye to posterior scale), length (mm), sex, egg retention (females), and origin determined by presence (natural) or absence (hatchery) of an adipose fin. For all carcasses, surveyors also collect scale samples for age determination.

*Upper Grande Ronde River, Lookingglass Creek and Catherine Creek weirs:* Three weirs (with traps), located on the mainstem Grande Ronde River (rkm 291; measured from the Grande Ronde River mouth), Catherine Creek (rkm 32), and Lookingglass Creek (rkm 3) are primarily used to monitor and manage returning adult Chinook but are also used to enumerate returns and evaluate timing of steelhead entering the basins prior to spawning (McLean et al. 2013). The Lookingglass Creek trap is located at the ODFW Lookingglass hatchery but all traps are operated by CTUIR.

Depending on water conditions, traps are installed from mid-February to early March, and are checked daily. Few steelhead are trapped after mid-June. Data on fork lengths, maturity, genetics, migration status, scales, sex, and presence of marks or tags are collected on all fish (ODFW et al. 2014). For the Catherine Creek and upper Grande Ronde River traps, all natural origin and hatchery origin adult steelhead are marked with an opercle punch and passed above the weirs to spawn naturally. At the Lookingglass trap, all hatchery origin fish are euthanized. Weir count data is used to determine percent hatchery origin spawners (pHOS) and age proportions derived from scales and age-length relationships from live adult steelhead (McLean et al. 2013). The Catherine Creek and upper Grande Ronde River traps also provide data to calculate a correction factor for index spawning ground surveys.

### *Deer Creek Fish per Redd Ratio*

A data analysis flow diagram is included in Appendix A for visual representation of this method.

Deer Creek, a third-order tributary, flows north from the Wallowa Mountains and enters the Wallowa River at rkm 18 (Banks 2013). Deer Creek is one of the few regional creeks where a full census count of steelhead redds can be completed and where a weir exists from which an accurate and precise count of steelhead can be obtained (Ruzycki 2012). From the redd surveys and counts at the weir, an annual fish per redd ratio is calculated which is used widely throughout northeast Oregon for expanding steelhead redd counts, from spawning ground surveys, to estimate number of spawners.

Each year since 2002, annual multiple-pass spawning ground surveys have been conducted on a bi-weekly basis on four reaches covering the initial 19.3 km of Deer Creek. Surveys occur from the end of March to early June each year, and are initiated after the first female steelhead is passed above the weir. Steelhead redd surveys on Deer Creek are based on the same standard ODFW methods as used on all watersheds in northeast Oregon (Ruzycki 2012). Surveyors walk downstream from the upstream end of each reach and count all redds, live fish, and carcasses observed.

The weir on Deer Creek is located 0.1 rkm upstream of its confluence with the Wallowa River at the Big Canyon acclimation facility, and is operated by ODFW. The weir becomes operational beginning in late January or early February and remains in place until at least ten days after the last fish is captured. Adult steelhead trapped at the Deer Creek weir are inspected for fin marks, counted, measured, and sexed. Steelhead with adipose fin-clips are removed at the weir. Steelhead without an adipose fin-clip are marked with a left-operculum punch if no other mark exists, and released upstream of the weir to spawn naturally. Adults that fall back to the weir are collected if dead or moribund, inspected for operculum punches and spawning condition, and passed below the weir. Only steelhead that are passed before the final spawning ground surveys are included in the fish estimate. In years when the weir is not operational due to water conditions, or was not installed prior to the first fish passing, total steelhead above the weir (used for fish/redd ratio) is estimated using the ratio of marked to unmarked fallbacks (S. Banks, June 19, 2014 memorandum, on Deer Creek summer steelhead spawning ground surveys).

The yearly fish per redd estimate is developed by dividing the estimated number of natural origin steelhead above the weir by the total observed redds from census surveys (Ruzycki 2012). To estimate fish per redd for years before Deer Creek was surveyed (1959-2001) an average of the first four years of Deer Creek fish per redd estimates (2002-2005) was calculated and the value of 2.1 fish per redd was used for all years prior to 2002 (ICTRT 2010).

## Analysis Methods

Data analysis flow diagrams are included in Appendix A for visual representation of these analysis methods.

### *Abundance*

For the GRUM steelhead population, total spawner abundance refers to the number of fish that have actually spawned, not the fish in river or the number of fish returning to the river. Since this abundance value is determined from redds and a spawner per redd expansion, all pre-spawning mortality has been accounted for in the abundance estimates.

*Natural Origin Spawner Abundance (NOSA):* NOSA is calculated by multiplying total spawner abundance (TSA) by one minus the proportion of hatchery origin spawners (pHOS) obtained from the upper Grande Ronde, Catherine Creek and Lookingglass Creek weir counts:

$$NOSA = TSA*(1\text{-}pHOS)$$

*Natural Origin Broodstock Removed:* No broodstock program in place. One exception was in 1987 where 21 natural Grande Ronde steelhead spawners were used for broodstock (L. Clarke, ODFW, personal communication)

*Proportion Hatchery Origin Spawners (pHOS):* Prior to 1989, there was no reliable method of enumerating hatchery spawners, and since there were no hatchery programs in place in the basin, pHOS was assumed to be zero. From 1990-2002, hatchery fish were direct released into Catherine Creek and the Upper Grande Ronde River, and pHOS was calculated by dividing the estimated number of direct stream released hatchery steelhead spawners by the estimated total spawners. From 2002 to present, the pHOS is calculated by dividing the total number of adipose fin-clipped steelhead by total steelhead captured at the Catherine Creek, Lookingglass Creek, and upper Grande Ronde River weirs.

*Total Spawner Abundance (TSA) – index surveys (1967-2007):* Currently, this method of estimating total spawners is maintained for comparison purposes, but since 2008, total spawner abundance estimates from the GRTS design (below) are the formal reported values.

Variability in spawning habitat quality and capacity is incorporated in this abundance estimate by using the ICTRT's historical intrinsic potential (ICTRT 2007) to expand redd observations per unit survey reach to unsurveyed reaches. To estimate redds in the population, the number of redds per weighted $m^2$ of intrinsic habitat in the index survey reaches are multiplied by the total $m^2$ of weighted intrinsic habitat available in drainages where reaches were surveyed. The estimated relative suitability of a habitat for spawning and rearing of anadromous salmonid species is inferred from stream characteristics including channel size, gradient, valley width, and habitat quality using GIS modeling (ICTRT 2007).

The estimated number of redds in each reach is calculated using the intrinsic method above, and then by an annual correction factor in each of three drainages (Catherine Creek, Lookingglass Creek, and upper Grande Ronde River). More adults escape to Lookingglass and Catherine creeks than the spawning ground surveys estimates predict, and fewer return to the upper Grande Ronde River. Therefore, redds estimated in each drainage is adjusted by multiplying redd densities in index reaches by the potential spawning area in each drainage, then multiplying by the ratio of actual/estimated adults at each of three weirs (Catherine Creek, Lookingglass Creek, and upper Grande Ronde River). This average correction factor (calculated from years 2001-2006) was used for all years prior to 2007. From 2007 to current, annual correction factors are calculated and used. After the estimated number of redds in each drainage is calculated, the values are summed and then multiplied by the fish per redd ratio from Deer Creek. Spawning surveys were not performed in the GRUM during 1984 and 1991, so the number of redds was estimated by using the density of redds in Joseph Creek for those years divided by the mean ratio of Joseph Creek to GRUM redd density from 1970-2004.

*Total Spawner Abundance (TSA) – GRTS surveys (2008-present):* The currently reported value of TSA is determined by summing the product of the weight value ($W$), number of redds observed/km surveyed at each site (*i*), and the fish per redd ratio determined from Deer Creek Surveys as:

$$TSA = \sum_{i=1}^{n} W(\frac{Redds}{km})_i (\frac{Fish}{Redd})$$

$W$ equals the distance of available spawning habitat in km (determined from GIS layer) divided by the number of sites surveyed as:

$$W=(\frac{km\ avail.}{no.\ sites})$$

A locally weighted neighborhood variance estimator (Stevens and Olsen 2004), which incorporates the pair-wise dependency of all points and the spatially constrained nature of the design, is used to estimate a 95% confidence interval of the spawner abundance estimate using the spsurvey package for R statistical software (R Development Core Team 2005).

*Proportion at Age (AgeProp):* Data to calculate proportion at age is provided by CTUIR using scales from steelhead captured at weirs on the Upper Grande Ronde River, Catherine Creek, and the Lookingglass Creek (C. Crump, CTUIR, personal communication). Prior to 1999, scales were not collected, so a constant age proportion was developed from the mean proportion at age from scales and an age-length relationships (for each sex) from natural origin steelhead collected at all three weirs from 1999-2004.

For most years after 1999, scales were collected on all steelhead captured at the three weirs. Scale ages were determined from readable scales collected from natural origin steelhead and proportion at age was developed. Exceptions to scale aging were from 1999-2001, 2004 and 2006, where adult steelhead returning to the weirs were sexed and measured for length, but not aged. For these years, an age-length relationship (for each sex) was developed from 2002 and 2003 scale age data to estimate proportion at age for each 50 mm size group and sex category.

### Productivity

Adult productivity for the GRUM population is reported as spawner recruits per spawner. Spawner 'recruits' are natural origin fish only and estimates are derived from NOSA and age structure. Spawners (TSA) includes both natural and hatchery origin spawners.

*Recruits per Spawner (RperS):* Recruits per spawner productivity is estimated by using the age proportion of natural origin spawners to assign the recruits back to a brood year. The recruits for each brood year is summed, and divided by the TSA for that brood year to calculate RperS ratios.

*Hatchery Spawners (HatcherySpawners):* From 1990-2002, hatchery spawners resulted from direct stream releases of smolts in Catherine Creek and the upper Grande Ronde River. After 2002, the number of hatchery spawners is estimated by multiplying pHOS by TSA. The ODFW currently manages the GRUM for natural origin steelhead where hatchery influence is considered negligible.

$$Hatchery\ Spawners = pHOS*TSA$$

*Recruits:* Natural origin spawner abundance in a specific spawning year is multiplied by the age proportion to assign natural origin recruits back to a brood year. Total recruits by brood year is the sum of age 4, 5, and 6 natural origin spawners from that brood year, and is the metric used as the "recruits" of the RperS calculation.

*Harvest:* Not applicable to RperS calculations since spawner recruits are used in the RperS calculations.

**Table 1. Summary of Grande Ronde River Upper Mainstem Summer Steelhead population methods adjustments**

| ***Years*** | **Methods** |
|---:|---|
| *1967-1983* | *Index survey. Hatchery proportion assumed to be 0.* |
| *1984* | *Index surveys were not conducted this year. Redds were estimated based on relationship with Joseph Creek Index surveys and proportion in each index survey reach. Hatchery proportion assumed to be 0.* |
| *1985* | *Index surveys were not conducted in McCoy Creek this year. Redds for McCoy Creek were estimated based on proportion in each index survey reach. Hatchery proportion assumed to be 0.* |
| *1986-1988* | *Index surveys. Hatchery proportion assumed to be 0. Constant age proportion.* |
| *1989-1990* | *Index surveys. Hatchery proportion estimated based on returns from estimated direct stream releases in Catherine Creek and the Upper Grande Ronde River.* |
| *1991* | *Index surveys were not conducted this year. Redds were estimated based on relationship with Joseph Creek Index surveys and proportion in each index survey reach. Hatchery proportion estimated based on returns from estimated direct stream releases in Catherine Creek and the Upper Grande Ronde River* |
| *1992-2002* | *Index surveys. Hatchery proportion estimated based on returns from estimated direct stream releases in Catherine Creek and the Upper Grande Ronde River.* |
| *2003-2007* | *Index surveys. Hatchery proportion estimated based on capture of hatchery returns at the weirs on Catherine Creek and the Upper Grande Ronde River.* |
| *2008-2013* | *GRTS based surveys. Hatchery proportion estimated based on capture of hatchery returns at the weirs on Catherine Creek and the Upper Grande Ronde River.* |

### *Joseph Creek Summer Steelhead Population*

*Date Modified: 3/3/2015*

## Population Description

Joseph Creek is located in northeastern Oregon and southeastern Washington and is a tributary to the Grande Ronde River at rkm 7 (measured from the Grande Ronde River mouth) (Banks et al. 2013). The spawning area used by Joseph Creek summer steelhead is 1,428 $km^2$, and consists of three major spawning areas (MaSAs) - Chesnimnus, Swamp, and Elk; and three minor spawning areas (MiSAs) - Joseph, Cottonwood, and Lower Joseph (ICTRT 2010). Spawning is widely distributed throughout the population area and spawners are predominately natural origin (ICTRT 2010). Joseph Creek is managed by ODFW for natural origin steelhead (Banks et al. 2014).

Annual evaluation of summer steelhead population abundance for Joseph Creek occurs though redd surveys utilizing both index spawning ground surveys and a stratified probabilistic survey design. Ongoing index spawning ground surveys are currently used for trend comparisons only. In 2012, a GRTS design was applied to spawning ground surveys to supply a more statistically robust population estimate with confidence bounds (Banks et al. 2014). In 2010, the Integrated Status and Effectiveness Monitoring Program installed a PIT-tag interrogation site at rkm 3 that provides an annual population estimate based on a mark-resight method. In 2011, the Nez Perce tribe installed a weir and adult trap (rkm 3.4) that provide an annual population estimate, age structure, and hatchery proportion for the population (Kucera et al. 2013). Although an annual population estimate is made at the weir and the PIT-tag interrogation site by the Nez Perce tribe, currently the official total spawner abundance estimates are derived from GRTS surveys conducted by ODFW and are reported to the ICTRT and NOAA for status evaluation of the population. Estimates and methods from these multiple approaches will be assessed in the future to determine a preferred approach.

## Field methods (spatial and temporal design)

*Index spawning ground surveys (1970-2011):* Index spawning ground surveys are conducted at 10 index sites located in tributaries to Joseph Creek. Index surveys occur in all three MaSAs, but none of the MiSAs. Each index site is surveyed once, to capture all potential spawning, between April and June. Surveys are generally conducted annually by ODFW Wallowa District staff. Index spawning ground surveys are conducted with standard ODFW methods (Ruzycki 2012; Susac and Jacobs 1999). Generally, surveyors walk upstream from the bottom of each survey reach and count all redds. In 2012, the protocol was adjusted to maintain index spawning ground surveys for historical continuity, but to use the (GRTS) design to achieve a statistically useful dataset (Dobos et al. 2012).

*GRTS spawning ground surveys (2012-present):* Spawning adult steelhead are monitored using a probabilistic sampling approach that incorporates a survey-site selection procedure created for the EMAP. The GRTS design achieves a spatially balanced distribution of sites selected at random from the available spawning habitat to extrapolate an estimate of spawner abundance (Jacobs et al. 2009). This method follows the Oregon Plan for Salmon and Watersheds Monitoring Program approach (Stevens 2002).

Survey sites were limited to the current steelhead spawning and rearing distribution, which was defined by redd and fish counts from previous index spawning ground surveys, professional judgment, and barriers identified during habitat surveys for summer steelhead. This information is annually updated to include newly identified barriers as well as new reaches of spawning habitat. All reaches upstream of known barriers to anadromous fish passage were eliminated from the potential sampling area. Approximately 25 sites are targeted annually for surveys and are selected as follows (Banks et al. 2013):

- 10 sites repeated annually
- 15 sites repeated once every 3 years on a staggered basis

Incorporating a 1:100,000 digital stream network, GIS was used to insure an unbiased and spatially balanced selection of sites. The GIS site selection process generated geographic coordinates (i.e. latitude and longitude) for each candidate site. A two-kilometer reach was established encompassing each candidate site. Topographic maps were produced showing the downstream and upstream ends of each survey reach along with the included GRTS point. In the field, crews used a handheld GPS to locate the established survey reaches. Some candidate sites were not surveyed due to denial of permission from private landowners or because sites were located upstream of previously unknown fish passage barriers. In such events, replacement sites were drawn from a pre-selected list of 'over-sample' sites (Fitzgerald et al. 2013). Because the GRTS procedure orders samples so that any consecutively numbered sample set is a randomly chosen, spatially-balanced sample, it has the ability to substitute consecutive samples when needed (Adams et al. 2011). This offers several major advantages. First, if any segment is unusable, the next segment in the GRTS draw can be substituted and the sample design will remain spatially balanced and randomized.

Spawning ground surveys are conducted with standard ODFW methods (Ruzycki 2012; Susac and Jacobs 1999). To reduce bias of surveyor observations, surveyors are rotated through sites and partners if logistics allow. Surveyors record the number of new redds as well as previously identified flagged redds, and mark each with a handheld GPS unit. Visibility codes of C1 to C5 indicating clear (C1) or moderate (C2) visibility; visible only due to presence of a flag (C3), not visible due to water clarity (C4), and unidentifiable despite adequate water clarity (C5) are assigned to each flagged redd.

If steelhead carcasses are encountered, they are examined to obtain population and life history information by recording fork length (mm), MEPS (middle of the eye to posterior scale), length (mm), sex, egg retention (females), and origin determined by presence (natural) or absence (hatchery) of an adipose fin. For all carcasses, surveyors also collect scale samples for age determination.

*Nez Perce weir and adult traps:* In 2011 a resistance board weir and upstream and downstream adult traps were installed in Joseph Creek at rkm 3.4 by the Nez Perce tribe (Kucera et al. 2013). The weir and adult traps were installed to collect natural origin steelhead abundance data, validate spawning ground survey redd counts, estimate percent hatchery origin in the run; and to determine migration timing, age structure, and life history characteristics of the Joseph Creek steelhead population (Kucera et al. 2013). The trap is in place from January through June and is checked daily (ODFW et al. 2014). A detailed description of Nez Perce weir operations can be found in Kucera et al. (2013). For the purpose of this reporting, only the percent hatchery composition (pHOS) is used from weir data to calculate natural origin spawner abundance.

## Analysis Methods

Data analysis flow diagrams are included in Appendix A for visual representation of these analysis methods.

### *Abundance*

For the JOS steelhead population, total spawner abundance refers to the number of fish that have actually spawned, not the fish in river or the number of fish returning to the river. Since this abundance value is determined from redds and a spawner per redd expansion, all pre-spawning mortality has been accounted for in the abundance estimates.

*Natural Origin Spawner Abundance (NOSA):* NOSA is calculated by multiplying TSA by one minus the proportion hatchery origin spawners (pHOS) obtained from the Joseph Creek weir counts:

$$NOSA = TSA*(1\text{-}pHOS)$$

*Natural Origin Broodstock Removed (NOBroodstockRemoved):* No hatchery programs exist within the Joseph Creek population area.

*Proportion Hatchery Origin Spawners (pHOS):* The pHOS is calculated by dividing the total number of adipose fin-clipped fish by all live fish captured at the weirs that could be observed for marks (Kucera et al. 2013).

*Total Spawner Abundance (TSA) – index surveys (1970-2011):* Currently, this method of estimating total spawners is maintained for comparison but since 2012 total spawner abundance estimates from the GRTS design (below) are the formal reported values.

From 1970 through 2011, annual index reach spawning ground surveys and intrinsic potential of habitat for spawning was used to estimate total abundance of adult summer steelhead in the Joseph Creek Basin. During years when there were missing data for one or more index reaches because of problems with scheduling, run-off conditions, access, weather, etc., the previous completed years were used to estimate an average proportion of total redds observed in each of the 10 index reaches. Average proportion of total redds is applied to years with missing data to estimate redds in index reaches that were not surveyed (ICTRT 2009).

For each MaSA containing index reaches, total annual redds are estimated by multiplying redd densities in index reaches (redds/$m^2$ weighted habitat) by the total $m^2$ of weighted habitat currently used in the MaSA. The sum of annual redd counts in the Chesnimnus, Swamp, and Elk MaSAs, are divided by the current weighted intrinsic potential $m^2$ of high quality habitat, as an annual average estimate of redds/$m^2$ for the Joseph Creek population. Redds in the Joseph, lower Joseph and Cottonwood MiSAs are estimated by multiplying the annual population-wide redds/$m^2$ by the current weighted intrinsic potential per $m^2$ for these three MiSAs. Annual redds in each MaSA and MiSA are summed to obtain an annual redd estimate for the Joseph Creek population. The estimated total annual redds are then multiplied by the Deer Creek fish per redd ratio to estimate total spawner abundance.

*Total Spawner Abundance (TSA) – GRTS surveys (2012-present):* The currently reported value of TSA is determined by summing the product of the weight value ($W$), number of redds observed/km surveyed at each site ($i$), and the fish per redd ratio determined from Deer Creek Surveys as:

$$TSA = \sum_{i=1}^{n} W\left(\frac{Redds}{km}\right)_i \left(\frac{Fish}{Redd}\right)$$

$W$ equals the distance of available spawning habitat in km (determined from GIS) divided by the number of sites surveyed as:

$$W = \left(\frac{km\ avail.}{no.sites}\right)$$

A locally weighted neighborhood variance estimator (Stevens and Olsen 2004), which incorporates the pair-wise dependency of all points and the spatially constrained nature of the design, is used to estimate a 95% confidence interval of the abundance estimate using the spsurvey package for R statistical software (R Development Core Team 2005).

*Proportion at Age (AgeProp):* A constant age proportion (using ages 4, 5, and 6) is used in all years of analysis for the Joseph Creek population. Currently, the best available data is from the GRUM population which is used as a surrogate for Joseph Creek. Detailed methods can be found in the Proportion at Age heading in the GRUM summer steelhead population methods description.

## Productivity

Adult productivity for the Joseph Creek steelhead population is reported as spawner recruits per spawner. Spawner recruits are natural origin fish only and estimates are derived from NOSA and age structure. Spawners (TSA) includes both natural and hatchery origin spawners.

*Recruits per Spawner (RperS):* Recruits per spawner productivity is estimated by using the age proportion of natural origin spawners to assign the recruits back to a brood year. The recruits for each brood year is summed, and divided by TSA for that brood year to calculate RperS ratios.

*Hatchery Spawners (HatcherySpawners):* The number of hatchery spawners is estimated by multiplying pHOS by TSA. The ODFW currently manages the Joseph Creek population for natural origin steelhead where hatchery influence is considered negligible.

$$Hatchery\ Spawners = pHOS*TSA$$

*Recruits:* Natural origin spawner abundance in a specific spawning year is multiplied by the age proportion to assign natural origin recruits back to a brood year. Total recruits by brood year is the sum of age 4, 5, and 6 natural origin spawners from that brood year, and is the metric used as the "recruits" of the RperS calculation.

*Harvest (HarvestAdj):* Not applicable to RperS calculations since spawner recruits are used in the RperS calculations.

**Table 2. Summary of Joseph Creek Summer Steelhead population methods adjustments**

| *Years* | *Methods* |
|---|---|
| *1970-2010* | *Index surveys; pHOS assumed to be 0* |
| *2011* | *Index surveys; pHOS calculated at Nez Perce weir (Kucera et al. 2013)* |
| *2012-2013* | *GRTS surveys; pHOS calculated at Nez Perce weir (Kucera et al. 2013)* |
| *2014* | *GRTS surveys; Weir not operated; pHOS average of 2011-2013 pHOS* |

### *Wallowa River Summer Steelhead Population*

*Date Modified: 3/3/2015*

### Population Description

The ICTRT (2010) has identified four MaSAs and two MiSAs within the Wallowa River summer steelhead population. Spawning is distributed widely throughout the population from lower elevation areas in Howard Creek to upper elevation areas in the Wallowa Mountains. Primary spawning areas include the Minam River, Bear Creek, Lostine River and Wallowa River, as well as smaller tributaries. Spawners are predominantly natural-origin fish. Although hatchery fish are released in the population and straying does occur, very low stray rates and a high degree of homing fidelity to acclimation release locations has been documented.

Insufficient data is collected for a full Wallowa River summer steelhead population estimate, however full census counts are conducted on Deer Creek, a tributary to the Wallowa River, and index redd surveys are conducted by ODFW Wallowa District staff on three tributaries to the Wallowa River (Prairie Creek, Whiskey Creek, and upper Wallowa River).

## Imnaha River Summer Steelhead MPG

The Imnaha River MPG includes one extant summer steelhead population, the Imnaha River population (Figure 3). Steelhead spawning occurs in the upper mainstem Imnaha River and a variety of tributaries including Cow, Lightning, Horse, Big Sheep, Little Sheep, Grouse, and Gumboot creeks (ICTRT 2010). The Imnaha River steelhead population was assigned as a single population MPG by the ICTRT based primarily on comparisons of samples of within-basin genetic diversity levels versus samples from Grande Ronde, Clearwater and Salmon River populations. Populations in the Imnaha River summer steelhead MPG were listed as 'threatened' under the Endangered Species Act (ESA) in 1997 (U.S. Office of the Federal Register 1997). Spawners include natural origin fish and hatchery fish from the Little Sheep Creek hatchery program. Supplementation with hatchery fish is ongoing in Little Sheep and Big Sheep creeks, and hatchery strays are known to stray into the lower river tributaries.

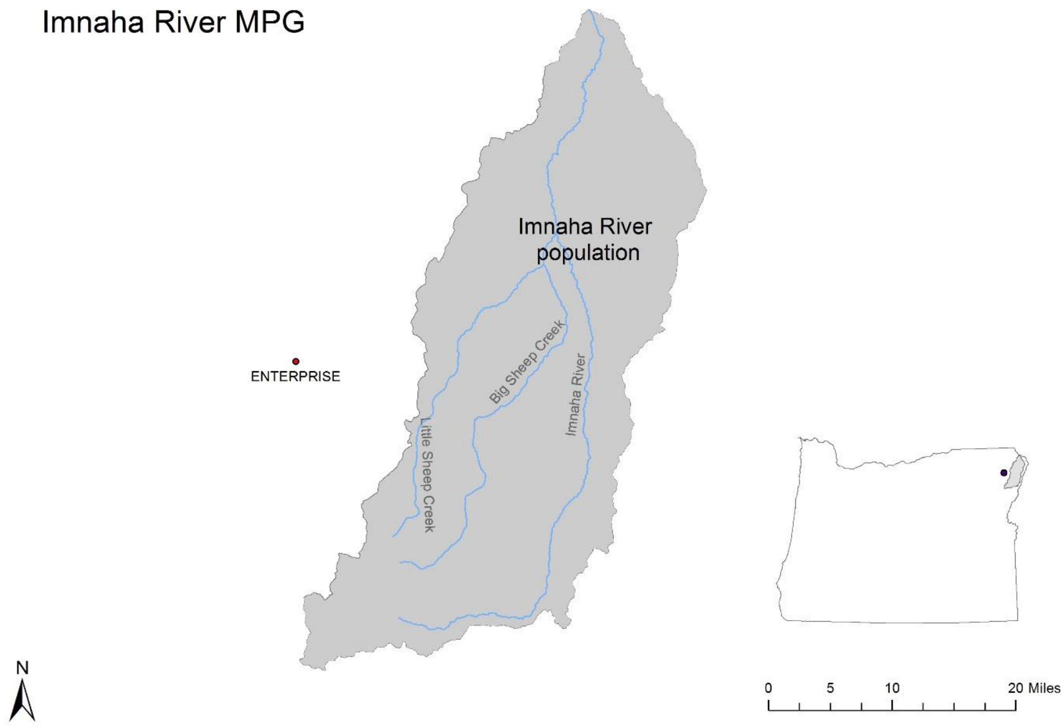


**Figure 3. Imnaha River population boundary within the Imnaha River MPG**

## *Imnaha River Summer Steelhead Population*

*Date Modified: 3/3/2015*

## Population Description

The Imnaha River subbasin is located in northeastern Oregon and encompasses an area approximately 2,202 $km^2$. The mainstem Imnaha River flows north for 128 km from its headwaters in the Eagle Cap Wilderness, to its confluence with the Snake River at rkm 309 (Harbeck et al. 2015). The ICTRT (2010) has identified four MaSAs and three MiSAs within the Imnaha River steelhead population. Spawning is distributed widely throughout the population boundaries from lower elevation, lower river tributaries, to high elevation streams in the Wallowa Mountains. Major production areas include Cow, Lightning, Horse, Little Sheep, and Big Sheep creeks, as well as the upper mainstem Imnaha River and tributaries. Spawners include natural-origin fish and hatchery fish from the Little Sheep Creek hatchery program. Supplementation with hatchery fish is ongoing in Little Sheep and Big Sheep creeks, and hatchery strays are known to stray into the lower river tributaries.

Historically, insufficient data has been collected for a full Imnaha River population estimate (ICTRT 2010) but the call for abundance, population growth, spatial distribution, and life history information on adult steelhead from the Imnaha River prompted a monitoring and evaluation study that began in 2011 by the Nez Perce Tribe (Harbeck et al. 2015). The Nez Perce Tribe has documented spawning in Gumboot Creek, Freezeout Creek, Dry Creek, Crazyman Creek and the upper Imnaha mainstem. Data collection is obtained via PIT tag detections, weir interrogations, spawning ground surveys, scale analysis and known age fish. The upper Imnaha abundance is determined using tagged steelhead from the Integrated Status and Effectiveness Monitoring Program (ISEMP) project which representatively marks natural adult steelhead at Lower Granite Dam with PIT tags. The PIT tags are placed into subsampled natural adults, thus defining the number and ratio of non-tagged to tagged adults above Lower Granite Dam.

A full population estimate is still not available at this time and proper status and trend assessment will require continued monitoring and the development of long term data sets (Harbeck et al. 2015).

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# APPENDICES

## Appendix A. Data Analysis and Data Management Flow Diagrams

For printing on 11” x 17” paper, maps can be downloaded separately for each population by going to the following link: https://nrimp.dfw.state.or.us/DataClearinghouse/default.aspx?p=202&XMLname=1101.xml

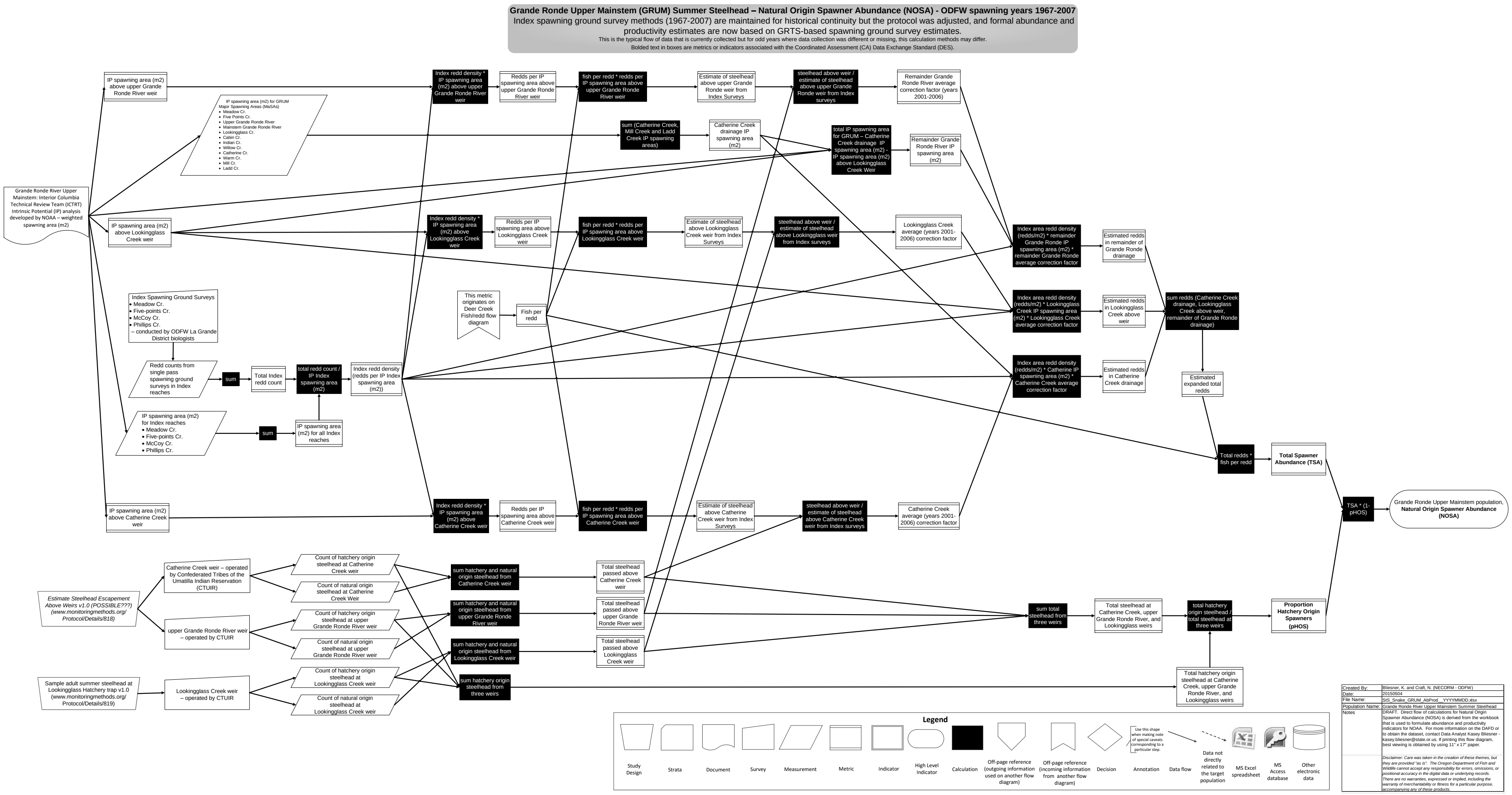



**Figure A-1. Grande Ronde Upper Mainstem (GRUM) Summer Steelhead – Natural Origin Spawner Abundance (NOSA) – ODFW - spawning years 1967-2007**

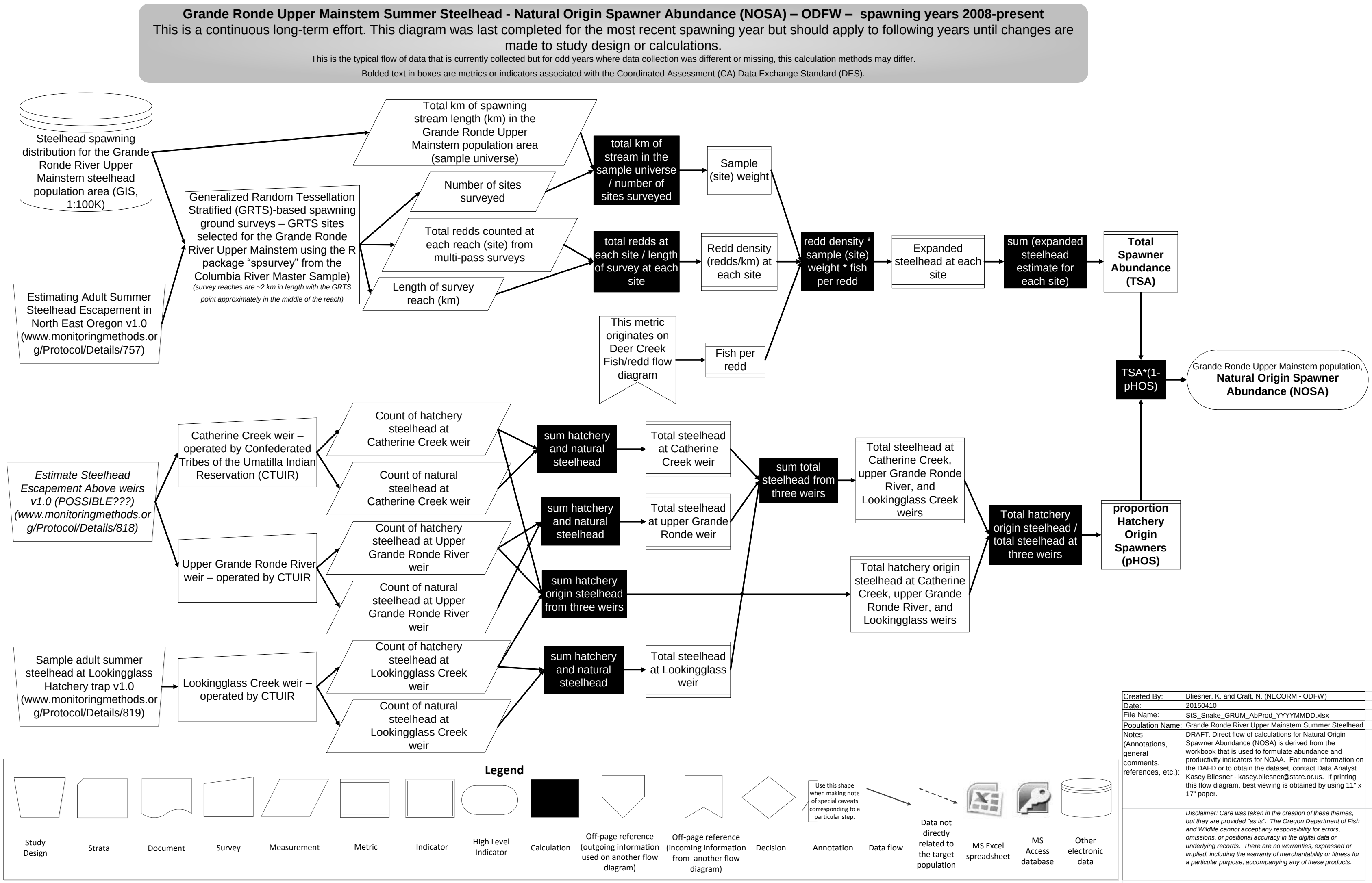


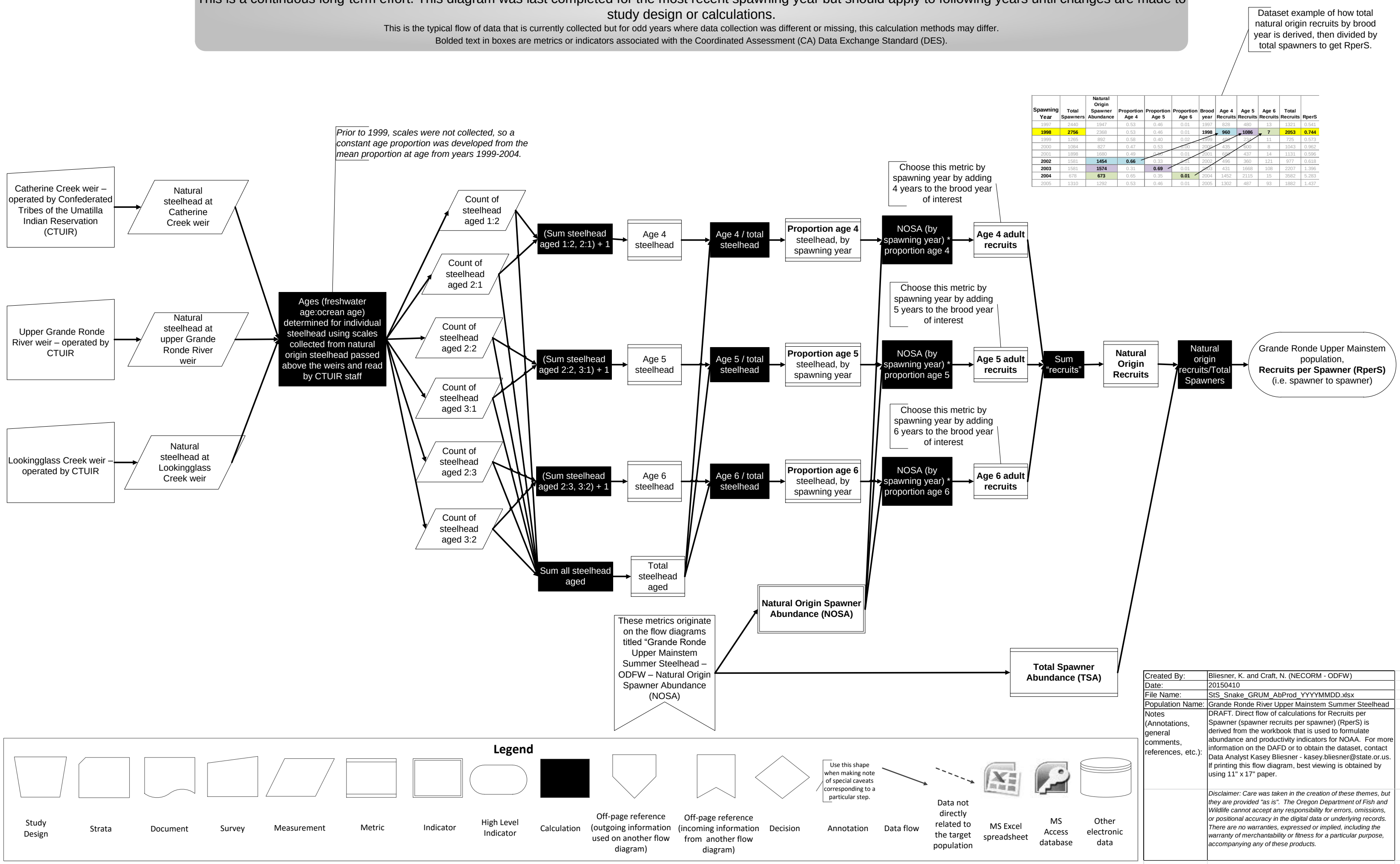

**Figure A-2. Grande Ronde Upper Mainstem Summer Steelhead - Natural Origin Spawner Abundance (NOSA) - ODFW – spawning years 2008-present**

**Grande Ronde Upper Mainstem Summer Steelhead – Recruits per Spawner (RperS) – ODFW – brood years 1967-present**

This is a continuous long-term effort. This diagram was last completed for the most recent spawning year but should apply to following years until changes are made to study design or calculations.

This is the typical flow of data that is currently collected but for odd years where data collection was different or missing, this calculation methods may differ.

Bolded text in boxes are metrics or indicators associated with the Coordinated Assessment (CA) Data Exchange Standard (DES).




| Spawning Year | Total Spawners | Natural Origin Spawner Abundance | Proportion Age 4 | Proportion Age 5 | Proportion Age 6 | Brood year | Age 4 Recruits | Age 5 Recruits | Age 6 Recruits | Total Recruits | RperS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1997 | 2440 | 1947 | 0.53 | 0.46 | 0.01 | 1997 | 828 | 480 | 13 | 1321 | 0.541 |
| 1998 | 2756 | 2368 | 0.53 | 0.46 | 0.01 | 1998 | 960 | 1086 | 7 | 2053 | 0.744 |
| 1999 | 1265 | 892 | 0.58 | 0.40 | 0.02 | 1999 | 480 | 234 | 11 | 725 | 0.573 |
| 2000 | 1084 | 827 | 0.47 | 0.53 | 0.00 | 2000 | 435 | 600 | 8 | 1043 | 0.962 |
| 2001 | 1898 | 1680 | 0.49 | 0.50 | 0.01 | 2001 | 680 | 437 | 14 | 1131 | 0.596 |
| 2002 | 1581 | 1454 | 0.66 | 0.33 | 0.01 | 2002 | 496 | 360 | 121 | 977 | 0.618 |
| 2003 | 1581 | 1574 | 0.31 | 0.69 | 0.01 | 2003 | 431 | 1668 | 108 | 2207 | 1.396 |
| 2004 | 678 | 673 | 0.65 | 0.35 | 0.01 | 2004 | 1452 | 2115 | 15 | 3582 | 5.283 |
| 2005 | 1310 | 1292 | 0.53 | 0.46 | 0.01 | 2005 | 1302 | 487 | 93 | 1882 | 1.437 |

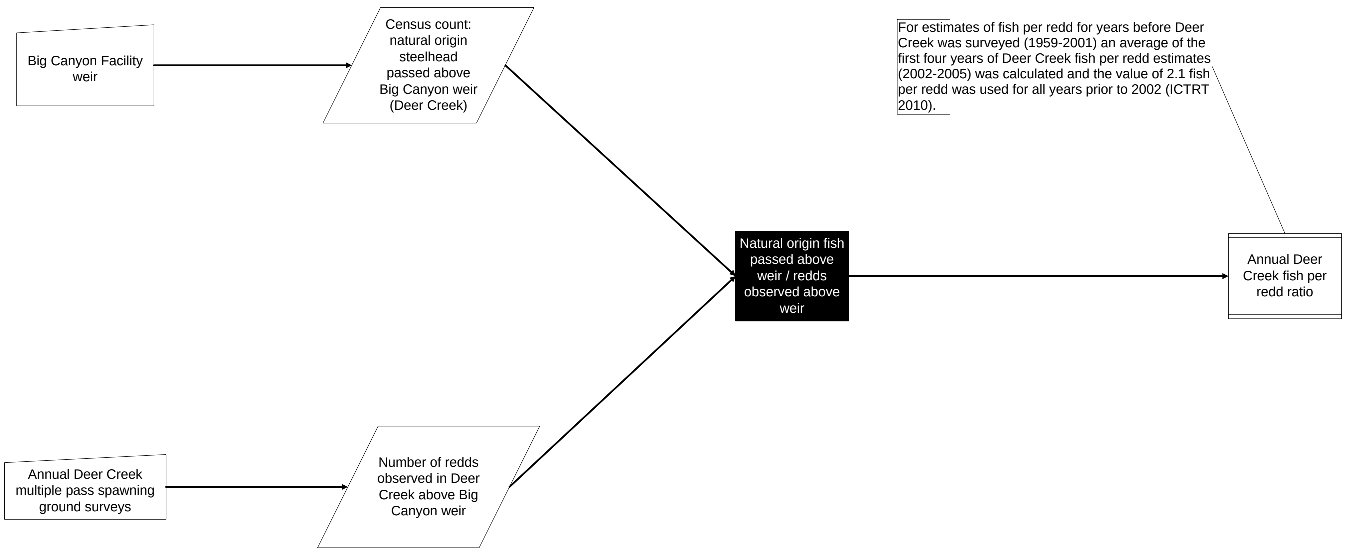
| | |
|---|---|
| Created By: | Bliesner, K. and Craft, N. (NECORM - ODFW) |
| Date: | 20150410 |
| File Name: | StS_Snake_GRUM_AbProd_YYYYMMDD.xlsx |
| Population Name: | Grande Ronde River Upper Mainstem Summer Steelhead |
| Notes (Annotations, general comments, references, etc.): | DRAFT. Direct flow of calculations for Recruits per Spawner (spawner recruits per spawner) (RperS) is derived from the workbook that is used to formulate abundance and productivity indicators for NOAA. For more information on the DAFD or to obtain the dataset, contact Data Analyst Kasey Bliesner - kasey.bliesner@state.or.us. If printing this flow diagram, best viewing is obtained by using 11" x 17" paper. |
| | *Disclaimer: Care was taken in the creation of these themes, but they are provided "as is". The Oregon Department of Fish and Wildlife cannot accept any responsibility for errors, omissions, or positional accuracy in the digital data or underlying records. There are no warranties, expressed or implied, including the warranty of merchantability or fitness for a particular purpose, accompanying any of these products.* |

**Figure A-3. Grande Ronde Upper Mainstem Summer Steelhead – Recruits per Spawner (RperS) – ODFW – brood years 1967-present**

**Deer Creek Summer Steelhead – Fish per Redd ratio – ODFW – spawning years 1959-present**

This is a continuous long-term effort. This diagram was last completed for the most recent spawning year but should apply to following years until changes are made to study design or calculations.

This is the typical flow of data that is currently collected but for odd years where data collection was different or missing, this calculation methods may differ.




| | |
|---|---|
| Created By: | Craft, N. and Bliesner, K. (NECORM - ODFW) |
| Date: | 20150520 |
| File Name: | StS_SNAKE_DeerCr_FishperRedd_DAFD_20150520 |
| Population Name: | Not applicable |
| Notes (Annotations, general comments, references, etc.): | DRAFT. Direct flow of calculations for fish per redd is derived from several workbooks from the Big Canyon Facitlity weir data and annual redds surveys. For more information on the DAFD or to obtain the dataset, contact Data Analyst Kasey Bliesner - kasey.bliesner@state.or.us. If printing this flow diagram, best viewing is obtained by using 11" x 17" paper. |
| | *Disclaimer: Care was taken in the creation of these themes, but they are provided "as is". The Oregon Department of Fish and Wildlife cannot accept any responsibility for errors, omissions, or positional accuracy in the digital data or underlying records. There are no warranties, expressed or implied, including the warranty of merchantability or fitness for a particular purpose, accompanying any of these products.* |

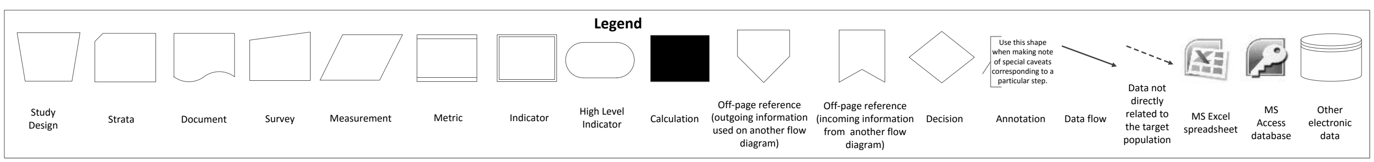



**Figure A-4. Deer Creek Summer Steelhead –Fish per Redd ratio –ODFW –spawning years 1959-present**

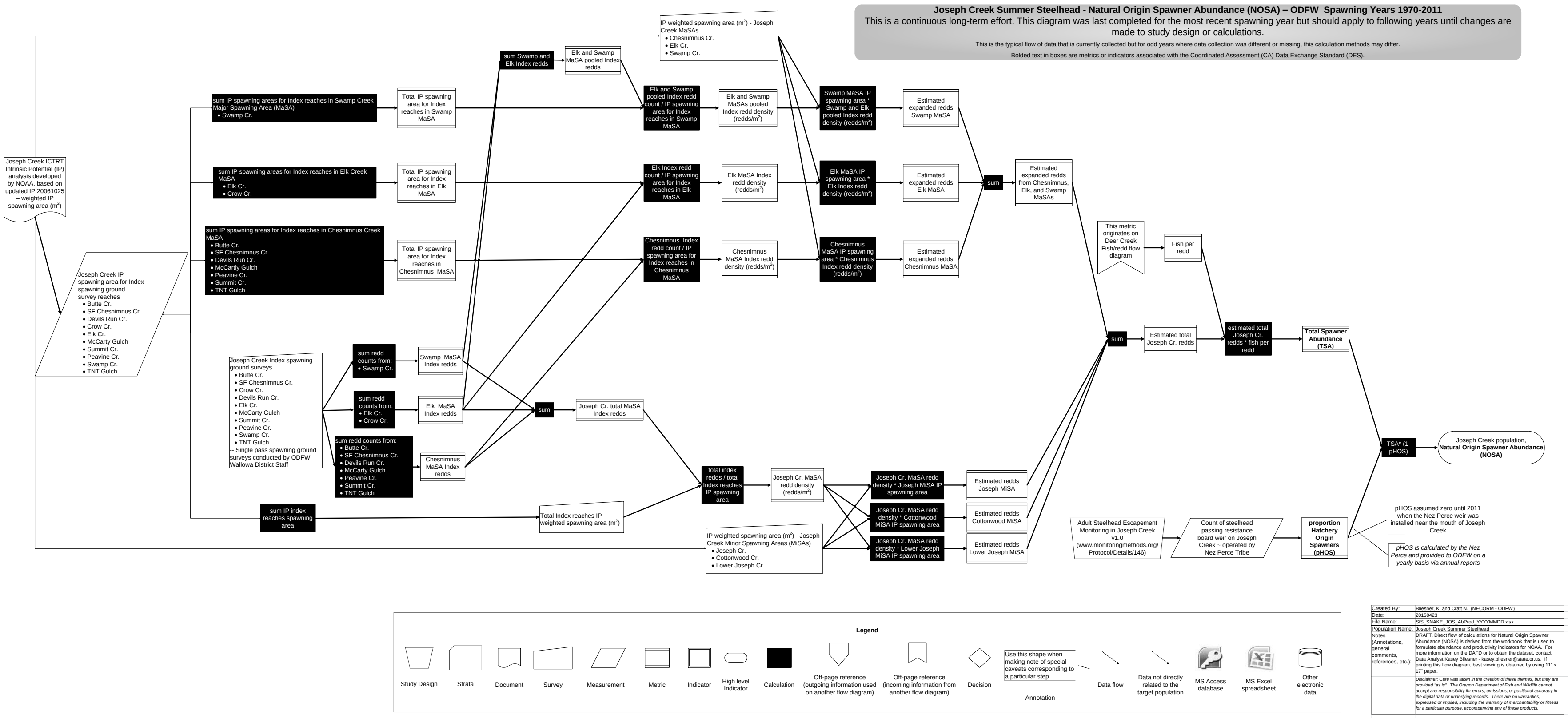



**Figure A-5. Joseph Creek Summer Steelhead - Natural Origin Spawner Abundance (NOSA) – ODFW - spawning years 1970-2011**

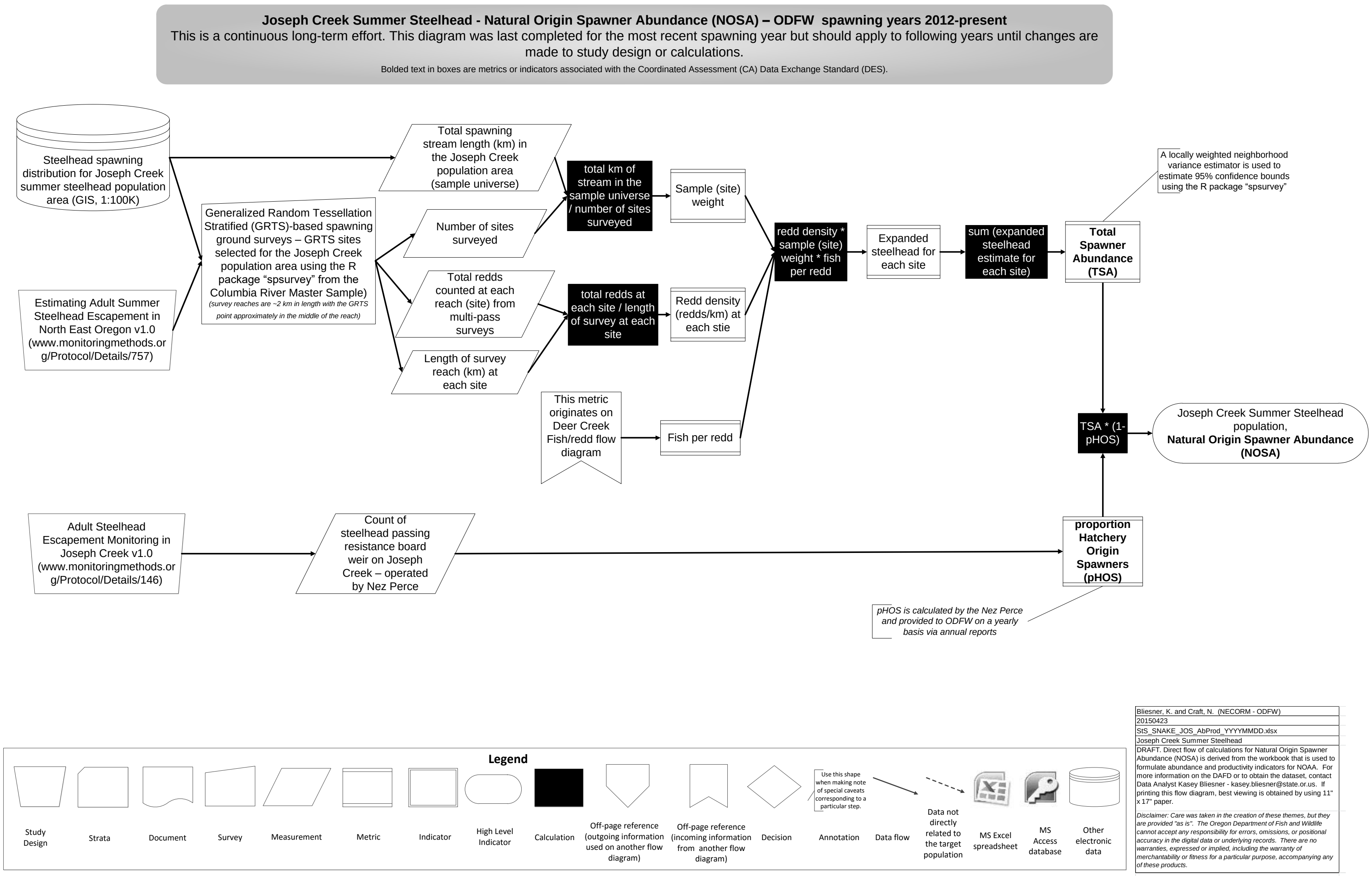



**Figure A-6. Joseph Creek Summer Steelhead - Natural Origin Spawner Abundance (NOSA) – ODFW - spawning years 2012-present**

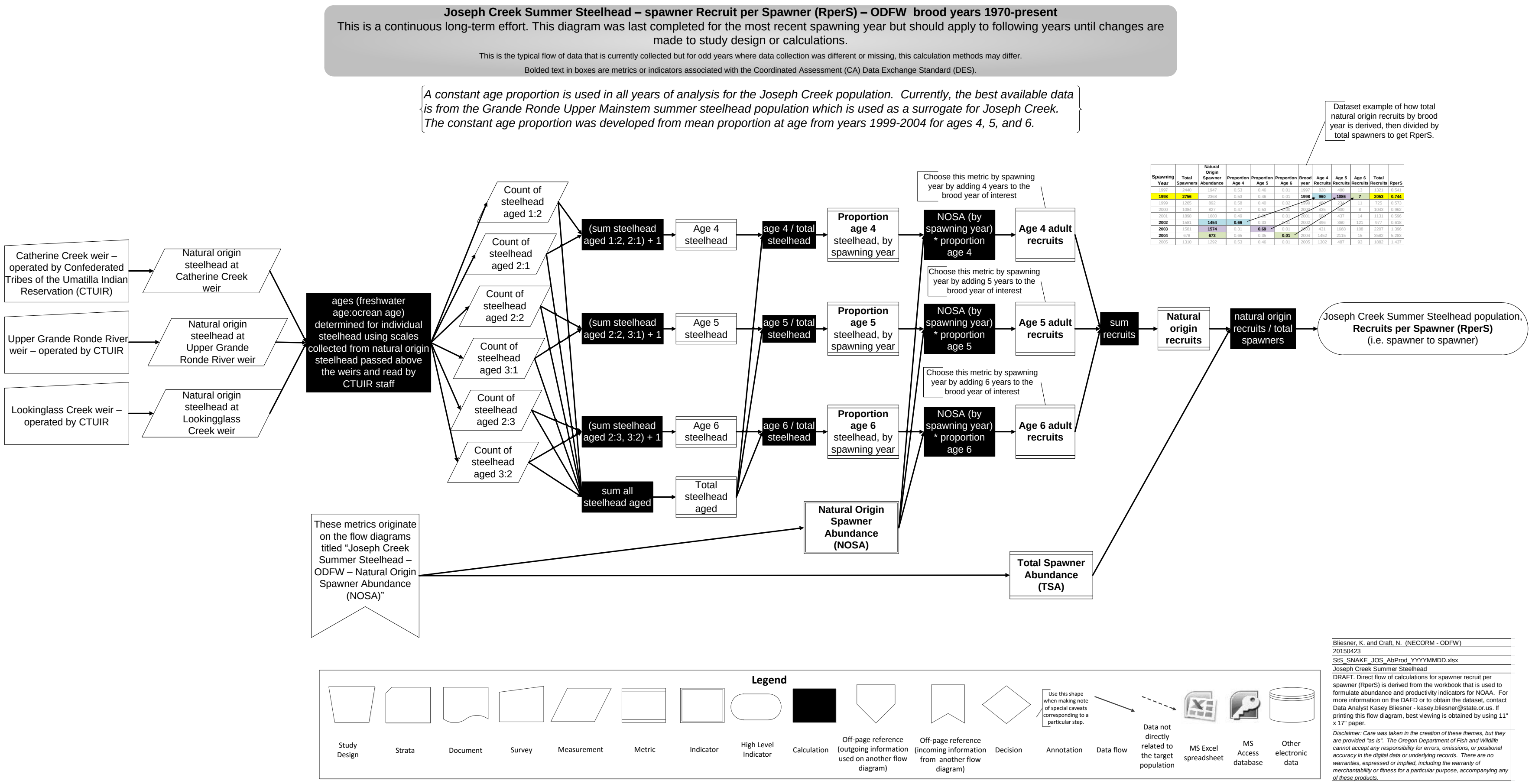



**Figure A-7. Joseph Creek Summer Steelhead – spawner Recruit per Spawner (RperS) – ODFW - brood years 1970-present**

# Appendix B. Official NOAA population names

Steelhead (Snake River Basin DPS) - Grande Ronde River Lower Mainstem summer-run
Steelhead (Snake River Basin DPS) - Grande Ronde River Upper Mainstem summer-run
Steelhead (Snake River Basin DPS) - Joseph Creek summer-run
Steelhead (Snake River Basin DPS) - Wallowa River summer-run
Steelhead (Snake River Basin DPS) - Imnaha River summer-run

# Appendix C. Data Contacts

## Data Stewards

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Nadine Craft (Nadine.M.Craft@state.or.us)

## Project Leads

Snake River Steelhead DPS— **Jim Ruzycki** (James.R.Ruzycki@state.or.us)

Joseph Creek—Ted Sedell (Edwin.R.Sedell@state.or.us)

Upper Grande Ronde—Ted Sedell

Middle Columbia Steelhead DPS—**Jim Ruzycki**

Deschutes River Eastside—Derrek Faber (Derrek.M.Faber@state.or.us)

Deschutes River Westside—Derrek Faber

Fifteenmile Creek—Derrek Faber

John Day River Basin Wide MPG—Jim Ruzycki

Lower Mainstem John Day River—Jim Ruzycki

Middle Fork John Day River—Jim Ruzycki

North Fork John Day River—Jim Ruzycki

South Fork John Day River—Jim Ruzycki

Upper Mainstem John Day River—Jim Ruzycki

Umatilla River—Lance Clarke (Lance.R.Clarke@state.or.us)

Walla Walla River—Lance Clarke

Snake River Chinook ESU— **Jim Ruzycki**

Big Sheep Creek—Tim Hoffnagle (Timothy.L.Hoffnagle@state.or.us); Joseph Feldhaus (Joseph.Feldhaus@state.or.us)

Catherine Creek—Tim Hoffnagle; Joseph Feldhaus

Grande Ronde River—Tim Hoffnagle; Joseph Feldhaus

Imnaha —Tim Hoffnagle; Joseph Feldhaus

Lostine River—Tim Hoffnagle; Joseph Feldhaus

Minam River—Tim Hoffnagle; Joseph Feldhaus

Wenaha River—Tim Hoffnagle; Joseph Feldhaus

Middle Columbia Chinook ESU—**Jim Ruzycki**

Upper Mainstem John Day River—Chris Bare (Christopher.M.Bare@state.or.us)

Lower Mainstem John Day River—Chris Bare

Middle Fork John Day River—Chris Bare

North Fork John Day River—Chris Bare