Investigations into the Life History of Naturally Produced Spring Chinook Salmon and Summer Steelhead in the Grande Ronde River Subbasin

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ABSTRACT

Juvenile Spring Chinook Salmon and Summer Steelhead Life History Monitoring

We determined migration timing, abundance, and survival of juvenile spring Chinook salmon *Oncorhynchus tshawytscha* and steelhead *Oncorhynchus mykiss* using rotary screw traps at five locations in the Grande Ronde River Subbasin. Abundance estimates of juvenile Chinook salmon and steelhead migrants was lower in 2015 than the past 3 – 5 years in our four study streams, except for juvenile steelhead migrants in the Upper Grande Ronde River. The low abundances resulted from lower spawners in 2013 and may also have been affected by low stream flows.

Combining spring Chinook salmon migrant abundance estimates and survival estimates with estimates of spawners, obtained from Lower Snake River Compensation Plan - Oregon Evaluation Project, we estimate smolts per spawner, which is an indicator for the Viable Salmonid Population (VSP) parameter, productivity. In Catherine Creek, we were unable to estimate survival of the early migrants due to insufficient observations of PIT-tagged fish, and therefore we are not able to estimate smolt equivalents and productivity for the 2013 brood year. We estimated that in Lostine River the number of spring Chinook salmon smolt equivalents leaving Lostine River was 18,034 for the 2013 brood year, for productivity of 52 smolts per spawner. We estimated that in Minam River the number of spring Chinook salmon smolt equivalents leaving Minam River was 12,654 for the 2013 brood year, for productivity of 41 smolts per spawner. We estimated that in upper Grande Ronde River the number of spring Chinook salmon smolt equivalents leaving upper Grande Ronde River was 15,114 for the 2013 brood year, for productivity of 48 smolts per spawner.

The relationship between number of migrants and the size of fish seemed to hold in 2015. In most streams in 2015, the lower number of migrants resulted in larger spring migrants than in recent years with higher abundance. Habitat restoration projects funded by BPA and Bureau of Reclamation in the Upper Grande Ronde River watershed are addressing habitat capacity which should, in turn, result in an increase in productivity, such as smolts/spawner.

Steelhead emigrant abundance was above the trend line in the Upper Grande Ronde River and below the trend line in Catherine Creek, and the Minam and Lostine rivers. In the future, this project will combine the out-migrant estimates, age structure, and survival rates to quantify the number of smolts by age and relate to the appropriate number of spawners to estimate smolts/spawner, a VSP indicator of productivity.

Steelhead Spawner Surveys

We conducted 166 surveys in the Upper Grande Ronde River (UGRR) basin and 78 surveys in the Joseph Creek basin from 24 February through 10 June 2015 to determine summer steelhead Oncorhynchus mykiss redd abundance and adult escapement for these two populations. We sampled 29 random, spatially-balanced sites throughout the UGRR basin encompassing 61.6 km

(6.9%) of an estimated 892 km of available steelhead spawning habitat. In Joseph Creek, we surveyed 24 sites encompassing 48.3 km (12.6 of the 384 km of available spawning habitat). During these surveys we observed 246 steelhead redds and 12 live steelhead in the UGRR basin and 286 redds and 47 live steelhead in the Joseph Creek basin. We observed eight carcasses in Joseph Creek basin and three carcasses in the UGRR basin.

On 18.7 km of Deer Creek, 49 redds, 39 live steelhead, and 49 carcasses were observed during five survey visits. A total of 66 adult steelhead were passed above a permanent weir on Deer Creek based on marked and unmarked fallbacks at the weir, resulting in a 1.37 fish:redd ratio for the 2015 spawning season.

Abundance of Steelhead Spawners at the Population Level

Using the fish:redd ratio extrapolated from Deer Creek surveys, adult steelhead escapement estimates for the UGRR and Joseph Creek basins were 4,837 adult steelhead (95% C.I.: 2,946–6,728) and 2,967 adult steelhead (95% C.I.: 1,976–3,958)respectively. Escapement estimates in the UGRR sub-basin had been relatively stable from 2008-2012, but showed a substantial decrease in 2013. Estimates from 2014-2015 rebounded from this low, but still were lower than the long term average. The UGRR estimate was roughly half of its running average over that period of time. This was the third GRTS-based steelhead spawning ground survey in Joseph Creek, and estimates were the highest we have observed through this project.

Steelhead and Chinook Salmon Parr Surveys, Parr Density, and Distribution.

Salmonids were observed at 52 of the 55 surveyed CHaMP sites in 2015. Three sites went dry early in the summer, and were not surveyed for fish.

Steelhead were most widely distributed of the salmonids, and found in every stream. Chinook were more restricted in their distribution, but were observed in relatively high numbers in some smaller tributaries: Fly, Clark and Sheep creeks.

Overall counts for both species were higher than in the past four years. We observed 8,126 juvenile Chinook and 7,398 juvenile steelhead at all sites. Most individuals were in the age zero size category, though we did observe a higher than average number of precocious male Chinook (100-200 mm) during snorkel surveys.

Our population estimation formulae were updated in 2015 through comparisons of mark/recapture population estimates to snorkel counts. The resulting formulae had a higher ratio of population estimate to snorkel count, and thus our abundance estimates are much higher in 2015 than 2011 – 2014. The new formulae will be retroactively applied to older snorkel data to standardize comparisons of fish abundance and density across years.

Introduction

The goal of this project is to investigate the critical habitat, abundance, migration patterns, survival, and alternate life history strategies exhibited by spring Chinook salmon and summer steelhead juveniles from distinct populations in the Grande Ronde River and Imnaha River subbasins (Figures 1 and 2). This project will provide information on abundance of spring Chinook salmon and steelhead parr , estimates for egg-to-migrant survival for spring Chinook salmon and migrant survival for steelhead, estimate the Viable Salmonid Population (VSP) Indicator smolts per spawner for four populations of spring Chinook salmon, and assess stream conditions in selected study streams. This study provides a means for long term monitoring of juvenile salmonid production in the Grande Ronde and Imnaha River subbasins that is essential for assessing the success of restoration and enhancement efforts including hatchery supplementation and habitat improvement. As hatchery supplementation of spring Chinook salmon continues in the Grande Ronde Subbasin, we will monitor abundance of migrants, life history characteristics, and survival to various life stages to provide data to the Lower Snake River Compensation Plan - Oregon Evaluation project to determine the effectiveness of this management action.

This project coordinates and collaborates with many projects, including Columbia River Intertribal Fish Commission (CRITFC) and their project 2009-004-00 Monitoring Recovery Trends in Key Spring Chinook Habitat Variables and Validation of Population Viability Indicators, the Columbia Habitat and Monitoring Program (CHaMP) project 2011-006-00, and Lower Snake River Compensation Plan - Oregon Evaluation project. This project collects genetic samples from juvenile Chinook salmon and provides them to NOAA Fisheries for the Columbia Basin-wide Relative Reproductive Success (RSS) study, project 1989-096-00. This project provides data for the Interior Columbia Technical Recovery Team (ICTRT) spring Chinook salmon life cycle model.

Objectives for FY15:

1. Document the in-basin migration patterns and estimate abundance of spring Chinook salmon juveniles in Catherine Creek and the upper Grande Ronde, Minam, and Lostine rivers.

2. Determine overwinter mortality and the relative success of fall (early) migrant and spring (late) migrant life history strategies for spring Chinook salmon from tributary populations in Catherine Creek and the upper Grande Ronde, and Lostine rivers, and the relative success of fall (early) migrant and spring (late) migrant life history strategies for spring Chinook salmon from the Minam River.

3. Estimate and compare smolt survival probabilities at main stem Columbia and Snake River dams for migrants from five local, natural populations of spring Chinook salmon in the Grande Ronde River and Imnaha River subbasins.

4. Document the annual migration patterns for spring Chinook salmon juveniles from five local, natural populations in the Grande Ronde River and Imnaha River subbasins: Catherine Creek, Upper Grande Ronde, Lostine, Minam, and Imnaha rivers.

5. Document patterns of movement and estimate abundance of juvenile steelhead from tributary populations in Catherine Creek, the upper Grande Ronde, Lostine and the Minam rivers including migration timing, and duration.

6. Estimate and compare survival probabilities to main stem Columbia and Snake River dams for summer steelhead from four tributary populations: Catherine Creek and the upper Grande Ronde, Lostine, and Minam rivers.

7. Describe aquatic habitat conditions, using water temperature and discharge, in Catherine Creek and the upper Grande Ronde, Lostine, and Minam rivers.

8. Estimate adult steelhead escapement to the Upper Grande Ronde and Joseph Creek populations.

9. Estimate density and distribution of steelhead parr from the Upper Grande Ronde population and Chinook salmon parr from the Upper Grande Ronde and Catherine Creek populations.

The project addresses the following strategy questions associated with Fish Population Status Monitoring:

- Assess the status and trend of juvenile abundance and productivity of natural origin fish populations.
  What are the status and trend of juvenile abundance and productivity of fish populations?

- Assess the status and trend of spatial distribution of fish populations.
  What are the status and trend of spatial distribution of fish populations?

- Assess the status and trend of diversity of natural and hatchery origin fish populations.
  What are the status and trend of diversity of natural and hatchery origin fish populations?

The focal species are Snake River Spring/Summer Chinook salmon and Snake River steelhead.

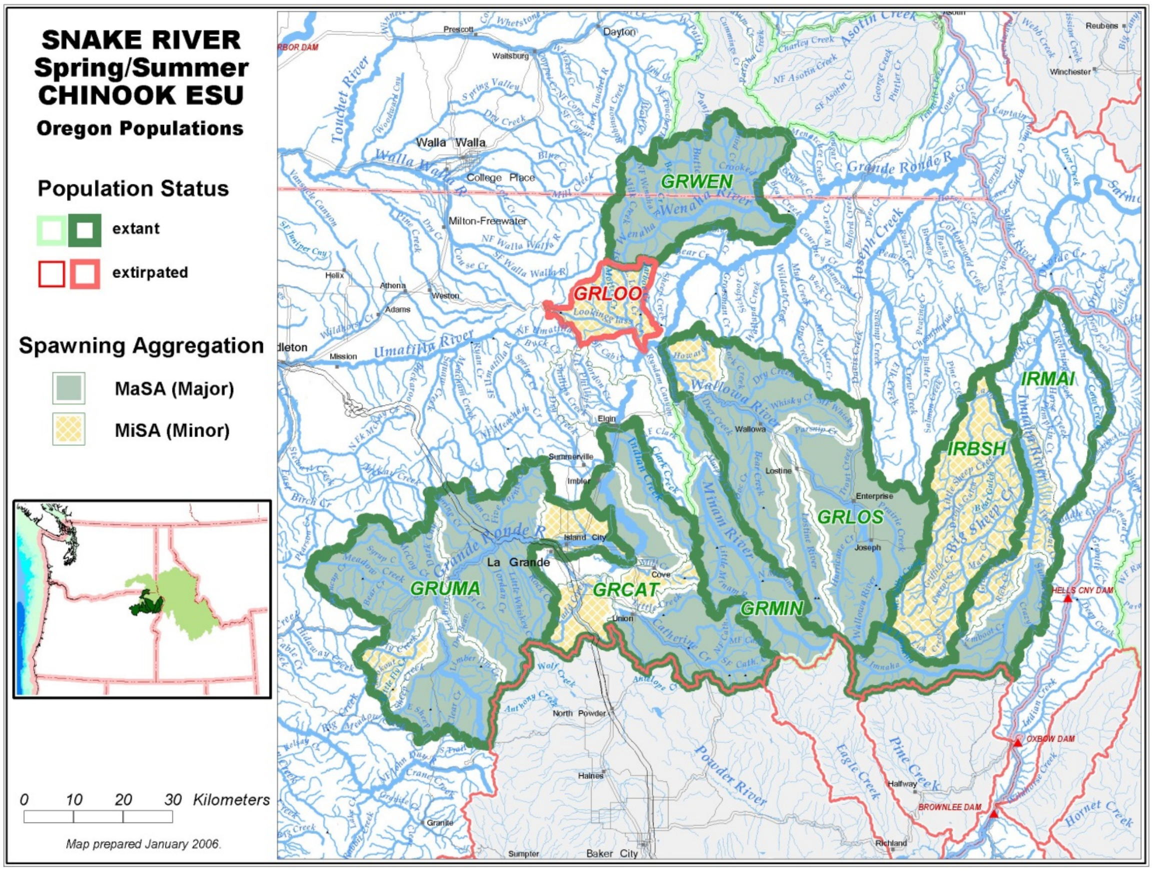

Figure 1. Map of the Grande Ronde-Imnaha spring Chinook salmon MPG with individual Chinook salmon populations identified. This project monitors these populations within this MPG: Upper Grande Ronde River (GRUMA), Catherine Creek (GRCAT), Minam River (GRMIN), Lostine River (GRLOS), and Imnaha River (IRMAI).

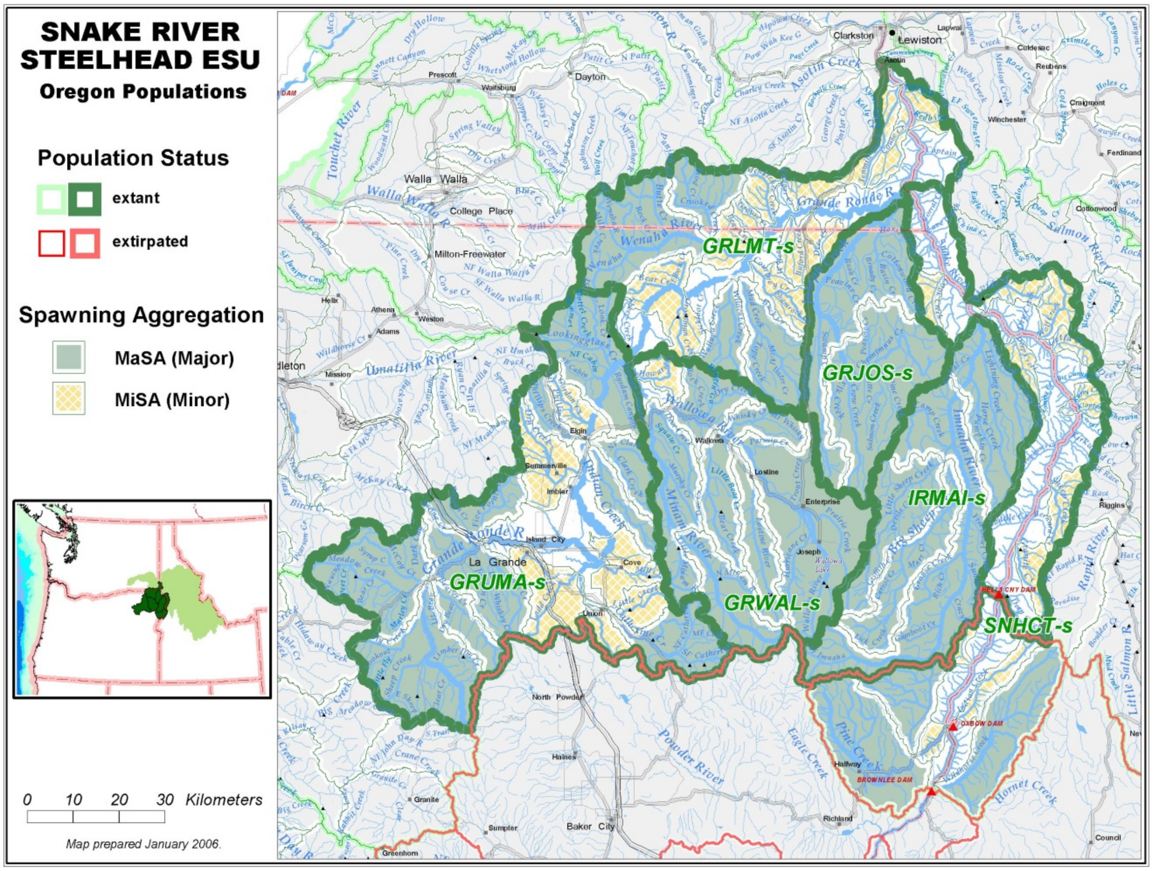

Figure 2. Map of the Grande Ronde-Imnaha steelhead MPG with individual steelhead populations identified. This project monitors these populations within this MPG: Upper Grande Ronde River (GRUMA-s), Wallowa River (GRWAL-s), and Joseph Creek (GRJOS-s).

Juvenile Spring Chinook Salmon and Summer Steelhead Life History Monitoring

Introduction

Numerous enhancement activities, including hatchery supplementation and habitat restoration, have been undertaken to recover spring Chinook salmon populations in Grande Ronde River Subbasin. Supplementation programs have been initiated by Oregon Department of Fish and Wildlife, the Confederated Tribes of the Umatilla Indian Reservation, and the Nez Perce Tribe using endemic broodstock from Catherine Creek and Lostine and upper Grande Ronde rivers. This study provides a means for long term monitoring of juvenile salmonid production in the Grande Ronde and Imnaha River subbasins that is essential for assessing the success of restoration and enhancement efforts including hatchery supplementation and habitat improvement. As hatchery supplementation of spring Chinook salmon continues in the Grande Ronde Subbasin, we will monitor abundance of migrants, life history characteristics, and survival to various life stages to determine the effectiveness of this management action.

Methods

Life history of spring Chinook salmon and summer steelhead (1992-026-04):
http://www.monitoringmethods.org/Protocol/Details/217

The locations of the rotary screw traps are shown in Figure 3.

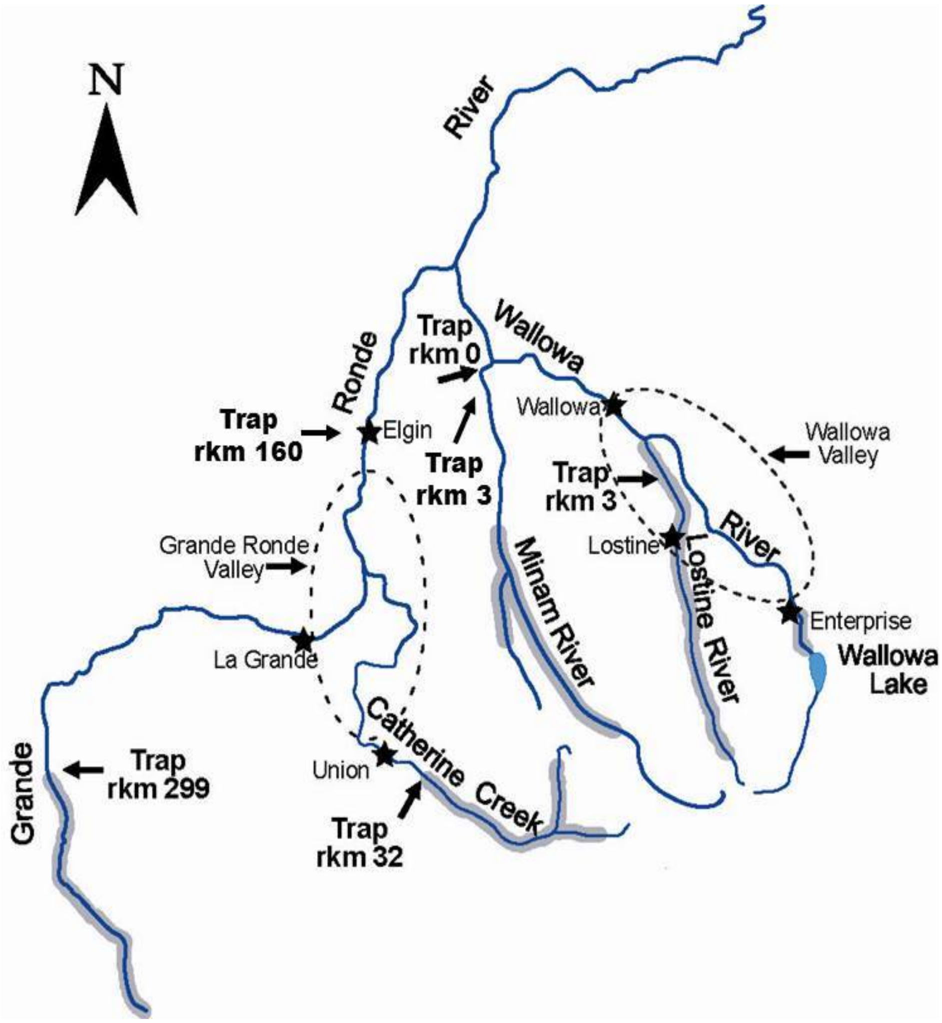

Figure 3. Locations of fish traps in Grande Ronde River Subbasin during the study period. Shaded areas delineate spring Chinook salmon spawning and upper rearing areas. Dashed lines indicate Grande Ronde and Wallowa river valleys.

Results

Spring Chinook Salmon

We estimated a minimum of 12,325 ± 896 juvenile spring Chinook salmon emigrated from Catherine Creek upper rearing areas during MY 2015 (Figure 4). Based on total minimum estimate, 83% (10,261 ± 290) migrated early and 17% (2,064 ± 848) migrated late.

We estimated a minimum of 24,133 ± 1,673 juvenile spring Chinook salmon emigrated from Lostine River during MY 2015 (Figure 5). Based on the minimum estimate, 72% (17,314 ± 1,553) of juvenile spring Chinook salmon migrated early, while 28% (6,819 ± 623) migrated late.

We estimated a minimum of 19,624 ± 924 juvenile spring Chinook salmon emigrated from Minam River during MY 2015 (Figure 6). Based on the minimum estimate, 49% (9,679 ± 587) of juvenile spring Chinook salmon migrated early and 51% (9,945 ± 713) migrated late.

We estimated a minimum of 13,935 ± 544 juvenile spring Chinook salmon emigrated from upper Grande Ronde River during MY 2015 (Figure 7). Based on the minimum estimate, 15% (2,152 ± 66) of juvenile spring Chinook salmon migrated early and 85% (11,783 ± 540) migrated late.

The middle Grande Ronde River trap at Elgin fished for fished for 80 d between 3 March 2015 and 8 June 2015. We estimated a minimum of 13,133 ± 1,737 juvenile spring Chinook salmon emigrated from upper rearing areas.

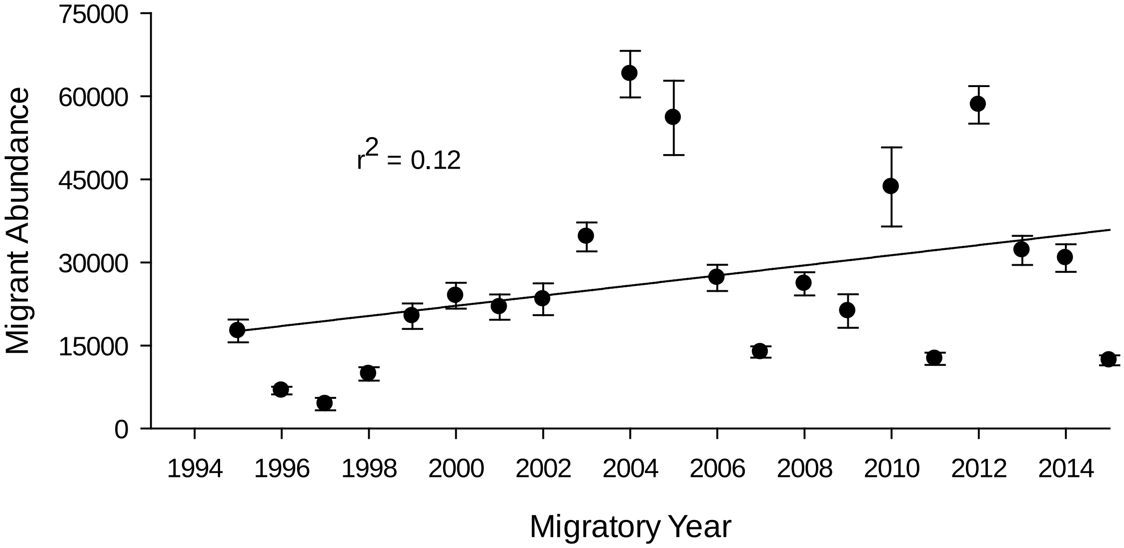

Figure 4. Spring Chinook salmon migrant abundance estimates at the Catherine Creek trap site by migratory year. Error bars are 95% confidence intervals.

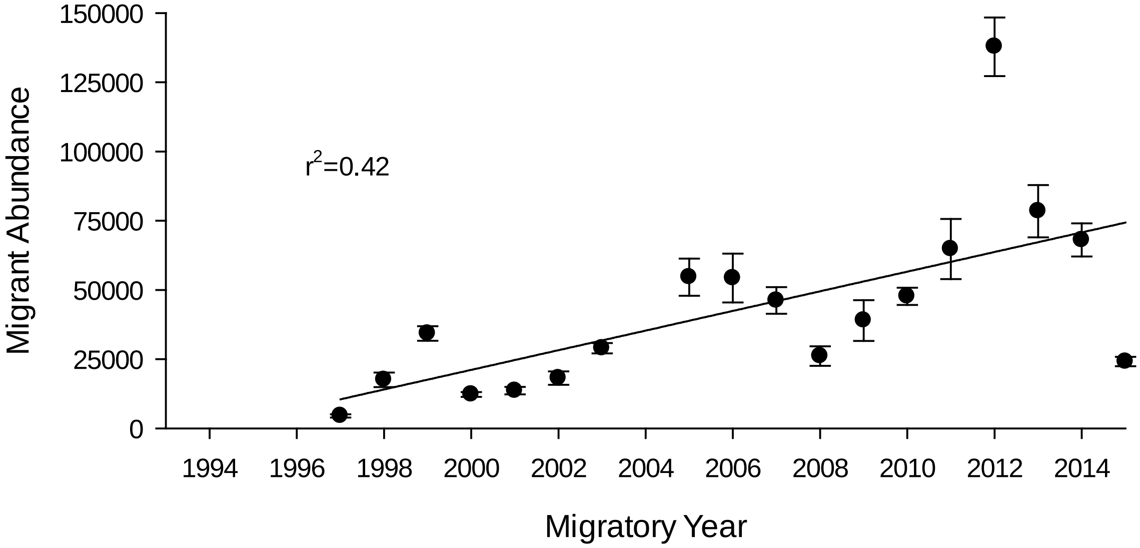

Figure 5. Spring Chinook salmon migrant abundance estimates at the Lostine River trap site by migratory year. Error bars are 95% confidence intervals.

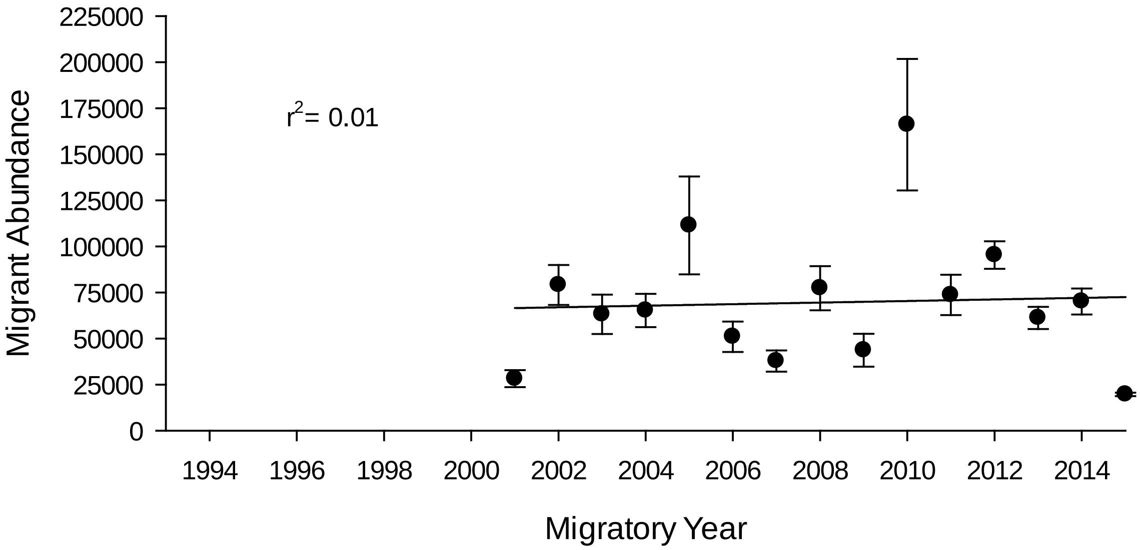

Figure 6. Spring Chinook salmon migrant abundance estimates at the Minam River trap site by migratory year. Error bars are 95% confidence intervals.

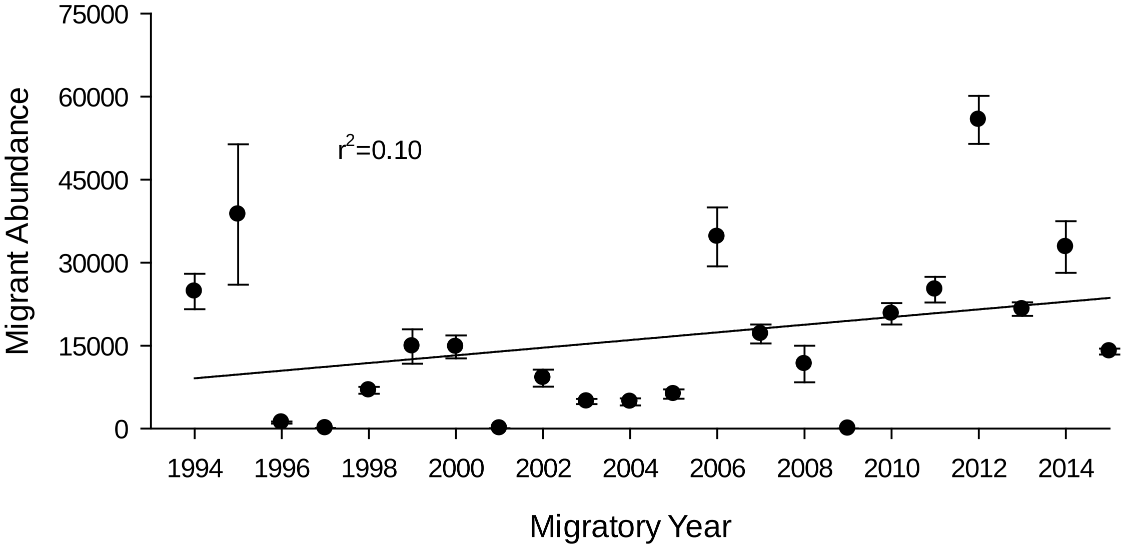

Figure 7. Spring Chinook salmon migrant abundance estimates at the upper Grande Ronde River trap site by migratory year. Error bars are 95% confidence intervals.

Fork lengths of juvenile spring Chinook salmon migrants at each of our rotary screw traps are shown in Figures 8 – 11. Mean fork lengths of migrants at the Catherine Creek, Minam, Lostine, and upper Grande Ronde River traps during the 2015 migratory year were within the range of fork lengths seen at these traps in previous years. We have observed that the length of fall migrants is negatively correlated with the abundance of parr in late summer (ODFW unpublished data). The data from 2015 generally supports this trend, as the lower number of migrants in 2015 is associated with larger migrants, relative to the last several years.

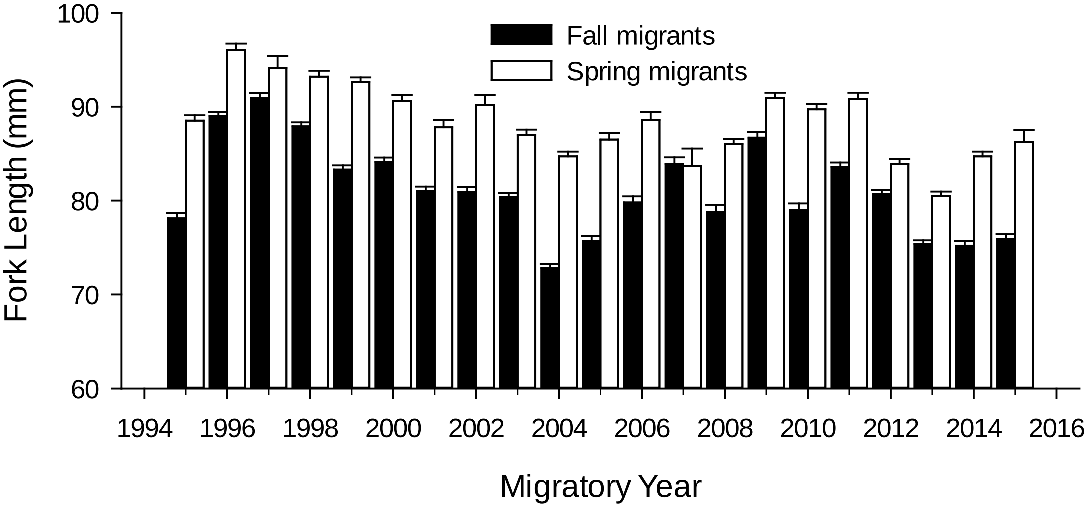

Figure 8. Fork length of spring Chinook salmon migrants captured at the Catherine Creek rotary screw trap by migratory year. Error bars are 95% confidence intervals.

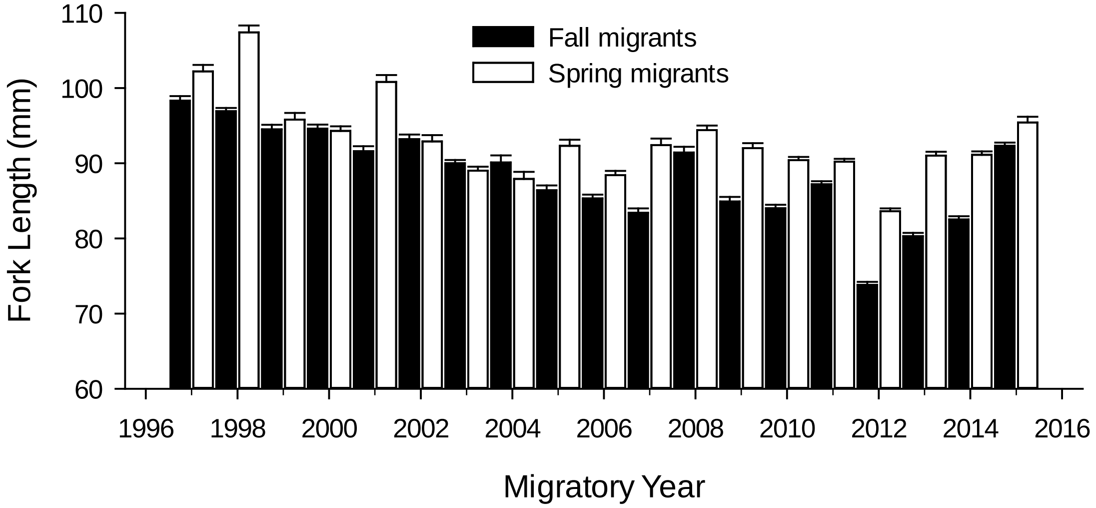

Figure 9. Fork length of spring Chinook salmon migrants captured at the Lostine River rotary screw trap by migratory year. Error bars are 95% confidence intervals.

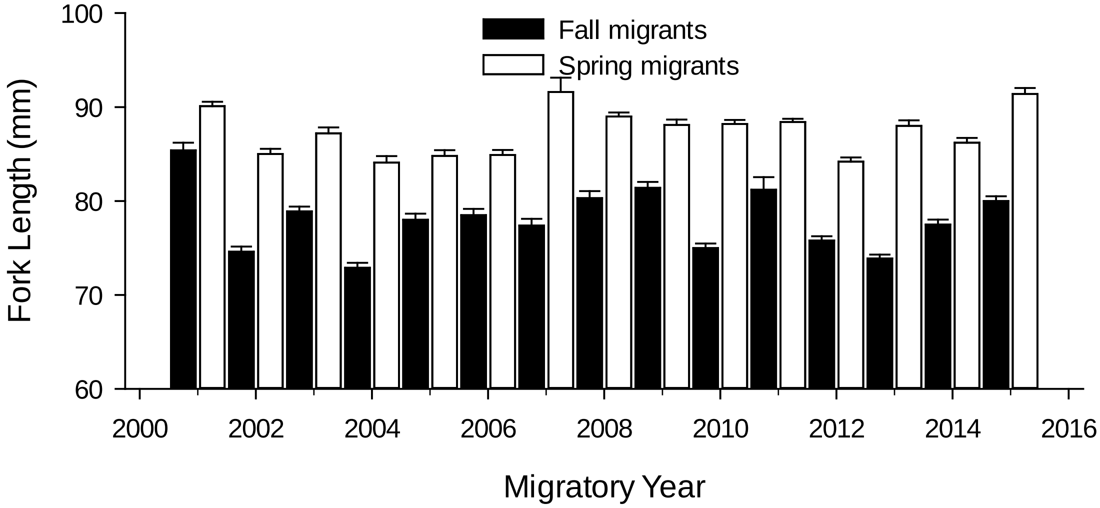

Figure 10. Fork length of spring Chinook salmon migrants captured at the Minam River rotary screw trap by migratory year. Error bars are 95% confidence intervals.

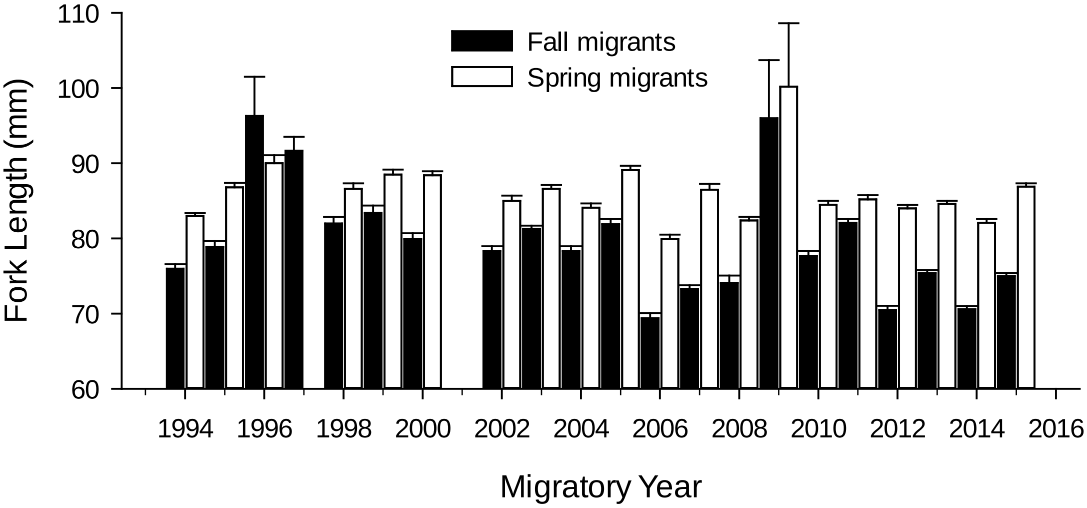

Figure 11. Fork length of spring Chinook salmon migrants captured at the upper Grande Ronde River rotary screw trap by migratory year. Error bars are 95% confidence intervals.

Survival probabilities to Lower Granite Dam for parr tagged during summer 2014 were 0.056 for Upper Catherine Creek, 0.061 for Lower Catherine Creek, 0.139 for Imnaha, 0.215 for Lostine, 0.131 for Minam, and 0.158 for upper Grande Ronde river populations (Figure 12). Generally, survival probabilities during MY 2015 fell within ranges previously reported; however, confidence intervals for these survival estimates in migratory year 2015 were very large, due in part to the relatively low number of multiple PIT tag detections in the hydrosystem.

Catherine Creek winter, and spring tag group survival probabilities to Lower Granite Dam were 0.040 and 0.280, respectively. Insufficient PIT tag detections prevented survival estimation of Catherine Creek fall migrants. Survival probabilities for Lostine River fall, winter, and spring tag groups were 0.168, 0.281, and 0.470, respectively. Probability of survival for the middle Grande Ronde River spring tag group was 0.601. Survival probabilities for Minam River fall and spring tag groups were 0.199 and 0.711, respectively. Upper Grande Ronde River fall, winter, and spring tag group survival probabilities to Lower Granite Dam were 0.086, 0.070, and 0.303, respectively. Survival probabilities, similar to past years, were generally higher for spring tag groups, likely because these fish were not subject to overwinter mortality that summer, fall, and winter tag groups experienced (Figure 12).

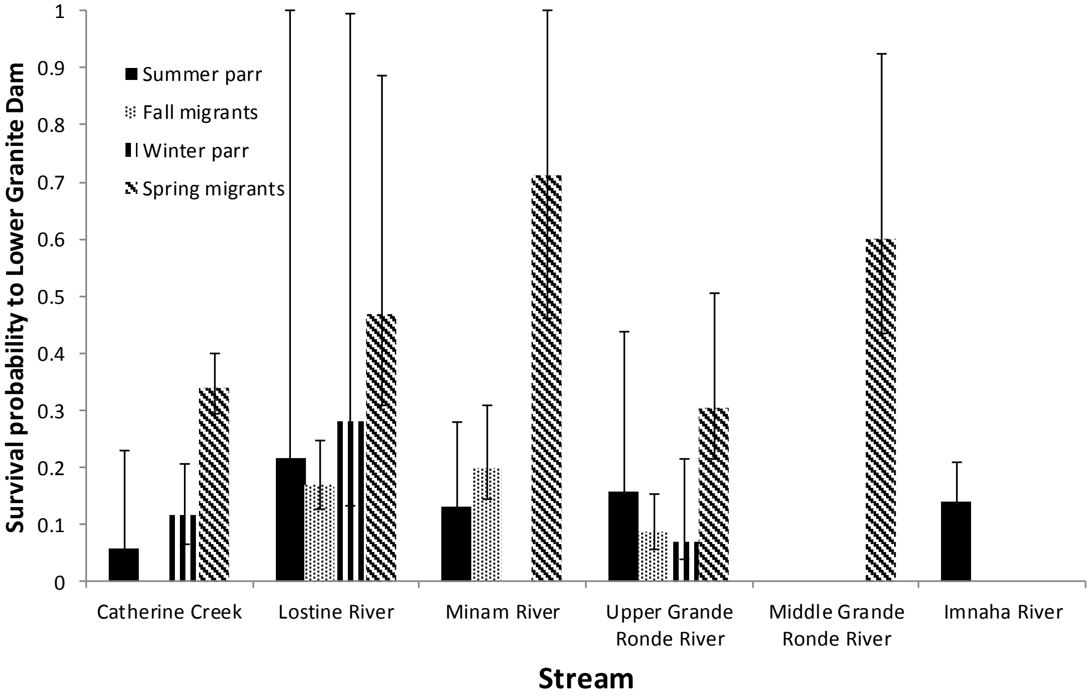

Figure 12. Survival probability to Lower Granite Dam of juvenile spring Chinook salmon PIT tagged at various life stages for the 2015 migratory year. Error bars are 95% confidence intervals.

Smolt equivalents are defined as the estimated number of smolts from a population that successfully emigrate from a specified area (Hesse et al. 2006). Combining the survival probability data with our migrant abundance estimates, we estimated the number of smolt equivalents produced in our study streams upstream of our rotary screw traps. In migratory year 2015 we estimated 13,008 smolt equivalents from Lostine River, 12,654 smolt equivalents from Minam River, and 12,394 smolt equivalents from upper Grande Ronde River (Figure 13). We were not able to estimate smolt equivalents from Catherine Creek in migratory year 2015 due to insufficient PIT tag detections of the fall tag group. Spring Chinook salmon smolt equivalents were lower in the Upper Grande Ronde River, Minam River, and Lostine River in 2015 compared to the last 5 years, due primarily to the lower spawner abundance in 2013.

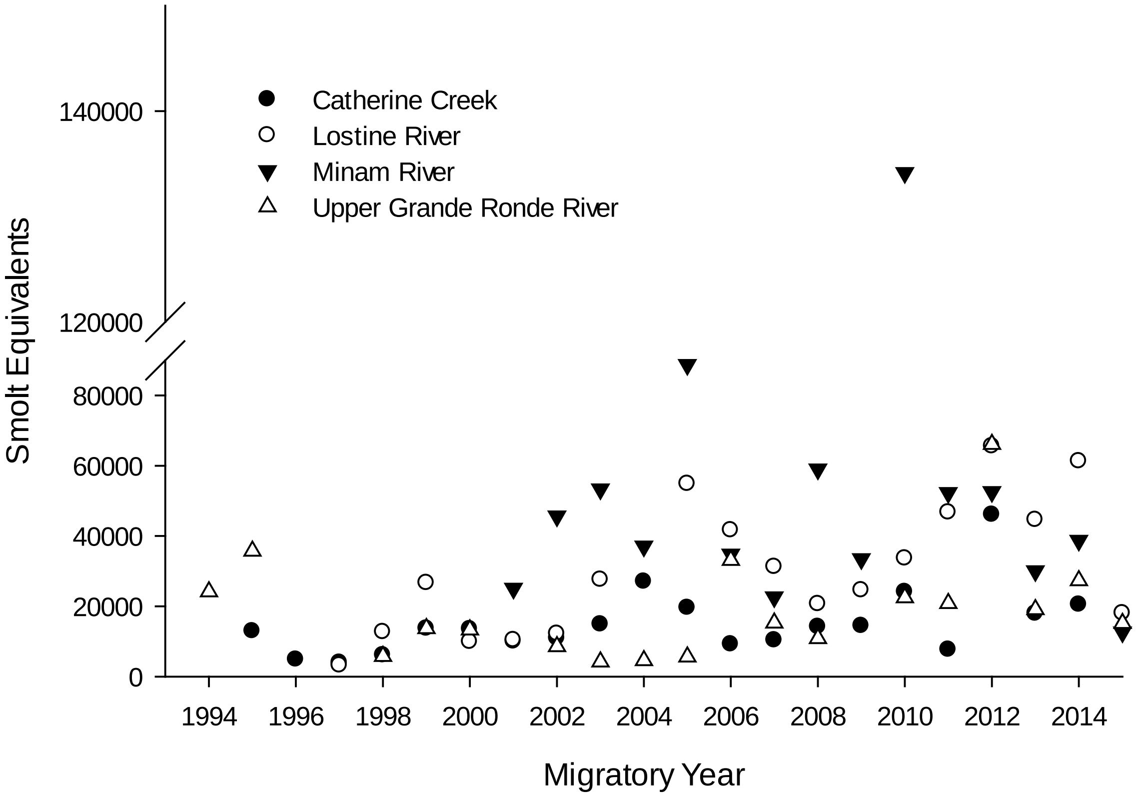

Figure 13. Spring Chinook salmon smolt equivalents produced from redds upstream of rotary screw traps in four study streams by migratory year.

We were not able to estimate productivity of spring Chinook salmon in Catherine Creek for the 2013 brood year (2015 migratory year) due to insufficient PIT tag detections. Estimated productivity in Catherine Creek from previous years is shown in Figure 14. Estimated productivity of spring Chinook salmon in Lostine River was 52 smolts per spawner for the 2013 brood year (2015 migratory year, Figure 15). Estimated productivity of spring Chinook salmon in Minam River was 41 smolts per spawner for the 2013 brood year (2015 migratory year, Figure 16). Estimated productivity of spring Chinook salmon in upper Grande Ronde River was 48 smolts per spawner for the 2013 brood year (2015 migratory year, Figure 17).

Plots of smolts per spawner versus spawners for each of the study streams show that productivity, as measured as smolts per spawner, decreases at higher spawner densities (Figures 18 – 21).

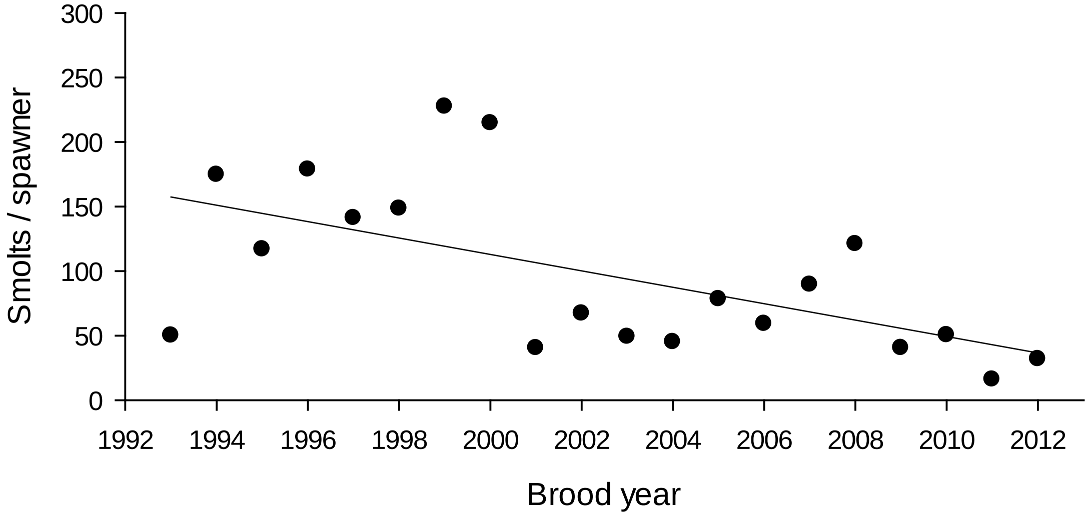

Figure 14. Spring Chinook salmon smolt equivalents produced per spawner in Catherine Creek by brood year. No estimate for brood year 2013.

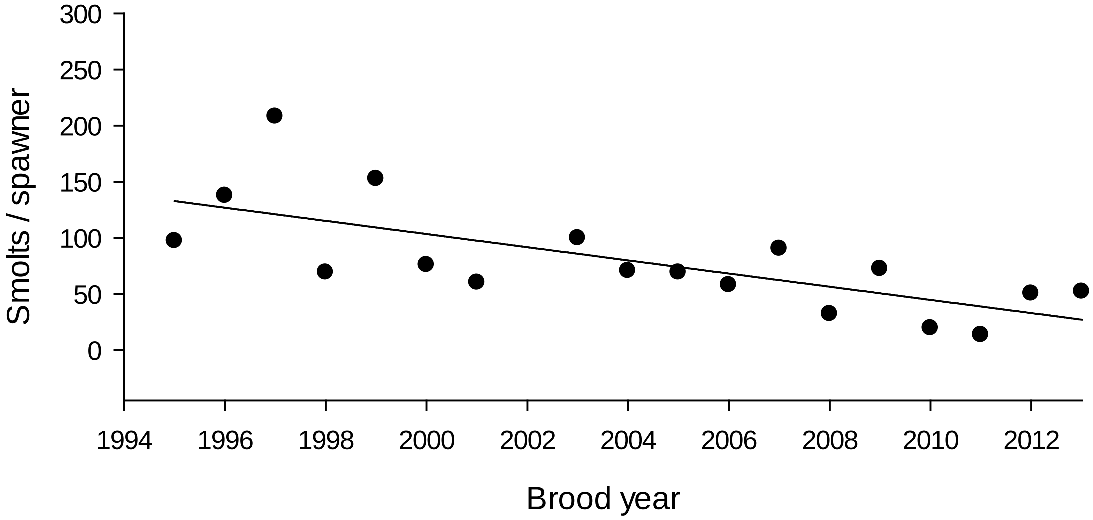

Figure 15. Spring Chinook salmon smolt equivalents produced per spawner in Lostine River by brood year.

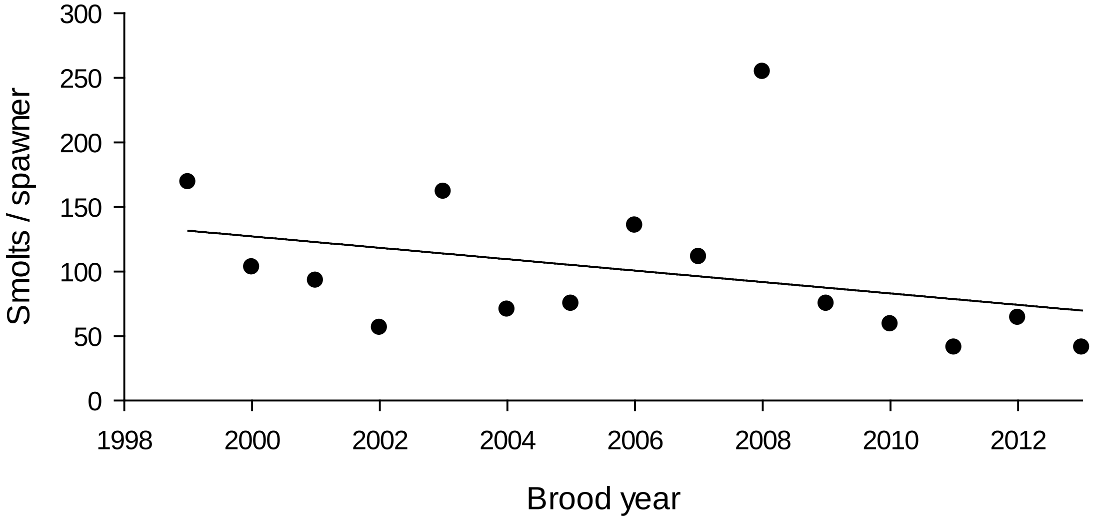

Figure 16. Spring Chinook salmon smolt equivalents produced per spawner in Minam River by brood year.

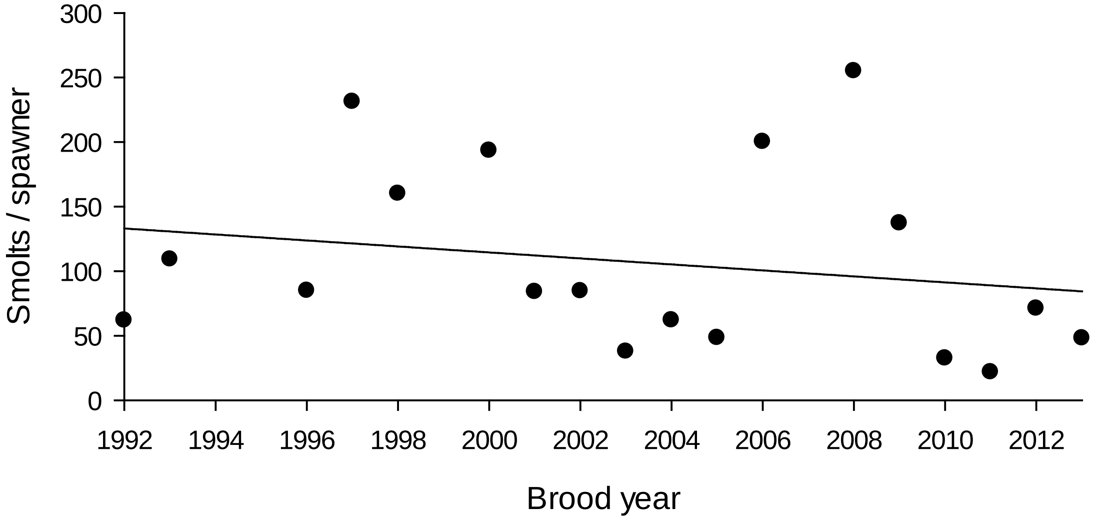

Figure 17. Spring Chinook salmon smolt equivalents produced per spawner in upper Grande Ronde River by brood year.

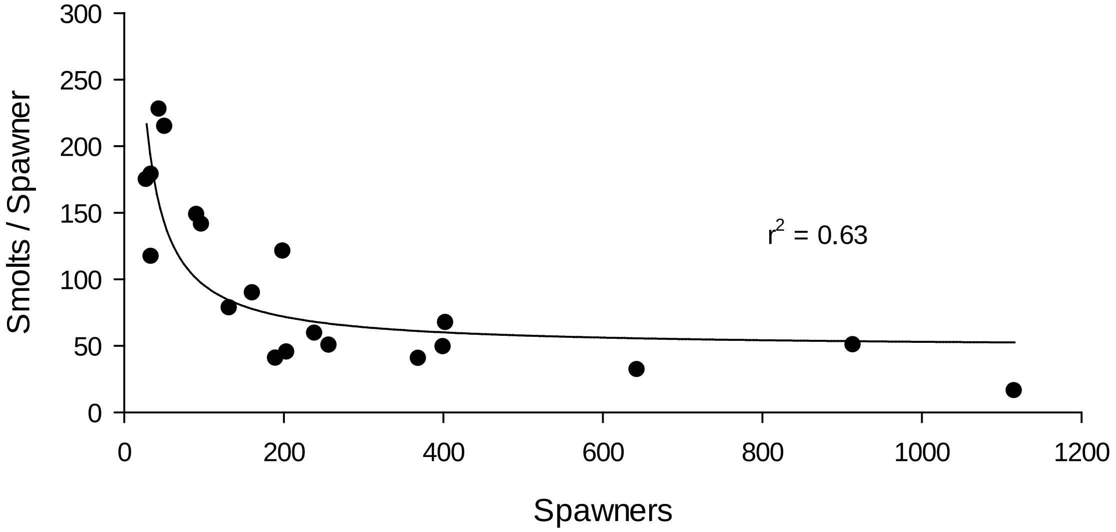

Figure 18. Spring Chinook salmon smolt equivalents produced per spawner in Catherine Creek by number of spawners. No Smolts/spawner estimate for 2015.

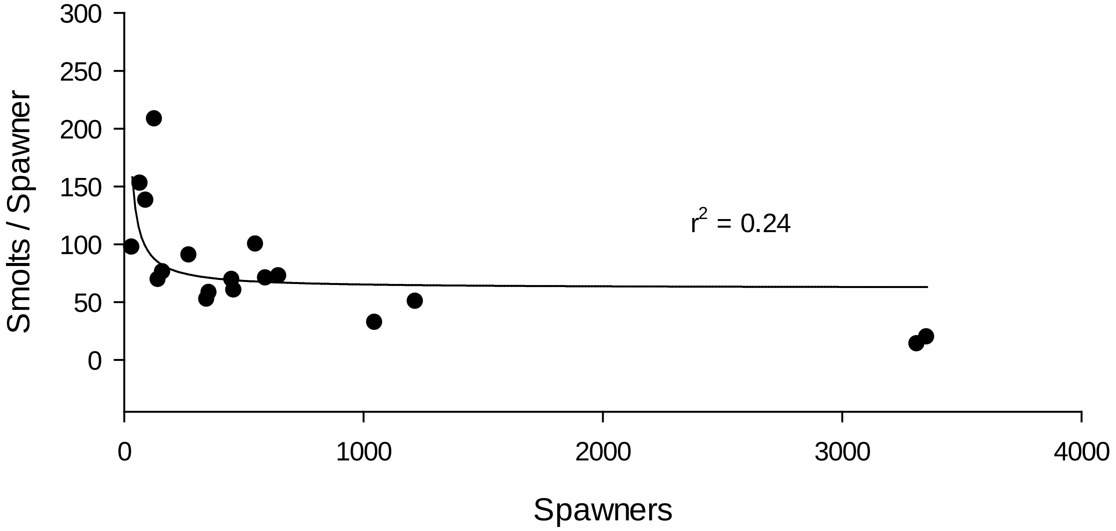

Figure 19. Spring Chinook salmon smolt equivalents produced per spawner in Lostine River by number of spawners.

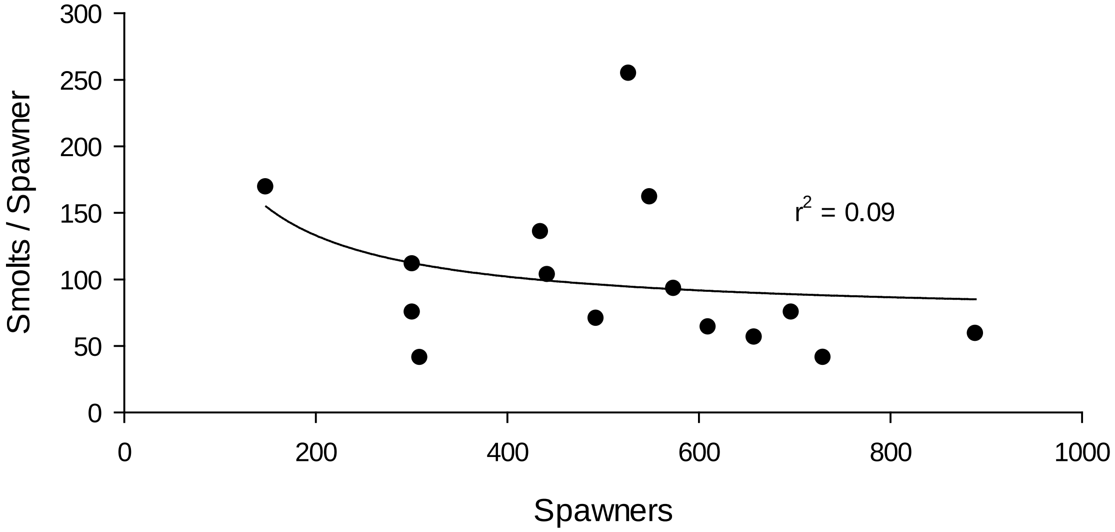

Figure 20. Spring Chinook salmon smolt equivalents produced per spawner in Minam River by number of spawners.

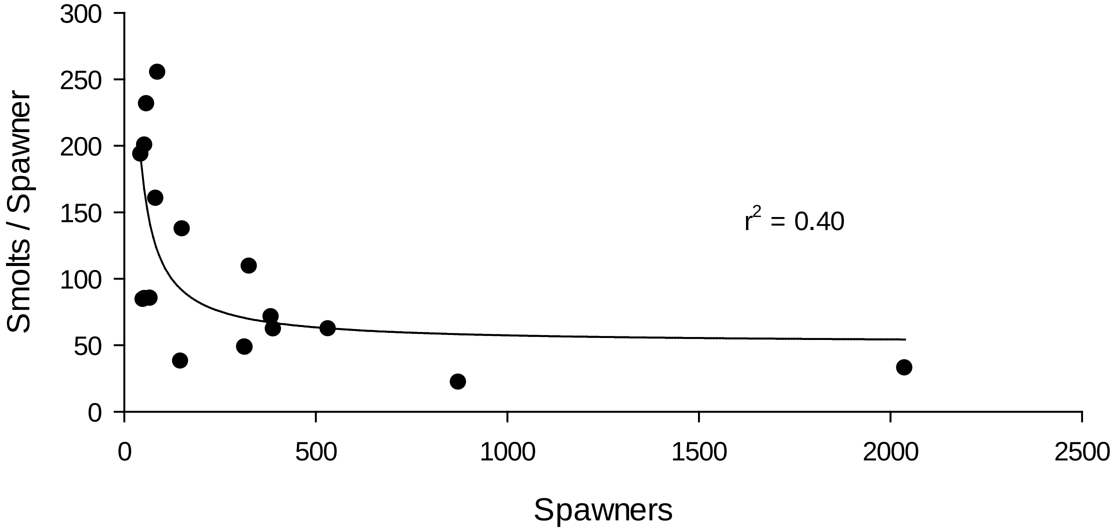

Figure 21. Spring Chinook salmon smolt equivalents produced per spawner in upper Grande Ronde River by number of spawners.

Steelhead

We estimated a minimum of 11,275 ± (95% CI, 1,652) juvenile steelhead migrated from Catherine Creek upper rearing areas during MY 2015 (Figure 22). Based on total minimum abundance estimate, 31% (3,469 ± 221) migrated early and 69% (7,806 ± 1,637) migrated late. MY 2015 proportion of juvenile steelhead emigrating from upper rearing areas as late migrants (69%) is within those proportions previously reported during 1997-2015.

We estimated a minimum of 15,099 ± 1,352 juvenile steelhead emigrated From Lostine River upper rearing areas during MY 2015 (Figure 23). Based on total minimum abundance estimate, 68% (10,259 ± 1,119) of juvenile steelhead migrated early and 32% (4,840 ± 759) migrated late. MY 2015 proportion of juvenile steelhead emigrating from upper rearing areas as late migrants (32%) is within those proportions previously reported during 1997-2015.

We estimated a minimum of 21,111 ± 1,707 juvenile steelhead migrated from Minam River rearing areas during MY 2015 (Figure 24). Based on total minimum abundance estimate, 38% (8,086 ± 1,269) migrated early and 62% (13,025 ± 1,141) migrated late. Proportion of juvenile steelhead emigrating as late migrants, during MY 2015, is consistent with proportions from previous migration years.

We estimated a minimum of 23,030 ± 1,516 juvenile steelhead emigrated from upper rearing areas of upper Grande Ronde River during MY 2015, which is within estimates from previous migration years (Figure 25). Based on total minimum abundance estimate, 4% (1,026 ± 73) were early migrants and 96% (22,004 ± 1,515) were late migrants. Predominant late migration of juvenile steelhead in upper Grande Ronde River is consistent for all migration years studied to date.

The middle Grande Ronde River trap fished for 80 d between 3 March 2015 and 18 June 2015. We estimated a minimum of 30, 940 ± 6,801 juvenile steelhead emigrated from upper rearing areas.

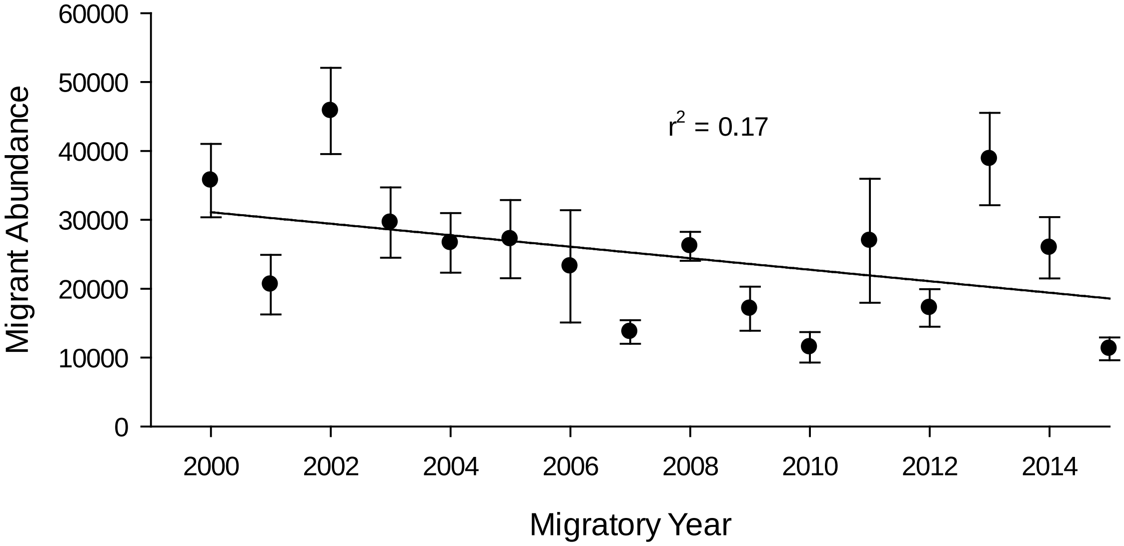

Figure 22. Steelhead migrant abundance estimates at the Catherine Creek trap site by migratory year. Error bars are 95% confidence intervals.

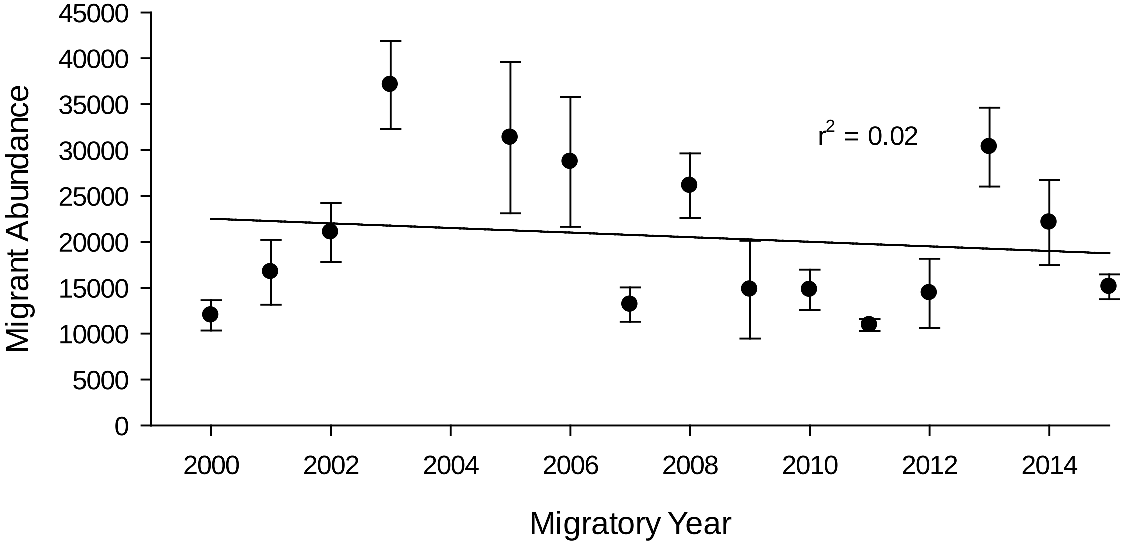

Figure 23. Steelhead migrant abundance estimates at the Lostine River trap site by migratory year. Error bars are 95% confidence intervals.

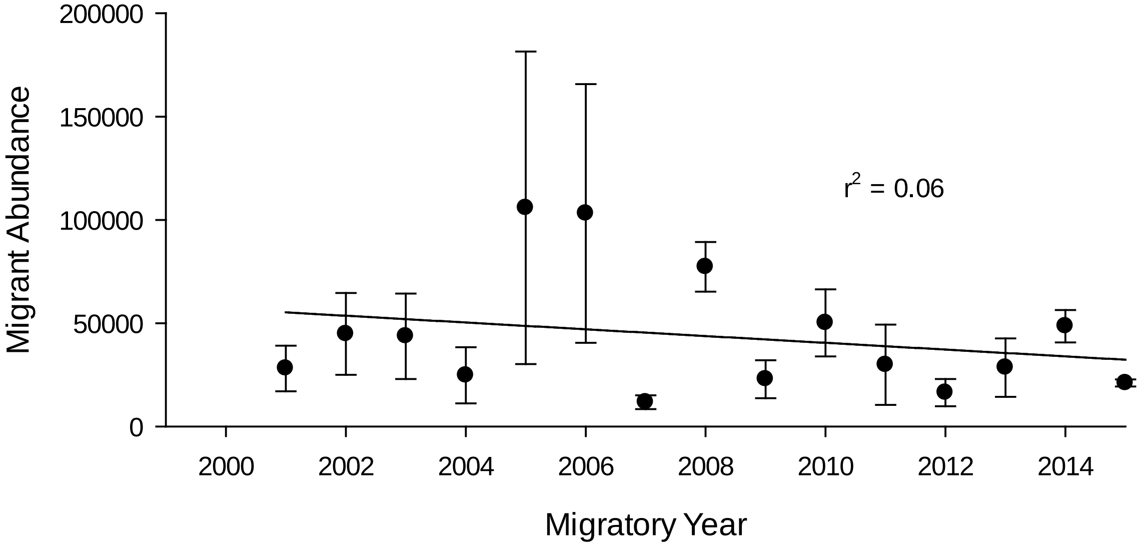

Figure 24. Steelhead migrant abundance estimates at the Minam River trap site by migratory year. Error bars are 95% confidence intervals.

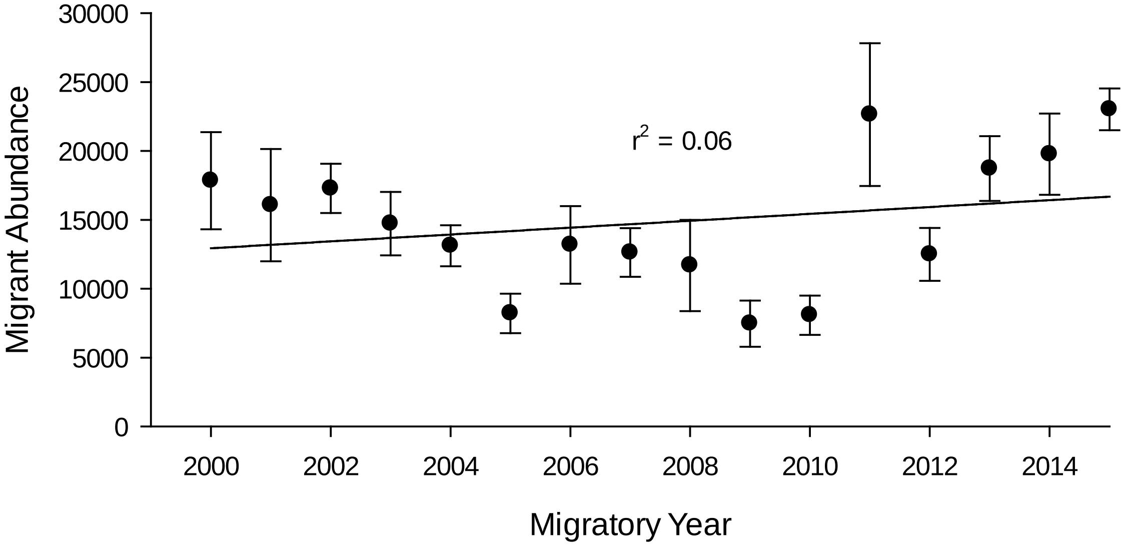

Figure 25. Steelhead migrant abundance estimates at the upper Grande Ronde River trap site by migratory year. Error bars are 95% confidence intervals.

Summer steelhead collected at trap sites during MY 2015 comprised five age-groups. Early migrants ranged from 0 to 3 years of age, while late migrants ranged from 1 to 4 years of age (Table 1). Majority of Lostine River (45.3%) early migrants were age 1, while majority of Catherine Creek (53.5%), Minam River (76.2%), and upper Grande Ronde River (56.3%) early migrants were age 0. Majority of Catherine Creek (65.7%), and Lostine River (54.7%) late migrants were age 1, while majority of middle Grande Ronde River (64.6%) and upper Grande Ronde River (45.0%) late migrants were age 2, and majority of Minam River (57.8%) late migrants were age 3 (Table 1).

Table 1. Age structure of early and late steelhead migrants collected at trap sites during MY 2015. The same four cohorts were represented in each migration period, but ages increased by one year from early migrants to late migrants (e.g., age-0 early migrants were same cohort as age-1 late migrants). Age structure was based on frequency distribution of sampled lengths and allocated using an age–length key. Means were weighted by migrant abundance at trap sites.

	Percent				
Emigrant type and trap site	Age-0	Age-1	Age-2	Age-3	Age-4
Early					
Catherine Creek	53.5	35.6	10.9	0.0	0.0
Lostine River	41.9	45.3	12.8	0.5	0.0
Minam River	76.2	27.6	15.9	0.2	0.0
Upper Grande Ronde River	56.3	32.3	12.0	0.4	0.0
Late					
Catherine Creek	0.0	65.7	27.6	6.7	0.0
Lostine River	0.0	54.7	29.5	15.7	0.0
Minam River	0.0	24.8	32.8	42.3	0.2
Upper Grande Ronde River	0.0	32.5	45.0	31.2	0.4
Early and Late[a]					
Middle Grande Ronde River	0.0	11.9	64.6	23.6	0.0

[a] Middle Grande Ronde River trap was located downstream from Catherine Creek and upper Grande Ronde River overwinter rearing reaches resulting in early and late emigrants being sampled simultaneously during spring emigration.

Probability of surviving and migrating, during migration year of tagging, to Lower Granite Dam for steelhead tagged in fall 2014 ranged from 0.025 to 0.170 for all four spawning tributaries (Table 26). Probabilities of migration and survival, for larger steelhead (FL ≥ 100 mm) tagged during spring 2015, ranged from 0.312 to 1.000 for all five populations studied (Table 26). Generally, probabilities of migration and survival, during spring 2015, were similar for all five populations studied compared to previous years. The probabilities of migration and survival for Catherine Creek and Minam River steelhead tagged in fall 2014 were the lowest compared to previous years.

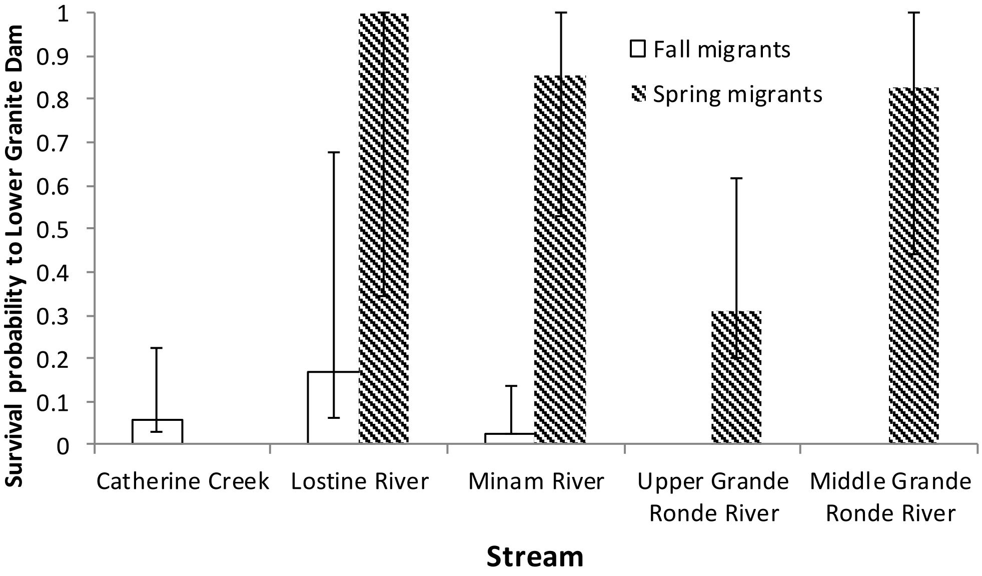

Figure 26. Probability of surviving and migrating, in the first year to Lower Granite Dam, for steelhead PIT-tagged at screw traps on Catherine Creek and Lostine, middle Grande Ronde, Minam, and upper Grande Ronde rivers during fall 2014 and spring 2015 (MY 2015). Catherine Creek and upper Grande Ronde River early migrants overwinter upstream of middle Grande Ronde River trap site, so no fall tag group was available for that site. No estimates for Catherine creek spring migrants or Upper Grande Ronde River fall migrants for MY 2015.

Conclusions

In 2015, we saw relatively low numbers of juvenile spring Chinook salmon from all of our study streams, resulting from the moderate number of spawners in 2013. We saw larger spring Chinook salmon spring migrants at lower spawner densities, which typically results in higher survival to Lower Granite Dam. However, spring migration conditions in 2015 may have negated survival advantages of larger fish, as the estimated survival to Lower Granite Dam was on the low end of the range for spring migrants from the Grande Ronde Basin populations. The lower survival of the out-migrants results in low estimates of smolts/spawner, one indicator of the VSP parameter productivity. Habitat restoration projects funded by BPA and Bureau of Reclamation in the Upper Grande Ronde River watershed are addressing habitat capacity which should, in turn, result in an increase in productivity, such as smolts/spawner.

Steelhead emigrant abundance was above the trend line in the Upper Grande Ronde River and below the trend line in Catherine Creek and the Minam and Lostine rivers. In the future, this project will combine the out-migrant estimates, age structure, and survival rates to quantify the number of smolts by age and relate to the appropriate number of spawners to estimate smolts/spawner, a VSP indicator of productivity.

Steelhead Spawner Surveys

Introduction

Summer steelhead in the Grande Ronde River subbasin fall within the Snake River Distinct Population Segment (DPS) and are listed as threatened under the Endangered Species Act (62 FR 43937; August 18, 1997). The Upper Grande Ronde River (UGRR) and Joseph Creek watersheds (Figure 27) support two of the four Major Population Groups (MPG) in the Grande Ronde River subbasin. These populations are segregated based on topographic, genetic, and behavioral evidence of interactions. Historically, the Grande Ronde River was one of the more significant anadromous fish producing rivers in the Columbia River basin. Despite recovery efforts, these populations remain depressed relative to historic levels.

The goal of this project is to annually evaluate summer steelhead population abundance for the UGRR, and recently Joseph Creek, by conducting surveys of redds and spawning activity. These surveys provide those data needed to estimate adult steelhead escapement, improve our understanding of habitat utilization, and contribute to productivity and survival estimates for these populations.

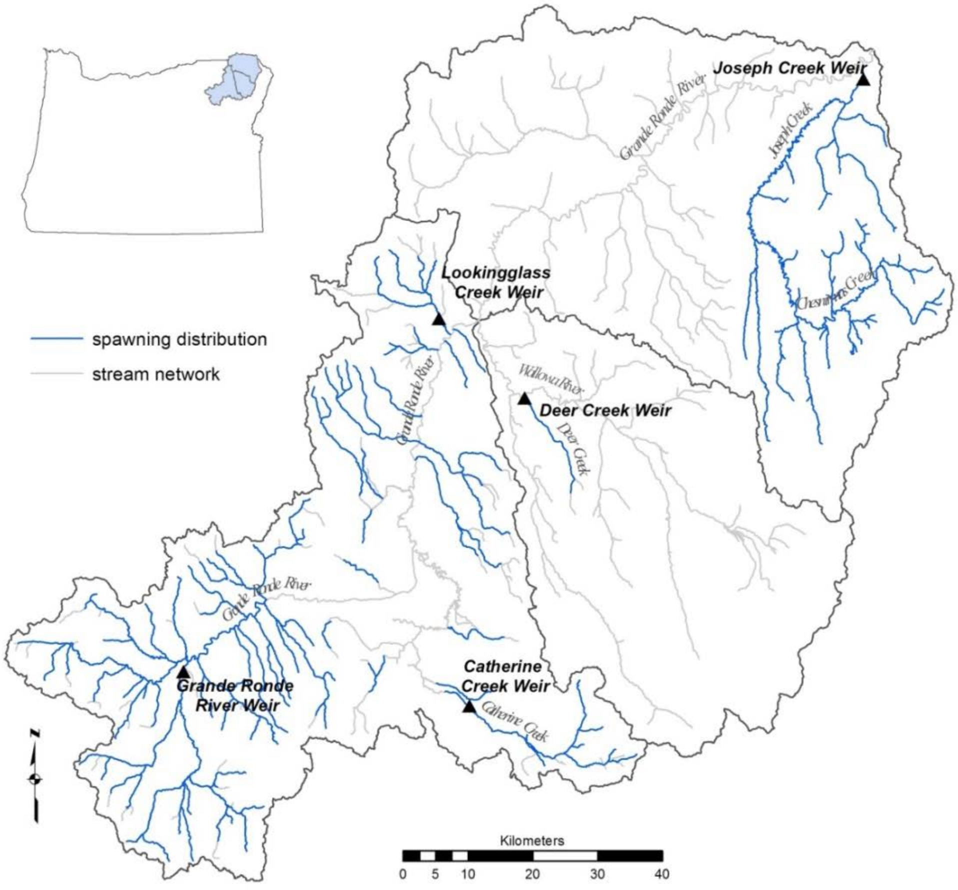

Figure 27. Grande Ronde River basin, divided by 4th order HUC. Steelhead distribution highlighted in blue for Joseph and UGRR subbasins.

Methods

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

Results

We surveyed 29 sites in the UGRR (Figure 2) encompassing 61.6 km of an estimated 892 km (6.9 %) available steelhead spawning habitat. One site was not surveyed due to persistent high discharge and accessibility. This site was not included in our calculations. Stream classification for the 29 surveyed sites was distributed evenly (11 sites in source classification, 8 in transport, and 10 in depositional). Four sites were located above the Grande Ronde River weir, two above the Catherine Creek weir, and one above the Lookingglass Creek weir.

Available spawning habitat was estimated at 897 km at the beginning of 2013 season, but we removed 5.2 km from Wright Slough, Orodell Ditch, and Conley Creek after determining this section of stream was ditched, had extremely low gradient, and little to no gravel available for spawning.

We conducted 166 surveys in the UGRR basin in 2015, with a mean interval of 14.7 days between surveys. A total of 246 steelhead redds were observed at 20 of the 29 sites (Table 3). Redds were not evenly distributed among stream classifications: 19 (7%) were found in source areas, 127 (52%) in transport, and 100 (41%) in depositional reaches. A total of 12, live adult steelhead were observed in the UGRR. Of these fish none had an observable adipose fin clip, nine were of wild origin, and three were of unknown origin. Two male and one female carcass were observed at three sites during our surveys in the UGGR basin.

Twenty-four sites were surveyed in Joseph Creek and tributaries, encompassing 48.3 km of an estimated 384 km (12.6 %) available spawning habitat, all of which were above the weir. One site was not surveyed due landowner access issues later in the season. Stream classification for the 24 sites was random with 10 sites surveyed in source classification, eight in transport, and six in depositional.

A total of 78 surveys were completed in the Joseph Creek basin, with a mean interval of 20.3 days between surveys. We found 286 steelhead redds at 17 of the 24 sites (Table 4). More redds were found in the depositional stream classification (n=185, 75%), than source or transport reaches (n=57 (10%) and 44 (15%) respectively). Forty-seven live adult steelhead were observed at eight sites, while eight dead, adult steelhead were found at five sites. No adipose-clipped hatchery fish were observed during our Joseph Creek surveys.

We conducted five surveys on Deer Creek encompassing 18.7 km of utilized spawning habitat from the weir to the USFS road 8270 bridge. In previous years, additional surveys were conducted upstream of these 18.7 km, and no redds or adult steelhead were observed. On 18.7 km of Deer Creek, 49 redds, 39 live steelhead, and 49 carcasses were observed during five survey visits.

Based on our redd observations, onset of spawn timing was similar between the UGRR and Joseph Creek basins, but a little later for Deer Creek. We observed the first redds on 24 February in the UGRR, March 10 Joseph Creek basins and 09 April in Deer Creek. The last redds were observed on 10 June in the UGRR, 19 May in Joseph Creek and 26 May in Deer Creek. By

21 April 48% of the total redds in the UGRR basin were observed. By 07 April 59% of the total redds in the Joseph Creek basin were observed. By the third survey on 23April, 73% of the total redds were observed on Deer Creek. Onset of redd building was similar among basins as well as peak redd observations. The onset of redd building occurred weeks earlier than in previous years (Fitzgerald et al. 2013, Banks et al. 2014). In past years, UGRR redds were first observed during the descending limb of the hydrographs in early May to late June. However, this year flows in the UGRR was relatively flat and the descending limb didn't occur until late May when almost 100% of the redds were built (Figure 4). Surveys on Deer Creek coincided with low discharge periods.

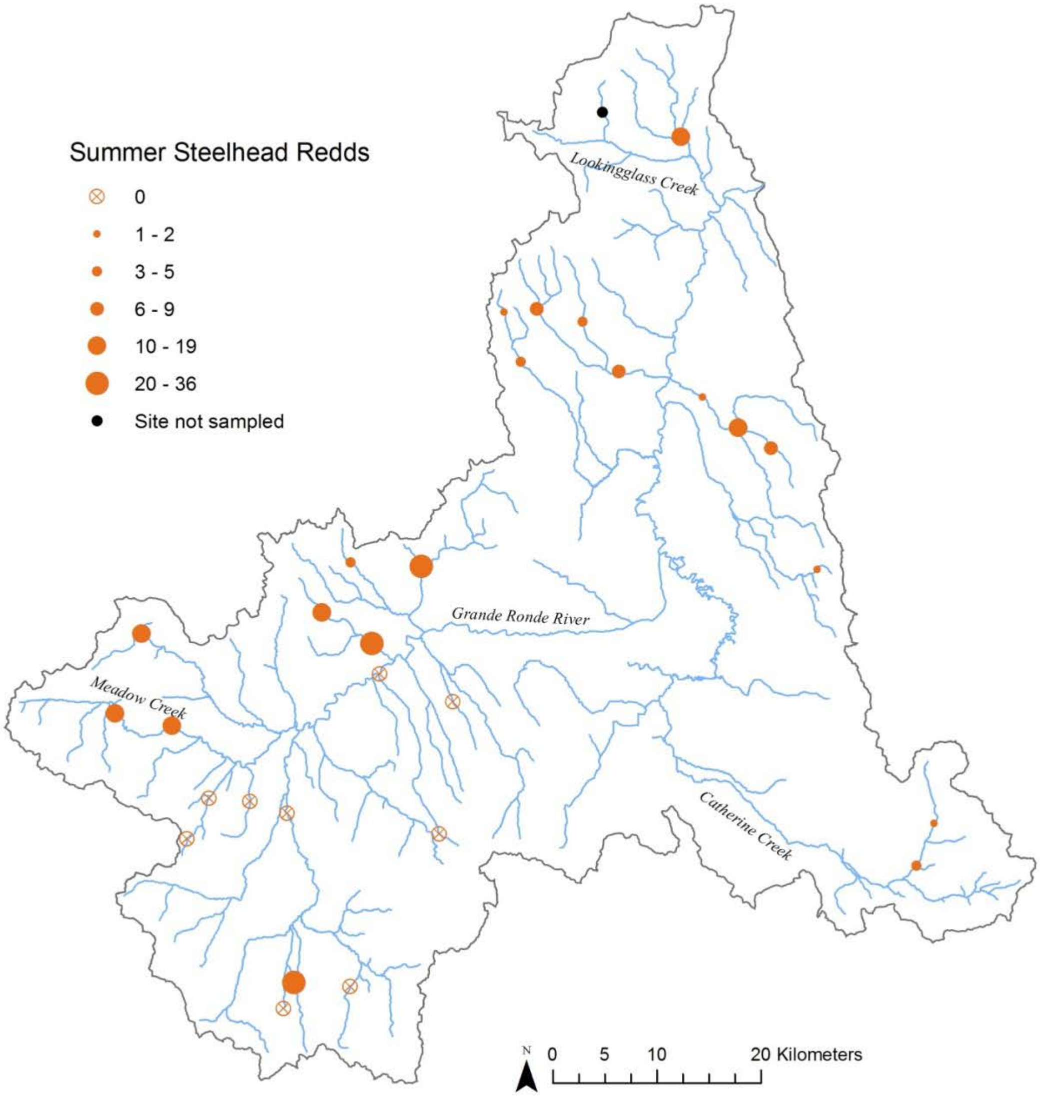

Figure 28. Map of the Upper Grande Ronde River basin displaying count of redds observed at each site in 2015. The two sites not surveyed were due to continual high flows and dangerous wading conditions.

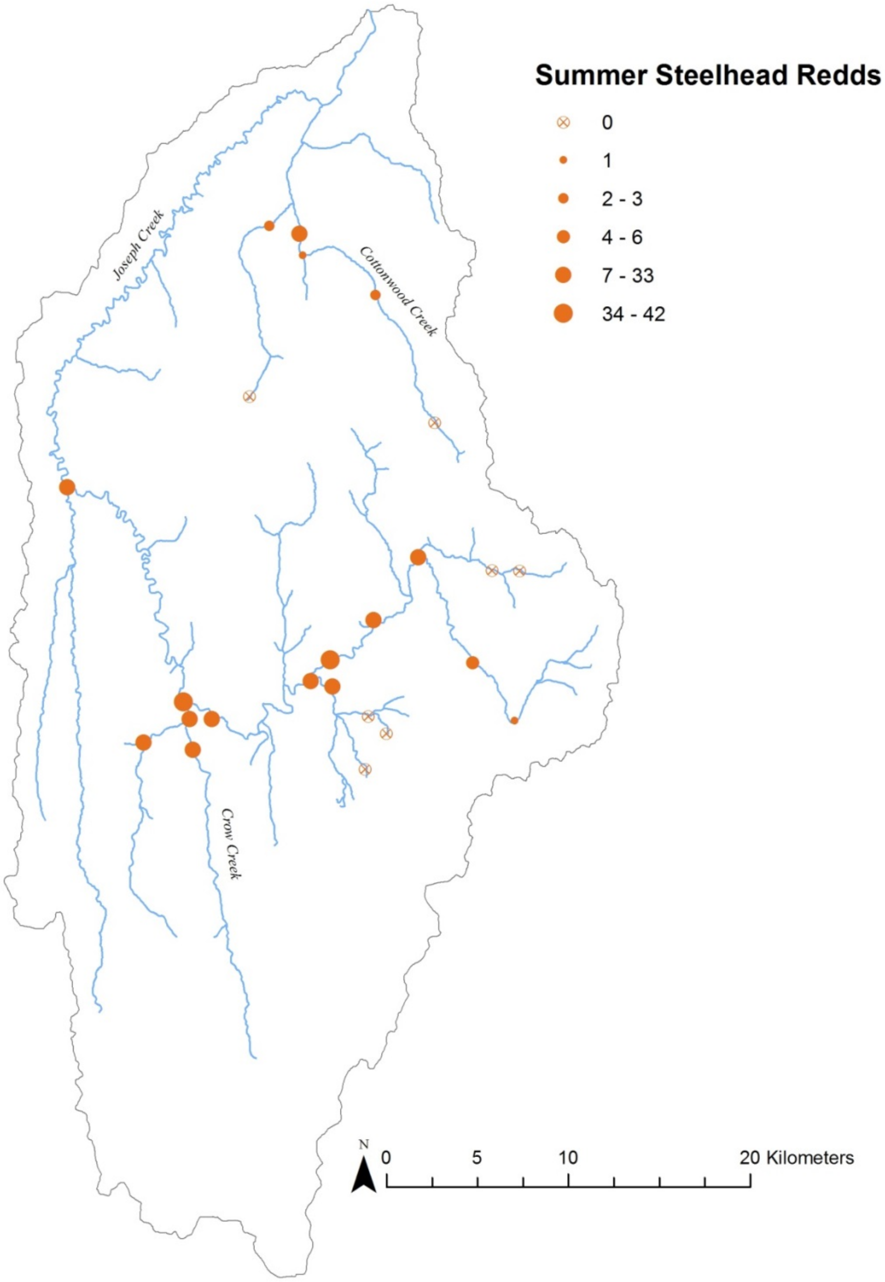

Figure 29. Map of the Joseph Creek basin showing count of redds observed at each site in 2015.

Conclusions

Water clarity during surveys was good in both the UGRR and Joseph Creek basins throughout most of the season. Water clarity and our ability to observe redds generally improved as the season progressed. Restriction of snow to higher elevations, low precipitation, and moderate to low flows in March resulted in early access to most sites and good visibility. Flows were generally higher, and persisted longer in Lookingglass, Deer, and Catherine creeks, and other tributaries flowing from the Wallowa Mountains due to their high elevation headwaters. However, they were much lower than in previous years and we had early and consistent access throughout the spawning season. Our protocol indicates that surveys should be conducted at two week intervals and we achieved this in the UGRR.

The efficiency of our surveys on larger tributaries (i.e. Lookingglass and Catherine creeks) was better this year than in previous. We observed 16 redds in Little Lookingglass Creek this year and in most years we usually observed zero redds due to our inability to cross or even walk in the channel for significant stretches because of high water flows.

The fish:redd ratio from Deer Creek correlated strongly with the total water volume from UGRR (Figure 7). This suggests that the use of fish:redd is an appropriate method to compensate for our ability to successfully observe redds throughout the basin based on water conditions.

Redds were observed earlier in the year than had been in previous years. In past years most redds were first observed during descending limbs of the hydrograph. However, this year the hydrograph didn’t display its typical pulse in early spring and the flow remained consistently low the spawning season. Nevertheless, any relationship of spawning to stream flow may be obscured by artifacts of our sampling technique. Our ability to observe redds is strongly influenced by water clarity, which is generally better on the descending limb of hydrographs than on rising limbs. Our observations of redds usually occur during these descending periods; however, they do not indicate exactly when the redd was made. Deer creek surveys illustrate this point. We were only able to survey during the low water periods between peaks in the hydrograph (Figure 5). However, redds were likely built during the high water periods between surveys. Our surveys cannot determine or estimate when redds were built (unless we observe fish actively spawning) limiting our ability to infer a relationship between flow and spawning activities.

Timing of initial redd observations was similar across both basins and in Deer Creek. However, the progression of redd building appeared to be slower in Joseph Creek. This seems counterintuitive, as Joseph Creek is lower in elevation, and generally warmer than UGRR or Deer Creek. We observed a two week lag (early March) between redd building in UGRR and Joseph Creek (Figure 4). This lag period was also observed 2012 -2014 (Dobos et al. 2012, Fitzgerald et. al 2013, Banks et al. 2014), the first three years of Joseph Creek surveys. However, the lag period was in early April those years. We were unable to determine if this is a real discrepancy in spawn timing, or an inability to effectively survey Joseph Creek tributaries during March and early April. Surveyors recorded water clarity (scale 1-3) at each survey event, and water clarity did improve substantially in Joseph Creek by early April. However, if water clarity/redd visibility was limiting our counts, one would expect a rapid increase in redd counts once water clarity improved. This was not the case, as redd observations climbed steadily after mid-April, but not faster than UGRR or Deer Creek.

Population-scale escapement estimates had relatively poor precision for both Joseph Creek and UGRR (95% CI ~39% of the estimate). This is similar to better than last year's precision estimate of ~38% of estimate. Confidence intervals have consistently been 30–35% of the UGRR escapement estimate since 2009 (Table 9). This is despite our refinement of known steelhead spawning distribution, which has been reduced in length by 31% since 2008. It appears that the variable distribution of redds throughout the spawning distribution inflates the confidence intervals. In particular, observations of zero redds substantially increase the confidence interval, and certain streams are not likely to produce redds regardless of the number of adults returning. In 2015 we observed zero redds at 31% of our UGRR basin sites, and 29% of those in Joseph Creek. With continued observations of zero redds at some survey sites, it seems unlikely that precision will improve unless some other method of identifying appropriate spawning habitat can be found.

This is our fourth year of attempting to correlate redd locations with stream classifications. Redd observations were highest in transport reaches for UGRR and highest in depositional reaches for Joseph basins. This distribution is similar to Joseph Creek observations in 2012 - 2014, but far different for UGRR streams (Dobos et. al 2012, Fitzgerald et. al 2013, Banks et al. 2014). There seems to be only minor utility in attempting to relate stream classification generated from landscape level variables to redd locations. Steelhead are likely not choosing appropriate spawning sites at the landscape scale. With the overlap of CHaMP sites and steelhead spawning ground surveys, we are exploring other potential relationships between redd building and small-scale habitat characteristics.

We will continue to define the extent of these identified stream reaches deemed unsuitable for spawning and locate similar reaches when they are selected in our sample draw. As the spawning distribution is refined, precision in our escapement estimates should increase. We will also continue to monitor trends of both methods and relate redd locations to immediate habitat to gain better understanding of how spawning habitat is utilized.

Abundance of Steelhead Spawners at the Population Level

Introduction

Summer steelhead in the Grande Ronde River basin fall within the Snake River Distinct Population Segment (DPS) and are listed as threatened under the Endangered Species Act (62 FR 43937; August 18,1997). The Upper Grande Ronde River (UGRR) and Joseph Creek watersheds support two of the four Major Population Groups (MPG) in the Grande Ronde River basin. These populations are segregated based on topographic, genetic, and behavioral evidence of interactions. Historically, the Grande Ronde River was one of the more significant anadromous fish producing rivers in the Columbia River Basin. Despite recovery efforts, these populations remain depressed relative to historic levels.

The goal of this project is to annually evaluate summer steelhead population abundance for the UGRR, and recently Joseph Creek, by conducting surveys of redds and spawning activity. These surveys provide the data needed to estimate adult steelhead escapement, improve our understanding of habitat utilization, and contribute to productivity and survival estimates for these populations.

Methods

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

Results

A fish:redd ratio of 1.37 (66/49) was generated using the number of fish passed above the weir at Deer Creek and the number of redds observed there in 2015. We recovered 16 hatchery males and 3 hatchery females that fell back to the weir. We included these adults in our total spawner estimate.

Using this ratio and a single weight value for all stream classifications (30.8), 4,837 adult steelhead (95% C.I.: 2,946–6,728) escaped into the UGRR basin and naturally spawned (Table 9; Figure 6). No adipose-clipped hatchery fish were observed during surveys on the UGRR. Using this same method with a weight value of 16, 2,967 adult steelhead (95% C.I.: 1,976–3,958) escaped into the Joseph Creek basin. Three adipose-clipped hatchery fish (1 carcass; 2 live fish) were observed during surveys on Joseph Creek.

Using the weight values for each strata, source (50.1), transport (27.0), and depositional (19.7), we estimated that 4,228 (95% CI, 2,944–5,513) adult steelhead for the UGRR population. For Joseph Creek estimates changed by only one fish: using the weight values for each strata, source (15.9), transport (14.3), and depositional (15.8), we estimated that 3,201 (95% CI, 2,431–3,972) adult steelhead returned to spawn.

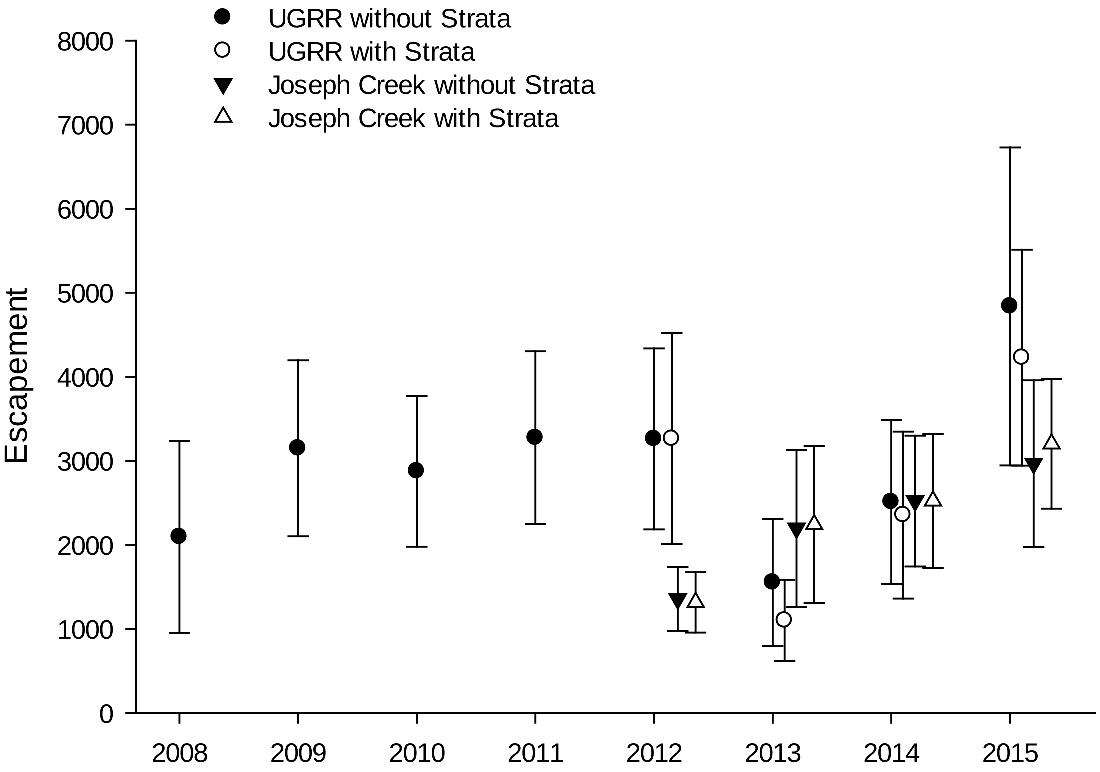

Figure 30. Escapement estimates with 95% confidence intervals for steelhead in the Upper Grande Ronde River basin using a single weight value, 2008–2014 and using strata weights for the three classifications of stream type for UGRR and Joseph Creek, 2012–2015.

Conclusions

Population-scale escapement estimates had relatively poor precision for both Joseph Creek and UGRR (95% CI ~39% of the estimate). This is similar to better than last year's precision estimate of ~38% of estimate. Confidence intervals have consistently been 30–35% of the UGRR escapement estimate since 2009. This is despite our refinement of known steelhead spawning distribution, which has been reduced in length by 31% since 2008. It appears that the variable distribution of redds throughout the spawning distribution inflates the confidence intervals. In particular, observations of zero redds substantially increase the confidence interval, and certain streams are not likely to produce redds regardless of the number of adults returning. In 2015 we observed zero redds at 31% of our UGRR basin sites, and 29% of those in Joseph Creek. With continued observations of zero redds at some survey sites, it seems unlikely that precision will improve unless some other method of identifying appropriate spawning habitat can be found.

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2014). There seems to be only minor utility in attempting to relate stream classification generated from landscape level variables to redd locations. Steelhead are likely not choosing appropriate spawning sites at the landscape scale. With the overlap of CHaMP sites and steelhead spawning ground surveys, we are exploring other potential relationships between redd building and small-scale habitat characteristics.

We will continue to define the extent of these identified stream reaches deemed unsuitable for spawning and locate similar reaches when they are selected in our sample draw. As the spawning distribution is refined, precision in our escapement estimates should increase. We will also continue to monitor trends of both methods and relate redd locations to immediate habitat to gain better understanding of how spawning habitat is utilized.

Steelhead and Chinook Salmon Parr Surveys, Parr Density, and Distribution

Introduction

Human impacts on fish populations are apparent in the Grande Ronde River basin, a tributary to the Lower Snake River. Historically, the Grande Ronde River supported several anadromous salmonid runs, including spring, summer and fall Chinook salmon, sockeye salmon, coho salmon and summer steelhead (ODFW 1990). During the past century numerous factors, including those mentioned above, have led to a reduction in salmonid stocks. Today, the only viable populations remaining are spring Chinook salmon and summer steelhead. Snake River spring/summer Chinook salmon, including Grande Ronde River spring Chinook salmon, were listed as threatened under the Endangered Species Act (ESA) in 1992; summer steelhead in 1997.

Numerous habitat restoration and protection projects have occurred within the Grande Ronde River basin, and other Columbia River sub-basins, over the past decades in attempt to improve native salmonid populations. The effectiveness of these projects at increasing native salmonid production and/or use has not been systematically evaluated. The CHaMP program systematically characterizes stream habitats in a spatially balanced manner and allows both status and trend monitoring (Bouwes et al. 2011). Coupling these habitat characterizations with salmonid presence and abundance will improve our understanding of the most important habitats for salmonid production, and allow appropriate targeting for restoration and protection actions.

Methods

Fifty-five habitat and fish monitoring locations were chosen within the UGRR River sub-basins for 2015. Site locations were generated with the generalized random tessellated stratification (GRTS) design for the fifth year of the Columbia Habitat Monitoring Program (CHaMP) (Bouwes et al. 2011). Within the UGRR sub-basin, CHaMP sites were split into two groups based on spawning and rearing distributions of Chinook salmon and summer steelhead. Only streams within the known (or assumed) anadromous fish spawning distribution were eligible for selection. Habitat metrics were assessed at all 55 sites using CHaMP protocols (Bouwes et al. 2011). Two crews completed habitat surveys, one from Oregon Department of Fish and Wildlife (ODFW) and the other from the Columbia River Inter-Tribal Fish Commission (CRITFC). Site length varied based on stream size and was approximately 20 times the bankfull width (minimum 120 m, maximum 600 m). All outputs from CHaMP habitat surveys are housed in a central database available at www.champmonitoring.org. Habitat data are not reported here.

Only 52 of the 55 UGRR CHaMP sites (Tables 1 and 2) were surveyed for juvenile salmonids via either a single-pass snorkel protocol (Juvenile Salmonid Density & Distribution in Northeast Oregon Watersheds, http://www.monitoringmethods.org/Protocol/Details/370) or single-pass backpack electrofishing. Two sites were dry, and the other was a special project with no fish sampling involved. Staff from ODFW and CRITFC completed fish surveys. Most streams were snorkeled, however, a handful of streams were too small to effectively snorkel, and single-pass electrofishing was used instead. In 2015, 48 sites were snorkeled, and 4 were electrofished (Tables 1 and 2).

The four electrofishing-only sites were sampled with a single backpack electrofishing unit (Smith-Root model LR-20) during low flow periods (late June and July 2015). Direct current was used at all sites, with frequency and voltage adjusted to permit efficient capture of fish. Block nets were placed at the bottom and top of sites if the stream was flowing continuously. Some sites had only intermittent flow, and block nets were not used if fish were trapped within the sample reach by stretches of dry stream channel. A single electrofishing pass was completed in an upstream direction. Only salmonids were netted, while a visual estimate of non-salmonid relative abundance (abundant, common, or rare) was made throughout the survey. Netted fish were kept in a bucket until the entire channel unit had been sampled. All salmonids captured were identified to species, measured (fork length, mm), and released in the unit they were collected. No marks or tags were placed on/in any fish. Metrics calculated from electrofishing surveys included: catch per unit effort (CPUE, no. fish/hour), mean length and relative density (fish per 100m^2). Abundance estimates were calculated with a correction factor relating electrofishing catch to mark/recapture population estimates (Horn and Sedell 2012).

Electrofishing Abundance Est. (all unit types): $NHat = 1.7507 * Efish\ Count$

Updating snorkel correction factors

In addition to single-pass fish sampling, we conducted mark-recapture population estimates at a subset of sites to calibrate our single-pass sampling (details below). Juvenile Chinook salmon and steelhead population estimates were conducted in concert with single-pass snorkel surveys (and/or single pass electrofishing surveys for very small sites) at a subset of UGRR CHaMP sites in 2015. The objective was to compare single-pass snorkel counts with a statistically defensible estimate of juvenile salmonid abundance within distinct habitat units identified through the CHaMP protocol (i.e. scour pools, riffles). The end product is a “snorkel correction factor” that allows us to estimate juvenile salmonid abundance with confidence limits from only single-pass snorkel or electrofishing surveys. This is the second iteration of this study, as we conducted it in 2012 with the same methodology. We were able to successfully obtain population estimates in at least one habitat unit at 35 sites.

Single-pass surveys were conducted before mark/recapture at any given site, and occurred less than 24 hours prior to the first electrofishing capture attempt. At each survey site we randomly selected one fastwater unit (riffle, rapid or fast-non turbulent) and one slow water unit (any pool except off-channel) on which to attempt mark/recapture. These units were blocked off with seine nets (1/4” mesh) prior to the first capture attempt. In almost all cases, a backpack electrofisher and dipnets (1/4” mesh) were used to collect fish. In a few cases of larger streams, a bag seine was employed and the electrofisher used to drive fish to the seine. All salmonids were measured (FL, mm) and those meeting minimum size criteria (~45 mm FL) were marked with a small fin clip and returned to the unit captured. Unique clips were used for each unit sampled at a given CHaMP site to identify escapees. Additionally, condition of fish (i.e. burns, parasites, eroded fins) and mortalities were noted. Fish were allowed to rest for a minimum of three hours, and a maximum of 24 hours before recapture was attempted, allowing marked fish to redistribute within the unit (Banks 2011). In many cases, this meant that block seines were left in stream overnight.

Recapture attempts in any given habitat unit followed the same methods as the first capture attempt. So, if a bag seine was used on the first run, it was used again on the recapture run. Also, the electrofishing time (effort) on the recapture attempt had to be approximately equal to or more than the first capture attempt. All salmonids collected on the recapture attempt were measured (FL) and the presence of the fin clip noted.

Population estimates were calculated using the Chapman-modified estimator (Seber 1982), which is preferred for small sample populations:

$$\hat{N} = \frac{(n_1+1)\times(n_2+1)}{(m_2+1)} - 1$$

where $\hat{N}$ is the population estimate, n_1 is the total number of fish captured and marked on the first capture event, n_2 is the total number of fish captured on the second capture event, and m_2 is the number of previously marked fish captured during the second event.

Variance around $\hat{N}$, and associated confidence intervals, were not calculated using a standard variance estimator (which assumes normal distribution and reasonable sample size) due to the extremely small sample size within some of these units. Instead we calculated 95% C.I. using a table produced by Chapman (1948, reproduced in Hayes et al. 2007) for recaptures <50. This table calculates confidence interval based on a Poisson distribution. The estimates of the C.I. are obtained by multiplying a table value (determined by recaptured by no. recaptures) by the product of the number of fish caught in the first and second sampling runs (i.e. n_1 x n_2). If total capture of unique target fish was higher than calculated lower 95% C.I., total capture was substituted as the lower C.I. boundary (this occurred at every site where fish were captured).

We explored a few different modeling approaches with this dataset prior to arriving at the final model. For all models, the dependent variable was given by the mark-recapture estimate of fish abundance. We included a set of four potential explanatory variables including snorkel count, year, channel unit type, and size (Table 2). For all modeling approaches, we started with a global model that included all explanatory variables as well as first-order interactions between snorkel count and the other three factor variables.

First we used a generalized linear modeling approach assuming a Poisson error distribution. This method requires no data transformation and is generally regarded as the most statistically sound approach for analysis of count data (Crawley 2007). Unfortunately, model results indicated a very high degree of overdispersion in the data and the predicted curves were not biologically reasonable.

Our second approach utilized a linear model in which the population estimates and the snorkel counts were square root transformed. The square root transformation is commonly recommended for linear modeling analysis of count data. Unfortunately, diagnostic plots and the Shapiro-Wilk test for normality indicated that the assumption of normality of the residuals was violated, despite the data transformation.

Finally, we performed a linear model analysis using log-transformed population estimates and snorkel counts. Diagnostic plots for the final model indicated a slight deviation from normality at the tail ends of the dataset, but model assumptions were generally satisfied. Although the Shapiro-Wilk test still indicated that the residuals from the final model were not normally distributed, these tests are generally regarded as overly conservative. Our model selection procedure began by fitting a global model as described above (Table 2; model 1) using the lm function in Program R. Next, we examined the summary output from model 1 and removed any variables that were not statistically significant at the $\alpha = 0.05$ level. This resulted in removal of all interaction terms from the global model. Thus, model 2 contained the explanatory variables snorkel count, year, size, and type. The model summary from model 2 indicated that the type effect was also not significant, so it was dropped. The resulting model (model 3) included snorkel count, year, and size. We then examined 4 additional models to explore whether simpler models with fewer variables could provide a reasonably good fit to the data (see models 4-7 in Table 2).

All models were compared using Akaike's Information Criterion (AIC) in addition to other model fit criteria such as R^2 and variable P-values (Table 3). As a general rule of thumb, models with AIC differences (ΔAIC) values between 0 and 2 have substantial empirical support for selection as the best-fitting model, values between 4 and 7 indicate considerably less empirical support, and values > 10 indicate essentially no empirical support (Burnham and Anderson 2002).

Table 2. Set of candidate linear models used to estimate population abundance.

Model	Model formulation
1	ln(Population estimate) = Year + Size + Type + Ln(Snorkel count) + Year*Ln(Snorkel count) + Type*Ln(Snorkel count) + Size*Ln(Snorkel count)
2	ln(Population estimate) = Year + Size + Type + Ln(Snorkel count)
3	ln(Population estimate) = Year + Size + Ln(Snorkel count)
4	ln(Population estimate) = Size + Ln(Snorkel count)
5	ln(Population estimate) = Year + Ln(Snorkel count)
6	ln(Population estimate) = Type + Ln(Snorkel count)
7	ln(Population estimate) = Ln(Snorkel count)

*Size = larger or smaller than ~10m bankfull width, Type = pool or fastwater (i.e. riffle) channel unit type

Results

In the UGRR sub-basin, Chinook were usually the dominant salmonid in mainstem snorkel surveys (Figure 31), with counts in the hundreds, while counts were in the dozens for tributaries (Appendix Table B-24). A total of 8,126 juvenile Chinook were observed during snorkel surveys, and 95% were in the <100 mm size categories (age 0), while the remaining 5% were above 100mm. Chinook were most abundant in mainstem UGRR and Catherine Creeks (Figure 32), with fewer observed in the larger tributaries like Sheep Creek, Clark Creek and lower Fly Creek. There were many more tributary observations of Chinook in 2015 than in the previous year.

Steelhead were more widely distributed than Chinook (Figure 33), with individuals observed at most sites in 2015. Counts were lower than Chinook for the first time in five years, with 7,398 individuals observed. Steelhead counts were higher than in previous years, with many sites having counts over 100 individuals. Approximately 2/3 of the steelhead observed were in the size classes <50 mm and 50-79 mm. We made no differentiation between resident and anadromous individuals, and it is possible that many individuals observed in the smaller streams were resident rainbow trout, not steelhead. No adult steelhead were observed due to the timing of surveys.

Other fish taxa observed during snorkeling were bull trout, mountain whitefish (Prosopium williamsoni), northern pikeminnow (Ptychocheilus oregonensis), redside shiner (Richardsonius balteatus), speckled dace (Rhinichthys osculus), longnose dace (Rhinichthys cataractae), sculpin (Cottus spp.), bridgelip and unidentified suckers (Catostomus spp.), unidentified catfish (Ictalurus spp.) and sunfish (Lepomis spp.) (Appendix Table B-25). Bull trout were only observed in Catherine Creek (mainstem, north and south forks) and the upper reaches of UGRR. Mountain whitefish, northern pikeminnow and suckers were generally seen in the mainstem Catherine Creek and UGRR sites, while dace, redside shiners and sculpins were observed in mainstem and lower gradient tributary sites, like Meadow Creek. In many cases, dace and shiners outnumbered salmonids in the same reaches. The smallest, high gradient sites generally produced only steelhead and sculpin. Catfish and sunfish were rarely observed in Meadow Creek and the UGRR mainstem.

Four sites in two streams, Burnt Corral and West Chicken creeks, were electrofished instead of snorkeled. These sites are very small, and snorkeling is not practical. Steelhead and Chinook were both captured via electrofishing, and steelhead outnumbered the Chinook by a wide margin. Juvenile steelhead were captured at all four sampled sites, while Chinook were only captured at two sites (Appendix Table B-26). Captures were highest in West Chicken Creek with 48 steelhead and 7 Chinook, and lowest at the most upstream Burnt Corral Creek site with only 16 steelhead captured in the whole site (approx. 120 meters long).

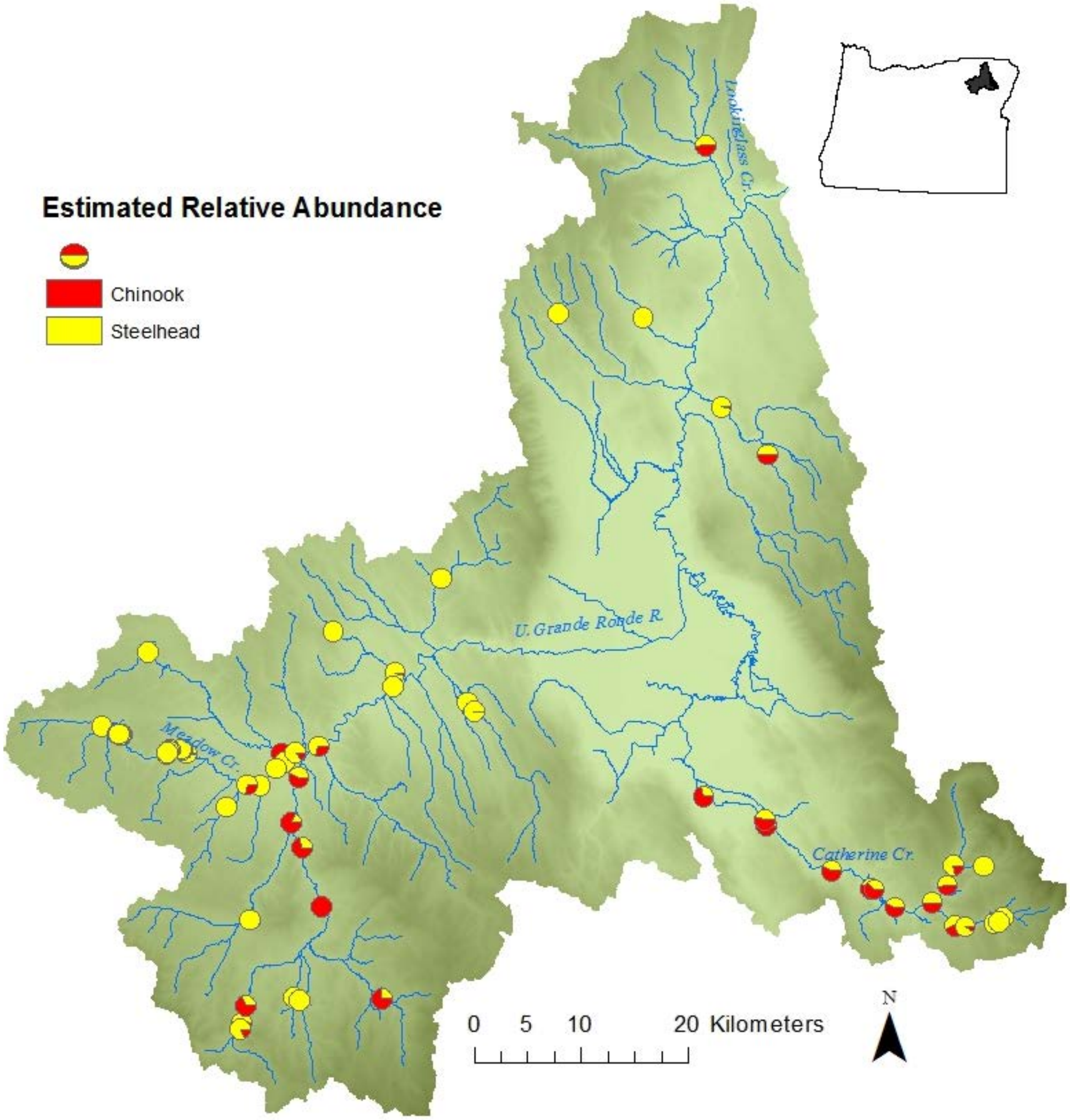

Figure 31. Proportional distribution of juvenile steelhead and Chinook salmon observed via snorkel and electrofishing surveys, 2015.

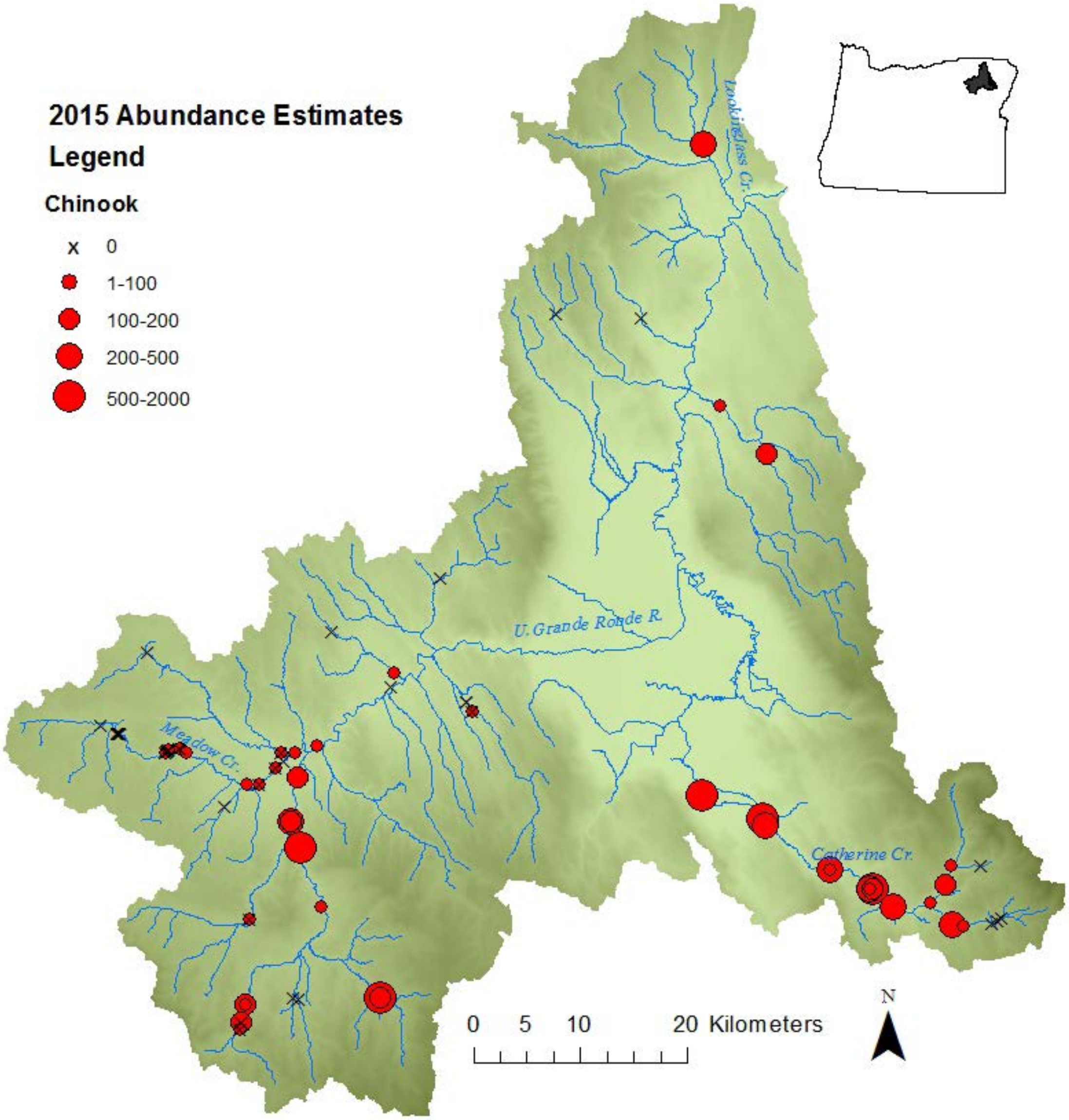

Figure 32. Spatial distribution and site level abundance estimates of Chinook salmon observed during snorkel and electrofishing surveys of the UGRR basin, 2015. Concentric circles indicate repeat snorkel surveys.

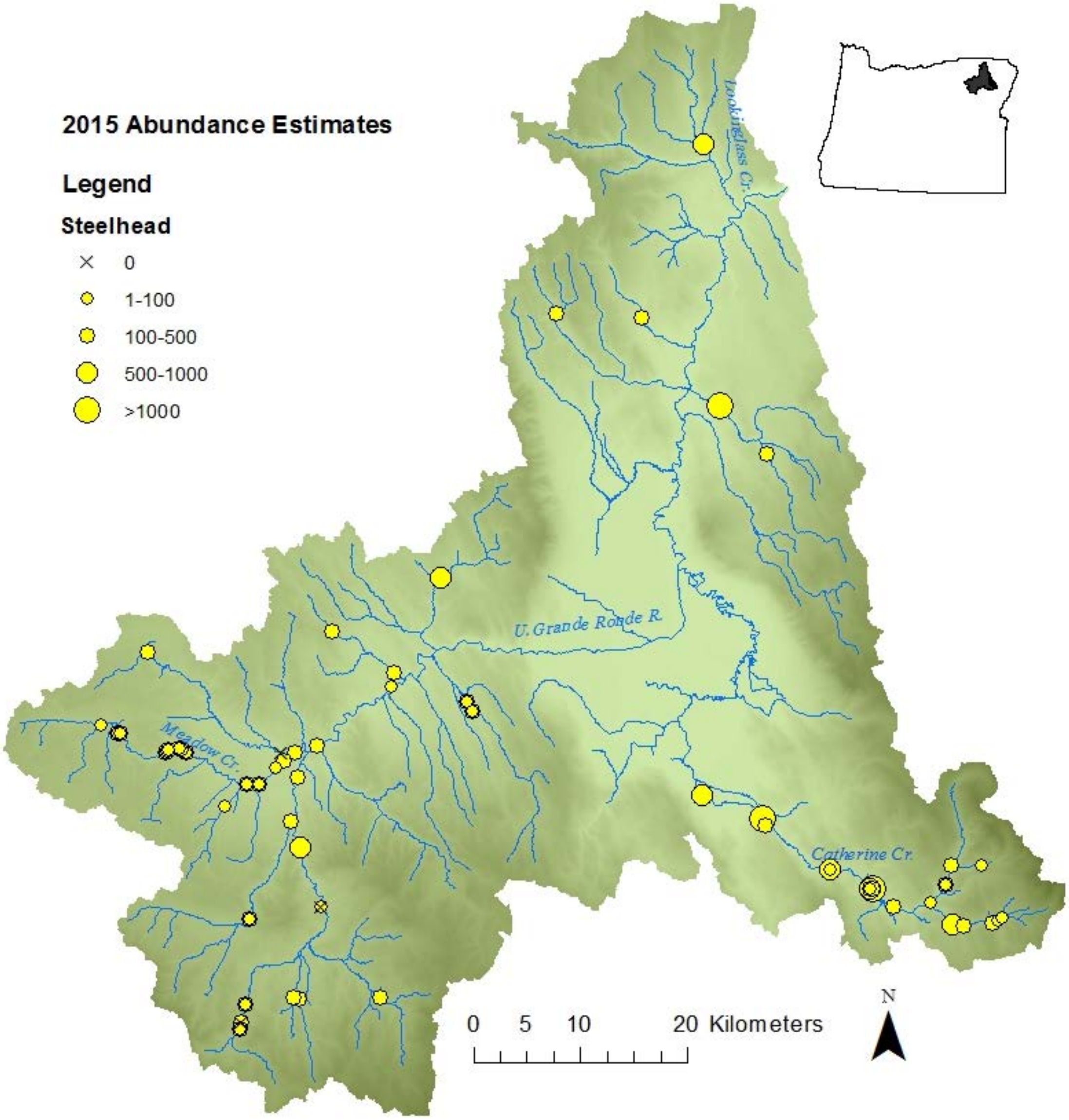

Figure 33. Spatial distribution and site level abundance estimates of steelhead observed during snorkel surveys of the UGRR basin, 2015. Concentric circles indicate repeat snorkel surveys.

Updating Snorkel Correction Factor

The best-fitting model in terms of AIC was model 3 ($R^2 = 0.64$, $\Delta AIC = 0$), which contained the explanatory variables snorkel count, year and size. Although all model coefficients were statistically significant, the year effect was only moderately significant ($P = 0.03$) compared with the other model terms which had P-values less than 0.0001. In addition, the relative importance metric (*lmg*) for the year effect, which indicates the proportion of the R^2 contributed by each of the model variables, was only 0.02 compared with relative importance scores of 0.17 and 0.80 for the size and snorkel count variables respectively (Lindeman *et al.* 1980). Moreover, the inclusion of a year effect in a predictive model that is intended for use in years than those in which the data was collected is problematic and may lead to unintended biases in model predictions.

The next best model in terms of AIC was model 2 (R² = 0.64, ΔAIC = 1.04), which included the variables snorkel count, year, size, and type. Although this model was supported in terms of AIC, the type variable was not statistically significant (P = 0.28) and explained essentially none of the variation in fish abundance (*lmg* = 0.005). For these reasons, we considered this model to be inadequate for predictive purposes.

The only other model considered competitive in terms of AIC was model 4 (R² = 0.62, ΔAIC = 3.03). All explanatory variables in this model were highly significant. Relative importance metrics for size and snorkel count were 0.17 and 0.83 respectively. Although this model did not have the lowest AIC score among the candidate models, the R² value was very similar to model 3, indicating that the addition of a year effect for model 3 did little to improve model fit. Additionally, the fact that model 4 does not include a year effect makes it more useful for predictive purposes. For these reasons, we considered model 4 to be the best model among the set of models examined.

Examination of the model results from model 4 (Table 4) indicated that population estimates were generally higher relative to snorkel counts in big streams versus little streams (Figure 34). In other words, snorkelers were better able to count fish in small streams versus large streams, which makes intuitive sense. In big streams, the estimated ratio of snorkel counts to population size (i.e., the fraction of total fish observed by snorkelers) ranged from about 0.10 to 0.52 as snorkel counts increased from 1 to 200 (Appendix Table B-27). Similarly in small streams, the estimated ratio of snorkel counts to population size ranged from 0.17 to 0.95. In addition, the relationship between snorkel counts and population estimates was non-linear with population estimates increasing more rapidly relative to snorkel counts at low abundance and gradually leveling off at higher abundance.

Table 3. Model selection summary table. Plus signs indicate factor variables or interactions that were included in the model. Interactions are denoted by a “:”.

Model	(Int)	lgc	siz	typ	yer	lgc: siz	lgc: typ	lgc: yer	df	logLik	AICc	delta	weight	AdjR²
3	2.20	0.68	+		+				5	-93.67	198.06	0.00	0.54	0.64
2	2.26	0.69	+	+	+				6	-93.04	199.10	1.04	0.32	0.64
4	2.33	0.68	+						4	-96.31	201.09	3.03	0.12	0.62
1	2.53	0.58	+	+	+	+	+	+	9	-92.76	205.76	7.70	0.01	0.63
5	1.62	0.74			+				4	-100.58	209.63	11.57	0.00	0.58
7	1.76	0.74							3	-101.69	209.66	11.60	0.00	0.57
6	1.84	0.75		+					4	-100.97	210.40	12.34	0.00	0.58

Table 4. Model coefficients from model 4.

Model coefficients	Estimate	Std. Error	t value	Pr(>|t|)	Signif. codes
(Intercept)	2.1879	0.2332	9.384	4.97e-15	***
Size (small)	-0.60631	0.1824	-3.325	0.0013	**
Ln (Snorkel count)	0.73351	0.0632	11.603	2.00e-16	***

Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.7296 on 91 degrees of freedom

Multiple R-squared: 0.6662,   Adjusted R-squared: 0.6589

F-statistic: 90.83 on 2 and 91 DF, p-value: < 2.2e-16

Regression Formulae for Small and Large sites

Small: Ln(Pop. Est.) = .73351 * Ln(Snkl.Cnt.) + 1.58159

Large: Ln(Pop. Est.) = .73351 * Ln(Snkl.Cnt.) + 2.1879

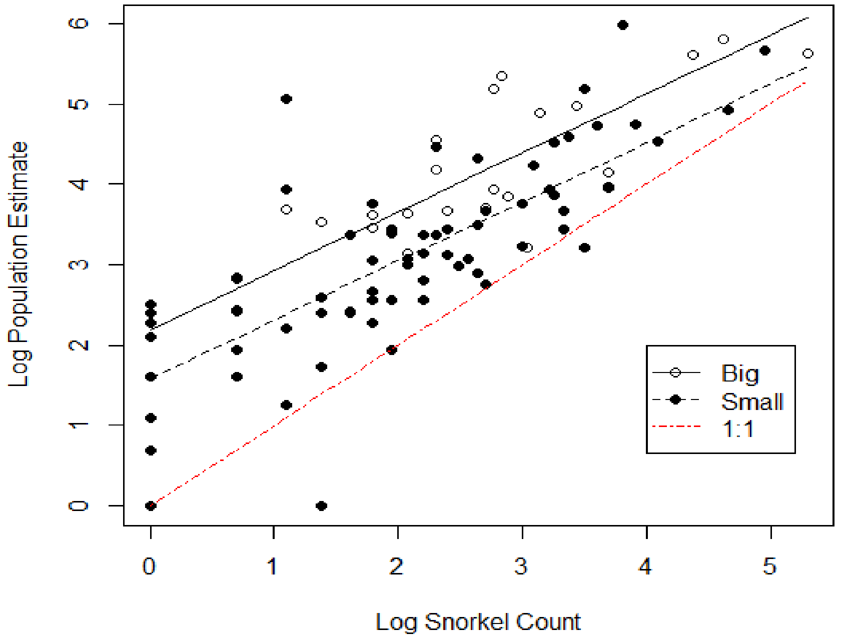

Figure 34. Relationship between log-transformed snorkel counts and log-transformed mark-recapture population estimates showing fitted lines from model 4.

Conclusions

The observed distribution of juvenile Chinook salmon was more widespread than in previous years. Although the majority of juvenile Chinook were using the mainstem Catherine Creek and

Upper Grande Ronde River, their primary spawning areas (Feldhaus et al. 2012, many juvenile Chinook were observed in other tributaries. In particular, Clark Creek, Sheep Creek and lower Fly Creek contained substantial numbers of Chinook during summer 2015. We also observed 3 adult Chinook in upper Clark Creek. This is the third observation of adults in that reach of Clark Creek, indicating that out-plantings by local fisheries managers may be taking hold there. The substantial number of Chinook observed in Sheep Creek is not a surprise, as some spawning occurs there during good adult Chinook return years (Feldhaus et al. 2012). Finally, lower Fly Creek appeared to be a significant thermal refuge for juvenile salmonids. Hundreds of juvenile chinook were observed within a kilometer of the confluence with the Grande Ronde River, which is regularly >20°C during summer days.

One of our goals is to constantly refine the known spawning and rearing distribution for steelhead in UGRR subbasin. This information is used by other ODFW research projects to define their sample space. There were a handful of sites that contained no juvenile salmonids in summer 2015. However, we believe this is due to a particularly poor snow/water year, causing sites to go dry early in the season (Dry Creek, Little Phillips Creek). These streams have documented spawning by steelhead, and were not removed from the sample universe.

There was substantial variation on the snorkel comparison with population estimates. And although there is still a relatively large amount of variation in the data that is not explained by the best regression model mentioned above, we feel that model 4 fits that data reasonably well and should provide a useful means of expanding snorkel counts to account for unobserved fish during snorkel surveys. Additional years of paired snorkel and mark-recapture data could shed some light on potential environmental causes for the apparent year effect observed in the data. We would recommend that previous abundance estimates from 2011-2014 that were generated from the earlier 2012 mark-recapture study in the Upper Grande Ronde basin be maintained as-is to preserve consistency in datasets that have been used already for a number of different analyses. However, abundance estimates from 2015 and future years should be generated from the new model results presented in this paper or by other models generated collaboratively between CRITFC and ODFW.

Adaptive Management and Lessons Learned

Results of this project are used by the Grande Ronde Basin Atlas and Expert Panel process to inform habitat restoration in the Grande Ronde River basin funded by Bonneville Power Administration and Bureau of Reclamation. Juvenile salmonid density and spatial distribution and life history study results help identify critical reaches for habitat restoration actions. The density dependence relationship between Chinook salmon spawner abundance and smolt production illustrates the need to increase carrying capacity and associated juvenile production in the Chinook salmon populations in the basin.

Combining the juvenile salmonid density and spatial distribution with CHaMP (project 2011-006-00) habitat data is used to evaluate the effectiveness of habitat restoration actions and inform future habitat actions.

Over the long term, the results of our population status and trend monitoring will show the fish response to habitat restoration actions and the effectiveness of the spring Chinook salmon hatchery supplementation program.

We provide summarized juvenile Chinook salmon and steelhead survival and abundance data and steelhead spawner data to NOAA Fisheries for the AMIP Life Cycle Model.

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Appendix A: Use of Data and Products

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/).

Juvenile spring Chinook salmon and steelhead abundance and survival data, steelhead spawner data, and steelhead and spring Chinook salmon parr density and distribution data are provided to the Grande Ronde River Basin Atlas and Expert Panel processes to inform the habitat restoration planning and implementation.

Appendix B: Detailed Results

Juvenile Spring Chinook Salmon and Summer Steelhead Life History Monitoring

WE H: Abundance and Migration of Juvenile Salmonids in Study Streams During Migration Year 2013, and
WE I: Survival and Relative Success of Juvenile Salmonids from the Grande Ronde and Imnaha Subbasins

Appendix Table B-1. Dates of tagging and number of spring Chinook salmon parr PIT-tagged in various northeast Oregon streams during summer 2014 and 2015.

Migration year and stream	Tagging Dates	Number PIT-tagged	Distance to Lower Granite Dam (km)
2015 (*Summer 2014)*			
Upper Catherine Creek	24 Jul, 28–30 Jul	999	371–383
Lower Catherine Creek	21 Jul–23 Jul	999	356–359
Imnaha River	11 Aug–13 Aug	998	221–233
Lostine River	4 Aug–6 Aug	999	271–308
Minam River	18 Aug–21 Aug	995	276–290
Upper Grande Ronde	25 Aug–27 Aug	1,000	418–428
2016 (*Summer 2015)*			
Upper Catherine Creek	20 Jul-22 Jul	1,000	371–383
Lower Catherine Creek	14 Jul-16 Jul	999	356–359
Imnaha River	11 Aug-13 Aug	998	221–233
Lostine River	4 Aug-6 Aug	999	271–308
Minam River	17 Aug-20 Aug	995	276–290
Upper Grande Ronde	24 Aug-26 Aug	1,000	418–428

Appendix Table B-2. Juvenile spring Chinook salmon catch at five general trap locations in Grande Ronde River Subbasin during MY 2015. Early migration period starts 1 July 2013 and ends 28 January 2013. Late migration period starts 29 January and ends 30 June 2014. The period a trap operated was used to identify total number of days fished, with percentage in parentheses, during each migration period.

Trap site	Migration period	Sampling period	Days fished	Trap catch
Catherine Creek	Summer	1 Jul 14–9 Sep 14	71 (100)	1,510
	Early	10 Sep 14–12 Nov 14	61 (95)	5,515
	Late	5 Mar 15–17 Jun 15	99 (94)	2,719
Lostine River	Early	10 Sep 14–28 Jan 15	111 (79)	3,729
	Late	29 Jan 15–18 Jun 15	120 (85)[a]	702[a]
			6 (4)[b]	54[b]
Middle Grande Ronde River	Late	3 Mar 15–8 Jun 15	80 (82)	1,464
Minam River	Early	12 Sep 14–12 Nov 14	62 (100)	5,509
	Late	27 Feb 15–18 Jun 15	102 (91)	1,685
Upper Grande Ronde River	Summer	1 Jul–8 Aug14	27 (69)	34
	Early	20 Sep 14–12 Nov 14	52 (96)	1,675
	Late	10 Mar 15–17 Jun 15	90 (90)[a]	3,923[a]
			9 (9)[b]	9[b]

[a] Continuous 24 h trapping

[b] Sub-sampling with 1 to 4 h trapping.

Appendix Table B- 3. Fork lengths of juvenile spring Chinook salmon collected from study streams during MY 2015. Early and late migrants were captured with a rotary screw trap on each study stream. Summer and winter tag group fish were captured using netting techniques upstream from rotary screw traps. Min = minimum, Max = maximum.

	Lengths (mm) of fish collected					Lengths (mm) of fish tagged and released				
Stream and tag group	*n*	Mean	SE	Min	Max	*n*	Mean	SE	Min	Max
Catherine Creek										
Summer (upper)	1,228	62.1	0.24	39	126	999	64.1	0.19	55	102
Summer (lower)	1,004	70.2	0.19	51	88	999	70.3	0.19	55	88
Early migrants	1,256	75.9	0.26	54	127	703	75.5	0.31	56	102
Winter	611	78.5	0.34	53	114	597	78.6	0.34	55	114
Late migrants	222	86.2	0.68	56	121	218	86.4	0.68	58	121
Lostine River										
Summer	998	68.4	0.27	55	107	998	68.4	0.27	55	107
Early migrants	1,543	92.3	0.22	64	146	1,124	93.0	0.26	67	124
Winter	634	83.7	0.28	66	105	597	83.8	0.29	66	105
Late migrants	770	95.4	0.40	54	163	681	95.2	0.39	63	163
Middle Grande Ronde River										
Spring emigrants	1,188	102.4	0.28	70	129	843	100.6	0.31	70	127
Minam River										
Summer	995	69.8	0.23	55	102	995	69.8	0.23	55	102
Early migrants	1,219	80.0	0.26	48	126	1,093	80.3	0.26	55	113
Late migrants	1,158	91.4	0.32	62	161	958	90.7	0.26	62	120
Upper Grande Ronde River										
Summer	1,043	65.6	0.24	46	118	1,000	65.6	0.20	55	94
Summer Migrants	24	60.1	3.45	40	92	-	-	-	-	-
Early migrants	888	75.0	0.21	57	129	679	74.4	0.21	57	96
Winter	658	72.4	0.28	56	102	60	72.5	0.29	56	102
Late migrants	1,707	86.9	0.22	61	112	802	85.3	0.27	65	109

Appendix Table B- 4. Weights of juvenile spring Chinook salmon collected from study streams during MY 2015. Early and late migrants were captured with a rotary screw trap on each study stream. Summer and winter tag group fish were captured using netting techniques upstream from rotary screw traps. Min = minimum, Max = maximum.

	Weights (g) of fish collected					Weights (g) of fish tagged and released				
Stream and group	*n*	Mean	SE	Min	Max	*n*	Mean	SE	Min	Max
Catherine Creek										
Summer (upper)	1,003	3.2	0.06	1.6	27.9	997	3.1	0.03	1.6	13.7
Summer (lower)	998	4.2	0.04	1.5	8.6	998	4.2	0.04	1.5	8.6
Early migrants	1,256	5.0	0.06	1.8	20.7	704	4.9	0.06	1.9	11.7
Winter	604	5.4	0.07	1.9	14.7	596	5.4	0.07	1.9	14.7
Late migrants	222	7.2	0.17	2.0	19.9	218	7.2	0.17	2.1	19.9
Lostine River										
Summer	999	3.9	0.05	1.6	15.5	999	3.9	0.05	1.6	15.5
Early migrants	1,543	9.0	0.07	3.2	38.0	1,124	9.3	0.08	3.2	24.2
Winter	633	6.5	0.07	3.0	12.9	597	6.5	0.07	3.0	12.9
Late migrants	770	9.6	0.14	1.5	43.6	681	9.4	0.12	2.5	40.0
Middle Grande Ronde River										
Spring emigrants	1,169	11.3	0.11	3.0	67.7	825	10.5	0.10	3.0	22.6
Minam River										
Summer	995	4.0	0.04	1.6	13.2	995	4.0	0.04	1.6	13.2
Early migrants	1,219	5.8	0.06	1.3	28.6	1,093	5.8	0.06	1.7	15.8
Late migrants	1,158	8.4	0.12	2.2	52.5	958	8.0	0.07	2.2	18.2
Upper Grande Ronde River										
Summer	1,006	3.3	0.04	1.5	20.2	1,000	3.3	0.03	1.5	10.1
Summer Migrants	8	5.1	0.95	1.0	9.3	-	-	-	-	-
Early migrants	888	4.4	0.05	1.8	23.2	679	4.3	0.04	1.8	9.5
Winter	655	4.3	0.05	1.7	10.9	598	4.3	0.05	1.7	10.9

Appendix Table B- 5. Survival probability to Lower Granite Dam of juvenile spring Chinook salmon tagged during summer 2014 and detected at Columbia and Snake river dams during 2015.

Stream	Number PIT-tagged and released	Survival probability (95% CI)
Upper Catherine Creek	999	0.056 (0.024–0.230)
Lower Catherine Creek	999	0.061 (0.020–0.800)
Imnaha River	998	0.139 (0.101–0.208)
Lostine River	999	0.215 (0.087–1.120)
Minam River	995	0.131 (0.079–0.278)
Upper Grande Ronde River	1,000	0.158 (0.085–0.438)

Appendix Table B- 6. Juvenile spring Chinook salmon survival probability by location and tag group from time of tagging to Lower Granite Dam. Spring Chinook salmon were tagged from fall 2014 to spring 2015 and detected at dams during 2015.

Stream and tag group	Number PIT-tagged and released	Survival probability (95% CI)
Catherine Creek		
Fall (trap)	704	(a)
Winter (above trap)	597	0.040 (0.013–0.555)
Spring (trap)	218	0.280 (0.104–3.941)
Lostine River		
Fall (trap)	1,124	0.168 (0.125–0.246)
Winter (above trap)	597	0.281 (0.131–0.994)
Spring (trap)	681	0.470 (0.307–0.885)
Middle Grande Ronde River		
Spring (trap)	844	0.601 (0.435–0.925)
Minam River		
Fall (trap)	1,093	0.199 (0.143–0.307)
Spring (trap)	958	0.711 (0.461–1.318)
Upper Grande Ronde River		
Fall (trap)	684	0.086 (0.057–0.152)
Winter (above trap)	600	0.070 (0.037–0.215)
Spring (trap)	802	0.303 (0.214–0.505)

[a] Data were insufficient to calculate a survival probability.

Appendix Table B- 7. Juvenile steelhead catch at five general trap locations in Grande Ronde River Subbasin during MY 2015. Early migration period starts 1 July 2014 and ends 28 January 2015. Late migration period starts 29 January and ends 30 June 2015. The period a trap operated was used to identify total number of days fished, with percentage in parentheses, during each migration period.

Trap site	Migration period	Sampling period	Days fished / days operated	Trap catch
Catherine Creek	Early	11 Sep 13–21 Nov 13	66 (92)	1,883
	Late	19 Feb 14–30 Jun 14	114 (86)[a]	1,330[a]
			5 (4)[b]	13[b]
Lostine River	Early	12 Sep 13–28 Jan 14	92 (66)	1,293
	Late	29 Jan 14–12 Jun 14	117 (87)[a]	352[a]
			4 (3)[b]	9[b]
Middle Grande Ronde River	Late	26 Feb 14–17 Jun 14	100 (89)	748
Minam River	Early	13 Sep 13–21 Nov 13	64 (91)	4,090
	Late	28 Feb 14–6 Jun 14	91 (85)	1,534
Upper Grande Ronde River	Early	12 Sep 13–21 Nov 13	58 (82)	1,655
	Late	5 Mar 14–30 Jun 14	99 (84)	1,263

[a] Continuous 24 h trapping.

[b] Sub-sampling with 1 to 4 h trapping.

Appendix Table B- 8. Age structure of early and late steelhead migrants collected at trap sites during MY 2015. The same four cohorts were represented in each migration period, but ages increased by one year from early migrants to late migrants (e.g., age-0 early migrants were same cohort as age-1 late migrants). Age structure was based on frequency distribution of sampled lengths and allocated using an age–length key. Means were weighted by migrant abundance at trap sites.

	Percent				
Emigrant type and trap site	Age-0	Age-1	Age-2	Age-3	Age-4
Early					
Catherine Creek	53.5	35.6	10.9	0.0	0.0
Lostine River	41.9	45.3	12.8	0.5	0.0
Minam River	76.2	27.6	15.9	0.2	0.0
Upper Grande Ronde River	56.3	32.3	12.0	0.4	0.0
Mean	55.3	32.3	12.0	0.4	0.0
CV (%)	25.7	43.0	21.1	124.2	0.0
Late					
Catherine Creek	0.0	65.7	27.6	6.7	0.0
Lostine River	0.0	54.7	29.5	15.7	0.0
Minam River	0.0	24.8	32.8	42.3	0.2
Upper Grande Ronde River	0.0	32.5	45.0	31.2	0.4
Mean	0.0	32.9	37.2	29.7	0.2
CV (%)	0.0	64.8	21.0	53.3	80.3
Early and Late[a]					
Middle Grande Ronde River	0.0	11.9	64.6	23.6	0.0

[a] Middle Grande Ronde River trap was located downstream from Catherine Creek and upper Grande Ronde River overwinter rearing reaches resulting in early and late emigrants being sampled simultaneously during spring emigration.

Appendix Table B- 9. Travel time to Lower Granite Dam of wild steelhead PIT-tagged at screw traps during spring 2015 and subsequently arriving at Lower Granite Dam (LGD) during spring 2015.

	Distance to	Number	Travel time (d)		
Stream	LGD (km)	detected	Median	Min	Max
Catherine Creek	362	1	14	14	14
Lostine River	274	13	17	8	31
Middle Grande Ronde River	258	39	24	7	55
Minam River	245	39	44	11	69
Upper Grande Ronde River	397	30	25	8	73

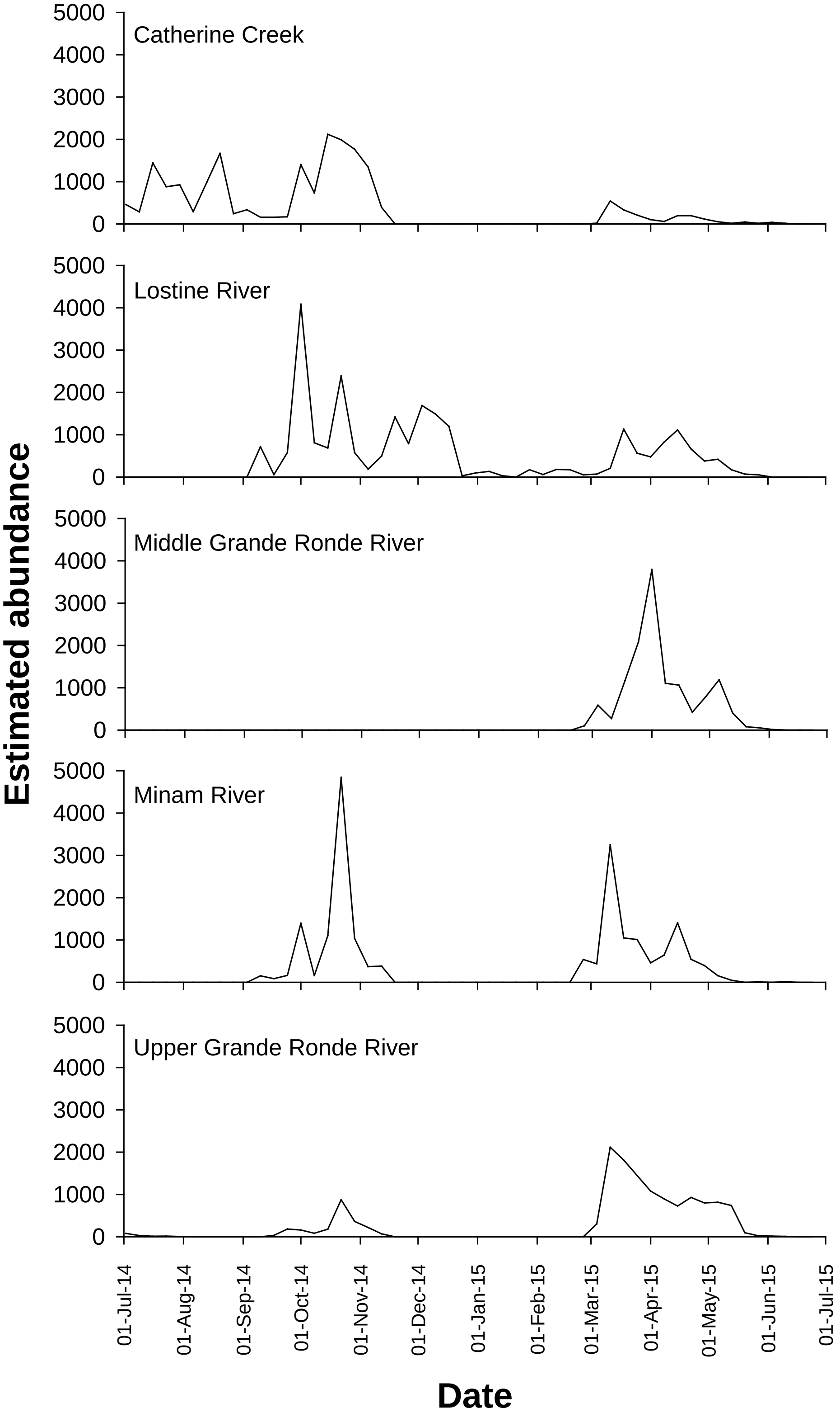
Appendix Table B- 10. Probability of surviving and migrating, in the first year to Lower Granite Dam, for steelhead PIT-tagged at screw traps on Catherine Creek and Lostine, middle Grande Ronde, Minam, and upper Grande Ronde rivers during fall 2014 and spring 2015 (MY 2015). Catherine Creek and upper Grande Ronde River early migrants overwinter upstream of middle Grande Ronde River trap site, so no fall tag group was available for that site.

Season and location tagged	Number tagged	Number detected	Probability of surviving and migrating in the first year (95% CI)
Fall			
Catherine Creek	676	26	0.056 (0.030–0.225)
Lostine River	607	37	0.170 (0.064–0.679)
Minam River	563	14	0.025 (<0.000–0.134)
Upper Grande Ronde River	503	6	(a)
Spring (FL ≥ 100 mm)			
Catherine Creek	158	9	(a)
Lostine River	225	51	1.071 (0.346–13.284)
Middle Grande Ronde River	890	225	0.828 (0.443–2.338)
Minam River	607	185	0.858 (0.530–1.763)
Upper Grande Ronde River	979	137	0.312 (0.200–0.617)

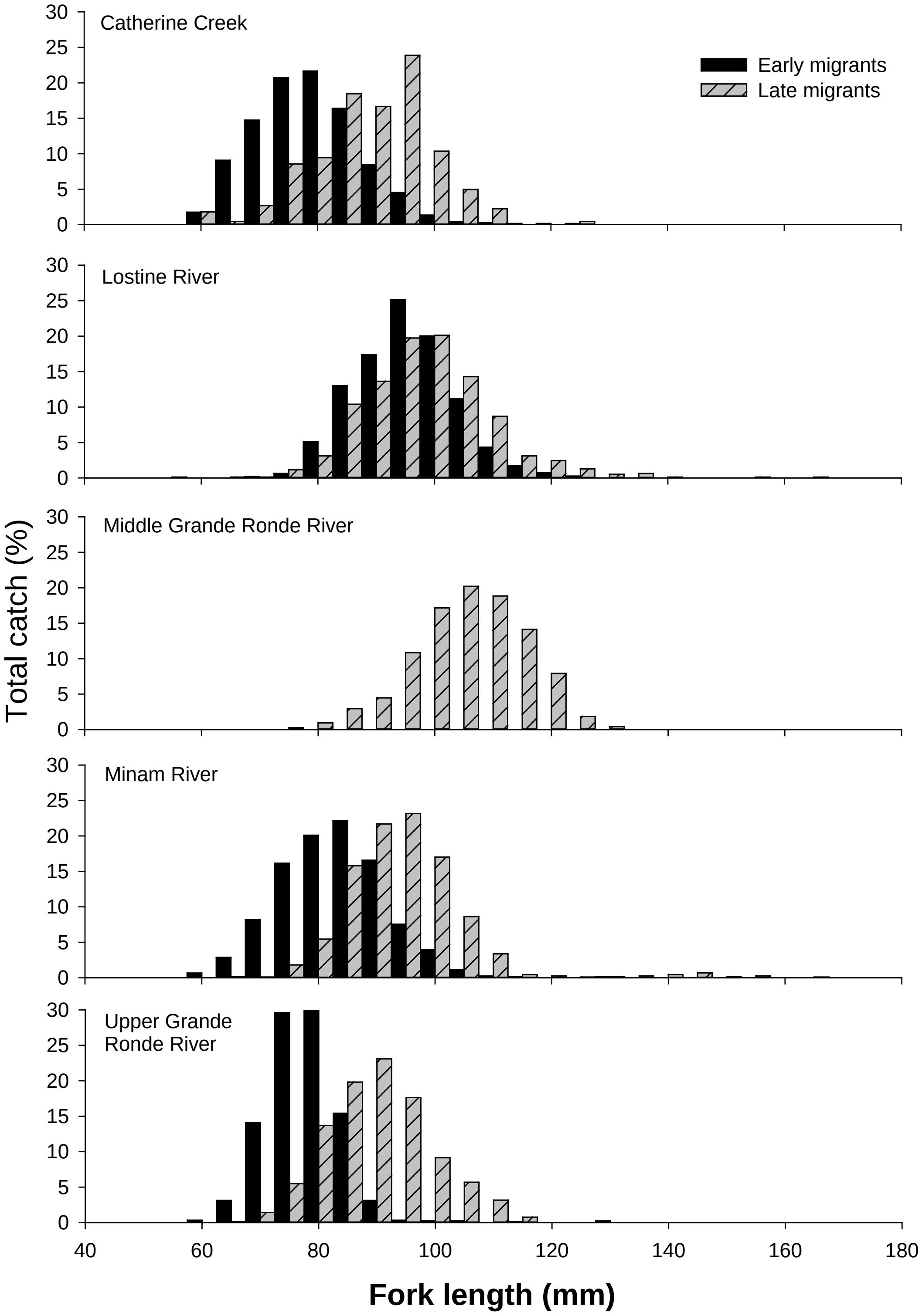
[a] Data were insufficient to calculate a survival probability.

Appendix Table B- 11. PIT tagged early migrating steelhead sampled by screw trap in the Grande Ronde Basin, and subset subsequently detected at Snake and Columbia River dams during spring 2015. Italicized headings represent smolt age at time detections were recorded at a dam. Means are weighted by sample size (*n*).

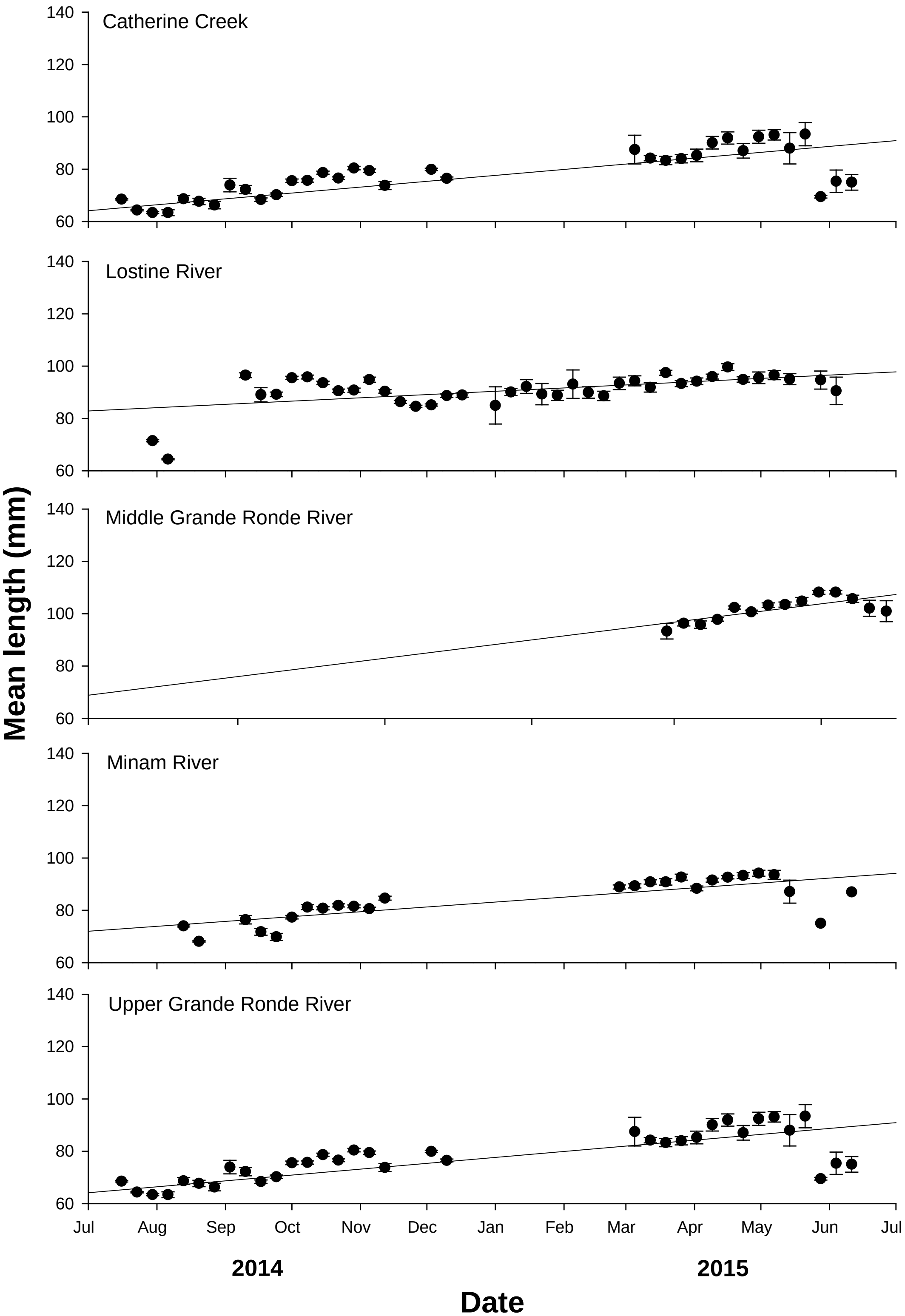
Trap site	*n*	Age-0 *Age-1 smolt*	Age-1 *Age-2 smolt*	Age-2 *Age-3 smolt*	Age-3 *Age-4 smolt*
		PIT tagged fish with known age (%)			
Catherine Creek	173	30.1	47.4	22.5	1.4
Lostine River	220	32.7	43.2	22.7	3.7
Minam River	134	27.4	37.1	31.9	1.6
Upper Grande Ronde River	22	22.9	42.5	33.1	1.7
Mean		28.3	42.5	27.5	1.7
CV (%)		14.9	10.0	20.7	92.2
	PIT tagged fish detected at dams (%)				
Catherine Creek	2	0	100	0	0
Lostine River	1	0	100	0	0
Minam River	0	0	0	0	0
Upper Grande Ronde River	0	0	0	0	0
Mean		0	50	0	0
CV (%)		0	1.2	0	0



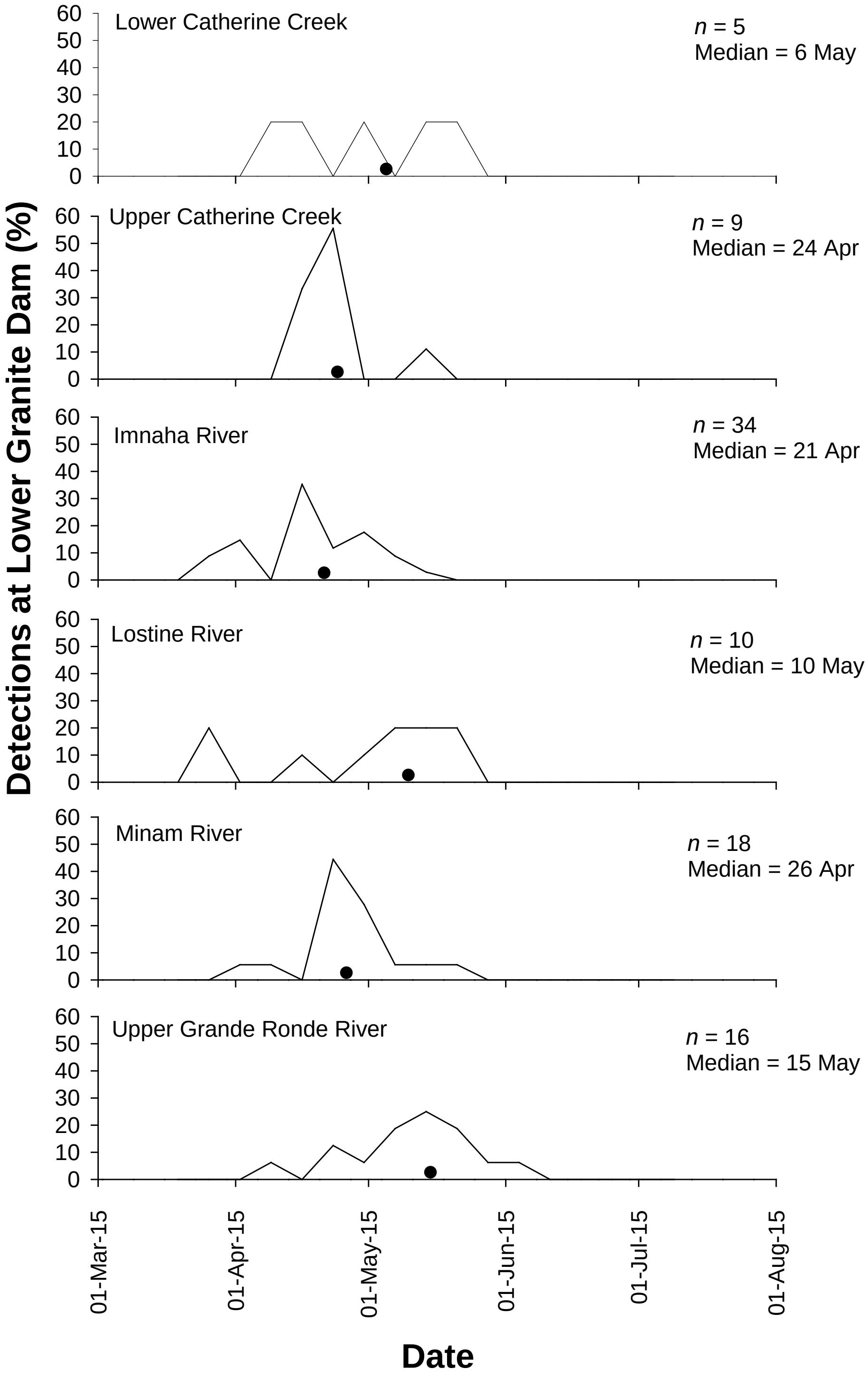
Appendix Figure B-1. Estimated migration timing and abundance for juvenile spring Chinook salmon migrants sampled by rotary screw traps during MY 2015.



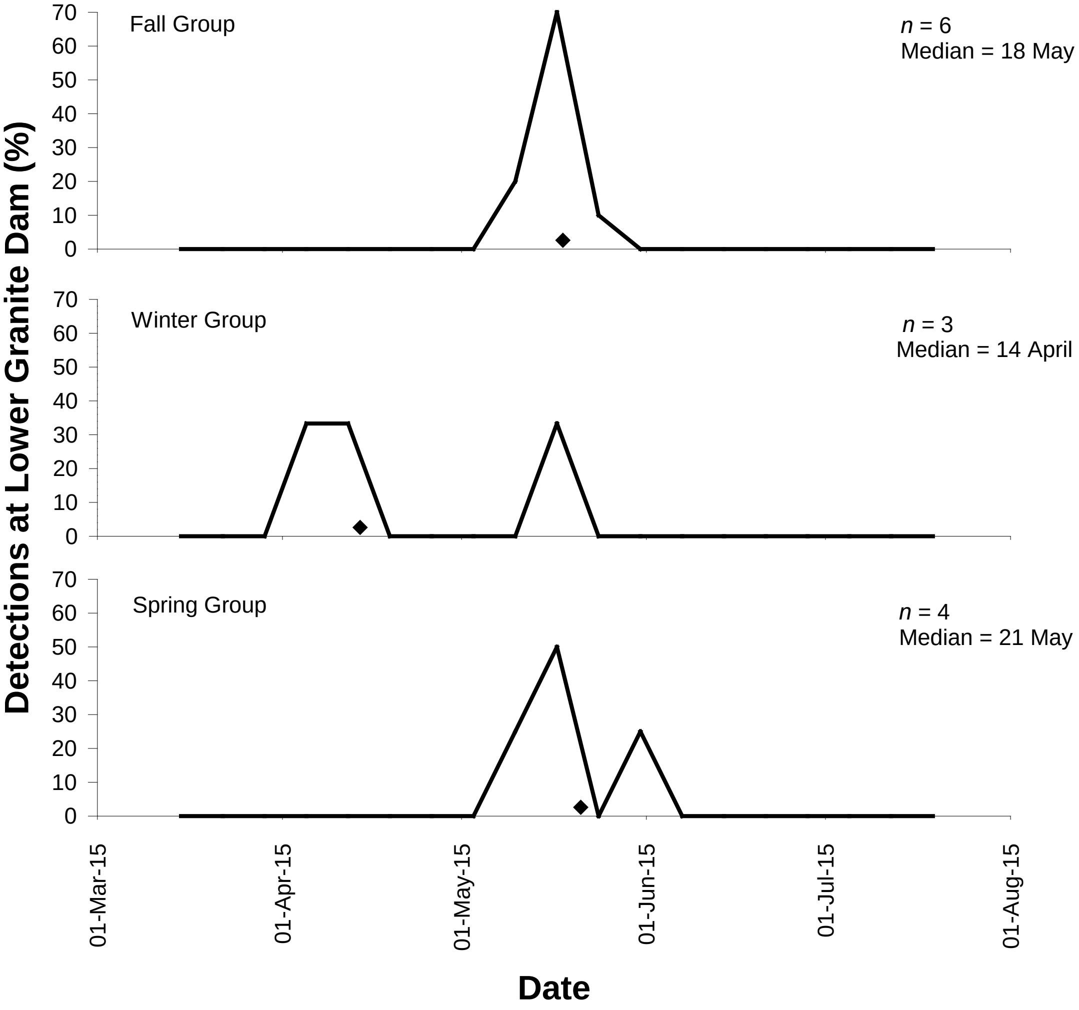
Appendix Figure B-2. Length frequency distribution (fork length) of early and late migrating juvenile spring Chinook salmon captured at Catherine Creek (rkm 32), Lostine (rkm 3), middle Grande Ronde (rkm 160), Minam (rkm 0), and upper Grande Ronde (rkm 299) river traps during MY 2014.



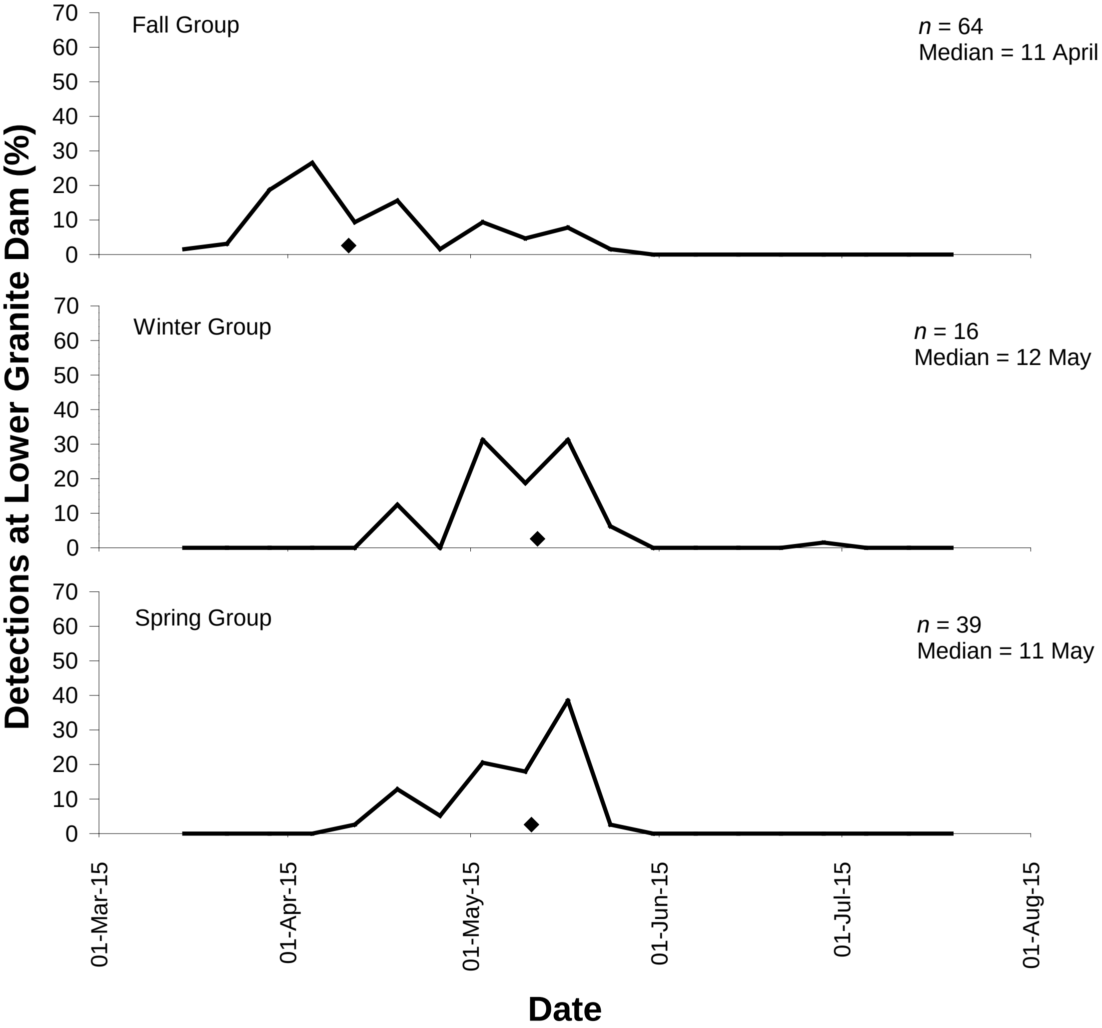
Appendix Figure B-3. Weekly mean fork lengths and associated standard error for spring Chinook salmon captured by rotary screw traps in Grande Ronde River Subbasin during MY 2015.



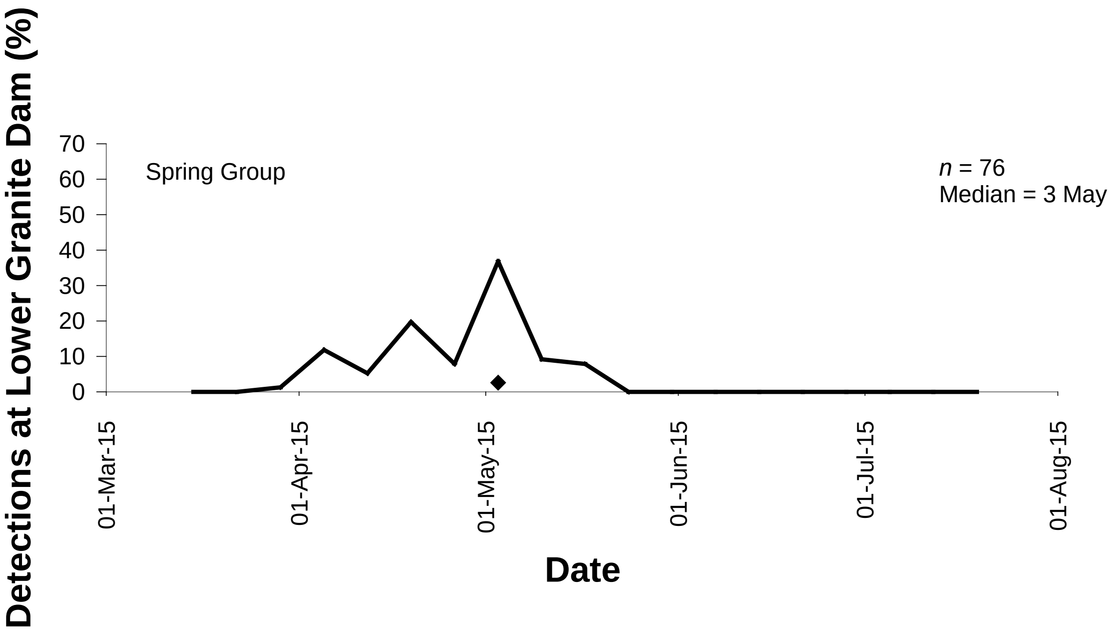
Appendix Figure B-4. Dates of arrival, during 2015 at Lower Granite Dam, of spring Chinook salmon PIT-tagged as parr in Catherine Creek and Imnaha, Lostine, Minam, and upper Grande Ronde rivers during summer 2014. Data was summarized by week and expressed as percentage of total detected. Detections were expanded for spillway flow. ♦ = median arrival date.



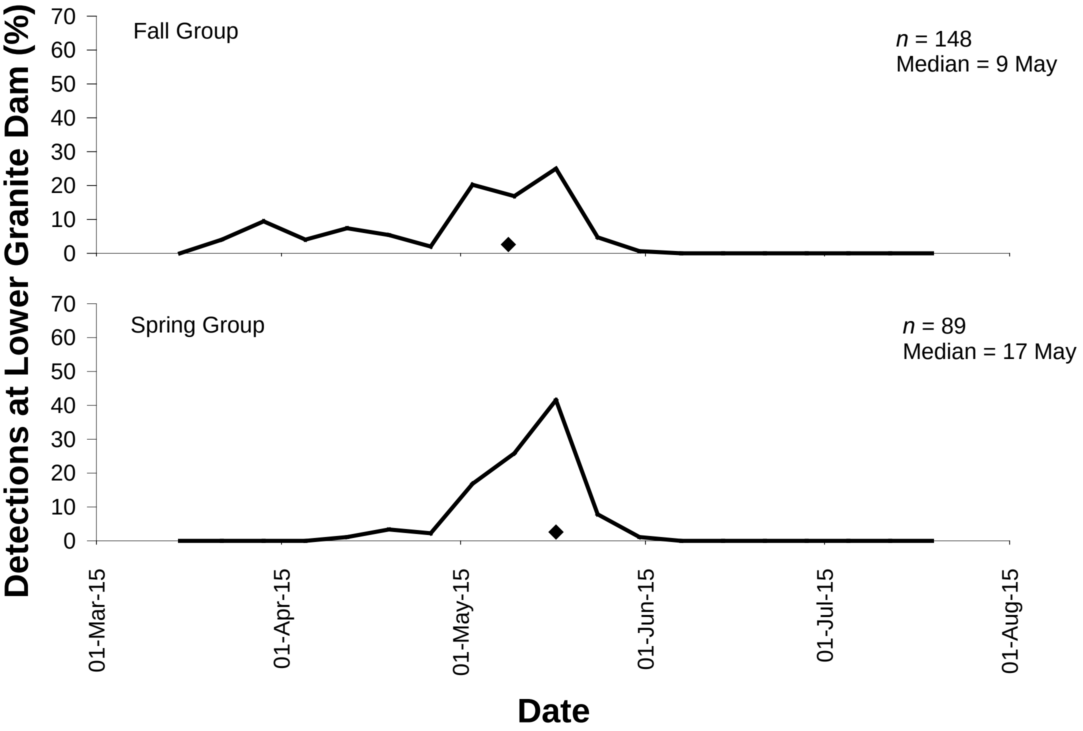
Appendix Figure B-5. Dates of arrival, during 2015 at Lower Granite dam, for fall, winter, and spring tag groups of juvenile spring Chinook salmon PIT-tagged from Catherine Creek. Data was summarized by week and expressed as percentage of total detected. Detections were expanded for spillway flow. ◆ = median arrival date.



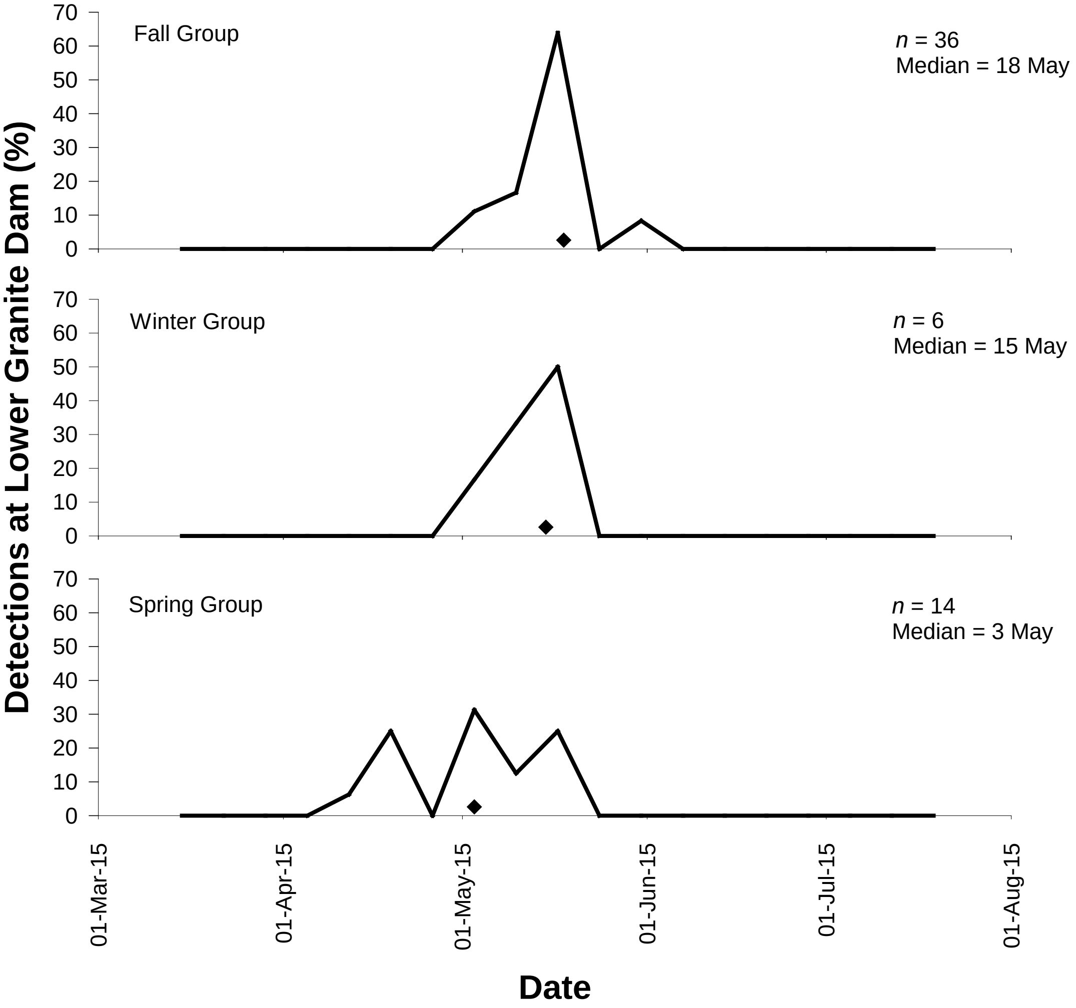
Appendix Figure B-6. Dates of arrival, during 2015 at Lower Granite dam, for fall, winter, and spring tag groups of juvenile spring Chinook salmon PIT-tagged from Lostine River. Data was summarized by week and expressed as percentage of total detected. Detections were expanded for spillway flow. ◆ = median arrival date.



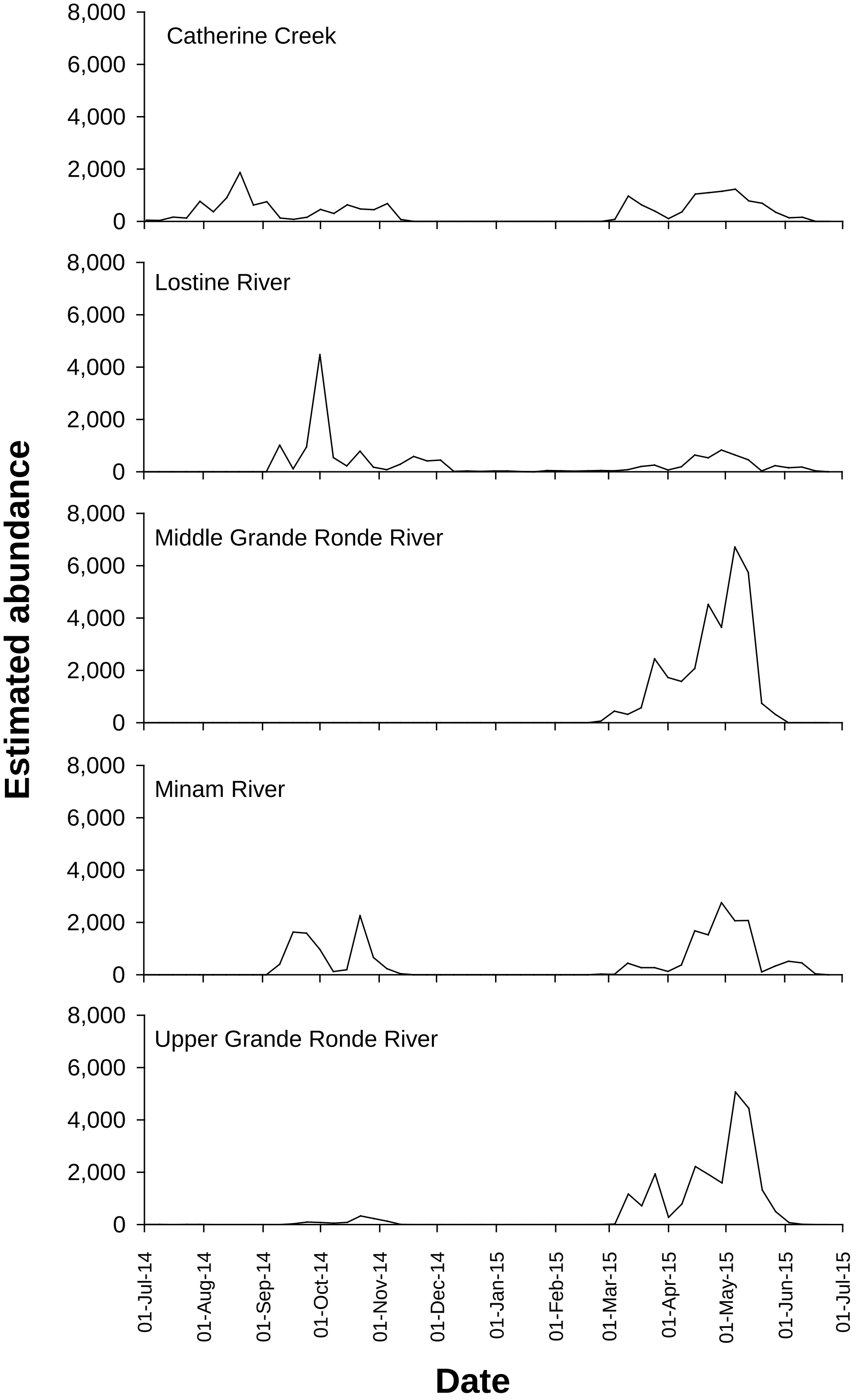
Appendix Figure B-7. Dates of arrival, during 2015 at Lower Granite dam, for the spring tag group of juvenile spring Chinook salmon PIT-tagged from middle Grande Ronde River. Data was summarized by week and expressed as percentage of total detected. Detections were expanded for spillway flow. ◆ = median arrival date.



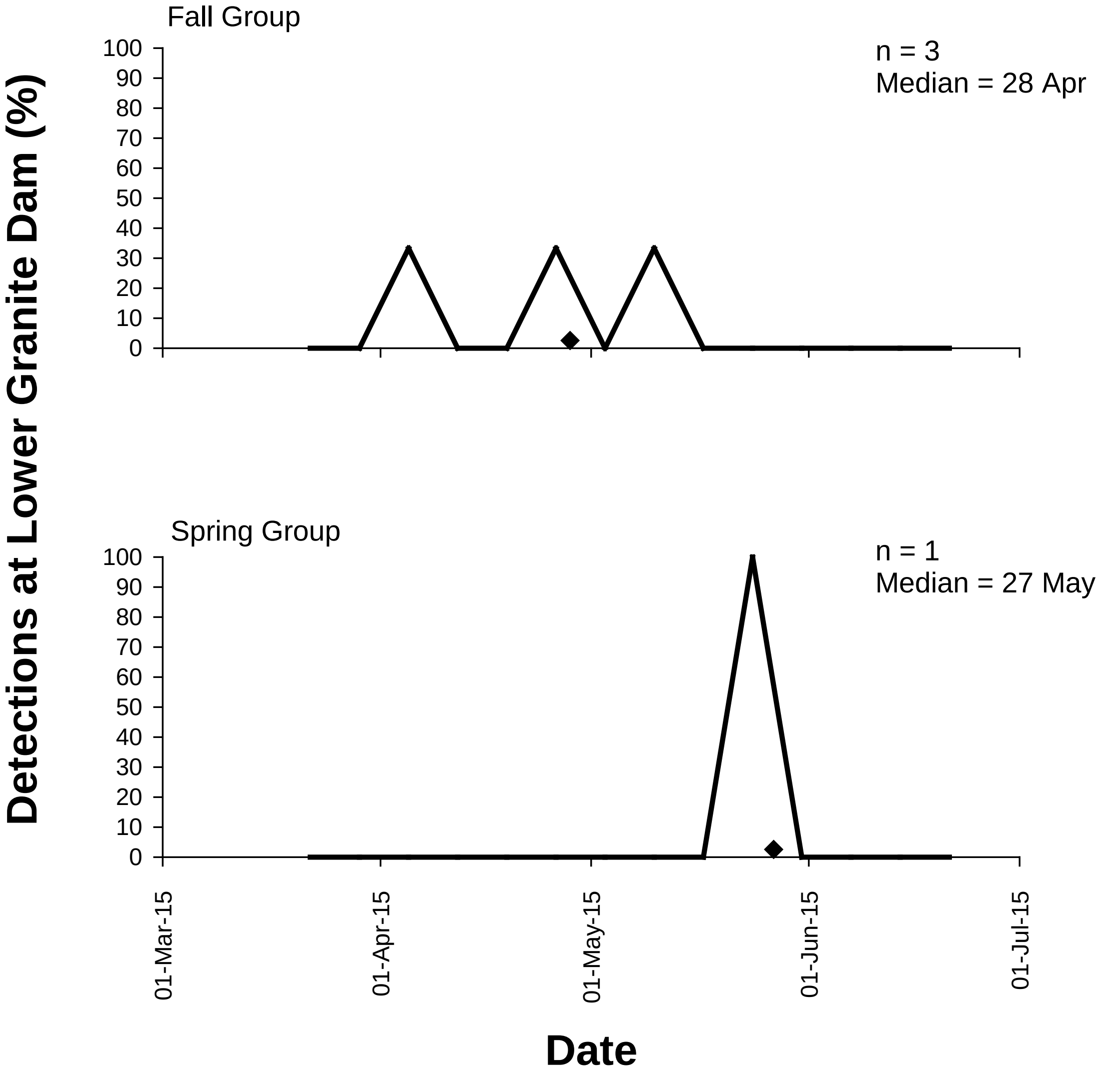
Appendix Figure B-8. Dates of arrival, during 2015 at Lower Granite dam, for fall and spring tag groups of juvenile spring Chinook salmon PIT-tagged from Minam River. Data was summarized by week and expressed as percentage of total detected. Detections were expanded for spillway flow. ◆ = median arrival date.



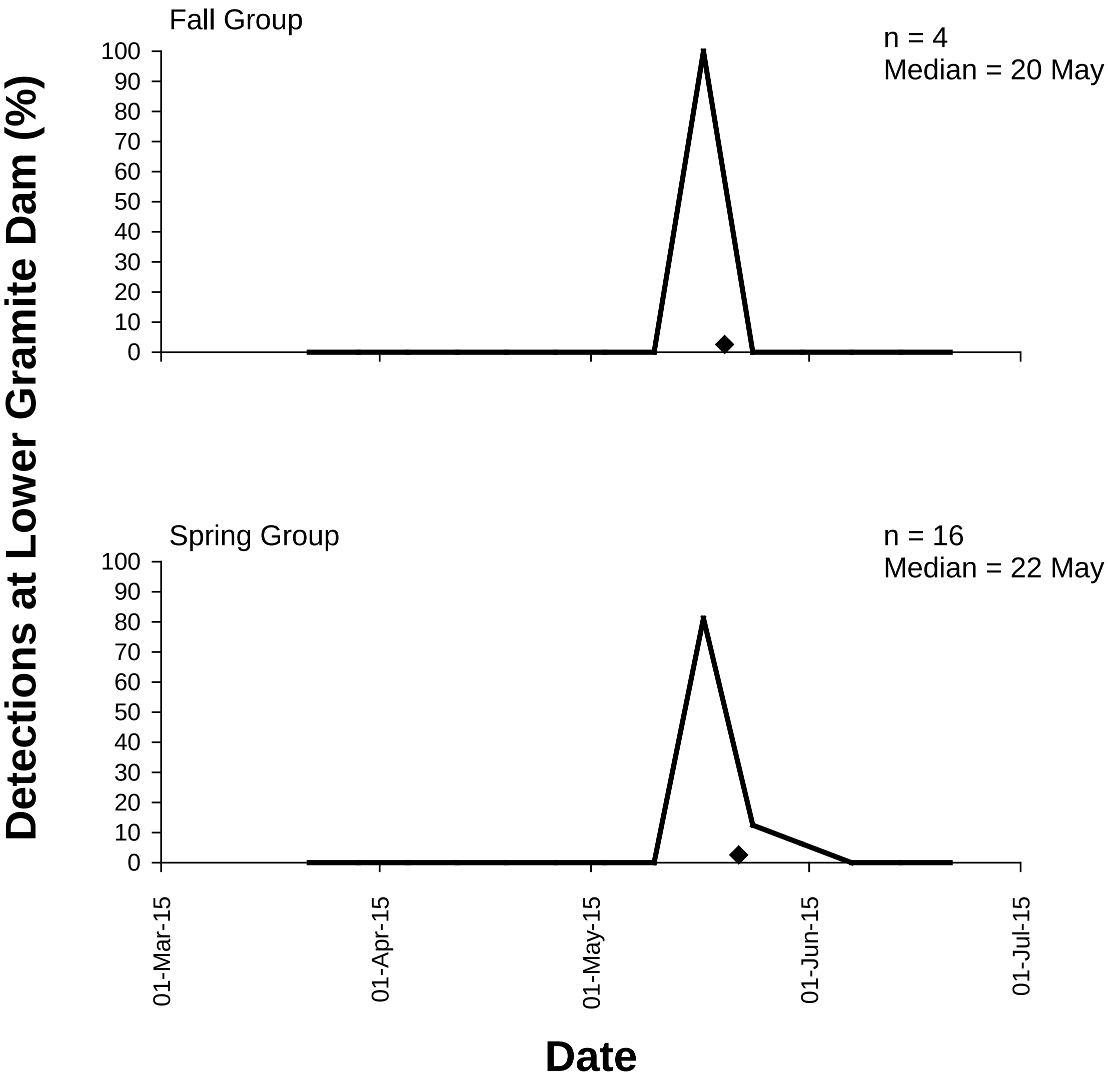
Appendix Figure B-9. Dates of arrival, during 2014 at Lower Granite dam, for fall, winter, and spring tag groups of juvenile spring Chinook salmon PIT-tagged from upper Grande Ronde River. Data was summarized by week and expressed as percentage of total detected. Detections were expanded for spillway flow. ◆ = median arrival date.



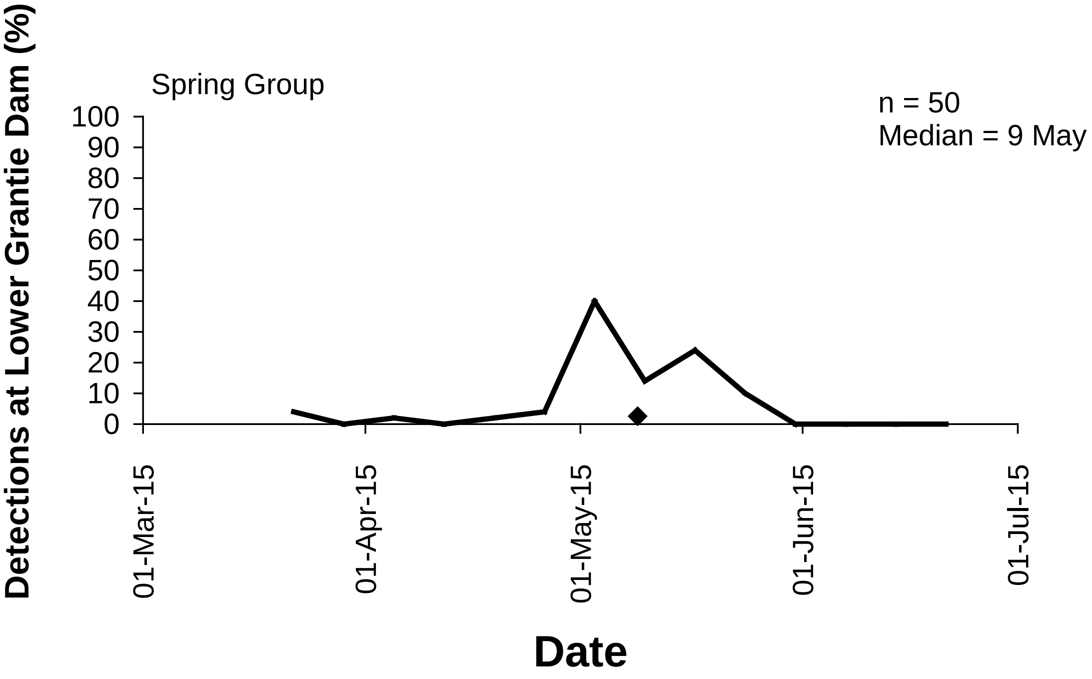
Appendix Figure B-10. Estimated migration timing and abundance of juvenile summer steelhead migrants captured by rotary screw trap during MY 2015.



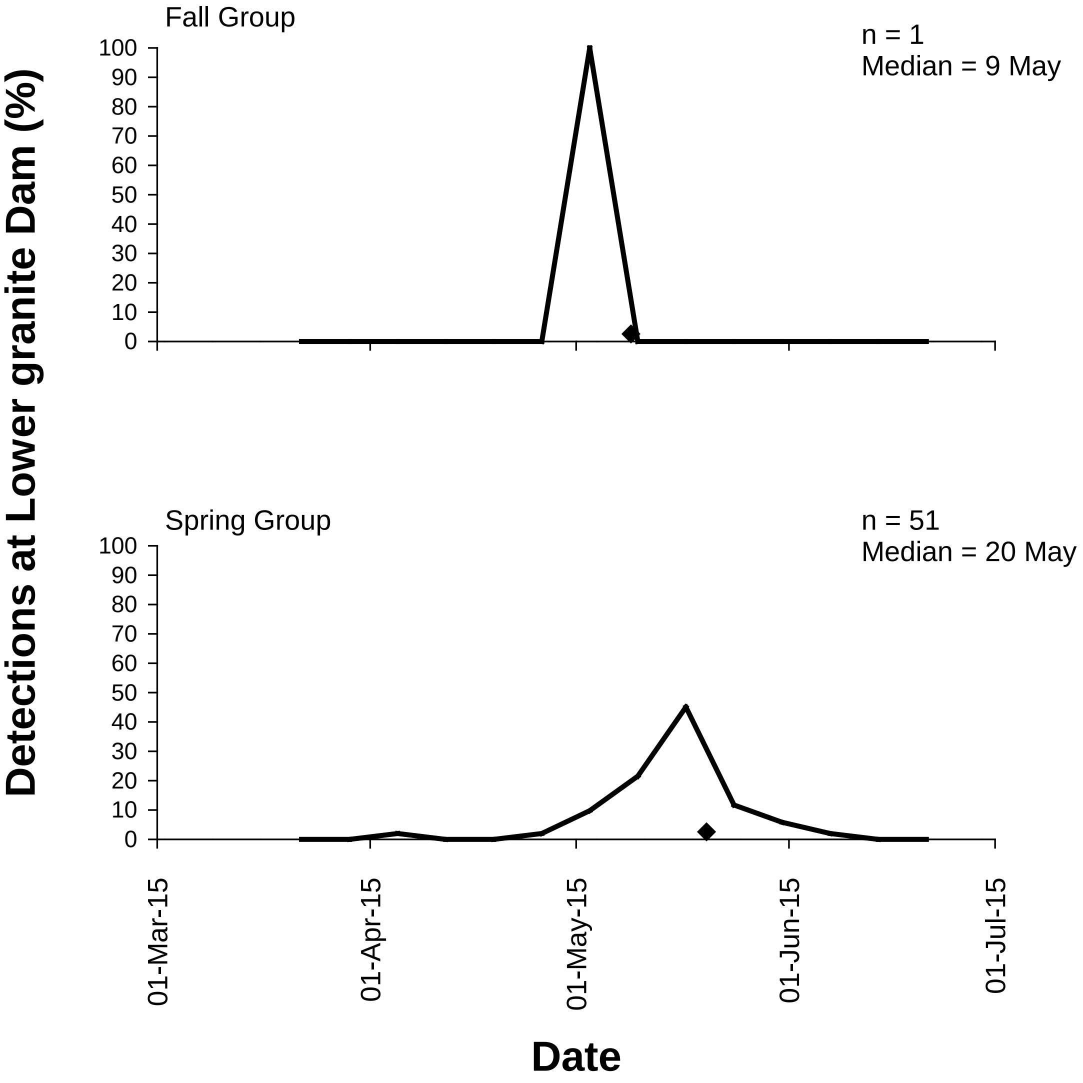
Appendix Figure B-11. Dates of arrival, in 2015, at Lower Granite Dam for fall and spring tag groups of steelhead PIT-tagged from Catherine Creek, and expressed as a percentage of total detected for each group. Detections were expanded for spillway flow. ♦ = median arrival date.



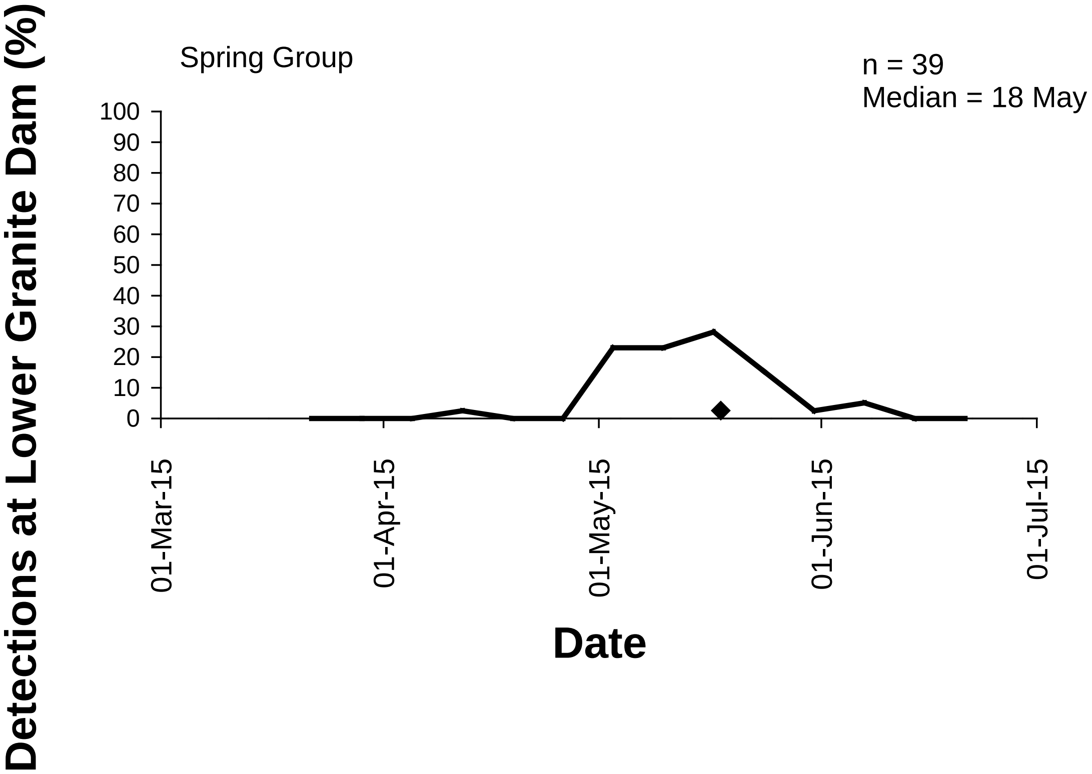
Appendix Figure B-12. Dates of arrival, in 2015, at Lower Granite Dam for fall and spring tag groups of steelhead PIT-tagged from Lostine River, and expressed as a percentage of total detected for each group. Detections were expanded for spillway flow. ♦ = median arrival date.



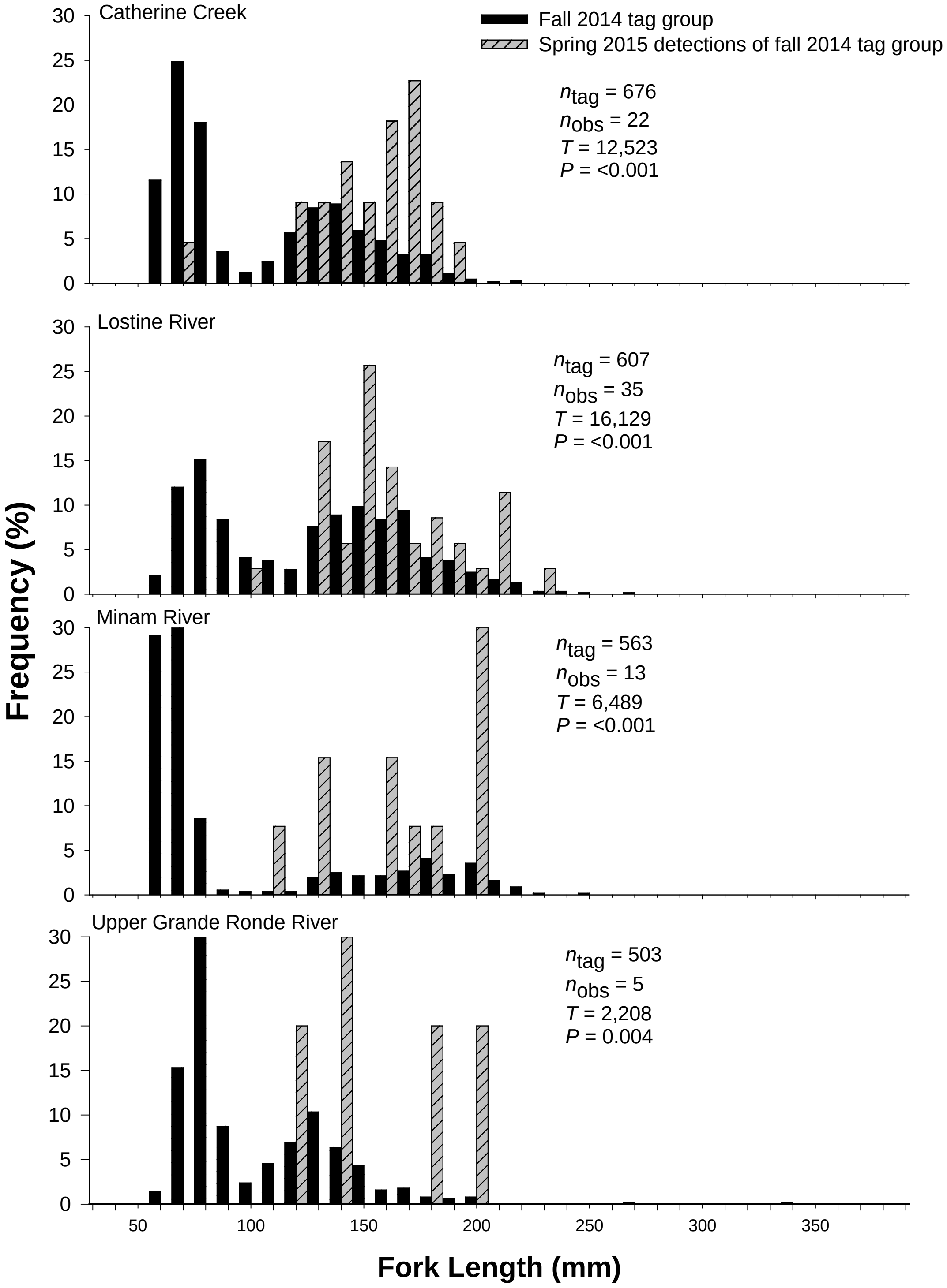
Appendix Figure B-13. Dates of arrival, in 2015, at Lower Granite Dam for fall and spring tag groups of steelhead PIT-tagged from middle Grande Ronde River, and expressed as a percentage of total detected for each group. Detections were expanded for spillway flow. ♦ = median arrival date.



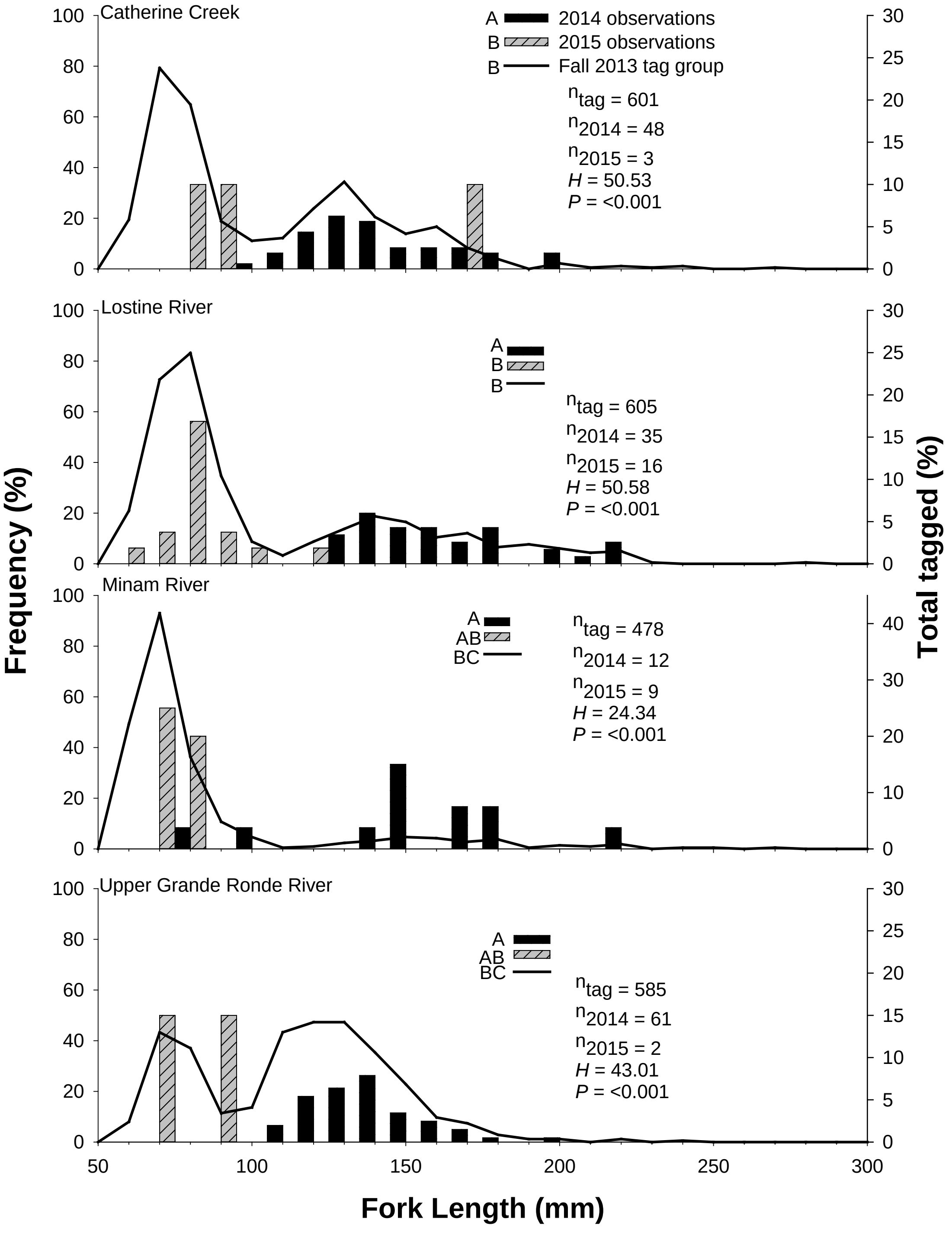
Appendix Figure B-14. Dates of arrival, in 2015, at Lower Granite Dam for fall and spring tag groups of steelhead PIT-tagged from Minam River, and expressed as a percentage of total detected for each group. Detections were expanded for spillway flow. ♦ = median arrival date.



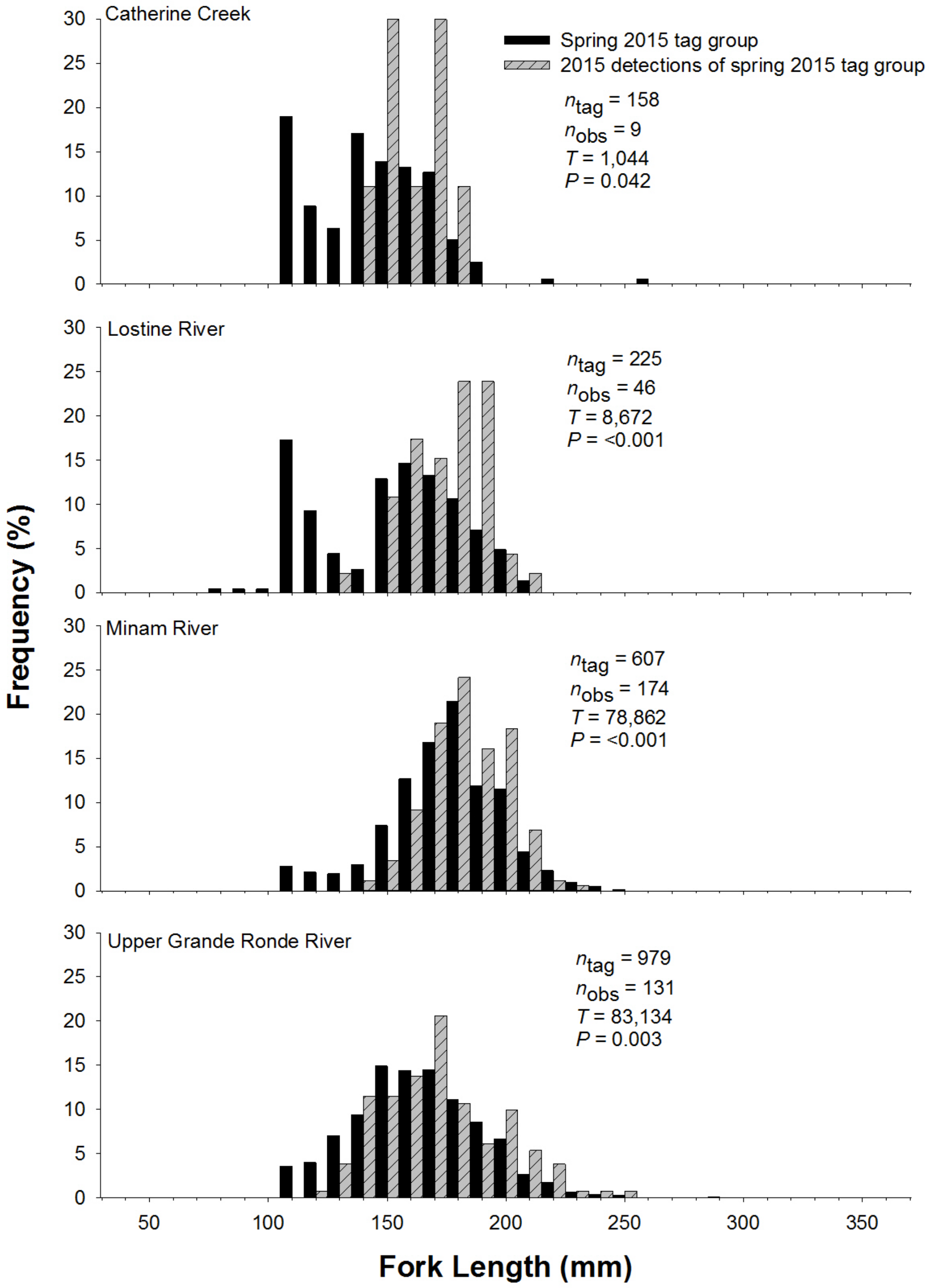
Appendix Figure B-15. Dates of arrival, in 2015, at Lower Granite Dam for the spring tag group of steelhead PIT-tagged from upper Grande Ronde River, and expressed as a percentage of total detected for each group. Detections were expanded for spillway flow. ♦ = median arrival date.



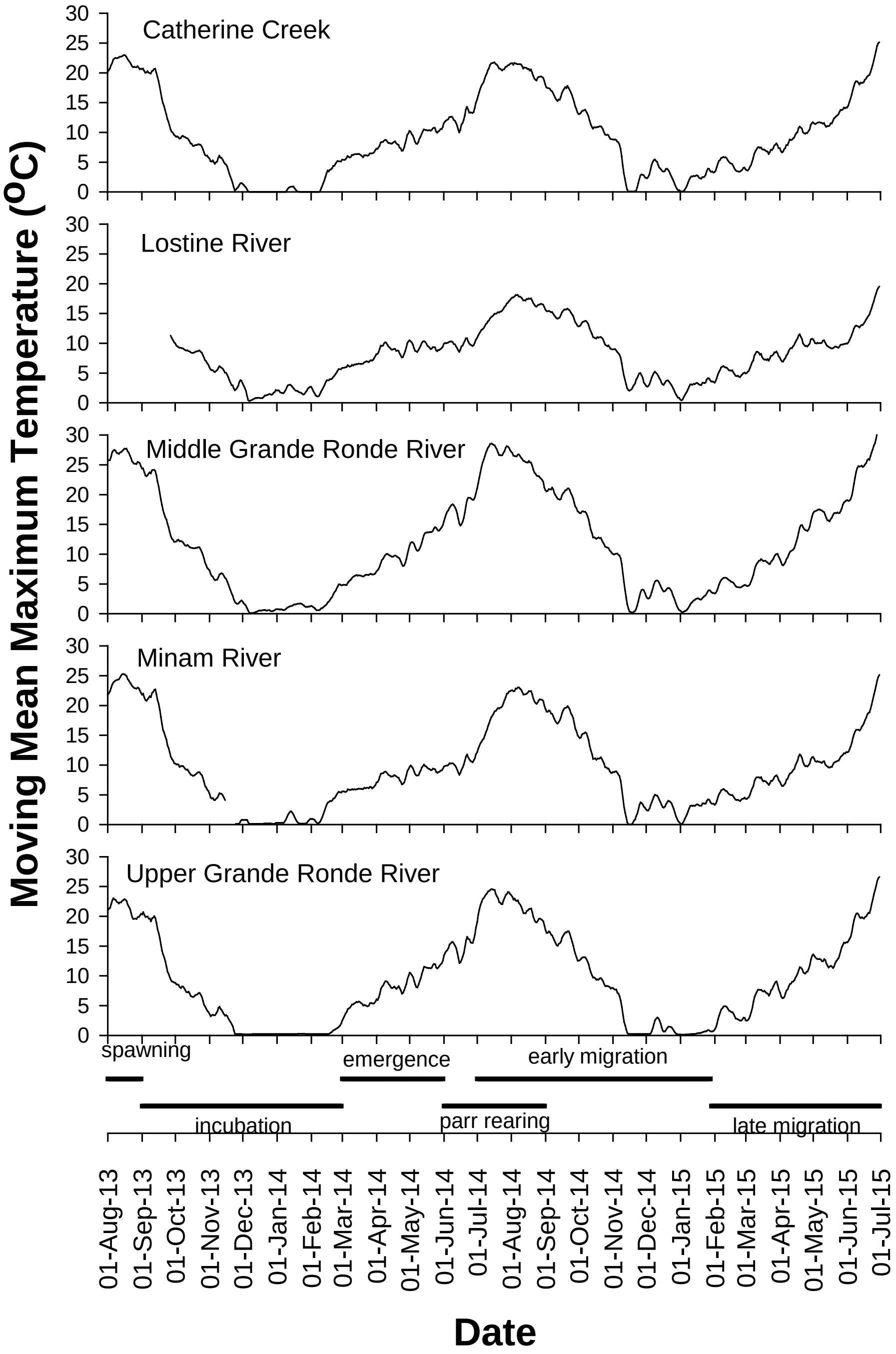
Appendix Figure B-16. Length frequency distributions for all steelhead PIT-tagged at screw traps during fall 2014 and those subsequently observed at Snake or Columbia river dams during spring 2015. Fork lengths are based on measurements taken at time of tagging. Frequency is expressed as percent of total number tagged (n_{tag}). 'n_{obs}' is number detected.



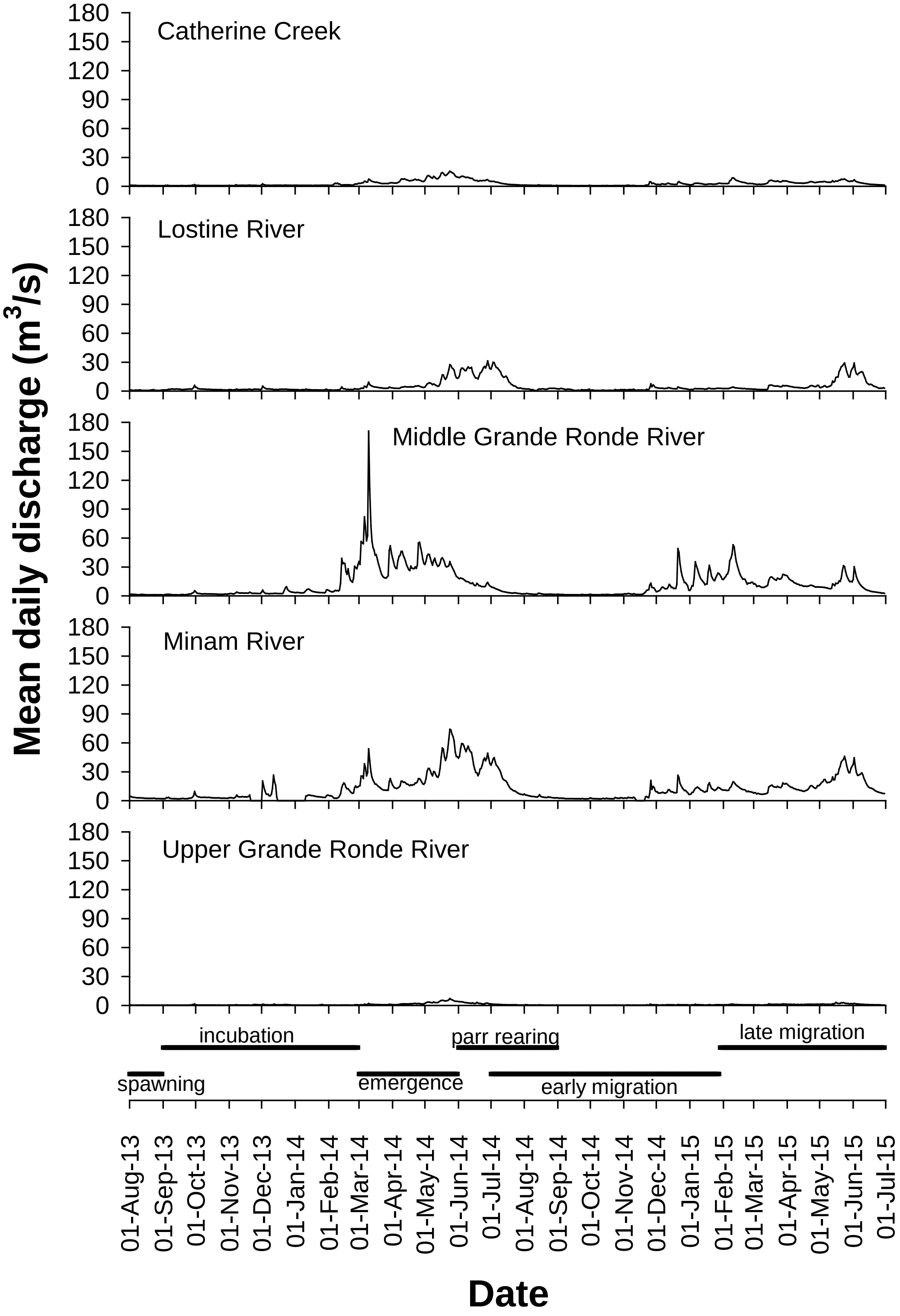
Appendix Figure B-17. Length frequency distributions for steelhead PIT-tagged at screw traps during fall 2013, and those subsequently observed at Snake or Columbia river dams during 2014 and 2015. Frequency is expressed as percent of total number tagged. ‘H’ is the test statistic for the Kruskal–Wallis one-way ANOVA on ranks of lengths. Dunn’s all pair-wise multiple comparison procedure was employed to compare groups among Catherine Creek, Lostine, and Minam rivers (α = 0.05).



Appendix Figure B-18. Length frequency distributions for steelhead PIT-tagged at screw traps during spring 2015, and those subsequently observed at Snake or Columbia river dams during spring 2015. Data were compared using the Mann-Whitney rank-sum test. Fork lengths are based on measurements taken at time of tagging. Frequency is expressed as percent of total number tagged (n_{tag}), and 'n_{obs}' represents number detected.



Appendix Figure B-19. Moving mean of maximum water temperature from four study streams in Grande Ronde River Subbasin during MY 2015. Data corresponds with juvenile spring Chinook salmon in-basin egg-to-emigrant life stages. Missing portions of a trend line represent periods where data were not available.



Appendix Figure B-20. Average daily discharge from four study streams in the Grande Ronde River Subbasin during MY 2015. Data corresponds with juvenile spring Chinook salmon in-basin egg-to-emigrant life stages.

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Appendix Table B-12. Steelhead spawning ground survey characteristics, location and stream classification for sites in the UGRR basin, 2015.

Site ID	Stream	Panel	Stream Classification	Survey Distance (km)	Upstream Latitude	Upstream Longitude	Downstream Latitude	Downstream Longitude
CBW05583-095642	McCoy Creek	Panel 2	Transport	2.25	45.33986	-118.549122	45.35167	-118.567439
dsgn4-000001	North Fork Catherine Creek	Panel 2	Depositional	2.30	45.11974	-117.647623	45.13171	-117.628805
dsgn4-000168	North Fork Catherine Creek	Panel 2	Depositional	1.78	45.15209	-117.617520	45.16747	-117.605616
dsgn4-000205	Grande Ronde River	Panel 2	Depositional	2.25	45.32210	-118.259900	45.31181	-118.277140
ORW03446-006894	Dry Creek	Panel 2	Transport	2.25	45.56483	-118.076598	45.57764	-118.093546
ORW03446-007768	Dry Creek	Random	Source	2.25	45.63670	-118.116580	45.62136	-118.112210
ORW03446-010990	Little Phillips Creek	Random	Source	1.99	45.62780	-118.015500	45.64500	-118.020200
ORW03446-016600	Graves Creek	Random	Source	1.50	45.27843	-118.181980	45.28575	-118.189080
ORW03446-018904	Spring Creek	Annual	Transport	2.39	45.34725	-118.307330	45.33805	-118.286129
ORW03446-049208	Camp Creek	Panel 2	Source	2.34	45.38646	-117.758490	45.39038	-117.737670
ORW03446-059352	Clark Creek	Annual	Depositional	1.84	45.50022	-117.819943	45.51500	-117.828889
ORW03446-065720	Spring Creek	Panel 2	Transport	2.37	45.35793	-118.324996	45.36594	-118.345920
ORW03446-077704	Burnt Corral Creek	Panel 2	Source	2.22	45.22095	-118.476224	45.20598	-118.491617
ORW03446-079752	Grande Ronde River	Annual	Depositional	1.99	45.17927	-118.389368	45.19335	-118.395185
ORW03446-101102	Phillips Creek	Annual	Depositional	2.30	45.56971	-117.993709	45.56694	-117.973246
ORW03446-101560	Meadow Creek	Annual	Transport	1.97	45.29236	-118.612176	45.28316	-118.602238
ORW03446-108270	Little Phillips Creek	Panel 2	Transport	1.94	45.59398	-118.007900	45.61066	-118.016300
ORW03446-111960	Pelican Creek	Panel 2	Transport	2.19	45.39508	-118.293712	45.40877	-118.309351
ORW03446-118408	West Chicken Creek	Annual	Source	1.95	45.02682	-118.403583	45.04449	-118.403882
ORW03446-118856	Marley Creek	Random	Source	1.87	45.18785	-118.446230	45.20443	-118.439770
ORW03446-120904	Burnt Corral Creek	Annual	Source	2.13	45.17401	-118.516512	45.18431	-118.499661
ORW03446-125832	Meadow Creek	Annual	Depositional	2.17	45.26362	-118.551468	45.27139	-118.533272
ORW03446-130030	Clark Creek	Panel 2	Depositional	2.26	45.54977	-117.891010	45.54264	-117.871564
ORW03446-147928	Five Points Creek	Annual	Depositional	2.36	45.41072	-118.201787	45.40341	-118.222762
ORW03446-149464	Middle Fork Clark Creek	Panel 2	Source	2.13	45.50890	-117.806050	45.49634	-117.789890
ORW03446-155196	Clear Creek	Random	Source	1.92	45.02863	-118.326700	45.02850	-118.326700
ORW03446-159368	Chicken Creek	Panel 2	Transport	1.87	45.04709	-118.392366	45.04710	-118.392420
ORW03446-170478	Little Lookingglass Creek	Panel 2	Depositional	2.10	45.75443	-117.878045	45.76761	-117.887897
ORW03446-177134	East Phillips Creek	Annual	Source	2.20	45.63454	-118.055699	45.62304	-118.072221

Appendix Table B-13. Steelhead spawning ground survey characteristics, location and stream classification for sites in the Joseph Creek basin, 2015.

Site ID	Stream	Panel	Stream Classification	Survey Distance (km)	Upstream Latitude	Upstream Longitude	Downstream Latitude	Downstream Longitude
CBW05583-002175	Crow Creek	Annual	Transport	2.07	45.69023	-117.150370	45.70545	-117.15186
CBW05583-012802	Cottonwood Creek	Panel 1	Source	1.97	45.89784	-116.996640	45.91148	-117.00802
CBW05583-043522	Broady Creek	Panel 1	Source	1.70	45.94215	-117.101000	45.94788	-117.08126
CBW05583-045183	Elk Creek	Panel 1	Transport	1.95	45.67850	-117.171720	45.69487	-117.18499
CBW05583-051026	Unnamed trib to Alder	Annual	Source	1.69	45.69084	-117.011250	45.70425	-117.02264
CBW05583-087554	Cottonwood Creek	Panel 1	Source	1.10	45.85616	-116.978200	45.86228	-116.97984
CBW05583-112130	Devils Run Creek	Annual	Source	2.02	45.78225	-116.969200	45.78081	-116.98547
CBW05583-116562	Alder Creek	Panel 1	Transport	2.23	45.70334	-117.025960	45.70532	-117.05077
CBW05583-128514	Chesnimnus Creek	Panel 1	Transport	1.95	45.71588	-116.934840	45.72763	-116.95046
CBW05583-141826	Basin Creek	Annual	Source	2.12	45.91900	-117.059000	45.93269	-117.05829
CBW05583-167426	Chesnimnus Creek	Annual	Depositional	2.44	45.75440	-116.998440	45.75067	-117.01907
CBW05583-169810	Chesnimnus Creek	Annual	Transport	2.08	45.71144	-116.911870	45.65759	-116.92303
CBW05583-237503	Swamp Creek	Panel 1	Depositional	2.08	45.80855	-117.229320	45.82245	-117.23183
CBW05583-258175	Chesnimnus Creek	Panel 1	Depositional	2.07	45.70521	-117.136170	45.71422	-117.15567
CBW05583-301570	Cottonwood Creek	Annual	Source	1.88	45.93356	-117.052350	45.94326	-117.05991
CBW05583-318978	Chesnimnus Creek	Panel 1	Depositional	2.21	45.73194	-117.050870	45.72186	-117.06529
CBW05583-354818	West Fork Broady Creek	Panel 1	Source	2.02	45.86955	-117.095730	45.87912	-117.08801
CBW05583-389247	Chesnimnus Creek	Annual	Depositional	1.94	45.69840	-117.121006	45.70513	-117.13607
CBW05583-394754	Devils Run Creek	Panel 1	Source	2.02	45.77077	-116.911930	45.77286	-116.93246
CBW05583-487551	Crow Creek	Panel 1	Source	2.04	45.67705	-117.139950	45.69023	-117.15037
CBW05583-493394	Salmon Creek	Annual	Transport	1.92	45.70401	-117.049560	45.71857	-117.05021
CBW05583-509778	Pine Creek	Panel 1	Transport	2.05	45.67738	-117.029690	45.68976	-117.03870
CBW05583-515586	Chesnimnus Creek	Annual	Depositional	2.40	45.73674	-117.033240	45.73187	-117.05089
CBW05583-527874	Devils Run Creek	Panel 1	Transport	2.33	45.07765	-116.927380	45.77810	-116.94788

Appendix Table B-14. Completion dates and general results for redd surveys in the Upper Grande Ronde River basin and Deer Creek, 2015.

Short Site ID	Stream	Mean No. days between surveys	Redd Count	1st Survey	2nd Survey	3rd Survey	4th Survey	5th Survey	6th Survey	7th Survey	8th Survey
000001	North Fork Catherine Creek	12.7	5	3/24/2015	4/7/2015	4/20/2015	4/30/2015	5/11/2015	5/28/2015	6/8/2015	
000168	North Fork Catherine Creek	12.7	1	3/24/2015	4/7/2015	4/20/2015	4/30/2015	5/11/2015	5/28/2015	6/8/2015	
000205	Grande Ronde River	14.3	0	3/16/2015	4/1/2015	4/14/2015	4/28/2015	5/12/2015			
006894	Dry Creek	15.0	4	2/25/2015	3/18/2015	3/30/2015	4/13/2015	4/27/2015	5/11/2015		
007768	Dry Creek	13.5	2	3/18/2015	3/30/2015	4/13/2015	4/27/2015	5/11/2015			
016600	Graves Creek	14.5	0	3/16/2015	4/1/2015	4/14/2015					
[a]018904	Spring Creek	13.3	29	2/24/2015	3/13/2015	3/31/2015	4/8/2015	4/13/2015	4/28/2015	5/12/2015	5/27/2015
041944	Jordan Creek	14.0	0	4/7/2015	4/20/2015	5/5/2015					
049208	Camp Creek	16.0	1	4/16/2015	4/28/2015	5/19/2015	6/3/2015				
059352	Clark Creek	16.5	18	2/24/2015	3/11/2015	3/24/2015	4/6/2015	4/20/2015	5/5/2015	6/3/2015	
065720	Spring Creek	14.2	19	3/16/2015	3/31/2015	4/13/2015	4/28/2015	5/12/2015	5/27/2015	6/9/2015	
077704	Burnt Corral Creek	14.0	0	3/17/2015	3/30/2015	4/15/2015	4/27/2015	5/12/2015			
079752	Grande Ronde River	14.3	0	3/16/2015	4/1/2015	4/14/2015	4/28/2015	5/12/2015	5/27/2015	6/10/2015	
095642	McCoy Creek	13.2	16	3/23/2015	4/6/2015	4/22/2015	5/5/2015	5/18/2015	5/27/2015	6/10/2015	
101102	Phillips Creek	13.5	6	3/25/2015	4/8/2015	4/21/2015	5/5/2015	5/18/2015			
101560	Meadow Creek	15.6	18	3/23/2015	4/6/2015	4/22/2015	5/4/2015	5/18/2015	6/9/2015		
108270	Little Phillips Creek	14.2	4	3/25/2015	4/8/2015	4/21/2015	5/6/2015	5/18/2015	6/4/2015		
111960	Pelican Creek	16.2	3	3/19/2015	3/31/2015	4/13/2015	5/4/2015	5/18/2015	6/8/2015		
118408	West Chicken Creek	17.8	0	3/23/2015	4/7/2015	4/21/2015	5/19/2015	6/2/2015			
118856	Marley Creek	14.5	0	3/17/2015	3/30/2015	4/15/2015					
120904	Burnt Corral Creek	14.5	0	3/30/2015	4/15/2015	4/27/2015	5/12/2015	5/27/2015			
125832	Meadow Creek	14.0	17	3/23/2015	4/6/2015	4/22/2015	5/6/2015	5/18/2015			
130030	Clark Creek	14.0	1	2/25/2015	3/11/2015	3/24/2015	4/6/2015	4/23/2015	5/5/2015	5/20/2015	6/3/2015
147928	Five Points Creek	14.2	36	3/17/2015	3/31/2015	4/15/2015	4/30/2015	5/14/2015	5/28/2015	6/10/2015	
149464	Middle Fork Clark Creek	15.4	7	3/24/2015	4/6/2015	4/20/2015	5/5/2015	5/20/2015	6/9/2015		
155196	Clear Creek	18.7	0	4/7/2015	4/21/2015	5/19/2015	6/2/2015				
159368	Chicken Creek	17.8	34	3/23/2015	4/7/2015	4/21/2015	5/19/2015	6/2/2015			
170478	Little Lookingglass Creek	13.7	16	3/18/2015	3/30/2015	4/13/2015	4/27/2015	5/10/2015	5/26/2015	6/8/2015	
177134	East Phillips Creek	15.5	9	4/8/2015	4/21/2015	5/4/2015	5/18/2015	6/9/2015			

Appendix Table B-15. Completion dates and general results for redd surveys in the in the Joseph Creek basin, 2015.

Site ID	Stream	Mean No. days between surveys	Redd Count	1st Survey	2nd Survey	3rd Survey	4th Survey
002175	Crow Creek	21.0	12	3/11/2015	4/1/2015	4/22/2015	
012802	Cottonwood Ceek	21.0	2	3/10/2015	3/13/2015	4/21/2015	5/12/2015
043522	Broady Creek	21.0	2	3/9/2015	3/30/2015	4/20/2015	5/11/2015
045183	Elk Creek	21.0	19	3/11/2015	4/1/2015	4/22/2015	5/13/2015
051026	Unnamed	21.0	0	3/17/2015	4/8/2015	4/28/2015	
087554	Cottonwood Creek	0	0	3/25/2015			
112130	Devils Run Creek	20.0	21	3/19/2015	4/6/2015	4/29/2015	5/18/2015
116562	Alder Creek	21.3	0	3/17/2015	4/8/2015	4/27/2015	5/20/2015
128514	Chesnimnus Creek	17.3	5	3/23/2015	4/14/2015	4/27/2015	5/14/2015
141826	Basin Creek	20.7	1	3/10/2015	3/30/2015	4/20/2015	5/11/2015
167426	Chesnimnus Creek	18.3	33	3/19/2015	4/15/2015	4/27/2015	5/13/2015
169810	Chesnimnus Creek	17.3	1	3/23/2015	4/14/2015	4/27/2015	5/14/2015
237503	Swamp Creek	0	18	5/5/2015			
258175	Chesnimnus Creek	21.3	42	3/16/2015	4/6/2015	4/29/2015	5/19/2015
301570	Cottonwood Creek	21.0	22	3/10/2015	3/31/2015	4/21/2015	5/12/2015
318978	Chesnimnus Creek	22.7	29	3/12/2015	4/2/2015	4/27/2015	5/19/2015
354818	West Fork Brady Creek	0	0	5/6/2015			
389247	Chesnimnus Creek	22.7	21	3/12/2015	4/7/2015	4/29/2015	5/19/2015
394754	Devils Run Creek	18.3	0	3/24/2015	4/13/2015	4/29/2015	5/18/2015
487551	Crow Creek	21.0	9	3/11/2015	4/1/2015	4/22/2015	
493394	Salmon Creek	21.3	7	3/17/2015	4/8/2015	4/27/2015	5/20/2015
509778	Pine Creek	20.0	0	3/18/2015	4/8/2015	4/27/2015	
515586	Chesnimnus Creek	19.3	42	3/16/2015	4/7/2015	4/27/2015	5/13/2015
527874	Devils Run Creek	18.3	0	3/24/2015	4/13/2015	4/29/2015	5/18/2015

Appendix Table B-16. Locations, dates, and characteristics of live steelhead observations in the UGRR and Deer Creek basins, 2015.

Site ID	Stream	Observation Date	Fin Clip	On/Off Redd
18904	Spring Creek	3/13/2015	No	On
147928	Five Points Creek	3/31/2015	No	On
177134	East Phillips Creek	4/8/2015	Unknown	Off
Deer3-0	Deer Creek	4/9/2015	Unknown	Off
Deer3-0	Deer Creek	4/9/2015	Unknown	Off
Deer3-0	Deer Creek	4/9/2015	Unknown	Off
Deer3-0	Deer Creek	4/9/2015	No	Off
Deer3-0	Deer Creek	4/9/2015	Unknown	Off
Deer3-0	Deer Creek	4/9/2015	Yes	NR
Deer3-0	Deer Creek	4/9/2015	Yes	On
Deer3-0	Deer Creek	4/9/2015	No	On
Deer3-0	Deer Creek	4/9/2015	Unknown	Off
Deer6-3	Deer Creek	4/9/2015	Unknown	On
Deer6-3	Deer Creek	4/9/2015	Unknown	On
Deer6-3	Deer Creek	4/9/2015	No	Off
Deer6-3	Deer Creek	4/9/2015	Unknown	Off
Deer6-3	Deer Creek	4/9/2015	No	On
Deer6-3	Deer Creek	4/9/2015	Unknown	On
65720	Spring Creek	4/13/2015	No	Off
65720	Spring Creek	4/13/2015	No	Off
108270	Little Phillips Creek	4/21/2015	No	Off
108270	Little Phillips Creek	4/21/2015	Unknown	Off
101560	Meadow Creek	4/22/2015	Unknown	On
Deer8-6	Deer Creek	4/23/2015	Yes	Off
Deer8-6	Deer Creek	4/23/2015	No	Off
Deer8-6	Deer Creek	4/23/2015	Unknown	Off
18904	Spring Creek	4/27/2015	No	On
147928	Five Points Creek	4/30/2015	No	Off
159368	Chicken Creek	5/4/2015	No	Off
177134	East Phillips Creek	5/4/2015	No	On
Deer3-0	Deer Creek	5/7/2015	No	Off
Deer3-0	Deer Creek	5/7/2015	No	Off
Deer3-0	Deer Creek	5/7/2015	No	Off
Deer3-0	Deer Creek	5/7/2015	Yes	Off
Deer3-0	Deer Creek	5/7/2015	Yes	Off
Deer3-0	Deer Creek	5/7/2015	No	Off
Deer3-0	Deer Creek	5/7/2015	No	Off
Deer3-0	Deer Creek	5/21/2015	No	Off
Deer3-0	Deer Creek	5/21/2015	No	Off
Deer3-0	Deer Creek	5/21/2015	No	Off
Deer3-0	Deer Creek	5/21/2015	Yes	Off
Deer3-0	Deer Creek	5/21/2015	No	Off
Deer3-0	Deer Creek	5/21/2015	No	Off
Deer3-0	Deer Creek	5/21/2015	No	Off
Deer3-0	Deer Creek	5/21/2015	Yes	Off
Deer3-0	Deer Creek	5/21/2015	Yes	Off
Deer3-0	Deer Creek	5/21/2015	No	Off
Deer3-0	Deer Creek	5/21/2015	No	Off
Deer3-0	Deer Creek	5/21/2015	No	Off
Deer3-0	Deer Creek	5/21/2015	No	Off
Deer3-0	Deer Creek	5/21/2015	No	Off

Appendix Table B-17. Locations, dates, and characteristics of live steelhead observations in the Joseph Creek basin, 2015.

SiteIDShort	StreamName	Observation Date	Fin Clip	On/Off Redd
002175	Crow Creek	4/1/2015	No	Off
002175	Crow Creek	4/1/2015	Unknown	Off
012802	Cottonwood Creek	4/21/2015	No	Off
012802	Cottonwood Creek	3/31/2015	Unknown	Off
012802	Cottonwood Creek	3/31/2015	Unknown	Off
012802	Cottonwood Creek	3/31/2015	Unknown	Off
012802	Cottonwood Creek	3/31/2015	Unknown	Off
012802	Cottonwood Creek	3/31/2015	Yes	On
012802	Cottonwood Creek	3/31/2015	No	On
043522	Broady Creek	3/30/2015	No	Off
043522	Broady Creek	3/30/2015	No	On
043522	Broady Creek	3/30/2015	No	On
045183	Elk Creek	4/22/2015	Unknown	On
045183	Elk Creek	4/1/2015	Unknown	On
045183	Elk Creek	4/1/2015	No	Off
045183	Elk Creek	4/1/2015	No	Off
045183	Elk Creek	4/1/2015	No	On
045183	Elk Creek	4/1/2015	No	On
045183	Elk Creek	4/1/2015	Unknown	On
112130	Devils Run Creek	4/29/2015	No	Off
112130	Devils Run Creek	4/29/2015	No	Off
112130	Devils Run Creek	4/6/2015	No	Off
258175	Chesnimnus Creek	4/29/2015	No	Off
258175	Chesnimnus Creek	3/16/2015	Unknown	Off
258175	Chesnimnus Creek	3/16/2015	Unknown	Off
258175	Chesnimnus Creek	3/16/2015	Unknown	On
258175	Chesnimnus Creek	3/16/2015	Unknown	On
258175	Chesnimnus Creek	4/6/2015	Unknown	Off
258175	Chesnimnus Creek	4/6/2015	No	Off
258175	Chesnimnus Creek	4/6/2015	No	On
301570	Cottonwood Creek	3/31/2015	No	On
301570	Cottonwood Creek	3/31/2015	Unknown	Off
301570	Cottonwood Creek	3/31/2015	Unknown	Off
318978	Chesnimnus Creek	4/28/2015	Unknown	Off
318978	Chesnimnus Creek	4/2/2015	Unknown	Off
318978	Chesnimnus Creek	4/2/2015	Unknown	On
318978	Chesnimnus Creek	4/2/2015	No	On
318978	Chesnimnus Creek	4/2/2015	Unknown	On
389247	Chesnimnus Creek	4/29/2015	No	Off
389247	Chesnimnus Creek	5/19/2015	Yes	On
389247	Chesnimnus Creek	5/19/2015	Yes	On
515586	Chesnimnus Creek	4/27/2015	No	Off
515586	Chesnimnus Creek	4/27/2015	No	Off
515586	Chesnimnus Creek	4/7/2015	No	Off
515586	Chesnimnus Creek	4/7/2015	No	Off
515586	Chesnimnus Creek	4/7/2015	No	On
515586	Chesnimnus Creek	4/7/2015	Unknown	On

Appendix Table B-18. Locations, dates, and characteristics of dead steelhead observations in Joseph and Deer Creek basins, 2015.

Site ID	Population	Stream Name	Date Observed	Fish Sex	Fork Length (mm)	Origin
18904	UGR	Spring Creek	3/31/2015	Male	854	Wild
45183	Joseph	Elk Creek	4/22/2015	Female	675	Unknown
45183	Joseph	Elk Creek	4/22/2015	Female	690	Wild
45183	Joseph	Elk Creek	4/1/2015	Female	695	Wild
112130	Joseph	Devils Run Creek	4/29/2015	Female	690	Wild
112130	Joseph	Devils Run Creek	4/29/2015	Female	685	Wild
258175	Joseph	Chesnimnus Creek	4/29/2015	Male	601	Wild
389247	Joseph	Chesnimnus Creek	4/29/2015	Female	520	Hatchery
515586	Joseph	Chesnimnus Creek	4/7/2015	Female	665	Wild
Deer3-0	Deer	Deer Creek	5/7/2015	Male	730	Wild
Deer3-0	Deer	Deer Creek	5/7/2015	Female	675	Wild
Deer3-0	Deer	Deer Creek	5/7/2015	Male	760	Hatchery
Deer3-0	Deer	Deer Creek	5/7/2015	Male	690	Wild
Deer3-0	Deer	Deer Creek	4/23/2015	Female	725	Wild
Deer3-0	Deer	Deer Creek	4/23/2015	Female	725	Wild
Deer3-0	Deer	Deer Creek	5/26/2015	Male	741	Wild
Deer3-0	Deer	Deer Creek	5/21/2015	Unknown	-	Wild
Deer3-0	Deer	Deer Creek	5/21/2015	Male	575	Hatchery
Deer3-0	Deer	Deer Creek	5/21/2015	Female	680	Wild
Deer3-0	Deer	Deer Creek	5/21/2015	Male	774	Hatchery
Deer3-0	Deer	Deer Creek	5/21/2015	Female	740	Wild
Deer3-0	Deer	Deer Creek	5/21/2015	Female	530	Hatchery
Deer3-0	Deer	Deer Creek	5/21/2015	Male	520	Hatchery
Deer3-0	Deer	Deer Creek	5/21/2015	Female	620	Wild
Deer3-0	Deer	Deer Creek	5/21/2015	Male	510	Hatchery
Deer3-0	Deer	Deer Creek	5/21/2015	Female	708	Wild
Deer3-0	Deer	Deer Creek	5/21/2015	Female	601	Wild
Deer3-0	Deer	Deer Creek	5/21/2015	Male	630	Hatchery
Deer3-0	Deer	Deer Creek	5/21/2015	Male	521	Hatchery
Deer3-0	Deer	Deer Creek	5/21/2015	Male	549	Hatchery
Deer3-0	Deer	Deer Creek	5/21/2015	Male	710	Wild
Deer3-0	Deer	Deer Creek	5/21/2015	Female	660	Wild
Deer3-0	Deer	Deer Creek	5/21/2015	Female	570	Wild
Deer3-0	Deer	Deer Creek	5/21/2015	Female	720	Wild
Deer3-0	Deer	Deer Creek	5/21/2015	Male	520	Hatchery
Deer3-0	Deer	Deer Creek	5/21/2015	Male	522	Wild
Deer3-0	Deer	Deer Creek	5/21/2015	Female	672	Wild
Deer3-0	Deer	Deer Creek	5/21/2015	Female	660	Wild
Deer3-0	Deer	Deer Creek	5/21/2015	Female	598	Wild
Deer3-0	Deer	Deer Creek	5/21/2015	Male	636	Wild
Deer3-0	Deer	Deer Creek	5/21/2015	Male	510	Hatchery
Deer3-0	Deer	Deer Creek	5/21/2015	Female	530	Wild
Deer3-0	Deer	Deer Creek	5/21/2015	Male	580	Hatchery
Deer3-0	Deer	Deer Creek	5/21/2015	Female	580	Wild
Deer3-0	Deer	Deer Creek	5/21/2015	Male	500	Wild
Deer3-0	Deer	Deer Creek	5/21/2015	Male	480	Hatchery
Deer3-0	Deer	Deer Creek	5/21/2015	Female	622	Wild
Deer3-0	Deer	Deer Creek	5/21/2015	Female	676	Hatchery
Deer3-0	Deer	Deer Creek	5/21/2015	Male	730	Wild
Deer3-0	Deer	Deer Creek	5/21/2015	Male	554	Wild
Deer3-0	Deer	Deer Creek	5/21/2015	Male	560	Wild
Deer3-0	Deer	Deer Creek	5/21/2015	Male	674	Wild
Deer3-0	Deer	Deer Creek	5/21/2015	Female	660	Wild

Site ID	Population	Stream Name	Date Observed	Fish Sex	Fork Length (mm)	Origin
Deer3-0	Deer	Deer Creek	5/21/2015	Female	594	Wild
Deer3-0	Deer	Deer Creek	5/21/2015	Male	535	Hatchery
Deer3-0	Deer	Deer Creek	5/21/2015	Male	562	Hatchery
Deer3-0	Deer	Deer Creek	5/21/2015	Male	527	Hatchery
Deer3-0	Deer	Deer Creek	5/21/2015	Female	573	Wild
130030	UGR	Clark Creek	4/23/2015	Female	72	Wild
147928	UGR	Five Points Creek	4/30/2015	Male	78	Wild

Appendix Table B-19. Annual results of steelhead spawning ground surveys, 2008−2015. Available spawning habitat was refined yearly based on previous surveys.

Year	No. of sites	Spawning habitat (km)	Weight value	Redds observed	Distance surveyed (km)	Fish:redd ratio	Total spawner escapement	95% CI	CI as % of escapement
UGRR basin									
2008	29	1,301	44.9	24	64.2	4.07	2,096	±1,142	54.50%
2009	30	1,178	39.3	42	59.9	3.81	3,148	±1,047	33.20%
2010	29	934	32.2	109	56.4	1.6	2,876	±897	31.20%
2011	28	929	33.2	44	59.5	4.75	3,275	±1,028	31.40%
2012	30	897	29.9	70	60.7	3.14	3,261	±1,077	33.00%
2013	29	892	30.8	52	56.1	1.91	1,553	±757	48.70%
2014	29	892	30.8	65	61.3	2.67	2,512	±974	38.77%
2015	29	892	30.8	246	61.6	1.37	4,837	±1,891	39.09%
Joseph Creek basin									
2012	30	384	12.8	67	58.4	3.14	1,357	±380	28.00%
2013	26	384	14.8	153	51.5	1.91	$2,197_a$	±934	42.50%
2014	25	384	15.4	130	51.8	2.67	$2,522_b$	±778	30.85%
2015	24	384	16	286	48.3	1.37	$2,967_c$	±991	33.40%

a. With 2.2% hatchery proportion the total natural spawners is 2,149 (95% CI ±913).

b. With 1.1% hatchery proportion the total natural spawners is 2,494 (95% CI ±769).

c. With 1.8% hatchery proportion the total natural spawners is 2,914 (95% CI ±938.

Appendix Table B-20. Origin of adult steelhead passed above Joseph Creek, UGRR, Catherine Creek, Lookingglass Creek and Deer Creek weirs in 2015.

	Natural Origin	Hatchery Origin	Proportion Hatchery (%)	Total Fish
Joseph Creek*	2,917	53	1.8%	2,970
UGRR**	30	0	0	30
Catherine Creek**	293	0	0	293
Lookingglass Creek**	290	15	4.9%	305
Deer Creek***	58	8	12.1%	66

*John Robbins, Nez Perce Tribe, Department of Fisheries Resources Management, unpublished data, personal communication

**Michael McLean, Confederated Tribes of the Umatilla Indian Reservation, Department of Natural Resources, Fisheries Program, unpublished data, personal communication

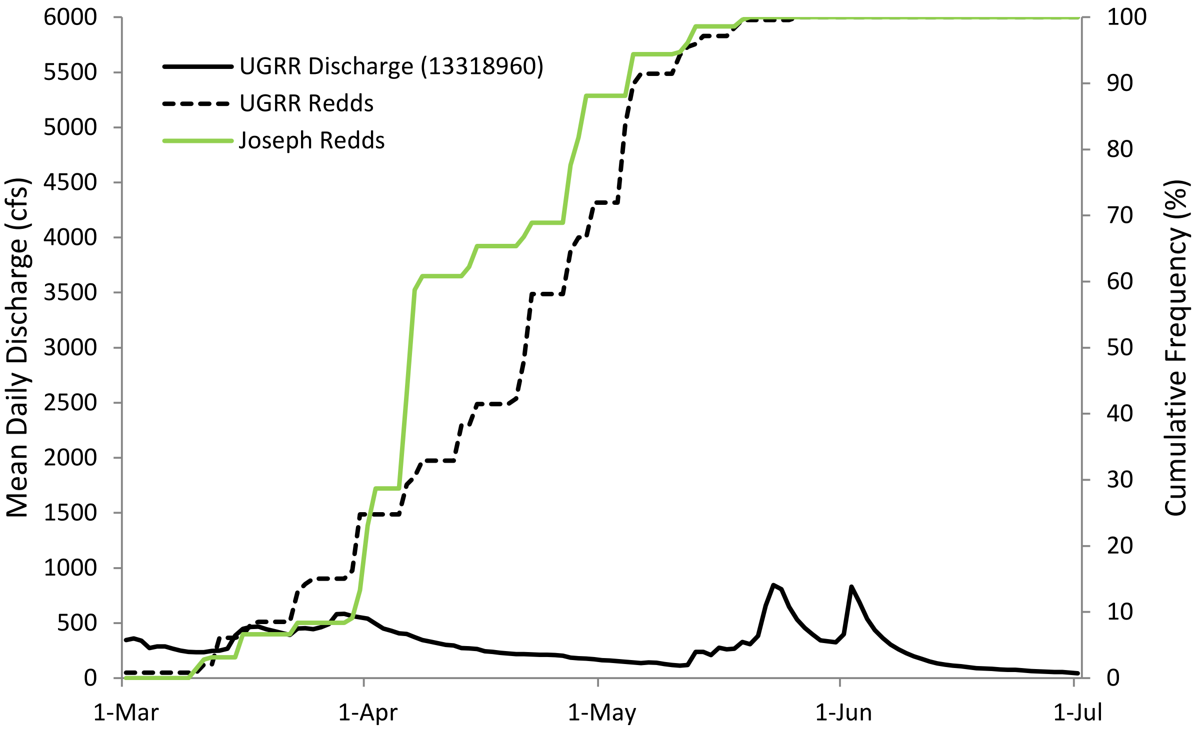
***Michael Flesher, Oregon Department of Fish & Wildlife, La Grande Fish Research, unpublished data, personal communication

Appendix Table B-21. Survey characteristics and spawning survey results, grouped by stream classification type for UGRR basin, 2015.

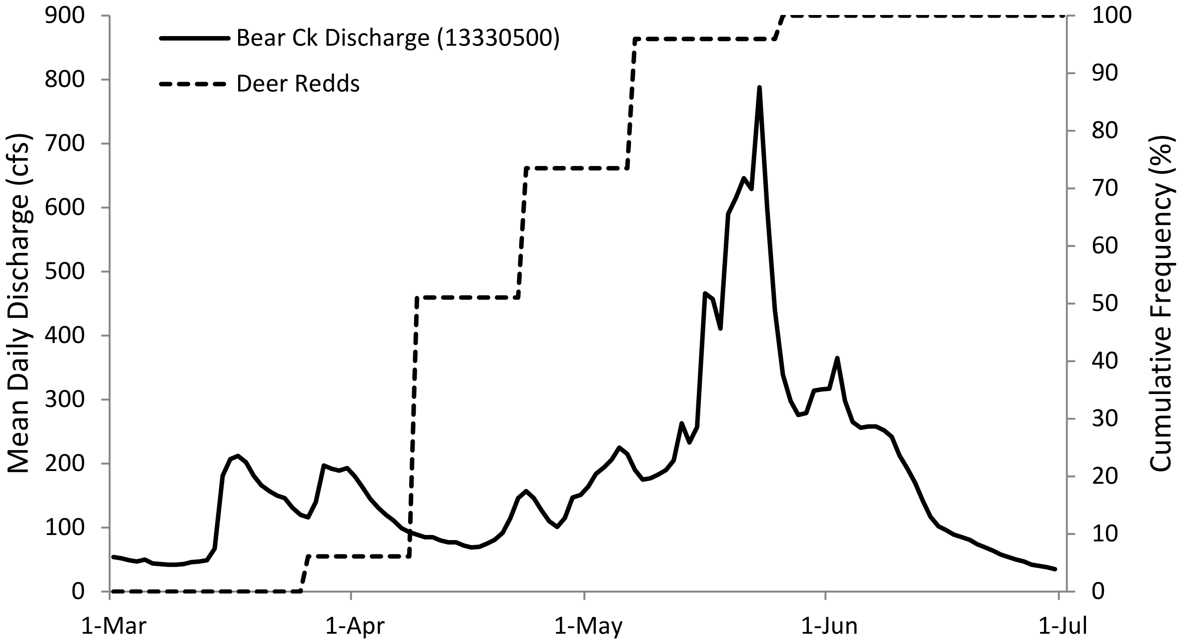
Stream Classification	No. of sites	Spawning habitat (km)	Weight value	Distance surveyed (km)	Total redds observed	Redds per km	Spawner escapement	Lower 95% CI	Upper 95% CI
Source	11	453	41.18	22.98	19	0.8	490	84	896
Transport	8	243	30.38	17.23	127	7.4	2,489	1,573	3,405
Depositional	10	197	19.70	21.35	100	4.3	1,249	446	2,053
Total	**29**	**892**	**91.27**	**61.56**	**246**	**12.5**	**4,228**	**2,944**	**5,513**

Appendix Table B-22. Survey characteristics and spawning survey results, grouped by stream classification type for Joseph Creek basin, 2015.

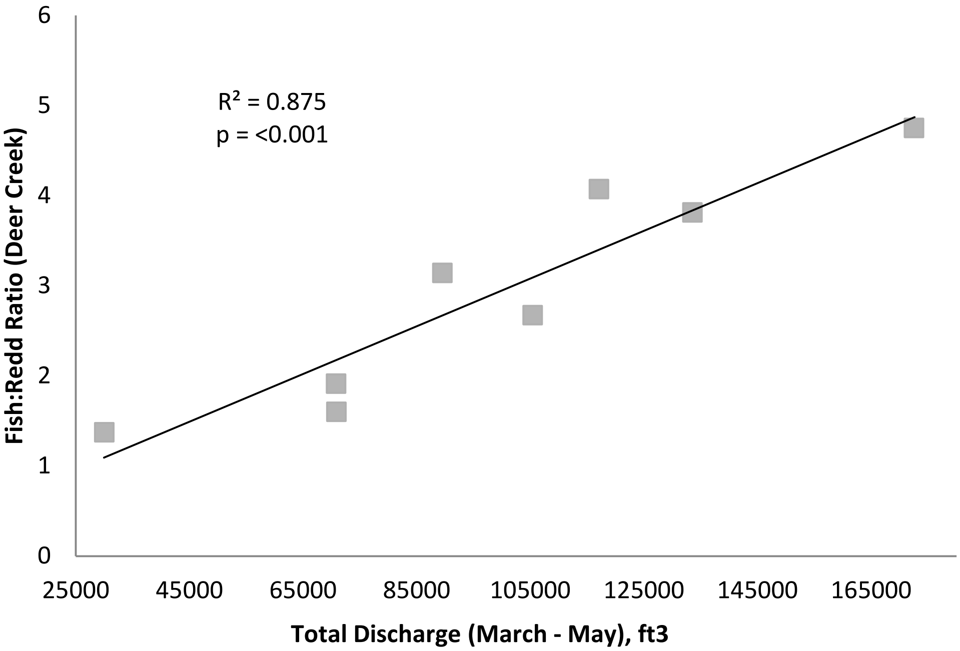
Stream Classification	No. of sites	Spawning habitat (km)	Weight value	Distance surveyed (km)	Total redds observed	Redds per km	Spawner escapement	Lower 95%CI	Upper 95% CI
Source	10	159	15.9	18.55	57	3.1	636	80	1,191
Transport	8	115	14.4	16.58	44	2.7	438	177	699
Depositional	6	111	18.5	13.13	185	14.1	2,127	1,661	2,593
Total	**24**	**384**	**48.8**	**48.26**	**286**	**19.9**	**3,201**	**2,431**	**3,972**



Appendix Figure B-21. Cumulative frequency of observed redds and mean daily discharge during the spawning period for the UGRR basin (OWRD station #13318960) in 2015.



Appendix Figure B-22. Cumulative frequency of observed redds during the spawning period for Deer Creek and discharge from neighboring Bear Creek (OWRD station #13330500) in 2015.



Appendix Figure B-23 Relationship between total discharge in UGRR (Perry Station) and the fish:redd ratio derived from Deer Creek surveys, 2008−2015.

Steelhead and Chinook Salmon Parr Surveys, Steelhead and Chinook Salmon Parr Density, and Distribution

Appendix Table B-23. Basic descriptors and locations of UGRR basin CHaMP survey sites sampled in 2015.

Site ID	Stream	Easting	Northing	Mean BF Width(m)	Site Length(m)	Sample Method	Agency
CBW05583-013226	S.F. Catherine Creek	455944	4995020	7.6	163.7	Snorkel	ODFW
CBW05583-013882	Peet Creek	373285.5	5013217	2.5	114.7	Efish	ODFW
CBW05583-015162	McCoy Creek	389446	5013221	6.7	165.6	Snorkel	CRITFC
CBW05583-073130	S.F. Catherine Creek	451381	4994477	9.5	191.4	Snorkel	ODFW
CBW05583-086186	Catherine Creek	428505	5007532	14.6	342.7	Snorkel	ODFW
CBW05583-086954	S.F. Catherine Creek	452340	4994341	7.9	163.5	Snorkel	ODFW
CBW05583-095642	McCoy Creek	377391	5023153	8.0	162.1	Snorkel	ODFW
CBW05583-109994	M.F. Catherine Creek	454289	4999943	5.7	161.2	Snorkel	CRITFC
CBW05583-135615	Gordon Creek	424812.5	5052328.5	5.4	133.7	Snorkel	ODFW
CBW05583-142490	Clark Creek	435852	5039113.5	10.3	162.4	Snorkel	ODFW
CBW05583-228666	Sheep Creek	384622.25	4988279.5	5.8	127.9	Snorkel	CRITFC
CBW05583-252730	Meadow Creek	389676	5012418	15.8	405.5	Snorkel	ODFW
CBW05583-285498	Meadow Creek	387308	5010321	13.6	342.3	Snorkel	CRITFC
CBW05583-335162	Sheep Creek	385075	4989867	4.6	124.0	Snorkel	CRITFC
CBW05583-340138	Catherine Creek	434250	5004561	15.3	324.0	Snorkel	CRITFC
CBW05583-381866	S.F. Catherine Creek	455061	4994526	8.8	202.0	Snorkel	ODFW
CBW05583-382778	Burnt Corral Creek	382826	5006897	3.8	117.6	Efish	ODFW
CBW05583-405674	Catherine Creek	434102	5005124	16.7	329.1	Snorkel	CRITFC
CBW05583-417962	Catherine Creek	443763	4998235	19.7	276.3	Snorkel	CRITFC
CBW05583-421786	Rock Creek	406959	5017229	13.2	215.5	Snorkel	CRITFC
CBW05583-453946	Sheep Creek	384468	4987666.5	6.7	165.3	Snorkel	CRITFC
CBW05583-480666	Waucup Creek	372811	5016477	3.3	124.2	Snorkel	ODFW
CBW05583-486202	Grande Ronde River	390935	5004334	17.2	364.5	Snorkel	ODFW
CBW05583-487322	Rock Creek	407504	5016354	7.9	163.2	Snorkel	CRITFC
CBW05583-491690	Catherine Creek	437180	5002020	22.0	480.0	Snorkel	CRITFC
CBW05583-498490	Meadow Creek	386120	5010440	12.7	213.5	Snorkel	CRITFC
CBW05583-506682	Fly Creek	390051	5006738	10.6	212.8	Snorkel	CRITFC
CBW05583-514874	Meadow Creek	388866	5011831	17.0	323.6	Snorkel	CRITFC
CBW05583-527786	Catherine Creek	445893	4996417.5	15.8	271.8	Snorkel	ODFW
CBW05583-531882	N.F. Catherine Creek	450849	4998263	10.4	236.0	Snorkel	CRITFC
dsgn4-000001	N.F. Catherine Creek	449392.5	4996710	12.0	254.8	Snorkel	ODFW
dsgn4-000006	West Chicken Creek	389627	4990426	3.2	121.4	Snorkel	ODFW
dsgn4-000009	Grande Ronde River	397788.5	4989994.5	7.3	167.1	Snorkel	CRITFC
dsgn4-000010	Catherine Creek	444030.5	4998165.5	18.2	307.7	Snorkel	CRITFC
dsgn4-000092	Spring Creek	400310.9	5020246.2	6.6	129.8	Snorkel	ODFW
dsgn4-000094	Fly Creek	385814.2	4997841.7	6.9	161.3	Snorkel	ODFW
dsgn4-000161	S.F. Catherine Creek	455539	4994700.5	7.2	203.5	Snorkel	ODFW
dsgn4-000168	N.F. Catherine Creek	451484	5000077.5	11.1	214.6	Snorkel	ODFW
dsgn4-000202	Grande Ronde River	390902	5010922.5	15.7	444.2	Snorkel	CRITFC
dsgn4-000205	Grande Ronde River	400044	5018986	29.8	623.9	Snorkel	ODFW
dsgn4-000213	Meadow Creek	390705.5	5013202.5	31.1	350.9	Snorkel	ODFW

Site ID	Stream	Easting	Northing	Mean BF Width(m)	Site Length(m)	Sample Method	Agency
dsgn4-000245	Grande Ronde River	392876	5013713.5	24.6	611.8	Snorkel	CRITFC
dsgn4-000277	Grande Ronde River	392551	4998767	16.1	367.9	Snorkel	CRITFC
ORW03446-065720	Spring Creek	394727	5024363	5.4	125.3	Snorkel	ODFW
ORW03446-077704	Burnt Corral Creek	384049	5008477	4.5	120.4	Snorkel	ODFW
ORW03446-101560	Meadow Creek	374247	5015664	7.1	160.4	Snorkel	ODFW
ORW03446-120904	Burnt Corral Creek	381596	5004132	3.5	124.7	Snorkel	ODFW
ORW03446-125832	Meadow Creek	378731	5013662	11.0	248.9	Snorkel	ODFW
ORW03446-130030	Clark Creek	431732	5043720	9.6	169.9	Snorkel	ODFW
ORW03446-137980	Catherine Creek	440167	5000114	15.3	270.1	Snorkel	CRITFC
ORW03446-147928	Five Points Creek	405006	5028876	10.5	236.0	Snorkel	ODFW
ORW03446-159368	Chicken Creek	390100	4990155	3.5	123.1	Snorkel	ODFW
ORW03446-170478	L. Lookinglass Creek	431299	5068156	8.9	197.0	Snorkel	ODFW
ORW03446-177134	East Phillips Creek	416894	5053052	6.2	126.1	Snorkel	ODFW

Appendix Table B-24. Raw counts of steelhead and Chinook by size class for CHaMP sites snorkeled and electrofished (denoted with *) in 2015.

			*O. mykiss/*Steelhead Counts					Chinook Size Counts				Bull Trout Counts			
		Est. Fork Length (mm)→	<80	80-130	130-200	>200	Total	<100	>100	Adult	Juv. Tot.	<80	80-130	130-200	>200
Site ID	Waterbody	Date													
CBW05583-013226	South Fork Catherine Creek	8/13	0	2	3	2	7	0	0	0	0	0	1	6	9
CBW05583-013882	Peet Creek*	6/29	0	4	8	0	12	0	0	0	0	0	0	0	0
CBW05583-015162	McCoy Creek	7/30	0	0	0	0	0	2	0	0	2	0	0	0	0
CBW05583-073130	South Fork Catherine Creek	8/3	123	42	26	19	210	203	4	0	207	0	1	3	0
CBW05583-086186	Catherine Creek	8/17	100	16	11	0	127	391	20	0	411	0	0	0	0
CBW05583-086954	South Fork Catherine Creek	8/14	76	27	14	13	130	11	0	0	11	0	0	0	0
CBW05583-095642	McCoy Creek	6/24	106	4	2	0	112	0	0	0	0	0	0	0	0
CBW05583-109994	Mid. Fork Catherine Creek	7/31	0	1	2	0	3	0	0	0	0	0	8	9	2
CBW05583-135615	Gordon Creek	7/22	190	8	2	1	201	0	0	0	0	0	0	0	0
CBW05583-142490	Clark Creek	7/10	85	29	10	1	125	150	12	0	162	0	0	0	0
CBW05583-228666	Sheep Creek	7/29	16	15	6	1	38	40	0	0	40	0	0	0	0
CBW05583-252730	Meadow Creek	6/15	6	16	16	4	42	0	0	0	0	0	0	0	0
CBW05583-285498	Meadow Creek	8/1	19	8	10	0	37	0	0	0	0	0	0	0	0
CBW05583-335162	Sheep Creek	7/29	8	25	5	3	41	141	4	0	145	0	0	0	0
CBW05583-340138	Catherine Creek	8/1	56	13	11	5	85	238	0	0	238	0	0	1	0
CBW05583-381866	South Fork Catherine Creek	8/13	3	17	17	8	45	0	0	0	0	0	0	0	4
CBW05583-382778	Burnt Corral Creek*	6/27	3	8	4	0	15	0	0	0	0	0	0	0	0
CBW05583-405674	Catherine Creek	8/1	113	52	40	0	205	356	1	1	357	0	0	0	0
CBW05583-417962	Catherine Creek	7/31	92	19	8	1	120	337	0	12	337	0	0	0	0
CBW05583-421786	Rock Creek	7/30	16	23	6	0	45	0	0	0	0	0	0	0	0
CBW05583-453946	Sheep Creek	7/29	13	7	4	0	24	5	0	0	5	0	0	0	0
CBW05583-480666	Waucup Creek	6/24	20	0	0	2	22	0	0	0	0	0	0	0	0
CBW05583-486202	Grande Ronde River	7/27	30	69	49	15	163	581	130	0	711	0	0	0	0
CBW05583-487322	Rock Creek	7/30	236	4	0	0	240	1	0	0	1	0	0	0	0
CBW05583-491690	Catherine Creek	8/1	299	33	19	0	351	832	1	1	833	0	0	0	0
CBW05583-498490	Meadow Creek	8/1	13	14	9	1	37	15	1	0	16	0	0	0	0
CBW05583-506682	Fly Creek	7/30	15	15	7	2	39	328	0	0	328	0	0	0	0
CBW05583-514874	Meadow Creek	7/30	1	0	2	0	3	0	0	0	0	0	0	0	0
CBW05583-527786	Catherine Creek	8/18	120	1	0	0	121	171	0	0	171	0	0	0	0
CBW05583-531882	North Fork Catherine Creek	7/31	26	39	50	8	123	159	3	1	162	0	3	3	1

			*O. mykiss/*Steelhead Counts					Chinook Size Counts				Bull Trout Counts			
		Est. Fork Length (mm)→	<80	80-130	130-200	>200	Total	<100	>100	Adult	Juv. Tot.	<80	80-130	130-200	>200
Site ID	Waterbody	Date													
dsgn4-000001	North Fork Catherine Creek	8/5	1	0	0	0	1	1	0	0	1	0	0	0	0
dsgn4-000006	West Chicken Creek	6/25	7	14	3	0	24	0	0	0	0	0	0	0	0
dsgn4-000009	Grande Ronde River	7/25	33	13	10	0	56	278	4	11	282	0	2	2	1
dsgn4-000010	Catherine Creek	7/31	310	78	27	2	417	105	5	5	1059	0	0	0	0
dsgn4-000092	Spring Creek	7/8	127	0	0	0	127	4	0	0	4	0	0	0	0
dsgn4-000094	Fly Creek	6/28	21	4	11	7	43	1	1	0	2	0	0	0	0
dsgn4-000161	South Fork Catherine Creek	7/28	0	1	0	9	10	0	0	0	0	0	1	1	3
dsgn4-000168	North Fork Catherine Creek	7/26	21	19	10	8	58	13	2	0	15	0	4	1	0
dsgn4-000202	Grande Ronde River	7/29	2	30	15	1	48	85	0	0	85	0	0	0	0
dsgn4-000205	Grande Ronde River	7/22	4	1	5	2	12	0	0	0	0	0	0	0	0
dsgn4-000213	Meadow Creek	7/15	89	14	3	4	110	15	0	0	15	0	0	0	0
dsgn4-000245	Grande Ronde River	7/29	16	7	6	0	29	15	0	0	15	0	0	0	0
dsgn4-000277	Grande Ronde River	7/30	0	0	0	0	0	16	0	0	16	0	0	0	0
ORW03446-065720	Spring Creek	7/8	116	19	4	1	140	0	0	0	0	0	0	0	0
ORW03446-077704	Burnt Corral Creek*	6/26	16	7	2	0	25	0	0	0	0	0	0	0	0
ORW03446-101560	Meadow Creek	7/25	17	9	2	1	29	0	0	0	0	0	0	0	0
ORW03446-120904	Burnt Corral Creek*	6/27	9	7	0	0	16	0	0	0	0	0	0	0	0
ORW03446-125832	Meadow Creek	7/25	47	6	16	16	85	0	0	0	0	0	0	0	0
ORW03446-130030	Clark Creek	7/10	814	51	40	14	919	24	22	3	46	0	0	0	0
ORW03446-137980	Catherine Creek	8/2	111	25	16	0	152	291	3	3	294	0	0	0	0
ORW03446-147928	Five Points Creek	7/12	289	69	36	13	407	0	0	0	0	0	0	0	0
ORW03446-159368	Chicken Creek	6/25	17	9	10	2	39	0	0	0	0	0	0	0	0
ORW03446-170478	Little Lookingglass Creek	7/29	55	45	38	12	150	185	14	2	199	0	1	1	0
ORW03446-177134	East Phillips Creek	7/11	37	9	1	0	47	0	0	0	0	0	0	0	0

Appendix Table B-25. Fish species/taxa observed during snorkel surveys, 2015. Percentage represents the proportional count of individuals, and is unrelated to fish size or biomass. Species codes at bottom of table.

Reach ID	Stream Name	Date	Dominant (>50%)	Common (10-49%)	Rare (<10%)
Reach ID	**Stream Name**	**Date**	**Dominan**	**Common Sp**	**Rare Sp**
CBW05583-013226	South Fork Catherine	8/13	BT	ST	MW
CBW05583-013882	Peet Creek	6/29	ST	CT	
CBW05583-015162	McCoy Creek	7/30	NP	RS, SU, DC	IC, CH
CBW05583-073130	South Fork Catherine	8/3/	CH	ST	BT
CBW05583-086186	Catherine Creek	8/17	CH	NP, ST, RS	MW, LD, CT
CBW05583-086954	South Fork Catherine	8/14	ST		CH
CBW05583-095642	McCoy Creek	6/24	ST		SD, RS
CBW05583-109994	Middle Fork Catherine	7/31	BT	ST	
CBW05583-135615	Gordon Creek	7/22	ST	CT	
CBW05583-142490	Clark Creek	7/10	CH	ST	LD, SD
CBW05583-228666	Sheep Creek	7/29	CH	ST	CT
CBW05583-252730	Meadow Creek	6/15	RS	DC, ST	SU, NP
CBW05583-285498	Meadow Creek	8/1/	NP	RS, SD, LD, SU	ST, CT
CBW05583-335162	Sheep Creek	7/29	CH	ST, RS	LD
CBW05583-340138	Catherine Creek	8/1/	CH	ST	BT, MW, DC
CBW05583-381866	South Fork Catherine	8/13	ST	BT	MW
CBW05583-382778	Burnt Corral Creek	6/27	ST	CT	
CBW05583-405674	Catherine Creek	8/1/	CH	ST	MW, DC, LD
CBW05583-417962	Catherine Creek	7/31	CH	ST, MW	CT, LD
CBW05583-421786	Rock Creek	7/30	ST	DC	CT
CBW05583-453946	Sheep Creek	7/29	ST		LD
CBW05583-480666	Waucup Creek	6/24	DC	ST	RS, SU
CBW05583-486202	Grande Ronde River	7/27	CH	ST, LD, SD	NP, MW, SU
CBW05583-487322	Rock Creek	7/30	ST	SD	NP, CH, SU
CBW05583-491690	Catherine Creek	8/1/	CH	ST, MW	DC
CBW05583-498490	Meadow Creek	8/1/	RS	NP, SD, LD, ST	SU, CT, CH
CBW05583-506682	Fly Creek	7/30	CH	ST, NP, SU	LD
CBW05583-514874	Meadow Creek	7/30	NP	RS, SD, SU	LD, ST
CBW05583-527786	Catherine Creek	8/18	CH	ST	MW
CBW05583-531882	North Fork Catherine	7/31	CH	BT, ST	CT, MW
dsgn4-000001	North Fork Catherine	8/5/	ST	CH, MW	
dsgn4-000006	West Chicken Creek	6/25	ST		CT
dsgn4-000009	Grande Ronde River	7/25	CH	ST	CT, MW, BT
dsgn4-000010	Catherine Creek	7/31	CH	ST	MW, CT
dsgn4-000092	Spring Creek	7/8/	ST	CH	CT
dsgn4-000094	Fly Creek	6/28	ST	SU	DC, CH
dsgn4-000161	South Fork Catherine	7/28	ST	BT	MW
dsgn4-000168	North Fork Catherine	7/26	ST	CH	BT
dsgn4-000202	Grande Ronde River	7/29	NP	RS, SU, SD, LD	CT, CH, ST
dsgn4-000205	Grande Ronde River	7/22	NP, RS	DC	CT, ST

dsgn4-000213	Meadow Creek	7/15	RS, NP	SD, ST, SU	CT, CH, CN,
dsgn4-000245	Grande Ronde River	7/29	DC	RS, NP, SU	MW, CT, CH, ST
dsgn4-000277	Grande Ronde River	7/30	CH	CT	MW
ORW03446-065720	Spring Creek	7/8/	ST		
ORW03446-077704	Burnt Corral Creek	6/26	ST	CT	
ORW03446-101560	Meadow Creek	7/25	NP	LD, ST	RS
ORW03446-101560	Meadow Creek	8/26	NP, RS	ST, SD	LD, CT, SU
ORW03446-101560	Meadow Creek	9/14	NP	SD, RS, ST	SU
ORW03446-120904	Burnt Corral Creek	6/27	ST		
ORW03446-125832	Meadow Creek	7/25	SD	ST, NP, RS	LD, CT
ORW03446-125832	Meadow Creek	8/26	SD	NP, RS, ST	LD, CH, CT, SU
ORW03446-125832	Meadow Creek	9/14	NP	ST, RS	SU, SD, CH
ORW03446-130030	Clark Creek	7/10	ST	SD, LD	CT, CH, RS
ORW03446-137980	Catherine Creek	8/2/	CH	ST, MW	LD
ORW03446-147928	Five Points Creek	7/12	ST		LD
ORW03446-159368	Chicken Creek	6/25	ST		
ORW03446-170478	Little Lookinglass	7/29	CH	ST	CT, BT
ORW03446-177134	East Phillips Creek	7/11	ST		

ST=Steelhead, CH=Chinook, BT=Bull Trout, CN=unk. Sunfish, CT=Sculpin, DC=unk. dace, IC=unk. Catfish, MW=Mtn. Whitefish, LD=Longnose Dace, NP=Northern Pikeminnow, RS=Redside Shiner, SD=Speckled Dace, SU=unk. sucker

Appendix Table B-26. Capture statistics for electrofished sites, 2015.

Site ID	Stream	**Species**	Date	n	Mean FL (mm)	St. Dev. FL (mm)
CBW05583-382778	Burnt Corral Creek	**ST**	6/27	15	108.4	31.1
dsgn4-000006	W. Chicken Creek	**CH**	6/26	7	61.0	5.7
dsgn4-000006	W. Chicken Creek	**ST**	6/26	48	94.9	28.9
ORW03446-077704	Burnt Corral Creek	**CH**	6/27	3	71.0	6.1
ORW03446-077704	Burnt Corral Creek	**ST**	6/27	35	99.7	25.6
ORW03446-120904	Burnt Corral Creek	**ST**	6/27	16	122.9	19.6

Appendix Table B-27. Summary table of predicted population estimates for big and small streams for a range of snorkel counts frST model 4. Ratios of snorkel counts to population estimates are provided to indicate the average fraction of the total population that was observed by snorkelers at different levels of abundance.

	Big			Small		
Snorkel Count	PopEst	95% CI	Count:PopEst	PopEst	95% CI	Count:PopEst
1	9	[6, 14]	0.11	5	[4, 7]	0.20
2	15	[10, 22]	0.13	8	[6, 10]	0.25
3	20	[14, 29]	0.15	11	[9, 13]	0.27
4	25	[17, 35]	0.16	13	[11, 16]	0.31
5	29	[21, 41]	0.17	16	[13, 19]	0.31
6	33	[24, 46]	0.18	18	[15, 22]	0.33
7	37	[27, 51]	0.19	20	[17, 24]	0.35
8	41	[30, 56]	0.20	22	[19, 27]	0.36
9	45	[33, 61]	0.20	24	[20, 29]	0.38
10	48	[35, 66]	0.21	26	[22, 31]	0.38
15	65	[48, 88]	0.23	35	[29, 43]	0.43
20	80	[59, 109]	0.25	44	[35, 54]	0.45
25	95	[70, 128]	0.26	52	[41, 65]	0.48
30	108	[79, 148]	0.28	59	[46, 75]	0.51
35	121	[88, 166]	0.29	66	[51, 86]	0.53
40	133	[97, 184]	0.30	73	[55, 96]	0.55
45	145	[105, 202]	0.31	79	[60, 106]	0.57
50	157	[113, 219]	0.32	86	[64, 115]	0.58
60	180	[127, 253]	0.33	98	[71, 134]	0.61
70	201	[141, 286]	0.35	110	[79, 153]	0.64
80	222	[155, 319]	0.36	121	[86, 171]	0.66
90	242	[167, 350]	0.37	132	[92, 189]	0.68
100	261	[179, 381]	0.38	143	[98, 207]	0.70
110	280	[191, 412]	0.39	153	[104, 224]	0.72
120	299	[202, 442]	0.40	163	[110, 241]	0.74
130	317	[213, 472]	0.41	173	[116, 258]	0.75
140	335	[223, 501]	0.42	182	[121, 275]	0.77
150	352	[233, 531]	0.43	192	[126, 291]	0.78
160	369	[243, 559]	0.43	201	[132, 308]	0.80
170	386	[253, 588]	0.44	210	[137, 324]	0.81
180	402	[263, 616]	0.45	219	[142, 340]	0.82
190	418	[272, 644]	0.45	228	[146, 356]	0.83
200	435	[281, 672]	0.46	237	[151, 372]	0.84

Appendix C: List of Metrics and Indicators

Metrics collected by this project include:

- Abundance of juvenile spring Chinook salmon migrants
- Length of spring Chinook salmon migrants
- Survival of spring Chinook salmon migrants to Lower Granite Dam from several life stages
- Abundance of juvenile steelhead migrants
- Probability of surviving and migrating to Lower Granite Dam of juvenile steelhead migrants
- Age of juvenile steelhead migrants
- Length of juvenile steelhead migrants by age
- Steelhead redd abundance in the Upper Grande Ronde River Watershed and in the Joseph Creek Watershed
- Density and distribution of steelhead and Chinook salmon parr in the upper Grande Ronde River Watershed

Indicators calculated by this project include:

- Number of spring Chinook salmon smolt equivalents produced by population
- Number of spring Chinook salmon smolt equivalents produced per spawner by population
- Adult steelhead escapement in the Upper Grande Ronde River Watershed and in the Joseph Creek Watershed