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

Annual Technical Report

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ABSTRACT

The goal of this project is to provide basinwide status and trend data for anadromous salmonids in the John Day River basin. To accomplish this, we estimated: 1) out-migrant abundance of summer steelhead *Oncorhynchus mykiss* and spring Chinook *Oncorhynchus tshawytscha*, 2) physical characteristics of outmigrant salmonids, 3) smolt-to-adult -ratios (SAR) for summer steelhead and spring Chinook, 4) summer steelhead life history patterns, and 5) productivity of summer steelhead and spring Chinook populations. We tagged 2,928 juvenile spring Chinook and 2,888 juvenile summer steelhead with passive integrated transponder (PIT) tags during the spring of 2011. We estimate 82,241 (95% CI 73,721–92,713) juvenile spring Chinook and 50,976 (95% CI 42,269–62,601) juvenile steelhead migrated past our Mainstem rotary screw trap (RST) at river kilometer (rkm) 326 between October 1st 2010 and June 5th 2011. We estimate 21,322 (95% CI 17,906–26,217) juvenile spring Chinook and 18,301 (95% CI 11,522–30,028) steelhead migrated past our Middle Fork RST (rkm 24) between September 28th 2010 and June 3rd 2011. We also estimate that 41,274 (95% CI 37,016–46,696) juvenile steelhead and 723 (95% CI 450–1,199) juvenile Chinook migrated past our South Fork RST (rkm 10) between September 24th, 2010 and June 17th 2011. Summer steelhead SAR for the 2009 migration year was 8.57% (95% CI 7.30%–10.36%). Spring Chinook SAR for the 2008 migration year was 6.26% (95% CI 5.65%–7.01%). The age structure of steelhead out-migrants was 18.1% age-1, 71.9% age-2 and 10.0% age-3. For the 2009 spring Chinook brood year, we estimate freshwater production to be 176 smolts/redd for the upper Mainstem and 85 smolts/redd for the Middle Fork. For the 2007 summer steelhead brood year, we estimate 43 migrants per spawner (95% CI 23–145) in the South Fork.

ACKNOWLEDGMENTS

We acknowledge the assistance and cooperation of private landowners throughout the John Day River basin who allowed us to survey on their private property. Additionally, we thank Jeff Neal and Brent Smith for providing guidance and advice. Furthermore we thank our crew members; Alan Garner, Rebecca Seyferth, Travis Jones, James Latshaw, Mikaela Alley, and Chris Holsclaw for their invaluable assistance. This project was funded by the U.S. Department of Energy, Bonneville Power Administration, Environment, Fish, and Wildlife-Project number 1998-016-00; Contract 00051809 and we thank Jason Karnezis for assistance with contract administration.

INTRODUCTION

The John Day River subbasin supports one of the last remaining intact wild populations of spring Chinook salmon and summer steelhead in the Columbia River Basin. These populations remain depressed relative to historic levels and limited information is available for steelhead life history. Numerous habitat protection and rehabilitation projects have been implemented in the basin to improve salmonid freshwater production and survival. However, these projects often lack effectiveness monitoring. While our monitoring efforts outlined here will not specifically measure the effectiveness of any particular project, they will provide necessary programmatic or watershed (status and trend) information to help evaluate project-specific effectiveness monitoring efforts as well as meet some data needs as index stocks. Our continued monitoring efforts to estimate salmonid smolt abundance, age structure, SAR, freshwater production, freshwater habitat use, and distribution of critical life states will enable managers to assess the long-term effectiveness of habitat projects and to differentiate freshwater and ocean survival.

Because Columbia Basin managers have identified the John Day subbasin spring Chinook population as an index population for assessing the effects of alternative future management actions on salmon stocks in the Columbia Basin (Schaller et al. 1999) we continue our ongoing studies. This project is high priority based on the level of emphasis by the Northwest Power and Conservation Council (NPCC) Fish and Wildlife Program, Independent Scientific Advisory Board (ISAB), Independent Scientific Review Panel (ISRP), NOAA National Marine Fisheries Service (NMFS), and the Oregon Plan for Salmon and Watersheds (OWEB). Each of these groups has placed priority on monitoring and evaluation to provide the real-time data to guide restoration and adaptive management in the region.

STUDY AREA

The John Day River Basin is located in north-central and northeastern Oregon (Figure 1), and is the fourth largest drainage basin in the state. The basin is bounded by the Columbia River to the north, the Blue Mountains to the east, the Strawberry and Aldrich Mountains to the south, and the Ochoco Mountains to the west. The John Day River originates in the Strawberry Mountains at an elevation near 1,800 m (5,900 ft) and flows approximately 457 km (284 miles) to its mouth, at an elevation of 90 m (295 ft), at river km 351 (river mile 217) of the Columbia River. It is the second longest free-flowing river in the continental United States and, along with the Yakima River, it is one of only two major tributaries to the Columbia River managed for wild salmon and steelhead. There are no dams or hatcheries located on the John Day River, although numerous irrigation diversions dot the drainage. Major tributaries flowing into the Mainstem John Day River include the North Fork, Middle Fork, and South Fork John Day rivers. The North Fork is the largest tributary, contributing approximately 60% of the flow to the Mainstem. The John Day River basin contains 15,455 km of stream habitat available for fish, but only 4,628 km (30%) are known or assumed to be used for various anadromous salmonid life history stages. Spring Chinook salmon primarily spawn in the upper Mainstem above the mouth of Indian Creek, in the Middle Fork above Armstrong Creek, and the North Fork above the mouth of Camas Creek. Important spawning tributaries of the North Fork include Granite Creek and its tributaries (Clear Creek and Bull Run Creek; hereafter called Granite Creek System) and Desolation Creek. Spawning has also occurred in Bridge Creek in the lower John Day River basin, the South Fork, the North Fork tributaries Camas Creek, Trail Creek, Big Creek, and Crawfish Creek, and the Mainstem tributary Deardorff Creek. Summer steelhead sampled during this study have a spawning and rearing distribution in the Mainstem, South Fork, Middle Fork, and North Fork channels and tributaries of the John Day River upstream of rkm 298 where the North Fork and Mainstem merge. Summer steelhead also spawn and rear in the lower Mainstem tributaries downstream of rkm 298. Maps of the distribution of both Chinook and steelhead in the John Day River basin can be viewed at: http://www.streamnet.org/mapping_apps.cfm. Spring Chinook smolt at age 1, and spend 1 to 3 years in the ocean before they return to freshwater and pass Bonneville Dam from mid April to early July. Steelhead smolt at ages 1 to 4, and spend either 1 or 2 years in saltwater before returning as adults. Adult return timing at Bonneville Dam ranges from late June to early October, with a peak in August. John Day Basin steelhead are classified as "A-run" summer steelhead, as distinguished by a length at return of < 78 cm and returning over Bonneville Dam primarily from July to September. When juvenile steelhead are referenced in this document, we acknowledge the presence of alternative life-history forms and that juveniles of all sizes may be either resident (redband trout) or anadromous (steelhead) life-history forms. These alternate life-history forms are typically morphologically indistinguishable when examined as immature parr. We therefore refer to all *O. mykiss* captured in our traps that are < 300 mm fork length as juvenile steelhead.

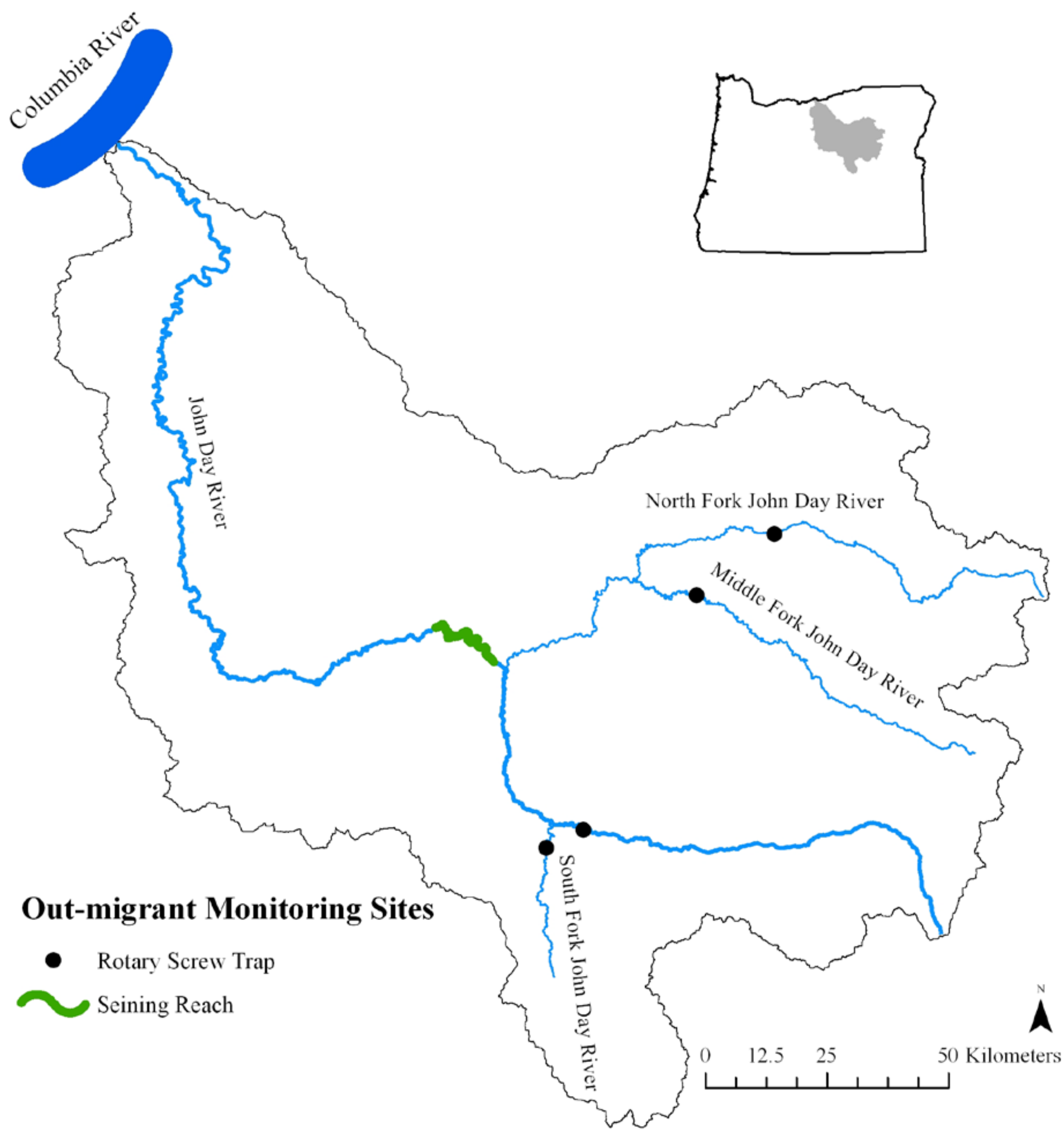

Figure 1. Map of John Day River basin out-migrant monitoring sites.

METHODS

Juvenile Chinook and Steelhead Capture and Tagging

During the 2011 migration year (defined as 1 September 2010–30 June 2011), juvenile spring Chinook and summer steelhead migrants were captured at three rotary screw trap (RST) sites to estimate out-migrant abundance, smolt-to-adult return (SAR), and to study life history characteristics of steelhead in the John Day River subbasin. Seining in the Mainstem John Day River (rkm 274–296) was not performed during 2011. A fourth RST site was attempted in the upper North Fork (rkm 093), however due to its install being delayed and high spring runoff it was only operated 2 nights over the season. Two RSTs were located in the Upper Mainstem fourth level HUC and are hereafter referred to as the Mainstem trap at rkm 352 (just upstream of Dayville) and South Fork trap located at rkm 10 of the South Fork John Day River. The Mainstem trap was relocated in 2007 from its previous site at rkm 326 to the current site near the Flat Creek access road of the Phillip Schneider Wildlife Area upstream of the confluence with the South Fork John Day River. A third RST was located in the Middle Fork John Day River at rkm 24 near Ritter and is hereafter referred to as the Middle Fork trap. The Mainstem, South Fork, Middle Fork traps are all located downstream of the majority of known spring Chinook spawning habitat. Some summer rearing and spawning does occur in Bridge Creek (Bouwes et al. 2010) and likely occurs in other tributaries downstream of our collection sites. The Middle Fork trap site is upstream of four fish bearing tributaries entering the Middle Fork including Six-mile Creek, Three-mile Creek, Long Creek, and Eight-mile Creek.

At the Mainstem and South Fork trap sites we fished either a 1.52 or 2.44 m diameter RST depending on water conditions to optimize trap efficiency. Both sizes of RSTs were fished at the Mainstem and South Fork trap sites when water levels allowed. A 1.52 m diameter RST was fished at the Middle Fork (rkm 24) trap site. Traps were either removed or stopped during times of ice, high discharge, and during warm summer months after fish ceased migrating. All RSTs are equipped with live boxes, which safely hold juvenile fish for 24 h intervals. All RSTs were typically fished four nights each by lowering cones on Monday and raising cones on Friday. Traps were checked daily during the weekly fishing periods. We assumed that all fish captured were out-migrants. Non-target fish species were identified, enumerated, and returned to the stream. Captured juvenile spring Chinook and steelhead out-migrants were anesthetized with tricane methane sulfonate (MS-222), interrogated for passive integrated transponder tags (PIT tags) or external marks, enumerated, weighed to the nearest 0.1 g, and measured (fork length, FL; mm). We followed PTAGIS marking procedures when handling, PIT tagging, and marking juvenile migrants (PTAGIS 1999, Keefe et al. 1998, Hart and Pitcher 1969). All PIT-tag information was submitted to the PIT tag Information System (PTAGIS).

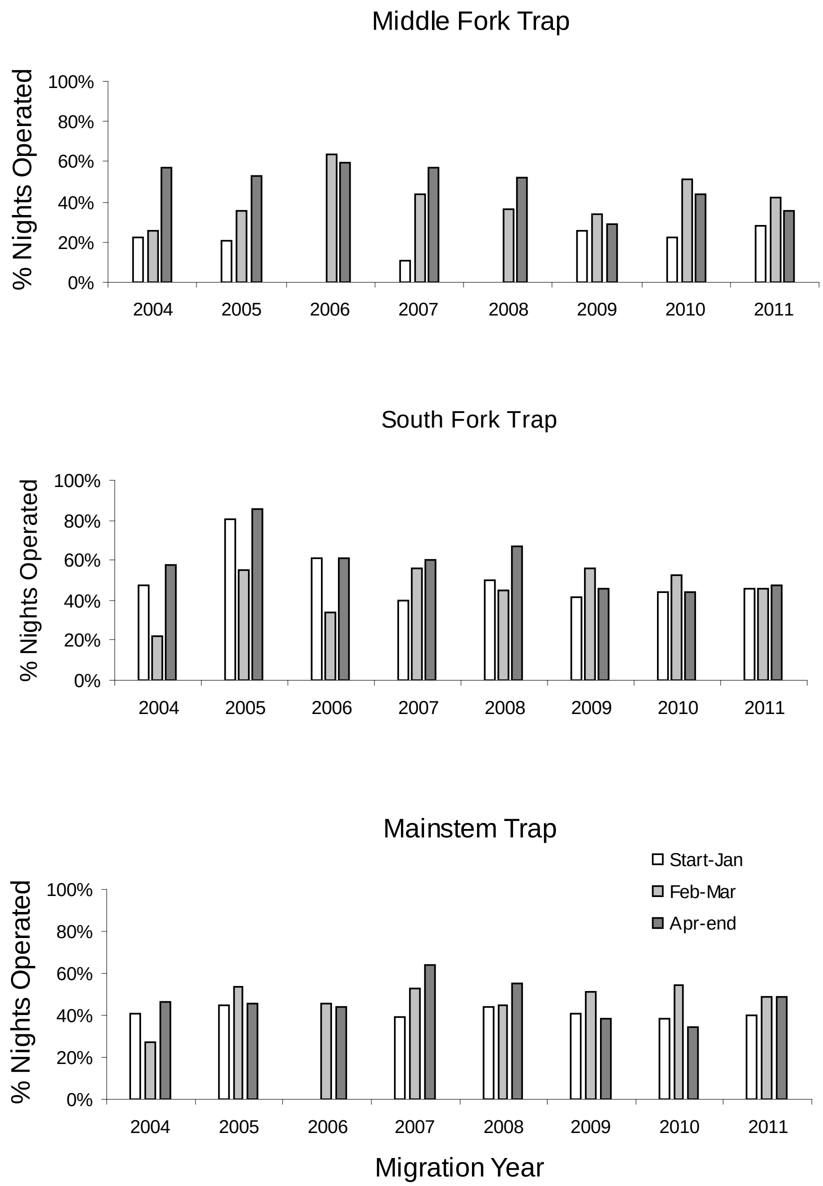

Figure 2. Proportion of nights operated for each trap site by migration year and trapping season.

Trapping efficiency (TE) was estimated separately for each fish species at each RST site by releasing previously marked fish upstream of the trap and then counting the number of marked fish recaptured (Thedinga et al. 1994). Trapping efficiency fish were marked with a pan-jet paint mark below the surface of the fish's skin, by inserting a PIT tag, or by making a small angled clip to a caudal fin lobe (Hart and Pitcher 1969, Keefe et al. 1998). Trapping efficiency fish were held in the tubs of a timed release device (design modified from Miller et al. 2000), which had circulated river water and released after dark 1.8 rkm upstream of the South Fork trap, 1.1 rkm upstream of the Middle Fork trap, and 1.3 rkm upstream of the Mainstem trap. Trap efficiency (TE) was estimated from the equation:

$$TE = R/M \qquad (1)$$

where M is the number of marked fish released upstream and R is the number of marked fish recaptured.

We used trap efficiency estimates to stratify the trapping data into homogeneous periods. We then used the Bailey estimator to estimate out-migrant abundance (Steinhorst et al. 2004) for each strata. Abundances estimated within strata were expanded for days when the traps were not operated. We assumed that the estimated mean daily number of migrants during each sampling period also migrated on each day that the trap was not operated.

Additional life history, parasite, and mark information was also collected from captured fish. The presence of trematode cysts (black spot disease; *Neascus sp.*) on captured smolts was noted. We identified fin clips on adult steelhead and spring Chinook captured to determine if they were of hatchery origin. Sex, MEPS length, FL, and scale samples were taken when adult steelhead carcasses were observed. Snouts of carcasses were collected for coded wire tag identification.

The FL, weight (W; g), and coefficient of condition (K) were reported for both fall/winter (24 September 2010 to 31 January 2011) and spring (1 February 2011 to 17 June 2011) migrating juvenile spring Chinook and steelhead. Coefficient of condition (K) was calculated as:

$$K = 100\ W/L_F^{3} \qquad (2)$$

where W is weight, and L_F is fork length (Saltzman 1977).

First and last detection dates, mean, standard error (SE), and range of travel time for spring PIT tagged out-migrants to reach John Day and Bonneville Dams and the Columbia Estuary from the release sites were summarized for each species.

We assessed the production of out-migrants per adult female spawner for the upper Mainstem and Middle Fork Chinook populations to evaluate whether density dependent regulation was present. We regressed the natural log of smolts per redd against brood year redd count to model the progeny per parent relationship. Secondly, we plotted the residuals from this linear regression against brood year. This approach allows for evaluation of trends in productivity after accounting for the density-dependence of stream salmonid populations. Positive residual values indicate higher productivity than expected given the adult spawner population of each specific brood year. Temporal trends in residuals can be interpreted as changes in the productivity of the population being measured without the confounding effects of starting stock size (e.g., Mueter et al. 2007).

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

We used detections of adult salmon and steelhead (originally PIT tagged in the John Day River basin by our project) at Federal Columbia River Power System (FCRPS) Facilities to estimate smolt-to-adult ratio (SAR). Estimates of SAR were constructed as follows: first, we used Program SURPH to estimate the number of PIT tagged smolts exiting the John Day River basin which were alive when emigrating past John Day Dam (point estimate and 95% confidence intervals, DART 2011). Second, the quotient of returning adult PIT tag detections divided by the point estimate of smolts crossing John Day Dam was our estimate of SAR. Confidence bounds for SAR were estimated as the quotient of adult detections divided by upper and lower confidence limits of emigrating smolts. Hence, our estimate of SAR includes migration from John Day Dam through the Columbia River to the ocean and back to Bonneville Dam, but excludes migration through the John Day River. We used all spring Chinook smolts PIT tagged at our RST's or seining operation in the John Day River basin for our estimate of SAR. To maintain consistency in our SAR estimate for steelhead among years, we used only juvenile steelhead PIT tagged at our RSTs in the John Day River basin from 1 February to 30 June of each migration year.

South Fork John Day Adult Steelhead Population Estimate

The South Fork John Day was established as an "Intensively Monitored Watershed" in 2003. In response to this designation, a Generalized Random Tesselation Stratified (GRTS) spawning survey design was developed and applied specifically to the South Fork John Day summer steelhead population beginning in 2006. This GRTS design encompassed all habitat accessible to steelhead upstream of our RST located at RKM 10 of the South Fork. Steelhead escapement estimates for this population have been reported for the 2006–2010 adult return years (spawning years 2007–2011) by Banks et al. (2011). Concurrent with these escapement estimates, PIT tagging of emigrating juvenile steelhead at the South Fork RST since 2004 allows us to estimate the return of adult steelhead from the South Fork population to Bonneville Dam for run years 2006–2011. We present these PIT tag based adult return estimates for this population for comparison with both the spawning survey estimates and recovery goals for this population.

Estimates of abundance for the South Fork steelhead population at Bonneville Dam were constructed as follows. We summarized detections of South Fork John Day adult steelhead at Bonneville Dam by migration year and saltwater age (one salt or two salt). Total detections for each cohort were divided by the number of out-migrant juvenile steelhead PIT tagged at the South Fork RST in each respective year. The quotient of this relationship is the "steelhead recruitment ratio" for each migration year-age group. The steelhead recruitment ratio is hence an estimate of the percent of the tagged individuals which: a) expressed an anadromous life history, and b) survived. We then estimated the total South Fork steelhead population at Bonneville Dam as the product of the steelhead recruitment ratio times the total out-migrant population estimate at the South Fork RST (and associated 95% Confidence Intervals of the population estimate). This population estimation assumed that: a) juvenile steelhead PIT tagged at the RST were representative of the entire migrant population; b) there was no tag loss between tagging and adult return; and c) the adult ladder PIT tag detection systems at Bonneville Dam were 100% effective at detecting returning adult steelhead.

RESULTS

Juvenile Chinook Capture and Tagging

At our Mainstem trap (rkm 352) we captured 4,399 juvenile spring Chinook migrants during the fall/winter trapping period. During the spring period we captured 2,319, and PIT tagged 2,280. We estimate that 82,241 (95% CI, 73,721–92,713) juvenile spring Chinook migrated past the trap during the trapping season (Figure 3). Mean FL of juvenile Chinook captured during the fall/winter period was 99.9mm (Figure 6), with a mean K of 1.14 (Figure 5). Spring migrants had a mean FL of 103.4mm (Figure 8) with a mean K of 1.15 (Figure 7). Of the 3,846 Chinook examined for black spot infestation, 91 (2.4%) had visible signs.

At the South Fork trap we captured 84 and PIT tagged 23 juvenile Chinook over the entire season. Fall migrants had a mean FL of 103.4mm (Figure 6) and a mean K of 1.10 (Figure 5). Spring migrants had a mean FL of 103.9mm (Figure 8) and a mean K of 1.10 (Figure 7). No black spot infestation was observed on Chinook at this trap. We estimate that 723 (95% CI, 450–1,199) juvenile Chinook migrated past the trap site over the trapping season.

At our Middle Fork trap we captured a total of 721 juvenile Chinook migrants during the fall/winter trapping period. During the 2011 spring migration we captured 643 and PIT tagged 623. We estimate that 21,322 (95% CI, 17,906–26,217) juvenile Spring Chinook migrated past the trap site over the trapping season (Figure 4). Mean FL of juvenile Chinook captured during the fall/winter was 89.1mm (Figure 6) with a mean K of 1.12 (Figure 5). During the spring trapping period the mean FL of captured individuals was 93.7mm (Figure 8) with a mean K of 1.08 (Figure 7). The presence of black spot was observed on 5.0% of examined fish (65 of 1,289 individuals)

Based on adult Spring Chinook redd counts and our smolt emigration abundance estimate, we estimate the freshwater production of the Middle Fork to be 85 smolts/redd (95% CI, 71–104) for the 2009 brood year (Figure 9). There was suggestive evidence of a negative linear relationship between ln smolts/redd and the number of redds ($r^2 = 0.48$, $P = 0.06$). For the upper Mainstem population, we estimate the freshwater production was 176 smolts/redd (95% CI, 158–198) for the 2009 brood year (Figure 10). There was no significant evidence of a negative linear relationship between ln smolts/redd and the number of redds ($r^2 = 0.35$, $P = 0.12$) in the upper Mainstem population. The residuals from these regressions, when plotted against brood year, showed no apparent trend for the Middle Fork population (Figure 11). However, the residuals for the upper Mainstem population appear to have a positive trend over time (Figure 11).

Collectively, we PIT Tagged 2,928 juvenile Spring Chinook at our rotary screw trap sites during the spring migration from 1 February 2011 to 17 June 2011. Peak movements were recorded during the fall (October through December) at the Mainstem and Middle Fork traps sites and then again in April at the Mainstem site (Figure 12).

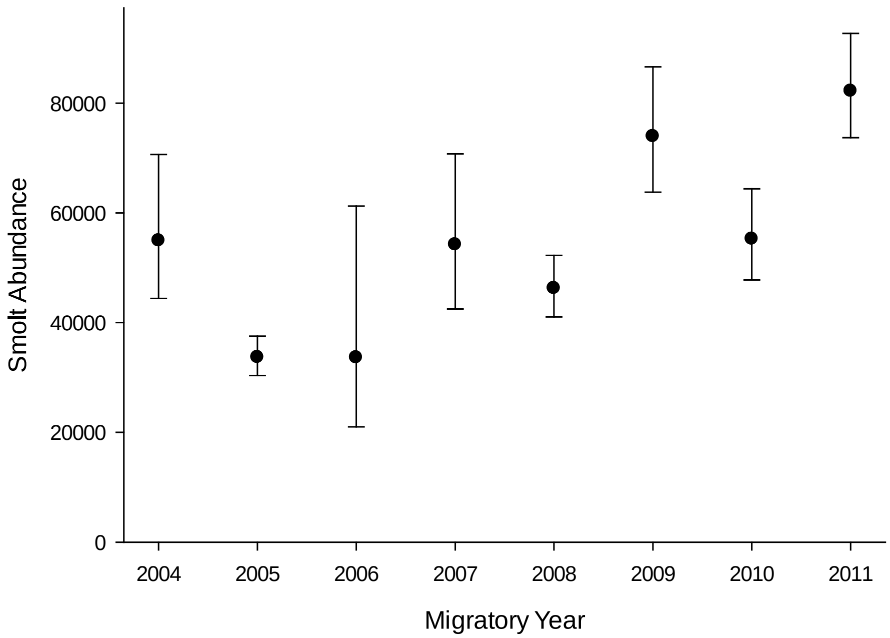

Figure 3. Mainstem trap spring Chinook abundance estimate by migratory year. Error bars are 95% confidence intervals.

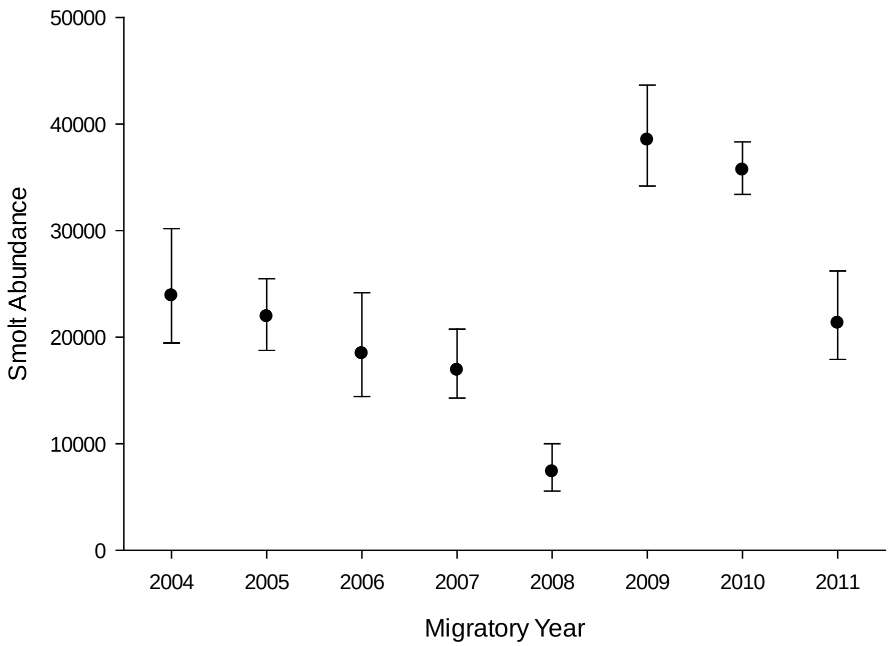

Figure 4. Middle Fork trap spring Chinook abundance estimate by migratory year. Error bars are 95% confidence intervals.

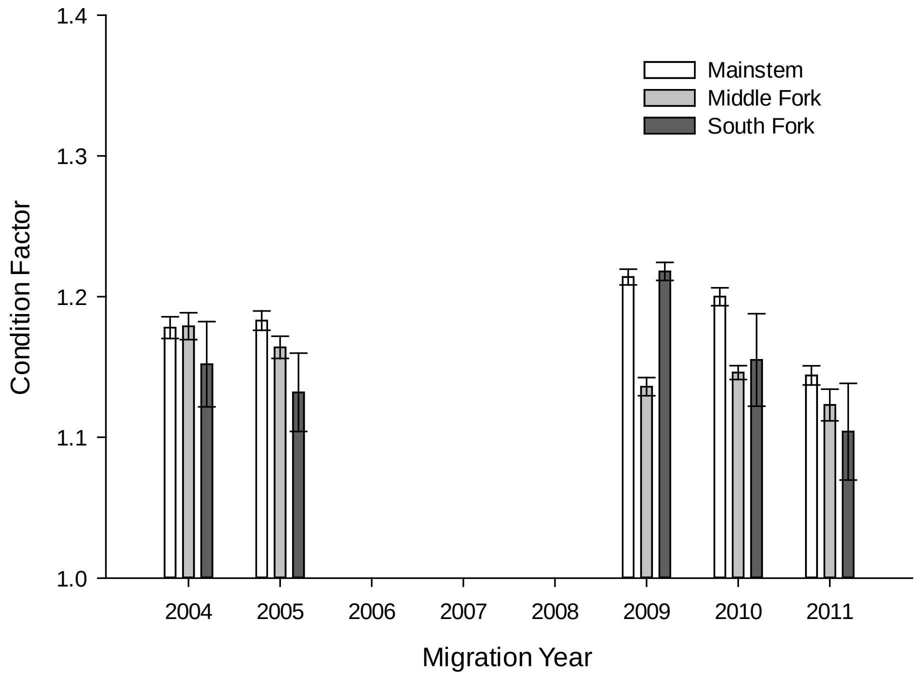

Figure 5. Condition factor of fall migrant Chinook parr captured at three rotary screw trap sites in the John Day River basin. Error bars are 95% confidence intervals. Not all traps were operated during fall for migration years 2006 through 2008, precluding analysis of variance for fall migrants during those migration years.

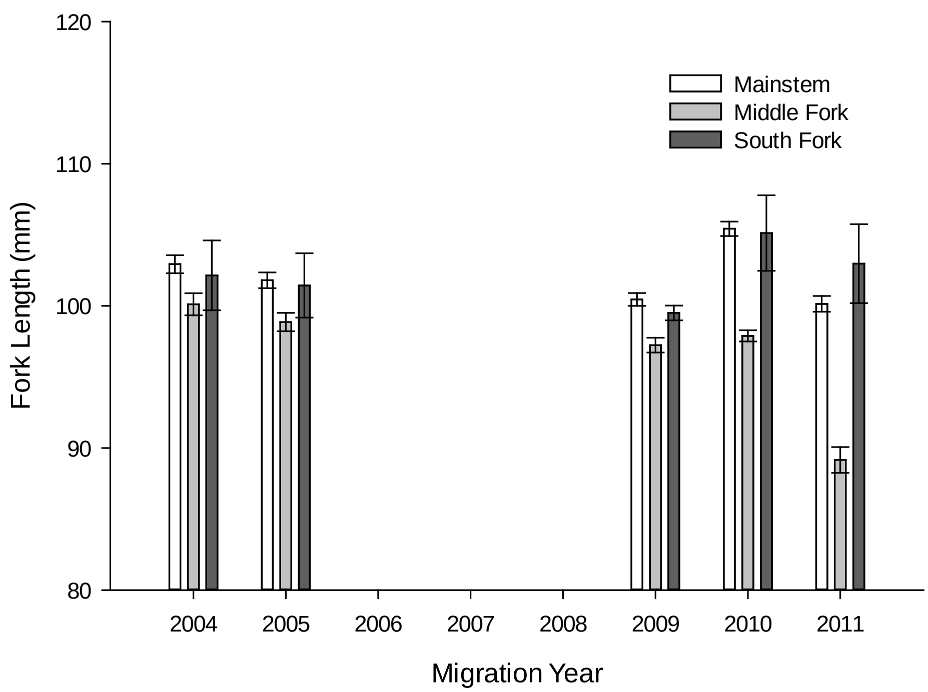

Figure 6. Fork length of fall migrant Chinook parr captured at three rotary screw trap sites in the John Day River basin. Error bars are 95% confidence intervals. Not all traps were operated during fall for migration years 2006 through 2008, precluding analysis of variance for fall migrants during those migration years.

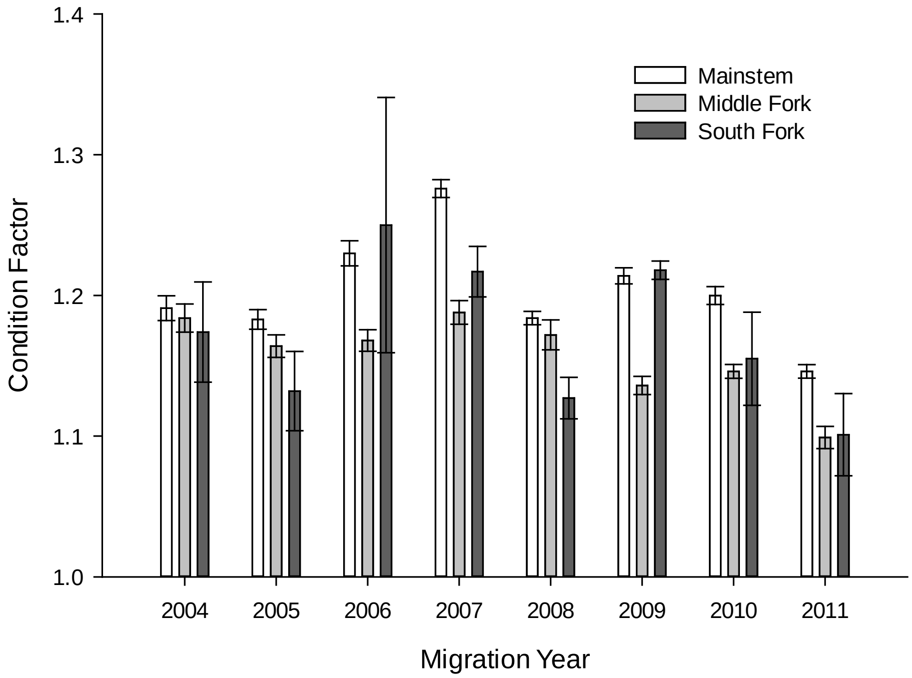

Figure 7. Condition factor of spring migrant Chinook parr captured at three rotary screw trap sites in the John Day River basin. Error bars are 95% confidence intervals.

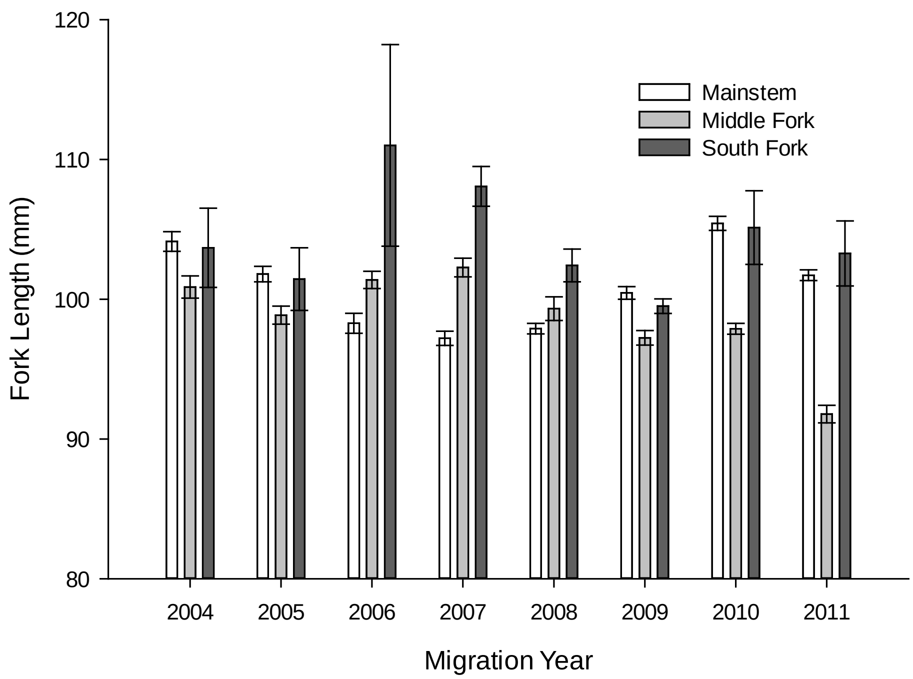

Figure 8. Fork length of spring migrant Chinook parr captured at three rotary screw trap sites in the John Day River basin. Error bars are 95% confidence intervals.

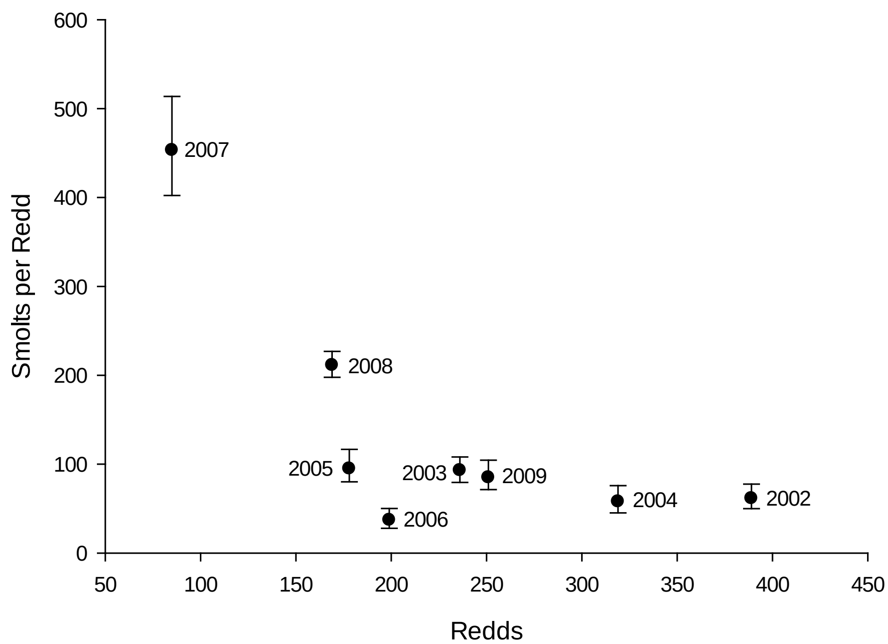

Figure 9. Middle Fork John Day spring Chinook smolt per redd estimates for brood years 2002 through 2009. Error bars are 95% confidence intervals.

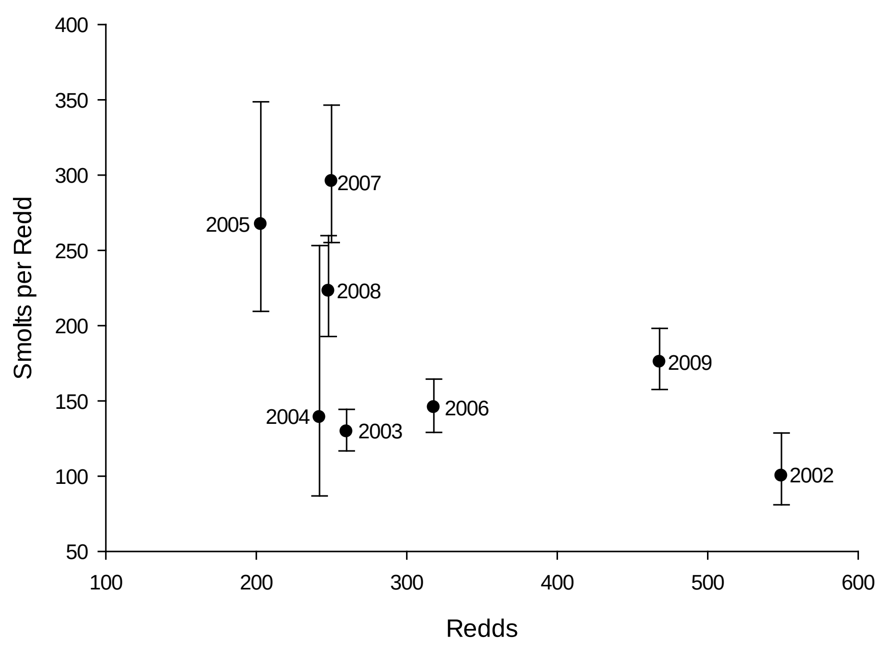

Figure 10. Upper Mainstem John Day spring Chinook smolt per redd estimates for brood years 2002 through 2009. Error bars are 95% confidence intervals.

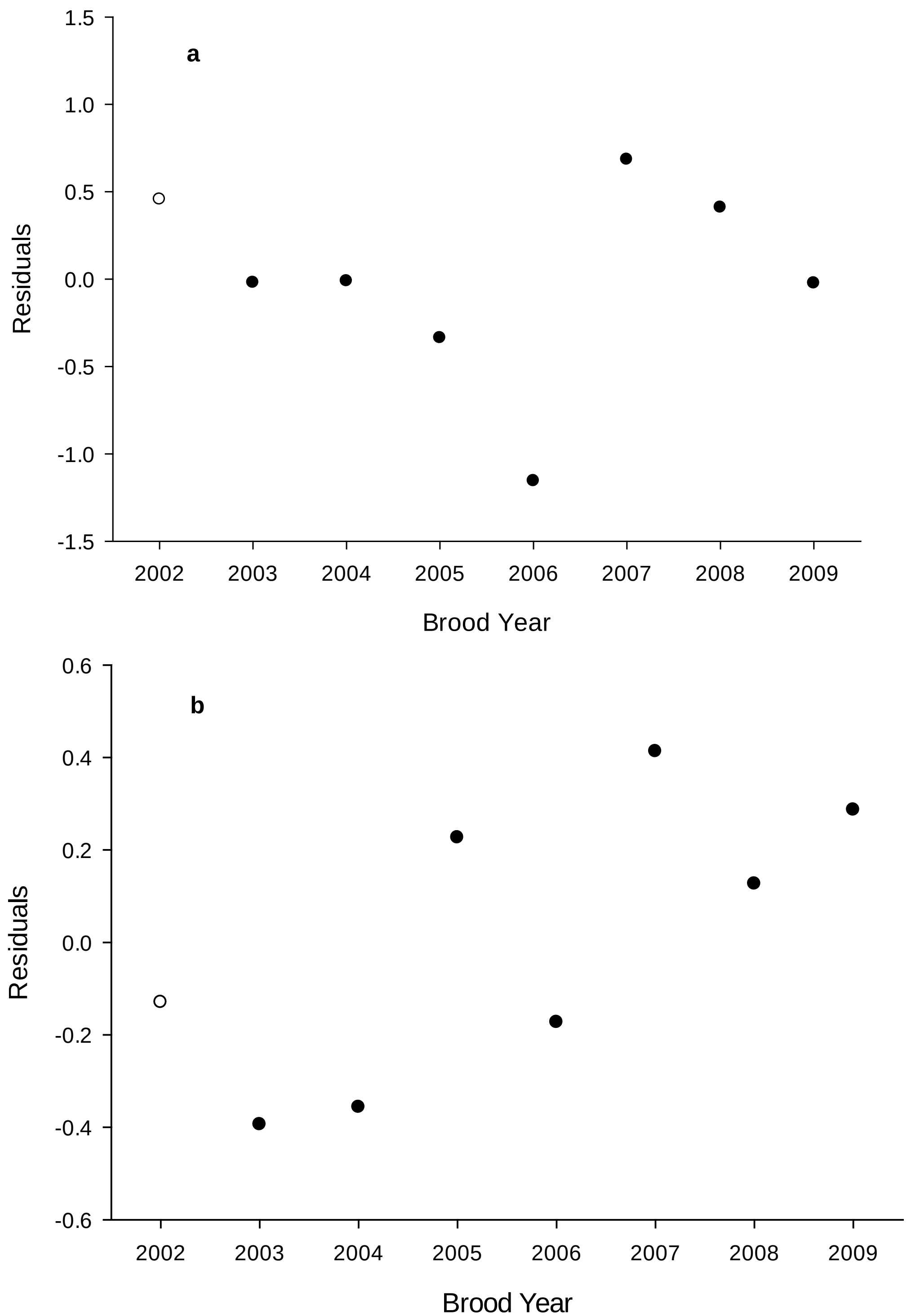

Figure 11. The residuals from a regression of natural log smolts per redd versus redd abundance plotted against brood year. Panel a is the Middle Fork John Day River spring Chinook population, and panel b is the Upper Mainstem John Day River spring Chinook population.

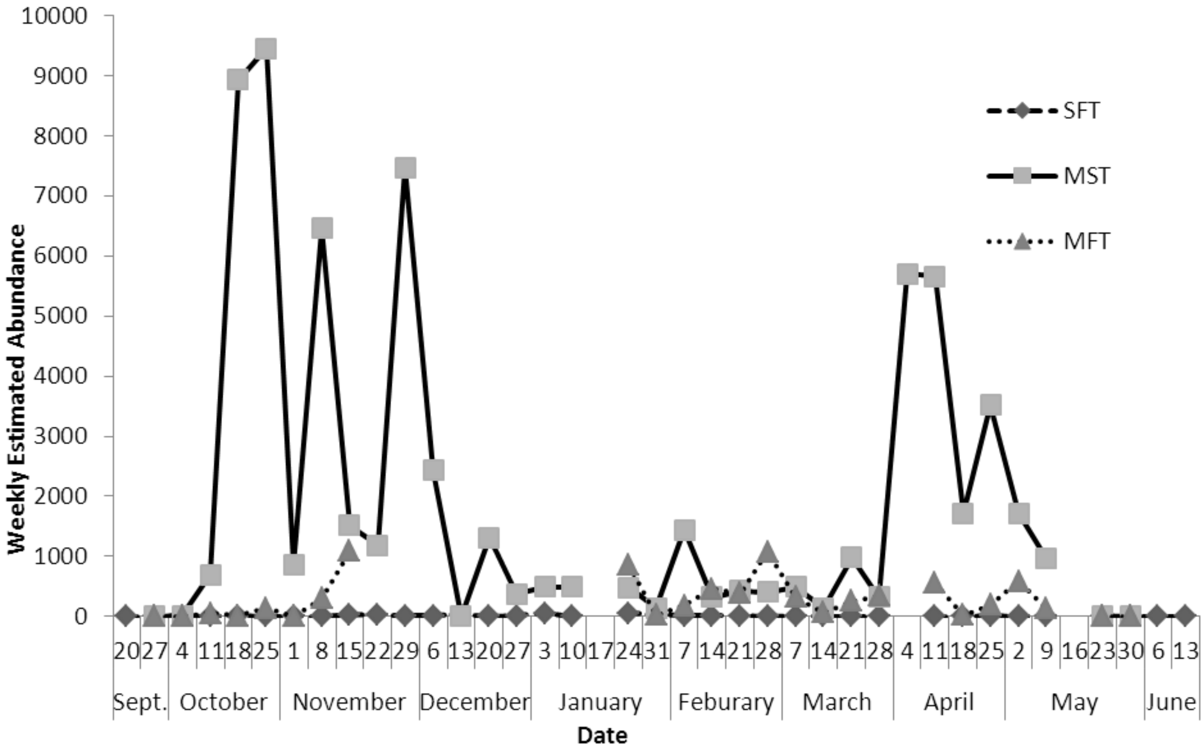

Figure 12. Estimated weekly number of juvenile spring Chinook migrating past rotary screw traps operated in the John Day River basin during migratory year 2011.

Juvenile Steelhead Capture and Tagging

Collectively, we PIT tagged 2,888 juvenile summer steelhead at our three rotary screw trap sites from 1 February 2011 through 17 June 2011. Spring migration timing peaked in late April and early May at all trap sites. There was an additional fall movement in October and November at the Mainstem trap and South Fork trap respectively (Figure 22).

At our Mainstem trap we captured 1,147 steelhead migrants during the fall/winter period. We captured 1,250 and PIT tagged 1,204 steelhead migrants during the spring period. We estimate that 50,976 (95% CI 42,269–62,601) juvenile steelhead migrated past the Mainstem trap site over the trapping season (Figure 14). The 2011 migration estimate was 69% higher than the 2010 migration estimate, but was not significantly different from the 2009 estimate (Figure 14). Fall migrants had a mean FL of 141.5mm (Figure 18), and a mean K of 1.07 (Figure 17). Spring migrants had a mean FL of 164.1mm (Figure 20) with a mean K of 1.01 (Figure 19). Of the 1,922 examined for Black Spot infestation 4 (0.2%) showed visible signs. We estimated the age structure of 1,204 steelhead migrants to be 13.1% age 1, 80.3% age 2, and 6.6% age 3 (Figure 16 and Appendix Table 12).

At the Middle Fork trap we captured 460 and PIT tagged 392 steelhead migrants from 28 September 2010 through 3 June 2011. We estimate a total of 18,301 (95% CI 11,522–30,028) juvenile steelhead migrated past the trap site during the trapping period (Figure 15). Fall migrants had a mean FL of 157.6mm (Figure 18) and a mean K of 1.04 (Figure 17). Mean FL of the spring migrants was 164.2mm (Figure 20) with a mean K of 1.00 (Figure 19). Of the 439 juvenile steelhead examined for Black Spot, one (0.2%) showed visible signs of infestation. We estimate the age structure the steelhead migrants to be 6.9% age 1, 69.5% age 2, and 23.7% age 3 (Figure 16 and Appendix Table 12). Based on our adult summer steelhead redd counts and abundance estimates in the Middle Fork we estimate the preliminary ratio of out-migrants produced per spawner (excluding possible age 4 out-migrants) for the 2008 brood year to be 34 (95% CI 12– undetermined; Table 1).

At our South Fork trap site we captured 2,486 juvenile steelhead during the fall/winter trapping period. We captured 1,324 and PIT tagged 1,291 steelhead migrants during the spring period. We estimate that 41,274 (95% CI 37,016–46,696) juvenile steelhead migrated past the trap site during the trapping season (Figure 13). The mean FL of fall migrants was 139.4mm (Figure 18) with a mean K of 1.03 (Figure 17). The mean FL of captured spring migrants was 154.6mm (Figure 20) with a mean K of 1.01 (Figure 19). Of 3,268 juvenile Steelhead examined for Black Spot, none showed visible signs. We estimate the age structure of migrants to be 21.8% age 1, 73.4% age 2, 4.7% age 3 and 0.1% age 4 (Figure 16 and Appendix Table 12). Based on adult summer steelhead redd counts and juvenile migrant abundance estimates in the South Fork we estimate a final ratio of 50 out-migrants/spawner (95% CI 27–169) for brood year 2007. For brood year 2008, we estimate a preliminary ratio (excluding possible age 4 out-migrants) of 26 out-migrants per spawner (95% CI 16–56) (Figure 21 and Appendix Table 13).

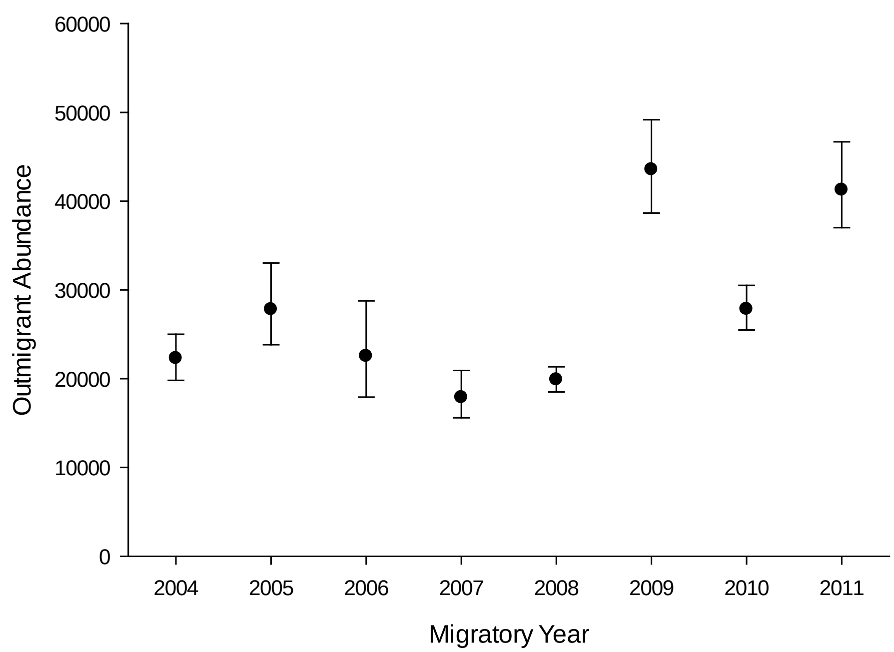

Figure 13. South Fork trap summer steelhead abundance estimate by migratory year. Error bars are 95% confidence intervals.

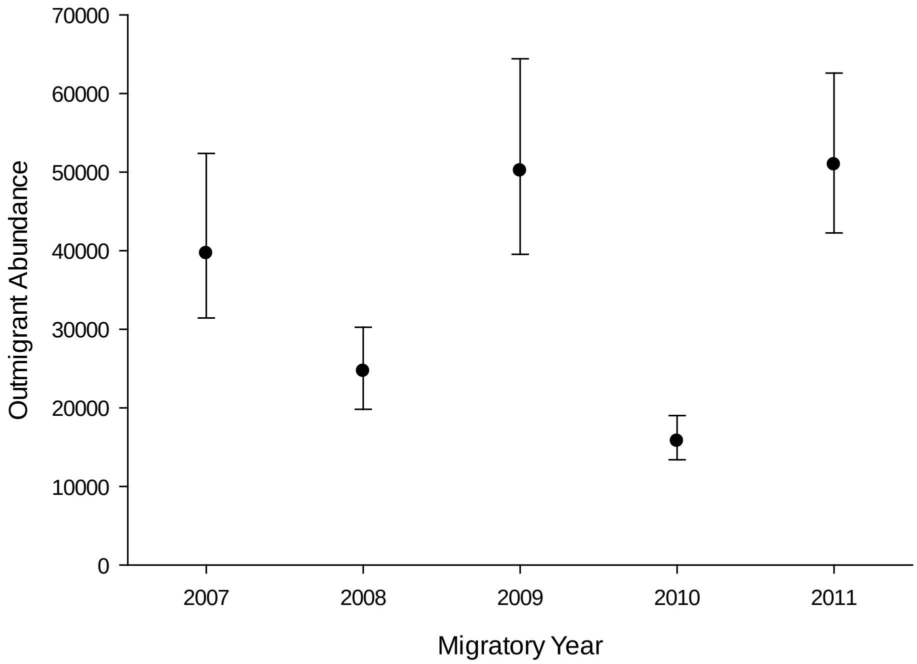

Figure 14. Mainstem trap summer steelhead abundance estimates by migratory year. Error bars are 95% confidence intervals.

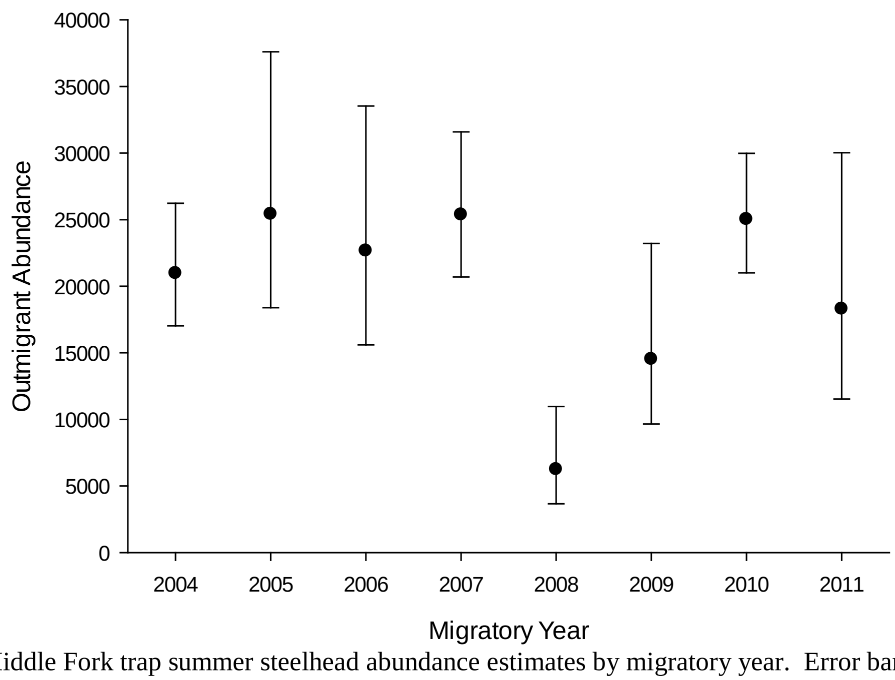

Figure 15. Middle Fork trap summer steelhead abundance estimates by migratory year. Error bars are 95% confidence intervals.

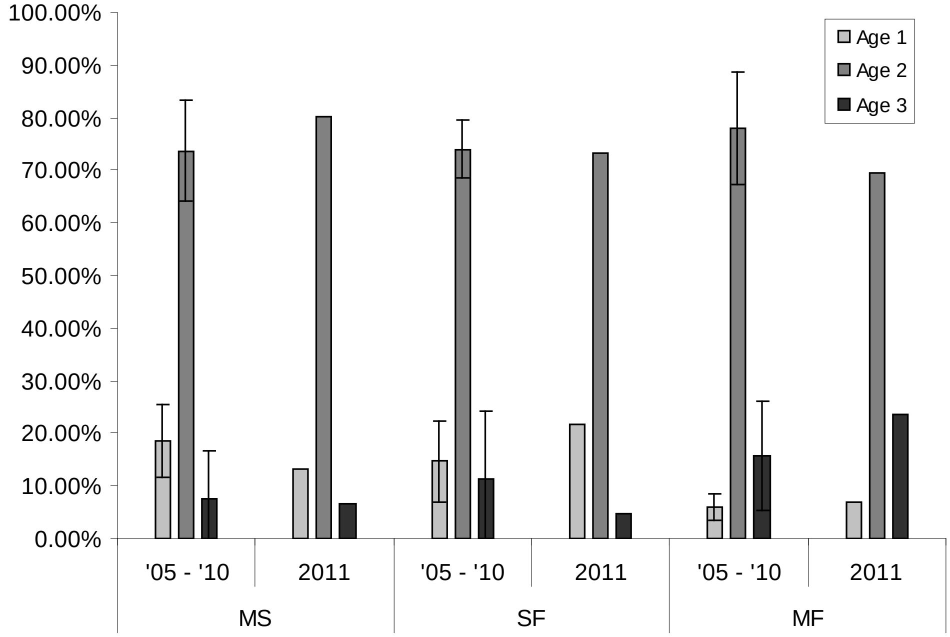

Figure 16. Estimated age composition of spring captured summer steelhead migrants for migratory year 2011 and mean estimated age composition for migratory years 2005–2010. Error bars represent 95% confidence intervals.

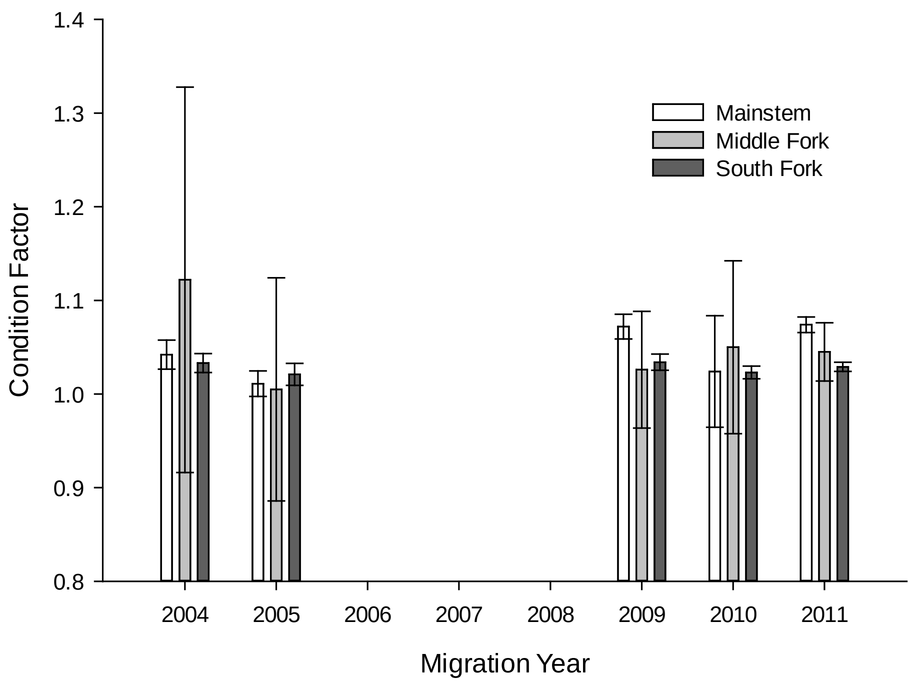

Figure 17. Condition factor of fall migrant summer steelhead parr from three populations in the John Day River basin. Error bars are 95% confidence intervals. Not all traps were operated during fall for migration years 2006 through 2008, precluding analysis of variance for fall migrants during those migration years.

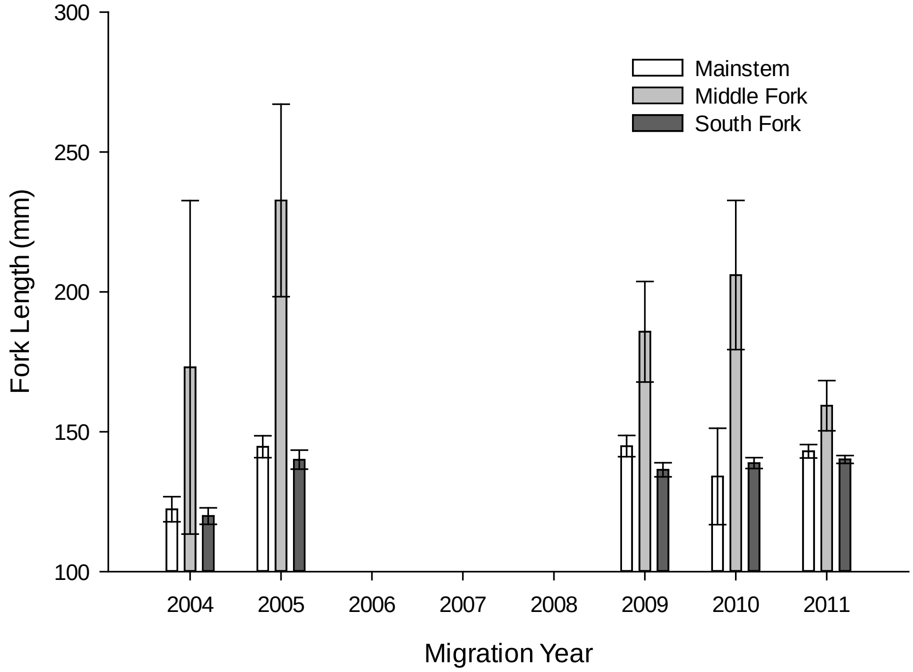

Figure 18. Fork length of fall migrant steelhead from three populations in the John Day River basin. Error bars are 95% confidence intervals. Not all traps were operated during fall for migration year 2006–08.

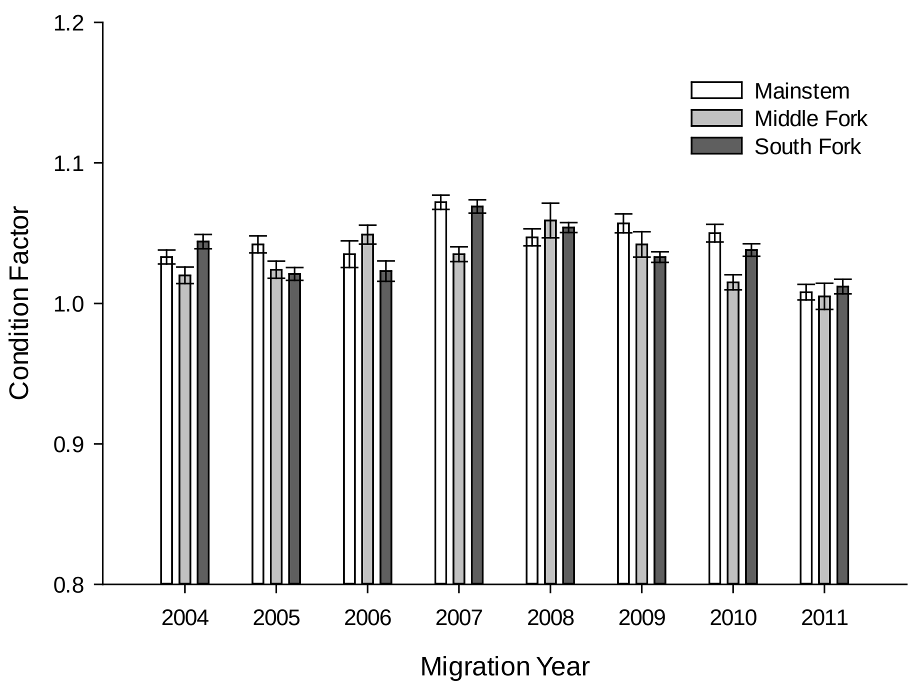

Figure 19. Condition factor of spring migrant steelhead from three populations in the John Day River basin. Error bars are 95% confidence intervals.

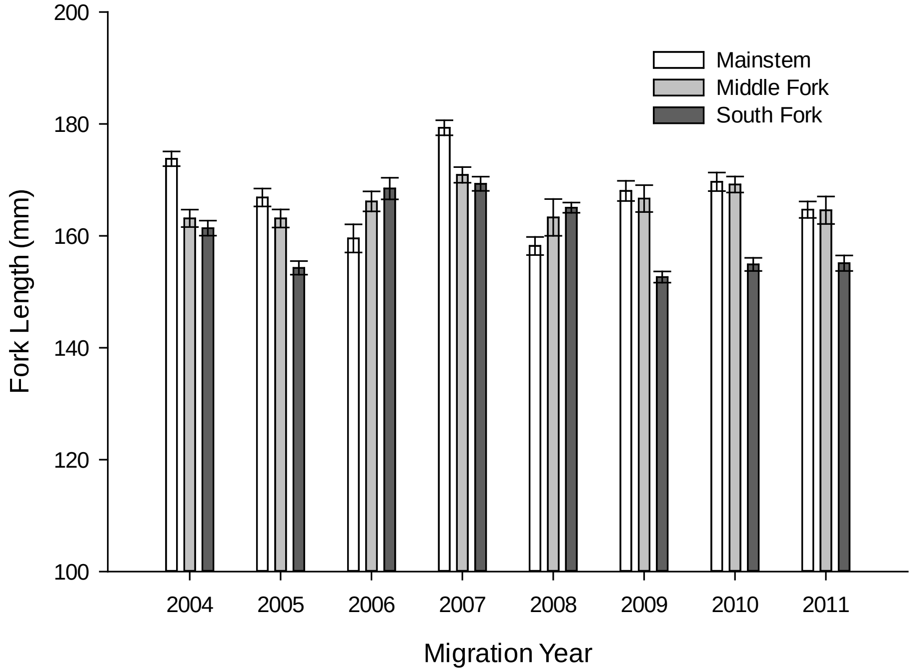

Figure 20. Fork length of spring migrant steelhead from three populations in the John Day River basin. Error bars are 95% confidence intervals.

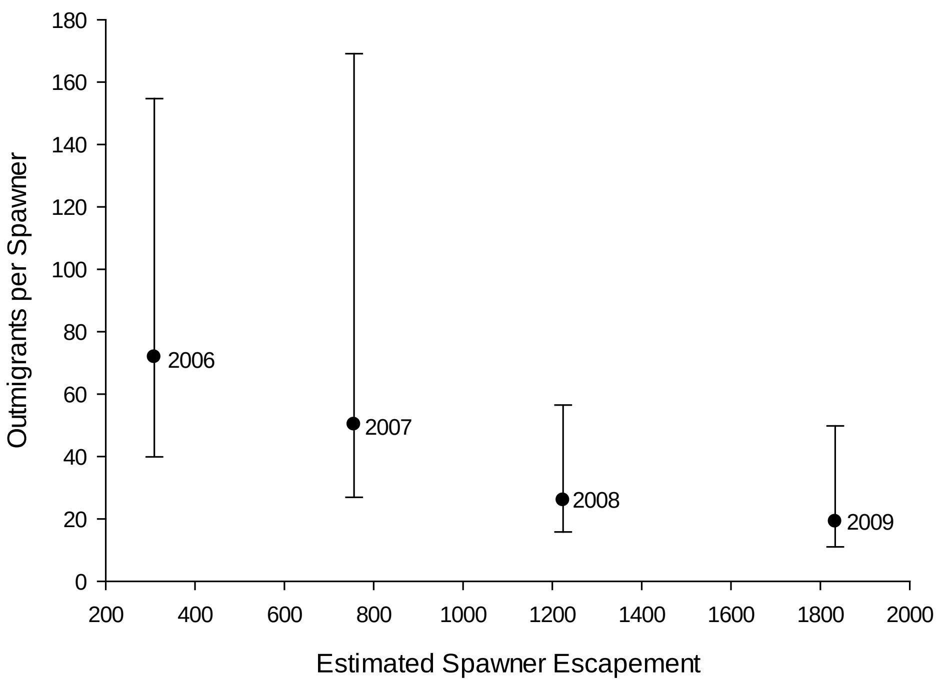

Figure 21. Estimated out-migrants per spawner production from the South Fork John Day River steelhead population for the 2006–2009 brood years. The 2009 brood year is incomplete, but currently includes the majority of anticipated smolts. Error bars are 95% confidence intervals.

Table 1. Middle Fork John Day River summer steelhead out-migrants per spawner estimates based on smolt abundance estimate from rotary screw trap and escapement estimates from the Middle Fork Intensively Monitored Watershed (James et al 2010).

Brood Year	Escapement	95% CI		Out-migrant Estimate	95% CI		Out-migrants / Spawner	95% CI	
2008	769	0	1,675	25,859[a]	20,748	33,012	34[a]	12	-
2009	2,114	1,326	2,901	14,663[b]	9,642	23,194	7[b]	3	17
2010	1,820	1,040	2,598		Currently Incomplete				

[a] Preliminary estimate possible age 4 smolts not included.
[b] Preliminary estimate age-3 and age 4 smolts not included.

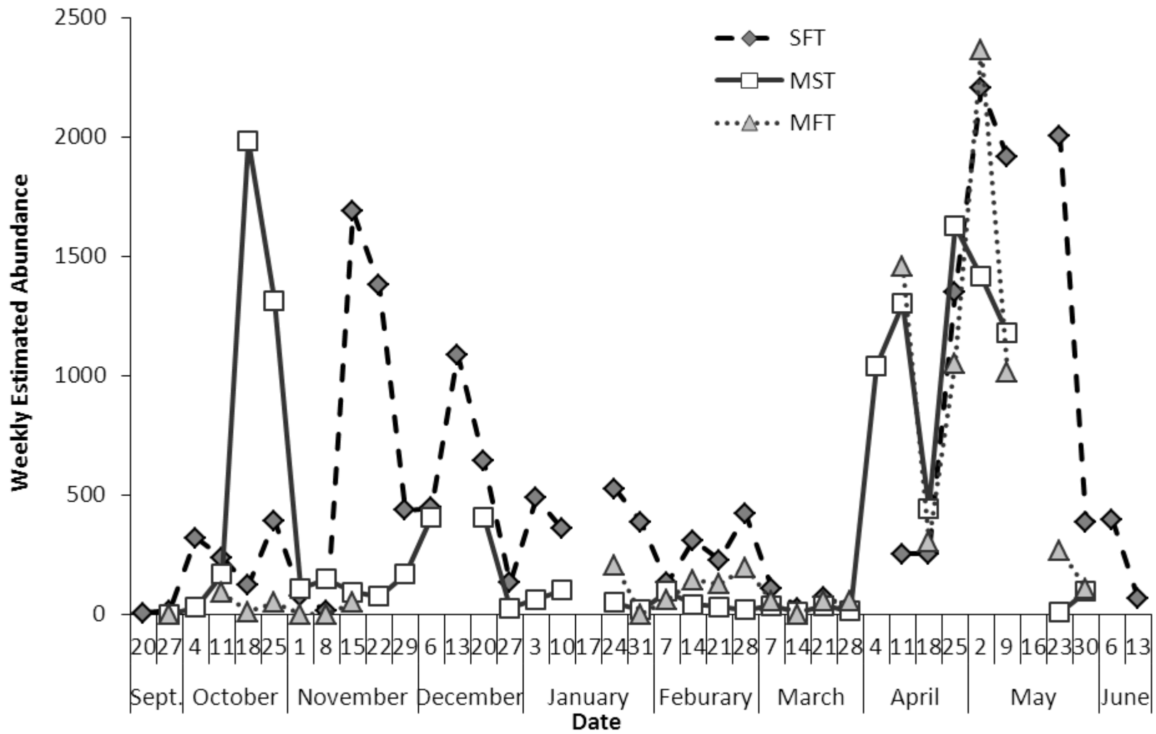

Figure 22. Estimated weekly number of summer steelhead migrating past rotary screw traps operated in the John Day River basin during migratory year 2011.

Incidental Catch and Observations

We captured 14 non-target species and 2 non-target salmonid life stages in our rotary screw traps during the 2011 migration. A total of 15 adult steelhead were captured and released unharmed from the trap with the exception of one that was captured at the Mainstem on 25 May 2011. This steelhead appeared to be a carcass that floated into the trap. All steelhead observed at the traps in migration year 2011 were of wild origin. Additionally, 40 Chinook fry and 56 O. mykiss fry were enumerated and released. We captured 287 juvenile pacific lamprey of two morphologies (silver coloration with developed eyes, and brown coloration with less developed eye spots). Other notable species captured included the introduced species bluegill, and largemouth bass, and the invasive rusty crayfish. (Table 2)

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

Of the 2,928 juvenile Spring Chinook PIT tagged and released at all rotary screw trap sites between 1 February 2011 and 17 June 2011; 0.3% (8) were detected at the McDonald Ford array, 34.8% (1018) were detected at John Day Dam, 4.8% (141) were detected at Bonneville Dam, and 1.2% were detected by the Columbia River estuary trawling operation. John Dam Detections occurred from 4 April 2011–14 June 2011 with 50% of these recorded by 16 May 2011. Mean travel time from all sites to John Day Dam was 38 days (± 0.7 days SE, range 3–119 days). Detections at Bonneville Dam occurred from 28 April 2011–5 June 2011with 50% of these recorded by 13 May 2011. Mean travel time from all sites to Bonneville Dam was 47 days (± 2.0 days SE, range 5–97 days). Detections in the Columbia River estuary trawling operation occurred from 13 May 2011–25 May 2011, the mean travel time was 35 days (± 4.0 days SE, range 13–94 days; Table 3)

Of the 2,888 juvenile steelhead out-migrants PIT tagged and released from all rotary screw traps sites from 1 February 2011–17 June 2011; 0.8 % (22) were detected at the McDonald Ford array, 30.7 % (887) were detected at John Day Dam, 4.5 % (131) were detected at Bonneville Dam, and 1.9% (55) were detected in the Columbia River estuary trawling operation. John Day Dam detections occurred between 3 April 2011–23 June 2011 with 50% of these recorded by 16 May 2011. Mean travel time from all sites to John Day Dam was 18 days (± 0.6 days SE, range 2–103 days). Bonneville detections occurred between 26 April 2011–14 June 2011 with 50% of these recorded by 12 May 2011. Mean travel time from all sites to Bonneville Dam was 19 days (± 1.5 days, 4–94 days). Detections in the Columbia River estuary trawling operation occurred from 27 April 2011–8 June 2011, the mean travel time was 21 days (± 2.2 days, range 6–86 days, Table 3).

Table 2. Number of each fish species captured incidentally at the trap sites (24 September 2010 to 17 June 2011).

	Trap Site		
Species	Mainstem	Middle Fork	South Fork
Wild Adult Steelhead (O. mykiss)	8	1	6
Chinook Fry (O. tshawytscha)	39	1	0
Steelhead Fry (O. mykiss)	28	2	26
Brown Bullhead (Ameiurus nebulosus)	0	1	0
Bluegill (Lepomis macrochirus)	3	0	0
Bull Trout (Salvelinus confluentus)	2	3	0
Chiselmouth (Acrocheilus alutaceus)	581	36	23
Dace species (Rhinichthys spp.)	63	161	308
Northern Pikeminnow (Ptychocheilus oregonensis)	857	169	1115
Sculpin (Cottus spp.)	0	17	76
Small Mouth Bass (Micropterus dolomieui)	7	196	0
Large Mouth Bass (Micropterus salmoides)	32	0	0
Sucker species (Catostomus spp.)	1257	636	1566
Red Side Shiner (Richardsonius balteatus)	852	308	1798
West Slope Cutthroat (O. clarki lewisi)	2	0	3
Juvenile Pacific Lamprey (Lampetra tridentata)			
No developed eyes	39	66	155
With developed eyes	1	3	23
Rusty Crayfish (Orconectes rusticus)	1359	0	2256
Signal Crayfish (Pacifastacus leniusculus)	31	33	60

Table 3. Number detected (N), first and last detection dates, and mean, standard error (SE) and range of travel time (days) to detection at McDonald Ford, John Day Dam, Bonneville Dam, and the Columbia River Estuary during 2011 for spring Chinook and summer steelhead smolts PIT tagged in the John Day Basin.

Species	Detection Location	N	Detection Dates	Travel Time Mean	SE	Range
Spring Chinook	McDonald Ford	8	5/5–5/15	43	12.2	3–88
	John Day Dam	1018	4/4–6/14	38	0.7	3–119
	Bonneville Dam	141	4/28–6/5	47	2.0	5–97
	Estuary	22	5/13–5/25	35	4.0	13–94
Summer Steelhead	McDonald Ford	13	5/1–5/16	22	6.0	4–88
	John Day Dam	887	4/3–6/23	18	0.6	2–103
	Bonneville Dam	131	4/26–6/14	19	1.5	4–94
	Estuary	55	4/27–6/8	21	2.2	6–86

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

Of the 267 John Day River spring Chinook detected at Bonneville Dam as adults, 247 were PIT tagged as smolts for the John Day basin SAR estimate and 20 were PIT tagged by other John Day research projects. The recently completed SAR estimate for the 2008 migration year (discounting possible age-6 returns) was 6.3% (95% CI 5.7%–7.0%; Figure 23) (Appendix Table 8). Return data for subsequent cohorts are not yet complete, but preliminary estimates for the 2009 migration is 7.2% (95% CI 6.5–8.1%) without the return of age-5 adults. Adult detections at Bonneville Dam occurred primarily between April and June with 39 (15%) detections in April, 184 (69%) detections in May, 42 (6%) detections in June, and 1 (0.4%) on 5 August 2011. One fish was not detected at Bonneville Dam, but was later detected at McNary Dam. The age structure of the returning Spring Chinook was 14.2% (38 fish) age 3, 73.8% (197 fish) age 4, and 11.9% (32 fish) age 5. Twenty-two (8.2%) 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, 13 (4.9%) were detected at Ice Harbor Dam, and six (2.2%) were detected at Lower Granite Dam (Table 4).

A total of 288 adult summer steelhead PIT tagged as juveniles in the John Day basin were detected in the FCRPS in 2011. Of these, 285 were detected for the first time as adults at Bonneville Dam from 1 July 2011–2 November 2011. Of these, 140 (49.1%) were detected in July, 131 (46.0%) in August, 9 (3.2%) in September, 4 (1.4%) in October, and 1 (0.4%) on November 2nd. One fish was detected at McNary Dam in 2011 without being detected at Bonneville Dam.

Two fish, that appear to be returning kelts (steelhead that survived first spawning and are returning to spawn again; PIT codes: 3D9.1BF201F9D5 and 3D9.1C2C430C8D) were detected at Bonneville in 2011. These two steelhead were detected in prior years and thus were not added to SAR estimates this year since they had been counted on their first return. One-hundred-five (36.7%) of the John Day origin returning steelhead were detected at FCRPS facilities above the mouth of the John Day River. All of these were detected at McNary Dam, 27 (9.5%) were detected at Ice Harbor Dam, and 20 (7.0%) at Lower Granite Dam (Table 4).

A total of 216 returning steelhead were tagged as juveniles for the John Day basin SAR estimate for migration years 2009 and 2010. Of these, 126 (58.3%) were one-ocean fish and 90

(41.7%) were two ocean fish. In 2009, the SAR estimate for juvenile summer steelhead was 8.6% (95% CI 7.3% - 10.4%; Figure 24; Appendix Table 10).

Spring Chinook and summer steelhead originating from the John Day River basin have experienced similar SAR's in recent years (Figure 25). The SARs for each species from John Day Dam to the ocean and back to Bonneville Dam have been significantly correlated (r = 0.96, P = 0.003). The SARs for steelhead exceeded Chinook in all years (Figure 25).

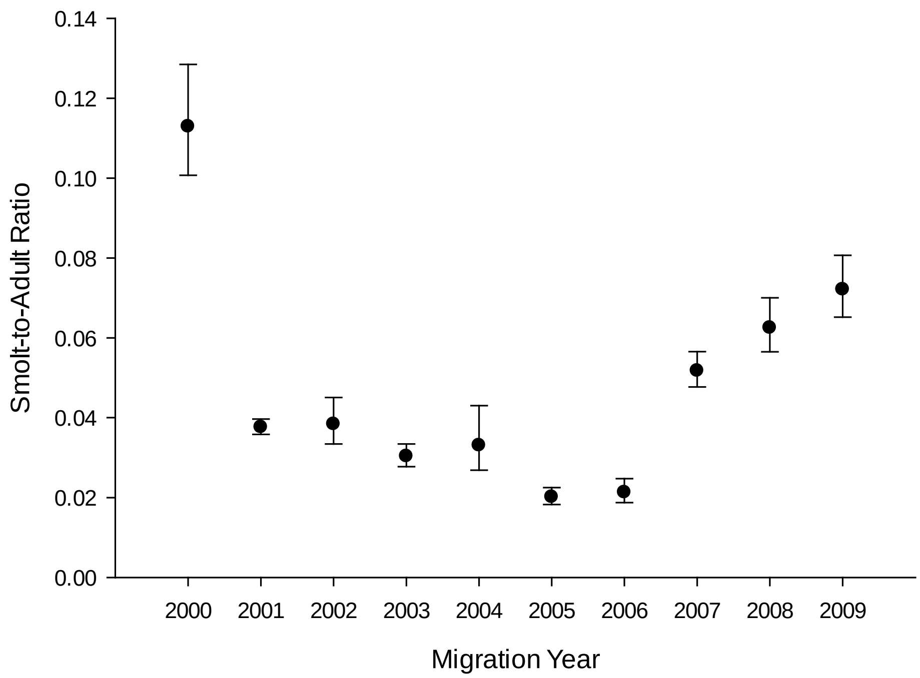

Figure 23. Trends in smolt-to-adult ratio (SAR) of juvenile spring Chinook tagged with Passive Integrated Transponder tags in the John Day River basin during migration years 2000–2009. SAR is estimated from smolt migration past John Day Dam to adult detection at Bonneville Dam. Error bars are 95% confidence intervals.

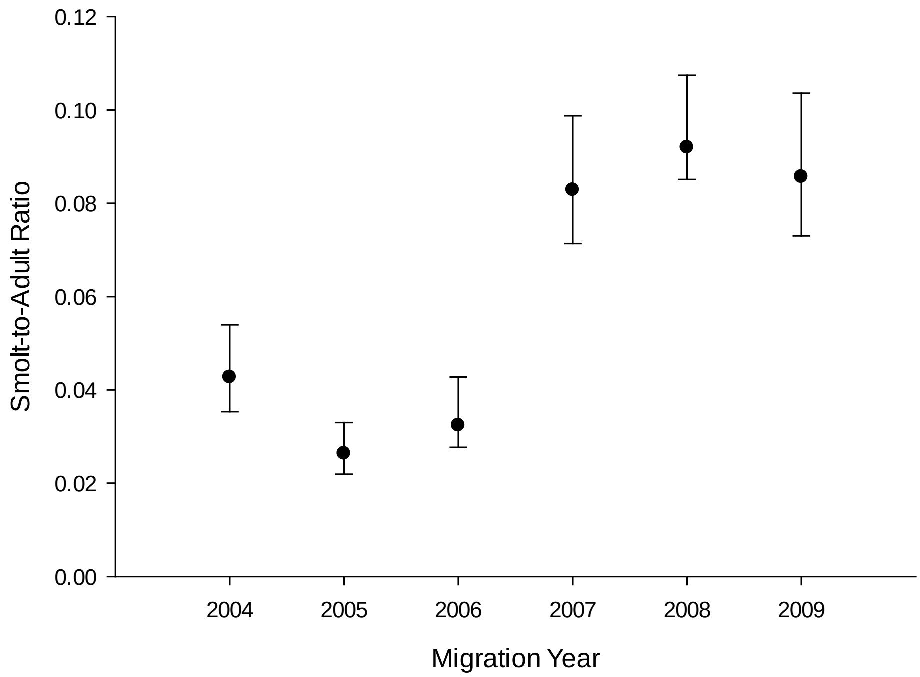

Figure 24. Trends in smolt-to-adult ratio (SAR) of juvenile summer steelhead tagged with Passive Integrated Transponder tags in the John Day River basin during migration years 2004–2009. SAR is estimated from smolt migration past John Day Dam to adult detection at Bonneville Dam. Error bars are 95% confidence intervals.

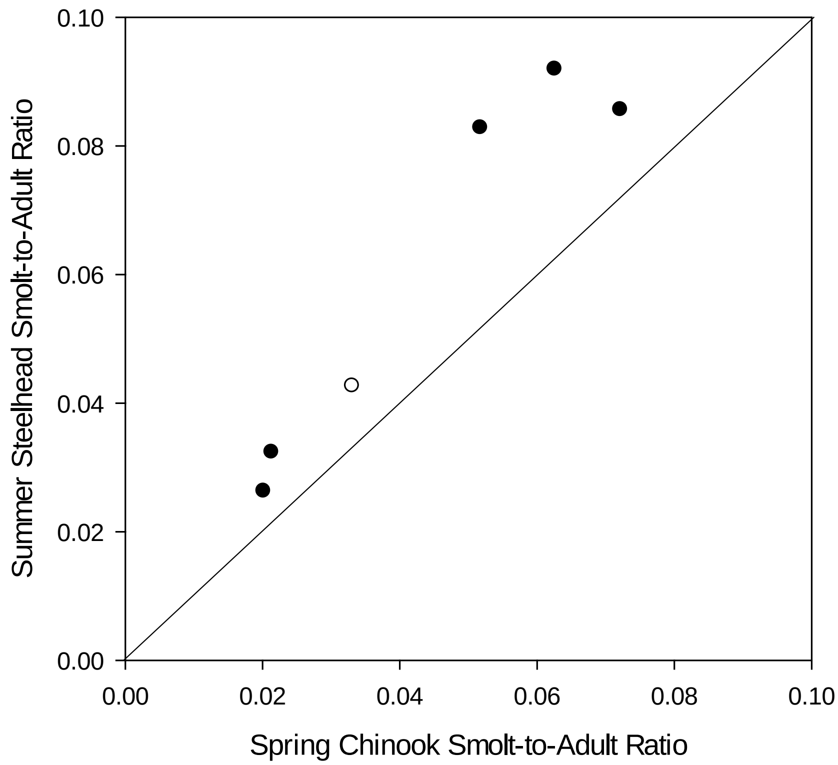

Figure 25. Relationship between point estimates of smolt-to-adult ratio (SAR) of summer steelhead and spring Chinook tagged with Passive Integrated Transponder tags in the John Day River basin during migration years 2004–2009. SAR is estimated from smolt migration past John Day Dam to adult detection at Bonneville Dam. The straight line denotes a 1:1 relationship between SAR of steelhead and Chinook.

Table 4. Detection histories of 286 adult summer steelhead that returned during the summer of 2011 and 267 adult spring Chinook that returned during the spring of 2011 that were PIT tagged as juveniles in the John Day basin.

	Summer Steelhead	Spring Chinook
Number of first time John Day origin PIT tag detections at FCRPS facilities	286	267
% Detected at Bonneville Dam	99.7 %	99.6 %
% Detected at McNary Dam	36.7 %	8.2 %
% Detected at Ice Harbor Dam	9.4 %	4.8 %
% Detected at Lower Granite Dam	7.0 %	2.3 %

South Fork John Day Adult Steelhead Population Estimate

Our estimated summer steelhead production ratio for South Fork John Day steelhead ranged from a low of 0.004 for 2-salt adults from the 2006 migration year to a high of 0.052 for 1-salt adults from the 2008 migration year (Table 5). Run-year specific adult steelhead estimates at Bonneville Dam have ranged from a low of 389 to a high of 1,568 (Table 5). South Fork adult steelhead estimates at Bonneville Dam are compared to spawning survey estimates and recovery goals in Figure 26.

Table 5. Matrix used for estimation of South Fork John Day River adult steelhead return at Bonneville Dam. The summer steelhead (StS) recruitment ratio is the quotient of number of adult detections at Bonneville Dam divided by the number of out-migrants tagged with Passive Integrated Transponder tags. The StS recruitment ratio was then multiplied by the total estimate of out-migrants to estimate the number of adults crossing Bonneville Dam by migration year and saltwater age. One and two salt adults were summed diagonally (as indicated by shading patterns) to estimate total adult returns to Bonneville Dam for each run year.

			StS Ratio		**Out-migrants * StS Ratio**			
Migration Year	#Out-migrants PIT Tagged	Total Out-migrants	1-Salt Adults	2-Salt Adults	1-Salt Adults	2-Salt Adults	Total Adults	Run Year
2004	1879	22,298	-	0.006	-	142	422	2006
2005	2391	27,820	0.010	0.005	279	*151*	*389*	2007
2006	1704	22,539	0.011	0.004	*238*	79	765	2008
2007	1644	17,888	0.038	0.015	685	*272*	*1312*	2009
2008	2774	19,901	0.052	0.022	*1040*	445	1498	2010
2009	2731	43,575	0.024	0.021	1053	*894*	*1568*	2011
2010	1527	27,851	0.024	-	*675*	-	-	*2012*

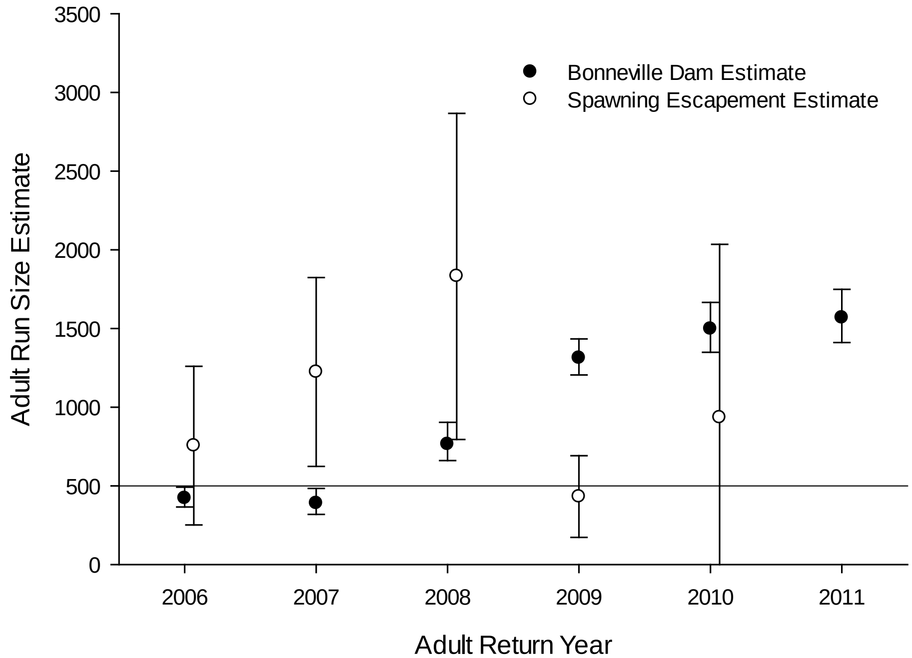

Figure 26. Comparison of adult steelhead estimates for the South Fork John Day River population. The spawning escapement estimates are derived from probabilistic spawning surveys in the South Fork population, reported by Banks et al. 2011. Bonneville Dam estimates are from detections of returning Passive Integrated Transponder tagged adults corrected by out-migrant population estimates at the South Fork John Day River rotary screw trap. The horizontal line denotes the National Oceanic and Atmospheric Administration's recovery goal of 500 adults for this population.

DISCUSSION

Smolt-to-Adult Ratios

The SAR's we have observed for John Day spring Chinook have varied by more than 5-fold, and appear cyclical over the past decade. Spring Chinook experienced high SAR during the first estimated year (migration year 2000), followed by lower estimates from migration year 2001 to migration year 2006. Estimates of SAR increased for migration years 2007 through 2009. Our data set for steelhead is shorter, but shows similar cyclical trends, with low SAR for migration years 2004 to 2006, followed by higher estimates in migration years 2007 to 2009. The cycles of SAR that we have observed are consistent with the concept of cyclical patterns in productivity in the Northeast Pacific Ocean (e.g., Mueter et al. 2007). Furthermore, the patterns in SAR observed for John Day basin salmonids are consistent with those observed for other salmonid populations in the Columbia River basin (Tuomikoski et al. 2011).

Our observed SAR for John Day River basin Chinook was consistently lower (mean = 28%) than for steelhead (Figure 24). However, based on 2011 age structure, Chinook were more than twice as likely as steelhead to spend two or more years in the ocean. This suggests that mortality in our SAR estimates was weighted toward the first year. This is consistent with other studies of salmonids which have found most smolt-to-adult mortality occurring in the first year of ocean residence (e.g., Quinn 2005). Indeed, the initial few months of ocean entry appear critical to lifetime ocean survival (e.g., Hansen and Quinn 1998). The disparate length of Chinook and steelhead when exiting the John Day River also may influence SAR. Prior evidence suggests higher SAR for larger smolts, both within a species (e.g., steelhead, Ward et al. 1989), and between species (e.g., Quinn 2005). This factor likely contributes to our observation of higher SAR for steelhead smolts which are approximately 60mm larger than Chinook smolts when exiting the John Day River.

Freshwater Production of Spring Chinook

Upper Mainstem

Our upper Mainstem juvenile out-migrant Chinook abundance estimate for 2011 was the highest we have recorded and was 33% higher than the previous year. Mainstem out-migrant abundance has had a generally positive trend since trapping started in 2004. During migration year 2011 the fall migration of juvenile Chinook out-migrants resulted in the majority of our smolt estimate which is a divergence from previous observations. We suspect this was primarily caused by the inability to trap effectively during the extremely high spring flows rather than the migration pattern shifting.

Fork length and condition factor of fall migrants was at its lowest level since the trap was installed in 2004. Spring migrant condition factor was also at the lowest level observed. Brood year 2009 was the second highest redd estimate since 2002 apparently resulting in increased intra-specific competition, lower growth rates, and less fit smolts. These lines of evidence corroborate the declining smolt per redd values at higher levels of escapement (Figure 10). Although we did not find a statistically significant negative relationship between smolt recruitment (ln smolts/redd) and redd abundance, these individual condition data support the notion that density-dependence is limiting the production of Chinook smolts from the upper Mainstem.

The positive trend in residuals from the smolts/redd relationship for the upper Mainstem (Figure 11) suggests that freshwater productivity of this population is increasing over time. There are several possible hypotheses regarding this apparent increase in productivity. The upper Mainstem has had extensive habitat restoration and passage barrier removals conducted in recent years. These efforts may be contributing to increased productivity. Alternatively, summer streamflows have been above average in recent years. Increased streamflow may be a contributing factor, or even the primary factor driving increases in productivity. Irrespective of the causal mechanism, this non-stationarity makes interpretation of stock-recruitment functions (i.e., smolts/redd) difficult. Caution should be used when interpreting these stock-recruit data. More years of monitoring will be necessary in order to fit a stock-recruitment curve to a stationary data set, and better understand the relative influences of habitat restoration versus environmental conditions.

Middle Fork

The 2011 Middle Fork Chinook smolt estimate was near the average reported since 2004. However, extremely high flows during the spring of 2011 hampered trapping efforts at this site, reducing the percent of nights sampled as compared to the other trap sites (Figure 2). The typical springtime peak movement of Chinook was not observed during this trapping season (Figure 12). Hence, our estimate is calculated from a constant low level movement and may underestimate the true out-migrant abundance.

Fork length and condition factor of captured individuals was the lowest observed at this site since 2004 for both fall/winter and spring capture groups. This appears consistent with the concept of density-dependent limitations on freshwater production from the Middle Fork. Our individual condition data corroborate the marginally significant negative relationship we have thus far observed between recruitment (smolts/redd) and spawning stock abundance (redd count). It appears that the number of smolts produced per redd reaches a minimum level at approximately 250 redds. The 2009 brood year was approximately at this point, and produced less-fit smolts than in prior years. In contrast to the plot of residuals for the upper Mainstem population, there is no apparent trend in the residuals for the Middle Fork population (Figure 11). The residuals for the Middle Fork population thus far appear symmetrically distributed about the zero point. This suggests that freshwater productivity of the Middle Fork population has been stable over our period of monitoring.

South Fork

Despite the fact that no Chinook redds were observed in the South Fork during 2009, we estimate that 723 juvenile Chinook migrated past the South Fork trap during the trapping season. This suggests that Chinook parr migrated into the South Fork and reared there for some period of time prior to emigration. PIT tag recaptures at the South Fork trap recovered Chinook parr that were tagged at the Mainstem trap after 1 June in prior years. This indicates that the South Fork is likely being used by Mainstem-produced parr as summer rearing habitat, and reporting these fish as new would likely result in double counting them.

Basinwide

We did not produce a basin wide Chinook smolt estimate as we have in past years because seining just downstream of the North Fork confluence (Mainstem John Day rkm 298) was not performed. We attempted to install and operate a rotary screw trap in the upper North Fork near the mouth of Desolation Creek (North Fork rkm 93) to capture emigrating Chinook smolts, however high flows hampered its install and operation. Thus, we were not able to estimate basinwide Chinook smolt production. Seining the Mainstem John Day at rkm 298 in tandem with operation of all traps (including the North Fork) over the next few years will allow us to extrapolate an estimate for the 2009 brood year.

Freshwater Production of Summer Steelhead

South Fork Trap

The South Fork trap 2011 migration year estimate of steelhead out-migrants was the second highest recorded since 2004 and was 33% higher than the 2010 migration year estimate. The trend since 2004 has been relatively stable, with the exception of the 2009 and 2011 migratory years which were significantly higher than other years. The age structure of the 2011 out-migrants had a higher proportion of age-1 migrants and a lower proportion of age-3 migrants when compared to the average age structure since 2005. Fork length and condition factor for both fall/winter and spring migrants was within the range reported since 2004.

It appears that out-migrants produced per spawner in the South Fork John Day decreases with increasing escapement. This suggests density dependent regulation of out-migrant production in the South Fork. The 2006 brood out-migrants per spawner estimate (47, 95% CI's 28–109) was 9% higher than the 2007 (43, 95% CI's 23–145) estimate. Escapement estimates and overall out-migrant production for the 2007 brood (756 spawners, 32,446 out-migrants) were larger than the 2006 brood (309 spawners, 14,411 out-migrants). This pattern continues for the 2008 brood year which had even higher escapement and smolt estimates, excluding potential age-4 smolts, (1,224 spawners, 33,573 out-migrants) but only an estimated 27 (95% CI 16–60) out-migrants per spawner. Continued years of out-migrant trapping will allow us to parameterize a stock-recruitment function for the South Fork steelhead population and better define the current carrying capacity of the basin.

Middle Fork Trap

The Middle Fork trap steelhead abundance estimate was the third lowest estimate reported since 2004 and was 37% lower than the previous year. Again, as with Chinook trapping, high flows during the spring of 2011 hampered trapping efforts at this site, reducing the percent of nights sampled as compared to the other trap sites (Figure 2). These abundance estimates should be interpreted with caution in years when a lower than normal percentage of nights were sampled.

Fork length and condition factor of captured out-migrants during the fall/winter and spring periods was within the range reported since 2004. Similarly, the age structure of steelhead out-migrants observed at the Middle Fork trap was comparable to prior years. We do not have sufficient years of outmigrant-per-spawner data for the Middle Fork population to estimate the influence of density dependence on production.

Mainstem Trap

The mean K of fall/winter migrants at the Mainstem was the highest observed since 2004. Conversely, spring migrants had a mean K that was the lowest yet observed at this site. A possible explanation for this dichotomy is the way we fished the trap during the fall of 2010 versus previous years. Prior to 2010 we fished the same location in the fall as we do in the spring regardless of the traps effectiveness at low flows. In the Fall of 2010 we attempted a new site in order to maximize low flow trapping efficiency and the success of this resulted in a larger sample size for steelhead in the Fall than we have had in the past. We may have caught a greater proportion of larger fish in the fall than in prior years. An increased sample size of fall migrants, which are not as far along in the physically taxing smoltification process, may also have contributed to the increase in fall K. The age structure of steelhead out-migrants observed at the Mainstem trap was similar to the average reported since 2004.

South Fork John Day Adult Steelhead Population Estimate

We explored a second method to estimate the South Fork adult steelhead population using South Fork origin PIT tag detections returning to Bonneville corrected by South Trap population estimate. The 2011 return year resulted in the highest estimate of South Fork origin adults (1,568 adults). The trend from return year 2006 through 2011 has been positive. This trend is similar to the trend in adult escapement of spring Chinook salmon, and suggests that a common influence is largely responsible for changes in abundance. Our data suggest that, given the observed levels of spawning escapement, survival rate in the Columbia River and Pacific Ocean largely regulates inter-annual changes in abundance.

The NOAA recovery goal for abundance of the South Fork steelhead population is an escapement of 500 adults to the South Fork (NMFS 2009). Our estimates suggest that for 4 of the past 6 years the South Fork steelhead return to Bonneville Dam has surpassed this target. The South Fork population appears to be producing freshwater returns of adult steelhead up to three-fold greater than targeted in the recovery plan. The survival and homing rate of these adults from Bonneville Dam to the South Fork John Day River remains unknown however. Estimating this survival rate is an important element of future work. Enhanced PIT tag detection systems in the Lower Mainstem and South Fork John Day (operated by NOAA's Integrated Status and Effectiveness Monitoring Project, with support from ODFW) may allow us to estimate survival and homing from Bonneville Dam to the John Day and South Fork John Day respectively. Future years of PIT-tag returns will also allow us to evaluate spawner-to-spawner replacement and determine if productivity of the South Fork population meets the recovery goal.

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APPENDIX TABLES

Appendix Table 1. Number (N), mean, and range of fork length (mm), mass (g), and coefficient of condition for spring Chinook migrants captured at rotary screw traps on the John Day River during two periods (Fall/Winter, 24 September 2010 to 31 January 2011; and Spring, 1 February 2011 to 17 June 2011).

		Fork Length (mm)				Weight (g)				Coefficient of Condition			
Location	Period	N	Mean	Min	Max	N	Mean	Min	Max	N	Mean	Min	Max
Mainstem	Fall/Winter	1566	99.9	73	142	1379	11.8	3.6	37.2	1379	1.14	0.43	1.80
Middle Fork	Fall/Winter	666	89.1	66	183	513	8.1	2.9	17.5	513	1.12	0.59	1.78
South Fork	Fall/Winter	57	103.4	78	134	55	12.3	4.8	20.4	55	1.10	0.83	1.59
All Sites	Fall/Winter	2289	96.8	66	183	1947	10.9	2.9	37.2	1947	1.14	0.43	1.80
Mainstem	Spring	2280	103.4	75	193	1459	12.9	3.8	44.2	1459	1.15	0.58	1.75
Middle Fork	Spring	622	93.7	70	132	552	9.2	3	25.9	552	1.08	0.64	1.76
South Fork	Spring	23	103.9	87	126	22	12.7	7.3	22	22	1.10	0.72	1.31
All Sites	Spring	2925	101.4	70	193	2033	11.9	3	44.2	2033	1.13	0.58	1.76

Appendix Table 2. Upper Mainstem John Day River smolt/redd ratios based on estimates of smolt abundance and census redd counts for spring Chinook salmon, 2002–2009 brood years.

Brood year	Number of redds	Migrati on year	Trapping period	Smolt Estimate	95% CI	Smolt/redd	95% CI
2002	549	2004	10/23/03–6/24/04	54,968	44,420–70,653	100	81–129
2003	260	2005	10/4/04–7/6/05	33,696	30,356–37,533	130	117–144
2004	242	2006	2/10/06–6/26/06	33,642	21,006–61,272	139	87–253
2005	203	2007	10/12/06–6/22/07	54,261	42,524–70,768	267	209–349
2006	318	2008	10/10/07–6/20/08	46,305	41,027–52,289	146	129–164
2007	250	2009	9/30/08–7/14/09	73,961	63,795–86,624	296	255–346
2008	248	2010	10/7/09 – 6/28/10	55,291	47,810–64,407	223	193–260
2009	468	2011	10/1/10 – 6/5/11	82,241	73,721–92,713	176	158–198

Appendix Table 3. Middle Fork John Day River smolt/redd ratios based on estimates of smolt abundance and census redd counts for spring Chinook salmon, 2002–2009 brood years.

Brood Year	Number of redds	Migration Year	Trapping period	Smolt Estimate	95% CI	Smolt/redd	95% CI
2002	389	2004	10/29/03–6/23/04	23,901	19,449–30,188	61	50–78
2003	236	2005	10/6/04–6/17/05	21,957	18,747–25,489	93	79–108
2004	319	2006	3/6/06–6/22/06	18,465	14,423–24,186	58	45–76
2005	178	2007	10/31/06–6/14/07	16,901	14,279–20,755	95	80–117
2006	199	2008	2/12/08–6/20/08	7,382	5,553–9,990	37	28–50
2007	85	2009	9/29/08–6/18/09	38,519	34,191–43,658	453	402–514
2008	169	2010	10/7/09 – 6/25/10	35,712	33,413–38,333	211	198–227
2009	251	2011	9/28/10 – 6/3/11	21,322	17,906–26,217	85	71–104

Appendix Table 4. Smolts/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 prior to the 1999 brood year are from Lindsay et al. (1986).

Brood Year	Redds	Smolt Abundance	95% CI		Smolts per redd	95% CI	
			Lower	Upper		Lower	Upper
1978	611	169,000	80,000	257,000	277	131	421
1979	641	83,000	52,000	113,000	129	81	176
1980	306	94,000	1,000	211,000	307	3	690
1981	401	64,000	40,000	89,000	160	100	222
1982	498	78,000	64,000	93,000	157	129	187
1998	-	38,770	30,663	50,539	-	-	-
1999	478	81,848	69,362	97,991	171	145	205
2000	1,869	85,726	73,557	98,895	46	39	53
2001	1,863	83,228	75,887	91,107	45	41	49
2002	1,959	93,174	75,872	113,900	48	39	58
2003	1,354	124,293	94,346	164,680	92	70	122
2004	1,531	74,293	39,507	149,530	49	26	98
2005	878	41,905	33,307	53,984	48	38	61
2006	909	70,319	60,580	82,802	77	67	91
2007	746	55,055	46,842	64,957	74	63	87
2008	963	141,531	123,997	161,164	147	129	167
2009	1,221	-	-	-	-	-	-

Appendix Table 5. Trap site, smolt migration year, trapping period, summer steelhead abundance estimate, and 95% confidence intervals of estimates 2004 –2011

Trap site	RKm	MY	Period	Abundance	95% CI Lower	95% CI Upper
South Fork	10	2004	10/10/03–6/18/04	22,298	19,804	25,007
		2005	9/2/04–6/17/05	27,820	23,824	33,048
		2006	10/7/05– 6/21/06	22,539	17,930	28,770
		2007	10/13/06– 6/16/07	17,888	15,596	20,924
		2008	10/4/07 –6/19/08	19,901	18,500	21,334
		2009	9/30/08 –6/25/09	43,575	38,670	49,181
		2010	10/6/09 –6/30/10	27,851	25,477	30,528
		2011	9/24/10 –6/17/11	41,274	37,016	46,696
Mainstem	326	2004	1/13/04 –6/23/04	53,757	37,444	78,425
		2005	10/4/04 –6/30/05	50,452	34,631	82,959
		2006	2/9/06 –6/25/06	63,617	23,287	100,310
	352	2007	10/12/06– 6/22/07	39,676	31,450	52,388
		2008	10/10/07 –6/20/08	24,664	19,806	30,275
		2009	10/1/08 –7/15/09	50,198	39,541	64,436
		2010	10/7/09 –6/30/10	15,774	13,396	19,007
		2011	10/1/10 –6/5/11	50,976	42,269	62,601
Middle Fork	24	2004	10/28/03 –6/22/04	20,974	17,021	26,238
		2005	10/6/04 –6/15/05	25,426	18,398	37,605
		2006	3/6/06 –6/21/06	22,668	15,598	33,540
		2007	10/30/06– 6/14/07	25,381	20,703	31,594
		2008	2/12/08 –6/20/08	6,248	3,657	10,970
		2009	9/29/08 –6/18/09	14,522	9,646	23,223
		2010	10/6/09 –6/24/10	25,032	21,016	29,982
		2011	9/28/10 –6/3/11	18,301	11,522	30,028

Appendix Table 6. Number (N), mean, and range of fork length (mm), mass (g), and coefficient of condition for steelhead migrants captured at rotary screw traps on the John Day River during two periods (Fall/Winter, 24 September 2010–31 January 2011; Spring, 1 February 2011–17 June 2011).

		Fork Length (mm)				Weight (g)				Coefficient of Condition			
Trap/Seine Site	Season	N	Mean	Min	Max	N	Mean	Min	Max	N	Mean	Min	Max
Mainstem	Fall/Winter	718	141.5	66	241	627	34.2	2.6	122.3	627	1.07	0.58	1.64
Middle Fork	Fall/Winter	47	157.6	115	237	44	47.5	14.3	143.3	44	1.04	0.84	1.25
South Fork	Fall/Winter	1974	139.4	71	256	1822	31.6	2.6	188.7	1822	1.03	0.33	1.67
All Sites	Fall/Winter	2739	140.3	66	256	2493	32.5	2.6	188.7	2493	1.04	0.33	1.67
Mainstem Trap	Spring	1204	164.1	69	252	1098	46.9	3.7	140.5	1098	1.01	0.52	1.55
Middle Fork	Spring	392	164.2	88	244	387	47.1	6.9	146.8	387	1.00	0.78	1.22
South Fork	Spring	1288	154.6	71	274	1219	40.7	3.5	204.8	1219	1.01	0.38	1.45
All Sites	Spring	2884	159.9	69	274	2704	44.2	3.5	204.8	2704	1.01	0.38	1.55

Appendix Table 7. Migration year, number of smolts PIT tagged, estimated smolt survival to John Day Dam, adult PIT tag return years, number and age of PIT tagged adults detected at Bonneville Dam and in the John Day Basin during the return years, and estimated smolt-to-adult ratio (SAR) of John Day spring Chinook salmon PIT tagged during migration years 2000–2009.

Migration	Smolts	Survival to John Day Dam			Returning Adult Detections				
Year	Tagged	Point Estimate	Lower	Upper	Age 3	Age 4	Age 5	Age 6	Total
2000	1,852	1,275	1,121	1,429	4	112	28		144
2001	3,893	2,737	2,598	2,875	7	80	15	1	103
2002	4,000	2,605	2,219	2,992	5	86	9		100
2003	6,147	4,221	3,830	4,613	5	110	13		128
2004	4,435	2,813	2,161	3,465	5	68	20		93
2005	5,794	3,920	3,511	4,330	8	61	10		79
2006	3,418	2,252	1,940	2,564	2	34	12		48
2007	4,055	2,745	2,512	2,978	20	116	6		142
2008	3,998	2,973	2,655	3,291	22	148	16		186
2009	4,005	2,814	2,516	3,113	10	193[b]			203

[b] one fish not detected at Bonneville but observed at upstream arrays

Appendix Table 8. Estimated survival rate of spring Chinook from John Day Dam to adult detection at Bonneville Dam.

Migration Year	SAR (John Day Dam to Adult)		
	Point Estimate	Lower	Upper
2000	11.3%	10.1%	12.9%
2001	3.8%	3.6%	4.0%
2002	3.8%	3.3%	4.5%
2003	3.0%	2.8%	3.3%
2004	3.3%	2.7%	4.3%
2005	2.0%	1.8%	2.3%
2006	2.1%	1.9%	2.5%
2007	5.2%	4.8%	5.6%
2008	6.3%	5.6%	7.0%
2009	7.2%[a]	6.5%	8.1%

[a] preliminary estimate, age 5 fish return next year.

Appendix Table 9. Migration year, number of smolts PIT tagged, estimated smolt survival to John Day Dam, adult PIT tag return years, number and saltwater age of PIT tagged adults detected at Bonneville Dam of summer steelhead PIT tagged during migration years 2004–2009.

Migration	Smolts	Survival to John Day Dam			Adult Detections		
Year	Tagged	Point Estimate	Lower	Upper	1-salt	2-salt	Total
2004	3,682	2,413	1,909	2,916	59	44	103
2005	4,779	3,152	2,516	3,788	55	28	83
2006	1,834	1,482	1,122	1,733	30	18	48
2007	4,016	2,982	2,501	3,462	180	67	247
2008	3,991	3,360	2,876	3,631	213	96	309
2009	3,946	2,300	1,902	2,698	104	93	197

Appendix Table 10. Estimated survival rate of summer steelhead from John Day Dam to adult detection at Bonneville Dam.

	SAR (John Day Dam to Adult)		
Migration Year	Point Estimate	Lower	Upper
2004	4.3%	3.5%	5.4%
2005	2.6%	2.2%	3.3%
2006	3.2%	2.8%	4.3%
2007	8.3%	7.1%	9.9%
2008	9.2%	8.5%	10.7%
2009	8.6%	7.3%	10.4%

Appendix Table 11. Trap location, season, number of scale samples taken (n), and percent age composition of four size categories (fork length, FL) of juvenile summer steelhead sampled at three rotary screw trap sites during the fall/winter and spring seasons of the 2011 migration.

Location	Season	FL (mm)	n	Age 1	Age 2	Age 3	Age 4
Middle Fork Trap	Fall/Winter	65-90	0				
		91-120	5		100		
		121-200	26	4	85	12	
		≥ 201	5		60	40	
	Spring	65-90	1	100			
		91-120	8	75	25		
		121-200	56	7	66	27	
		≥ 201	22		45	55	
Mainstem Trap	Fall/Winter	65-90	13	100			
		91-120	25	28	72		
		121-200	32		94	6	
		≥ 201	20		100		
	Spring	65-90	17	100			
		91-120	22	77	23		
		121-200	54	15	78	7	
		≥ 201	50		80	20	
South Fork Trap	Fall/Winter	65-90	25	92	8		
		91-120	25	40	60		
		121-200	25	4	84	12	
		≥ 201	27		70	26	4
	Spring	65-90	30	97	3		
		91-120	52	81	19		
		121-200	51	18	80	2	
		≥ 201	32		88	13	

Appendix Table 12. Estimated age structure by migratory year of juvenile steelhead captured at rotary screw trap sites in the John Day River from 2005 to 2011.

		Age Structure (%)			
	MY	1	2	3	4
Mainstem	2005	15.0%	74.5%	10.5%	0.1%
	2006	17.9%	58.2%	23.9%	0.0%
	2007	8.3%	86.0%	5.7%	0.0%
	2008	23.6%	75.1%	1.3%	0.0%
	2009	19.9%	77.4%	2.7%	0.0%
	2010	26.8%	71.1%	2.1%	0.0%
	2011	13.1%	80.3%	6.6%	0.0%
South Fork	2005	16.0%	78.5%	5.5%	0.2%
	2006	0.1%	63.9%	36.0%	0.0%
	2007	16.2%	73.6%	10.1%	0.2%
	2008	18.7%	76.6%	4.7%	0.0%
	2009	19.7%	74.8%	5.5%	0.1%
	2010	17.5%	76.5%	6.0%	0.0%
	2011	21.8%	73.4%	4.7%	0.1%
Middle Fork	2005	8.7%	62.1%	27.7%	0.8%
	2006	4.1%	68.7%	26.9%	0.2%
	2007	5.6%	84.6%	9.1%	0.0%
	2008	7.5%	86.6%	5.9%	0.0%
	2009	2.1%	80.8%	17.1%	0.0%
	2010	7.8%	84.8%	7.3%	0.0%
	2011	6.9%	69.5%	23.7%	0.0%

Appendix Table 13. South Fork John Day River summer steelhead out-migrants per spawner estimates based on out-migrant abundance estimate from rotary screw trap and escapement estimates from the South Fork Subsample spawning surveys during the 2006–2011 brood years (Banks et al 2011).

Brood Year	Escapement	95% CI		Out-migrant Estimate	95% CI		Out-migrants / Spawner	95% CI	
2006	309	145	472	22,210	18,822	22,434	72	40	155
2007	756	252	1,260	38,000	33,925	42,623	50	27	169
2008	1,224	624	1,824	31,834[a]	28,851	35,241	26[a]	16	56
2009	1,833	795	2,867	35,154[b]	31,614	39,601	19[b]	11	50
2010	432	173	692	Currently Incomplete					
2011	934	0	2,034						

[a] Age 4 smolts not included.
[b] Age 3 and age 4 smolts not included.