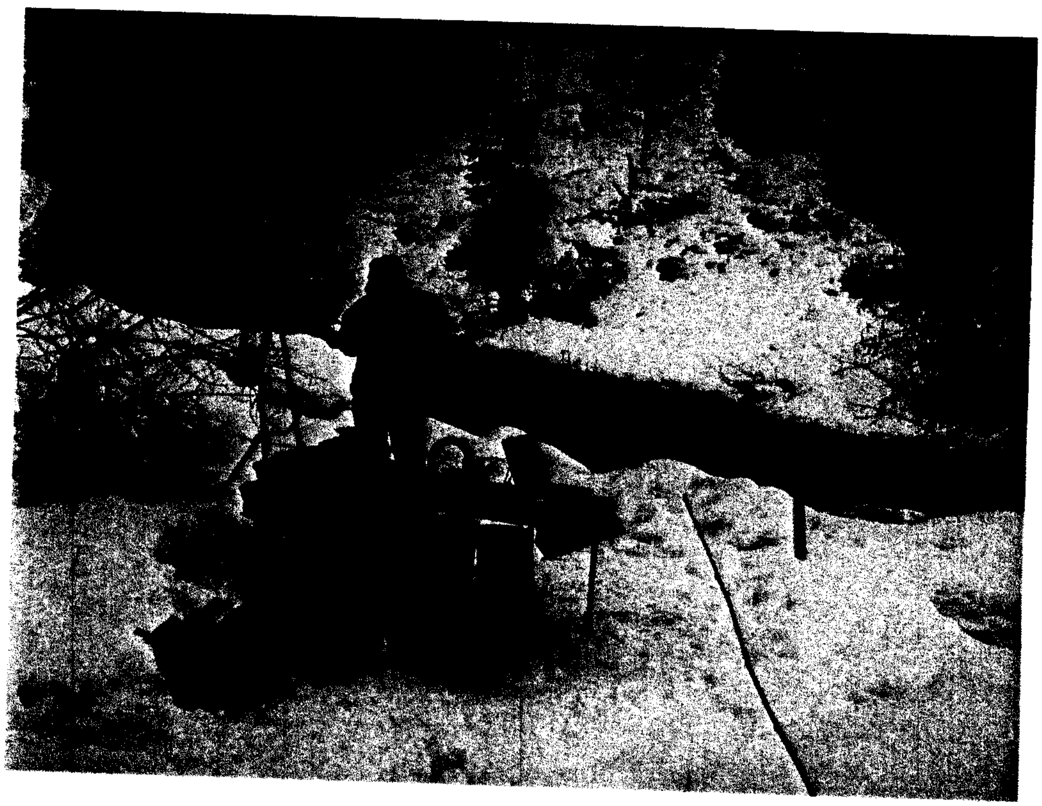
POTLATCH RIVER STEELHEAD MONITORING AND EVALUATION PROJECT

Annual Report
2009



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ABSTRACT

Objectives of the Potlatch River Steelhead Monitoring and Evaluation (PRSME) project are to establish baseline levels of steelhead trout *Oncorhynchus mykiss* production and productivity and provide an umbrella monitoring component to the numerous habitat restoration projects currently occurring within the drainage. In 2008, the project expanded the monitoring effort into both the upper and lower Potlatch River drainages. This expanded effort was continued in 2009. A total of 170 adult steelhead were captured and handled at PRSME weir sites during the 2009 field season. Seventy eight and 91 unique steelhead were captured at the lower and upper drainage weirs respectively. Mark-recapture occurrences resulted in adult steelhead escapement estimates of 135 (95% CI 79-252) and 92 (95% CI 50-152) spawners in the Big Bear and East Fork Potlatch River drainages. Adult escapement estimates for 2009 fell within the range of adult escapement estimates for the drainages from previous years. Mark-recapture juvenile steelhead trapping at screw traps on Big Bear Creek and the East Fork Potlatch River during the 2009 field season resulted in outmigration estimates of 6,348 (95% CI, 5,355-7,716) and 11,202 (95% CI, 9,555-13,110) at the two sites respectively. Smolt arrival estimates to Lower Granite Dam were 38% and 5% respectively from Big Bear Creek and the East Fork Potlatch River screw traps. Summer roving PIT tagging was increased during the 2009 field season. We tagged 2,627 juvenile steelhead across the entire Potlatch River drainage. Subsequent detections from these fish will provide valuable insight into juvenile movements and over summer habitat use and survival at a tributary level. A total of 82 snorkel sites were sampled throughout the Potlatch River drainage during the 2009 field season. Steelhead densities, predominately juveniles (age-1 and age-2) and fry (age-0) for the entire drainage were 1.08 and 1.42 fish / 100 m^2 respectively (SE = 1.02 and 0.55). Juvenile steelhead densities were highest within the Little Bear Creek drainage (Little Bear Creek and West Fork Little Bear Creek) with 5.59 fish/100 m^2. The Potlatch River Steelhead Monitoring and Evaluation Project continues to expand our knowledge of steelhead within the drainage as well as guide monitoring and prioritize habitat restoration work.

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INTRODUCTION

The Potlatch River Steelhead Monitoring and Evaluation (PRSME) project was initiated in 2005 using Pacific Coastal Salmon Recovery Funds. In 2008, the project was expanded into the upper Potlatch River watershed using National Oceanic and Atmospheric Administration (NOAA) Fisheries Intensively Monitored Watershed Funds. The additional funds allowed work to occur simultaneously throughout the entire drainage. The expanded project in 2008 was initiated to assess steelhead production and productivity throughout the entire Potlatch River drainage.

The Potlatch River likely has the strongest component of wild steelhead present within the Clearwater River Lower Mainstem population (Bowersox et al. 2008). The Interior Columbia River Technical Recovery Team (ICTRT) estimated that the Potlatch River drainage contains one Major Spawning Aggregation (Upper Potlatch River; including Big Bear Creek and East Fork Potlatch River) and two Minor Spawning Aggregations (Middle Potlatch Creek and Little Potlatch Creek)(NOAA Draft Recovery Plan 2006). They estimated that the Potlatch River drainage comprises 25% of the historic intrinsic potential of the Clearwater River Lower Mainstem steelhead population (NOAA Draft Recovery Plan 2006). The lower Clearwater River steelhead population is important to steelhead recovery; however no information was available regarding population production and productivity. This project was designed to establish baseline indices regarding population dynamics and expand the knowledge of steelhead life history strategies within the Potlatch River and the lower Clearwater River as a whole.

The Potlatch River is a drainage that has undergone significant amounts of change over the past 150 years. Land practices and manipulation associated with agricultural use and timber harvest have significantly altered the aquatic habitats present within the drainage as well as flow dynamics associated with the hydrograph. These changes have resulted in a variety of limiting factors identified by previous work (Johnson 1985; Bowersox and Brindza 2006) within the drainage. These limiting factors include:

1) Extreme flow variation,
2) High summer water temperatures,
3) Lack of riparian habitat,
4) High sediment loads, and
5) Low densities of in-stream structure.

Despite the significantly altered condition of aquatic habitats within the Potlatch River drainage, it does support an important population of wild steelhead trout. Aside from general distribution and abundance data (Schriever and Nelson 1999; Bowersox and Brindza 2006) limited information was available with regards to levels of productivity, production, and life history strategies for this population.

Potlatch River steelhead are genetically distinct from other local populations such as Dworshak hatchery strain steelhead (Byrne 2005). The geographic location of the drainage and lack of hatchery influence within Potlatch River steelhead make understanding population dynamics of this group extremely important regarding recovery actions for Clearwater River steelhead (ICTRT 2003).

In recent years, the Potlatch River has received additional focus from governmental and non-governmental agencies regarding its restoration potential. The Latah Country Soil and

Water Conservation District, Idaho Department of Fish and Game, Natural Resource Conservation Service, and the U.S. Forest Service have begun significant restoration efforts throughout the drainage. The goal of the ongoing Pacific Coastal Salmon Recovery Funds (PCSRF) project is to determine steelhead population response (production and productivity) to habitat enhancement.

This study is designed to provide baseline information on steelhead within the Potlatch River drainage as well as an umbrella monitoring component to habitat restoration projects being implemented within the drainage. The framework needs to be adaptive as well as rigid. It needs to be capable of shifting with monitoring needs as well as being able to detect population changes within the Potlatch River.

This report contains results from 2009 which was the fifth field season for the monitoring and evaluation effort in the lower drainage and the second field season in the upper drainage. Field activities included adult escapement estimation, juvenile outmigration estimates, juvenile survival estimates, in-stream density estimates, and habitat surveys.

OBJECTIVES

1) Establish baseline levels of steelhead production and productivity throughout the Potlatch River drainage.
2) Provide a monitoring component to the numerous habitat restoration projects currently ongoing within the Potlatch River drainage.
3) Describe steelhead life history strategies exhibited within the Potlatch River drainage.

STUDY AREA

The Potlatch River drainage is located in Latah, Nez Perce, and Clearwater counties. The mainstem Potlatch River is 89.4 km long and has a total drainage area of 152,621 Ha (Department of Agriculture 1994). The drainage is approximately 78% private ownership (Schriever and Nelson 1999). The lower watershed, which includes the Big Bear drainage, is dominated almost entirely by private ownership while the upper watershed, which includes the East Fork Potlatch River drainage, has two dominate landowners, Potlatch Timber Corporation and the U.S. Forest Service (Figure 1). Dominant land use and land type differ between the two drainage areas. The lower drainage is dominated by agricultural use and agricultural uplands and canyon bottomlands while the upper drainage is dominated by timberland and timberland ecotypes (Bowersox and Brindza 2006). Intensively monitored tributaries are Big Bear Creek and the East Fork Potlatch River drainages (Figure 1). The bulk of monitoring infrastructure is located in these drainages (Appendix A).

Mean daily stream discharge measured at the USGS flow site (13341570) approximately two miles above the mouth of the Potlatch River, ranged from 5,040 to 21cfs during the 2009 trapping season (Figure 2). Stream flows exceeded 1,000 cfs for 57 days during the 2009 adult trapping season (Figure 2). Stream temperature, as measured at the Big Bear Creek weir, ranged from a low of 2°C early in the season to a high of 22°C near the end of the adult trapping season.

METHODS

Adult Sampling

Picket weirs were constructed to capture upstream migrating adult steelhead on February 20th and February 21st at Big Bear and Little Bear Creeks, respectively (Appendix A). Initially, weirs were outfitted with only an upstream migrant trap box. Both weirs were maintained and checked for fish daily. Weirs were not operational due to high flows for 22 days at Little Bear and 29 days at Big Bear Creek weir during the spring trapping season.

Floating weirs were constructed to capture upstream migrating adult steelhead on March 15th and March 18th at the East and West Fork Potlatch River, respectively (Appendix A). Initially, weirs were outfitted with only an upstream migrant trap box. Both weirs were maintained and checked for fish daily. The East Fork Potlatch River and West Fork Potlatch River weirs remained operational for the entire trapping season, although kelt captures were limited during some high flow events.

Trapped upstream migrants at all traps were collected from the trap box and anesthetized in MS-222. Upstream fish were marked with a right operculum punch and passive integrated transponder (PIT) tagged in the left cheek. The gender, weight, length, and the presence of any marks were recorded for all fish handled. All fish were scanned for previous PIT-tags and wild upstream migrants were released above the weir. Hatchery fish captured at the weirs were relocated below the weir. Traps were pulled after adult steelhead kelt outmigration was complete.

Downstream trap boxes were installed at lower weir locations by April 17th and by April 29th at upper weir locations. Crowding techniques using nets and temporary barriers were also used at all weir locations to capture additional kelts within 100 m of the upstream side of the weir. Fish captured in the downstream box or by net were given a left operculum punch and released immediately downstream of the weir. Gender, weight, length, the presence of a previous operculum punch and/or PIT tag and PIT tag number if present were recorded for all fish captured.

Total adult escapement above the weirs was calculated using a maximum likelihood estimator (Steinhorst et al., 2004) using the variables of total kelt steelhead captured during the trapping season, marked adults passed upstream and number of marked adults recaptured as kelts. Assumptions required are that marked and unmarked adults had the same survival during spawning and individual fish are captured independently with equal probability.

Scale samples were collected from 166 of 170 unique adult fish captured during the 2009 field season. Scales were not collected if fish were severely deteriorated at the time of capture. Scales were collected posterior to the dorsal fin above the lateral line. Three or four scales were taken from each side of the fish. Scales were stored on Rite-in-Rain paper inside scale envelopes. The scale samples were sent to the Nampa Research Aging Laboratory in Nampa, Idaho to be read and assigned freshwater and ocean ages.

Ten steelhead, tagged as juveniles in 2005, 2006 and 2007 were detected at Bonneville Dam during the fall of 2008 as upstream adult migrants. Nine of these fish were subsequently detected passing Lower Granite Dam later in the migration. One fish detected at Bonneville was not detected at Lower Granite. These fish are included in this report since they spawned in the spring of 2009. Run timing, travel time from juvenile to adult detections, travel time from Bonneville to Lower Granite Dam, and travel time from Lower Granite Dam to the Potlatch River drainage are included in this report.

Juvenile Sampling

A rotary screw trap was operated on Big Bear Creek and the East Fork Potlatch River during the 2009 field season (Appendix A). The Big Bear Creek trap was located approximately 250 m from the confluence with the Potlatch River and below the confluence of Big Bear and Little Bear Creeks. Therefore, the screw trap estimated total juvenile steelhead emigration out of both Big Bear and Little Bear Creeks and their tributaries. The East Fork Potlatch River screw trap was located approximately 300 m above the confluence with the mainstem Potlatch River. Screw traps were checked daily throughout the spring and fall trapping seasons. Spring trapping was conducted on Big Bear Creek from March 19th - June 11th and March 19th – July 9th at the East Fork Potlatch River during the spring outmigration. The traps were no longer operational by early June at the Big Bear Creek site and early July at the East Fork Potlatch River site due to insufficient flows. The traps were also operated in the fall from December 18th till December 24th at the Big Bear Creek site and from November 12th till December 4th at the East Fork Potlatch River site. The short fall trapping seasons were a result of insufficient flows and river icing at the end of the season. During sampling periods, trapping was only interrupted due to extremely high or low stream discharge. All fish captured at the screw traps were identified and enumerated. All steelhead were weighed, measured, and scanned for the presence of PIT tags. Juvenile steelhead (>75 mm) not previously tagged were anesthetized using MS-222 solution and tagged in the abdomen with a PIT tag following PIT tagging best practice procedures (Columbia Basin Fish and Wildlife Authority 1999). All PIT tagged individuals were allowed to recover in live wells and were then released approximately 500 m upstream of the screw trap to estimate trapping efficiency. Tag files were created within the P3 PIT tag data management computer program and uploaded to the PTAGIS (www.psmfc.org) database daily. In addition, sub-samples of non-target species were weighed and measured.

Total juvenile steelhead outmigration from Big Bear Creek and the East Fork Potlatch River was estimated using Gauss software, specifically the Bailey modified maximum likelihood method developed by Steinhorst et al. (2004). The trapping season was divided into periods based upon trapping efficiency for each trap. A running average of weekly trapping efficiency was plotted in order to determine appropriate outmigration periods. Trapping days were grouped based upon periods of similar recapture probability. Input variables included; number of marked (PIT tagged) fish released upstream for recapture, number of marked fish recaptured, and the number of unmarked fish captured. Assumptions required for the use of this method are that all fish, marked and unmarked, are captured independently with the same probability during each period. Juvenile out-migrant survival to Lower Granite Dam was estimated using Survival Under Proportional Hazards (SURPH) 2.2 software.

A total of 226 and 278 scales were randomly sampled from the out-migrating juveniles collected at the screw trap on Big Bear Creek and the East Fork Potlatch River, respectively. Every fifth fish had scales taken in order to spread samples out over the entire juvenile outmigration. Scales were sampled posterior to the dorsal fin above the lateral line. Scales were stored on Rite-in-Rain paper inside scale envelopes. The scale samples were sent to the Nampa Research Aging Laboratory in Nampa, Idaho to be read and assigned freshwater ages.

To estimate juvenile in-stream survival in the lower Potlatch River tributaries, juvenile steelhead/rainbow trout were PIT tagged throughout the drainage during the 2007-2008 field seasons. Fly-fishing and backpack electroshocking were conducted at randomly selected locations throughout the tributaries to collect fish for PIT tagging. All juvenile steelhead/rainbow trout, >75 mm, were anesthetized in MS-222, measured, weighed, and PIT tagged. The PIT tag data was uploaded to the PTAGIS database on a daily basis. Detections at the mainstem Potlatch River Juliaetta array and Lower Granite Dam will be used to estimate in-stream survival in future years.

Mark-resight snorkel surveys were conducted throughout Potlatch River tributaries during the 2009 field season. Sample sites were selected using a generalized random-tessellation stratification design to provide a spatially balanced panel of survey sites (Stevens and Olsen 2004). Potential sites for the Potlatch River basin were obtained from personnel at the US-EPA, Corvallis, Oregon. Mark-resight snorkeling protocols were consistent with techniques outlined in Copeland et al. 2008. A minimum of 20 sites were completed in Big Bear Creek and the East Fork Potlatch River drainages to provide enough statistical power to track changes in juvenile steelhead density over time. This sample size was generated by conducting a power analysis on 2008 snorkel data from the Potlatch River drainage.

Roving Tagging 2009

Roving tagging was conducted throughout the lower Potlatch River basin from May 28th through August 1st during the 2009 field season. During this timeframe fish were tagged early in the day to ensure water temperatures did not exceed the 18°C maximum tagging temperature threshold. Fish were released in close proximity to their place of capture within their respective tributaries.

PIT-tag Arrays

Two in-stream PIT-tag arrays were operated during the 2009 field season. The arrays are located on Big Bear Creek, approximately 250 meters above the confluence with the mainstem Potlatch River and on the mainstem Potlatch River roughly 13 km above the confluence with the Clearwater River (Appendix A). The Big Bear Creek array was operated with six PVC antennas for most of the field season. There are two arrays, upstream and downstream, at the site and each consist of three antennas spreading across the width of the channel at the site. High flows caused antenna failures for significant amounts of time during the 2009 field season at the Big Bear Creek array. Both electronic failures and physical breakdowns were responsible for these failures. Issues with array operations were highly correlated to high flow events. In 2009, two additional antennas were added to the mainstem Potlatch River Juliaetta array (Appendix A), for a total of six antennas at that site. The arrays are configured with three upstream antennas and three downstream antennas. The additional antennas were installed in late July of 2009, when river levels were at the lowest and migration activity minimal. The Juliaetta array antennas are manufactured as a flat panel design by Biomark, Inc. of Boise Idaho. The mainstem Juliaetta array site was operational for the entire 2009 field season except for two brief power outages at the site.

A third in-stream array was installed in late July and early August of 2009 and is located approximately 500 m below the confluence of the East Fork and West Fork Potlatch Rivers, at RKM 61, near Helmer, Idaho. This array consists of four flat panel antennas, arranged in an upstream and downstream array configuration. This array was not operational until October 14, 2009, and was operational through the fall outmigration and the end of 2009.

All array sites are registered with the Columbia River Basin PTAGIS database, as in-stream interrogation sites. Site location codes for Big Bear Creek, Juliaetta and Upper Potlatch River arrays are KHS, JUL, and HLM respectively. All data collected from the sites is uploaded to the PTAGIS database on a semi-monthly basis. All issues encountered with each array are documented in the Site Event Logs on the PTAGIS Operations and Maintenance Website (http://www.ptoccentral.org). PIT-tag array detections will be used to generate adult steelhead escapement estimates, estimate survival in different stream reaches and understand juvenile movement and rearing habitat selection in the Potlatch River drainage.

Habitat Surveys

Low Water Habitat Availability Surveys were conducted to estimate and evaluate wetted habitat quality present within lower Potlatch River tributaries. Transects were walked August 3rd - August 6th 2009. Tributaries were stratified into upland and canyon reaches to disperse transects throughout each tributary. Two 500 m transects were walked within each strata and in each tributary resulting in four transects per tributary. The length of wetted habitat and the number of pools were recorded within each transect. In addition to wetted habitat and pool density we also measured the maximum depth, modal depth, pool length, pool width, and whether or not salmonids were present (visual observation) for all pools within the transect.

RESULTS

Adult Abundance and Migration Timing

A total of 170 unique adult steelhead were captured during the 2009 field season. Of these fish, 78 were captured at lower drainage weirs (Big Bear and Little Bear) and 91 were captured at upper drainage weirs (East and West Fork). Results for the upper and lower drainages will be reported separately in this section of the report.

A total of 78 unique adult steelhead were captured at the lower Potlatch River weirs during the 2009 trapping season. Of these, 22 were captured and marked as upstream pre-spawn migrants. Sixty-five adult steelhead were captured as downstream post-spawn migrants; 10 of these fish were recaptures. The mark-recapture occurrences resulted in an adult steelhead escapement estimate into the Big Bear drainage (Big Bear and Little Bear Creeks) of 135 (95% CI 79-252) fish.

The first upstream spawner arrived at the lower weirs on March 2nd at Little Bear Creek (Figure 3). Fifty percent of the run was passed upstream by March 19th and the final upstream spawner arrived at the lower weirs on May 14th (Figure 3). The first downstream post-spawn kelt was trapped at the lower weirs on April 18th; fifty percent and final kelt arrival occurred on May 12th and May 26th , respectively (Figure 3).

A total of 91 unique adult steelhead were captured at upper Potlatch River weirs during the 2009 field season. There were 69 unique adult steelhead captured at the East Fork Potlatch River weir. Of these, 59 were captured and marked as upstream pre-spawn migrants. Twenty-six adult steelhead were captured as downstream post-spawn migrants; 16 of these fish were recaptures. This resulted in an adult steelhead escapement estimate of 92 (95% CI 50 - 152) fish in the East Fork Potlatch River system. Since there were no recaptured kelts at the West Fork Potlatch River, no mark-recapture escapement estimate was generated for that population.

There were 22 upstream migrant adult steelhead captured at the West Fork Potlatch River weir resulting in a minimum escapement estimate of 22 fish.

The first upstream spawner arrived at the upper weirs on March 26th at the East Fork Potlatch River weir (Figure 4). Fifty percent of the run was passed upstream by April 21st and the final upstream spawner arrived at the upper weirs on May 16th (Figure 4). The first downstream post-spawn kelt was trapped at the upper weirs on April 30th; fifty percent and final kelt arrival occurred on May 13th and June 15th , respectively (Figure 4).

Adult Life History Characteristics

Length of female steelhead captured at lower drainage weirs ranged from 580 – 815 mm and males ranged from 580 – 861 mm (Table 1). Female steelhead captured in the upper drainage ranged from 553 – 781 mm and males ranged from 550 – 865 mm in length (Table 1).

The observed sex ratio from the 2009 field season was 1.2 males per female at both the lower and upper drainage weir locations. The observed ratio does not differ significantly (Chi-Square P = 0.382, 95% CI) from the expected ratio of 1:1. Total unique captures of males and females were 43 and 35 at lower weirs and 49 and 43 at upper weirs, respectively. The estimated number of fish by sex comprising the 2009 run was 74 and 61 fish in the lower drainage and 49 and 43 in the upper drainage for males and females respectively.

Scale samples were taken from 166 of the 170 adult steelhead captured during the 2009 field season. Scale samples from 165 fish were able to be aged. Scale analysis displayed a variety of freshwater and ocean life history strategies being utilized within the population (Figure 5). The 2-Fresh 2-Ocean and 2-Fresh 1-Ocean life histories were the most prevalent with 88 and 79 % of the fish sampled displaying these strategies at the lower and upper weirs respectively (Figure 5). Freshwater residency ranged from 1-3 years and adult ocean residency was 1-2 years (Figure 5).

Ten adult steelhead PIT tagged as juveniles by the PRSME project were detected ascending Bonneville Dam and nine of the ten were again detected crossing Lower Granite Dam (Appendix B). In addition to the PRSME tagged returning adult fish, six additional adult steelhead were detected at the Juliaetta array during the 2009 field season. All six individuals were tagged at Lower Granite Dam by NOAA personnel as out-migrating smolts in 2006. These fish were grouped with PRSME tagged fish and were assumed to be Potlatch River steelhead. Within this group, one fish that was detected at Bonneville Dam was not detected at Lower Granite Dam. The first upstream adult was detected at Bonneville Dam on June 19th, 2008 and the last detection was September 12th, 2008 (Appendix B). The first upstream adult was detected at Lower Granite Dam on August 8th, 2008 and the last detection was October 28, 2008 (Appendix B). Upstream spawners were detected at the Juliaetta array from February 1st through March 19th during the 2009 migration (Appendix B). Mean travel time from Bonneville Dam to Lower Granite Dam was 47 days and mean travel time from Lower Granite Dam to the Juliaetta array on the mainstem Potlatch River was 166 days. Ocean life histories included 1-ocean and 2-ocean and these life histories represented evenly at 31% and 69% respectively for the fifteen know ocean age returning adults.

Juvenile Emigration

Juvenile Out-migration

The rotary screw trap on Big Bear Creek was operated during the spring trapping season from March 19th until June 11th, 2009. During this period, the trap operated a total of 80 nights. A total of 1168 unique steelhead were captured, 926 of which were PIT tagged and released above the trap. Of these, 182 were recaptured. The trapping season was subsequently grouped into four periods with different trapping efficiencies (Table 2). An estimated 6,348 juveniles emigrated during the spring of 2009 from the Big Bear Creek system (95% CI, 5,355-7,716)(Table 2). In addition, the rotary screw trap was also operated during the fall of 2009 from December 18th through December 24th for a total of 7 nights. A total of 53 juvenile steelhead were captured, 45 of which were PIT tagged. Subsequent releases resulted in three recaptures and efficiency for the trapping period of 0.066 (Table 3). We estimated 610 juvenile steelhead out-migrated from Big Bear Creek during this brief fall trapping period (95% CI 230-1104)(Table 3).

The rotary screw trap on the East Fork Potlatch River was operated from March 19th until July 9th, 2009. During this period, the trap operated a total of 78 nights. A total of 1702 unique steelhead were captured, 1244 of which were PIT tagged and released above the trap. Of these, 191 were recaptured. The trapping season was subsequently grouped into three periods with different trapping efficiencies (Table 4). An estimated 11,202 juveniles emigrated from the East Fork Potlatch River system (95% CI, 9,555-13,110)(Table 4). In addition, the rotary screw trap was also operated during the fall of 2009 from November 12th through December 4th for a total of 23 nights. A total of 32 unique juvenile steelhead were captured. All captured fish were sub-tagging length (<75 mm). The absence of mark-recapture tagging resulted in a minimum estimate of 32 juvenile steelhead out-migrating during this period.

Lengths of juvenile steelhead captured at Big Bear Creek and the East Fork Potlatch River screw traps ranged from 73 – 250 mm and 55 – 191 mm, respectively. There was considerable differentiation in size class distribution between the two traps. Juvenile steelhead sampled from Big Bear Creek screw trap had a larger size distribution and older age distribution than those sampled at East Fork Potlatch River screw trap (Figure 6 and 7). Mean length of juvenile steelhead sampled at Big Bear Creek was 147.1 mm and in the East Fork Potlatch River was 87.9 mm.

Age distribution of juvenile steelhead also differed between the Big Bear Creek and East Fork Potlatch River screw traps. Scales were taken off 198 and 274 juvenile steelhead at Big Bear Creek and East Fork Potlatch screw traps, respectively during the 2009 spring outmigration. The dominant age class represented was age-2 (67%) at Big Bear Creek and age-1 (86%) at the East Fork Potlatch River (Figure 7). Age-1 fish from the Big Bear drainage occupied much large size classes than did age-1 fish from the East Fork drainage (Figure 8). However, age-classes were less differentiated in age-2 and age-3 length distributions (Figure 8). Even though there are marked differences in age-class distributions of juvenile steelhead being captured at the screw traps; overall length-weight relationship comparisons show similar growth curves for both populations (Figure 9).

Smolt Outmigration

2009 Smolt Out-migrant Survival

A total of 341 fish tagged at screw traps during the spring 2009 outmigration were detected in the hydropower system (302-Big Bear and 39-East Fork Potlatch). The overall smolt arrival estimate to Lower Granite Dam from Big Bear Creek and the East Fork Potlatch was 38% and 5%, respectively (SE 0.02 and 0.01). Capture probabilities were 43% and 29% respectively. Out-migrating smolts from Big Bear Creek were observed at Lower Granite Dam April 21st - June 8th and April 26th - May 30th for the East Fork Potlatch River. Length of fish observed in the hydropower system in 2009 ranged from 78 – 215 mm.

Smolt Out-migration/Juvenile Rearing Strategies

The majority of Big Bear Creek juveniles tagged at the screw trap actively out-migrate to the ocean during the same year. During the 2008 and 2009 trapping seasons 70% and 92% of the detections of fish out-migrating through the hydropower system occurred the same year as tagging (Table 5). The East Fork Potlatch River displays a different pattern with most fish tagged at the screw trap actively migrating out of the hydropower system the following year (62 and 65 % for the 2008 and 2009 tag years) (Table 5). Also, 2009 spring tagged juvenile steelhead from Big Bear Creek had an arrival estimate of 82% (SE 0.11) at Juliaetta array during the spring/summer outmigration season while East Fork Potlatch River fish had a smolt arrival estimate of 19% (SE 0.05). It is important to note that these numbers do not account for any possible differences in residency between the populations.

2008 Roving Tagged Fish Survival

A total of 1,108 fish were tagged in during the 2008 field season, during annual roving tagging efforts. Overall survival probability for fish tagged in tributary streams during the 2008 field season to Lower Granite Dam during the 2009 outmigration season was 0.16 (SE 0.02) (Table 6). Individual tributary survival probabilities ranged from 0.24 (SE 0.16) – 0.09 (SE 0.04) in Corral Creek and West Fork Little Bear Creek, respectively (Table 6). Detection probabilities for these two tributaries were the inverse of survival probabilities with lowest detection probability for any tributary occurring in Corral Creek (0.14, SE 0.13) and the highest detection probability being for the West Fork Little Bear Creek (0.50, SE 0.20) and Big Bear Creek (0.50 SE 0.14) (Table 6).

2009 Roving Tagging

A total of 2,627 fish were tagged within the entire drainage during 2009 (Table 7). Estimates on run timing and over summer survival will become available as these fish out-migrate past Lower Granite Dam and Juliaetta array during the spring of 2010.

Snorkel Surveys

Snorkel surveys were conducted June 10^{th} – 17^{th} during the 2009 field season. A total of 82 snorkel sites were sampled throughout the Potlatch River drainage. Steelhead densities, predominately juveniles (age-1 and age-2) and fry (age-0) for the entire drainage were 1.08 and 1.42 fish / 100 m^2, respectively (SE = 1.02 and 0.55) (Table 8). Juvenile steelhead densities were highest within the Little Bear Creek drainage (Little Bear Creek and West Fork Little Bear Creek) with 5.59 fish/100m^2 (Table 8). Steelhead age-0 fry densities were extremely variable. Highest mean abundance of fry was found on the Middle Potlatch Creek and Cedar Creek with densities of 22.45 and 9.11 fish/100m^2, respectively (Table 8). Low densities of age-0 fry were observed elsewhere throughout the drainage. Overall, steelhead showed a wide distribution across most suitable habitat present within the Potlatch River drainage.

Low Water Habitat Surveys

Low water habitat availability surveys conducted during the 2009 field season estimated 79% of stream channel within the lower Potlatch was wetted during the first week in August. Corral Creek had the lowest average percent wetted habitat of the tributaries with only 36% wetted habitat at the survey sites (Appendix 3). Pine Creek and Little Bear Creeks had the highest percentage of wetted habitat with 100 and 97 % wetted, respectively (Appendix 3). Corral Creek also had the lowest pool density with 0.60/100 m^2 and West Fork Little Bear Creek had the highest pool density with 1.95 pools/100 m^2 (Appendix 3).

Brood Year Productivity

Complete brood year productivity estimates in juveniles / spawner have been generated for two brood years on the Big Bear Creek drainage. Juveniles / spawner estimates have ranged from 62.3 in brood year 2005 up to 269.9 in brood year 2006 (Table 9). A partial (missing age-3) estimate has been generated for brood year 2007 with 88.6 juveniles / spawner. Initial productivity estimates for Big Bear Creek fit a density-dependent relationship based upon limited habitat for juvenile rearing.

Given the later start date for adult trapping on the East Fork Potlatch River (2008) we have only generated one partial brood year productivity estimate for that population. The partial estimate (missing age-2 and age-3) for brood year 2008 is 199.8 juveniles/spawner (Table 9).

DISCUSSION

Juveniles/spawner productivity estimates on Big Bear Creek are showing a strong density-dependent relationship within that drainage. Productivity increased from BY 2005 to BY 2006 with the juveniles/spawner estimate increasing from 62.3 to 269.9, respectively. This corresponded with the significant drop in estimated adult female escapement from 154.1 to 22.8 female spawners from 2005 to 2006. The partial BY 2007 estimate also fits the same density-dependent curve with a minimum of 88.6 juveniles/spawner. These data suggest significant rearing habitat limitations within the Big Bear Creek drainage. Jonsson et al. (1998) observed a similar pattern on the River Imsa, Norway with significant density dependent effects on Atlantic Salmon, *Salmo salar*. They observed higher loss rates in egg – smolt and egg – adult as freshwater egg density increased in spawning areas (Jonsson et al. 1998). Keeley (2001) found increased mortality and decreased growth in juvenile steelhead when competition over resources was increased. It is possible that high densities and limited late summer rearing habitat reduce age-2 and age-3 growth and survival in the Big Bear Creek population. We believe that juvenile outmigration production will be much more dependent upon juvenile rearing habitat availability than adult female escapement for particular brood years in Big Bear Creek drainage.

Further evidence of density-dependent survival relationships within the Potlatch River drainage is also apparent in the survival data for roving tagged fish. Results showed that survival to Lower Granite Dam was lowest in the West Fork Little Bear Creek roving tagged population. The West Fork of Little Bear Creek routinely has some of the highest juvenile steelhead densities of any Potlatch River tributary during early summer snorkel surveys and during roving tagging efforts. It is possible that this high initial density in early summer becomes habitat limited by late summer and this tributary is subject to high levels of juvenile mortality later in the year.

Habitat limitations and density-dependent relationships exhibited within the Big Bear Creek drainage provide further justification for habitat restoration within the drainage. Streams within the Big Bear Creek drainage (Big Bear Creek, Little Bear Creek, and West Fork Little Bear Creek) have been identified as high priority drainages for habitat restoration by the Potlatch River Watershed Management Plan (Resource Planning Unlimited 2007). While juvenile steelhead densities and adult escapement within the Big Bear Creek drainage appear to be some of the highest within the Potlatch River drainage, we believe the drainage likely has the greatest potential for increased steelhead production with appropriate habitat restoration actions. Fish are already filling what habitat is available within the drainage and appear to be severely habitat limited. If additional habitat is created by way of increased base-flows during summer rearing time period juvenile steelhead survival and production will increase.

Juvenile steelhead rearing habitat condition and fragmentation are the limiting factor in juvenile steelhead production in the lower Potlatch River tributaries. We suggest that habitat restoration efforts throughout the Potlatch River drainage focus on increasing the quality and availability of late summer rearing habitats for juvenile steelhead. The Low Water Habitat Availability Protocol (LWHAP) surveys have been implemented in the lower Potlatch River tributaries to give habitat restoration agencies a baseline condition of this limiting factor. The LWHAP data will provide additional insight on the severity of summer rearing habitat deficiencies on the juvenile steelhead population in the Big Bear Creek drainage. Annual brood year productivity estimates appear to be density dependent and we assume limited by juvenile rearing habitat availability. The LWHAP surveys are providing a statistically robust method of estimating late summer rearing habitat on an annual basis. As we continue to build an annual dataset capable of tracking juvenile steelhead production and summer rearing habitat condition we will be able to relate annual rearing habitat conditions to subsequent years juvenile steelhead outmigration from Big Bear Creek screw trap. This data will be invaluable in linking brood year productivity to what we believe to be the most limiting factor in Big Bear Creek drainage, late summer rearing habitat.

Documenting East Fork Potlatch River juvenile steelhead emigrating out of their natal tributary to rear an additional year in downstream reaches prior to active ocean out-migration has significant habitat restoration and protection implications within the Potlatch River watershed. Prior to documenting this life history strategy the mainstem Potlatch River was considered to be a migration corridor with little juvenile rearing habitat potential due to its degraded habitat. However, recent data suggests the mainstem Potlatch River and lower

Potlatch River tributaries provide valuable rearing habitat to upper Potlatch River juvenile steelhead. The number of 2009 tagged juveniles detected moving past Juliaetta array in 2009 and 2010 was 15 and 16 respectively. If you assume a 50% annual mortality rate, nearly twice as many East Fork Potlatch River juveniles are rearing an additional year above Juliaetta array as those that passed during their tagging year. Therefore a large portion of the population is utilizing habitat above the Juliaetta array for rearing. Also, we have had East Fork Potlatch River juvenile fish detected at the Big Bear Creek array after being tagged earlier in the year at the East Fork River screw trap. This illustrates that some East Fork Potlatch River juvenile steelhead are rearing an additional year in Big Bear Creek and likely other lower Potlatch River tributaries. This makes habitat restoration and protection in these drainages even more important.

Differences between emergence timing and natal stream habitat parameters between Big Bear Creek and East Fork Potlatch River juvenile steelhead appear to play a significant factor in life history strategies exhibited within the populations. Growth rates are similar between the populations, however East Fork Potlatch adult steelhead have spawned on average one month later than Big Bear Creek adults. This we believe will result in fry emergence occurring approximately one month later as well. Chandler and Bjornn (1988) found early emergent fish were longer and larger by the end of the experiment than late emerging fish; however instantaneous daily growth rates for the two groups were very similar. Metcalfe and Thorpe (1992) found that early emergent Atlantic Salmon were more likely to out-migrate than late emerging fish when occupying the same habitat. They believed that early emerging fish's size advantage allowed an earlier outmigration to the ocean (Metcalfe and Thorpe 1992). When early and late emergence occurs within different natal tributaries with different thermal regimes and water chemistry, such as Big Bear Creek and the East Fork Potlatch River, it is possible that the opposite is true. Late emerging fish in the East Fork Potlatch River population appear to move to downstream mainstem areas in search of better rearing habitat to prepare them for outmigration the following year and Big Bear Creek juveniles utilize natal stream habitat which has adequate rearing conditions.

The East Fork Potlatch River is subject to more severe winter conditions and colder winter water temperatures given its higher elevation than Big Bear Creek (Elevation at mouth, 820 and 385 m respectively). We assumed that East Fork Potlatch River fish were growing slower; however, it now appears they grow at a similar rate but are smaller at age than Big Bear Creek juveniles due to the later emergence and shorter growing season. This results in much smaller age-1 fish in the East Fork Potlatch River when captured the following spring. A number of studies have shown positive correlations between smolt size and survival (Ward and Slaney 1988; Ward et al. 1989). This would lead us to believe that East Fork River juvenile steelhead survive at a much lower rate than Big Bear Creek juveniles based upon size at length at age data collected from the screw traps. However, we have also documented that East Fork Potlatch River fish typically rear an additional year downstream of the screw trap given the higher detection rates at the Juliaetta array one year after tagging. Quinn and Peterson (1996) found with fall tagged and spring recaptured Coho salmon, *Oncorhynchus kisutch*, smaller fall tagged juveniles that reared in lake habitats had higher over-winter growth rates than larger fall tagged stream dwelling juveniles. Smaller fall tagged juvenile fish rearing in lake habitats were actually larger than fall tagged juveniles rearing in stream habitats (Quinn and Peterson 1996). If East Fork Potlatch River fish migrate to better rearing locations in mainstem habitats after their first year it is possible that they will be similar sized and have similar survival rates to Big Bear Creek juveniles by the time they out-migrate as smolts.

Wild Steelhead Population Comparison

Potlatch River steelhead continued to display a mix of "A" and "B" life history characteristics among successfully returning adult fish. Columbia River fisheries agencies have classified Snake River steelhead in "A" and "B" runs for harvest management. "A" Run steelhead tend to return to freshwater earlier, at a younger age, and smaller size than "B" run populations (CBFWA 1990). In 2009, 18.3% of adult steelhead captured at PRSME weirs were over the 775 mm B-run designated length (CBFWA 1990). Although it is a small sample size, of the 16 previously PIT-tagged upstream migrants, 38% crossed Bonneville Dam after the August, 25th "A" vs. "B" migration designation (CBFWA 1990). Within the same group of known ocean age migrants returning to the Potlatch River, 69% displayed a 2-ocean residency with the rest of the individuals displaying 1-ocean life history strategies. Data from 2009 is similar to adult size, run timing, and ocean residency data collected in previous years by the PRSME project (Bowersox et al, 2009). We believe that most wild steelhead populations will display a similar level of life history diversity and span the "A" vs. "B" designation classifications.

Variation in life history characteristics and strategies has been well documented within wild steelhead populations (Ward and Slaney 1988, Maher and Larkin 1955, Chapman 1958, and Peven et al. 1994). We have observed a variety of life history strategies within the Potlatch River and even differences in life history strategies between the upper and lower drainages. In an effort to understand how the Potlatch compares to the larger landscape we wanted to compare some life history characteristics of the Potlatch River population to neighboring populations. Projects currently being operated by Washington Department of Fish and Wildlife on Asotin Creek, WA and Idaho Department of Fish and Game on Fish Creek, ID provide to closest wild steelhead populations with similar data being collected to the Potlatch River, ID. Asotin Creek and Fish Creek are classified as "A" and "B" steelhead populations respectively.

Adult steelhead returning to spawn in the three drainages displayed a total of ten different freshwater-ocean life history strategies. Freshwater rearing ranged from 1 to 4 years in Asotin Creek and Fish Creek and 1 to 3 years in the Potlatch River (Table 10). Ocean rearing ranged from 1-3 years in Potlatch River and Fish Creek samples and 1-2 years in Asotin Creek samples (Table 10). The 2:1 and 2:2 life history strategies were consistently the most prevalent in the Potlatch River and Asotin Creek populations (Table 10). Fish Creek followed a similar distribution on most years except for 2009 when 76% of the population exhibited a 3:2 life history. Ocean age of returning fish varied for each population and within each adult migration year (Table 11). In general, Fish Creek had a higher percentage of 2-ocean life histories than did Asotin Creek and the Potlatch River except for 2008 when sampling was limited due to water conditions. The highest percentage of 1-ocean life history fish was consistently found in Asotin Creek (Table 11). Three ocean life histories were only observed in Fish Creek and the Potlatch River at low levels (Table 11). General trends show Fish Creek being the older ocean age population but there is a mix of life histories represented in all three populations.

Differences in adult run timing have also been assumed to contribute to differences in "A" versus "B" steelhead populations. During migration year 2009 (2010 spawners) the Fish Creek adult steelhead did pass Bonneville Dam later than the Asotin Creek and Potlatch River steelhead (Figure 10). Fifty percent of the upstream migrants had passed Bonneville Dam by August 1st, August 11th, and September 3rd for Asotin Creek, Potlatch River, and Fish Creek respectively. In addition, 10%, 16% and 76% of the populations passed Bonneville Dam after the August 25th "B" run date criteria. This data does show a noticeable difference in migration timing among the three populations, especially in Fish Creek, however; these findings are based on a fairly small subsample of the populations especially Asotin Creek and Potlatch River (n = 30 and 25 respectively). Additional years of data and more PIT-tagged adults returning will help determine if this is consistent from year to year. Interestingly, the last fish to pass Bonneville Dam during the 2009 adult migration from the three populations was from Asotin Creek (Figure 10).

Life history strategies exhibited by the three wild steelhead populations displayed small but significant differences. The Fish Creek population was comprised of more 2-ocean individuals than Asotin Creek or Potlatch River and adult migration timing from the ocean was later for the one year we plotted. Both of these occurrences should result in larger adults returning to Fish Creek than the other two populations, hence the "B" run designation. This comparison does provide some evidence for additional diversity in Potlatch River steelhead given that is contains an older ocean life history component and later migration past Bonneville Dam than Asotin Creek and younger ocean life history and earlier migration past Bonneville than Fish Creek.

Wild steelhead populations are complex and require multiple years of data to even begin to understand population dynamics and the suite of life history strategies utilized. The population comparison contained in this report is brief and limited in scope. However, it does show some distinct differences among the three populations within the criteria analyzed. It also illustrates the complexities of wild steelhead populations and why these populations are so resilient. We believe that the "A" versus "B" run designation is likely useful at describing broad trends observed in these different populations; however, it is an over generalized description of these complex populations and should be used with that understanding.

Monitoring Equipment Improvements

PIT-Tag array operation varied widely in 2009. The Juliaetta array on the mainstem Potlatch at rkm 13, operated nearly continuously with minimal downtime for maintenance or technical issues. However, the Big Bear Creek array operation was sporadic for the entire juvenile outmigration and adult migration. Three antennas were destroyed during high flow events, due to poor anchoring and debris build-up on exciter cables. In addition to the physical problems with the antennas, there was significant downtime due to technical problems with the power source and the multiplexing transceiver. In late July and early August, all the antennas at the Big Bear Creek array were removed and re-installed to be flush with the surface of the substrate. Also, exciter cables were anchored along downstream side of antennas to reduce debris build-up during high flow events. To address the technical issues within the enclosure, relays were replaced within the power source, and the timer was fine tuned to prevent the batteries from losing their charge. Although the Big Bear Creek array has had sporadic operation since its initial installation in 2007, it continues to be a useful tool and provides important life history and run timing data.

In 2009, a new wing and live box extension was installed at the East Fork Potlatch weir site to allow for the volitional capture of post-spawn steelhead. The wing is a modified version of a resistance board weir that is shorter in length and light enough to stand near vertical at lower stream flows. The box extension was added to the upstream live box, and utilized a fyke opening and cod triggers to retain kelts once in the downstream kelt box. We recommend outfitting trap boxes with cod triggers to retain adult steelhead at both upstream and downstream capture locations.

Due to the flashy nature of the Big Bear Creek drainage, the weirs on Little Bear and Big Bear Creeks were comprised for long portions of the 2009 adult trapping season. Improved weir designs will be installed in 2010 to attempt to reduce weir failures at the lower Potlatch River weir sites. The proposed design will incorporate attributes of both the resistance board weirs and picket weirs. The new design will use the semi-permanent rail section and live box of the resistance board weir and the rigid panels of the picket weirs. The result will be a weir that can withstand higher stream flows, but not get buried in bedload.

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Table 1. Length characteristics for male and female upstream spawners captured and lower and upper Potlatch River, Idaho, weirs during the 2009 field season.

Location	Sex	n	Min Length (mm)	Max Length (mm)	Average Length (mm)	SD	SE
Lower Weirs	Female	33	580	815	695	76.7	13.35
Lower Weirs	Male	43	580	861	702.44	88.38	13.48
Upper Weirs	Female	41	553	781	651.54	67.59	10.56
Upper Weirs	Male	48	550	865	680.06	87.74	12.66

Table 2. Numbers of juvenile steelhead captured, marked and recaptured at the Big Bear Creek, Idaho, screw trap including four single period out-migrant estimates and the total outmigration estimate for the 2009 spring trapping season. Also included is an average efficiency, migrant estimate, 95% confidence intervals (CI) and Standard Error for each sample period.

Dates	Captured	Marked	Recaptured	Average Efficiency	Migrant Estimate	Lower 95% CI	Upper 95% CI	SE
3/20 - 4/27	109	103	11	0.11	945	545	1677	318.2
4/28 - 5/20	379	379	47	0.12	3000	2294	4079	449.5
5/21 - 5/30	657	422	120	0.28	2297	1936	2702	204.6
5/31 - 6/10	23	22	4	0.18	106	41	230	45.9
Total	1168	926	182	0.17	6348	5355	7716	605.6

Table 3. Numbers of juvenile steelhead captured, marked, recaptured, and resulting migrant estimate for Big Bear Creek, Idaho, screw trap during the 2009 fall trapping season.

Dates	Captured	Marked	Recaptured	Efficiency	Migrant Estimate	Lower 95% CI	Upper 95% CI	SE
12/18 - 12/24	53	45	3	0.066	610	230	1104	225.9

Table 4. Numbers of juvenile steelhead captured, marked and recaptured at the East Fork Potlatch River, Idaho, screw trap including three single period out-migrant estimates and the total out-migration estimate for the 2009 spring trapping season. Also included is an average efficiency, migrant estimate, 95% confidence intervals (CI) and Standard Error for each sample period.

Dates	Captured	Marked	Recaptured	Average Efficiency	Migrant Estimate	Lower 95% CI	Upper 95% CI	SE
3/27 - 5/10	851	513	82	0.16	5270	4325	6516	570.1
5/11 - 5/21	651	571	94	0.16	3920	3234	4749	404.8
5/22 - 7/1	200	160	15	0.09	2013	1230	3524	588.8
Total	1702	1244	191	0.14	11202	9555	13110	904.3

Table 5. Number of juvenile steelhead tagged by tag year at Potlatch River, Idaho, screw traps with subsequent detections in the Columbia River hydropower system. Percent of the total number of detections for a tagging year is shown beside number of unique detections for each detection year. All detections represent unique individual fish detections (i.e. a fish detected at Lower Granite Dam will have subsequent downstream detections removed from record).

Trap	Tag Year	Total Tagged	Total Detected	n / Detection Year		
		n^1	n^2	2008	2009	2010
BIGBEC	**2008**	1064	433	306 (70%)	127 (30%)	
	2009	973	330		302 (92%)	28 (8%)
POTREF	**2008**	422	102	36 (35%)	63 (62%)	3 (3%)
	2009	1287	112		39 (35%)	73 (65%)

Table 6. Summary table of survival probabilities to Lower Granite Dam for fish tagged in Potlatch River, Idaho, tributaries during the summer of 2008. Detection data was queried from the 2009 out-migration season.

Stream	# tags	Survival Probability(SE)	Detection Probability(SE)
Corral Creek	59	0.24 (0.16)	0.14 (0.13)
Cedar Creek	122	0.10(0.03)	0.33 (0.14)
Pine Creek	285	0.20 (0.03)	0.43 (0.07)
West Fork Little Bear Creek	113	0.09 (0.04)	0.50 (0.20)
Little Bear Creek	113	0.17 (0.05)	0.37 (0.14)
Big Bear Creek	123	0.16(0.04)	0.50(0.14)
Total	815	0.16 (0.02)	0.40 (0.04)

Table 7. Number of juvenile steelhead/rainbow trout PIT tagged in Potlatch River, Idaho, tributaries during roving tagging in the 2009 field season.

[redacted]	
Big Bear Creek	189
[redacted]	
Corral Creek	238
[redacted]	
Pine Creek	613
[redacted]	
East Fork Potlatch River	212
[redacted]	

Table 8. Snorkel survey salmonid density summary data from sites snorkeled in the Potlatch River watershed, Idaho, during the 2009 field season May 28th through June 24th. Non-salmonid presence was recorded during surveys but is not reported on this table.

		Average Density (Fish/100m²)				
Stream	**Sites (n)**	**Steelhead (O. mykiss)**	**Trout, Fry (Oncorhynchus var. species)**	**Chinook Salmon**	**Brook Trout**	**Coho Salmon**
Big Bear Creek	8	1.47	1.06	0.00	0.00	0.00
Bob's Creek	5	0.15	0.09	0.00	10.70	0.00
Brush Creek	2	0.00	0.00	0.00	0.00	0.00
Cedar Creek	3	1.38	9.11	0.00	0.00	0.00
Corral Creek	4	0.55	0.22	0.00	0.00	0.00
Cougar Creek	1	0.00	0.00	0.00	0.00	0.00
Dry Creek	1	0.00	0.00	0.00	0.00	0.00
E. F. Big Bear Creek	2	3.33	0.23	0.00	0.00	0.00
E.F.Potlatch	10	1.78	0.35	0.00	3.40	0.00
Feather Creek	1	0.00	0.00	0.00	3.65	0.00
Jackson Creek	1	1.04	0.00	0.00	0.00	0.00
Laguna Creek	1	1.78	0.00	0.00	0.00	0.00
Leopold Creek	2	0.86	0.00	0.00	0.00	0.00
Little Bear Creek	5	5.83	1.28	0.00	0.36	2.61
M. F. Big Bear Creek	2	0.00	0.00	0.00	0.00	0.00
Middle Potlatch Creek	4	0.09	22.45	0.00	0.00	0.00
Porcupine Creek	1	0.00	0.00	0.00	0.00	0.00
Potlatch River	9	0.44	0.06	0.03	0.01	0.00
Purdue Creek	1	0.00	0.00	0.00	0.00	0.00
Randal Flats Creek	1	0.00	0.00	0.00	0.00	0.00
Ruby Creek	4	0.00	0.00	0.00	3.79	0.00
Schwartz Creek	3	1.91	0.16	0.00	0.00	0.00
Talapus Creek	2	0.00	0.00	0.00	0.00	0.00
W. F. Little Bear Cr.	5	5.35	0.54	0.00	0.00	0.04
West Fork Potlatch River	2	1.05	0.00	0.00	0.10	0.00
Overall Average	**3.2**	**1.08**	**1.42**	**0.00**	**0.88**	**0.11**

Table 9. Estimate of brood year productivity in juvenile steelhead out-migrants / female spawner in Big Bear Creek and East Fork Potlatch River, Idaho.

Location	BY	Adult Escapement Estimate	Proportion Female	# female spawners	Juvenile Outmigration Age - 0	Age-1	Age-2	Age-3	Total BY Production	Juveniles/Spawner
Big Bear	2005	214	0.72	154.1	0.0	3091.2	6414.0	87.1	9592.3	62.3
Big Bear	2006	57	0.4	22.8	0.0	2740.0	2496.7	916.6	6153.3	269.9
Big Bear	2007	108	0.74	79.9	0.0	2903.2	4175.4	*	7078.6	88.6
Big Bear	2008	121	0.39	47.0	0.0	1256.0	*	*	1256.0	
Big Bear	2009	135	0.45	61.3	0.0	*	*	*		
East Fork	2008	140	0.36	50.4	583.0	9485.9	*	*	10069.0	199.8
East Fork	2009	92	0.46	42.8	0.0	*	*	*		

Table 10. Freshwater – Ocean ages of spawning adult steelhead captured at weirs on Asotin Creek, Washington, Potlatch River, Idaho, and Fish Creek, Idaho, during the 2007-2009 trapping season. First number represents freshwater age and second number represents ocean age (i.e. 2:1 = 2 – freshwater, 1 – ocean life history). The 2007 Potlatch River samples only include Big Bear Creek drainage and the 2008 Fish Creek sample was low because of a weir blow out.

			% Of Run By Age									
Stream	**Year**	**n**	***1:1***	***1:2***	***2:1***	***2:2***	***3:1***	***3:2***	***2:3***	***3:3***	***4:1***	***4:2***
Asotin Cr	**2007**	**241**	2.7	2.7	30.6	48.0	12.7	3.3	0.0	0.0	0.0	0.0
	2008	**286**	4.2	0.4	57.4	22.8	11.4	3.4	0.0	0.0	0.2	0.2
	2009	**356**	2.0	2.4	40.9	33.3	13.1	6.8	0.0	0.0	0.6	0.6
Potlatch R	**2007**	**39**	0.0	0.0	17.9	56.4	5.1	12.8	7.7	0.0	0.0	0.0
	2008	**115**	0.8	5.2	44.3	30.4	3.4	4.3	9.5	1.7	0.0	0.0
	2009	**143**	0.6	1.3	39.4	44.7	11.8	2.3	0.0	0.0	0.0	0.0
Fish Cr	**2007**	**81**	4.4	25.0	11.7	50.0	4.4	2.9	1.4	0.0	0.0	0.0
	2008	**17**	0.0	0.0	25.0	25.0	25.0	16.0	8.3	0.0	0.0	0.0
	2009	**124**	0.0	0.0	0.0	7.5	10.0	76.0	0.9	0.9	2.0	2.0

Table 11. Ocean age summary for adult steelhead captured at weirs during the 2007-2009 field seasons on Asotin Creek, Washington, Potlatch River, Idaho, and Fish Creek, Idaho. The 2007 Potlatch River samples only include Big Bear Creek drainage and the 2008 Fish Creek sample was low because of a weir blow out.

Stream	**Year**	**1-Ocean**	**2-Ocean**	**3-Ocean**
Asotin Cr	**2007**	46	54	0
	2008	73.2	26.8	0
	2009	56.6	43.1	0
Potlatch R	**2007***	23	69.2	7.7
	2008	48.5	39.9	11.2
	2009	51.75	48.25	0
Fish Cr	**2007**	20.5	77.9	1.4
	2008*	50	41	8.3
	2009	12	85.5	1.8

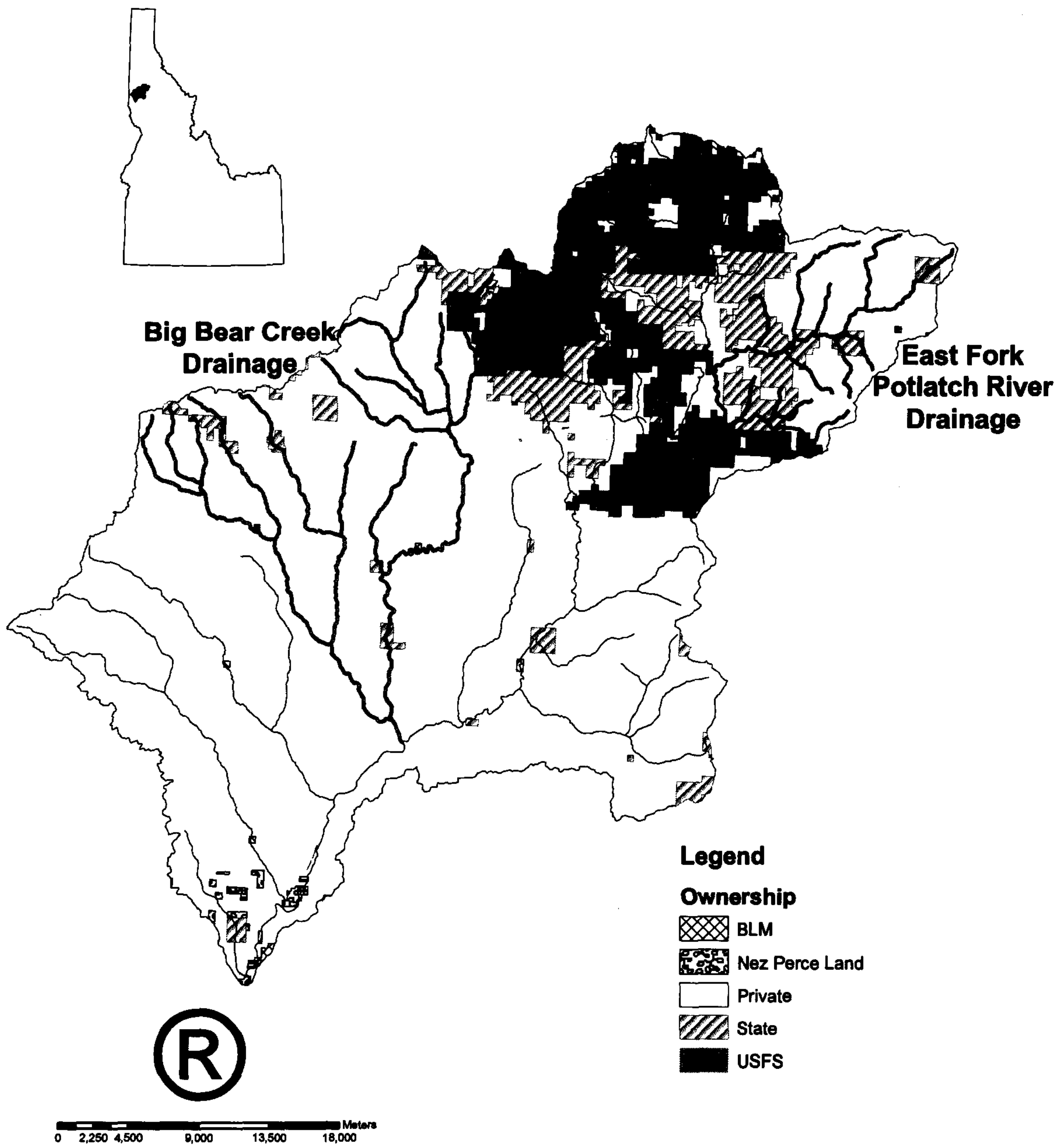


Figure 1. Potlatch River Drainage, Idaho, with intensively monitored tributaries, Big Bear and East Fork Potlatch River, highlighted in lower and upper portion of the drainage.

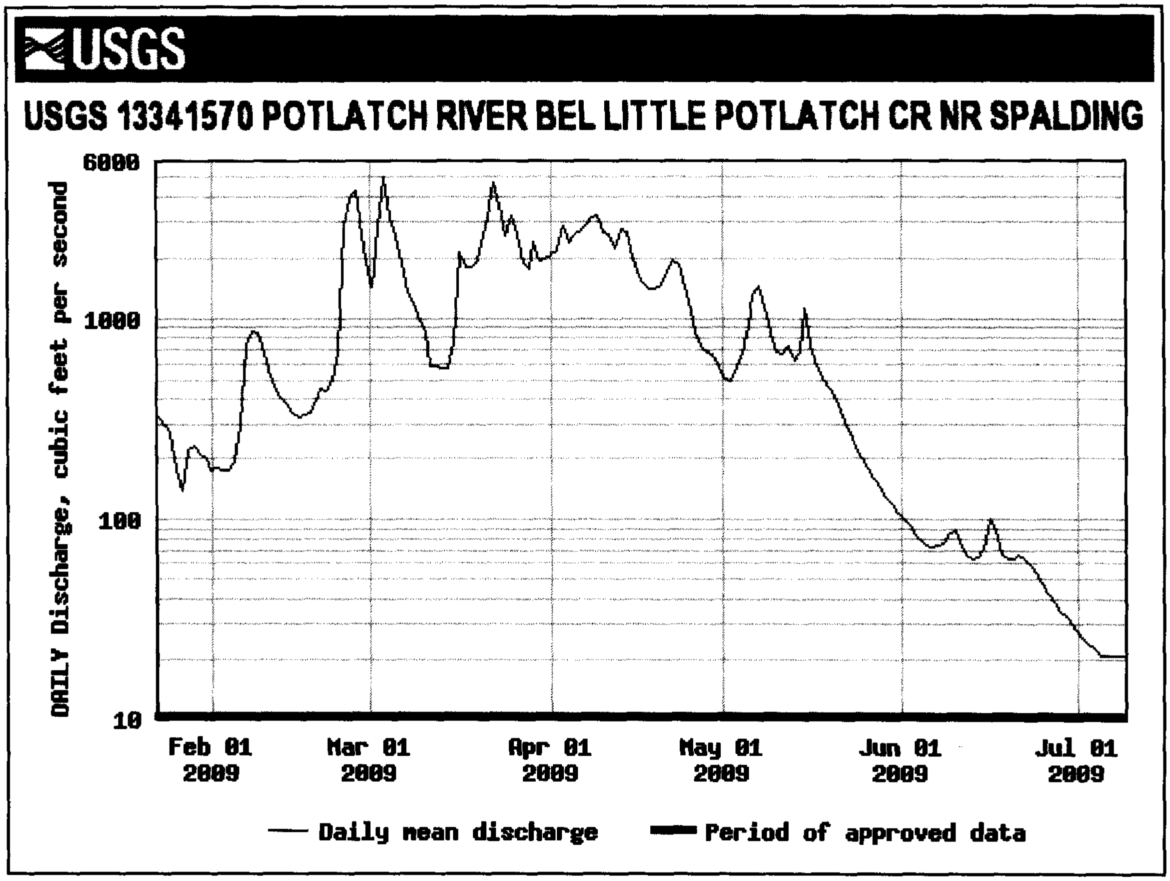


Figure 2. Daily mean discharge of mainstem Potlatch River, Idaho, recorded during the 2009 adult steelhead trapping season.

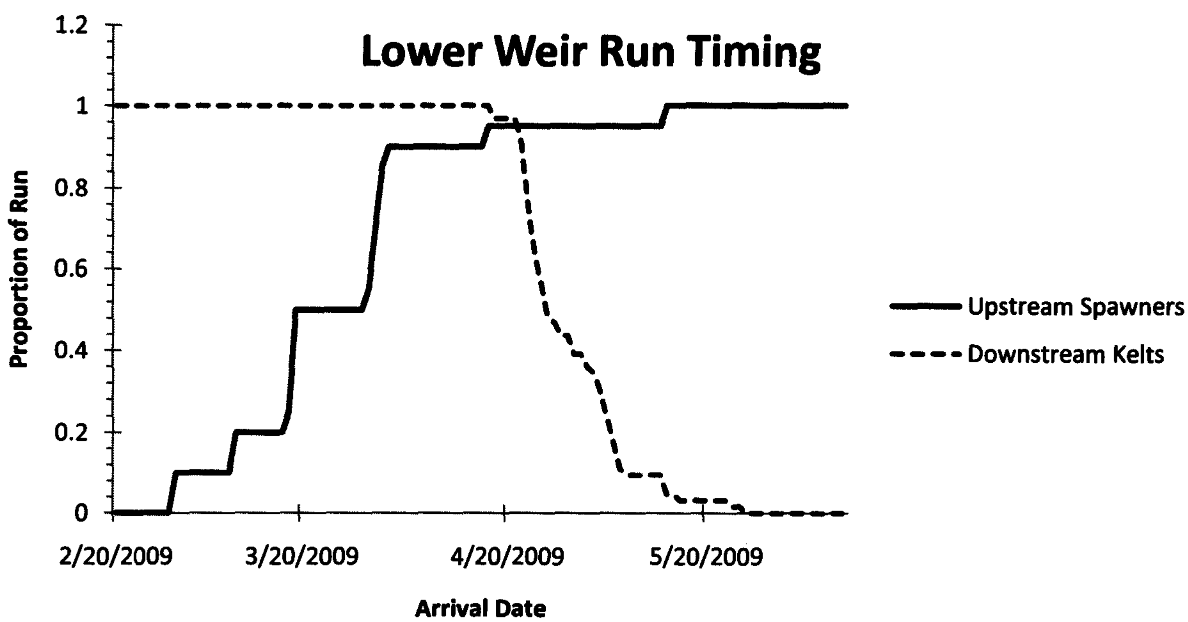


Figure 3. Spawning migration timing of adult steelhead captured at Big Bear Creek drainage, Idaho, weirs during the 2009 trapping season

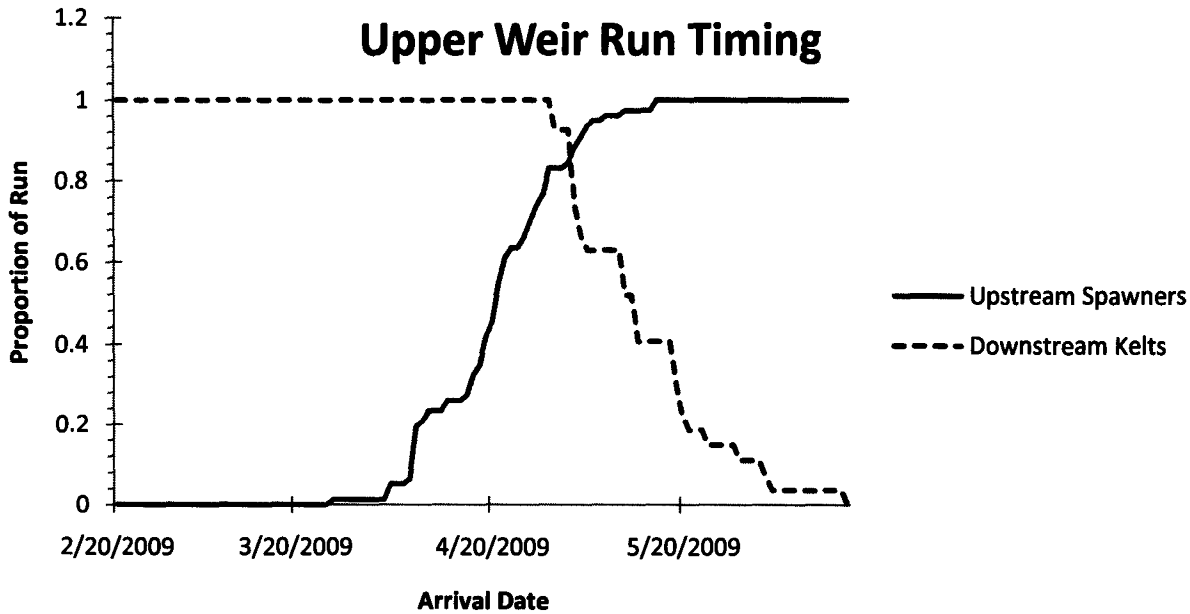


Figure 4. Spawning migration timing of adult steelhead captured at upper Potlatch River, Idaho, weirs during the 2009 trapping season.

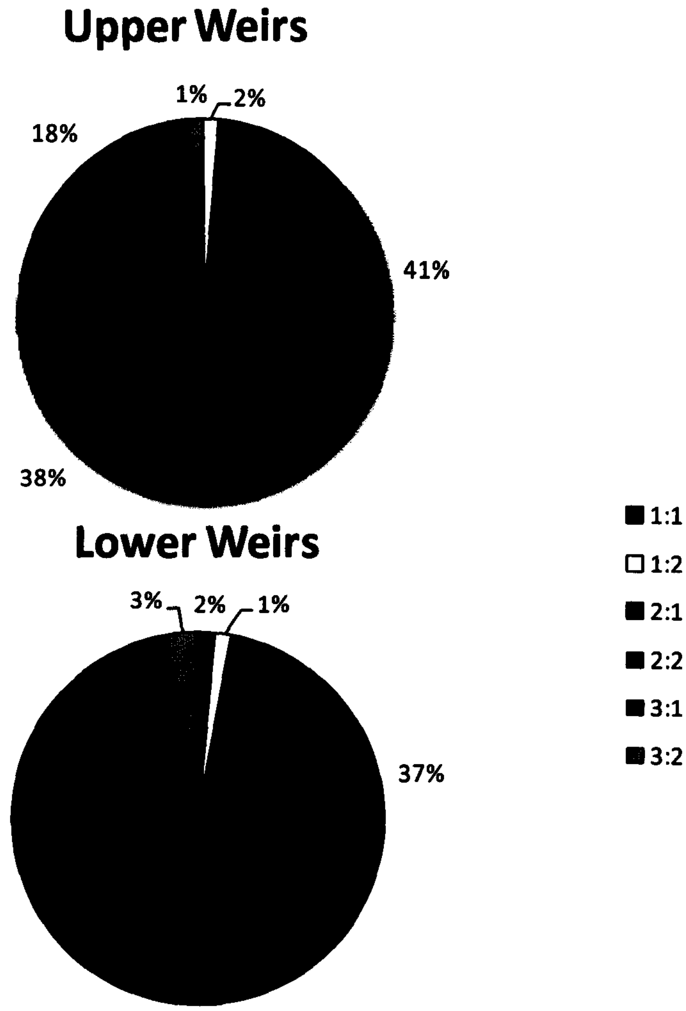


Figure 5. Observed percentages of various freshwater and ocean life history strategies in adult steelhead captured at lower and upper weirs during the 2009 field season (n = 70 and 72 at the Lower and Upper Potlatch River, Idaho, weirs respectively). First number in legend represents freshwater age and second number represents ocean age (i.e. 2:1 = 2 – freshwater, 1 – ocean life history).

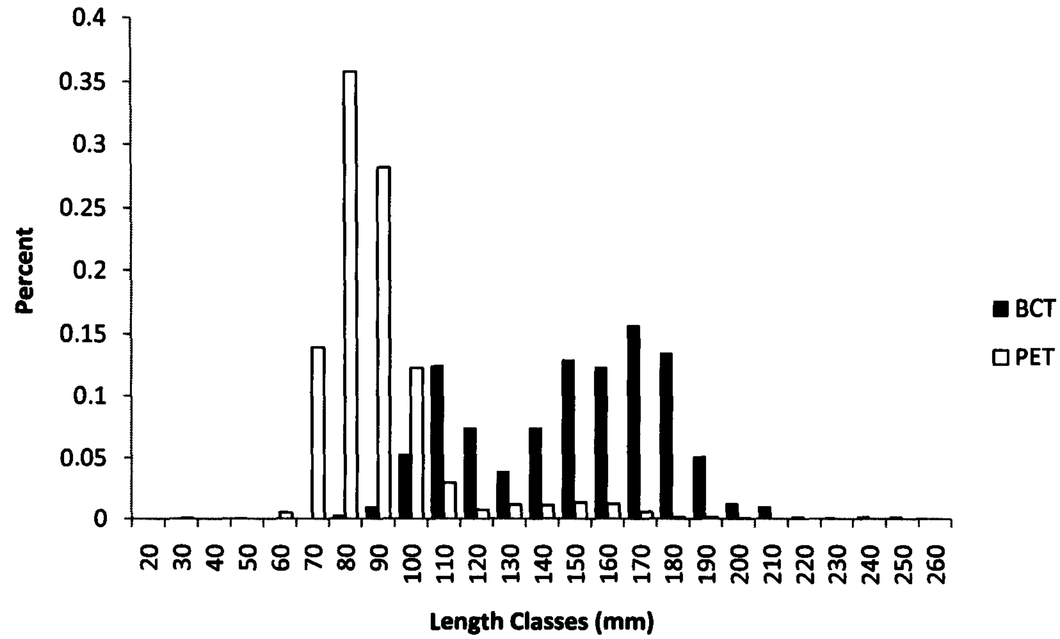


Figure 6. Length frequency histogram of juvenile steelhead captured and measured at the Big Bear Creek and East Fork Potlatch River, Idaho, screw traps in the spring of 2009.

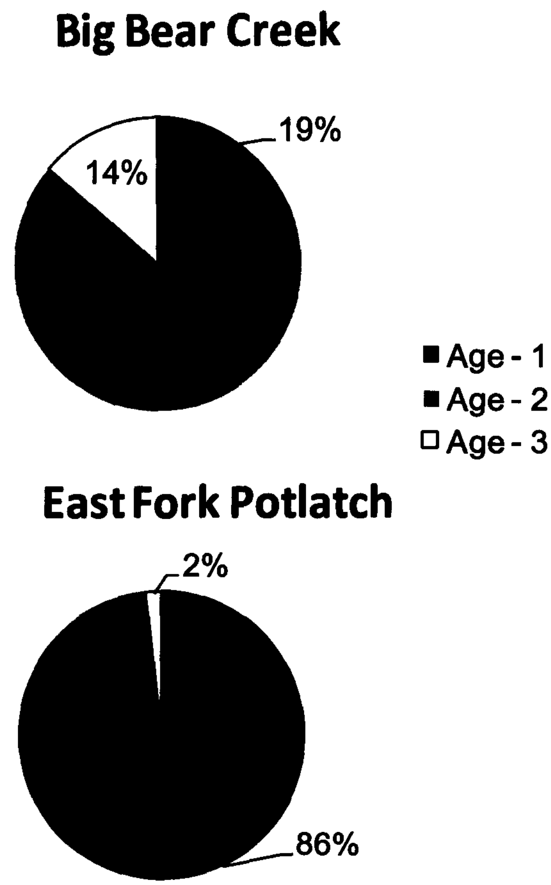


Figure 7. Age composition of juvenile steelhead scales samples from screw traps on Big Bear Creek and East Fork Potlatch River, Idaho, during the 2009 field season (n = 198 and 274 at Big Bear Creek and East Fork Potlatch River, respectively).

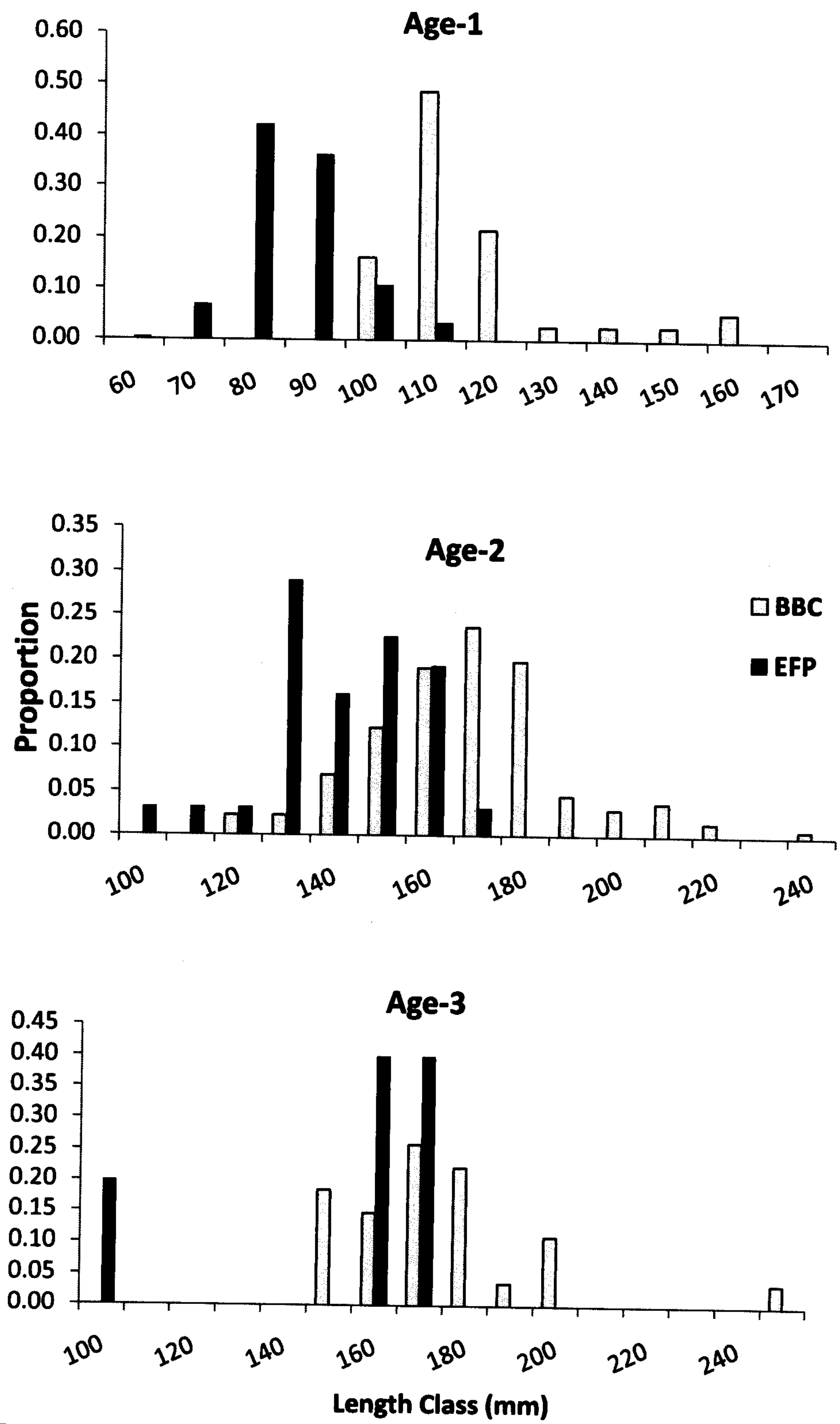


Figure 8. Length frequency of juvenile steelhead captured at Big Bear Creek and the East Fork Potlatch River, Idaho, screw traps by year class.

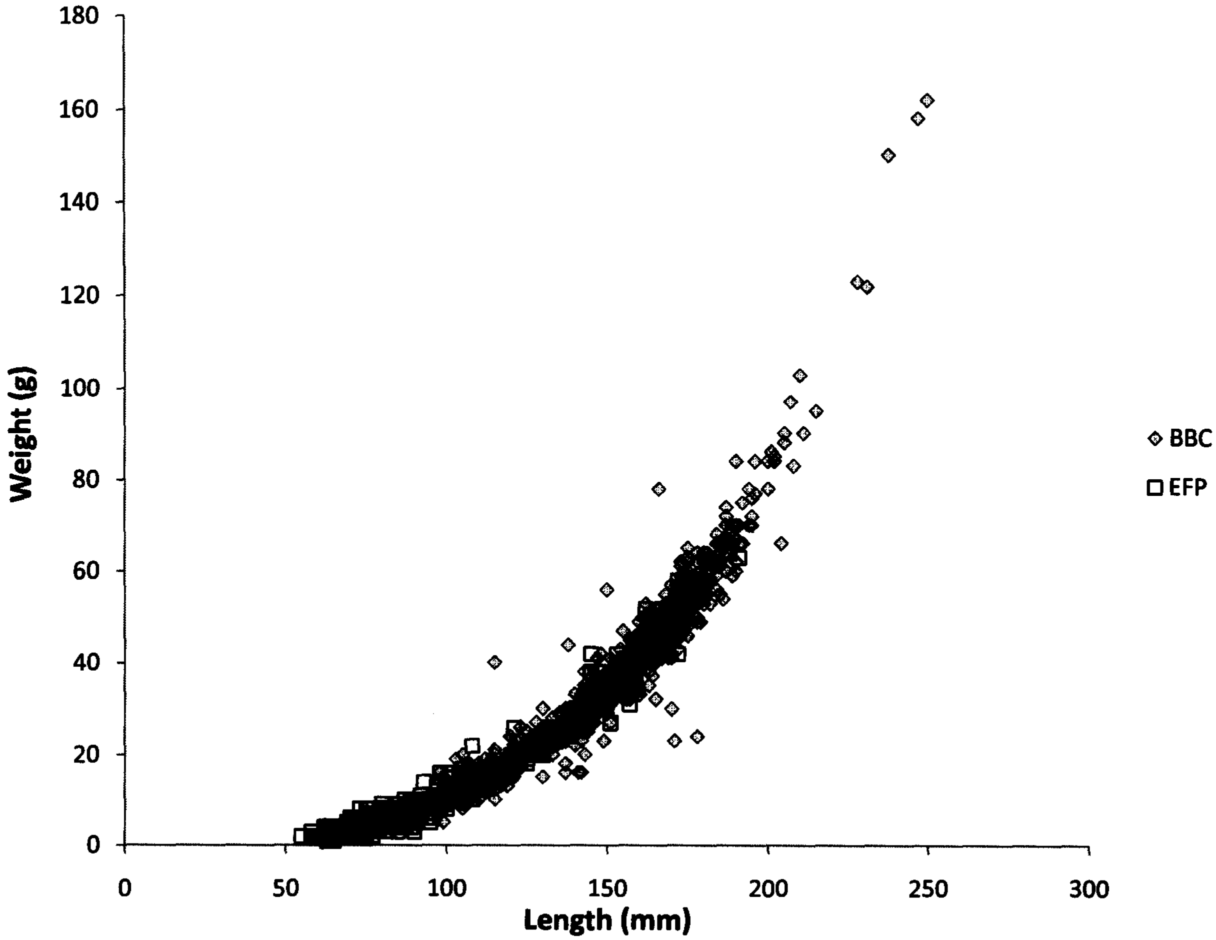


Figure 9. Length-weight relationships of fish captured at Big Bear Creek and East Fork Potlatch River, Idaho, screw traps during the spring 2009 trapping season.

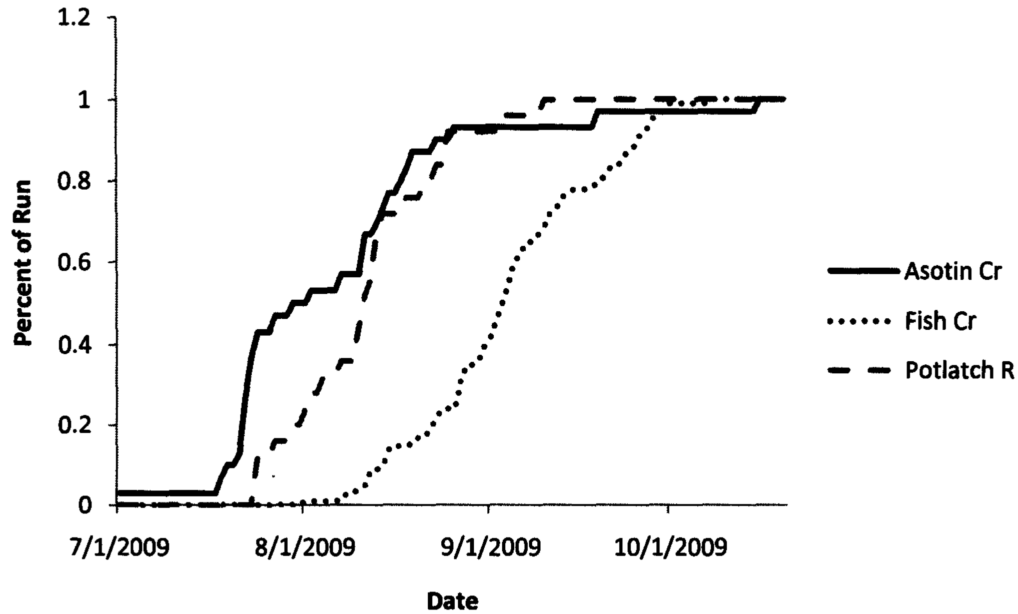
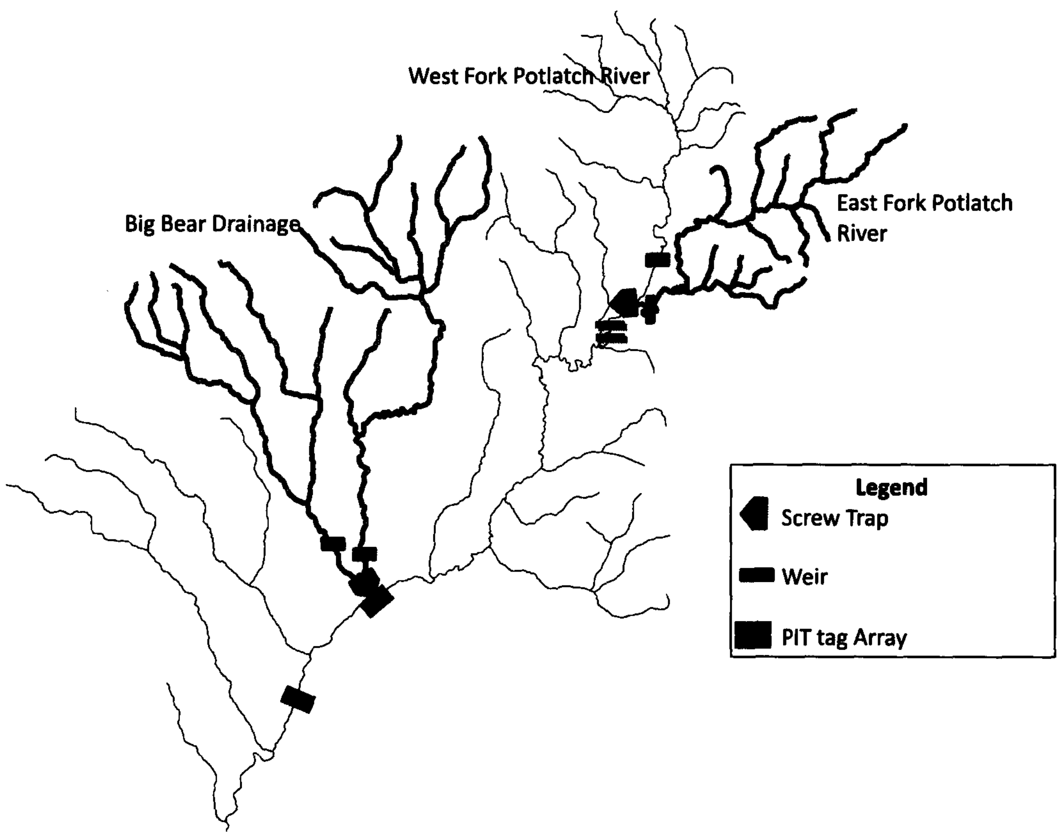


Figure 10. Migration timing during summer/fall 2009 at Bonneville Dam of three wild steelhead populations Asotin Creek, Washington, Fish Creek, Idaho, and Potlatch River Idaho, (n = 30, 78, and 25 respectively).

APPENDICIES

Appendix A: Map of intensive monitoring drainages and associated sampling infrastructure within the Potlatch River drainage, Idaho, by the completion of the 2009 field season.



Appendix B: Potlatch River drainage, Idaho, returning adult steelhead (tagged by PRSME or NOAA as juveniles) upstream spawning migration characteristics through the Columbia River hydropower system. ** 3D9.1BF26ACB15 was not observed above BON and 3D9.1BF232805F was observed in the Potlatch River system, Idaho, at Big Bear Creek array above Juliaetta array.

Tag ID	Juvenile Release Site	Tag Date	BON Observation Date	GRA Observation Date	JUL Observation Date	BON-GRA Travel Time	GRA-JUL Travel Time
3D9.1BF26AB016	BIGBEC	05/12/07	07/16/08	09/11/08	03/18/09	57	188
3D9.1BF2480E51	BIGBEC	05/20/06	09/07/08	09/25/08	03/19/09	18	104
3D9.1BF246A771	BIGBEC	05/21/06	09/12/08	09/29/08	03/18/09	17	170
3D9.1BF2468CA0	BIGBEC	04/26/07	07/11/08	10/14/08	02/01/09	95	110
3D9.1BF2468C90	BIGBEC	05/05/06	09/01/08	10/16/08	03/18/09	45	153
3D9.1BF246A9B0	BIGBEC	05/04/07	07/21/08	10/28/08	03/01/09	99	124
3D9.1BF26ACB15	BIGBEC	05/11/07	08/03/08	*	*	*	*
3D9.1BF246A368	POTR	07/19/05	08/06/08	10/24/08	03/05/09	79	192
3D9.1BF27192BE	POTR	04/10/07	07/22/08	08/08/08	03/16/09	18	220
3D9.1BF246A00F	POTR	07/28/05	09/07/08	09/24/08	03/19/09	17	176
3D9.1BF2623152	GRA	05/15/06	06/19/08	07/02/08	03/02/09	14	244
3D9.1BF258B106	GRA	05/14/06	09/06/08	09/27/08	03/02/09	22	157
3D9.1BF22ED620	GRA	05/07/06	07/29/08	10/10/08	02/17/09	74	131
3D9.1BF2450AD3	GRA	05/10/06	09/03/08	09/23/08	03/05/09	20	164
3D9.1BF239D7A7	GRA	05/18/06	08/24/08	10/12/08	03/09/09	50	149
3D9.1BF232805F	GRA	06/02/06	07/18/08	08/12/08	3/1/2009*	87	202
					Mean Travel Days	47	166

Appendix C. Low Water Habitat Availability Protocol results from the 2009 survey in the Potlatch River watershed, Idaho. Surveys were performed between 8-3-09 and 8-6-09.

Creek	Strata	Site	Total Wetted Length(m)	% Wetted	Total # Pools	Total Length of Pools(m)	Average Pools/100m
Big Bear	U	UBC1	500.00	1.00	10.00	78.00	2.00
Big Bear	U	UBC3	500.00	1.00	10.00	101.30	2.00
Big Bear	L	LBBC1	282.60	0.57	2.00	79.10	0.40
Big Bear	L	LBBC2	500.00	1.00	10.00	87.90	2.00
Big Bear Average			**445.65**	**0.89**	**8.00**	**86.58**	**1.60**
Little Bear	U	ULBC1-A	482.00	0.96	10.00	151.20	2.00
Little Bear	U	ULBC2	492.00	0.98	10.00	211.70	2.00
Little Bear	L	LLBC1	474.30	0.95	8.00	79.10	1.60
Little Bear	L	LLBC2	500.00	1.00	10.00	87.90	2.00
Little Bear Average			**487.08**	**0.97**	**9.50**	**132.48**	**1.90**
WFLBC	U	UWF1	500.00	1.00	10.00	102.90	2.00
WFLBC	U	UWF2	410.20	0.82	10.00	106.50	2.00
WFLBC	L	LWF4	493.90	0.99	10.00	65.10	2.00
WFLBC	L	LWF5	500.00	1.00	9.00	110.50	1.80
WF Little Bear Average			**476.03**	**0.95**	**9.75**	**96.25**	**1.95**
Cedar	U	UCEC3	274.30	0.55	3.00	12.40	0.60
Cedar	U	CECU2	191.60	0.38	2.00	27.80	0.40
Cedar	L	CEC1	500.00	1.00	10.00	109.60	2.00
Cedar	L	CEC2	201.20	0.40	3.00	29.80	0.60
Cedar Average			**291.78**	**0.58**	**4.50**	**44.90**	**0.90**
Pine	U	UPC2-A	500.00	1.00	0.00	0.00	0.00
Pine	U	UPC3-A	500.00	1.00	0.00	0.00	0.00
Pine	L	LPC5-A	500.00	1.00	5.00	31.20	1.00
Pine	L	LPC6-A	500.00	1.00	9.00	80.00	1.80
Pine Average			**500.00**	**1.00**	**3.50**	**27.80**	**0.70**
Corral	U	UCOC7	251.80	0.50	10.00	68.50	2.00
Corral	U	UCOC4	71.40	0.14	1.00	24.00	0.20
Corral	L	LCOC1	11.10	0.02	0.00	0.00	0.00
Corral	L	LCOC2	379.40	0.76	1.00	18.80	0.20
Corral Average			**178.43**	**0.36**	**3.00**	**27.83**	**0.60**
Drainage Average			**396.49**	**0.79**	**6.38**	**69.30**	**1.28**

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