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HATCHERY BASELINE MONITORING

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Contents

List of Tables

List of Figures

Section 1: Introduction

The National Marine Fisheries Service (NMFS) listed spring Chinook salmon *Oncorhynchus tshawytscha* and winter steelhead *O. mykiss* in the upper Willamette River Evolutionarily Significant Unit (ESU) as threatened under the Endangered Species Act (ESA; NMFS 1999a; NMFS 1999b). As a result, any actions taken or funded by a federal agency in the ESU must be evaluated to assess whether they are likely to jeopardize threatened and endangered species, or result in the destruction or impairment of critical habitat. Several hatcheries produce and release hatchery salmonids in the upper Willamette Basin (Figure 1), which may impact wild populations of listed species. All hatcheries are operated by the Oregon Department of Fish and Wildlife (ODFW) and are funded (50–100%) by the U.S. Army Corps of Engineers (Corps).

Potential risks of artificial propagation programs have been widely debated (e.g. Kostow and Zhou 2006; Levin and Williams 2002). Risks include disease transfer, competition for food and spawning sites, increased predation, increased incidental mortality from harvest, loss of genetic variability, genetic drift, and domestication (Steward and Bjornn 1990; Hard et al. 1992; Cuenco et al. 1993; Busack and Currens 1995, and Waples 1999). Hatcheries can also bolster spawner abundance—a critical consideration for those populations on the verge of extirpation—by providing a genetic reserve, as well as providing marine-derived nutrients in streams (Steward and Bjornn 1990; Cuenco et al. 1993). Recent work, however, has shown that some hatchery fish tend to have lower reproductive success than wild fish even when broodstocks are largely comprised of wild fish (Araki et al. 2007), and productivity parameters are depressed when large numbers of hatchery salmonids mix with wild fish (Chilcote et al. 2011). However, reproductive success studies focused specifically on spring Chinook salmon have yielded conflicting results with some suggesting lower reproductive success for hatchery Chinook salmon (Williamson et al. 2010) and others showing little difference between hatchery and natural-origin fish (Hess et al. 2012).

The objective of this project is to conduct baseline monitoring of returning adult fish and to evaluate the potential effects of hatchery programs on naturally spawning populations of spring Chinook salmon and winter steelhead in the upper Willamette River Basin. Restoration of spring

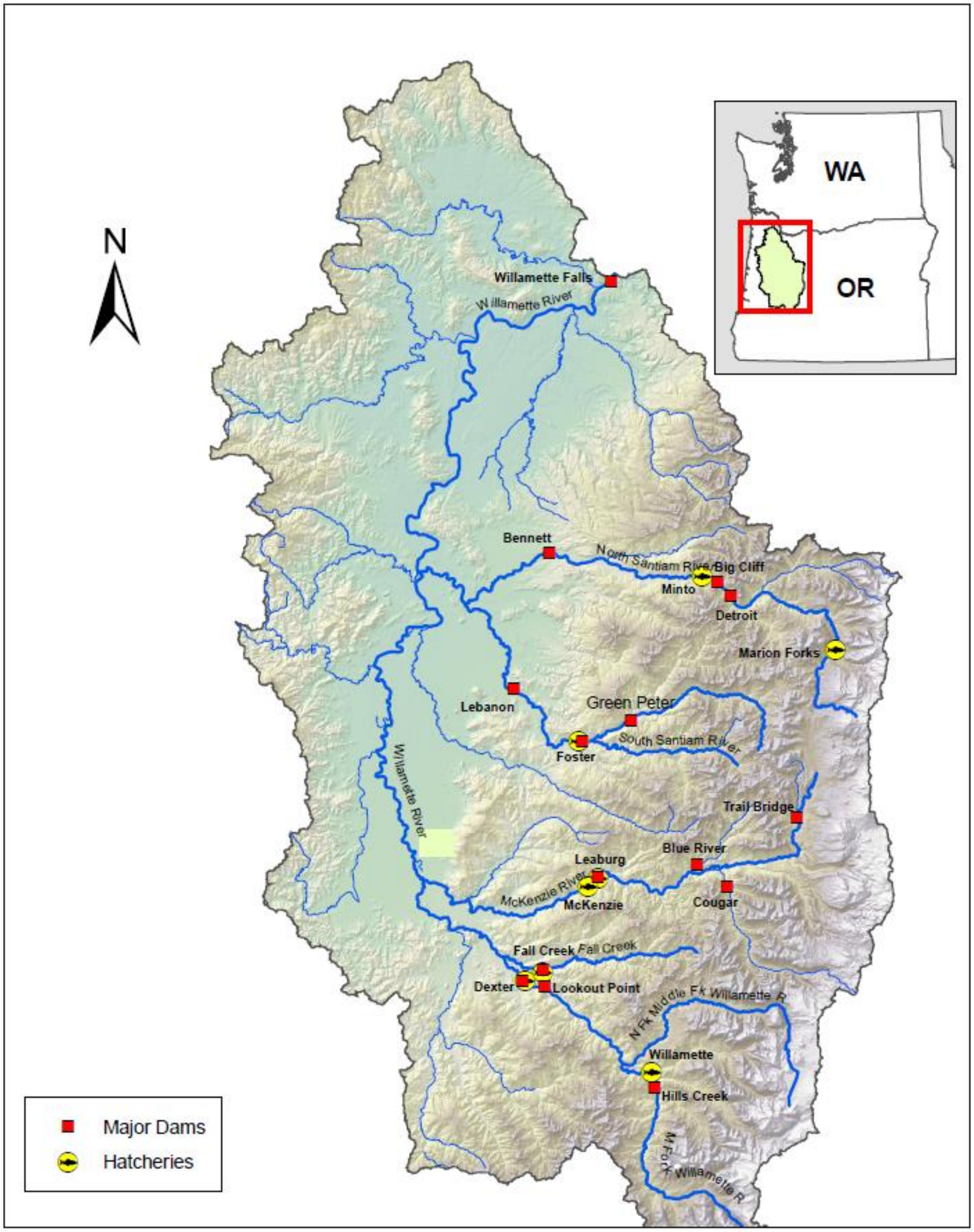

Figure 1. The Willamette Basin with major dams, hatcheries, and fish collection facilities.

Chinook salmon under the ESA and the implementation of ODFW's Native Fish Conservation Policy requires monitoring the number of hatchery and wild fish that comprise the spawning populations in the Willamette basin. The Willamette Project Biological Opinion identified the need to reduce hatchery fish spawning in the wild to "the lowest extent possible (0–10%)" (NOAA 2008).

In the Willamette Basin upstream of Willamette Falls (Figure 1), there are four distinct spring Chinook salmon hatchery programs (i.e., North Santiam [Stock 21], South Santiam [Stock 24], McKenzie [Stock 23], and Middle Fork Willamette [Stock 22]) that are managed for integrated harvest augmentation as part of the WHMP. These hatchery stocks, as well as all naturally spawned spring Chinook salmon in the Upper Willamette Basin, are included in the Upper Willamette River Evolutionary Significant Unit (ESU).

The Upper Willamette Summer Steelhead Hatchery Program is managed to provide fish for sport fisheries and to replace loss of fisheries caused by habitat and passage loss/degradation in the Willamette Basin and other lower Columbia basins. Summer steelhead are not native to the Willamette Basin upstream of Willamette Falls. Summer steelhead were first brought into the South Santiam River as mitigation for lost winter steelhead production in areas inundated by Foster and Green Peter reservoirs. The hatchery program currently includes annual smolt releases into the North Santiam, McKenzie, and Middle Fork Willamette rivers. Because summer steelhead are not native to the upper Willamette Basin and could interact negatively with ESA-listed species, the Willamette Project Biological Opinion (BiOP; NMFS 2008) required the USACE to collect information to describe the nature and extent of these potential effects.

This report fulfills a requirement under Task Order NWPPM-10-FH-06, covering activities of May 2011–June 2012 that were implemented by ODFW on behalf of the Corps to assist with meeting the requirements of the reasonable and prudent alternatives (RPAs) and measures prescribed in the Willamette Project Biological Opinion (BiOp) of July 2008 (NOAA 2008). The Corps provided funding to continue ongoing monitoring activities and initiate long-term planning. The relationship between spring Chinook salmon prioritized objectives, RPAs, and 2011 work tasks is depicted in Figure 2. A detailed list of tasks associated with the work is provided in Appendix 1.

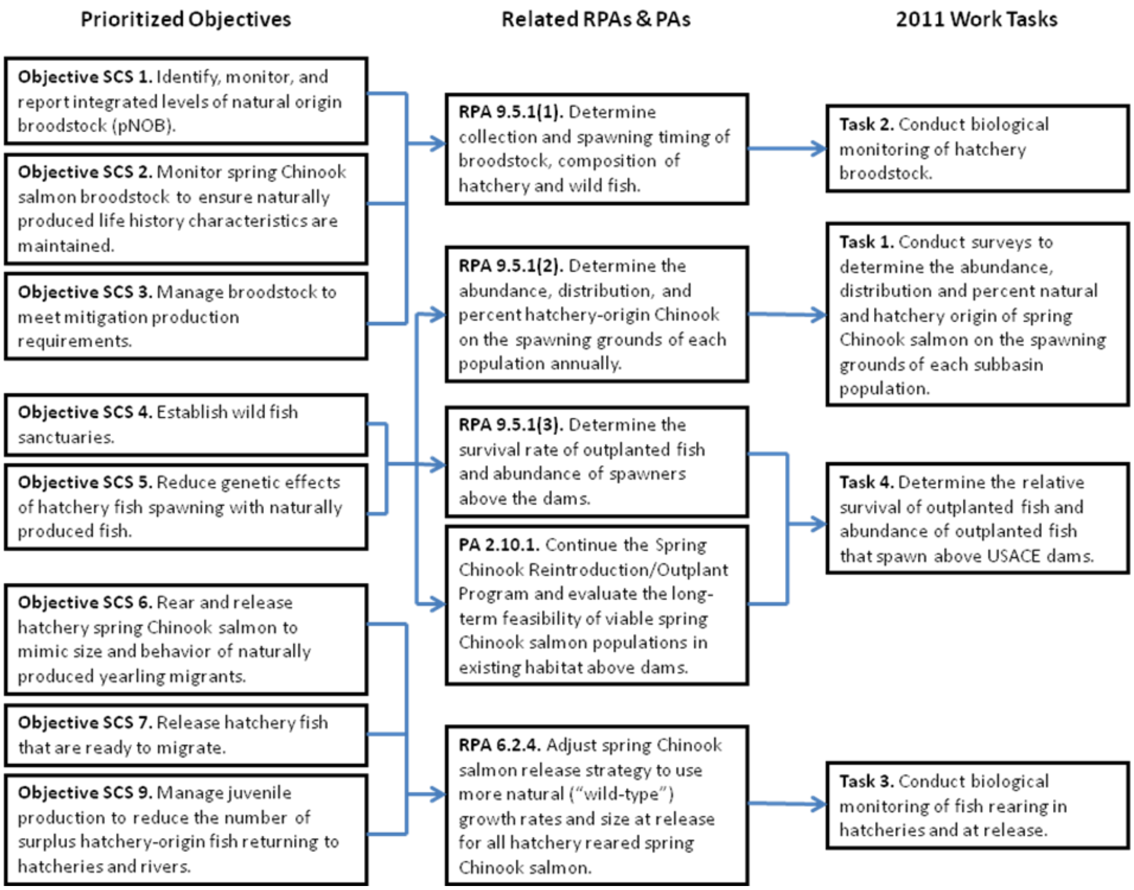

Figure 2. Relationship between Prioritized Objectives, Reasonable and Prudent Alternatives (RPAs), Proposed Actions (PAs), and Work Tasks conducted in 2011 for spring Chinook hatchery programs in the Upper Willamette Basin.

The ultimate goal of ODFW's Hatchery Research, Monitoring and Evaluation (HRME) program is to inform decisions on operation of the USACE Willamette Valley Hatchery Mitigation Program so that mitigation goals are met while minimizing negative impacts on naturally-produced, listed species and promoting their conservation and recovery. Progress towards that goal will follow achievement of three overarching objectives:

1. Develop and maintain hatchery broodstocks to meet mitigation, conservation, and recovery goals, and comply with existing genetic guidelines (Hatchery Genetic Management Plans);

2. Rear and release high quality hatchery fish to minimize impacts on naturally produced fish and promote conservation and recovery of listed species;

3. Manage adult returns to minimize impacts on naturally produced populations and to aid in recovery goals.

Section 1.1 Tasks

Task 1. Conduct surveys to determine the abundance, distribution and origin (hatchery or naturally-produced) of spring Chinook salmon on the spawning grounds of each subbasin population. (Objectives addressed: SCS 4 and SCS 5)

The purpose of this task is to describe the abundance, distribution, and composition (i.e., hatchery vs. natural origin fish) of adult spring Chinook salmon returning to spawn in Upper Willamette Basin tributaries. This task aims to describe, at varying spatial scales (Appendix 2), the population of adult returns with respect to: run size and timing, numbers of natural and hatchery origin fish collected for broodstock and outplanting, peak spawning dates, redd distribution and density, estimated natural spawning escapement, the proportion of hatchery origin fish on spawning grounds (PHOS), pre-spawning mortality (PSM) on spawning grounds, the age structure of the natural spawning population, hatchery stray rates, and harvest rates. To accomplish this, we employed a variety of data collection methods, such as monitoring the number of adipose fin clipped and unclipped adults arriving at dams and fish collection facilities, tracking the fate and disposition of fish entering traps and/or transported to hatcheries, conducting redd and carcass surveys on spawning grounds, sampling carcasses that were spawned at hatcheries, and compiling fish recapture data from RMIS.

The spawning ground surveys conducted as part of Task 1 are aimed at characterizing the naturally spawning population in accessible stream reaches downstream of USACE dams. Similar spawning ground surveys were conducted above these dams as well but are included under Task 4 as described below. This separation has been made to specifically monitor and evaluate outplanting efforts in stream reaches blocked by dams and the potential of these reaches to serve for reintroduction purposes and as sanctuaries for wild fish populations. Comparisons of estimated spawning population parameters (e.g., peak redd counts, redd densities, PHOS, and PSM) between spawning areas downstream and upstream of USACE dams are a useful tool for identifying reaches with relatively greater habitat potential and for evaluating hatchery management practices. Such comparisons are also addressed under Task 4.

Task 2. Conduct biological monitoring of hatchery broodstock. (Objectives addressed: SCS 1, SCS 2, and SCS 3)

The purpose of this task is to obtain estimates of origin (hatchery, wild, strays), size, age structure, run timing, and spawn timing. The intent is to ensure that broodstock collected and spawned in each hatchery program adequately meet mitigation, conservation, and recovery goals and comply with existing genetic guidelines.

Task 3. Conduct biological monitoring of fish rearing in hatcheries and at release. (Objectives addressed: SCS 6, SCS 7, and SCS 9)

This task involves monitoring of fish performance both in-hatchery (survival, growth) and post-release (migratory performance).

Task 4. Determine the relative survival of outplanted fish and abundance of outplanted fish that spawn above USACE dams. (Objectives addressed: SCS 4 and SCS 5)

The purpose of this task is to monitor and evaluate outplanting efforts in each of the four major Upper Willamette River subbasins. As mentioned above, the components of this task include: conducting spawning ground surveys in reaches where fish have been outplanted, collecting data on spawning population parameters (e.g., peak redd counts, redd densities, PHOS, and PSM) and analysis of spawning population parameters at varying spatial scales (Appendix 2). In addition, genetic sampling of outplanted fish is conducted in support of ongoing parentage studies at several projects and a study on the genetic diversity of the Willamette spring Chinook salmon populations (Johnson and Friesen 2013).

Section 1.2 Spring Chinook Salmon Production Program Goals

Section 1.2.1: Broodstock Collection and PNOB Goals

The intent of broodstock collection protocols at the UWR hatcheries is to sequester enough broodstock to ensure sufficient returning adults to support all mitigation requirements (e.g. harvestable fish, broodstock for the next generation, fish for outplanting, etc.) while simultaneously ensuring that the fish taken for broodstock are phenotypically similar to naturally-produced fish (e.g. run timing, spawn timing, age structure, etc.).

In 2011 broodstock collection began on 26 May 2011 and occurred through 3 October 2011. Collection protocols varied by hatchery. In the North Santiam subbasin, broodstock were collected in temporary traps at Upper and Lower Bennett dams and transported to McKenzie Hatchery for holding and spawning because the Minto Fish Collection Facility was under construction. In the South Santiam subbasin collection occurs at a trap in Foster Dam and fish are transported by truck to the nearby hatchery. In the McKenzie subbasin fish volunteer to the ladder on site at the hatchery. In the Middle Fork Willamette subbasin fish are captured at the Dexter Dam trap and transported by truck to the Willamette Hatchery further upstream. At capture, adult salmon are anesthetized with CO_2 to facilitate handling, except that the temporary protocols in place on the North Santiam did not permit use of anesthesia and fish were handled without anesthesia.

Spawning protocols are relatively uniform across hatcheries whereby adults are crowded, anesthetized with MS222 or CO_2, and checked for ripeness. Unripe fish are returned to holding areas and ripe fish are killed and bled. Eggs are removed from females into spawning buckets and fertilized using a 1:1 sex ratio.

Incorporation of natural origin fish into the broodstock may ultimately be set at 5% per ongoing discussions and development of the HGMPs but currently varies widely by hatchery. In the North Santiam during 2011 natural-origin fish were incorporated into the broodstock as part of an experiment to evaluate differences between hatchery- and natural-origin fish (Sharpe et al. *in review*). In the South Santiam subbasin no natural-origin fish were incorporated into the brood because downstream juvenile survival at Foster Dam may be high enough such that natural-origin adults are better off spawning above the Dam. In the McKenzie River the natural-origin adults that volunteer to the hatchery were incorporated into the brood because most unclipped adults (putative "wild" fish) that enter the hatchery are often unclipped hatchery fish; returning all unclipped fish to the river would increase PHOS among river spawners, an undesirable outcome. Natural-origin fish captured at Dexter Dam in the Middle Fork Willamette were all incorporated into brood at the Willamette Hatchery. Poor holding, spawning, and rearing conditions below Dexter Dam and recurrent high pre-spawning mortality rates above Lookout Point Dam, coupled with presumably poor downstream juvenile survival at Lookout Point and Dexter dams, led to the management decision to incorporate all unclipped (and thus a small number of naturally-produced) fish into brood in 2011.

Section 1.2.2: Outplanting and PHOS Protocols and Goals

Outplanting protocols vary widely throughout the subbasins. When the outplant goal is focused upon disposition of excess hatchery-origin fish (North Santiam, McKenzie, Middle Fork Willamette subbasins), outplanting generally begins relatively early in the run when it becomes apparent that the run size will be adequate to provide sufficient broodstock, and ends late. Exceptions exist at the McKenzie Hatchery and Dexter Trap when ongoing research projects require outplants at specific times either to test a particular practice (Dexter Trap: early outplants) or to experimentally manipulate PHOS (McKenzie Hatchery: genetic pedigree study). When outplanting is focused upon the disposition of unclipped fish (South Santiam River and the Cougar Dam trap in the South Fork McKenzie River) then outplanting begins and ends with the capture of the first and last unclipped adult fish.

In the North Santiam River the ultimate goal is to outplant using fish captured at the Minto Fish Collection Facility, but as that facility was under construction in 2011, outplanted fish (adipose clipped only) were captured and trucked from the trap at Upper Bennett Dam with adults released in both the Breitenbush and North Santiam arms of the reservoir. On the South Santiam River only unclipped fish captured at the Foster Dam trap were outplanted with outplant locations ranging from near the head of reservoir to multiple locations further upstream. On the McKenzie River outplants from the McKenzie Hatchery were exclusively adipose clipped fish taken to the South Fork McKenzie River to complement mostly unclipped fish transported from the Cougar Dam adult trap in support of a research project evaluating productivity of hatchery- and natural-origin spawners (Banks et al. *in prep*.). Outplanting in the Middle Fork Willamette Subbasin is a highly complex procedure. Adult fish from the Dexter Dam trap are outplanted into the Middle Fork Willamette above Hills Creek Dam to support recovery efforts for bull trout and into Little Fall Creek, a tributary to the Middle Fork Willamette River entering below Dexter Dam. Adults from both the Dexter trap and Willamette Hatchery are also outplanted in the North Fork Middle Fork Willamette River above Lookout Point Reservoir in various locations to support ongoing research into causes of pre-spawning mortality (Schreck et al. 2013; Mann et al. 2011). Finally, unclipped adults captured at the Fall Creek Dam trap are outplanted above Fall Creek Reservoir to continue recovery efforts there.

Section 1.2.3: Marking and Tagging of Hatchery Chinook Salmon

Adult hatchery fish are identified using a combination of marks that were applied to the juveniles prior to release. All hatchery-origin Chinook salmon receive adipose fin clips and a secondary thermal otolith mark. In addition, a portion of the juvenile hatchery Chinook salmon are released with coded-wire tags (CWTs). A summary of marks applied in 2011 appears in Table 1. Specific information on CWT releases is from the Regional Mark information System (RMIS) available online at http://www.rmpc.org/. On average, 687,000 CWT spring Chinook salmon are released into the basin annually (2000 – 2010; Shaun Clements, ODFW, pers. comm.) with more than 100,000 tagged fish typically released from each hatchery.

Section 2: Methods

Section 2.1 Estimating Spawner Parameters: Distribution, Abundance, and Proportion of Hatchery and Natural-Origin Chinook Salmon

Section 2.1.1: Monitoring Adult Returns

The majority of the spring Chinook salmon adults that pass Willamette Falls enter the North Santiam, South Santiam, McKenzie, and Middle Fork Willamette subbasins to spawn. In 2011, returns specific to each subbasin were monitored through spawning surveys and at fish ladders or collection facilities in each of the four subbasins. Depending on management objectives for each of the subbasin hatchery programs, fish captured at collection facilities were retained for broodstock, outplanted above USACE dams, recycled downstream for additional angling opportunities, sold for profit, donated to tribes, or used for stream enrichment.

2.1.1.1 Spawner Surveys: We surveyed four major eastside tributaries (North Santiam, South Santiam, McKenzie, and Middle Fork Willamette) in the Willamette Basin upstream of Willamette Falls (Figure 1) in 2011 by boat and on foot to count spring Chinook salmon carcasses and redds following established protocols (Schroeder et al. 2007; Gallagher et al. 2007; Boydstun and McDonald 2005; Kenaston et al. 2009; Cannon et al. 2010). We counted redds from late August through October to encompass the peak times of spawning based on data from surveys conducted in past years. Detailed maps of the subbasins are provided in the Results section and descriptions of the reaches are provided in Appendix 3.

For boat surveys we used rafts with elevated viewing towers on large river sections. On some river sections the raft stayed on one side of the river over the entire length of the section to count redds, whereas on other sections the raft crossed the river to count redds on both sides. Similar techniques were used on medium-sized rivers except that we used small rafts with viewing platforms lacking elevated towers. In tributaries that were inaccessible to walking surveys we used inflatable kayaks. All boat surveys were conducted in a downstream direction except that a small number of reaches required paddling or rowing upstream a short distance (<100 m) when the only boat launch site was below a reach break that could not be safely passed.

For walking surveys, a stream was classified as medium if the surveyor had to cross the stream to observe areas on the other side, or small if the surveyor could observe both sides of the stream without crossing (Schroeder et al. 2005). Observers counted redds and recorded global positioning system (GPS) coordinates for each redd in a river section. All walking surveys were conducted in a downstream direction except in a few instances when a surveyor completed a section and had the opportunity to assist a partner in an upstream reach by surveying upstream.

2.1.1.2 Carcass Sampling*:* During spawning surveys all carcasses that could be recovered by hand or with long-handled gaffs were examined for adipose fin clips to determine the proportion of hatchery fish on spawning grounds. We measured carcasses (cm fork length), determined sex, and estimated the proportion of remaining eggs in female fish to document pre-spawning mortality (details in section 2.1.2.5, below). Carcasses in water too deep to permit recovery or too degraded to permit inspection were recorded as unprocessable. We collected otoliths and scale samples from processable carcasses without fin-clips to differentiate unclipped hatchery fish from naturally-produced fish using results from otolith analyses performed by the Washington Department of Fish and Wildlife Otolith Laboratory (*see Proportion of Hatchery Spawners*, below). We used hand-held detectors manufactured by Northwest Marine Technology, Inc. (Tumwater, WA) to determine if carcasses with adipose fin clips had a CWT, and in the Middle Fork Willamette River to determine if unclipped carcasses had a CWT. Fish with CWTs and without fin clips might simply be mis-clipped fish, fish with regenerated adipose fins or fish from "double-index release groups" (intentionally released without a fin clip for fishery management purposes). We collected the snouts of tagged fish and put them in plastic bags with individually numbered labels. Tags were removed and identified at the ODFW Clackamas Fish Identification Laboratory to establish the origin of tagged fish.

2.1.1.3 Monitoring Fish Passage at Bennett and Leaburg Dams*:* We used underwater video cameras to observe net upstream movement of salmon and steelhead at the Upper Bennett Dam ladder (Figure 2) on the North Santiam River and the Leaburg Dam ladders on the McKenzie River (Figure 4). The video equipment uses software that automatically scans and records fish movement and creates video files from these images (FishTick, SalmonSoft, Inc., Portland, OR). The captured video images were reviewed and species, presence or absence of an adipose fin clip, direction of movement (upstream or downstream) were noted so that the net upstream movement of spring Chinook salmon by hatchery or wild origin could be estimated. We attempted to operate the video systems continuously throughout the migration season. When a video system failed we estimated the number of fish that may have passed during these outages based on simple linear extrapolation of fish counts recorded during the time when the video equipment was operating normally on the same day.

2.1.1.3.1 Video Monitoring at Bennett Dam*:* In response to the need for minimizing negative impacts on listed fish, a number of fish monitoring improvements on the North Santiam River have occurred. In 2005, a new vertical slot fishway replaced the existing pool and weir fishway at Upper Bennett Dam. The vertical slot design provides passage for multiple fish species over a wide range of flows and requires less adjustment to control flows. The new fishway was equipped with an adjacent trapping facility to accommodate future management or research activities. Efforts were made to incorporate a fish viewing window into the trap, but proved unsuccessful due to overriding budget constraints. In 2006, no fish monitoring occurred due to budget limitations, but the fish trap was operated briefly to demonstrate the trap's ability to capture adult salmonids. In 2007, the Bennett Dam fishway traps were operated on a limited basis to collect migration data and assess the ability of the new Upper Bennett Dam ladder to pass fish upstream. A portable underwater camera installed in the Upper Bennett fishway documented passage of significant numbers of adult spring Chinook salmon in June 2007, confirming proper fishway function. In 2008, Oregon Department of Fish & Wildlife Restoration and Enhancement Program grant funding was secured to purchase and install video recording equipment in the Upper Bennett Dam fish ladder. A steel view chamber and weir panels were installed in the fishway to house the video equipment and guide fish past the viewing window. A small shed was placed upslope of the fishway to house electronics and a battery bank used to power the equipment (e.g., camera, lights, DVR recorder). The facility proved beneficial at minimizing impact on ESA-listed species, but was too labor intensive due to the need to frequently change batteries. Additionally, periodic power outages and inadequate illumination, especially at night, precluded sufficient collection of critical data in 2008.

In 2009, Hatchery operations and maintenance funds were used to improve the facility. A 5 KW propane generator, 75 amp chargers, and large 1500+ amp hour capacity battery bank was installed in August 2009 to provide constant power to the video equipment. The new system, while an improvement, still proved somewhat labor intensive in that propane cylinders required recharging about every 10 days. In 2010, an on-site 150 gallon propane tank was installed to replace the smaller 8 gallon propane cylinders which fueled the generator. The new tank is now filled by service truck every six weeks. Additional LED lighting substantially improved illumination at night and resulted in markedly improved data collection.

Also in 2010, preliminary planning was initiated for investigating power supply possibilities to Lower Bennett Dam fish ladder for future fish video monitoring. In 2011, a power supply to the Lower Bennett Dam fishway was installed. The new power supply provides a stable source of electricity to operate current and future video monitoring equipment. The power supply is also ready to accommodate a 100 amp electrical service and fiber optic line to a future new Lower Bennett dam fishway with built in view chamber. Video equipment (camera, lights, custom Plexiglas camera box, and laptop computer with fish detection software) was purchased and tested successfully. Design, fabrication, and test fitting of the Lower Bennett Dam fish ladder guidance weirs were performed. Installation of video equipment in the Lower Bennett Dam fishway is scheduled for spring of 2012.

In 2011, the Upper Bennett Dam trap was used to collect North Santiam spring Chinook salmon brood due to the reconstruction of the Minto Fish Collection Facility. Marked spring Chinook salmon were loaded into trucks and transported to McKenzie Hatchery while unmarked spring Chinook salmon in excess of broodstock needs and hatchery summer steelhead were allowed to pass upstream. Fish collected or passed at the trap were added to video fish counts to reflect total daily passage. We used video recording equipment at Leaburg Dam on the McKenzie River and Upper Bennett Dam on the North Santiam River to monitor the number of fish migrating upstream. An adult fish trap is also present at both sites. The Leaburg trap was used to selectively remove adipose clipped Chinook salmon in August and September when relatively small numbers of unclipped Chinook salmon were attempting to pass upstream. The Upper Bennett trap was used to collect Chinook salmon broodstock for transport to and holding at McKenzie Hatchery while the Minto trap and holding facility on the North Santiam River is being rebuilt. Also, clipped fish were collected at upper Bennett Dam for outplanting above Detroit Reservoir.

Passage of spring Chinook salmon at Upper Bennett Dam was monitored 1 January –31 December 2011 with video recording equipment located in the fishway. The video system uses software that automatically identifies frames containing fish and creates video files. Fish counts were compiled from the video files by species and by presence or absence of adipose fin clips. Fish that were observed moving downstream were subtracted from the total counts. Video monitoring was operated continuously and no adjustments to counts were necessary. Monitoring at Lower Bennett Dam was not conducted in 2011 because the video system at that facility is still being developed (see section 1.2.4).

2.1.1.3.2 Video Monitoring at Leaburg Dam*:* Passage of spring Chinook salmon through the fishways at Leaburg Dam was monitored with video recording equipment. We recorded fish passage at both the left-bank and right-bank fish ladders.

Section 2.1.2: Data Analysis

2.1.2.1 Peak Redd Counts and Peak Redd Densities*:* The peak redd count is the maximum number of redds observed in each survey section over the course of the survey season and represents an estimate of the total number of redds constructed by Chinook salmon in each section. When redd counts differed between initial surveys and resurveys conducted to evaluate variability in redd counts (described below) the resurvey counts were used to replace the initial counts. Peak redd densities were calculated by dividing the peak redd count by the length (km) of each section.

2.1.2.2 Escapement Estimates*:* We used the peak count expansion method to estimate total spawning escapement where we assumed that the peak redd count in any reach of interest adequately reflected the relative abundance of fish that spawned in that reach, each redd was constructed by one female, and each female spawned with 1.5 males (Gallagher et al. 2007; Boydstun and McDonald 2005).

An escapement estimate (E) derived from the peak count expansion method was calculated by the following equations:

$E = F_{spawn} + M_{spawn}$, where

$F_{spawn} = Redd_{peak}/Redd_{female}$,

$M_{spawn} = F_{spawn} \times 1.5$

F_{spawn} = number of spawning females,

M_{spawn} = number of spawning males,

$Redd_{peak}$ = peak redd count,

$Redd_{female}$ = number of redds/spawning female = 1.

We then parsed the total escapement estimate into hatchery and wild spawning cohorts by using the PHOS estimates derived from carcass sampling with adjustments that followed otolith analyses. Clearly there is a large effect that the string of assumptions has on the accuracy of the estimates and there are no estimates of precision associated with redd count expansions. Therefore, these values should be used with caution.

2.1.2.3 Variability of Redd Counts*:* In 2011, we assessed differences in redd counts between surveyors during foot and raft surveys by following up normal boat and walking surveys with a second survey ("resurvey") by our most experienced surveyors.

Re-surveys are surveys conducted in addition to regularly scheduled surveys, and conducted in the same way as the surveys (see survey methods this report). Final estimates of redd densities (number of redds per river km in each section of surveyed river) followed the peak count method. Redds accumulate on the spawning grounds through the season until they reach a maximum. Because redds are for the most part a fixture on the landscape during the period of time spawning occurs, it is reasonable to assume the peak count adequately represents the number of viable redds within a particular area and minimizes temporal bias within a spawning season (Dunham et al. 2001; Muhlfeld et al. 2006). The purpose of the re-survey is to estimate bias in census counts among different observers. For this reason, re-surveys were conducted as closely as practical in time and space to the peak count surveys using similar equipment, protocols, river and weather conditions, and spatial coverage (Dennis et al. 2010). Resurveys were conducted in areas of known high redd densities where surveys in earlier years indicated redd superimposition routinely occurred. When compiling redd count data and determining peak redd counts for survey reaches, counts obtained from the resurveys were used in place of the corresponding initial counts. Resurveys were not conducted in the Middle Fork Willamette subbasin because redd densities rarely indicate redd superimposition occurs below Dexter Dam.

2.1.2.4 Proportion of Hatchery Spawners*:* We combined counts of clipped and unclipped fish wherever they were encountered (at video counting stations, during spawner surveys, and during monitoring of adult fish entering hatchery traps) with validation of hatchery or wild origin from otolith data to derive the proportion of hatchery spawners (PHOS) at various spatial scales. The spatial scales included basin-wide, by subbasin, above and below dams, and, in some cases, by river reach. To differentiate between hatchery and wild Chinook salmon and to implement a selective fishery, all hatchery spring Chinook salmon in the Willamette basin, beginning with the 1997 brood year, have been marked with adipose fin clips, CWTs, or both. Thermal marks are also induced in the otoliths of all hatchery Chinook salmon released in the basin to provide an additional mark for identifying unclipped hatchery fish. Some juvenile Chinook salmon are inadvertently released without a fin clip at a rate that varies by hatchery and by brood year (Schroeder et al. 2005). However, the percentage of unclipped fish in hatchery releases has decreased in recent years with the implementation of automated fin-clipping systems. Other factors that contribute to the return of unclipped hatchery fish include the release of unclipped hatchery fish with CWTs (double-index), and natural regeneration of partially clipped adipose fins.

We estimated the proportion of natural-origin (wild) and hatchery-origin fish in 2011 by examining otoliths collected from carcasses on the spawning grounds. We collected samples from adult spring Chinook salmon carcasses without fin clips on spawning grounds and at hatcheries in four sub-basins (McKenzie, North and South Santiam, Middle Fork Willamette). Otoliths were collected and placed into individually numbered vials. The samples were subsequently sent to the otolith laboratory operated by Washington Department of Fish and Wildlife for analysis of thermal marks. The proportion of hatchery origin spawners (PHOS) was derived from the counts of fin-clipped fish (AD), unclipped thermally-marked fish (UTM) and total count of fish examined (TOT) using the equation

PHOS = [AD + UTM]/TOT),

where total counts varied depending on the spatial scale at which we were attempting to estimate PHOS. An exception to this procedure occurred in 2011 for the North Fork Middle Fork Willamette River. Because no unclipped fish are supposed to be outplanted above Lookout Point Dam the field crews were erroneously not instructed to sample otoliths. Two unclipped fish were encountered during surveys but, because we did not have otoliths available to determine actual origin, we used the proportion of unclipped otolith-marked fish encountered below Dexter Dam to parse the two fish into one hatchery- and one natural-origin.

We also used the otoliths to adjust estimates of the proportion of natural-origin brood (PNOB) in the hatcheries using the counts of non-thermally marked unclipped broodstock ($WILD_B$), and the total number of broodstock (TOT_B) using the equation

$PNOB = WILD_B/TOT_B$.

We compared PHOS estimates between subbasins and between river reaches below dams within subbasins using contingency table analyses (G-tests) where observed values were the estimated counts of wild- and hatchery-origin carcasses.

2.1.2.5 Pre-spawning Mortality*:* We surveyed major tributaries of the Willamette basin by boat and on foot in 2011 to estimate pre-spawning mortality (PSM) based on the proportion of unspawned female salmon carcasses observed. For the purpose of discussion in this document we arbitrarily categorize PSM as low, medium and high when estimates were less than 20%, from 20% to 50%, and above 50%, respectively. The surveys were conducted in a manner identical to the spawner surveys (described above) but began in the summer prior to any spawning to permit observation of any early mortality that occurred as salmon reached spawning tributaries. Female carcasses were also checked for spawning success during the regular spawning surveys and redd counts through early October so that pre-spawning mortality could be assessed over the entire run. For every female salmon carcass that could be recovered during the pre-spawning and spawning surveys the gut cavity was cut open to visually judge the relative abundance of eggs. Female carcasses with intact or relatively intact skeins (i.e. greater than 50% eggs remaining) were considered unspawned. The 50% threshold is arbitrary but in practical terms virtually all female carcasses had either essentially no eggs remaining or completely intact skeins. We then calculated PSM by dividing the number of unspawned female carcasses by the total number of female carcasses where spawning status was observed.

2.1.2.6 Straying of Hatchery Fish*:* In the Willamette basin a stray is defined as any hatchery fish that does not return to its hatchery of origin and either spawns naturally or is encountered at another hatchery. In addition to estimating PHOS (described above) in each subbasin we estimated the contribution to PHOS of strays from outside the subbasin into which the juveniles were originally released.

We used handheld tag detectors to check for CWTs in carcasses recovered during surveys. The decimal codes of CWTs were read at ODFW's Clackamas Fish Identification Laboratory to identify the release site. We estimated the extent and origin of stray hatchery fish by expanding the number of recovered fish with a specific tag code to the percentage of fish in that release group that were tagged. For example, if one CWT from a McKenzie release was recovered in the South Santiam River when 10% of the McKenzie fish received CWTs, we assumed an additional nine McKenzie fish from that release strayed into the South Santiam River.

Section 2.2: Reintroduction Efforts

We intercepted salmon for outplanting (and broodstock collection, fish sales, fish donation, and stream enrichment) at adult fish traps at the left (south) bank ladder of the Leaburg dam, Dexter Dam, Foster Dam and the Upper and Lower Bennett dams. Biological data and specimens (fork length, sex, scales, presence of tags or fin clips, otoliths [from lethally sampled fish], DNA) were collected. The count of adult fish outplanted above project dams was used as the initial basis for adult abundance above dams, modified by estimates of abundance and distribution based on spawner surveys (described below).

We collected biological data from all Chinook salmon that were outplanted. Data collected from spawned fish included fork length, sex, and presence or absence of an adipose fin clip. Scales and otoliths were collected from all unclipped fish. We collected tissue samples (small portion of a fin stored in 100% ethanol) from outplanted fish, and recorded sex along with presence or absence of a fin clip.

Section 2.3: Broodstock Sampling

2.3.1 Collection, Spawn Timing, Composition, and Disposition of Broodstock. Traps are operated for each of the Willamette spring Chinook salmon hatcheries to collect broodstock. Chinook salmon are also trapped at Leaburg Dam and Leaburg Hatchery and then transported to McKenzie River Hatchery. Disposition of collected salmon is recorded at each hatchery by presence or absence of an adipose fin clip.

Section 2.4: Within Hatchery Monitoring

2.4.1 Adult Monitoring*:* The bulk of within hatchery monitoring involved tracking the fate and disposition of adult fish at each of the hatcheries. The data were acquired by a combination of (1) direct sampling by HRME staff at each hatchery during outplanting and spawning activities, (2) queries of the data provided by the hatchery managers to the Hatchery Management Information System (HMIS), and (3) interviews with the hatchery managers to verify portions of the data that were provided to HMIS.

2.4.2 Juvenile Monitoring*:* Juvenile sampling at the hatchery facilities and during emigration is not formally a part of the HRME Baseline Monitoring tasks but juveniles were routinely monitored as a part of the work performed under HRME "Uncertainty Research" activities. Details on methods employed and results obtained are provided under separate cover (Tinus et al. *in review*; Sharpe et al. *in review*).

We obtained summaries of the number of fish released, rearing locations, release locations and size at release in 2011 for both summer-run steelhead and Chinook salmon by querying HMIS for those data (Appendix 5). We also queried RMIS to obtain information on Chinook salmon liberation dates and release locations for CWT fish from Willamette hatcheries (Appendix 5). Steelhead have not been released with CWTs since the 1980s.

Table 1. Marking of juvenile Chinook salmon released in 2011.

Stock	Tag Code	Release Date	Avg Weight (g)	CWT/AD/OT	AD/OT[1]	Release Location
North Santiam (021)	090393	03/23/11	35.97	53,167	197,367	North Santiam River
North Santiam (021)	090391	04/12/11	34.86	55,092	171,703	North Santiam River
North Santiam (021)	090392	03/02/11	32.61	53,656	155,676	North Santiam River
South Santiam (024)	090349	02/28/11	47.95	30,646	72,935	Molalla River
South Santiam (024)	090262	02/14/11	48.2	31,854	394,230	South Santiam River
South Santiam (024)	090263	03/16/11	48.72	31,534	257,442	South Santiam River
South Santiam (024)	090478	10/28/11	52.68	51,248	253,222	South Santiam River
McKenzie (023)	090389	03/09/11	46.24	105,441	357,970	McKenzie River
McKenzie (023)	090388	01/27/11	38.08	100,243	276	McKenzie River
McKenzie (023)	090533	11/03/11	43.16	152,674	0	McKenzie River
McKenzie (023)	090534	11/03/11	43.16	200,162	0	McKenzie River
McKenzie (023)	094654	03/31/11	41.2	26,901	221,965	Youngs Bay (Columbia R.)
MF Willamette (022)	090340	03/29/11	38.08	23,807	229,565	Blind Slough (Columbia R.)
MF Willamette (022)	090341	03/30/11	34.86	26,941	73,421	Tongue Point (Columbia R.)
MF Willamette (022)	090232	02/11/11	50.96	31,961	622,370	MF Willamette River
MF Willamette (022)	090384	01/28/11	39.27	90,617	116,686	MF Willamette River
MF Willamette (022)	090385	01/28/11	46.05	92,470	239,271	MF Willamette River
MF Willamette (022)	090386	04/13/11	56.63	78,446	158,096	MF Willamette River
MF Willamette (022)	090472	11/01/11	58.08	264,372	51,415	MF Willamette River
MF Willamette (022)	090339	03/04/11	36.55	27,256	426,214	Youngs Bay (Columbia R.)
		Tagged/Marked for release in the UWR		1,423,583	3,048,659	
			Total Tagged	1,528,488	3,999,824	

[1] "CWT/AD/OT" indicates numbers of juveniles receiving coded wire tags, adipose fin clips and thermal otolith marks. “AD/OT” indicates numbers of juveniles receiving adipose fin clips and thermal otolith marks only.

Section 3: Results

Section 3.1: Abundance, Distribution, and Composition of Adult Spring Chinook Salmon

Section 3.1.1 Adult Returns:

In 2011 the total count of spring Chinook salmon ascending Willamette Falls was 45,147 (43,748 adults and 1,399 jacks). Fish arrived beginning on 25 February, peaked on 25 May and concluded 15 August (by convention: Chinook salmon counted after 15 August are considered fall Chinook salmon). The run at Willamette Falls was predominated by hatchery returns, with more than 70% of the 2011 run originating from WHMP hatcheries (ODFW/WDFW 2012).

In 2011, spring Chinook salmon adults and jacks were collected at Upper Willamette Basin facilities beginning in late May or early June at all facilities, and concluding in early September through early October at the South Santiam, McKenzie, and Dexter facilities. Collections at Upper Bennett Dam on the North Santiam River concluded in early August (Appendix 4).

Section 3.1.2 Redd Counts, Redd Distribution, and Spawn Timing:

We used a combination of spawning ground surveys, hatchery records, and dam counts to derive indices of spawner density and estimates of run size and spawner escapement for hatchery- and natural-origin Chinook salmon in the four basins of interest. For each subbasin, summary data on redd counts, redd densities, and pre-spawning mortality rates are provided in the form of maps with pooling of the counts and rates across multiple sample reaches to illustrate general patterns of abundance and distribution. The pooled reaches are generally bounded by points where some measure of control of fish movement exists, such as at traps or dams. In some cases the pooled reaches represent particular tributary streams where new surveys were conducted in 2011 (e.g. Little Fall Creek in the Middle Fork Willamette) or where unusual management options were exercised in 2011 and detailed information on survey results in those tributaries might be of particular interest (e.g., the Little North Santiam River where no outplanting occurred in 2011). A description of how survey reaches were pooled for which metrics is presented in draft form in Appendix 2.

North Santiam River: The North Santiam River (Figures 3 and 4) was surveyed July through October 2011. Redd construction was first observed the week of 31 August and peak redd counts were obtained in the week of 28 September. As in previous years, redd density in 2011 was highest in the section between Upper Bennett and Minto dams. Within that reach the highest redd densities were observed immediately below Minto Dam. Redd densities were significantly higher between Bennett and Minto dams in 2011 compared to recent historical values (2005 – 2010: 10.6 redds/km vs. 4.9 $\pm$ 0.7 redds/km [mean $\pm$ SEM]; $t = -8.0$; df = 5; $P < 0.001$) for that reach (Tables 1 and 2). Redd density below Bennett Dam differed significantly in 2011 from recent values (2005 – 2010: 2.9 redds/km vs. 1.4 $\pm$ 0.5 redds/km [mean $\pm$ SEM]; $t = -2.9$; df = 5; $P = 0.035$), an outcome that might be explained if the operation of the Bennett Dam trap delayed upstream migration of adult fish.

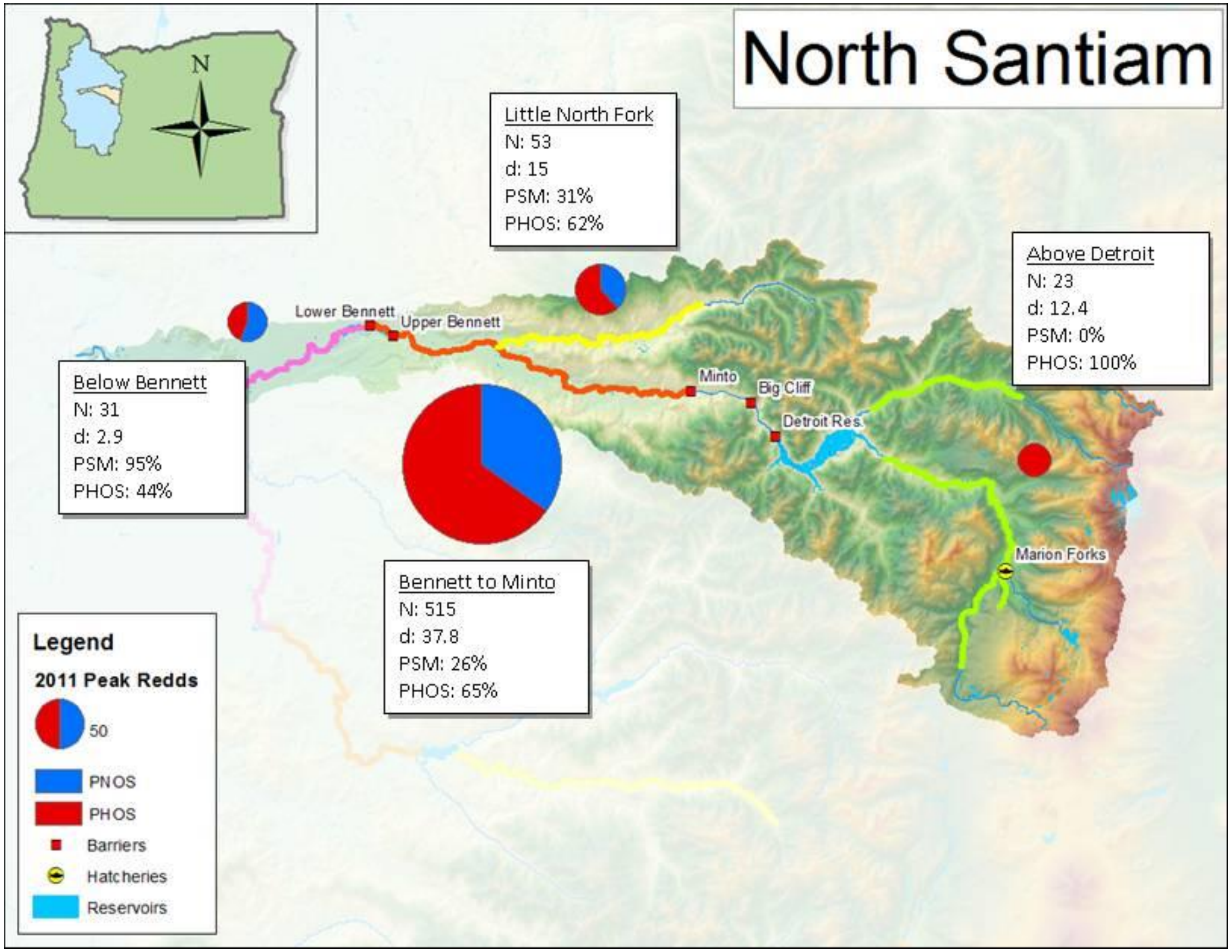

Figure 3. Spawner survey and carcass recovery results for the North Santiam River, 2011. Colored sections indicate major survey reaches. Pie charts indicate peak redd counts (also indicated by "N") by their size and proportion of hatchery-origin spawners (PHOS). d = Redd density (redds/km) and PSM = pre-spawning mortality.

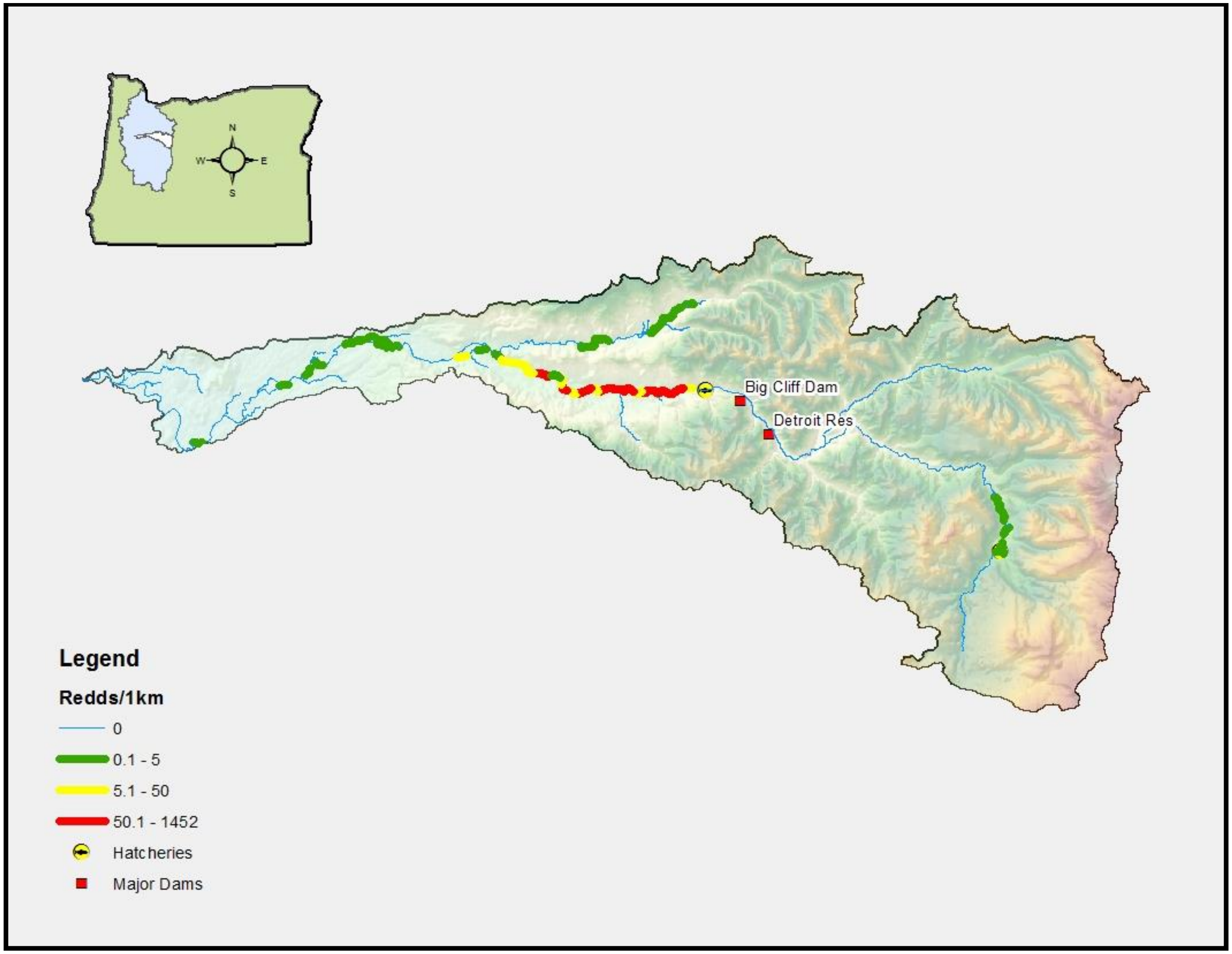

Figure 4. Redd density (peak redd count/km) in the North Santiam subbasin,2011.

South Santiam River: The South Santiam River (Figures 5 and 6) was surveyed July through October 2011. Redd construction was first observed the week of 24 August and peak redd counts (Table 2) were obtained in the week of 21 September. As in previous years, the redd density in 2011 was highest in the section between the town of Lebanon and Foster Dam. Within that reach the highest redd densities were observed immediately adjacent to and below Foster Dam, near the South Santiam Hatchery. Redd counts and densities in 2011 were similar to recent historical redd densities (Table 3) above Lebanon Dam (2005 – 2010: 22.4 redds/km vs. 20.7 ± 3.1 redds/km [mean ± SEM]; t = -0.6; df = 5; *P* = 0.605) and below Lebanon Dam (2005 – 2010: 0.2 redds/km vs. 2.216 ± 1.8 redds/km [mean ± SEM]; t = 1.1; df = 2; *P* = 0.389).

McKenzie River: The McKenzie River (Figures 7 and 8) was surveyed July through October 2011. Redd construction was first observed the week of 7 September and peak redd counts (Table 2) were obtained in the week of 28 September. As in previous years, the redd density in 2011 was highest in the section below Leaburg Dam. Within that reach the highest redd densities were observed immediately below Leaburg Dam near the McKenzie Fish Hatchery. Moderate redd densities were observed above Leaburg Dam with a decreasing trend in both PSM and PHOS upstream. Redd counts and densities in 2011 were similar to recent historical redd densities (Table 3) above Leaburg Dam (2005 – 2010: 11.7 redds/km vs. 99.0 ± 1.4 redds/km [mean ± SEM]; t = -2.0; df = 5; *P* = 0.100) and below Leaburg Dam (2005 – 2010: 22.8 redds/km vs. 16.4 ± 3.4 redds/km [mean ± SEM]; t = -1.891; df = 5; *P* = 0.117).

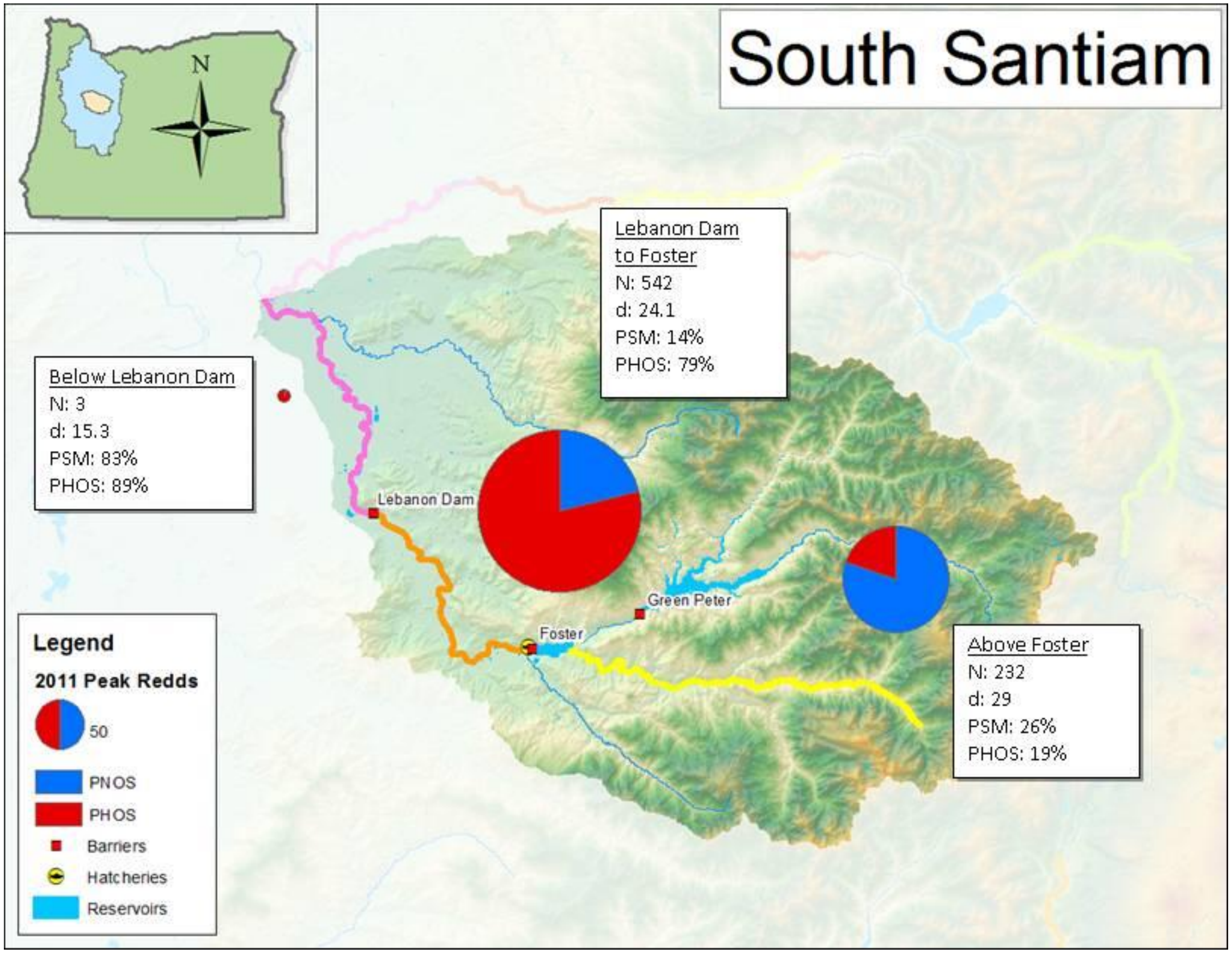

Figure 5. Spawner survey and carcass recovery results for the South Santiam River, 2011. Colored sections indicate major survey reaches. Pie charts indicate peak redd counts (also indicated by "N") by their size and proportion of hatchery-origin spawners (PHOS). d = Redd density (redds/km) and PSM = pre-spawning mortality.

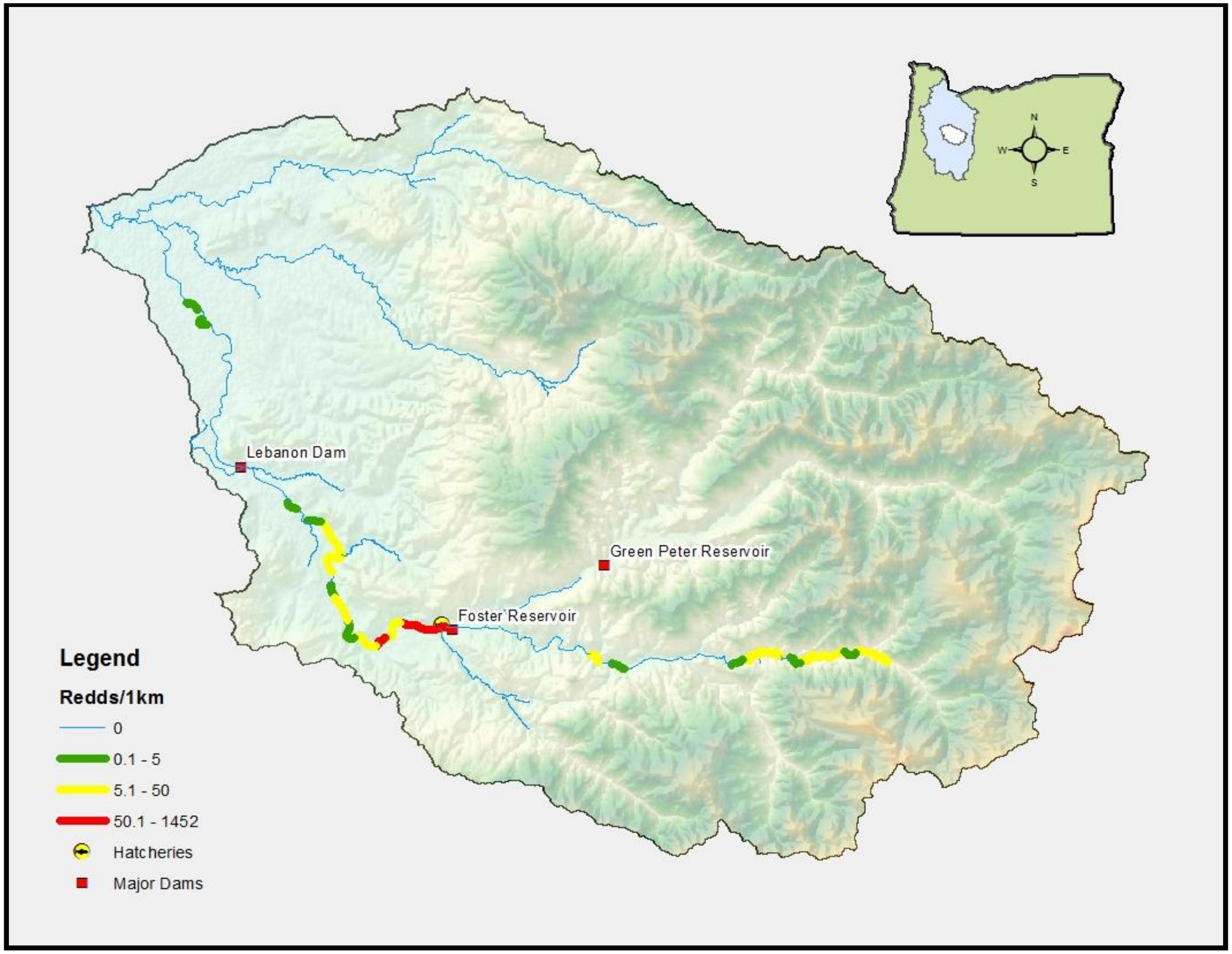

Figure 6. Redd density (peak redd count/km) in the South Santiam Subbasin, 2011.

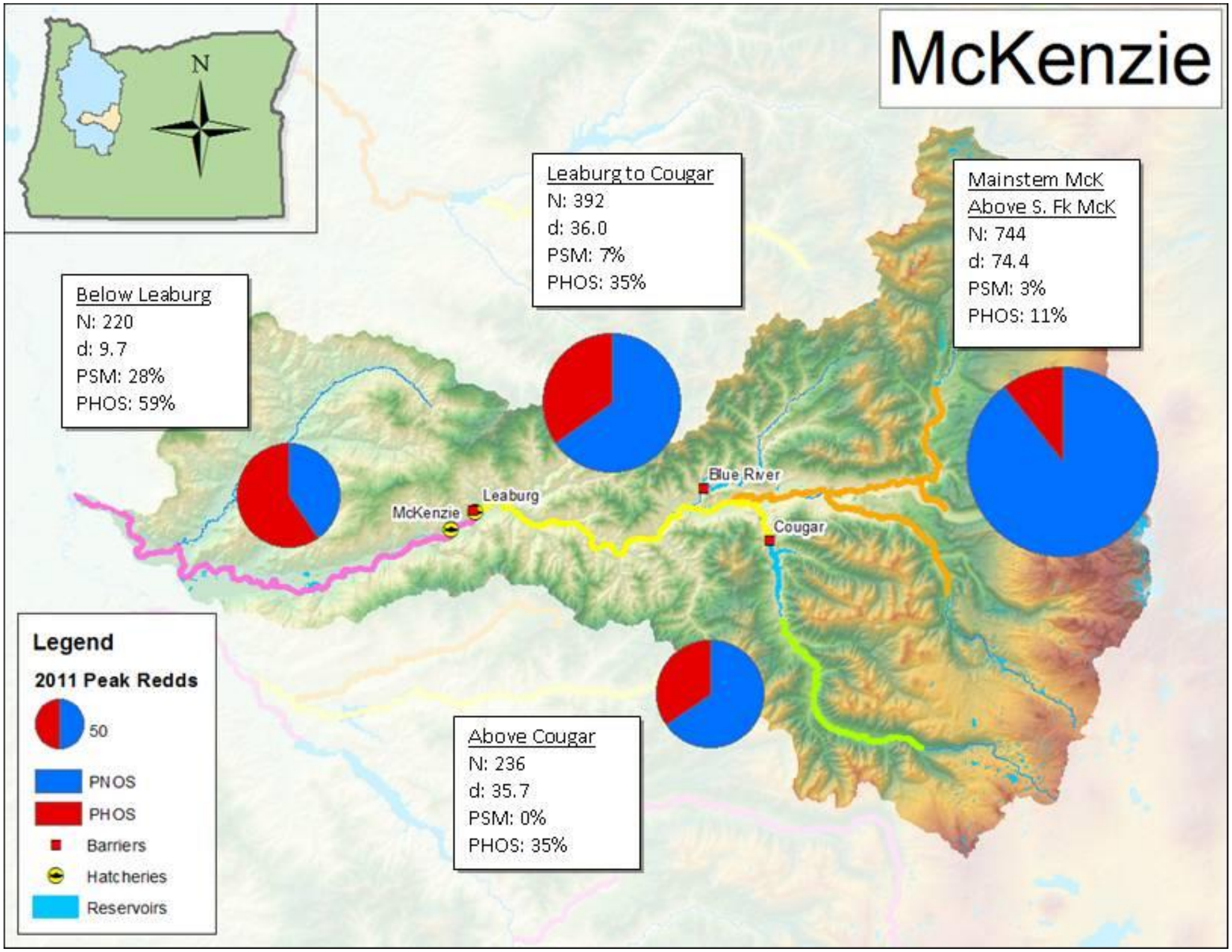

Figure 7. Spawner survey and carcass recovery results for the McKenzie River, 2011. Colored sections indicate major survey reaches. Pie charts indicate peak redd counts (also indicated by "N") by their size and proportion of hatchery-origin spawners (PHOS). d = Redd density (redds/km) and PSM = pre-spawning mortality.

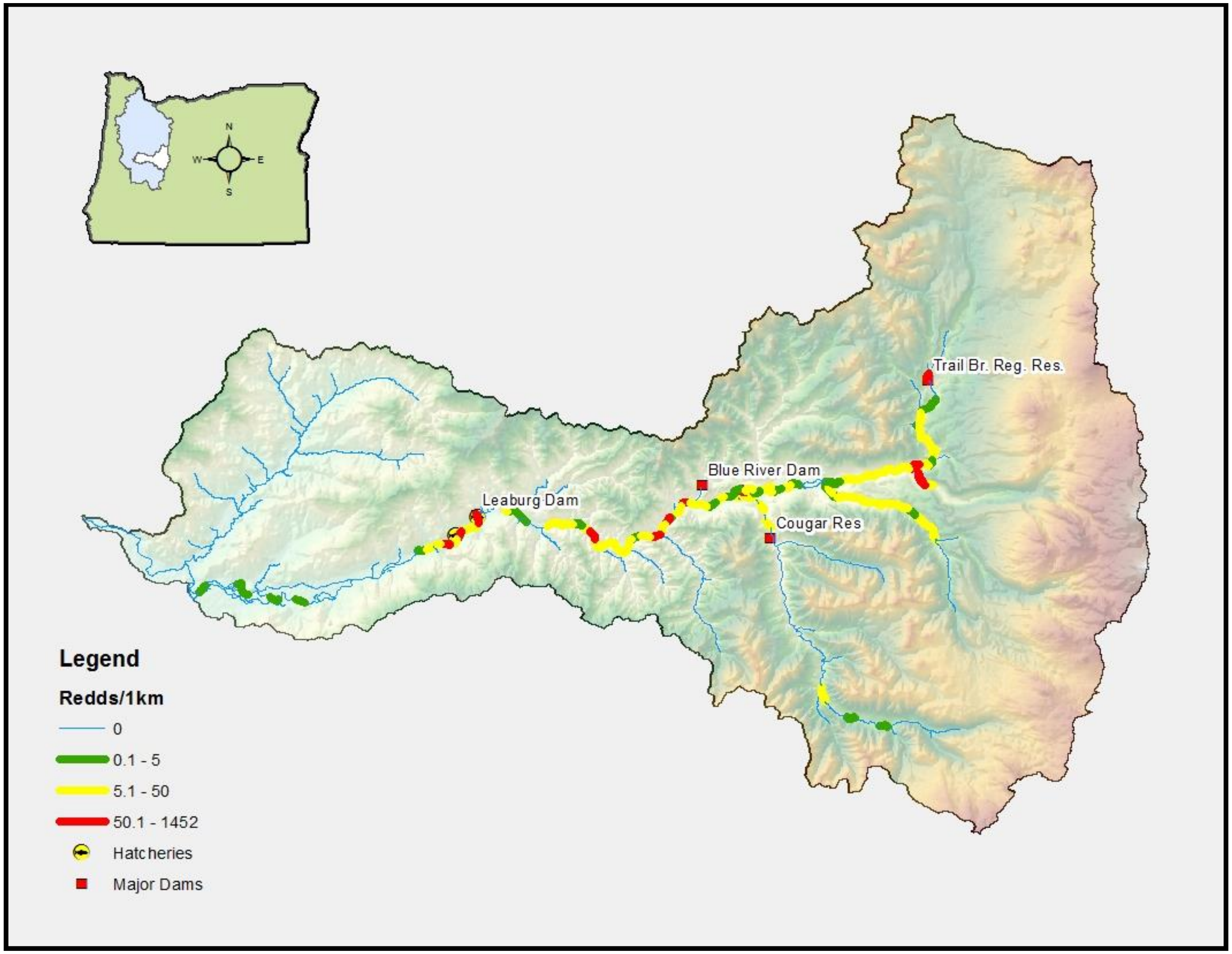

Figure 8. Redd density (peak redd count/km) in the McKenzie Subbasin, 2011.

Middle Fork Willamette River: The Middle Fork Willamette River (Figures 9 and 10) was surveyed July through October with some additional surveys in Fall Creek and the North Fork Middle Fork beginning in June. The supplemental surveys were conducted as part of an independent study examining pre-spawning mortality (Mann et al. 2011). Most redds were constructed in the reach immediately downstream of Dexter Dam. Redd construction was first observed the week of 24 August and peak redd counts (Table 2) were obtained in the week of 28 September. Redd densities in 2011 were similar to recent historical redd densities (Table 3) below Dexter Dam (2005 – 2010: 6.8 redds/km vs. 3.7 $\pm$ 1.6 redds/km [mean $\pm$ SEM]; t = -2.0; df = 5; P = 0.100) and in Fall Creek (2005 – 2010: 2.2 redds/km vs. 3.6 $\pm$ 1.1 redds/km [mean $\pm$ SEM]; t = 1.296; df = 5; P = 0.252).

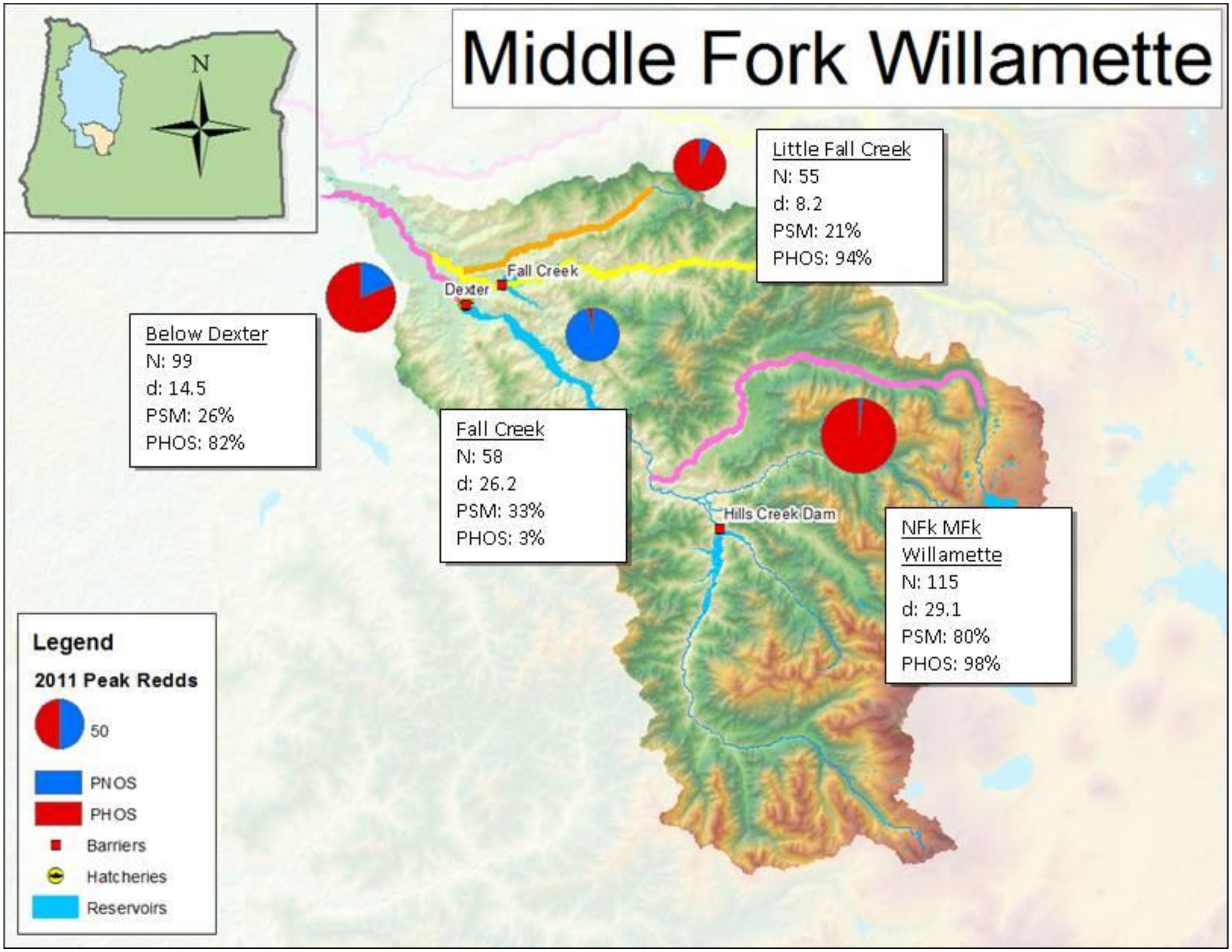

Figure 9. Spawner survey and carcass recovery results for the Middle Fork Willamette River, 2011. Colored sections indicate major survey reaches. Pie charts indicate peak redd counts (also indicated by "N") by their size and proportion of hatchery-origin spawners (PHOS). d = Redd density (redds/km) and PSM = pre-spawning mortality.

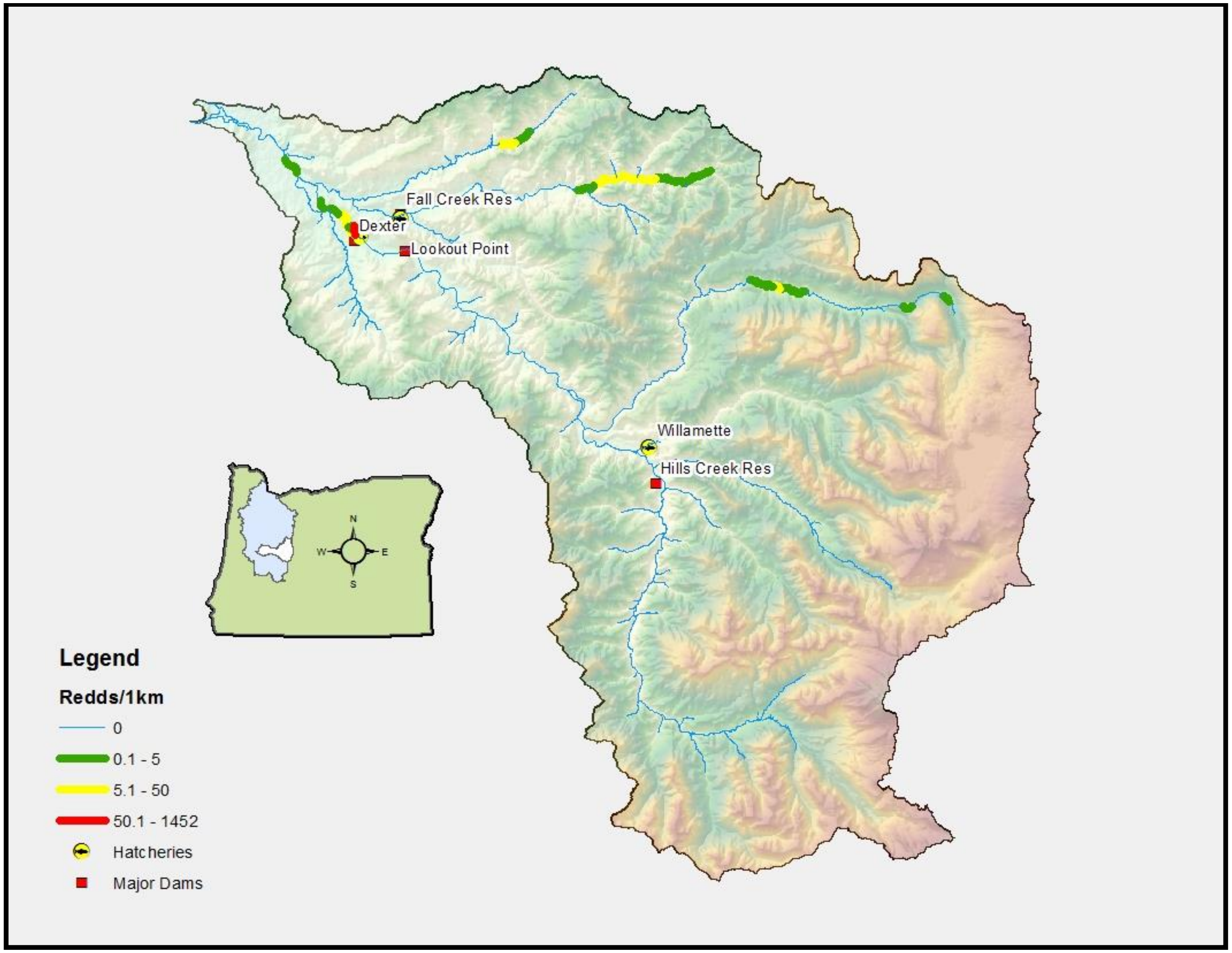

Figure 10. Redd density (peak redd count/km) in the Middle Fork Willamette subbasin, 2011. Surveys were not conducted in the Middle Fork Willamette above Hills Creek Reservoir.

Table 2. Peak redd counts by subbasin and survey section in 2011. An asterisk under "Peak Redd Count" indicates that resurvey counts (i.e. not initial survey counts) were used as the basis for subsequent estimates of escapement and redd densities.

Subbasin	Survey Section	Peak Redd Count	Date of Peak Count	Number of Surveys
North Santiam River	**North Santiam Mainstem**			
	Minto Dam to Packsaddle	47	9/20/11	11
	Packsaddle to Gate's Bridge	180*	9/30/11	16
	Gate's Bridge to Mill City	126*	9/30/11	16
	Mill City to Fisherman's Bend	61*	9/30/11	16
	Fisherman's Bend to Mehama	72*	9/30/11	16
	Mehama to Powerlines	8	9/29/11	13
	Powerlines to Upper Bennett (Stayton Is.)	21	10/3/11	9
	North Channel-Stayton Is to Stayton	13	9/29/11	6
	South Channel-Upper Bennett to Stayton	8	9/20/11	9
	Stayton to Shelburn	7	9/20/11	12
	Shelburn to Green's Bridge	3	10/4/11	8
	North Santiam above Detroit			
	North Santiam	23	9/28/11	5
	Breitenbush	0	9/28/11	1
	Little North Santiam			
	Elkhorn Bridge to Salmon Falls	5	9/29/11	5
	Salmon Falls to Camp Cascade	15	9/29/11	5
	Camp Cascade to Narrows	14	10/3/11	6
	Narrows to Golf Bridge	4	10/3/11	5
	Golf Bridge to Bear Cr Bridge	9	10/20/11	4
	Bear Cr Bridge to Lunkers Bridge	6	10/20/11	4
South Santiam	**South Santiam Mainstem**			
	Foster to Pleasant Valley	493	10/17/11	14
	Pleasant Valley to McDowell Cr	34	10/3/11	10
	McDowell Cr to Waterloo	15	10/3/11	10
	Gill's Landing to Sanderson's	3	10/5/11	4
	South Santiam above Foster			
	Falls to Soda Fork	39	9/15/11	5
	Soda Fork to Little Boulder Cr	22	10/10/11	6
	Little Boulder Cr to Trout Cr C.G.	38	10/4/11	5
	Trout Cr C.G. to 2nd Trib below C.G.	16	9/20/11	7

Subbasin	Survey Section	Peak Redd Count	Date of Peak Count	Number of Surveys
	2nd Trib below C.G. to Gordon Cr Rd	53	9/20/11	7
	Gordon Cr Rd to Moose Cr Bridge	19	10/4/11	5
	Moose Cr Bridge to Cascadia Park	17	9/22/11	1
	Cascadia Park to High Deck Rd	14	10/22/11	1
	High Deck Rd to Shot Pouch Rd	9	9/22/11	2
	Shot Pouch Rd to River Bend Park	5	9/27/11	3

	McKenzie Mainstem			
	Spawning Channel	45	9/22/11	6
	Olallie C.G. to Belknap	119	9/26/11	5
	Belknap to Paradise	71	10/6/11	6
	Paradise to McKenzie Trail	36	10/6/11	5
	McKenzie Trail to McKenzie Bridge	9	9/26/11	10
	McKenzie Bridge to Hamlin	79	9/26/11	10
	Hamlin to S.F. McKenzie	1	10/6/11	10
	S.F. McKenzie to Forest Glen	28	9/26/11	10
	Forest Glen to Rosboro Bridge	183*	10/7/11	13
	Rosboro Bridge to Ben & Kay	105*	10/7/11	13
	Helfrich to Leaburg Lake	12	9/19/11	7
	Leaburg Dam to Leaburg Landing	220*	9/27/11	12
	Horse Creek			
McKenzie River	Pothole Cr to Trail Bridge	19	9/29/11	2
	Trail Bridge to Separation Cr	11	9/29/11	3
	Separation Cr to Road Access	29	9/29/11	3
	Road Access to Braids	27	9/29/11	3
	Braids to Avenue Cr	52	9/22/11	4
	Avenue Cr to Bridge	70	9/29/11	3
	Bridge to Mouth	55	10/5/11	3
	Lost Creek			
	Cascade to Campground	32	10/5/11	4
	Campground to Split Pt	46	10/5/11	4
	Split Pt to Hwy Bridge	40	10/10/11	4
	Hwy Bridge to Mouth	3	9/29/11	3
	South Fork McKenzie Above Cougar			
	SF 1 mile above confluence of Elk Cr	2	10/17/11	
	Elk Cr to Roaring River	3	10/18/11	6
	Roaring River to Twin Springs C.G.	7	10/18/11	6

Subbasin	Survey Section	Peak Redd Count	Date of Peak Count	Number of Surveys
	Twin Springs C.G. to Homestead C.G.	29	10/18/11	8
	Homestead C.G. to Dutch Oven C.G.	15	10/5/11	8
	Dutch Oven to Rebel Cr	54	9/22/11	10
	Rebel Cr to Hardy Cr	65	10/11/11	10
	Hardy to Reservoir	66	9/22/11	9
	South Fork McKenzie Below Cougar			
	Dam to Bridge	50	9/28/11	11
	Bridge to Mouth	46	10/14/11	12

Middle Fork Willamette River	**Middle Fork Mainstem**			
	Dexter to Pengra	97	10/4/11	13
	Pengra to Jasper	2	10/4/11	12
	Fall Creek			
	Falls to Gold Cr	3	9/30/11	8
	Gold Cr to Hehe Cr	34	10/6/11	19
	Hehe Cr to NFD 1828 Bridge	11	10/7/11	10
	NFD 1828 Bridge to Portland Cr	9	10/7/11	12
	Portland Cr to Bedrock campground	1	9/23/11	10
	Bedrock campground to Johnny Cr Bridge	0	9/23/11	11
	Johnny Cr Bridge to Release Site	0	9/14/11	10
	Release Site to Reservoir	0	8/10/11	5
	Little Fall Creek			
	NFD 1806 Bridge to NFD 1818 Bridge	0	9/26/11	4
	NFD 1818 Bridge to Fish Ladder	55	9/19/11	5
	North Fork Middle Fork			
	Kiahanie Bridge to Release Site	37	9/28/11	18
	NFD 1944 Bridge to Kiahanie Bridge[2]	0	8/12/11	Unk
	Minute Cr to NFD 1944 Bridge	1	9/21/11	Unk
	2nd to last pullout to Minute Cr	13	9/15/11	Unk

[2] Surveys from this point downstream conducted by University of Idaho surveyors. Number of surveys is unknown.

Table 3. Current and recent historical redd densities in comparable spawning reaches.

Basin, Section	2011 Redds	Reach Length (km)	Redds/km						
			2011	2010	2009	2008	2007	2006	2005
North Santiam									
Bennett to Minto Dam	568	52.8	10.6	6.2	3.7	3.4	7.8	3.6	4.6
Below Bennett Dam	31	3.2	2.9	1.7	1.1	0.1	3.8	0.7	0.9
South Santiam									
Lebanon to Foster Dam	542	24.1	22.4	32.5	20.0	8.6	20.0	21.1	21.9
Below Lebanon Dam	3	15.3	0.2	5.9	--	--	--	0.1	0.6
McKenzie									
Above Leaburg Dam	1,136	110.4	11.7	10.1	5.3	6.3	14.3	7.5	10.4
Below Leaburg Dam	220	9.7	22.8	27.2	17.3	24.4	14.6	7.5	7.8
Middle Fork Willamette									
Dexter–Jasper	99	14.5	6.8	1.5	2.5	9.3	0.6	7.6	0.6
Fall Creek	58	26.2	2.2	2.6	1.4	3.4	1.1	8.3	5.0

Section 3.1.3 Age Structure and Size Distribution on Spawning Grounds:

The age structure of wild- and hatchery-origin fish collected during spawner and carcass surveys, as determined from scale analysis, is presented in Figure 11 and Table 4. Size distribution of wild- and hatchery-origin fish collected during spawner and carcass surveys is shown in Figure 12 and Table 5.

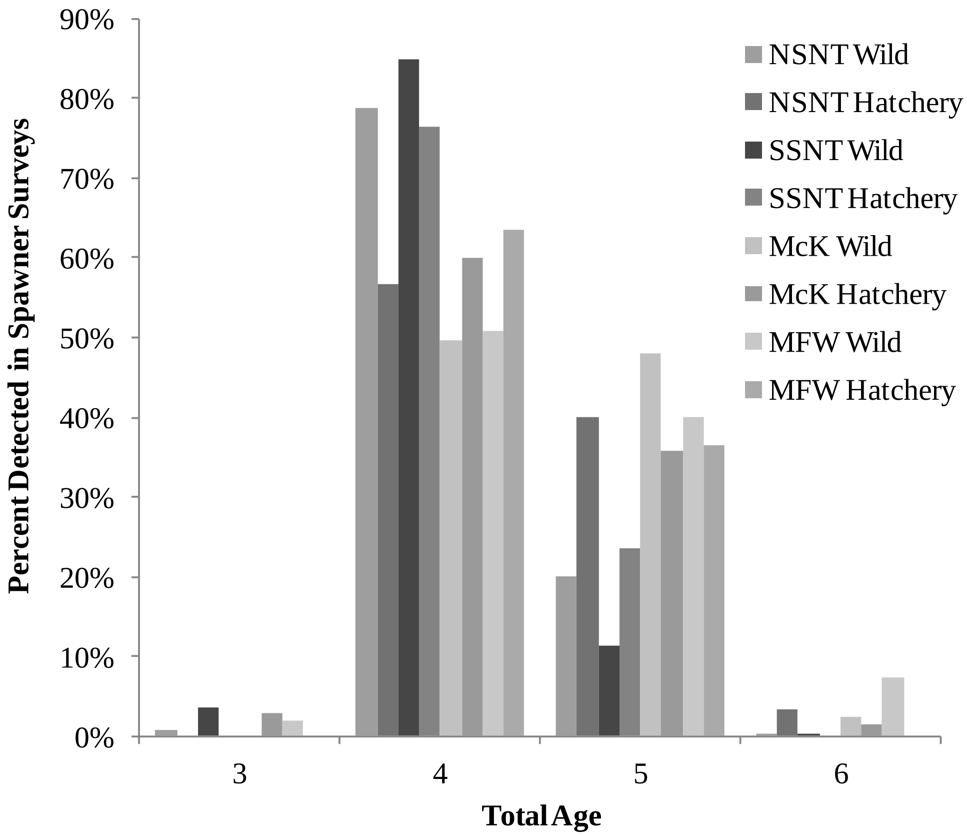

Figure 11. Age structure of wild- and hatchery-origin Chinook salmon on spawning grounds, 2011. NSNT, SSNT, McK and MFW indicate North Santiam, South Santiam, McKenzie, and Middle Fork Willamette rivers, respectively.

Table 4. Age structure of Chinook salmon collected during spawner and carcass surveys, 2011. NSNT, SSNT, McK and MFW indicate North Santiam, South Santiam, McKenzie, and Middle Fork Willamette rivers, respectively.

Total Age	NSNT Wild	NSNT Hatchery	SSNT Wild	SSNT Hatchery	McK Wild	McK Hatchery	MFW Wild	MFW Hatchery
3	0.7%	0.0%	3.5%	0.0%	0.0%	2.9%	1.8%	0.0%
4	78.9%	56.7%	84.9%	76.4%	49.7%	60.0%	50.9%	63.6%
5	20.0%	40.0%	11.3%	23.6%	48.1%	35.7%	40.0%	36.4%
6	0.4%	3.3%	0.3%	0.0%	2.3%	1.4%	7.3%	0.0%
N	280	60	345	72	308	70	55	22

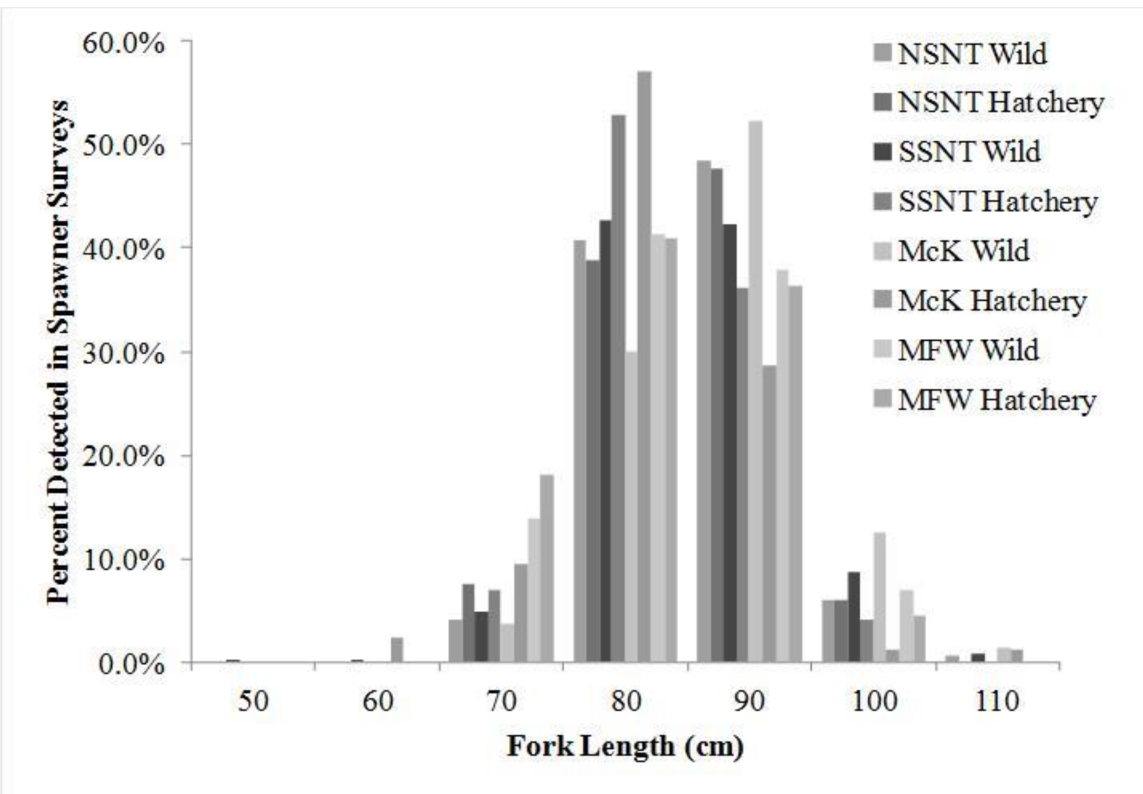

Figure 12. Size distribution of Chinook salmon collected during spawner and carcass surveys, 2011.

Table 5. Size distribution of Chinook salmon collected during spawner and carcass surveys, 2011. NSNT, SSNT, McK and MFW indicate North Santiam, South Santiam, McKenzie, and Middle Fork Willamette rivers, respectively.

Fork Length (cm)	NSNT Wild	NSNT Hatchery	SSNT Wild	SSNT Hatchery	McK Wild	McK Hatchery	MFW Wild	MFW Hatchery
40	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
50	0.0%	0.0%	0.3%	0.0%	0.0%	0.0%	0.0%	0.0%
60	0.0%	0.0%	0.3%	0.0%	0.0%	2.4%	0.0%	0.0%
70	4.0%	7.5%	4.9%	6.9%	3.8%	9.5%	13.8%	18.2%
80	40.8%	38.8%	42.6%	52.8%	29.9%	57.1%	41.4%	40.9%
90	48.5%	47.8%	42.3%	36.1%	52.3%	28.6%	37.9%	36.4%
100	6.0%	6.0%	8.7%	4.2%	12.5%	1.2%	6.9%	4.5%
110	0.7%	0.0%	0.9%	0.0%	1.5%	1.2%	0.0%	0.0%
N	299	67	345	72	344	84	58	22
Mean	81.56	80.63	81.00	78.94	83.42	77.56	79.29	78.91
SEM	0.37	0.81	0.39	0.73	0.39	0.77	1.01	1.68
Median	81	81	81	79	83	77	79.5	80
Mode	79	81	82	81	87	77	75	80

Section 3.1.4 Spawner Abundance:

3.1.4.1: North Santiam: We estimated that total spawner abundance (escapement) in the North Santiam Subbasin, based strictly on redd count expansion, was 1,555 fish of which 545 were wild-origin and 1,010 were hatchery-origin (Table 6). Spawner abundance above Detroit Dam was low because of the small number of Chinook salmon we were able to trap and outplant from the Bennett Dam trap. We estimated that 51wild and 82 hatchery-origin fish spawned in the Little North Santiam River. Hatchery-origin fish must have strayed into that tributary because no outplanting of hatchery fish occurred there in 2011, but some of the wild origin spawners might have resulted from natural production there.

3.1.4.2 South Santiam: We estimated that escapement of wild-origin and hatchery-origin fish in the South Santiam subbasin was 753 and 1,189 fish, respectively. The majority of wild-origin spawning occurred above Foster dam; we estimated that spawner abundance there was 468 wild and 112 hatchery fish. We estimated very few spawners below Lebanon Dam, supporting the idea that another video monitoring site might be useful at that location.

3.1.4.3 McKenzie: Total spawner abundance in the McKenzie subbasin was estimated at 3,980 spawners in 2011 (2,903 wild origin and 1,077 hatchery-origin). By convention, the McKenzie subbasin is divided into four reaches of interest:

1. Below Leaburg Dam, where we estimated spawner abundance of 224 wild and 326 hatchery-origin spawners.
2. Between Leaburg Dam and the confluence with the South Fork McKenzie River plus the South Fork McKenzie River up to Cougar Dam. We estimated spawners at 631 wild-origin and 349 hatchery-origin fish in that reach.
3. The mainstem McKenzie River above the confluence with the South Fork McKenzie River. This reach is considered the “sanctuary” for wild-origin fish in the subbasin and we estimated 1,664 wild-origin and 196 hatchery-origin spawners. That estimate does not include the spawners that might have resulted from the 2011 outplanting of 69 hatchery-origin spawners above Trail Bridge Dam.
4. The South Fork McKenzie River above Cougar Reservoir. Surveys in this reach support a broad-reaching experiment attempting to evaluate potential for using hatchery-origin fish

to achieve recovery in otherwise depauperate habitat, the details of which have been reported elsewhere (Zymonas et al. 2013). Our expansion of redd counts generated estimates of 385 wild-origin and 205 hatchery-origin spawners above Cougar Dam in 2011.

3.1.4.4 Middle Fork Willamette: Results from our surveys indicated that 818 fish (200 wild-origin and 618 hatchery-origin) spawned in the Middle Fork Willamette subbasin in 2011, not including hatchery-origin fish that might have spawned above Hills Creek Reservoir where surveys were not conducted. We estimated that 45 wild-origin and 202 hatchery-origin fish spawned below Dexter Dam in 2011, not including spawners in Little Fall Creek. A small number of hatchery-origin fish were outplanted for the first time in Little Fall Creek in 2011and we estimated that 9 wild-origin and 129 hatchery-origin fish spawned there in 2011. In addition, we estimated that 140 wild origin and 5 hatchery-origin fish spawned above Fall Creek Reservoir while 5 wild-origin and 282 hatchery-origin fish spawned in the North Fork Middle Fork Willamette River above Lookout Point Reservoir.

Table 6. Chinook salmon spawner abundance estimates, 2011. Estimates derived by redd count expansion were parsed into hatchery- and wild-origin using otolith data.

Subbasin, Section	Estimated Spawner Abundance: Hatchery-origin	Wild-origin
North Santiam		
Bennett to Minto Dam	837	451
Below Bennett Dam	34	43
Little North Santiam	82	51
Above Detroit Dam	58	0
Subbasin Total	1,010	545
South Santiam		
Lebanon to Foster Dam	1,070	285
Below Lebanon Dam	7	1
Above Foster Dam	112	468
Subbasin Total	1,189	753
McKenzie		
Above S. Fk Confluence	196	1,664
Below Leaburg Dam	326	224
Leaburg - S. Fk Confluence	273	477
South Fork below Cougar Dam	76	154
Above Cougar Dam	205	385
Subbasin Total	1,077	2,903
Middle Fork Willamette		
Dexter Dam to Jasper	202	45
Little Fall Cr.	129	9
Above Fall Creek Dam	5	140
NF Middle Fork above Lookout Point Dam	282	5
Subbasin Total	618	200

Section 3.1.5 Estimates of pre-spawning mortality:

Pre-spawning mortality varied widely among subbasins and among river reaches within subbasins. Several factors can potentially affect estimates of pre-spawning mortality derived from recovery of female carcasses. Survey efforts can vary spatially and temporally from year to year. These differences can affect recovery of salmon carcasses: scavengers and high river flow can affect the length of time that carcasses remain in river sections where they can be located and recovered by surveyors. Late season carcasses can be difficult to recover after flows begin to increase, and since these fish are more likely to be successful spawners, there is the potential for systematic bias. We believe that pre-spawning mortality estimates of outplanted fish are affected by the time of the year that fish are released upstream of dams, the quality of release sites, and water temperature. For those reasons we view our estimates of pre-spawning mortality in relative terms of low, medium or high corresponding to estimates of less than 20%, between 20 and 50%, and above 50%, respectively, rather than as absolute values.

3.1.5.1 North Santiam: The greatest pre-spawning mortality in the North Santiam River was observed in the river reaches downstream of Upper Bennett Dam (Table 7). Of the 43 female carcasses examined, 41 had intact or nearly intact egg skeins (95% PSM). Pre-spawning mortality in the river reaches between Upper Bennett Dam and Minto and in the Little North Santiam River (26% and 31%, respectively) were considered moderate. We did not adequately estimate PSM above Detroit Reservoir because too few spawners were outplanted to permit useful sample sizes of female carcasses examined, but the single female carcass that was recovered was spawned. For comparative purposes, we pooled spawned and unspawned female carcass counts in the mainstem above Bennett Dam with counts from Little North Santiam River and compared the pooled counts to those below Bennett Dam. The PSM rate was significantly greater below Bennett Dam ($G = 84.2$, $df = 1$, $P < 0.001$) when compared to PSM rates between Bennett and Minto dams.

Table 7. Carcass sampling results, 2011. Wild and hatchery carcasses were derived from counts of unclipped and clipped carcasses and were adjusted using results from otolith analysis. PHOS and PNOS are proportion of hatchery- and natural origin spawners, respectively. PSM is pre-spawn mortality rate derived from inspection of female carcasses.

Subasin, section	Processed Carcasses	Unclipped Carcasses	Clipped Carcasses	Wild Carcass Estimate	Hatchery Carcass Estimate	PHOS	PNOS	Spawned Females	Unspawned Females	PSM
North Santiam										
Bennett to Minto Dam	748	278	470	262	486	65%	35%	336	121	26%
Below Bennett Dam	68	40	28	38	30	44%	56%	2	41	95%
Little North Santiam	52	22	30	20	32	62%	38%	11	5	31%
Above Detroit	5	0	5	0	5	100%	0%	1	0	0%
				320	553	63%	37%			
South Santiam										
Lebanon to Foster Dam	750	185	565	159	597	79%	21%	441	72	14%
Below Lebanon Dam	9	1	8	1	8	89%	11%	1	5	83%
Above Foster	294	294	0	237	57	19%	81%	95	34	26%
				397	662	63%	37%			
McKenzie										
Above S. Fk Confl.	152	143	9	136	16	11%	89%	98	3	3%
Below Leaburg Dam	219	94	125	89	130	59%	41%	98	38	28%
Above Cougar	27	17	6	15	8	35%	65%	17	0	0%
Leaburg - S. Fk Confl.	118	79	39	75	43	36%	64%	53	7	12%
South Fork below Cougar	76	65	21	61	30	33%	67%	61	1	2%
				376	227	38%	62%			
Middle Fork Willamette										
Dexter–Jasper	137	42	95	25	112	82%	18%	70	24	26%
NF Middle Fork	56	2	54	1	55	98%	2%	8	32	80%
Fall Creek	64	64	0	62	2	3%	97%	20	10	33%
Little Fall Cr.	30	3	27	2	29	94%	6%	11	3	21%
				90	198	69%	31%			

3.1.5.2 South Santiam: The greatest pre-spawning mortality in the South Santiam River was observed in the river reaches downstream of Lebanon Dam (Table 7). Six female carcasses were examined and five had intact or nearly intact egg skeins (83% PSM). Pre-spawning mortality in the river reaches between Lebanon Dam and Foster Dam and above Foster Dam (14% and 26%, respectively) were considered low and moderate, respectively. For comparative purposes, we pooled spawned and unspawned female carcass counts in the mainstem South Santiam River and compared the pooled counts to those above Foster Dam. The PSM rate was significantly greater above Foster Dam (G = 8.8, df = 1, $P = 0.003$).

3.1.5.3 McKenzie: Pre-spawning mortality throughout the McKenzie was generally low but was moderate in the reaches below Leaburg Dam (Table 7). For comparative purposes, we pooled spawned and unspawned female carcass counts in the mainstem McKenzie River above Leaburg Dam (excluding the South Fork above Cougar Dam) and compared the pooled counts to those below Leaburg Dam. The PSM rate was significantly greater below Leaburg Dam (G = 37.0, df = 1, $P < 0.001$).

3.1.5.1 Middle Fork Willamette: Pre-spawning mortality estimates were moderate to high throughout the Middle Fork Willamette River (Table 7). The highest PSM was observed in the North Fork Middle Fork (80%) and the lowest was observed in Little Fall Creek (21%). We directly compared PSM rates between Little Fall Creek and the North Fork Middle Fork; these were significantly different (G = 14.82, df = 1, $P < 0.001$).

Section 3.1.6 Origin on Spawning Grounds:

During surveys in 2011, we sampled unclipped Chinook salmon carcasses and collected 334 readable otoliths in the North Santiam River, 454 in the South Santiam River, 378 in the McKenzie River, and 76 in the Middle Fork Willamette River. Twenty three additional otoliths were collected but were unreadable or had cryptic thermal marks and were excluded from these analyses (1.8% of the total collection).

Fish were initially categorized as naturally produced based on absence of an adipose fin clip. Final estimates of the proportion of hatchery-origin spawners (Table 7) were derived after otolith analyses (Table 8) allowed adjustments based on the proportions of unclipped hatchery-origin fish. Estimates of the percent hatchery-origin spawners (PHOS) differed significantly between the McKenzie, where overall PHOS (survey reaches pooled) was relatively low, and all other subbasins, where PHOS was uniformly high ($G = 161.4$, $df = 3$, $P < 0.001$).

We also examined PHOS estimates in the North Santiam and McKenzie rivers (below dams) to describe spatial variation within subbasins. The South Santiam and Middle Fork Willamette rivers were excluded from this analysis because too few carcasses were recovered in the South Santiam River below Lebanon Dam and there is only a single relatively short survey reach below Dexter Dam on the Middle Fork Willamette River. Clearly, hatchery-origin fish were not distributed evenly throughout the North Santiam and McKenzie rivers. In the North Santiam River hatchery fish were proportionately more abundant in the upper reaches (above Bennett Dam: $G = 15.02$, $df = 1$, $P < .001$) and in the McKenzie River Hatchery fish were proportionately more abundant in the lower reaches (above Leaburg Dam: $G = 81.11$, $df = 1$, $P < 0.001$).

Table 8. Analysis results for otoliths collected from spawning ground surveys in 2011 and examined for thermal marks to verify wild status of unclipped adults.

Area	# Readable Otoliths from Unclipped Fish	# Thermally Marked	% Thermally Marked
North Santiam Below Detroit Dam	313	18	5.8%
Little North Santiam	21	2	9.5%
North Santiam Total	**334**	**20**	**6.0%**
South Santiam Below Foster Dam	180	25	13.9%
South Santiam above Foster Dam	274	53	19.3%
South Santiam Total	**454**	**78**	**17.2%**
Horse Creek	65	0	0.0%
Lost Creek	5	1	20.0%
McKenzie	231	13	5.6%
South Fork McKenzie Below Cougar Dam	59	4	6.8%
South Fork McKenzie Above Cougar Dam	15	2	13.3%
McKenzie Total	**375**	**20**	**5.6%**
MF Willamette Below Dexter Dam	41	17	41.5%
Little Fall Cr.	2	1	50.0%
Fall Creek	42	1	2.4%
North Fork Middle Fork	0	NA	NA
MF Willamette Total	**85**	**19**	**22.4%**

3.1.6.1 North Santiam: As in previous years the PHOS estimates (Table 7) in the North Santiam River greatly exceeded the recovery goal of 10%. Only clipped Chinook salmon were outplanted above Detroit Dam in 2011 but because of difficulties encountered in operating the Upper Bennett Dam trap, few fish were outplanted and we did not effectively segregate spawners by origin. We expect that when the Minto Facility is in operation in 2013 a larger proportion of hatchery spawners can be used for recovery efforts above Detroit and lessen the immediate impact on wild spawners below Detroit Dam.

3.1.6.2 South Santiam: As in previous years the PHOS estimates (Table 7) in the South Santiam River greatly exceeded the recovery goal of 10%. Unlike outplanting operations in the North Santiam River, only unclipped Chinook salmon are outplanted above Foster Dam but, because a substantial number of unclipped fish were actually hatchery-origin (based on thermal marks), PHOS targets were exceeded even there.

3.1.6.3 McKenzie: As in previous years the PHOS estimates (Table 7) in the McKenzie River exceeded the recovery goal of 10%. However, as noted above, PHOS in the McKenzie is the lowest among the subbasins and, in the reaches above the confluence with the South Fork McKenzie River) the PHOS estimate approached the 10% goal.

3.1.6.4 Middle Fork Willamette: As in previous years the PHOS estimates (Table 7) in the Middle Fork Willamette River greatly exceeded the recovery goal of 10%. However, as in the South Santiam above Foster Dam, only unclipped fish are outplanted in Fall Creek. A single otolith from the 43 collected from carcasses in Fall Creek was thermally marked so PHOS in that portion of the subbasin met recovery goals. The remainder of the subbasin was dominated by hatchery spawners.

Section 3.1.7 Straying:

For the purposes of this section we report straying as the incidence of hatchery-origin fish released as juveniles in one subbasin but recovered as adults in a different subbasin. As in past years the vast majority of tags were recovered in the subbasins into which the tagged juveniles were released, in both samples collected at hatcheries (Table 9) and on spawning ground surveys (Table 10).

Section 3.1.8 Variability of redd counts:

During the 2011 adult spring Chinook salmon spawning-ground surveys, a total of seven comprehensive re-surveys were conducted on river sections below project dams on the North and South Santiam rivers and on the McKenzie River. Of those seven surveys, four were conducted closely enough in time and under comparable flows and weather conditions to be considered valid under the definition outlined in the Methods section. The three re-surveys not considered valid by the criteria described above were disqualified because of an unexpected increase in discharge flow (~340 cfs from 2,660 to 3,000) from project dams on the North Santiam River. The four valid re-surveys were conducted on the McKenzie and South Santiam rivers below project dams. All observers were similarly trained; re-surveyors were the more senior personnel. The mean and standard error (SE) are given for each of the four valid re-surveyed sections (Table 11). In Table 11 subbasin and standardized sections indicate where on major tributaries to the Willamette River surveys and re-surveys were conducted. A single re-survey is matched with a standard survey and mean and standard error (SE) given; N = 2 for all re-surveys. Within a particular section, the re-survey occurred after the regularly scheduled survey and right and left river bank surveys are matched. The re-surveys noted by (*) in Table 11 were excluded because of the unexpected increase in flow in the North Santiam River. All surveys were conducted with a raft and tower, and right and left bank spatial coverage was comparable.

During the 2011 survey, re-surveys were not conducted above project dams on the North or South Santiam rivers, but were conducted below project dams on the South Santiam and McKenzie rivers. Redd counts are useful for indicating where spawning activity is occurring with respect to both timing and habitat characteristics. Variation in counts is typical among observers even, as in this case, where counts are not samples of sub-units within a larger area, or of discrete periods of time within a larger temporal range, but direct census counts over the entire spawning season (Dunham et al., 2001; Muhlfeld et al. 2006). Both over-counts and under-counts are common; neither the direction nor magnitude of the bias can be known with certainty

Table 9. Coded and blank wire tag (BWT) recoveries at hatcheries in 2011. Note that the recovery of Marion Forks fish at McKenzie Hatchery is because in 2011 North Santiam broodstock were held and spawned at McKenzie Hatchery.

Recovery Hatchery	Hatchery of Origin	Stock	Release site	Tag Recoveries
Clackamas	Willamette	South Santiam	Molalla	14
Clackamas	McKenzie	McKenzie	McKenzie	2
Clackamas	Marion Forks	Marion Forks	Detroit Reservoir	2
Marion Forks	Marion Forks	Marion Forks	Detroit Reservoir	11
Marion Forks	Marion Forks	Marion Forks	North Santiam	8
Marion Forks	Willamette	South Santiam	Molalla	4
Marion Forks	BWT	BWT	BWT	3
Marion Forks	McKenzie	McKenzie	McKenzie	3
South Santiam	South Santiam	South Santiam	South Santiam	432
South Santiam	Willamette	South Santiam	South Santiam	10
South Santiam	Willamette	South Santiam	Molalla	8
McKenzie	BWT	BWT	BWT	1,442
McKenzie	McKenzie	McKenzie	McKenzie	714
McKenzie	Marion Forks	Marion Forks	Detroit Reservoir	18
McKenzie	Marion Forks	Marion Forks	North Santiam	15
McKenzie	Willamette	South Santiam	Molalla	15
McKenzie	Leaburg	Clackamas	Clackamas	1
McKenzie	South Santiam	South Santiam	South Santiam	1
Willamette/Dexter	Willamette	Willamette	Mid Fk Willamette	657
Willamette/Dexter	BWT	BWT	BWT	4
Willamette/Dexter	Willamette	South Santiam	Molalla	1
Willamette/Dexter	McKenzie	McKenzie	McKenzie	1

Table 10. Coded and blank wire tag (BWT) recoveries during spawning ground surveys in 2011.The origin of BWT fish is technically "unknown". However, recovery of BWTs occurred only in the McKenzie, and only McKenzie Hatchery released BWTs in the broods contributing to these returns.

Recovery Basin	Hatchery of Rearing	Stock	Release Location	Tag Recoveries
Molalla	Marion Forks	Santiam	N. Santiam	1
Molalla	Willamette	Santiam	Molalla	9
N. Fk Santiam	Marion Forks	Santiam	Detroit Res.	24
N. Fk Santiam	Marion Forks	Santiam	N. Santiam	15
N. Fk Santiam	Willamette	Santiam	Molalla	9
L. N. Santiam	Willamette	Santiam	Molalla	1
S. Fk Santiam	S. Santiam	Santiam	S. Santiam	28
S. Fk Santiam	Willamette	Santiam	S. Santiam	6
McKenzie	McKenzie	McKenzie	McKenzie	25
McKenzie	Marion Forks	Santiam	Detroit Res.	1
McKenzie	Willamette	Santiam	Molalla	2
McKenzie	Unknown (BWT)	Unknown (BWT)	Unknown (BWT)	47
Willamette	Willamette	Willamette	Willamette	6

without direct sampling of eggs in an identified redd (Dunham et al. 2001; Muhlfeld et al. 2006). These data indicate where spawning activity is occurring and to what extent in a relative sense. When combined with information from carcasses found on the spawning grounds, redd surveys provide useful information about where subsequent juvenile production may be expected to occur. In these surveys the number of redds encountered within river sections span two orders of magnitude and counts varied at both high and low redd densities. The re-surveys show that with respect to inter-observer variation, the variation in counts among observers is low enough to be confident that spawning activity is in fact occurring, and at what general levels (e.g. low, medium, high).

Table 11. Comparison of redd counts from surveys and resurveys, 2011. "NA" indicates that resurveys were invalid because environmental conditions changed between the survey and resurvey (see text).

Subbasin	Section	Date	River Bank	Redd Count	Mean (SE)
*North Santiam	Gate's Bridge to Mill City	9/27/2011	Left	99	NA
		9/30/2011	Left	72	
		10/3/2011	Left	139	
	Gate's Bridge to Mill City	9/27/2011	Right	54	
		9/30/2011	Right	54	
		10/3/2011	Right	46	
*North Santiam	Mill City to Fisherman's Bend	9/27/2011	Left	97	NA
		9/30/2011	Left	53	
		10/3/2011	Left	68	
	Mill City to Fisherman's Bend	9/27/2011	Right	4	
		9/30/2011	Right	8	
		10/3/2011	Right	11	
*North Santiam	Packsaddle to Gate's Bridge	9/27/2011	Left	84	NA
		9/30/2011	Left	51	
		10/3/2011	Left	74	
	Packsaddle to Gate's Bridge	9/27/2011	Right	118	
		9/30/2011	Right	129	

Subbasin	Section	Date	River Bank	Redd Count	Mean (SE)
		10/3/2011	Right	66	
South Santiam	Foster to Pleasant Valley	9/28/2011	Left	581	464 (117.5)
		9/28/2011	Left	346	
	Foster to Pleasant Valley	9/28/2011	Right	100	95 (5.5)
		9/28/2011	Right	89	
McKenzie	Forest Glen to Rosboro Bridge	10/6/2011	Left	82	96 (13.5)
		10/7/2011	Left	109	
	Forest Glen to Rosboro Bridge	10/6/2011	Right	60	67 (7.0)
		10/7/2011	Right	74	
McKenzie	Rosboro Bridge to Ben & Kay	10/6/2011	Left	49	63 (13.5)
		10/7/2011	Left	76	
	Rosboro Bridge to Ben & Kay	10/6/2011	Right	21	25 (4.0)
		10/7/2011	Right	29	
McKenzie	Leaburg Dam to Leaburg Landing	9/26/2011	Both	326	273 (53.0)
		9/27/2011	Both	220	

Section 3.1.9 Video Monitoring*:*

3.1.9.1 North Santiam (Upper Bennett Dam): Counts of spring Chinook salmon passing upstream of Upper Bennett Dam in 2011 are provided in Figure 13. The first unclipped adult was observed the week of April 27 and the first clipped adult was noted the following week. The peak count for both unclipped and clipped adults occurred the week of July 13. The final observations of unclipped and clipped adults occurred the weeks of November 9 and October 19, respectively. Adipose clips on jack salmon could not readily be discerned because of the size of the fish and fin so those counts were pooled. The first, peak, and last jacks were observed the weeks of May 18, July 13, and September 28, respectively. A relatively small number of fish that were trapped at Upper Bennett Dam and subsequently passed upstream were included in counts to better reflect total passage even though they were not technically counted using the video system.

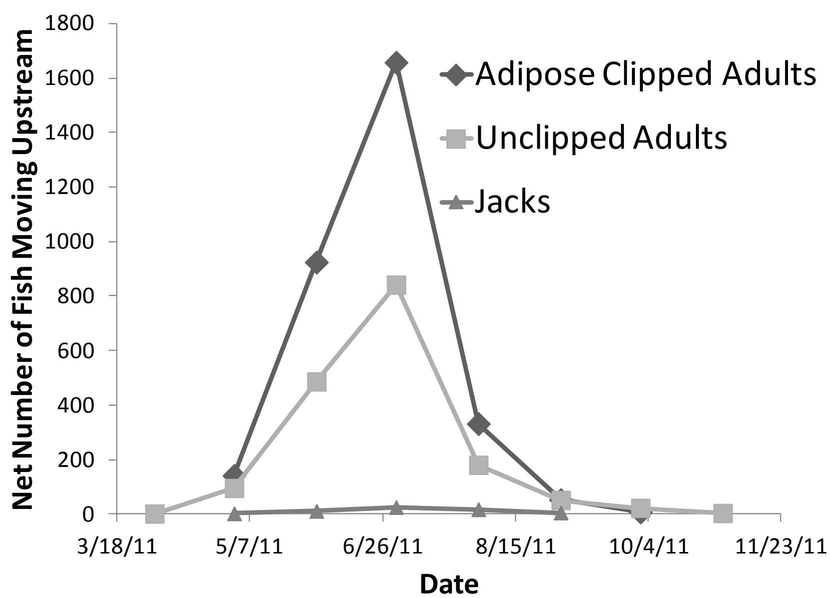

Figure 13. Net number of marked and unmarked spring Chinook salmon counted at Upper Bennett Dam by month, 2011. Counts of jacks are incorporated into the figure but were not differentiated between marked and unmarked.

3.1.9.2 McKenzie River (Leaburg Dam): Counts of spring Chinook salmon passing upstream of Leaburg Dam in 2011 are provided in Figure 14. The first unclipped adult was observed the week of May 11 and the first clipped adult was noted the week of June 15. The peak count for unclipped adults occurred the week of July 6. Counts of clipped adults showed two peaks; one coincident with that of unclipped fish and the other during the week of September 7. The final observations of unclipped and clipped adults occurred the weeks of November 9 and October 19, respectively. Adipose clips on jack salmon could not readily be discerned because of the size of the fish and fin so those counts were pooled. Only three jacks were observed, all passing the weeks of July 6 (N = 1) and 13 (N = 2). Sixty adult Chinook salmon were removed from the ladder between August 24 and September 28 to help reduce PHOS in the subbasin.

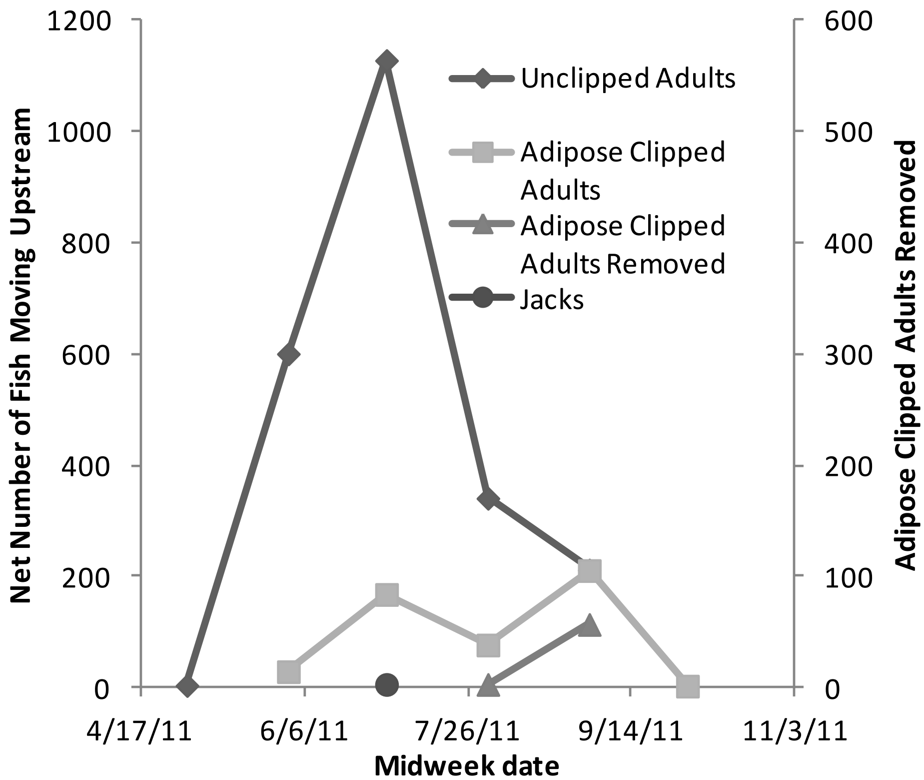

Figure 14. Net number of marked and unmarked spring Chinook salmon counted at Leaburg Dam by month, 2011 (left axis) and number of marked adult Chinook removed (right axis).

Section 3.2: Reintroduction Efforts

Section 3.2.1 Number of Chinook Salmon Released Upstream of Dams*:*

3.2.1.1 North Santiam: Outplanting of adult Chinook salmon above Detroit Dam in the North Santiam in 2011 was confounded by the need to capture adults at Upper Bennett Dam because the Minto trapping facility was under construction. The original design of the trap at Upper Bennett Dam did not appear to allow operation as intended. Adult fish have to turn right out of the fish ladder and volunteer through a fyke entry into the trapping chamber and we think that the fish were reluctant to do so in general and easily able to back out of the fyke at will. We installed a second trap in the ladder at Upper Bennett Dam and a supplemental trap at the Lower Bennett Dam site to increase the catch rate, but even with three traps operating we were not successful at capturing enough fish for broodstock and the full complement of fish for outplanting above Detroit. The original goal for the level of outplanting was 1,500 adipose-clipped adults above Detroit split between the North Santiam (900) and the Breitenbush (600) rivers. Only 151 fish (85 males, 63 females and three jacks) were outplanted and all were released in the North Santiam arm of Detroit Reservoir. All were sampled for DNA. We anticipate that when the Minto Fish Collection Facility is in operation in 2013, a larger number of hatchery origin fish will be available for outplanting.

A summary on outplanting activities in the North Santiam River is provided in Table 12 and details on all fish dispositions, including outplanting, are provided in Appendix Table 4-1.

Table 12. Adult Chinook salmon outplanted above Detroit Dam, 2011.

Source	Sex	N. Santiam Above Detroit	Breitenbush	Total
		Raw Counts		
Unmarked	F	0	0	0
	M	0	0	0
	J	0	0	0
Marked	F	63	0	63
	M	85	0	85
	J	3	0	3
Sub-Total	F	63	0	63
	M	85	0	85
	J	3	0	3
Total	All	151	0	151

3.2.1.2 South Santiam: Outplanting operations at Foster Dam were successful in 2011. All unclipped fish captured in the trap were DNA sampled and trucked to release sites above Foster Dam. Although only unclipped Chinook salmon are outplanted, 19.3% of otoliths collected from carcasses during spawner surveys above Foster indicated the fish were unclipped hatchery adults. A summary on outplanting activities in the South Santiam River is provided in Table 13 and details on all fish dispositions, including outplanting, are provided in Appendix Table 4-1.

Table 13. Outplanting of adult Chinook salmon above Foster Dam, 2011. Otolith Analysis Adjustment in parentheses is the estimate of percent thermally marked otoliths from unclipped fish.

Source	Sex		Riverbend Campground	Gordon Road	Total
			Raw Counts		
Unmarked	F		462	135	597
	M		420	198	618
	J		1	6	7
Marked	F		0	0	0
	M		0	0	0
	J		0	0	0
Sub-Total	F		462	135	597
	M		420	198	618
	J		1	6	7
Total	All		883	339	1,222
			Estimates Based on Otolith Analysis Adjustment (19.3%)		
Wild	F	-	373	109	482
	M	-	339	160	498
	J	-	1	5	6
Hatchery	F	-	89	26	115
	M	-	81	38	119
	J	-	0	1	1
Sub-Total	F	-	462	135	597
	M	-	420	198	618
	J	-	1	6	7
Total	All	-	388	345	1,222
% Wild	F	-	81%	81%	81%
	M	-	81%	81%	81%
	J	-	100%	83%	86%

3.2.1.3 McKenzie: Outplanting activities in the McKenzie subbasin were successful in 2011. The principal activities included outplanting to sites above Cougar Dam as part of a DNA pedigree study where hatchery-origin spring Chinook salmon were outplanted from the McKenzie Hatchery in numbers roughly equal to wild-origin spring Chinook salmon outplanted from a trapping operation below Cougar Dam. A summary of the outplanting efforts in the South Fork McKenzie is presented here (Table 14) but a more detailed report is provided under separate cover as an annual report for another USACE-funded study (Zymonas et al. 2013). Additional detail on fish dispositions, including outplanting, is provided in Appendix Table 4-1.

3.2.1.4 Middle Fork Willamette: Outplanting efforts in the Middle Fork Willamette River were successful in 2011. Adult spring Chinook salmon were captured at the Dexter Dam trap and trucked to various release locations in the Middle Fork and North Fork Middle Fork in support of an ongoing project examining pre-spawning mortality rates (1,609 males, 1,597 females and 252 jacks). A relatively small number of fish (132) were outplanted in Little Fall Creek and that system was added to the spawning survey rotation to begin assessing the potential for recovery of the species in that tributary. A summary on outplanting activities in the Middle Fork Willamette River is provided in Table 15 and details on all fish dispositions, including outplanting, are provided in Appendix Table 4-1.

Table 14. Outplanting of adult Chinook salmon above Cougar Dam, 2011. Otolith Analysis Adjustment in parentheses is the estimate of percent thermally marked otoliths from unclipped fish.

Source	Sex		Cougar Dam Passage Facility	McKenzie Hatchery	Total
Raw Counts					
Unmarked	F		153	0	153
	M		200	0	200
	J		2	0	2
Marked	F		8	175	183
	M		22	166	188
	J		0	4	4
Sub-Total	F		161	175	336
	M		222	166	388
	J		2	4	6
Total	All		385	345	730
% Unmarked	F		95.1	0	46
	M		90.1	0	52
	J		100	0	33
Estimates Based on Otolith Analysis Adjustment (13.3%)					
Wild	F	-	134	0	134
	M	-	175	0	175
	J	-	2	0	2
Hatchery	F	-	27	175	202
	M	-	47	166	213
	J	-	0	4	4
Sub-Total	F	-	161	175	336
	M	-	222	166	388
	J	-	2	4	6
Total	All	-	388	345	730
% Wild	F	-	83%	0%	40%
	M	-	79%	0%	45%
	J	-	100%	0%	33%

Table 15. Outplanting of adult Chinook salmon above Lookout Point Dam, 2011. Otolith Analysis Adjustment in parentheses is the estimate of percent thermally marked otoliths from unclipped fish.

Source	Sex		Middle Fork and N. Fork Middle Fork
Raw Counts			
Unmarked	F		5
	M		4
	J		0
Marked	F		1,592
	M		1,605
	J		252
Sub-Total	F		1,597
	M		1,609
	J		252
Total	All		3,458
Estimates Based on Otolith Analysis Adjustment (41.9%)			
Wild	F	-	3
	M	-	2
	J	-	0
Hatchery	F	-	1,594
	M	-	1,607
	J	-	252
Sub-Total	F	-	1,597
	M	-	1,609
	J	-	252
Total	All	-	3,458
% Wild	F	-	0.19%
	M	-	0.12%
	J	-	0.00%

Section 3.2.2 Origin of Chinook Salmon Released Upstream of Dams:

3.2.2.1 North Santiam: Only adipose-clipped adult Chinook salmon were outplanted above Detroit Reservoir in the North Santiam River; PHOS was 100%.

3.2.2.2 South Santiam: Only adipose intact fish were outplanted from the Foster Dam trap to the South Santiam River above the dam. Analyses were conducted on otoliths collected during pre-spawning mortality and spawner surveys. We found thermal marks on 53 of the otoliths from 274 carcasses sampled during pre-spawn mortality and spawner surveys. Therefore, the PHOS above Foster Dam in 2011 was 19.3%.

3.2.2.3 McKenzie: A mixture of adipose clipped and adipose intact fish were released above Cougar Dam. We recovered 21 unclipped carcasses during pre-spawn mortality and spawner surveys and 3 of their otoliths were thermally marked. Therefore, PHOS above Cougar Dam in 2011 was estimated at 35%.

3.2.2.4 Middle Fork Willamette: Only adipose-clipped adult Chinook salmon were to be outplanted above Dexter Dam in the North Fork Middle Fork Willamette River, but two unclipped carcasses were recovered during surveys. Otoliths were not obtained from those carcasses so we used the proportion of thermally marked otoliths from below Dexter (41.5%) to derive a PHOS estimate of 98%. Surveys were not conducted above Hills Creek Dam on the Middle Fork Willamette but because outplanting procedures were similar between the outplant locations we assume that PHOS above Hill Creek Dam was also 98%. In Fall Creek only unclipped fish were trucked upstream of Fall Creek Dam but otolith analyses indicated that 3% of the unmarked fish were of hatchery origin (PHOS = 3%).

Section 3.3 Broodstock Sampling at Hatcheries

Section 3.3.1 Origin of Broodstock:

3.3.1.1 North Santiam: All broodstock for the North Santiam Hatchery program were collected in the Upper and Lower Bennett Dam traps in 2011 because the Minto Dam trap further upriver was under construction. The majority of broodstock were clipped hatchery fish (Table 16) but some unclipped fish were collected and transported to McKenzie Hatchery for spawning to accommodate an ongoing study of experimental crosses of hatchery- and wild-origin fish (C. Sharpe, *in review*). Thermal marks on otoliths from unclipped fish indicated that 5% (5 thermal marks/95 otoliths read) of the unclipped fish were actually of hatchery origin. Overall, in 2011 the PNOB was 0.17 in the North Santiam Hatchery program (Table 17).

3.3.1.2 South Santiam: All broodstock for the South Santiam Hatchery program were collected at the Foster Dam trap. Only adipose clipped fish are incorporated into the South Santiam broodstock (Table 16). Therefore, in 2011 PNOB was zero (Table 17).

Table 16. Collection and spawning of marked and unmarked Chinook salmon adults at Willamette hatcheries, 2011.

Action	Facility	Marked Males	Marked Females	Marked Jacks	Unmarked Males	Unmarked Females	Unmarked Jacks	Total
Collect	Bennett/Marion Forks	346	303	24	100	76	4	853
Collect	S. Santiam Hatchery	4,364	3,105	300	618	597	9	8,993
Collect	McKenzie Hatchery	3,115	2,535	147	77	59	0	5,933
Collect	Willamette Hatchery	3,233	3,407	364	60	51	30	7,145
Spawn	Bennett/Marion Forks	224	228	0	51	47	0	550
Spawn	S. Santiam Hatchery	338	348	10	0	0	0	696
Spawn	McKenzie Hatchery	717	745	7	73	52	0	1,594
Spawn	Willamette Hatchery	748	689	11		74[1]		1,448

[1] Records did not differentiate between males, females and jacks for Willamette Hatchery broodstock.

3.3.1.3 McKenzie: A mixture of adipose clipped and unclipped fish were incorporated in to the McKenzie Hatchery program (Table 17). Thermal marks on otoliths from unclipped fish that volunteered to the McKenzie Hatchery indicated that 40.2% (39 thermal marks/97 otoliths read) of the unclipped fish were actually of hatchery origin (Table 17); PNOB was 0.04.

3.3.1.4 Middle Fork Willamette: A mixture of adipose clipped and unclipped fish were incorporated in to the Willamette Hatchery program (Table 17). Thermal marks in otoliths from the unclipped fish indicated that 60.8% were actually unclipped hatchery fish and PNOB was therefore 0.02.

Table 17. Estimates of integration of natural-origin spawners as broodstock in Willamette hatcheries, 2011. Note that in 2011, North Santiam broodstock were held and spawned at McKenzie Hatchery because of the Minto facility construction.

Stock	Hatchery	# Clipped Spawners	# Unclipped Spawners	Otoliths Read	Unclipped Thermal Marks	pNOB
North Santiam	McKenzie	452	96	96	5	0.17
South Santiam	South Santiam	696	0	NA	NA	0.00
McKenzie	McKenzie	1,462	97	97	39	0.04
M. Fk Willamette	M. Fk Willamette	1,363	74	74	45	0.02

Section 3.3.2 Broodstock Collection Timing, Age, and Size Distributions:

3.3.2.1 North Santiam: Collection timing of broodstock for the North Santiam hatchery program, used by convention as a proxy for run timing, is provided in Figure 15. Importantly, broodstock collection in 2011 occurred at the Bennett dams. When construction at the Minto Fish Collection Facility is complete broodstock collection will likely occur later. Size distributions of the North Santiam broodstock by sex are provided in Figure 16: females tended to be larger than males (Mann-Whitney Test; U = 909.5, T = 2134.5; P = 0.019). We compared age structure between NOB and HOB among North Santiam broodstock (Figure 17) and found that HOB broodstock tended to be older (Mann-Whitney Test; U = 3083.5, T = 6086.5; P = 0.021). Similarly, we compared sizes of NOB and HOB fish (Figure 18) but did not detect a significant difference.

3.3.2.2 South Santiam: Collection timing of broodstock for the South Santiam Hatchery program, used by convention as a proxy for run timing, is provided in Figure 15. Size distributions of the South Santiam broodstock by sex are provided in Figure 16: males tended to be larger than females (Mann-Whitney Test; U = 844, T = 1834.0; P = 0.020). We compared age structure between HOB fish collected during spawner surveys (NOB fish are not used in the South Santiam program) (Figure 19) and found that HOB broodstock tended to be older (Mann-Whitney Test; U = 10606.0, T = 16862.0; P = 0.003). Similarly, we compared sizes of natural-origin spawners on the spawning grounds and HOB fish at the hatchery (Figure 20) and found that the natural-origin fish tended to be larger (Mann-Whitney Test; U = 10049.5, T = 12677.5; P = 0.011).

3.3.2.3 McKenzie: Collection timing of broodstock for the McKenzie Hatchery program, used by convention as a proxy for run timing, is provided in Figure 15. Size distributions of the McKenzie broodstock by sex are provided in Figure 16: males tended to be larger than females (Mann-Whitney Test; U = 809.5, T = 2529.5; P = 0.004). We compared age structure between HOB and NOB fish (Figure 21) and found that HOB broodstock tended to be older (Mann-Whitney Test; U = 2046.5, T = 3642.5; $P < 0.001$). Similarly, we compared sizes of NOB and HOB fish at the hatchery (Figure 22) and found that the natural-origin fish tended to be larger (Mann-Whitney Test; U = 1978, T = 5610; P = 0.011).

3.3.2.4 Middle Fork Willamette: Collection timing of broodstock for the Middle Fork Willamette Hatchery program, used by convention as a proxy for run timing, is provided in Figure 15. Size distributions of the Middle Fork Willamette broodstock by sex are provided in Figure 16. We found no statistically significant difference in size between sexes (Mann-Whitney Test; U = 1007, T = 1910; P = 0.141). We compared age structure between HOB and NOB fish (Figure 23) and found no statistically significant difference (Mann-Whitney Test; U = 519.5, T = 1118.5;

P = 0.196). Similarly, we compared sizes of NOB and HOB fish at the hatchery (Figure 24) and found no statistically significant difference (Mann-Whitney Test; U = 553, T = 1187; P = 0.272).

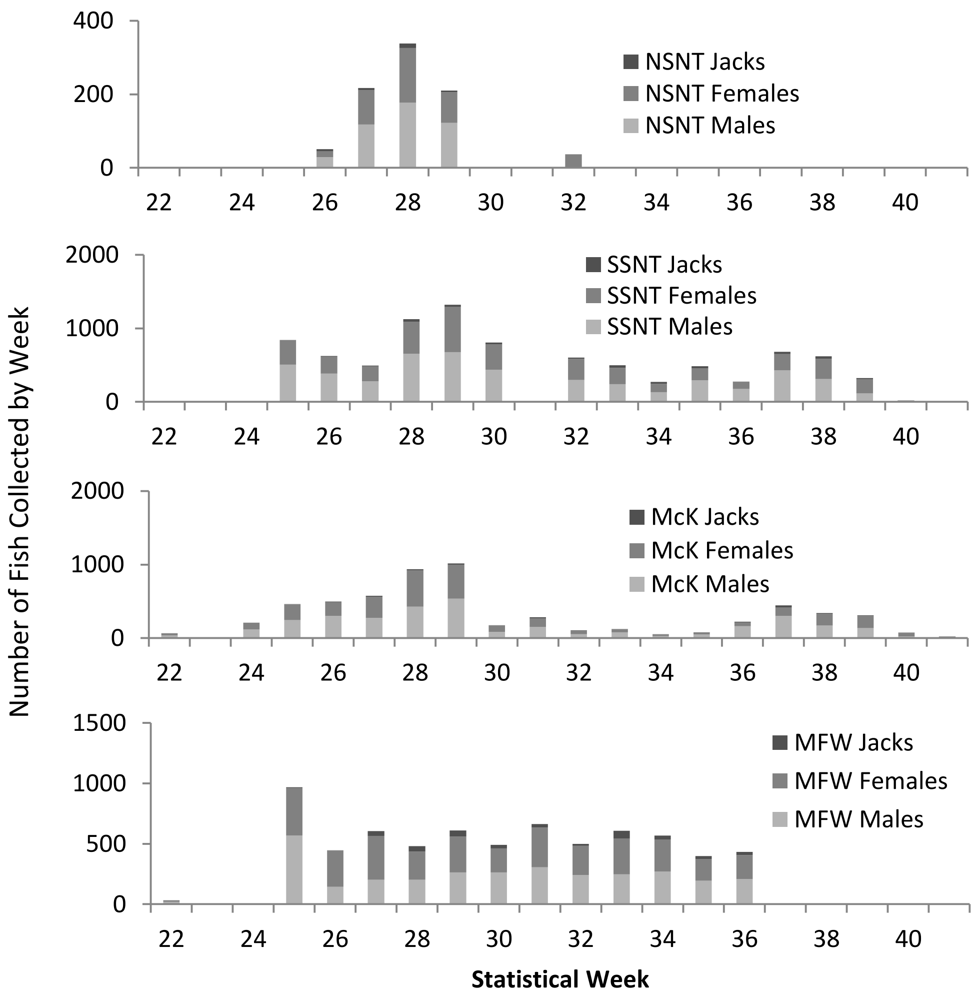

Figure 15. Collection timing of adult and jack Chinook salmon at all facilities, 2011. NSNT, SSNT, McK, and MFW indicate North Santiam, South Santiam, McKenzie and Middle Fork Willamette hatcheries, respectively.

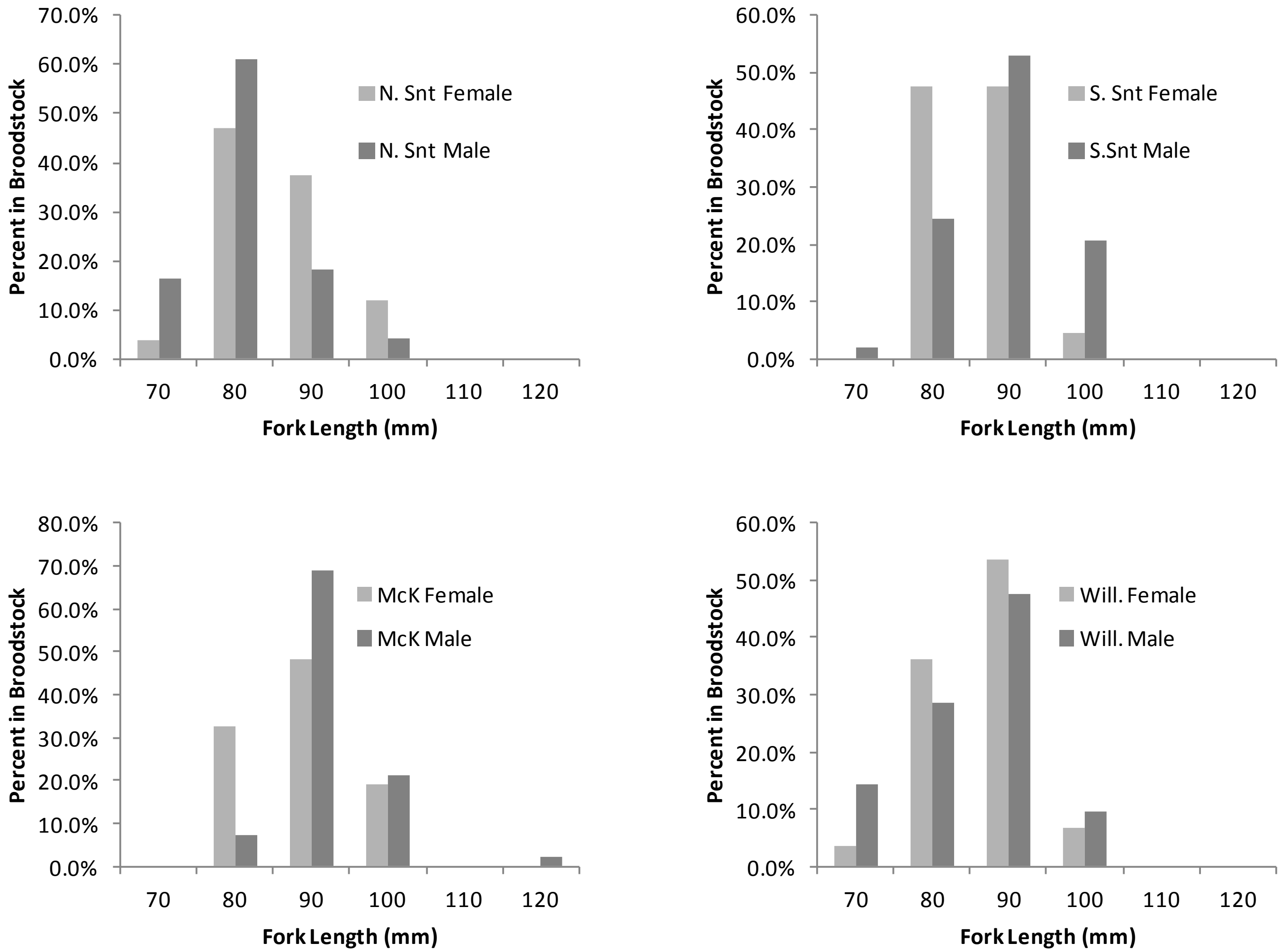

Figure 16. Size frequency of male and female Chinook salmon used in broodstock, 2011. Data from N = 100 at each hatchery; jacks were excluded (only 3 jacks among samples taken, all at S. Santiam).

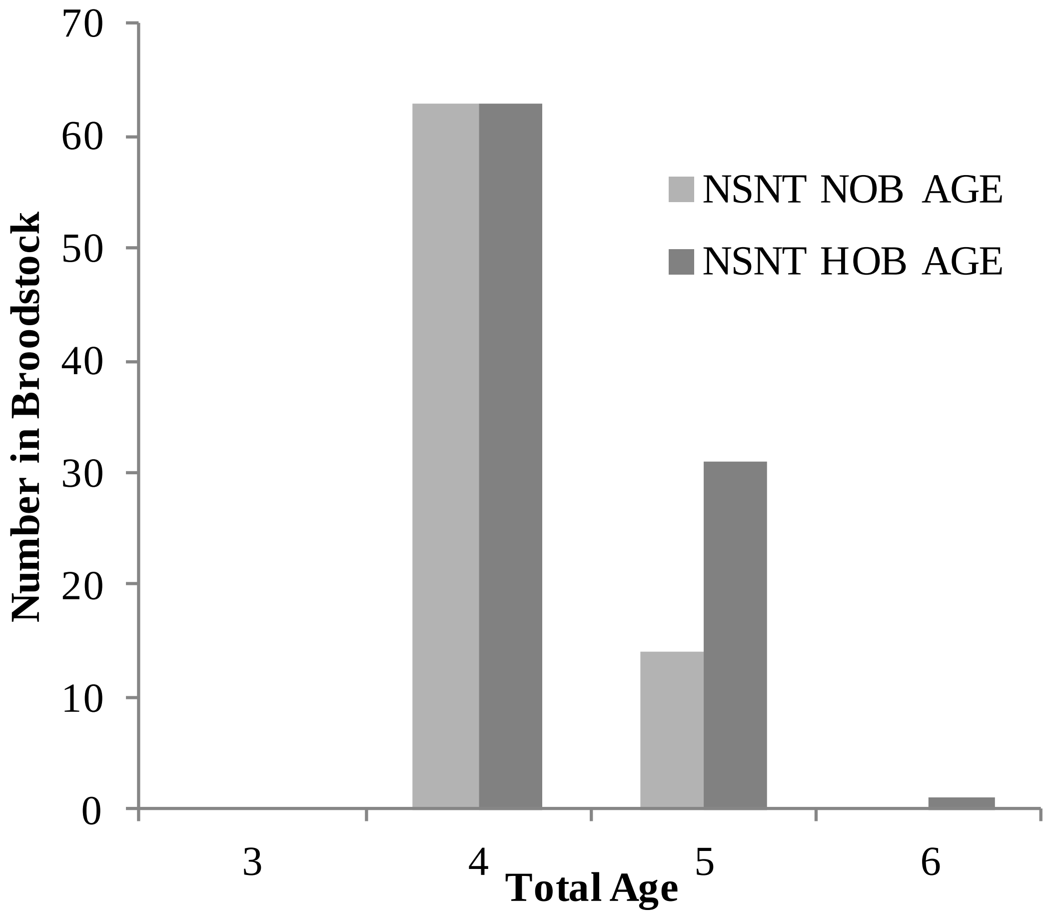

Figure 17. Age structure of Chinook salmon used for North Santiam broodstock, 2011. Sample sizes (readable scales) were 77 and 95 for NOB and HOB respectively.

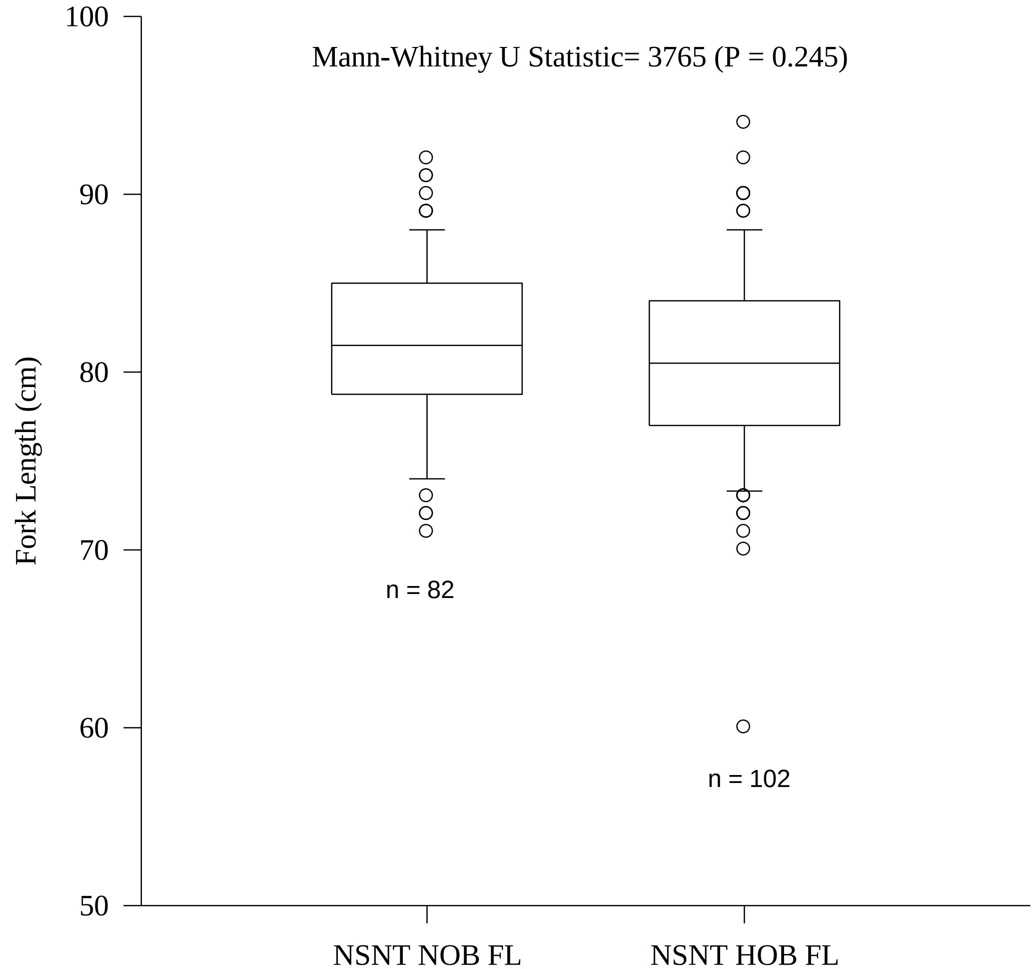

Figure 18. Size comparison of North Santiam Chinook salmon broodstock used for spawning, 2011.

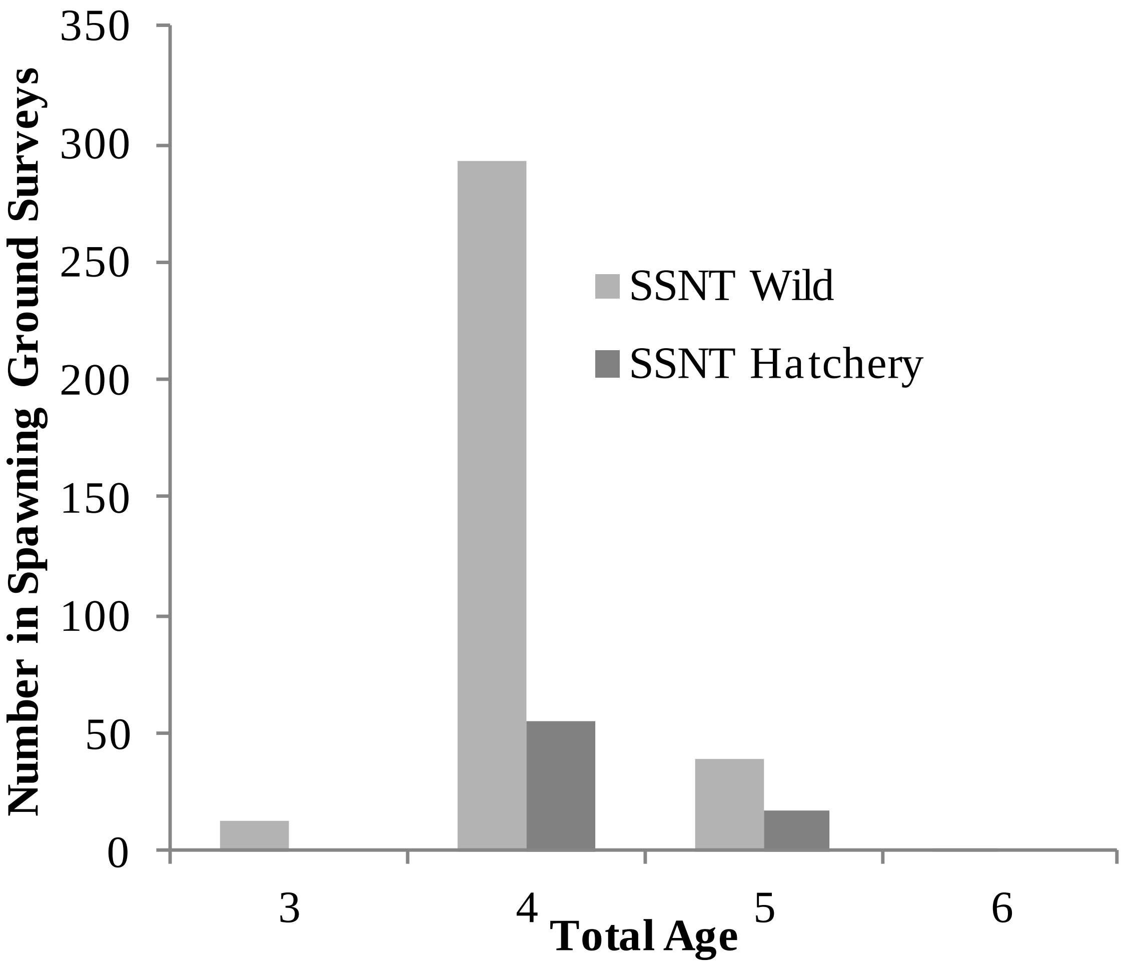

Figure 19. Age structure of wild- and hatchery-origin Chinook salmon in the South Santiam River, 2011. Note wild-origin Chinook salmon were not integrated into broodstock there in 2011 and the figure compares sizes of fish sampled on the spawning grounds.

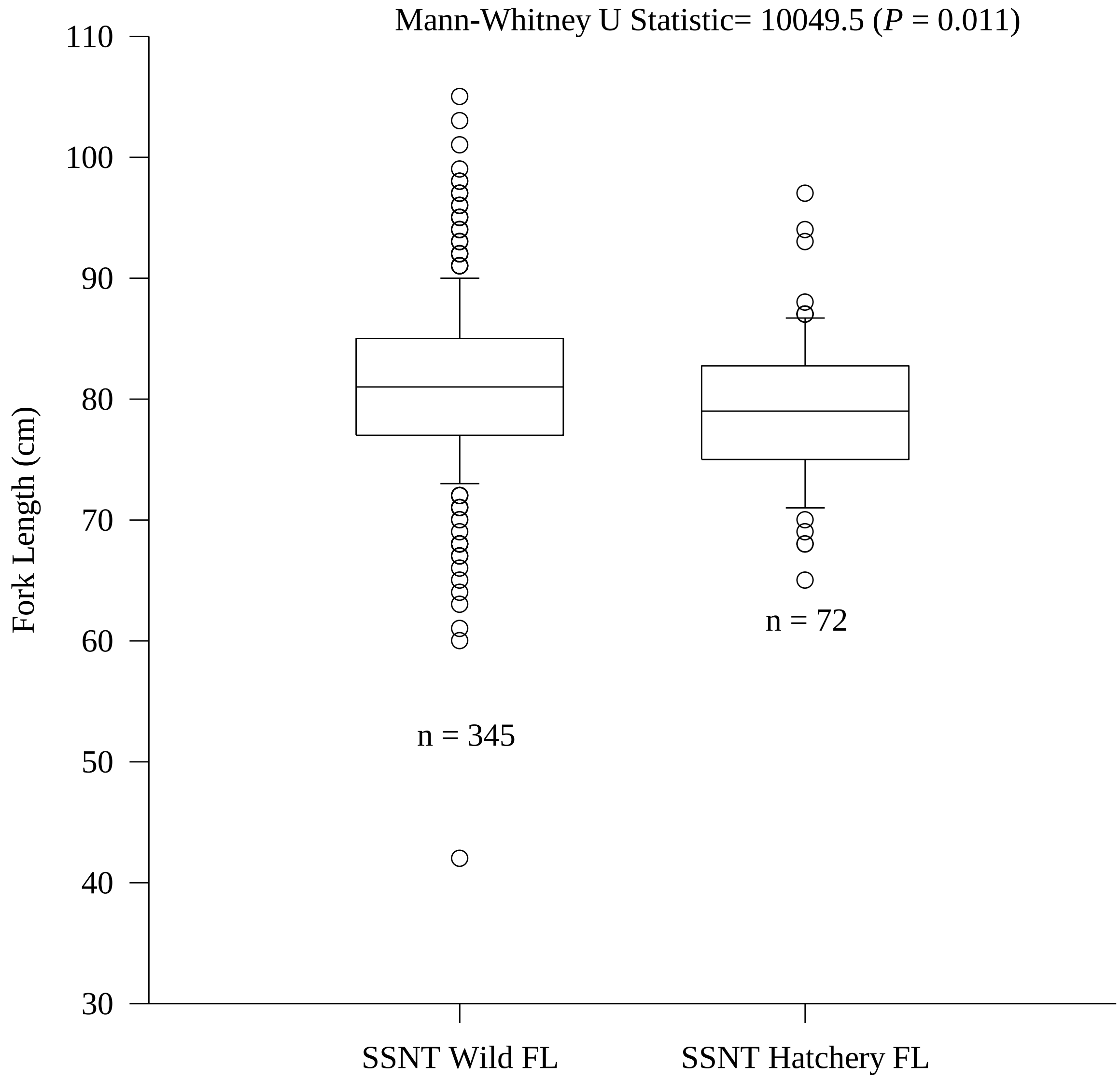

Figure 20. Fork length of hatchery- and wild-origin Chinook salmon in the South Santiam River, 2011. Note wild-origin Chinook salmon were not integrated into broodstock there in 2011 and the figure compares sizes of fish sampled on the spawning grounds.

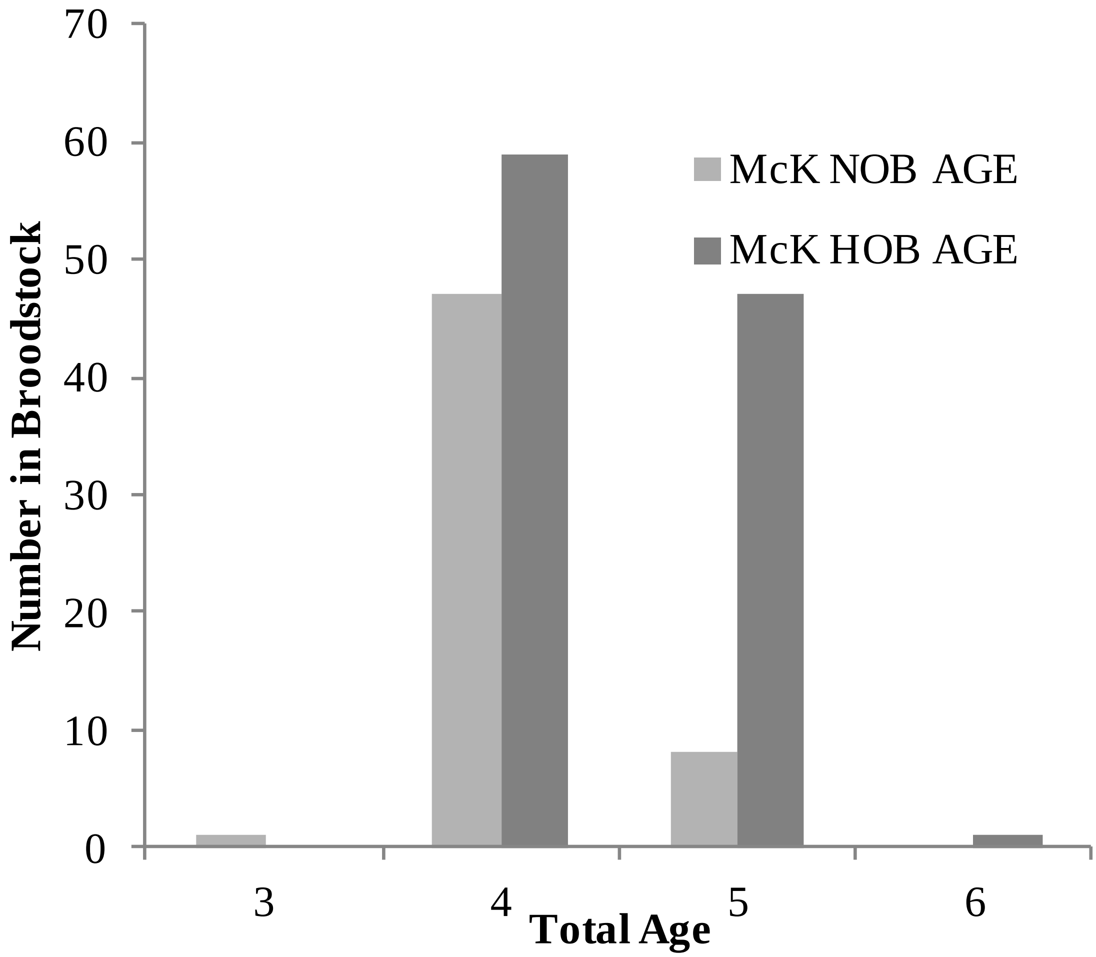

Figure 21. Age structure of NOB and HOB Chinook salmon broodstock at McKenzie Hatchery, 2011.

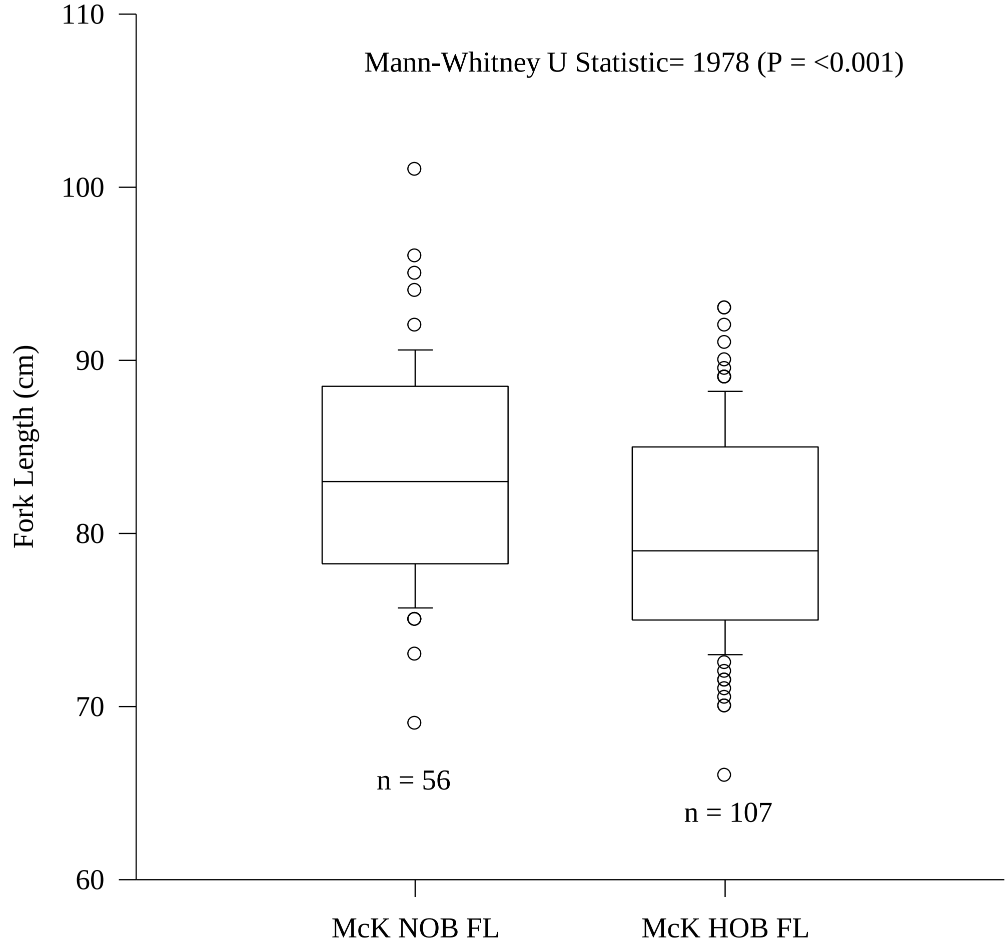

Figure 22. Fork length of McKenzie Hatchery NOB and HOB broodstock, 2011.

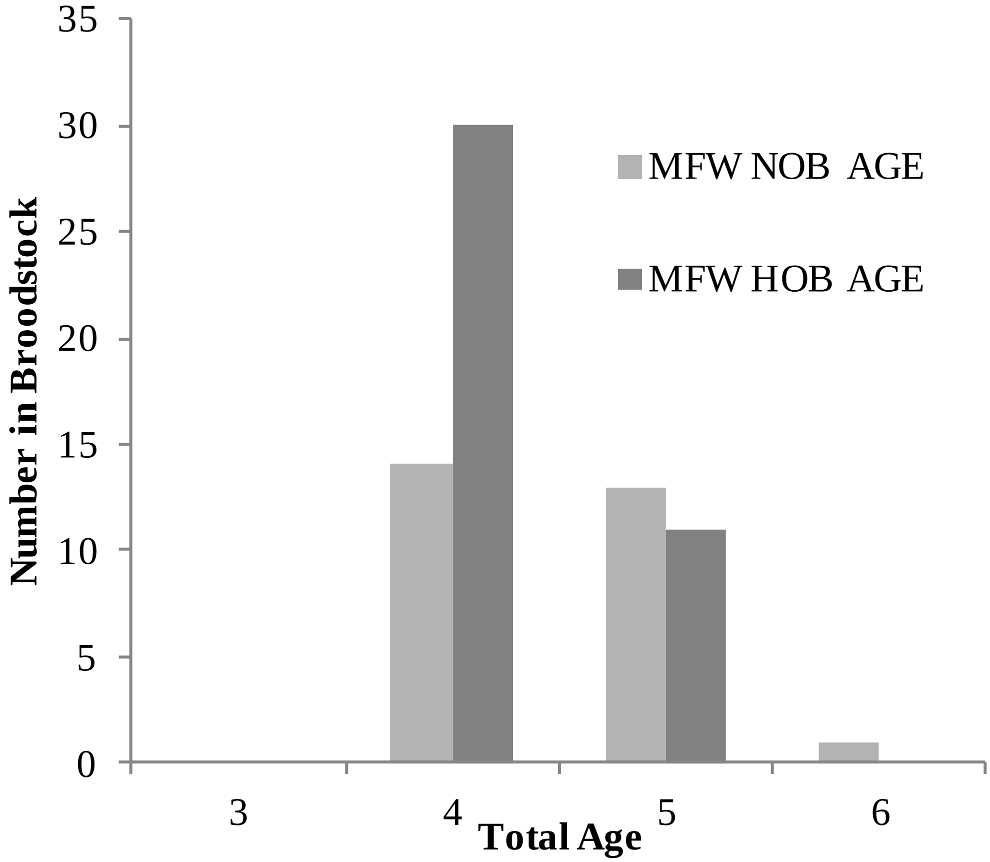

Figure 23. Age structure of NOB and HOB Chinook salmon broodstock at Willamette Hatchery, 2011.

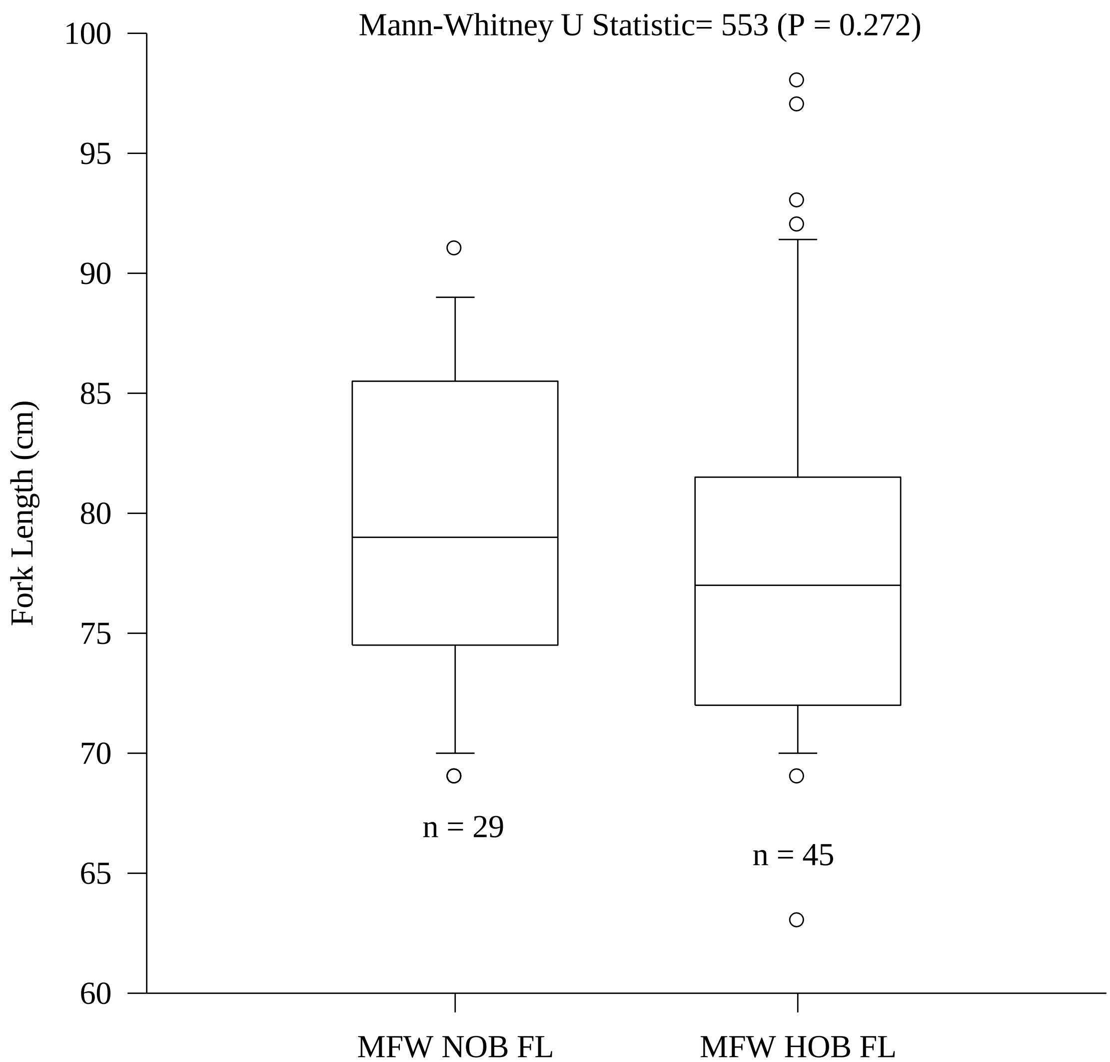

Figure 24. Size comparison of Willamette Hatchery NOB and HOB broodstock, 2011.

Section 4: Discussion

We were successful conducting relatively comprehensive Chinook salmon spawner and pre-spawn mortality surveys in 2011. Spawner surveys were conducted over the entire spawning season in all reaches that have traditionally been surveyed both below project dams for naturally escaped adult Chinook salmon, and in the majority of the reaches above project dams for outplanted fish. One exception was that comprehensive survey data were not obtained for survey reaches above Hills Creek Dam on the Middle Fork Willamette River. In past years those reaches were typically surveyed during spawner surveys for bull trout by ODFW and USFS personnel and that did not occur in 2011. An attempt will be made in 2012 to provide support from the HRME program to ensure that those surveys are conducted.

Redd densities, which we think serve as a useful index for spatial distribution and relative spawner abundance did not differ significantly from recent historical redd densities except in the North Santiam River above Bennett Dam where higher densities were noted than in recent years. It seems likely that the increase in the North Santiam River might be related to the operation on the Upper Bennett trap while the new Minto trap is under construction. In past years, adult Chinook salmon were removed in large numbers at Minto and released above Detroit Reservoir. In 2011 we were barely able to capture and transfer enough North Santiam fish for broodstock and relatively few fish were removed for outplanting. The hatchery-origin fish that would otherwise have been removed from the reaches between Bennett Dam and Minto might have contributed to the increased redd densities relative to previous years.

We attempted to use the use the peak count expansion method to directly estimate actual spawner abundance and while we think the results should we used with caution, there is some support for their utility. The peak count expansion estimate for total number of natural-origin spawners in the McKenzie River above Leaburg Dam was 2,605 fish (all mainstem spawners plus tributaries including the South Fork McKenzie River). A partially independent estimate of McKenzie River spawner escapement in 2011 (K. Schroeder ODFW, Pers. Comm.) used a combination of counts of unclipped fish passing Leaburg Dam, historical estimates of fall-back over the dam, otolith data from spawner surveys, and pre-spawning mortality estimates. That estimate for natural-origin Chinook salmon that spawned above Leaburg Dam in 2011 was 2,190 fish. No estimates of precision are available for either method. We reiterate that, given our efforts to estimate and characterize variance in redd counts (reported in this document), when combined with information from carcasses found on the spawning grounds, redd surveys provide the most useful information about where subsequent juvenile production may be expected to occur, where spawning activity is occurring, and at what general levels (e.g. low, medium, high).

We think that our carcass recovery efforts during pre-spawn mortality and spawner surveys provide useful information on where in the subbasins the well-being of the potential spawners may be seriously compromised. Spawner holding conditions were relatively benign throughout the subbasins in 2011 but we detected specific instances of high and low PSM that suggest some opportunities for future research and monitoring efforts.

In the North Santiam River we noted high PSM below Upper Bennett Dam and, while the evidence is not conclusive, we think that the difficulties in operation of that trapping facility in 2011 might have contributed to the observed levels of PSM. If upstream migration of some of the adult fish were delayed to the point that the spawners were forced to hold in conditions of lower water quality and, in addition, some injuries were sustained by fish attempting to circumvent the ladder/trap, then PSM rates might have increased for fish holding beneath the dam. In addition, there was a small but significant increase in 2011 in the number of redds that were created below Bennett Dam, compared to 2005 through 2010.

In the South Santiam River PSM rates were greater above Foster Dam compared to below the dam and, because habitat quality above the dam is thought to be superior to that below the dam the higher PSM rates might be associated with the stress of capture, crowding, anesthesia (via CO_2), loading, transport, and release of outplanted fish.

In the McKenzie River PSM rates were relatively low in 2011 but they were significantly elevated below Leaburg Dam compared to rates above Leaburg.

In the Middle Fork Willamette Basin adults were outplanted in Little Fall Creek and PSM rates in that tributary were lower than those observed in the North Fork Middle Fork. We did not specifically track some variables that might be associated with differences in PSM rates in the two areas such as timing of outplants or loading densities in the transport trucks but the distances, and thus time of transport, between Dexter Dam and the outplant sites are suggestive of a useful metric for testing in the future.

One of the more pressing Conservation and Recovery goals in the Upper Willamette subbasins is to achieve PHOS goals of 10% or less. Clearly, that goal is ambitious. In one instance where only unclipped fish are passed into the spawning reaches above a dam (Foster Dam on the South Santiam River) the PHOS goal was still exceeded because of the number of unclipped hatchery fish returning. We do not think that the issue can be resolved by increasing the clipping rate of hatchery fish because the automated tagging and clipping trailers already perform with very high efficiency. The sheer size of juvenile fish releases necessary to support fisheries translates into returns of relatively abundant fish that cannot be visually identified as hatchery origin. Sorting procedures based solely on presence or absence of a fin clip will not always be adequate to permit creation of wild fish sanctuaries that meet existing PHOS goals.

In 2011we were successful at outplanting large numbers of adult Chinook salmon into otherwise depauperate habitat in the South Santiam, McKenzie and Middle Fork Willamette rivers but not in the North Santiam River. We think that our procedures for operation of the Bennett Dam facility have improved because of the experience gained in 2011 and we are more confident of success in outplanting more fish from that facility in 2012.

We expect that in 2012 we will conduct surveys and perform monitoring at hatcheries and traps for Chinook salmon very similar in scope to that of the work described in this document. We anticipate increasing the scope of work monitoring winter- and summer-run steelhead but the magnitude of increased attention paid to that species will depend on availability of funding.

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Appendix 1: Summary of Tasks

Summary of anadromous fish monitoring and hatchery sampling tasks addressed in this report. RPA=reasonable and prudent alternative (NMFS 2008).

SPRING CHINOOK SALMON

Task 1.1: Determine abundance, distribution, & percent hatchery-origin fish on spawning grounds [RPA 9.5.1(2)]

Conduct surveys downstream of federal dams in the North Santiam, South Santiam, McKenzie, MF Willamette basins

1. Conduct spawning surveys to count redds

2. Assess variability in redd counts among crews with re-surveys

3. Conduct spawning surveys to collect carcasses for differentiating hatchery fish from wild fish (fin clips & otoliths)

4. Estimate pre-spawning mortality

5. Assess straying of hatchery fish between basins using coded-wire tags recovered from carcasses

Task 1.2: Monitor clipped & unclipped fish passing Leaburg and Upper Bennett dams [RPA 9.5.1(2)]

Collect information on run size & composition of run (using data from Task 1.1), removal of hatchery fish

1. Operate video recording equipment and count clipped and unclipped fish passing Leaburg Dam

2. Operate adult fish trap in the Leaburg Dam fishway when feasible to remove clipped fish [RPA 6.1.4, interim measure]

3. Operate video recording equipment and count clipped and unclipped fish passing upper Bennett Dam

4. Investigate feasibility of video monitoring at Lower Bennett and Lebanon dams

Task 2.1: Collection, spawn timing, and H/W composition for broodstock management [RPA 9.5.1(1) & 6.2.2]

Hatchery monitoring of returns and broodstocks

1. Record data on return date, numbers of clipped & unclipped fish, disposition (collect biological data on outplants and spawned fish)

2. Collect otoliths on unclipped fish used for broodstock to determine proportion of wild fish

3. Operate Leaburg fishway trap to collect unclipped fish to supplement broodstock [see Task 1.2(2)]

4. Develop monitoring of fin-clipped and unclipped fish at Bennett dams for index of broodstock management (under Task 1.2)

Task 2.2: Determine survival of outplanted fish and abundance of spawners [RPA 9.5.1(3) & 6.2.3; Proposed Action 2.10.1]

Conduct surveys upstream of federal dams in the North Santiam, South Santiam, McKenzie, MF Willamette basins

1. Record numbers, clip information, date, release locations for outplanted Chinook salmon

2. Collect tissue samples from outplanted Chinook salmon to determine spawning success and parentage analysis of returning adults

3. Conduct spawning surveys to count redds as measure of abundance, survival, and distribution of outplants

4. Conduct spawning surveys to collect carcasses for proportion of hatchery and wild fish in some outplant areas

5. Estimate pre-spawning mortality for outplanted Chinook salmon

6. Assist in collection of information needed for condition study in Middle Fork Willamette River and Fall Cr.

STEELHEAD

Task 3.1: Determine the extent of summer steelhead reproduction in the wild [RPA 9.5.2(1) and 6.1.9].

1. Develop a study plan for genetics study and initiate field collections

2. Work with geneticists (Services, OSU) to develop study plan to determine parentage and introgression

3. Review plan and design with ODFW managers, and with independent review group

4. Initiate field collections of tissue samples in North and South Santiam using traps, electrofishing, seines

5. Collect tissue samples on unclipped steelhead smolts in Willamette at Sullivan Plant and using seines or electrofishing

6. Collect tissue samples on winter-run and summer-run steelhead adults if needed to increase reference samples

7. Collect tissue samples from adult resident and hatchery rainbow trout - potential parentage sources

Task 3.2: Evaluate release strategies for summer steelhead to increase migration and reduce impacts on wild fish [RPA 6.1.6].

1. Develop study plans to implement volitional releases and monitor outmigration, and initiate field work

2. Develop plans to implement volitional emigration from release facilities and evaluate factors influencing volitional emigration

3. Develop plans to monitor outmigration of summer steelhead releases past Willamette Falls

4. Develop plans to monitor presence, distribution, and size of residual hatchery steelhead in tributaries and main stem.

Appendix 2: Spatial Scales Associated With Abundance, Spatial Distribution, and Diversity Metrics

Subbasin	River Section	Survey Reach (downstream to upstream extent)	Carcass Surveys	Redd Surveys	Peak Redd Count	Redd Density	pHOS	PSM	Escape-ment
North Santiam							X		
	downstream of Minto Dam								X
		downstream of Upper Bennett Dam			X	X	X	X	
		Green's Bridge to Shelburn	X	X	X				
		Shelburn to Stayton	X	X	X				
		Stayton to South Channel-Upper Bennett Dam	X	X	X				
		Stayton to North Channel-Stayton Island	X	X	X				
		Upper Bennett Dam to Minto Dam			X	X	X	X	
		Stayton to North Channel-Stayton Island	X	X	X				
		Upper Bennett (Stayton Island) to Powerlines	X	X	X				
		Powerlines to Mehama	X	X	X				
		Mehama to Fisherman's Bend	X	X	X				
		Fisherman's Bend to Mill City	X	X	X				
		Mill City to Gate's Bridge	X	X	X				
		Gate's Bridge to Packsaddle	X	X	X				
		Packsaddle to Minto Dam	X	X	X				
	upstream of Minto Dam	Minto to Big Cliff Dam (Not currently surveyed)			X	X	X	X	
	Little North Santiam				X	X	X	X	X

Subbasin	River Section	Survey Reach (downstream to upstream extent)	Carcass Surveys	Redd Surveys	Peak Redd Count	Redd Density	pHOS	PSM	Escape-ment
		Lunkers Bridge to Bear Creek Bridge	X	X	X				
		Bear Creek Bridge to Golf Bridge	X	X	X				
		Golf Bridge to Narrows	X	X	X				
		Narrows to Camp Cascade	X	X	X				
		Camp Cascade to Salmon Falls	X	X	X				
		Salmon Falls to Elkhorn Bridge	X	X	X				
South Santiam	downstream of Foster Dam	downstream of Lebanon Dam			X	X	X	X	X
		Sanderson's to Gill's Landing	X	X	X				
		Lebanon Dam to Foster Dam			X	X	X	X	
		Waterloo to McDowell Creek	X	X	X				
		McDowell Creek to Pleasant Valley	X	X	X				
		Pleasant Valley to Foster Dam	X	X	X				
	upstream of Foster Dam				X	X	X	X	X
		River Bend Park to Shot Pouch Road	X	X	X				
		Shot Pouch Rd to High Deck Road	X	X	X				
		High Deck Rd to Cascadia Park	X	X	X				
		Cascadia Park to Moose Creek Bridge	X	X	X				
		Moose Creek Bridge to Gordon Creek Road	X	X	X				
		Gordon Cr. Rd to 2nd Trib. downstream of C.G.	X	X	X				
		2nd Trib. downstream of C.G. to Trout Creek C.G.	X	X	X				
		Trout Creek C.G. to Little Boulder Creek	X	X	X				
		Little Boulder Creek to Soda Fork	X	X	X				
		Soda Fork to Falls	X	X	X				
McKenzie									

Subbasin	River Section	Survey Reach (downstream to upstream extent)	Carcass Surveys	Redd Surveys	Peak Redd Count	Redd Density	pHOS	PSM	Escape-ment
	downstream of Leaburg Dam				X	X	X	X	X
		Leaburg Landing to Leaburg Dam	X	X	X				
	upstream of Leaburg Dam						X		X
		Leaburg Dam to Forest Glen			X	X	X	X	
		Leaburg Lake to Helfrich	X	X	X				
		Ben & Kay to Rosboro Bridge	X	X	X				
		Rosboro Bridge to Forest Glen	X	X	X				
		upstream of Forest Glen			X	X	X	X	
		Forest Glen to South Fork McKenzie	X	X	X				
		South Fork McKenzie to Hamlin	X	X	X				
		Hamlin to McKenzie Bridge	X	X	X				
		McKenzie Bridge to McKenzie Trail	X	X	X				
		McKenzie Trail to Paradise	X	X	X				
		Paradise to Belknap	X	X	X				
		Belknap to Olallie C.G.	X	X	X				
		Spawning Channel	X	X	X				
		Horse Creek							
		Mouth to Bridge	X	X	X				
		Bridge to Avenue Creek	X	X	X				
		Avenue Creek to Braids	X	X	X				
		Braids to Road Access	X	X	X				
		Road Access to Separation Creek	X	X	X				
		Separation Creek to Trail Bridge	X	X	X				
		Trail Bridge to Pothole Creek	X	X	X				
		Lost Creek							

Subbasin	River Section	Survey Reach (downstream to upstream extent)	Carcass Surveys	Redd Surveys	Peak Redd Count	Redd Density	pHOS	PSM	Escape-ment
		Mouth to Hwy Bridge	X	X	X				
		Hwy Bridge to Split Pt	X	X	X				
		Split Pt to Campground	X	X	X				
		Campground to Cascade	X	X	X				
		South Fork McKenzie downstream of Cougar Dam			X	X	X	X	
		Mouth to Bridge	X	X	X				
		Bridge to Cougar Dam	X	X	X				
	South Fork McKenzie River, upstream of Cougar Dam				X	X	X	X	X
		Reservoir to Hardy	X	X	X				
		Hardy Creek to Rebel Creek	X	X	X				
		Rebel Creek to Dutch Oven	X	X	X				
		Dutch Oven C.G. to Homestead C.G.	X	X	X				
		Homestead C.G. to Twin Springs C.G.	X	X	X				
		Twin Springs C.G. to Roaring River	X	X	X				
		Roaring River to Elk Creek	X	X	X				
		SF 1 mile upstream of confluence of Elk Creek	X	X	X				
Middle Fork Willamette	Jasper to Dexter Dam				X	X	X	X	X
		Jasper to Pengra	X	X	X				
		Pengra to Dexter Dam	X	X	X				
	Fall Creek				X	X	X	X	X
		Reservoir to Release Site	X	X	X				
		Release Site to Johnny Creek Bridge	X	X	X				
		Johnny Creek Bridge to Bedrock campground	X	X	X				
		Bedrock campground to Portland Creek	X	X	X				

Subbasin	River Section	Survey Reach (downstream to upstream extent)	Carcass Surveys	Redd Surveys	Peak Redd Count	Redd Density	pHOS	PSM	Escape-ment
		Portland Creek to NFD 1828 Bridge	X	X	X				
		NFD 1828 Bridge to Hehe Creek	X	X	X				
		Hehe Creek to Gold Creek	X	X	X				
		Gold Creek to Falls	X	X	X				
	Little Fall Creek				X	X	X	X	X
		Fish Ladder to NFD 1818 Bridge	X	X	X				
		NFD 1818 Bridge to NFD 1806 Bridge	X	X	X				
	North Fork Middle Fork Willamette				X	X	X	X	X
		Minute Creek to 2nd to last pullout	X	X	X				
		NFD 1944 Bridge to Minute Creek	X	X	X				
		Kiahanie Bridge to NFD 1944 Bridge	X	X	X				
		Release Site to Kiahanie Bridge	X	X	X				

Appendix 3: Survey reaches for upper Willamette subbasin pre-spawn mortality and spawner surveys

SubBasin	River	Description	Start River Mile	End River Mile	Total Distance	Comment
Santiam	**Santiam**	**Mouth to I-5 Bridge**	**0**	**6.4**	**6.4**	
Santiam	Santiam	I-5 Bridge to Jefferson	6.4	10	**3.6**	
Santiam	Santiam	Jefferson to Confluence	10	12.1	**2.1**	covered on N/S surveys
N. Santiam	**N. Santiam**	**Mouth/Jefferson to Green's Bridge**	**0**	**2.9**	**2.9**	**covers part of MS Santiam**
N. Santiam	N. Santiam	Green's Bridge to Shelburn	2.9	11.1	**8.2**	
N. Santiam	N. Santiam	Shelburn to Stayton	11.1	16.6	**5.5**	
N. Santiam	N. Santiam	Stayton to North Channel-Stayton Is	16.6	19.8	**3.2**	
N. Santiam	N. Santiam	Stayton to South Channel-Upper Bennett	19.8	23	**3.2**	
N. Santiam	N. Santiam	Upper Bennett to Powerlines	23	26.5	**3.5**	
N. Santiam	N. Santiam	Powerlines to Mehama	26.5	30	**3.5**	
N. Santiam	N. Santiam	Mehama to Fisherman's Bend	30	36.5	**6.5**	
N. Santiam	**Little N. Santiam**	**Mouth to NF Park**	**0**	**3**	**3**	
N. Santiam	Little N. Santiam	NF Park to Lunkers Bridge	3	7	**4**	
N. Santiam	Little N. Santiam	Lunkers Bridge to Bear Creek Bridge	7	8.9	**1.9**	
N. Santiam	Little N. Santiam	Bear Creek Bridge to Golf Bridge	8.9	12.3	**3.4**	
N. Santiam	Little N. Santiam	Golf Bridge to Narrows	12.3	13.2	**0.9**	
N. Santiam	Little N. Santiam	Narrows to Camp Cascade	13.2	14.4	**1.2**	
N. Santiam	Little N. Santiam	Camp Cascade to Salmon Falls	14.4	15.3	**0.9**	
N. Santiam	Little N. Santiam	Salmon Falls to Elkhorn Bridge	15.3	16.3	**1**	
N. Santiam	N. Santiam	Fisherman's Bend to Mill City	36.5	38.5	**2**	
N. Santiam	N. Santiam	Mill City to Gate's Bridge	38.5	42.3	**3.8**	
N. Santiam	N. Santiam	Gate's Bridge to Packsaddle	42.3	45.1	**2.8**	
N. Santiam	N. Santiam	Packsaddle to Minto Dam	45.1	45.3	**0.2**	
N. Santiam	**Breitenbush**	**Upper Arm Picnic Area to Byars Creek**	**0**	**1.4**	**1.4**	
N. Santiam	Breitenbush	Byars Creek to Humbug Creek	1.4	2.9	**1.5**	
N. Santiam	Breitenbush	Humbug Creek to Fox Creek	2.9	4.3	**1.4**	
N. Santiam	Breitenbush	Fox Cr. to Scorpion Cr	4.3	5.7	**1.4**	

SubBasin	River	Description	Start River Mile	End River Mile	Total Distance	Comment
N. Santiam	Breitenbush	Scorpion Cr. to Hill Cr	5.7	7.3	**1.6**	
N. Santiam	Breitenbush	Hill Cr. to SF Breitenbush	7.3	9.2	**1.9**	
N. Santiam	N. Santiam abv Detroit	Cooper's Ridge to Misery Cr	73.8	76.2	**2.4**	river mile
N. Santiam	N. Santiam abv Detroit	Misery Cr. to Whitewater Cr.	76.2	78.4	**2.2**	
N. Santiam	N. Santiam abv Detroit	Whitewater Cr. to Pamelia	78.4	81.15	**2.75**	
N. Santiam	N. Santiam abv Detroit	Pamelia Creek to Minto Creek	81.15	83.95	**2.8**	
N. Santiam	N. Santiam abv Detroit	Minto Creek to Horn Creek	83.95	85.15	**1.2**	
N. Santiam	**Marion Creek**	**Mouth to Hatchery Weir**	**0**	**0.7**	**0.7**	
N. Santiam	**Horn Creek**	**Mouth to Hatchery Weir**	**0**	**0.5**	**0.5**	
N. Santiam	N. Santiam abv Detroit	Horn Creek to Bugaboo Creek	0.7	2.4	**1.7**	
N. Santiam	N. Santiam abv Detroit	Bugaboo to Straight Cr	2.4	5	**2.6**	
N. Santiam	N. Santiam abv Detroit	Straight Cr. to Parish Lake Road	5	8.5	**3.5**	
S. Santiam	**S. Santiam**	**Mouth/Jefferson to Sanderson's**	**0**	**10**	**10**	**Covers part MS Santiam**
S. Santiam	S. Santiam	Sanderson's to Gill's Landing/Lebanon	10	19.7	**9.7**	
S. Santiam	S. Santiam	Waterloo to McDowell Creek	19.7	24	**4.3**	
S. Santiam	S. Santiam	McDowell Creek to Pleasant Valley	24	29.4	**5.4**	
S. Santiam	S. Santiam	Pleasant Valley to Foster	29.4	33.9	**4.5**	
S. Santiam	S. Santiam abv Foster	River Bend Park to Shot Pouch Rd	46.6	48.9	**2.3**	river mile +2.6
S. Santiam	S. Santiam abv Foster	Shot Pouch Rd to High Deck Rd	48.9	50.6	**1.7**	
S. Santiam	S. Santiam abv Foster	High Deck Rd to Cascadia Park	50.6	52.2	**1.6**	
S. Santiam	S. Santiam abv Foster	Cascadia Park to Moose Creek Bridge	52.2	53.7	**1.5**	
S. Santiam	S. Santiam abv Foster	Moose Creek Bridge to Gordon Creek Rd	53.7	56.4	**2.7**	
S. Santiam	S. Santiam abv Foster	Gordon Creek Rd to 2nd Trib below C.G.	56.4	58.2	**1.8**	
S. Santiam	S. Santiam abv Foster	2nd Trib below C.G. to Trout Creek C.G.	58.2	59.7	**1.5**	
S. Santiam	S. Santiam abv Foster	Trout Creek C.G. to Little Boulder Creek	59.7	61.8	**2.1**	
S. Santiam	S. Santiam abv Foster	Little Boulder Creek to Soda Fork	61.8	63.6	**1.8**	
S. Santiam	S. Santiam abv Foster	Soda Fork to Falls	63.6	66.1	**2.5**	distance is estimated?
McKenzie	**McKenzie**	**Armitage to Hayden**	**4.1**	**14.3**	**10.2**	**4.1 to mouth**

SubBasin	River	Description	Start River Mile	End River Mile	Total Distance	Comment
McKenzie	McKenzie	Hayden to Bellinger	14.3	18.7	**4.4**	manually measured
McKenzie	McKenzie	Bellinger to Hendricks	18.7	24.2	**5.5**	manually measured
McKenzie	McKenzie	Hendricks to Dearhorn	24.2	31.8	**7.6**	
McKenzie	McKenzie	Dearhorn to Leaburg Landing	31.8	33.9	**2.1**	
McKenzie	McKenzie	Leaburg Landing to Leaburg Dam	33.9	39.9	**6**	
McKenzie	McKenzie	Leaburg Lake to Helfrich	39.9	44.3	**4.4**	
McKenzie	McKenzie	Ben & Kay to Rosboro Bridge	44.3	50.8	**6.5**	
McKenzie	McKenzie	Rosboro Bridge to Forest Glen	50.8	56.5	**5.7**	
McKenzie	McKenzie	Forest Glen to S.F. McKenzie	56.5	58.9	**2.4**	
McKenzie	**S. Fork McKenzie**	**Mouth to Bridge**	**0**	**2.1**	**2.1**	
McKenzie	S. Fork McKenzie	Bridge to Cougar Dam	2.1	4.4	**2.3**	
McKenzie	S. Fork McK abv Cougar	Cougar Reservoir to NFD 1980	9.1	11.1	**2**	river mile
McKenzie	S. Fork McK abv Cougar	NFD 1980 to Rebel Creek	11.1	13.8	**2.7**	
McKenzie	S. Fork McK abv Cougar	Rebel Creek to Dutch Oven C.G.	13.8	16.2	**2.4**	
McKenzie	S. Fork McK abv Cougar	Dutch Oven C.G. to Homestead C.G.	16.2	18.1	**1.9**	
McKenzie	S. Fork McK abv Cougar	Homestead C.G. to Twin Springs C.G.	18.1	20.2	**2.1**	
McKenzie	S. Fork McK abv Cougar	Twin Springs C.G. to Roaring River	20.2	22.3	**2.1**	
McKenzie	S. Fork McK abv Cougar	Roaring River to Elk Creek	22.3	25.1	**2.8**	
McKenzie	McKenzie	S.F. McKenzie to Hamlin	58.9	59.2	**0.3**	
McKenzie	McKenzie	Hamlin to McKenzie Bridge	59.2	67.5	**8.3**	
McKenzie	**Horse Creek**	**Mouth to Bridge**	**0**	**2.4**	**2.4**	
McKenzie	Horse Creek	Bridge to Avenue Creek	2.4	5.9	**3.5**	
McKenzie	Horse Creek	Avenue Creek to Braids	5.9	7.1	**1.2**	
McKenzie	Horse Creek	Braids to Road Access	7.1	9.2	**2.1**	
McKenzie	Horse Creek	Road Access to Separation Creek	9.2	10.7	**1.5**	
McKenzie	Horse Creek	Separation Creek to Trail Bridge	10.7	11.8	**1.1**	
McKenzie	Horse Creek	Trail Bridge to Pothole Creek	11.8	13.5	**1.7**	
McKenzie	McKenzie	McKenzie Bridge to McKenzie Trail	67.5	69.1	**1.6**	

SubBasin	River	Description	Start River Mile	End River Mile	Total Distance	Comment
McKenzie	McKenzie	McKenzie Trail to Paradise	69.1	70.6	**1.5**	
McKenzie	McKenzie	Paradise to Belknap	70.6	73.9	**3.3**	
McKenzie	**Lost Creek**	**Mouth to Hwy 126 Bridge**	**0**	**0.5**	**0.5**	
McKenzie	Lost Creek	Hwy 126 Bridge to Split Pt	0.5	1	**0.5**	
McKenzie	Lost Creek	Split Pt to Limberlost CG	1	2.5	**1.5**	
McKenzie	Lost Creek	Limberlost CG to Cascade	2.5	3	**0.5**	
McKenzie	Lost Creek	Cascade to Spring	3	5.3	**2.3**	
McKenzie	McKenzie	Belknap to Olallie C.G.	73.9	79.4	**5.5**	
McKenzie	McKenzie	to Spawning Channel	79.4	79.5	**0.1**	
M. Fork	**Fall Creek**	**Reservoir to Release Site**	**13.7**	**15**	**1.3**	**release site RM -1.3**
M. Fork	Fall Creek	Release Site to Johnny Creek Bridge	15	19.7	**4.7**	
M. Fork	Fall Creek	Johnny Cr Bridge to Bedrock campground	19.7	21	**1.3**	
M. Fork	Fall Creek	Bedrock campground to Portland Creek	21	22	**1**	RM for portland creek
M. Fork	Fall Creek	Portland Creek to NFD 1828 Bridge	22	23.7	**1.7**	
M. Fork	Fall Creek	NFD 1828 Bridge to Hehe Creek	23.7	25.5	**1.8**	
M. Fork	Fall Creek	Hehe Creek to Gold Creek	25.5	29	**3.5**	
M. Fork	Fall Creek	Gold Creek to Falls	29	30	**1**	
M. Fork	**Little Fall Creek**	**Fish Ladder to NFD 1818 Bridge**	**12.9**	**15.4**	**2.5**	**ladder RM measured manually**
M. Fork	Little Fall Creek	NFD 1818 Bridge to NFD 1806 Bridge	15.4	17.9	**2.5**	manually measured
M. Fork	Little Fall Creek	NFD 1806 Bridge to Trib below NFD 400	17.9	21.7	**3.8**	exact Loc'n?
M. Fork	M. Fork	Jasper to Pengra	195.1	200.3	**5.2**	topo RM
M. Fork	M. Fork	Pengra to Dexter	200.3	203	**2.7**	
M. Fork	**N. Fork M. Fork**	**1926 Bridge to Release Site**	**15.5**	**18.3**	**2.8**	
M. Fork	N. Fork M. Fork	Release Site to Kiahanie Bridge	18.3	22.8	**4.5**	
M. Fork	N. Fork M. Fork	Kiahanie Bridge to 1944 Bridge	22.8	28.2	**5.4**	
M. Fork	N. Fork M. Fork	1944 Bridge to Minute Creek	28.2	32.1	**3.9**	
M. Fork	N. Fork M. Fork	Minute Creek to 2nd to last pullout/RM 33.6	32.1	33.6	**1.5**	

SubBasin	River	Description	Start River Mile	End River Mile	Total Distance	Comment
M. Fork	N. Fork M. Fork	2nd to last pullout/RM 33.6 to Skookum Cr	33.6	36.4	**2.8**	

Appendix 4: Hatchery Chinook Salmon Disposition

Appendix Table 4-1. Complete collection and disposition records for Willamette Hatcheries in 2011.

Hatchery	Date	Stock	Unspawned Males	Unspawned Females	Jacks	Disposition Type
S. Sant.	6/7/11	24	2	0	0	COLLECT
S. Sant.	6/13/11	24	87	67	0	COLLECT
S. Sant.	6/15/11	24	112	108	0	COLLECT
S. Sant.	6/16/11	24	309	161	0	COLLECT
S. Sant.	6/20/11	24	173	93	4	COLLECT
S. Sant.	6/23/11	24	141	82	5	COLLECT
S. Sant.	6/24/11	24	69	57	0	COLLECT
S. Sant.	6/28/11	24	179	147	11	COLLECT
S. Sant.	7/1/11	24	100	57	0	COLLECT
S. Sant.	7/5/11	24	321	225	14	COLLECT
S. Sant.	7/7/11	24	335	207	21	COLLECT
S. Sant.	7/12/11	24	313	261	1	COLLECT
S. Sant.	7/13/11	24	150	133	0	COLLECT
S. Sant.	7/14/11	24	214	221	29	COLLECT
S. Sant.	7/18/11	24	249	204	20	COLLECT
S. Sant.	7/19/11	24	95	66	6	COLLECT
S. Sant.	7/20/11	24	95	72	0	COLLECT
S. Sant.	8/1/11	24	147	150	12	COLLECT
S. Sant.	8/4/11	24	153	134	7	COLLECT
S. Sant.	8/10/11	24	241	224	34	COLLECT
S. Sant.	8/17/11	24	133	113	25	COLLECT
S. Sant.	8/22/11	24	235	124	21	COLLECT
S. Sant.	8/24/11	24	57	39	7	COLLECT

Hatchery	Date	Stock	Unspawned Males	Unspawned Females	Jacks	Disposition Type
S. Sant.	9/1/11	24	176	95	7	COLLECT
S. Sant.	9/8/11	24	430	220	32	COLLECT
S. Sant.	9/13/11	24	310	276	32	COLLECT
S. Sant.	9/22/11	24	116	189	19	COLLECT
S. Sant.	9/29/11	24	10	7	2	COLLECT
South Santiam Collections Subtotals			**4952**	**3732**	**309**	
S. Sant.	6/16/11	24	137	62	0	GIVE AWAY
S. Sant.	6/20/11	24	95	29	4	GIVE AWAY
S. Sant.	7/12/11	24	109	91	1	GIVE AWAY
S. Sant.	7/19/11	24	18	20	6	GIVE AWAY
S. Sant.	8/4/11	24	14	10	7	GIVE AWAY
S. Sant.	8/10/11	24	41	38	32	GIVE AWAY
S. Sant.	8/17/11	24	43	30	5	GIVE AWAY
S. Sant.	8/17/11	24	100	74	20	GIVE AWAY
S. Sant.	8/22/11	24	38	30	7	GIVE AWAY
S. Sant.	8/22/11	24	113	85	7	GIVE AWAY
S. Sant.	8/22/11	24	49	30	7	GIVE AWAY
S. Sant.	8/24/11	24	58	28	6	GIVE AWAY
S. Sant.	9/1/11	24	79	42	2	GIVE AWAY
S. Sant.	9/8/11	24	482	246	30	GIVE AWAY
S. Sant.	9/13/11	24	319	284	32	GIVE AWAY
South Santiam Give Away Subtotals			**1695**	**1099**	**166**	
S. Sant.	6/28/11	24	1	1	0	OTHER
S. Sant.	7/1/11	24	3	2	0	OTHER
S. Sant.	7/5/11	24	5	5	0	OTHER
S. Sant.	7/12/11	24	3	2	0	OTHER
S. Sant.	7/18/11	24	1	1	0	OTHER
S. Sant.	7/19/11	24	1	0	0	OTHER
S. Sant.	7/31/11	24	1	2	0	OTHER

Hatchery	Date	Stock	Unspawned Males	Unspawned Females	Jacks	Disposition Type
S. Sant.	8/1/11	24	2	3	0	OTHER
S. Sant.	8/4/11	24	0	0	0	OTHER
S. Sant.	8/10/11	24	3	3	0	OTHER
S. Sant.	8/17/11	24	1	7	0	OTHER
S. Sant.	8/22/11	24	7	18	0	OTHER
S. Sant.	8/24/11	24	13	19	1	OTHER
S. Sant.	9/1/11	24	131	68	3	OTHER
S. Sant.	9/1/11	24	3	5	0	OTHER
S. Sant.	9/8/11	24	0	0	0	OTHER
S. Sant.	9/13/11	24	0	0	0	OTHER
S. Sant.	9/14/11	24	0	15	4	OTHER
S. Sant.	9/21/11	24	0	0	3	OTHER
S. Sant.	9/22/11	24	97	162	19	OTHER
S. Sant.	9/22/11	24	0	0	0	OTHER
S. Sant.	9/29/11	24	5	4	0	OTHER
S. Sant.	9/29/11	24	0	0	3	OTHER
S. Sant.	9/29/11	24	0	0	0	OTHER
S. Sant.	9/29/11	24	52	20	14	OTHER
South Santiam Other Disposition Subtotals			**329**	**337**	**47**	
S. Sant.	6/7/11	24	2	0	0	RELEASES
S. Sant.	6/13/11	24	30	20	0	RELEASES
S. Sant.	6/16/11	24	133	50	0	RELEASES
S. Sant.	6/16/11	24	39	49	0	RELEASES
S. Sant.	6/20/11	24	30	25	0	RELEASES
S. Sant.	6/23/11	24	88	29	0	RELEASES
S. Sant.	6/23/11	24	16	18	1	RELEASES
S. Sant.	6/24/11	24	39	8	0	RELEASES
S. Sant.	6/24/11	24	12	13	0	RELEASES
S. Sant.	6/28/11	24	23	16	0	RELEASES

Hatchery	Date	Stock	Unspawned Males	Unspawned Females	Jacks	Disposition Type
S. Sant.	7/1/11	24	94	41	0	RELEASES
S. Sant.	7/1/11	24	15	17	0	RELEASES
S. Sant.	7/5/11	24	221	96	0	RELEASES
S. Sant.	7/5/11	24	35	49	0	RELEASES
S. Sant.	7/7/11	24	37	40	0	RELEASES
S. Sant.	7/12/11	24	174	96	0	RELEASES
S. Sant.	7/12/11	24	21	45	0	RELEASES
S. Sant.	7/13/11	24	119	84	0	RELEASES
S. Sant.	7/13/11	24	20	39	0	RELEASES
S. Sant.	7/14/11	24	18	21	0	RELEASES
S. Sant.	7/18/11	24	31	29	0	RELEASES
S. Sant.	7/19/11	24	70	31	0	RELEASES
S. Sant.	7/19/11	24	17	20	0	RELEASES
S. Sant.	7/20/11	24	16	19	0	RELEASES
S. Sant.	7/20/11	24	93	58	0	RELEASES
S. Sant.	8/1/11	24	24	22	0	RELEASES
S. Sant.	8/4/11	24	149	121	0	RELEASES
S. Sant.	8/4/11	24	19	13	0	RELEASES
S. Sant.	8/10/11	24	243	210	0	RELEASES
S. Sant.	8/10/11	24	26	29	2	RELEASES
S. Sant.	8/17/11	24	25	18	0	RELEASES
S. Sant.	8/22/11	24	16	13	0	RELEASES
S. Sant.	8/24/11	24	13	8	0	RELEASES
S. Sant.	9/1/11	24	16	9	2	RELEASES
S. Sant.	9/8/11	24	40	22	2	RELEASES
S. Sant.	9/13/11	24	40	22	0	RELEASES
S. Sant.	9/22/11	24	34	20	0	RELEASES
S. Sant.	9/29/11	24	3	1	0	RELEASES
	South Santiam Releases Subtotals		**2041**	**1421**	**7**	

Hatchery	Date	Stock	Unspawned Males	Unspawned Females	Jacks	Disposition Type
S. Sant.	6/15/11	24	112	108	0	SOLD
S. Sant.	6/28/11	24	159	131	11	SOLD
S. Sant.	7/7/11	24	292	166	17	SOLD
S. Sant.	7/14/11	24	229	233	29	SOLD
S. Sant.	7/18/11	24	249	194	20	SOLD
S. Sant.	8/1/11	24	132	138	12	SOLD
	South Santiam Sold Subtotals		**1173**	**970**	**89**	
McKenzie	5/26/11	23	38	25	1	COLLECT
McKenzie	6/6/11	23	66	60	0	COLLECT
McKenzie	6/9/11	23	54	30	0	COLLECT
McKenzie	6/13/11	23	245	214	2	COLLECT
McKenzie	6/20/11	23	192	116	2	COLLECT
McKenzie	6/22/11	23	111	71	6	COLLECT
McKenzie	6/27/11	23	245	254	9	COLLECT
McKenzie	7/1/11	23	32	33	2	COLLECT
McKenzie	7/5/11	23	420	471	15	COLLECT
McKenzie	7/7/11	23	10	21	1	COLLECT
McKenzie	7/11/11	23	379	299	14	COLLECT
McKenzie	7/12/11	23	28	31	1	COLLECT
McKenzie	7/15/11	23	129	126	5	COLLECT
McKenzie	7/19/11	23	8	9	0	COLLECT
McKenzie	7/20/11	23	76	77	2	COLLECT
McKenzie	7/28/11	23	155	114	15	COLLECT
McKenzie	8/2/11	23	56	44	6	COLLECT
McKenzie	8/10/11	23	81	40	5	COLLECT
McKenzie	8/16/11	23	30	19	2	COLLECT
McKenzie	8/24/11	23	50	23	2	COLLECT
McKenzie	9/2/11	23	164	52	9	COLLECT

Hatchery	Date	Stock	Unspawned Males	Unspawned Females	Jacks	Disposition Type
McKenzie	9/6/11	23	129	31	6	COLLECT
McKenzie	9/10/11	23	168	79	24	COLLECT
McKenzie	9/12/11	23	94	74	6	COLLECT
McKenzie	9/15/11	23	67	69	6	COLLECT
McKenzie	9/18/11	23	86	85	3	COLLECT
McKenzie	9/19/11	23	21	16	0	COLLECT
McKenzie	9/22/11	23	26	52	2	COLLECT
McKenzie	9/26/11	23	22	47	1	COLLECT
McKenzie	10/3/11	23	10	12	0	COLLECT
	McKenzie Collection Subtotals		**3192**	**2594**	**147**	
McKenzie	6/20/11	23	189	87	2	GIVE AWAY
McKenzie	6/22/11	23	93	26	6	GIVE AWAY
	McKenzie Give Away Subtotals		**282**	**113**	**8**	
McKenzie	7/31/11	21	33	42	0	OTHER
McKenzie	8/31/11	21	2	23	0	OTHER
McKenzie	9/14/11	21	0	0	0	OTHER
McKenzie	9/21/11	21	12	0	24	OTHER
McKenzie	9/28/11	21	82	27	4	OTHER
McKenzie	9/30/11	21	3	2	0	OTHER
McKenzie	7/31/11	23	15	12	0	OTHER
McKenzie	7/31/11	23	2	7	0	OTHER
McKenzie	8/31/11	23	9	12	0	OTHER
McKenzie	8/31/11	23	3	11	5	OTHER
McKenzie	9/12/11	23	9	3	11	OTHER
McKenzie	9/18/11	23	48	2	0	OTHER
McKenzie	9/18/11	23	48	0	0	OTHER
McKenzie	9/19/11	23	7	5	7	OTHER
McKenzie	9/20/11	23	25	25	23	OTHER
McKenzie	9/22/11	23	185	9	10	OTHER

Hatchery	Date	Stock	Unspawned Males	Unspawned Females	Jacks	Disposition Type
McKenzie	9/22/11	23	0	0	0	OTHER
McKenzie	9/26/11	23	125	175	21	OTHER
McKenzie	9/30/11	23	9	12	0	OTHER
McKenzie	9/30/11	23	12	9	0	OTHER
McKenzie	10/3/11	23	9	5	0	OTHER
McKenzie	10/3/11	23	100	83	10	OTHER
McKenzie	10/4/11	23	15	15	0	OTHER
McKenzie	10/4/11	23	25	25	0	OTHER
McKenzie	10/26/11	23	15	15	0	OTHER
McKenzie	11/7/11	23	0	0	0	OTHER
McKenzie	11/8/11	23	30	70	0	OTHER
McKenzie	11/10/11	23	44	0	0	OTHER
McKenzie	11/10/11	23	20	30	0	OTHER
McKenzie	11/15/11	23	0	0	0	OTHER
McKenzie	11/17/11	23	0	0	0	OTHER
McKenzie	11/22/11	23	38	60	20	OTHER
McKenzie	11/23/11	23	29	28	6	OTHER
McKenzie Other Disposition Subtotals			**954**	**707**	**141**	
McKenzie	7/1/11	23	3	0	0	RELEASES
McKenzie	7/7/11	23	5	12	0	RELEASES
McKenzie	7/12/11	23	20	26	1	RELEASES
McKenzie	7/19/11	23	8	9	0	RELEASES
McKenzie	8/2/11	23	20	24	2	RELEASES
McKenzie	8/10/11	23	20	20	0	RELEASES
McKenzie	8/16/11	23	28	17	2	RELEASES
McKenzie	8/24/11	23	35	42	1	RELEASES
McKenzie	9/6/11	23	35	28	6	RELEASES
McKenzie	9/15/11	23	214	80	11	RELEASES
McKenzie	9/22/11	23	25	25	0	RELEASES

Hatchery	Date	Stock	Unspawned Males	Unspawned Females	Jacks	Disposition Type
McKenzie	9/23/11	23	91	75	3	RELEASES
McKenzie	10/4/11	23	2	2	0	RELEASES
McKenzie	9/28/11	21	39	10	0	RELEASES
McKenzie Releases Subtotals			**545**	**370**	**26**	
McKenzie	6/27/11	23	231	237	9	SOLD
McKenzie	7/5/11	23	356	350	13	SOLD
McKenzie	7/11/11	23	293	248	13	SOLD
McKenzie	7/20/11	23	75	78	2	SOLD
McKenzie	7/28/11	23	140	107	14	SOLD
McKenzie Sold Subtotals			**1095**	**1020**	**51**	
McKenzie	6/21/11	21	7	2	2	TRANSFER IN
McKenzie	6/23/11	21	22	14	4	TRANSFER IN
McKenzie	6/26/11	21	12	9	3	TRANSFER IN
McKenzie	6/27/11	21	25	23	0	TRANSFER IN
McKenzie	6/28/11	21	31	23	2	TRANSFER IN
McKenzie	6/30/11	21	24	25	1	TRANSFER IN
McKenzie	7/2/11	21	26	13	0	TRANSFER IN
McKenzie	7/7/11	21	55	61	6	TRANSFER IN
McKenzie	7/7/11	21	65	36	0	TRANSFER IN
McKenzie	7/8/11	21	57	52	6	TRANSFER IN
McKenzie	7/11/11	21	43	22	1	TRANSFER IN
McKenzie	7/12/11	21	54	38	3	TRANSFER IN
McKenzie	7/13/11	21	25	24	0	TRANSFER IN
McKenzie	8/4/11	21	0	37	0	TRANSFER IN
McKenzie	7/11/11	23	2	3	0	TRANSFER IN
McKenzie	8/23/11	23	0	1	0	TRANSFER IN
McKenzie	8/24/11	23	0	1	0	TRANSFER IN
McKenzie	8/31/11	23	0	1	0	TRANSFER IN
McKenzie	9/7/11	23	1	1	0	TRANSFER IN

Hatchery	Date	Stock	Unspawned Males	Unspawned Females	Jacks	Disposition Type
McKenzie	9/9/11	23	4	3	0	TRANSFER IN
McKenzie	9/14/11	23	11	12	0	TRANSFER IN
McKenzie	9/15/11	23	1	2	0	TRANSFER IN
McKenzie	9/20/11	23	0	1	0	TRANSFER IN
McKenzie	9/21/11	23	3	6	0	TRANSFER IN
McKenzie	9/22/11	23	0	4	1	TRANSFER IN
McKenzie	9/23/11	23	0	4	1	TRANSFER IN
McKenzie	9/30/11	23	0	2	0	TRANSFER IN
McKenzie Transfers In Subtotals			**468**	**420**	**30**	
Willamette	7/30/11	22	29	51	0	OTHER
Willamette	8/31/11	22	59	19	2	OTHER
Willamette	9/7/11	22	10	10	3	OTHER
Willamette	9/13/11	22	0	0	0	OTHER
Willamette	9/13/11	22	9	15	4	OTHER
Willamette	9/20/11	22	40	84	0	OTHER
Willamette	9/20/11	22	4	17	4	OTHER
Willamette	9/27/11	22	0	1	0	OTHER
Willamette	9/27/11	22	13	13	0	OTHER
Willamette	9/27/11	22	12	13	0	OTHER
Willamette	9/27/11	22	43	7	17	OTHER
Willamette Hatchery Other Disposition Subtotals			**219**	**230**	**30**	
Willamette	8/31/11	22	42	34	0	RELEASES
Willamette Hatchery Releases Subtotals			**42**	**34**	**0**	
Willamette	6/14/11	22	329	186	3	TRANSFER IN
Willamette	6/15/11	22	9	6	0	TRANSFER IN
Willamette	6/16/11	22	238	210	2	TRANSFER IN
Willamette	6/21/11	22	144	298	2	TRANSFER IN
Willamette	6/22/11	22	6	9	0	TRANSFER IN

Hatchery	Date	Stock	Unspawned Males	Unspawned Females	Jacks	Disposition Type
Willamette	6/30/11	22	12	161	1	TRANSFER IN
Willamette	7/6/11	22	24	20	17	TRANSFER IN
Willamette	7/13/11	22	45	61	5	TRANSFER IN
Willamette	7/14/11	22	6	14	0	TRANSFER IN
Willamette	7/27/11	22	15	5	0	TRANSFER IN
Willamette	8/3/11	22	12	12	0	TRANSFER IN
Willamette	8/17/11	22	18	13	0	TRANSFER IN
Willamette	8/18/11	22	6	3	0	TRANSFER IN
Willamette Hatchery Transfers In Subtotals			**864**	**998**	**30**	
Dexter	5/26/11	22	14	6	0	COLLECT
Dexter	5/26/11	22	6	8	0	COLLECT
Dexter	6/14/11	22	329	186	3	COLLECT
Dexter	6/15/11	22	9	6	0	COLLECT
Dexter	6/16/11	22	238	210	2	COLLECT
Dexter	6/16/11	22	12	13	0	COLLECT
Dexter	6/21/11	22	144	298	2	COLLECT
Dexter	6/22/11	22	6	9	0	COLLECT
Dexter	6/30/11	22	202	364	38	COLLECT
Dexter	6/30/11	22	16	12	0	COLLECT
Dexter	7/6/11	22	202	232	46	COLLECT
Dexter	7/13/11	22	262	297	52	COLLECT
Dexter	7/13/11	22	12	8	0	COLLECT
Dexter	7/14/11	22	6	14	0	COLLECT
Dexter	7/20/11	22	8	12	0	COLLECT
Dexter	7/20/11	22	12	6	0	COLLECT
Dexter	7/21/11	22	262	199	31	COLLECT
Dexter	7/26/11	22	11	12	0	COLLECT
Dexter	7/27/11	22	305	330	28	COLLECT
Dexter	7/27/11	22	15	5	0	COLLECT

Hatchery	Date	Stock	Unspawned Males	Unspawned Females	Jacks	Disposition Type
Dexter	8/3/11	22	242	241	16	COLLECT
Dexter	8/11/11	22	248	295	63	COLLECT
Dexter	8/16/11	22	10	15	0	COLLECT
Dexter	8/17/11	22	255	247	32	COLLECT
Dexter	8/18/11	22	6	3	0	COLLECT
Dexter	8/24/11	22	182	167	24	COLLECT
Dexter	8/24/11	22	11	14	0	COLLECT
Dexter	9/1/11	22	208	198	27	COLLECT
	Dexter Collection Subtotals		**3233**	**3407**	**364**	
Dexter	7/21/11	22	30	26	6	OTHER
Dexter	7/27/11	22	33	53	1	OTHER
Dexter	8/3/11	22	27	13	0	OTHER
Dexter	8/11/11	22	32	38	5	OTHER
Dexter	8/17/11	22	40	19	2	OTHER
Dexter	8/24/11	22	22	20	3	OTHER
Dexter	9/1/11	22	11	8	0	OTHER
Dexter	10/21/11	22	195	177	17	OTHER
	Dexter Other Disposition Subtotals		**390**	**354**	**34**	
Dexter	5/26/11	22	6	8	0	RELEASES
Dexter	6/16/11	22	12	13	0	RELEASES
Dexter	6/30/11	22	16	12	0	RELEASES
Dexter	7/13/11	22	12	8	0	RELEASES
Dexter	7/20/11	22	12	6	0	RELEASES
Dexter	7/21/11	22	232	173	25	RELEASES
Dexter	7/26/11	22	11	12	0	RELEASES
Dexter	7/27/11	22	272	277	27	RELEASES
Dexter	8/3/11	22	203	216	16	RELEASES
Dexter	8/11/11	22	161	196	42	RELEASES
Dexter	8/11/11	22	55	61	16	RELEASES

Hatchery	Date	Stock	Unspawned Males	Unspawned Females	Jacks	Disposition Type
Dexter	8/16/11	22	10	15	0	RELEASES
Dexter	8/17/11	22	197	215	30	RELEASES
Dexter	8/24/11	22	160	147	21	RELEASES
Dexter	8/24/11	22	11	14	0	RELEASES
Dexter	9/1/11	22	197	190	27	RELEASES
	Dexter Releases Subtotals		**1567**	**1563**	**204**	
Dexter	6/30/11	22	190	203	37	SOLD
Dexter	7/6/11	22	178	212	29	SOLD
Dexter	7/13/11	22	217	236	47	SOLD
	Dexter Sold Subtotals		**585**	**651**	**113**	
Dexter	5/26/11	22	14	6	0	TRANSFER OUT
Dexter	6/14/11	22	329	186	3	TRANSFER OUT
Dexter	6/15/11	22	9	6	0	TRANSFER OUT
Dexter	6/16/11	22	238	210	2	TRANSFER OUT
Dexter	6/21/11	22	144	298	2	TRANSFER OUT
Dexter	6/22/11	22	6	9	0	TRANSFER OUT
Dexter	6/30/11	22	12	161	1	TRANSFER OUT
Dexter	7/6/11	22	24	20	17	TRANSFER OUT
Dexter	7/13/11	22	45	61	5	TRANSFER OUT
Dexter	7/14/11	22	6	14	0	TRANSFER OUT
Dexter	7/20/11	22	8	12	0	TRANSFER OUT
Dexter	7/27/11	22	15	5	0	TRANSFER OUT
Dexter	8/3/11	22	12	12	0	TRANSFER OUT
Dexter	8/17/11	22	18	13	0	TRANSFER OUT
Dexter	8/18/11	22	6	3	0	TRANSFER OUT
	Dexter Transfers Out Subtotals		**886**	**1016**	**30**	

Appendix 5: Juvenile Chinook Salmon and Steelhead Liberation in 2011

Appendix Table 5-1. Numbers and pounds of UWR hatchery spring Chinook salmon (ChS) and summer steelhead (StS) released in the UWR basin or from lower Columbia River netpens in 2011. Data are from HMIS and parsed by rearing or release facility and stock.

Rearing or Acclimation Facility	Species	Stock	Fry (number)	Fry (pounds)	Fingerlings (number)	Fingerlings (pounds)	Smolts (number)	Smolts (pounds)	Release Location	Basin
Marion Forks H	ChS	21	0	0	138,857	1,984	0	0	Detroit Reservoir	UWR
Minto Ponds	ChS	21	0	0	0	0	687,301	52,265	North Santiam R.	UWR
Dexter Ponds	ChS	22	0	0	0	0	1,746,235	191,806	MF Willamette R.	UWR
Willamette H	ChS	22	212,580	1,421	80,744	673	0	0	Hills Cr. Res.	UWR
McKenzie H	ChS	23	0	0	125,170	1,292	1,223,902	111,459	McKenzie R.	UWR
S. Santiam H	ChS	24	0	0	0	0	911,283	100,353	South Santiam R.	UWR
Willamette H	ChS	24	0	0	0	0	229,978	23,380	Molalla R.	UWR
									UWR Total Numbers	5,356,050
									UWR Total Pounds	484,633
Youngs Bay	ChS	23	0	0	0	0	249,139	22,649	Youngs Bay	L. Col.
Youngs Bay	ChS	22	0	0	0	0	453,470	36,570	Youngs Bay	L. Col.
Tongue Point	ChS	22	0	0	0	0	100,557	7,735	Tongue Point	L. Col.
Blind Slough	ChS	22	0	0	0	0	253,503	21,303	Blind Slough	L. Col.
									Out of Basin Total Numbers	1,056,669
									Out of Basin Total Pounds	88,257
Dexter Ponds	StS	24	0	0	0	0	61,015	13,293	MF Willamette R.	UWR
Leaburg H	StS	24	0	0	0	0	111,596	22,989	McKenzie R.	UWR
S. Santiam H	StS	24	0	0	0	0	189,720	42,160	South Santiam R.	UWR
Willamette H	StS	24	0	0	0	0	66,000	Unknown	North Santiam R.	UWR
Willamette H	StS	24	0	0	0	0	96,386	17,569	Willamette R.	UWR
									UWR Total Numbers	524,717

Appendix Table 5-2. Liberation dates and locations for coded-wire tagged UWR hatchery spring Chinook salmon released in 2011. The number of untagged juvenile Chinook salmon released on the same date and location is also provided. Data are from RMIS.

Stock	Tag Code	Release Date	Avg. Weight (g)	Tagged Count	Untagged Count	Release Location
North Santiam (021)	090393	03/23/11	35.97	53,167	197,367	North Santiam River
North Santiam (021)	090391	04/12/11	34.86	55,092	171,703	North Santiam River
North Santiam (021)	090392	03/02/11	32.61	53,656	155,676	North Santiam River
South Santiam (024)	090349	02/28/11	47.95	30,646	72,935	Molalla River
South Santiam (024)	090262	02/14/11	48.2	31,854	394,230	South Santiam River
South Santiam (024)	090263	03/16/11	48.72	31,534	257,442	South Santiam River
South Santiam (024)	090478	10/28/11	52.68	51,248	253,222	South Santiam River
McKenzie (023)	090389	03/09/11	46.24	105,441	357,970	McKenzie River
McKenzie (023)	090388	01/27/11	38.08	100,243	276	McKenzie River
McKenzie (023)	090533	11/03/11	43.16	152,674	0	McKenzie River
McKenzie (023)	090534	11/03/11	43.16	200,162	0	McKenzie River
McKenzie (023)	094654	03/31/11	41.2	26,901	221,965	Youngs Bay (Columbia R.)
MF Willamette (022)	090340	03/29/11	38.08	23,807	229,565	Blind Slough (Columbia R.)
MF Willamette (022)	090341	03/30/11	34.86	26,941	73,421	Tongue Point (Columbia R.)
MF Willamette (022)	090232	02/11/11	50.96	31,961	622,370	MF Willamette River
MF Willamette (022)	090384	01/28/11	39.27	90,617	116,686	MF Willamette River
MF Willamette (022)	090385	01/28/11	46.05	92,470	239,271	MF Willamette River
MF Willamette (022)	090386	04/13/11	56.63	78,446	158,096	MF Willamette River
MF Willamette (022)	090472	11/01/11	58.08	264,372	51,415	MF Willamette River
MF Willamette (022)	090339	03/04/11	36.55	27,256	426,214	Youngs Bay (Columbia R.)
			Total Tagged	1,528,488		