Escapement and Productivity of Summer Steelhead and Spring Chinook Salmon in the John Day River

BPA Project # 1998-016-00

Report covers work performed under BPA contract #74969 and #71583

Report was completed under BPA contract #74969

1/1/2017 - 12/31/2017

Bare, C. M., K. B. DeHart, T. M. Jones, J. J. Rogers, I. A. Tattam and J. R. Ruzycki

Oregon Department of Fish and Wildlife

January 31, 2018

This report was funded by the Bonneville Power Administration (BPA), U.S. Department of Energy, as part of BPA's program to protect, mitigate, and enhance fish and wildlife affected by the development and operation of hydroelectric facilities on the Columbia River and its tributaries. The views in this report are the author's and do not necessarily represent the views of BPA.

This report should be cited as follows:

Bare, C. M., K. B. DeHart, J. J. Rogers, T. M. Jones, I. A. Tattam, and J. R. Ruzycki. 2018. Escapement and Productivity of Steelhead and Spring Chinook Salmon in the John Day River, 2017 Annual Report, Bonneville Power Administration Project 1998-016-00, {71 Electronic Pages}

Table of Contents

List of Figures iii

1. Abstract 7

2. Introduction 9

A. Fish Population Status Monitoring 9

Adult Steelhead Monitoring Objectives 10

Juvenile Salmonid Summer Rearing Monitoring Objectives 10

Juvenile Salmonid Out-Migration Monitoring Objectives 10

Productivity Monitoring Objectives 10

Smolt-to-Adult Ratio Monitoring Objectives 10

B. Tributary Habitat RM&E 11

3. Methods: Protocols, Study Designs, and Study Area 11

Fish Population Status Monitoring Protocols and Study Designs 11

Adult Steelhead Monitoring 11

Juvenile Salmonid Summer Rearing Monitoring 12

Juvenile Salmonid Out-Migration Monitoring 12

Productivity Monitoring 12

Smolt-to-Adult Ratio Monitoring 12

Tributary Habitat Monitoring Protocols and Study Designs 12

Study Area 13

4. Results 15

Adult Steelhead Monitoring 15

Juvenile Salmonid Summer Rearing Monitoring 16

Juvenile Salmonid Out-Migration Monitoring 18

Productivity Monitoring 24

Smolt-to-Adult Ratio Monitoring 26

Tributary Habitat Status and Trends 27

5. Discussion and Adaptive Management 27

6. Bibliography 29

Appendix A: Use of Data, Products & Publications 37

Appendix B: Detailed Results 39

Juvenile Salmonid Summer Rearing Monitoring 39

Productivity of Spring Chinook Salmon and Summer Steelhead 44
Appendix C 61

List of Figures

Figure 1. Map of 2017 monitoring sites for John Day River basin summer steelhead spawning escapement, and summer juvenile rearing. 13

Figure 2. Map of annually operated John Day River basin out-migrant monitoring sites. 14

Figure 3. Annual adult steelhead escapement estimates for the South Fork John Day River basin from 2006 to 2017. Error bars indicate 95% confidence intervals. 15

Figure 4. Proportion of adult steelhead observed in the John Day River basin identified as hatchery origin from 2004 to 2017 (bars). Also shown is the percentage of hatchery steelhead smolts collected and barge transported from Lower Granite Dam (Snake River) two years prior to the spawning year (triangles). 16

Figure 5. Mean fork length (FL) of juvenile *O. mykiss* sampled in the Middle Fork John Day River 2011–2017 summer juvenile fish sampling. Error bars represent 95% confidence intervals. 17

Figure 6. Mean fork length (FL) of juvenile *O. mykiss* sampled in the South Fork John Day River during 2011–2017. Error bars represent 95% confidence intervals. 17

Figure 7. Mean condition factor of juvenile *O. mykiss* (≥100 mm) sampled in the South Fork and Middle Fork populations during 2011–2017. Error bars represent 95% confidence intervals. 18

Figure 8. Summer steelhead out-migrant abundance estimates by population and migratory year. 19

Figure 9. Summer steelhead smolt equivalent (smolts at John Day Dam) abundance estimates by population and migratory year. 19

Figure 10. Mean fork length of fall migrant steelhead emigrating past four trap sites in the John Day River basin. Error bars are 95% confidence intervals. 20

Figure 11. Mean fork length of spring migrant steelhead emigrating past four trap sites in the John Day River basin. Error bars are 95% confidence intervals. 20

Figure 12. Estimated age composition of summer steelhead out-migrants captured at the Mainstem (MS), South Fork (SF), Middle Fork (MF), and North Fork (NF) John Day River traps. Age composition for

migratory year 2017 is compared with the prior 11 years. Error bars represent 95% confidence intervals. 21

Figure 13. Chinook fall parr (October-February) migrant abundance estimate at the Upper Mainstem trap site by migratory year. Error bars are 95% confidence intervals. The trap was not operated during fall 2006 and 2007.. 22

Figure 14. Chinook fall parr (October–December) migrant abundance estimates at the Middle Fork trap site by migratory year. Error bars are 95% confidence intervals. The trap was not operated during fall 2006 and fall 2008.. 22

Figure 15. Chinook out-migrant abundance estimates by population and migration year. 23

Figure 16. Chinook smolt equivalent (estimated smolts at John Day Dam) estimates by population and migratory year.. 23

Figure 17. Estimated summer steelhead smolt equivalents per spawner for the South Fork and Middle Fork John Day River populations.. 24

Figure 18. Middle Fork John Day spring Chinook spring migrant smolts per redd for brood years 2002–2015. Error bars are 95% confidence intervals. 25

Figure 19. Upper Mainstem John Day spring Chinook spring migrant smolts per redd estimates for brood years 2002–2015. Error bars are 95% confidence intervals. 25

Figure 20. Smolt-to-adult survival of juvenile spring Chinook and summer steelhead tagged with Passive Integrated Transponder tags in the John Day River basin during smolt migration years 2000–2015. Survival is estimated from smolt passage at John Day Dam to adult detection at Bonneville Dam. Error bars are 95% confidence intervals. 26

Figure 21. Proportion of nights operated for each trap site by migration year. 45

Figure 22. Fork length of fall migrant Chinook parr captured at four rotary screw trap sites in the John Day River basin. Error bars are 95% confidence intervals. Some traps were not operated during fall for migration years 2006 through 2008. 46

Figure 23. Condition factor of fall migrant Chinook captured at four rotary screw trap sites in the John Day River basin. Error bars are 95% confidence intervals. Some traps were not operated during fall for migration years 2006 through 2008. 46

Figure 24. Condition factor of spring migrant Chinook captured at four rotary screw trap sites in the John Day River basin. Error bars are 95% confidence intervals. 47

Figure 25. Fork length of spring migrant Chinook captured at four rotary screw trap sites in the John Day River basin. Error bars are 95% confidence intervals. 47

Figure 26. Estimated weekly number of juvenile spring Chinook migrating past rotary screw trap and seining operations in the John Day River basin during migratory year 2017. 48

Figure 27. Weekly catch per unit effort (CPUE, number/seine haul) of spring Chinook smolts captured while seining during 2017. 48

Figure 28. Mean fork length and condition factor of juvenile Chinook captured seining the John Day River between river kilometers 274 and 296. Capture periods vary slightly but are generally between February and May of each migration year. Error bars are 95% confidence intervals. No seining was conducted during migratory year 2011. 49

Figure 29. Average fork length for juvenile Chinook captured while seining the John Day River between river kilometers 274 and 296 vs. brood year redd count. 49

Figure 30. Smolt abundance estimates from spring seining of juvenile spring Chinook salmon emigrating from the entire John Day River basin. Estimates prior to the 2000 migration year are from Lindsay et al. (1986). 50

Figure 31. Smolt per redd ratios based on recent and historic estimates of smolt abundance and census redd counts for spring Chinook salmon for the entire John Day River basin. Historic estimates from the 1978–1982 brood years are from Lindsay et al. (1986). 51

Figure 32. The residuals from a regression of natural log Chinook smolts per redd versus basin-wide Chinook salmon redd abundance plotted against brood year. 52

Figure 33. Mean condition factor of fall out-migrant summer steelhead collected at four John Day River basin trap sites. Error bars are 95% confidence intervals. Not all traps were operated during fall for migration years 2006 through 2008. 54

Figure 34. Mean fork length of fall out-migrant summer steelhead collected at four John Day River basin trap sites. Error bars are 95% confidence intervals. Not all traps were operated during fall for migration years 2006–08. 54

Figure 35. Mean condition factor of spring out-migrant steelhead collected at four John Day River basin trap sites. Error bars are 95% confidence intervals. 55

Figure 36. Mean fork length of spring out-migrant steelhead collected at four John Day River basin trap sites. Error bars are 95% confidence intervals. 55

Figure 37. Estimated weekly number of summer steelhead migrating past rotary screw traps operated in the John Day River basin during migratory year 2017. 56

Figure 38. Relationship between point estimates of smolt-to-adult ratio (SAR) of summer steelhead and spring Chinook tagged with Passive Integrated Transponder tags in the John Day River basin during migration years 2004–2013. SAR is estimated from smolt migration past John Day Dam to adult detection at Bonneville Dam. The straight line denotes a 1:1 relationship between SAR of steelhead and Chinook. 59

Figure 39. Comparison of adult steelhead estimates for the South Fork John Day River population. The spawning escapement estimates include both wild and hatchery origin adults and are derived from probabilistic spawning surveys in the South Fork population. Bonneville Dam estimates are from detections of returning Passive Integrated Transponder tagged adults corrected by out-migrant population estimates at the South Fork John Day River rotary screw trap. The horizontal dotted line denotes the National Oceanic and Atmospheric Administration's recovery goal of 500 adults for this population. 60

1. Abstract

During 2017 we monitored the status and trend of anadromous salmonids in the John Day River basin. Specific metrics were: 1) spawning escapement of adult summer steelhead *Oncorhynchus mykiss* in the South Fork John Day River population, 2) origin (hatchery or wild) of adult summer steelhead in the entire John Day River basin, 3) summer rearing density of *O. mykiss* in the South Fork and Middle Fork populations, 4) out-migrant abundance of summer steelhead and spring Chinook *Oncorhynchus tshawytscha*, 5) productivity (recruits per parental spawner) of select summer steelhead and spring Chinook populations, and 6) smolt-to-adult-ratios (SAR) for summer steelhead and spring Chinook describing survival through Columbia River and Pacific Ocean life history phases.

We estimated that 252 adult steelhead escaped to spawn in the South Fork John Day River during 2017, all of which were estimated to be wild-origin. Of the steelhead throughout the John Day River basin which could be visually identified as having or lacking an adipose fin, 0% were classified as hatchery-origin. Concurrent with juvenile steelhead density estimation, we collected Columbia Habitat Monitoring Program (CHaMP) data at 26 sites in the South and Middle forks of the John Day River.

Juvenile salmonid out-migrant abundance estimates during migratory year 2017 were comparable with prior years. Per-capita out-migrant production decreased in 2017, suggesting density-dependent limitations on freshwater production from the large spawner broods in 2014 and 2015. Smolt-to-adult survival for the 2015 migration year declined as compared to prior years for steelhead, but was consistent with prior years for earlier migrating Chinook.

<u>Lessons Learned</u>

Despite increases in out-migrant abundance during 2010-2012, some John Day salmonid populations continue to exhibit low freshwater productivity. The Middle Fork appears to have the poorest freshwater productivity of the populations we monitored. Continued out-migrant trapping revealed that fewer than 2,000 Chinook smolts reached John Day Dam in 2015. As expected based on this poor smolt production, only 29 Chinook redds were observed in the Middle Fork during 2017. While our tracking of this cohort is encouraging from a monitoring perspective—our out-migrant trapping and smolt survival estimates accurately predicted adult abundance, this cohort was discouraging from a population recovery perspective. Additional freshwater rearing environment alterations (principally--reduction in maximum stream temperature through increased stream shading) are required to increase the productivity of the Chinook and steelhead populations in the Middle Fork.

Acknowledgments

We acknowledge the assistance and cooperation of private landowners throughout the John Day River basin who allowed us to survey on their property. The cooperation of private landowners, the Confederated Tribes of the Warm Springs Reservation, and the Confederated Tribes of the Umatilla Reservation were essential in meeting our project objectives. We thank District Biologists Brent Smith and Kirk Handley for providing advice and assistance. Furthermore, we thank our crew members Brandon Smith, Logan Breshears, AJ VanDomelen, Justin Thorson, Brenna Rietmann, Susie Dobkins, Trevor Kumec and Erika Porter for their invaluable assistance. This project was funded by the U.S. Department of Energy, Bonneville Power Administration, and we thank Eric Leitzinger for assistance with contract administration.

2. Introduction

A. Fish Population Status Monitoring

The John Day River, located in northeastern Oregon, supports five wild populations of summer steelhead (*Oncorhynchus mykiss)* and three populations of wild spring chinook (*Oncorhynchus tschawytscha)* with no hatchery supplementation. However, these populations remain depressed relative to historic levels. In 1999, the National Marine Fisheries Service (NMFS) listed the Middle Columbia River summer steelhead Distinct Population Segment (DPS), which includes the John Day River Major Population Group (MPG), as threatened under the Endangered Species Act (ESA). Although numerous habitat protection and rehabilitation projects have been implemented within the John Day River basin to improve steelhead and other salmonid freshwater production and survival, it has been difficult to estimate the effectiveness of these projects without a systematic program in place to collect information on the status, trends, and distribution of spawning activity, juvenile salmonids, and aquatic habitat conditions within the basin.

Prior to the inception of this project, population and environmental monitoring of steelhead in the basin consisted of a combination of index spawning surveys and periodic monitoring of some status and trend indicators. While index spawning data is useful for drawing inference about long-term trends in adult steelhead abundance, they are limited for determining the status of steelhead escapement or distribution at the population or MPG scale because survey sites are not randomly selected and are likely biased towards streams with higher fish abundance. A broader approach to the monitoring and evaluation of status and trends in anadromous and resident salmonid populations and their habitats was needed to provide data to effectively support restoration efforts and guide alternative future management actions in the basin.

The Independent Scientific Review Panel (ISRP) recommended that the region move away from index surveys and embrace probabilistic sampling for most population and habitat monitoring. To meet the ISRP recommendation, the structure and methods employed by the Oregon Plan for Salmon and Watersheds Monitoring Program were extended to the John Day basin. This approach incorporates the sampling strategy of the United States Environmental Protection Agency's (EPA) Environmental Monitoring and Assessment Program (EMAP). This research effort employs a statistically based and spatially explicit sampling design to answer key monitoring questions, integrate on-going sampling efforts, and improve agency coordination. The current program seeks to integrate project objectives focused on summer steelhead spawning metrics, juvenile salmonid metrics, and aquatic habitat conditions.

This project provides information as directed by two measures of the Columbia River basin Fish and Wildlife Program. Measure 4.3C specifies that key indicator naturally spawning populations should be monitored to provide detailed stock status information. In addition, measure 7.1C identifies the need for collection of population status, life history, and other data on wild and naturally spawning populations. This project was developed in direct response to the recommendations and needs of regional modeling efforts, the ISRP, the FCRPS BiOp, the Fish and Wildlife Program, the Oregon Plan for Salmon and Watersheds, and the Columbia Basin Fish and Wildlife Authority Multi-Year Implementation Plan.

Adult Steelhead Monitoring Objectives

1. Monitor status and trends of steelhead spawning distribution and abundance.
2. Estimate hatchery fraction of steelhead spawning population(s).
3. Provide background data that can be used for:
    a. Stock assessment and recovery planning.
    b. Comparison data for long-term effectiveness monitoring of habitat projects.
    c. Annual estimates of spawner escapement, age structure, smolt-to-adult ratio, egg-to-smolt survival, smolt-per-spawner ratio, and freshwater habitat use.

Juvenile Salmonid Summer Rearing Monitoring Objectives

1. Monitor status and trend of juvenile salmonid abundance in the Middle Fork and South Fork John Day River populations.
2. Characterize abundance and density of juvenile salmonids at site and population scales.
3. Evaluate relative condition metrics of juvenile *O. mykiss*.
4. Evaluate age structure of juvenile salmonids in the Middle Fork and South Fork John Day River populations.

Juvenile Salmonid Out-Migration Monitoring Objectives

1. Monitor the status and trend of out-migrant juvenile salmonid abundance.
2. Evaluate size and condition of out-migrant juvenile salmonids.
3. Evaluate age structure of out-migrant juvenile salmonids.

Productivity Monitoring Objectives

1. Estimate smolts per parental spawner for steelhead and Chinook populations.
2. Monitor status and trends in steelhead and Chinook productivity.
3. Assess productivity of natural salmonid populations and possible correlative factors.
4. Provide productivity measures for TRT recovery planning and implementation.

Smolt-to-Adult Ratio Monitoring Objectives

1. Tag emigrating summer steelhead to estimate smolt-to-adult ratio and provide tagged juveniles for Comparative Survival Study (CSS).
2. Tag emigrating spring chinook to estimate smolt-to-adult ratio and provide tagged juveniles for Comparative Survival Study (CSS).
3. Monitor status and trends of steelhead and Chinook survival rates.

This Project Supports the Fish and Wildlife (F&W) Program Strategies:

- Assess the status and trend of adult natural and hatchery origin abundance of fish populations for various life stages.

- Assess the status and trend of spatial distribution of fish populations.
- Assess the status and trend of diversity of natural and hatchery origin fish populations.

This project answers (provides data to help answer) the F&W Program Management Questions:

- What are the status and trend of adult abundance of natural and hatchery origin fish populations?
- What are the status and trend of spatial distribution of fish populations?
- What are the status and trend of diversity of natural and hatchery origin fish populations?

B. Tributary Habitat RM&E

The same objectives outlined in section A of this Introduction are applicable to section B as well and therefore will not be differentiated in the Methods or Results sections of this report. The data collected for these objectives will help evaluate population scale trends, which can be viewed as the product of restoration efforts, background environmental conditions (e.g., magnitude and timing of precipitation), and starting stock abundance. These data will additionally be used to represent the John Day Basin populations as an index stock for comparison with other Columbia River populations. Our continued monitoring efforts to estimate salmonid smolt abundance, age structure, SAR, freshwater production, freshwater habitat use, and distribution of critical life stages will enable managers to assess the long-term effectiveness of habitat projects and to differentiate freshwater and ocean survival.

This Project Supports the Fish and Wildlife (F&W) Program Strategy:

- Monitor and evaluate tributary habitat conditions that may be limiting achievement of biological performance objectives.

This project answers (provides data to help answer) the F&W Program Management Questions:

- What are the tributary habitat limiting factors (ecological impairments) or threats preventing the achievement of desired tributary habitat performance objectives?

3. Methods: Protocols, Study Designs, and Study Area

Fish Population Status Monitoring Protocols and Study Designs

Adult Steelhead Monitoring

Estimating Adult Summer Steelhead Escapement in North East Oregon;
http://www.monitoringmethods.org/Protocol/Details/757

Juvenile Salmonid Summer Rearing Monitoring

Juvenile Salmonid Density & Distribution in Northeast Oregon Watersheds; http://www.monitoringmethods.org/Protocol/Details/370

Determine genetic structure of John Day subbasin steelhead populations; http://www.monitoringmethods.org/Protocol/Details/444

Juvenile Salmonid Out-Migration Monitoring

Estimating Salmonid Smolt Abundance in Northeast-Central, Oregon; http://www.monitoringmethods.org/Protocol/Details/456

John Day Basin Chinook Smolt Monitoring; http://www.monitoringmethods.org/Protocol/Details/457

Productivity Monitoring

Estimating Adult Summer Steelhead Escapement in North East Oregon; http://www.monitoringmethods.org/Protocol/Details/757

Estimating Salmonid Smolt Abundance in Northeast-Central, Oregon; http://www.monitoringmethods.org/Protocol/Details/456

Smolt-to-Adult Ratio Monitoring

Smolt-to-Adult-Ratio (1998-016-00); http://www.monitoringmethods.org/Protocol/Details/372

Tributary Habitat Monitoring Protocols and Study Designs

Scientific Protocol for Salmonid Habitat Surveys within the Columbia Habitat Monitoring Program (CHaMP); http://www.monitoringmethods.org/Protocol/Details/416

Study Area

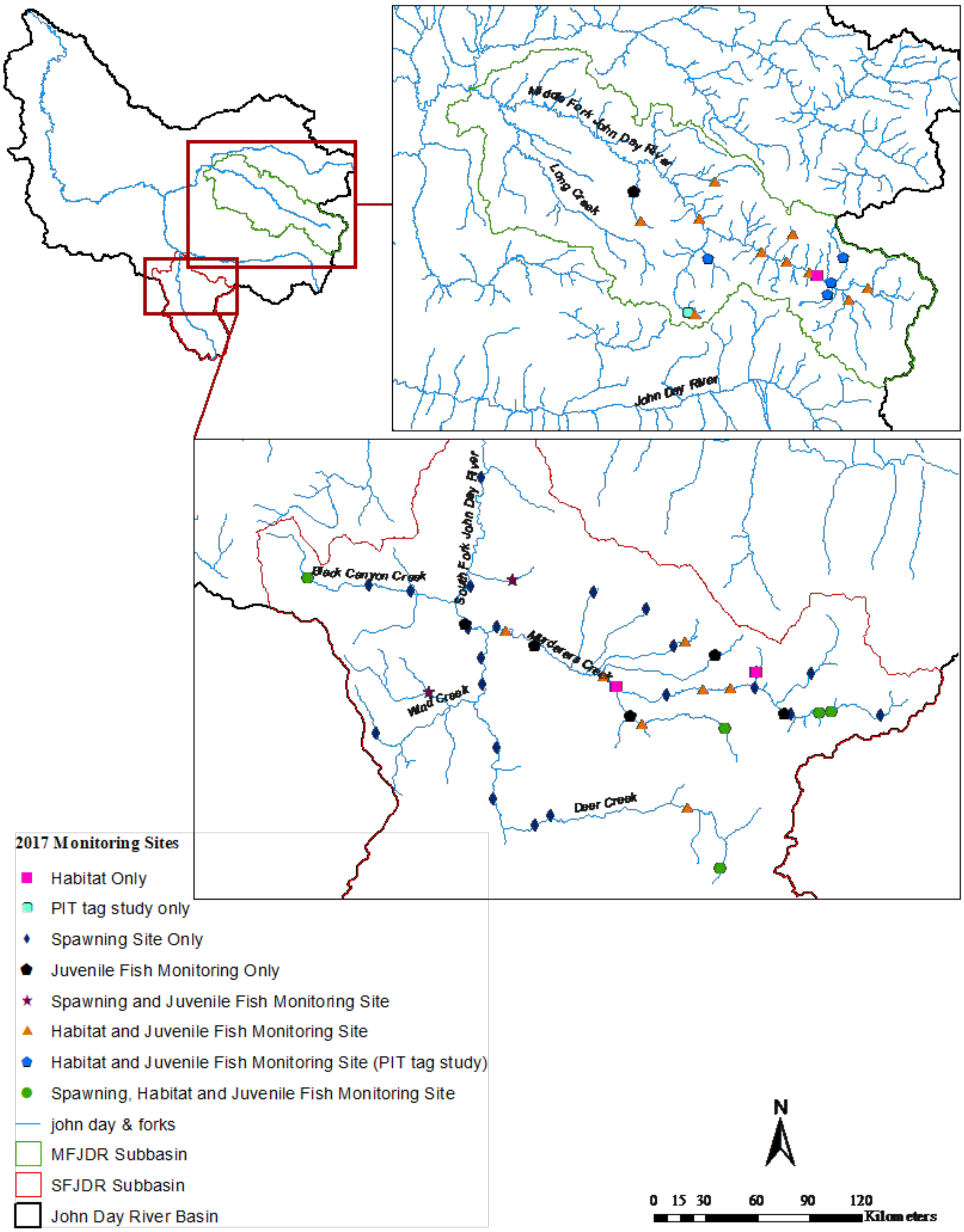

Figure 1. Map of 2017 monitoring sites for John Day River basin summer steelhead spawning escapement, and summer juvenile rearing.

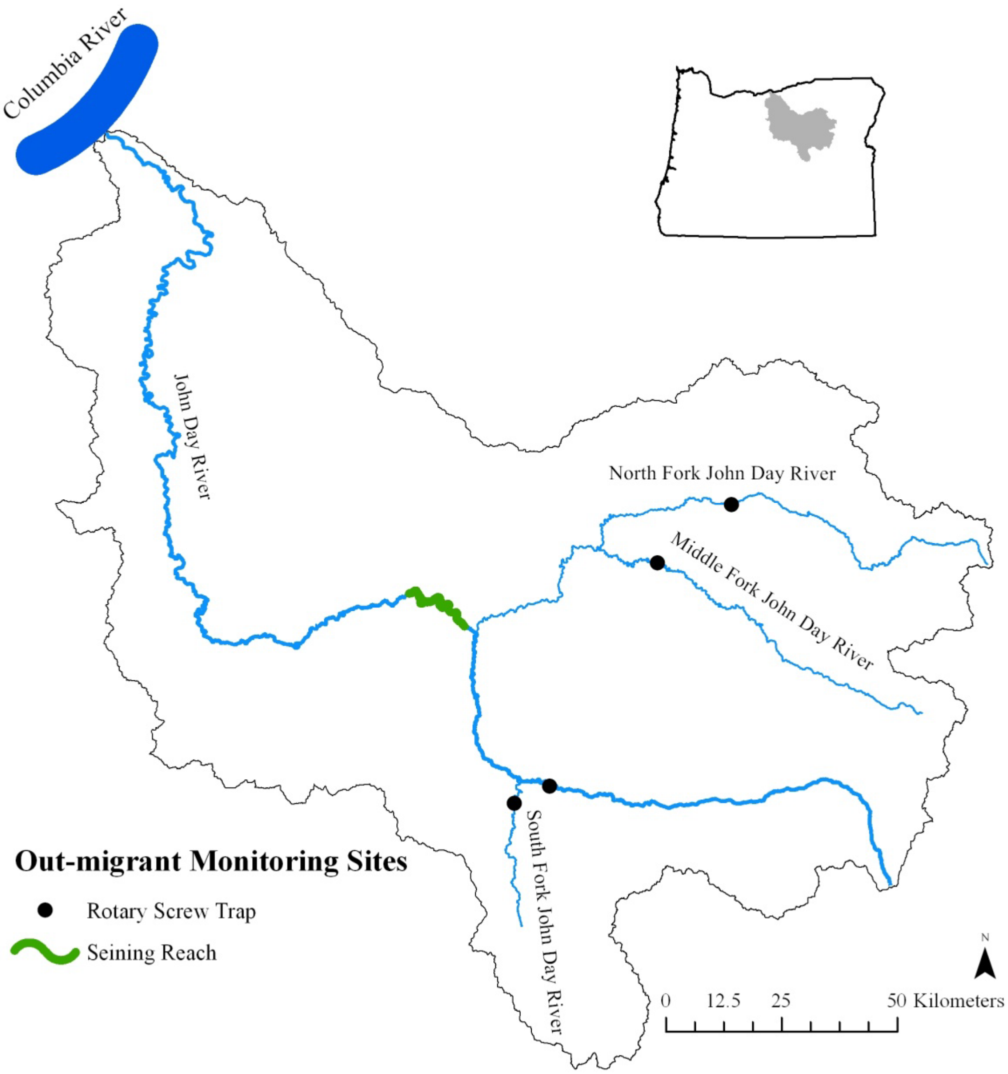

Figure 2. Map of annually operated John Day River basin out-migrant monitoring sites.

4. Results

Adult Steelhead Monitoring

Adult summer steelhead escapement monitoring during 2017 was focused on the South Fork John Day River population; we did not estimate escapement at the Major Population Group scale for the John Day River. In the South Fork John Day River basin, we observed redds at 25% of sites surveyed. We observed 16 redds in the 55 km of sampled stream; resulting in an estimated 0.3 redds/km for the basin. The total South Fork steelhead escapement was estimated at 252, with 100% Natural-origin Spawner Abundance (NoSA) (Figure 3). The NOAA recovery goal for abundance of the South Fork steelhead population is an escapement of 500 adults (NMFS 2009). Our results indicate escapement has exceeded this goal in 9 of the 12 years that we have estimated spawning abundance in the South Fork (Figure 3).

We estimated the proportion of hatchery origin spawners (PHoS) throughout the entire John Day River basin at 0% in 2017 (Figure 4). This is the 1st year we have not observed any hatchery-origin steelhead in the John Day River basin. This first observation of 0 PHoS correlates with the lowest observed smolt transportation fraction two years earlier, which was markedly lower than all other years (Figure 4).

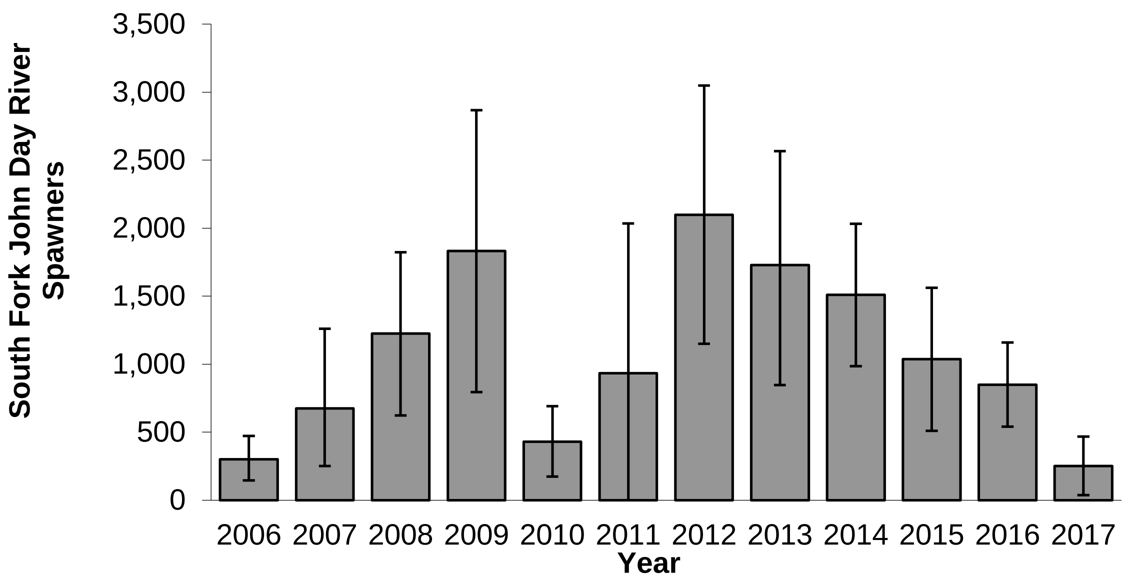

Figure 3. Annual adult steelhead escapement estimates for the South Fork John Day River basin from 2006 to 2017. Error bars indicate 95% confidence intervals.

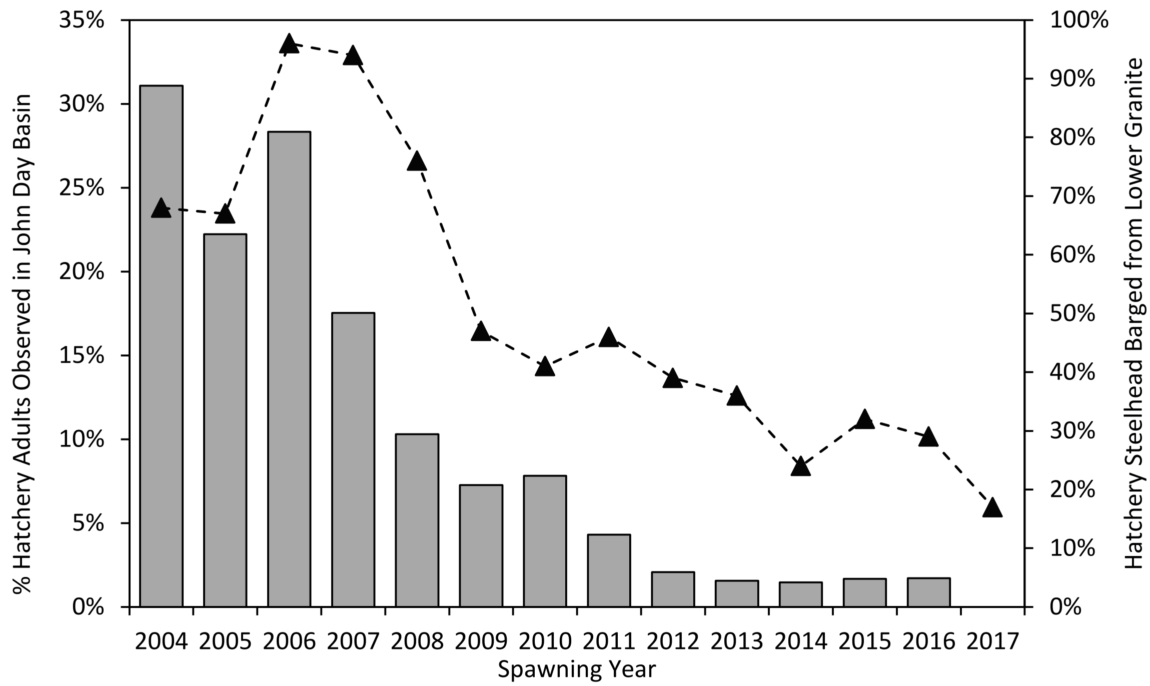

Figure 4. Proportion of adult steelhead observed in the John Day River basin identified as hatchery origin from 2004 to 2017 (bars). Also shown is the percentage of hatchery steelhead smolts collected and barge transported from Lower Granite Dam (Snake River) two years prior to the spawning year (triangles).

Juvenile Salmonid Summer Rearing Monitoring

Mean fork length of juvenile steelhead in both the Middle Fork and South Fork populations increased significantly in 2017, as compared to the prior two years. Increased mean size, most likely created by increased individual growth rate, is a plausible response to the decreased spawner density observed in the recent several years. Condition factor showed no significant difference from the prior two years in either population, however. This suggests that condition factor of juvenile steelhead may be more influenced by density-independent factors, such as streamflow and temperature. High stream flows and cool temperatures during spring 2017, the primary annual growth period, may have had a substantial influence on condition factor measured at the end of summer.

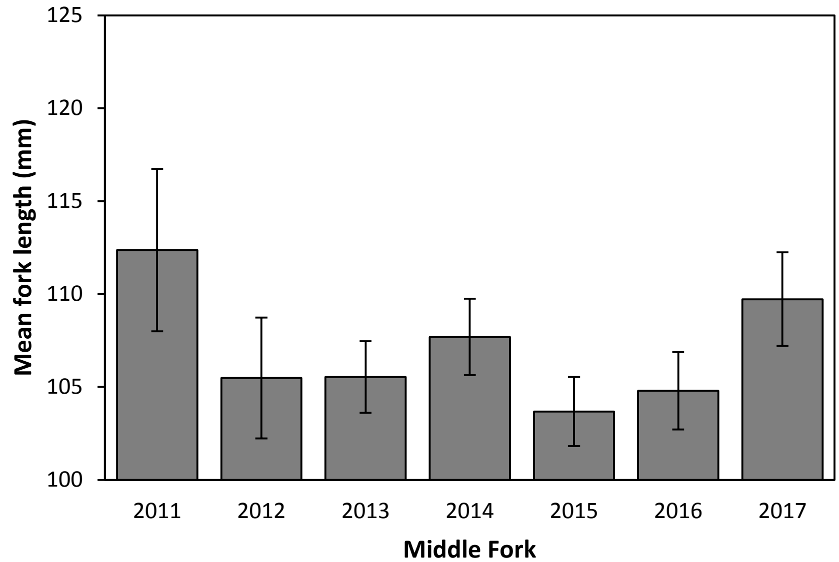

Figure 5. Mean fork length (FL) of juvenile *O. mykiss* sampled in the Middle Fork John Day River 2011–2017 summer juvenile fish sampling. Error bars represent 95% confidence intervals.

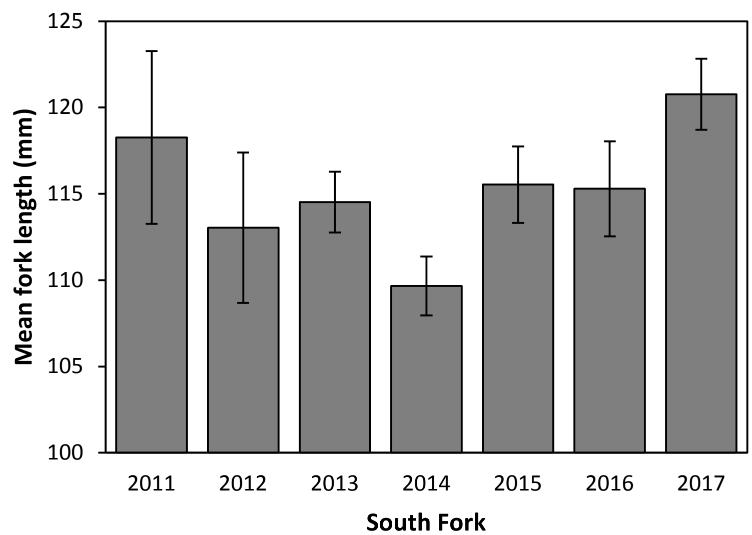

Figure 6. Mean fork length (FL) of juvenile *O. mykiss* sampled in the South Fork John Day River during 2011–2017. Error bars represent 95% confidence intervals.

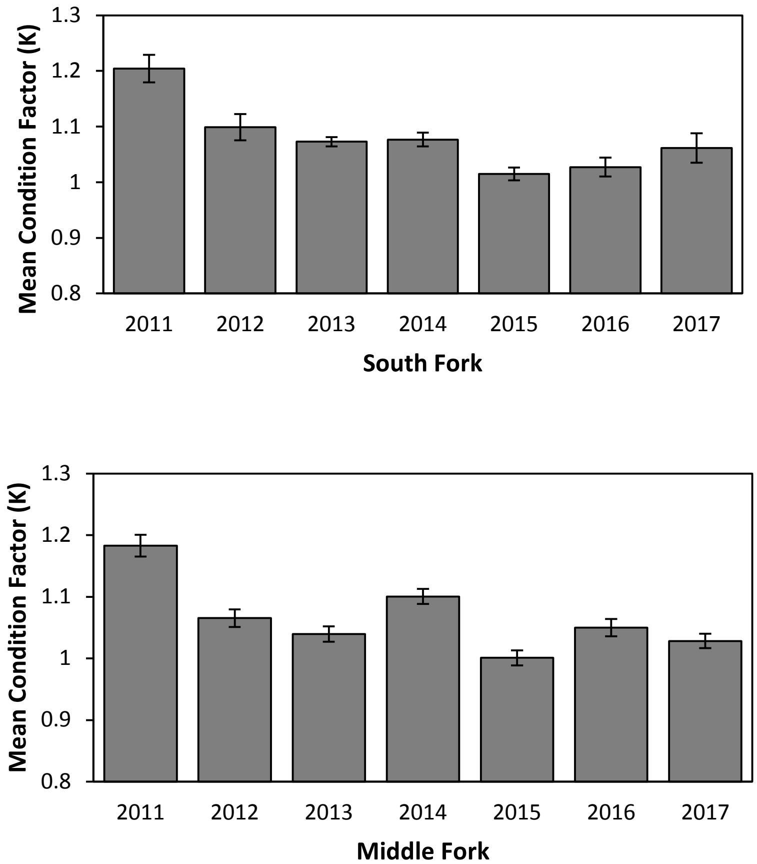

Figure 7. Mean condition factor of juvenile *O. mykiss* (≥100 mm) sampled in the South Fork and Middle Fork populations during 2011–2017. Error bars represent 95% confidence intervals.

Juvenile Salmonid Out-Migration Monitoring

Juvenile Steelhead Capture and Tagging

Out-migrant abundance of juvenile steelhead from the South Fork, Upper Mainstem, and Middle Fork populations during 2017 remained consistent with prior years. All three populations appear to have similar temporal trends in production (Figure 8). The estimated smolt equivalents (smolts alive at John Day Dam) produced from each population has also remained consistent through time, with the exception of several low abundance years for the Middle Fork population (Figure 9). While the South Fork population produces more “out-migrants” than the Middle Fork population, there appears to be little difference in production of smolt equivalents between the two populations. This is likely due to larger individual size and higher survival of Middle Fork out-migrants.

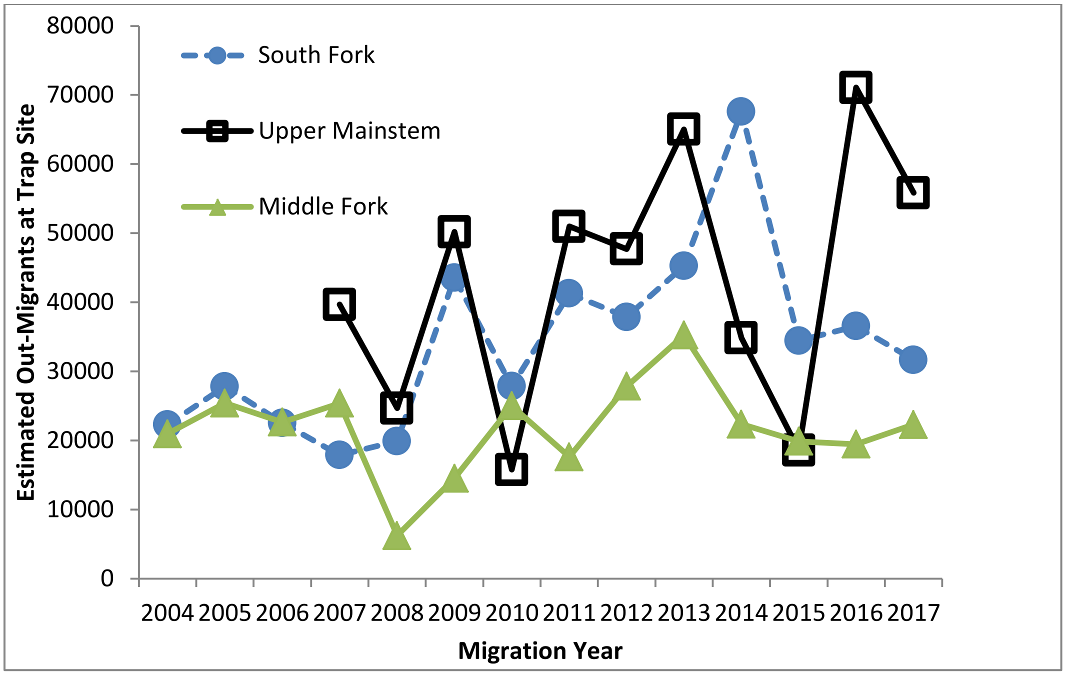

Figure 8. Summer steelhead out-migrant abundance estimates by population and migratory year.

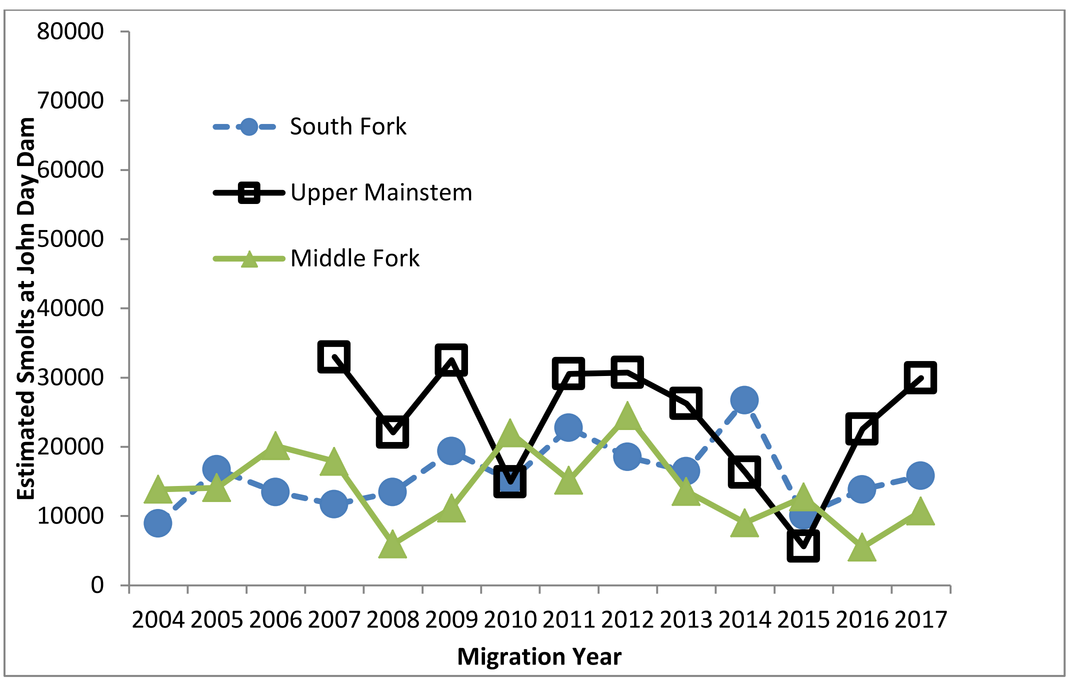

Figure 9. Summer steelhead smolt equivalent (smolts at John Day Dam) abundance estimates by population and migratory year.

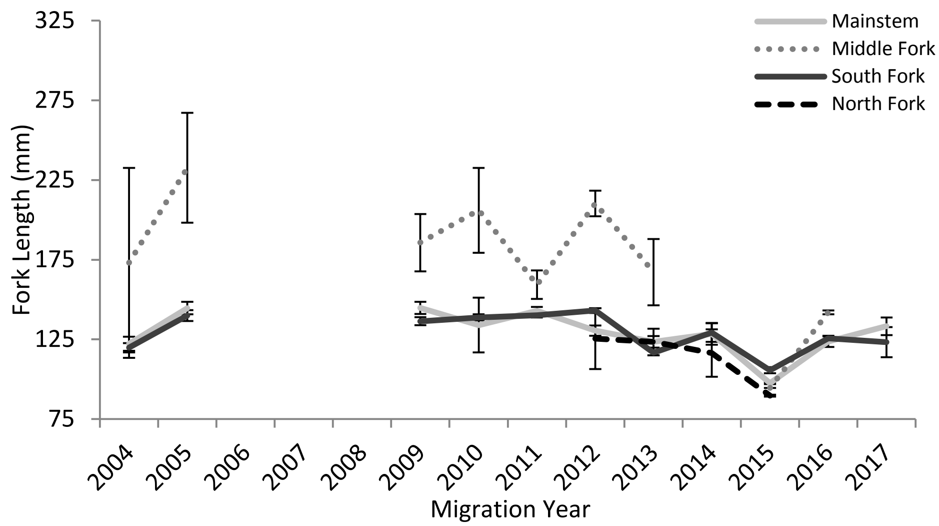

Figure 10. Mean fork length of fall migrant steelhead emigrating past four trap sites in the John Day River basin. Error bars are 95% confidence intervals.

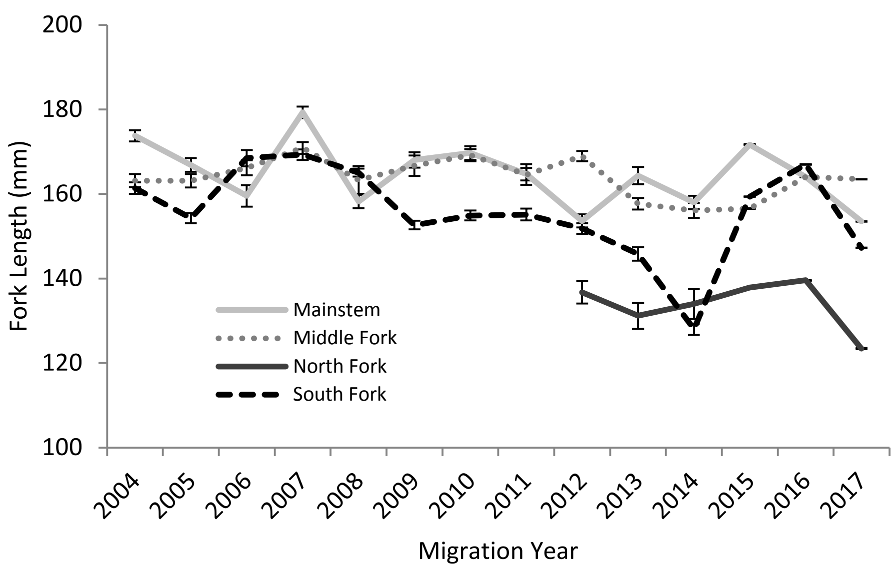

Figure 11. Mean fork length of spring migrant steelhead emigrating past four trap sites in the John Day River basin. Error bars are 95% confidence intervals.

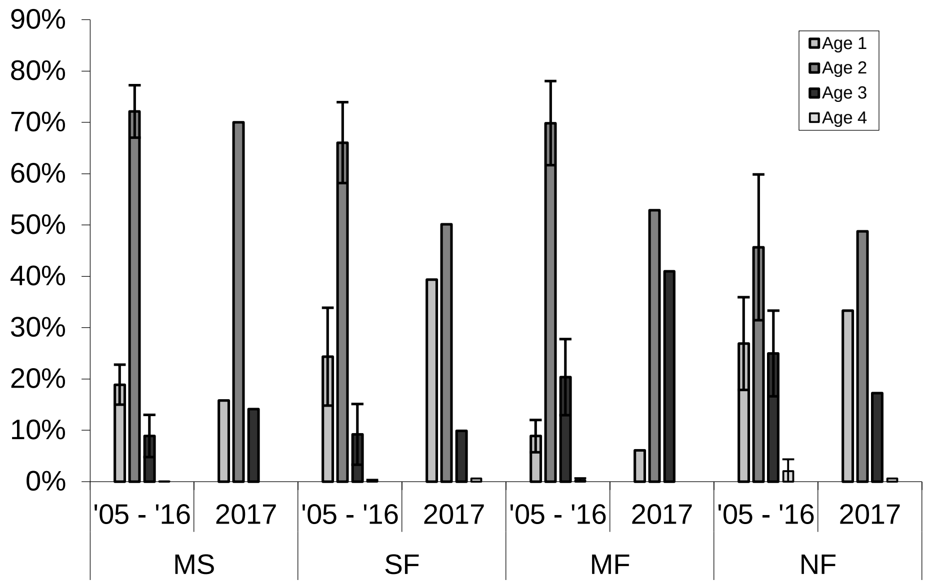

Figure 12. Estimated age composition of summer steelhead out-migrants captured at the Mainstem (MS), South Fork (SF), Middle Fork (MF), and North Fork (NF) John Day River traps. Age composition for migratory year 2017 is compared with the prior 11 years. Error bars represent 95% confidence intervals.

Juvenile Chinook Capture and Tagging

Out-migrant abundance of Chinook during 2017 was consistent with most prior years. The Middle Fork population continued to rebound from the lowest production observed during migration year 2015. Out-migrant production from the Middle Fork during 2017 was comparable with the long-term mean for this population (Figure 15). While Chinook smolt equivalent production from the Middle Fork rebounded, smolt equivalent production from the Upper Mainstem population remained significantly less than peak production levels observed during migration years 2012 and 2013 (Figure 16).

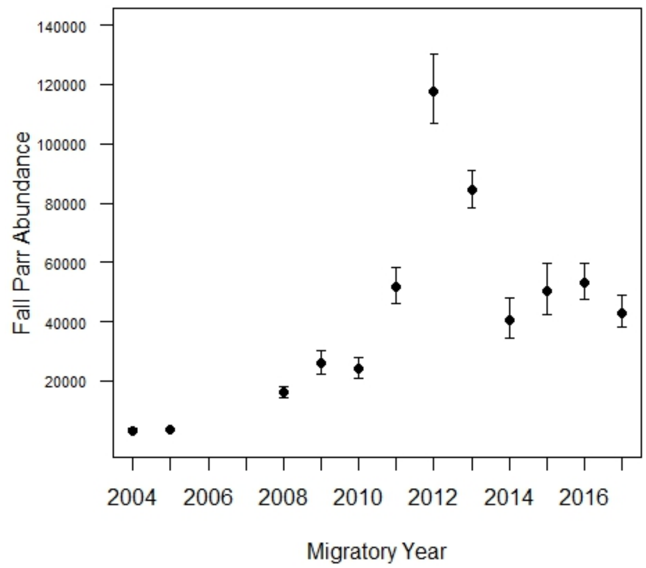

Figure 13. Chinook fall parr (October-February) migrant abundance estimate at the Upper Mainstem trap site by migratory year. Error bars are 95% confidence intervals. The trap was not operated during fall 2006 and 2007.

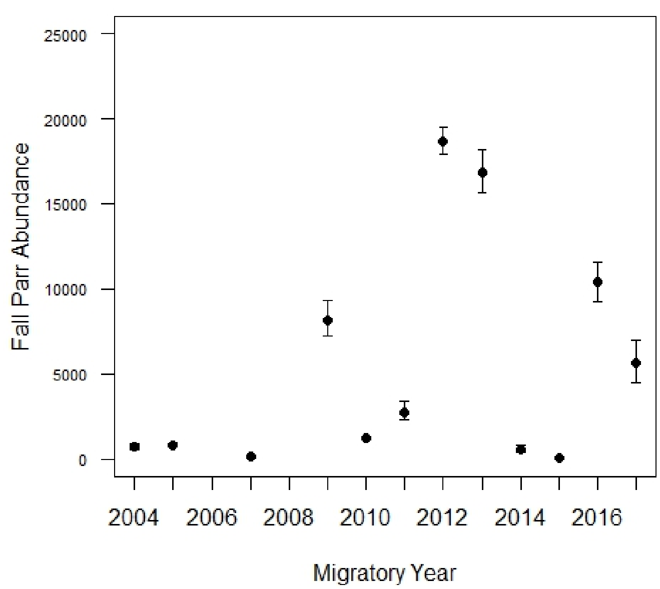

Figure 14. Chinook fall parr (October–December) migrant abundance estimates at the Middle Fork trap site by migratory year. Error bars are 95% confidence intervals. The trap was not operated during fall 2006 and fall 2008.

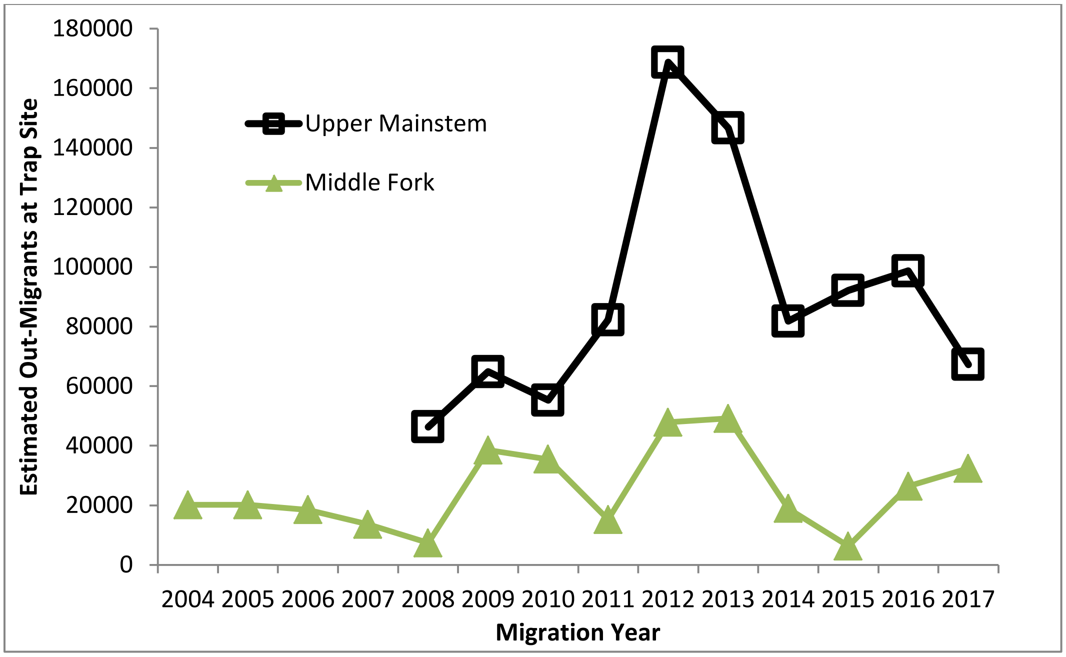

Figure 15. Chinook out-migrant abundance estimates by population and migration year.

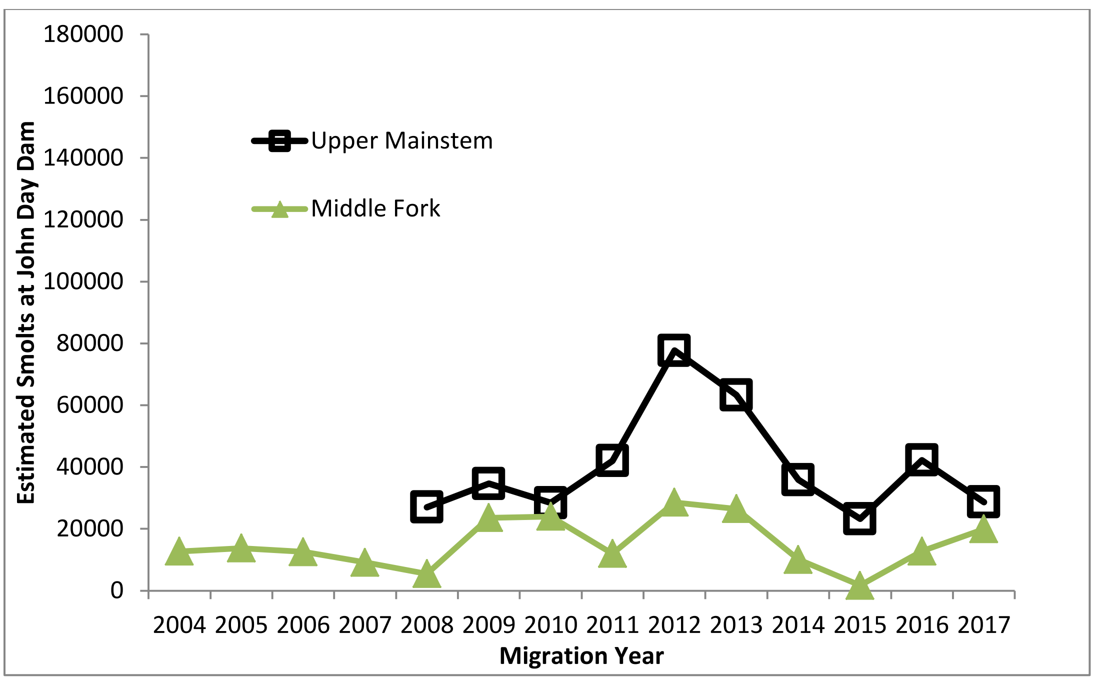

Figure 16. Chinook smolt equivalent (estimated smolts at John Day Dam) estimates by population and migratory year.

Productivity Monitoring

Estimates of steelhead smolts-per-spawner for the South Fork and Middle Fork populations both show declining rates of per-capita production with increasing spawner abundance. While there are as yet too few years of data available for either population to develop stock-recruit relationships, there appears to be a comparable density-dependent influence on smolt production in both steelhead populations (Figure 17).

Evidence for density dependent production is also present in the Upper Mainstem Chinook population (Figure 19), but is much weaker in the Middle Fork Chinook population (Figure 18). Indeed, a nearly 7-fold range in production has been observed for the Middle Fork population at low spawner abundance (circa 100 redds); indicating that density-independent factors have a larger influence on production in this population. Maximum stream temperature remains the most important density-independent production factor for Chinook.

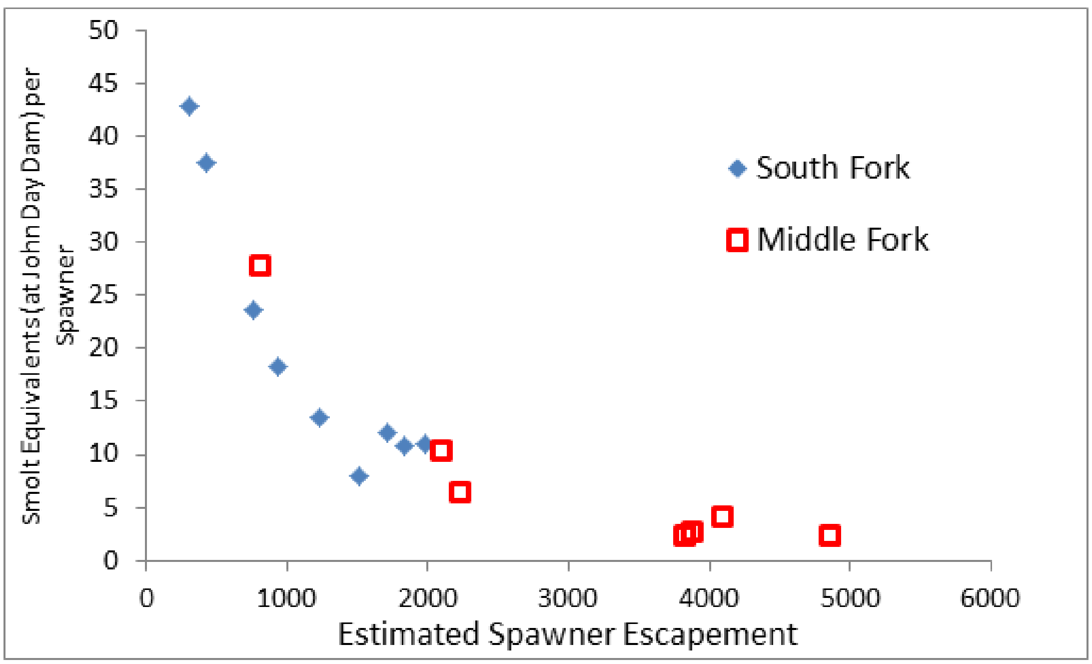

Figure 17. Estimated summer steelhead smolt equivalents per spawner for the South Fork and Middle Fork John Day River populations.

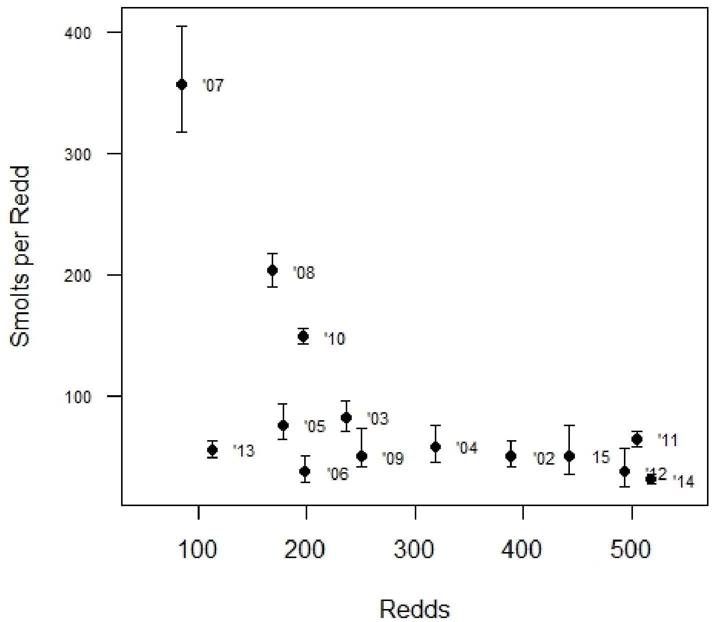

Figure 18. Middle Fork John Day spring Chinook spring migrant smolts per redd for brood years 2002–2015. Error bars are 95% confidence intervals.

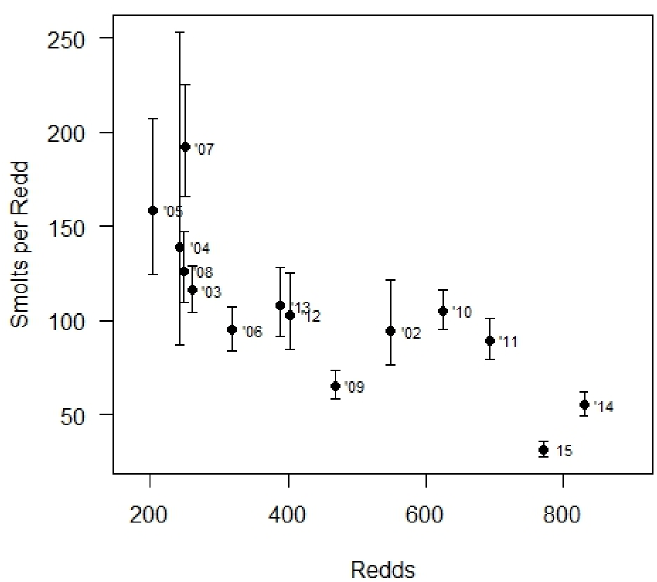

Figure 19. Upper Mainstem John Day spring Chinook spring migrant smolts per redd estimates for brood years 2002–2015. Error bars are 95% confidence intervals.

Smolt-to-Adult Ratio Monitoring

Smolt-to-adult ratio (SAR) for Chinook during the 2015 migratory year remained consistent with most prior years (Figure 20). Conversely, steelhead SAR for the 2015 migration year was the lowest recorded since our PIT tagging of steelhead began during migratory year 2004 (Figure 20). Migratory year 2015 was also the first year in our data set during which Chinook SAR exceeded steelhead SAR. It is possible that the earlier emigration timing of Chinook afforded better estuary and near shore ocean conditions than were present later during 2015 when steelhead arrived. Regardless of mechanism, the lowest observed tagging-estimated SAR for steelhead during the 2015 migratory year was corroborated by the lowest-observed South Fork John Day adult escapement estimate in 2017.

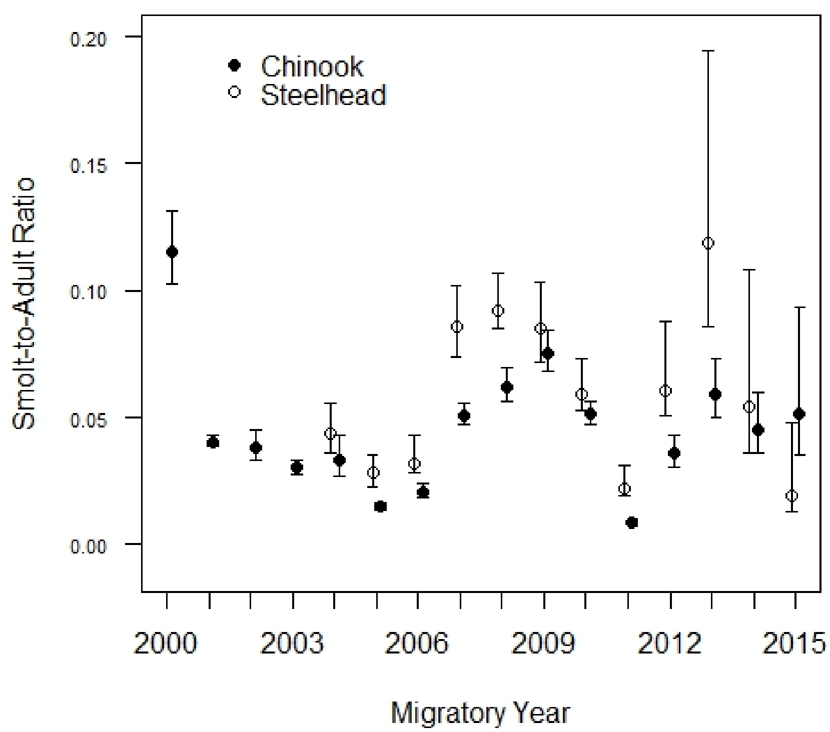

Figure 20. Smolt-to-adult survival of juvenile spring Chinook and summer steelhead tagged with Passive Integrated Transponder tags in the John Day River basin during smolt migration years 2000–2015. Survival is estimated from smolt passage at John Day Dam to adult detection at Bonneville Dam. Error bars are 95% confidence intervals.

Tributary Habitat Status and Trends

A complete analysis of the CHaMP habitat data collected in the South Fork and Middle Forks of the John Day River is beyond the scope of work for this contract. We have coordinated with Project 2003-017-00 (Integrated Status and Effectiveness Monitoring Project) to ensure thorough analysis of CHaMP habitat data as the time-series grows and allows evaluation of temporal trend. As an example, the CHaMP data were combined with fish abundance data for the Middle Fork John Day steelhead population to publish a life-cycle model (McHugh et al. 2017). This publication integrates multiple data streams, and used the CHaMP data to help predict the efficacy of different restoration strategies (e.g., in-channel large wood placement, riparian vegetation recovery, etc.).

As the time-series grows, we will estimate egg to young-of-the-year survival, young-of-the-year to parr survival, and parr-to-smolt survival. As part of future contracts, we will use an information-theoretic framework to evaluate the relationship among habitat metrics (collected via the CHaMP protocol) and our estimates of fish survival at both a population and site scale. This analysis will help identify potential impairments that can be targeted for remediation.

5. Discussion and Adaptive Management

Adult steelhead escapement in the South Fork John Day River during 2017 did not meet the recovery goal for abundance. Adult-smolt recruitment modeling of the South Fork John Day River indicates that maximum sustained production of smolts for this population is achieved at approximately 1,200 spawners.

The 2015 smolt migration year marked the first time in our monitoring that SAR for Chinook has exceeded steelhead SAR. Migration timing differences during 2015 may have contributed to this novel result. Chinook migrated earlier than steelhead, as usual, which apparently afforded markedly higher survival rates during 2015. Fall migrating Chinook parr, which wintered further downstream also had higher trap to dam survival during MY 2015, another unusual finding. These results suggest that fish wintering upstream (e.g., spring migrating Chinook, and spring migrating steelhead) were cued to migrate too late during this low-discharge year and “missed” the best migration and survival window. The short window for successful migration demonstrates the importance of a diverse portfolio of life-history strategies. The fall migrants out-produced the spring migrants, and hence buoyed the entire cohort, especially for the Upper Mainstem Chinook population. From a monitoring perspective, these results demonstrate that continuing to track metrics such as the migratory timing of smolts is just as important as monitoring overall abundance.

Since 2008 there has been a decline in the proportion of hatchery-origin spawners in the John Day River summer steelhead MPG. This trend was preceded by declines in the proportion of hatchery steelhead smolts barge transported through the Columbia and Snake rivers. Our

2017 results corroborate prior years and documents the first year that steelhead PHoS in the John Day River basin was at 0%. The low PHoS was anticipated based on low barge transport fractions through the Snake River during spring 2015. This correlation suggests that limiting smolt transportation in the Snake River to < 20% of the total smolt population may be able to produce 0% PHoS estimates in the John Day River during future years. Of equal importance, low smolt transport fractions will also minimize straying of natural-origin Snake River adults, which are equally likely to stray into the John Day River when barged.

Using CHaMP habitat data to predict capture efficiency for juvenile steelhead appeared effective during 2017. This approach allowed us to estimate abundance at each site, while reducing our total number of site visits, and the total number of fish handled ("take"). We will continue to refine this approach in 2018; and incorporate a subset of two-pass mark-recapture sites into an updated suite of models when predicting capture efficiency.

We contributed to publication of a life-cycle model (LCM) manuscript in 2017 (McHugh et al. 2017). The LCM documented in this paper demonstrated that physical habitat manipulations in the Middle Fork John Day River will provide small benefits to steelhead abundance and productivity. Maximizing shade, through restoration of vegetation or other means, is the most beneficial of the evaluated options for Middle Fork steelhead. This LCM can form the basis of informed adaptive management in 2018 and beyond, and be a vehicle to better integrate our CHaMP, juvenile fish, and productivity monitoring data set with the project planning process employed by practitioners of habitat restoration.

6. Bibliography

Banks, S.K., C.M. Bare, A.M. Bult, C.A. James, I.A. Tattam, J.R. Ruzycki, and R.W. Carmichael. 2011. Steelhead Escapement and Juvenile Production Monitoring in the John Day Basin: Annual Progress Report. 2011 technical report, project no. 199801600.

Bare, C.M., A.M. Bult, I.A. Tattam, J.R. Ruzycki, and R.W. Carmichael. 2011. Chinook Salmon Productivity and Escapement Monitoring in the John Day River Basin. 2011 technical report, project no. 212909.

Bear, E.A., T.E. McMahon, and A.V. Zale. 2007. Comparative Thermal Requirements of Westslope Cutthroat Trout and Rainbow Trout: Implications for Species Interactions and Development of Thermal Protection Standards, Transactions of the American Fisheries Society, 136:4, 1113-1121.

Bouwes, N., J. Moberg, N. Weber, B. Bouwes, S. Bennett, C. Beasley, C.E. Jordan, P. Nelle, M. Polino, S. Rentmeester, B. Semmens, C. Volk, M.B. Ward, and J. White. 2011. Scientific protocol for salmonid habitat surveys within the Columbia Habitat Monitoring Program. Prepared by the Integrated Status and Effectiveness Monitoring Program and published by Terraqua, Inc., Wauconda, WA.

Bouwes, N, N. Weber, S. Bennett, J. Moberg, B. Bouwes, and C. Jordan. 2010. Tributary Habitat Monitoring at the Watershed or Population Scale: Preliminary Recommendations for Standardized Fish Habitat Monitoring in the Columbia River Basin. Prepared by the Integrated Status and Effectiveness Monitoring Program for Bonneville Power Administration. 104 pp.

Bouwes, N., Weber, N., Archibald, M., Langenderfer, K., Wheaton, J., Tattam, I., Pollock, M., and C. E. Jordan. 2010. The integrated status and effectiveness monitoring project: John Day Basin pilot project. 2009 Annual Technical Report. Available online at: https://pisces.bpa.gov/release/documents/documentviewer.aspx?doc=P117044

Carlson, S.R., L.G. Coggins, and C.O. Swanton. 1998. A simplified design for mark-recapture estimation of salmon smolt abundance. Alaska Fishery Research Bulletin 5(2):88-102.

Carmichael, R.W., G. Claire, J. Seals, S. Onjukka, J. Ruzycki, and W. Wilson. 2002. "John Day basin spring Chinook salmon escapement and productivity monitoring; fish research project Oregon", 2000-2001 annual report, project no. 199801600.

Carmichael, R.W. and B.J. Taylor. 2009. Conservation and Recovery Plan for Oregon Steelhead Populations in the Middle Columbia River Steelhead Distinct Population Segment.

http://www.nwr.noaa.gov/Salmon-Recovery-Planning/Recovery-Domains/Interior-Columbia/Mid-Columbia/upload/Mid-C-Oregon.pdf.

Chao, A. 1989. Estimating animal abundance with capture frequency data. Journal of Wildlife Management. 52:295-300.

Chilcote, M.W. 2001. Conservation assessment of steelhead populations in Oregon. Oregon Department of Fish and Wildlife, Portland, OR.

Chilcote, M.W. 2003. Relationship between natural productivity and the frequency of wild fish in mixed spawning populations of wild and hatchery steelhead (Oncorhynchus mykiss). Canadian Journal of Fisheries and Aquatic Sciences. 60:1057-1067.

Crawford, B.A., and S. Rumsey. 2009 (Draft). Guidance for monitoring recovery of Pacific Northwest salmon and steelhead listed under the Federal Endangered Species Act (Idaho, Oregon, and Washington). NOAA's National Marine Fisheries Service – Northwest Region, Portland, OR.

DART. 2011. Data access in real time. School of Aquatic and Fishery Sciences. University of Washington. http://www.cbr.washington.edu/dart/dart.html

Dempson, J.B., and D.E. Stansbury. 1991. Using partial counting fences and a two-sample stratified design for mark-recapture estimation of an Atlantic salmon population. North American Journal of Fisheries Management. 11:27-37.

Feldhaus J.W. 2006. The Physiological Ecology of Redband Rainbow Trout (*Oncorychus mykiss gairdneri*) in the South Fork John Day River, Oregon. Master's Thesis. Oregon State University, Corvallis, Oregon.

Firman, J.C., and S.E. Jacobs. 2001. A survey design for integrated monitoring of salmonids. First Int. Symp. On GIS in Fishery Science. (http://osu.orst.edu/Dept/ODFW/spawn/pdf%20files/reports/emap%20paper.pdf).

Handley K. A., C.A. James, J.R. Ruzycki. R.W. Carmichael. 2011. Fish Population Monitoring in the Middle Fork John Day River Intensively Monitored Watershed. Annual Technical Report. (OWEB Contract Number: 208-920-7776)

Hansen, L. P., and T. P. Quinn. 1998. The marine phase of the Atlantic salmon (Salmo salar) life cycle, with comparison to Pacific salmon. Canadian Journal of Fisheries and Aquatic Sciences 55 (Supplement 1): 104-118.

Hare, S.R., N.J. Mantua, and R.C. Francis. 1999. Inverse production regimes: Alaska and west coast Pacific salmon. Fisheries 24(1):6–14.

Hart, P.J.B. and T.J. Pitcher. 1969. Field trials of fish marking using a jet inoculator. Journal of Fish Biology. 1:383-385.

Hillman, T. W. 2006. Monitoring Strategy for the Upper Columbia Basin. Draft Report, August 2006. BioAnalysts, Inc. Report for Upper Columbia Salmon Recovery Board. Wenatchee, Washington.

ICTRT (Interior Columbia Technical Recovery Team). 2003. Independent populations of Chinook, steelhead and sockeye for listed evolutionarily significant units within the interior Columbia River domain. Draft. July 2003. Available at www.nwfsc.noaa.gov/trt/col_docs/independentpopchinsteelsock.pdf

Jacobs S., J. Firman, G. Susac, E. Brown, B. Riggers, 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.

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.

Jacobs, S.E., W. Gaeuman, M. Weeber, S.L. Gunckel, and S.J. Starcevich. 2009. Utility of a probabilistic sampling design to determine bull trout population status using redd counts in basins of the Columbia River Plateau. North American Journal of Fisheries Management. 29:1590-1604.

James, C.A., J.R. Ruzycki. R.W. Carmichael. 2009. Fish population monitoring in the middle fork John Day River intensively monitored watershed. Annual Technical Report. (OWEB Contract Number: 208-920-6931).

James, C. A., J.R. Ruzycki. R.W. Carmichael. 2010. Fish Population Monitoring in the Middle Fork John Day River Intensively Monitored Watershed. Annual Technical Report. (OWEB Contract Number: 208-920-6130).

James, C.A., M.L. Garriott, A.M. Bult, J.R. Ruzycki, and R.W. Carmichael. 2006. Implementation of the Environmental Monitoring and Assessment Program (EMAP) Protocol in the John Day Subbasin of the Columbia Plateau Province: Annual Progress Report. 2005-2006 Technical report, project no. 199801600.

James, C.A., M.L. Garriott, A.M. Bult, J.R. Ruzycki, and R.W. Carmichael. 2007. Implementation of the Environmental Monitoring and Assessment Program (EMAP) Protocol in the John Day Subbasin of the Columbia Plateau Province: Annual Progress Report. 2006-2007 Technical report, project no. 199801600, 75 electronic pages,http://pisces.bpa.gov/release/documents/documentviewer.aspx?doc=P105188.

Jonasson, B. C., V. D. Albaladejo, R. W. Carmichael. 2000. Oregon Department of Fish and Wildlife, Annual Progress Report July 17, 1998 to June 30, 1999 to Bonneville Power Administration, Portland, OR, Contract 98BI11646, Project 98-016-00, 31 electronic pages (BPA Report DOE/BP-11646-1) http://efw.bpa.gov/Publications/I11646-1.pdf.

Keefe, M.L., and five co-authors. 1998. Investigations into the early life history of naturally produced spring chinook salmon in the Grande Ronde River basin. Oregon Department of Fish and Wildlife, La Grande, OR. Annual Progress Report to Bonneville Power Administration. Project No. 92-026-04
(http://efw.bpa.gov/Environment/EW/EWP/DOCS/REPORTS/HABITAT/H33299-4.pdf).

Larsen, D.P., T.M. Kincaid, S.E. Jacobs, and N.S. Urquhart. 2001. Designs for evaluating local and regional scale trends. BioScience 51(12):1069-1078.

Lindsay, R. B., W. J. Knox, M. W. Flesher, B. J. Smith, E. A. Olsen and L. S. Lutz 1986. Study of wild spring Chinook salmon in the John Day River system. Final Report of Oregon Department of Fish and Wildlife to Bonneville Power Administration (Contract DE-A19-83BP39796), Portland, OR. http://.efw.bpa.gov/Environment/EW/EWP/DOCS/REPORTS/HABITAT/H39796-1.pdf.

Maxell, B.A. 1999. A power analysis on the monitoring of bull trout stocks using redd counts. North American Journal of Fisheries Management 19:860-866.

McCormick, J.L., A.M. Bult, J.R. Ruzycki, R.W. Carmichael. 2008. Implementation of the Environmental Monitoring and Assessment Program (EMAP) Protocol in the John Day Subbasin of the Columbia Plateau Province: Annual Progress Report. 2007-2008 technical report, project no. 199801600.

McCormick, J.L., A.M. Bult, J.R. Ruzycki, R.W. Carmichael. 2009. Implementation of the Environmental Monitoring and Assessment Program (EMAP) Protocol in the John Day Subbasin of the Columbia Plateau Province: Annual Progress Report. 2008-2009 technical report, project no. 199801600.

McCormick, J.L., A.M. Bult, J.R. Ruzycki, R.W. Carmichael. 2010. Implementation of the Environmental Monitoring and Assessment Program (EMAP) Protocol in the John Day Subbasin: Annual Technical Report. 2009-2010 technical report, project no. 199801600.

Miller, B. A., J. D. Rodgers and M. F. Solazzi. 2000. An automated device to release marked juvenile fish for measuring trap efficiency. North American Journal of Fisheries Management 20:284-287.

Moore, K.M., and S.V. Gregory. 1989. Geomorphic and riparian influences on the distribution and abundance of salmonids in a Cascade Mountain Stream. Pages 256-261 in: D. Abell, ed., Proceedings of the California Riparian Systems Conference; 1988 September 22-24, 1988; Davis, CA. Gen. Tech. Rep. PSW-110. Berkeley CA: Pacific Southwest Forest Range and Experiment Station, U.S.D.A.

Moore, K. M. S., K. K. Jones, and J. M. Dambacher. 1999. Methods for stream habitat surveys. Oregon Department of Fish and Wildlife.
(http://osu.orst.edu/Dept/ODFW/freshwater/inventory/availinfo.html - Field Survey Methods)

Moran, P., D. A. Dightman, R. S. Waples, and L. K. Park. 1997. PCR-RFLP analysis reveals substantial population-level variation in the introns of Pacific salmon (Oncorhynchus spp.). Mol. Mar. Biol. Biotechnol. 6:318-330.

Mueter, F. J, J. L. Boldt, B. A. Megrey, and R. M. Peterman. 2007. Recruitment and survival of Northeast Pacific Ocean fish stocks: temporal trends, covariation, and regime shifts. Canadian Journal of Fisheries and Aquatic Sciences 64:911-927.

NCEAS. 2010. The Salmon Monitoring Advisor Website. https://salmonmonitoringadvisor.org.

Nicholas, J.W., and L. Van Dyke. 1982. Straying of adult coho salmon to and from private hatchery at Yaquina Bay, Oregon. Oregon Department of Fish and Wildlife, Information report (fish) 82-10, Portland, Oregon.

National Marine Fisheries Service (NMFS). 2009. Middle Columbia River Steelhead Distinct Population Segment ESA Recovery Plan. http://www.nwr.noaa.gov/Salmon-Recovery-Planning/Recovery-Domains/Interior-Columbia/Mid-Columbia/Mid-Col-Plan.cfm

Northwest Power & Conservation Council. 2009. Columbia River Basin Fish & Wildlife Program. http://www.nwppc.org/library/2009/2009-09.pdf.

PTAGIS. 1999. The Columbia Basin PIT Tag Information System. PIT Tag Operations Center. Pacific States Marine Fisheries Commission.

Quinn, T.P. 2005. The behavior and ecology of Pacific salmon and trout. University of Washington Press, Seattle.

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, URL http://www.R-project.org.

Rodgers, J.D. 2000. Abundance of Juvenile Coho Salmon in Oregon Coastal Streams, 1998 and 1999. Monitoring Program Report Number OPSW-ODFW-2000-1, Oregon Department of Fish and Wildlife, Portland, Oregon. (http://osu.orst.edu/dept/pacrim/pdf's/snkrep99.pdf).

Rodgers, J.D. 2001. Monitoring of the Abundance of Juvenile Salmonids in Oregon Coastal Streams, 2000. Monitoring Program Report Number OPSW-ODFW-2001-1, Oregon Department of Fish and Wildlife, Portland.

Rodtka, M.C., and J.P. Volpe. 2007: Effects of Water Temperature on Interspecific Competition between Juvenile Bull Trout and Brook Trout in an Artificial Stream. Transactions of the American Fisheries Society, 136:1714-1727.

Roni, P., editor. 2005. Monitoring stream and watershed restoration. American Fisheries Society, Bethesda, Maryland.

Roper, B.B., Buffington, J.M., Bennett, S., Lenigan, S.H., Archer, E., Downie, S., Faustini, J., Hillman, T., Hubler, S., Jones, K., Jordan, C., Kaufmann, P., Merritt, G., Moyer, C., and Pleus, A. In press. A comparison of the performance and compatibility of protocols used by seven monitoring programs to measure stream habitat in the Pacific Northwest. North American Journal of Fisheries Management.

Rosenberger, A. E., and J. B. Dunham. 2005. Validation of abundance estimates from mark–recapture and removal techniques for rainbow trout captured by electrofishing in small streams. North American Journal of Fisheries Management 25:1395–1410.

Ruzycki, J., W. Wilson, R. Carmichael, B. Jonasson. 2002. John Day basin spring Chinook salmon escapement and productivity monitoring; fish research project Oregon, 1999 -2000 annual report, project no. 199801600, 41 electronic pages, (BPA Report DOE/BP-00000498-1), http://efw.bpa.gov/Publications/A00000498-1.pdf.

Ruzycki, J, R., T.L. Schultz, W. Wilson, J. Schricker and R. Carmichael. 2008. Chinook salmon productivity and escapement monitoring in the John Day River basin. 2007 Annual Report. Oregon Water Enhancement Board (OWEB) contract 207-906

Saltzman B. 1977. Manual for Fish Management. Oregon Department of Fish and Wildlife. Portland, OR.

Schaller, H.A., C.E. Petrosky, and O.P. Langess.1999. Contrasting patterns of productivity and survival rates for stream-type chinook salmon populations of the Snake and Columbia River. Canadian Journal of Fisheries and Aquatic Resources 56:1031-1045.

Schaller, H.A., and 14 coauthors. 2007. Comparative Survival Study (CSS) of PIT-Tagged Spring/Summer Chinook and Steelhead In the Columbia River Basin Ten-year Retrospective Summary Report.

Schultz, T, W. Wilson, J. Ruzycki, R. Carmichael, J. Schricker, D. Bondurant 2006. Escapement and productivity of Spring Chinook and Summer Steelhead in the John Day River Basin. 2003-2004 Annual Report. Project No. 199801600,101 electronic pages, (BPA Report DOE/BP-00005840-4). http://pisces.bpa.gov/release/document/documentviewer.aspx?doc=00005840-4

Schultz, T, W. Wilson, J. Ruzycki, R. Carmichael, J. Schricker. 2007. Escapement and productivity of Spring Chinook and Summer Steelhead in the John Day River Basin. 2005-2006 Annual Report. Project No. 199801600 (BPA contract 25467).

Selong, J.H., T.E. McMahon, A.V. Zale and F.T. Barrows. 2001: Effect of Temperature on Growth and Survival of Bull Trout, with Application of an Improved Method for Determining Thermal Tolerance in Fishes. Transactions of the American Fisheries Society 130:1026-1037.

Steinhorst, K., Y. Wu, B. Dennis, and P. Kline. 2004. Confidence intervals for fish out-migration estimates using stratified trap efficiency methods. Agricultural, Biological, and Environmental Statistics. 9:284-299.

Stevens, D.L. 2002. Sampling Design and Statistical Analysis Methods for the Integrated Biological and Physical Monitoring of Oregon Streams. The Oregon Plan for Salmon and Watersheds Report Number: OPSW-ODFW-2002-07.

Stevens, Jr., D.L. and A. R. Olsen. 2003. Variance estimation for spatially balanced samples of environmental resources. Environmetrics. 14:593-610.

Stevens, D.L. and A.R. Olsen. 2004. Spatially balanced sampling of natural resources. Journal of the American Statistical Association. 99:262-278.

Susac, G.L., 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 F145-R-08. Portland, Oregon.

Tattam, I.A. 2006. Seasonal life history of *Oncorynchus mykiss* in the South Fork John Day River Basin, Oregon. Master's Thesis. Oregon State Univeristy, Corvallis, Oregon.

Tattam, I. A., J. R. Ruzycki, P. B. Bayley, H. W. Li, and G. R. Giannico. 2013. The influence of release strategy and migration history on capture rate of *Oncorhynchus mykiss* in a rotary screw trap. North American Journal of Fisheries Management 33:237–244.

Tattam, I.A., J.R. Ruzycki, H. W. Li, and G. R. Giannico. 2013. Body size and growth rate influence emigration timing of *Oncorhynchus mykiss*. Transactions of the American Fisheries Society 142:1406–1414.

Temple, G.M., and T.N. Pearsons. 2006. Evaluation of the recovery period in mark-recapture population estimates of rainbow trout in small streams. North American Journal Fisheries Management 26:941-948.

Thedinga J.F., M.L. Murphy, S.W. Johnson, J.M. Lorenz, and K.V. Koski. 1994. Determination of salmonid smolt yield with rotary screw traps in the Situk River, Alaska, to predict effects of glacial flooding. North American Journal of Fisheries Management. 14:837-851.

Thom B., K. Jones, P. Kavanagh and K. Reis. 2000. 1999 Stream Habitat Conditions in Western Oregon. Monitoring Program Report Number OPSW-ODFW-2000-5, Oregon Department of Fish and Wildlife, Portland, Oregon.

Tuomikoski, J., J. McCann, T. Berggren, H. Schaller, P. Wilson, S. Haeseker, J. Fryer, C. Petrosky, E. Tinus, T. Dalton, and R. Ehlke. 2011. Comparative survival study of PIT tagged spring/summer Chinook and summer steelhead. 2011 Annual Report. http://www.fpc.org/documents/CSS/2011%20CSS%20Annual%20Report--Final.pdf.

Ward, B. R., P. A. Slaney, A. R. Facchin, and R. W. Land. 1989. Size-biased survival in steelhead trout (*Oncorhynchus mykiss*): Back-calculated lengths from adult's scales compared to migrating smolts at the Keogh River, British Columbia. Canadian Journal of Fisheries and Aquatic Sciences 46:1853-1858.

White, G.C., D.R. Anderson, K.P Burnham, and D.L. Otis. 1982. Capture-recapture and removal methods for sampling closed populations. Los Alamos National Laboratory LA-8787-NERP. 235 pp.

Wiley, D., M. Garriott, and J.R. Ruzycki. 2004. Implementation of the Environmental Monitoring and Assessment Program (EMAP) Protocol in the John Day Subbasin of the Columbia Plateau Province. 2003-2004 Technical Report, Project No. 199801600, 56 electronic pages, (BPA Report DOE/BP-00015113-1). http://efw.bpa.gov/Publications/A00015113-1.pdf.

Wiley, D.J., M.L. Garriott, J.R. Ruzycki, R.W. Carmichael. 2005. Implementation of the Environmental Monitoring Program (EMAP) protocol in the John Day subbasin of the Columbia Plateau Province: Annual Progress Report. 2004-2005 Technical report, project no. 199801601, 90 electronic pages, (BPA Report DOE/BP-00015113-2), http://efw.bpa.gov/Publications/A00015113-2.pdf.

Wilson, W.H., J.R. Ruzycki, B.C. Jonasson, and R.W. Carmichael. 2002. ''Fish Research Project Oregon'', Project No. 1998-01600, 41 electronic pages, (BPA Report DOE/BP- 00000498-1) http://efw.bpa.gov/Publications/A00000498-2.pdf.

Wilson, W.H., T.J. Seals, J.R. Ruzycki, S. Onjukka, G. Claire, and R.W. Carmichael. 2003. ''Fish Research Project Oregon'', Project No. 1998-01600, 63 electronic pages, (BPA Report DOE/BP-00000498-2) http://efw.bpa.gov/Publications/A00000498-2.pdf.

Wilson, W., T. Schultz, T. Goby, J. Ruzycki, R. Carmichael, S. Onjukka, G. O'Connor. 2005. John Day basin Chinook salmon escapement and productivity monitoring, 2002-2003 annual report, project no. 199801600, 165 electronic pages, (BPA Report DOE/BP-00005840-2), http://efw.bpa.gov/Publications/A00005840-2.pdf.

Wilson, W., J. Schricker, J. Ruzycki, R. Carmichael. 2007. John Day basin Chinook salmon escapement and productivity monitoring, 2002-2003 annual report, project no. 199801600.

Wilson, W., J. Schricker, J. Ruzycki, R. Carmichael. 2008. John Day basin Chinook salmon escapement and productivity monitoring, 2002-2003 annual report, project no. 199801600.

Appendix A: Use of Data, Products & Publications

Viable Salmonid Population (VSP) indicator and metric data that support and feed ODFW's Recovery Planning and BiOP reporting needs 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. 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(s). 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 (SPS; https://www.webapps.nwfsc.noaa.gov/apex/f?p=261:home:0) database and StreamNet (http://www.streamnet.org/).

Columbia Habitat Monitoring Program. 2015. CHaMP data stored and analyses provided online at www.champmonitoring.org.

PTAGIS. 2015. The Columbia Basin PIT Tag Information System. PIT Tag Operations Center. Pacific States Marine Fisheries Commission. Data stored and retrieved online at www.ptagis.org.

Tuomikoski, J., J. McCann, B. Chockley, H. Schaller, P. Wilson, S. Haeseker, J. Fryer, C. Petrosky, E. Tinus, T. Dalton, R. Ehlke, and R. Lessard. 2012. Comparative survival study of PIT tagged spring/summer Chinook and summer steelhead. 2012 Annual Report. http://www.fpc.org/documents/CSS/2012%20CSS%20Annual%20Report--Final.pdf.

Refereed Publications:

McHugh, P. A., W. C. Saunders, N. Bouwes, C. E. Wall, S. Bangen, J. M. Wheaton, M. Nahorniak, J. R. Ruzycki, I. A. Tattam, and C. E. Jordan. 2017. Linking models across scales to assess the viability and restoration potential of a threatened population of steelhead (*Oncorhynchus mykiss*) in the Middle Fork John Day River, Oregon, USA. Ecological Modelling 355:24–38.

Tattam, I.A., J.R. Ruzycki, J.L. McCormick, and R.W. Carmichael. 2015. Length and condition of wild Chinook Salmon smolts influence age at maturity. Transactions of the American Fisheries Society 144:1237–1248.

Tattam, I. A., J. R. Ruzycki, P. B. Bayley, H. W. Li, and G. R. Giannico. 2013. The influence of release strategy and migration history on capture rate of *Oncorhynchus mykiss* in a rotary screw trap. North American Journal of Fisheries Management 33:237–244.

Tattam, I.A., J.R. Ruzycki, H. W. Li, and G. R. Giannico. 2013. Body size and growth rate influence emigration timing of *Oncorhynchus mykiss*. Transactions of the American Fisheries Society 142:1406–1414.

Tattam, I.A., H. W. Li, G.R. Giannico, and J.R. Ruzycki. 2016. Seasonal changes in spatial patterns of *Oncorhynchus mykiss* growth require year-round monitoring. Ecology of Freshwater Fish. doi: 10.1111/eff.12287.

Narum, S. R., T. L. Schultz, D. M. VanDoorink, and D. Teel. 2008. Localized genetic structure persists in wild populations of Chinook salmon in the John Day River despite gene flow from outside sources. Transactions of the American Fisheries Society 137: 1650–1656.

Appendix B: Detailed Results

Juvenile Salmonid Summer Rearing Monitoring

Juvenile sampling of *Oncorhynchus mykiss* and *O. tshawytscha* has been conducted by the Columbia Habitat Monitoring Program (CHaMP) crew in the John Day River Basin since 2011. Since 2014, sampling has been limited to the Middle Fork John Day River (MFJDR) and South Fork John Day River (SFJDR) basins. In 2016 and 2017, we varied our sampling protocol to decrease the amount of time and fish handling necessary to obtain accurate abundance estimates. Using habitat and mark-recapture data, we modeled our capture efficiency to move from a 2-pass mark-recapture sampling protocol to a single pass sampling protocol. For the majority of our sites, we have been employing a mark-recapture method to estimate abundance at each site. This involves two sampling events to capture fish, by means of electroshocking or by snorkel herding. On the first sampling event, captured fish are marked with a fin clip and released back into the site. The second sampling event occurs between three and twenty-four hours later and involves handling all fish to determine if fish are newly captured or recaptures. By creating a model to predict capture efficiency using habitat variables, we were able to sample only once without marking fish and use these data to estimate abundance.

To create the model, we used data from 28 sites (14 from MFJDR, 14 from SFJDR) sampled in 2015 or 2016 using the mark-recapture method to determine capture efficiency at each site. We also used habitat metric data collected at the same 28 sites to determine which metrics could predict capture efficiency. We started by running a correlation matrix with variables we felt could potentially impact capture efficiency to remove variables which were auto-correlated. Once we narrowed our usable metrics down, we used the remaining five metrics in a binomial logistic regression to determine which metrics would produce the best fit model to predict capture efficiency. We ran the models separately for sites in the SFJDR and MFJDR. After comparing AIC values, we determined the best fit model for the MFJDR included percent boulder and conductivity. The best fit model for the SFJDR included mean pool depth and mean fork length. We then used a jackknife technique to validate the models and compare predicted vs observed values.

During our juvenile monitoring in September and October 2017, we continued to use 2-pass mark-recapture at 16 sites (5 were PIT tag study sites) to refine our model. Five of these 16 mark-recapture sites (CBW05583-051058, CBW05583-231026, CBW05583-461938, CBW05583-363890, and CBW05583-013322) were not scheduled to be sampled in 2017. They were sampled as single pass sites in 2016 but we were unable to predict capture efficiency because at least one metric at each site fell outside of the model parameters. At the remaining

18 sites, we conducted 1-pass sampling, then used our model to determine abundance. Abundance estimates were calculated for these 34 sites where juvenile *O. mykiss* were present (Table 2). Tennessee Creek (Site ID: CBW05583-183666), Squaw Creek (Site ID: CBW05583-186098), Summit Creek (Site ID: CBW05583-161522), and Dry Fork Clear Creek (Site ID: CBW05583-215794) were dry by September, so they were not sampled for fish. No fish were found in Jackass Creek (Site ID: CBW05583-091762). Abundance estimates were not calculated for juvenile *O. tshawytscha* due to a lack of recapture data; however, the number captured at sites in the MFJDR and SFJDR are reported in Table 3. Juvenile *O. mykiss* were the most frequently observed salmonid in both the MFJDR and SFJDR.

Survey reaches ranged from 120–400 m depending on the average bankfull width derived during CHaMP habitat surveys. We surveyed 4.7 km of the MFJDR and SFJDR basins during the fall of 2017 (Table 1). We captured a total of 1,744 *O. mykiss* and 144 *O. tshawytscha* juveniles (≥70 mm) plus 470 *O. mykiss* and 22 *O. tshawytscha* fry (<70 mm) during surveys.

Scale samples were collected from a subset of fish at each site to determine ages of fish captured. Due to amount of time needed to process scale data, age data of 2017 fish will be presented in the 2018 annual report. Age data from 2016 is presented as an appendix in this report.

Discussion/Conclusions

Given delays in CHaMP data processing, we are still conducting estimates of juvenile abundance, as they rely on habitat metrics. Mean fork length of juvenile steelhead in both the Middle Fork and South Fork populations increased significantly in 2017, as compared to the prior two years. Increased mean size, most likely created by increased individual growth rate, is a plausible response to the decreased spawner density observed in the recent several years. Condition factor showed no significant difference from the prior two years in either population, however. This suggests that condition factor of juvenile steelhead may be more influenced by density-independent factors, such as streamflow and temperature. High stream flows and cool temperatures during spring 2017, the primary annual growth period, may have had a substantial influence on condition factor measured at the end of summer.

Table 1. Site identification number, stream, subbasin, panel type, survey length and start/end coordinates for juvenile salmonid fish surveys conducted in the MFJDR and SFJDR basins from September to October 2017. * Indicates sites where juvenile steelhead were PIT tagged to monitor growth, in-situ survival, and parr-to-smolt conversion probability.

SiteID	Stream	Subbasin	Panel	Survey Length (m)	Start Coordinates		End Coordinates	
					Latitude	Longitude	Latitude	Longitude
OJD03458-000505	Camp Creek	MFJDR	Three1	120	44.56086	-118.82920	44.56030	-118.82822
CBW05583-383986*	Camp Creek	MFJDR	Three2	120	44.56561	-118.84158	44.56530	-118.84063
CBW05583-232178	Clear Creek	MFJDR	Three1	120	44.57961	-118.49815	44.57987	-118.49803
CBW05583-469746*	Davis Creek	MFJDR	Three1	120	44.58685	-118.53804	44.58612	-118.53874
CBW05583-518642	Deadwood Creek	MFJDR	Three1	120	44.76404	-118.77879	44.76408	-118.77780
CBW05583-531698	Lemon Creek	MFJDR	Three1	120	44.68149	-118.61483	44.68231	-118.61486
CBW05583-050162*	Lick Creek	MFJDR	Three1	120	44.64651	-118.79374	44.64606	-118.79274
CBW05583-314610	Middle Fork John Day River	MFJDR	Three1	240	44.62176	-118.58071	44.62221	-118.57848
OJD03458-000147	Middle Fork John Day River	MFJDR	Three1	400	44.70689	-118.81475	44.70500	-118.81187
CBW05583-290034	Middle Fork John Day River	MFJDR	Three1	160	44.64103	-118.62894	44.63983	-118.62794
CBW05583-353778	Middle Fork John Day River	MFJDR	Three1	280	44.65492	-118.68048	44.65370	-118.68072
CBW05583-282354	Middle Fork John Day River	MFJDR	Three1	120	44.59337	-118.45228	44.59269	-118.45249
CBW05583-013322	Slide Creek	MFJDR	Three3	120	44.75132	-118.95076	44.75091	-118.95213
CBW05583-316426	Slide Creek	MFJDR	Three1	120	44.70441	-118.94039	44.70375	-118.93975
OJD03458-000536*	Vinegar Creek	MFJDR	Three3	160	44.60464	-118.53027	44.60551	-118.52906
CBW05583-381682*	Vinegar Creek	MFJDR	Three3	120	44.64281	-118.50401	44.64377	-118.50432
CBW05583-134002	Bark Cabin	SFJDR	Three1	120	44.25636	-120.40490	44.25558	-119.40435
CBW05583-054130	Deer Creek	SFJDR	Three1	120	44.20303	-119.36655	44.20304	-119.36507
CBW05583-345970	Duncan Creek	SFJDR	Three1	120	44.30709	-119.36680	44.30739	-119.36530
CBW05583-091762	Jackass Creek	SFJDR	Three1	120	44.34813	-119.51581	44.74136	-118.63140
CBW05583-363890	Murderers Creek	SFJDR	Three3	120	44.26169	-119.27993	44.26124	-119.27937
CBW05583-085362	Murderers Creek	SFJDR	Three1	120	44.26227	-119.23941	44.26244	-119.23842
CBW05583-150898	Murderers Creek	SFJDR	Three1	120	44.26184	-119.24899	44.26177	-119.24816
CBW05583-423282	Murderers Creek	SFJDR	Three1	120	44.27713	-119.34915	44.27713	-119.34915
OJD03458-000032	Murderers Creek	SFJDR	Three1	120	44.27793	-119.32792	44.27805	-119.32648

CBW05583-437106	Murderers Creek	SFJDR	Three1	120	44.28659	-119.43759	44.28685	-119.43778
CBW05583-231026	Murderers Creek	SFJDR	Three3	120	44.30635	-119.49666	44.30592	-119.49538
CBW05583-460402	Murderers Creek	SFJDR	Three1	160	44.31588	-119.52268	44.31639	-119.52098
OJD03458-000097	North Fork Wind Creek	SFJDR	Three1	120	44.27655	-119.58969	44.27737	-119.59601
OJD03458-000532	South Fork Deer Creek	SFJDR	Three1	120	44.16515	-119.33849	44.16428	-119.33839
CBW05583-461938	South Fork John Day River	SFJDR	Three3	200	44.32016	-119.55751	44.31852	-119.55699
CBW05583-226674	South Fork Murderers Creek	SFJDR	Three1	120	44.25243	-119.33129	44.25243	-119.33124
CBW05583-265074	South Fork Murderers Creek	SFJDR	Three1	120	44.26153	-119.41613	44.26118	-119.41489
CBW05583-051058	Thorn Creek	SFJDR	Three3	120	44.29868	-119.33954	44.29859	-119.33957

Table 4. Age data from scales collected from juvenile *O. mykiss* during the 2017 sampling season with mean, minimum, and maximum fork length (mm) of fish in each age group for the MFJDR and SFJDR. Scales only collected from fish ≥ 60mm.

Subbasin	Age	Count	Percent	Mean Length (mm)	Min Length (mm)	Max Length (mm)
MFJDR	0	25	5.1	66.68	60	81
MFJDR	1	139	28.5	100.59	74	139
MFJDR	2	47	9.6	144.60	112	180
MFJDR	3	4	0.8	179.75	135	220
SFJDR	0	62	12.7	67.68	60	80
SFJDR	1	135	27.7	105.51	72	162
SFJDR	2	69	14.1	148.20	117	235
SFJDR	3	7	1.4	176.14	142	205

Productivity of Spring Chinook Salmon and Summer Steelhead

At our Mainstem trap we captured 2,177 and PIT tagged 1,002 juvenile spring Chinook migrants during the fall/winter trapping period. During the spring period we captured 4,210, and PIT tagged 3,599. We estimated that during the fall/winter period (Oct 2016–Jan 2017) 43,013 (95% CI, 38,208 – 49,092) spring Chinook parr migrated past the trap. During the spring migration (February 2017 to June 2017) we estimated 24,228 (95% CI, 21,521 – 27,652) age-1 spring Chinook out-migrated past the trap site. We also estimated that 30,390 (95% CI, 27,595 – 33,423) age-0 Chinook migrated past the trap site between May 11th and July 7th. We estimated mean FL of juvenile Chinook captured during the fall/winter period was 96 mm, with a mean K of 1.09. Spring migrants prior to May 15th had a mean FL of 99 mm with a mean K of 1.19. After May 15th when the migration shifts primarily to age-0 parr the mean FL was 87mm with a mean K of 1.25.

At the South Fork trap we captured 176 juvenile Chinook over the entire season. Fall migrants had a mean FL of 100 mm and a mean K of 0.98. Spring migrants had a mean FL of 103 mm and a mean K of 1.07. We estimated that 969 (95% CI, 696 – 2,045) juvenile Chinook migrated past the trap site.

At the North Fork trap site we captured 1,966 Chinook parr during the fall trapping period (between October 19th and December 2nd). During this fall trapping period we estimated that 32,778 (95% CI, 26,252 – 41,152) smolts migrated past the trap. The mean observed FL was 81 mm with an average K of 1.03. During the spring trapping period we estimated that 22,817 (95% CI, 18,275 – 28,647) smolts migrated past the trap during. The mean observed FL was 86 mm with an average K of 1.11.

At our Middle Fork trap we captured a total of 351 juvenile Chinook during fall (October 21st – December 6th) before the trap had to be shut down due to ice flows. We estimated that 5,615 (95% CI, 4,475 – 7,007) parr migrated past the trap during this period. During the spring trapping period (February 24th– June 16th, 2017) we captured 1,343. We estimated that 22,319 (95% CI, 15,130 – 33,013) Chinook smolts migrated past the trap during this period. Mean FL of juvenile Chinook captured during the fall/winter was 89 mm with a mean K of 1.12. During the spring trapping period the mean FL of captured individuals was 98 mm with a mean K of 1.14.

During the seining season (February 17th – May 22nd, 2017) we captured 2,031 Chinook smolts and PIT tagged 1,994. We estimated 112,550 (95% CI, 85,774 – 157,616) smolts migrated through the seining reach during this time period. Catch per unit effort indicated the peak smolt run occurred between late March and mid-April. Captured Chinook smolts had an average FL of 107 mm with an average condition factor of 1.12.

Based on adult Spring Chinook redd counts and our smolt emigration abundance estimate, freshwater production of the Middle Fork was 51 smolts/redd (95% CI, 34 - 75) for the 2015 brood year. For the upper Mainstem population, freshwater production was estimated to be 31 smolts/redd (95% CI, 27 - 35) for the 2015 brood year. Basin wide, based on Chinook emigration through the seining reach, freshwater production was 69 smolts/redd (95% CI, 53 - 97) for the 2015 brood year. Basin wide there was strong evidence of a negative linear relationship between ln smolts/redd and the number of redds

($r^2 = 0.70$, $P < 0.001$). The residuals from these regressions, when plotted against brood year, showed no apparent temporal trend for any of the populations. These data hence suggest no detectable change in freshwater productivity of these Chinook populations through our monitoring period.

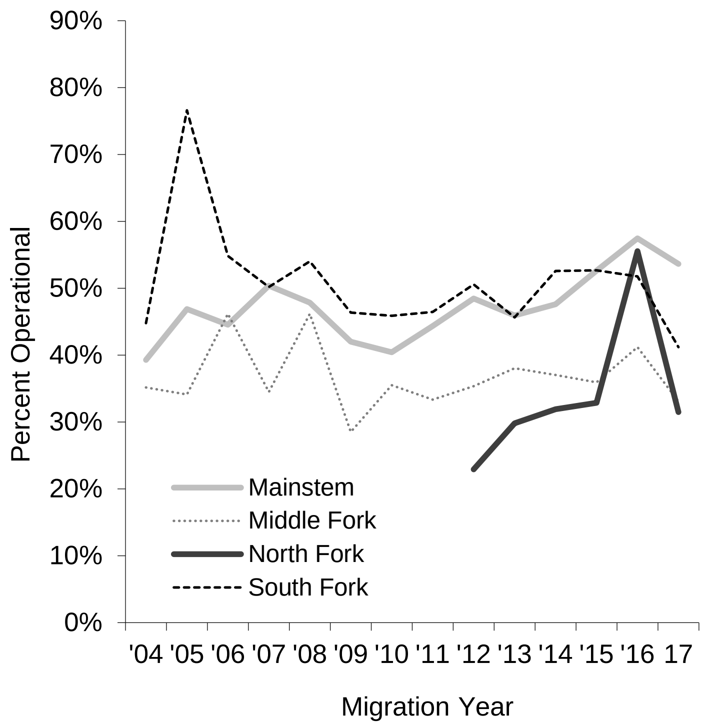

Figure 21. Proportion of nights operated for each trap site by migration year.

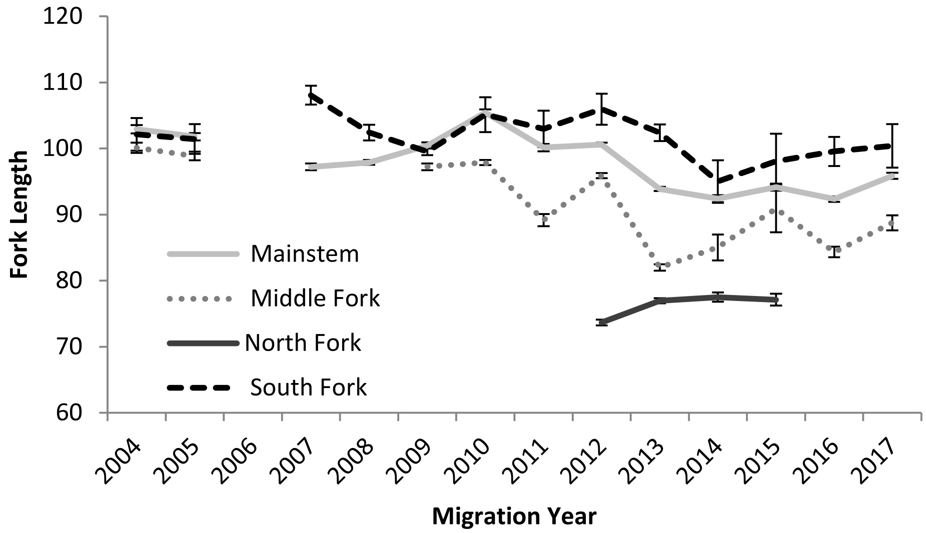

Figure 22. Fork length of fall migrant Chinook parr captured at four rotary screw trap sites in the John Day River basin. Error bars are 95% confidence intervals. Some traps were not operated during fall for migration years 2006 through 2008.

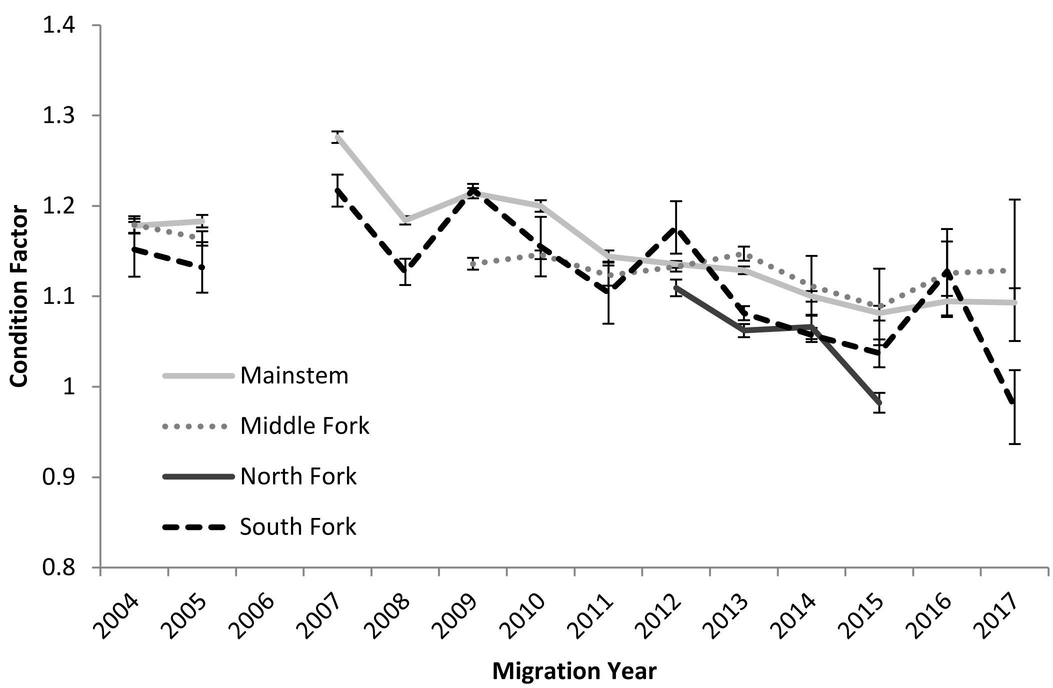

Figure 23. Condition factor of fall migrant Chinook captured at four rotary screw trap sites in the John Day River basin. Error bars are 95% confidence intervals. Some traps were not operated during fall for migration years 2006 through 2008.

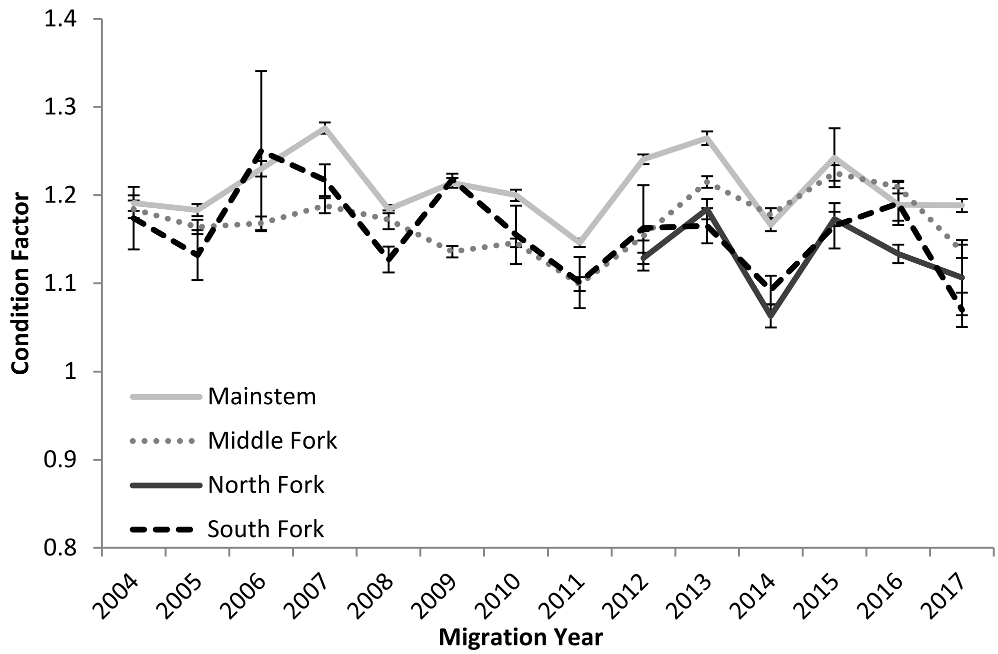

Figure 24. Condition factor of spring migrant Chinook captured at four rotary screw trap sites in the John Day River basin. Error bars are 95% confidence intervals.

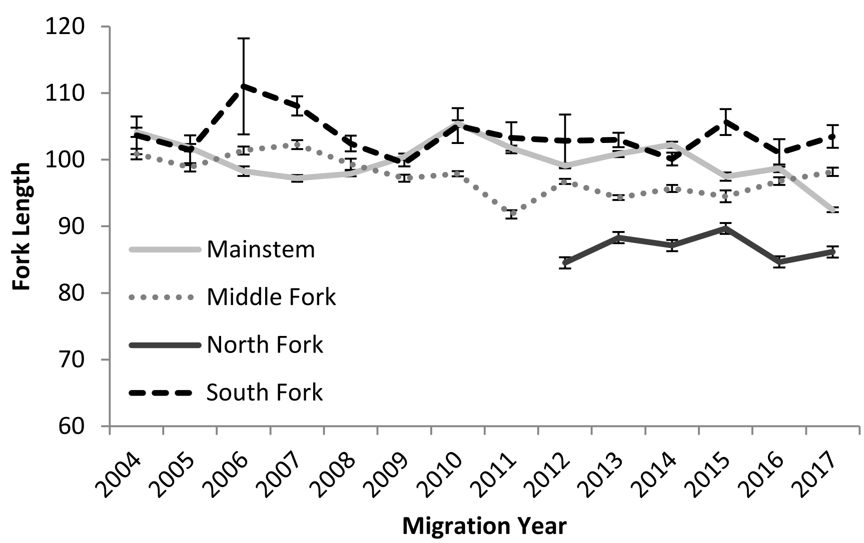

Figure 25. Fork length of spring migrant Chinook captured at four rotary screw trap sites in the John Day River basin. Error bars are 95% confidence intervals.

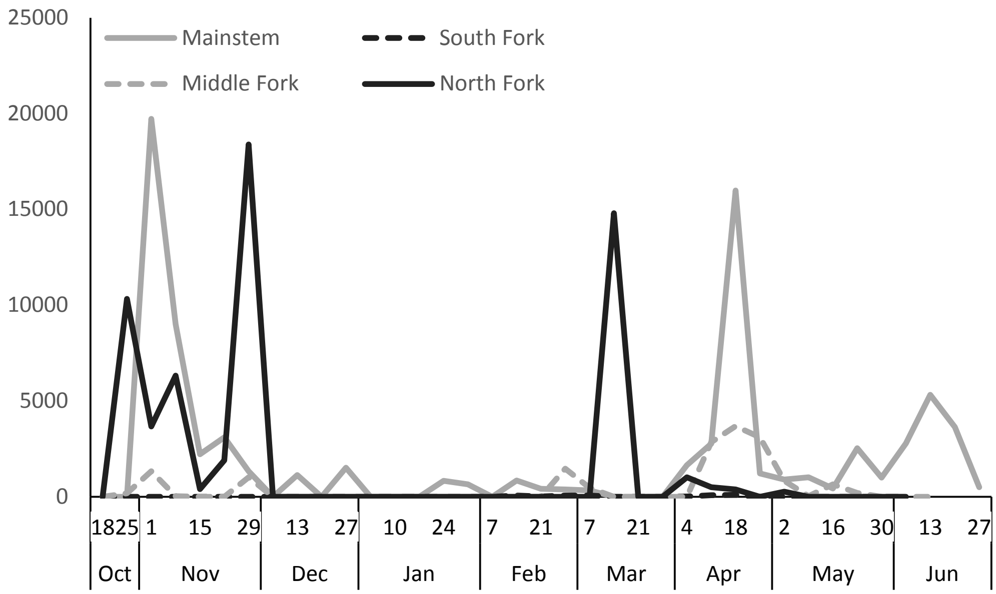

Figure 26. Estimated weekly number of juvenile spring Chinook migrating past rotary screw trap and seining operations in the John Day River basin during migratory year 2017.

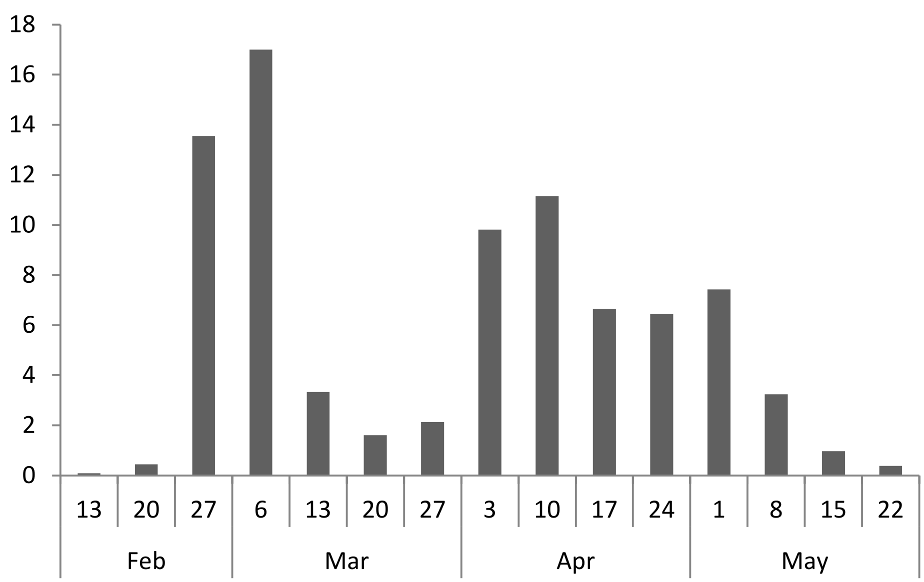

Figure 27. Weekly catch per unit effort (CPUE, number/seine haul) of spring Chinook smolts captured while seining during 2017.

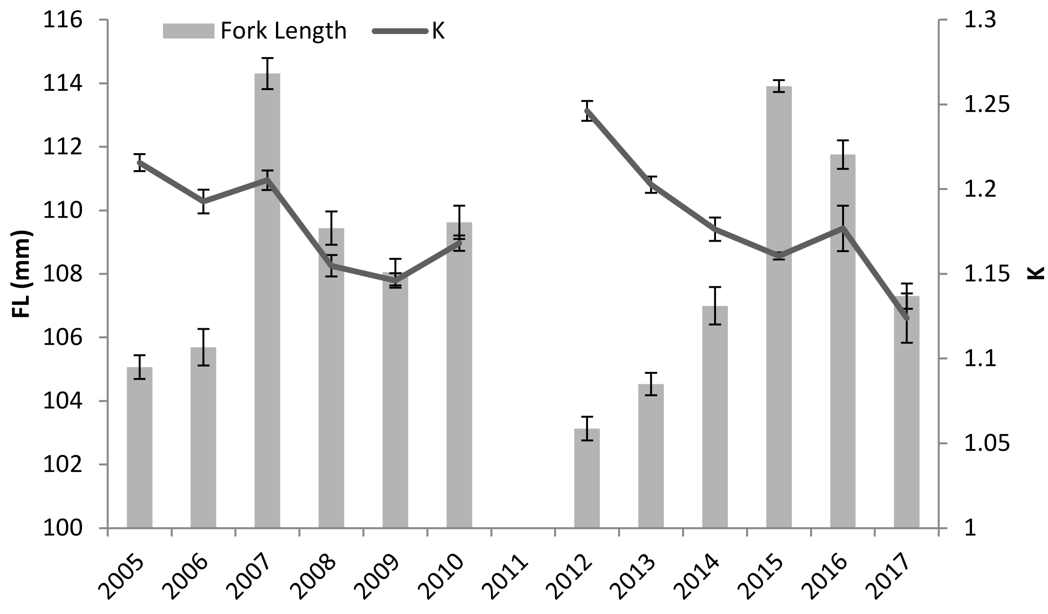

Figure 28. Mean fork length and condition factor of juvenile Chinook captured seining the John Day River between river kilometers 274 and 296. Capture periods vary slightly but are generally between February and May of each migration year. Error bars are 95% confidence intervals. No seining was conducted during migratory year 2011.

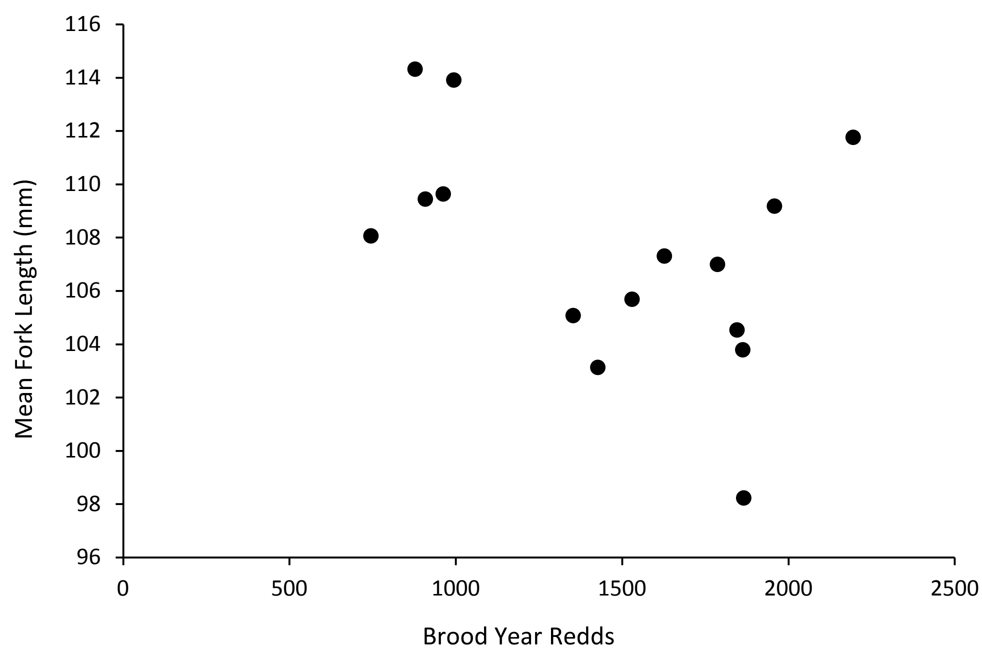

Figure 29. Average fork length for juvenile Chinook captured while seining the John Day River between river kilometers 274 and 296 vs. brood year redd count.

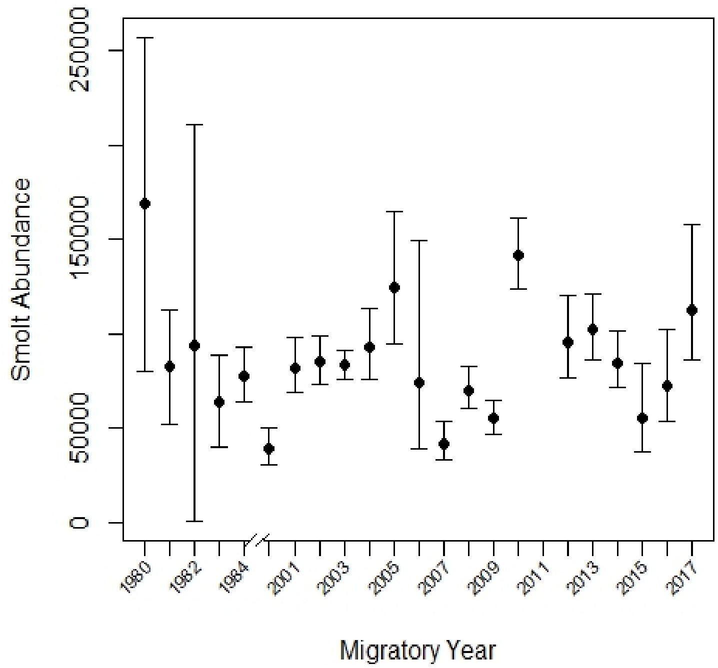

Figure 30. Smolt abundance estimates from spring seining of juvenile spring Chinook salmon emigrating from the entire John Day River basin. Estimates prior to the 2000 migration year are from Lindsay et al. (1986).

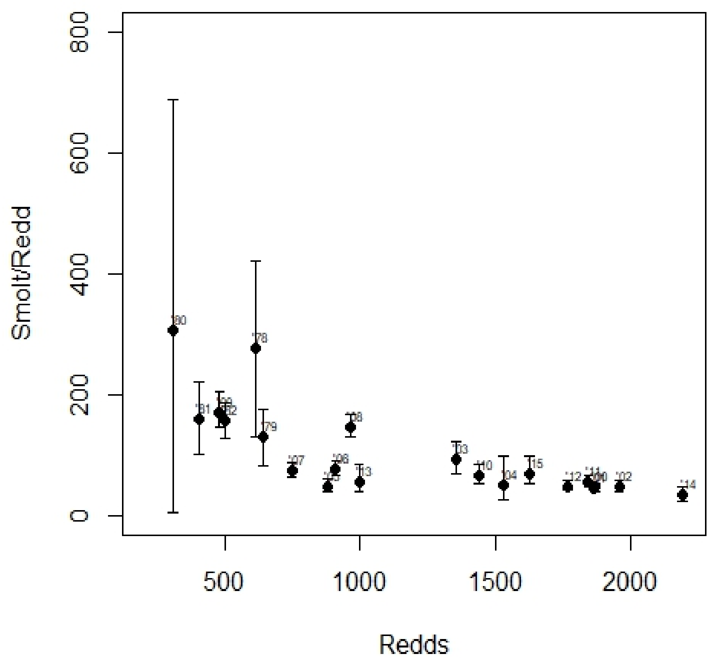

Figure 31. Smolt per redd ratios based on recent and historic estimates of smolt abundance and census redd counts for spring Chinook salmon for the entire John Day River basin. Historic estimates from the 1978–1982 brood years are from Lindsay et al. (1986).

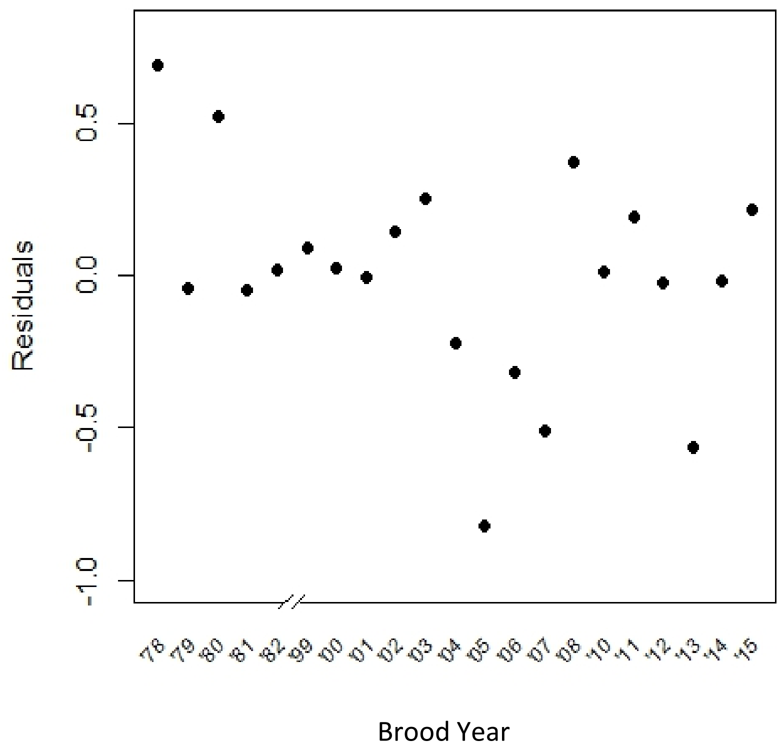

Figure 32. The residuals from a regression of natural log Chinook smolts per redd versus basin-wide Chinook salmon redd abundance plotted against brood year.

Juvenile Steelhead Capture and Tagging

Collectively, we PIT tagged 2,794 juvenile summer steelhead during migration year 2017. Spring migration timing peaked during late April and early May at all trap sites. At our Mainstem trap estimate that 55,831 (95% CI, 44,408 – 71,705) juvenile steelhead migrated past the Mainstem trap site over the trapping season. Fall migrants had a mean FL of 133 mm, and a mean K of 1.01. Spring migrants had a mean FL of 153 mm with a mean K of 1.03. The age structure of steelhead migrants was 16% age 1, 70% age 2, and 14% age 3.

At the Middle Fork trap we estimate a total of 22,321 (95% CI, 15,132 – 33,016) juvenile steelhead migrated past the trap site during the trapping period. Mean FL of the spring migrants was 163 mm with a mean K of 1.04. The age structure of steelhead migrants was 6% age-1, 53% age-2, and 41% age-3. Based on our adult summer steelhead redd counts and abundance estimates in the Middle Fork there were 6 out-migrant produced per spawner for the 2014 brood year (95% CI, 3–10). The 2015 spawning year's smolt per spawner estimate is incomplete and remains unreported because of the high proportion of age 3 smolts produced in this system.

At the North Fork trap site we estimate that 6,558 (95% CI, 4,133 – 9,889) steelhead migrated past the trap site. The mean FL of captured spring migrants was 124 mm with a mean K of 1.04. The age structure of the out-migrants was 33% age-1, 49% age-2, 17% age-3, and 1% age-4.

At our South Fork trap site we estimate that 31,662 (95% CI, 26,622 – 36,954) juvenile steelhead migrated past the trap site during the trapping season. The mean FL of fall migrants was 123 mm with a mean K of 0.97. The mean FL of spring migrants was 147 mm with a mean K of 1.02. The age structure of migrants was 39% age-1, 50% age-2, 10% age-3, and 1% age-4. Based on adult summer steelhead redd counts and juvenile migrant abundance estimates in the South Fork we estimate a ratio of 34 out-migrants per spawner (95% CI,18 - 101) for brood year 2015.

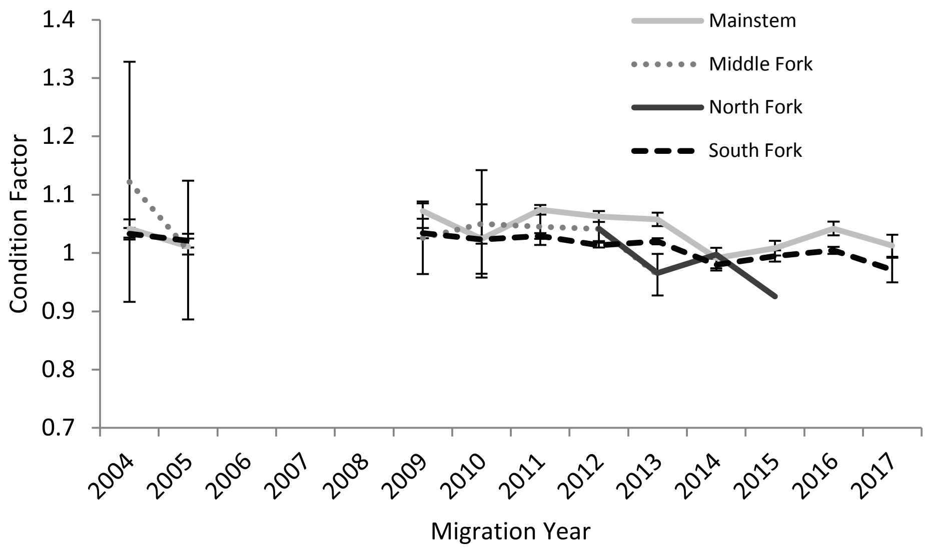

Figure 33. Mean condition factor of fall out-migrant summer steelhead collected at four John Day River basin trap sites. Error bars are 95% confidence intervals. Not all traps were operated during fall for migration years 2006 through 2008.

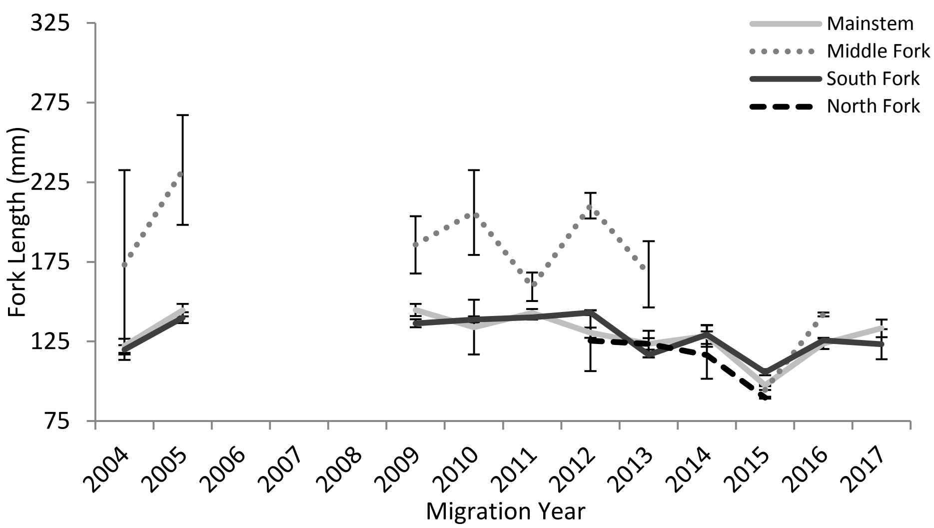

Figure 34. Mean fork length of fall out-migrant summer steelhead collected at four John Day River basin trap sites. Error bars are 95% confidence intervals. Not all traps were operated during fall for migration years 2006–08.

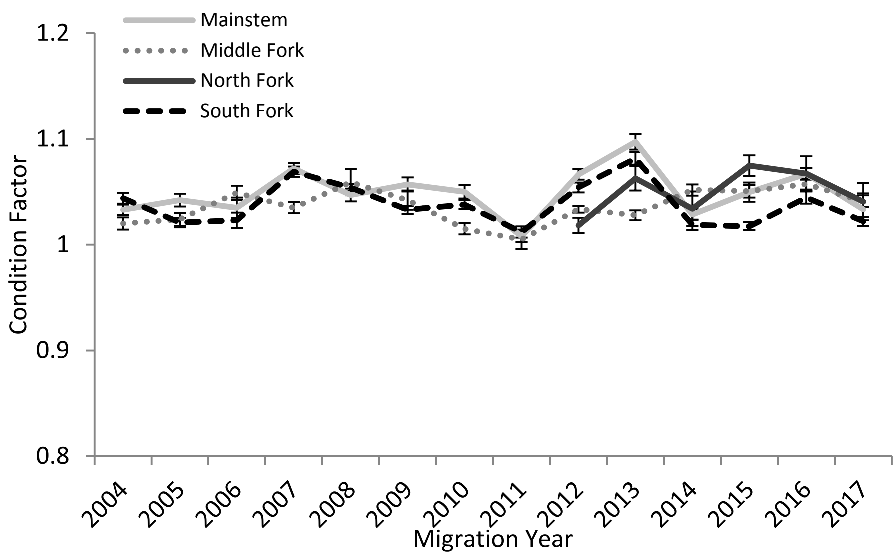

Figure 35. Mean condition factor of spring out-migrant steelhead collected at four John Day River basin trap sites. Error bars are 95% confidence intervals.

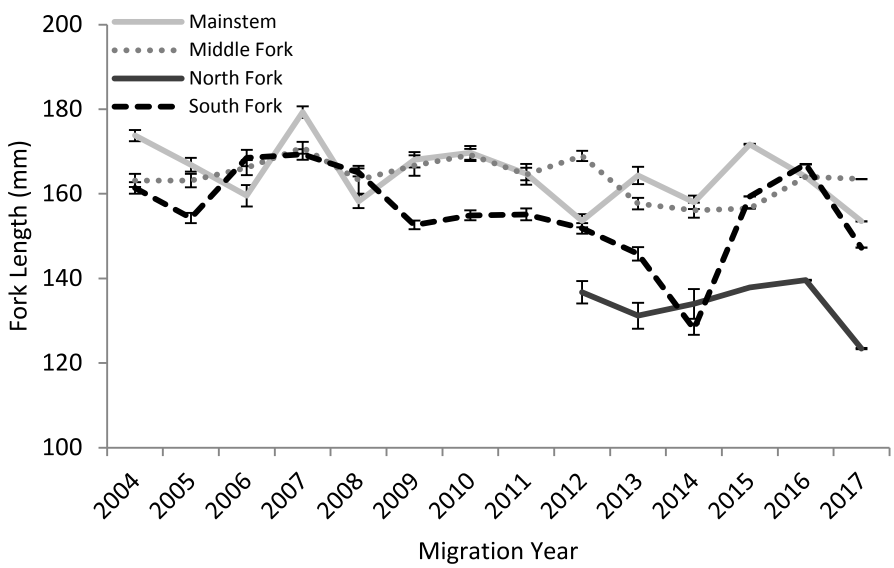

Figure 36. Mean fork length of spring out-migrant steelhead collected at four John Day River basin trap sites. Error bars are 95% confidence intervals.

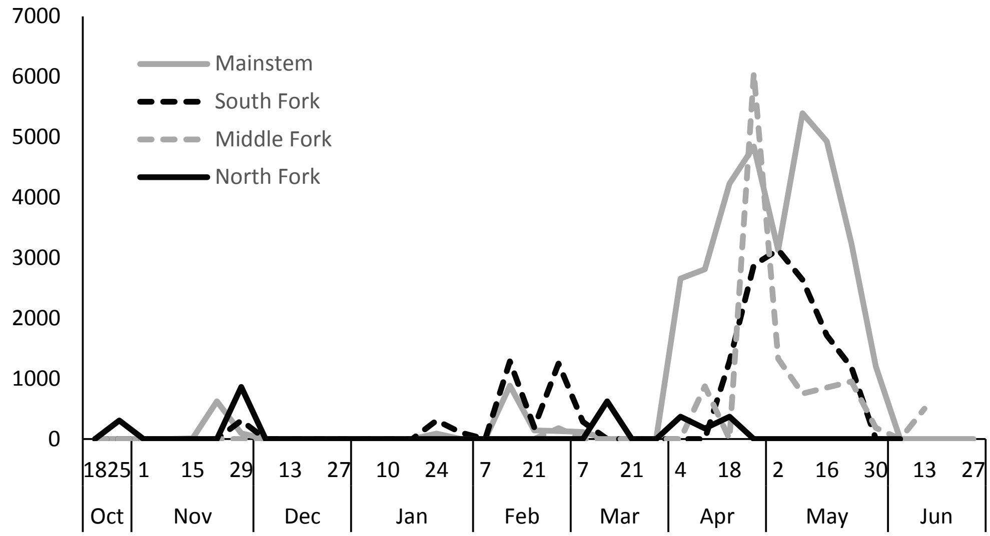

Figure 37. Estimated weekly number of summer steelhead migrating past rotary screw traps operated in the John Day River basin during migratory year 2017.

Incidental Catch and Observations

We captured 18 non-target species and two non-target salmonid life stages in our rotary screw trap and seining sets during migration year 2017, including four adult steelhead; all were of wild origin. Additionally, 98 Chinook fry (<65mm) and 58 O. mykiss fry (<65mm) were enumerated and released. We captured 1,545 juvenile pacific lamprey of two morphologies (silver coloration with developed eyes, and brown coloration with less developed eye spots), and 2 adult pacific lamprey. Other notable species captured included the introduced species bluegill, largemouth bass, and the invasive rusty crayfish. (Table 5).

Species	Trap Site MS	MF	NF	SF	Seine
Wild Adult Steelhead (*O. mykiss)*	2	-	-	1	1
Hatchery Adult Steelhead (*O. mykiss)*	-	-	-	-	-
Chinook Fry (*O. tshawytcha)*	1	4	93	-	-
Steelhead Fry (*O. mykiss)*	17	1	31	9	-
Bull Trout (*Salvelinus confluentus)*	1	1	2	-	1
Sockeye Smolt (*O. nerka)*	-	-	-	-	-
West Slope Cutthroat *(O. clarki lewisi)*	-	-	-	-	-
Sucker species *(Catostomus spp.)*	4488	359	100	304	102
Red Side Shiner (*Richardsonius balteatus)*	1233	35	41	355	3
Dace species *(Rhinichthys spp.)*	203	27	291	16	3
Pacific Lamprey *(Entosphenus tidentata)*					
Juvenile - No Developed Eyes	55	118	1251	16	2
Juvenile - With Developed Eyes	39	3	47	14	-
Adult	-	1	1	-	-
Northern Pikeminnow (*Ptychocheilus oregonensis)*	1391	122	14	272	334
Chiselmouth (*Acrocheilus alutaceus)*	387	1	-	9	47
Brown Bullhead (*Ameiurus nebulosus)*	1	-	-	-	4
Sculpin (*Cottus spp.)*	1	-	40	8	-
Mountain White Fish (*Prosopium williamsoni)*	3	-	-	-	1
Small Mouth Bass (*Micropterus dolomieui)*	32	69	2	-	13
Large Mouth Bass (*Micropterus salmoides*)	22	-	-	-	-
Carp (*Cyprinus carpio*)	-	-	-	-	3
Bluegill (*Lepomis macrochirus)*	14	-	-	-	-
Rusty Crayfish (*Orconectes rusticus)*	3414	-	-	4058	17
Signal Crayfish (*Pacifastacus leniusculus)*	-	3	35	1	-

Table 5. Number of each fish species captured incidentally by site (19 October 2016 to 3 July 2017).

PIT Tag Detections of Juveniles at Federal Columbia River Power System Facilities

Table 6. Number detected (N), first and last detection dates, and mean, standard error (SE) and range of travel time (days) to John Day Dam during 2017 for spring Chinook and summer steelhead smolts PIT tagged at tagging sites in the John Day Basin.

<table>
<tr><th rowspan="2">Species</th><th rowspan="2">Site</th><th rowspan="2">Group</th><th rowspan="2">N</th><th rowspan="2">Detection Dates</th><th rowspan="2">50% Detected</th><th colspan="2">Travel Time (days)</th></tr>
<tr><th>Mean</th><th>SE</th></tr>
<tr><td rowspan="3">Summer Steelhead</td><td rowspan="2">South Fork</td><td>Fall</td><td>5</td><td>4/9–5/25</td><td>4/30</td><td>117</td><td>11.9</td></tr>
<tr><td>Spring</td><td>343</td><td>4/18–6/13</td><td>5/8</td><td>28</td><td>1.7</td></tr>
<tr><td>Middle Fork</td><td>Spring</td><td>146</td><td>4/26–6/21</td><td>5/9</td><td>15</td><td>0.9</td></tr>
<tr><td rowspan="3">Spring Chinook</td><td rowspan="2">Mainstem</td><td>Fall</td><td>59</td><td>4/18–5/6</td><td>4/27</td><td>151</td><td>2.2</td></tr>
<tr><td>Spring</td><td>268</td><td>4/20–6/20</td><td>5/1</td><td>41</td><td>1.5</td></tr>
<tr><td>Seining Reach</td><td>Spring</td><td>501</td><td>4/11–5/27</td><td>5/2</td><td>32</td><td>0.8</td></tr>
</table>

Summer steelhead were tagged in three groups during the 2017 migratory year; at the South Fork trap during the fall and spring and at the Middle Fork trap during the spring. Steelhead tagged at the South Fork trap during the fall were at large for an average of 158 days (SE 4.1) between tagging and detection at John Day Dam. Small sample size (n = 32) precluded survival estimates for South Fork fall migrants. The spring tag group from the South Fork were detected at John Day Dam an average of 20 days (SE 2.5 days) after tagging and had an estimated survival of 45.1% (SE 7.32%) from 74 detections. Spring tagging group detections occurred at John Day Dam between April 19th and May 9th with 50% of them being recorded by May 13th.

The steelhead tagged at the Middle Fork trap during the spring had an estimated survival of 28.2% (SE 5.6%) from 47 detections. These fish were at large for an average of 17 days between tagging and detection at the dam. Fifty percent of detections occurred by May 13th.

PIT Tag Detection of Adults at Federal Columbia River Power System Facilities

Ninety-five spring Chinook were detected in 2017 at the Mainstem Columbia detection sites that were tagged as juveniles for the John Day river SAR estimate. The recently completed SAR estimate for the 2015 migration year (discounting possible age-6 returns) was 5.9% (95% CI, 5.0% - 7.3). The age structure of the returning Spring Chinook was 18% (17 fish) age 3, 76% (72 fish) age 4, and 6% (6 fish) age 5. Fifteen (16%) of the John Day origin returning adults were detected at sites upstream of the mouth of the John Day river. All of these fish were detected at McNary Dam.

A total of 42 adult summer steelhead PIT tagged as juveniles at RST sites in the John Day basin were detected in the FCRPS in 2017. All of these adults were first detected at Bonneville with 90% being detected at The Dalles Dam. In total, 61% of all John Day steelhead were detected at McNary.

A total of 65 returning steelhead were tagged as juveniles for the John Day basin SAR estimate for migratory year 2014. Of these, 42 (64%) were one-ocean fish and 24 (36%) were two-ocean fish. In 2014, the SAR estimate for juvenile summer steelhead was 5.4% (95% CI, 3.6% -10.8%).

Spring Chinook and summer steelhead originating from the John Day River basin have experienced similar SAR in recent years (Figure 32). The SARs for each species from John Day Dam to the ocean and back to Bonneville Dam are significantly correlated ($r = 0.87$, $P < 0.001$). The SAR for steelhead exceeded Chinook in all years.

Figure 38. Relationship between point estimates of smolt-to-adult ratio (SAR) of summer steelhead and spring Chinook tagged with Passive Integrated Transponder tags in the John Day River basin during migration years 2004–2013. SAR is estimated from smolt migration past John Day Dam to adult detection at Bonneville Dam. The straight line denotes a 1:1 relationship between SAR of steelhead and Chinook.

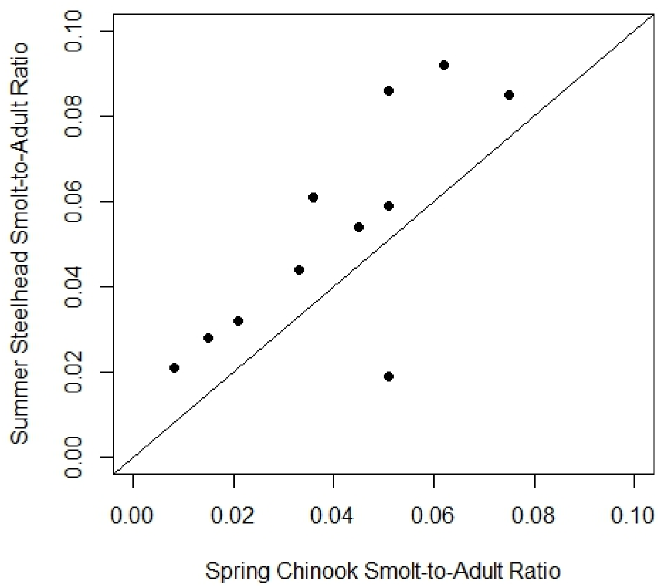

Table 7. Detections of adult summer steelhead and spring Chinook salmon, originally PIT-tagged at rotary screw trap sites or by seining in the John Day basin, which returned to the Columbia River during 2015, 2016, and 2017.

	Summer Steelhead			Spring Chinook		
	2015	2016	2017	2015	2016	2017
John Day-origin PIT Tagged Adults Detected by FCRPS	108	42	52	120	95	55
% Detected at Bonneville Dam:	99.1%	100%	96.2%	95.8%	100%	98.2%
% Detected at The Dalles Dam:	78.7%	90.7%	76.9%	93.3%	95.8%	85.5%
% Detected at McNary Dam:	63.0%	60.5%	59.6%	10.8%	15.6%	20.0%
% Detected at Lower Granite Dam:	4.6%	7.0%	15.4%	6.7%	7.3%	14.6%

South Fork John Day Adult Steelhead Population Estimate

Run-year specific adult steelhead estimates at Bonneville Dam ranged from a low of 468 to a high of 1,575. We estimated 1,098 South Fork origin steelhead crossed Bonneville Dam during summer 2017 en route to spawning in spring 2018.

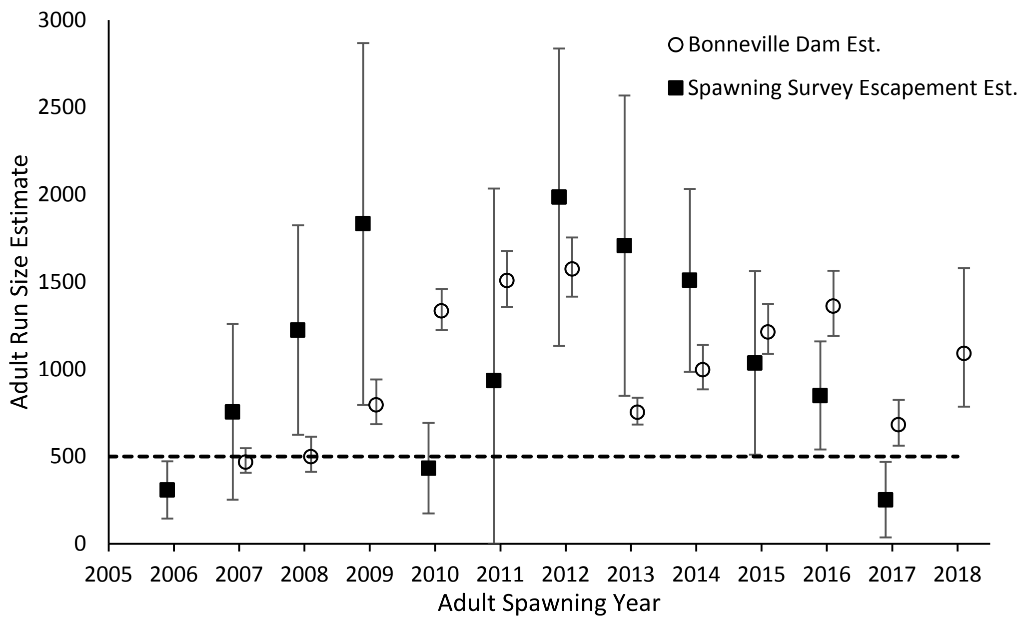

Figure 39. Comparison of adult steelhead estimates for the South Fork John Day River population. The spawning escapement estimates include both wild and hatchery origin adults and are derived from probabilistic spawning surveys in the South Fork population. Bonneville Dam estimates are from detections of returning Passive Integrated Transponder tagged adults corrected by out-migrant population estimates at the South Fork John Day River rotary screw trap. The horizontal dotted line denotes the National Oceanic and Atmospheric Administration's recovery goal of 500 adults for this population.

Appendix C

Category	Subcategory	Subcategory Focus 1	Subcategory Focus 2	Specific Metric Title
Classification of Ecological or Geological Attribute	Habitat Type			Channel Area Type - Channel Unit Summary Tier 2
Classification of Ecological or Geological Attribute	Habitat Type			Tier1 - Channel Unit Summary
Classification of Ecological or Geological Attribute	Habitat Type			Tier1 - Channel Unit Tier 1 Summary
Classification of Ecological or Geological Attribute	Habitat Type			Tier2 - Channel Unit Summary
Classification of Ecological or Geological Attribute	Habitat Type			Tier2 - Channel Unit Summary Tier 2
Fish	Abundance of Fish	Fish Life Stage: Adult - Spawner	Fish Origin: Both	Hatchery vs Wild Observations
Fish	Abundance of Fish	Fish Life Stage: Adult - Spawner	Fish Origin: Both	Spawner Escapement Estimates By Hatchery or Wild Origin
Fish	Abundance of Fish	Fish Life Stage: Adult - Spawner	Fish Origin: Natural	Spawner Abundance
Fish	Abundance of Fish	Fish Life Stage: Juvenile - Migrant	Fish Origin: Natural	Abundance of Emigrating Salmonid Smolts
Fish	Age Structure: Fish	Fish Life Stage: Juvenile - Migrant		Smolt Age Composition
Fish	Age Structure: Fish	Fish Life Stage: Juvenile Fish		Juvenile Age Composition
Fish	Condition Factor			Smolt Condition Factor
Fish	Density of Fish Species	Fish Life Stage: Juvenile - Parr		Juvenile Salmonid Reach Density
Fish	Density of Fish Species	Fish Life Stage: Juvenile - Parr	Fish Origin: Natural	Juvenile Salmonid Density
Fish	Distribution of Fish Species	Fish Life Stage: Juvenile - Parr		Juvenile Salmonid Distribution
Fish	Genetics: Fish Diversity, Fitness or Variation	Fish Origin: Natural		Genetic diversity metrics (Fst, Fis, Fit, Gst, etc.)
Fish	Genetics: Fish Diversity, Fitness or Variation	Fish Origin: Natural		Dendrogram

Fish	Progeny-per-Parent Ratio (P:P) (Productivity)	Fish Life Stage: RANGE: Adult to Juvenile		Freshwater Productivity
Fish	Spawning/Nesting	Fish Origin: Both		Number of Observed Steelhead Redds
Fish	Spawning/Nesting	Fish Origin: Both		Redd Density
Fish	Stray Rate	Fish Origin: Hatchery		PHOS
Fish	Survival Rate: Fish	Fish Life Stage: Adult - Returner	Fish Origin: Natural	Adult Survival
Fish	Survival Rate: Fish	Fish Life Stage: Juvenile - Migrant	Fish Origin: Natural	Parr to Smolt Survival
Fish	Survival Rate: Fish	Fish Life Stage: RANGE: Egg to Juvenile	Fish Origin: Natural	Egg-to-Smolt Survival
Fish	Survival Rate: Fish	Fish Life Stage: RANGE: Juvenile to Adult	Fish Origin: Natural	Smolt-to-adult-Ratio
Fish	Survival Rate: Fish	Fish Life Stage: RANGE: Juvenile to Adult	Fish Origin: Natural	Smolt-to-Adult Ratio
Fish	Timing of Life Stage: Fish	Fish Life Stage: Juvenile - Migrant		Smolt Migration Timing
Hydrology/Water Quantity	Flow			Site Discharge
Landscape Form & Geomorphology	Abundance of Habitat Types	Habitat Type: Channel: Pools		Slow/Pool Count
Landscape Form & Geomorphology	Abundance of Habitat Types	Habitat Type: Channel: Pools		Slow/Pool Percent
Landscape Form & Geomorphology	Abundance of Habitat Types	Habitat Type: Channel: Riffles		Fast-Turbulent Count
Landscape Form & Geomorphology	Abundance of Habitat Types	Habitat Type: Channel: Runs/Glides		Fast-NonTurbulent Area
Landscape Form & Geomorphology	Abundance of Habitat Types	Habitat Type: Channels		Area - Channel Unit Summary
Landscape Form & Geomorphology	Abundance of Habitat Types	Habitat Type: Channels		Area - Channel Unit Summary Tier 2
Landscape Form & Geomorphology	Abundance of Habitat Types	Habitat Type: Channels		Area - Channel Unit Tier 1 Summary
Landscape Form & Geomorphology	Abundance of Habitat Types	Habitat Type: Channels		Count - Channel Unit Summary Tier 2
Landscape Form & Geomorphology	Abundance of Habitat Types	Habitat Type: Channels		Count - Channel Unit Tier 1 Summary
Landscape Form & Geomorphology	Abundance of Habitat Types	Habitat Type: Channels		Volume - Channel Unit Summary

Landscape Form & Geomorphology	Abundance of Habitat Types	Habitat Type: Channels		Volume - Channel Unit Summary Tier 2
Landscape Form & Geomorphology	Abundance of Habitat Types	Habitat Type: Channels		Volume - Channel Unit Tier 1 Summary
Landscape Form & Geomorphology	Composition/Structure of Habitat Types	Habitat Type: Channel: Pools		Slow/Pool Average Residual Depth
Landscape Form & Geomorphology	Composition/Structure of Habitat Types	Habitat Type: Channel: Pools		Slow/Pool Volume
Landscape Form & Geomorphology	Composition/Structure of Habitat Types	Habitat Type: Channel: Riffles		Fast-Turbulent Volume
Landscape Form & Geomorphology	Composition/Structure of Habitat Types	Habitat Type: Channel: Runs/Glides		Fast-NonTurbulent Volume
Landscape Form & Geomorphology	Density of Habitat Type	Habitat Type: Channel: Pools		Slow/Pool Area
Landscape Form & Geomorphology	Density of Habitat Type	Habitat Type: Channel: Pools		Slow/Pool Frequency
Landscape Form & Geomorphology	Density of Habitat Type	Habitat Type: Channel: Riffles		Fast-Turbulent Area
Landscape Form & Geomorphology	Density of Habitat Type	Habitat Type: Channel: Riffles		Fast-Turbulent Frequency
Landscape Form & Geomorphology	Density of Habitat Type	Habitat Type: Channel: Riffles		Fast-Turbulent Percent
Landscape Form & Geomorphology	Density of Habitat Type	Habitat Type: Channel: Runs/Glides		Fast-NonTurbulent Count
Landscape Form & Geomorphology	Density of Habitat Type	Habitat Type: Channel: Runs/Glides		Fast-NonTurbulent Frequency
Landscape Form & Geomorphology	Density of Habitat Type	Habitat Type: Channel: Runs/Glides		Fast-NonTurbulent Percent
Landscape Form & Geomorphology	Density of Habitat Type	Habitat Type: Channels		Frequency - Channel Unit Summary Tier 2
Landscape Form & Geomorphology	Density of Habitat Type	Habitat Type: Channels		Frequency - Channel Unit Tier 1 Summary
Landscape Form & Geomorphology	Density of Habitat Type	Habitat Type: Channels		Percent - Channel Unit Summary
Landscape Form & Geomorphology	Density of Habitat Type	Habitat Type: Channels		Percent - Channel Unit Summary Tier 2
Landscape Form & Geomorphology	Density of Habitat Type	Habitat Type: Channels		Percent - Channel Unit Tier 1 Summary
Landscape Form & Geomorphology	Density of Instream Wood			Bankfull Large Wood Frequency per 100m
Landscape Form & Geomorphology	Density of Instream Wood			Wetted Large Wood Frequency per 100m

Landscape Form & Geomorphology	Depth: Bathymetry			Average Depth Thalweg Exit
Landscape Form & Geomorphology	Depth: Bathymetry			Average Depth Thalweg Exit - Channel Unit Tier 1 Summary
Landscape Form & Geomorphology	Depth: Bathymetry			Average Max Depth - Channel Unit Summary Tier 2
Landscape Form & Geomorphology	Depth: Bathymetry			Average Max Depth - Channel Unit Tier 1 Summary
Landscape Form & Geomorphology	Depth: Bathymetry			Average Residual Depth
Landscape Form & Geomorphology	Depth: Bathymetry			Average Residual Depth - Channel Unit Tier 1 Summary
Landscape Form & Geomorphology	Depth: Bathymetry			Centerline Depth Profile Filtered CV
Landscape Form & Geomorphology	Depth: Bathymetry			Centerline Depth Profile Filtered Mean
Landscape Form & Geomorphology	Depth: Bathymetry			Depth Thalweg Exit - Channel Unit Summary
Landscape Form & Geomorphology	Depth: Bathymetry			Max Depth - Channel Unit Summary
Landscape Form & Geomorphology	Depth: Bathymetry			Residual Depth - Channel Unit Summary
Landscape Form & Geomorphology	Depth: Bathymetry			Thalweg Depth Profile Filtered Mean
Landscape Form & Geomorphology	Depth: Bathymetry			Water Depth StdDev
Landscape Form & Geomorphology	Distribution of Habitat Type	Habitat Type: Channel: Pools		Slow/Pool Spacing
Landscape Form & Geomorphology	Distribution of Habitat Type	Habitat Type: Channel: Riffles		Fast-Turbulent Spacing
Landscape Form & Geomorphology	Distribution of Habitat Type	Habitat Type: Channel: Runs/Glides		Fast-NonTurbulent Spacing
Landscape Form & Geomorphology	Distribution of Habitat Type	Habitat Type: Channels		Spacing - Channel Unit Summary Tier 2
Landscape Form & Geomorphology	Distribution of Habitat Type	Habitat Type: Channels		Spacing - Channel Unit Tier 1 Summary
Landscape Form & Geomorphology	Edge/Density/Sinuosity	Habitat Type: Channels		Sinuosity Via Centerline
Landscape Form & Geomorphology	Edge/Density/Sinuosity	Habitat Type: Channels		Site Sinuosity
Landscape Form & Geomorphology	Elevation			Standard Deviation of the Detrended DEM

Landscape Form & Geomorphology	Gradient			Site Water Surface Gradient
Landscape Form & Geomorphology	Gradient			Thalweg Depth Profile Filtered CV
Landscape Form & Geomorphology	Gradient			Water Surface Gradient Profile Filtered CV
Landscape Form & Geomorphology	Gradient			Water Surface Gradient Profile Filtered Mean
Landscape Form & Geomorphology	Length/Width/Area	Habitat Type: Channels		Bankfull Volume
Landscape Form & Geomorphology	Length/Width/Area	Habitat Type: Channels		Site Bankfull Area
Landscape Form & Geomorphology	Length/Width/Area	Habitat Type: Channels		Site Length Bankfull
Landscape Form & Geomorphology	Length/Width/Area	Habitat Type: Channels		Site Length Thalweg
Landscape Form & Geomorphology	Length/Width/Area	Habitat Type: Channels		Site Length Wetted
Landscape Form & Geomorphology	Length/Width/Area	Habitat Type: Channels		Site Wetted Area
Landscape Form & Geomorphology	Length/Width/Area	Habitat Type: Channels		Thalweg to Centerline Length Ratio
Landscape Form & Geomorphology	Size: Wood Structure			Bankfull Large Wood Volume by Site
Landscape Form & Geomorphology	Size: Wood Structure			Bankfull Large Wood Volume by Tier1
Landscape Form & Geomorphology	Size: Wood Structure			Bankfull Large Wood Volume in Fast-NonTurbulent
Landscape Form & Geomorphology	Size: Wood Structure			Bankfull Large Wood Volume in Fast-Turbulent
Landscape Form & Geomorphology	Size: Wood Structure			Bankfull Large Wood Volume in Slow/Pools
Landscape Form & Geomorphology	Size: Wood Structure			Wetted Large Wood Volume by Site
Landscape Form & Geomorphology	Size: Wood Structure			Wetted Large Wood Volume by Tier1
Landscape Form & Geomorphology	Size: Wood Structure			Wetted Large Wood Volume in Fast-NonTurbulent
Landscape Form & Geomorphology	Size: Wood Structure			Wetted Large Wood Volume in Fast-Turbulent
Landscape Form & Geomorphology	Size: Wood Structure			Wetted Large Wood Volume in Slow/Pools
Landscape Form & Geomorphology	Species Cover	Habitat Type: Channels		Fish Cover Composition Artificial

Landscape Form & Geomorphology	Species Cover	Habitat Type: Channels		Fish Cover Composition Artificial - Channel Unit Tier 1 Summary
Landscape Form & Geomorphology	Species Cover	Habitat Type: Channels		Fish Cover Composition LWD
Landscape Form & Geomorphology	Species Cover	Habitat Type: Channels		Fish Cover Composition LWD - Channel Unit Tier 1 Summary
Landscape Form & Geomorphology	Species Cover	Habitat Type: Channels		Fish Cover Composition None
Landscape Form & Geomorphology	Species Cover	Habitat Type: Channels		Fish Cover Composition None - Channel Unit Tier 1 Summary
Landscape Form & Geomorphology	Species Cover	Habitat Type: Channels		Fish Cover Composition Total
Landscape Form & Geomorphology	Species Cover	Habitat Type: Channels		Fish Cover Composition Total - Channel Unit Tier 1 Summary
Landscape Form & Geomorphology	Species Cover	Habitat Type: Channels		Fish Cover Composition Undercut
Landscape Form & Geomorphology	Species Cover	Habitat Type: Channels		Fish Cover Composition Undercut - Channel Unit Tier 1 Summary
Landscape Form & Geomorphology	Species Cover	Habitat Type: Channels		Fish Cover Composition Vegetation
Landscape Form & Geomorphology	Species Cover	Habitat Type: Channels		Fish Cover Composition Vegetation - Channel Unit Tier 1 Summary
Landscape Form & Geomorphology	Width to Depth Ratio			Bankfull WidthToDepth Ratio Profile Filtered CV
Landscape Form & Geomorphology	Width to Depth Ratio			Bankfull WidthToDepth Ratio Profile Filtered Mean
Landscape Form & Geomorphology	Width to Depth Ratio			Wetted WidthToDepth Ratio Profile Filtered CV
Landscape Form & Geomorphology	Width to Depth Ratio			Wetted WidthToDepth Ratio Profile Filtered Mean
Landscape Form & Geomorphology	Width: Bankfull			Bankfull Width Constriction Profile Filtered CV
Landscape Form & Geomorphology	Width: Bankfull			Bankfull Width Constriction Profile Filtered Mean
Landscape Form & Geomorphology	Width: Bankfull			Bankfull Width Profile Filtered CV
Landscape Form & Geomorphology	Width: Bankfull			Bankfull Width Profile Filtered Mean
Landscape Form & Geomorphology	Width: Bankfull			Integrated Bankfull Width

Landscape Form & Geomorphology	Width: Wetted			Integrated Wetted Width
Landscape Form & Geomorphology	Width: Wetted			Wetted Width Constriction Profile Filtered CV
Landscape Form & Geomorphology	Width: Wetted			Wetted Width Constriction Profile Filtered Mean
Landscape Form & Geomorphology	Width: Wetted			Wetted Width Profile Filtered CV
Landscape Form & Geomorphology	Width: Wetted			Wetted Width Profile Filtered Mean
Light	Light Concentration			Average Summer Solar Access
Light	Light Concentration			Canopy No Cover
Light	Light Concentration			Groundcover No Cover
Light	Light Concentration			Understory No Cover
Macroinvertebrates	Drift Density	Habitat Type: Channels		Drift Biomass Density
Other	Not Applicable			Change Detection Results
Other	Not Applicable			Channel Unit Number - Channel Unit Summary
Other	Not Applicable			Channel UnitID - Channel Unit Summary
Other	Not Applicable			Geo Database
Other	Not Applicable			Log File
Other	Not Applicable			Results File
Sediment/Substrate/Soils	Accretion Rates/ Aggradation			Area of Deposition By Channel Area T-1
Sediment/Substrate/Soils	Accretion Rates/ Aggradation			Area of Deposition By Channel Area T0
Sediment/Substrate/Soils	Accretion Rates/ Aggradation			Area of Deposition By Tier 1 T-1
Sediment/Substrate/Soils	Accretion Rates/ Aggradation			Area of Deposition By Tier 1 T0
Sediment/Substrate/Soils	Accretion Rates/ Aggradation			Area of Deposition For Site T-1
Sediment/Substrate/Soils	Accretion Rates/ Aggradation			Area of Deposition For Site T0
Sediment/Substrate/Soils	Accretion Rates/ Aggradation			Net Volume of Difference By Channel Area T-1
Sediment/Substrate/Soils	Accretion Rates/ Aggradation			Net Volume of Difference By Channel Area T0
Sediment/Substrate/Soils	Accretion Rates/ Aggradation			Net Volume of Difference By Tier 1 T-1

Sediment/Substrate/Soils	Accretion Rates/ Aggradation			Net Volume of Difference By Tier 1 T0
Sediment/Substrate/Soils	Accretion Rates/ Aggradation			Net Volume of Difference For Site T-1
Sediment/Substrate/Soils	Accretion Rates/ Aggradation			Net Volume of Difference For Site T0
Sediment/Substrate/Soils	Accretion Rates/ Aggradation			Percent Deposition By Channel Area T-1
Sediment/Substrate/Soils	Accretion Rates/ Aggradation			Percent Deposition By Channel Area T0
Sediment/Substrate/Soils	Accretion Rates/ Aggradation			Percent Deposition By Tier 1 T-1
Sediment/Substrate/Soils	Accretion Rates/ Aggradation			Percent Deposition By Tier 1 T0
Sediment/Substrate/Soils	Accretion Rates/ Aggradation			Percent Deposition For Site T-1
Sediment/Substrate/Soils	Accretion Rates/ Aggradation			Percent Deposition For Site T0
Sediment/Substrate/Soils	Accretion Rates/ Aggradation			Volume of Deposition By Channel Area T-1
Sediment/Substrate/Soils	Accretion Rates/ Aggradation			Volume of Deposition By Channel Area T0
Sediment/Substrate/Soils	Accretion Rates/ Aggradation			Volume of Deposition By Tier 1 T-1
Sediment/Substrate/Soils	Accretion Rates/ Aggradation			Volume of Deposition By Tier 1 T0
Sediment/Substrate/Soils	Accretion Rates/ Aggradation			Volume of Deposition For Fast Non-Turbulent T-1
Sediment/Substrate/Soils	Accretion Rates/ Aggradation			Volume of Deposition For Fast Non-Turbulent T0
Sediment/Substrate/Soils	Accretion Rates/ Aggradation			Volume of Deposition For Fast Turbulent T-1
Sediment/Substrate/Soils	Accretion Rates/ Aggradation			Volume of Deposition For Fast Turbulent T0
Sediment/Substrate/Soils	Accretion Rates/ Aggradation			Volume of Deposition For Site T-1
Sediment/Substrate/Soils	Accretion Rates/ Aggradation			Volume of Deposition For Site T0
Sediment/Substrate/Soils	Accretion Rates/ Aggradation			Volume of Deposition For Slow/Pools T-1
Sediment/Substrate/Soils	Accretion Rates/ Aggradation			Volume of Deposition For Slow/Pools T0
Sediment/Substrate/Soils	Accretion Rates/ Aggradation			Volume of Difference By Channel Area T-1
Sediment/Substrate/Soils	Accretion Rates/ Aggradation			Volume of Difference By Channel Area T0

Sediment/Substrate/Soils	Accretion Rates/ Aggradation			Volume of Difference By Tier 1 T-1
Sediment/Substrate/Soils	Accretion Rates/ Aggradation			Volume of Difference By Tier 1 T0
Sediment/Substrate/Soils	Accretion Rates/ Aggradation			Volume of Difference For Site T-1
Sediment/Substrate/Soils	Accretion Rates/ Aggradation			Volume of Difference For Site T0
Sediment/Substrate/Soils	Bed Scour/Erosion Rate			Area of Erosion By Channel Area T-1
Sediment/Substrate/Soils	Bed Scour/Erosion Rate			Area of Erosion By Channel Area T0
Sediment/Substrate/Soils	Bed Scour/Erosion Rate			Area of Erosion By Tier 1 T0
Sediment/Substrate/Soils	Bed Scour/Erosion Rate			Area of Erosion By Tier 1 T-1
Sediment/Substrate/Soils	Bed Scour/Erosion Rate			Area of Erosion For Site T-1
Sediment/Substrate/Soils	Bed Scour/Erosion Rate			Area of Erosion For Site T0
Sediment/Substrate/Soils	Bed Scour/Erosion Rate			Percent Erosion By Channel Area T-1
Sediment/Substrate/Soils	Bed Scour/Erosion Rate			Percent Erosion By Channel Area T0
Sediment/Substrate/Soils	Bed Scour/Erosion Rate			Percent Erosion By Tier 1 T-1
Sediment/Substrate/Soils	Bed Scour/Erosion Rate			Percent Erosion By Tier 1 T0
Sediment/Substrate/Soils	Bed Scour/Erosion Rate			Percent Erosion For Site T-1
Sediment/Substrate/Soils	Bed Scour/Erosion Rate			Percent Erosion For Site T0
Sediment/Substrate/Soils	Bed Scour/Erosion Rate			Volume of Erosion By Channel Area T-1
Sediment/Substrate/Soils	Bed Scour/Erosion Rate			Volume of Erosion By Channel Area T0
Sediment/Substrate/Soils	Bed Scour/Erosion Rate			Volume of Erosion By Tier 1 T-1
Sediment/Substrate/Soils	Bed Scour/Erosion Rate			Volume of Erosion By Tier 1 T0
Sediment/Substrate/Soils	Bed Scour/Erosion Rate			Volume of Erosion For Fast Non-Turbulent T-1
Sediment/Substrate/Soils	Bed Scour/Erosion Rate			Volume of Erosion For Fast Non-Turbulent T0
Sediment/Substrate/Soils	Bed Scour/Erosion Rate			Volume of Erosion For Fast Turbulent T-1

Sediment/Substrate/Soils	Bed Scour/Erosion Rate			Volume of Erosion For Fast Turbulent T0
Sediment/Substrate/Soils	Bed Scour/Erosion Rate			Volume of Erosion For Site T-1
Sediment/Substrate/Soils	Bed Scour/Erosion Rate			Volume of Erosion For Site T0
Sediment/Substrate/Soils	Bed Scour/Erosion Rate			Volume of Erosion For Slow/Pools T-1
Sediment/Substrate/Soils	Bed Scour/Erosion Rate			Volume of Erosion For Slow/Pools T0
Sediment/Substrate/Soils	Composition: Substrate/Soil-Dominant Size			Boulder and Cobbles
Sediment/Substrate/Soils	Composition: Substrate/Soil-Dominant Size			Boulder and Cobbles - Channel Unit Tier 1 Summary
Sediment/Substrate/Soils	Composition: Substrate/Soil-Dominant Size			Boulders
Sediment/Substrate/Soils	Composition: Substrate/Soil-Dominant Size			Boulders - Channel Unit Tier 1 Summary
Sediment/Substrate/Soils	Composition: Substrate/Soil-Dominant Size			Coarse and Fine Gravel
Sediment/Substrate/Soils	Composition: Substrate/Soil-Dominant Size			Coarse and Fine Gravel - Channel Unit Tier 1 Summary
Sediment/Substrate/Soils	Composition: Substrate/Soil-Dominant Size			Cobbles
Sediment/Substrate/Soils	Composition: Substrate/Soil-Dominant Size			Cobbles - Channel Unit Tier 1 Summary
Sediment/Substrate/Soils	Composition: Substrate/Soil-Dominant Size			D16
Sediment/Substrate/Soils	Composition: Substrate/Soil-Dominant Size			D50
Sediment/Substrate/Soils	Composition: Substrate/Soil-Dominant Size			D84
Sediment/Substrate/Soils	Composition: Substrate/Soil-Dominant Size			Particles Less Than 2mm

Sediment/Substrate/Soils	Composition: Substrate/Soil-Dominant Size			Particles Less Than 6mm
Sediment/Substrate/Soils	Composition: Substrate/Soil-Dominant Size			Sand and Fines
Sediment/Substrate/Soils	Composition: Substrate/Soil-Dominant Size			Sand and Fines - Channel Unit Tier 1 Summary
Sediment/Substrate/Soils	Embeddedness			Avg Fast Water Cobble Embeddedness
Sediment/Substrate/Soils	Embeddedness			Std Deviation of Fast Water Cobble Embeddedness
Vegetation/Plants	Composition: Vegetative Species Assemblage			Big Tree Cover
Vegetation/Plants	Composition: Vegetative Species Assemblage			Coniferous Cover
Vegetation/Plants	Composition: Vegetative Species Assemblage			Ground Cover
Vegetation/Plants	Composition: Vegetative Species Assemblage			Non-Woody Cover
Vegetation/Plants	Composition: Vegetative Species Assemblage			Understory Cover
Vegetation/Plants	Composition: Vegetative Species Assemblage			Woody Cover
Water Quality	Alkalinity	Habitat Type: Channels		Alkalinity
Water Quality	Conductivity			Conductivity