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

Annual Report 2012

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Executive Project Summary

Abundance and Migration of Juvenile Salmonids in Study Streams during Migration Year 2012, and
Survival and Relative Success of Juvenile Salmonids from the Grande Ronde and Imnaha Subbasins

We determined migration timing and abundance of juvenile spring Chinook salmon *Oncorhynchus tshawytscha* and steelhead *Oncorhynchus mykiss* using rotary screw traps at five locations in the Grande Ronde River Subbasin. In Catherine Creek, we estimated 58,445 juvenile spring Chinook salmon and 17,198 steelhead migrated from upper rearing areas, and 62% of the Chinook salmon and 16% of the steelhead migrated in fall. In Lostine River, we estimated 137,830 juvenile spring Chinook salmon and 14,401 steelhead migrated from upper rearing areas, and 75% of the Chinook salmon and 59% of the steelhead migrated in fall. In Minam River, we estimated 95,284 juvenile spring Chinook salmon and 16,474 steelhead migrated from upper rearing areas, and 81% of the Chinook salmon and 17% of the steelhead migrated in fall. In upper Grande Ronde River, we estimated 55,814 juvenile spring Chinook salmon and 12,497 steelhead migrated from upper rearing areas, and 32% of the Chinook salmon and 3% of the steelhead migrated in fall. In middle Grande Ronde River, insufficient trap efficiency prohibited an abundance estimate of juvenile Chinook salmon or juvenile steelhead produced in the Upper Grande Ronde Watershed.

Combining abundance estimates and survival estimates, we estimated that in Catherine Creek the number of spring Chinook salmon smolt equivalents leaving Catherine Creek was 44,703 for the 2012 migratory year (2010 brood year), for productivity of 125 smolts per redd. We estimated that in Lostine River the number of spring Chinook salmon smolt equivalents leaving Lostine River was 65,176 for the 2010 brood year, for productivity of 94 smolts per redd. We estimated that in Minam River the number of spring Chinook salmon smolt equivalents leaving Minam River was 52,564 for the 2010 brood year, for productivity of 186 smolts per redd. We estimated that in upper Grande Ronde River the number of spring Chinook salmon smolt equivalents leaving upper Grande Ronde River was 46,616 for the 2010 brood year, for productivity of 184 smolts per redd.

Steelhead Spawner Surveys

We conducted 170 surveys in the Upper Grande Ronde River (UGRR) watershed and 111 surveys in the Joseph Creek watershed from 12 March through 27 June 2012 to determine summer steelhead *Oncorhynchus mykiss* redd abundance and adult escapement for these two populations. We sampled 30 random, spatially-balanced sites throughout the UGRR basin encompassing 60.7 km (6.8%) of an estimated 897 km of available steelhead spawning habitat. In Joseph Creek, we surveyed 30 sites encompassing 58.4 km (15%) of the 384 km of available spawning habitat. During these surveys we observed 70 steelhead redds and 21 live steelhead in the UGRR watershed and 67 redds and 13 live steelhead in the Joseph Creek watershed. In Joseph Creek, data was collected on five carcasses observed during surveys, no carcasses were observed in the UGRR watershed. On 18.5 km of Deer Creek, 22 redds and 9 live steelhead were observed during six survey visits. A total of 69 wild-origin adult steelhead were passed above a permanent weir on Deer Creek, resulting in a 3.14 fish/redd ratio for the 2012 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 3,261 (95% C.I.: 2,184 – 4,336) and 1,357 (95% C.I.: 977 – 1,736) respectively. Escapement estimates in the UGRR sub-basin have changed little over the past five years, with confidence intervals overlapping for all years. This was the first GRTS-based steelhead spawning ground survey in Joseph Creek, and no multi-year comparisons could be made.

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

Fish were observed through snorkel surveys at 53 of 55 sites (two went dry) where habitat monitoring occurred in 2012 (CHaMP Sites). Steelhead were found at all sites, Chinook salmon *O. tshawytscha* 30 of the 53, and bull trout *Salvelinus confluentus* at only 7 sites. We observed 2,624 juvenile steelhead through our surveys, and no adults. We counted 4,796 juvenile Chinook, and most were concentrated in the main stem UGRR and Catherine Creek, though they were found in several tributaries to these streams. Of note, both juvenile and adult Chinook salmon (actively spawning) were observed in Clark Creek, a tributary that meets the UGRR near Elgin. Clark Creek was previously considered outside the spawning and rearing distribution for Chinook. Bull trout were only observed in upper Catherine Creek and the most upstream site in the UGRR main stem.

Mean densities of Chinook salmon and steelhead were statistically higher in pools than fastwater habitat units across all sites. No differences were seen between fish density in other habitat unit types.

Chinook salmon and steelhead densities were highest in upper Catherine Creek and its north and south forks, followed by the UGRR main stem. Steelhead densities were highest in Rock, Gordon and Clark creeks.

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. This project will provide information on abundance of spring Chinook salmon and steelhead parr and estimates for egg-to-migrant survival for spring Chinook salmon and migrant survival for steelhead, 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.

Objectives for FY12:

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. Document and describe overwinter rearing reaches in the Grande Ronde Valley of Chinook salmon early migrants from Catherine Creek.

9. Estimate reach survival through the Grande Ronde Valley of Chinook salmon migrants from Catherine Creek.

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

11. 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.

Work Elements

WE H: Abundance and Migration of Juvenile Salmonids in Study Streams During Migration Year 2012, and
WE I: Survival and Relative Success of Juvenile Salmonids from the Grande Ronde and Imnaha Subbasins

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 1.

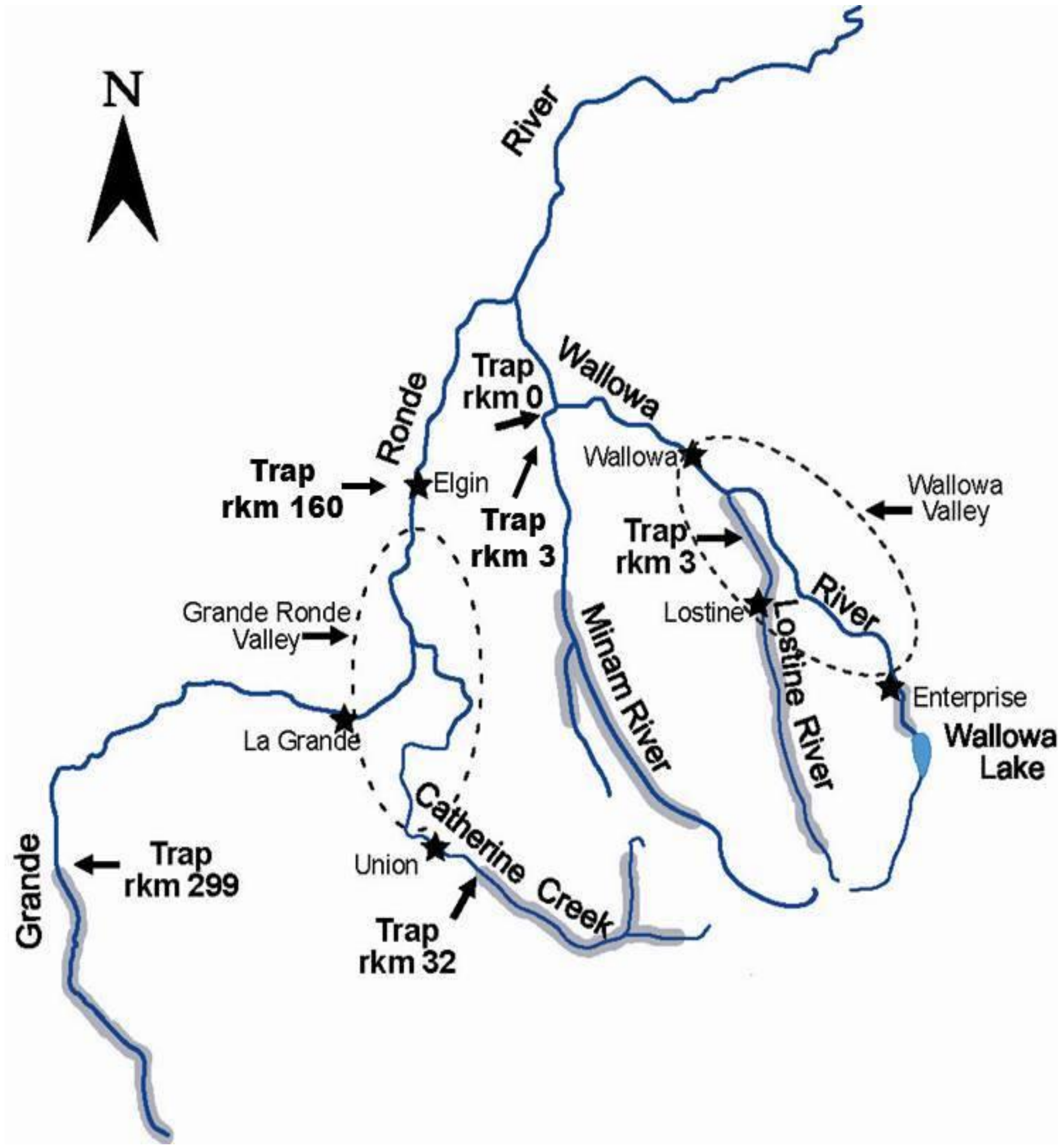

Figure 1. Locations of fish traps in Grande Ronde River Subbasin during the study period. Shaded areas delineate spring Chinook salmon spawning and upper rearing areas. Dashed lines indicate Grande Ronde and Wallowa river valleys.

Results

Spring Chinook Salmon

We estimated a minimum of 58,445 ± 3,393 juvenile spring Chinook salmon emigrated from Catherine Creek upper rearing areas during MY 2012. This migrant estimate was within ranges previously reported during this study (Figure 2). Based on total minimum estimate, 62% (36,404 ± 986) migrated early and 38% (22,041 ± 3,247) migrated late. Typically, emigration from Catherine Creek upper rearing areas is higher during the early migration period.

We estimated a minimum of 137,830± 10,590 juvenile spring Chinook salmon emigrated from Lostine River during MY 2012. This was the largest abundance estimate produced for Lostine River (Figure 3) and second largest reported during this study for all monitored sites. Based on the minimum estimate, 75% (103,001 ± 8,715) of juvenile spring Chinook salmon migrated early, while 25% (34,829 ± 6,016) migrated late. The Lostine River population appears to be similar to that of Catherine Creek in that the largest emigration has been typically observed during the early migration period.

We estimated a minimum of 95,284 ± 7,501 juvenile spring Chinook salmon emigrated from Minam River during MY 2012 (Figure 4). Based on the minimum estimate, 81% (77,172 ± 6,660) of juvenile spring Chinook salmon migrated early and 19% (18,112 ± 3,451) migrated late.

We estimated a minimum of 55,814 ± 4,349 juvenile spring Chinook salmon emigrated from upper Grande Ronde River during MY 2012 (Figure 5). Based on the minimum estimate, 32% (17,824 ± 449) of juvenile spring Chinook salmon migrated early and 68% (37,990 ± 4,326) migrated late.

The middle Grande Ronde River trap at Elgin fished for 105 d between 5 March 2012 and 25 June 2012, but insufficient trap efficiency precluded abundance and migration timing estimation.

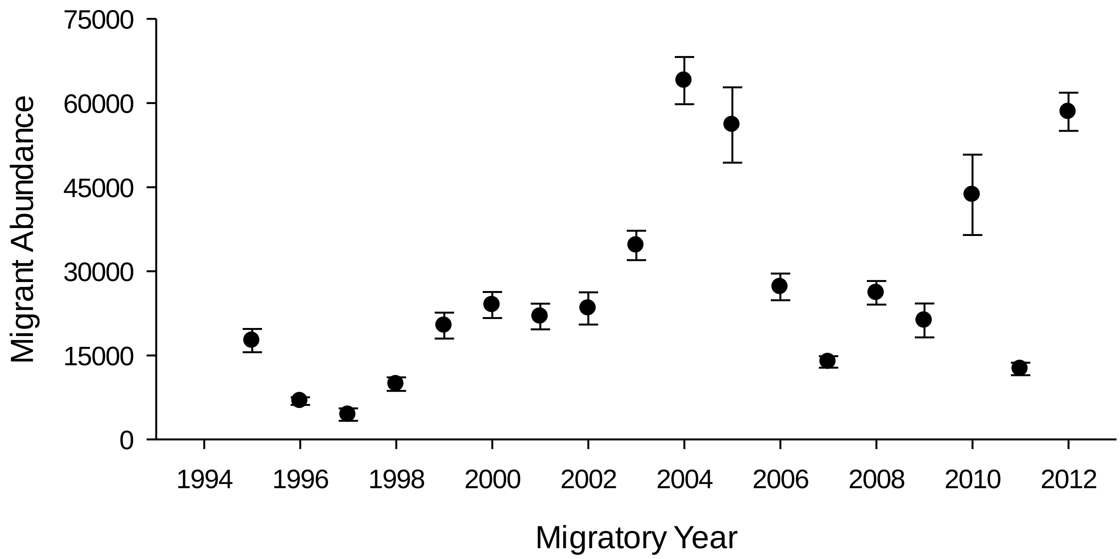

Figure 2. Spring Chinook salmon migrant abundance estimates at the Catherine Creek trap site by migratory year. Error bars are 95% confidence intervals.

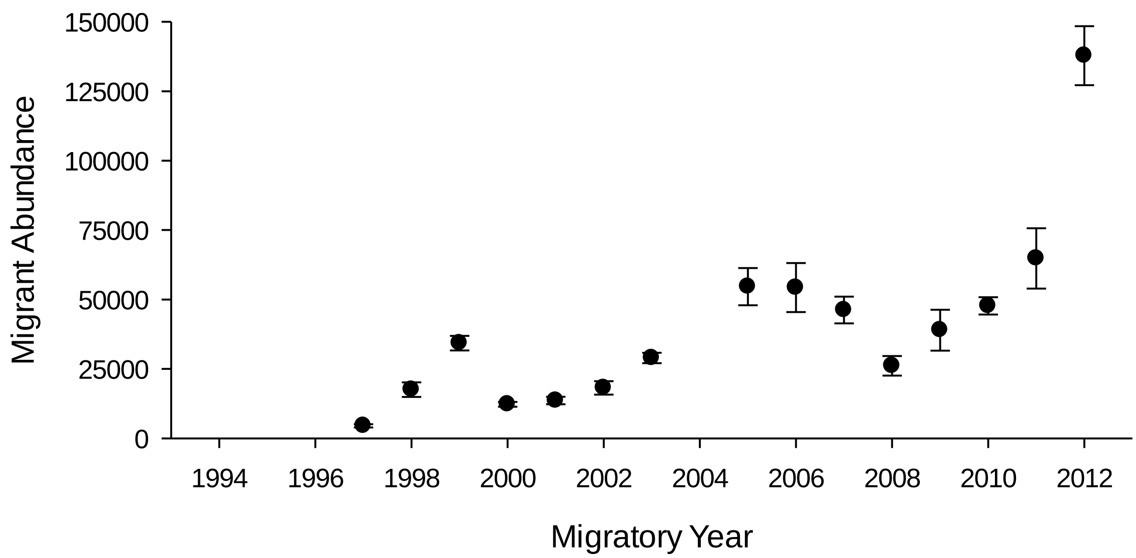

Figure 3. Spring Chinook salmon migrant abundance estimates at the Lostine River trap site by migratory year. Error bars are 95% confidence intervals.

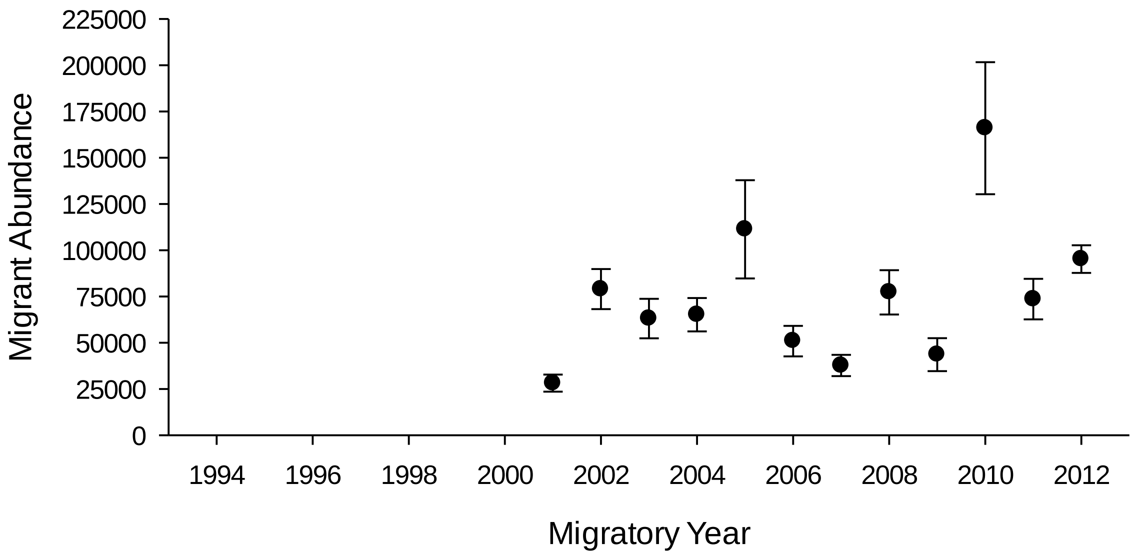

Figure 4. Spring Chinook salmon migrant abundance estimates at the Minam River trap site by migratory year. Error bars are 95% confidence intervals.

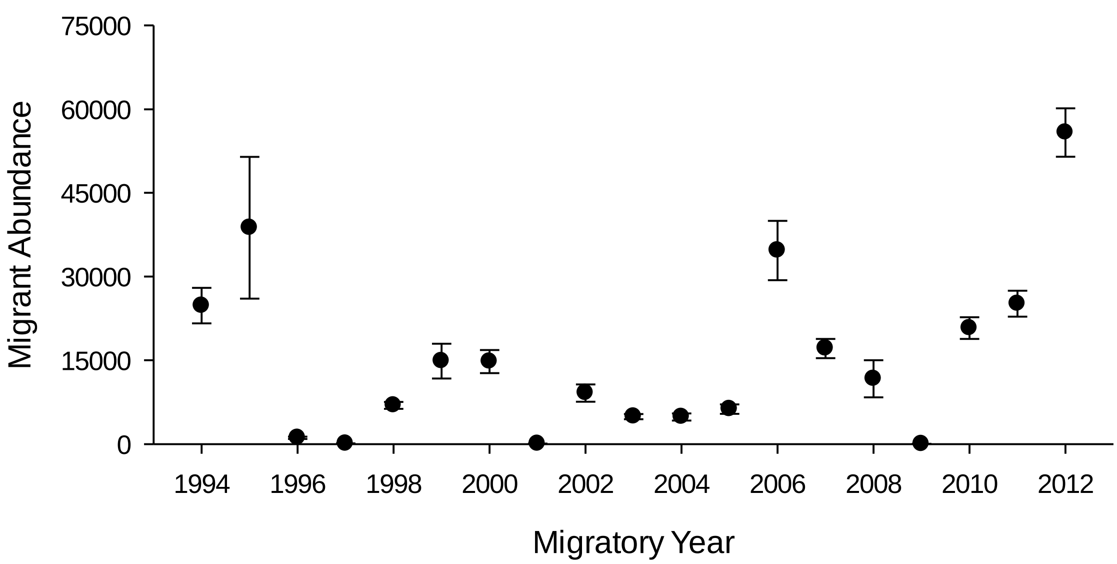

Figure 5. Spring Chinook salmon migrant abundance estimates at the upper Grande Ronde River trap site by migratory year. Error bars are 95% confidence intervals.

Fork lengths of juvenile spring Chinook salmon migrants at each of our rotary screw traps are shown in Figures 6 – 9. Mean fork lengths of migrants at the Catherine Creek, Minam and upper Grande Ronde River traps during the 2012 migratory year were within the range of fork lengths seen at these traps in previous years. The fall and spring migrants captured at the Lostine River trap were the smallest we have seen since we began monitoring in migratory year 1997 and we also estimated the largest number of juvenile Chinook salmon migrants at this trap. We have observed that the length of fall migrants is negatively correlated with the abundance of parr in late summer (ODFW unpublished data).

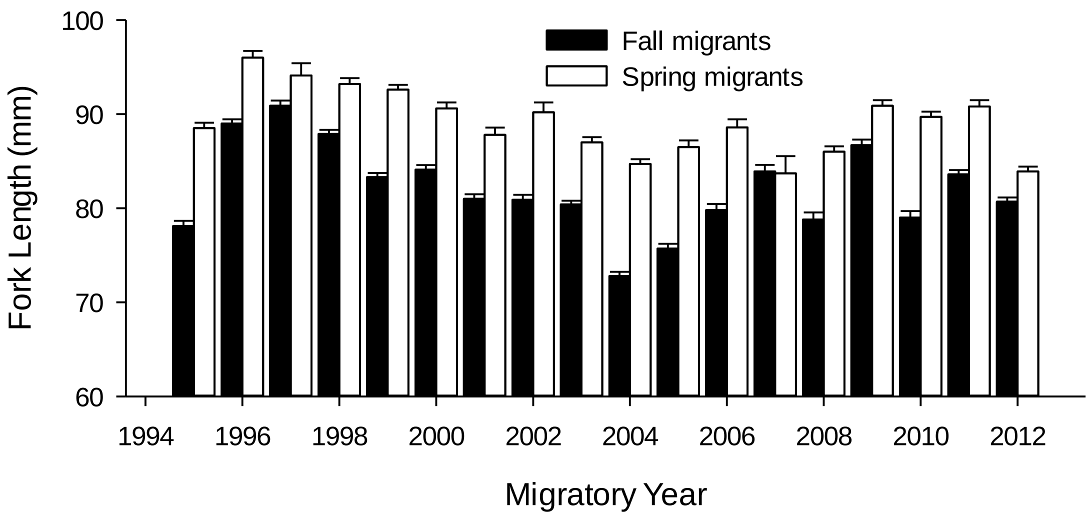

Figure 6. Fork length of spring Chinook salmon migrants captured at the Catherine Creek rotary screw trap by migratory year. Error bars are 95% confidence intervals.

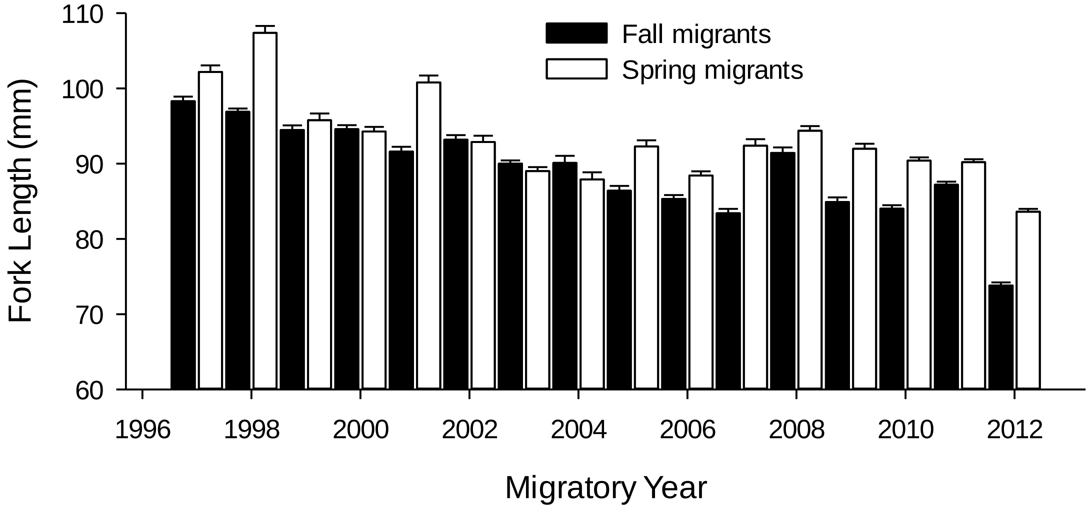

Figure 7. Fork length of spring Chinook salmon migrants captured at the Lostine River rotary screw trap by migratory year. Error bars are 95% confidence intervals.

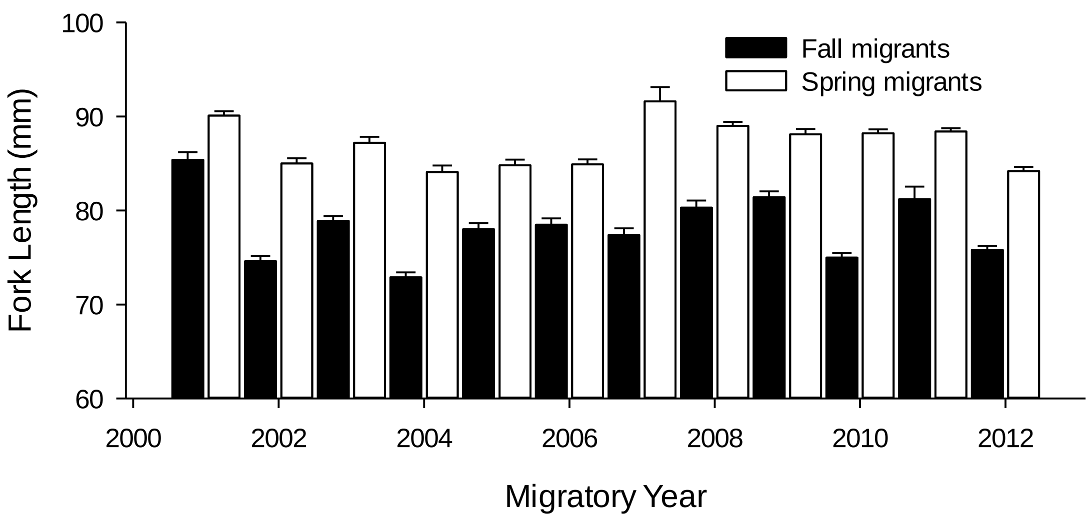

Figure 8. Fork length of spring Chinook salmon migrants captured at the Minam River rotary screw trap by migratory year. Error bars are 95% confidence intervals.

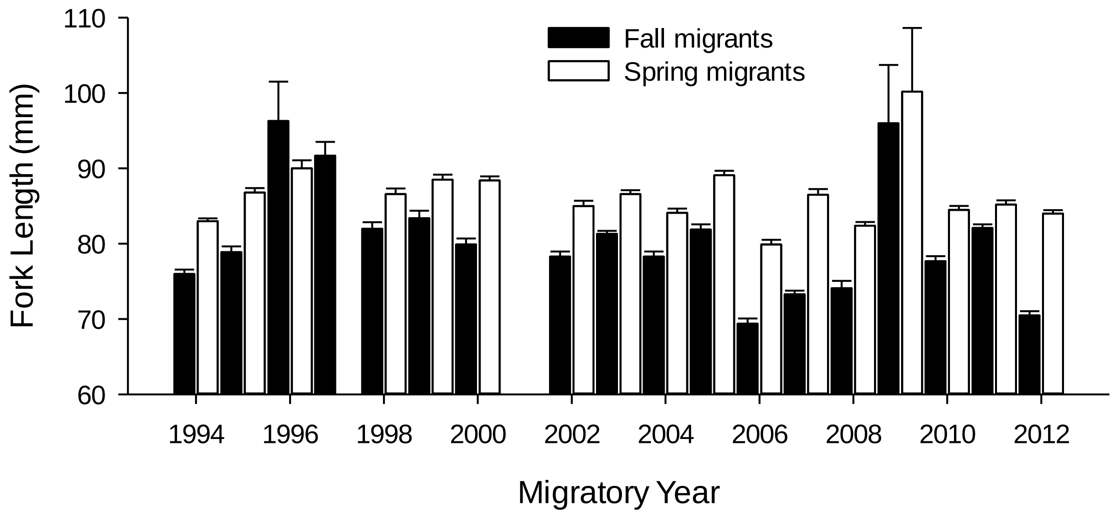

Figure 9. Fork length of spring Chinook salmon migrants captured at the upper Grande Ronde River rotary screw trap by migratory year. Error bars are 95% confidence intervals.

Survival probabilities to Lower Granite Dam for parr tagged during summer 2011 were 0.116 for Catherine Creek, 0.182 for Imnaha, 0.086 for Lostine, 0.110 for Minam, and 0.083 for upper Grande Ronde river populations (Figure 10). Generally, survival probabilities during MY 2012 fell within ranges previously reported; however, upper Grande Ronde River survival probability was the lowest reported survival estimate previously reported.

Catherine Creek fall, winter, and spring tag group survival probabilities to Lower Granite Dam were 0.188, 0.099, and 0.302, respectively. Survival probabilities for Lostine River fall, winter, and spring tag groups were 0.162, 0.076, and 0.550, respectively. Probability of survival for the middle Grande Ronde River spring tag group was 0.677. Survival probabilities for Minam River fall and spring tag groups were 0.225 and 0.504, respectively. Upper Grande Ronde River fall, winter, and spring tag group survival probabilities to Lower Granite Dam were 0.196, 0.043, and 0.405, 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 10).

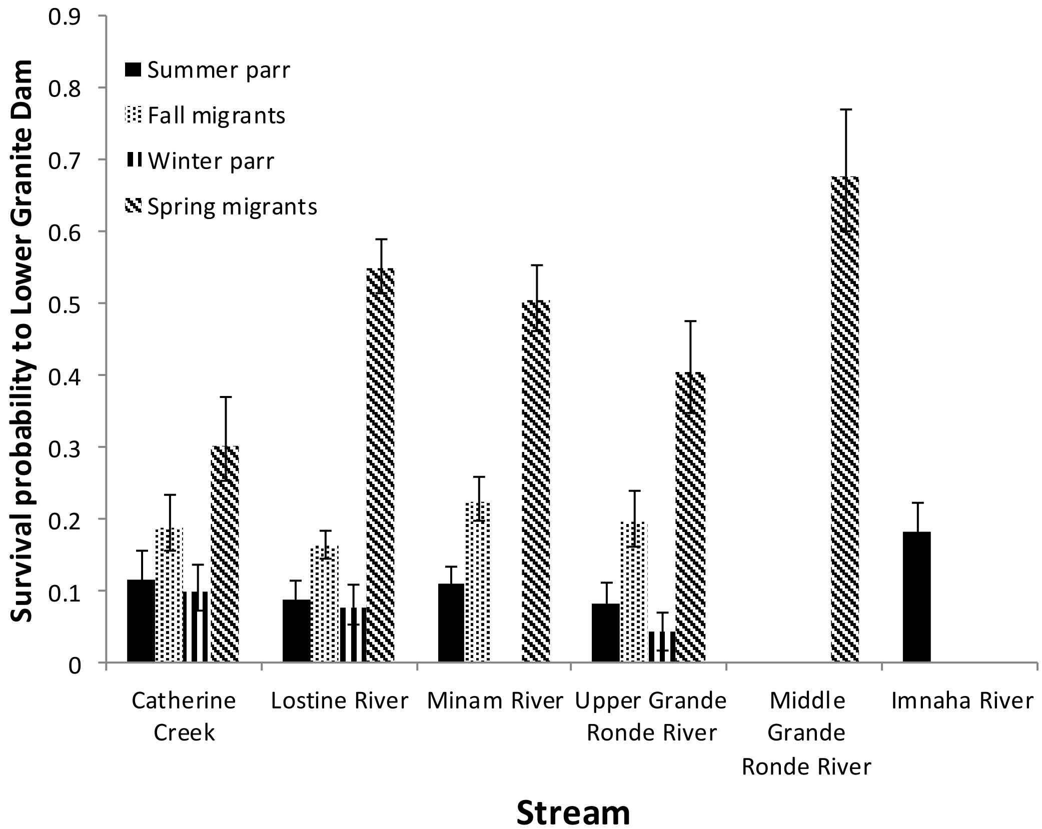

Figure 10. Survival probability to Lower Granite Dam of juvenile spring Chinook salmon PIT tagged at various life stages for the 2012 migratory year. Error bars are 95% confidence intervals.

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 2012 we estimated 44,703 smolt equivalents from Catherine Creek, 65,167 smolt equivalents from Lostine River, 52,564 smolt equivalents from Minam River, and 46,616 smolt equivalents from upper Grande Ronde River (Figure 11).

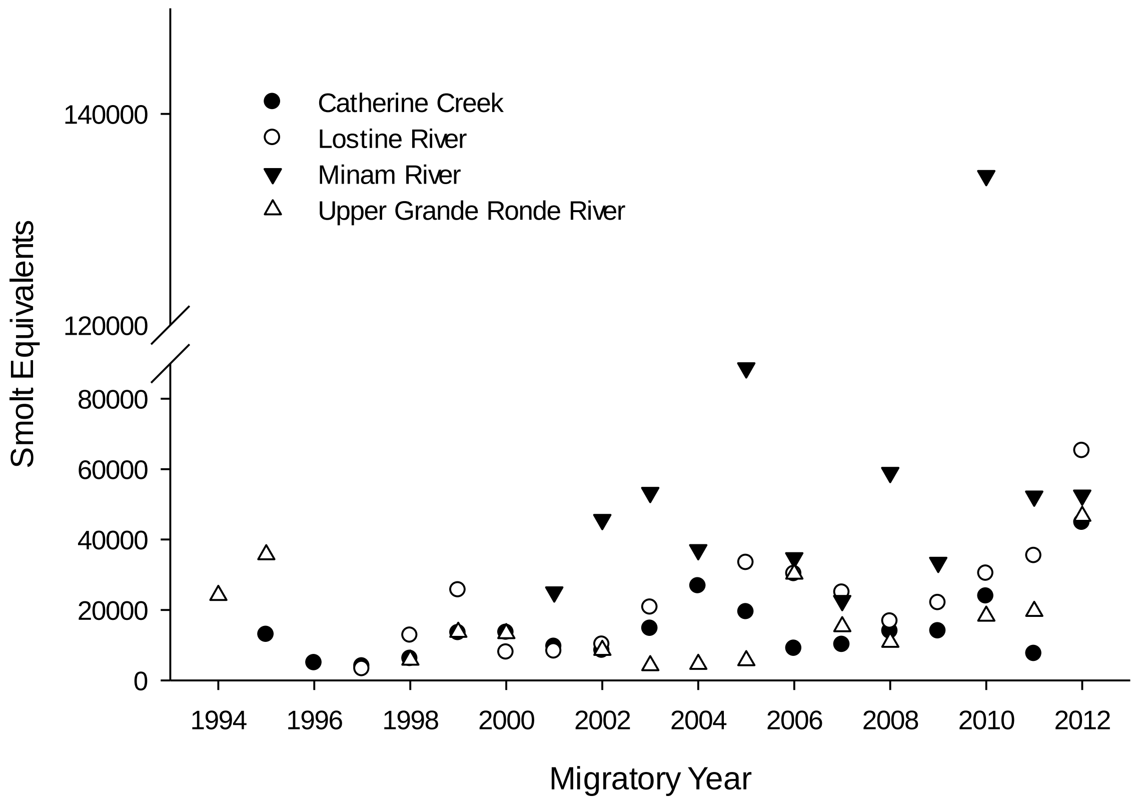

Figure 11. Spring Chinook salmon smolt equivalents produced from redds upstream of rotary screw traps in four study streams by migratory year.

Estimated productivity of spring Chinook salmon in Catherine Creek was 125 smolts per redd for the 2012 migratory year (2010 brood year). This value is in the lower end of the range we have observed in Catherine Creek since the 1995 migratory year (Figure 12). Estimated productivity of spring Chinook salmon in Lostine River was 94 smolts per redd for the 2012 migratory year (2010 brood year). This value is the lowest we have observed in Lostine River since the 1997 migratory year (Figure 13), and coincides with the highest redd count we have observed in this period. Estimated productivity of spring Chinook salmon in Minam River was 186 smolts per redd for the 2012 migratory year (2010 brood year). This value is the lowest we have observed in Minam River since the 2001 migratory year (Figure 14), and coincides with the highest redd count we have observed in this period. Estimated productivity of spring Chinook salmon in upper Grande Ronde River was 184 smolts per redd for the 2012 migratory year (2010 brood year). This value is in the lower end of the range we have observed in upper Grande Ronde River since the 1994 migratory year (Figure 15).

Plots of smolts per redd versus redds for each of the study streams show that productivity, as measured as smolts per redd, decreases at the higher redd counts (Figures 16 – 19).

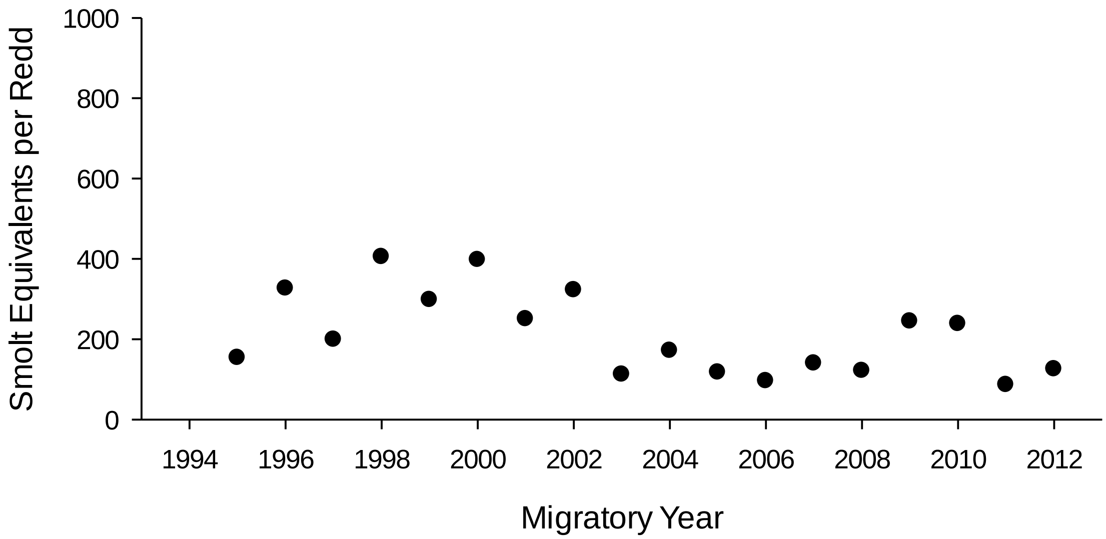

Figure 12. Spring Chinook salmon smolt equivalents produced per redd in Catherine Creek by migratory year.

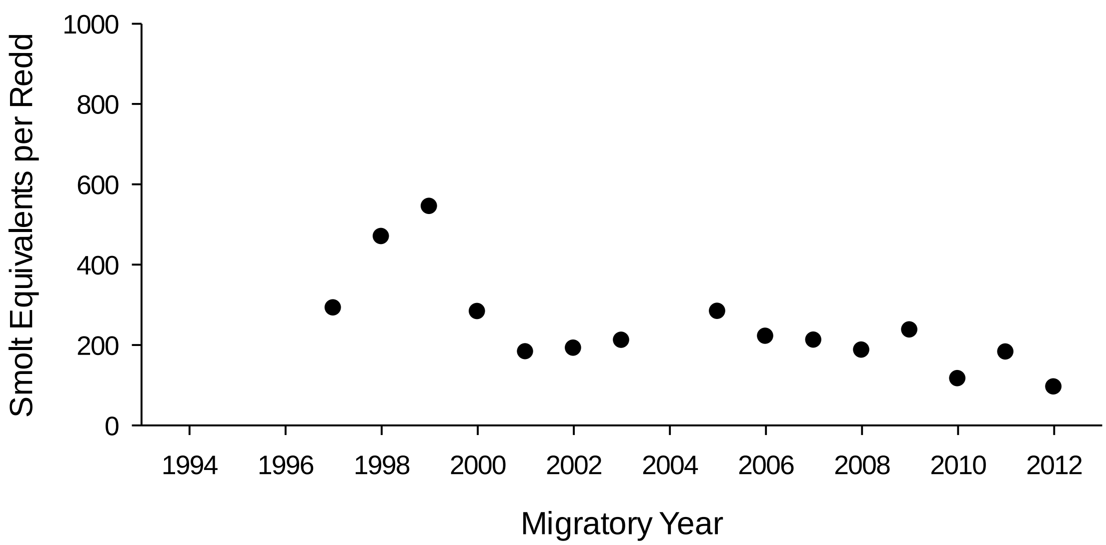

Figure 13. Spring Chinook salmon smolt equivalents produced per redd in Lostine River by migratory year.

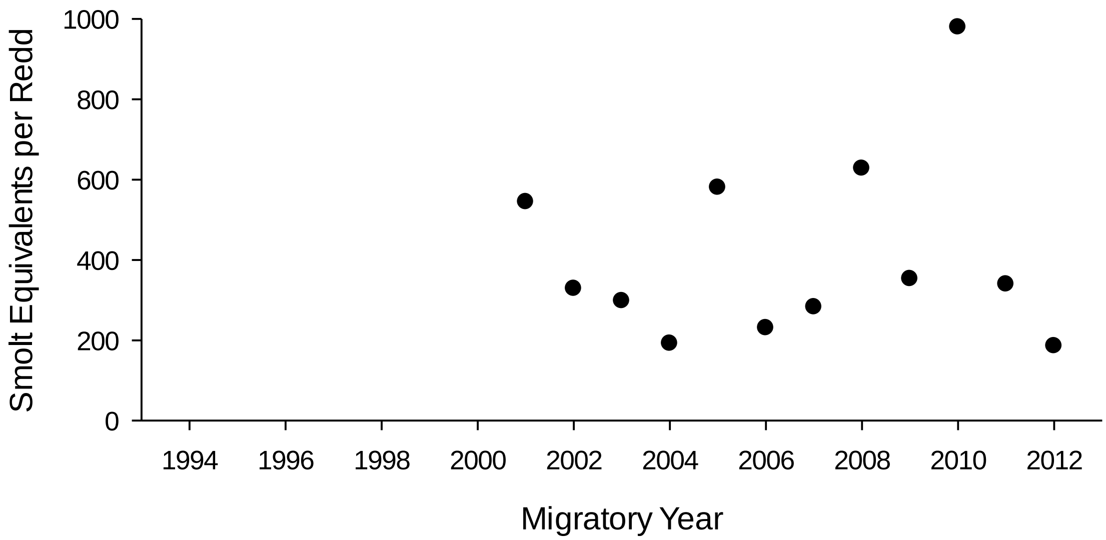

Figure 14. Spring Chinook salmon smolt equivalents produced per redd in Minam River by migratory year.

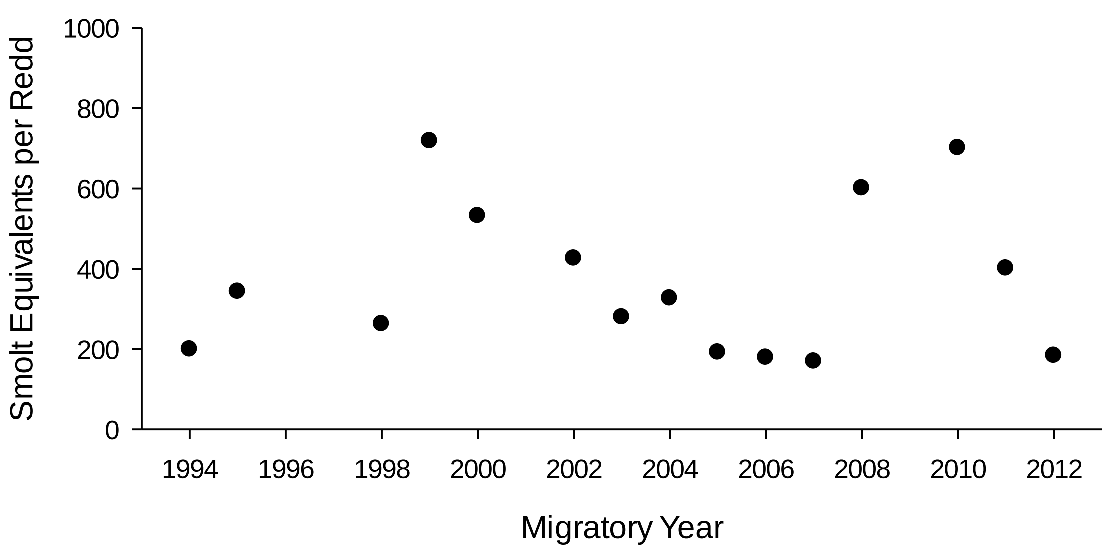

Figure 15. Spring Chinook salmon smolt equivalents produced per redd in upper Grande Ronde River by migratory year.

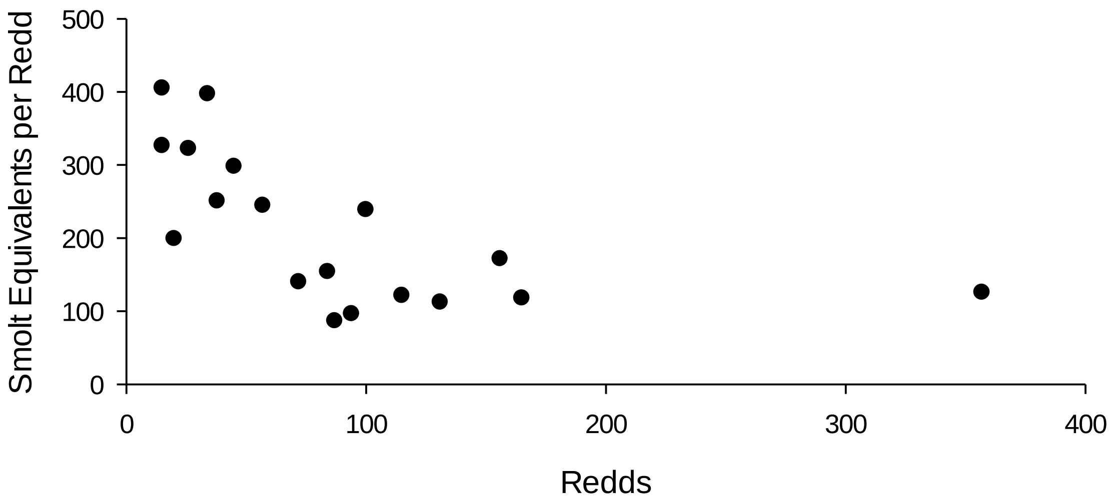

Figure 16. Spring Chinook salmon smolt equivalents produced per redd in Catherine Creek by number of redds.

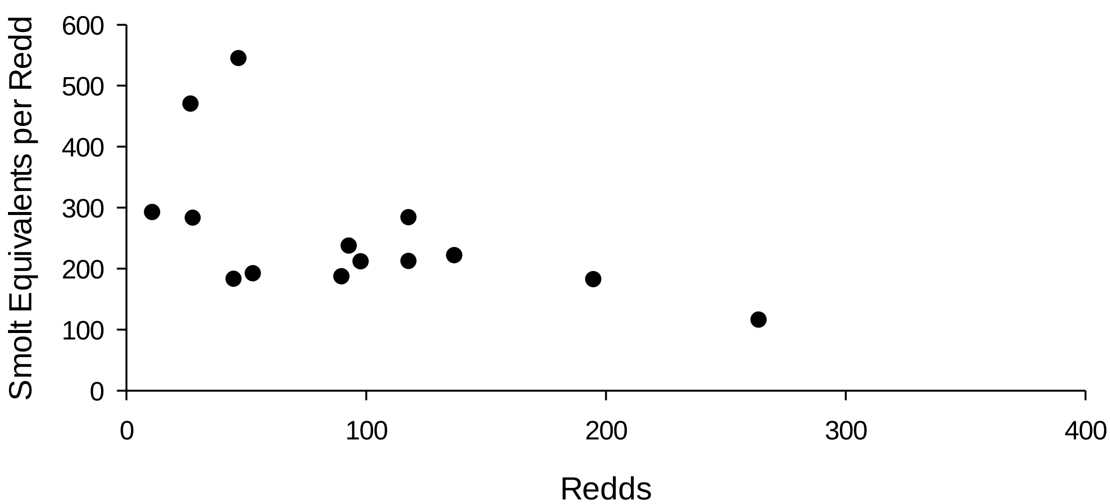

Figure 17. Spring Chinook salmon smolt equivalents produced per redd in Lostine River by number of redds.

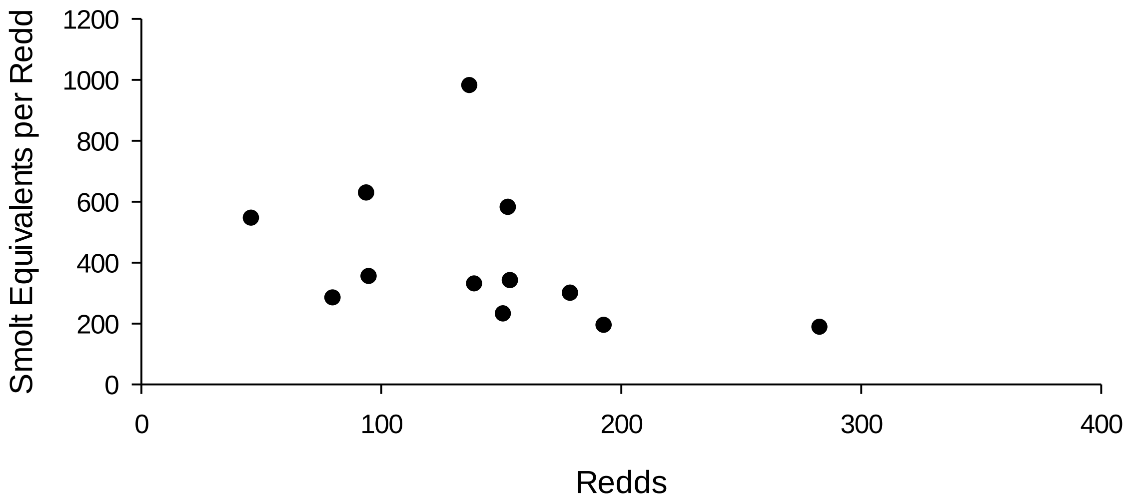

Figure 18. Spring Chinook salmon smolt equivalents produced per redd in Minam River by number of redds.

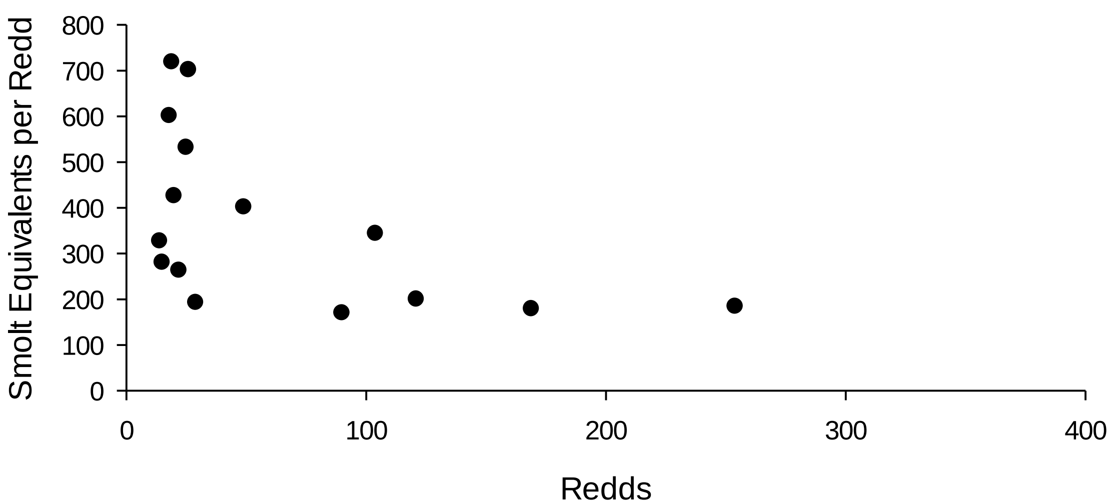

Figure 19. Spring Chinook salmon smolt equivalents produced per redd in upper Grande Ronde River by number of redds.

Radio-telemetry data of tagged spring Chinook salmon migrants in Catherine Creek collected in 2012 has not been analyzed yet. However, a cursory look at data from 2012 shows similar patterns of overwinter habitat use as seen in previous years. Early migrants occupied a reach of

Catherine Creek residing between Union, OR and the mouth of Mill Creek for overwinter rearing from October through February. To a lesser extent, lower reaches of Catherine Creek and portions of the Grande Ronde River were occupied. Median weekly linear range was high during fall migration however, decreased toward zero (i.e., no movement) during winter. A considerable increase in movement occurred during mid-December and mid-January coinciding with elevated water temperatures. A gradient shift occurs within this reach near the mouth of Pyles Creek, where Catherine Creek transitions from complex habitat comprised of riffles and pools to homogenized deep run habitat. During free flowing conditions, juvenile spring Chinook salmon preferred deep water and slow currents near cover and the bank throughout their distribution; however, coarse substrates were optimal within the high gradient reach, while silt was most suitable in the low gradient reach. In the high gradient reach, use of slower mean column velocities and coarse woody debris significantly increased with surface ice presence. Survival of radio-tagged juvenile Chinook salmon appeared relatively high through fall and winter.

Steelhead

We estimated a minimum of 17,198 ± (95% CI, 2,732) juvenile steelhead emigrated from Catherine Creek upper rearing areas during MY 2012. This migrant estimate was within the range previously reported during this study (Figure 20). Based on total minimum abundance estimate, 16% (2,824 ± 321) migrated early and 84% (14,374 ± 2,713) migrated late. MY 2012 proportion of juvenile steelhead emigrating from upper rearing areas as late migrants (84%) is considerably higher than those proportions previously reported during 1997-2010, but lower than that reported in 2011 (91%).

We estimated a minimum of 14,401 ± 3,764 juvenile steelhead emigrated from Lostine River upper rearing areas during MY 2012. This migrant estimate was within the range previously reported during this study (Figure 21). Based on total minimum abundance estimate, 59% (8,533± 2,813) of juvenile steelhead migrated early and 41% (5,868 ± 2,502) migrated late.

We estimated a minimum of 16,474 ± 6,555 juvenile steelhead emigrated from Minam River during MY 2012. This migrant estimate was in the lower end of the range previously reported during this study (Figure 22). Based on total minimum abundance estimate, 17% (2,795 ± 1,128) migrated early and 83% (13,679 ± 6,457) migrated late. Proportion of juvenile steelhead emigrating as late migrants, during MY 2012, is consistent with proportions from previous migration years.

We estimated a minimum of 12,497 ± 1,925 juvenile steelhead emigrated from upper rearing areas of upper Grande Ronde River during MY 2012, which is within estimates from previous migration years (Figure 23). Based on total minimum abundance estimate, 3% (380 ± 47) were early migrants and 97% (12,117 ± 1,924) were late migrants. Predominant late migration of juvenile steelhead in upper Grande Ronde River is consistent for all migration years studied to date.

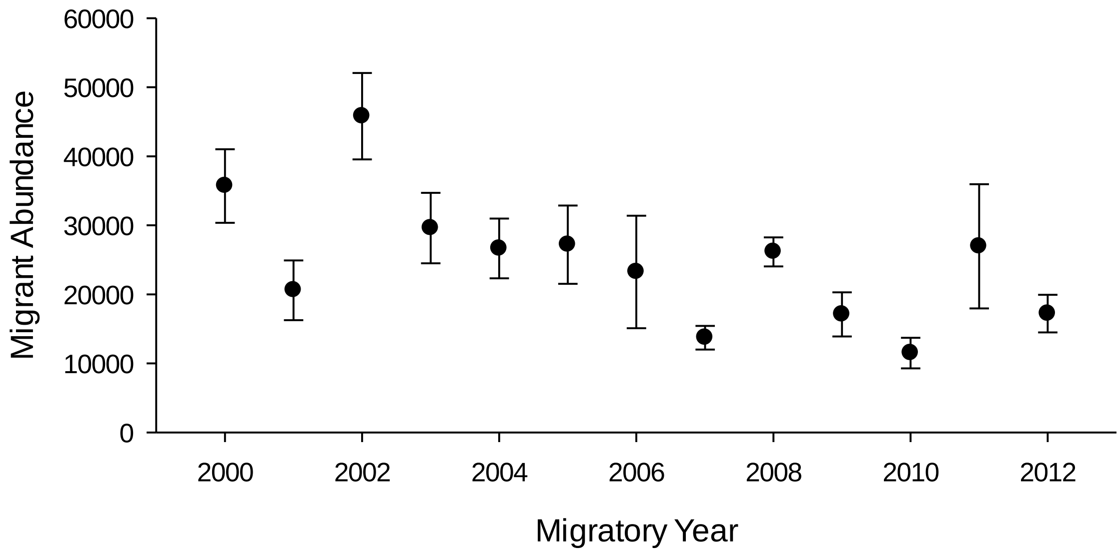

Figure 20. Steelhead migrant abundance estimates at the Catherine Creek trap site by migratory year. Error bars are 95% confidence intervals.

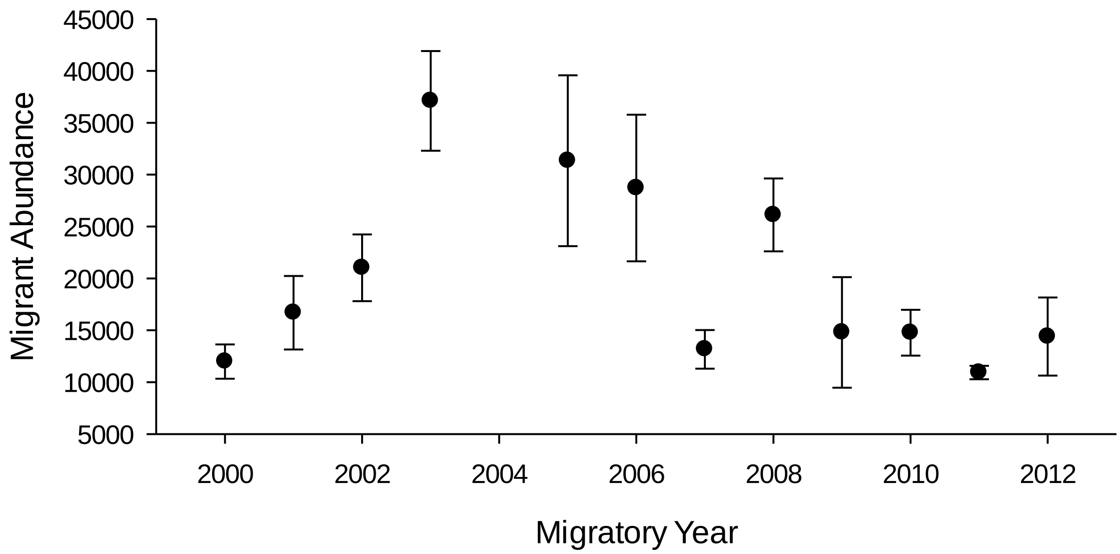

Figure 21. Steelhead migrant abundance estimates at the Lostine River trap site by migratory year. Error bars are 95% confidence intervals.

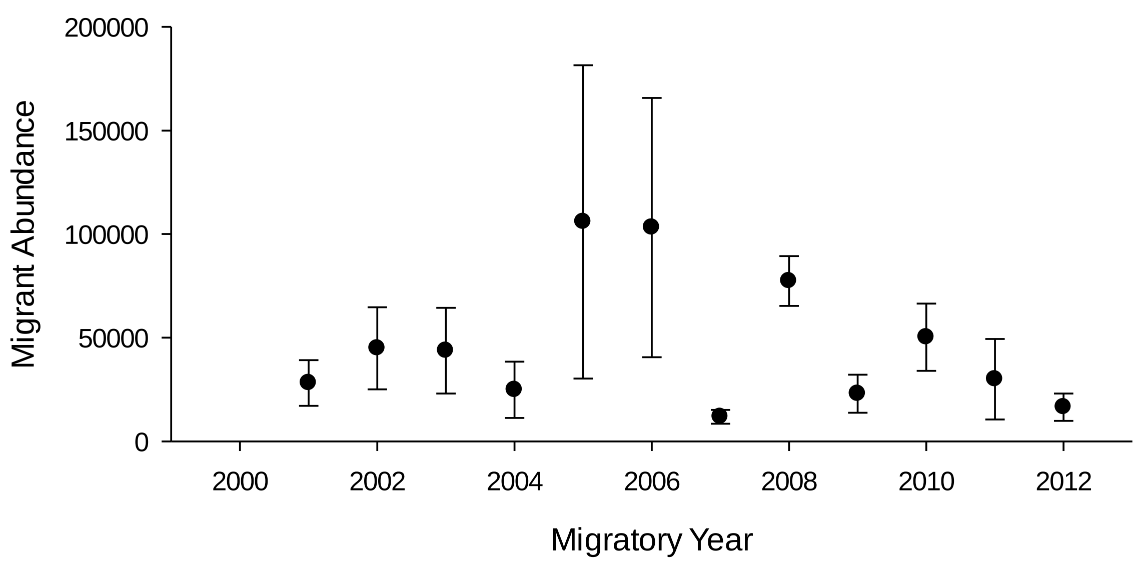

Figure 22. Steelhead migrant abundance estimates at the Minam River trap site by migratory year. Error bars are 95% confidence intervals.

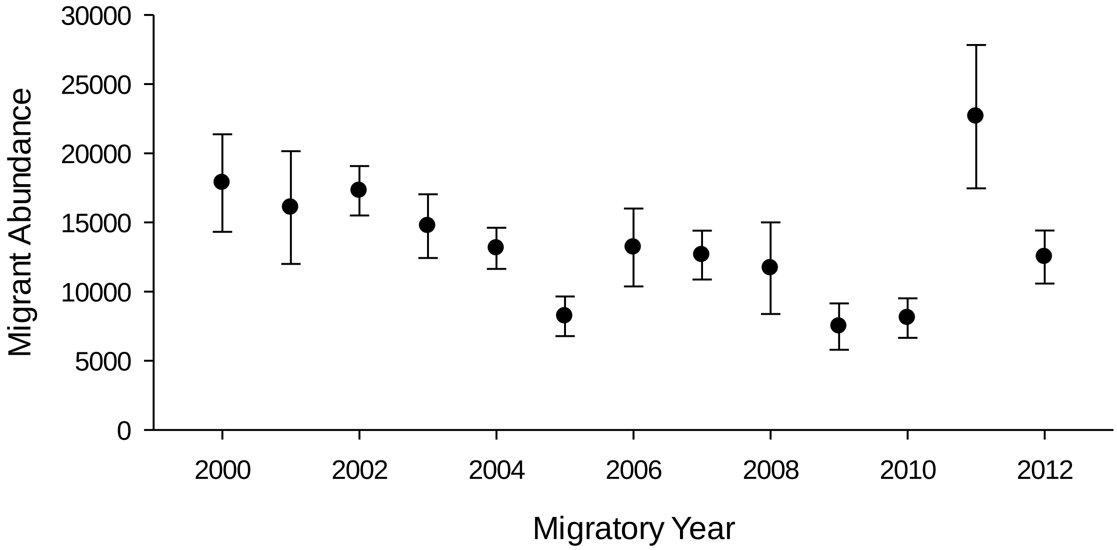

Figure 23. Steelhead migrant abundance estimates at the upper Grande Ronde River trap site by migratory year. Error bars are 95% confidence intervals.

Summer steelhead collected at trap sites during MY 2012 comprised five age-groups. Early migrants ranged from 0 to 4 years of age, while late migrants ranged from 1 to 4 years of age (Table 1). Majority of Catherine Creek (63.2%) and upper Grande Ronde River (79.4%) early migrants were age 1, while the largest proportion of Lostine River (51.1%) and Minam River (42.9%) early migrants were age 0. Majority of Catherine Creek (55.0%) and Lostine River (65.2%) late migrants were age 1, while majority of middle and upper Grande Ronde River (52.7% and 66.6%, respectively) late migrants were age 2, and the largest proportion of Minam River (38.1%) late migrants were age 3 (Table 1).

Table 1. Age structure of early and late steelhead migrants collected at trap sites during MY 2012. 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	21.1	63.2	15.7	0.0	0.0
Lostine River	51.1	42.4	6.4	0.1	0.0
Minam River	42.9	19.6	32.6	4.9	0.0
Upper Grande Ronde River	6.9	79.4	13.2	0.0	0.5
Late					
Catherine Creek	0.0	55.0	40.3	4.4	0.4
Lostine River	0.0	65.2	23.6	11.2	0.0
Minam River	0.0	34.4	26.2	38.1	1.4
Upper Grande Ronde River	0.0	19.9	66.6	13.4	0.1
Early and Late[a]					
Middle Grande Ronde River	0.0	34.2	52.7	13.1	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 2011 ranged from 0.134 to 0.250 for all four spawning tributaries (Figure 24). Probabilities of migration and survival, for larger steelhead (FL ≥ 115 mm) tagged during spring 2012, ranged from 0.391 to 0.822 for all five populations studied (Figure 24). Generally, probabilities of migration and survival, during spring 2012, were moderate to relatively high for all five populations studied compared to previous years.

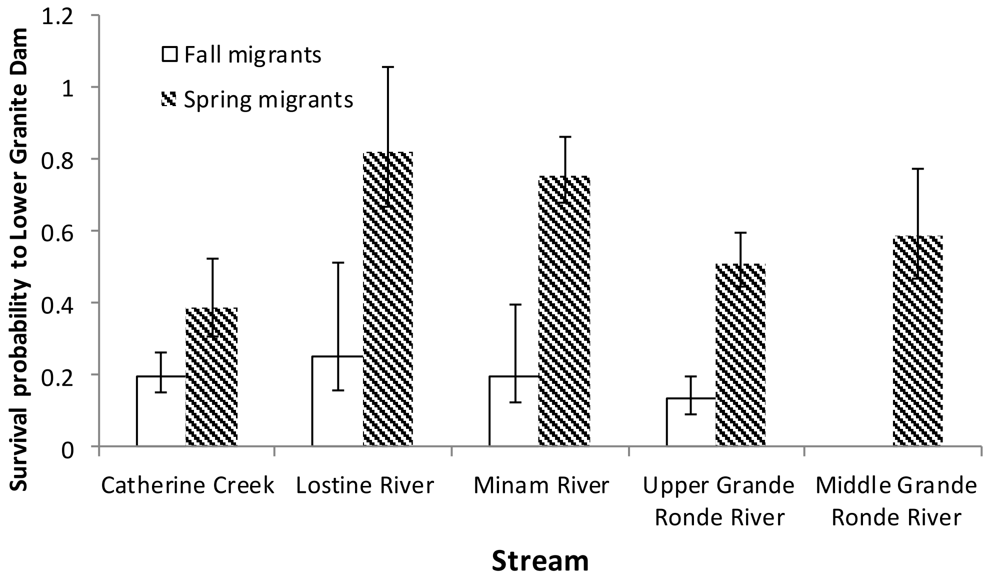

Figure 24. Probability of surviving and migrating, in the first year to Lower Granite Dam, for steelhead PIT-tagged at screw traps on Catherine Creek and Lostine, middle Grande Ronde, Minam, and upper Grande Ronde rivers during fall 2011 and spring 2012 (MY 2012). Catherine Creek and upper Grande Ronde River early migrants overwinter upstream of middle Grande Ronde River trap site, so no fall tag group was available for that site.

Conclusions

In general, high Chinook salmon redd counts in streams in 2010 resulted in smaller out-migrants in migratory year 2012 and lower productivity, as measured as smolts/redd, than in years with lower redd counts. The higher density of redds, whether of hatchery or natural spawners, produced more total migrants but produced lower numbers of smolts per redd.

We will add a second trap at our middle Grande Ronde River site at Elgin to try to capture more migrating salmonids and produce abundance estimates of spring Chinook salmon and steelhead smolts leaving the Grande Ronde Valley.

WE L: 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 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 the data needed to estimate adult steelhead escapement, improve our understanding of habitat utilization, and contribute to productivity and survival estimates for these populations.

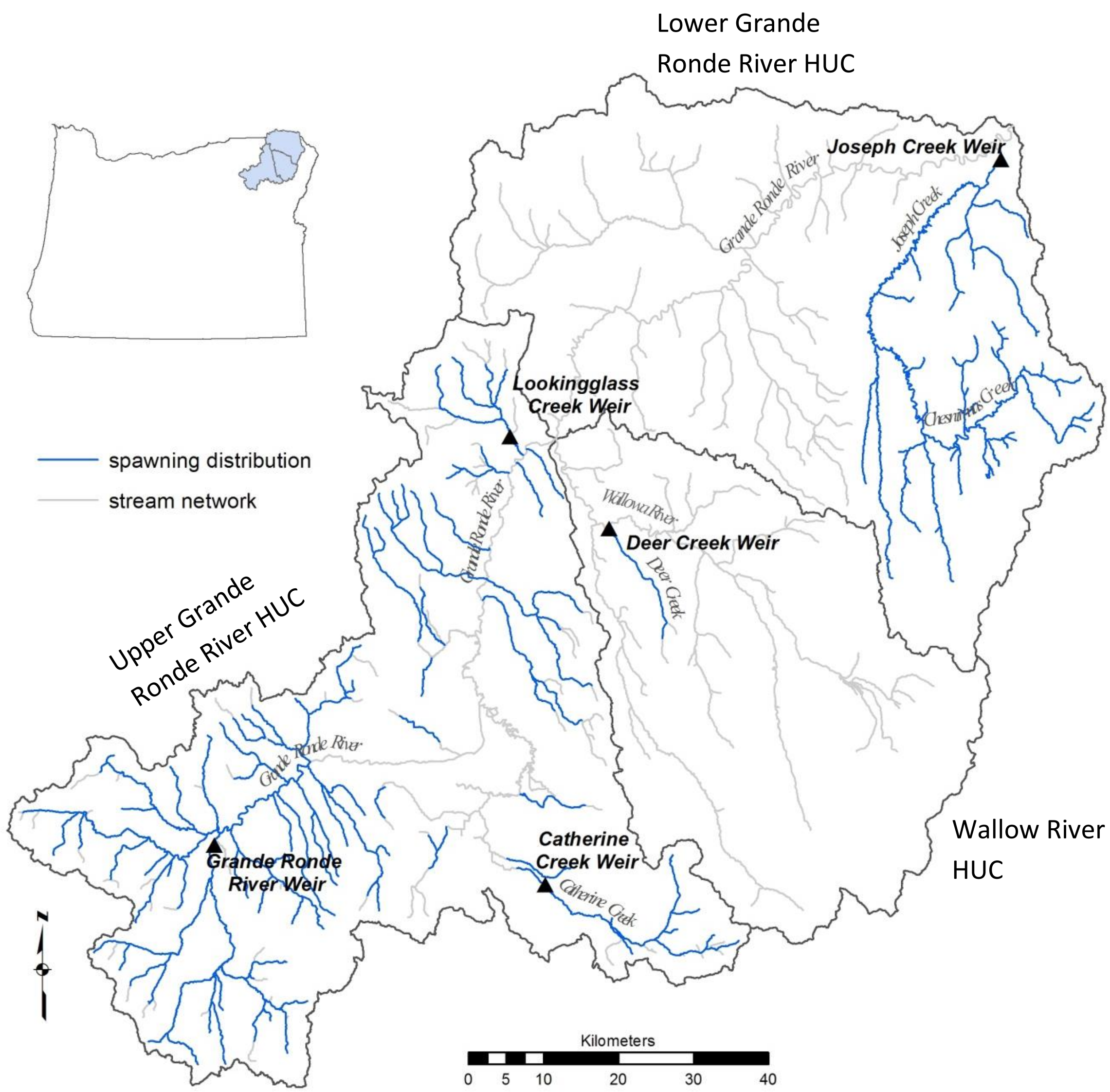

Figure 25. Grande Ronde River Basin, divided by 4th order HUC.

Methods

Estimating Adult Summer Steelhead Escapement in North East Oregon

https://www.monitoringmethods.org/Protocol/Details/757

Results

We surveyed 30 sites on the UGRR (Figure 26) encompassing 60.7 km of an estimated 897 km (6.5%) available steelhead spawning habitat (Appendix Table B-12). We conducted 170 surveys in the UGRR basin in 2012, with a mean interval of 17 d between surveys. A total of 70 steelhead redds were observed at 21 of the 30 sites (Appendix Table B14). Redds were not evenly distributed amongst the stream classifications: 23 redds (33%) were found in source areas, 31 (44%) in transport, and 16 (23%) in depositional reaches (Figure 26). A total of 21 live, adult steelhead were also observed at seven of the 30 sites in the basin (Appendix Table B-16). Two of those had no adipose fin, indicating hatchery origin.

Thirty sites were surveyed in Joseph Creek and tributaries (Figure 27), encompassing 58.4 km of an estimated 384 km (15.2%) available spawning habitat (Appendix Table B-13), all of which were above the weir. A total of 111 surveys were completed in the Joseph Creek watershed. We found 67 steelhead redds at 22 of the 30 sites (Appendix Table B-15). More redds were found in the depositional stream classification (n=33, 49%), than source or transport reaches (17 redds each, 25%, Figure 27). Water visibility was more challenging in Joseph Creek than UGRR, and surveys had a mean interval of 20 d once conditions allowed for access. Thirteen live, adult steelhead were seen at six of the sites (Appendix Table B-17), while five dead, adult steelhead were found at four sites (Appendix Table B-18). All live and dead steelhead in the Joseph Creek watershed surveys retained an adipose fin and were considered wild-origin.

We conducted six surveys on Deer Creek encompassing 18.5 km of what is believed to be all available spawning habitat from the weir to the USFS Road 8270 bridge. In previous years, additional surveys were conducted upstream of these 18.5 km, and no redds or adult steelhead were observed. We observed 22 redds on our visits to Deer Creek, 17 (77%) of which were discovered in the lower 9.6 km.

The Catherine Creek and the Grande Ronde River weirs were operable 1 March and the Lookingglass weir was continually operated (permanent structure). During the spring of 2012, 275 wild-origin adult steelhead were passed at the Lookingglass Creek weir, 329 at the Catherine Creek weir, and 13 at the Grande Ronde River weir. The first adult steelhead were passed on 12 March at the Lookingglass Creek and the Grande Ronde River weirs and 14 March at the Catherine Creek weir. One adult hatchery steelhead was trapped and removed at the Lookingglass weir. The last fish were passed on 29 May at the Grande Ronde River, 2 June at Lookingglass Creek and 5 June at Catherine Creek (CTUIR, unpublished data).

Adult steelhead were captured at the weir operated by Nez Perce Tribe (NPT) near the mouth of Joseph Creek and all fish (wild- and hatchery-origin) were passed above for natural spawning. High flows, ice and debris rendered the trap inoperable for 17 days during the months of February through April. The first adult steelhead were passed 27 January and the last was passed 24 May. During the spring of 2012, 264 wild adult steelhead and 12 hatchery adult steelhead were passed above the weir (Paul Kuchera, NPT, unpublished data).

At the Deer Creek weir, 69 adult wild-origin steelhead were passed upstream to spawn naturally. The weir was installed and operating 13 February trapping the first fish on 18 May. The weir was removed 29 May, 10 days after the last wild-origin fish was passed. One adult hatchery male was found in the weir without an opercle punch, the mark signifying it was trapped and handled at the weir on its upward migration. This fish was suspected to have migrated upstream prior to the installation of the weir panels. No additional hatchery or wild-origin unmarked adult steelhead were observed above the weir.

Spawn timing, based on our redd observations, was similar among the surveyed watersheds. We observed the first redds on 2 April in the UGRR (Appendix Figure B-21), 3 April in Deer Creek (Appendix Figure B-22) and 12 April in Joseph Creek. The last redds were observed on 13 June in the UGRR, 11 June in Deer Creek , and 27 June in Joseph Creek. By the third survey on 17 April, 55% of the total redds were observed on Deer Creek. By 10 May, 51% of the total redds were observed in the UGRR and 49% were observed in Joseph Creek.

Most redds in the UGRR basin were first observed during the descending hydrographs of early April and late April to late May (Appendix Figure B21). The six visits to Deer Creek coincided with low discharge periods. In Joseph Creek, few redds were discovered until flows declined below 500 cfs in late April.

New redd observations were associated with morning temperatures in all three basins. The majority of redds in the UGRR and Deer Creek were first observed with morning temperatures 2 - 8ºC (Appendix Figure B23). Joseph Creek redd observations occurred when temperatures were significantly higher than in UGRR or Deer Creek (χ^2= 351.7, 28 d.f., $p<0.001$), most >10 ºC.

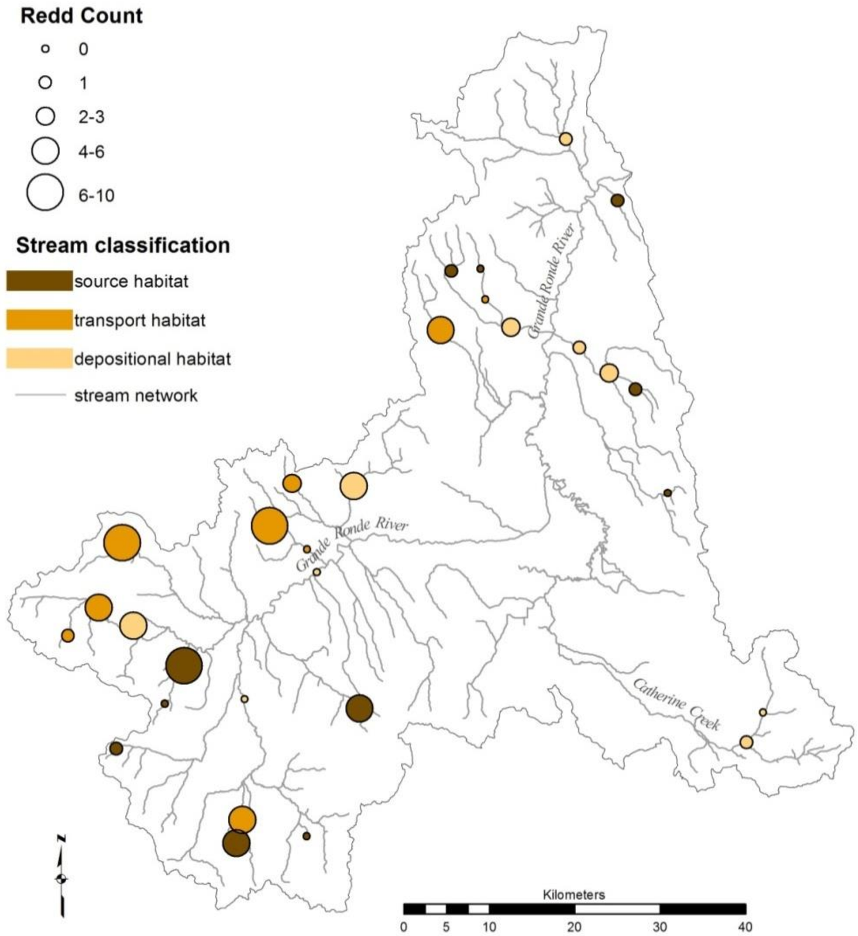

Figure 26. Map of the Upper Grande Ronde River watershed showing density, locations, and stream classification of redds observed in 2012.

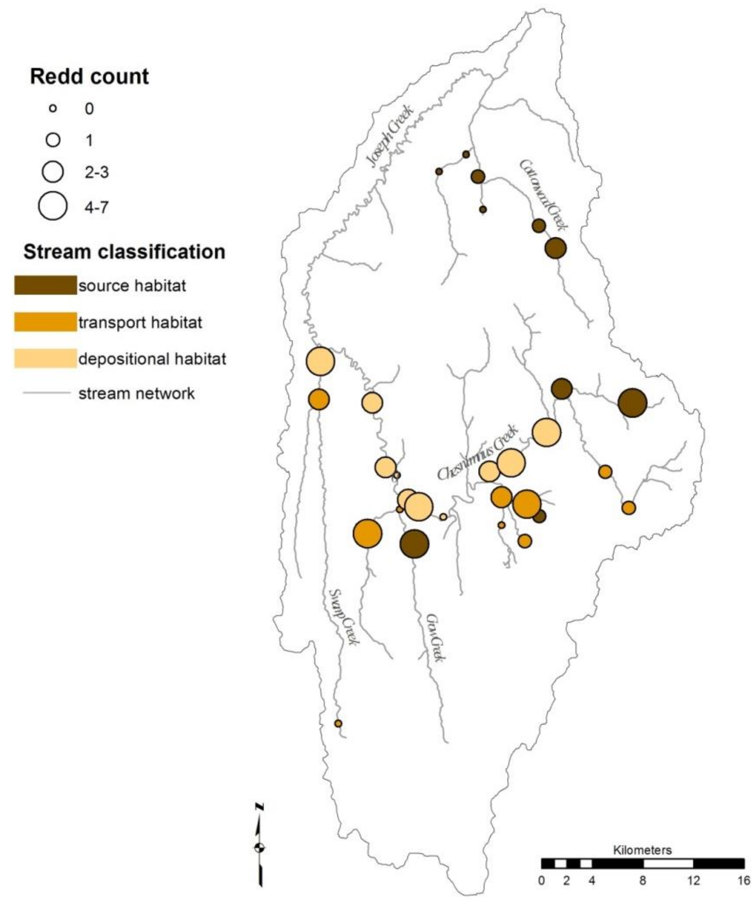

Figure 27. Map of the Joseph Creek watershed showing density, locations, and stream classification of redds observed in 2012.

Conclusions

Water clarity during surveys was marginal to good in both the UGRR and Joseph Creek watersheds throughout most of the season. Water clarity and our ability to observe redds generally improved as the season progressed, especially after April. Restriction of snow to higher elevations, relatively low precipitation, and moderate to low flows in May resulted in early access to most sites and good visibility. Flows were generally higher, and persisted longer in Deer Creek, Catherine Creek, and other tributaries flowing from the Wallowa Mountains due to their high elevation headwaters. Although our protocol indicates that surveys be conducted at two week intervals, flow conditions often increased the time between visits.

This was the initial year of surveys in the Joseph Creek drainage and there was concern about our ability to survey throughout the spring season. The upper portion of the basin had generally poor water visibility and high turbidity at moderate flows. As a result, the total number of surveys completed at the various sites was generally less than in the UGRR basin. That said, our crews were able to survey multiple times at sites, and spread surveys throughout the season. A year with higher snow quantity will likely make this more of a challenge, but we have demonstrated that implementing the sampling regime was feasible, despite periodic high water turbidity.

Water volume appears to play a significant role in our ability to observe redds. Total water volume correlated strongly with our annual redd observations in the UGRR (Appendix Figure B-24). However, this relationship appears to be mitigated by using the fish:redd ratio from Deer Creek. Fish:redd showed the opposite relationship with total discharge, and also correlated strongly with the total number of redd observations from the UGRR (Appendix Figure B-25). This all 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. It also helps explain why escapement estimates, which incorporate both values, have been similar across all years, despite substantial differences in total redd counts (Figure 28).

Most redds were first observed during descending limbs of the hydrograph, in both UGRR and Joseph Creek basins. However, this tells us little about the relationship of spawning to stream flow. 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. Even though our observations of redds were during these descending periods, 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 (Appendix Figure B-22). However, redds were likely built during the high water periods between surveys. Our surveys cannot determine or estimate when redds were built, 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 temperatures during which those observations were made varied significantly (Appendix Figure B-23, Chi-square, 28 d.f., $p<0.001$). Stream temperatures in Joseph Creek and tributaries were several degrees higher during the spawning season, especially in May and early June. Most redds found in the Joseph Creek drainage were first discovered when morning temperatures were >10ºC (Appendix Figure B-23).

WE M: 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 to redd ratio of 3.14 (69/22) was generated using the number of fish passed above the weir at Deer Creek and the number of redds observed there in 2012. Using this ratio and a single weight value for all stream classifications (29.9), an estimated 3,261 adult steelhead (95% CI, 2,184 – 4,336) escaped into the UGRR watershed and naturally spawned (Appendix Table B-19). Two hatchery steelhead were observed, one in Spring Creek and the other in West Chicken Creek. The hatchery fraction was 0.09 which expanded to approximately 293 hatchery fish that strayed into the UGRR. Using this same method with a weight value of 12.8, an estimated 1,357 adult steelhead (95% CI, 977 – 1,736) escaped into the Joseph Creek watershed. No adipose-clipped hatchery fish were observed during surveys on Joseph Creek.

Stratifying surveys by stream classification resulted in a similar escapement estimate for both basins, but did little to improve confidence intervals. Using the weight values for each strata, source (41.1), transport (27.3), and depositional (19.9), we estimated that 3,264 (95% CI, 2,008 –

4,520) adult steelhead for the UGRR population (Figure 28). For Joseph Creek, using the weight values for each strata, source (15.9), transport (11.5), and depositional (11.1), we estimate that 1,316 (95% CI, 957 – 1,675) adult steelhead returned to spawn (Appendix Table B-21).

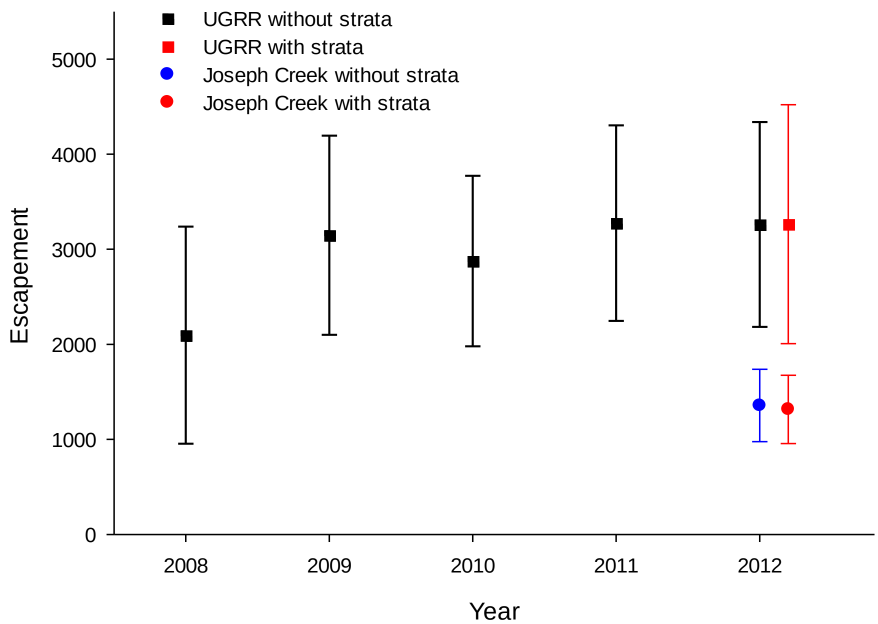

Figure 28. Escapement estimates with 95% confidence intervals for steelhead in the Upper Grande Ronde River watershed using a single weight value, 2008–2012 and using strata weights for the three classifications of stream type for UGRR and Joseph Creek, 2012.

Conclusions

We were able to provide population-scale escapement estimates with relatively good precision (95% CI < 34% of the estimate). However, this is no better than in past years. Confidence intervals have consistently been 30 – 35% of the UGRR escapement estimate since 2009 (Appendix Table B-19). 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. 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.

We attempted to improve our estimate precision and isolate areas of differential use by stratifying survey reaches by stream classification (source, transport or depositional). Each strata of sites was given a different GRTS weight based on length of streams available for spawning that fall within that strata. Results were mixed. In the UGRR basin, stratification resulted in a 5% increase in confidence intervals around the escapement estimate. Conversely, the Joseph Creek basin confidence intervals decreased by about 5% when stratified (Appendix Table B-21). These small changes in precision are likely the result of spatial scale. The stream classes used in our analyses were estimated in GIS at intervals of 200 linear meters. Steelhead are not likely choosing appropriate spawning areas at this scale. Thus, our inability to associate observations of redds based on stream classification is possibly due to the coarseness of scale for those stream classes. We will continue to explore analysis and stratification of spawning habitat, attempt to increase the precision of our escapement estimates at the watershed scale, and associate spawning use with specific stream characteristics that can be predicted/measured and used to refine the spawning distribution further. Preferably, habitat measures could be estimated using GIS, rather than intensifying measurements taken during field surveys.

We will continue to define the extent of these identified stream reaches 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.

WE N: Steelhead and Chinook Salmon Parr Surveys, and
WE O: Steelhead and Chinook Salmon 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 sub-basin for 2012. Habitat monitoring locations were generated with the generalized random tessolated stratification (GRTS) design for the second year of the Columbia Habitat Monitoring Program (CHaMP) (Bouwes et al. 2011). Only streams within the known (or assumed) anadromous fish spawning distribution were eligible for selection. Two crews completed these 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).

Fifty-three of the 55 CHaMP sites (Appendix Table B-22) were surveyed for juvenile salmonids via a single-pass snorkel protocol (Juvenile Salmonid Density & Distribution in Northeast Oregon Watersheds, http://www.monitoringmethods.org/Protocol/Details/370).

Results

Salmonids were observed at all 53 snorkeled CHaMP sites. Steelhead were found at all sites, Chinook salmon at 30 of the 53, and bull trout *Salvelinus confluentus* at only 7 sites. At both Dry Creek and Peet Creek (the two dry sites), steelhead were observed just outside of the CHaMP reach, but those data were anecdotal and not included in our figures and analyses.

Chinook salmon were usually the dominant salmonid in main stem snorkel surveys (Figure 29), with counts in the hundreds, while counts were in the dozens for tributaries (Appendix Table B-24). The majority of observed Chinook salmon were in the 50 – 80 mm size category, corresponding with age 0 fish. However, a handful of fish in the >100 mm size category were also observed, corresponding to age 1 fish (Appendix Table B-24). Chinook salmon were most abundant in main stem UGRR and CC (Figure 30), with fewer observed in the larger tributaries like Sheep Creek, Meadow Creek, and the CC Forks. They were usually not seen in small tributaries (<8 m bankfull width). However, they were observed at all three sites in Clark Creek, a tributary that enters the UGRR in Elgin. Anecdotally, several adult Chinook salmon (both with and w/o adipose fin clips) were observed spawning at those same sites. Clark Creek is not surveyed for adult Chinook salmon by any other research/monitoring programs, so no carcass data was collected.

Overall steelhead counts were lower than Chinook salmon counts, and only exceeded 100 individuals at a few sites. However, they were more widely distributed than Chinook salmon (Figure 31). Steelhead size classes were more variable than Chinook, with fish >250 mm observed with some regularity. 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. Most steelhead were 70 – 200 mm, corresponding with the age 1 and age 2 classes (Appendix Table B-24). Age 0 steelhead were smaller than 70 mm, and were lumped into the young-of-year (YOY) salmonid category for snorkel surveys. These YOY were observed through electrofishing, and were generally 40 – 60 mm fork length. No adult steelhead were observed due to the timing of surveys.

Juvenile Chinook salmon and steelhead densities were significantly higher (Tukey's Test, $p<0.05$) in pools than fastwater units or runs (Appendix Table B-25). There was no statisticaly significant difference between densities in fastwater units compared to runs. Catherine Creek sites had the highest pool densities of Chinook, followed by lower Fly Creek and main stem UGRR. Steelhead pool densities were highest in Rock, Gordon and Clark Creeks.

Mean steelhead densities in pools and runs were higher at sites without Chinook salmon present than those with Chinook salmon (Appendix Table B-25). Conversely, mean steelhead densities in riffles were lower at sites without Chinook. This suggests that steelhead may prefer pool and run habitats, but are "pushed" into riffles in the presence of Chinook. However, these mean values were strongly influenced by a few sites with extremely high densities (i.e. Rock Creek). Median steelhead densities were not significantly different (Mann Whitney U test, p

>0.60 for all three unit types). Thus, densities do not appear to be influenced by inter-species competition.

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-23). Bull trout were only observed in Catherine Creek (main stem, north and south forks) and the upper reaches of UGRR (Appendix Table B-23). Mountain whitefish, northern pikeminnow and suckers were generally seen in the main stem Catherine Creek and UGRR sites, while dace, redside shiners and sculpins were observed in main stem and lower gradient tributary sites, like Meadow Creek. In many cases, dace and shiners outnumbered salmonids in the same reaches (Appendix Table B-23). The smallest, high gradient sites generally produced only steelhead and sculpin. Catfish and sunfish were rarely observed in Meadow Creek and the UGRR main stem.

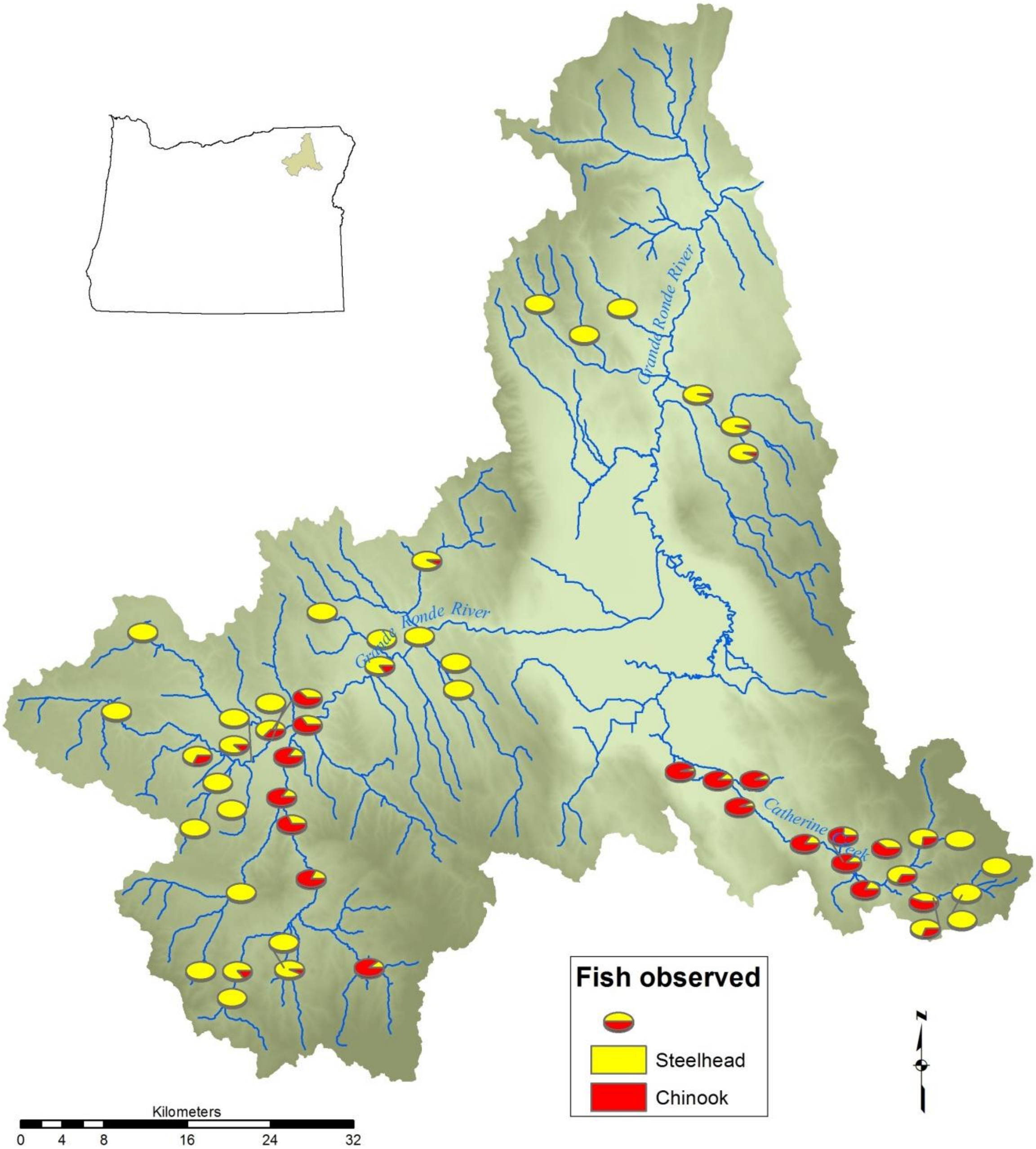

Figure 29. Proportional distribution of juvenile steelhead and Chinook salmon observed via snorkel surveys, 2012.

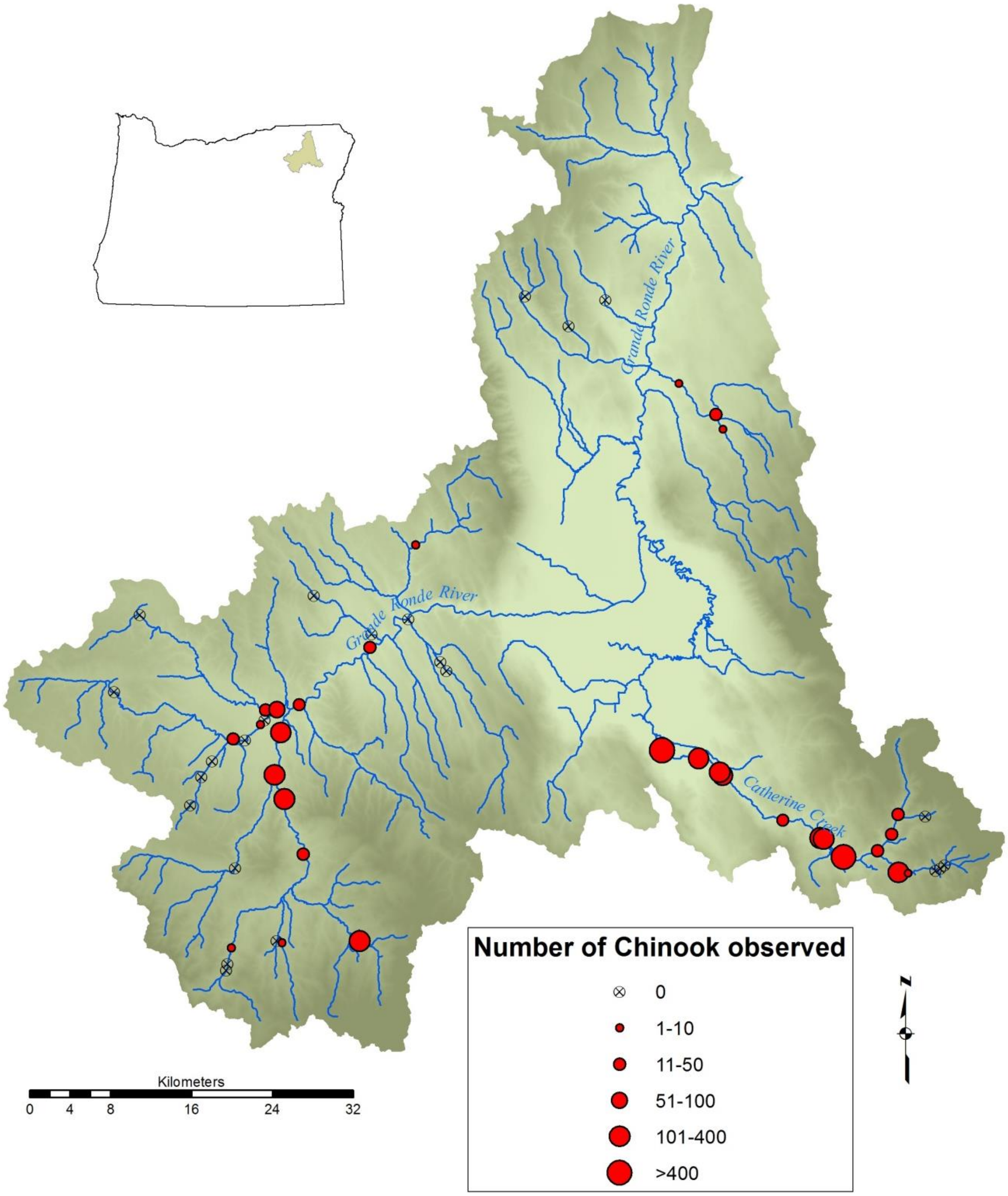

Figure 30. Spatial distribution and counts of Chinook salmon observed during snorkel surveys of the UGRR basin, 2012.

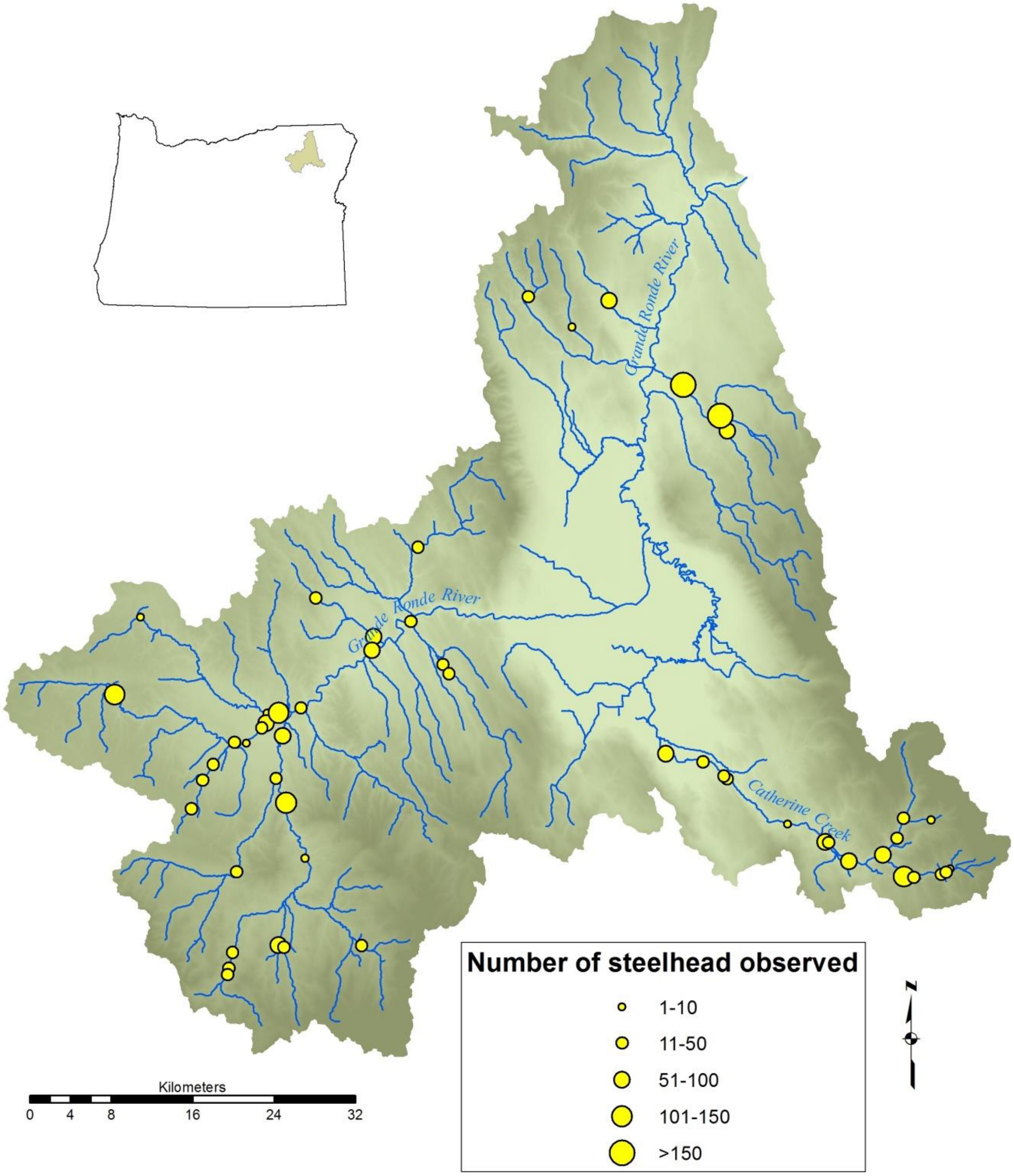

Figure 31. Spatial distribution and raw counts of steelhead observed during snorkel surveys of the UGRR basin, 2012.

Conclusions

The observed distribution of juvenile Chinook salmon was generally consistent with previous surveys and local estimation of the Chinook salmon rearing habitat. The majority of fish were using the main stem Catherine Creek and Upper Grande Ronde River during their first summer. These areas are also the primary spawning grounds for UGRR Chinook salmon (Feldhaus et al. 2012). However, adult and juvenile Chinook salmon were observed in Clark Creek, a stream not currently considered Chinook salmon spawning or rearing distribution.

There are several potential explanations for the presence of Chinook salmon in Clark Creek: 1. In summer 2012, 114 adult Chinook salmon of hatchery origin, captured at the Catherine Creek weir, were moved to Indian Creek (M. McClean, CTUIR, personal comm.). Indian Creek neighbors Clark Creek. It seems likely that some of these adults would leave Indian Creek and enter Clark Creek prior to spawning. 2. The mouth of Clark Creek is geographically close to the mouth of Lookingglass Creek, which has a Chinook salmon-producing fish hatchery. Chinook salmon adults observed in Clark Creek may have strayed from Lookingglass. 3. Clark Creek Chinook salmon could have been strays from throughout the Grande Ronde basin. 4. Clark Creek has been producing Chinook salmon naturally, and the adults observed in 2012 were returning to their natal stream. In all likelihood, the presence of spawning Chinook salmon in Clark Creek is some combination of the above four scenarios. Unfortunately, no genetic or tag data was obtained from the adults, and their origin remains unknown.

One of our goals is to constantly refine the spawning and rearing distribution for steelhead in UGRR sub-basin. The presence of *O. mykiss* at all of our surveyed sites suggests all are within that distribution, and no refinement to the distribution resulted from these surveys.

Steelhead <70mm were generally identifiable around the 45mm size. The current protocol restricts enumeration of steelhead to >70 mm FL. However, steelhead could be visually differentiated from Chinook salmon except for the smallest of individuals. These should be counted in future years.

There was significant difficulty in snorkeling small stream sites, especially during low water periods. Snorkeling is well suited for larger wadable streams that allow the surveyor to continuously “crawl” upstream. However, small sites require the surveyor to periodically stand and walk, which can scatter upstream fish. Also, many riffles in the small streams were too shallow to submerge one’s head far enough to see any fish present. Snorkel surveys in these small sites need to be calibrated or replaced with electrofishing surveys to obtain more accurate representations of the fish present.

Salmonid densities estimated from snorkel surveys were higher in pools than riffles or runs. This is consistent with conventional wisdom and the literature. However, snorkeling visibility is usually less in shallow, fast water than in pools. It is possible that snorkeling underestimates fish use of shallower waters. We are in the midst of developing a correction for snorkel counts vs.

population estimates that will allow us to generate a more defensible approximation of fish distribution and use across stream habitat types.

Conclusions

The trends in Chinook salmon out-migrant abundance appear to be stable to slightly increasing through time, and are dependent on the number of redds. Trends in steelhead out-migrant abundance are not so apparent.

In general, we have observed that Chinook salmon productivity, as measured as smolts produced per redd, decreases as the number of redds increases in the Grande Ronde populations with the current conditions.

Steelhead escapement in the upper Grande Ronde River watershed has remained stable over the past five years.

The observed distribution of juvenile Chinook salmon was generally consistent with previous surveys and local estimation of the Chinook salmon rearing habitat. Juvenile steelhead were observed at all 53 sites surveyed in 2012.

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Appendix A: Use of Data and Products

Oregon Department of Fish and Wildlife is in the process of developing a data management plan for Columbia Basin RM&E projects. Project staff will participate in the plan development and the outcome should be a data repository that includes data collected by this project.

Appendix B: Detailed Results

WE H: Abundance and Migration of Juvenile Salmonids in Study Streams During Migration Year 2012, 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 2011 and 2012.

Migration year and stream	Tagging Dates	Number PIT-tagged	Distance to Lower Granite Dam (km)
2012 (*Summer 2011*)			
Catherine Creek	15 Aug–17 Aug	998	363–383
Imnaha River	22 Aug–25 Aug	998	221–233
Lostine River	6 Sept–8 Sept	1000	271–308
Minam River	29 Aug–1 Sept	999	276–290
Upper Grande Ronde	12 Sept–14 Sept	1000	418–428
2013 (*Summer 2012)*			
Catherine Creek	31 Jul–3 Aug, 5 Sept	975	363–383
Imnaha River	13 Aug–15 Aug, 5 Sept	995	221–233
Lostine River	6 Aug–9 Aug	999	271–308
Minam River	20 Aug–23 Aug	997	276–290
Upper Grande Ronde	27 Aug–29 Aug	996	418–428

Appendix Table B-2. Juvenile spring Chinook salmon catch at five general trap locations in Grande Ronde River Subbasin during MY 2012. Early migration period starts 1 July 2011 and ends 28 January 2012. Late migration period starts 29 January and ends 30 June 2012. 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	19 Sept 11 – 2 Dec 11	69/74 (93)	17,387
	Late[a]	23 Feb 12 – 13 Jun 12	111/111 (100)	2,087
	Late[b]	24 Mar 12 – 17 Apr 12	6/25 (24)	153
Lostine River	Early	21 Sept 11 – 28 Jan 12	104/128(81)	30,153
	Late[a]	29 Jan 12 – 16 May 12	95/109 (87)	3,903
	Late[b]	24 Mar 12 – 20 Apr 12	7/28 (25)	357
Middle Grande Ronde River	Late[a]	5 Mar 12 – 25 Jun 12	105/112 (94)	467
Minam River (rkm 1)	Early	21 Sept 11 – 1 Dec 11	60/71(85)	20,709
	Late[a]	12 Mar 12 – 16 May 12	64/65 (98)	1,879
Minam River (rkm 3)	Late[a]	19 Mar 12 – 15 May 12	43/57 (75)	1,624
Upper Grande Ronde River	Early	21 Sept 11 – 16 Nov 11	51/56(84)	13,659
	Late[a]	9 Mar 12 – 13 Jun 12	94/96 (91)	9,814
	Late[b]	23 Mar 12 – 17 Apr 12	10/26 (38)	1,192

[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 2012. 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	1,080	64.7	0.23	40	93	995	65.7	0.22	55	93
Early migrants	1,706	80.7	0.22	57	115	1,150	79.9	0.24	57	108
Winter	499	81.4	0.34	61	102	499	81.4	0.34	61	102
Late migrants	1,243	83.9	0.26	44	119	1,032	82.5	0.26	55	109
Lostine River										
Summer	1,350	60.3	0.23	41	89	998	64.0	0.21	54	89
Early migrants	2,436	73.8	0.21	44	113	1,889	73.4	0.23	55	113
Winter	513	69.1	0.36	44	93	499	69.5	0.35	54	93
Late migrants	2,041	83.6	0.20	53	115	1,832	84.1	0.20	55	115
Middle Grande Ronde River										
Spring emigrants	438	93.8	0.51	66	135	437	93.7	0.52	66	135
Minam River										
Summer	1,091	64.3	0.23	44	90	989	65.5	0.22	55	90
Early migrants	1,589	75.8	0.23	49	116	1,298	76.7	0.23	56	106
Late migrants	1,188	84.2	0.23	64	117	1,016	84.1	0.25	64	117
Upper Grande Ronde River										
Summer	1,404	60.5	0.24	42	93	983	64.6	0.23	54	93
Early migrants	968	70.5	0.28	45	102	605	72.0	0.33	51	100
Winter	259	69.2	0.55	53	99	257	69.3	0.55	54	99
Late migrants	1,362	84.0	0.24	60	113	632	82.2	0.32	62	107

Appendix Table B- 4. Weights of juvenile spring Chinook salmon collected from study streams during MY 2012. 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	1,078	3.4	0.04	0.9	9.8	993	3.5	0.04	1.7	9.8
Early migrants	1,706	5.9	0.05	2.0	16.8	1,150	5.7	0.05	2.0	13.7
Winter	498	5.9	0.07	2.5	11.3	498	5.9	0.07	2.5	11.3
Late migrants	1,243	6.4	0.06	0.9	18.7	1,032	6.1	0.05	1.8	12.5
Lostine River										
Summer	1,348	2.8	0.03	0.8	8.6	998	3.2	0.04	1.6	8.6
Early migrants	2,432	4.6	0.04	0.8	19.8	1,887	4.5	0.05	1.7	16.1
Winter	510	3.7	0.06	0.8	8.7	496	3.7	0.06	1.5	8.7
Late migrants	2,039	6.6	0.05	1.4	18.5	1,831	6.7	0.05	1.7	18.5
Middle Grande Ronde River										
Spring emigrants	398	8.8	0.18	2.8	27.7	397	8.8	0.18	2.8	27.7
Minam River										
Summer	1,089	3.3	0.04	0.7	9.0	987	3.4	0.04	0.7	9.0
Early migrants	1,582	4.8	0.05	1.3	17.0	1,296	5.0	0.05	1.7	14.0
Late migrants	1,187	6.3	0.06	2.4	18.9	1,015	6.3	0.06	2.4	18.9
Upper Grande Ronde River										
Summer	1,404	2.7	0.03	0.8	9.7	983	3.3	0.04	1.6	9.7
Early migrants	884	3.8	0.05	0.7	11.2	550	4.0	0.06	1.7	9.1
Winter	259	3.6	0.09	1.3	9.9	257	3.7	0.09	1.3	9.9
Late migrants	1,266	6.3	0.06	1.9	16.9	557	5.7	0.08	2.2	13.0

Appendix Table B- 5. Survival probability to Lower Granite Dam of juvenile spring Chinook salmon tagged during summer 2011 and detected at Columbia and Snake river dams during 2012.

Stream	Number PIT-tagged and released	Survival probability (95% CI)
Catherine Creek	998	0.116 (0.090–0.154)
Imnaha River	998	0.182 (0.151–0.221)
Lostine River	1,000	0.086 (0.066–0.113)
Minam River	999	0.110 (0.090–0.134)
Upper Grande Ronde River	1,000	0.083 (0.063–0.111)

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 2011 to spring 2012 and detected at dams during 2012.

Stream and tag group	Number PIT-tagged and released	Survival probability (95% CI)
Catherine Creek		
Fall (trap)	1,153	0.188 (0.155–0.232)
Winter (above trap)	501	0.099 (0.072–0.135)
Spring (trap)	1,033	0.302 (0.254–0.370)
Lostine River		
Fall (trap)	1,890	0.162 (0.143–0.184)
Winter (above trap)	500	0.076 (0.053–0.107)
Spring (trap)	1,848	0.550 (0.515–0.589)
Middle Grande Ronde River		
Spring (trap)	437	0.677 (0.600–0.770)
Minam River		
Fall (trap)	1,299	0.225 (0.196–0.259)
Spring (trap)	1,018	0.504 (0.461–0.554)
Upper Grande Ronde River		
Fall (trap)	606	0.196 (0.160–0.239)
Winter (above trap)	258	0.043 (0.013 SE)
Spring (trap)	632	0.405 (0.348–0.476)

Appendix Table B- 7. Juvenile steelhead catch at five general trap locations in Grande Ronde River Subbasin during MY 2012. Early migration period starts 1 July 2011 and ends 28 January 2012. Late migration period starts 29 January and ends 30 June 2012. 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	19 Sept 11 – 2 Dec 11	69/74 (93)	607
	Late[a]	23 Feb 12 – 13 Jun 12	111/111 (100)	804
	Late[b]	24 Mar 12 – 17 Apr 12	6/25 (24)	36
Lostine River	Early	21 Sept 11 – 28 Jan 12	104/128(81)	1,093
	Late[a]	29 Jan 12 – 16 May 12	95/109 (87)	457
	Late[b]	24 Mar 12 – 20 Apr 12	7/28 (25)	13
Middle Grande Ronde River	Late[a]	5 Mar 12 – 25 Jun 12	105/112 (94)	455
Minam River (rkm 1)	Early	21 Sept 11 – 1 Dec 11	60/71(85)	246
	Late[a]	12 Mar 12 – 16 May 12	64/65 (98)	406
Minam River (rkm 3)	Late[a]	19 Mar 12 – 15 May 12	43/57 (75)	232
Upper Grande Ronde River	Early	21 Sept 11 – 16 Nov 11	51/56(84)	205
	Late[a]	9 Mar 12 – 13 Jun 12	94/96 (91)	1,786
	Late[b]	23 Mar 12 – 17 Apr 12	10/26 (38)	112

[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 2012. 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	21.1	63.2	15.7	0.0	0.0
Lostine River	51.1	42.4	6.4	0.1	0.0
Minam River	42.9	19.6	32.6	4.9	0.0
Upper Grande Ronde River	6.9	79.4	13.2	0.0	0.5
Mean	36.4	50.3	12.7	0.6	0.1
CV (%)	42.7	43.4	104.8	489.2	0.0
Late					
Catherine Creek	0.0	55.0	40.3	4.4	0.4
Lostine River	0.0	65.2	23.6	11.2	0.0
Minam River	0.0	34.4	26.2	38.1	1.4
Upper Grande Ronde River	0.0	19.9	66.6	13.4	0.1
Mean	0.0	39.8	44.3	15.5	0.4
CV (%)	0.0	51.1	44.6	95.2	0.0
Early and Late[a]					
Middle Grande Ronde River	0.0	34.2	52.7	13.1	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 2012 and subsequently arriving at Lower Granite Dam (LGD) during spring 2012.

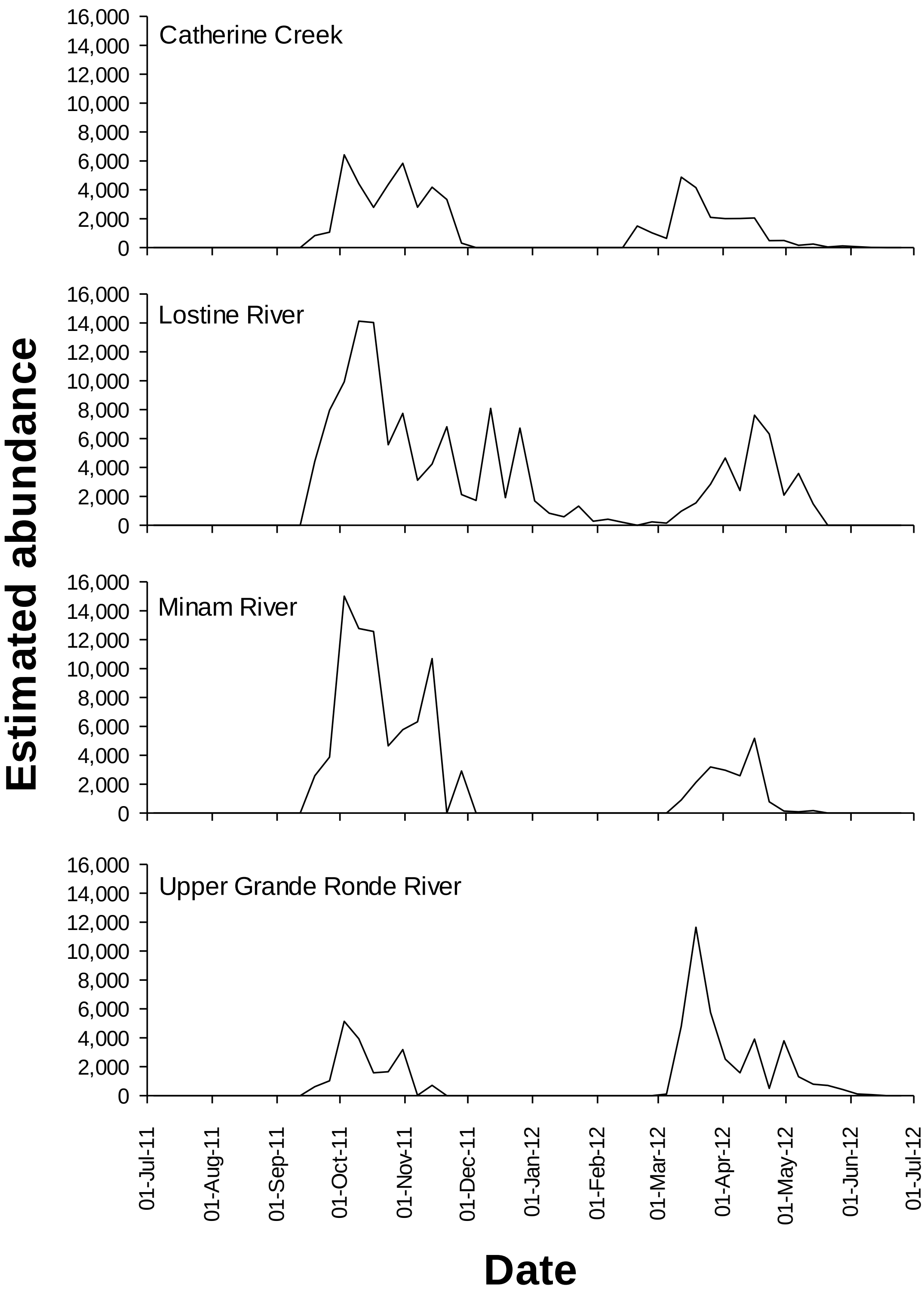
Stream	Distance to LGD (km)	Number detected	Travel time (d) Median	Min	Max
Catherine Creek	362	35	24	5	68
Lostine River	274	40	10	4	30
Middle Grande Ronde River	258	42	7	3	69
Minam River	245	82	10	2	59
Upper Grande Ronde River	397	102	28	5	71

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 2011 and spring 2012 (MY 2012). 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.

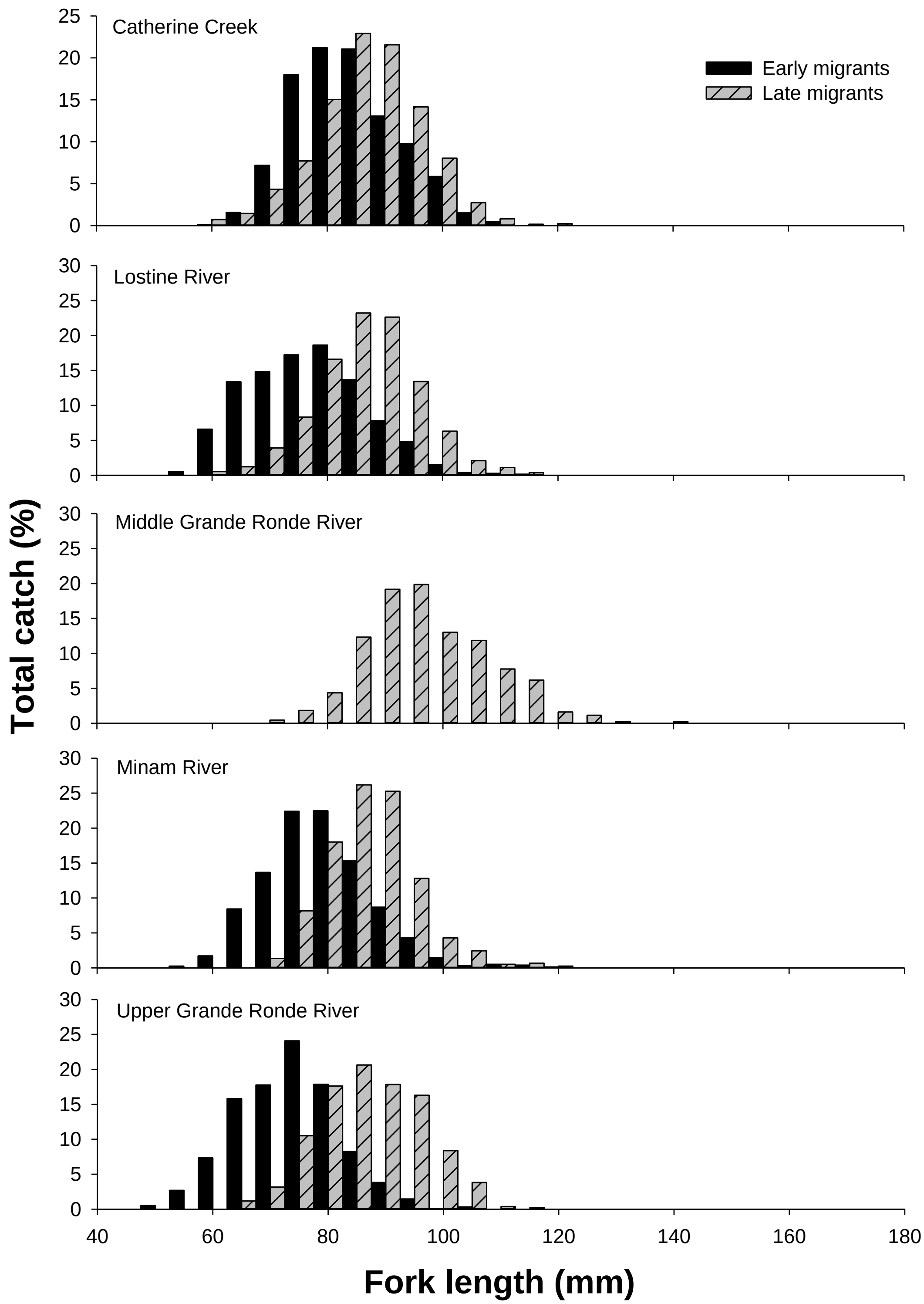
Season and location tagged	Number tagged	Number detected	Probability of surviving and migrating in the first year (95% CI)
Fall			
Catherine Creek	503	82	0.197 (0.154–0.263)
Lostine River	590	72	0.250 (0.158–0.512)
Minam River	144	24	0.196 (0.124–0.394)
Upper Grande Ronde River	197	25	0.134 (0.089–0.195)
Spring (FL ≥ 115 mm)			
Catherine Creek	327	97	0.391 (0.308–0.526)
Lostine River	150	90	0.822 (0.669–1.055)
Middle Grande Ronde River	252	105	0.588 (0.467–0.775)
Minam River	374	238	0.758 (0.677–0.862)
Upper Grande Ronde River	658	255	0.513 (0.447–0.595)

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 2012. Italicized headings represent smolt age at time detections were recorded at a dam. Means are weighted by sample size (*n*).

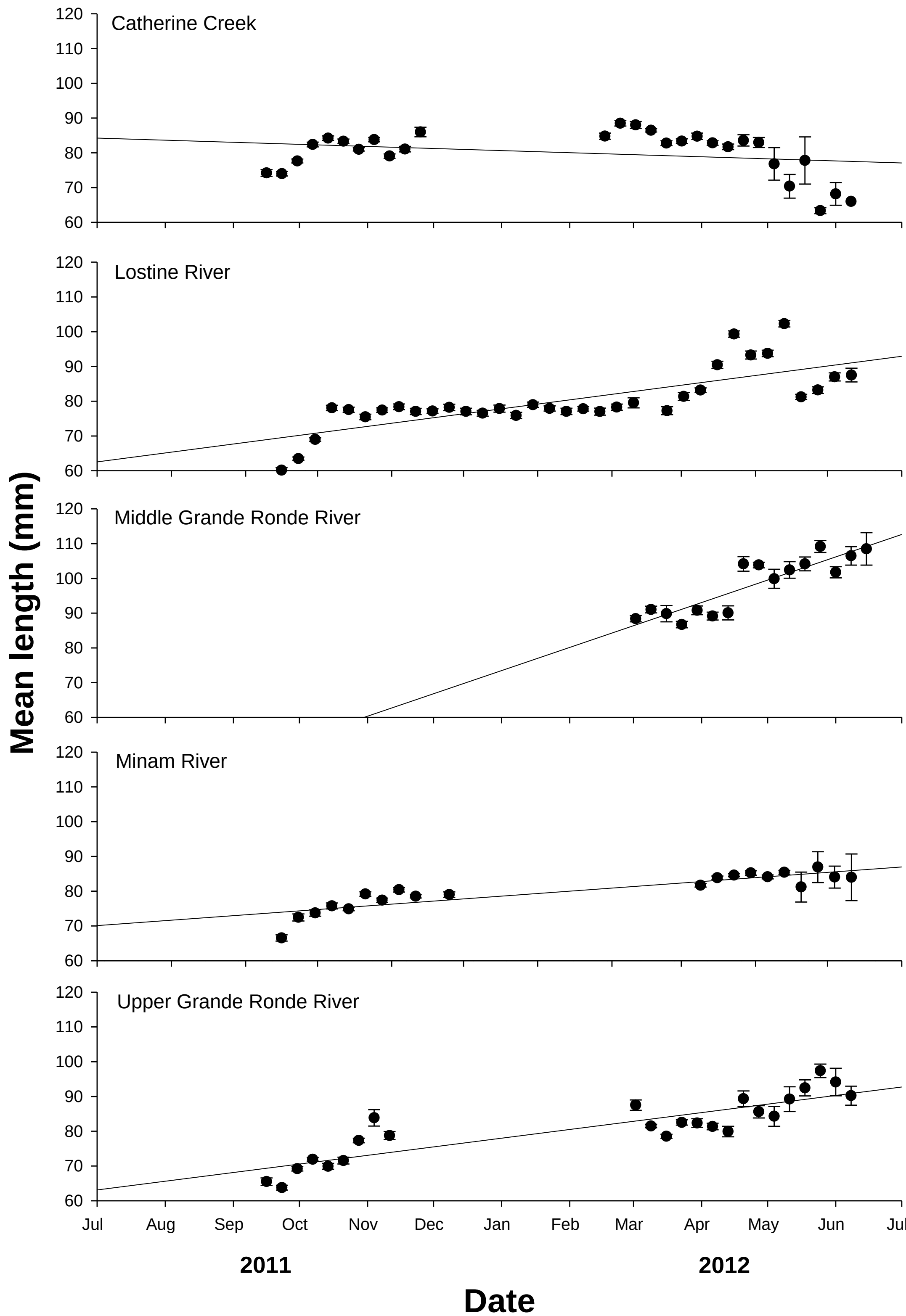
Trap site	*n*	Age-0 *Age-1 smolt*	Age-1 *Age-2 smolt*	Age-2 *Age-3 smolt*	Age-3 *Age-4 smolt*
PIT tagged fish with known age (%)					
Catherine Creek	178	31	49	20	0
Lostine River	198	22	60	17	1
Minam River	114	22	24	46	8
Upper Grande Ronde River	106	10	74	16	0
Mean		21.4	51.6	24.8	2.1
CV (%)		41.1	41.0	58.4	184.3
PIT tagged fish detected at dams (%)					
Catherine Creek	25	0	80	20	0
Lostine River	33	0	73	27	0
Minam River	19	0	63	26	11
Upper Grande Ronde River	12	0	75	25	0
Mean		0.0	72.7	24.6	2.6
CV (%)		0.0	9.7	13.1	200.0



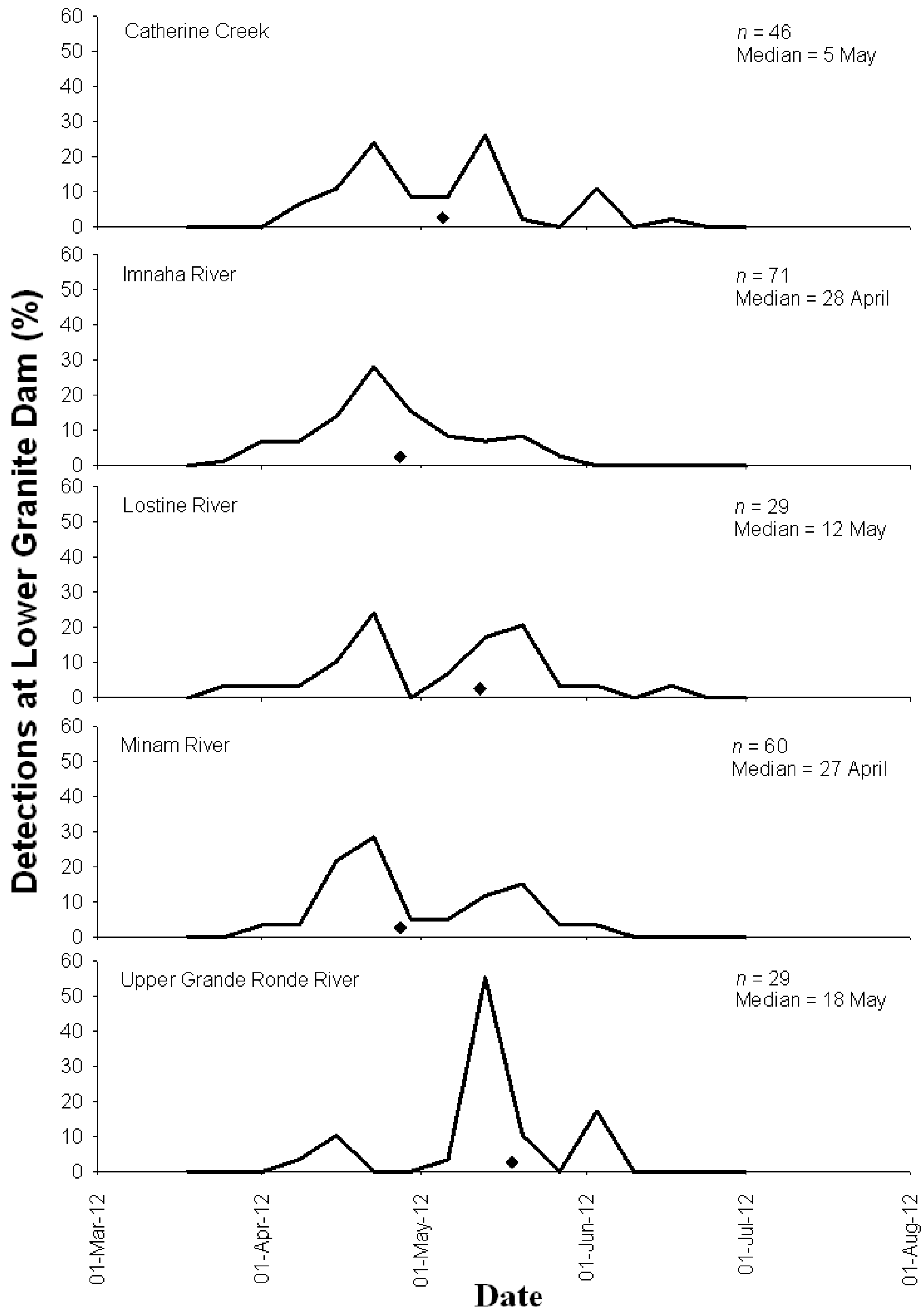
Appendix Figure B-1. Estimated migration timing and abundance for juvenile spring Chinook salmon migrants sampled by rotary screw traps during MY 2012. Traps were located at rkm 32 on Catherine Creek, rkm 3 on Lostine River, rkm 0 on Minam River, and rkm 299 on upper Grande Ronde River.



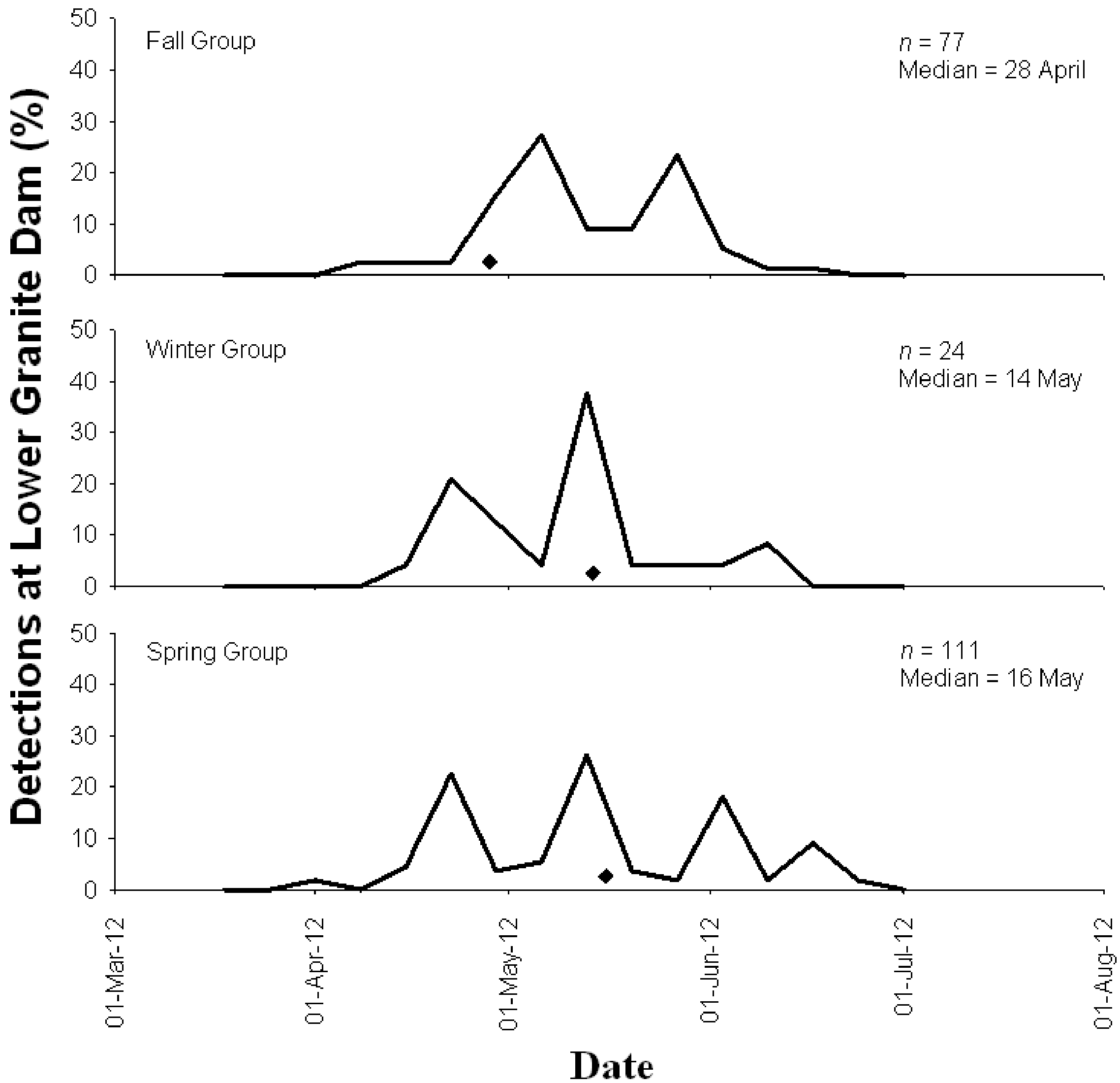
Appendix Figure B-2. Length frequency distribution (fork length) of early and late migrating juvenile spring Chinook salmon captured at Catherine Creek (rkm 32), Lostine (rkm 3), middle Grande Ronde (rkm 160), Minam (rkm 0), and upper Grande Ronde (rkm 299) river traps during MY 2012.



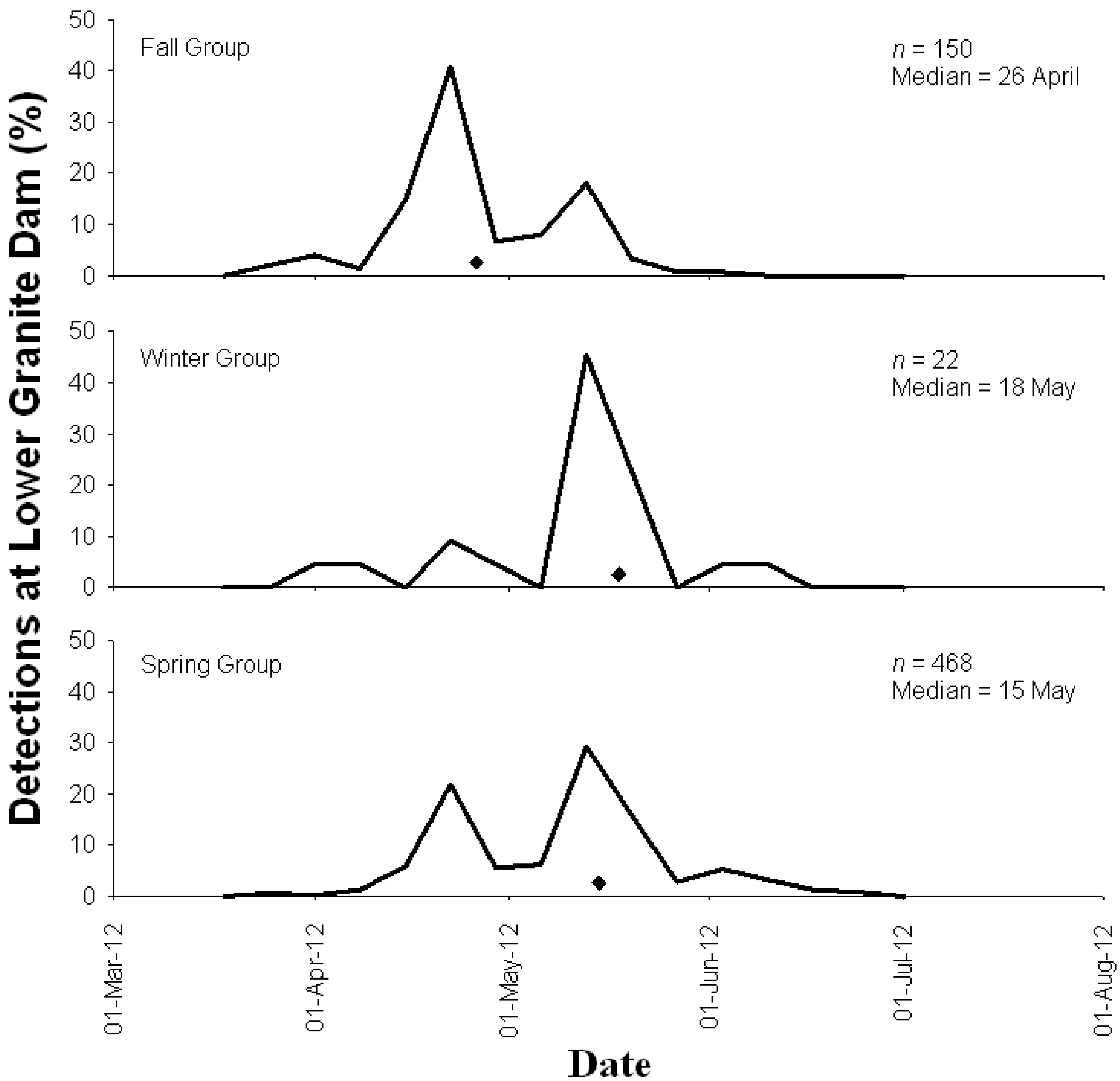
Appendix Figure B-3. Weekly mean fork lengths and associated standard error for spring Chinook salmon captured by rotary screw traps in Grande Ronde River Subbasin during MY 2012.



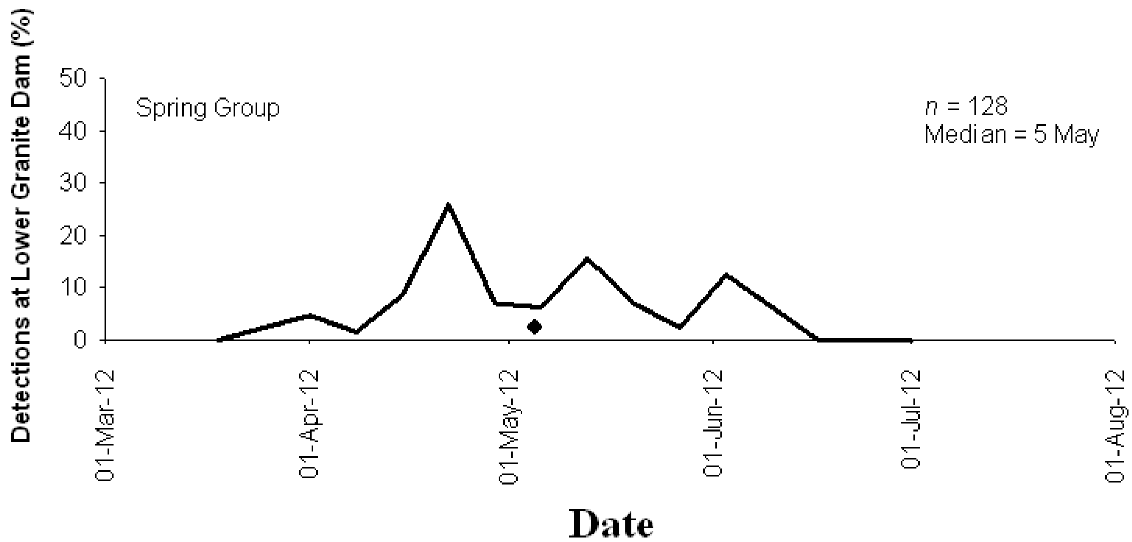
Appendix Figure B-4. Dates of arrival, during 2012 at Lower Granite Dam, of spring Chinook salmon PIT-tagged as parr in Catherine Creek and Imnaha, Lostine, Minam, and upper Grande Ronde rivers during summer 2011. Data was summarized by week and expressed as percentage of total detected. Detections were expanded for spillway flow. ♦ = median arrival date.



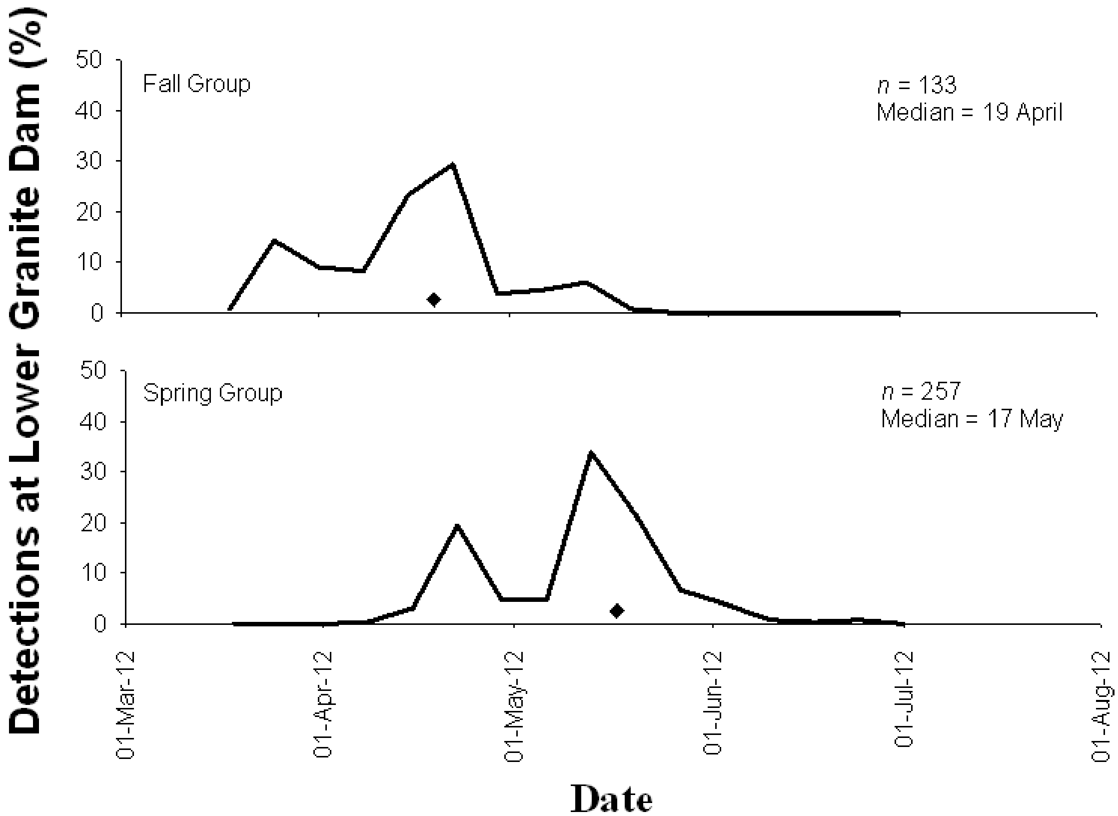
Appendix Figure B-5. Dates of arrival, during 2012 at Lower Granite dam, for fall, winter, and spring tag groups of juvenile spring Chinook salmon PIT-tagged from Catherine Creek. Data was summarized by week and expressed as percentage of total detected. Detections were expanded for spillway flow. ◆ = median arrival date.



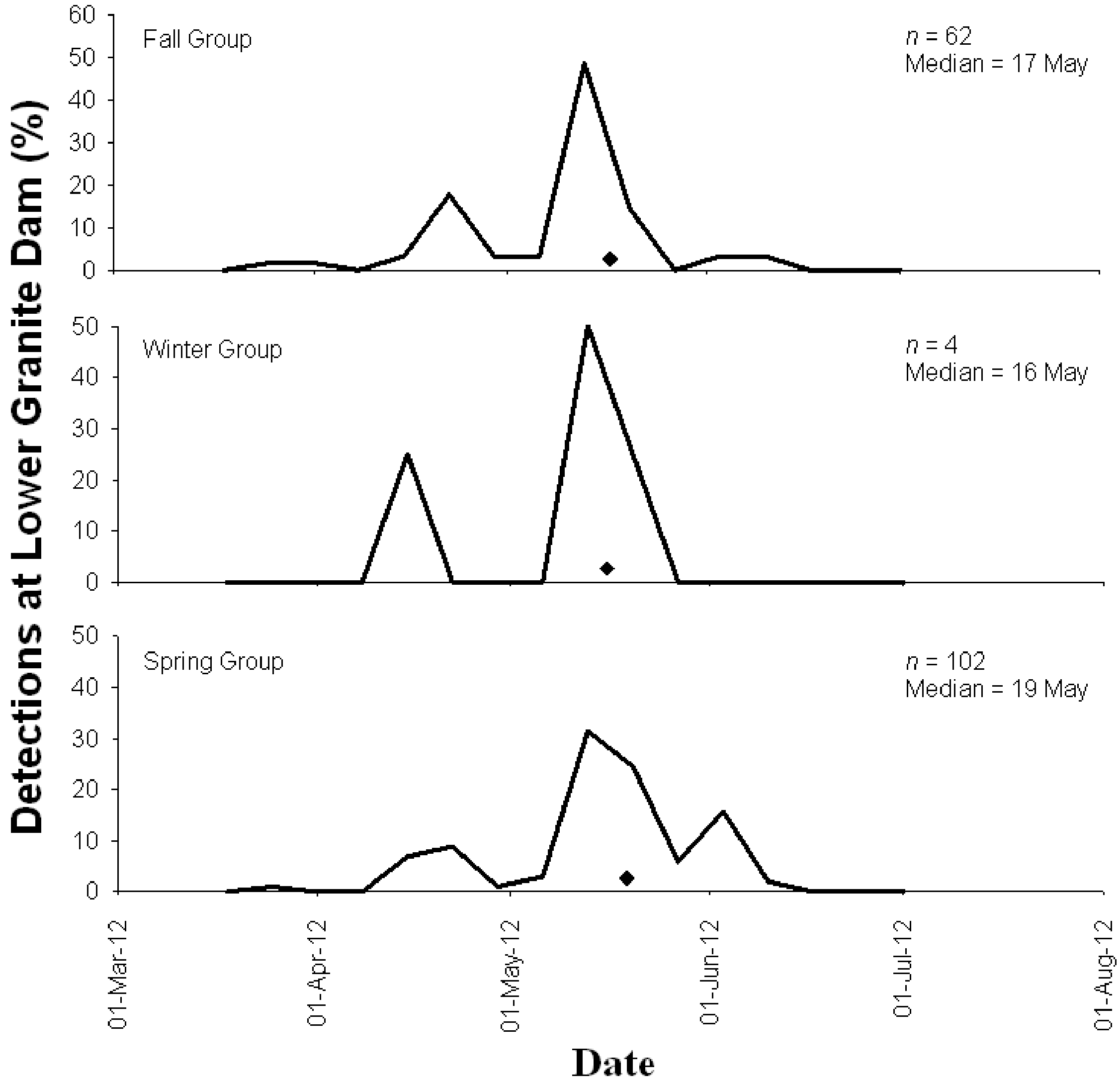
Appendix Figure B-6. Dates of arrival, during 2012 at Lower Granite dam, for fall, winter, and spring tag groups of juvenile spring Chinook salmon PIT-tagged from Lostine River. Data was summarized by week and expressed as percentage of total detected. Detections were expanded for spillway flow. ◆ = median arrival date.



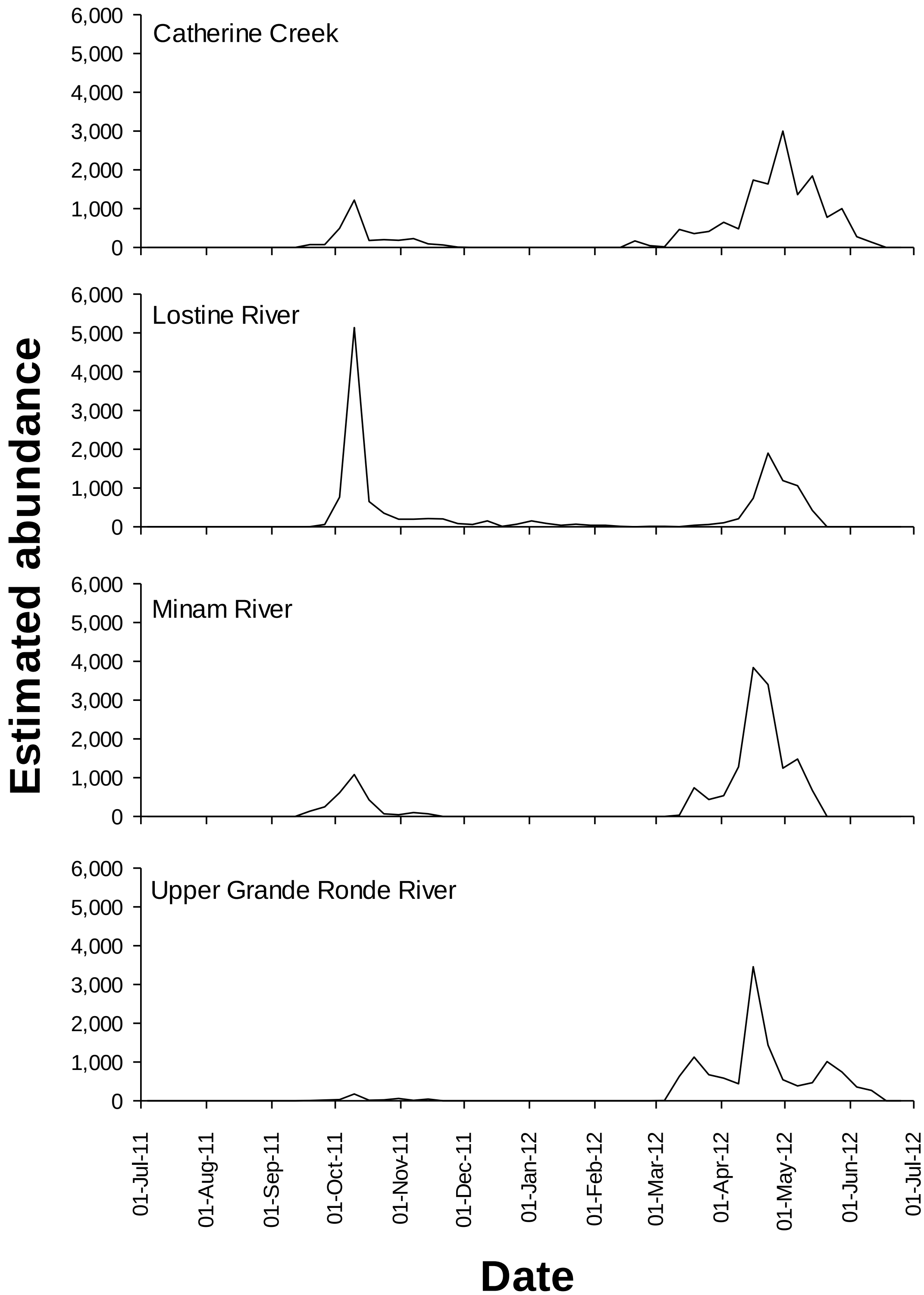
Appendix Figure B-7. Dates of arrival, during 2012 at Lower Granite dam, for the spring tag group of juvenile spring Chinook salmon PIT-tagged from middle Grande Ronde River. Data was summarized by week and expressed as percentage of total detected. Detections were expanded for spillway flow. ◆ = median arrival date.



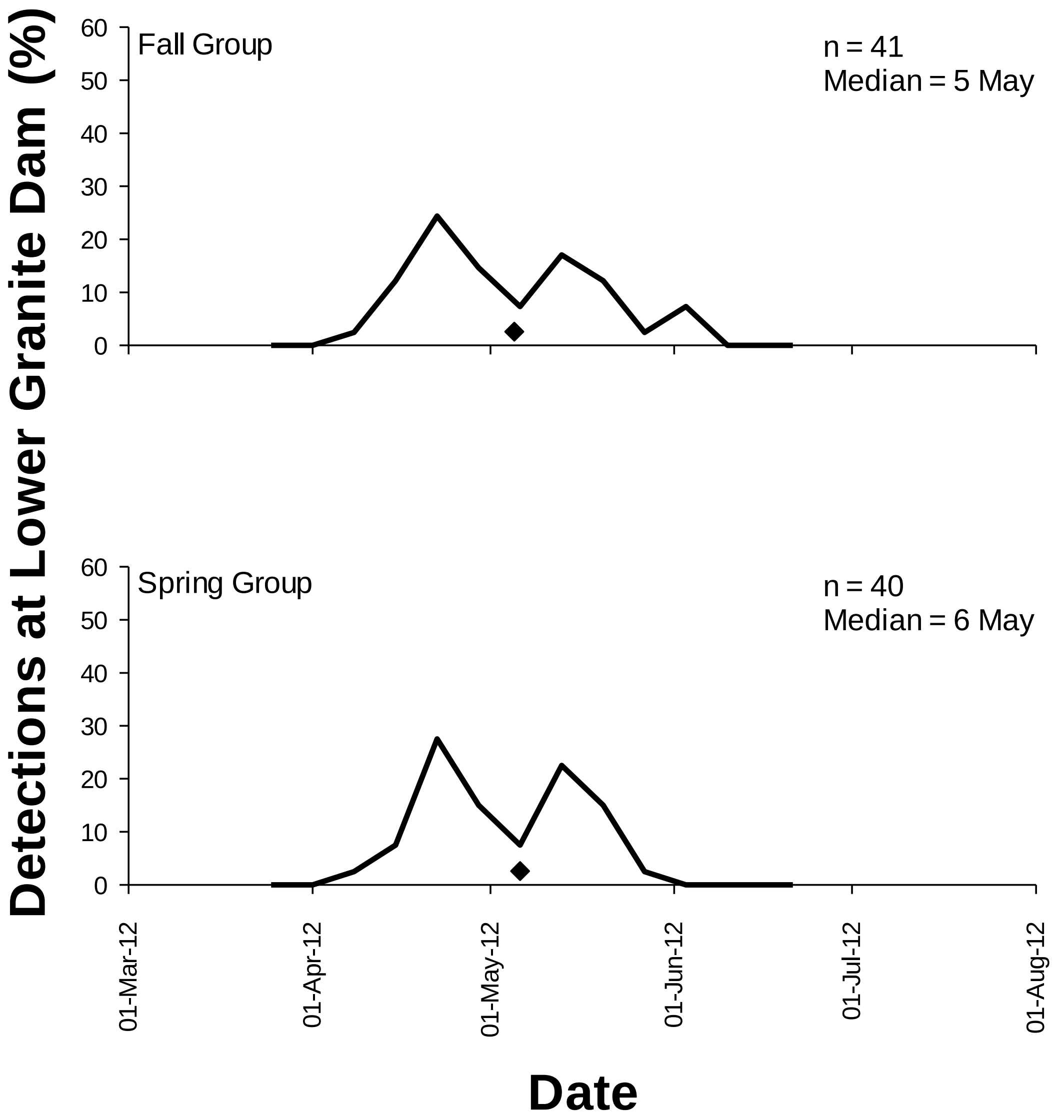
Appendix Figure B-8. Dates of arrival, during 2012 at Lower Granite dam, for fall and spring tag groups of juvenile spring Chinook salmon PIT-tagged from Minam River. Data was summarized by week and expressed as percentage of total detected. Detections were expanded for spillway flow. ◆ = median arrival date.



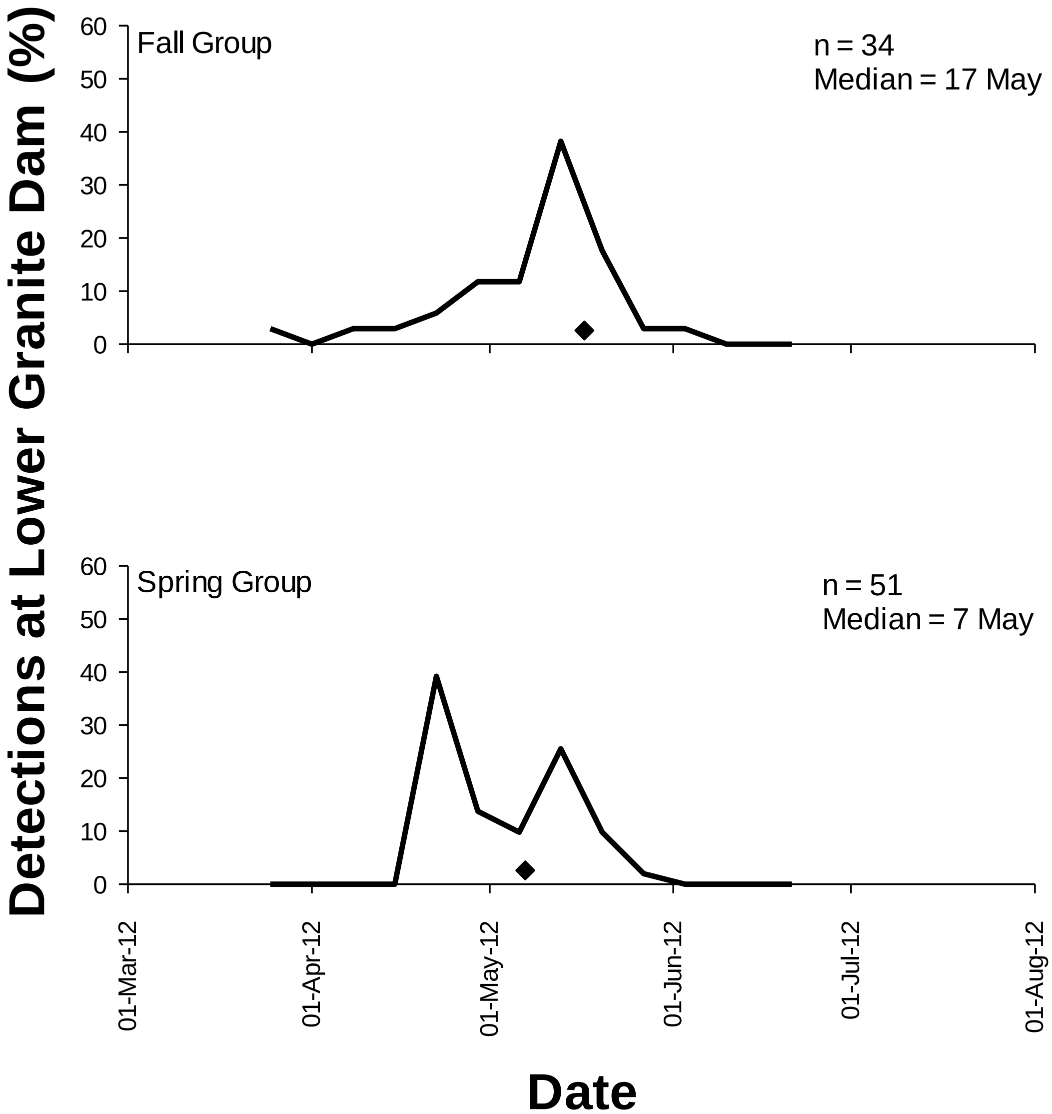
Appendix Figure B-9. Dates of arrival, during 2012 at Lower Granite dam, for fall, winter, and spring tag groups of juvenile spring Chinook salmon PIT-tagged from upper Grande Ronde River. Data was summarized by week and expressed as percentage of total detected. Detections were expanded for spillway flow. ♦ = median arrival date.



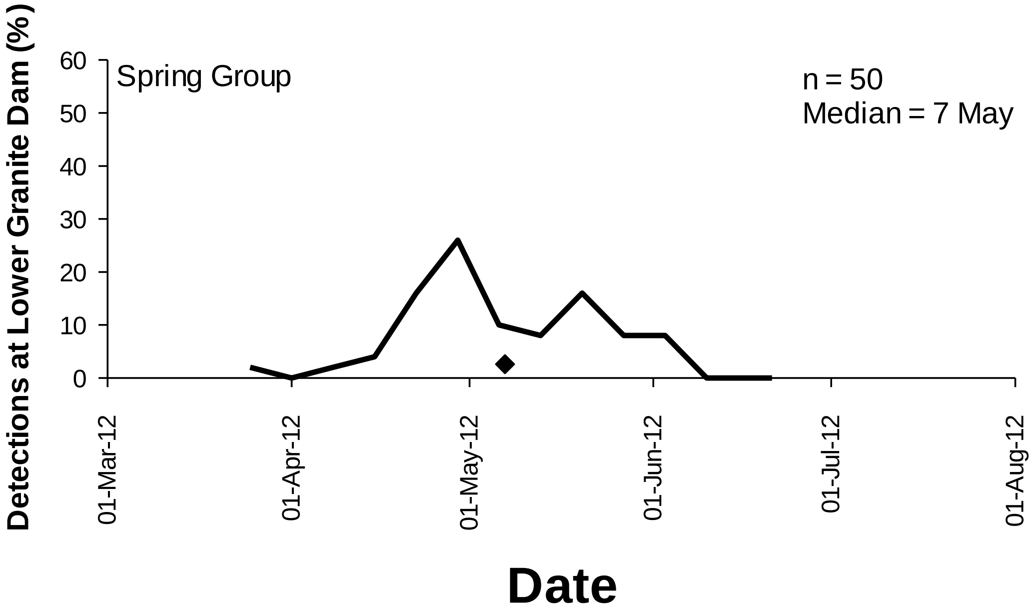
Appendix Figure B-10. Estimated migration timing and abundance of juvenile summer steelhead migrants captured by rotary screw trap during MY 2012. Traps were operated at rkm 32 on Catherine Creek, rkm 3 on Lostine River, rkm 0 on Minam River, and rkm 299 on upper Grande Ronde River.



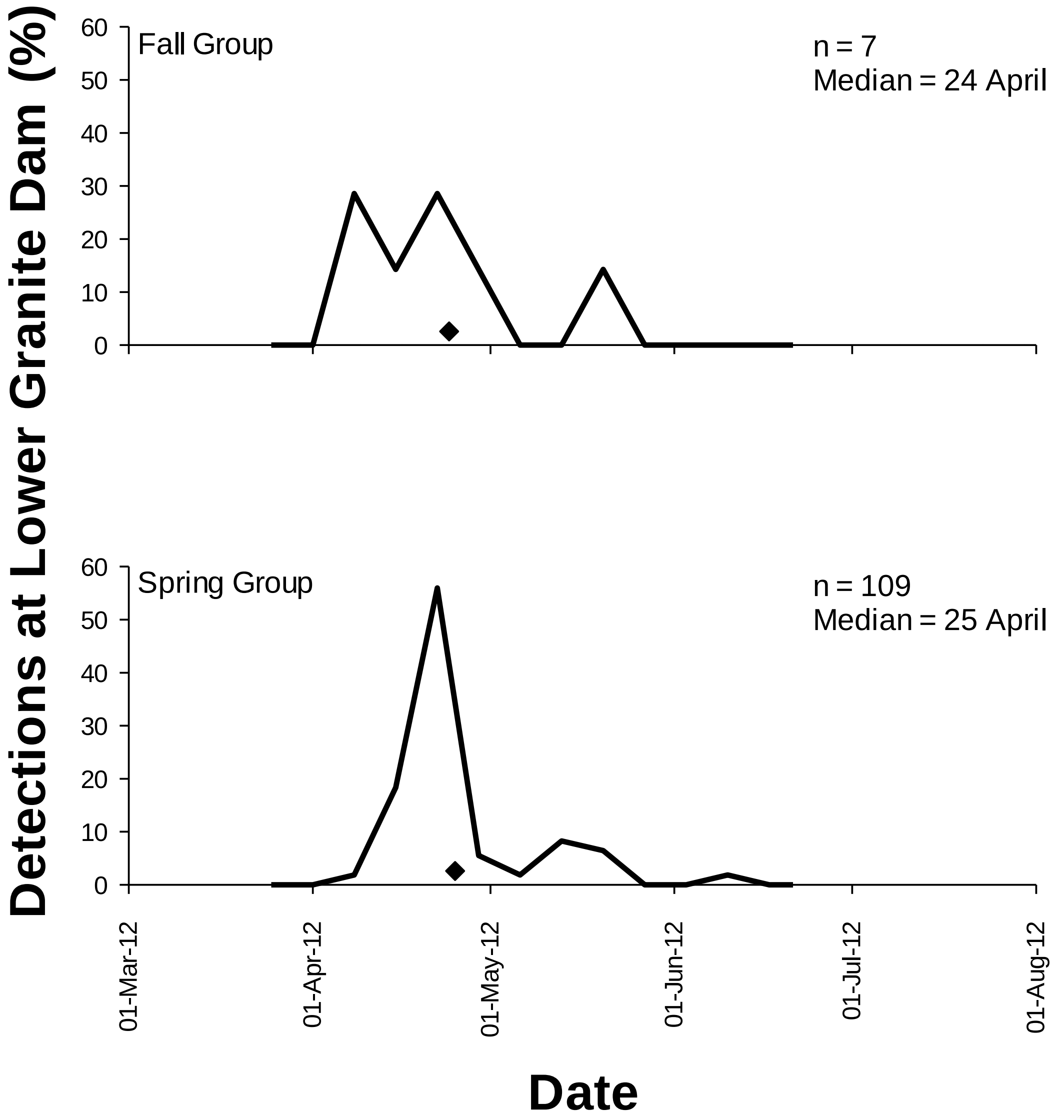
Appendix Figure B-11. Dates of arrival, in 2012, at Lower Granite Dam for fall and spring tag groups of steelhead PIT-tagged from Catherine Creek, and expressed as a percentage of total detected for each group. Detections were expanded for spillway flow. ♦ = median arrival date.



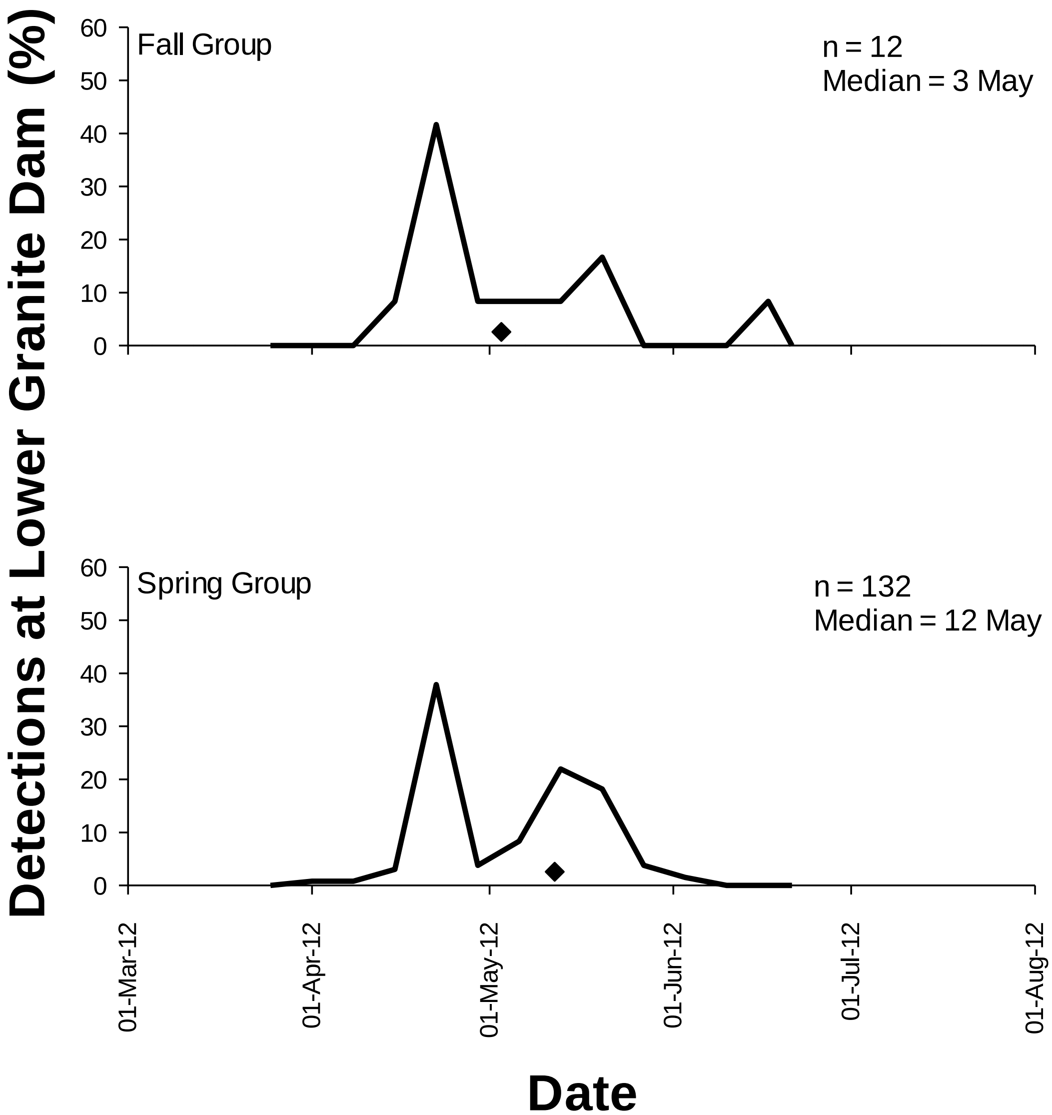
Appendix Figure B-12. Dates of arrival, in 2012, at Lower Granite Dam for fall and spring tag groups of steelhead PIT-tagged from Lostine River, and expressed as a percentage of total detected for each group. Detections were expanded for spillway flow. ♦ = median arrival date.



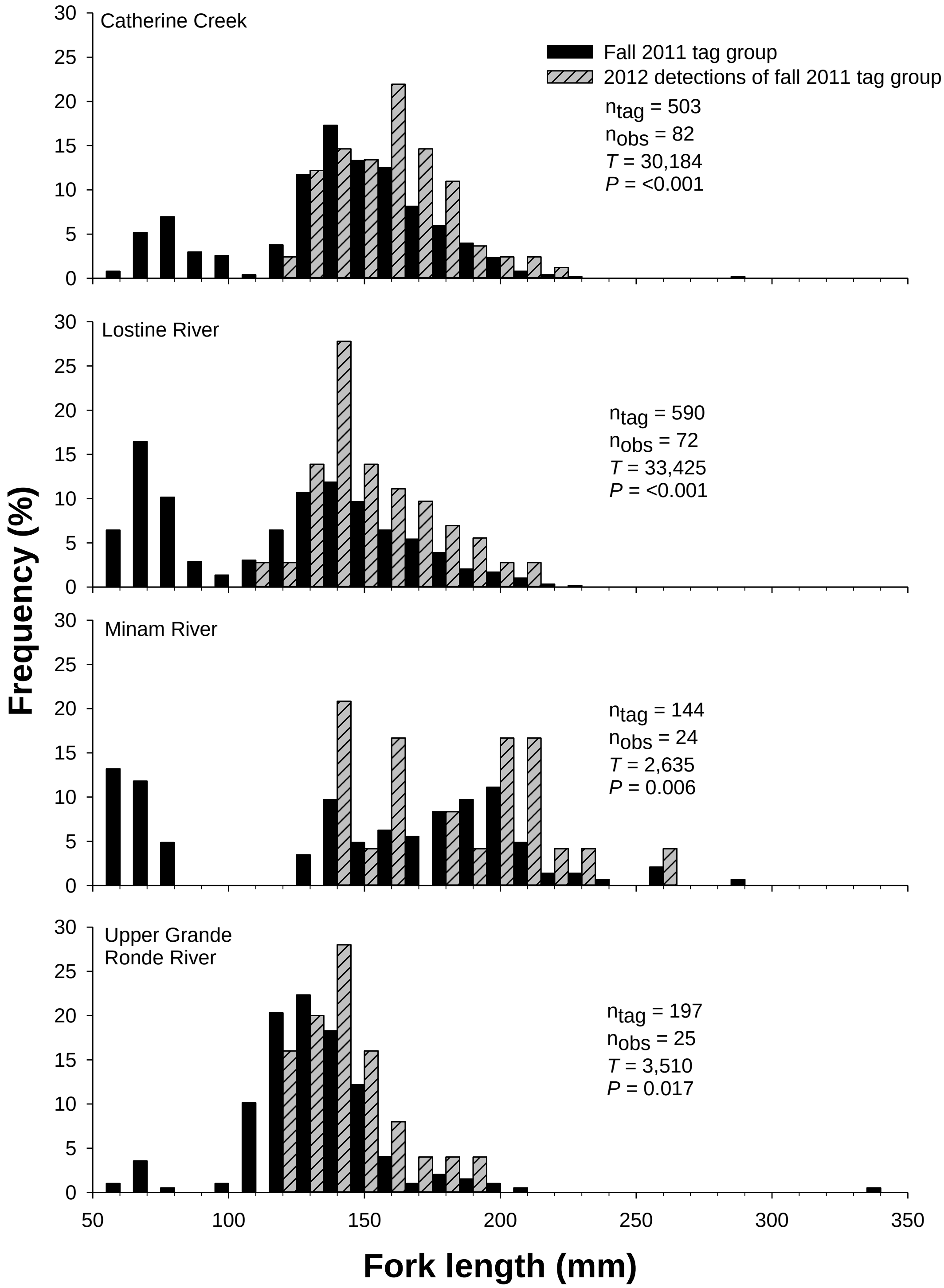
Appendix Figure B-13. Dates of arrival, in 2012, at Lower Granite Dam for fall and spring tag groups of steelhead PIT-tagged from middle Grande Ronde River, and expressed as a percentage of total detected for each group. Detections were expanded for spillway flow. ♦ = median arrival date.



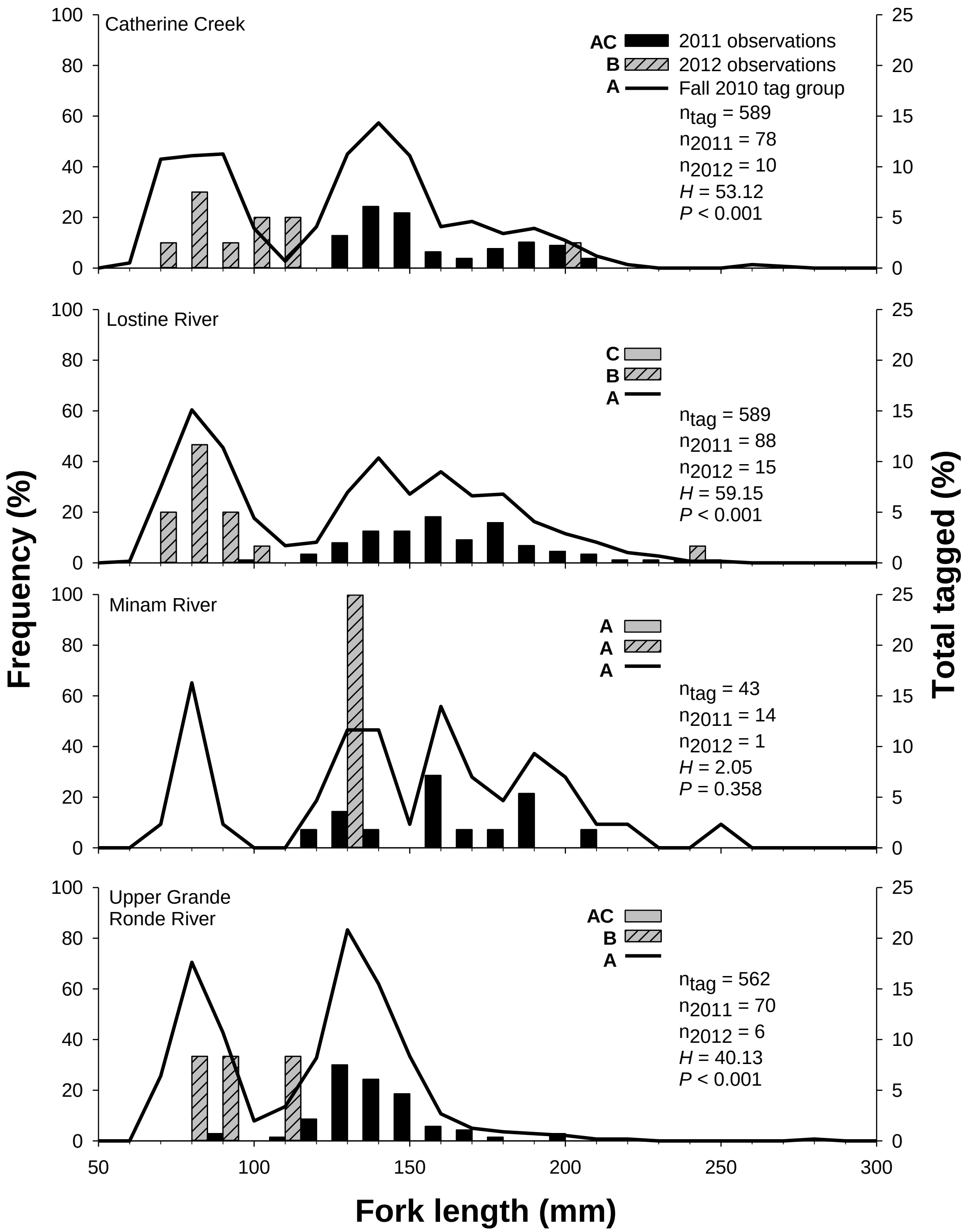
Appendix Figure B-14. Dates of arrival, in 2012, at Lower Granite Dam for fall and spring tag groups of steelhead PIT-tagged from Minam River, and expressed as a percentage of total detected for each group. Detections were expanded for spillway flow. ♦ = median arrival date.



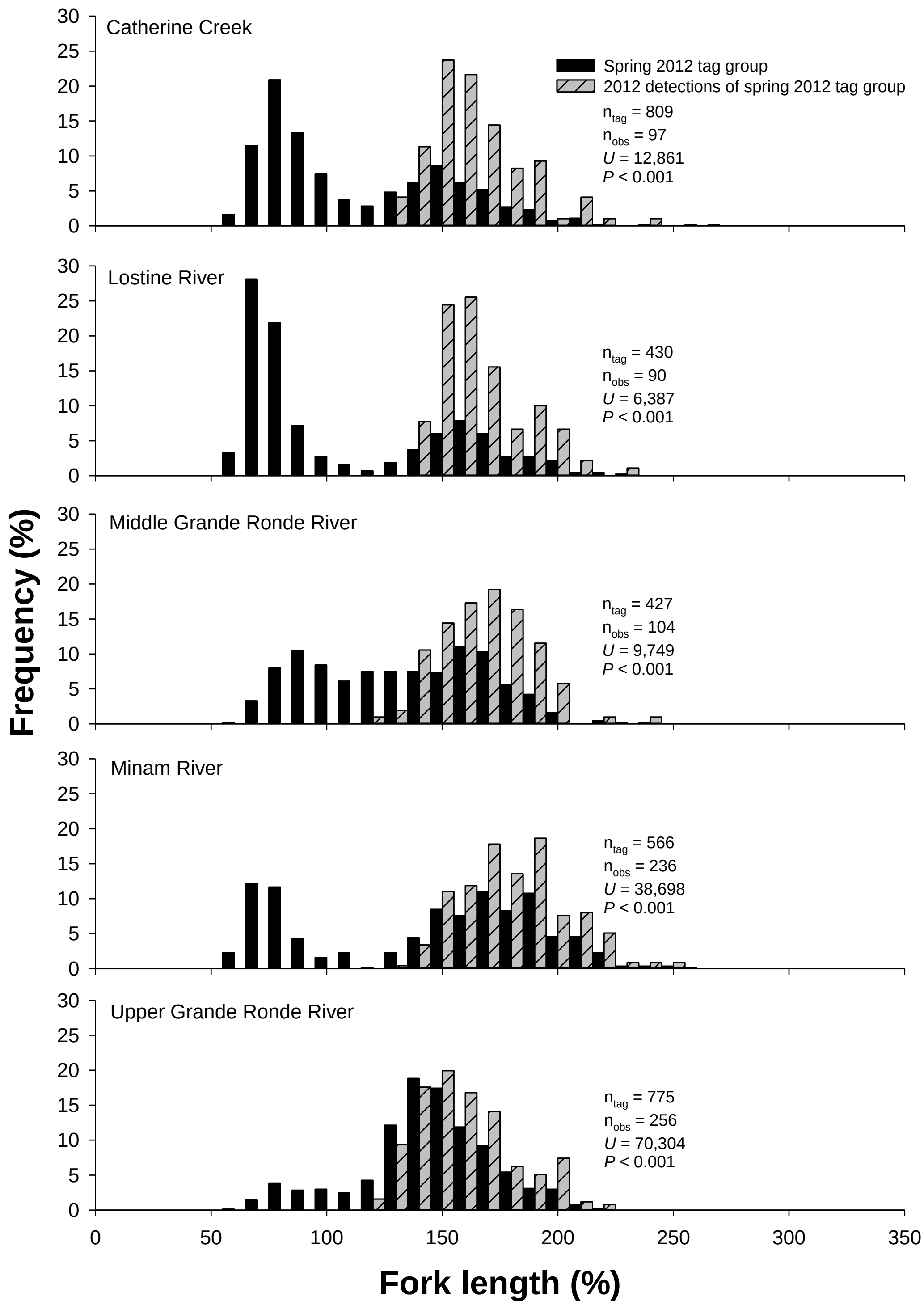
Appendix Figure B-15. Dates of arrival, in 2012, at Lower Granite Dam for fall and spring tag groups of steelhead PIT-tagged from upper Grande Ronde River, and expressed as a percentage of total detected for each group. Detections were expanded for spillway flow. ♦ = median arrival date.



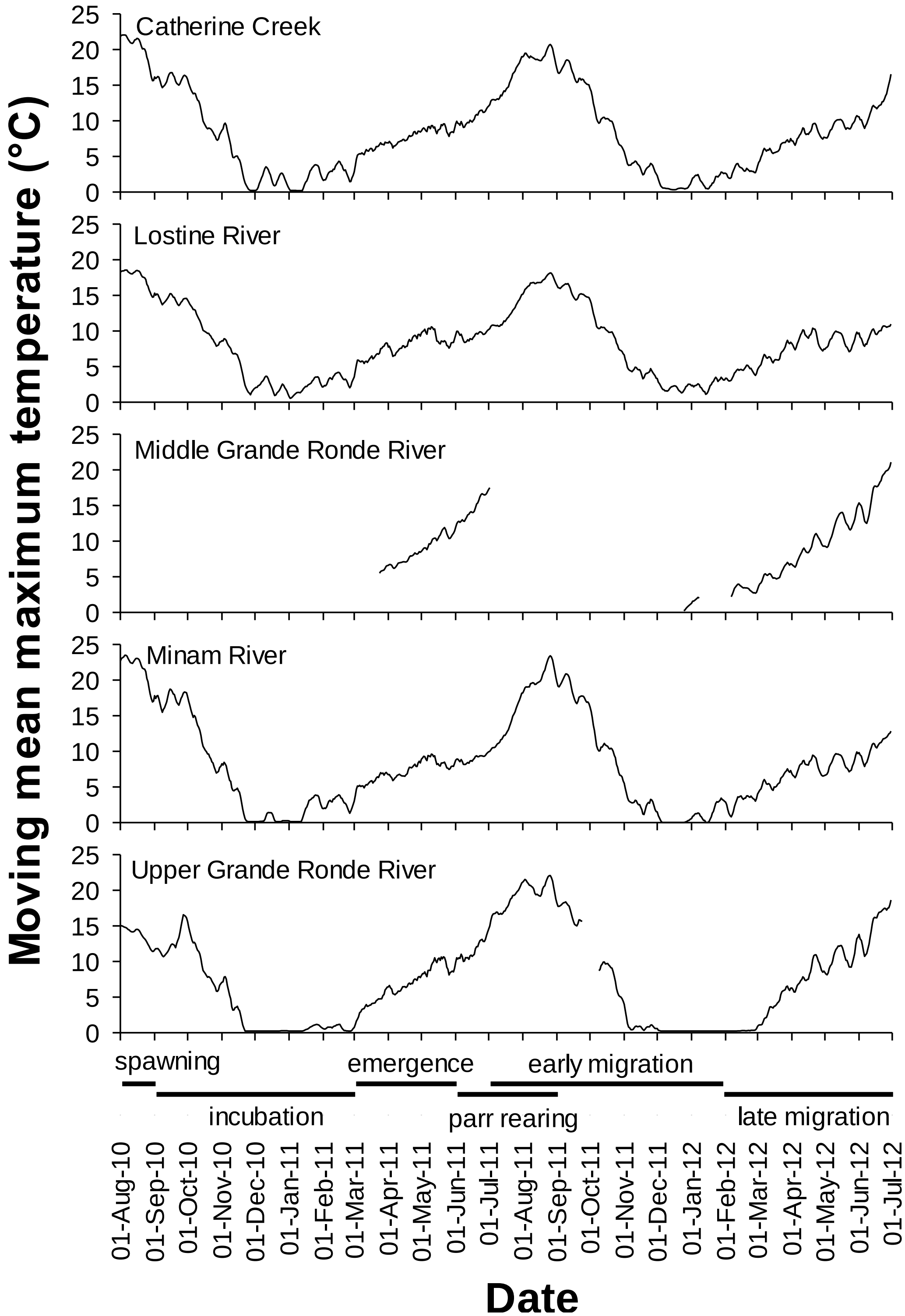
Appendix Figure B-16. Length frequency distributions for all steelhead PIT-tagged at screw traps during fall 2011 and those subsequently observed at Snake or Columbia river dams during spring 2012. Fork lengths are based on measurements taken at time of tagging. Frequency is expressed as percent of total number tagged (n_{tag}). 'n_{obs}' is number detected.



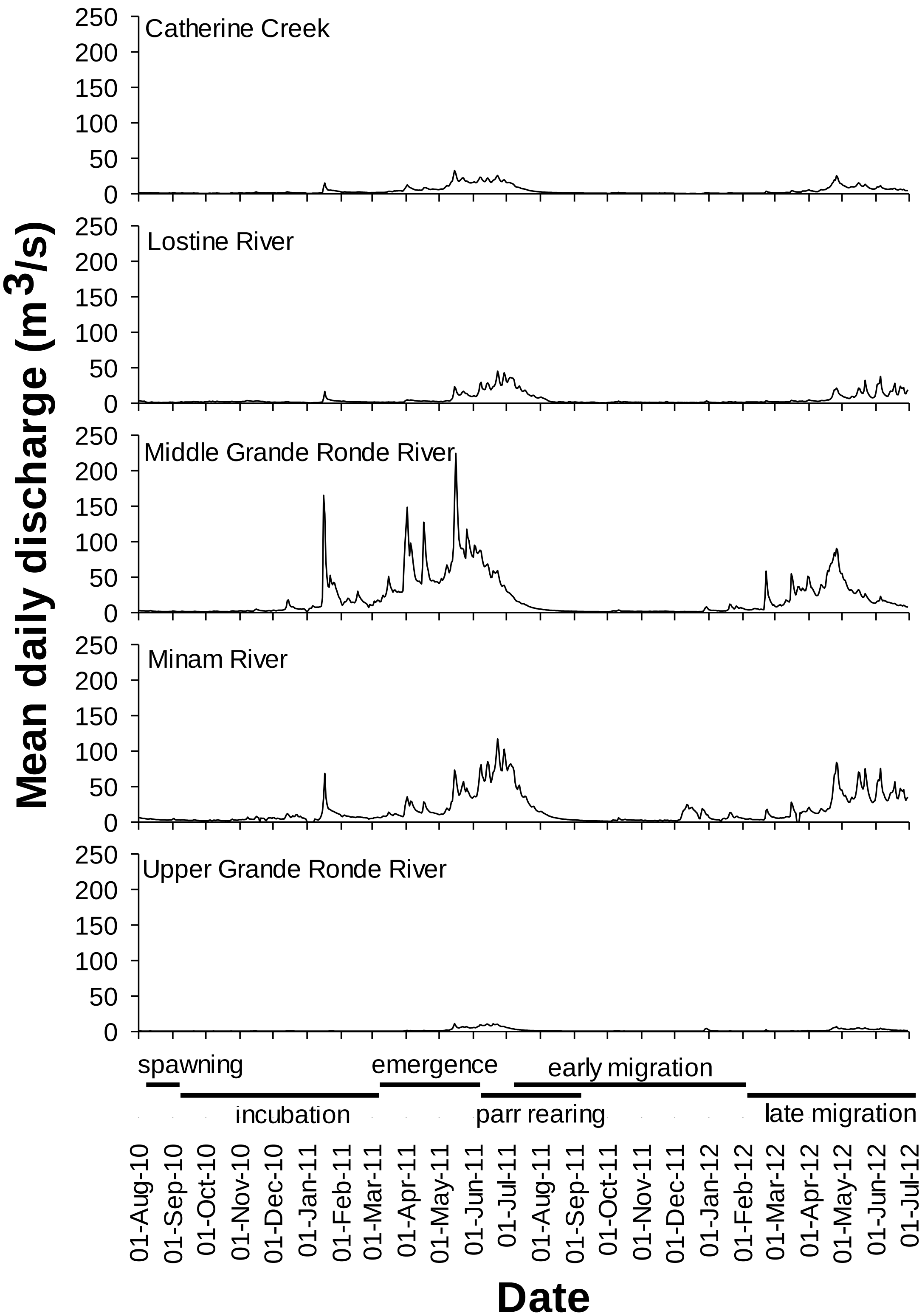
Appendix Figure B-17. Length frequency distributions for steelhead PIT-tagged at screw traps during fall 2010, and those subsequently observed at Snake or Columbia river dams during 2011 and 2012. Frequency is expressed as percent of total number tagged. 'H' is the test statistic for the Kruskal–Wallis 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 2012, and those subsequently observed at Snake or Columbia river dams during spring 2012. 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 2012. 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 2012. Data corresponds with juvenile spring Chinook salmon in-basin egg-to-emigrant life stages.

WE L: Steelhead Spawner Survey, and

WE M: Abundance of Steelhead Spawners at the Population Level

Appendix Table B-12. Steelhead spawning ground survey characteristics, location and stream classification for sites in the UGRR basin, 2012.

Site ID	Stream	Survey Frequency	Stream Classification	Survey Distance (km)	GRTS point		Downstream point of survey		Upstream point of survey	
					Latitude	Longitude	Latitude	Longitude	Latitude	Longitude
079752	Grande Ronde River	Annual	Depositional	1.94	45.1834	-118.3883	45.1793	-118.3894	45.1934	-118.3947
177134	East Phillips Creek	Annual	Source	1.97	45.6280	-118.0615	45.6345	-118.0557	45.6230	-118.0722
147928	Five Points Creek	Annual	Depositional	2.02	45.4047	-118.2171	45.4108	-118.2017	45.4032	-118.2229
120904	Burnt Corral Creek	Annual	Source	1.90	45.1807	-118.5073	45.1740	-118.5167	45.1804	-118.5071
118408	West Chicken Creek	Annual	Source	2.32	45.0318	-118.4058	45.0250	-118.4052	45.0445	-118.4039
059352	Clark Creek	Annual	Depositional	1.95	45.5155	-117.8297	45.5003	-117.8202	45.5157	-117.8297
018904	Spring Creek	Annual	Transport	2.07	45.3393	-118.2893	45.3472	-118.3075	45.3379	-118.2863
125832	Meadow Creek	Annual	Depositional	1.89	45.2637	-118.5514	45.2637	-118.5515	45.2714	-118.5331
101102	Phillips Creek	Annual	Depositional	1.95	45.5671	-117.9746	45.5697	-117.9935	45.5670	-117.9733
101560	Meadow Creek	Annual	Transport	1.86	45.2832	-118.6023	45.2922	-118.6120	45.2834	-118.6022
125256	Waucup Creek	Once	Transport	2.06	45.2547	-118.6487	45.2547	-118.6490	45.2702	-118.6435
119868	Beaver Creek	Once	Source	2.06	45.1702	-118.2175	45.1587	-118.2169	45.1737	-118.2202
010990	Little Phillips Creek	Once	Source	1.99	45.6297	-118.0173	45.6450	-118.0202	45.6278	-118.0155
094600	Fly Creek	Once	Source	1.83	45.1347	-118.5813	45.1280	-118.5906	45.1372	-118.5726
022844	Little Clear Creek	Once	source	2.16	45.0376	-118.3013	45.0372	-118.3011	45.0518	-118.3122
170478	Little Lookingglass Creek	Panel 2	Depositional	2.03	45.7635	-117.8836	45.7676	-117.8879	45.7544	-117.8780
149464	Middle Fork Clark Creek	Panel 2	Source	1.96	45.4976	-117.7913	45.4963	-117.7899	45.5089	-117.8061
111960	Pelican Creek	Panel 2	Transport	2.22	45.4090	-118.3091	45.4088	-118.3094	45.3951	-118.2937
130030	Clark Creek	Panel 2	Depositional	2.25	45.5435	-117.8733	45.5426	-117.8716	45.5498	-117.8910
006894	Dry Creek	Panel 2	Transport	2.29	45.5665	-118.0795	45.5776	-118.0935	45.5648	-118.0766
159368	Chicken Creek	Panel 2	Transport	1.92	45.0562	-118.3959	45.0471	-118.3924	45.0471	-118.3924
057838	Duncan Canyon Creek	Panel 2	Source	1.84	45.6964	-117.8087	45.6970	-117.8086	45.7088	-117.8232
065720	Spring Creek	Panel 2	Transport	2.03	45.3652	-118.3442	45.3659	-118.3459	45.3579	-118.3250
077704	Burnt Corral Creek	Panel 2	Source	2.11	45.2202	-118.4767	45.2060	-118.4916	45.2209	-118.4762
049208	Camp Creek	Panel 2	Source	1.99	45.3868	-117.7483	45.3904	-117.7377	45.3865	-117.7585
108270	Little Phillips Creek	Panel 2	Transport	2.00	45.5972	-118.0118	45.6107	-118.0163	45.5940	-118.0079
095642	McCoy Creek	Panel 2	Transport	2.02	45.3511	-118.5653	45.3517	-118.5674	45.3399	-118.5491
000001	North Fork Catherine Creek	Panel 2	Depositional	2.04	45.1221	-117.6432	45.1317	-117.6288	45.1197	-117.6476
000168	North Fork Catherine Creek	Panel 2	Depositional	1.99	45.1527	-117.6170	45.1675	-117.6056	45.1521	-117.6175
000205	Grande Ronde River	Panel 2	Depositional	2.04	45.3150	-118.2757	45.3118	-118.2771	45.3221	-118.2599

Appendix Table B-13. Steelhead spawning ground survey characteristics, location and stream classification for sites in the Joseph Creek basin, 2012.

				Survey	GRTS point		Downstream point of survey		Upstream point of survey	
Site ID	Stream	Survey Frequency	Stream Classification	Distance (km)	Latitude	Longitude	Latitude	Longitude	Latitude	Longitude
002175	Crow Creek	Annual	Transport	2.02	45.7033	-117.1550	45.7045	117.1527	45.6905	117.1500
040895	Davis Creek	Annual	Transport	2.07	45.7837	-117.2322	45.7841	117.2298	45.7717	117.2435
051026	Unnamed Creek	Annual	Source	1.61	45.6945	-117.0136	45.7043	117.0226	45.6908	117.0113
112130	Devils Run Creek	Annual	Source	2.02	45.7842	-116.9856	45.7808	116.9855	45.7823	116.9692
141826	Basin Creek	Annual	Source	1.50	45.9138	-117.0579	45.9327	117.0583	45.9190	117.0590
150018	Cottonwood Creek	Annual	Source	1.76	45.8842	-116.9856	45.8977	116.9963	45.8846	116.9856
167426	Chesnimnus Creek	Annual	Depositional	2.05	45.7536	-117.0031	45.7507	117.0191	45.7544	116.9984
169810	Chesnimnus Creek	Annual	Transport	2.03	45.6978	-116.9229	45.6976	116.9230	45.7114	116.9119
240130	Broady Creek	Annual	Source	1.83	45.9535	-117.0725	45.9586	117.0648	45.9480	117.0815
263762	Swamp Creek	Annual	Transport	2.04	45.5533	-117.2259	45.5656	117.2245	45.5516	117.2257
288594	Chesnimnus Creek	Annual	Depositional	2.10	45.6968	-117.1113	45.6974	117.1169	45.7030	117.1015
301570	Cottonwood Creek	Annual	Source	1.80	45.9375	-117.0616	45.9433	117.0599	45.9336	117.0524
351746	Joseph Creek	Annual	Depositional	2.04	45.7338	-117.1676	45.7419	117.1657	45.7327	117.1605
389055	Joseph Creek	Annual	Depositional	2.08	45.7800	-117.1784	45.7810	117.1805	45.7686	117.1757
389247	Chesnimnus Creek	Annual	Depositional	1.94	45.7053	-117.1373	45.7067	117.1380	45.6980	117.1204
411474	Salmon Creek	Annual	Transport	2.01	45.6893	-117.0526	45.7029	117.0492	45.6875	117.0538
493394	Salmon Creek	Annual	Transport	1.90	45.7092	-117.0513	45.7186	117.0502	45.7040	117.0496
515586	Chesnimnus Creek	Annual	Depositional	1.99	45.7331	-117.0400	45.7319	117.0509	45.7367	117.0332
012802	Cottonwood Creek	Panel 1	Source	1.92	45.9008	-117.0016	45.9118	117.0077	45.8978	116.9964
043522	Broady Creek	Panel 1	Source	1.70	45.9421	-117.1010	45.9480	117.0815	45.9431	117.0999
045183	Elk Creek	Panel 1	Transport	2.01	45.6875	-117.1887	45.6947	117.1855	45.6789	117.1922
089602	Joseph Creek	Panel 1	Depositional	2.01	45.7277	-117.1561	45.7315	117.1581	45.7185	117.1597
116562	Alder Creek	Panel 1	Transport	2.00	45.7034	-117.0258	45.7053	117.0508	45.7033	117.0260
128514	Chesnimnus Creek	Panel 1	Transport	1.95	45.7239	-116.9448	45.7276	116.9505	45.7159	116.9348
237503	Swamp Creek	Panel 1	Depositional	2.02	45.8108	-117.2291	45.8225	117.2319	45.8085	117.2293
258175	Chesnimnus Creek	Panel 1	Depositional	2.07	45.7095	-117.1446	45.7144	117.1556	45.7067	117.1380
318978	Chesnimnus Creek	Panel 1	Depositional	2.02	45.7276	-117.0624	45.7219	117.0653	45.7319	117.0509
394754	Devils Run Creek	Panel 1	Source	2.02	45.7721	-116.9144	45.7729	116.9325	45.7708	116.9119
487551	Crow Creek	Panel 1	Source	1.98	45.6786	-117.1414	45.6904	117.1500	45.6769	117.1397
509778	Pine Creek	Panel 1	Transport	1.95	45.6773	-117.0297	45.6898	117.0387	45.6774	117.0297

Appendix Table B-14. Completion dates and general results for surveys in the Upper Grande Ronde River watershed and Deer Creek,2012.

Site ID	Stream	No. of surveys completed	Mean no. of days between surveys	Redd count	1st Survey Date	2nd Survey Date	3rd Survey Date	4th Survey Date	5th Survey Date	6th Survey Date	7th Survey Date	8th Survey Date	9th Survey Date
079752	Grande Ronde River	5	25	0	3/13	3/29	4/9	5/30	6/19				
177134	East Phillips Creek	4	15	1	4/30	5/15	5/29	6/14					
147928	Five Points Creek	4	22	4	3/26	4/11	5/8	5/31					
120904	Burnt Corral Creek	5	15	0	4/9	4/24	5/9	5/22	6/6				
118408	West Chicken Creek	7	14	5	3/27	4/9	4/25	5/8	5/22	6/5	6/19		
059352	Clark Creek	7	16	2	3/12	4/2	4/16	5/2	5/14	5/31	6/18		
018904	Spring Creek - Hilgard	8	14	0	3/13	3/27	4/10	4/23	5/8	5/23	6/4	6/25	
125832	Meadow Creek	8	13	5	3/14	3/29	4/10	5/1	5/17	5/30	6/11	6/13	
101102	Phillips Creek	9	13	2	3/12	3/22	4/2	4/16	5/2	5/15	5/29	6/11	6/25
101560	Meadow Creek	6	13	4	4/9	4/19	5/1	5/15	5/30	6/12			
125256	Waucup Creek	5	14	1	4/19	5/1	5/16	5/30	6/12				
119868	Beaver Creek	3	13	4	5/18	5/29	6/13						
010990	Little Phillips Creek	8	14	0	3/12	3/30	4/11	4/30	5/16	5/29	6/8	6/20	
094600	Fly Creek	5	15	1	4/16	5/3	5/16	5/30	6/13				
022844	Little Clear Creek	4	14	0	4/25	5/7	5/22	6/6					
170478	Little Lookingglass Creek	6	18	1	3/20	4/10	5/7	5/29	6/8	6/20			
149464	Middle Fork Clark Creek	5	17	1	4/10	4/30	5/14	5/31	6/18				
111960	Pelican Creek	5	15	3	4/16	5/1	5/17	5/30	6/13				
130030	Clark Creek	5	17	1	4/10	5/2	5/14	5/31	6/18				
006894	Dry Creek	8	13	5	3/22	4/2	4/6	4/25	5/7	5/23	6/4	6/20	
159368	Chicken Creek	8	13	4	3/19	4/2	4/12	4/24	5/7	5/22	6/5	6/19	
057838	Duncan Canyon Creek	5	22	1	3/12	4/11	4/30	5/16	6/7				
065720	Spring Creek	8	15	7	3/15	3/28	4/10	4/23	5/8	5/23	6/4	6/25	
077704	Burnt Corral Creek	7	14	10	3/14	3/27	4/10	4/24	5/9	5/22	6/6		
049208	Camp Creek	3	24	0	5/10	6/14	6/27						
108270	Little Phillips Creek	7	14	0	3/30	4/11	4/30	5/15	5/29	6/8	6/20		
095642	McCoy Creek	5	14	7	4/16	5/1	5/15	5/30	6/12				
000001	North Fork Catherine Creek	5	25	1	3/14	3/29	4/18	5/29	6/20				
000168	North Fork Catherine Creek	3	38	0	4/5	4/18	6/20						
000205	Grande Ronde River	2	27	0	5/23	6/19							
N/A	Deer Creek	6	16	22	3/21	4/3	4/17	5/2	5/21	6/11			

Appendix Table B-15. Completion dates and general results for surveys in the Joseph Creek watershed, 2012.

Site ID	Stream	No. of surveys completed	Mean no. of days between surveys	Redd count	1st Survey Date	2nd Survey Date	3rd Survey Date	4th Survey Date	5th Survey Date
002175	Crow Creek	5	22	0	3/15	4/5	4/19	5/8	6/11
040895	Davis Creek	2	34	3	4/12	5/16			
051026	Unnamed Creek	4	19	1	4/10	4/24	5/15	6/5	
112130	Devils Run Creek	4	19	3	4/9	4/23	5/14	6/4	
141826	Basin Creek	5	20	0	3/12	4/3	4/16	5/7	5/30
150018	Cottonwood Creek	4	25	2	3/14	4/18	5/8	5/29	
167426	Chesnimnus Creek	5	19	5	3/20	4/9	4/26	5/21	6/4
169810	Chesnimnus Creek	5	18	1	3/27	4/11	4/23	5/14	6/5
240130	Broady Creek	3	22	0	4/17	5/9	5/31		
263762	Swamp Creek*	1	0	0	5/23				
288594	Chesnimnus Creek	3	20	0	5/3	5/21	6/11		
301570	Cottonwood Creek	5	20	1	3/12	4/3	4/17	5/9	5/30
351746	Joseph Creek	2	15	3	5/22	6/6			
389055	Joseph Creek	2	15	2	5/22	6/6			
389247	Chesnimnus Creek	3	14	7	5/10	5/21	6/7		
411474	Salmon Creek	4	19	0	4/10	4/24	5/15	6/5	
493394	Salmon Creek	4	21	2	4/5	4/24	5/15	6/6	
515586	Chesnimnus Creek	5	19	5	3/19	4/9	5/1	5/15	6/4
012802	Cottonwood Creek	4	25	1	3/14	4/18	5/8	5/29	
043522	Broady Creek	4	26	0	3/13	4/17	5/9	5/31	
045183	Elk Creek	5	19	4	3/19	4/4	4/25	5/17	6/4
089602	Joseph Creek	2	15	0	5/22	6/6			
116562	Alder Creek	4	21	5	4/5	4/24	5/15	6/6	
128514	Chesnimnus Creek	4	18	1	4/11	4/23	5/14	6/5	
237503	Swamp Creek	2	42	7	5/16	6/27			
258175	Chesnimnus Creek	3	14	2	5/10	5/21	6/7		
318978	Chesnimnus Creek	5	19	2	3/19	4/9	5/1	5/15	6/4
394754	Devils Run Creek	3	24	5	4/25	5/14	6/11		
487551	Crow Creek	5	22	4	3/15	4/5	4/19	5/8	6/11
509778	Pine Creek	4	19	1	4/10	4/24	5/15	6/5	

*determined to be unsuitable spawning habitat, more marsh/wetland than stream, removed from sample frame for future years

Appendix Table B-16. Locations, dates, and characteristics of live steelhead observations the UGRR watershed, 2012.

Site ID	Stream	Date observed	Fin clip	Origin	Near redd
077704	Burnt Corral Creek	4/10/2012	NA	Unknown	No
059352	Clark Creek	4/2/2012	NA	Unknown	NA
059352	Clark Creek	4/2/2012	NA	Unknown	NA
101560	Meadow Creek	4/9/2012	NA	Unknown	Yes
101560	Meadow Creek	4/9/2012	NA	Unknown	Yes
147928	Five Points Creek	5/8/2012	NA	Unknown	No
065720	Spring Creek	5/8/2012	AD	Hatchery	No
118408	West Chicken Creek	5/7/2012	None	Wild	Yes
118408	West Chicken Creek	5/7/2012	NA	Unknown	No
118408	West Chicken Creek	5/7/2012	None	Wild	No
077704	Burnt Corral Creek	5/9/2012	None	Wild	No
170478	Little Lookingglass Creek	5/7/2012	None	Wild	Yes
170478	Little Lookingglass Creek	5/7/2012	None	Wild	Yes
118408	West Chicken Creek	5/22/2012	None	Wild	No
118408	West Chicken Creek	5/22/2012	AD	Hatchery	No
077704	Burnt Corral Creek	5/22/2012	NA	Unknown	No
077704	Burnt Corral Creek	5/22/2012	NA	Unknown	No
077704	Burnt Corral Creek	5/22/2012	NA	Unknown	No
101560	Meadow Creek	5/30/2012	None	Wild	No
101560	Meadow Creek	5/30/2012	NA	Unknown	No
101560	Meadow Creek	5/30/2012	NA	Unknown	No

Appendix Table B-17. Locations, dates, and characteristics of live steelhead observations the Joseph Creek watershed, 2012.

Site ID	Stream	Date observed	Fin clip	Origin	Near redd
045183	Elk Creek	3/19/2012	None	Wild	No
045183	Elk Creek	4/4/2012	NA	Unknown	No
045183	Elk Creek	4/4/2012	NA	Unknown	No
167426	Chesnimnus Creek	4/9/2012	NA	Unknown	No
167426	Chesnimnus Creek	4/9/2012	NA	Unknown	No
167426	Chesnimnus Creek	4/9/2012	NA	Unknown	No
318978	Chesnimnus Creek	5/1/2012	NA	Unknown	No
318978	Chesnimnus Creek	5/1/2012	NA	Wild	No
112130	Devils Run Creek	5/14/2012	None	Wild	No
112130	Devils Run Creek	5/14/2012	None	Wild	No
112130	Devils Run Creek	5/14/2012	NA	Unknown	No
318978	Chesnimnus Creek	5/15/2012	NA	Unknown	No
515586	Chesnimnus Creek	5/1/2012	NA	Unknown	Yes

Appendix Table B-18. Locations, dates, and characteristics of dead steelhead observations the Joseph Creek watershed, 2012.

Site ID	Stream	Date observed	Sex	Fork length	Fin Clip	Origin
389247	Chesnimnus Creek	5/10/2012	Male	620	None	Wild
112130	Devils Run Creek	5/14/2012	Male	560	None	Wild
389247	Chesnimnus Creek	5/21/2012	Male	700	None	Wild
351746	Joseph Creek	5/22/2012	Male	730	None	Wild
389055	Joseph Creek	5/22/2012	Male	500	None	Wild

Appendix Table B-19. Annual results of steelhead spawning ground surveys, 2008−2012. Available spawning habitat was refined yearly based on previous surveys.

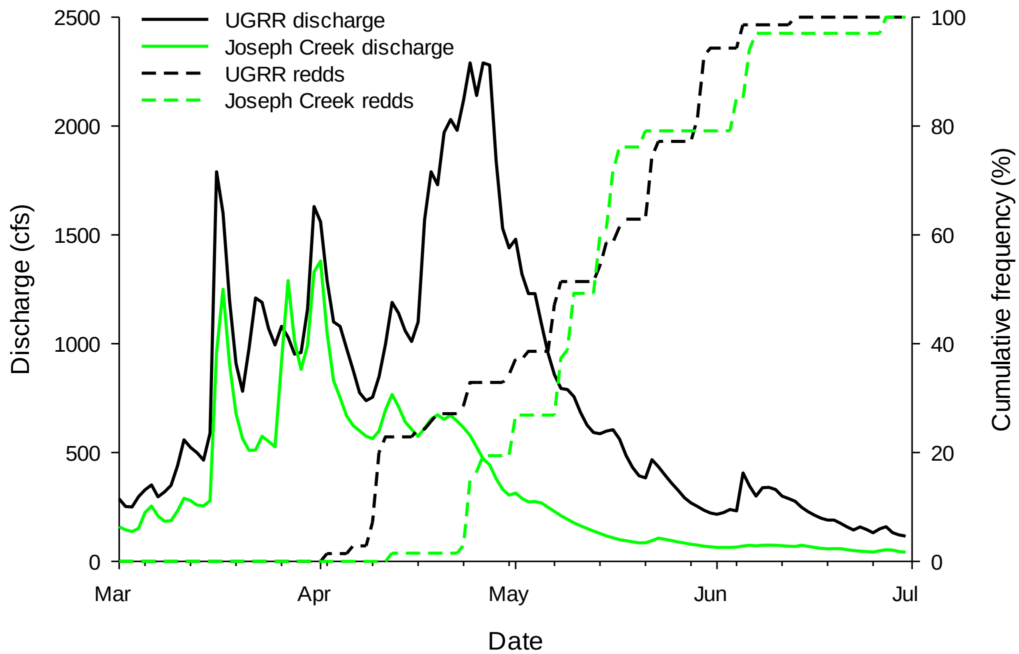
Year	No. of sites	Spawning habitat (km)	Weight value	Redds observed	Distance surveyed (km)	Fish/redd ratio	Spawner escapement	SE	95% CI	CI as % of escapement
UGRR basin										
2008	29	1301	44.9	24	64.2	4.07	2096	583	±1142	54.5%
2009	30	1178	39.3	42	59.9	3.81	3148	534	±1047	33.2%
2010	29	934	32.2	109	56.4	1.60	2876	457	±897	31.2%
2011	28	929	33.2	44	59.5	4.75	3275	524	±1028	31.4%
2012	30	897	29.9	70	60.7	3.14	3261	549	±1077	33.0%
Joseph Creek basin										
2012	30	384	12.8	67	58.4	3.14	1357	193	±380	28.0%

Appendix Table B-20. Survey characteristics and results, grouped by stream classification type for UGRR basin, 2012.

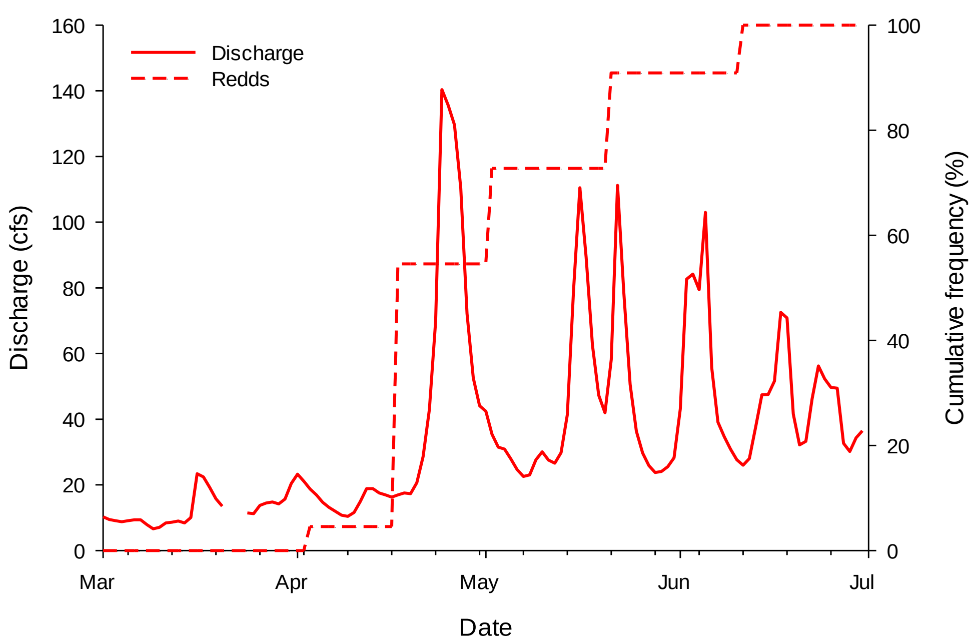
Stream Classification	No. of sites	Spawning habitat (km)	Weight value	Distance surveyed (km)	Total redds observed	Spawner escapement	Standard error	Lower 95%CI	Upper 95% CI
Source	11	452.3	41.1	22.1	23	1413	514	406	2419
Transport	9	245.8	27.3	18.5	31	1346	312	735	1956
Depositional	10	198.6	19.9	20.1	16	505	155	202	809
Total	**30**	**896.7**	**29.9**	**60.7**	**70**	**3264**	**641**	**2008**	**4520**

Appendix Table B-21. Survey characteristics and results, grouped by stream classification type for Joseph Creek basin, 2012.

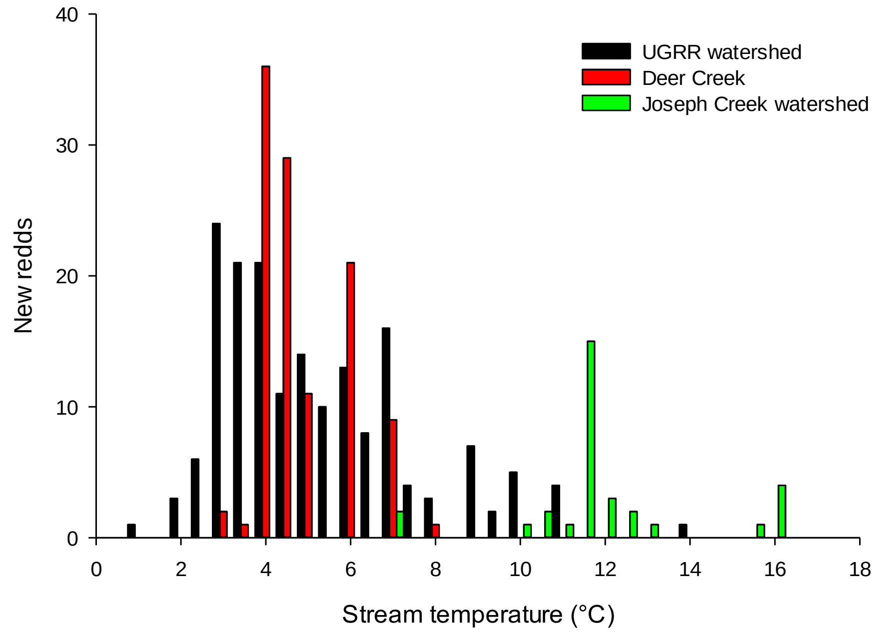
Stream Classification	No. of sites	Spawning habitat (km)	Weight value	Distance surveyed (km)	Total redds observed	Spawner escapement	Standard error	Lower 95%CI	Upper 95% CI
Source	10	159.0	15.9	18.1	17	440	84	275	606
Transport	10	114.7	11.5	20.0	17	306	93	125	488
Depositional	10	110.5	11.1	20.3	33	569	133	308	831
Total	**30**	**384.2**	**12.8**	**58.4**	**67**	**1316**	**183**	**957**	**1675**



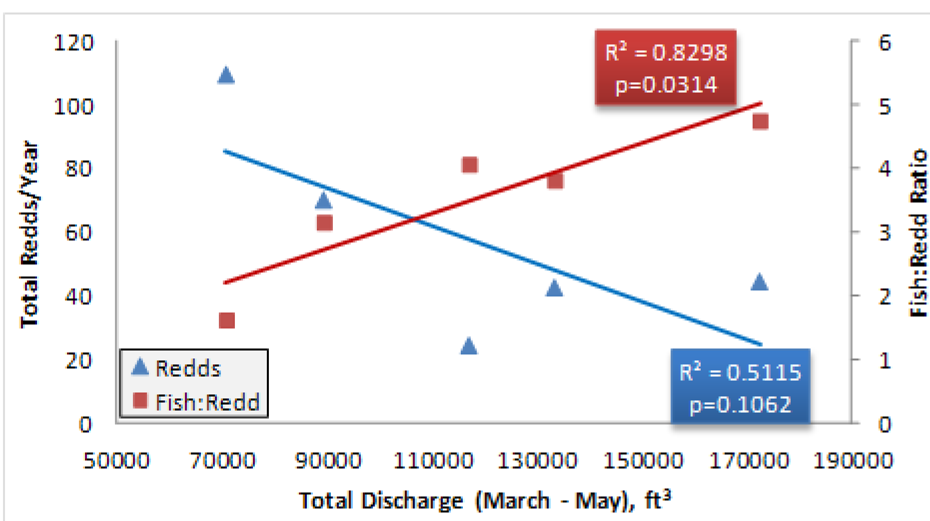
Appendix Figure B-21. Cumulative frequency of observed redds and mean daily discharge during the spawning period for the UGRR (USGS station #13318960) and Joseph Creek (WA DOE station ID 35G060) watersheds in 2012.



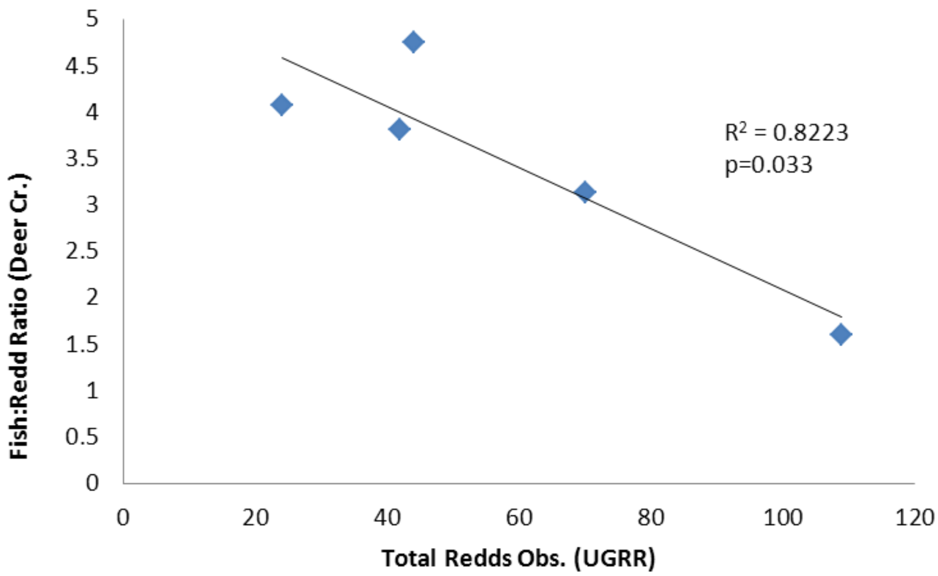
Appendix Figure B-22. Cumulative frequency of observed redds and mean daily discharge during the spawning period for Deer Creek in 2012.



Appendix Figure B-23. Morning stream temperatures (before 12:00pm) at sites where new redds were observed on surveys of the UGRR and Deer Creek during 2008–2012 and Joseph Creek during 2012. Morning temperatures were significantly higher in Joseph Creek than Deer Creek or UGRR (Chi-square= 351.713, 28 d.f., P <0.001).



Appendix Figure B-24. Relationships between total number of redds observed and cumulative stream discharge, and fish:redd ratio and discharge, UGRR 2008 - 2012. Discharge measured at UGRR Perry Station.



Appendix Figure B-25. Relationship between the fish:redd ratio calculated on Deer Creek, and total redd observations from the UGGR basin, 2008 - 2012.

***WE N: Steelhead and Chinook Salmon Parr Surveys,* and**
WE O: Steelhead and Chinook Salmon Parr Density and Distribution

Appendix Table B-22. Basic descriptors and location of CHaMP survey sites sampled via snorkeling.

Site ID	Waterbody	Easting	Northing	Mean BF Width(m)	Site Lgth(m)	Primary Bedform
CBW05583-013226	S.F. Catherine Creek	455944	4995015	7.8	160	Step-Pool
CBW05583-015162	McCoy Creek	389449	5013223	6.7	160	Pool-Riffle
CBW05583-073130	S.F. Catherine Creek	451379	4994478	8.1	200	Confined
CBW05583-086186	Catherine Creek	428497	5007558	13	280	Meandering
CBW05583-086954	S.F. Catherine Creek	452316	4994323	6.8	160	Step-Pool
CBW05583-095642	McCoy Creek	377422	5023173	6.5	160	Plane-Bed
CBW05583-109994	M.F.Catherine Creek	454280	4999914	7.6	160	Step-Pool
CBW05583-135615	Gordon Creek	424809	5052330	5	120	Pool-Riffle
orw03446-137980	Catherine Creek	440173	5000121	13.9	280	Confined
CBW05583-142490	Clark Creek	435914	5039014	7	160	Pool-Riffle
CBW05583-228666	Sheep Creek	384626	4988277	5.1	125	Pool-Riffle
CBW05583-240730	Rock Creek	403953	5021634	5.7	120	Plane-Bed
CBW05583-252730	Meadow Creek	389327	5012258	19.4	400	Pool-Riffle
CBW05583-285498	Meadow Creek	387315	5010320	15.9	320	Straight
CBW05583-335162	Sheep Creek	385074	4989862	5.4	122	Pool-Riffle
CBW05583-340138	Catherine Creek	434390	5004795	15.7	320	Straight
CBW05583-381866	S.F. Catherine Creek	455062	4994512	8.2	200	Confined
CBW05583-382778	Burnt Corral Creek	382842	5006893	4.6	120	Pool-Riffle
CBW05583-405674	Catherine Creek	434106	5005126	13.7	323	Straight
CBW05583-417962	Catherine Creek	443766	4998234	12.6	280	Meandering
CBW05583-421786	Rock Creek	406958	5017231	9.2	200	Straight
CBW05583-453946	Sheep Creek	384473	4987677	6.2	160	Pool-Riffle
CBW05583-486202	Grande Ronde River	390938	5004341	16.7	360	Confined
CBW05583-487322	Rock Creek	407509	5016358	7.9	160	Pool-Riffle
CBW05583-498490	Meadow Creek	386108	5010459	9.9	200	Straight
CBW05583-506682	Fly Creek	390059	5006744	9.4	200	Straight
CBW05583-514874	Meadow Creek	388872	5011817	14.6	320	Meandering
CBW05583-527786	Catherine Creek	446029	4996234	13.5	280	Pool-Riffle
CBW05583-531882	N.F. Catherine Creek	450859	4998261	11.7	240	Confined
dsgn4-000001	N.F. Catherine Creek	449371	4996716	11	240	Plane-Bed
dsgn4-000006	West Chicken Creek	389584	4990351	6	120	Meandering
dsgn4-000009	Grande Ronde River	397764	4989984	6.7	160	Pool-Riffle
dsgn4-000010	Catherine Creek	444092	4998116	13.4	293	Isld-Braided

Appendix Table B-22. Continued.

Site ID	Waterbody	Easting	Northing	Mean BF Width(m)	Site Lgth(m)	Primary Bedform
dsgn4-000092	Spring Creek	400289	5020277	6	120	Pool-Riffle
dsgn4-000093	Meadow Creek	374570	5015668	9	200	Pool-Riffle
dsgn4-000094	Fly Creek	385782	4997741	8	160	Pool-Riffle
dsgn4-000161	S.F. Catherine Creek	455510	4994708	8.5	200	Step-Pool
dsgn4-000168	N.F. Catherine Creek	451583	5000213	9.9	200	Pool-Riffle
dsgn4-000202	Grande Ronde River	390906	5010918	20.3	440	Confined
dsgn4-000204	Catherine Creek	432089	5006592	11.8	240	Straight
dsgn4-000205	Grande Ronde River	400032	5018959	31.8	600	Straight
dsgn4-000213	Meadow Creek	390600	5013216	14.6	320	Braided
dsgn4-000245	Grande Ronde River	392830	5013594	30	600	Confined
dsgn4-000277	Grande Ronde River	392566	4998783	17.3	360	Straight
ORW03446-059352	Clark Creek	435230	5040546	8.8	200	Meandering
ORW03446-065720	Spring Creek	394731	5024362	4.6	120	Pool-Riffle
ORW03446-077704	Burnt Corral Creek	383975	5008414	4.5	120	Pool-Riffle
ORW03446-108270	Little Phillips Creek	421068	5049923	5.9	120	Plane-Bed
ORW03446-120904	Burnt Corral Creek	381607	5004136	2.9	120	Pool-Riffle
ORW03446-130030	Clark Creek	431722	5043727	7.3	160	Pool-Riffle
ORW03446-147928	Five Points Creek	405005	5028887	11.2	240	Isld-Braided
ORW03446-159368	Chicken Creek	390100	4990157	3.6	120	Pool-Riffle
ORW03446-177134	East Phillips Creek	416888	5053060	5.5	120	Pool-Riffle

Appendix Table B- 23. Fish species observed during snorkel surveys, 2012, with salmonids in bold.

Site ID	Waterbody	Date	Dominant	Common	Rare
CBW05583-013226	S.F. Catherine Creek	9/25	***ST***	***BT***	
CBW05583-015162	McCoy Creek	8/8	RS	NP, ***CH***	***ST***, MS
CBW05583-073130	S.F. Catherine Creek	9/18	***CH***	***ST***	
CBW05583-086186	Catherine Creek	7/24	RS	***CH,*** LD, ***ST***	CT, MW
CBW05583-086954	S.F. Catherine Creek	9/25	***ST***	***CH***	
CBW05583-095642	McCoy Creek	7/30	SD	BS***, ST***	
CBW05583-109994	M.F. Catherine Creek	9/26	***BT***	***ST***	
CBW05583-135615	Gordon Creek	8/22	CT	***ST***	
ORW03446-137980	Catherine Creek	9/27	***CH***	***ST***	***BT***
CBW05583-142490	Clark Creek	9/17	***ST***	CT, LD	SD, NP, ***CH***
CBW05583-228666	Sheep Creek	9/26	***ST***		
CBW05583-240730	Rock Creek	7/10	SD	LD, CT, ***ST***	NP
CBW05583-252730	Meadow Creek	9/5	SD	LD, CT, RS, ***ST***	NP
CBW05583-285498	Meadow Creek	8/6	SD	RS, NP, SU	LD, ***ST***
CBW05583-335162	Sheep Creek	8/9	LD	***ST***, NP, RS	***CH,*** CT, MS
CBW05583-340138	Catherine Creek	9/27	***CH***	***ST***, MW	CT, RS
CBW05583-381866	S.F. Catherine Creek	9/25	***ST***	***BT***	
CBW05583-382778	Burnt Corral Creek	7/12	***ST***		CT
CBW05583-405674	Catherine Creek	9/27	***CH***	***ST***	LD
CBW05583-417962	Catherine Creek	9/24	***CH***	***ST***	***BT***
CBW05583-421786	Rock Creek	8/7	***ST***	MS	
CBW05583-453946	Sheep Creek	8/9	***ST***		CT
CBW05583-486202	Grande Ronde River	8/29	***CH***	***ST,*** MW, LD, BS	NP, SD, RS
CBW05583-487322	Rock Creek	8/7	SD	MS, ***ST***	
CBW05583-498490	Meadow Creek	9/26	RS	***ST***, NP	SD, LD, ***CH,*** BS, SU
CBW05583-506682	Fly Creek	8/8	***CH***	***ST***	MS, NP, SD
CBW05583-514874	Meadow Creek	8/8	NP	RS, ***ST,*** MS	***CH***, CN
CBW05583-527786	Catherine Creek	9/20	***CH***	***ST***	LD, CT, ***BT***
CBW05583-531882	N.F. Catherine Creek	9/26	***CH***	***ST***	CT
dsgn4-000001	N.F. Catherine Creek	9/12	***ST***	***CH***	***BT***
dsgn4-000006	West Chicken Creek	7/16	***ST***	CT	
dsgn4-000009	Grande Ronde River	8/7	***CH***	***ST***	CT, ***BT***
dsgn4-000010	Catherine Creek	9/27	***CH***	***ST***	
dsgn4-000092	Spring Creek	8/1	CT	***ST***	
dsgn4-000093	Meadow Creek	8/20	SD	CT, RS, LD, ***ST***	NP
dsgn4-000094	Fly Creek	8/21	LD	***ST***	
dsgn4-000161	S.F. Catherine Creek	9/26	***ST***	***BT***	
dsgn4-000168	N.F. Catherine Creek	9/11	***ST***	***CH***	***BT***, SD

Appendix Table B- 23. Continued.

Site ID	Waterbody	Date	Dominant	Common	Rare
dsgn4-000202	Grande Ronde River`	8/10	***CH***	RS, SD, NP	CT, LD
dsgn4-000204	Catherine Creek	9/27	***CH***	***ST***, MW	***BT***
dsgn4-000205	Grande Ronde River	8/28	CT	RS, LD, SD, BS,	CN, NP
dsgn4-000213	Meadow Creek	8/13	NP	BS, LD, CT, RS,	CN, IC
dsgn4-000245	Grande Ronde River	8/9	SD	LD, MS, NP, RS	***ST, CH,*** CT, MW
dsgn4-000277	Grande Ronde River	9/26	***CH***	***ST***	SD
ORW03446-059352	Clark Creek	9/6	CT	LD, SD, BS, ***ST***	NP, MW, **CH**
ORW03446-065720	Spring Creek	7/23	***ST***		
ORW03446-077704	Burnt Corral Creek	7/31	***ST***	CT	
ORW03446-108270	Little Phillips Creek	7/18	***ST***		
ORW03446-120904	Burnt Corral Creek	7/11	***ST***		
ORW03446-130030	Clark Creek	9/5	SD	***ST,*** CT, NP, LD	MW, ***CH,*** BS
ORW03446-147928	Five Points Creek	8/30	***ST***	CT	***CH***
ORW03446-159368	Chicken Creek	7/17	***ST***	***CH***	LD
ORW03446-177134	East Phillips Creek	7/18	***ST***		

Species Codes: ST = steelhead, CH = Chinook Salmon, BT = bull trout, MW = mountain whitefish, CT = Cottis *spp,* MS = mottled sculpin, SD = speckled dace, LD = Longnose dace, RS = redside shiner, NP = northern pikeminnow, BS = bridgelip sucker, SU = unid. Sucker, CN = unid. Sunfish, IC = unid. catfish

Appendix Table B-24. Counts of steelhead and Chinook size and age classes (see methods) for CHaMP sites snorkeled in 2012.

			Steelhead					Chinook				
		FL (mm)→	70-130	130-200	200-250	>250		50-80	>100			
Site ID	Waterbody	Date	Age 1	Age 2	Age 3	Age 4+	Total	Age 0	Age 1+	Other	Adult	Total
CBW05583-013226	South Fork Catherine Creek	9/25	1	4	3	1	9	0	0	0	0	0
CBW05583-015162	McCoy Creek	8/8	6	1	0	0	7	11	1	0	0	12
CBW05583-073130	South Fork Catherine Creek	9/18	65	33	25	2	125	153	5	0	0	158
CBW05583-086186	Catherine Creek	7/24	29	30	5	1	65	1222	11	0	0	1233
CBW05583-086954	South Fork Catherine Creek	9/25	11	4	6	0	21	9	0	0	0	9
CBW05583-095642	McCoy Creek	7/30	2	1	1	0	4	0	0	0	0	0
CBW05583-109994	Middle Fork Catherine Creek	9/26	0	2	1	1	4	0	0	0	0	0
CBW05583-135615	Gordon Creek	8/22	70	16	0	0	86	0	0	0	0	0
CBW05583-142490	Clark Creek	9/17	86	12	2	0	100	7	0	0	1	8
CBW05583-228666	Sheep Creek	9/26	18	0	0	0	18	0	0	0	0	0
CBW05583-240730	Rock Creek	7/10	13	7	4	0	24	0	0	0	0	0
CBW05583-252730	Meadow Creek	9/5	78	15	2	0	95	0	0	0	0	0
CBW05583-285498	Meadow Creek	8/6	5	3	0	1	9	0	0	0	0	0
CBW05583-335162	Sheep Creek	8/9	33	13	4	0	50	5	4	0	0	9
CBW05583-340138	Catherine Creek	9/27	24	10	4	0	38	391	3	0	0	394
CBW05583-381866	South Fork Catherine Creek	9/25	8	17	4	0	29	0	0	0	0	0
CBW05583-382778	Burnt Corral Creek	7/12	25	7	0	0	32	0	0	0	0	0
CBW05583-405674	Catherine Creek	9/27	12	12	4	0	28	341	25	0	0	366
CBW05583-417962	Catherine Creek	9/24	53	12	3	1	69	217	12	0	0	229
CBW05583-421786	Rock Creek	8/7	23	0	0	0	23	0	0	0	0	0
CBW05583-453946	Sheep Creek	8/9	17	4	0	1	22	0	0	0	0	0
CBW05583-486202	Grande Ronde River	8/29	81	44	7	1	133	282	10	0	0	292
CBW05583-487322	Rock Creek	8/7	21	7	0	0	28	0	0	0	0	0
CBW05583-498490	Meadow Creek	9/26	15	8	1	0	24	10	1	0	0	11
CBW05583-506682	Fly Creek	8/8	37	4	0	1	42	222	8	0	0	230
CBW05583-514874	Meadow Creek	8/8	10	24	0	1	35	1	4	0	0	5
CBW05583-527786	Catherine Creek	9/20	76	13	4	0	93	412	10	0	0	422

Appendix Table B-24. Continued.

			Steelhead					Chinook				
		FL (mm)→	70-130	130-200	200-250	>250		50-80	>100			
Site ID	Waterbody	Date	Age 1	Age 2	Age 3	Age 4+	Total	Age 0	Age 1+	Other	Adult	Total
CBW05583-531882	North Fork Catherine Creek	9/26	13	12	5	0	30	43	5	0	0	48
dsgn4-000001	North Fork Catherine Creek	9/12	43	15	2	0	60	29	0	0	0	29
dsgn4-000006	West Chicken Creek	7/16	40	13	0	0	53	0	0	0	0	0
dsgn4-000009	Grande Ronde River	8/7	19	5	1	0	25	166	20	0	0	186
dsgn4-000010	Catherine Creek	9/27	37	4	2	1	44	304	3	0	0	307
dsgn4-000092	Spring Creek	8/1	50	15	1	0	66	0	0	0	0	0
dsgn4-000093	Meadow Creek	8/20	94	17	0	0	111	0	0	0	0	0
dsgn4-000094	Fly Creek	8/21	15	0	0	0	15	0	0	0	0	0
dsgn4-000161	South Fork Catherine Creek	9/26	5	9	5	0	19	0	0	0	0	0
dsgn4-000168	North Fork Catherine Creek	9/11	5	25	3	0	33	12	0	0	0	12
dsgn4-000202	Grande Ronde River	8/10	51	21	0	0	72	385	1	0	0	386
dsgn4-000204	Catherine Creek	9/27	8	9	15	3	35	235	13	0	0	248
dsgn4-000205	Grande Ronde River	8/28	64	33	3	0	100	19	0	0	0	19
dsgn4-000213	Meadow Creek	8/13	58	77	5	1	141	71	8	0	0	79
dsgn4-000245	Grande Ronde River	8/9	4	6	3	1	14	27	0	0	0	27
dsgn4-000277	Grande Ronde River	9/26	2	2	0	0	4	18	0	0	0	18
ORW03446-059352	Clark Creek	9/6	150	31	3	0	184	11	0	0	0	11
ORW03446-065720	Spring Creek	7/23	30	15	1	0	46	0	0	0	0	0
ORW03446-077704	Burnt Corral Creek	7/31	26	3	1	0	30	0	0	0	0	0
ORW03446-108270	Little Phillips Creek	7/18	1	4	3	0	8	0	0	0	0	0
ORW03446-120904	Burnt Corral Creek	7/11	12	5	0	0	17	0	0	0	0	0
ORW03446-130030	Clark Creek	9/5	148	36	4	0	188	8	1	0	0	9
ORW03446-137980	Catherine Creek	9/27	5	1	0	0	6	32	1	0	0	33
ORW03446-147928	Five Points Creek	8/30	35	1	0	0	36	3	0	0	0	3
ORW03446-159368	Chicken Creek	7/17	34	11	2	0	47	4	0	0	0	4
ORW03446-177134	East Phillips Creek	7/18	25	2	0	0	27	0	0	0	0	0
Total			**1793**	**975**	**139**	**17**	**2624**	**4650**	**146**	**0**	**1**	**4797**
% Total			**68.3%**	**25.7%**	**5.3%**	**0.6%**		**96.9%**	**3.0%**	**0**	**0.01%**	

Appendix Table B-25. Density of juvenile Chinook salmon (CH) and steelhead (ST) observed during snorkel surveys, 2012. Fastwater units include riffles, cascades and rapids.

			Density (fish/100m2)					
			Pool units		Run units		Fastwater units	
Site ID	Stream	Date	ST	CH	ST	CH	ST	CH
CBW05583-013226	South Fork Catherine Creek	9/25	6.70	0.00	0.00	0.00	9.87	0.00
CBW05583-015162	McCoy Creek	8/8	20.09	12.56	0.00	0.00	0.00	0.00
CBW05583-073130	South Fork Catherine Creek	9/18	38.43	62.36	0.00	0.00	10.55	11.92
CBW05583-086186	Catherine Creek	7/24	12.53	260.10	1.77	73.61	11.28	106.69
CBW05583-086954	South Fork Catherine Creek	9/25	18.44	6.43	0.00	0.00	4.21	0.00
CBW05583-095642	McCoy Creek	7/30	4.29	0.00	0.00	0.00	0.63	0.00
CBW05583-109994	Middle Fork Catherine Creek	9/26	2.52	0.00	0.00	0.00	1.86	0.00
CBW05583-135615	Gordon Creek	8/22	82.74	0.00	12.50	0.00	18.80	0.00
CBW05583-142490	Clark Creek	9/17	78.23	10.95	5.56	0.00	26.99	0.00
CBW05583-228666	Sheep Creek	9/26	11.97	0.00	4.81	0.00	0.00	0.00
CBW05583-240730	Rock Creek	7/10	16.93	0.00	0.00	0.00	3.36	0.00
CBW05583-252730	Meadow Creek	9/5	4.99	0.00	3.93	0.00	9.64	0.00
CBW05583-285498	Meadow Creek	8/6	6.44	0.00	0.88	0.00	0.00	0.00
CBW05583-335162	Sheep Creek	8/9	49.01	3.26	8.33	0.00	13.89	0.00
CBW05583-340138	Catherine Creek	9/27	18.77	84.44	2.99	54.01	0.00	0.84
CBW05583-381866	South Fork Catherine Creek	9/25	11.67	0.00	5.90	0.00	17.46	0.00
CBW05583-382778	Burnt Corral Creek	7/12	31.70	0.00	24.11	0.00	4.03	0.00
CBW05583-405674	Catherine Creek	9/27	16.24	179.97	1.06	7.54	1.77	9.99
CBW05583-417962	Catherine Creek	9/24	11.84	32.66	0.00	0.00	5.33	8.64
CBW05583-421786	Rock Creek	8/7	283.33	0.00	0.00	0.00	0.00	0.00
CBW05583-453946	Sheep Creek	8/9	16.12	0.00	50.00	0.00	2.84	0.00
CBW05583-486202	Grande Ronde River	8/29	26.85	70.37	0.00	0.00	14.41	14.91
CBW05583-487322	Rock Creek	8/7	253.57	0.00	0.00	0.00	0.00	0.00
CBW05583-498490	Meadow Creek	9/26	3.60	1.14	3.98	1.99	10.72	6.43
CBW05583-506682	Fly Creek	8/8	44.84	205.87	22.65	296.87	0.00	0.00
CBW05583-514874	Meadow Creek	8/8	23.16	5.01	0.00	0.00	0.00	0.00
CBW05583-527786	Catherine Creek	9/20	10.56	55.87	3.35	53.82	5.48	5.68
CBW05583-531882	North Fork Catherine Creek	9/26	19.14	27.03	13.16	26.32	11.58	9.65
dsgn4-000001	North Fork Catherine Creek	9/12	4.32	4.31	0.00	0.00	2.85	0.94
dsgn4-000006	West Chicken Creek	7/16	19.57	0.00	0.00	0.00	11.57	0.00
dsgn4-000009	Grande Ronde River	8/7	12.75	118.70	0.00	45.45	9.43	33.57
dsgn4-000010	Catherine Creek	9/27	6.56	40.80	7.34	15.72	8.73	51.43
dsgn4-000092	Spring Creek	8/1	40.74	0.00	25.93	0.00	19.50	0.00
dsgn4-000093	Meadow Creek	8/20	13.49	0.00	31.00	0.00	10.91	0.00
dsgn4-000094	Fly Creek	8/21	1.36	0.00	7.22	0.00	2.22	0.00

Appendix Table B-25. Continued.

Site ID	Stream	Date	Density (fish/100m2)					
			Pool Units		Run Units		Fastwater Units	
			ST	CH	ST	CH	ST	CH
dsgn4-000161	South Fork Catherine Creek	9/26	3.06	0.00	0.00	0.00	1.26	0.00
dsgn4-000168	North Fork Catherine Creek	9/11	4.25	0.56	0.00	0.00	2.29	0.90
dsgn4-000202	Grande Ronde River	8/10	13.35	53.27	4.34	11.12	1.29	9.03
dsgn4-000204	Catherine Creek	9/27	8.62	49.96	1.09	7.65	0.84	0.42
dsgn4-000205	Grande Ronde River	8/28	6.45	0.00	1.36	0.42	6.40	1.53
dsgn4-000213	Meadow Creek	8/13	4.43	1.11	6.26	6.94	4.91	1.56
dsgn4-000245	Grande Ronde River	8/9	1.46	24.28	0.18	0.00	2.07	0.16
dsgn4-000277	Grande Ronde River	9/26	0.00	0.00	1.08	6.86	2.27	4.54
ORW03446-059352	Clark Creek	9/6	41.84	4.62	64.35	9.26	30.16	0.00
ORW03446-065720	Spring Creek	7/23	38.93	0.00	35.92	0.00	2.46	0.00
ORW03446-077704	Burnt Corral Creek	7/31	9.41	0.00	6.67	0.00	3.47	0.00
ORW03446-108270	Little Phillips Creek	7/18	13.27	0.00	0.00	0.00	1.23	0.00
ORW03446-120904	Burnt Corral Creek	7/11	21.80	0.00	0.00	0.00	2.80	0.00
ORW03446-130030	Clark Creek	9/5	41.07	2.08	14.29	0.00	9.80	0.00
ORW03446-137980	Catherine Creek	9/27	2.06	15.91	1.16	0.00	0.00	0.00
ORW03446-147928	Five Points Creek	8/30	2.02	0.00	16.67	2.78	1.05	0.00
ORW03446-159368	Chicken Creek	7/17	29.17	0.00	25.32	0.00	13.93	2.30
ORW03446-177134	East Phillips Creek	7/18	27.04	0.00	0.00	0.00	3.19	0.00
	Mean		***28.15***	***25.16***	***7.83***	***11.71***	***6.40***	***5.30***
	Mean at sites with CH		*19.00*	*44.45*	*6.88*	*20.68*	*7.07*	*9.37*
	Mean at sites without CH		*40.07*		*9.08*		*5.53*	
	Median		***13.35***	***0.00***	***1.36***	***0.00***	***3.36***	***0.00***
	Median at sites with CH		*13.05*	*14.24*	*1.56*	*1.20*	*5.12*	*1.23*
	Median at sites without CH		*13.49*		*0.88*			

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 redd (or adult) by population
- Adult steelhead escapement in the Upper Grande Ronde River Watershed and in the Joseph Creek Watershed