A Compendium of Viable Salmonid Population Abundance and Productivity Field and Analysis Methods for Natural Origin Steelhead Populations in the Middle Columbia River DPS of Northeast Oregon from 1959 to 2015

Authors
Richard W. Carmichael
Kasey L. Bliesner[1]
Will Cameron
Lance R. Clarke
Nadine M. Craft
Derrek M. Faber
Dana G. Kurtz
James R. Ruzycki
Eric Tinus[2]

May 2015

Northeast-Central Oregon Fish Research and Monitoring Program (NECORM)
Oregon Department of Fish and Wildlife
Eastern Oregon University, Badgley Hall 203
La Grande, OR 97850

This report is available at: https://nrimp.dfw.state.or.us/DataClearinghouse/default.aspx?p=202&XMLname=1100.xml

[1] Corresponding author

[2] North Willamette Watershed District Office, Clackamas, Oregon

Table of Contents

List of Tables

List of Figures

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: Coded-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 were 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, or 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 Middle Columbia 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 also 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 data analyst, Kasey Bliesner (Appendix C).

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 Middle Columbia River Steelhead DPS in north-central Oregon contain 12 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.

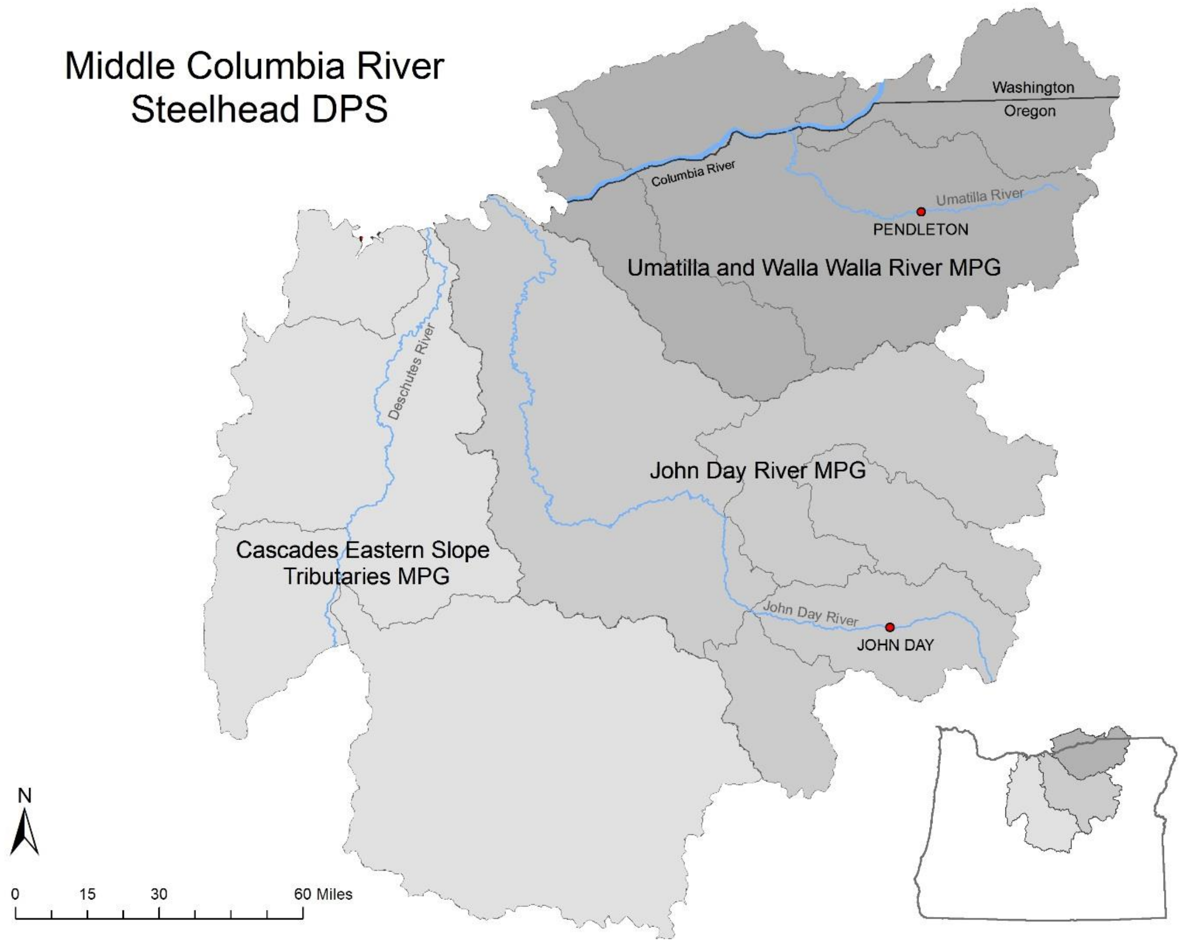


Figure 1. Cascades Eastern Slope Tributaries, John Day River and Umatilla/Walla Walla River MPG boundaries within the Middle Columbia River Steelhead DPS

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, W. Cameron, L. R. Clarke, N. M. Craft, D. M. Faber, D.G. Kurtz, J. R. Ruzycki, and E. Tinus. 2015. A Compendium of Viable Salmonid Population Abundance and Productivity Field and Analysis Methods for Natural Origin Steelhead Populations in the Middle Columbia River DPS of Northeast Oregon from 1959 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

The Oregon Department of Fish and Wildlife shall not be held liable for improper or incorrect use of the data described and/or contained herein. Oregon Department of Fish and Wildlife shall be acknowledged as data contributors to any reports or other products derived from these data (see citation information above). This data was developed based on a variety of sources. 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 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. 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

Middle Columbia River Steelhead DPS

The range of the Middle Columbia steelhead Distinct Population Segment (DPS) extends over approximately 90,649 km^2 in the Columbia plateau of eastern Washington and eastern Oregon (National Marine Fisheries Service [NMFS] 2009). The Mid-Columbia Steelhead DPS was listed as threatened under the Endangered Species Act (ESA) on May 24, 1999 and reaffirmed as a DPS on February 6, 2006 (U.S. Office of the Federal Register 1999, 2006). The Middle Columbia River Steelhead Distinct Population Segment ESA Recovery Plan was developed to guide the recovery of these populations (Carmichael and Taylor 2010, NMFS 2009). The Mid-Columbia steelhead DPS contains four Major Population Groups (MPGs) - Yakima River, Cascades Eastern Slope Tributaries, John Day River, and Umatilla/Walla Walla Rivers. Collectively the four MPGs contain 17 extant (existing) and 3 extirpated (locally extinct) independent populations. The Oregon portion of the DPS includes 10 extant populations – Fifteenmile Creek, Deschutes River Eastside, Deschutes River Westside, Lower Mainstem John Day, North Fork John Day, Middle Fork John Day, South Fork John Day, Upper Mainstem John Day, Umatilla River and Walla Walla River; and two extirpated populations – Deschutes/Crooked River and Willow Creek (Figures 2-4). Five extant populations and one extirpated population of Mid-C steelhead reside on the Washington side of the Columbia River.

The State of Oregon monitors the Mid-Columbia steelhead populations that occupy Oregon tributaries in coordination with its co-managers, the Confederated Tribes of the Warm Springs Reservation of Oregon (CTWSRO) and the Confederated Tribes of the Umatilla Indian Reservation (CTUIR). Recovery status and methods used to generate the current status review of the Mid-Columbia River steelhead DPS are described in the Interior Columbia Technical Review Team (ICTRT) Status Review (ICTRT 2010).

Cascades Eastern Slope Tributaries MPG

The Cascades Eastern Slope Tributaries MPG includes three extant steelhead populations in Oregon (Deschutes River Eastside, Deschutes River Westside, and Fifteenmile Creek) (Figure 2) and two in Washington (Klickitat River and Rock Creek). There are also two extirpated populations; Crooked River in Oregon and White Salmon River in Washington. This MPG has a geographically complex range, embracing one major river system – the Deschutes – and several smaller subbasins on both sides of the Columbia River. The Deschutes subbasin stretches over 27,712 km^2 of land in central Oregon and covers 11% of Oregon's land area (NMFS 2009). The Oregon populations within this MPG are summer run with the exception of the Fifteenmile Creek population which is designated as a winter run.

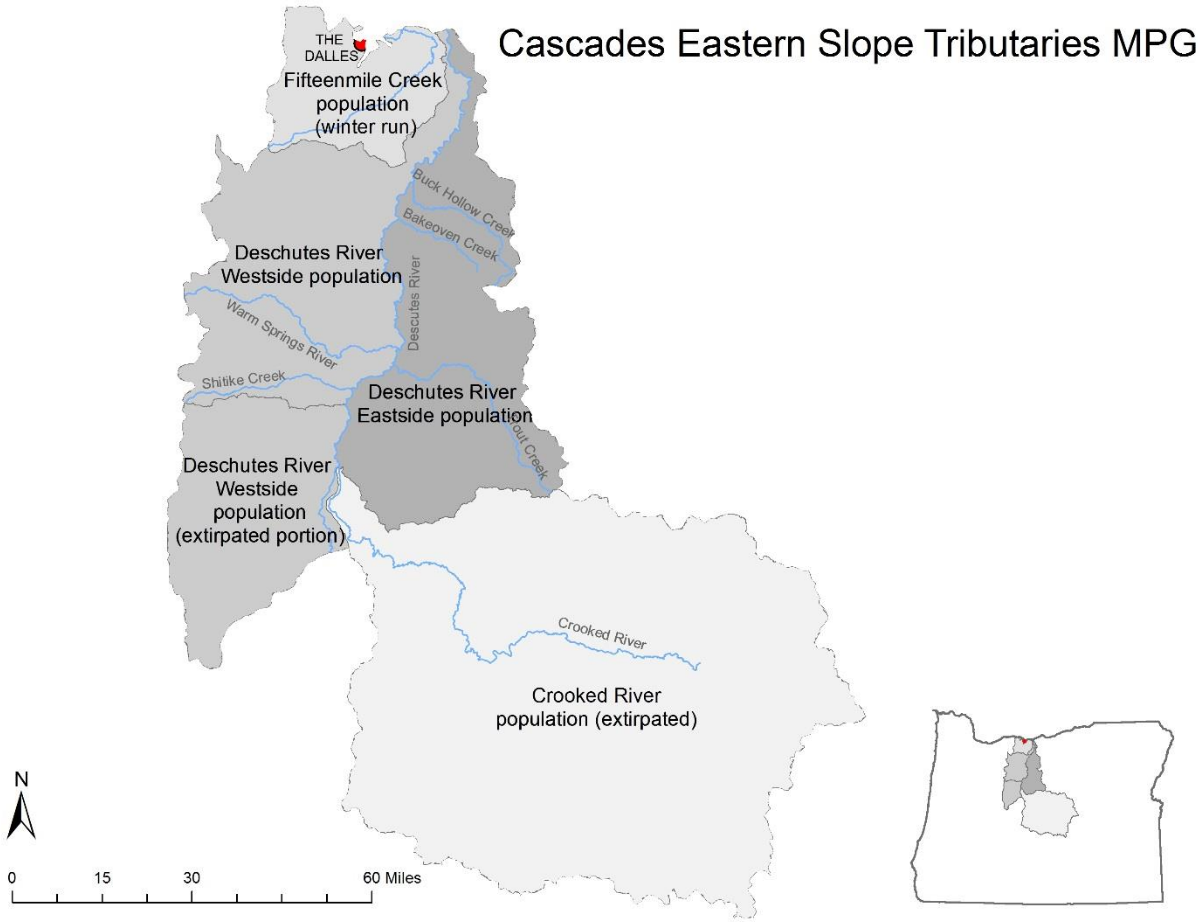


Figure 2. Individual population boundaries within the Cascades Eastern Slope Tributaries MPG

Fifteenmile Creek Winter Steelhead Population

Date Modified: 3/3/2015

Population Description

The Fifteenmile Creek (FIF) winter steelhead population is one of five extant populations in the Cascades Eastern Slope Tributaries MPG within the Mid-Columbia steelhead DPS, listed as threatened in 1999 and reaffirmed in 2006 (U.S. Office of the Federal Register 1999, 2006). The Interior Columbia Technical Review Team (ICTRT) has identified three MaSAs and five MiSAs within the FIF population boundary. The three MaSAs are upper Fifteenmile, Eightmile, and Fivemile creeks. The population boundary extends outside the Fifteenmile Creek subbasin to encompass the Rock Creek, Mill Creek, and Threemile Creek drainages which directly enter the Columbia River downstream from Fifteenmile Creek. These drainages account for four of the five MiSAs. The remaining MiSA is the lower portion of Fifteenmile Creek. Current spawning distribution is similar to historic, with major production areas in Fifteenmile, Ramsey, Eightmile, and Fivemile creeks (Carmichael and Taylor 2010).

The Fifteenmile Creek watershed in north-central Oregon supports a native population of steelhead that is without influence of previous hatchery augmentation and is considered the most inland winter race of steelhead in the Columbia River Basin.

A comprehensive monitoring and evaluation program is designed to assess status and trend, abundance, productivity, spatial structure, life history, and life stage specific survival of steelhead in the FIF population. Population performance metrics and indicators are estimated from data collected with the operation of a weir/trap to sample adult steelhead, a juvenile outmigrant trap (rotary screw trap), spawning surveys, juvenile surveys throughout the watershed, and from the installation of passive integrated transponder (PIT) tag arrays at strategic sites throughout the basin. This data supports evaluation of the population based on the criteria chosen by NOAA to define the viability of a population. Abundance and productivity estimates serve as a foundation for status and trends monitoring, ESA viability assessments, and for life cycle modeling.

Field Methods: (spatial and temporal design)

Index spawning ground surveys (1985-present): Estimates of abundance of adult steelhead spawners in the Fifteenmile Creek subbasin were based on redds observed during single pass spawning ground surveys conducted annually by the Oregon Department of Fish and Wildlife (ODFW) and U.S. Forest Service (USFS) personnel in selected survey units in upper Fifteenmile, Ramsey, and Eightmile creeks from 1985 through 2002 (Carmichael and Taylor 2010). Surveys were conducted by one or two experienced surveyors moving in an upstream direction. Previously uncounted redds were identified, redd age was assessed, and redds were flagged and/or marked with a brightly-colored, painted rock in the redd depression. Live fish were identified to species, tallied, and, if possible, fin marks were identified (Poxon et al. 2012).

Observed redd densities (redds/m^2) were extrapolated to unsurveyed reaches of currently occupied spawning habitat. Variability in spawning habitat quality and capacity were incorporated in the abundance estimate by using the ICTRT's historical intrinsic potential (ICTRT 2007) to expand redd observations per unit survey reach to unsurveyed reaches. The intrinsic potential is 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 using GIS modeling (Carmichael and Taylor 2010).

Stratified-random sampling design, spawning ground surveys (2003-present): In 2003, a stratified-random sampling design was implemented that was largely based on the standard methods for conducting steelhead redd surveys (Susac and Jacobs 1999, Jacobs et al. 2000, Jacobs et al. 2001). Under this new protocol, the majority of steelhead spawning grounds in each of Fifteenmile Creek (72 km), Eightmile Creek (39 km), Fivemile Creek (32 km), and Ramsey Creek (16 km) were divided into approximately 8 km strata which were further divided into five approximately 1.6 km sub-reaches. Originally, one sub-reach from each stratum was randomly selected for inclusion into the survey set each year. Beginning in 2008, Global positioning system (GPS) units were used to record redd location. In 2011 the protocol was modified to include two contiguous sub-reaches from each stratum. In addition, six of the 100 1.6 km reaches in the basin (two each in Fifteenmile Creek, Ramsey Creek, and Eightmile Creek) were identified as known high-density spawning "index" reaches, and were included automatically in each year's survey sample to provide abundance trend information. Up to three passes were conducted on each reach, and passes were conducted approximately bi-weekly (Poxon et al. 2012). Additionally, the protocol was adjusted so that each survey was conducted by no less than two surveyors, with at least one surveyor being an experienced surveyor with a minimum of one year of prior redd survey experience. Previously uncounted redds were marked with flagging; and the date of the survey, redd number, and redd condition were marked on the flagging. Stratified random spawning ground surveys were not performed in 2013, but resumed along with surveys of the "index" reaches as conditions allowed in 2014 and beyond.

Weir/adult trap, and video monitoring (2011-present): Beginning in 2011, returning adult steelhead were trapped using a resistance-panel weir (Tobin 1994, Stewart 2002, Stewart 2003). The weir is currently located approximately 100 m downstream of the confluence of Fifteenmile and Eightmile creeks. The weir was installed in the main channel of Fifteenmile Creek approximately midway between the exit and re-entry of a side channel that is regularly inundated during elevated winter flows. An "A-frame" picket weir (no trap box) was installed on the side channel such that adults were forced to migrate up the main channel where they could be intercepted by the resistance-panel weir. The weirs were cleaned and the trap was checked at least once daily and trapped steelhead were sampled for sex, fork length, scales, genetics, presence of marks or tags, and origin (natural or hatchery). All trapped natural origin steelhead were passed upstream of the weir/trap, whereas known hatchery steelhead (as identified by presence of certain marks/tags) were euthanized and sent to the USFWS Pathology Lab in Willard, WA for pathological/parasitological evaluation. Previously untagged natural origin steelhead received PIT tags and a secondary mark (diamond-shaped operculum punch) prior to release (Poxon et al. 2012).

In 2012, an attempt to increase overall trapping efficiency while reducing weir effects was made by making two modifications to the weir. A lighted, video-monitored bypass chute was installed adjacent to the resistance-panel weir bulkhead on the side of the weir opposite of the trap live-box and the entrance to the trap live-box was modified to an adjustable-height finger weir design (Poxon et al. 2014).

Passive-entry kelt trap (2011-present): Beginning in 2011, kelts (post-spawn steelhead returning to the ocean) were also trapped at the weir site using a passive-entry kelt trap. Kelts were sampled for the same information as returning adults before being passed downstream of the weir. Previously untagged kelts received PIT tags prior to release, and known hatchery kelts were euthanized and sent to the Willard Pathology Lab (Poxon et al. 2012). PIT-tag codes and biological data for all tagged adults were uploaded to the PIT Tag Information System (PTAGIS) database, an internet-accessible data clearinghouse for Columbia River basin PIT tag data operated and maintained by the Pacific States Marine Fisheries Commission (PSMFC).

In-basin PIT tag interrogation arrays (2011-present): Two in-stream, full-duplex (FDX-B) PIT tag interrogation arrays were installed in the Fifteenmile Creek watershed in 2011 at the confluences of Eightmile Creek and Fivemile Creek, as well as at the confluences of Fifteenmile Creek and Ramsey Creek for the purpose of detecting PIT-tagged juvenile and returning adult steelhead and to determine the broad-scale distribution of tagged adult steelhead spawners (Poxon et al. 2012). Those arrays were installed by NOAA Fisheries as a part of a separate Bonneville Power Administration (BPA) contract. In addition, tags were interrogated at the Fifteenmile Creek weir/trap. For 2012, the array was expanded to include new sites at the confluences of Fifteenmile and Eightmile creeks; and Fifteenmile and Dry creeks. Similar to the existing sites, antennae at both new sites were installed in the horizontal "pass over" style and logged PIT tag codes and times for each detection. The Huggins Closed-Captures model in Program MARK was used to estimate the efficiency of the entire array (eight detection sites, 24 antennas) from the detection histories of adult steelhead tagged at and released above the weir/trap. Array efficiency for tagged adult steelhead was estimated to be 95.3% (Poxon et al. 2014). Data offloads at all sites are automated and executed daily and detection data are compiled and uploaded to the PTAGIS database.

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 FIF 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. All pre-spawning mortality has been accounted for in the abundance estimates either because the abundance value is determined from redds and a fish per redd expansion or because the timing of steelhead trapped at the weir occurs during the spawning period such that any pre-spawn mortality has likely already occurred. In addition, spawners migrate back out as kelts and are encountered at the downstream kelt trap. Prior to 2011, all spawners were assumed to be natural origin because there were few live spawners observed on spawning surveys and all were natural origin. Since 2011, the hatchery stray proportion was determined from trapped fish at the weir.

Natural Origin Spawner Abundance (NOSA) - index spawning ground surveys (1985-2002): Prior to 2002, the annual FIF population estimate was determined by adding redd densities from upper Fifteenmile, Ramsey, and Eightmile creeks for each year from 1985 through 2002 (Carmichael and Taylor 2010).

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 weighed 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).

For years when streams in the Fifteenmile Creek subbasin were not surveyed (most notably Fivemile Creek prior to 2003) assumptions were made that redd density in unsurveyed streams were generally evenly distributed and synchronous with the entire population (Poxon et al. 2012). Average proportional relations relative to the Fifteenmile Creek mainstem were used to estimate spawning activity in unsurveyed streams (Fivemile Creek redds represent approximately 15% of the Fifteenmile Creek mainstem redds). Redds were then expanded to fish by multiplying total redds by 2.1 fish per redd, derived from summer steelhead in Deer Creek, a tributary of the Wallowa River (ICTRT 2010). The total number of steelhead redds constructed in the Fifteenmile Creek watershed during a given spawning season was estimated by expanding the survey counts first within each stratum, and then to the entire basin. Total redds were estimated as:

$$\hat{\tau}_{st}=\sum_{h=1}^{L} N_h \bar{y}_h$$

Where $\hat{\tau}_{st}$ is the un-biased estimate of the total number of redds in the basin, $\bar{y}_h$is the average number of redds observed during the spawning season in each survey reach within stratum h, N is the number of survey reaches in stratum h, and L is the total number of sampling strata in the basin (Thompson 1992, cited in Poxon et al. 2012).

Natural Origin Spawner Abundance (NOSA) – Stratified-random sampling design, spawning ground surveys (2003-2010): In this method, the total number of redds (estimated by expanding redd survey counts across the basin) was multiplied by the estimated number of fish per redd. The total number of steelhead redds constructed in the Fifteenmile Creek watershed was estimated by expanding the survey counts first within each stratum, and then to the entire basin. Total redds were estimated as:

$$\hat{\tau}_{st}=\sum_{h=1}^{L} N_h \bar{y}_h$$

Where $\hat{\tau}_{st}$ is the un-biased estimate of the total number of redds in the basin, $\bar{y}_h$is the average number of redds observed during the spawning season in each survey reach within stratum h, N is the number of survey reaches in stratum h, and L is the total number of sampling strata in the basin (Poxon et al. 2012,). Fish per redd estimates from Deer Creek were used to produce spawner abundance estimates with this method.

Natural Origin Spawner Abundance (NOSA) (2011-2012) – adult and kelt traps (mark-recapture): For the mark-recapture estimates, data from the weir/trap were used to estimate abundance according to the less-biased, Schnabel form of the Lincoln-Petersen estimator (Chapman 1951, cited in Poxon et al. 2012):

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

where $\hat{N}$ is the estimated abundance, M is the number of individuals initially marked, C is the number of individuals subsequently examined for marks, and R is the number of marked individuals from M that were recaptured in C. The variance of the abundance estimate was calculated according to Seber 1982, (cited in Poxon 2012):

$$\widehat{Var}(\hat{N})=\frac{(M+1)(C+1)(M-R)(C-R)}{(R+1)^2(R+2)}$$

$$\widehat{Var}(\widehat{N}) = \frac{(M+1)(C+1)(M-R)(C-R)}{(R+1)^2(R+2)}$$

Natural Origin Spawner Abundance (NOSA) (2013-present) – Weir/adult trap, kelt trap and video monitoring ('combined approach'): Abundance estimates beginning in 2013 are produced using a 'combined approach' that uses a combination of counts at the video-monitored bypass chute, daily kelt proportion data from the weir/trap (mark-recapture estimate above), and proportion run-timing data from the in-stream PIT array (Poxon et al. 2014). The PIT array abundance estimation method involves using mark-recapture data queried from PTAGIS that is entered into the Program MARK to estimate adult abundance based on known numbers of fish tagged, and subsequent PIT tag detections at Bonneville Dam and at the Fifteenmile PIT-tag antenna array (Poxon et al. 2014).

Natural Origin Broodstock Removed (NOBroodStockRemoved): Not applicable. No hatchery programs exist within the FIF population area.

Proportion of Hatchery Origin Spawners (pHOS): The calculation for proportion hatchery origin spawners (pHOS) = hatchery origin spawners/total spawner abundance. See methods described later for total spawner abundance (TSA), and Hatchery Origin Spawners.

Total Spawner Abundance (TSA): The TSA for the FIF population is calculated as:

$$TSA = NOSA + Hatchery\ Origin\ Spawners$$

Proportion at Age (AgeProp): From 1986-1991, age proportion was obtained from the average of age proportion from 1992-2009 at Powerdale Dam in Hood River (Reagan and Olsen 2008). From 1992 until 2009 (when the Powerdale dam was removed) age proportion was obtained from annual scale observations of winter steelhead captured at Powerdale Dam in the Hood River. Since 2011 age proportion has been derived from scales collected from trapped adults or a combination of scales and PIT tag detection histories. Total age is the sum of freshwater and ocean ages, plus an additional year due to overwintering in the Bonneville Pool before arriving on the spawning grounds (Poxon et al. 2014). For the year 2010 (before the Fifteenmile Creek weir was installed and after Powerdale Dam was removed), age proportion was assigned based on the 2011 proportion at the Fifteenmile Creek weir/trap.

Productivity

Adult productivity for the FIF 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 the total spawners (natural and hatchery adults spawning in the wild) for that brood year to calculate RperS ratios.

Hatchery Origin Spawners (HatcherySpawners): Hatchery origin steelhead in the FIF population have only been documented since the installation of the weir/adult trap in 2011, and when possible are removed. From 2011-2012, hatchery spawners in Fifteenmile Creek were determined from incoming hatchery origin adults vs. outgoing hatchery origin kelts encountered at the kelt trap, with efficiency rates factored in. Beginning in 2013, a video-monitored bypass chute was added to the adult and kelt trapping methods to form the 'combined approach' (see methods above) to calculate hatchery origin spawners (Poxon et al. 2014).

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 3, 4, 5, 6, and 7 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 1. Summary of Fifteenmile Creek Winter Steelhead population methods adjustments

Years	*Methods Adjustments*
1986-1991	*Age proportion obtained from the average of age proportion from 1992-2009 at Powerdale Dam in Hood River (Reagan and Olsen 2008)*
1992-2009	*Age proportion obtained from annual observation at Powerdale Dam in Hood River (Reagan and Olsen 2008)*
2010-2014	*Scale data collected from natural origin fish at the Fifteenmile Creek weir/adult trap installed in 2011. Age proportion for 2010 used scale data from 2011.*
2006	*No spawning ground observations are available for the 2006 spawning years due to poor water conditions. An estimate of the spawner abundance for 2006 is made by reconstructing the unknown 3 - 6 yr old cohorts from 2000 - 2003 based on the average proportion at age for years with observations.*
2009	*No spawning ground observations are available for the 2009 spawning years due to poor water conditions. An estimate of the spawner abundance for 2009 is made by reconstructing the unknown 3 - 6 yr old cohorts from 2003 - 2006 based on the average proportion at age for years with observations.*

Deschutes River Eastside Summer Steelhead Population

Date Modified: 3/3/2015

Population Description

The Deschutes River Eastside (DREST) summer steelhead population is one of five extant populations in the Cascades Eastern Slope Tributaries MPG within the Mid-Columbia steelhead DPS. The DREST population has six MaSAs and two MiSAs distributed in a dendritic pattern. The six MaSAs include Buck Hollow, Bakeoven, Upper and Lower Trout, Willow, and Ward/Antelope/Cold Camp creeks. Historically, Willow Creek was a significant production area but is not currently occupied because it is inaccessible. Neither of the two MiSAs (Jones and Campbell creeks) are currently occupied. Steelhead production is concentrated in Buck Hollow, Bakeoven and Trout Creeks, with some spawning in the mainstem from Trout Creek to Buck Hollow Creek (Carmichael and Taylor 2010). Spawners within the DREST population include natural-origin returns, hatchery returns from Deschutes River origin fish produced from Round Butte Hatchery, and out-of-DPS hatchery strays primarily from the Snake River basin.

Adult population metrics have been derived from data collected during spawning ground surveys (beginning in 1990), and more recently from the installation and operation of weirs and traps beginning in 2009 in Bakeoven and Buckhollow creeks (Faber et al. 2012). Trout Creek performance metrics continue to be estimated from redd counts. Starting in 2010, a before-after-control-impact (BACI) experimental design was implemented to quantify the effects of hatchery strays on productivity and evaluate the relative reproductive success of introgressed stray hatchery and natural origin steelhead that spawn in Bakeoven and Buck Hollow creeks. As part of the design, stray hatchery steelhead are excluded from Bakeoven Creek (treatment), but allowed to spawn in Buck Hollow Creek (control) until 2015 when hatchery strays will be removed from Buck Hollow Creek for a pre/post comparison. Passive Integrated Transponder (PIT) tag arrays were installed in 2012 to detect upstream and downstream movement of adults and juveniles.

Field Methods: (spatial and temporal design):

Index spawning ground surveys: Prior to 2009, estimates of the abundance of steelhead in the tributary production areas of the DREST population were based on single or multiple pass index spawning ground surveys in the MaSAs of Trout, Bakeoven, and Buck Hollow creeks. Single pass steelhead redd counts in the same river reach were conducted during late-March or early-April each year in Bakeoven and Buck Hollow creeks from 1990–2009 (Faber et al. 2012). Annual observations of redds began in 1993 in Trout Creek (excluding 1994). Redd surveys in Trout Creek continue to be the primary estimate method for this portion of the population but for Bakeoven and Buck Hollow creeks, ODFW now uses weir/trap structures and PIT tag arrays to estimate spawner abundance. Redd surveys are still conducted (when landowner access is provided) in Bakeoven and Buck Hollow Creeks to provide data to compare past methods with current methods (Faber et al. 2012).

Observed redd densities (redds/m^2) were extrapolated to unsurveyed reaches of currently occupied spawning habitat. Variability in spawning habitat quality and capacity were incorporated in the abundance estimate by using the ICTRT's historical intrinsic potential (ICTRT 2007) to expand redd observations per unit survey reach to unsurveyed reaches. The intrinsic potential is 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 using GIS modeling (ICTRT 2007).

Weir/trap structures, and PIT tag arrays:

Bakeoven and Buck Hollow creeks: In 2009, weir/trap structures were installed in Bakeoven and Buck Hollow creeks to provide a mark-recapture estimate of abundance for adult steelhead, validate single-pass redd surveys, and to estimate hatchery fraction from the ratio of marked to unmarked steelhead kelts encountered at the adult weir/trap (ODFW 2014). In the fall of 2010, a multiple year study to investigate the relative reproductive success of stray hatchery and natural origin steelhead and the influence of hatchery strays on natural productivity in Bakeoven and Buck Hollow creeks was implemented (Faber et al. 2012). Weir/trap structures are typically installed in early December and pulled in late May of the following year and trap live-boxes are checked daily with increased frequency during peak migration and during periods of high water and debris movement. Adult fish are enumerated, measured in FL (mm), sampled for scales and genetic tissue, and identified for sex and origin (hatchery or natural). Fish at the adult traps are also examined for PIT tags and coded wire tags (CWT) and, if released above the weir, are marked with a PIT tag (if not previously present) and an operculum punch (Faber et al. 2012). In addition, kelt traps (for post spawn steelhead returning to the ocean) are operated from February through May at the adult weir/trap sites and provide an estimate of weir capture efficiency by establishing a recapture site for steelhead originally captured at the adult weir/trap. Kelt traps are checked at least once daily and fish are enumerated and examined for operculum punches and PIT tags. The PIT tag arrays were installed approximately 200 m above the mouths of Bakeoven and Buck Hollow creeks in 2012 to complement weir/trap data (Faber et al. 2012). Naturally produced juvenile offspring and adult progeny returning to the creeks are also sampled and genotyped using the parentage based tagging (PBT) methods.

Trout Creek: In Trout Creek, monitoring structures include a smolt trap installed in 1998, adult traps in 2005, and 2 PIT tag arrays in 2009 and 2012. Due to the depth and velocity requirements of the smolt trap and vandalism concerns, the trapping location at river kilometer (rkm) 5.9 is above two known steelhead-spawning tributaries, Sagebrush (rkm 4.3) and Tenmile creeks (rkm 2.4). The smolt trap is generally operational from the beginning of March to mid-May and is checked daily (Nelson 2013). Low water levels can be a factor in how early the trap is removed. Adult estimates for Trout Creek continue to be based on redd counts, as recapture rates have been insufficient at the weir/trap to estimate adult abundance. Adult trapping operations located at rkm 0.8 and 10.4 have been difficult, and trapping efficiency is very low due to several high water events that collapsed the floating weir, allowing adults to pass the trapping facility (Nelson 2013). The PIT tag arrays that are used to complement weir/trap data are in Trout Creek at rkm 0.8 and 20.1 (confluence with Antelope Creek).

Analysis Methods

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

Abundance

For the DREST 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. All pre-spawning mortality has been accounted for in the abundance estimates either because the abundance value is determined from redds and a fish per redd expansion or the spawners migrate back out as kelts and are considered as post spawned when encountered at downstream kelt traps.

Natural Origin Spawner Abundance (NOSA): NOSA at the population level is calculated by summing the natural origin spawners from Bakeoven, Buck Hollow, and Trout creeks.

NOSA = natural origin spawners from Bakeoven Creek + Buck Hollow Creek + Trout Creek

Natural origin spawners from each tributary are calculated by multiplying the total spawners for each tributary by one minus the proportion of hatchery origin spawners obtained from Bakeoven, Buck Hollow, and Trout creek respectively:

*Natural origin spawners by individual tributary = total spawners from tributary * 1-(pHOS of tributary)*

Natural Origin Broodstock Removed (NOBroodStockRemoved): Not applicable. No hatchery programs exist within the DREST population area.

Proportion of Hatchery Origin Spawners (pHOS): A pHOS for each of the three tributaries is calculated to enumerate the number of natural origin fish in each tributary, which are then summed to obtain total NOSA. Then, the pHOS at the population level is calculated as one minus the proportion of total NOSA to TSA and is shown as:

$$pHOS = 1-(NOSA/TSA)$$

Details of how pHOS is calculated for each tributary: Before traps were installed in respective tributaries, visual observations during redd surveys were made to assess origin based on presence of a fin mark. For years when at least 10 fish were examined for the presence of adipose fins in each stream, the marked fish proportion was used for the pHOS (Carmichael and Taylor 2010). For years when fewer than ten fish were observed, pHOS was predicted for Buck Hollow Creek based on a linear regression of the percentage of hatchery fish on the spawning grounds in Buck Hollow Creek (from 1990-2009 when there were at least 10 fish available to examine) to the percentage of hatchery fish at Sherars Falls (predictor). Similarly, for years when fewer than ten fish were observed in Bakeoven Creek, pHOS was predicted based on a linear regression of the percentage of hatchery fish on the spawning grounds in Bakeoven Creek (from 1996-2009 when there were at least 10 fish examined) to the percentage of hatchery fish at Sherars Falls. In Bakeoven and Buck Hollow creeks, pHOS has been calculated from observations at weir/trap structures, and from PIT tag arrays since 2009 (Wilson et al. 2011). In Trout Creek, previous to the 2005 weir/trap installment, pHOS was estimated based on the ratio of marked fish to total fish observed on spawning grounds when at least 10 fish were examined. For years when fewer than 10 fish were examined, pHOS was predicted based on an average ratio of marked fish to total fish observed from years 2000-2003 and 2005 to present. Additional data will become available for pHOS as new information on the timing of returning adults are generated from PIT tag arrays in Bakeoven, Buck Hollow, and Trout creeks, installed in 2012. Trends in the Trout Creek hatchery proportion do not closely follow Buck Hollow and Bakeoven creeks and are considerably lower based on existing data.

Total Spawner Abundance (TSA) – spawning ground surveys (1978-2008): Prior to 2009, the DREST population estimate was determined by summing total redd estimates from Bakeoven, Buck Hollow, and Trout creeks, then expanding to fish by multiplying total redds by 2.1 fish per redd, derived from summer steelhead in Deer Creek, a tributary of the Wallowa River (ICTRT 2010).

Variability in spawning habitat quality and capacity were incorporated in the abundance estimate by using the ICTRT's historical intrinsic potential (ICTRT 2007) to expand redd observations per unit survey reach to unsurveyed reaches. To calculate expanded redds, the number of redds in the survey reaches were divided by the ratio of the area surveyed (m^2) to the intrinsic habitat potential (m^2). The fish per redd expansion factor is then applied to get TSA. The estimated relative suitability of a habitat for spawning and rearing of anadromous salmonid species under historical conditions is inferred from stream characteristics including channel size, gradient and valley width using GIS modeling (ICTRT 2007).

Total Spawner Abundance (TSA) – Weir/adult traps and spawning ground surveys (2009-present): Individual tributary estimates continue to be combined to make up the DREST population TSA, although methods for each tributary estimate have changed since 2009. The total abundance of adult spawners in Bakeoven and Buck Hollow is estimated by dividing the number of marked fish released upstream of the weir by the proportion of marked fish to marked and unmarked fish captured in the kelt trap using a less biased form of the Lincoln-Petersen estimator (Faber et al. 2012):

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

$$\widehat{Var}(\widehat{N})=\frac{(M+1)(C+1)(M-R)(C-R)}{(R+1)^2(R+2)}$$

Where $\widehat{N}$ is the estimated abundance, M is the number of individuals initially marked, C is the number of individuals subsequently examined for marks, and R is the number of marked individuals from M that were recaptured in C. Recapture rates of marked kelts at each kelt trap are reported for fish that were PIT-tagged at each weir/trap site. A closed capture model for downstream-migrating kelts was also used to estimate kelt trap efficiency for adult spawners above the weir/trap site (Faber et al. 2012). Trap efficiency was estimated using the Chapman form of the Lincoln-Peterson estimator:

$$TE=\frac{(R+1)}{(M+1)}$$

Trout Creek estimates are done using the redd count data and the ICTRT's historical intrinsic potential (Carmichael and Taylor 2010) to expand redd observations per unit survey reach to unsurveyed reaches. A fish per redd expansion factor from the Deer Creek fish per redd ratio is applied to get adult steelhead spawner abundance estimates.

Proportion at Age (AgeProp): Prior to 2009, age proportion information used to estimate progeny by brood year was based on the average of a two-year sample of scales from natural-origin adult steelhead (N=100) collected in the lower Deschutes River (Olsen et al. 1991). The resulting standard proportion for age was used from 1978-2008. Since 2009, age (from scales) has been evaluated from steelhead returning to Bakeoven and Buck Hollow creeks and is used to develop the age-return proportion for each of these creeks (Faber et al. 2012). This information is also used as a surrogate to Trout Creek until age information can be obtained from trap data or PIT tag arrays.

Productivity

Adult productivity for the DREST 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 the total spawners (natural and hatchery adults spawning in the wild) for that brood year to calculate RperS ratios.

Hatchery Spawners (HatcherySpawners): The number of hatchery spawners is estimated by multiplying pHOS by TSA.

Recruits (Recruits): Natural origin spawner abundance in a specific spawning year is multiplied by the age proportions to assign natural origin recruits back to a brood year. Total recruits by brood year is the sum of age 3, 4, 5, 6, and 7 natural origin spawners from that brood year, and is the metric used as 'recruits' in the RperS calculation.

Before 2009, recruits by brood year were obtained by multiplying TSA by the age structure of Deschutes River natural origin summer steelhead runs (constructed from aging scales collected in the Deschutes River by Olsen et al. 1991). The resulting standard proportion for age was used from 1978-2008. Since 2009, recruits have been estimated from age proportion data (scale analysis) taken from fish at the Bakeoven Creek and Buck Hollow Creek traps.

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

Table 2. Summary of Deschutes River Eastside Summer Steelhead population methods adjustments

Years	***Methods***
1990-1992, 1994, 2005	*No surveys conducted in Trout Creek. To estimate Trout Creek portion of DREST population, assume number of fish in Trout Creek is proportional to number of fish in Bakeoven and Buck Hollow. Calculate the mean proportion of Trout Creek fish to Bakeoven + Buck Hollow fish for all years that surveys were conducted in all three creeks. The mean proportion is then used to estimate the number of fish in Trout Creek.*
2006, 2008	*No surveys conducted in Bakeoven, Buck Hollow or Trout Creeks. Used proportion of Sherars Falls natural origin population estimate, based on regression of DREST spawner abundance estimate vs. Sherars unclipped estimate for years where spawning ground surveys were conducted in Buck Hollow, Bakeoven, and Trout Creeks.*
2009-2013	*From 2009 forward, TSA in Bakeoven and Buck Hollow creeks is estimated from mark-recapture at the adult traps, and NOSA is estimated by apportioning spawners into hatchery and natural, then subtracting hatchery fish that were removed downstream at traps. Trout Creek spawner abundance is still estimated using redd surveys.*

Deschutes River Westside Summer Steelhead Population (Extant portion)

Date Modified: 3/3/2015

Population Description

The Deschutes River Westside (DRWST) summer steelhead population is one of five extant populations in the Cascades Eastern Slope Tributaries MPG within the Mid-Columbia steelhead DPS. The DRWST population currently occupies four of the five historical MaSAs and seven of nine MiSAs. Current spawner distribution in MaSAs includes Shitike Creek, the Deschutes River mainstem, and Beaver and Mill creeks in the Warm Springs River subbasin. Steelhead reintroduction is currently underway in the historic MaSA of Whychus Creek which was previously inaccessible. Currently occupied MiSAs are Lower Warm Springs River and Lower Warm Springs River tributaries, and Wapinitia, Dry, Eagle, Oak Canyon, and Skookum creeks. Spawners within the DRWST population include natural-origin returns, hatchery returns from Deschutes River origin fish produced from Round Butte Hatchery, and out-of-DPS hatchery strays primarily from the Snake River basin.

Abundance estimates for the DRWST population of adult spawning steelhead are the sum of abundance estimates for three components of the population:

- Natural origin and hatchery origin fish that spawn in Shitike Creek
- Natural origin and hatchery origin fish that spawn in the mainstem Deschutes River from above the mouth of Trout Creek upstream to Pelton Reregulation Dam
- Natural origin fish that spawn upstream of the Warm Springs National Fish Hatchery (WSNFH) barrier dam at rkm 12.8 in the Warm Springs River

Deschutes River Westside Summer Steelhead Population (Extirpated portion)

The Metolius River and Whychus Creek are both part of the DRWST population but are currently considered extirpated (blocked) due to the Pelton-Round Butte dam complex. Current distribution is reduced significantly as a result of loss of accessibility to the MaSA of Whychus Creek drainage. The Metolius River was identified as a MaSA in the historically accessible habitat; however there is considerable uncertainty regarding the magnitude of historical steelhead production in this river (Carmichael and Taylor 2010). Recent conclusions suggest that the primary *O. mykiss* life history form in the Metolius River was resident and it is likely that little steelhead production occurred (Cramer and Beamsderfer 2001, cited in Carmichael and Taylor 2010). When the ICTRT conducted the spatial structure/diversity assessment, they did not consider the Metolius River as a MaSA due to the uncertainty in historical use.

Even though steelhead above the Pelton-Round Butte dam complex are considered extirpated, there is currently a hatchery run that is maintained through a capture and haul operation by the Round Butte Hatchery. These runs are not currently used in reporting spawning estimates for the Deschutes Westside but may be included in the future if returning fish (trap and haul) are considered natural runs.

Field Methods (spatial and temporal design)

Index spawning ground surveys:

Shitike Creek: Since 1982, the Confederated Tribes of Warm Springs Reservation of Oregon (CTWSRO) has conducted annual multiple pass redd surveys in index reaches of Shitike Creek. (Lovtang and Baker 2013). Surveys were conducted on each reach by one or two observers, walking or floating downstream. Redds were flagged on streamside vegetation as near as possible to each redd and numbered consecutively for each pass. A GPS point was collected for each redd, as well as descriptive information such as location of redd in stream, associated cover, fish presence on redds, and other observations (Lovtang and Baker 2013).

Mainstem Deschutes River: The ODFW conducts periodic spawning ground surveys on the mainstem Deschutes River from Trout Creek upstream to Pelton Reregulation Dam. Single pass aerial surveys were conducted in 1995 and 2001 (Pribyl 1995 and 2001, cited by Carmichael and Taylor 2010), and multiple pass surveys were conducted in 1996 and 1997 (Zimmerman and Reeves 2000).

Warm Springs River: Multiple pass redd surveys are also conducted in Warm Springs River by CTWSRO to monitor spatial distribution, but formal spawner abundance estimates are acquired through actual counts of natural origin steelhead that are passed above the WSNFH weir/trap (see weir/trap counts below).

Weir/trap counts:

Warm Springs River: The third component of the DRWST formal spawner abundance estimate is from the Warm Springs River with the enumeration of steelhead spawner abundance beginning in the 1980's at the WSNFH. Fish are counted near the ladder at the WSNFH, where a barrier weir/trap allows for the capture of all fish, with only natural origin steelhead being passed above the weir (Lovtang and Baker 2013).

Sherars Falls: Sherars Falls (rkm 69.2) in the lower Deschutes River has provided estimates of natural and hatchery summer steelhead passing the falls since 1977 using Peterson mark-recapture estimation techniques (Carmichael and Taylor 2010). The metrics collected at Sherars Falls are used as adjunct data to calculate population estimates or proportion of hatchery origin when data is missing in the mainstem Deschutes River, Warm Springs River, or Shitike Creek. The mark recapture estimates are made by using Floy tags to mark natural and hatchery summer steelhead captured at the Sherars Falls adult trap (located in the fish ladder at Sherars Falls) and making later recovery of both tagged and untagged fish at WSNFH and at the Pelton Fish Trap at rkm 160.9. The Sherars Falls trap is typically installed mid-June and removed early in November.

Analysis Methods

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

Abundance

For the DRWST 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. All pre-spawning mortality has been accounted for in the abundance estimates because the abundance value is determined from redds and a fish per redd expansion or because the timing of steelhead trapped at weirs occurs during the spawning period such that any pre-spawn mortality has likely already occurred.

Natural Origin Spawner Abundance (NOSA): Abundance estimates for the DRWST population of adult spawning steelhead are the sum of abundance estimates for three components of the population (see Population Description). NOSA is estimated by multiplying TSA by the average proportion of natural fish observed in each of the three components. The proportion of natural fish observed is calculated by subtracting the proportion of hatchery origin spawners (pHOS) from one:

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

Natural Origin Broodstock Removed (NO Broodstock Removed): No natural origin spawners are removed for broodstock. Round Butte Hatchery uses only Round Butte origin steelhead for broodstock.

Proportion of Hatchery Origin Spawners (pHOS): The pHOS for the DRWST population is estimated by summing estimates of hatchery numbers for Warm Springs River, Shitike Creek, and the Deschutes River mainstem, and dividing by TSA for the DRWST population. The pHOS for Warm Springs River is acquired directly from natural/hatchery proportions at the WSNFH, while pHOS for Shitike Creek and the mainstem Deschutes River (assumed to be equal proportions to the estimate at WSNFH) are calculated using the hatchery proportion entering WSNFH trap and multiplying it by the spawner abundance for Shitike Creek and the mainstem Deschutes River. Exceptions for Shitike Creek are for years 2001 and 2004-08 when pHOS was calculated directly from trap observations in Shitike Creek.

Total Spawner Abundance (TSA): Total spawner abundance estimates for the DRWST population are the sum of abundance estimates for three components of the population:

Warm Springs River: Census counts at WSNFH of natural origin steelhead passed upstream.

Shitike Creek: Observed redd densities (redds/m^2) in surveyed reaches are used to estimate redd densities in unsurveyed reaches. Variability in habitat quality and capacity throughout reaches in Shitike Creek is accounted for by using the ICTRT's historical intrinsic potential. The ICTRT intrinsic potential analyses are used to estimate redds per weighted m^2 of habitat in surveyed reaches. To estimate total redds in the population, observed redds are divided by the proportion of currently occupied habitat surveyed (weighted m^2) in Shitike Creek (Carmichael and Taylor 2010). Redds are then expanded to fish by multiplying total redds by a fish per redd expansion factor, derived from summer steelhead in Deer Creek, a tributary of the Wallowa River.

Mainstem Deschutes (Trout Creek upstream to Pelton Reregulation Dam): Single pass aerial redd surveys were conducted in 1995 and 2001 (Pribyl 1995 and 2001, cited by Carmichael and Taylor 2010), and multiple pass surveys were conducted in 1996 and 1997 (Zimmerman and Reeves 2000). Expanded redds from periodic aerial and boat surveys also use the Deer Creek fish per redd ratio. In years when surveys are not conducted, spawner abundance in the mainstem Deschutes is estimated by multiplying the number of natural origin steelhead that are passed above Sherars Falls by the mean proportion of the natural origin abundance estimate obtained from aerial and boat spawning ground surveys conducted in the mainstem Deschutes in 1995-97 and 2001.

Proportion at Age (AgeProp): Virtually no spawning steelhead in the DRWST population were sampled for age-at-return prior to 2009. Therefore, age structure from 1978-2008 is based on the average of a two-year sample of scales from natural origin adult steelhead (N=100) collected in the lower Deschutes River (Olsen, et al. 1991). The resulting standard proportion for age was used from 1978-2008. Since 2009, recruits are estimated from age proportion data (scale analysis) taken from fish at the Bakeoven Creek and Buck Hollow Creek traps, in the DREST population.

Productivity

Adult productivity for the DRWST steelhead population is calculated 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): The number of hatchery spawners is estimated by multiplying pHOS by TSA.

Recruits (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, 6, and 7 natural origin spawners from that brood year, and is the metric used as the 'recruits' of the RperS calculation. Before 2009, recruits by brood year were obtained by multiplying TSA by the age structure of Deschutes River natural origin summer steelhead runs (constructed from aging scales collected in the Deschutes River by Olsen et al. 1991). The resulting standard proportion at age was used from 1978-2008. Since 2009, recruits have been estimated from age proportion data (scale analysis) taken from fish at the Bakeoven Creek and Buck Hollow Creek traps, in the Deschutes River Eastside population.

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

Table 3. Summary of Deschutes River Westside Summer Steelhead population methods adjustments

Year	*Methods*
1978-2008	*Age and average age proportion of spawners in the Deschutes River were obtained from scales collected from natural origin Deschutes fish in the mainstem in 1970 and 1971 (Olsen et al. 1991).*
2009-2012	*Assume age proportion of Deschutes Westside populations are the same as age proportion of combined Bakeoven/Buck Hollow natural origin fish passed above weirs.*

Crooked River Summer Steelhead Population

Population Description

Date Modified: 3/3/2015

The functionally extirpated Crooked River summer steelhead population, located entirely above the Pelton Reregulation Dam in the Deschutes River subbasin, was historically part of the Cascades Eastern Slope Tributaries MPG within the Mid-Columbia steelhead DPS (Carmichael and Taylor 2010). Prior to the construction of the Pelton reregulation Dam, previous steelhead distribution was restricted in the Crooked River by construction of Ochoco Dam at rkm 16.1 in 1921 and further by Bowman Dam (rkm 112.6) constructed in 1961. Access to habitat above rkm 160.9 on the mainstem Deschutes River was blocked entirely in 1968 due to inadequate passage at the Pelton and Round Butte dams, thus terminating access to the Crooked River drainage. The ICTRT has identified ten MaSAs and two MiSAs within the Crooked River steelhead population.

The population boundaries are completely above the Pelton Reregulation Dam and, therefore, no estimates are made as all areas are currently inaccessible.

John Day River MPG

There are 5 extant summer run steelhead populations within the John Day River MPG: Lower Mainstem Tributaries, Middle Fork, North Fork, South Fork, and Upper Mainstem (Figure 3). The John Day River, which is completely within Oregon, flows west from the Blue Mountains and then north through a deeply carved, basaltic landscape and is the second-longest free-flowing river in the continental United States. There are no hydroelectric dams on the John Day River, and no releases of hatchery salmonids into lotic waters in the basin. In 1999 the National Marine Fisheries Service (NMFS) listed the Middle Columbia summer steelhead DPS, which includes the John Day River populations, as threatened under the ESA (U.S. Office of the Federal Register 1999). Adult abundance estimates have been made since 1959 using spawning ground surveys for the John Day River Basin as a whole, as well as the 5 populations within.

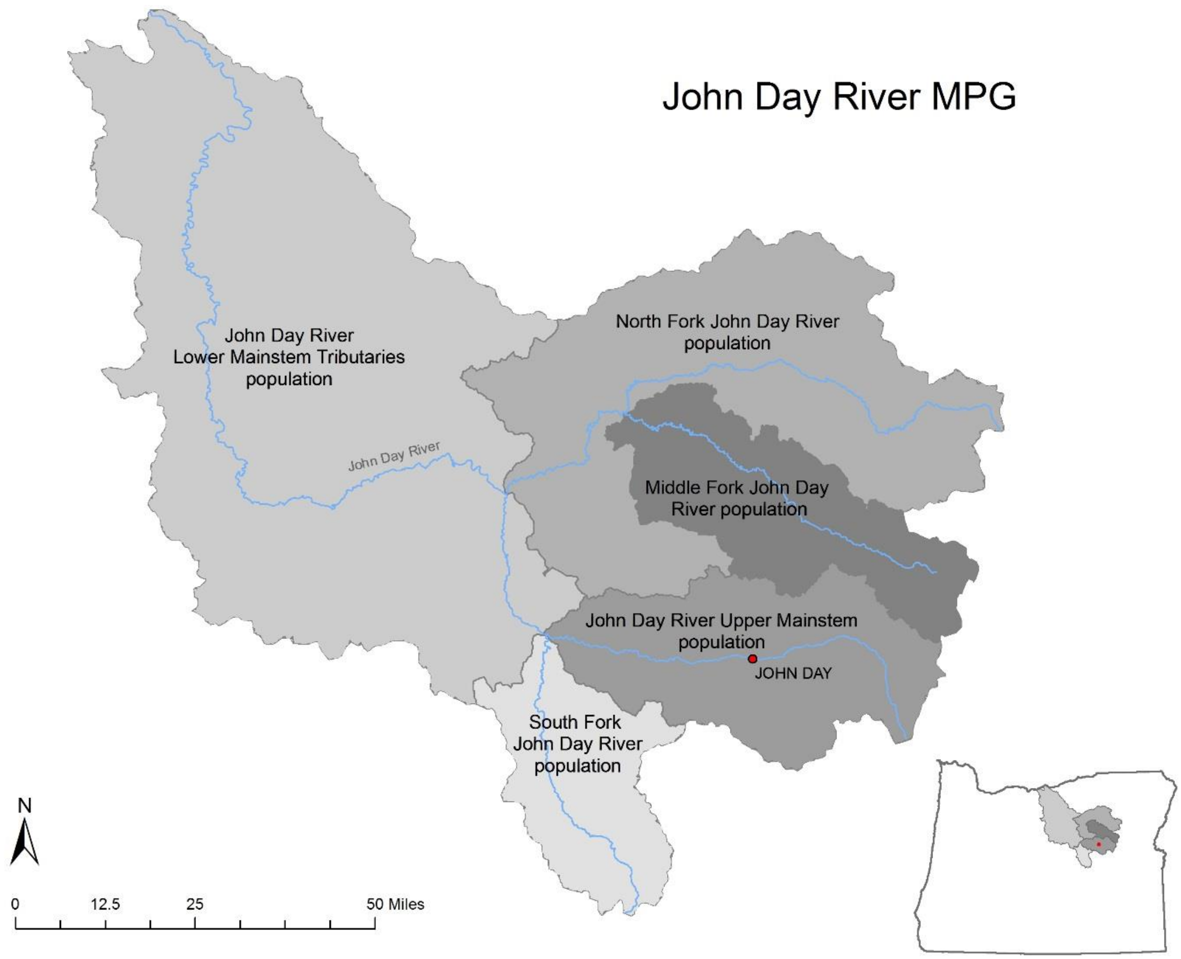


Figure 3. Individual population boundaries within the John Day River MPG

John Day River Lower Mainstem Tributaries Summer Steelhead Population

Date Modified: 01/12/2015

Population Description

The John Day River Lower Mainstem Tributaries (JDLM) summer steelhead population includes the mainstem John Day River and tributaries downstream of the South Fork John Day River and comprises 1339.8 km of spawning habitat. The ICTRT has identified 11 major spawning areas (MaSAs) and 19 minor spawning areas (MiSAs) within the Lower Mainstem John Day River population. Spawning is distributed broadly across the landscape in numerous watersheds that flow into the lower mainstem of the John Day River. The Rock, Thirtymile, Bridge, Service, Mountain and Butte creek drainages comprise a substantial proportion of the production area. In addition, multiple smaller drainages support production. Spawners within the Lower Mainstem population are predominantly natural-origin; however, outside-DPS hatchery fish, primarily from Snake River stocks, are present in the JDLM population.

Field methods (spatial and temporal design)

Index spawning ground surveys (1959-present): Since 1959, index spawning ground surveys have been conducted on several streams within the JDLMT and a subset of six index reaches have been used to estimate spawner abundance, including Bear, Kahler, Parrish, Pine, Rock, and Thirtymile creeks. Surveys are conducted annually by ODFW John Day District staff and 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.

From 2004-2012, ODFW conducted annual GRTS-based spawning ground surveys across the entire John Day MPG (Wiley et al. 2005). Approximately 50 sites were visited each year and a rotating panel design was implemented using a combination of annual sites, new sites, and sites repeated every four years. Comparison of index survey results and GRTS-based survey results showed that average redd densities from GRTS-based surveys were consistently lower than average density across the index reaches. The MPG-wide GRTS surveys have been discontinued, but a correction factor was developed from the surveys to adjust index results to account for the lower redd densities in non-index reaches. This single mean correction factor estimate was applied to index survey data from 1959-2003. A linear regression of GRTS redd density (dependent variable) to index redd density (independent variable) was developed using data from 2004-2009 surveys and has been used as a correction factor for index surveys since 2004. The MPG-wide GRTS-based spawning ground surveys are conducted with standard ODFW methods (Ruzycki 2012; Susac and Jacobs 1999).

Analysis Methods

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

Abundance

For the JDLM 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 fish per redd expansion, all pre-spawning mortality has been accounted for in the abundance estimates.

Natural Origin Spawner Abundance (NOSA): To obtain NOSA, total spawner abundance (TSA) is multiplied by the proportion of hatchery origin spawners (pHOS):

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

Natural Origin Broodstock Removed (NOBroodStockRemoved): Not applicable. No hatchery programs exist within the JDLM population area.

Proportion of Hatchery Origin Spawners (pHOS): Hatchery origin spawners were not recorded during spawning ground surveys until 1992, therefore, prior to 1992 pHOS was assumed to be zero. The pHOS is reported as a five-year running average (the yearly pHOS value is averaged with the two years prior and post the spawning year). The 5 year running average is used to provide a balance in the event that a particular year didn't provide enough information on number of hatchery spawners. From 1992-2001, the yearly pHOS value was estimated by dividing the total number of hatchery origin steelhead (live and dead) observed in basin-wide index surveys by the total number of live and dead fish observed in basin-wide index surveys. Since 2002, pHOS has been estimated separately for the JDLM. Estimates of pHOS for the JDLM are derived from counts of spawners encountered during GRTS and index spawning ground surveys, visual checks for fish, trapping and seining activities, and from steelhead captured at the weir/trap on Bridge Creek, operated by the Integrated Status and Effectiveness Monitoring Project (ISEMP) (http://www.isemp.org/watershed.php?chi=1).

Total Spawner Abundance (TSA): Annual estimates of spawning steelhead are generated by expanding from index redd counts. Redds and km surveyed are totaled for the season and redd density is calculated as total redds/total km surveyed. To estimate total number of redds in the JDLM, the 'surveyed' redd density is multiplied by the total stream km available for spawning in the JDLM population area. For years prior to GRTS surveys (1959-2003) total stream length was estimated as 1197.2 km by ODFW district biologists. In 2004, with the inception of GRTS-based surveys in the John Day MPG, the total stream length was estimated at 1339.8 km using GIS. The total population of redds is then converted to spawners by multiplying by the Deer Creek fish per redd ratio. The final estimate for TSA is then calculated by using a correction factor using one of two methods:

a) 1959-2003: An index-GRTS correction factor from the 2004-2005 ratio of index reach density to GRTS reach average density:

$$0.335 * \text{index spawners}$$

b) 2004-present: A linear regression to convert index densities to GRTS densities:

$$-0.0123 + (0.356 * \text{index spawners})$$

Age Proportion (AgeProp): Originally, age proportion was derived from scale readings of creel-sampled unmarked steelhead collected during the 1980s from above Tumwater Falls. This age proportion was applied to data from 1959 to 2006. In 2007 a new age proportion formula was derived from using scales of juvenile spring migrants (representing freshwater age) captured in rotary screw traps (RST) on the South Fork John Day, upper mainstem John Day, and Middle Fork John Day rivers; and adult age proportions from PIT tag returns (representing saltwater age) of John Day River steelhead observed at Columbia River dams (Bare et al. 2015).

Productivity

Adult productivity for the LMJDT steelhead population is reported as spawner recruits per spawner. Spawner 'recruits' are natural origin fish only and estimates are derived from NOSA and age proportion. 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 total spawners (natural and hatchery adults spawning in the wild) for that brood year, to calculate RperS ratios.

Total Spawners: Equal to TSA, methods detailed above.

Hatchery Origin Spawners (HatcherySpawners): The number of hatchery spawners is estimated by multiplying pHOS by TSA. The ODFW currently manages the JDLM for natural origin steelhead with no hatchery releases within the population.

$$Hatchery\ Spawners = pHOS*TSA$$

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 3, 4, 5, 6, and 7 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 4. Summary of John Day River Lower Mainstem Tributaries Summer Steelhead population methods adjustments

Years	***Methods***
1959-present	*Index spawning ground surveys*
1959-1991	*pHOS assumed zero*
1992-2001	*pHOS value from spawners during index surveys (compiled by MPG)*
2002-present	*pHOS from adult observations during index surveys, GRTS surveys, juvenile trapping and seining in JDLM and the Bridge Creek weir/trap (compiled for JDLM only)*
1959-2003	*Stream length from index surveys; correction factor developed for index-GRTS fish densities from 2004-2005 ratio of index density to GRTS density*
2004-present	*Updated stream length from GRTS surveys; correction factor developed for index-GRTS fish densities from a linear regression*
1960-2006	*Age proportion from scales of creel-sampled fish above Tumwater Falls*
2007-present	*Age proportion from scales of juveniles from RSTs and data from adult returns at PIT tag arrays*

North Fork John Day River Summer Steelhead Population

Date Modified: 01/12/2015

Population Description

The largest tributary to the John Day River is the North Fork John Day, which originates in the Wallowa-Whitman National Forest in the Blue Mountains at elevations near 8000 feet. The North Fork John Day River flows westerly for 180 km and joins the mainstem near Kimberly (rkm 298), 24 km below the town of Monument (NMFS 2009). The ICTRT has identified eight MaSAs and seven MiSAs within the North Fork John Day River (NFJD) steelhead population (Carmichael and Taylor 2010). Spawning is distributed broadly throughout the population boundaries including many tributaries and mainstem reaches of Cottonwood, Camas, Desolation, and Granite creeks and the upper North Fork John Day River. Spawners in the North Fork John Day River are primarily natural-origin fish; however, outside-DPS hatchery fish, primarily from Snake River stocks, are present in the NFJD population (Carmichael and Taylor 2010).

Field methods (spatial and temporal design)

Index spawning ground surveys (1963-present): Since 1963, index spawning ground surveys have been conducted on several streams within the NFJD and a subset of eight index reaches have been used to estimate spawner abundance, including Beaver, Fox, North Fork Trail, Olive, South Fork Trail, Middle Fork Trail, Wall and Wilson creeks. Surveys are conducted annually by ODFW John Day District staff and 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.

From 2004-2012, ODFW conducted annual GRTS-based spawning ground surveys across the entire John Day MPG (Wiley et al. 2005). Approximately 50 sites were visited each year and a rotating panel design was implemented using a combination of annual sites, new sites, and sites repeated every three years. Comparison of index survey results and GRTS-based survey results showed that average redd densities from GRTS-based surveys were consistently lower than average density across the index reaches. The MPG-wide GRTS surveys have been discontinued, but a correction factor was developed from the surveys to adjust index results to account for the lower redd densities in non-index reaches. This single mean correction factor estimate was applied to index survey data from 1963-2003. A linear regression of GRTS redd density (dependent variable) to index redd density (independent variable) was developed using data from 2004-2009 surveys and has been used as a correction factor for index surveys since 2004. The MPG-wide GRTS-based spawning ground surveys are conducted with standard ODFW methods (Ruzycki 2012; Susac and Jacobs 1999).

Analysis Methods

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

Abundance

For the NFJD 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 fish per redd expansion, all pre-spawning mortality has been accounted for in the abundance estimates.

Natural Origin Spawner Abundance (NOSA): To obtain natural origin spawner abundance, TSA is multiplied by pHOS:

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

Natural Origin Broodstock Removed (NO Broodstock Removed): Not applicable, no hatchery programs in the NFJD.

Proportion of Hatchery Origin Spawners (pHOS): Hatchery origin spawners were not recorded during spawning ground surveys until 1992, therefore, prior to 1992 pHOS was assumed to be zero. The pHOS is reported as a five-year running average (the yearly pHOS value is averaged with the two years prior and post the spawning year). The 5 year running average is used to provide a balance in the event that a particular year didn't provide enough information on number of hatchery spawners. From 1992-2001, the yearly pHOS value was estimated by dividing the total number of hatchery origin steelhead (live and dead) observed in basin-wide index surveys by the total number of live and dead fish observed in basin-wide index surveys. Since 2002, pHOS is jointly estimated for the upper basin populations (North Fork John Day, Middle Fork John Day, South Fork John Day, and the upper mainstem John Day rivers), and is computed separately from the JDLM. The pHOS for the upper basin is derived from counts of spawners encountered during GRTS and index spawning ground surveys, and opportunistic observations during juvenile trapping (Bare et al. 2015).

Total Spawner Abundance (TSA): Annual estimates of spawning steelhead are generated by expanding from index redd counts. Redds and km surveyed are totaled for the season and redd density is calculated as total redds/total km surveyed. To estimate total number of redds in the NFJD, the 'surveyed' redd density is multiplied by the total stream km available for spawning in the NFJD population area. For years prior to GRTS surveys (1963-2003) total stream length was estimated as 1194.3 km by ODFW district biologists. In 2004, with the inception of GRTS-based surveys in the John Day MPG, the total stream length was estimated at 1336.5 km using GIS. The total population of redds is then converted to spawners by multiplying by the Deer Creek fish per redd ratio. The final estimate for TSA is then calculated by using a correction factor using one of two methods:

a) 1963-2003: An index-GRTS correction factor from the 2004-2005 ratio of index reach density to GRTS reach average density:

$$0.335 * \text{index spawners}$$

b) 2004-present: A linear regression to convert index densities to GRTS densities:

$$-0.0123 + (0.356 * \text{index spawners})$$

Age Proportion (AgeProp): Originally, age proportion was derived from scale readings of creel-sampled unmarked steelhead collected during the 1980s from above Tumwater Falls. This age proportion was applied to data from 1963 to 2006. In 2007 a new age proportion formula was derived from using scales of juvenile spring migrants (representing freshwater age) captured in RSTs on the South Fork John Day, Upper Mainstem John Day, and Middle Fork John Day rivers; and adult age proportions from PIT tag returns (representing saltwater age) of John Day River steelhead observed at Columbia River Dams (Bare et al. 2015).

Productivity

Adult productivity for the NFJD steelhead population is reported as spawner recruits per spawner. Spawner 'recruits' are natural origin fish only and estimates are derived from NOSA and age proportion. Spawners (TSA) include 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 total spawners (natural and hatchery adults spawning in the wild) for that brood year, to calculate RperS ratios.

Total Spawners: Equal to TSA, methods detailed above.

Hatchery Origin Spawners (HatcherySpawners): The number of hatchery spawners is estimated by multiplying pHOS by TSA. The ODFW currently manages the NFJD for natural origin steelhead with no hatchery releases within the population.

$$Hatchery\ Spawners = pHOS*TSA$$

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 3, 4, 5, 6 and 7 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 5. Summary of North Fork John Day River Summer Steelhead population methods adjustments

Years	*Methods*
1963-present	*Index spawning ground surveys*
1963-1991	*pHOS assumed zero*
1992-2001	*pHOS value from spawners during index surveys (compiled by MPG)*
2002-present	*pHOS from adult observations during index surveys, GRTS surveys, juvenile trapping and seining in upper basin (compiled as one for JDUM, MFJD, NFJD, SFJD)*
1963-2003	*Stream length from index surveys; correction factor developed for index-GRTS fish densities from 2004-2005 ratio of index density to GRTS density*
2004-present	*Updated stream length from GRTS surveys; correction factor developed for index-GRTS fish densities from a linear regression*
1963-2006	*Age proportion from scales of creel-sampled fish above Tumwater Falls*
2007-present	*Age proportion from scales of juveniles from RSTs and data from adult returns at PIT tag arrays*

Middle Fork John Day River Summer Steelhead Population

Date Modified: 01/12/2015

Population Description

The Middle Fork John Day River originates in the Blue Mountains of the Malheur National Forest, flows westerly for 120 km, and merges with the North Fork John Day River about 30 km upstream from the town of Monument. The ICTRT has identified two MaSAs and no MiSAs within the Middle Fork John Day River (MFJD) summer steelhead population. Spawning is distributed broadly throughout the population boundaries including mainstem reaches in the lower and upper Middle Fork John Day River and Long Creek. There are numerous tributary spawning streams distributed from the lower end of the population boundary to the uppermost reaches. Spawners within the Middle Fork John Day River are primarily natural-origin fish; however, outside-DPS hatchery fish, primarily from Snake River stocks, are present in the MFJD population (Carmichael and Taylor 2010).

Field methods (spatial and temporal design)

Index spawning ground surveys (1964-2007): Since 1964, index spawning ground surveys have been conducted on several streams within the MFJD and a subset of four index reaches have been used to estimate spawner abundance, including Beaver, Camp, Deep, and Lick creeks. Surveys are conducted annually by ODFW John Day District staff and 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.

From 2004-2012, ODFW conducted annual GRTS-based spawning ground surveys across the entire John Day MPG (Wiley et al. 2005). Approximately 50 sites were visited each year and a rotating panel design was implemented using a combination of annual sites, new sites, and sites repeated every three years. Comparison of index survey results and GRTS-based survey results showed that average redd densities from GRTS-based surveys were consistently lower than average density across the index reaches. The MPG-wide GRTS surveys have been discontinued, but a correction factor was developed from the surveys to adjust index results to account for the lower redd densities in non-index reaches. This single mean correction factor estimate was applied to index survey data from 1964-2003. A linear regression of GRTS redd density (dependent variable) to index redd density (independent variable) was developed using data from 2004-2009 surveys and has been used as a correction factor for index surveys since 2004. The MPG-wide GRTS-based spawning ground surveys are conducted with standard ODFW methods (Ruzycki 2012; Susac and Jacobs 1999).

GRTS spawning ground surveys (2008-2014): Watershed scale coordinated restoration efforts, with the associated effectiveness monitoring programs, were initiated in the MFJD in 2004 to evaluate population level responses to restoration actions (Handley et al. 2012). These programs are programmatically referred to as Intensively Monitored Watershed (IMW) studies.

Beginning in 2008, GRTS-based spawning ground surveys were initiated for the MFJD, in which sites were assigned to one of three different panels using the Environmental Monitoring and Assessment Protocol (EMAP): sites visited every year (Annual Sites), sites visited every other year beginning with year-1 (Two-1), or sites visited every other year beginning in year-2 (Two-2). Although assigning sites to a panel is usually random, the MFJD design incorporated "legacy" sites that had been previously sampled during John Day MPG-wide monitoring. Approximately 30 sites were selected to be surveyed each year and were equally distributed between:

- 15 sites repeated annually
- 15 sites repeated once every two years (rotating)

Additional sites were selected within each panel as replacement sites in the event that a site had to be removed due to access restrictions, unidentified in-stream barriers, or unsuitable spawning habitat conditions (Handley 2012). A 1:100,000 Environmental Protection Agency (EPA) river reach file of summer steelhead distribution was used in the MFJD sub-basin for site selection. This spatial dataset is based on best professional knowledge provided by ODFW managers as well as other local agency biologists. The actual dataset utilized for site selection was modified to meet the objectives of this project. Specifically, stream segments downstream of a RST operated by ODFW at rkm 24 were excluded from GRTS sampling (Handley 2012) but the data collected upstream of the RST is expanded to include the whole population.

Sites were surveyed at approximately two week intervals from April-June, to quantify the number of unique redds constructed at each site. Survey reaches were approximately 2 km in length and encompassed the sample point derived from the GRTS design. Some candidate sites were not sampled due to a lack 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. 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). Every year the sampling universe is refined based on field observations of previously unknown barriers and other restrictions (e.g., dry streams) that limit fish life history stages, or the removal of barriers (e.g., road culverts) that previously limited access to habitat. These stream reaches are removed or added into the sample universe accordingly (Banks et al. 2013).

Spawning ground surveys are conducted with standard ODFW methods (Ruzycki 2012; Susac and Jacobs 1999). To reduce bias of surveyor observations, surveyors alternate site visits and partners if possible. 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.

Analysis methods

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

Abundance

For the MFJD 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 fish per redd expansion, all pre-spawning mortality has been accounted for in the abundance estimates.

Natural Origin Spawner Abundance (NOSA): To obtain natural origin spawner abundance, TSA is multiplied by pHOS:

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

Natural Origin Broodstock Removed (NOBroodstockremoved): Not applicable. No hatchery programs exist within the MFJD population area

Proportion of Hatchery Origin Spawners (pHOS): Hatchery origin spawners were not recorded during spawning ground surveys until 1992, therefore, prior to 1992 pHOS was assumed to be zero. The pHOS is reported as a five-year running average (the yearly pHOS value is averaged with the two years prior and post the spawning year). The 5 year running average is used to provide a balance in the event that a particular year didn't provide enough information on number of hatchery spawners. From 1992-2001, the yearly pHOS value was estimated by dividing the total number of hatchery origin steelhead (live and dead) observed in basin-wide index surveys by the total number of live and dead fish observed in basin-wide index surveys. Since 2002, pHOS is calculated jointly for the upper basin populations (North Fork John Day, Middle Fork John Day, South Fork John Day, and the upper mainstem John Day rivers), and is computed separately from the JDLM. The pHOS for the upper basin is derived from counts of spawners encountered during GRTS and index spawning ground surveys, and opportunistic observations during juvenile trapping and seining activities (Bare et al. 2015).

Total Spawner Abundance (TSA) – index surveys (1964-2007): Annual estimates of spawning steelhead are generated by expanding from index redd counts. Redds and km surveyed are totaled for the season and redd density is calculated as total redds/total km surveyed. To estimate total number of redds in the MFJD, the 'surveyed' redd density is multiplied by the total km of stream km available for spawning in the MFJD population area. For years prior to GRTS surveys (1964-2003) total stream km was estimated as 546.2 by ODFW district biologists. In 2004, with the inception of GRTS-based surveys in the John Day MPG, the total stream length was estimated at 611.2 km using GIS. The total population of redds is then converted to spawners by multiplying by the Deer Creek fish per redd ratio. The final estimate for TSA is then calculated by using a correction factor using one of two methods:

a) 1964-2003: An index-GRTS correction factor from the 2004-2005 ratio of index reach density to GRTS reach average density:

$$0.335 * \text{index spawners}$$

b) 2004-2007: A linear regression to convert index densities to GRTS densities:

$$-0.0123 + (0.356 * \text{index spawners})$$

Total Spawner Abundance (TSA) – GRTS Surveys (2008-present): The TSA was determined by summing the product of the weight value (W), number of redds observed/km surveyed at each site (i), and fish/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 layer) 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, Handley, et al. 2012), which incorporates the pair-wise dependency of all points and the spatially constrained nature of the design, was utilized to estimate 95% confidence intervals of the spawner abundance estimate using R statistical software (R Development Core Team 2005).

Proportion at Age (AgeProp): Originally, age proportion was derived from scale readings of creel-sampled unmarked steelhead collected during the 1980s from above Tumwater Falls. This age proportion was applied to data from 1964 to 2006. In 2007 a new age proportion formula was derived from using scales of juvenile spring migrants (representing freshwater age) captured in RSTs on the South Fork John Day, upper mainstem John Day, and Middle Fork John Day rivers; and adult age proportions from PIT tag returns (representing saltwater age) of John Day River steelhead observed at Columbia River dams (Bare et al. 2015).

Productivity

Adult productivity for the MFJD steelhead population is reported as spawner recruits per spawner. Spawner 'recruits' are natural origin fish only and estimates are derived from NOSA and age proportion. Spawners (TSA) include 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 total spawners (natural and hatchery adults spawning in the wild) for that brood year, to calculate RperS ratios.

Total Spawners: Equal to TSA, methods detailed above.

Hatchery Origin Spawners (HatcherySpawners): The number of hatchery spawners is estimated by multiplying pHOS by TSA. The ODFW currently manages the MFJD for natural origin steelhead with no hatchery releases within the population.

$$Hatchery\ Spawners = pHOS*TSA$$

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 3, 4, 5, 6, and 7 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 6. Summary of Middle Fork John Day River Summer Steelhead population methods summary

Years	*Methods*
1964-2007	*Index spawning ground surveys*
2008-present	*GRTS spawning ground surveys*
1964-1991	*pHOS assumed zero*
1992-2001	*pHOS value from spawners during index surveys (compiled by MPG)*
2002-present	*pHOS from adult observations during index surveys, GRTS surveys, juvenile trapping and seining in upper basin (compiled as one for JDUM, MFJD, NFJD, SFJD)*
1964-2003	*Stream length from index surveys; correction factor developed for index-GRTS fish densities from 2004-2005 ratio of index density to GRTS density*
2004-2007	*Updated stream length from GRTS surveys; correction factor developed for index-GRTS fish densities from a linear regression (index surveys not used after inception of GRTS in 2008)*
1964-2006	*Age proportion from scales of creel-sampled fish above Tumwater Falls*
2007-present	*Age proportion from scales of juveniles from RSTs and data from adult returns at PIT tag arrays*

South Fork John Day River Summer Steelhead Population

Date Modified: 01/15/2015

Population Description

The ICTRT has identified three MaSAs and no MiSAs within the South Fork John Day River (SFJD) steelhead population. A natural barrier at Izee Falls limits distribution in the mainstem South Fork John Day River. Spawning is distributed broadly throughout the population and 276.6 km of habitat are presently used for spawning boundaries including mainstem reaches in the South Fork John Day River, Murderers Creek, and Black Canyon Creek, as well as many tributaries. Spawners within the SFJD population are primarily natural-origin fish (Carmichael and Taylor 2010).

Field methods (spatial and temporal design)

Index spawning ground surveys (1960-2005): Since 1960, index spawning ground surveys have been conducted on several streams within the SFJD and a subset of six index reaches have been used to estimate spawner abundance, including Black Canyon, Deer, Tex, Wind and upper and lower Murderers Creek. Surveys are conducted annually by ODFW John Day District staff and 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.

From 2004-2012, ODFW conducted annual GRTS-based spawning ground surveys across the entire John Day MPG (Wiley et al. 2005). Approximately 50 sites were visited each year and a rotating panel design was implemented using a combination of annual sites, new sites, and sites repeated every three years.

Comparison of index survey results and GRTS-based survey results showed that average redd densities from GRTS-based surveys were consistently lower than average density across the index reaches. The MPG-wide GRTS surveys have been discontinued, but a correction factor was developed from the surveys to adjust index results to account for the lower redd densities in non-index reaches. This single mean correction factor estimate was applied to index survey data from 1960-2003. A linear regression of GRTS redd density (dependent variable) to index redd density (independent variable) was developed using data from 2004-2009 surveys and has been used as a correction factor for index surveys since 2004. The MPG-wide GRTS-based spawning ground surveys are conducted with standard ODFW methods (Ruzycki 2012; Susac and Jacobs 1999).

GRTS spawning ground surveys (2006-2014): A GRTS spawning survey design was developed and applied specifically to the SFJD summer steelhead population beginning in 2006 and encompassed all habitat accessible to steelhead upstream of a RST located at rkm 10 of the South Fork John Day River (Banks et al. 2013). Survey sites were assigned to one of three different panels using the Environmental Monitoring and Assessment Program (EMAP): sites visited every year (Annual Sites), sites visited every other year beginning with year-1 (Two-1), or sites visited every other year beginning in year-2 (Two-2). Approximately 30 sample sites are selected each year. In order to balance the needs of status (more random sites) and trend (more repeat sites) monitoring, the following rotating panel design was implemented for the population:

- 13 sites repeated every year (annual)
- 15 sites repeated once every three years on a staggered basis (rotating)

Sites were surveyed on multiple occasions, to quantify the number of unique redds constructed at each site, at approximately two week intervals to account for the temporal variation in spawning activity. Survey reaches were approximately 2 km in length and encompassed the sample point derived from the GRTS design. Some candidate sites were not sampled due to a lack 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. 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). Every year the sampling universe is refined based on field observations of previously unknown barriers and other restrictions (e.g., dry streams) that limit fish life history stages, or the removal of barriers (e.g., road culverts) that previously limited access to habitat. These stream reaches are removed or added into the sample universe accordingly (Banks et al. 2013).

Spawning ground surveys methods are conducted with standard ODFW methods (Ruzycki 2012; Susac and Jacobs 1999). To reduce bias of surveyor observations, surveyors alternate site visits and partners if possible. 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.

Analysis Methods

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

Abundance

For the SFJD 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 fish per redd expansion, all pre-spawning mortality has been accounted for in the abundance estimates.

Natural Origin Spawner Abundance (NOSA): Natural origin spawner abundance is calculated as:

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

Natural Origin Broodstock Removed (NOBroodstockremoved): Not applicable. No hatchery programs exist within the SFJD population area

Proportion Hatchery Origin Spawners (pHOS): Hatchery origin spawners were not recorded during spawning ground surveys until 1992, therefore, prior to 1992 pHOS was assumed to be zero. The pHOS is reported as a five-year running average (the yearly pHOS value is averaged with the two years prior and post the spawning year). The 5 year running average is used to provide a balance in the event that a particular year didn't provide enough information on number of hatchery spawners. From 1992-2001, the yearly pHOS value was estimated by dividing the total number of hatchery origin steelhead (live and dead) observed in basin-wide index surveys by the total number of live and dead fish observed in basin-wide index surveys. Since 2002, pHOS is jointly estimated for the upper basin populations (North Fork John Day, Middle Fork John Day, South Fork John Day, and the upper mainstem John Day rivers), and is computed separately from the JDLM. The pHOS for the upper basin is derived from counts of spawners encountered during GRTS and index spawning ground surveys, and opportunistic observations during juvenile trapping and seining activities (Bare et al. 2015).

Total Spawner Abundance (TSA) – index surveys (1960-2006): Annual estimates of spawning steelhead are generated by expanding from index redd counts. Redds and km surveyed are totaled for the season and redd density is calculated as total redds/total km surveyed. To estimate total number of redds in the SFJD, the 'surveyed' redd density is multiplied by the total km of stream km available for spawning in the SFJD population area. For years prior to GRTS surveys (1960-2003) total stream km was estimated as 247.1 by ODFW district biologists. In 2004, with the inception of GRTS-based surveys in the John Day MPG, the total stream length was estimated at 276.6 km using GIS. The total population of redds is then converted to spawners by multiplying by the Deer Creek fish per redd ratio. The final estimate for TSA is then calculated by using a correction factor using one of two methods:

a) 1960-2003: An index-GRTS correction factor from the 2004-2005 ratio of index reach density to GRTS reach average density:

$$0.335 * \text{index spawners}$$

b) 2004-2005: A linear regression to convert index densities to GRTS densities:

$$-0.0123 + (0.356 * \text{index spawners})$$

Total Spawner Abundance (TSA) – GRTS surveys (2006-present): The equations below are identical to other GRTS based designs but for the SFJD, the distance in the sampling universe only encompassed stream reaches within the South Fork population available for steelhead spawning and rearing and upstream of a rotary screw trap operated by ODFW (Banks et al. 2013). The TSA was determined by summing the product of the weight value (W), number of redds observed/km surveyed at each site (i), and fish/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 layer) divided by the number of sites surveyed as:

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

A locally weighted neighborhood variance estimator (Stevens and Olsen 2004, Bare et al. 2012), that incorporates the pair-wise dependency of all points and the spatially constrained nature of the design, was used to estimate a 95% confidence interval for the spawner abundance estimate using R statistical software (R Development Core Team 2005).

Proportion at Age (AgeProp): Originally, age proportion was derived from scale readings of creel-sampled unmarked steelhead collected during the 1980s from above Tumwater Falls. This age proportion was applied to data from 1960 to 2006. In 2007 a new age proportion formula was derived from using scales of juvenile spring migrants (representing freshwater age) captured in RSTs on the South Fork John Day, upper mainstem John Day, and Middle Fork John Day rivers; and adult age proportions from PIT tag returns (representing saltwater age) of John Day River steelhead observed at Columbia River dams (Bare et al. 2015).

Productivity

Adult productivity for the SFJD steelhead population is reported as spawner recruits per spawner. Spawner 'recruits' are natural origin fish only and estimates are derived from NOSA and age proportion. 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 total spawners (natural and hatchery adults spawning in the wild) for that brood year, to calculate RperS ratios.

Total Spawners: Equal to TSA, methods detailed above.

Hatchery Origin Spawners (HatcherySpawners): The number of hatchery spawners is estimated by multiplying pHOS by TSA. The ODFW currently manages the SFJD for natural origin steelhead with no hatchery releases within the population.

$$Hatchery\ Spawners = pHOS*TSA$$

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 3, 4, 5, 6, and 7 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 7. Summary of South Fork John Day River Summer Steelhead population methods adjustments

Years	*Methods*
1960-2005	*Index spawning ground surveys*
2006-present	*GRTS spawning ground surveys*
1960-1991	*pHOS assumed zero*
1992-2001	*pHOS value from spawners during index surveys (compiled by MPG)*
2002-present	*pHOS from adult observations during index surveys, GRTS surveys, juvenile trapping and seining in upper basin (compiled as one for JDUM, MFJD, NFJD, SFJD)*
1960-2003	*Stream length from index surveys; correction factor developed for index-GRTS fish densities from 2004-2005 ratio of index density to GRTS density*
2004-2005	*Updated stream length from GRTS surveys; correction factor developed for index-GRTS fish densities from a linear regression (index surveys not used after inception of GRTS in 2006)*
1960-2006	*Age proportion from scales of creel-sampled fish above Tumwater Falls*
2007-present	*Age proportion from scales of juveniles from RSTs and data from adult returns at PIT tag arrays*

John Day River Upper Mainstem Summer Steelhead Population

Population Description

Date Modified: 01/15/2015

The ICTRT has identified five MaSAs and no MiSAs within the John Day River Upper Mainstem (JDUM) steelhead population. Most of the production area resides in the Upper John Day MaSA. Spawning is distributed broadly across the population including mainstem reaches in the Upper John Day River, Canyon Creek, and Beech Creek, as well as in numerous tributaries from the town of Dayville, OR, upstream to the headwaters. Spawners within the Upper John Day River are primarily natural-origin fish, although a small proportion of out-of-DPS hatchery fish, primarily from Snake River stocks, are present in the JDUM population (Carmichael and Taylor 2010).

Field methods (spatial and temporal design)

Index spawning ground surveys 1959-2012, 2014-present: Since 1959, index spawning ground surveys have been conducted on several streams within the JDUM and a subset of ten index reaches have been used to estimate spawner abundance, including Bear, Beech, East Fork Beech, Belshaw, Canyon, Middle Fork Canyon, Cottonwood, McClellan, Riley, and Tinker creeks. Surveys are conducted annually by ODFW John Day District staff and 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.

From 2004-2012, ODFW conducted annual GRTS-based spawning ground surveys across the entire John Day MPG (Wiley et al. 2005). Approximately 50 sites were visited each year and a rotating panel design was implemented using a combination of annual sites, new sites, and sites repeated every three years. Comparison of index survey results with GRTS-based survey results showed that average redd densities from GRTS-based surveys were consistently lower than average density across the index reaches. The MPG-wide GRTS surveys have been discontinued, but a correction factor was developed from the surveys to adjust index results to account for the lower redd densities in non-index reaches. This single mean correction factor estimate was applied to index survey data from 1959-2003. A linear regression of GRTS redd density (dependent variable) to index redd density (independent variable) was developed using data from 2004-2009 surveys and has been used as a correction factor for index surveys since 2004. The MPG-wide GRTS-based spawning ground surveys are conducted with standard ODFW methods (Ruzycki 2012; Susac and Jacobs 1999).

GRTS spawning ground surveys (2013): In 2013, GRTS-based spawning ground surveys were continued for one year in the JDUM (from the previous basin-wide GRTS-based surveys). Sites were assigned to one of three different panels using the Environmental Monitoring and Assessment Protocol (EMAP): sites visited every year (Annual Sites), sites visited every other year beginning with year-1 (Two-1), or sites visited every other year beginning in year-2 (Two-2). Although assigning sites to a panel is usually performed in a random fashion, sites were incorporated into the JDUM that had been previously utilized by the John Day basin-wide monitoring. Approximately 30 sites were selected to be surveyed and were equally distributed between:

- 15 sites repeated annually
- 15 sites repeated once every 2 years (rotating)

Additional sites were selected within each panel as replacement sites in the event that a site had to be removed due to access restrictions, unidentified in-stream barriers, or unsuitable spawning habitat conditions. This GRTS-based survey was discontinued after one year due to lack of funding. Spawning surveys were conducted following standard ODFW methods (Ruzycki 2012; Susac and Jacobs 1999). Sites were surveyed on multiple occasions, to quantify the number of unique redds constructed at each site, at approximately two week intervals to account for the temporal variation in spawning activity. Survey reaches were approximately 2 km in length and encompassed the sample point derived from the GRTS design. Some candidate sites were not sampled due to a lack 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. 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). Every year the sampling universe is refined based on field observations of previously unknown barriers and other restrictions (e.g., dry streams) that limit fish life history stages, or the removal of barriers (e.g., road culverts) that previously limited access to habitat. These stream reaches are removed or added into our sample universe accordingly (Banks et al. 2013).

Spawning ground survey methods 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.

Analysis Methods

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

Abundance

For the JDUM 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 fish per redd expansion, all pre-spawning mortality has been accounted for in the abundance estimates.

Natural Origin Spawner Abundance (NOSA): To obtain natural origin spawner abundance, TSA is multiplied by pHOS:

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

Natural Origin Broodstock Removed (NOBroodStockRemoved): Not applicable. No hatchery programs exist within the JDUM population area.

Proportion of Hatchery Origin Spawners (pHOS): Hatchery origin spawners were not recorded during spawning ground surveys until 1992, therefore, prior to 1992 pHOS was assumed to be zero. The pHOS is reported as a five-year running average (the yearly pHOS value is averaged with the two years prior and post the spawning year). The 5 year running average is used to provide a balance in the event that a particular year didn't provide enough information on number of hatchery spawners. From 1992-2001, the yearly pHOS value was estimated by dividing the total number of hatchery origin steelhead (live and dead) observed in basin-wide index surveys by the total number of live and dead fish observed in basin-wide index surveys. Since 2002, pHOS is jointly estimated for the upper basin populations (North Fork John Day, Middle Fork John Day, South Fork John Day, and the upper mainstem John Day rivers), and is computed separately from the JDLM. The pHOS for the upper basin is derived from counts of spawners encountered during GRTS and index spawning ground surveys, and opportunistic observations during juvenile trapping and seining activities (Bare et al. 2015).

Total Spawner Abundance (TSA) – index surveys (1959-2012, 2014-present): Annual estimates of spawning steelhead are generated by expanding from index redd counts. Redds and km surveyed are totaled for the season and redd density is calculated as total redds/total km surveyed. To estimate total number of redds in the JDUM, the 'surveyed' redd density is multiplied by the total km of stream km available for spawning in the JDUM population area. For years prior to GRTS surveys (1959-2003) total stream km was estimated as 247.1 by ODFW district biologists. In 2004, with the inception of GRTS-based surveys in the John Day MPG, the total stream length was estimated at 276.6 km using GIS. The total population of redds is then converted to spawners by multiplying by the Deer Creek fish per redd ratio. The final estimate for TSA is then calculated by using a correction factor using one of two methods:

a) 1959-2003: An index-GRTS correction factor from the 2004-2005 ratio of index reach density to GRTS reach average density:

$$0.335 * \text{index spawners}$$

b) 2004-2012; 2014-present: A linear regression to convert index densities to GRTS densities:

$$-0.0123 + (0.356 * \text{index spawners})$$

Total Spawner Abundance (TSA) – GRTS surveys (2013): In 2013, a GRTS spawning survey design was continued in the JDUM for one additional year and the equations below are identical to other GRTS based designs. The TSA was determined by summing the product of the weight value (W), number of redds observed/km surveyed at each site (i), and fish/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 layer) divided by the number of sites surveyed as:

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

A locally weighted neighborhood variance estimator (Stevens and Olsen 2004, Bare et al. 2012), that incorporates the pair-wise dependency of all points and the spatially constrained nature of the design, was used to estimate a 95% confidence interval for the abundance estimate using R statistical software (R Development Core Team 2005).

Proportion at Age (AgeProp): Originally, age proportion was derived from scale readings of creel-sampled unmarked steelhead collected during the 1980s from above Tumwater Falls. This age proportion was applied to data from 1959 to 2006. In 2007 a new age proportion formula was derived from using scales of juvenile spring migrants (representing freshwater age) captured in RSTs on the South Fork John Day, upper mainstem John Day, and Middle Fork John Day rivers; and adult age proportions from PIT tag returns (representing saltwater age) of John Day River steelhead observed at Columbia River dams (Bare et al. 2015).

Productivity

Adult productivity for the JDUM steelhead population is reported as spawner recruits per spawner. Spawner 'recruits' are natural origin fish only and estimates are derived from NOSA and age proportion. 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 total spawners (natural and hatchery adults spawning in the wild) for that brood year, to calculate RperS ratios.

Total Spawners: Equal to TSA, methods detailed above.

Hatchery Origin Spawners (HatcherySpawners): The number of hatchery spawners is estimated by multiplying pHOS by TSA. The ODFW currently manages the JDUM for natural origin steelhead with no hatchery releases within the population.

$$Hatchery\ Spawners = pHOS*TSA$$

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 3, 4, 5, 6, and 7 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 8. Summary of John Day River Upper Mainstem Summer Steelhead population methods adjustments

Years	***Methods***
1959-2012, 2014-present	*Index spawning ground surveys*
2013	*GRTS spawning ground surveys*
1959-1991	*pHOS assumed zero*
1992-2001	*pHOS value from spawners during index surveys (compiled by MPG)*
2002-present	*pHOS from adult observations during index surveys, GRTS surveys, juvenile trapping and seining in upper basin (compiled as one for JDUM, MFJD, NFJD, SFJD)*
1959-2003	*Stream length from index surveys; correction factor developed for index-GRTS fish densities from 2004-2005 ratio of index density to GRTS density*
2004-2012, 2014-present	*Updated stream length from GRTS surveys; correction factor developed for index-GRTS fish densities from a linear regression (index surveys not used the year GRTS was implemented - 2013)*
1959-2006	*Age proportion from scales of creel-sampled fish above Tumwater Falls*
2007-present	*Age proportion from scales of juveniles from RSTs and data from adult returns at PIT tag arrays*

Umatilla/Walla Walla MPG

The Umatilla/Walla Walla MPG includes three extant steelhead populations in the Umatilla, Walla Walla, and Touchet rivers and one extirpated population from Willow Creek (Carmichael and Taylor 2010) (Figure 4). The Umatilla River is in Oregon, the Touchet River in Washington, and the Walla Walla River is in both states. The Umatilla River originates in the Blue Mountains of northeastern Oregon and flows north and west to enter the Columbia River at river kilometer (rkm) 465. Land use is mostly dryland and irrigated agriculture. The Walla Walla River also originates in Oregon and flows northwest into Washington to join the Columbia, while the Touchet originates in the Blue Mountains on the Washington side and flows south and west into the Walla Walla. The Walla Walla River basin is extensively and intensively irrigated, with timber harvest in the high and mid elevations (NMFS 2009). All three populations in this MPG are summer run. The Umatilla River and Walla Walla River populations are monitored with dam counts, PIT tag arrays, and spawning ground surveys.

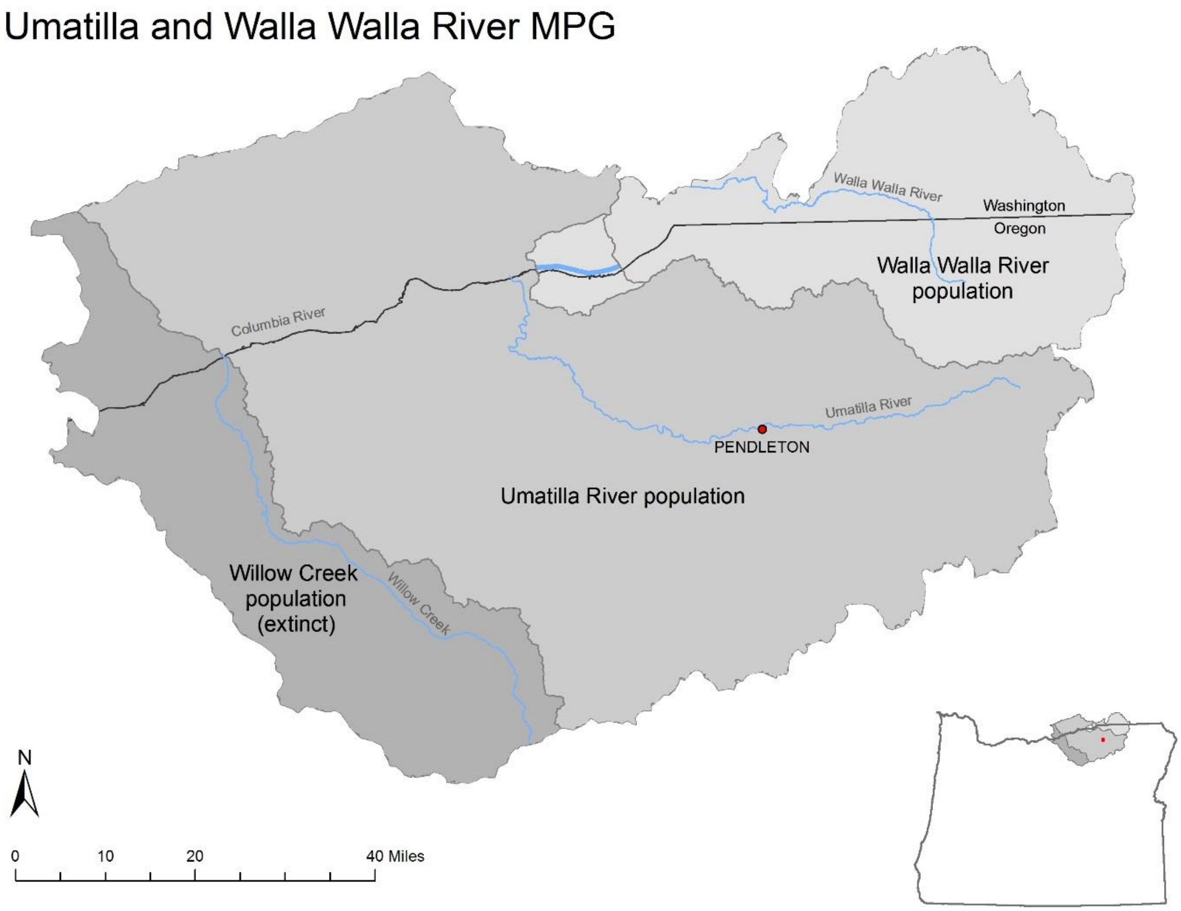


Figure 4. Individual population boundaries within the Umatilla and Walla Walla River MPG

Willow Creek Summer Steelhead Population

Population Description

Date Modified: 3/3/2015

The Willow Creek population is extinct and was designated as an independent population based on geographic distance from other populations and capacity sufficient to support an independent population (Carmichael and Taylor 2010). No estimate was found regarding the amount of habitat historically used within the Willow Creek population, and Goodson et al. (2005) made an assumption that summer steelhead would have used roughly 160 km of habitat in the Willow Creek basin, by comparing the Willow Basin size to others in the MPG.

Since the Willow Creek population is extinct, no estimates are made for this population.

Umatilla River Summer Steelhead Population

Population Description

Date Modified: 3/15/2014

The Umatilla River (UMA) summer steelhead population is one of three extant populations in the Umatilla/Walla Walla MPG within the Mid-Columbia steelhead DPS (Carmichael and Taylor 2010), and was listed as threatened in 1999 and reaffirmed in 2006 (U.S. Office of the Federal Register 1999, 2006). The ICTRT has identified 13 historic MaSAs and 3 MiSAs within the Umatilla River summer steelhead population (Carmichael and Taylor 2010). In addition, two MaSAs (Alder Creek and Glade Creek) and one MiSA (Fourmile Canyon) are direct tributaries to the Columbia River on the Washington side and were included in the Umatilla River population. Current spawning distribution is somewhat limited relative to historic and is concentrated in Birch Creek, Iskulpa Creek, Meacham Creek, the upper Umatilla River, and the north and south forks of the Umatilla River. There is documented recent year spawning in both Glade Creek and Alder Creek subbasins (Yakama Indian Nation Fisheries Program 2005, cited in Carmichael and Taylor 2010); however, it is uncertain if the distribution of spawners and the frequency of use meet the occupancy criteria.

Summer steelhead runs were substantially reduced in the Umatilla River by the early-1900s as a result of habitat degradation and agricultural development (Clarke et al. 2014). Summer steelhead are the only anadromous salmonid that were not extirpated from the Umatilla River system, although their spawning distribution has been substantially reduced. Spawners within the Umatilla River population include natural origin returns, hatchery origin returns of Umatilla River origin broodstock, and hatchery strays primarily originating from the Snake River basin. The Umatilla Fish Hatchery was constructed to reintroduce spring and fall Chinook Salmon and supplement summer steelhead in the Umatilla River. The steelhead supplementation effort is designed to increase natural production of steelhead in the system and support tribal, commercial, and recreational fisheries (Grant et al. 2007). The Umatilla Hatchery Monitoring and Evaluation (M&E) Project began in 1991 to evaluate hatchery rearing techniques and juvenile and adult production goals. Before 2010, hatchery origin fish composed a significant proportion of the naturally spawning fish (Grant et al. 2007), but from 2010-2014 just 23% of adults passed above TMFD have been hatchery origin (Hogg et al. 2014).

Field methods (spatial and temporal design)

Dam counts: The east bank fish ladder at Three Mile Falls Dam (TMFD) (rkm 5.9) is the primary counting and brood collection facility for adult steelhead and Chinook Salmon on the Umatilla River (Clarke et al. 2014) and all returning adults pass TMFD through the east bank fish ladder. Returns were enumerated at this location using an electronic fish counter from spawning years 1967 to 1984, mark-recapture methods from 1984 to 1988, after which an adult fish trapping and enumeration facility was constructed. The facility includes a back-lit viewing window, Denil steep-pass fishway, holding pond, and a fish sorting complex. Trapping was used to count returns through spring 1999, after which alternating trapping and video enumeration was implemented to reduce handing stress on fish (particularly federally-listed steelhead). Adults are enumerated at the ladder whenever river flow is adequate to provide fish passage, typically from mid-August until mid-July. Data collected during trapping includes date, disposition, and number of fish trapped by species, hatchery or natural origin, age class, gender, and marks. Hatchery-natural origin is determined by the respective absence or presence of an adipose fin for steelhead (Clarke et al. 2014).

Creel surveys: Creel surveys have been conducted on the Umatilla River since spawning year 1993. Objectives of the creel survey are to 1) estimate angling effort, catch, and harvest of steelhead, Chinook Salmon, and Coho Salmon, 2) provide information needed for adaptive management of the fisheries, 3) coordinate with law enforcement agencies, and 4) develop partnerships with sporting goods vendors to provide a supplemental coded wire tag (CWT) recovery source for steelhead (Clarke et al. 2014). A roving creel design is used to count and contact anglers. Sampling is stratified into upper and lower Umatilla River survey areas and two day types (weekdays/weekends plus holidays). Mean monthly creel statistics are calculated for each strata. The upper river is not surveyed in the fall due to low effort and catch but is typically shifted from the lower to upper river in January depending on how the fishery progressed in each area. Mean monthly creel statistics are calculated for each strata. Approximately 80-100% of the anglers observed during surveys are contacted and information is collected on residency, hours fished, whether angling trips were complete or incomplete, target species, gear type, and catch and harvest by species. Information on harvested steelhead include species, gender, fin clips and marks, measured fork length, and snouts from coded wire tagged fish. The number of released natural and hatchery steelhead are also collected (Clarke et al. 2014).

Analysis Methods

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

Abundance

For the UMA 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. All pre-spawning mortality has been accounted for in the abundance estimates because the timing of steelhead trapped at weirs occurs during the spawning period such that any pre-spawn mortality has likely already occurred.

Natural Origin Spawner Abundance (NOSA): Natural origin spawner abundance (NOSA) estimates for summer steelhead in the entire Umatilla River basin were derived from complete counts of natural origin adult returns to TMFD, then subtracting estimated natural origin broodstock collected and the estimated natural origin harvest above TMFD (tribal and non-tribal). Abundance of adult summer steelhead returning to TMFD has been recorded since the 1967 spawning year, but hatchery and natural returns were not separated at the dam until 1988, thus, all potential spawners from the 1967-1987 spawning years were considered natural origin (Grant et al. 2007). Fish counts at TMFD were not available for spawning years 1971-1972 and 1979, and estimates were reconstructed using an estimated mean brood age structure from 1992-1999 data.

Natural Origin Broodstock Removed (NOBroodStockRemoved): Actual counts collected from TMFD records. For years without TMFD data (1980 and1982), assumed 1 per 750 smolts produced. For years 1990-2012, the average natural origin broodstock removed is 1 per 1,776 smolts (W. Cameron, ODFW, personal communication).

Proportion of Hatchery Origin Spawners (pHOS): The calculation for proportion hatchery origin spawners (pHOS) = hatchery origin spawners/total spawner abundance.

Total Spawner Abundance (TSA): Abundance of adult summer steelhead returning to TMFD has been recorded since spawning year 1967, but hatchery and natural returns were not separated until 1988 (Grant et al. 2007). Starting in 1988, TSA estimates for natural origin and hatchery origin summer steelhead in the Umatilla River basin have been determined from complete counts of adult returns to TMFD, then subtracting estimated natural origin broodstock collected, natural origin harvest (non-tribal), and hatchery origin harvest above TMFD (tribal and non-tribal) (Cameron 2014, unpublished data).

Fish counts at Three Mile Falls Dam are not available for spawning years 1971-1972 and 1979. These counts were reconstructed using an estimated mean brood age structure from 1992-1999 data (Cameron 2014, unpublished data).

Proportion at Age (AgeProp): From 1994-2004 and 2006-2012, natural origin age proportion was determined by reading 100-150 scales per year collected from adults returning to TMFD. Mean age proportion of natural returns in brood years 1994-2004 was used for missing data in brood years 1967-1970, 1973-1978, and 1980-1993 (Cameron 2014, unpublished data). Mean age proportion of natural returns in spawning years 2007-2013 was used as preliminary data for the most recent year(s) in which scale data is pending.

Productivity

Adult productivity for the UMA 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 the total spawners (natural and hatchery adults spawning in the wild) for that brood year to calculate RperS ratios.

Hatchery Origin Spawners (HatcherySpawners): Total hatchery origin returns to TMFD minus all hatchery origin removals (mortality, broodstock, sacrificed for CWT recovery, and tribal and non-tribal harvest). Hatchery origin and natural origin returns were not separated at TMFD until spawning year 1988, thus, all potential spawners from 1967-1987 were considered natural origin (Grant et al. 2007).

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 3, 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): Harvest of natural steelhead was prohibited in the non-tribal fishery beginning in spawning year 1993 (Clarke et al. 2014). From 1988-1992, the number of hatchery fish (HSTS) harvested in the non-tribal fishery above TMFD was estimated as the 1994-2004 mean percent of the hatchery run above TMFD that were harvested (2.5 %) (Cameron 2014, unpublished data). For years when harvest of natural origin steelhead (NSTS) was allowed (prior to 1993), the natural origin harvest above TMFD was calculated as the 1992-2003 mean catch rate of natural origin fish corrected by an estimated percent of catch released (5.0 %). Tribal harvest of hatchery and natural origin was estimated (spawning years 1988-1992) as their respective mean percent of the run above TMFD harvested, determined from creel surveys in spawning years 1993-2001 (0.3% for NSTS, 6.4% for HSTS). For years prior to significant numbers of hatchery returns (spawning years 1967-1987) all harvest was assumed natural origin and estimated as 5.0 % and 6.7% of the total run above TMFD for the non-tribal and tribal fisheries respectively (W. Cameron, ODFW, personal communication).

Table 9. Summary of Umatilla River Summer Steelhead population methods adjustments

Years	***Methods***
1967-1984	*Fish enumerated using electronic fish counter at TMFD, all fish considered natural origin*
1984-1988	*Fish enumerated using mark-recapture methods at TMFD, all fish considered natural origin*
1989-2000	*Trapping at TMFD, ability for hatchery/natural origin distinction began*
2001-present	*Alternating of trapping and video enumeration to reduce handling of fish*
1993-present	*Creel surveys to estimate harvest*
1971-1972, 1979	*No TMFD counts. Estimates reconstructed using estimated mean brood age structure from 1992-1999.*
1981-1982	*No TMFD data for natural origin broodstock removed. Assumed to be 1 per 750 smolts produced.*
1994-2004, 2007-2013	*Age structure determined using scales collected (each year) from adults returning to TMFD. Average age structure from 1994-2004 used for years without data prior to spawning year 2007. Average age structure from spawning years 2007-2013 was used as a preliminary estimate for the most recent year(s).*
1988-1992	*Harvest of hatchery and natural steelhead in the tribal and non-tribal fisheries above TMFD was based on creel surveys from spawning years 1993-2004. See harvest section above for details.*

Walla Walla River Summer Steelhead Population

Population Description

***Date Modified**: 3/3/2015*

The Walla Walla River (WAWA) summer steelhead population is one of three extant populations in the Umatilla/Walla Walla MPG within the Mid-Columbia steelhead DPS (Carmichael and Taylor 2010), and was listed as threatened in 1999 and reaffirmed in 2006 (U.S. Office of the Federal Register 1999, 2006). The ICTRT has identified three historic MaSAs and two MiSAs within the Walla Walla River steelhead population. Currently two of three of the MaSAs are occupied, including Walla Walla and Mill. Spawning and rearing occur in the lower reaches of the Pine Creek MaSA (Carmichael and Taylor 2010). One of two MiSAs is occupied—Dry Creek in Washington. Two small watersheds which empty directly into the Columbia River below the Walla Walla River confluence are also included in the Walla Walla population boundaries (Juniper Canyon, OR and Switzler, WA). Current spawning distribution is substantially reduced relative to the historical intrinsic distribution and is concentrated in the South Fork Walla Walla River, North Fork Walla Walla River, Couse Creek, Mill Creek and Dry Creek (WA) (Carmichael and Taylor 2010). Spawners within the Walla Walla population are primarily natural origin fish with a small proportion of hatchery strays which are Snake River origin.

In 2007, BPA agreed to fund the Walla Walla Basin Monitoring and Evaluation Project (WWBMEP), a collaborative monitoring and restoration effort in the Walla Walla Basin that emphasizes population status and trend monitoring by CTUIR and Washington Department of Fish and Wildlife (WDFW) (Mendel et al. 2014). While field collections in the Walla Walla are done by CTUIR, ODFW currently calculates the Viable Salmonid Population (VSP) indicators and metrics that are submitted to NOAA.

Field methods (spatial and temporal design)

Nursery Bridge Dam (NBD): Fish counts are conducted at NBD on the Walla Walla River (rkm 70) by CTUIR. This counting facility provides an index of abundance for much of the primary spawning reaches in Oregon (North and South Fork Walla Walla River and Couse Creek) but does not include Mill Creek (WA) and other downstream areas or tributaries that are included as part of the WAWA steelhead population (Mendel et al. 2014). To account for this lack of information in other tributaries, ODFW uses an expansion factor of 1.503 to convert NBD counts to the entire WAWA natural origin spawning population, based on an intrinsic habitat potential model (Carmichael and Taylor 2010).

For spawning years 1993-2001, NBD counts were adjusted with mark-recapture methodology to correct for fish that jumped the dam. Few, if any fish are able to jump the dam following modification of the dam in 2002 (W. Cameron, personal communication). Data taken on fish from the mark-recapture study included sex, origin (natural-hatchery), and scales for aging (ICTRT 2009). Nearly all hatchery fish were removed at NBD by trapping from spawning years 1993-1999; trapping continued through 2001.

Since spawning year 2002, video monitoring at NBD has been used to estimate natural and hatchery origin steelhead abundance above NBD into the upper Walla Walla River (Mendel et al. 2014) and hatchery fish are allowed to pass above NBD to spawn naturally (Carmichael and Taylor 2010).

Analysis Methods

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

Abundance

For the WAWA 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. All pre-spawning mortality has been accounted for in the abundance estimates because the timing of steelhead trapped at weirs occurs during the spawning period such that any pre-spawn mortality has likely already occurred.

Natural Origin Spawner Abundance (NOSA): Abundance of natural origin summer steelhead in the portion of the Walla Walla River basin above NBD was determined from counts of natural adult returns to NBD (Carmichael and Taylor 2010). Natural origin spawner abundance for the entire Walla Walla River population was estimated by expanding abundance of spawners above NBD by a factor of 1.503. The expansion estimate was developed from the ratio of current smolt capacity of the entire population divided by the current smolt capacity above NBD. The current smolt capacity estimates were developed based on Ecosystem-Diagnosis-Treatment (EDT) analyses of current conditions. These counts did not include removals or mortality at and above the dam.

In spawning years 1993-2001, estimates were available for natural and hatchery return counts at NBD (Goodson et al. 2005). Poor video quality precluded the ability to distinguish between natural and hatchery fish in spawning years 2002-2003, and 2005. The estimated number of hatchery and naturally produced fish passing in those two years was calculated by multiplying the average hatchery-to-naturally produced ratio for spawning years 1993-2001 times the total number of fish estimated to have passed the trap.

Brood year 2004 NBD counts were too incomplete to be usable, therefore counts were estimated using average 1989-1996 brood age structure. Average run timing from spawning years 1993-2001 was used to fill gaps in video counts in spawning years 2002-2003 and 2005 (W. Cameron, ODFW, personal communication).

Natural Origin Broodstock Removed (NOBroodStockRemoved): Not applicable. No hatchery programs exist within the WAWA population area.

Proportion of Hatchery Origin Spawners (pHOS): The calculation for pHOS = hatchery origin spawners/total spawner abundance. Identification of hatchery origin is determined at NBD using video monitoring.

Total Spawner Abundance (TSA): Abundance of summer steelhead in the portion of the Walla Walla River basin above NBD was determined from counts of adult returns to the dam. (Carmichael and Taylor 2010). Methods of estimating dam counts for years and time periods with missing data are described above in the NOSA section. Spawner abundance for the entire WAWA natural origin summer steelhead population was estimated by expanding abundance of spawners above NBD by a factor of 1.503 (Carmichael and Taylor 2010).

Proportion at Age (AgeProp): Age proportion data in the Walla Walla used to estimate productivity were only available for the 1993-1995 spawning years (Goodson et al. 2005). Age proportion after spawning year 1995 was determined by taking a mean of ages from scale analyses of adults (ages 3-6) returning in spawning year 1993-1995 (Cameron 2014, unpublished data).

Productivity

Adult productivity for the WAWA 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 the total spawners (natural and hatchery adults spawning in the wild) for that brood year to calculate RperS ratios.

Hatchery Origin Spawners (HatcherySpawners): In spawning years 1993-2001 and 2007-2013, estimates were available for naturally and hatchery produced fish separately but from 2002-2005 changes in passage conditions precluded the ability to distinguish between natural and hatchery fish, therefore, the number of hatchery origin fish passing NBD was estimated as total fish passing the dam multiplied by the average 1993-2001 hatchery proportion (Cameron 2014, unpublished data).

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 3, 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): Harvest removals were not factored into the estimate of spawning abundance above NBD (T. Bailey, ODFW, personal communication, cited in Carmichael and Taylor 2010). Tribal and non-tribal fishing pressure is thought to be minimal. Recreational angling was prohibited from spawning year 1996-2002 and limited to retention of hatchery-origin fish after 2002 (ICTRT 2009).

Table 10. Summary of Walla Walla River Summer Steelhead population methods adjustments

Years	***Methods***
1993-2001	*NBD counts were adjusted with mark-recapture methodology to correct for fish that jumped the dam before modifications were done in spawning year 2002. Estimates available for naturally and hatchery produced fish separately.*
1993-1999	*Hatchery fish removed at NBD by trapping*
1993-1995	*Age proportion data from scales.*
1996-present	*Age determined by taking a mean of ages from scale analyses of adults (ages 3-6) returning in 1993-1995.*
1996-2002	*Recreational angling prohibited above NBD.*
2003-present	*Recreational angling limited to retention of hatchery-origin fish above NBD.*
2002-present	*Video monitoring at NBD used to estimate natural and hatchery origin steelhead abundance above NBD*
2002-2003, 2005	*Low water clarity precluded ability to distinguish between natural and hatchery fish using the video monitoring Calculated by multiplying the average 1993-2001 hatchery-to-naturally produced ratio times total number of fish estimated to have passed the trap*
2003	*Incomplete counts at NBD due to facility problems at the fish ladder. Estimate of uncounted fish were calculated as mean percent of run that passed NBD from Feb 21 - March 11 during spawning years 1993-2001 (12.3%).*
2004	*Incomplete counts at NBD due to facility problems at the fish ladder. TSA estimated from reconstructed brood age structure, and NBD counts were back-calculated from the estimated spawning abundance.*

LITERATURE CITED

References for the Mid-Columbia River and Snake River Steelhead DPSs; and the Snake River Spring Chinook ESU

Adams, P. B., L. B. Boydstun, S. P. Gallagher, M. K. Lacy, T. McDonald, K. E. Shaffer. 2011. California coastal salmonid population monitoring: strategy, design, and methods. Fish Bulletin 180. California Department of Fish and Game. 82 p. Available: Fish Bulletins - California Department of Fish and Wildlife.

Banks, S. K., C. M. Bare, K. B. DeHart, J. L. Latshaw, C. A. James, I. A. Tattam, J. R. Ruzycki, and R. W. Carmichael. 2013. Escapement and productivity of steelhead and spring Chinook Salmon in the John Day River. Report to the Bonneville Power Administration, project # 1998-016-00, Portland Oregon. Available: https://pisces.bpa.gov/release/documents/documentviewer.aspx?doc=P133811.

Bare C. M., Bult A. M., Tattam I. A., Ruzycki J. R., Carmichael R. W. 2012. Productivity and escapement monitoring In the John Day River basin. 2012 Annual Technical Report. Oregon Watershed Enhancement Board Contract number 212-909.

Bare, C. M., K. B. DeHart, J. A. Salgado, J. L. Latshaw, J. J. Rogers, I. A. Tattam, J. R. Ruzycki, and R. W. Carmichael. 2015. Escapement and productivity of steelhead and spring Chinook Salmon in the John Day River. Report to the Bonneville Power Administration, project # 1998-016-00, Portland Oregon. Available: http://www.cbfish.org/Report.mvc/SearchPublications/SearchByProjectAndContract.

Carmichael, R. W. and B. J. Taylor. 2010. Conservation and Recovery Plan for Oregon Steelhead Populations in the Middle Columbia River Steelhead Distinct Population Segment. Oregon Department of Fish and Wildlife, Unpl. Report. Available: http://www.dfw.state.or.us/fish/CRP/docs/mid_columbia_river/Oregon_Mid-C_Recovery_Plan_Feb2010.pdf.

Clarke, L. R., W. A. Cameron, R. S. Hogg, R. W. Carmichael, S. T. Onjukka, M. G. White, and J. Keniry. 2014. Umatilla Hatchery Monitoring and Evaluation Annual Report, 1/1/2013 - 12/31/2013. Report to the Bonneville Power Administration, project # 1990-005-00, Portland, Oregon. Available: https://pisces.bpa.gov/release/documents/documentviewer.aspx?doc=P136581.

Faber, D. M., W. H. Wilson, J. R. Ruzycki, and R. W. Carmichael. 2012. Investigation of relative reproductive success of stray hatchery and wild steelhead and influence of hatchery strays on natural productivity in the Deschutes River subbasin. Report to the Bonneville Power Administration, project # 2007-299-00, Portland, Oregon. Available: https://pisces.bpa.gov/release/documents/documentviewer.aspx?doc=P129856.

Goodson, K., B. McIntosh, M. Chilcote, and C. Corrarino, ed. 2005. Oregon Native Fish Status Report – Volume II Assessment Methods & Population Results. Oregon Department of Fish and Wildlife. Available: http://www.dfw.state.or.us/fish/onfsr/report.asp.

Grant, G., W. Cameron, D. Chess, R. Stonecypher, Jr., T. White, R. Carmichael, C. Contor, P. Kissner, and G. James. 2007. Comprehensive assessment of summer steelhead and Chinook Salmon restoration and enhancement efforts in the Umatilla River subbasin, 1992-2006. Technical Report to the Bonneville Power Administration (DOE/BP-00025172-2). Available: https://pisces.bpa.gov/release/documents/documentviewer.aspx?doc=P104098.

Handley, K. A., C. A. James. J. R. Ruzycki, and R. W. Carmichael. 2012. Fish population monitoring in the Middle Fork John Day River intensively monitored watershed. Annual Technical Report to the Oregon Watershed Enhancement Board (OWEB), contract number 208-920-7776.

Hogg, R. S., L. R. Clarke, W. A. Cameron, R. W. Carmichael, S. T. Onjukka, M. G. White, and S. E. Benda. 2014. Umatilla Hatchery Monitoring and Evaluation Annual Report, 1/1/2014 - 12/31/2014. Report to the Bonneville Power Administration, project # 1990-005-00, Portland, Oregon. Available: http://www.cbfish.org/Report.mvc/SearchPublications/SearchByProjectAndContract.

ICTRT (Interior Columbia Technical Recovery Team). 2007. Viability Criteria for Application to Interior Columbia Basin Salmonid ESUs. Draft report, March 2007. 91 pp. + appendices & attachments. Available: http://www.nwfsc.noaa.gov/trt/col/trt_viability.cfm.

ICTRT (Interior Columbia Technical Recovery Team). 2009. Current Status Reviews: Interior Columbia River Basin Salmon ESUs and Steelhead DPSs. Volume III. Mid-Columbia River Steelhead Distinct Population Segment (DPS). Available: https://collaboration.idfg.idaho.gov/VSP%20Status%20Documents/Status.Snake_Part%201-2_Intro,%20Methods.doc.

ICTRT (Interior Columbia Technical Recovery Team). 2010. Current Status Reviews: Interior Columbia River Basin Salmon ESUs and Steelhead DPSs. Volume I. Snake River Basin ESUs/DPSs https://collaboration.idfg.idaho.gov/VSP%20Status%20Documents/Status.Snake_Part%201-2_Intro,%20Methods.doc.

Jacobs, S., J. Firman, G. Susac, E. Brown, B. Riggers, and K. Tempel. 2000. Status of Oregon coastal stocks of anadromous salmonids. Monitoring program report number OPSW-ODFW-2000-3, Oregon Department of Fish and Wildlife, Portland, Oregon. Available: https://nrimp.dfw.state.or.us/CRL/Reports/2000-03.pdf.

Jacobs, S., J. Firman, and G. Susac. 2001. Status of Oregon coastal stocks of anadromous salmonids, 1999-2000. Monitoring program report number OPSW-ODFW-2001-3, Oregon Department of Fish and Wildlife, Portland, Oregon. Available: http://oregonstate.edu/dept/ODFW/spawn/pdf%20files/reports/01CoastalAdultSalmonidStatusReport.pdf.

Lovtang, J. and C. Baker. 2013. Monitoring Wild Populations of Spring Chinook Salmon (Oncorhynchus tshawytscha) and summer steelhead (O. mykiss) in tributaries of the lower Deschutes River within the boundaries of The Confederated Tribes of the Warm Springs of Oregon Reservation. Annual Report to the Bonneville Power Administration, project #2008-311-00, Portland, Oregon. Available: https://pisces.bpa.gov/release/documents/documentviewer.aspx?doc=P130609.

Mendel, G., B. Mahoney, R. Weldert, J. Olsen, J. Trump, and A. Fitzgerald. 2014. Walla Walla River Subbasin Salmonid Monitoring and Evaluation Project 2013 Annual Report. Report to the Bonneville Power Administration, project 2000-039-00, Portland, Oregon. Available: https://pisces.bpa.gov/release/documents/documentviewer.aspx?doc=P136355.

NMFS (National Marine Fisheries Service). 2009. Middle Columbia River Steelhead Distinct Population Segment ESA Recovery Plan. Northwest Region. November 30, 2009. Available: http://www.salmonrecovery.gov/Files/RecoveryPlans/mid-c-plan.pdf.

Nelson, Tom. 2013. Trout Creek annual report, habitat and summer steelhead annual monitoring. 2/1/2012 - 1/31/2013. Annual Report to the Bonneville Power Administration, project number 1994-042-00, Portland, Oregon. Available: https://pisces.bpa.gov/release/documents/documentviewer.aspx?doc=P138558.

ODFW (Oregon Department of Fish and Wildlife). 2014. Salmon and Steelhead Recovery Tracker, Mid-Columbia Steelhead Adult Abundance Monitoring Designs. Available: http://odfwrecoverytracker.org.

Olsen, E. A., R. B. Lindsay, and W. A. Burck. 1991. Summer steelhead in the Deschutes River, Oregon. Oregon Department of Fish and Wildlife. Unpublished draft information report. Portland, Oregon.

Poxon, B. D., D. M. Faber, J. R. Ruzycki, and R. W. Carmichael. 2012. Abundance, Productivity, and Life History of Fifteenmile Creek Steelhead, 8/16/2011 - 8/15/2012. Annual Technical Report to the Bonneville Power Administration, project # 2010-035-00, Portland, Oregon. Available: https://pisces.bpa.gov/release/documents/documentviewer.aspx?doc=P129817.

Poxon, B. D., D. M. Faber, J. R. Ruzycki, and R. W. Carmichael. 2014. Abundance, Productivity, and Life History of Fifteenmile Creek Steelhead, 1/1/2013 - 12/31/2013. Annual Technical Report to the Bonneville Power Administration, project # 2010-035-00, Portland, Oregon. Available: https://pisces.bpa.gov/release/documents/documentviewer.aspx?doc=P137267.

R Development Core Team. 2005. R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. ISBN 3-900051-07-0. Available: http://www.r-project.org/.

Ruzycki, J. R. 2012. Summer Steelhead Spawning Survey Procedures Manual. Oregon Department of Fish and Wildlife. Available: https://www.monitoringmethods.org/Protocol/Details/757.

Stewart, R. 2002. Resistance board weir panel construction manual. Alaska Department of Fish and Game, Division of Commercial Fisheries, Arctic-Yukon-Kuskokwim Region, Regional Information Report No. 3A02-21, Fairbanks, Alaska. Available: http://www.arlis.org/docs/vol1/57240706.pdf.

Stewart, R. 2003. Techniques for installing a resistance board fish weir. Alaska Department of Fish and Game, Division of Commercial Fisheries, Arctic-Yukon-Kuskokwim Region, Regional Information Report No. 3A03-26, Fairbanks, Alaska. Available: http://www.arlis.org/docs/vol1/54404175.pdf.

Susac, G.L., and S.E. Jacobs. 1999. Evaluation of spawning ground surveys for indexing the abundance of adult winter steelhead in Oregon coastal basins._Oregon Department of Fish and Wildlife Annual Progress Report, Project Contract Number F-145-R-08. Available: https://nrimp.dfw.state.or.us/crl/Reports/AnnPro/steel.pdf.

Tobin, J. H. 1994. Construction and performance of a portable resistance board weir for counting. U.S. Fish and Wildlife Service, Kenai Fishery Resource Office, Alaska Fisheries Technical Report Number 22, Kenai, Alaska. Available: http://www.fws.gov/alaska/fisheries/fish/Technical_Reports/t_1994_22.pdf.

U.S. Office of the Federal Register. 1999. Endangered and Threatened Species: Threatened Status for Two ESUs of Steelhead in Washington and Oregon. Federal Register 64:57 (25 March 1999): 14517-14528. Available: http://www.gpo.gov/fdsys/pkg/FR-1999-03-25/pdf/FR-1999-03-25.pdf.

U.S. Office of the Federal Register. 2006. Endangered and Threatened Species: Final Listing Determinations for 10 Distinct Population Segments of West Coast Steelhead. Federal Register 71:3 (5 January 2006): 834-862. Available: http://www.nmfs.noaa.gov/pr/pdfs/fr/fr71-834.pdf.

Wiley, D., M. Garriott, J. Ruzycki, and R. Carmichael. 2005. Implementation of the Environmental Monitoring and Assessment Program (EMAP) Protocol in the John Day Subbasin of the Columbia Plateau Province. Annual Report to the Bonneville Power Administration (DOE/BP-00015113-2), project # 199801600, Portland, Oregon. Available: https://pisces.bpa.gov/release/documents/documentviewer.aspx?doc=00015113-2.

Wilson, W.H., D.M. Faber, J.R. Ruzycki, and R.W. Carmichael. 2011. Investigation of Relative Reproductive Success of Stray Hatchery and Wild Steelhead and Influence of Hatchery Strays on Natural Productivity in the Deschutes River Subbasin. Annual Technical Report to the Bonneville Power Administration, contract #48830, Portland, Oregon. Available: https://pisces.bpa.gov/release/documents/documentviewer.aspx?doc=P124708.

Zimmerman, C.E. and G.H. Reeves. 2000. Population structure of sympatric anadromous and non-anadromous *Oncorhynchus mykiss*: evidence from spawning surveys and otolith microchemistry. Canadian Journal of Fisheries and Aquatic Sciences 57:2152-2162. Available: https://watershed.ucdavis.edu/skeena_river/documents/journals/Zimmerman(2000).pdf.

APPENDICES

Appendix A. Data Analysis and Data Management Flow Diagrams

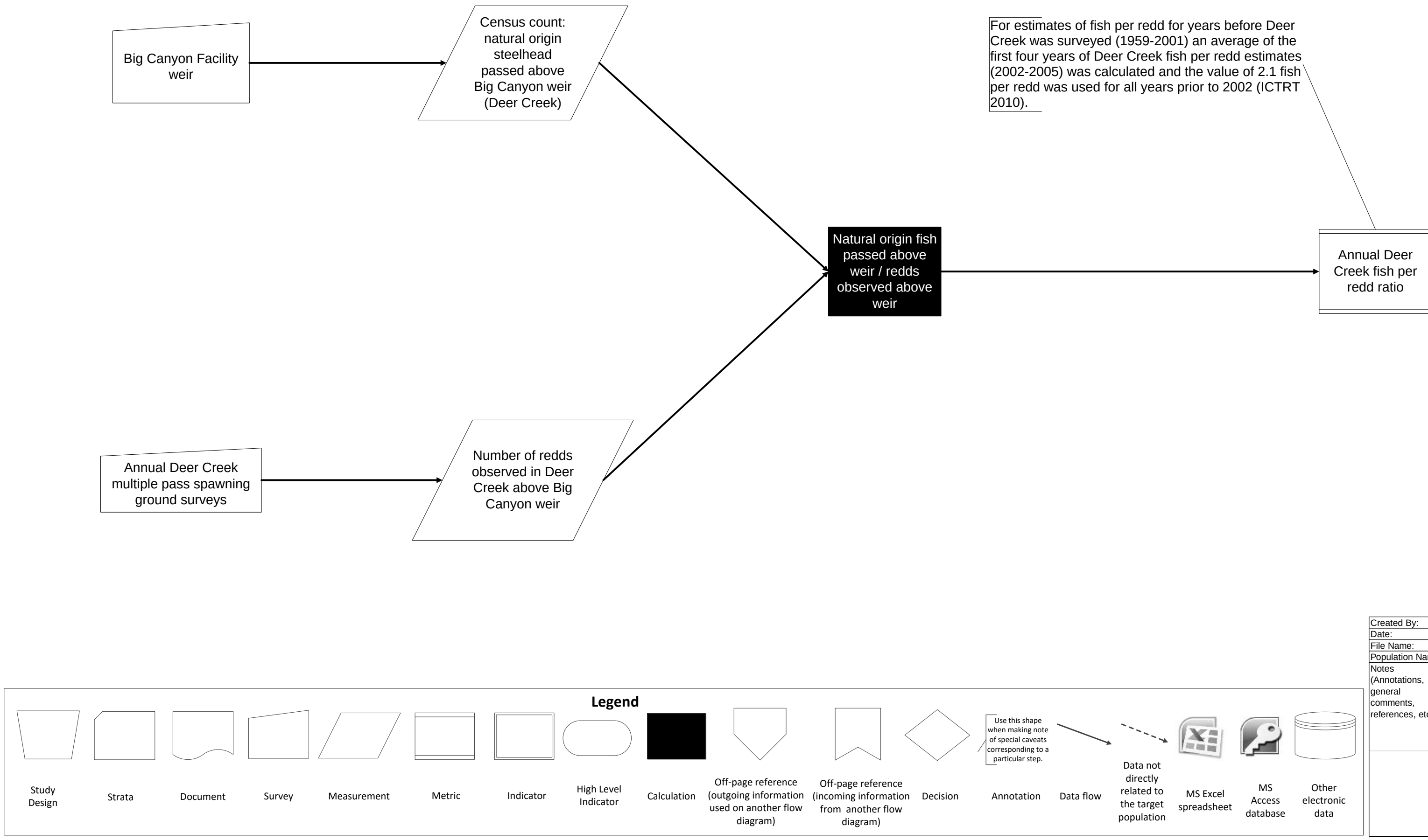
For printing on 11” x 17” paper, maps can be downloaded separately for each population by going to the following links:

Middle Columbia steelhead data analysis flow diagrams:
https://nrimp.dfw.state.or.us/DataClearinghouse/default.aspx?p=202&XMLname=1100.xml

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

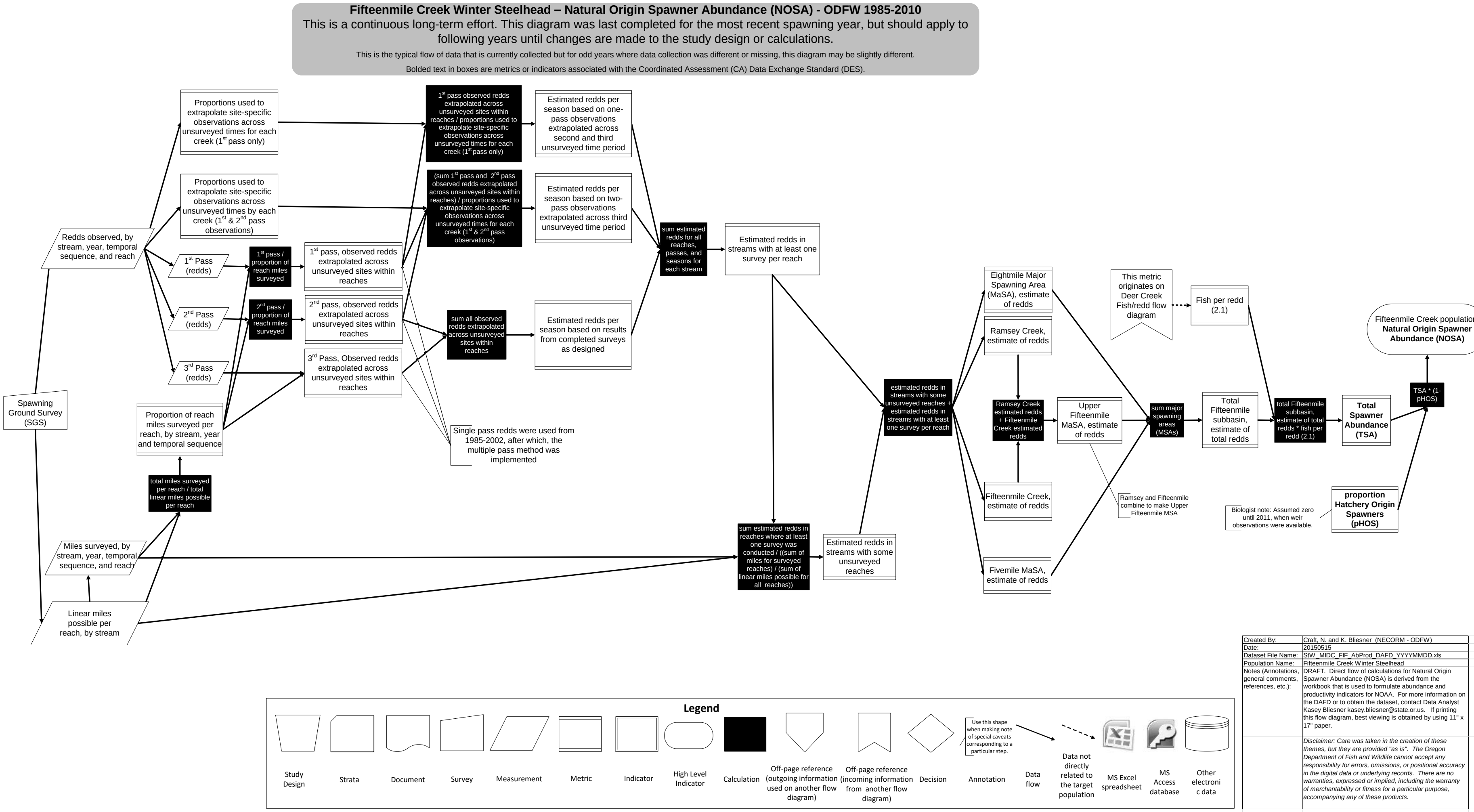


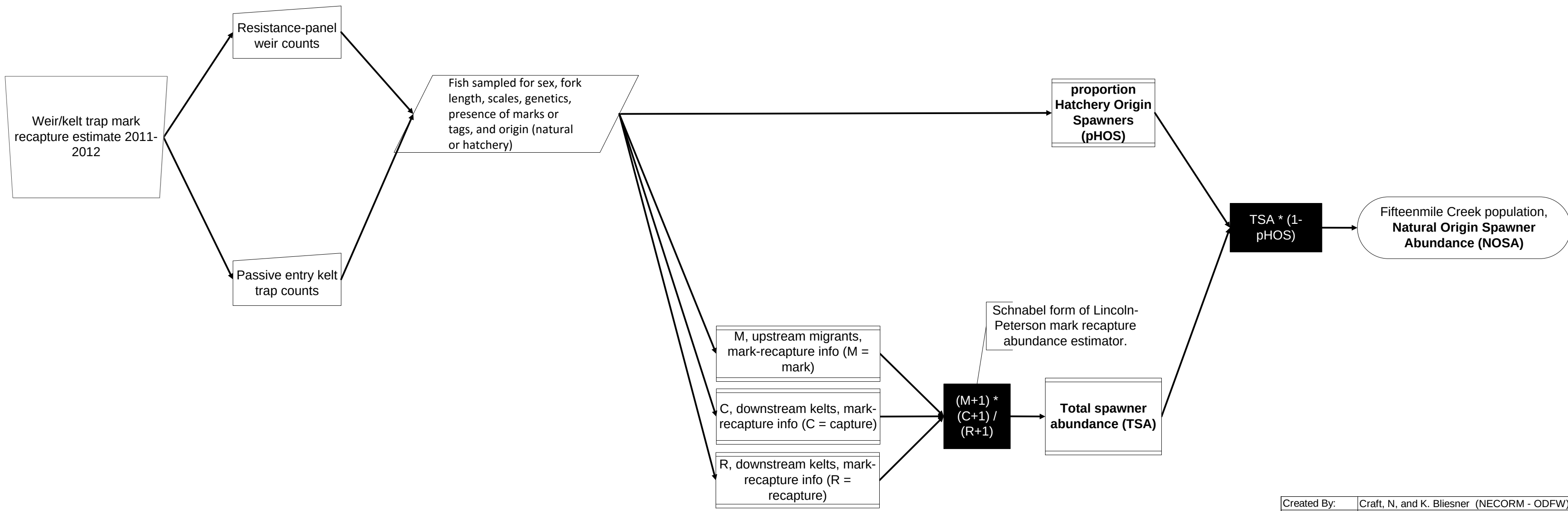
Figure A- 2. Fifteenmile Creek Winter Steelhead - Natural Origin Spawner Abundance (NOSA) – ODFW - spawning years 1985-2010

Fifteenmile Creek Winter Steelhead – Natural Origin Spawner Abundance (NOSA) - ODFW 2011-2012

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 the 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 diagram may be slightly different.

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



Created By:	Craft, N, and K. Bliesner (NECORM - ODFW)
Date:	20140225
Dataset File Nar	StW_MIDC_FIF_AbProd_DAFD_YYYYMMDD.xls
Population Name	Fifteenmile Creek Winter Steelhead
Notes (Annotations, general comments, references, etc.):	DRAFT. Direct flow of calculations for Natural Origin Spawner Abundance (NOSA) 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.

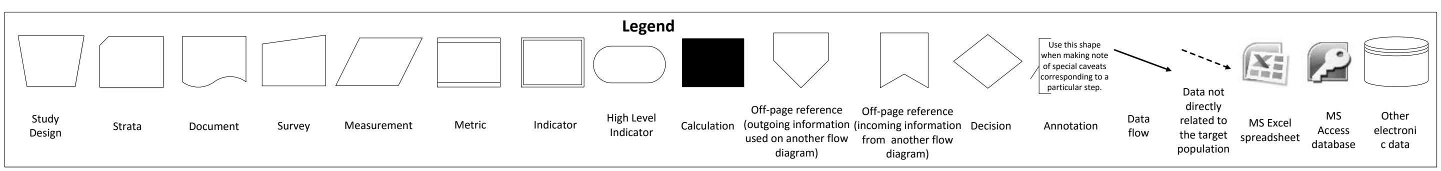
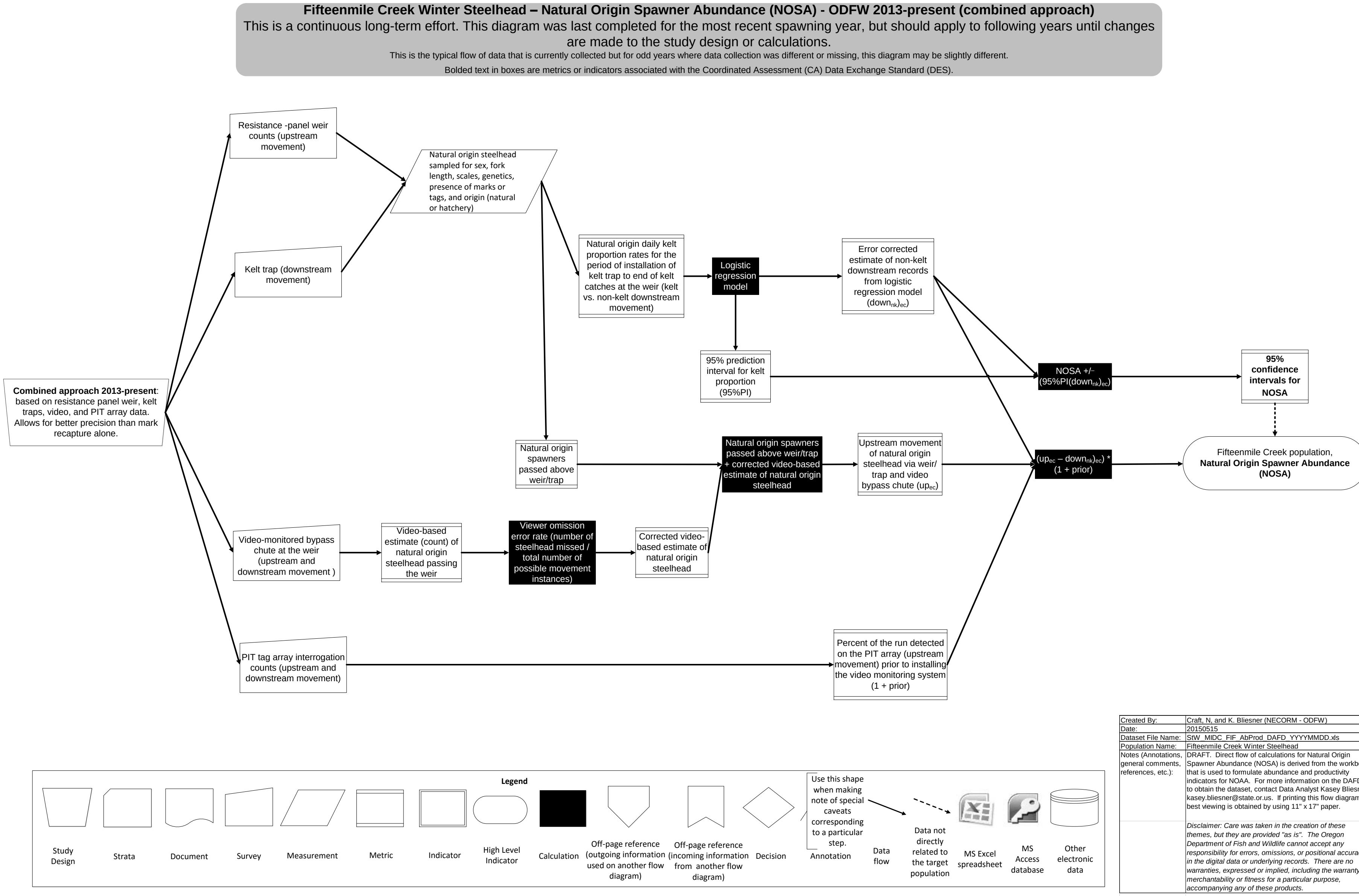


Figure A- 3. Fifteenmile Creek Winter Steelhead – Natural Origin Spawner Abundance (NOSA) – ODFW - spawning years 2011-2012



Created By:	Craft, N, and K. Bliesner (NECORM - ODFW)
Date:	20150515
Dataset File Name:	StW_MIDC_FIF_AbProd_DAFD_YYYYMMDD.xls
Population Name:	Fifteenmile Creek Winter Steelhead
Notes (Annotations, general comments, references, etc.):	DRAFT. Direct flow of calculations for Natural Origin Spawner Abundance (NOSA) 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- 4. Fifteenmile Creek Winter Steelhead – Natural Origin Spawner Abundance (NOSA) – ODFW - spawning years 2013 to present

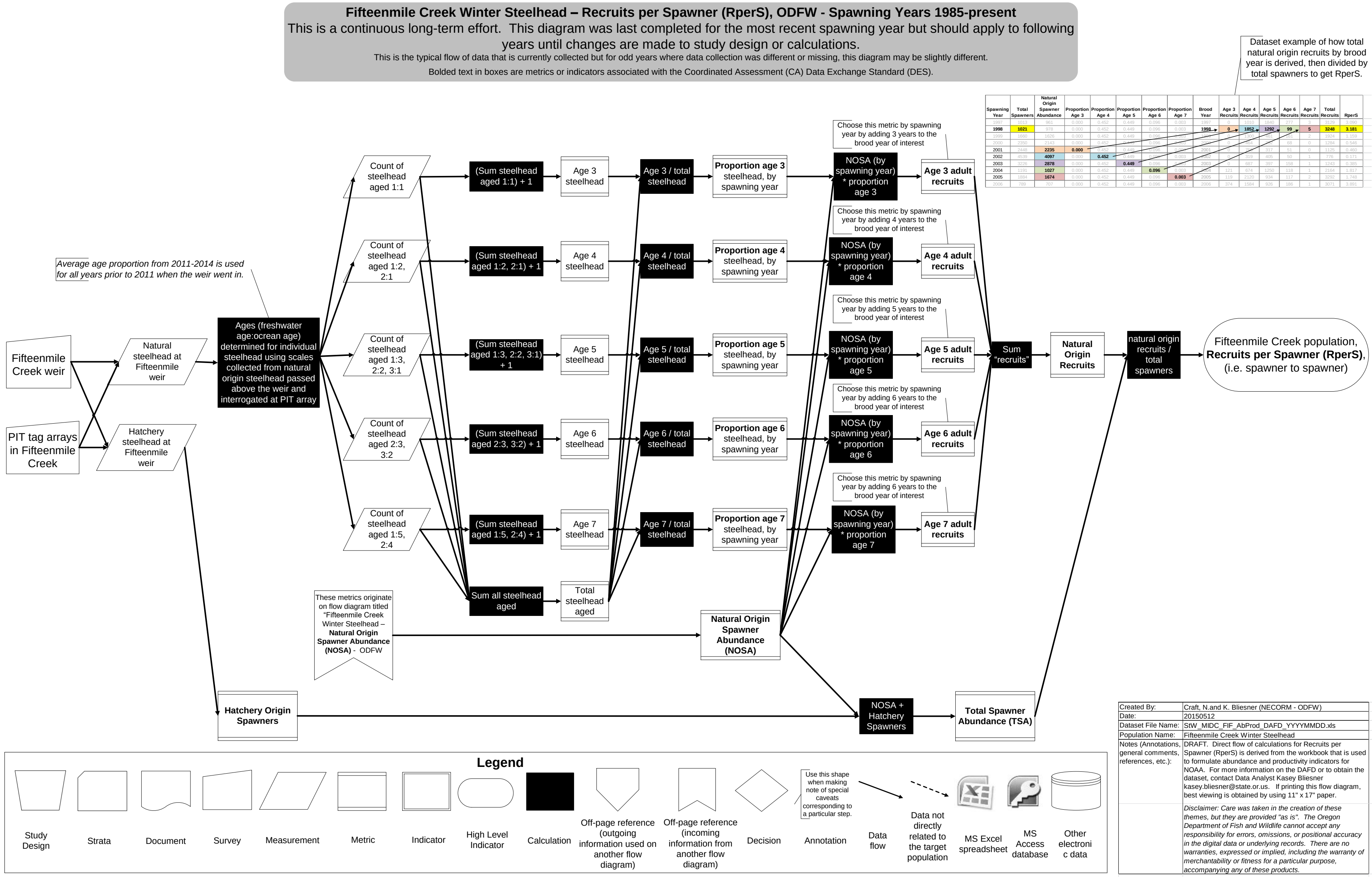
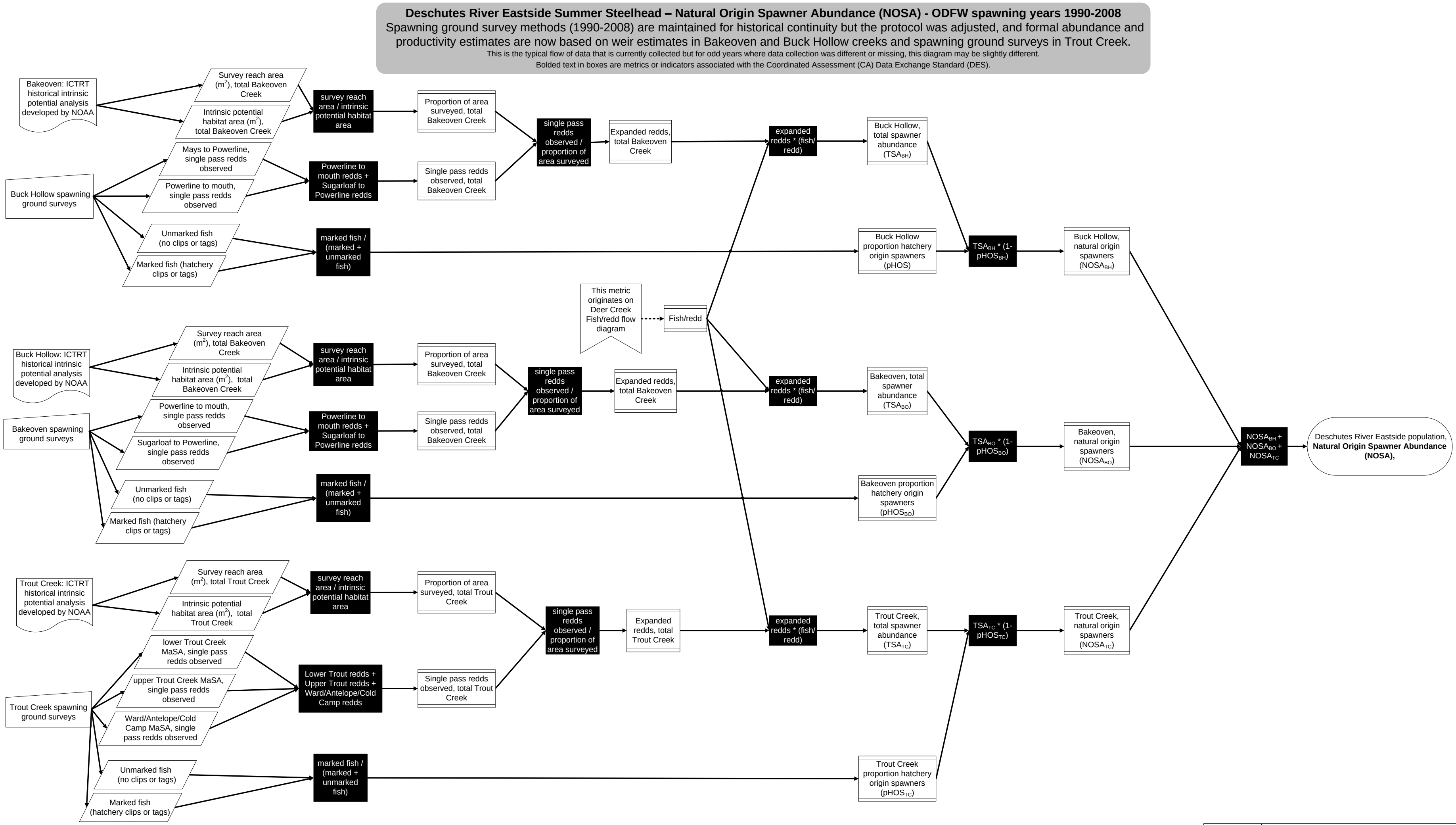
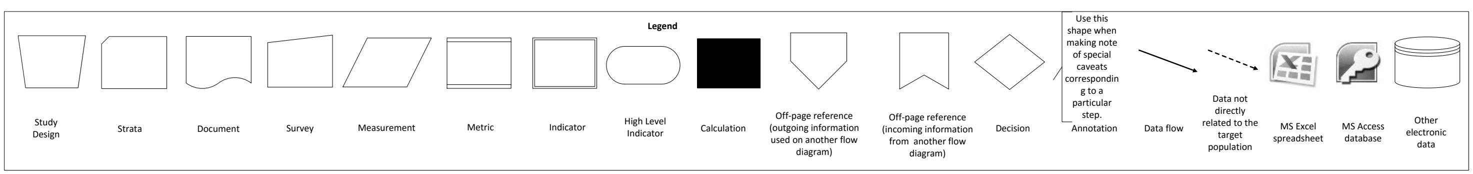


Figure A- 5. Fifteenmile Creek Winter Steelhead – Recruits per Spawner (RperS) - ODFW – brood years 1985-present





Created By:	Craft, N., Blieser, K. (NECORM - ODFW)
Date:	20150408
Dataset File Name:	StS_MIDC_DREST_AbProd_DAFD_YYYYMMDD.xlsx
Population Name:	Deschutes Eastside Summer Steelhead
Notes (Annotations, general comments, references, etc.):	DRAFT. Direct flow of calculations for Natural Origin Spawner Abundance (NOSA) 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- 6. Deschutes River Eastside Summer Steelhead – Natural Origin Spawner Abundance (NOSA) – ODFW - spawning years 1990-2008

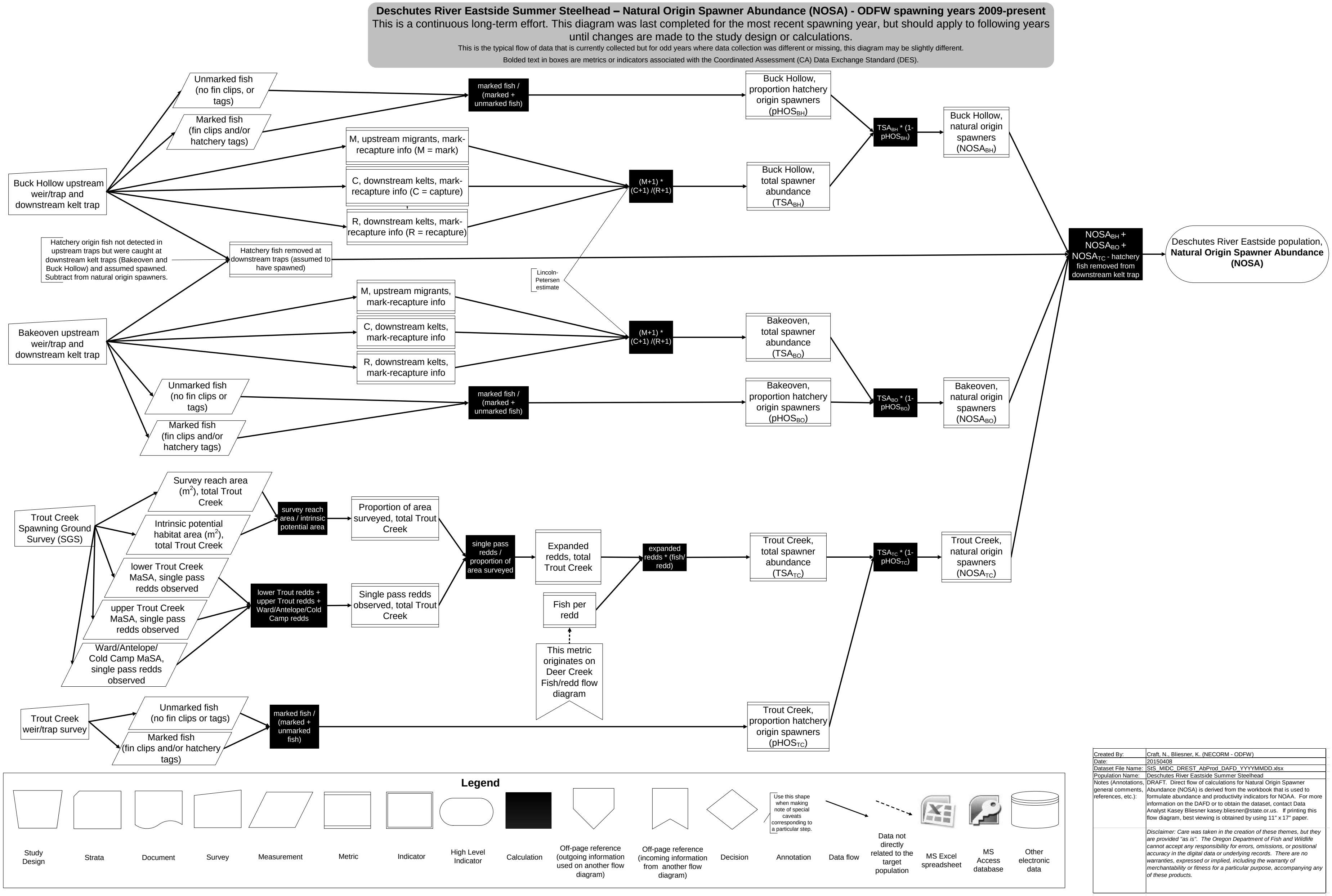


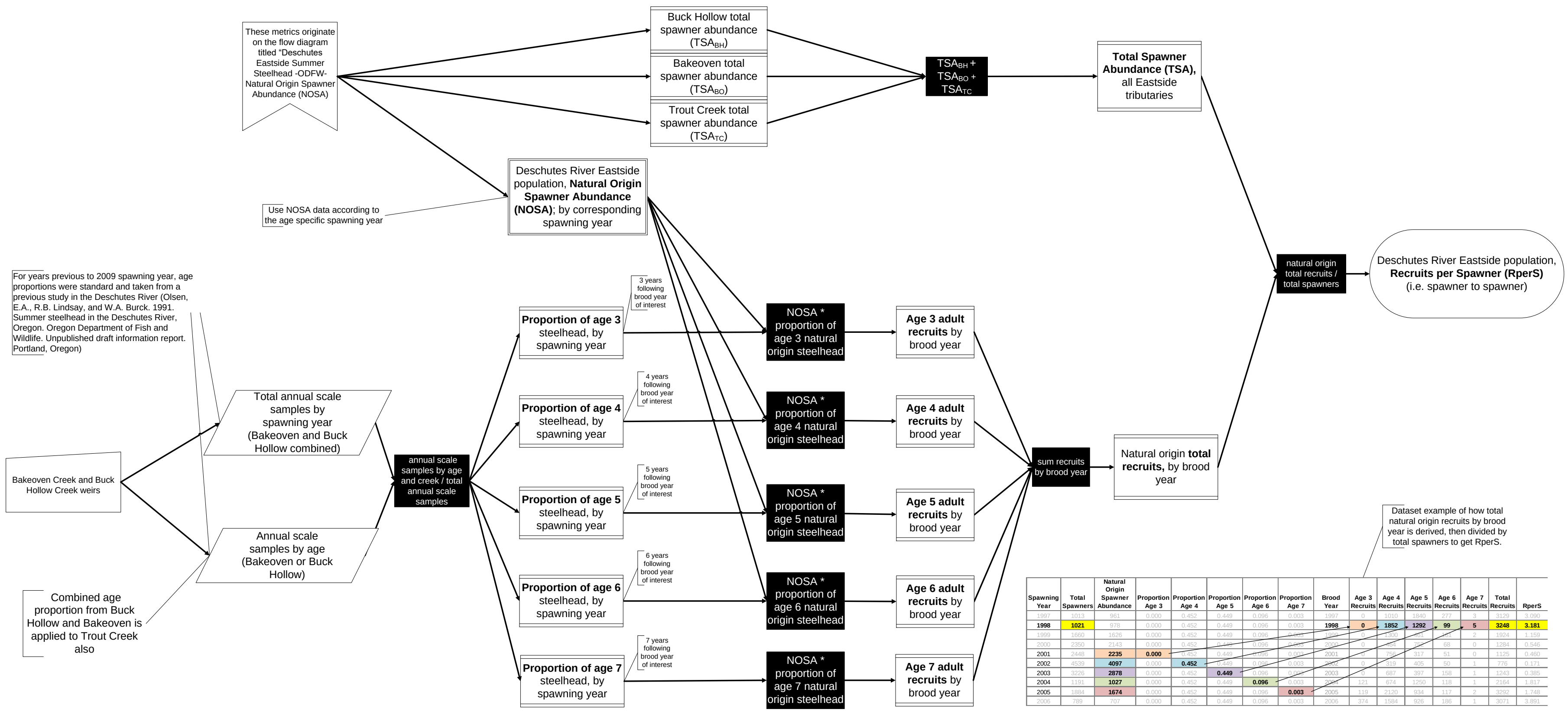
Figure A- 7. Deschutes River Eastside Summer Steelhead – Natural Origin Spawner Abundance (NOSA) – ODFW - spawning years 2009 to present

Deschutes River Eastside Summer Steelhead – Recruits per Spawner (RperS) - ODFW brood years 1990 - present

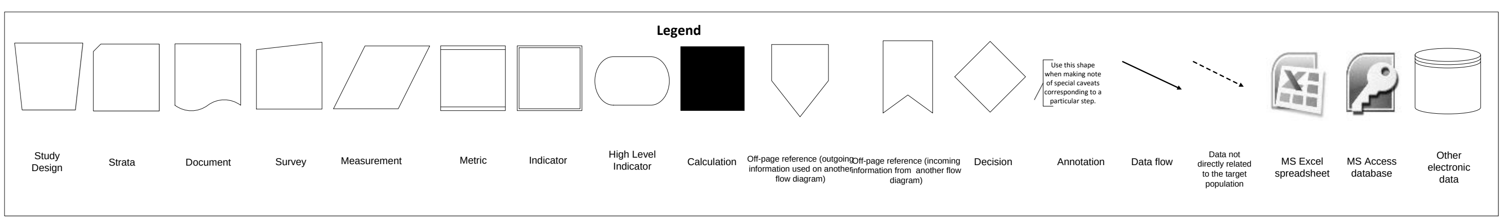
This is a continuous long-term effort. This diagram was last completed for the most recent spawning year, but should apply to following years until changes are made to the study design or calculations.

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

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 3	Proportion Age 4	Proportion Age 5	Proportion Age 6	Proportion Age 7	Brood Year	Age 3 Recruits	Age 4 Recruits	Age 5 Recruits	Age 6 Recruits	Age 7 Recruits	Total Recruits	RperS
1997	1013	961	0.000	0.452	0.449	0.096	0.003	1997	0	1010	1840	277	3	3129	3.090
1998	1021	978	0.000	0.452	0.449	0.096	0.003	1998	0	1852	1292	99	5	3248	3.181
1999	1660	1626	0.000	0.452	0.449	0.096	0.003	1999	0	1300	461	161	2	1924	1.159
2000	2350	2143	0.000	0.452	0.449	0.096	0.003	2000	0	464	752	68	0	1284	0.546
2001	2448	2235	0.000	0.452	0.449	0.096	0.003	2001	0	756	317	51	0	1125	0.460
2002	4539	4097	0.000	0.452	0.449	0.096	0.003	2002	0	319	405	50	1	776	0.171
2003	3226	2878	0.000	0.452	0.449	0.096	0.003	2003	0	687	397	158	1	1243	0.385
2004	1191	1027	0.000	0.452	0.449	0.096	0.003	2004	121	674	1250	118	1	2164	1.817
2005	1884	1674	0.000	0.452	0.449	0.096	0.003	2005	119	2120	934	117	2	3292	1.748
2006	789	707	0.000	0.452	0.449	0.096	0.003	2006	374	1584	926	186	1	3071	3.891



Created By:	Craft, N., Bliesner, K. (NECORM - ODFW)
Date:	20150408
Dataset File Name:	StS_MIDC_DREST_AbProd_DAFD_YYYYMMDD.xlsx
Population Name:	Deschutes River Eastside Summer Steelhead
Notes (Annotations, general comments, references, etc.):	DRAFT. Direct flow of calculations for 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.

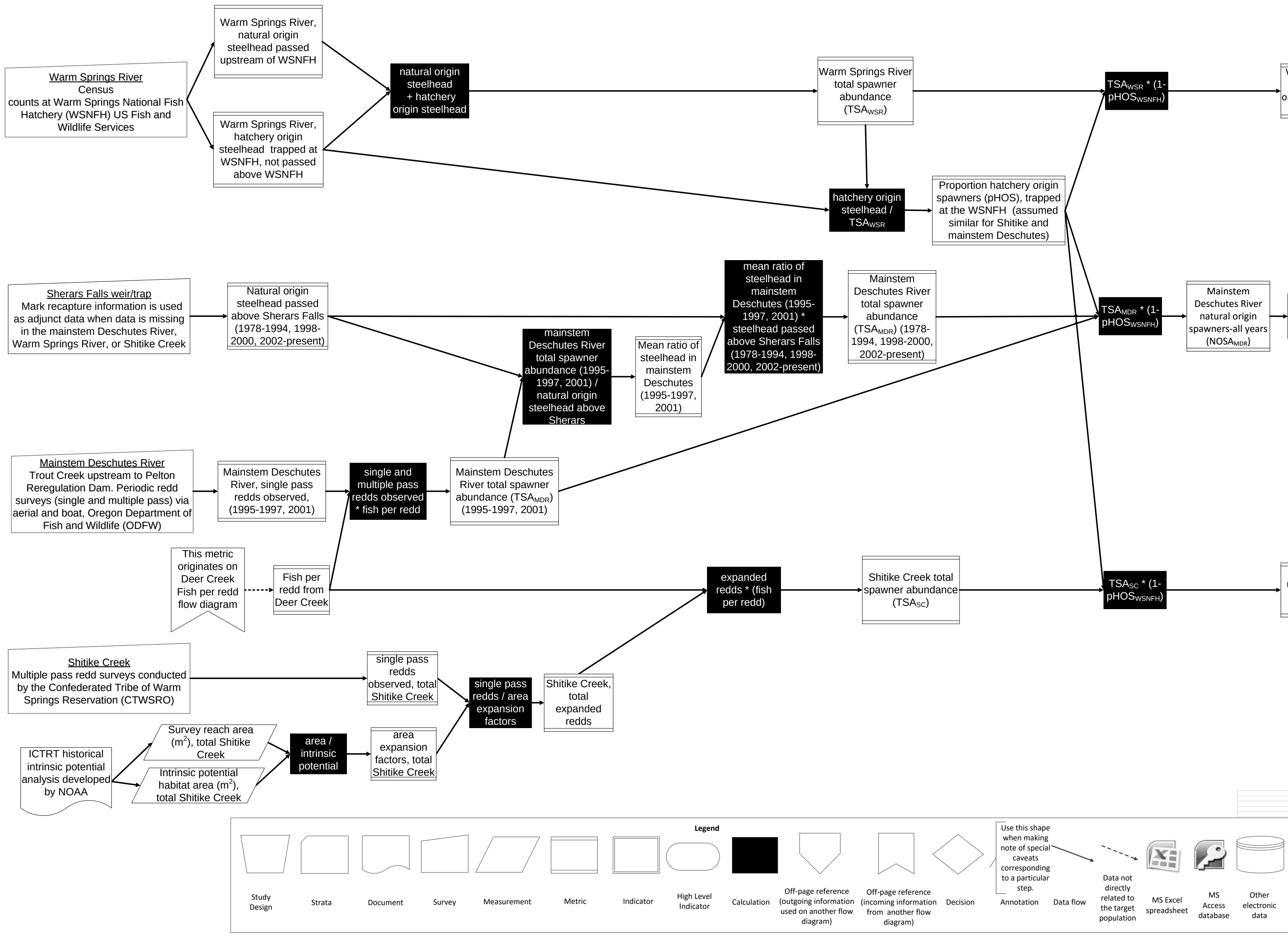
Figure A- 8. Deschutes River Eastside Summer Steelhead – Recruits per Spawner (RperS) – ODFW - brood years 1990 – present

Deschutes River Westside Summer Steelhead – Natural Origin Spawner Abundance (NOSA) - ODFW spawning years 1978 - 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 the 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 diagram may be slightly different.

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



Created By:	Craft, N., Bliesner, K. (NECORM)
Date:	20150415
File Name:	StS_MIDC_DRWST_AbProd_DAFD_YYYYMMDD.xlsx
Population Name:	Deschutes River Westside Summer Steelhead
Notes (Annotations, general comments, references, etc.):	DRAFT. Direct flow of calculations for Natural Origin Spawner Abundance (NOSA) 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- 9. Deschutes River Westside Summer Steelhead – Natural Origin Spawner Abundance (NOSA) – ODFW - spawning years 1978 to present

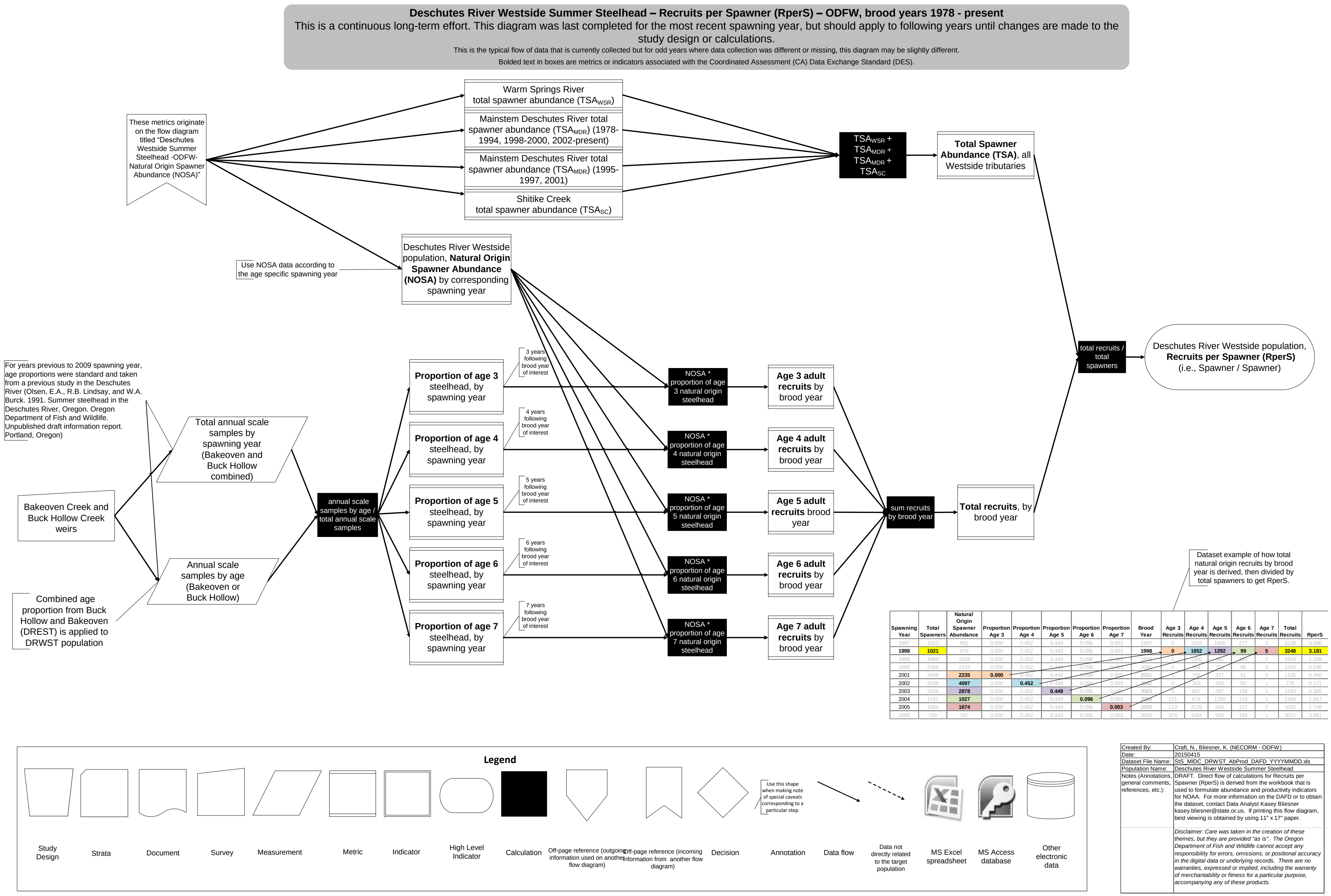
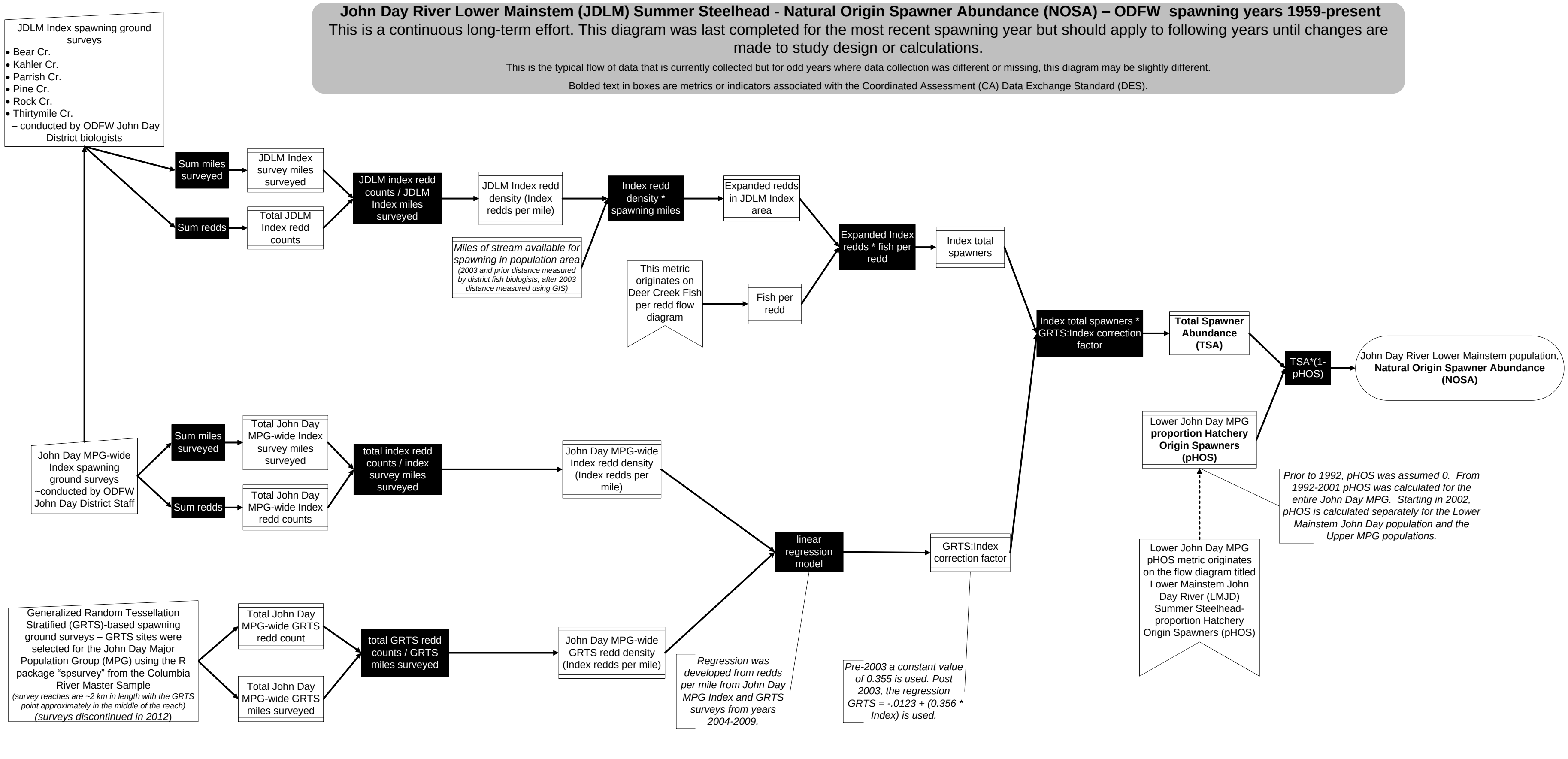
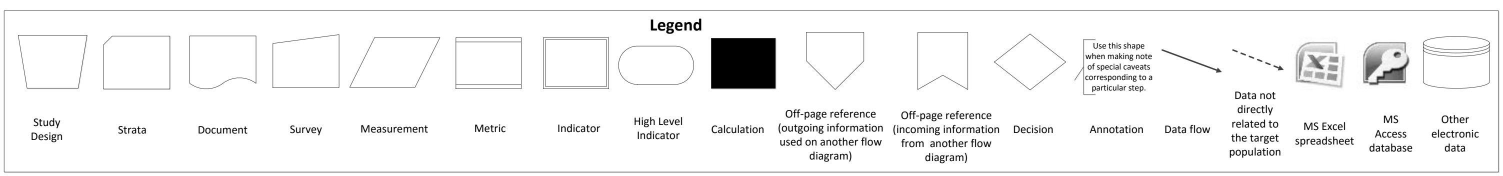


Figure A- 10. Deschutes River Westside Summer Steelhead – Recruits per Spawner (RperS) – ODFW - brood years 1978 to present





Created By:	Bliesner, K. and Craft, N. (NECORM - ODFW)
Date:	20150513
File Name:	StS_MidC_JohnDay_AbProd_DAFD_YYYYMMDD.xlsx
Population Name:	John Day Lower Mainstem Summer Steelhead
Notes (Annotations, general comments, references, etc.):	DRAFT. Direct flow of calculations for Natural Origin Spawner Abundance (NOSA) 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- 11. John Day River Lower Mainstem (JDLM) Summer Steelhead - Natural Origin Spawner Abundance (NOSA) – ODFW - spawning years 1959-present

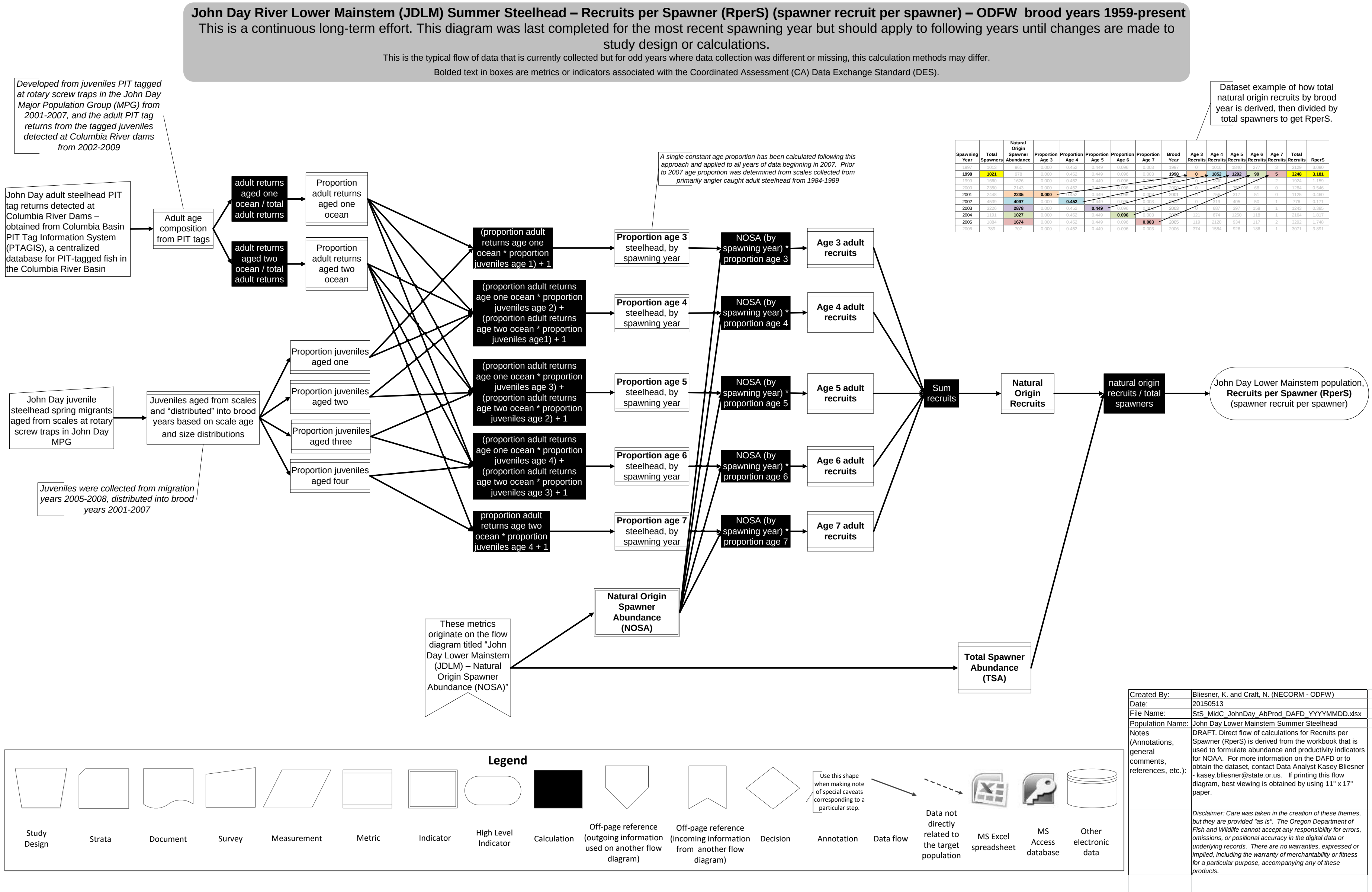


Figure A- 12. John Day River Lower Mainstem (JDLM) Summer Steelhead – Recruits per Spawner (RperS) (spawner recruit per spawner) – ODFW - brood years 1959-present

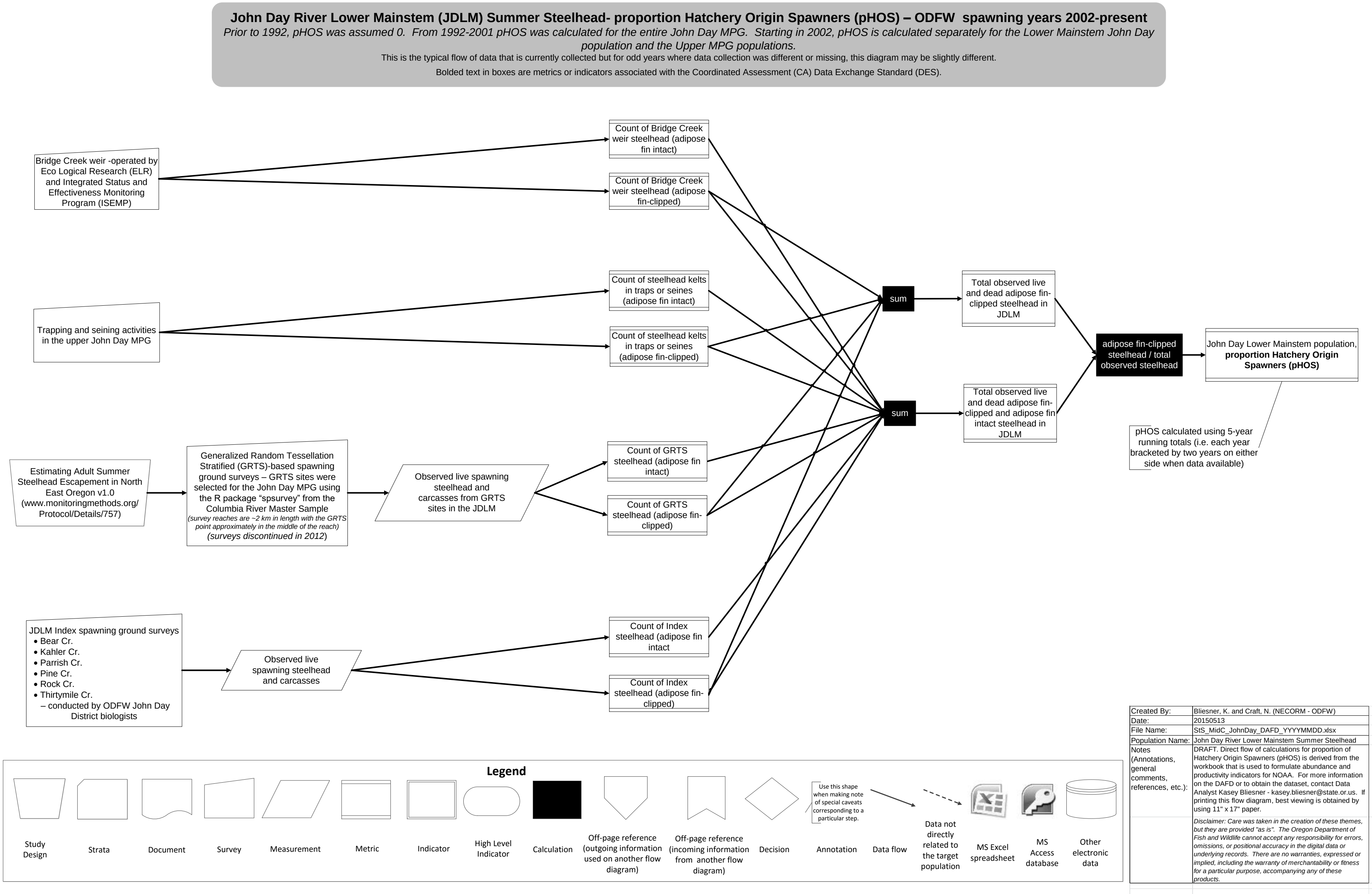


Figure A- 13. John Day River Lower Mainstem (JDLM) Summer Steelhead- proportion Hatchery Origin Spawners (pHOS) – ODFW - spawning years 2002-present

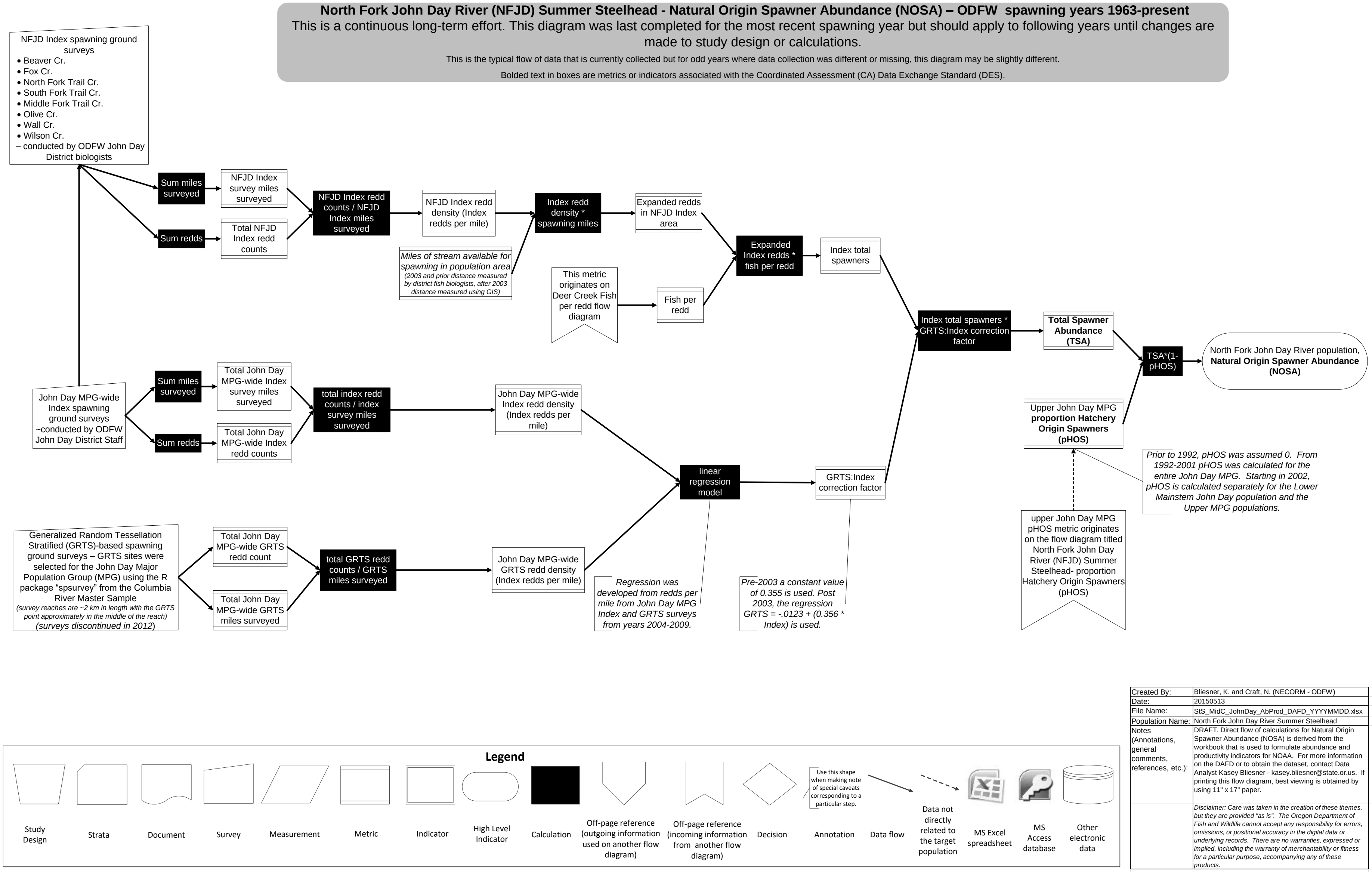


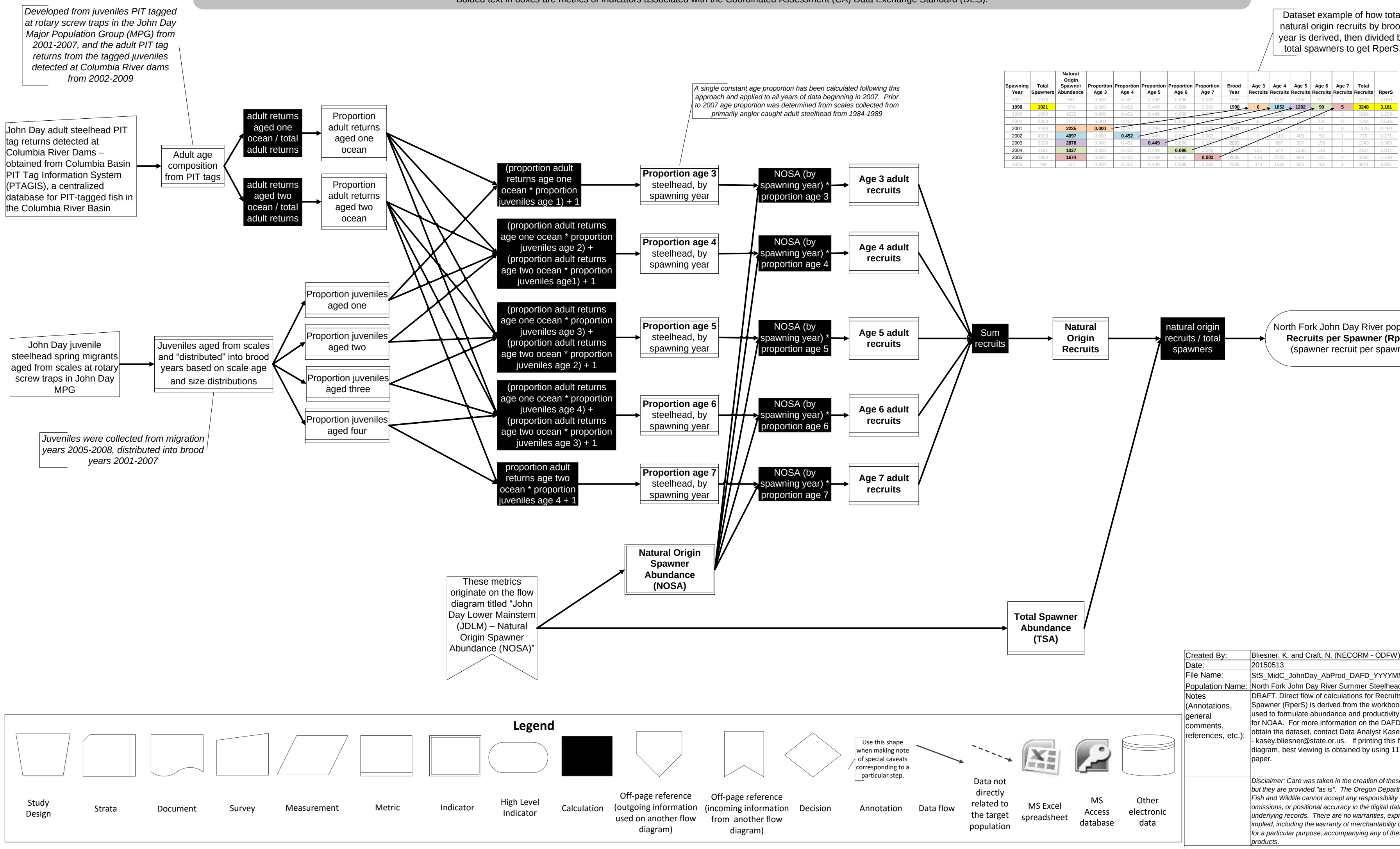
Figure A- 14. North Fork John Day River (NFJD) Summer Steelhead - Natural Origin Spawner Abundance (NOSA) – ODFW -spawning years 1963-present

North Fork John Day River (NFJD) Summer Steelhead – Recruits per Spawner (RperS) (spawner recruit per spawner) – ODFW brood years 1963-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 3	Proportion Age 4	Proportion Age 5	Proportion Age 6	Proportion Age 7	Brood Year	Age 3 Recruits	Age 4 Recruits	Age 5 Recruits	Age 6 Recruits	Age 7 Recruits	Total Recruits	RperS
1997	1013	961	0.000	0.452	0.449	0.096	0.003	1997	0	1010	1840	277	3	3129	3.090
1998	1021	978	0.000	0.452	0.449	0.096	0.003	1998	0	1852	1292	99	5	3248	3.181
1999	1660	1626	0.000	0.452	0.449	0.096	0.003	1999	0	1300	461	161	2	1924	1.159
2000	2350	2143	0.000	0.452	0.449	0.096	0.003	2000	0	464	752	68	0	1284	0.546
2001	2448	2235	0.000	0.452	0.449	0.096	0.003	2001	0	756	317	51	0	1125	0.460
2002	4539	4097	0.000	0.452	0.449	0.096	0.003	2002	0	319	405	50	1	776	0.171
2003	3226	2878	0.000	0.452	0.449	0.096	0.003	2003	0	687	397	158	1	1243	0.385
2004	1191	1027	0.000	0.452	0.449	0.096	0.003	2004	121	674	1250	118	1	2164	1.817
2005	1884	1674	0.000	0.452	0.449	0.096	0.003	2005	119	2120	934	117	2	3292	1.748
2006	789	707	0.000	0.452	0.449	0.096	0.003	2006	374	1584	926	186	1	3071	3.891

Created By:	Bliesner, K. and Craft, N. (NECORM - ODFW)
Date:	20150513
File Name:	StS_MidC_JohnDay_AbProd_DAFD_YYYYMMDD.xlsx
Population Name:	North Fork John Day River Summer Steelhead
Notes (Annotations, general comments, references, etc.):	DRAFT. Direct flow of calculations for 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- 15. North Fork John Day River (NFJD) Summer Steelhead – Recruits per Spawner (RperS) (spawner recruit per spawner) – ODFW - brood years 1963-present

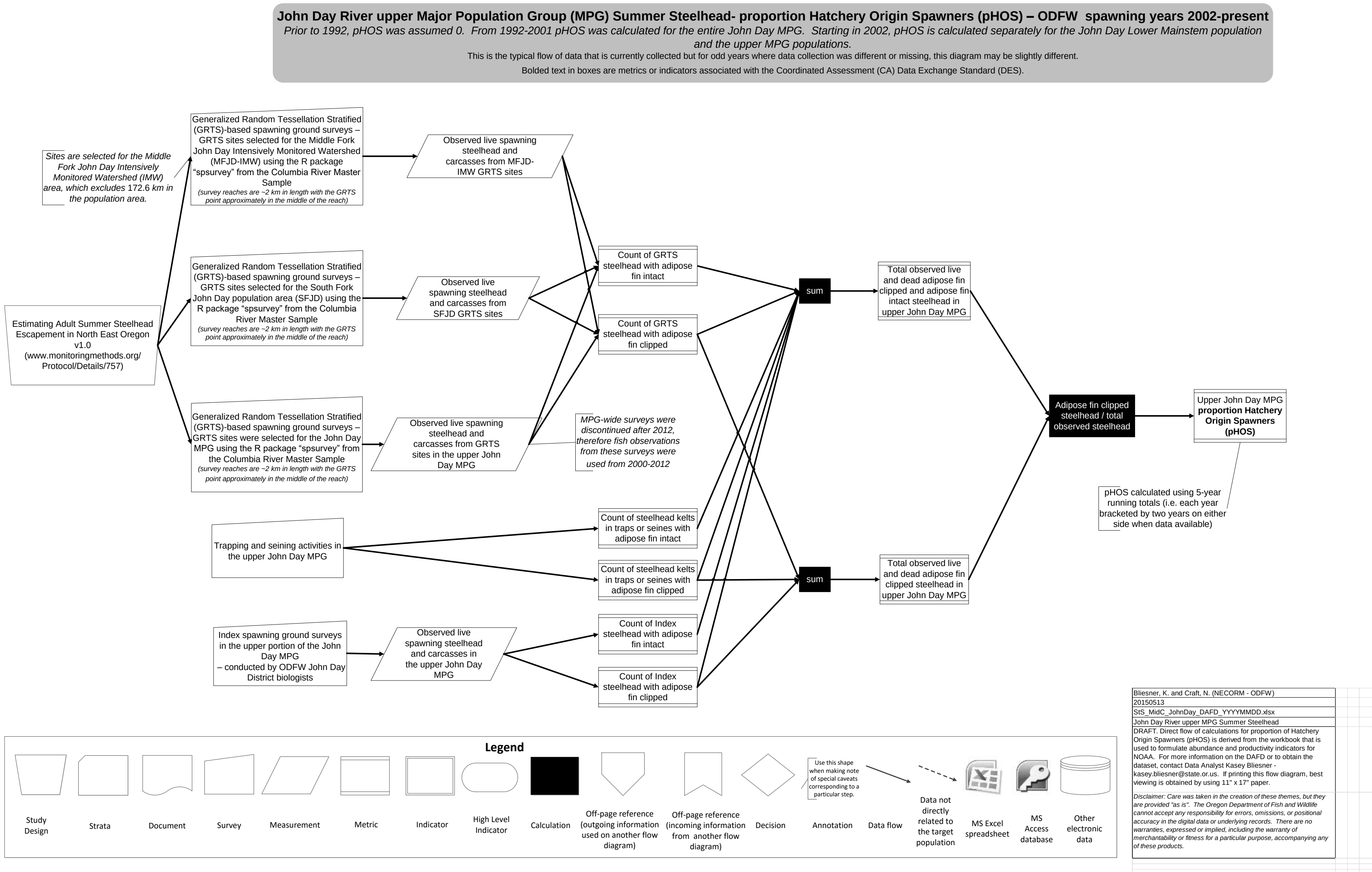


Figure A- 16. John Day River upper Major Population Group (MPG) Summer Steelhead- proportion Hatchery Origin Spawners (pHOS) – ODFW - spawning years 2002-present.

Note: This diagram is only shown once but applies to pHOS for all upper John Day River populations (North Fork, Middle Fork, South Fork, and Upper Mainstem John Day rivers)

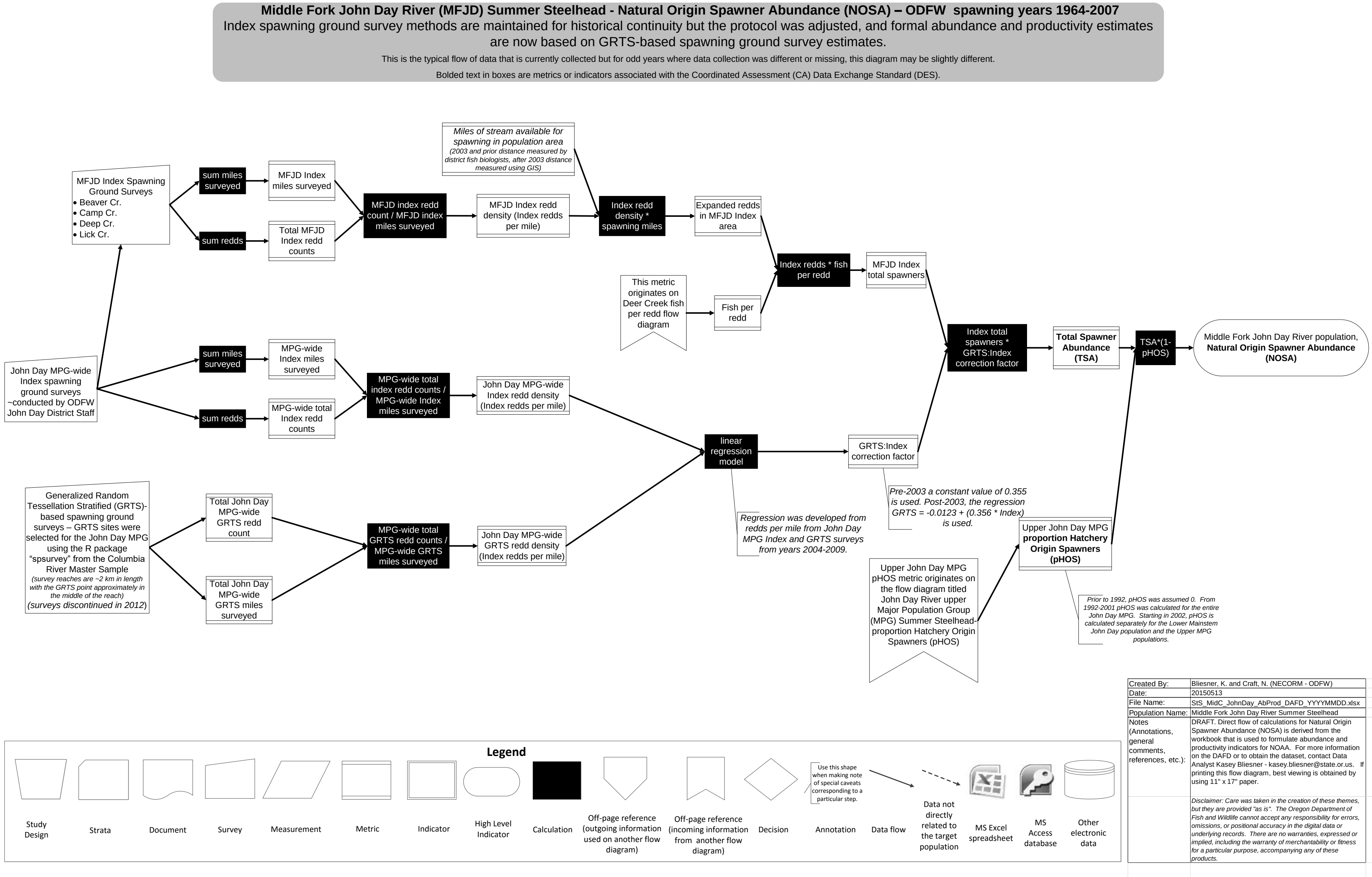


Figure A- 17. Middle Fork John Day River (MFJD) Summer Steelhead - Natural Origin Spawner Abundance (NOSA) – ODFW - spawning years 1964-2007

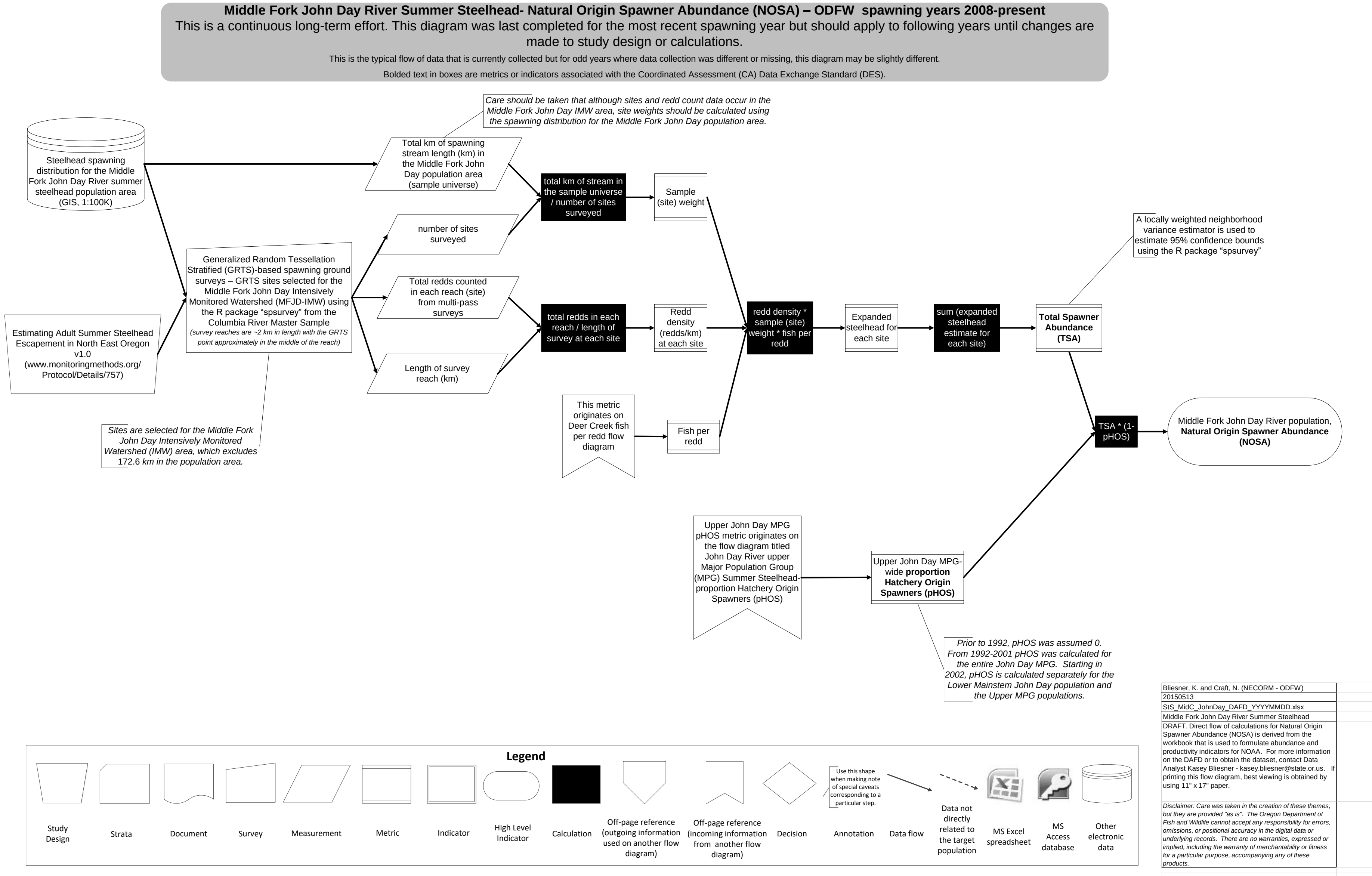


Figure A- 18. Middle Fork John Day River Summer Steelhead- Natural Origin Spawner Abundance (NOSA) – ODFW - spawning years 2008-present

Middle Fork John Day River (MFJD) Summer Steelhead – Recruits per Spawner (RperS) (spawner recruit per spawner) – ODFW brood years 1964-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).

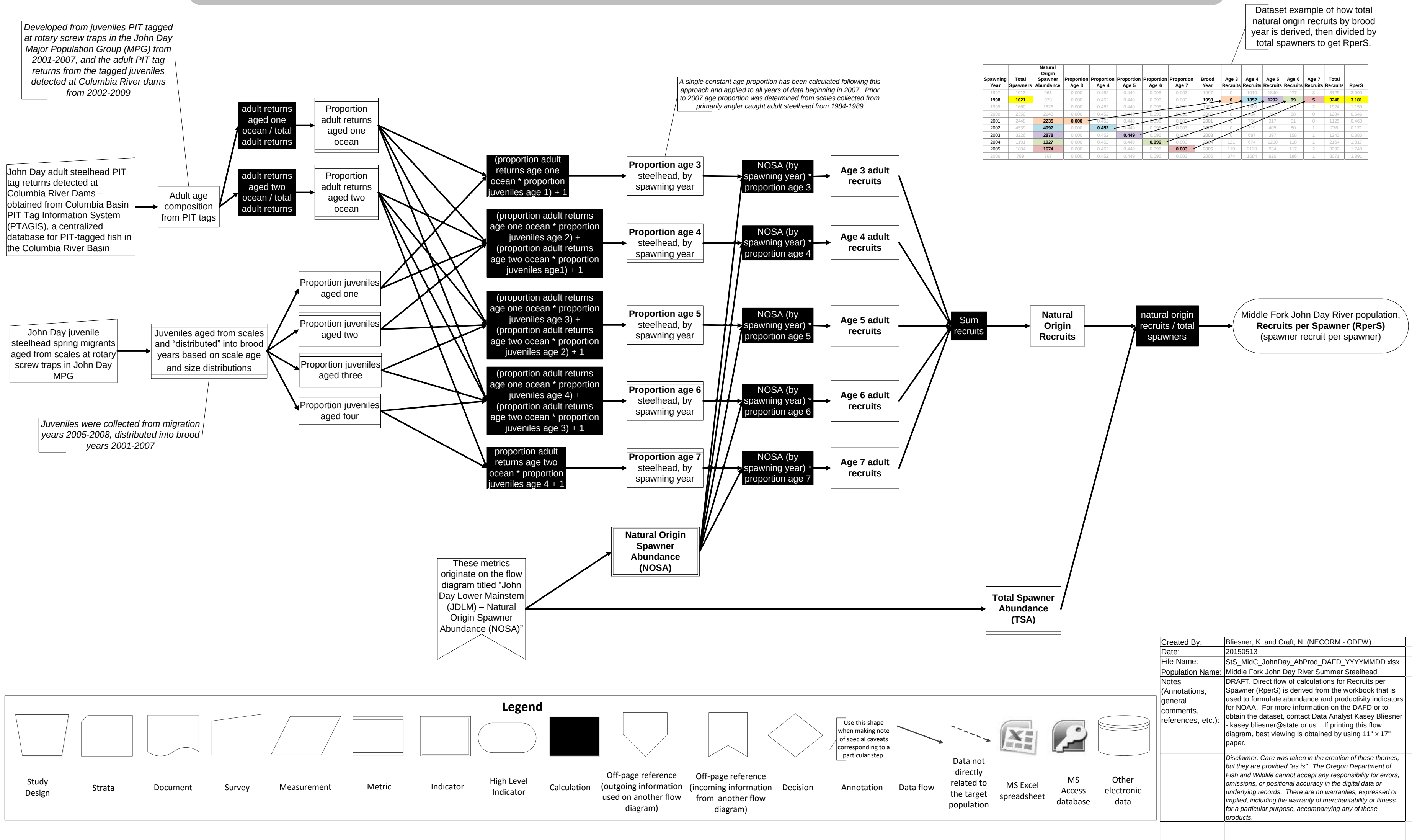


Figure A- 19. Middle Fork John Day River (MFJD) Summer Steelhead – Recruits per Spawner (RperS) (spawner recruit per spawner) – ODFW- brood years 1964-present

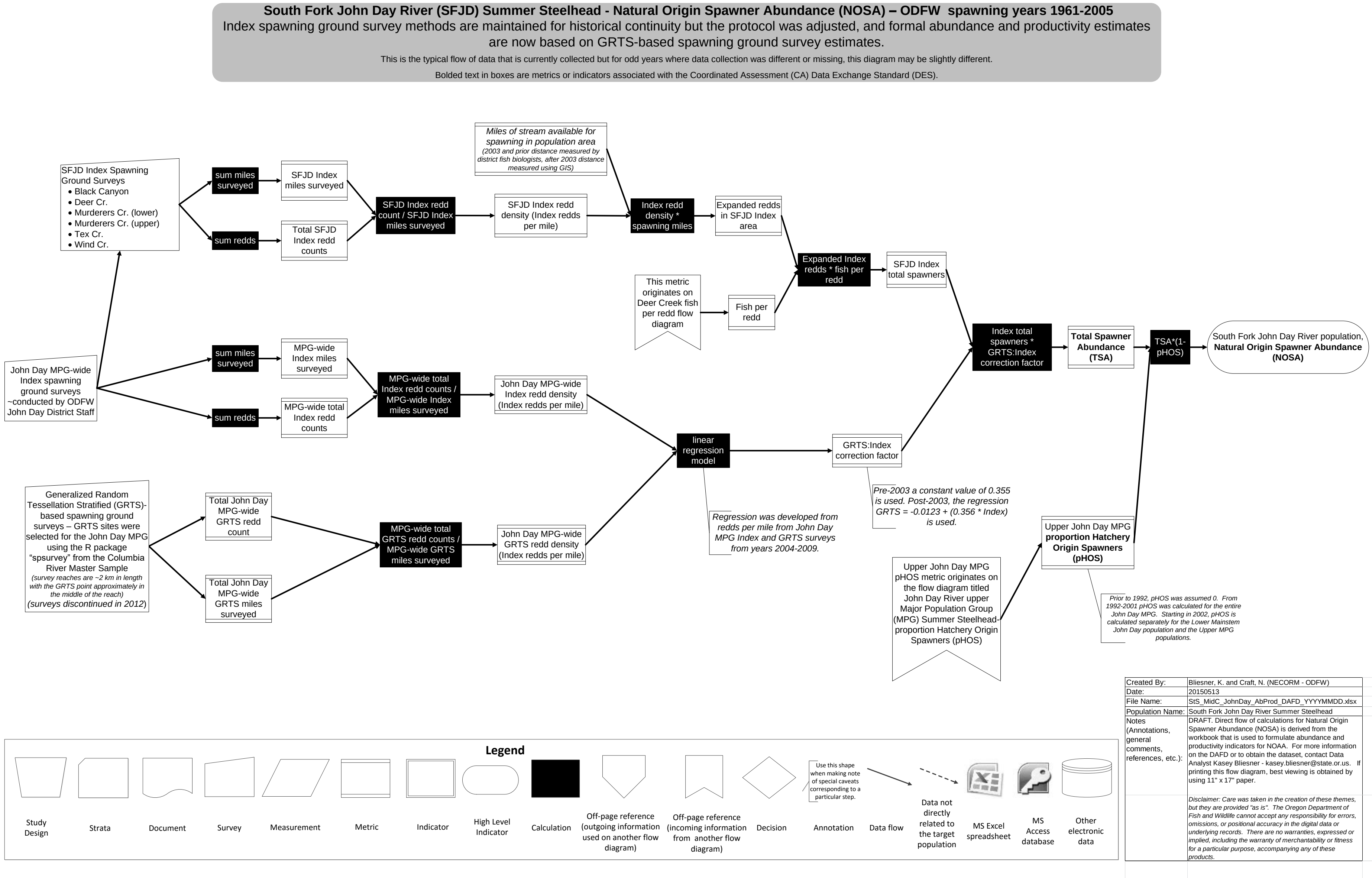


Figure A- 20. South Fork John Day River (SFJD) Summer Steelhead - Natural Origin Spawner Abundance (NOSA) – ODFW - spawning years 1961-2005

South Fork John Day River (SFJD) Summer Steelhead- Natural Origin Spawner Abundance (NOSA) – ODFW spawning years 2006-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 diagram may be slightly different.

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

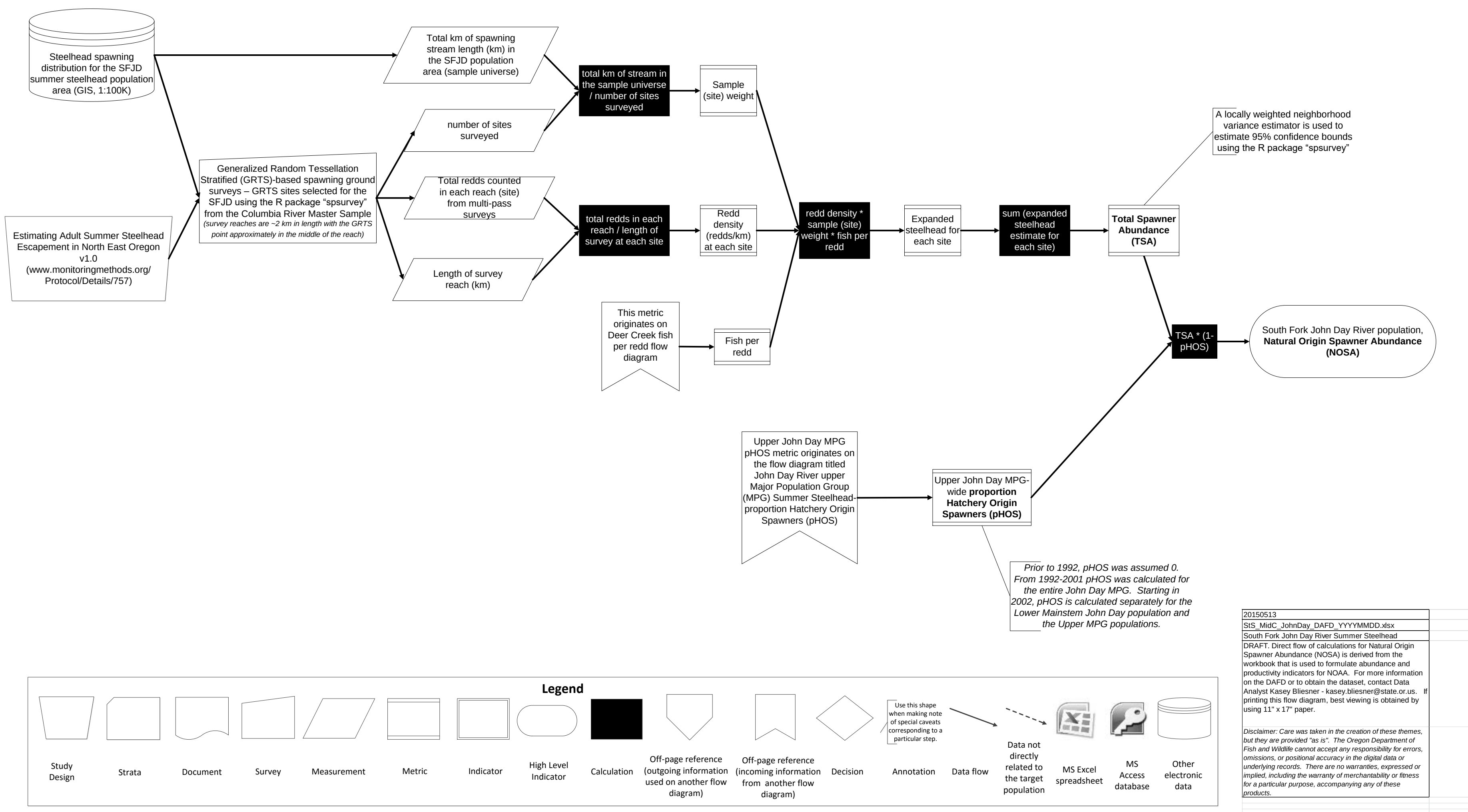


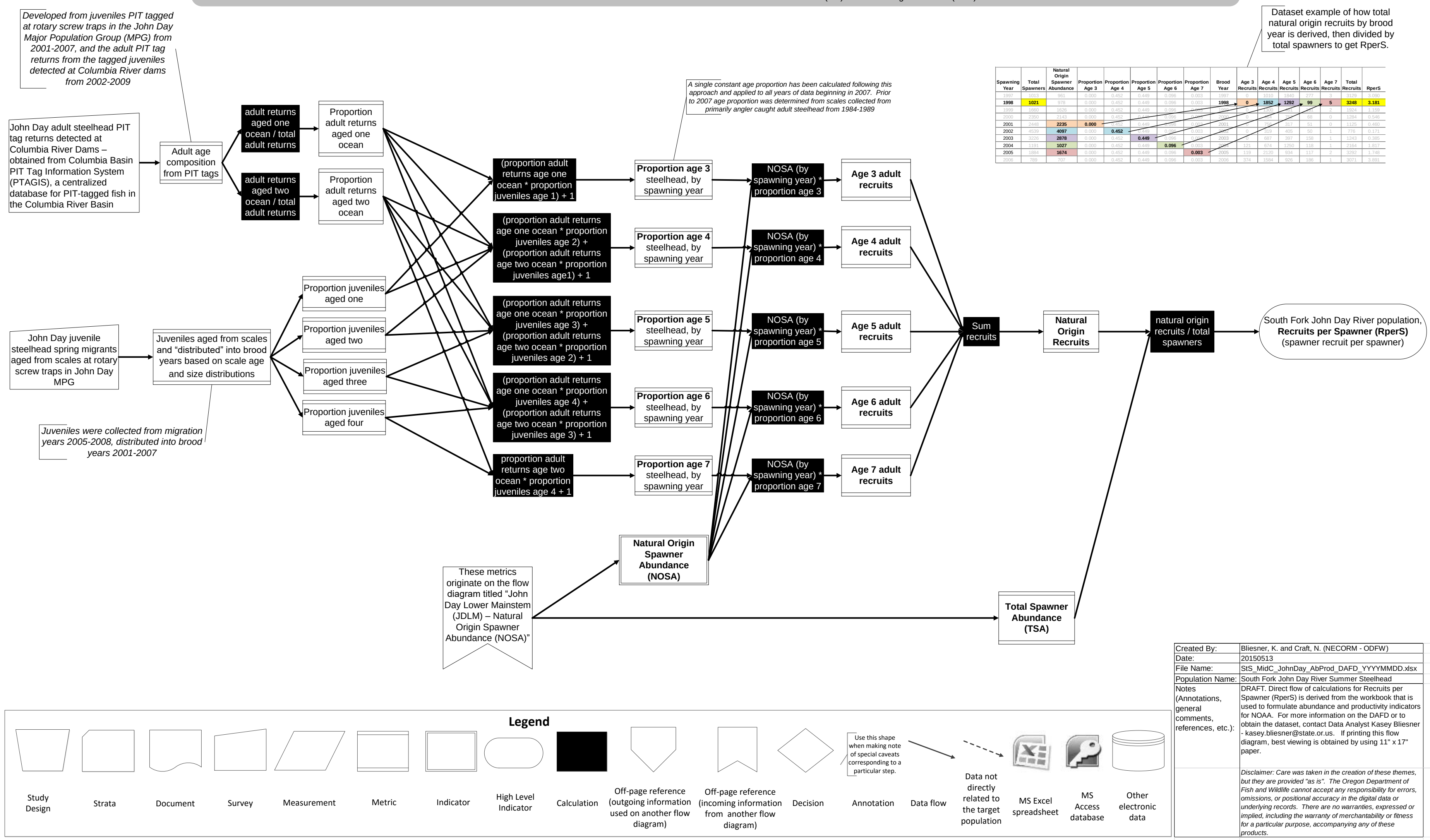
Figure A- 21. South Fork John Day River (SFJD) Summer Steelhead- Natural Origin Spawner Abundance (NOSA) – ODFW spawning years 2006-present

South Fork John Day River (SFJD) Summer Steelhead – Recruits per Spawner (RperS) (spawner recruit per spawner) – ODFW brood years 1960-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).



Created By:	Bliesner, K. and Craft, N. (NECORM - ODFW)
Date:	20150513
File Name:	StS_MidC_JohnDay_AbProd_DAFD_YYYYMMDD.xlsx
Population Name:	South Fork John Day River Summer Steelhead
Notes (Annotations, general comments, references, etc.):	DRAFT. Direct flow of calculations for 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.

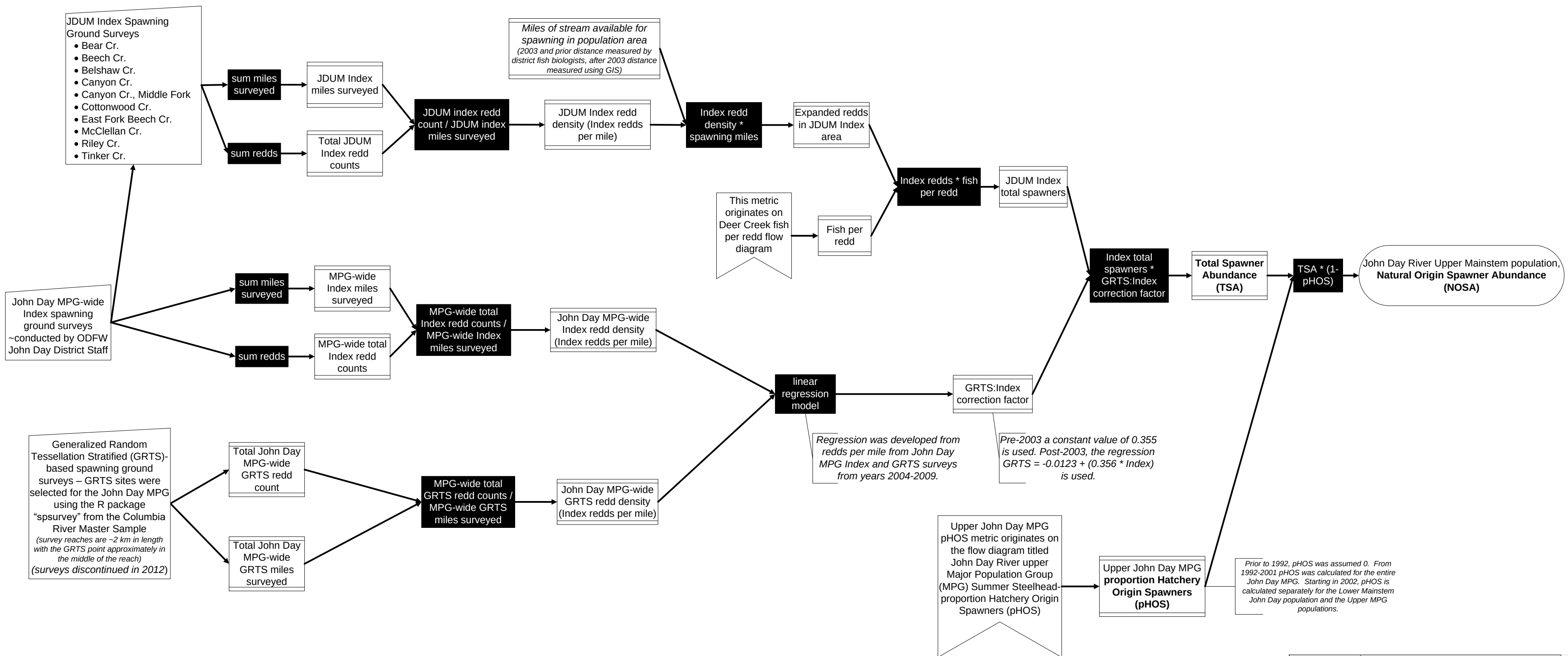
Figure A- 22. South Fork John Day River (SFJD) Summer Steelhead – Recruits per Spawner (RperS) (spawner recruit per spawner) – ODFW - brood years 1960-present

John Day River Upper Mainstem (JDUM) Summer Steelhead - Natural Origin Spawner Abundance (NOSA) – ODFW spawning years 1959-2012, 2014-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 diagram may be slightly different.

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



Created By:	Bliesner, K. and Craft, N. (NECORM - ODFW)
Date:	20150513
File Name:	StS_MidC_JohnDay_AbProd_DAFD_YYYYMMDD.xlsx
Population Name:	John Day River Upper Mainstem Summer Steelhead
Notes (Annotations, general comments, references, etc.):	DRAFT. Direct flow of calculations for Natural Origin Spawner Abundance (NOSA) 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.

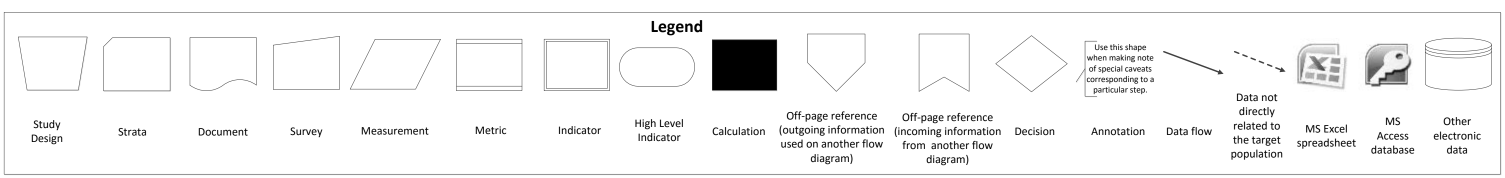


Figure A- 23. John Day River Upper Mainstem (JDUM) Summer Steelhead - Natural Origin Spawner Abundance (NOSA) – ODFW - spawning years 1959-2012, 2014-present

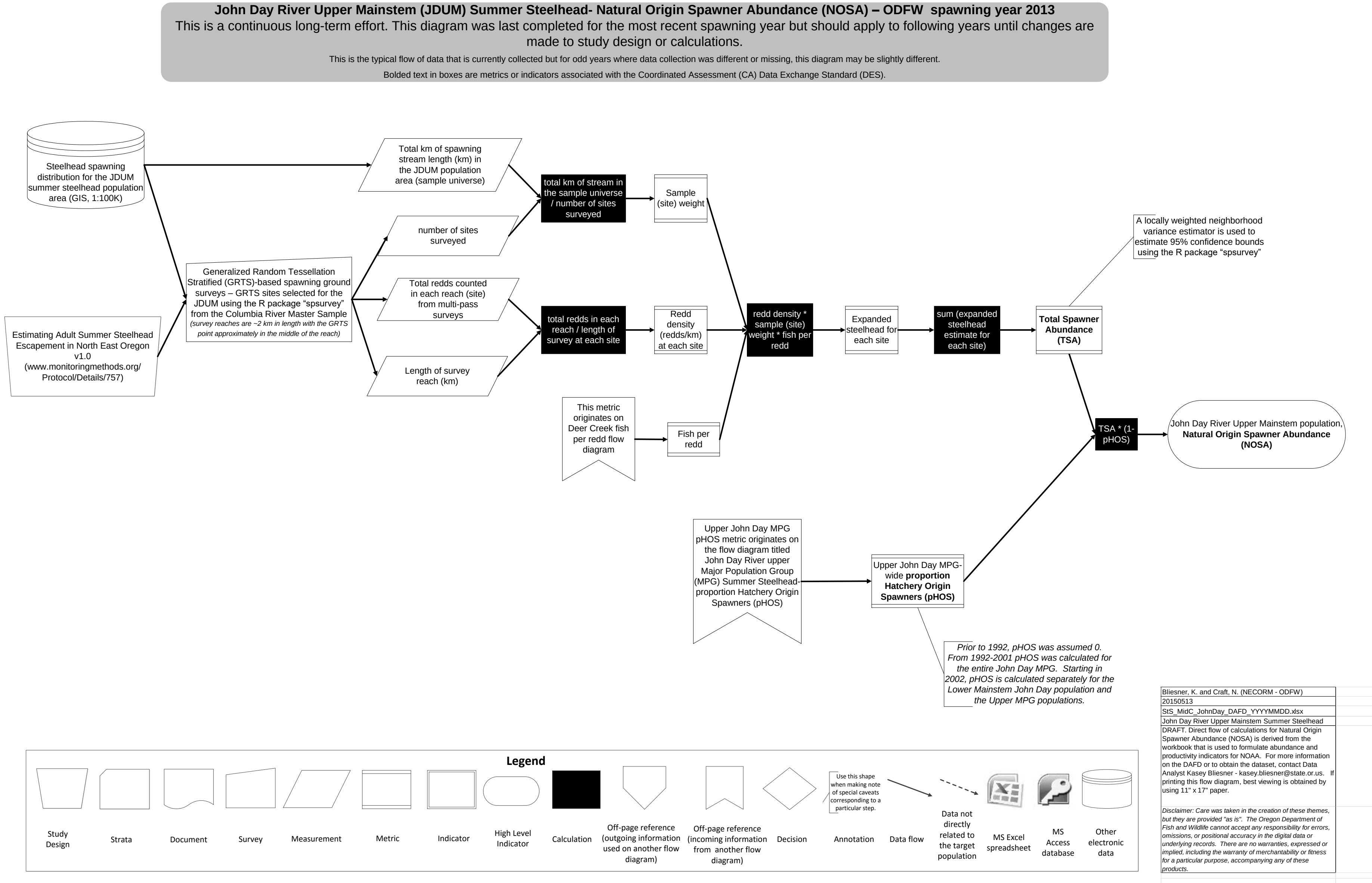


Figure A- 24. John Day River Upper Mainstem (JDUM) Summer Steelhead-Natural Origin Spawner Abundance (NOSA) –ODFW - spawning year 2013

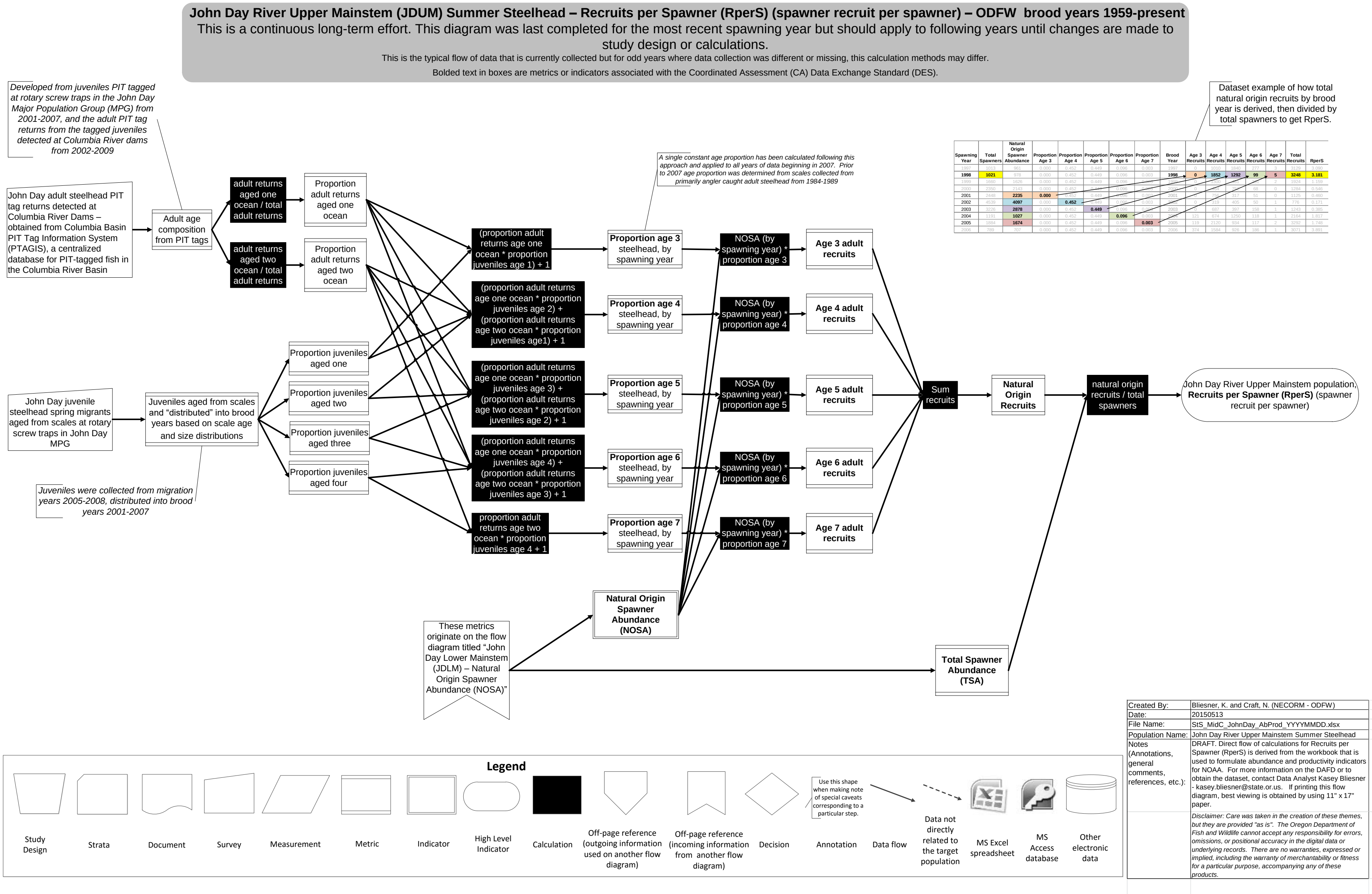


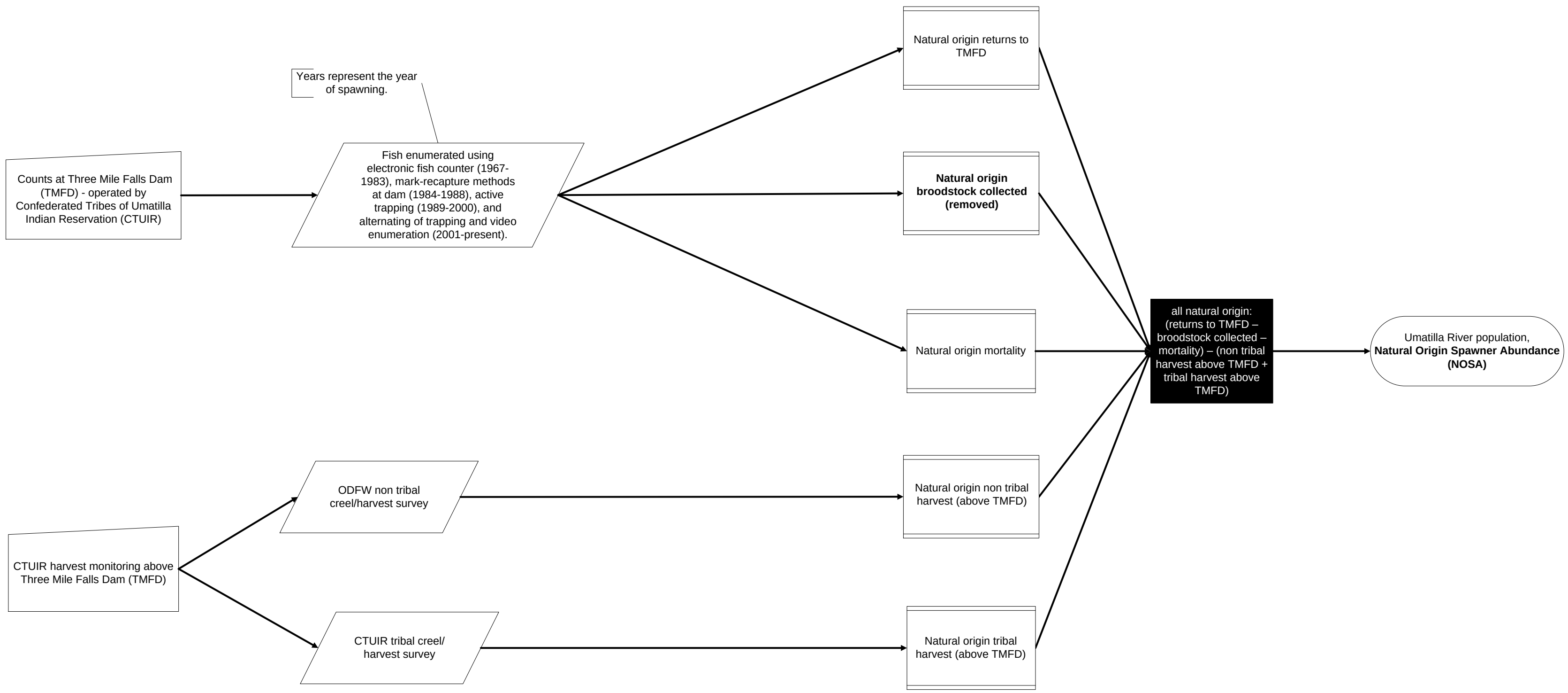
Figure A- 25. John Day River Upper Mainstem (JDUM) Summer Steelhead – Recruits per Spawner (RperS) (spawner recruit per spawner) – ODFW brood years 1959-present

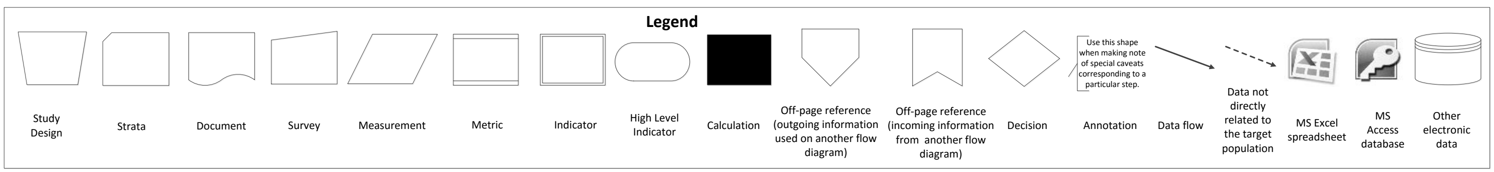
Umatilla River Summer Steelhead - Natural Origin Spawner Abundance (NOSA) - ODFW - spawning years 1967-present

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.

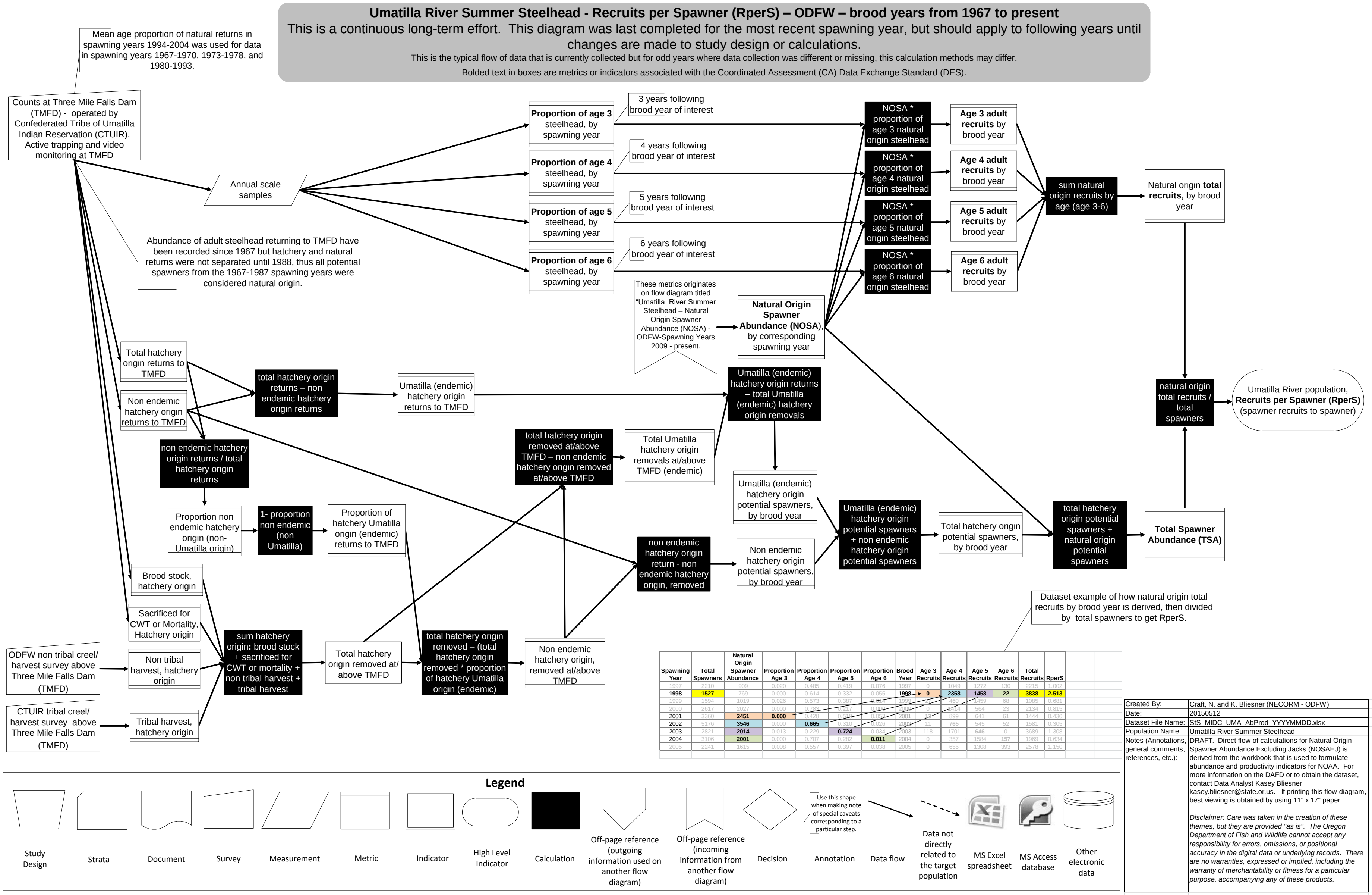
Bolded text in boxes are metrics or indicators associated with the Coordinated Assessment (CA) Data Exchange Standard (DES).





Created By:	Craft, N, and K. Bliesner (NECORM - ODFW)
Date:	20150512
Dataset File:	StS_MIDC_UMA_AbProd_DAFD_YYYYMMDD.xlsx
Population Name:	Umatilla River Summer Steelhead
Notes (Annotations, general comments, references, etc.):	DRAFT. Direct flow of calculations for Natural Origin Spawner Abundance (NOSA) 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- 26. Umatilla River Summer Steelhead - Natural Origin Spawner Abundance (NOSA) - ODFW - spawning years 1967-present



Spawning Year	Total Spawners	Natural Origin Spawner Abundance	Proportion Age 3	Proportion Age 4	Proportion Age 5	Proportion Age 6	Brood Year	Age 3 Recruits	Age 4 Recruits	Age 5 Recruits	Age 6 Recruits	Total Recruits	RperS
1997	2210	909	0.020	0.485	0.419	0.076	1997	0	1049	1272	130	2215	1.002
1998	1527	769	0.000	0.614	0.332	0.055	1998	0	2358	1458	22	3838	2.513
1999	1594	1019	0.026	0.573	0.387	0.014	1999	27	460	1459	68	1085	0.681
2000	2617	2027	0.000	0.783	0.217	0.000	2000	0	1414	564	23	2134	0.815
2001	3360	2451	0.000	0.428	0.519	0.053	2001	13	899	641	61	1444	0.430
2002	5176	3546	0.000	0.665	0.310	0.026	2002	11	765	545	52	1581	0.305
2003	2821	2014	0.013	0.229	0.724	0.034	2003	118	1701	646	0	3689	1.308
2004	3106	2001	0.000	0.707	0.282	0.011	2004	0	357	1584	157	1969	0.634
2005	2241	1615	0.008	0.557	0.397	0.038	2005	0	655	1308	393	2578	1.150

Created By:	Craft, N. and K. Bliesner (NECORM - ODFW)
Date:	20150512
Dataset File Name:	StS_MIDC_UMA_AbProd_YYYYMMDD.xlsx
Population Name:	Umatilla River Summer Steelhead
Notes (Annotations, general comments, references, etc.):	DRAFT. Direct flow of calculations for Natural Origin Spawner Abundance Excluding Jacks (NOSAEJ) 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.

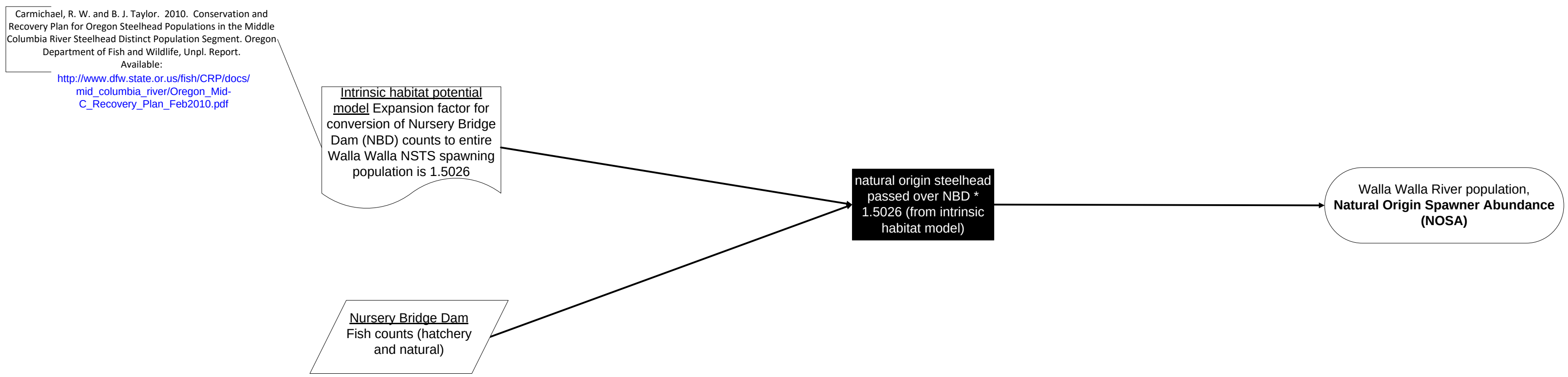
Figure A- 27. Umatilla River Summer Steelhead - Recruits per Spawner (RperS) – ODFW – brood years 1967 to present

Walla Walla River Summer Steelhead – Natural Origin Spawner Abundance (NOSA) - ODFW spawning years 1993 - 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 the 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).



Created By:	Craft, N. and Bliesner, K. (NECORM - ODFW)
Date:	20150519
Dataset File Name:	StS_MIDC_WAWA_AbProd_YYYYMMDD.xls
Population Name:	Walla Walla River Summer Steelhead
Notes (Annotations, general comments, references, etc.):	DRAFT. Direct flow of calculations for Natural Origin Spawner Abundance (NOSA) 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.

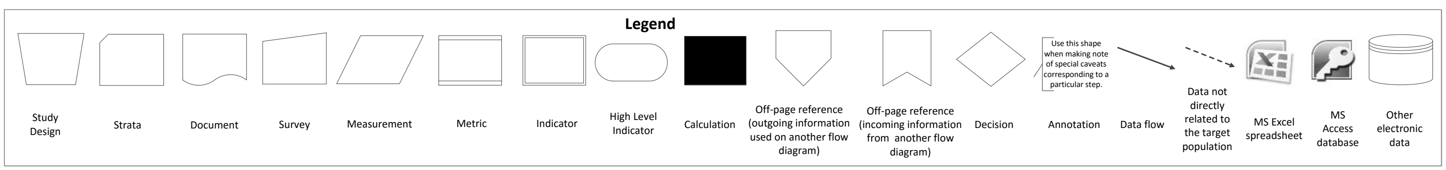
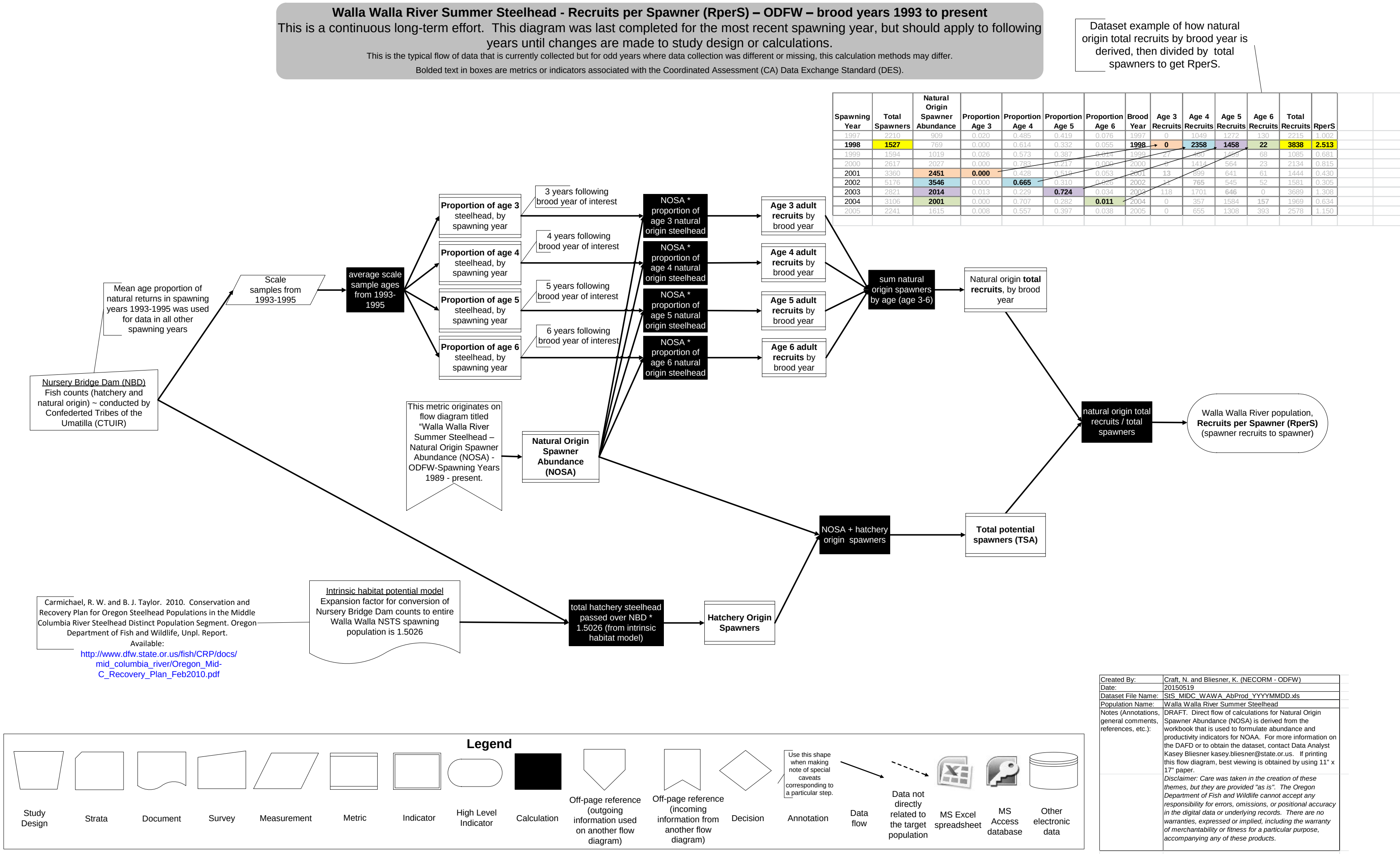


Figure A- 28. Walla Walla River Summer Steelhead – Natural Origin Spawner Abundance (NOSA) – ODFW - spawning years 1993 to present



Spawning Year	Total Spawners	Natural Origin Spawner Abundance	Proportion Age 3	Proportion Age 4	Proportion Age 5	Proportion Age 6	Brood Year	Age 3 Recruits	Age 4 Recruits	Age 5 Recruits	Age 6 Recruits	Total Recruits	RperS
1997	2210	909	0.020	0.485	0.419	0.076	1997	0	1049	1272	130	2215	1.002
1998	1527	769	0.000	0.614	0.332	0.055	1998	0	2358	1458	22	3838	2.513
1999	1594	1019	0.026	0.573	0.387	0.014	1999	27	460	1459	68	1085	0.681
2000	2617	2027	0.000	0.783	0.217	0.000	2000	0	1414	564	23	2134	0.815
2001	3360	2451	0.000	0.428	0.519	0.053	2001	13	899	641	61	1444	0.430
2002	5176	3546	0.000	0.665	0.310	0.026	2002	11	765	545	52	1581	0.305
2003	2821	2014	0.013	0.229	0.724	0.034	2003	118	1701	646	0	3689	1.308
2004	3106	2001	0.000	0.707	0.282	0.011	2004	0	357	1584	157	1969	0.634
2005	2241	1615	0.008	0.557	0.397	0.038	2005	0	655	1308	393	2578	1.150

Created By:	Craft, N. and Bliesner, K. (NECORM - ODFW)
Date:	20150519
Dataset File Name:	StS_MIDC_WAWA_AbProd_YYYYMMDD.xls
Population Name:	Walla Walla River Summer Steelhead
Notes (Annotations, general comments, references, etc.):	DRAFT. Direct flow of calculations for Natural Origin Spawner Abundance (NOSA) 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- 29. Walla Walla River Summer Steelhead - Recruits per Spawner (RperS) – ODFW – brood years 1993 to present

Appendix B. Official NOAA population names

Steelhead (Middle Columbia River DPS) - Fifteenmile Creek - winter
Steelhead (Middle Columbia River DPS) - Deschutes River Eastside - summer
Steelhead (Middle Columbia River DPS) - Deschutes River Westside - summer
Steelhead (Middle Columbia River DPS) - Crooked River - summer (extirpated)
Steelhead (Middle Columbia River DPS) - John Day River Lower Mainstem Tributaries summer
Steelhead (Middle Columbia River DPS) - North Fork John Day River - summer
Steelhead (Middle Columbia River DPS) - Middle Fork John Day River - summer
Steelhead (Middle Columbia River DPS) - South Fork John Day River - summer
Steelhead (Middle Columbia River DPS) - John Day River Upper Mainstem - summer
Steelhead (Middle Columbia River DPS) - Willow Creek - summer (extinct)
Steelhead (Middle Columbia River DPS) - Umatilla River - summer
Steelhead (Middle Columbia River DPS) - Walla Walla River - summer

Appendix C. Data Contacts

Data Stewards

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

Project Leaders

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 River—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 River—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