THE OREGON PLAN *for Salmon and Watersheds*

Salmonid Life Cycle Monitoring in Western Oregon Streams 2012-2014

Report Number: OPSW-ODFW-2015-2

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EXECUTIVE SUMMARY

In 1997, as part of the Oregon Plan for Salmon and Watersheds, the Oregon Department of Fish and Wildlife (ODFW) began the Salmonid Life Cycle Monitoring (LCM) project to monitor migration and survival of salmonid fishes (*Oncorhynchus* spp.) in western Oregon streams. This work is administered by the Northwest Region through the Western Oregon Fish Research and Monitoring Program. Here we report the results of two objectives of the LCM Project: 1) Estimate abundance of spawning adult and out-migrating juvenile salmonids that pass nine ODFW Life Cycle Monitoring sites, and 2) estimate marine and freshwater survival rates for coho salmon at the same sites. For this executive summary we only include findings for coho salmon. Data for other salmonids are within the report.

During the monitoring period covered in this report, from 1998-2014, we have observed multiple cycles and high and low coho salmon marine survival across the Oregon coast. Marine survival is a primary driver of adult abundance but variation in freshwater production also has an effect and exploring the correlations between environmental variables and smolt production is a future goal of the project. Survival and abundance is generally correlated across LCM sites, though there is a pattern where southern sites had higher survival relative to northern sites early in the monitoring period and lower survival later in the monitoring period. We were able to monitor coho smolt production across a range of spawner abundance; most sites exhibit density dependent freshwater survival with some sites exhibiting a smolt production capacity limit. In aggregate the LCM sites are representative of the Oregon coast coho salmon ESU in terms of spawner abundance, habitat quality, and juvenile production as evidenced by strong relationships with spatially balanced coast wide data collected by ODFW's Oregon Adult Salmonid Inventory and Sampling and Aquatic Inventory programs.

The North Fork Nehalem LCM site is located in close proximity to Nehalem fish hatchery, resulting in significant straying of hatchery origin coho and steelhead into the study basin in most years. A community-based program to donate hatchery stray fish captured at the adult traps to the food bank has been successfully implemented at this site to reduce hatchery fish impacts to wild runs. Distinguished as the largest LCM site, the North Fork Nehalem is unique among LCM sites because of the ability to parse adult and juvenile estimates by upper and lower basin making it amenable to studies of hatchery influence on productivity and survival. Significant numbers of wild coho, fall Chinook, and winter steelhead return to the basin throughout the year.

The EF Trask is the only LCM site with an adult trap located at a complete barrier (i.e. impassable dam), allowing for census counts of the number of adult coho, fall Chinook, steelhead, and sea-run cutthroat trout passed upstream of the trap. AUC estimates from live visual counts of coho and fall Chinook from spawning surveys conducted downstream of the dam are added to census counts from the adult trap to provide complete basin estimates for these species. Because most steelhead returning to EF Trask are handled, we are able to gain additional insights into life history traits such as repeat spawning and age structure through tagging and scale collections. The dam, ladder, and fish trap facilitating adult data collection at this site are slated to be removed summer 2016.

At the Mill Creek (Siletz) LCM site we have observed coho salmon smolt production over a range of spawner abundance which shows evidence for juvenile rearing capacity limits. A basin-wide large wood placement project is planned for this site in the summer of 2016, with a comprehensive monitoring plan in place to evaluate the effects on stream habitat, juvenile coho salmon overwinter survival, and smolt production. A combination of high trap efficiency and extensive survey effort at this site typically produces robust population estimates for adult coho salmon. Trap efficiency is much lower for steelhead, which are mostly of hatchery origin, and we do not estimate total steelhead spawner abundance.

The Mill Creek (Yaquina) site features a reservoir which provides good rearing habitat for coho salmon, and smolts are on average much larger than at other LCM sites. Marine survival rates for coho salmon at this site are typically higher than at other LCM sites, but freshwater survival rates can be extremely low. The adult trap design and hydraulics are such that all upstream migrating fish are handled, including jacks. Coho jack returns at this site are used in fisheries management as a predictor of coast wide adult marine survival.

Cascade Creek had low numbers of adult coho salmon and suffered brood year failure early in the monitoring period; our monitoring has documented the rebuilding coho abundance at this site to a level where juvenile capacity limits are apparent. Smolt trapping efficiency is very high at Cascade Creek, providing relatively precise estimates for out-migrating coho salmon and cutthroat trout. Steelhead abundance, both in terms of juvenile production and returning adult spawners, has consistently been very low throughout the monitoring period.

The West Fork Smith River above the trap site has recently experience large scale habitat restoration and LCM data on multiple life stages of multiple species of salmonids will provide before-after restoration effectiveness data.

Winchester Creek is the smallest LCM site, such that it may be flow limited in seasons with low rainfall, and the only LCM site where spawning gravel capacity is a limitation on coho salmon production. As the only site in the southern end of the Oregon coast coho ESU it provides an important signal of survival in this portion of the ESU.

The N Scappoose site is the only site on the project in the Lower Columbia coho salmon ESU. Coho smolt production per kilometer is much lower than observed in the coast ESU, but average smolt size is large, with average fork length nearly as long as the reservoir rearing smolts from Mill Creek Yaquina. Large smolt size at the site may result from decreased competition for resources, as spawner densities on N Scappoose Creek averaged only 10% of spawner densities across all LCM sites. Most of the coast LCM sites observed decreasing freshwater survival and/or declines in the number of smolts per female with increasing spawner abundance, presumably from density dependent effects. This has not been observed on N Scappoose Creek, where densities may be below the threshold where density dependent mortalities initiate. Although spawner densities are low, the two most recent cycles of the brood lines (2011-2013 and 2008-2010) have had higher average spawner abundance than first three cycles of the brood lines, beginning in 1999.

INTRODUCTION

In 1997, as part of the Oregon Plan for Salmon and Watersheds, the Oregon Department of Fish and Wildlife (ODFW) began monitoring survival and migration of salmonid fishes (*Onchorhynchus spp*.) in selected coastal basins. The primary objectives of the Salmonid Life-Cycle Monitoring (LCM) Project are to estimate abundance of adult salmonids and downstream migrating juvenile salmonids and estimate marine and freshwater survival rates for coho salmon (*Oncorhynchus kisutch*). The LCM Project also collects data and calculates the coho salmon marine survival prediction for fisheries management (Suring and Lewis 2013) and has evaluated the effects of habitat modification on salmonids (Solazzi et al. 2000, Johnson et al. 2005).

This report summarizes data collected at eight LCM basins for adult salmonids (1997-2013 return years) and out-migrating juveniles (1997-2014 sample years). In addition to previously unpublished data for the 2012-2014 sample years the out-migrant estimates have been recalculated with a new estimator (Bonner and Schwarz 2011). The report is organized into chapters for each LCM site from north to south along the Oregon Coast (Figure 1). LCM sites are located on North Scappoose Creek (Columbia River), North Fork Nehalem River, East Fork Trask River (Tillamook River basin), Mill Creek (Siletz River basin), Mill Creek (Yaquina River basin), Cascade Creek (Alsea River basin), West Fork Smith River (Umpqua River basin) and Winchester Creek (Coos River basin).

There are currently three additional sites monitored by the LCM project and cooperators where only out-migrant traps are present. We collect annual juvenile out-migrant estimates and associated data from these sites. They include the East Fork Lobster and upper main Lobster Creeks and Tenmile Creek. Data collection began in 1982 at the Lobster Creek sites and in 1992 Tenmile Creek. Out-migrant data was also collected at sites on the Little North Fork Wilson (1998-2013), Little South Fork Kilchis (1998-2006), upper East Fork Trask River (2007 and 2008), and Cummins Creek (1992-2012), but these sites are no longer in operation. Outmigrant data are available by request as annual contract reports that have been submitted to funding partners, and on the website https://nrimp.dfw.state.or.us/CRL/default.aspx?p=430.

GENERAL METHODOLOGY

Site-specific methodology details are provided within individual site chapters of this report, and in Solazzi et al. (2000, 2001). Methods have been designed for collecting data on salmonids; data on other species collected in the out-migrant traps are provided in Appendix 4.

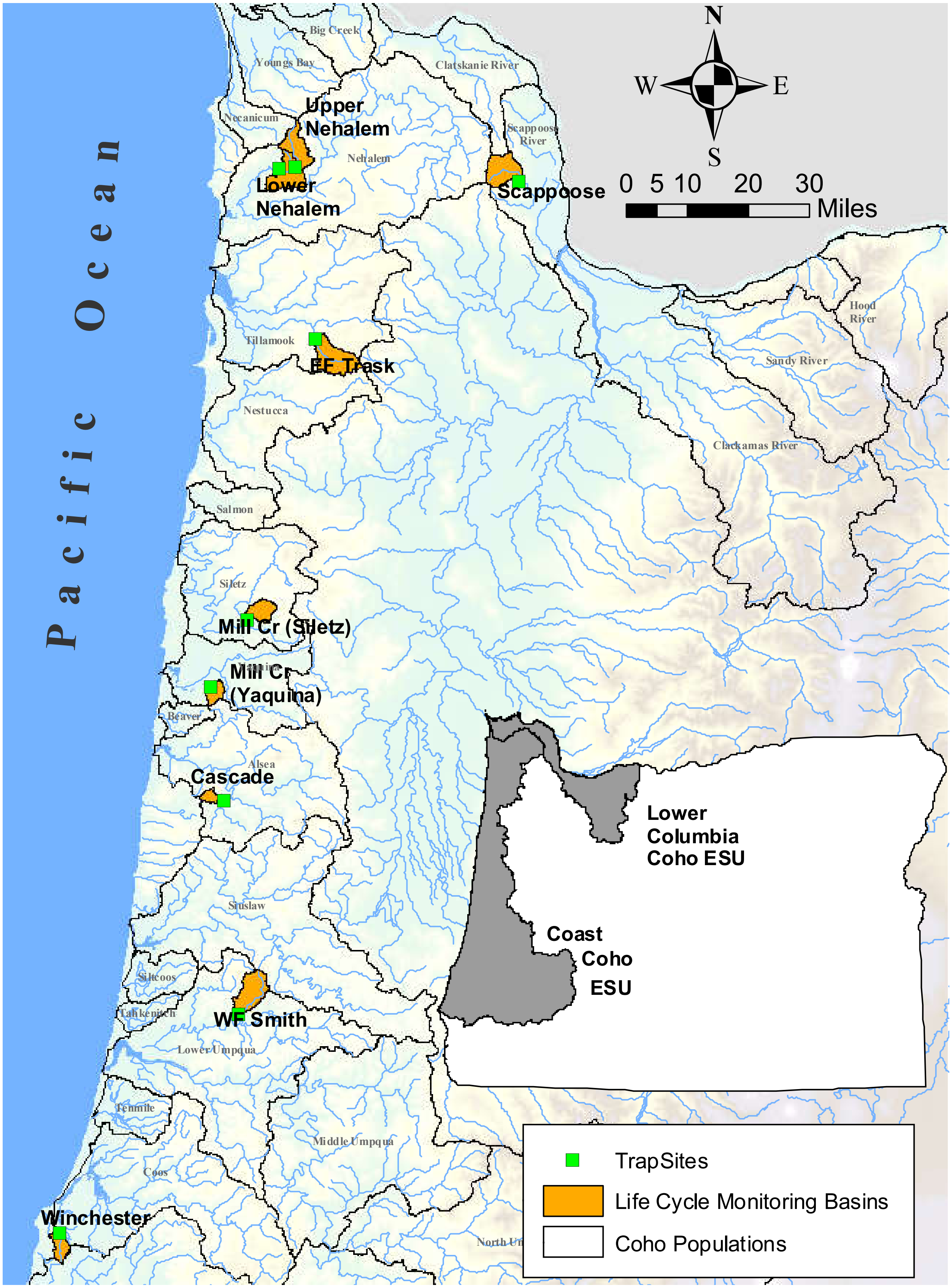

Figure 1. The Salmonid Life Cycle Monitoring Project trap sites and basins.

Adult Salmonids

Returning adult spawner populations were either directly counted, estimated by mark-recapture methodology (Ricker 1975), or estimated by area-under-the-curve (AUC) calculation based on live fish counts on spawner surveys (Beidler and Nickelson 1980). Adult fish traps at NF Scappoose Creek, EF Trask River, Mill Creek (Yaquina basin), and Cascade Creek are associated with dams or natural falls that are complete barriers to migration, and trap counts at these sites represent total numbers of fish returning to spawn above the trap. Traps operated in NF Nehalem River, Mill Creek (Siletz basin), WF Smith River and Winchester Creek are not total fish barriers, and estimated spawner numbers above the traps were made with mark-recapture methods. Estimates of spawner numbers by area-under-the-curve (AUC) calculation (portions of WF Smith River and EF Trask River) and by evaluation of hatchery and wild fish ratios (several sites) are discussed by individual site in their respective chapters.

Fish that entered traps were identified to species and sex and distinguished as wild or hatchery-produced based on presence or absence of an adipose fin clip. Jacks of coho salmon, winter steelhead (≤ 50 cm FL), and Chinook salmon (≤ 60 cm FL) were distinguished from adults.

Fish in the traps at incomplete barriers were tagged with Floy-brand tags (unique 4-digit number codes), normally one tag for each side of base of dorsal fin. Previously tagged winter steelhead were recorded as repeat spawners if tag codes or color pre-dated the current run year, and new tags were implanted if needed. At WF Smith River and NF Nehalem River, some fish entered the trap with tags implanted at sampling sites located downstream as part of broader basin-scale monitoring. Tag color and numbers of previously tagged fish were recorded and in some cases new tags were implanted.

Periodic surveys were conducted on spawning reaches to record number and distribution of redds and to determine the proportion of tagged fish among the spawner population upstream of the trap. Live fish were identified to species and observed for tag presence, color and number of tags, age class (jack or adult) and in some cases, presence of adipose fin clips (denoting hatchery fish). Unless presence/absence of tags and adipose fin-clips was certain, surveyors recorded these attributes as unknown. Carcasses were sampled to record species, sex, origin (wild or hatchery), color and number code of any tags or clips, and size class (jack coho salmon ≤ 43 cm mid-eye to posterior scale insertion (MEPS), jack Chinook salmon ≤ 51 cm MEPS). Other opportunities to record mark disposition of spawners included fish that re-entered the adult traps, that were caught in juvenile screw traps after spawning, recovery of carcasses on the trap barrier weirs or washed into ladders, recovery of tagged fish in fisheries or on surveys and locations downstream of the traps, and capture of live fish in a second, upstream, adult trap.

Estimations of spawner populations based on mark-recapture were made using a Petersen method (Ricker 1975), modified for tag loss (Caughely 1977):

$$N = \frac{(M(1-p^2) + 1)(C+1)}{(R + 1)}$$

where:

M = number of adult fish marked with Floy tags (2), excluding tagged fish recovered downstream of the trap site

C = number of adult fish observed for presence of tags (live fish and carcasses) on spawning surveys or other recovery opportunities, excluding fish for which presence of tag could not be determined

R = number of tagged fish observed

p^2 = probability that a fish lost both tags before being observed

The probability that a fish lost one of its implanted tags was estimated by the formula:

$$p = n_1 / (2n_2 + n_1)$$

where:

n_1 = number of fish observed with one tag

n_2 = number of fish observed with two tags

For sites that used mark-recapture population estimates variance and 95% confidence intervals were calculated with a bootstrap procedure (Thedinga et al. 1994; 1000 iterations used for each calculation) except for coho at the WF Smith sites. WF Smith coho variance estimation is covered in that chapter.

Juvenile Salmonids

Rotary screw traps or motorized incline-plane traps were used to capture juvenile salmonids migrating downstream. Traps generally began fishing from February to early March and, as stream flow allowed, were fished continuously until catch diminished to low levels or low stream flows precluded further trap operation, usually by mid-June. The traps were normally checked and cleared of fish and debris once a day with visits more frequent during storm events and periods of high debris transport.

Fish were anesthetized with MS-222 and enumerated by species and age or size class (nearest millimeter fork length, FL). Coho salmon *(O. kisutch)* were identified as fry (age 0) or smolts (age 1+). All chum salmon (*O. keta*) and Chinook salmon (*O. tshawytscha*) captured were fry and fingerlings (age 0). Trout species were measured by size classes that roughly corresponded to age classes, and trout fry (<60 mm FL) were not differentiated by species. Some O*. mykiss* and *O. clarki* across different age classes had signs of smolting (body silvering and reduced body weight:length relationship), and we assumed these fish were active anadromous migrants moving towards estuarine or marine waters. Only the largest size class of *O. mykiss* (≥120 mm FL) had a large percent of fish with signs of smolting (steelhead), and for purposes here were regarded as smolts. Although we made no assumption of active anadromous behavior for trapped fish not showing smolt transformation, we did assume that smaller

O. mykiss (classes 60-89 mm and 90-119 mm FL), were inherently anadromous and therefore termed them pre-smolts. For cutthroat trout size classes were 60-89, 90-119, 120-159, 160-249, and ≥ 250 mm FL. Many cutthroat ≥ 250 mm were kelts, and therefore not counted as juvenile fish, but reported here for inclusiveness. In this report, cutthroat trout collected in the out-migrant traps were termed generically as migrants, recognizing their diverse migrational life history strategies.

Capture efficiency of out-migrant traps was normally evaluated daily for each species and age/size class by marking up to 25 fish from each category with a small clip from the caudal lobe then releasing clipped fish upstream of the trap. Up to 50 fish of a category were marked at some traps such as when large numbers of fry were expected and efficiencies were low. Estimates of out-migrants were made by using the BTSPAS Package (Bonner and Schwarz 2014) in R (R Core Team 2015). Data were grouped by week using a diagonal recapture matrix.

During some high flows, often associated with excessive debris loads, the screw traps were not fished due to the inability to operate the traps safely and effectively. In these cases catch was inferred using the P-spline model in BTSPAS. While this allows data to be fit to the missing days, including accounting for variance during these periods, this relies on the assumption that out-migration during the non-trapping periods are similar to the observed periods. Most of these high flow events occurred in late February through March when smolt numbers were low relative to April and May; thus potential biases in the total season estimates were usually small. However, in some years, particularly 2009-2011 high flows have occurred during peak smolt out-migration in April and May at some sites, resulting in extended time periods when screw traps could not be fished. Biases in these years may have been more significant, especially if daily out-migrant movement past the trap was considerably different during high water, non-fishable conditions compared to the days preceding and following the high water event when the trap could be fished.

Non-salmonid fishes were counted in trap catch, but in most cases estimates of total migrants using mark-recapture methodology were not made. Lamprey ammocoetes were counted at most sites, but were not distinguished by species in basins where both Pacific lamprey (*Lampetra tridenta*) and western brook lamprey (*L. richardsoni*) occur.

In tables and figures that follow, bounds around estimates are 95% confidence intervals unless otherwise stated. For the results below, the following terms and definitions are used to describe the chronology of salmonid life history types and parameters:

Return Year:

- Coho: represents the year most adult fish are collected at the trap or observed upstream of the trap (October-December) although coho may spawn in January and February of the subsequent year. Composed of Age-3 adults and Age-2 jacks (i.e. 1996 Brood Year adults and 1997 Brood Year jacks form the 1999 Return Year).

- Steelhead: represents the year most adult fish are collected at the trap or observed upstream of the trap (January-May) although steelhead may be trapped in November and December of the preceding year. Composed of multiple age classes.

- Cutthroat: represents the year most adult fish spawn although cutthroat are often trapped in October-December of the preceding year. Composed of multiple age classes.

Brood Year:
- Coho: represents the first year that eggs are deposited for a Return Year (e.g. fish of the 1996 brood year were derived from the 1996 Return Year. This brood will return as adults to form the 1999 Return Year).

Sample Year:
- Juvenile salmonids: the year juvenile fish were collected at the juvenile trap (February-June).

Percent Freshwater (FW) Survival: the number of smolt out-migrants divided by the estimated number of eggs deposited in the corresponding brood year

Percent Marine Survival: the number of female wild adults returning to spawn divided by half the smolts produced from the corresponding brood year.

RESULTS AND DISCUSSION

Chapter 1: North Scappoose Creek (Lower Willamette River)

North (N) Scappoose Creek is a 3rd order tributary that joins South Scappoose Creek before entering the Multnomah Channel of the Willamette River at river km 3.25. Adult coho salmon, steelhead, and cutthroat trout are captured in N Scappoose Creek at a ladder and trap facility that provides passage around Bonnie Falls, a waterfall 10.6 river km upstream of the confluence with South Scappoose Creek. Because Bonnie Falls is a complete barrier to upstream migration, fish that are passed above the trap represent the total spawning population. Juvenile fish migrating downstream are captured with a rotary screw trap, located 1.8 river km downstream of Bonnie Falls. There are 19.5 km of stream accessible to anadromous salmonids above Bonnie Falls (Figure 2).

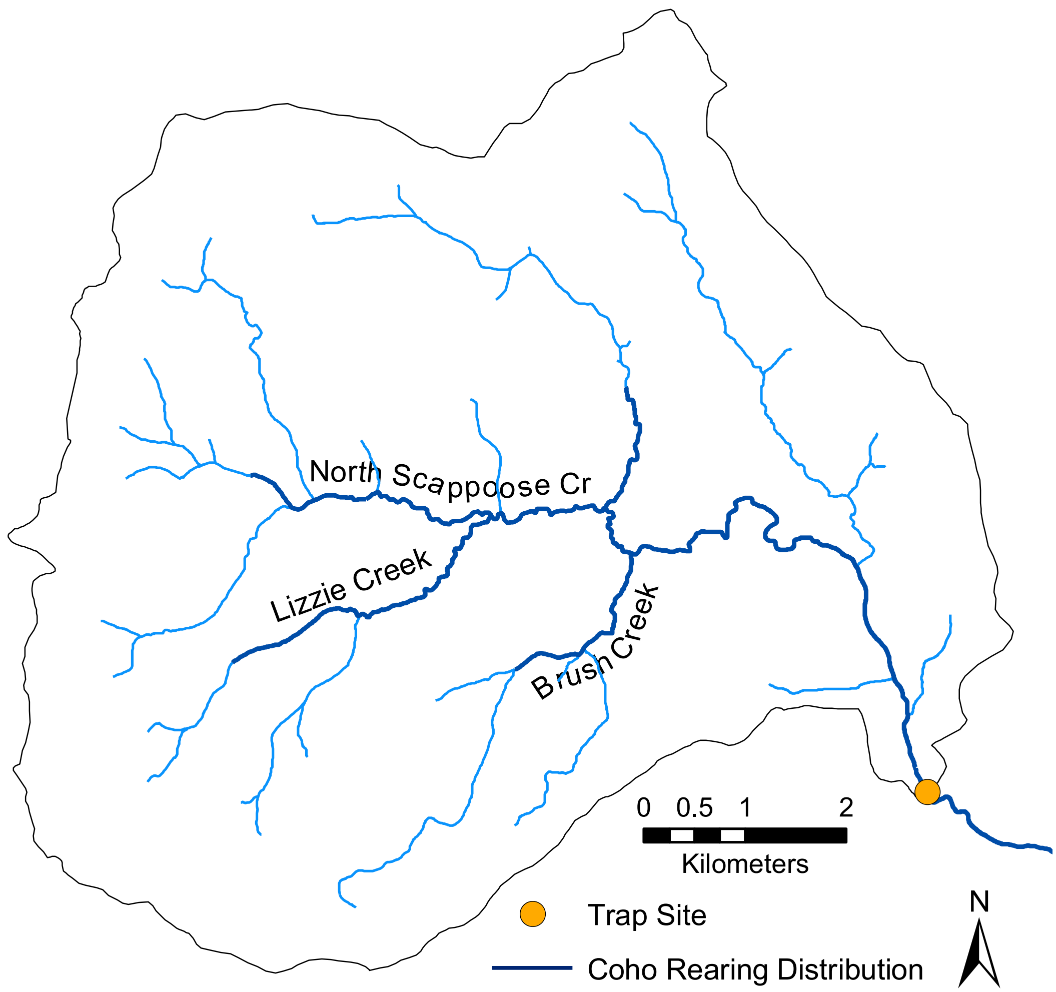

Figure 2. North Scappoose Creek showing the trap site at Bonnie Falls and extent of coho rearing distribution.

Site Specific Methods

In the fall of 2010 spawning habitat between the adult trap at Bonnie Falls and the smolt trap was identified and surveyed for adult coho. Spawning habitat in the stream reach between the adult and smolt traps includes a 1.8 km section of N Scappoose Creek and a 1.7 km segment of Fall Creek, a tributary of N Scappoose Creek. The spawning activity in these areas has been unaccounted for previous to 2010 and is not factored into adult returns or egg deposition.

To estimate egg deposition and adult returns in these segments surveyors used redd counts. Redd counts have been shown to be a reliable method of estimating fish numbers when resources are limited and fish abundance is low (Gallagher et al. 2010), as is the case in N Scappoose Cr. In the redd count method surveyors counted coho redds in the area between the traps, flagging each redd and marking each it with a brightly colored rock to reduce chances that a redd would be counted more than once. The total count of redds was multiplied by 1.19 to obtain the number of females (Gallagher 2005). The number of females from the red count was multiplied by the average number of eggs per female from the Bonnie Falls trap to obtain egg deposition in the area between the traps.

Coho Salmon

Coho spawning migration typically peaks in early to mid-November. The number of adult and jack coho salmon caught at the trap, including mortalities, (trap catch) and the number of coho salmon placed above the trap (spawning population) are given in Table 1. In all years the spawning population is equal to the trap catch, except in 1999 and in 2001. In both these years a single jack coho was found dead in the trap.

The spawning population has been low in relation to other LCM sites since monitoring began. Although the spawning populations in 2009 and 2010 were high relative to previous years, the populations in 2011 and 2012 were closer to the average. The two most recent brood cycles (2011-2013 and 2008-2010) have had a higher average and total spawning populations than in any of the first 3 brood cycles (1999-2001, 2002-2004, 2005-2007).

Jacks make up a high percentage of counts in the adult trap and in several years have exceeded the numbers of fully mature coho. Sex ratios have been variable, in most years there are more males than females, with the exceptions being 2008 and 2013. Hatchery coho are rare, and the last observation, a jack, was in 2003 (Table 1).

In 2013 the observed fallback rate for coho was 13.4%, much higher than the average rate of 4.9%. This was likely due to a new release location that was intended to reduce stress on the fish, but is closer in proximity to Bonnie Falls. Improvements to the release location which should decrease the fallback rate are planned for the fall of 2014.

Table 1. The number of wild and hatchery female (F), male (M), jack (J), coho salmon captured at the N Scappoose Creek adult trap and the estimated spawning population above the trap.

	Trap Catch						Spawning Population					
	Wild			Hatchery			Wild			Hatchery		
Return Year	F	M	J	F	M	J	F	M	J	F	M	J
1999	6	2	16	0	1	1	6	2	15	0	1	1
2000	17	25	14	0	0	1	17	25	15	0	0	1
2001	4	8	3	0	3	0	4	8	2	0	3	0
2002	19	28	18	0	0	0	19	28	18	0	0	0
2003	8	11	21	0	0	1	8	11	21	0	0	1
2004	15	21	3	0	0	0	15	21	3	0	0	0
2005	6	6	0	0	0	0	6	6	0	0	0	0
2006	14	16	28	0	0	0	14	16	28	0	0	0
2007	10	11	3	0	0	0	10	11	3	0	0	0
2008	2	0	25	0	0	0	2	0	25	0	0	0
2009	31	74	30	0	0	0	31	74	30	0	0	0
2010	63	73	3	0	0	0	63	73	3	0	0	0
2011	10	19	9	0	0	0	10	19	9	0	0	0
2012	15	29	29	0	0	0	15	29	29	0	0	0
2013	46	43	8	0	0	0	46	43	8	0	0	0

Estimates of the number of eggs, fry, smolts, and adult returns in N Scappoose Creek are summarized by brood year in Table 2, and the annual patterns are plotted in Figure 3. Marine and freshwater survival rates have not demonstrated a pattern or trend over the course of the monitoring. Freshwater survival rates did not show a relationship with female abundance ($R^2 = 0.024$), however female abundance was positively correlated to smolt abundance (Figure 4). At most other LCM sites freshwater survival rates had a tendency to decrease when spawner abundance increased, perhaps as a result of increased density-dependent mortality. This has not been observed on N Scappoose Creek, perhaps due to spawner densities being so low that they result in juvenile populations under the threshold of where density-dependent mortalities begin to take effect. The average number of female coho per kilometer of spawning/rearing habitat (spawner density) at N Scappoose is 0.91. This is nearly four times lower than the average at any other LCM site and less than 10% of the overall average across all LCM sites. Spawner density at N Scappoose has been lower than at any other LCM in all years except 2000, 2007, and 2010 when densities at Winchester Creek were slightly less.

Estimates of coho smolt migrants exiting N Scappoose Creek are given in Table 3 and plotted in Figure 3. Additional smolt data is given in Appendix 1. Peak coho smolt migration is typically in late April to mid-May and the vast majority of coho smolts migrate by early June. Although there is no detectable trend in smolt abundance over time, the four highest estimates have come in the last two brood cycles (2009-2011 and

Table 2. The estimated number of female spawners, egg deposition, fry, smolts, wild spawning adults, and freshwater and marine survival rates of coho salmon in N Scappoose Creek. The number of actual fish caught is reported (in parentheses) when trap efficiency could not be determined for a particular size class.

Brood	Female Spawners		Egg			Returning Adults (wild)		Percent Survival	
Year	Wild	Hatchery	Deposition	Fry	Smolts	F	M	FW	Marine
1996						6	3		
1997					1,406	17	24		2.4%
1998				(30)	200	4	8		4.0%
1999	6	0	15,891	(101)	678	19	28	4.3%	5.6%
2000	17	0	43,806	3,075	241	8	11	0.6%	6.6%
2001	4	0	9,905	1,261	573	15	21	5.8%	5.2%
2002	19	0	48,479	7,866	309	6	6	0.6%	3.9%
2003	8	0	21,599	18,137	589	14	16	2.7%	4.8%
2004	15	0	40,206	(358)	1,204	10	11	3.0%	1.7%
2005	6	0	10,919	10,967	(7)	2	0	na[a]	na[a]
2006	14	0	35,542	39,133	685	31	74	1.9%	9.1%
2007	10	0	25,104	4,145	2,125	63	73	8.5%	5.9%
2008	2	0	5,993	2,760	(24)	10	19	na[a]	na[a]
2009	31	0	76,577	67,630	1,611	15	29	2.1%	1.9%
2010	63	0	176,615	30,947	3,467	46	43	2.0%	2.7%
2011	10	0	25,684	(58)	632			2.5%	
2012	15	0	33,041	15,521	1,491			4.5%	
2013	46	0	103,878	(88)					

[a] survival could not be estimated due to low smolt production

2012-2014).The lack of an increasing trend over time may be driven by the weak brood line starting in brood year 2005 (smolt year 2007) and continuing in 2008 (smolt year 2010). This brood line improved in 2011 (smolt year 2013), but it remained weak relative to the two other brood lines.

The low smolt estimate in 2010 is related extremely low spawner abundance (2 females) in 2008. This low smolt abundance may have also been influenced by the large number of days (15) that we were unable to operate the trap due to high flow conditions in N Scappoose Creek. The trap was inoperable for 12 continuous days from late March into early April and it is possible that the high flows during this time could have swept smolts downstream of the trap site.

The low smolt estimate in 2007 does not seem to be driven by high flows or extremely low spawner abundance in 2005, although these factors may have contributed. Freshwater survival rates at other LCM trap sites during this time were above average. Crews noted low river levels in N Scappoose during 2007, resulting in the trap running at low rpms, which may have led to poor capture rates.

Table 3. The estimated number of juvenile salmonids migrating past the N Scappoose Creek juvenile trap. The number of actual fish caught is reported (in parentheses) when trap efficiency could not be determined for a particular size class. For cutthroat trout only the two largest size classes are shown. Additional out-migrant data are provided in the appendices.

Sample Year	Coho smolts ± CI	Steelhead smolts ≥ 120 mm ± CI	Cutthroat migrants ± CI 160-249 mm	Cutthroat migrants ± CI 120-159 mm
1999	1409 ± 149	416 ± 163	439 ± 184	192 ± 90
2000	200 ± 120	699 ± 202	325 ± 125	329 ± 169
2001	678 ± 359	814 ± 176	379 ± 82	353 ± 94
2002	242 ± 149	487 ± 159	229 ± 69	171 ± 49
2003	574 ± 53	(87)	274 ± 96	288 ± 100
2004	310 ± 151	646 ± 139	243 ± 47	227 ± 51
2005	589 ± 253	(75)	466 ± 298	(68)
2006	1207 ± 921	167 ± 186	428 ± 237	311 ± 125
2007	(7)	660 ± 204	405 ± 172	412 ± 110
2008	689 ± 98	498 ± 353	184 ± 157	260 ± 176
2009	2129 ± 794	730 ± 333	310 ± 127	359 ± 241
2010	(24)	(50)	(67)	(68)
2011	1612 ± 251	434 ± 204	(54)	1234 ± 780
2012	3468 ± 502	261 ± 182	(36)	2093 ± 1590
2013	632 ± 367	(33)	(31)	(58)
2014	1491 ± 361	601 ± 270	352 ± 172	323 ± 98

The spawning habitat between the adult and smolt traps contained a sizeable and variable portion of the egg deposition above the smolt trap (Table 4). Smolts are produced from these eggs, which are unaccounted for in adult estimates. This inflates freshwater survival rates. Marine survival rates are likewise deflated because a considerable portion of adults that return above the screw trap move into fall creek and do not enter the adult trap. These reaches will continue to be monitored in subsequent years.

Table 4. Estimates of spawners and egg deposition in spawning and rearing habitat between the Bonnie Falls adult trap and the N Fk Scappoose Creek smolt trapping site.

Brood Year	Redds	Females	Egg Deposition	Pct. of total Egg Deposition
2010	26	31	64,585	27%
2011	20	24	61,642	71%
2012	14	17	34,051	51%
2013	33	39	86,541	45%

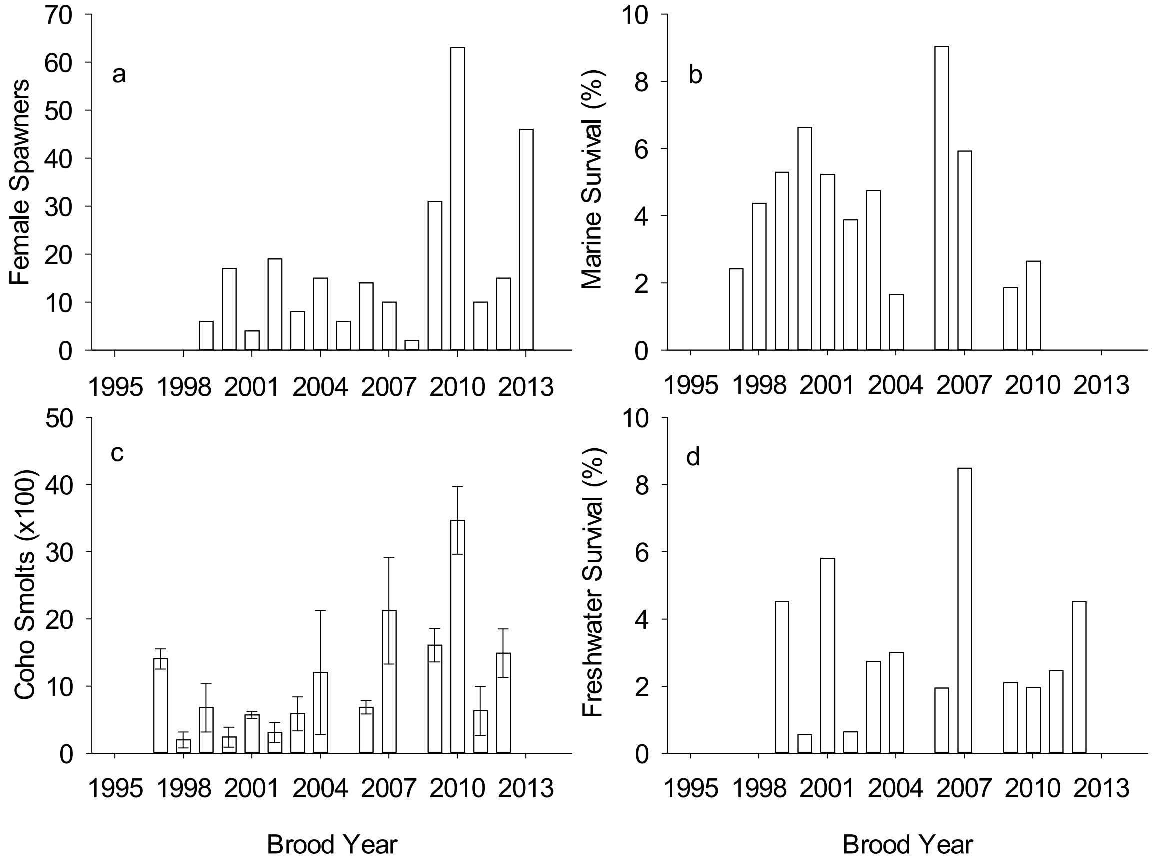

Figure 3. Annual trends in the (a) parental female spawner estimate, (b) percent marine survival, (c) smolt production estimate, and (d) percent freshwater survival for coho salmon in N Scappoose Creek upstream of Bonnie Falls.

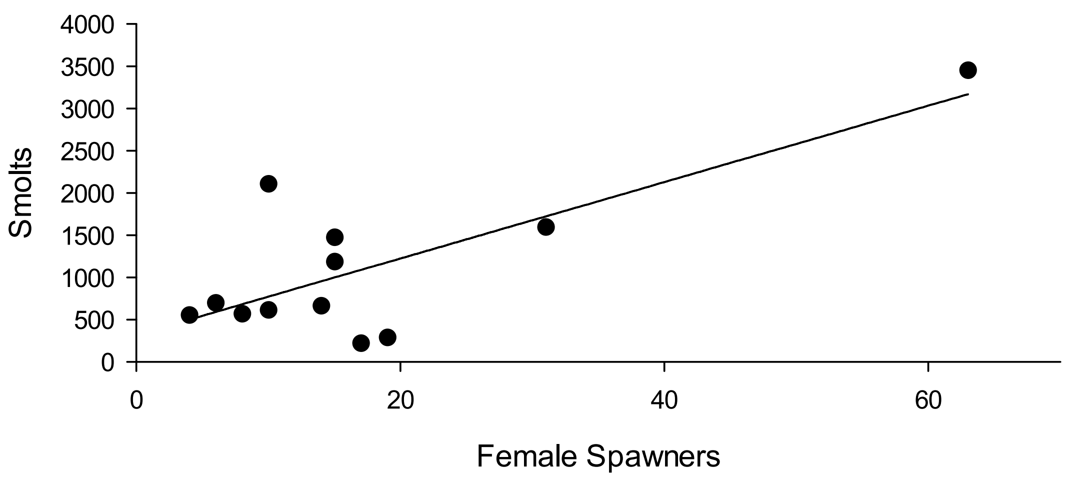

Figure 4. The relationship between coho smolt migrants and female spawners in N Scappoose Creek above the trap. The solid line is the regression line through all points (R^2=0.60, p=0.003).

Fall Chinook Salmon

Fall Chinook salmon have not be observed in the NF Scappoose adult trap nor have they been observed walking spawning surveys above the smolt trap site or in the smolt trap.

Winter Steelhead

The numbers of adult and jack winter steelhead captured in the N Scappoose adult trap and the number of fish passed above the trap to spawn in N Scappoose Creek are given in Table 5. Relatively high numbers of steelhead were caught in 2011 and 2012, but in 2013 and 2014 the catch was closer to average. Total and average numbers of steelhead in the first (2000-2003) and second (2004-2007) four year brood cycles (as reviewed by Busby et al. 1996) were lower than in the third brood cycle (2008-2011) and in the partial brood cycle from 2012-2014.

Estimates of the number of winter steelhead smolts leaving N Scappoose each spring are in Table 3. Peak migration of steelhead smolts is typically in mid-April to mid-May, and the average size of smolts is typically about 170 mm FL. Data on size, peak migration week, and pre-smolt estimates are given in Appendix 2. We have not detected a trend or pattern for steelhead smolt estimates.

Table 5. The number of female (F), male (M), jack (J) winter steelhead captured at the N Scappoose Creek adult trap and the estimated spawning population in N Scappoose Creek above the trap.

Return Year and Species	Trap Catch						Spawning Population					
	Wild			Hatchery			Wild			Hatchery		
	F	M	J	F	M	J	F	M	J	F	M	J
Steelhead												
2000	11	10	0	0	0	0	10	9	0	0	0	0
2001	5	7	0	0	0	0	5	7	0	0	0	0
2002	7	7	0	1	0	0	7	7	0	1	0	0
2003	12	8	1	1	1	0	12	8	1	1	1	0
2004	5	9	2	0	1	0	5	9	2	0	1	0
2005	11	11	1	1	0	0	11	11	1	1	0	0
2006	6	2	5	0	1	0	6	2	5	0	1	0
2007	6	9	1	0	0	0	6	9	1	0	0	0
2008	9	7	2	1	0	0	9	7	2	1	0	0
2009	3	5	2	0	0	0	3	5	2	0	0	0
2010	11	14	2	0	0	0	11	14	2	0	0	0
2011	23	16	1	0	0	0	23	16	1	0	0	0
2012	18	20	4	0	0	0	18	20	4	0	0	0
2013	14	8	1	0	1	0	14	8	1	0	1	0
2014	10	6	0	0	0	0	10	6	0	0	0	0

Cutthroat Trout

The numbers of adult cutthroat trout captured in the N Scappoose trap are given in Table 6. Trap catch does not include all adult migrants because the spacing of trap bars is wide enough for some adults to move through the trap, thus trap catch is not a good index of abundance. We did not collect any cutthroat of hatchery origin. Trap catch peaked at 91 cutthroat in 2011, but fell to a near record low of 7 in 2014. In earlier years cutthroat were typically the most common adult salmonid captured at Bonnie Falls, but in most recent years coho have out-numbered cutthroat.

Estimates of cutthroat trout downstream migrants in the two largest size classes are summarized in Table 3. Estimates for smaller size classes are given in Appendix 3. The week of peak migration is typically in late-April to early-May. Most cutthroat migrants that are 90-159 mm FL are partial silvered, whereas fish 160-249 mm FL are either partially silvered or completely silvered when they migrate from the stream. We have not detected a trend or pattern for cutthroat smolt estimates.

Table 6. The number of adult cutthroat trout (≥ 250 mm) captured in the N Scappoose River adult and out-migrant traps. Fish were caught October-June in the adult trap, and from February-June in the screw trap.

Return Year	Adult Ladder Trap[a]	Out-Migrant Screw Trap
2000	43	0
2001	44	0
2002	35	0
2003	27	0
2004	11	0
2005	30	5
2006	13	0
2007	50	0
2008	6	4
2009	21	8
2010	48	0
2011	91	0
2012	45	0
2013	65	0
2014	7	2

[a] Adult trap catch does not include all adult migrants entering the trap because the spacing of trap bars is wide enough for some adults to escape upstream.

Chapter 2: North Fork Nehalem River (Nehalem River)

The North Fork (NF) Nehalem River is a 4th order tributary that joins the Nehalem River at river km 4.5. Adult fish are trapped at a ladder on Waterhouse Falls, 20 km from the mouth, and at a ladder on a second waterfall, Fall Creek Falls, near Fall Creek 6.5 km upstream from Waterhouse Falls. Both waterfalls are partial migration barriers. Juvenile fish are trapped with rotary screw traps below each ladder. Monitoring began in the spring of 1998, with juvenile monitoring at the upper site beginning in 2000. We have defined the lower sub-basin as the area between the two ladders and the upper sub-basin as the area above the upper ladder. The NF Nehalem lower (38.6 km) and upper (38.5 km) sub-basins contain 77.1 km of stream accessible to anadromous salmonids (Figure 5).

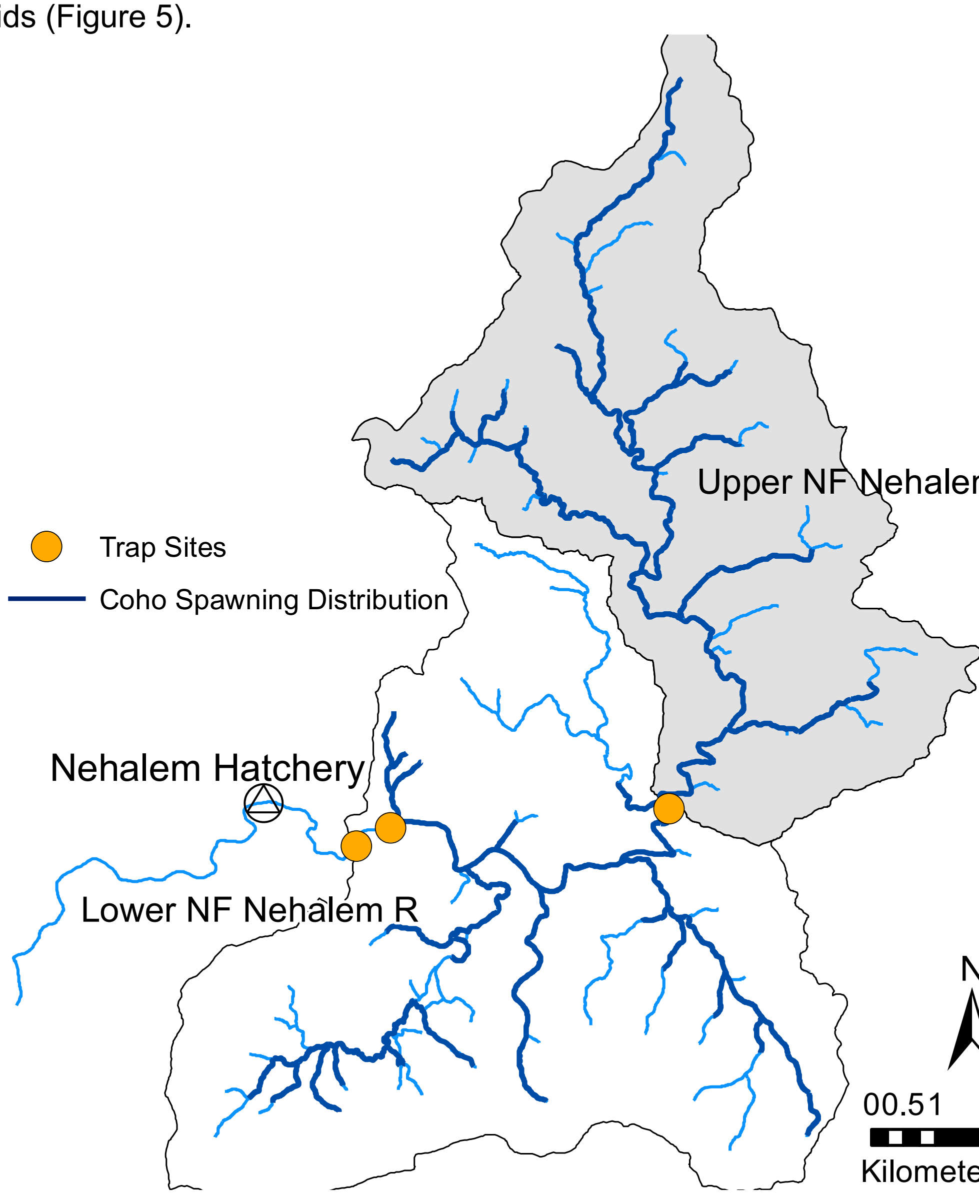

Figure 5. The North Fork Nehalem River upstream of Waterhouse Falls showing the upper and lower trap sites and the extent of coho rearing distribution.

The NF Nehalem site is unique among our Life Cycle Monitoring sites in having a coho and steelhead hatchery located nearby. The Nehalem Fish Hatchery (~ 2 km downstream of Waterhouse Falls) has two stocks of coho salmon and, through the 2008 brood year, had two stocks of winter steelhead. The 32 stock is of varied origin and has had no wild inputs since the 1960s. The 99 stock is derived from wild fish from Fishhawk Creek, a tributary to the upper Nehalem River. The 99 coho stock was started in 1978 with further wild inputs in 1981 and 1984. Steelhead were taken from Fishhawk Creek to initiate the 99 stock in 1982-1984, with no wild inputs thereafter. During the three year brood-cycle of coho salmon, the 32 stock is released as smolts and return as adults in two years and the 99 stock in one year. Both steelhead stocks were released as smolts and returned as adults each year through the 2012 return year. However, stocking of the 99 steelhead stock was eliminated after the 2008 brood year and only the 32 steelhead stock is now released.

Site Specific Methods

Adult Estimates

As detailed in the main methods section, we used a mark-recapture method to estimate the number of adult wild coho and fall Chinook salmon spawners, and winter steelhead spawners (including jacks) for the basin area upstream of Waterhouse Falls. In 2000-2002 no adjustments were made for tag loss because fish tagged at the ladders were also given an operculum punch. For coho and Chinook salmon, recaptures of marked fish included all fish captured alive in the upstream ladder, fish captured by anglers, and fish carcasses on spawner surveys or those washed into the ladders. For steelhead, recaptures also included live fish from surveys (visual presence/absence of tags and adipose fin-clips), and spawners captured in out-migrant traps in the spring. Chinook and steelhead are not tagged at the upper trap because of low recapture rates in the upper basin.

In the 2001 coho return year we began distinctly tagging coho salmon at the Fall Cr Falls adult trap to make an upper sub-basin estimate. Lower sub-basin estimates were calculated by subtracting the upper sub-basin wild and hatchery estimates from the total basin wild and hatchery estimates.

Hatchery fish were identified by an adipose fin clip or, through 2003, presence of a code wire tag (CWT) in double index coho and were handled differently from year to year depending on logistics and district and research program objectives (Table 7). Hatchery fish removed from the Waterhouse Falls trap and, in most years, the Fall Cr Falls trap, and female hatchery steelhead stripped of eggs were not considered to be spawners and therefore not included in the hatchery spawner estimate.

In years in which hatchery fish were tagged and passed and sufficient recoveries were made an independent mark-recapture estimate was calculated. In other years the number of hatchery spawners upstream of the trap was calculated by multiplying the wild spawner estimate by the hatchery:wild ratio of fish caught at the trap (and then

Table 7. Coho and steelhead hatchery fish handling at the Waterhouse Falls (a) and Fall Cr Falls (b) adult traps.

a

Coho Return Year	Coho	Steelhead Males	Steelhead Females
1998-2001	Removed	Returned to hatchery or recycled downstream	
2002-2004	Tagged and passed	Tagged and passed	
2005		Some males and females recycled in 2006	
2006		Nonripe: recycled downstream Ripe:transported to lakes	Ripe: stripped and passed
2007	Removed	Nonripe: recycled downstream Ripe:removed	Ripe: stripped and passed
2008	Some passed in 2008		
2009-2013			

b

Coho Return Year	Coho	Steelhead
1998	Passed	Passed
1999	Removed ex. double index	
2000		Tagged and passed
2001	Removed	
2002	Tagged and passed	
2003-2005		Passed
2006		Removed
2007-2013	Removed	

subtracting removed fish) and, in 2000, also the hatchery:wild ratio of survey carcass recoveries due to low trap efficiency. In years in which double index coho were not removed at the upper trap the number of double index coho passed was calculated using the number of adipose clipped coho captured at the upper trap and the ratio of double index to adipose clipped coho at the lower trap.

In NF Nehalem River prior to the 2004 return year, many hatchery coho salmon were given coded wire tags in their snouts rather than adipose fin clips, and these tags were identified with a metal detector. Hatchery coho spawner estimates in NF Nehalem River that were not independent of wild spawner estimates had variance calculated for combined wild and hatchery origin populations. The resulting confidence interval was then partitioned for hatchery fish based upon the percentage of hatchery fish in the total population.

Spawner surveys were conducted each year on mainstem and tributary reaches to recapture tags in both sub-basins. Survey effort varied among years and reaches and between sub-basins, depending on weather and flow levels and other project activities. Because fish were tagged at Waterhouse Falls only in 1998 and 1999, we did not differentiate survey effort between the upper and lower sub-basins in those years. In those years surveys were more numerous in the lower sub-basin because spawners, particularly Chinook salmon, were more abundant in this area. Beginning in 2000 effort increased in upper sub-basin surveys in order to find fish with upstream ladder tags, resulting in a balanced effort between the sub-basins. In both sub-basins reaches with relatively high fish abundance were usually surveyed more frequently. In coordination with other Oregon Plan spawner monitoring (probability-based surveys) some reaches in both sub-basins were surveyed every ten days without regard to fish abundance.

In addition to recording data as detailed in the general methods section, in 2000 we took scale samples from some coho carcasses that lacked marks for later identification of hatchery or wild growth patterns. In 2001, almost all unmarked coho were scale sampled or a snout was taken for later CWT interrogation. In 2002, 2003 and 2007-2009, snouts of almost all unmarked coho were removed and interrogated. For fish of which hatchery or wild origin could not be determined by marks or CWT's, the estimated number of double-index fish was determined by the numbers of adipose fin-clipped fish and the known ratio between adipose fin-clipped fish and double-indexed fish sampled at the ladders or that entered the hatchery.

Juvenile Estimates

We estimated the weekly number of juvenile coho, steelhead, Chinook, and cutthroat out-migrating past the two rotary screw traps from March to mid-June based on weekly strata as outlined in the general methods section. We calculated an upper sub-basin estimate from out-migrant catches at our upper screw trap, and a total basin estimate from catches at the lower screw trap. Subtraction of the upper sub-basin estimate from the total basin estimate yielded a lower basin estimate. To differentiate between marked fish for capture efficiency trials at each trap the upper lobe of the caudal fin was clipped at the upper trap and the lower lobe at the lower trap.

To estimate out-migrants at times when only one trap was operating we used out-migrant catch at the trap that could be fished as a guideline. For example, in 2000 the upstream trap was not installed until the end of March, but trapping began on schedule (near the beginning of March) at the downstream site. To adjust the upper sub-basin total season smolt estimate, the number of smolts estimated to have passed the upstream site after trap installation was increased by the percentage of the downstream trapping site total season estimate that migrated during the upstream site non-trapping period in March.

Coho Salmon

Coho Salmon Adults and Smolts in the Total Basin Upstream of Waterhouse Falls

Coho salmon usually begin to ascend the NF Nehalem River beginning in early September to early October with the arrival of fall rains and higher river flows. Coho usually arrived at the Waterhouse Falls adult trap by early to mid-October, with peak catches of hatchery fish occurring earlier than wild fish. Few hatchery coho were caught at this trap after mid-November, whereas small numbers of wild coho were usually captured through December and, sometimes, into late January. There was a high degree of annual variation in the number of hatchery versus wild adult coho, both for actual catch at Waterhouse Falls (Table 8) and estimated numbers in the total basin upstream of the falls (Table 9). Numbers of hatchery stray spawners were relatively low for the first three years of sampling, increased in 2001, were most abundant in 2002, the first of five years that trapped hatchery fish were passed, and have been highly variable over the last eleven years. Overall, the estimated number of hatchery coho strays spawning upstream of Waterhouse Falls ranged from a low of 22 adults in 2012 to a high of 3,332 adults in 2002 ($\bar{x}$ = 689 adults). Coded wire tag recoveries from hatchery coho captured at both Waterhouse and Fall Cr Falls adult traps and from spawning surveys upstream of Waterhouse Falls indicated that the majority of strays were from Nehalem Hatchery (99.3%). The remaining strays were from Trask (Tillamook basin) and Lewis (Lower Columbia, WA) River Hatcheries (0.6%, 0.1%, respectively).

The annual number of returning wild adult coho salmon also varied widely over the course of monitoring, reflecting large variation in marine survival rates. Wild adult coho catch at Waterhouse Falls ranged from a low of 227 adults in 1998 to a high of 2,373 adults in 2010 (Table 8). Estimates of wild adult spawners in the total basin upstream of Waterhouse Falls were considerably lower for the first three monitoring years ($\bar{x}$ = 671 adults) than for the last thirteen years ($\bar{x}$ = 1,813 adults), except in 2012 when only 389 wild adults returned to spawn (Table 9). Total estimated spawners (wild and hatchery) upstream of Waterhouse Falls ranged from a low of 411 adults in 2012 to a high of 5,790 adults in 2010 (Table 9).

We found no consistent relationship between the number of smolts released from the hatchery and the subsequent number of returning hatchery adults, nor the percentage of hatchery spawners among the naturally spawning population (Table 10). The number of hatchery smolts released declined over the years of monitoring, and two brood years with very similar smolt releases (1997 and 1999) produced both the second least and greatest number of returning adults that were trapped at Waterhouse Falls (55 and 1,015 adults, respectively; Table 10). Similarly, these two brood years also produced both the third least and greatest number of hatchery spawners above the falls (109 and 3,332 spawners, respectively; Table 9). The percentage of adult hatchery coho that were strays compared to the total estimated number of returning hatchery adults was quite variable, ranging from 16% for the 1995 brood to 62% for the 2005 brood (Table 10).

Table 8. The number of wild and hatchery female (F), male (M) adult and jack (J) coho salmon captured in the NF Nehalem River adult traps at Waterhouse Falls and at Fall Cr Falls and the total and upper sub-basin estimated spawning population.

	Trap Catch						Spawning Population					
Return	Wild			Hatchery			Wild			Hatchery [c]		
Year	F	M	J	F	M	J	F	M	J	F	M	J
Waterhouse Falls Trap/Total Basin												
1998	104	123	53	77	81	125	298	359	na	142	157	na
1999	227	234	4	345	307	13	369	376	na	209	183	na
2000	147	127	17	24	31	21	328	284	na	51	58	na
2001	181	202	7	311	284	49	937	1,085	na	1,281	790	na
2002[b]	189	217	5	474	541	46	712	855	na	1,574	1,758	na
2003	384	390	38	159	210	6	785	887	na	283	366	na
2004	282	214	14	89	111	91	905	911	na	257	390	233
2005	249	247	15	206	214	53	581	702	na	422	450	106
2006	319	413	7	123	201	3	443	594	na	149	235	na
2007	195	125	15	13	12	42	534	461	na	24	25	na
2008	489	362	7	425	359	73	903	771	na	446	406	na
2009	694	665	34	185	175	19	1,030	1,064	60	83	86	na
2010	1,325	1,048	19	390	312	31	2,595	2,431	53	403	361	na
2011	743	783	8	155	161	11	1,269	1,437	na	103	118	na
2012	161	174	23	61	85	12	184	205	na	9	13	na
2013	449	471	41	246	251	163	596	686	70	90	95	na
Fall Cr Falls Trap/Upper Sub-basin												
1998[a]	13	17	4	0	4	23						
1999	75	78	5	8	15	0	102	105	na	5	8	na
2000	34	30	5	1	1	2						
2001	155	195	0	13	24	6	263	332	na	9	17	na
2002[a]	152	215	2	153	224	2	353	486	na	384	547	na
2003	138	178	12	24	36	0	456	612	na	82	119	na
2004	153	179	17	11	31	22	235	322	na	15	40	na
2005	130	216	8	27	25	3	134	223	na	24	25	na
2006	183	235	6	15	27	0	218	284	na	18	32	na
2007	176	173	12	1	3	3	199	193	na	0	0	na
2008	271	269	4	22	38	3	289	295	na	2	3	na
2009	385	476	26	5	21	2	375	469	na	0	0	na
2010	884	1,037	12	2	19	2	932	1,129	na	0	2	na
2011	578	678	5	4	19	3	584	685	na	0	0	na
2012	64	64	6	1	1	3	62	65	na	0	0	na
2013	246	314	16	0	11	20	257	333	na	0	1	na

[a] One wild fish was unsexed. [b] One wild and one hatchery fish were unsexed

[c] Male and female ratios were based on the sex ratio of hatchery coho trapped at Waterhouse Falls or hatchery coho trapped at Waterhouse Falls, and untagged hatchery coho recoveries upstream of Waterhouse Falls

Table 9. The estimated number of total, wild and hatchery coho salmon spawners in the NF Nehalem River lower sub-basin (between the Waterhouse Falls and Fall Cr Falls adult traps), the upper sub-basin (upstream of the Fall Cr Falls trap), and the total basin.

Return Year	Total			Wild			Hatchery		
Lower Sub-basin									
1999	917	±	142	538	±	50	379	±	92
2001	3,472	±	1,000	1,427	±	411	2,045	±	589
2002	3,129	±	593	728	±	324	2,401	±	498
2003	1,052	±	302	604	±	173	448	±	129
2004	1,851	±	358	1,259	±	318	592	±	163
2005	1,749	±	197	926	±	172	823	±	108
2006	869	±	77	535	±	72	334	±	28
2007	652	±	194	603	±	185	49	±	9
2008	1,937	±	198	1,090	±	140	847	±	66
2009	1,419	±	112	1,250	±	106	169	±	9
2010	3,727	±	290	2,965	±	264	762	±	59
2011	1,658	±	161	1,437	±	154	221	±	13
2012	284	±	24	262	±	23	22	±	1
2013	876	±	78	692	±	70	184	±	16
Upper Sub-basin									
1999	220	±	47	207	±	34	13	±	13
2001	621	±	75	595	±	68	26	±	7
2002	1,770	±	212	839	±	125	931	±	171
2003	1,269	±	250	1,068	±	210	201	±	40
2004	612	±	69	557	±	67	55	±	14
2005	406	±	12	357	±	11	49	±	3
2006	552	±	33	502	±	30	50	±	3
2007	392	±	20	392	±	20	0	±	0
2008	589	±	24	584	±	23	5	±	0
2009	844	±	6	844	±	6	0	±	0
2010	2,063	±	37	2,061	±	36	2	±	0
2011	1,269	±	15	1,269	±	15	0	±	0
2012	127	±	3	127	±	3	0	±	0
2013	591	±	16	590	±	16	1	±	0
Total Basin									
1998	956	±	229	657	±	135	299	±	94
1999	1,137	±	292	745	±	121	392	±	171
2000	721	±	127	612	±	99	109	±	56
2001	4,093	±	997	2,022	±	427	2,071	±	570
2002	4,899	±	554	1,567	±	299	3,332	±	467
2003	2,321	±	169	1,672	±	153	649	±	73
2004	2,463	±	351	1,816	±	311	647	±	136
2005	2,155	±	197	1,283	±	172	872	±	108
2006	1,421	±	70	1,037	±	66	384	±	27
2007	1,044	±	193	995	±	184	49	±	9
2008	2,526	±	196	1,674	±	138	852	±	66
2009	2,263	±	112	2,094	±	106	169	±	9
2010	5,790	±	287	5,026	±	261	764	±	38
2011	2,927	±	161	2,706	±	153	221	±	12
2012	411	±	24	389	±	23	22	±	1
2013	1,467	±	77	1,282	±	69	185	±	10

Table 10. The number of coho salmon smolts released from Nehalem Hatchery, total returning hatchery adults entering hatchery, percent that were strays (not entering hatchery), and percent of strays among all adult spawners upstream of Waterhouse Falls. Shaded rows are releases of 99 stock; other years 32 stock coho were released.

		Returning Hatchery Adults				Stray Hatchery Adults		
				Strays				
Brood Year	Smolts Released	Total Adults	Entered Hatchery	Trapped W. H Falls	Jumped W. H. Falls	% of all Hatchery Adults	% of strays Trapped W. H Falls	% strays among all spawners
1995[a]	629,007	2,930	2,473	158	299	15.6	34.6	31.3
1996[a]	192,645	2,215	1,153	652	410	47.9	61.4	36.1
1997[a]	214,556	743	577	55	111	22.3	33.1	15.1
1998[a]	209,900	9,237	6,534	595	2,108	29.3	22.0	50.6
1999[b]	204,648	5,800	2,468	1,015	2,317	57.4	30.5	68.0
2000[b]	204,534	2,087	1,438	369	280	31.1	56.9	28.0
2001[b]	101,704	2,024	1,377	200	447	32.0	30.9	26.3
2002[b]	100,652	2,388	1,516	420	452	36.5	48.2	40.5
2003[b]	102,722	1,042	658	324	60	36.9	84.4	27.0
2004[a]	102,144	214	136	25	53	36.4	32.1	4.7
2005[a]	102,761	2,403	921	784[c]	698	61.7	52.9	33.7[c]
2006[a]	102,849	1,665	1,110	360	195	33.3	64.9	7.5
2007[a]	99,250	3,247	1,760	702	785	45.8	47.2	13.2
2008[a]	103,324	1,823	1,263	316	244	30.7	56.4	7.6
2009[a]	102,744	466	296	146	24	36.5	85.9	5.4
2010[a]	102,924	2,773	2,080	497	196	25.0	71.7	12.6

[a] Strays from the 1995-1998 and 2004-2010 brood years trapped at Waterhouse Falls were killed.
[b] Strays from the 1999-2003 brood years trapped at Waterhouse Falls were passed.
[c] Includes 154 hatchery coho that were trapped at Waterhouse Falls but passed upstream.

The percentage of adult hatchery coho strays that were trapped at Waterhouse Falls also had a high amount of variation, ranging from a low of 22% for the 1998 brood to a high of 86% for the 2009 brood (Table 10). River level at time of migration to the falls likely has a large influence on the number of hatchery strays trapped at Waterhouse Falls in a given year. For example, the majority of the hatchery coho that were trapped at Waterhouse Falls in the 2006 return year were captured during a rain event that caused a slight rise in river level after an extended low water period. Hatchery coho recoveries on spawning surveys and at the upper ladder in that year indicated that most fish were tagged at the lower ladder and did not jump the falls. Presumably, during the low October flows of that year, Waterhouse Falls was more difficult to ascend for fish migrating upstream, which resulted in more hatchery coho being trapped in the ladder.

Accurate estimates of coho fry were not possible at the out-migrant traps due to hazardous working conditions resulting from large storms and high flows in February and early March. Estimates of smolt out-migrants produced from the basin upstream of Waterhouse Falls ranged from 19,228 to 43,260 fish (Table 11). However, the mean number of smolts estimated to have migrated past the screw trap annually over the last

Table 11. The estimated number of female spawners, egg deposition, fry, smolts, wild spawning adults, and freshwater and marine survival rates of coho salmon in the NF Nehalem River upstream of Waterhouse Falls.

Brood Year	Female Spawners Wild	Female Spawners Hatchery	Egg Deposition	Fry	Smolts	Returning Adults (wild) F	Returning Adults (wild) M	Percent Survival FW	Percent Survival Marine
1996					43,260	369	376		1.7%
1997					20,194	328	284		3.3%
1998	298	142	1,158,208	na	30,951	937	1,085	2.7%	6.1%
1999	369	209	1,651,921	na	43,160	712	855	2.6%	3.3%
2000	328	51	1,061,026	na	19,603	785	887	1.8%	8.1%
2001	937	1,281	6,611,285	na	29,945	905	911	0.5%	6.0%
2002	712	1,574	7,234,089	na	39,019	581	702	0.5%	3.0%
2003	785	283	2,965,756	na	24,158	443	594	0.8%	3.7%
2004	905	257	3,374,021	na	26,905	534	461	0.8%	4.0%
2005	581	422	2,836,453	na	22,317	903	771	0.8%	8.1%
2006	443	149	1,786,064	na	20,830	1,030	1,064	1.2%	9.9%
2007	534	24	1,459,170	na	29,044	2,595	2,431	2.0%	17.9%
2008	903	446	4,176,504	na	27,106	1,269	1,437	0.6%	9.4%
2009	1,030	83	2,898,252	na	20,553	184	205	0.7%	1.8%
2010	2,595	403	9,083,940	na	37,852	596	686	0.4%	3.2%
2011	1,269	103	3,797,696	na	30,035			0.8%	
2012	184	9	492,536	na	19,228			3.9%	
2013	596	90	1,895,418	na					

ten years ($\bar{x}$ = 25,803 smolts) is significantly less than the number estimated annually over the first seven years ($\bar{x}$ = 32,305 smolts) of monitoring. Smolt numbers usually peaked from mid-April to mid-May and average fish length during week of peak migration was not correlated with when the peak week of migration occurred (Appendix 1).

Over seventeen years of trapping we have monitored nearly six brood cycles of the three coho brood lines. We observed a three year pattern in smolt abundance beginning for the1996 brood year of high, low, and moderate relative smolt abundance (Figure 6c). This pattern repeated for the 1999-2001 and 2002-2004 brood years but did not hold for the fourth or fifth brood cycles. However, one pattern that has held true is the 1997 brood line has consistently produced substantially less smolts ($\bar{x}$ = 20,761 smolts) than the 1996 ($\bar{x}$ = 34,150 smolts) and 1998 ($\bar{x}$ = 30,939 smolts) brood lines over the course of monitoring (Table 11). We did not find a significant relationship between female spawner numbers and smolt abundance (Figure 7) or between freshwater survival and smolt abundance. The years of highest smolt abundance do correspond to years of 99 stock hatchery coho releases and when the lower basin produced a higher proportion of total smolt production than most other years (Tables 10 and 12).

Estimates of freshwater survival were much higher in brood years when female spawner numbers and estimated egg deposition was lowest (*i.e.* 1998-2000, 2006, 2007, 2012; Table 11, Figure 6d) and smolts produced per female declined with increasing female spawners (Figure 8). Marine survival has varied annually (Figure 6b) with no consistent relationship between smolt numbers and subsequent adult returns.

Coho Salmon Adults and Smolts in the Upper and Lower Sub-Basins

Sub-basin estimates of wild and hatchery adult spawners could be made for the 1999 and 2001-2013 return years (Table 7, Figure 9). Wild adults were the majority in the upper sub-basin except in the 2002 return year when there were slightly more hatchery adults. Hatchery adults were always more abundant in the lower sub-basin than in the upper sub-basin with few hatchery adults estimated in the upper sub-basin in most years. In the lower sub-basin, hatchery adults were more abundant than wild adults during the 2001 and 2002 return years, but wild adults out-numbered hatchery adults in all other years. Confidence intervals around the estimates were generally greater for the lower sub-basin because these were made by subtracting upper sub-basin estimates from entire basin estimates and upper sub-basin variance was small relative to total basin variance. Lower sub-basin spawners were more abundant than upper sub-basin spawners in all return years except 2003 (Table 9).

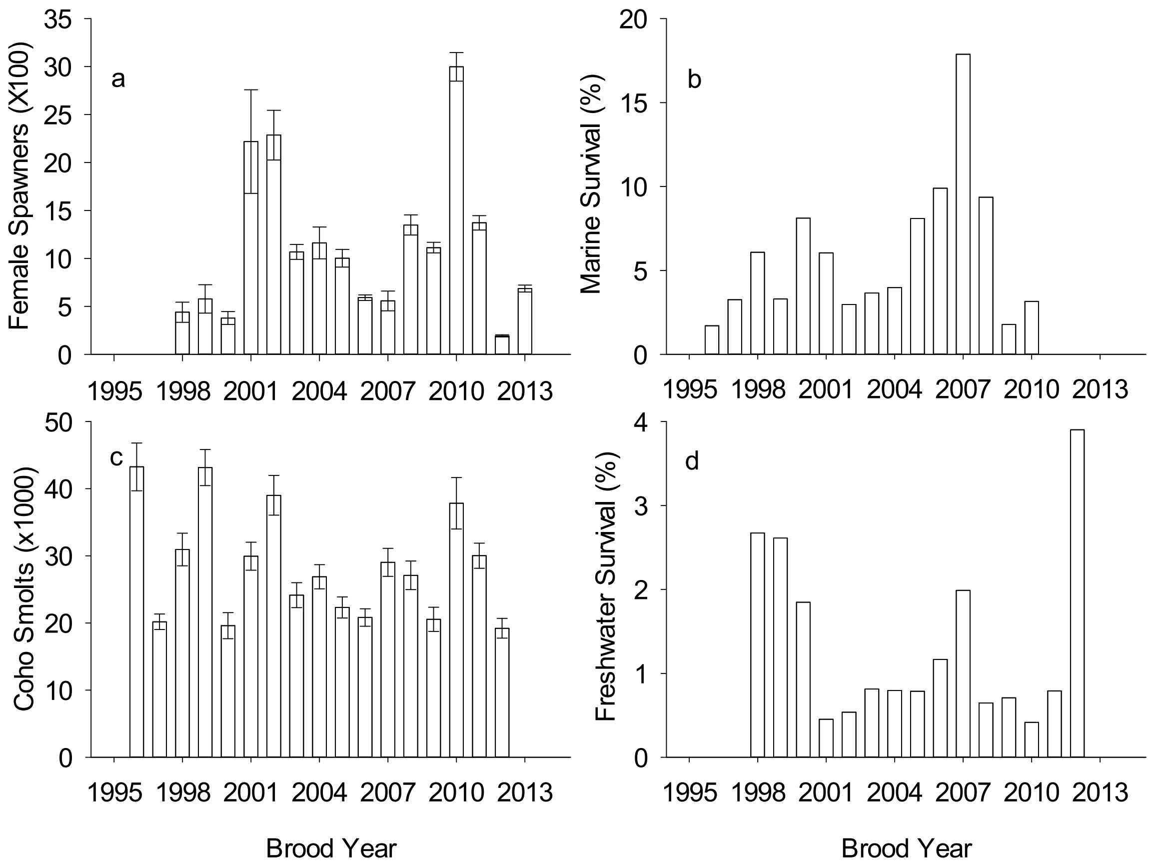

Figure 6. Annual trends in the (a) parental female spawner estimate, (b) percent marine survival, (c) smolt production estimate, and (d) percent freshwater survival for coho salmon in the NF Nehalem River upstream of Waterhouse Falls.

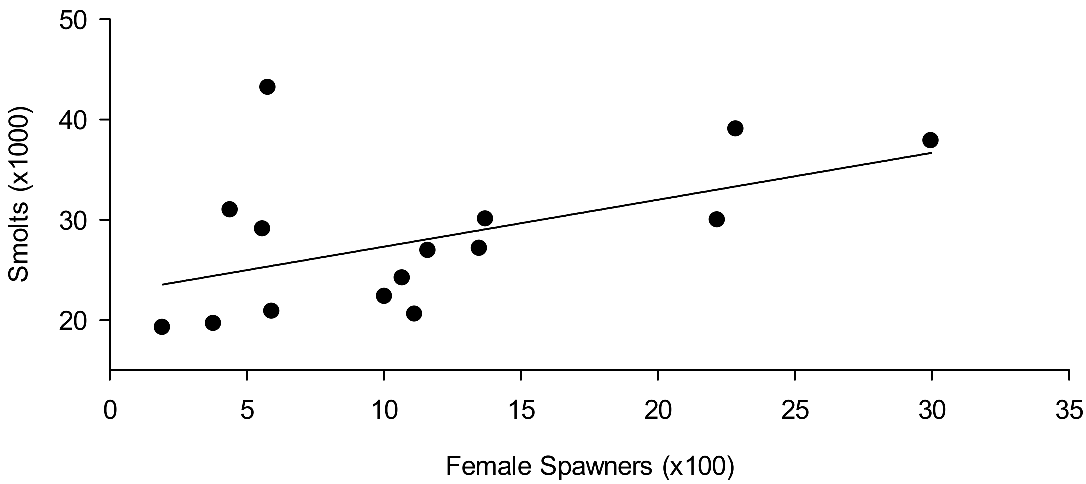

Figure 7. The relationship between coho smolt migrants and female spawners in the NF Nehalem River basin upstream of Waterhouse Falls. The solid line is the regression line through all points (R^2=0.26, P=0.055).

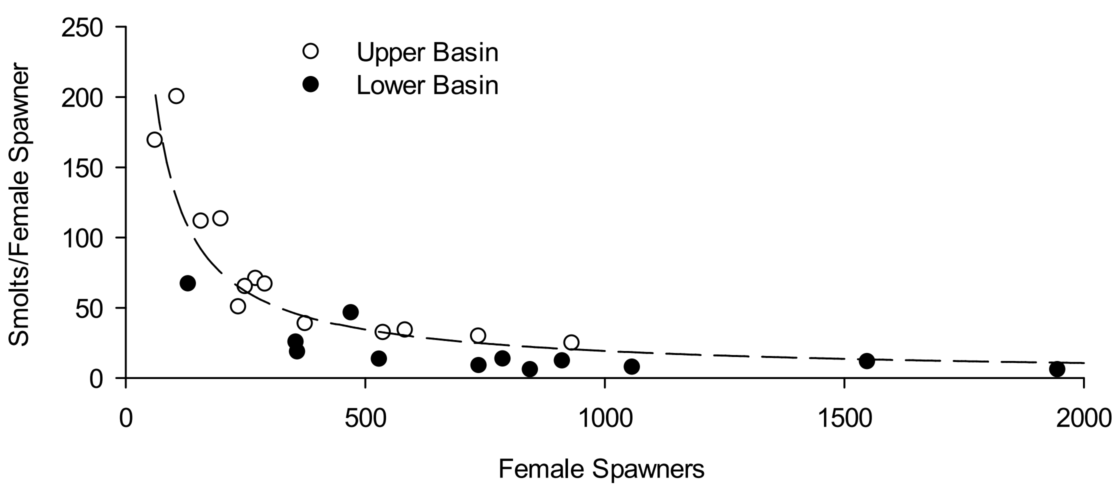

Figure 8. The relationship of coho salmon smolts per female spawner to total female spawners in the lower and upper sub-basins of the NF Nehalem River.

The number of coho smolts out-migrating from the two sub-basins was similar for sample years 2001, 2004, 2008, and 2014, but the upper sub-basin produced significantly more smolts in all other years (Table 12). Lower sub-basin smolt production varied over a wide range of female spawner densities, while upper sub-basin production was less variable over a much narrower range of female spawner densities. In both sub-basins, smolts per female decreased as the number of female spawners increased (Figure 8), indicating smolt production is limited by density dependent factors in the freshwater realm (Bradford et al. 1997). One such factor shown to influence smolt production is the availability of winter habitat (Brown and Hartman 1988; Nickelson et al. 1992; Beechie et al. 1994).

Hatchery adult straying and survival rates

Our monitoring indicates that a greater proportion of returning 99 stock coho stray to the spawning grounds upstream of Waterhouse Falls. Straying rates for the four brood years of the 99 stock averaged 47%, compared to an average of 31% for releases of the 32 stock (Table 10). However, there are factors in addition to stock type that could affect stray rates such as rainfall patterns. In one return year of the 99 stock (2002), fall rains did not begin until the second week of November and then continued unabated for almost two weeks. Flows were high throughout this period, and nearly the

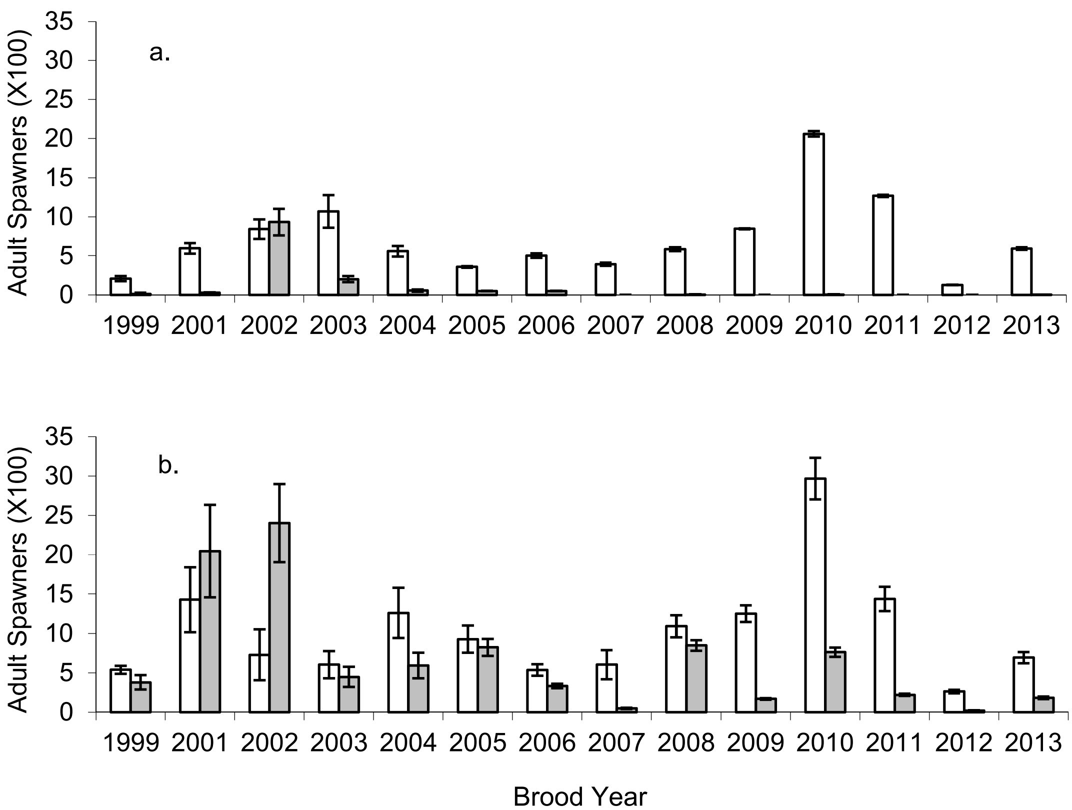

Figure 9. The estimated number of wild (clear bars) and hatchery (gray bars) adult coho salmon spawners in the a) upper and b) lower sub-basins of the NF Nehalem River.

Table 12. The estimated number of coho salmon smolt migrants in the NF Nehalem River lower and upper sub-basins. Data for smolts represent fish sampled in the second year following egg deposition (e.g., the 1996 brood year was sampled in 1998).

Sample Year	Lower Sub-basin Smolts ± CI			Upper Sub-basin Smolts ± CI		
2000	8,362	±	3,418	22,589	±	2,401
2001	21,753	±	3,468	21,407	±	2,207
2002	7,405	±	3,061	12,198	±	2,364
2003	10,731	±	2,385	19,214	±	1,156
2004	17,376	±	3,222	21,643	±	1,284
2005	6,933	±	2,313	17,225	±	1,378
2006	10,706	±	2,083	16,199	±	1,049
2007	4,723	±	2,540	17,594	±	1,993
2008	8,945	±	1,598	11,885	±	913
2009	6,551	±	2,881	22,493	±	1,993
2010	7,706	±	2,496	19,400	±	1,294
2011	6,181	±	2,081	14,372	±	1,035
2012	15,037	±	4,086	22,815	±	1,423
2013	10,331	±	2,193	19,704	±	1,133
2014	8,754	±	1,638	10,474	±	698

entire run of hatchery fish went upriver during this short time, as did the majority of wild fish. It is possible that the hatchery facility provided relatively little attraction flow relative to high river flows, or there may have been crowding near the hatchery outfall and pond during this truncated high flow period. Numbers of hatchery fish were much greater in the upper sub-basin in 2002 relative to other years.

Differences in observed stray rates may also be due to the fact we monitor only upriver strays. Soapstone Creek, which enters the river from the opposite bank near the hatchery, contains large amounts of spawning and rearing habitat. Spawning ground surveys show hatchery fish are present in Soapstone Creek though we do not have hatchery stray estimates for this creek. Similarly, straying rates into the Nehalem River or Foley Creek are unexamined. It is possible that 99 stock, derived from upriver input, do not stray more than 32 stock coho but stray upriver more where they are observed. A complete picture of hatchery:wild interactions would require monitoring of lower river straying as well.

Fall Chinook Salmon

Adult fall Chinook salmon begin to ascend the NF Nehalem River between late September and early October coinciding with higher river flows. Fall Chinook usually arrived at the lower trap by mid-October and peak catches typically occurred by mid to late November. A few Chinook were usually captured at the lower trap through December. Nehalem Hatchery does not release Chinook salmon, and in most years only a few spring and fall Chinook strays have been observed at the Waterhouse and Fall Cr Falls adult traps. Adult catches at the Waterhouse Falls adult trap ranged from a low of 44 fish in 2007 to a high of 339 fish in 1999 (Table 13). Jacks were caught in

Table 13. The number of female (F), male (M), and jack (J) fall Chinook salmon captured at the NF Nehalem River adult traps and estimated spawning population in the total basin (upstream of the Waterhouse Falls trap) and upper sub-basin (upstream of the Fall Cr Falls trap). Estimates were not made ("na") when few fish were captured in the ladders or recovered on surveys.

Return Year	Trap catch F	Trap catch M	Trap catch J	Estimated Spawners Total Adults ± CI[a]			F	M	J
Lower Trap/Total basin									
1998	90	74	3	633	±	211	325	308	na
1999	194	145	10	484	±	47	265	219	na
2000	10	43	3	138	±	66	28	110	na
2001	61	133	10	644	±	172	220	424	na
2002	70	50	3	876	±	512	461	415	na
2003	88	93	14	1,187	±	475	497	690	na
2004	69	100	15	522	±	146	201	321	na
2005	57	81	3	468	±	142	182	286	na
2006	142	145	1	1,398	±	355	742	656	na
2007	24	20	1	161	±	118	86	75	na
2008	33	32	11	178	±	76	98	80	na
2009	22	49	19	248	±	115	78	170	na
2010	62	61	15	420	±	150	176	244	na
2011	86	85	19	418	±	100	189	229	na
2012	29	68	35	412	±	191	129	283	na
2013	62	197	17	420	±	52	97	323	na
Upper Trap/Upper Sub-basin									
1998	2	11	0	na		na	na	na	na
1999	4	13	0	na		na	na	na	na
2000	0	6	0	na		na	na	na	na
2001	1	11	0	na		na	na	na	na
2002	7	23	0	63	±	38	17	46	na
2003	5	29	2	111	±	114	26	85	na
2004	1	3	0	na		na	na	na	na
2005	0	5	0	na		na	na	na	na
2006	0	5	0	na		na	na	na	na
2007	2	2	0	na		na	na	na	na
2008	1	3	0	na		na	na	na	na
2009	0	5	2	na		na	na	na	na
2010	1	9	1	na		na	na	na	na
2011	1	11	2	na		na	na	na	na
2012	0	1	0	na		na	na	na	na
2013	0	12	0	na		na	na	na	na

[a] For years where adult spawner estimates were made in the upper basin, the calculated lower confidence limit was less than the numbers of fish passed upstream in the trap and not later recovered downstream. Therefore, the number of fish passed is considered a lower limit.

relatively small numbers in all years. Estimated fall Chinook adult spawner numbers in the basin upstream of Waterhouse Falls years were highly variable between 1998 and 2006 (Range: 138-1,398 adults), remained low from 2007 through 2009 (Range: 161-248 adults), and have since plateaued at about 400 adults for the last four years, still

Table 14. The estimated number of sub-yearling (fry and fingerling) fall Chinook salmon migrants and week of peak migration from the NF Nehalem River total basin upstream of Waterhouse Falls. The out-migration year is the first year following egg deposition (e.g., the 1997 brood year was sampled in 1998).

Sample Year	Migrants ± CI			Peak week
1998	962,379	±	277,873	3/16-3/22
1999	364,880	±	111,728	4/05-4/11
2000	399,457	±	54,847	3/27-4/02
2001	96,924	±	29,506	4/09-4/15
2002	468,946	±	223,777	4/01-4/07
2003	419,546	±	86,191	4/14-4/20
2004	1,366,155	±	367,322	4/12-4/18
2005	138,669	±	39,535	4/04-4/10
2006	328,891	±	201,882	4/03-4/09
2007	703,663	±	150,308	4/09-4/15
2008	61,794	±	23,461	5/12-5/18
2009	71,219	±	24,314	4/27-5/03
2010	51,573	±	27,658	3/15-3/21
2011	190,689	±	231,901	3/07-3/13
2012	144,726	±	91,499	4/16-4/22
2013	47,731	±	35,202	4/01-4/07
2014	19,373	±	13,696	4/14-4/20

remaining significantly lower than mean abundance for the project monitoring duration ($\bar{x}$ = 538 adults; Table 13). The highest adult spawner estimate occurred in 2006 with an estimated 1,398 adults spawning upstream of Waterhouse Falls (Table 13, Figure 10a). Interestingly, this high adult return was followed in 2007 by the second lowest spawner return (161 adults) since monitoring began on the NF Nehalem River in 1998.

Low flows appear to influence the upstream migration of fall Chinook in some years, particularly females. Males made up 80% of spawners in the monitored basin during low flows of the 2000 return year. Males also predominated in the lower flow years of 2001 (66%), 2004 (61%), and 2013 (77%). The 2001 and 2013 return years had moderately low flows until mid-November and the 2004 return year had particularly low flows during most of November and early December. However, this pattern was not observed in all years. For instance, males also predominated in the 2005 and 2009 return years which had moderate to high flows throughout the fall trapping period.

Spawning occurs extensively in the lower gradient reaches of the NF Nehalem River lower sub-basin mainstem and tributaries. Relatively few Chinook migrate to the upper sub-basin (Table 13). Catches of adult fall Chinook salmon in the upstream trap ranged from 1 (2012) to 34 (2003), with males predominating. Upper sub-basin adult spawner population estimates could be made for the 2002 and 2003 return years (63 and 111 adults, respectively); however, 95% confidence intervals of these estimates were large. Few fall Chinook jacks were caught at the upper trap and their numbers were relatively low throughout the basin in all years.

Sub-yearling fall Chinook are displaced or move downstream soon after emergence (fry) or hold in freshwater for a few weeks before moving downstream (fingerlings). The majority of sub-yearling fall Chinook migrated downstream past the lower screw trap as fry with peak week of migration generally ranging from late March until late April (Table 14). In 2008, peak migration did not occur until mid-May likely due to abnormally cold water temperatures resulting from a large snow pack and cold spring. Estimated fry and fingerling abundance in the entire basin upstream of Waterhouse Falls was lowest in 2014 (19,373 migrants) and highest in 2004 (1,366,155 migrants). However, high flows and low trap efficiency in 2014 likely resulted in an underestimate of total fry migrants. Total sub-yearling out-migration appears to be related with the number of female spawners (Figure 10b).

Winter Steelhead

The first adult hatchery winter steelhead begin to ascend the NF Nehalem River from mid to late November. Hatchery winter steelhead usually arrived at the lower trap in small numbers in late November and peak catches typically occurred from mid-December through early February. A few hatchery winter steelhead in good body condition were captured at the Waterhouse Falls adult trap as late as May in a few years. These fish were likely stray wild broodstock steelhead released into the Wilson

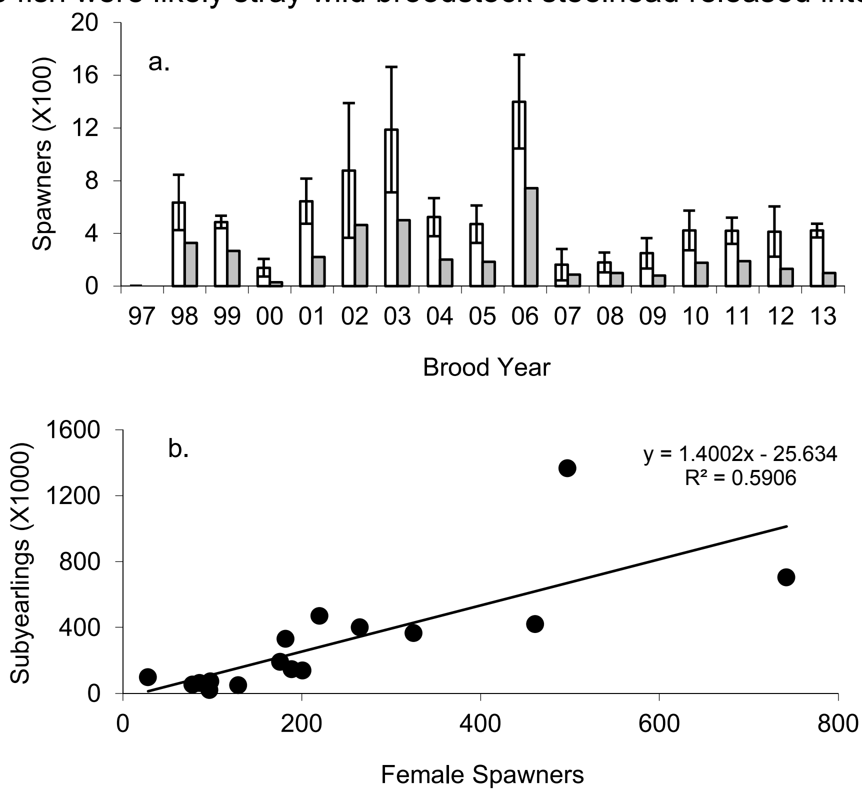

Figure 10. Estimated numbers of (a) total (clear bars) and female (shaded bars) fall Chinook salmon adult spawners, and (b) the relationship of migrant sub-yearling (fry and fingerling) numbers to female spawners in the NF Nehalem River total basin upstream of Waterhouse Falls.

Table 15. The number of wild and hatchery female (F), male (M) and unsexed (UA) adults and jack (J) winter steelhead captured in the NF Nehalem River adult trap at Waterhouse Falls.

	Wild				Hatchery			
Return Year	F	M	UA	J	F	M	UA	J
1999	44	39	0	17	19	25	0	5
2000	160	69	0	1	198	112	0	0
2001	98	91	0	18	114	71	0	15
2002	62	48	0	3	151	80	0	2
2003	45	29	0	2	55	35	1	6
2004	38	23	0	1	139	71	0	0
2005	64	44	0	4	91	58	0	2
2006	37	36	0	3	70	40	0	7
2007	67	41	0	3	162	83	0	8
2008	48	35	0	3	97	56	0	5
2009	53	28	0	6	46	33	0	3
2010	90	68	0	5	181	57	0	1
2011	105	87	0	11	120	52	0	8
2012	131	78	0	2	186	103	0	0
2013	118	80	0	3	122	87	0	0
2014	141	107	0	4	116	69	0	2

and Nestucca River basins (see EF Trask Chapter 3) because Nehalem and Fishhawk stock hatchery steelhead released from Nehalem Hatchery are early returning stocks. Wild winter steelhead generally returned over a long time period, with small numbers of adults typically arriving at the lower trap in late November and peak catches occurring between January and April depending on river levels and water temperature. In some years, small numbers of wild winter steelhead were captured at the adult traps into mid to late May.

Hatchery winter steelhead made up the majority of the catch at Waterhouse Falls in all return years except 1999, 2001, 2009, 2011, and 2014 (Table 15). Catches of hatchery winter steelhead ranged from a low of 44 adults in 1999 to a high of 310 adults in 2000. Overall, estimates of hatchery spawners showed a wider range than wild spawner estimates (Table 16). The two lowest (2001 and 2014; 126 and 86 adults, respectively) and highest (2002; 1,567 adults) estimates of hatchery spawners were in years when hatchery steelhead trapped at Waterhouse Falls were either removed (*i.e.* euthanized or stripped) or recycled. The other annual hatchery steelhead spawner estimates were all much nearer the lower value (Table 16; Range: 166-602 adults).

Trap catches of wild winter steelhead ranged from a low of 61 adults in 2004 to a high of 248 adults in 2014 (Table 15). The lowest estimate of wild steelhead spawners occurred in 2007 (209 adults) and the highest estimate in 2002 (869 adults). Overall, wild steelhead spawner abundance was highly variable between 1999 and 2006, remained low from 2007 through 2009, and then increased again until the last two years (Table 16). Total steelhead spawner estimates ranged from a low of 432 adults (2009)

Table 16. The estimated number of wild and hatchery female (F) and male (M) adult winter steelhead spawners in the NF Nehalem River total basin upstream of Waterhouse Falls. Males include both adult males and jacks.

				Wild					Hatchery[a]				
Return Year	Total Adults	± CI		Total Adults	± CI		F	M	Total Adults	± CI		F	M
1999	922	±	566	648	±	379	268	380	274	±	187	133	141
2000	655	±	128	410	±	55	208	202	245	±	73	99	146
2001	464	±	85	338	±	43	158	180	126	±	42	80	46
2002	2,436	±	1,645	869	±	537	425	444	1,567	±	1,108	894	673
2003	647	±	326	427	±	318	217	210	220	±	70	120	100
2004	667	±	139	228	±	115	136	92	439	±	78	232	207
2005	720	±	155	359	±	126	191	168	361	±	91	184	177
2006	1,024	±	676	422	±	308	207	215	602	±	397	257	345
2007	447	±	95	209	±	50	125	84	238	±	51	104	134
2008	464	±	141	221	±	77	112	109	243	±	74	164	79
2009	432	±	158	266	±	102	157	109	166	±	61	68	98
2010	656	±	133	369	±	82	199	170	287	±	58	141	146
2011	905	±	192	576	±	130	304	272	329	±	70	134	195
2012	1,162	±	252	617	±	141	370	247	545	±	118	297	248
2013	623	±	110	410	±	75	237	173	213	±	38	113	100
2014	456	±	49	370	±	41	210	160	86	±	9	30	56

[a] Male and female ratios were based on the sex ratio of hatchery steelhead trapped at Nehalem Hatchery or hatchery steelhead trapped at Nehalem Hatchery, Waterhouse Falls, and untagged hatchery steelhead recoveries upstream of Waterhouse Falls.

to a high of 2,436 adults (2002), with the other total steelhead estimates considerably closer to the low end of the range (Range: 447-1,024 adults; Table 16).

In all years, it appeared that the majority of returning hatchery steelhead entered the hatchery; the percentage that strayed to Waterhouse Falls was estimated to range from 14% in 2014 to 38% in 2002 (Table 17). Estimated straying rates were somewhat greater and more variable in the first four years of monitoring (20%-38%). Since this time, estimated straying rates have remained consistent, ranging from 17%-23%. The percentage of all hatchery steelhead strays trapped at Waterhouse Falls has been quite variable, ranging from 13% (2002) to 69% (2014). During years when hatchery steelhead were recycled or removed at the trap, the estimated proportion of hatchery strays among all spawners upstream of Waterhouse Falls ranged from 19%-64%. During years when they were passed, the estimated proportion ranged from 34%-66%. It is also possible that significant numbers of hatchery steelhead strayed into Soapstone Creek, as noted above for coho.

The estimated number of steelhead smolt migrants ranged from a low of 3,623 migrants in 2011 to a high of 7,876 migrants in 2000 (Table 18). Peak week of migration normally occurred during late April or early May (Appendix 2). Size at peak migration ranged from 157 mm to 183 mm which is slightly larger than naturally-produced steelhead smolts at most other LCM sites. Pre-smolt data is given in Appendix 2.

Table 17. The estimated numbers of returning hatchery winter steelhead (adults and jacks) that entered the hatchery, percent that were strays (not entering hatchery), and percent of strays among all adult spawners upstream of Waterhouse Falls.

	Returning Hatchery Adults				Stray Hatchery Adults		
			Strays				
Return Year	Total Adults	Entered Hatchery	Trapped W. H Falls	Jumped W. H. Falls	% of all Hatchery Adults	% of strays Trapped W. H Falls	% strays among all spawners
1999[a]	1,595	1,272	49	274	20.3	15.2	29.7
2000[a]	1,719	1,164	310	245	32.3	55.9	37.4
2001[a]	999	673	200	126	32.6	61.3	27.2
2002[a]	4,712	2,912	233	1,567	38.2	12.9	64.3
2003[b]	1,261	1,041	96	124	17.4	43.6	34.0
2004[b]	2,332	1,893	210	229	18.8	47.8	65.8
2005[b]	1,868	1,507	151	210	19.3	41.8	50.1
2006[ab]	3,009	2,407	117	485	20.0	19.4	58.8
2007[c]	2,524	2,048	253	223	18.9	53.2	53.2
2008[c]	1,799	1,393	158	248	22.6	38.9	52.4
2009[c]	1,405	1,154	82	169	17.9	32.7	38.4
2010[c]	2,955	2,414	239	302	18.3	44.2	43.8
2011[c]	2,539	2,028	180	331	20.1	35.2	36.4
2012[c]	4,802	3,957	289	556	17.6	34.2	46.9
2013[c]	2,855	2,429	209	217	14.9	49.1	34.2
2014[c]	2,019	1,746	187	86	13.5	68.5	18.9

[a] Strays were returned to hatchery or released near confluence with mainstem Nehalem River.
[b] Strays were passed.
[c] Non-ripe strays were released near the confluence with the Nehalem River, ripe females were stripped and passed upstream, and ripe males were released in nearby lakes or killed.

The estimated number of steelhead smolt migrants ranged from a low of 3,623 migrants in 2011 to a high of 7,876 migrants in 2000 (Table 18). Peak week of migration normally occurred during late April or early May (Appendix 2). Size at peak migration ranged from 157 mm to 183 mm which is slightly larger than naturally-produced steelhead smolts at most other LCM sites. Pre-smolt data is given in Appendix 2.

Cutthroat Trout

Cutthroat trout adults (≥ 250 mm) caught in the Waterhouse Falls adult trap were not tagged and no effort was made to estimate the numbers migrating upstream. In Table 19 we present catch of cutthroat trout adults in the Waterhouse Falls adult trap and out-migrant screw trap. The majority of adult cutthroat trout were caught in the adult trap during fall associated with freshets causing a rise in river levels, but catch varied widely among years. Peak catches of adult cutthroat trout typically occurred in October and November, with a few fish caught as late as the following March or April in some years. Cutthroat catch in the adult trap ranged from a low of one adult in return years 2001 through 2003 to a high of 90 adults in 2012 ($\bar{x}$ = 33 adults). Spring catches in the out-migrant trap ($\bar{x}$ = 13 adults) varied widely by month, and included resident

Table 18. The estimated number of trout migrating past the NF Nehalem River juvenile trap at Waterhouse Falls. The number of actual fish caught is reported (in parentheses) when trap efficiency could not be determined for a particular size class. For cutthroat trout, only the two largest size classes are shown. Additional out-migrant data are provided in the appendices.

Sample Year	Steelhead smolts ± CI ≥ 120 mm	Cutthroat migrants ± CI 160-249 mm	Cutthroat migrants ± CI 120-159 mm
1998	6,080 ± 1,103	(75)	1,787 ± 1,113
1999	4,216 ± 949	897 ± 384	2,044 ± 376
2000	7,876 ± 925	2,344 ± 1,084	3,118 ± 615
2001	7,764 ± 745	777 ± 290	3,375 ± 549
2002	3,635 ± 733	1,436 ± 819	2,831 ± 606
2003	4,673 ± 1,376	(96)	2,098 ± 1,362
2004	6,772 ± 1,670	(102)	2,541 ± 1,337
2005	4,765 ± 1,184	374 ± 269	1,609 ± 617
2006	4,723 ± 1,223	3,412 ± 2,054	4,221 ± 1,307
2007	4,076 ± 862	1,000 ± 529	3,385 ± 880
2008	3,632 ± 1,019	367 ± 253	2,954 ± 715
2009	6,979 ± 2,372	756 ± 376	6,144 ± 1,691
2010	4,459 ± 1,435	(74)	2,996 ± 1,105
2011	3,623 ± 1,333	(96)	2,607 ± 766
2012	4,555 ± 1,431	(77)	3,523 ± 976
2013	4,576 ± 1,339	(52)	3,111 ± 962
2014	4,745 ± 1,458	(34)	4,754 ± 1,872

fluvial fish, some of which may have been caught multiple times. Peak catch occurred from as early as March to as late as June in different years; with the greatest catch typically occurring in March and April.

Estimated numbers of the two larger size classes of juvenile cutthroat trout migrants are summarized in Table 18 and data on smaller size classes are found in Appendix 3. Cutthroat 120-159 mm were the most abundant size class captured in the juvenile trap, followed by those in the 160-249 mm and then the 90-119 mm size classes. An abundance estimate for the smallest size class (60-89 mm) was only possible in one year, 2001.

Table 19. The number of adult cutthroat trout (≥ 250 mm) captured in the NF Nehalem River adult and out-migrant screw traps at Waterhouse Falls. Fish were caught October-June in the adult trap and February-July in the screw trap.

Return Year	Adult Ladder Trap[a]	Out-Migrant Screw Trap
1998	na	10
1999	25	18
2000	17	26
2001	1	45
2002	1	35
2003	1	3
2004	82	11
2005	31	13
2006	8	6
2007	21	7
2008	12	6
2009	24	9
2010	44	7
2011	48	6
2012	90	6
2013	80	6
2014	43	0

[a] Adult trap catch does not include all adult migrants entering the trap because the spacing of trap bars is wide enough for some adults to escape upstream.

Chapter 3: EF Trask River (Trask River)

The East Fork (EF) Trask River is a 3rd order tributary of the South Fork of the Trask River. Adult fish are trapped one km upstream of the confluence with the South Fork Trask River at a ladder on a water supply dam which is a complete barrier to upstream migration. Out-migrant fish are trapped with a rotary screw trap 300 m upstream from the mouth. Spawning surveys during the adult trapping season are used to estimate spawning fish between the adult and screw traps. There are 46.0 km of stream accessible to anadromous salmonids (Figure 11), nearly all under Oregon Department of Forestry ownership. Monitoring began in 2004.

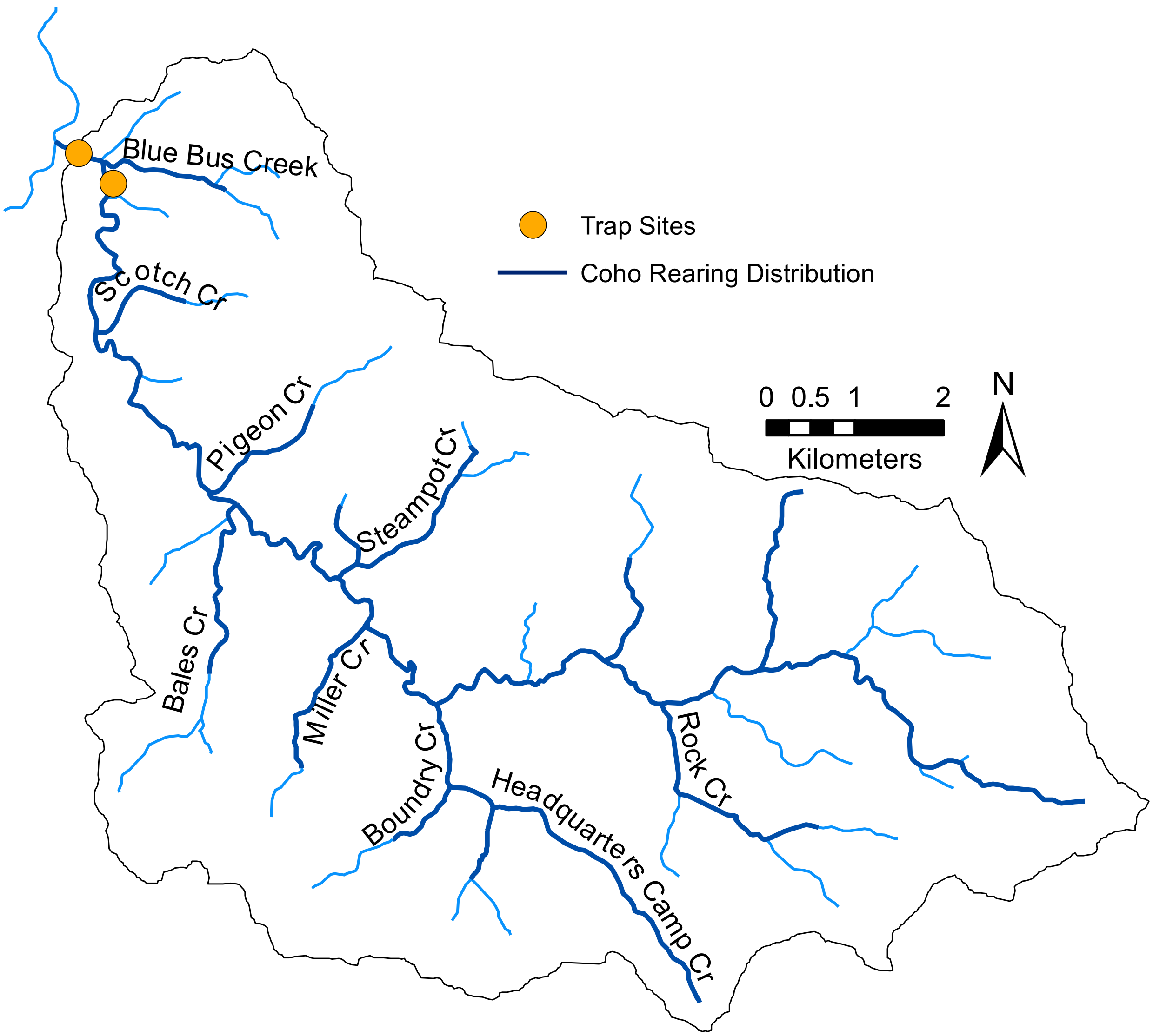

Figure 11. The East Fork Trask River showing the adult and out-migrant trap sites and the extent of coho rearing distribution.

Table 20. The number of wild adult female (F) male (M), and jack (J) coho salmon captured at the EF Trask River adult trap and passed upriver, wild adult AUC estimate derived from spawning surveys, and the total estimated spawning population upriver of the rotary screw trap. The 95% CIs are based on the variance calculated from the variation in AUC adult estimates from the individual spawning surveys.

Return	Adult Trap Catch			AUC	Estimated Spawners					
Year	F	M	J	Adults	Total Adults	±	CI	F	M	J
2004	138	143	8	29	310	±	10	152	158	10
2005	161	162	13	40	363	±	13	181	182	17
2006	188	192	11	35	415	±	20	205	210	15
2007	62	57	14	17	136	±	10	71	65	14
2008	246	236	22	69	551	±	35	281	270	33
2009	222	289	22	53	564	±	20	245	319	22
2010	270	301	69	71	642	±	34	304	338	86
2011	456	528	13	244	1,228	±	72	572	656	20
2012	180	161	18	30	371	±	15	196	175	18
2013	129	142	45	11	282	±	4	134	148	47

Coho Salmon

The number of adult and jack coho salmon captured in the EF Trask River adult trap, adult AUC estimates derived from spawning surveys, and total estimated number of adult and jack coho salmon spawning in the EF Trask River basin upstream of the rotary screw trap are shown in Table 20. The estimated number of adults that spawned in the EF Trask River downstream of the dam and upstream of the screw trap ranged from a low of 11 adults in 2013 to a high of 244 adults in 2011. Overall, AUC estimates derived from spawning surveys represented a small percentage of the total estimated spawners in the basin (Range: 4%-20%). This is not surprising considering AUC surveys only encompass approximately 5% of all coho habitat in the basin. Spawning surveys were conducted outside of the ten-day rotation during several weeks in November of 2006 and December of 2007 due to high flooding flows. As a result, AUC estimates may have misestimated the number of spawners in these two years due to the prevalence of high, turbid flows and the inability to survey for extended periods of time. However, since 2008, staff has been able to conduct AUC surveys within rotation throughout the fall trapping season.

AUC adult estimates were allocated to males and females by the sex ratio of adults captured in the adult trap and from carcasses found during spawning surveys. These numbers were then added to the number of males and females trapped and passed upstream of the dam to yield a total adult spawner estimate upstream of the screw trap. Variance was calculated based on variation among the AUC spawner estimates for the individual surveys. This estimate increased from 310 to 415 adults between 2004 and 2006, decreased to 136 adults in 2007, and then increased substantially from 551 to 1,228 adults between 2008 and 2011 before decreasing over the last two years (Table 20). Jack estimates remained fairly consistent between 2004 and 2013 (Range: 10-47 fish), except for the high count in 2010 (86 fish, Table 20). The high jack estimate in 2010 corresponded to extremely high marine survival for the 2007 brood and also indicated the high survival for the 2008 brood as well. The abnormally high marine survival for the 2007 brood is consistent with very high wild coho abundance reported from other North Coast LCM sites (e.g. NF Nehalem River, NF Scappoose Creek) and is likely at least partially attributable to good juvenile out-migrating conditions and high ocean productivity. However, it is likely that the point estimate for marine survival for this brood, 35%, was also inflated to some extent due to the inability to operate the screw trap for four days during peak smolt migration in 2009 and the removal of the smolt trap before out-migration was finished. It is possible a large number of coho smolts migrated past the screw trap during the non-fishing days and predicted catch did not accurately reflect this number, or that a portion of the run migrated after the trap was removed. This would have inflated marine survival to the abnormally high number we observed for the 2007 brood.

In 2004, 2010, and 2012, the majority of coho were captured in October (87%, 62%, and 57%, respectively). However, in all other return years the majority of coho were captured in November (Range: 49%-95%). This is likely in part due to the higher river flows occurring in September and October of these years compared to rivers flows experienced during this same time period in all other years.

Few hatchery coho were captured at the adult trap (Table 21) and none were observed on spawning surveys. Hatchery coho captured at the adult trap were killed, interrogated for the presence of a coded-wire tag (CWT, prior to the 2010 return year only), and then placed in the SF Trask River immediately upstream of the mouth of the EF Trask River or in the EF Trask River at the adult trap for stream enrichment. The source of the few hatchery strays captured at the adult trap is likely from Trask Hatchery, located approximately 17 rkm downstream. However, no CWTs were found to confirm the source of these hatchery strays.

Table 21. Number of coho salmon smolts released from Trask Hatchery, total returning hatchery coho adults entering hatchery, number of hatchery coho strays trapped at the EF Trask River adult trap, and percentage of hatchery coho strays among all coho adults trapped at the EF Trask River adult trap.

		Returning Hatchery Adults		
Return Year	Smolts Released	Entered Hatchery	Strays Trapped @ EF Trask Trap	% Strays Among All Coho Trapped @ EF Trask Trap
2004	97,355	2,067	1	0.3
2005	100,382	1,547	1	0.3
2006	102,669	1,519	3	0.8
2007	93,582	159	0	0.0
2008	102,656	3,453	5	1.0
2009	102,939	3,940	2	0.4
2010	99,263	4,443	2	0.3
2011	93,793	2,211	0	0.0
2012	96,582	453	5	1.4
2013	99,472	2,277	4	1.3

Estimates of female spawners, egg deposition, fry, smolts, wild adults, and freshwater and marine survival rates are provided for each brood in Table 22 and Figure 12. These data show an increase in marine survival from brood years 2003 through 2007 (Range: 6.4%-35.2%), corresponding to a general increase in spawner abundance. Both marine survival and spawner abundance remained high for the 2008 brood before decreasing over the last two years. Freshwater survival rates remained consistently low, ranging from 0.4%-1.2%.

Annual smolt estimates varied from a low of 1,725 smolts for the 2007 brood to a high of 6,441 smolts for the 2003 brood (Tables 22 and 23, Figure 12c). Fry numbers varied widely, but dropped significantly in 2008 to a low of 4,649 individuals (Table 22). This low number in 2008 reflects the substantial decrease in adult spawners the previous fall, and may have been exacerbated by the abnormally cold spring occurring throughout the juvenile trapping period that likely reduced and delayed downstream fry movement. Overall, freshwater survival rates and the number of smolts produced per female (9-30 smolts/female) were typically lower than those documented at other LCM trapping sites (Table 22, Figures 12d and 13). The number of coho smolt out-migrants had a positive relationship with spawner abundance although this relationship was not significant (Figure 13). Additional juvenile coho data can be found in Appendix 1.

Table 22. The estimated number of female spawners, egg deposition, fry, smolts, wild spawning adults, and freshwater and marine survival rates of coho salmon in the EF Trask River.

Brood	Female Spawners		Egg			Returning Adults (wild)		Percent Survival	
Year	Wild	Hatchery [a]	Deposition	Fry	Smolts	F	M	FW	Marine
2001						152	158		
2002						181	182		
2003					6,441	205	210		6.4%
2004	152	1	464,007	41,134	2,006	71	65	0.4%	7.1%
2005	181	0	501,673	34,405	3,375	281	270	0.7%	16.7%
2006	205	1	623,732	122,015	2,769	245	319	0.4%	17.7%
2007	71	0	199,132	4,649	1,725	304	338	0.9%	35.2%
2008	281	0	890,643	87,207	4,508	572	656	0.5%	25.4%
2009	245	0	651,617	53,273	4,407	196	175	0.7%	8.9%
2010	304	0	952,420	54,642	4,077	134	148	0.4%	6.6%
2011	572	0	1,709,621	107,480	5,156			0.3%	
2012	196	1	491,785	26,567	5,940			1.2%	
2013	134	0	379,739	13,725					

[a] Hatchery coho were killed and did not contribute to egg deposition.

Table 23. The estimated number of juvenile salmonids migrating past the EF Trask River juvenile trap. The number of actual fish caught is reported (in parentheses) when trap efficiency could not be determined for a particular size class. For cutthroat trout, only the two largest size classes are shown. Additional out-migrant data are provided in the appendices.

Sample Year	Coho smolts ± CI			Steelhead smolts ± CI ≥ 120 mm			Cutthroat migrants ± CI 160-249 mm			Cutthroat migrants ± CI 120-159 mm		
2005	6,441	±	1,143	2,308	±	921	568	±	255	3,755	±	808
2006	2,006	±	237	2,504	±	727	1,289	±	692	3,646	±	719
2007	3,375	±	414	8,020	±	4,089	(104)			4,517	±	1,419
2008	2,769	±	302	3,148	±	1,499	(32)			2,148	±	878
2009	1,725	±	253	5,874	±	4,006	(115)			6,247	±	1,725
2010	4,508	±	476	9,404	±	2,989	1,133	±	682	6,270	±	2,448
2011	4,407	±	406	4,847	±	1,278	(106)			4,186	±	1,543
2012	4,077	±	466	2,484	±	623	610	±	231	3,799	±	733
2013	5,156	±	480	11,699	±	4,522	2,196	±	1,049	4,166	±	780
2014	5,940	±	521	4,488	±	1,507	621	±	355	3,711	±	1,141

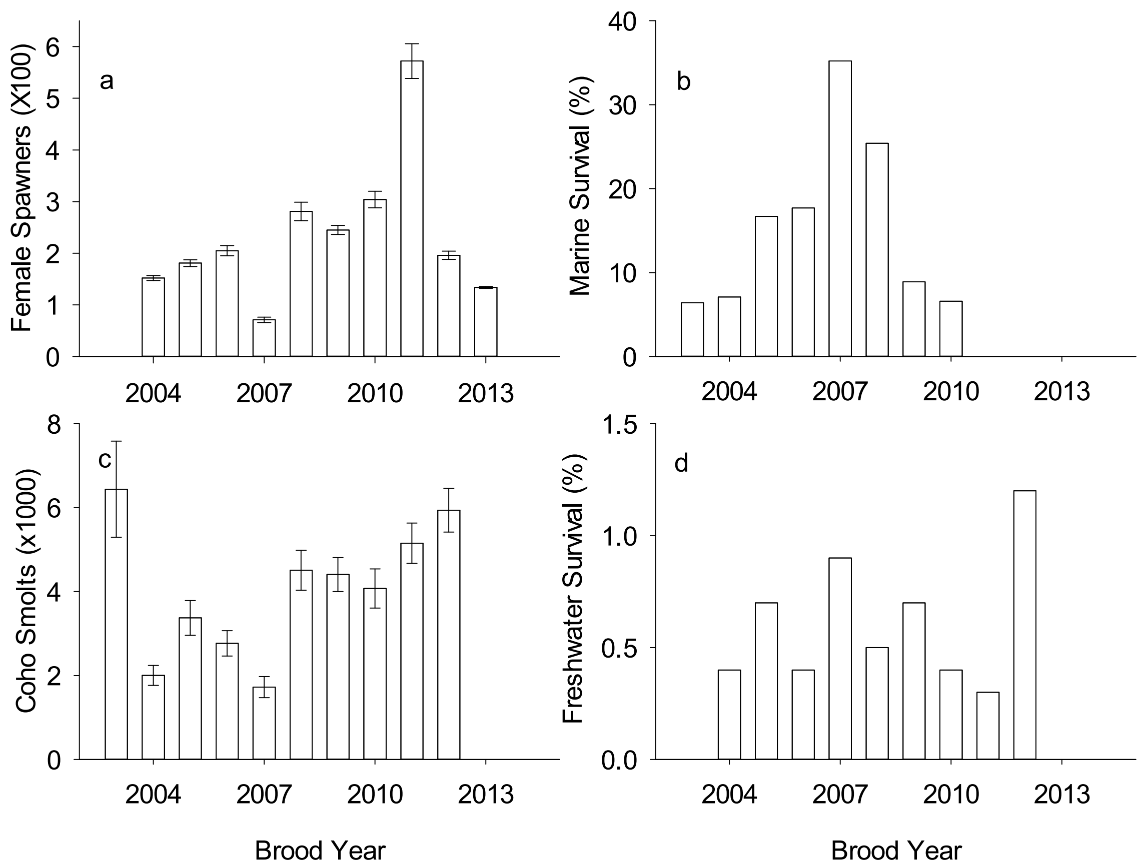

Figure 12. Annual trends in the (a) parental female spawner estimate, (b) percent marine survival, (c) smolt production estimate, and (d) percent freshwater survival for coho salmon in the EF Trask River.

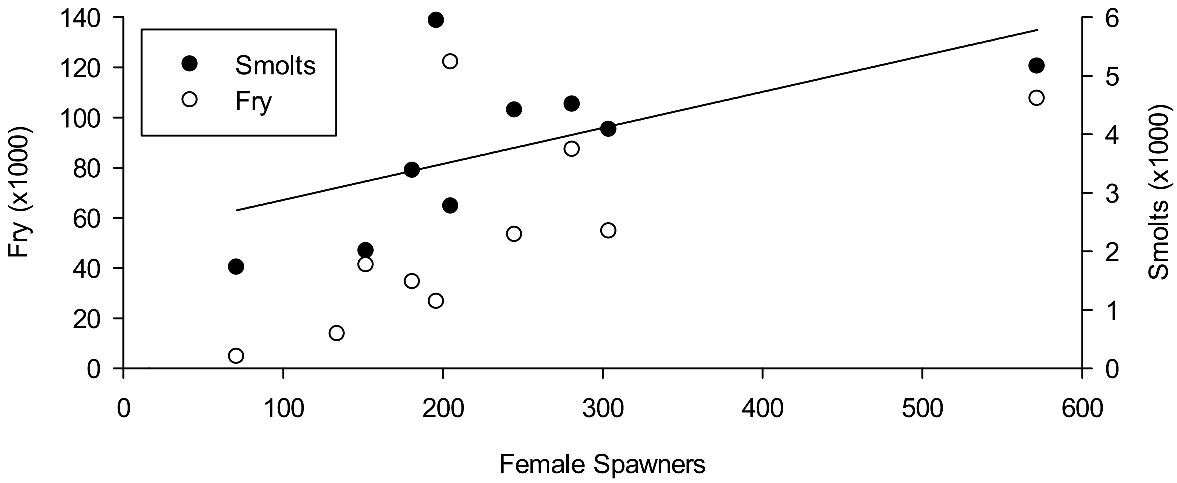

Figure 13. The relationship between coho smolt (solid symbols) and fry (clear symbols) migrants and female spawners in the EF Trask River. The solid line is the regression line between smolts and female spawners (R^2=0.37, P=0.08).

Fall Chinook Salmon

The number of adult and jack fall Chinook salmon captured in the EF Trask River adult trap, adult Chinook AUC estimates derived from spawning surveys, and total estimated number of adult and jack Chinook salmon spawning in the EF Trask River basin upstream of the rotary screw trap are shown in Table 24. The estimated number of adults that spawned in the EF Trask River downstream of the dam and upstream of the screw trap ranged from a low of 5 adults in 2007 to a high of 192 adults in 2006. In the 2006 and 2007 return years, high flows in November and December resulted in large gaps between spawning surveys due to the inability of surveyors to cross the EF Trask River to reach tributary surveys on the opposite bank and turbid water conditions in the main stem. In 2006, a significant number of fall Chinook carcasses were observed in Blue Bus Creek, a small tributary located approximately 300 m downstream of the adult ladder, after high flows receded and surveys could be continued. Fall Chinook found as carcasses in this stream during the initial surveys after the extended high water event in 2006 were sexed and added to the AUC estimate since these fish were not observed live to include in the AUC estimate calculation (see comments in Table 24). No adjustment was made in 2007 because few fall Chinook were observed on spawning surveys, or in any other year, because staff was not constrained by river flows and was able to survey within rotation throughout the fall.

Overall, AUC estimates derived from spawning surveys represented a significant percentage of the total estimated spawners in the basin (Range: 38%-76%). As stated above, in 2006 an exceptionally high number of live Chinook and post-spawn carcasses were observed in a short section of Blue Bus Creek. Chinook were observed in an approximately 200 m section of this tributary from its confluence with the EF Trask River upstream to a wood jam that, in addition to the small stream size, likely functioned as a barrier to further Chinook upstream migration. The disproportional amount of Chinook

Table 24. The number of female (F), male (M), and jack (J) fall Chinook salmon captured at the EF Trask River adult trap, wild adult AUC estimate derived from spawning surveys, and total estimated spawning population upriver of the rotary screw trap. The 95% CI's are based on the variance calculated from the variation in AUC adult estimates from the individual spawning surveys.

Return	Adult Trap Catch			AUC	Estimated Spawners					
Year	F	M	J	Adults	Total Adults ± CI			F	M	J
2004	4	4	0	25	33	±	9	23	10	2
2005	34	35	2	50	119	±	30	59	60	2
2006	40	99	3	192[a]	331	±	137	126	205	6
2007	4	4	0	5	13	±	5	7	6	0
2008	2	7	0	18	27	±	18	13	14	0
2009	5	24	1	29	58	±	20	17	41	3
2010	7	21	0	41	69	±	30	20	49	0
2011	3	3	0	114	120	±	88	90	30	0
2012	10	29	6	49	88	±	31	23	65	8
2013	13	53	1	57	123	±	38	32	91	1

[a] AUC estimate includes 44 Chinook found as carcasses and not observed live to include in AUC calculation. These carcasses were added to the final AUC estimate for this year.

spawning observed downstream of the EF Trask River dam in most years, in comparison to the total amount of anadromous habitat in the entire basin, seems to be at least partially attributable to passage difficulties at the dam. These problems may be exacerbated when low water conditions are prevalent in the fall, which apparently inhibits fall Chinook upstream migration at other LCM trapping sites (e.g. NF Nehalem River). Currently there is discussion to remove the dam entirely or upgrade the ladder to improve passage for both upstream and downstream migrating fish in the basin.

AUC adult estimates were allocated to males and females using the same method used for coho salmon to calculate an adult spawner estimate upstream of the screw trap. This spawner estimate increased from 33 to 331 adults between 2004 and 2006, but decreased substantially to 13 adults in 2007 (Table 24). The low return of fall Chinook in 2007 was consistent with low returns observed in many other coastal rivers. Since 2007, fall Chinook spawner abundance has shown a modest increase from 27 adults in 2008 to 123 adults in 2013, with males predominating in most years (Table 24).

The majority of fall Chinook were captured at the adult trap during November (82%). However, in some years a few Chinook were also captured in October. No hatchery Chinook were captured prior to the 2010 return year, however hatchery Chinook were captured at the trap in 2010, 2012, and 2013 (3, 8, and 2 fish, respectively). Although none of these fish had a CWT to confirm the source of these strays, it is probable that the origin of these fish were from Trask Hatchery, approximately 17 river km downstream.

Prior to 2007, only approximately 20% of fall Chinook released from Trask Hatchery were adipose-clipped (Chris Knutsen, personal communication), so the proportion of un-marked hatchery Chinook that may have been passed at the adult trap or observed on spawning surveys as wild prior to 2010 is unknown. In 2009, two un-marked fall Chinook that were tagged at the EF Trask adult trap were later recaptured downstream at Trask Hatchery. These fish were released back into the Trask River mainstem and it is unknown if either or both were actually of hatchery origin. Beginning in 2007 all hatchery fall Chinook released from Trask Hatchery were adipose-clipped, so we are now able to determine the true origin of fall Chinook captured at the EF Trask adult trap.

The number of fall Chinook juveniles estimated to have migrated downstream past the screw trap varied widely from a low of 7,293 out-migrants in 2008 to a high of 325,791 out-migrants in 2007 (Table 25). Both of these years followed the lowest and highest adult return years, respectively. The majority of fall Chinook out-migrated from the EF Trask River as fry in April or early May (Table 25). Significantly more Chinook fry were produced at higher female densities (Figure 14).

Table 25. The estimated number of sub-yearling (fry and fingerling) fall Chinook salmon migrants and week of peak out-migration in the EF Trask River. The out-migration year is the first year following egg deposition (e.g., the 1997 brood year was sampled in 1998).

Sample Year	Migrants ± 95% CI			Peak week
2005	136,458	±	143,403	5/02-5/08
2006	149,661	±	44,257	4/10-4/16
2007	325,791	±	64,382	4/09-4/15
2008	7,293	±	2,056	5/05-5/11
2009	27,896	±	4,728	4/20-4/26
2010	50,414	±	15,272	4/19-4/25
2011	25,020	±	8,312	4/18-4/24
2012	71,947	±	16,056	5/07-5/13
2013	47,670	±	25,835	4/01-4/07
2014	54,120	±	40,400	4/14-4/20

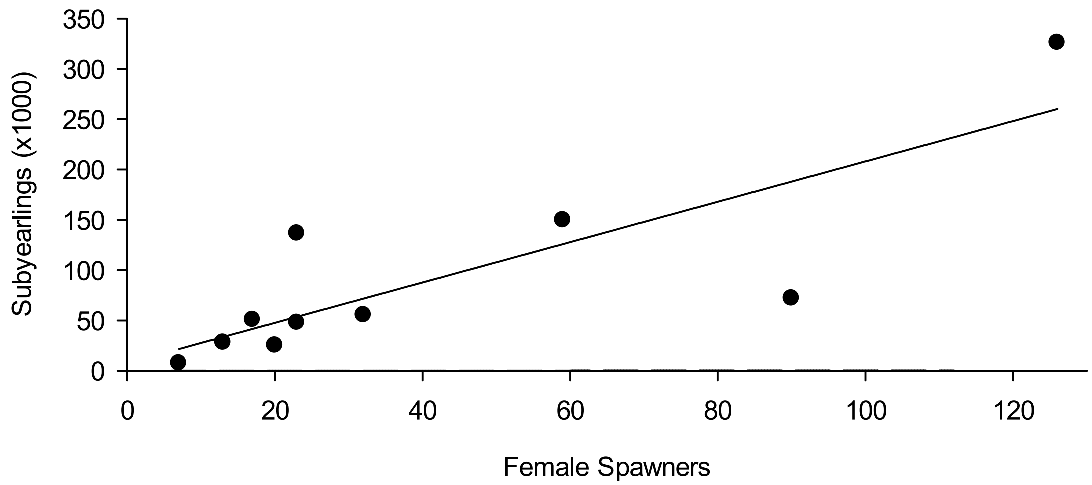

Figure 14. The relationship between migrant sub-yearling (fry and fingerling) and female Chinook spawner estimates in the EF Trask River. The solid line is the regression line through all points. (R^2=0.69, P=0.004).

Winter Steelhead

Both hatchery and wild summer and winter steelhead were captured at the EF Trask River adult trap. The source of hatchery steelhead captured at the adult trap is likely from nearby rivers (*i.e.* Wilson, Kilchis, and Nestucca Rivers) because no hatchery steelhead are released directly into the Trask River basin. Hatchery steelhead captured at the trap were composed of four different stocks, each marked with unique fin clips for identification. The source of hatchery summer steelhead captured at the trap was from Cedar Creek stock 47 summer steelhead (marked with an adipose and right maxillary clip). The original source of this stock is from Siletz River stock 33 summer steelhead, one of only three naturally-produced summer steelhead populations on the Oregon Coast (Rogue and Umpqua Rivers make up the other two populations; ODFW, 2008a). Hatchery summer steelhead adults are collected at Cedar Creek Hatchery, located on Three Rivers in the Nestucca River Basin, reared at Cedar Creek Hatchery, and then released into the Wilson and Nestucca River basins as smolts during spring (ODFW, 2008a).

The origin of hatchery winter steelhead captured at the EF Trask River adult trap was from Cedar Creek stock 47 and 47W and Wilson River stock 121W winter steelhead. Cedar Creek stock 47 hatchery winter steelhead (marked with an adipose and left maxillary clip) are currently collected at Cedar Creek Hatchery, reared at Tuffy Creek Rearing Pond on the South Fork Wilson River and Cedar Creek Hatchery, and released during spring into the Kilchis, Wilson, and Nestucca Rivers (ODFW, 2008b). Wild steelhead adults for the Cedar Creek stock 47W (marked with an adipose fin clip; W denotes wild broodstock) and Wilson River stock 121W (marked with an adipose fin clip; W denotes wild broodstock) hatchery programs are collected with hook and line by volunteer anglers fishing the Wilson and Nestucca Rivers. Cedar Creek stock 47W fish

Table 26. The number of wild and hatchery winter and summer steelhead captured at the EF Trask River adult trap and percentage of hatchery steelhead captured at the trap. In the 2005 and 2006 return years, Cedar Creek and Wild Broodstock hatchery winter steelhead were not differentiated. Un-marked summer steelhead include fish trapped during fall or thought to be summer steelhead based on visual identification.

	Winter Steelhead				Summer Steelhead		Total		
		Hatchery			Hatchery				
Return Year	Wild	Cedar Creek	Wild Brood	Total	Cedar Creek	Un-Marked	Hatchery	Steelhead	% Hatchery
2005	356	29[a]		385	25	6	54	416	13.0
2006	207	44[a]		251	29	10	73	290	25.2
2007	174	34	4	212	147	1	185	360	51.4
2008	175	9	8	192	27	7	44	226	19.5
2009	321	5	4	330	33	25	42	388	10.8
2010	358	17	23	398	21	10	61	429	14.2
2011	283	15	7	305	21	17	43	343	12.5
2012	447	9	6	462	8	7	23	477	4.8
2013	190	12	4	206	32	9	48	247	19.4
2014	218	9	27	254	14	5	50	273	18.3

[a] Cedar Creek and Wilson River stock hatchery winter steelhead were not differentiated.

are reared at Cedar Creek hatchery and then released as smolts into the Nestucca River basin during spring (ODFW, 2008b). Wilson River stock 121W fish are reared at Trask Hatchery and then released as smolts into the Wilson River basin during spring (ODFW, 2008c).

Nearly all hatchery summer steelhead were captured at the EF Trask River adult trap between September and December (98%; four fish were caught in January and one in February, March, and May) and, in most years, hatchery summer steelhead composed a fairly small percentage of the total steelhead catch at the trap (Table 26). However, in 2007, 147 hatchery summer steelhead were captured composing 41% of the total steelhead catch for that return year. In all other years, hatchery summer steelhead catch ranged from 2%-13% of the total steelhead catch. In all return years, a variable number of un-marked steelhead were also captured during fall (Range: 1-25 fish; Table 26). It is unlikely that these fish were early returning wild winter steelhead because wild winter steelhead are not generally known to return this early to their natal rivers to spawn. These steelhead were more likely progeny from naturally-spawning hatchery summer steelhead or fish that were accidentally not clipped prior to release.

In the 2005 and 2006 return years, Cedar Creek and wild broodstock hatchery winter steelhead were not differentiated by project staff. These stocks were differentiated in all other return years and data suggest that the majority of the hatchery winter steelhead catch at the EF Trask River adult trap in most years is of Cedar Creek stock origin (Table 26). Consistent with the differential run-timing of the two stocks, nearly all Cedar Creek stock hatchery winter steelhead were captured over a fairly narrow time period between the first week of December and last week of January (91%; two fish captured in November and all others in February or early March). Although the timing of some wild broodstock fish overlapped the predominant run-timing of Cedar Creek stock hatchery winter steelhead (*i.e.* captured in December and January), the majority of these fish (78%) were captured between February and early May. Overall, hatchery winter steelhead composed a fairly small percentage of the total steelhead catch at the trap (Range: 2%-15%).

All summer steelhead and all but four winter steelhead were passed upstream of the trap in the 2005 return year. However, no hatchery steelhead have been passed upstream of the trap since this time. The majority of hatchery steelhead captured between 2006 and 2008 were transported to two nearby waters (Tahoe Lake and Loren's Pond) to increase angling opportunities. Additionally, some non-ripe hatchery winter steelhead were also recycled to Sollie Smith on the lower Wilson River. However, due to the relatively small number of hatchery steelhead caught at the trap in most years and the difficulty of trying to recycle hatchery steelhead and accomplish other project objectives, no hatchery steelhead have been recycled since 2008. Currently, all hatchery steelhead are killed at the trap, snouts are removed, and carcasses placed in the EF Trask River for stream enrichment.

Few winter steelhead were observed on spawning surveys and because AUC estimates based on live fish counts are not considered appropriate for steelhead (Korman et al. 2002) the actual trap catch is considered to be the number of spawners upstream of the screw trap. Consequently, this number may slightly underestimate the actual number of wild spawners in the basin. The number of wild winter steelhead that spawned upstream of the screw trap ranged from a low of 174 fish in 2007 to a high of 447 fish in 2012 ($\overline{x}$ = 273 fish; Table 26). The majority of wild winter steelhead were captured at the trap between February and May (77%). However, wild winter steelhead were caught as early as late October in one year and as late as the second week in June in another year. The sex ratio of wild winter steelhead was typically biased to females, ranging from 0.83 to 1.40 females per male (jacks included as males; Table 27). Overall, wild winter steelhead catch at the EF Trask trap exhibited a declining trend between 2005 and 2008, reached a project high of 447 fish by 2012, and then catch dropped well below the project average over the last two years.

A total of 142 repeat spawning wild steelhead were captured at the trap since tagging began in the 2005 return year. However, up until the 2007 return year only a small percentage of returning wild steelhead would have been tagged, so few recaptures were made. Beginning in 2007, all wild steelhead were tagged to collect more information on frequency, sex ratio, and growth of repeat spawning steelhead, and significant recaptures have been made since this time. The majority of repeat spawning steelhead were female (79%) and average growth for both males and females between their first and second spawning year was approximately 65 mm (Table 28). Steelhead returning as jacks for their first spawning run grew significantly more than adults between their first and second spawning year, with an average growth of 146 mm

Table 27. The sex distribution of wild winter steelhead captured at the EF Trask River adult trap. Jacks were included as males in determining sex ratio.

Return Year	Wild Winter Steelhead					
	Females	Males	Unknowns	Jacks	Total	F:M
2005	198	150	0	8	356	1.25
2006	118	85	0	4	207	1.33
2007	97	75	0	2	174	1.26
2008	99	64	0	12	175	1.30
2009	155	157	0	9	321	0.93
2010	209	145	0	4	358	1.40
2011	153	122	0	8	283	1.18
2012	221	225	0	1	447	0.98
2013	105	80	0	5	190	1.24
2014	99	118	0	1	218	0.83

Table 28. The sex ratio, growth, and seasonal timing between recapture dates for repeat spawning steelhead captured at the EF Trask adult trap.

	Sex Ratio		Growth[a]	Timing[a]			
Sex	N	%	Average Growth (mm)		Timing (Days)	N	%
Female	112	78.9	64.4	All Sexes	1 Day	9	6.8
Male	26	18.3	66.1		≤15 Days	70	52.6
Jack	4	2.8	146.3		≤ 30 Days	111	83.5

[a] Only includes growth and timing between the first and second spawning year.

(Table 28). The majority of repeat spawning steelhead (84%) returned within 30 days of their previous recapture date and a few (7%) returned within one day of their previous capture date (Table 28). The largest disparities between recapture dates before and after the original capture were 65 and 54 days, respectively.

The estimated number of steelhead smolts migrating downstream past the EF Trask screw trap varied significantly (Range: 2,308-11,699 smolts; Table 23), however in many years it was difficult to make an accurate estimate due to low trap efficiency. Steelhead smolt peak migration generally occurred in late April, although in 2006 and again in 2011 peak migration did not occur until early to mid-May. Size at peak migration ranged from 166 mm to 188 mm, which is slightly larger than naturally-produced steelhead smolts at other monitoring sites. Steelhead smolt and pre-smolt data are presented in Appendix 2.

Cutthroat

The EF Trask River adult trap was more efficient at catching cutthroat trout adults (≥ 250 mm) in comparison to other LCM sites. At most other monitoring sites, the spacing of trap bars is wide enough to allow cutthroat trout adults to move through the trap. The EF Trask River adult trap appears to catch a higher percentage of cutthroat entering the trap, although it is unknown if trap catch constitutes the total number of cutthroat that actually passed upstream. Prior to 2010, no tags or external marks were applied to cutthroat to determine how many individuals subsequently fell back over the dam and re-entered the trap (fallbacks). Beginning in 2010, all cutthroat were operculum punched prior to being passed upstream to evaluate fallback percentage. The number of fallback cutthroat handled at the trap for the 2010 through 2014 return years (Range = 5-27 fish) composed a significant percentage of the entire run in those years (Range= 6%-25%). Thus, it is likely that some of the cutthroat caught in the trap prior to 2010 were also fallbacks. Because these fish would have been counted multiple times, cutthroat catch prior to 2010 may overestimate the number of spawners upstream of the trap.

Cutthroat catch at the adult trap was variable over the ten years, ranging from a low of 78 adults in 2008 to a high of 171 adults in 2005 (Table 29). In all years, the majority of cutthroat were captured in October and November (Range: 68%-92%) with successively fewer fish captured throughout the rest of the trapping season. Adult Cutthroat catch at the screw trap was also variable, with the lowest catch occurring in 2009 (8 fish) and the highest catch in 2013 (37 adults).

The estimated numbers of cutthroat trout out-migrants from the EF Trask River is summarized in Table 22 and in Appendix 3. The majority of out-migrants were in the 120-159 mm size class, followed by the 160-249 mm class, and then the 90-119 mm class. Few cutthroat in the 60-89 mm class were captured and an accurate estimate could not be made in any year. Peak week of migration for the three predominant size classes was typically between early May and mid-June.

Table 29. The number of adult cutthroat trout (≥ 250 mm) captured in the EF Trask River adult and out-migrant screw traps. Fish were caught September-April in the adult trap, and February-July in the screw trap.

Return Year	Adult Ladder Trap[a]	Out-Migrant Screw Trap
2005	171[b]	22
2006	122[b]	14
2007	126[b]	11
2008	78[b]	11
2009	135[b]	8
2010	79	13
2011	86	18
2012	98	13
2013	106	37
2014	87	9

[a] Adult trap catch does not include all adult migrants entering the trap because the spacing of trap bars is wide enough for some adults to escape upstream.

[b] Cutthroat were not marked so some fish may have been counted multiple times.

Chapter 4: Mill Creek (Siletz River)

Mill Creek in the Siletz River basin is a third order stream that enters the main-stem of the Siletz River at river km 82. The watershed encompasses an area of 33.8 km² with approximately 24 km of stream accessible to anadromous salmonids (Figure 15). Adult fish are trapped at a ladder on a waterfall 0.4 km upstream of the mouth. The waterfall is a partial migration barrier and so adult salmon and steelhead spawner estimates are made using the mark-recapture methods described in the general methods section. Juvenile salmonid out-migrants are captured using a rotary screw trap located less than 100 m upstream from the waterfall. Juvenile trapping at this site began in the spring of 1997, and adult trapping was initiated in the fall of 1997.

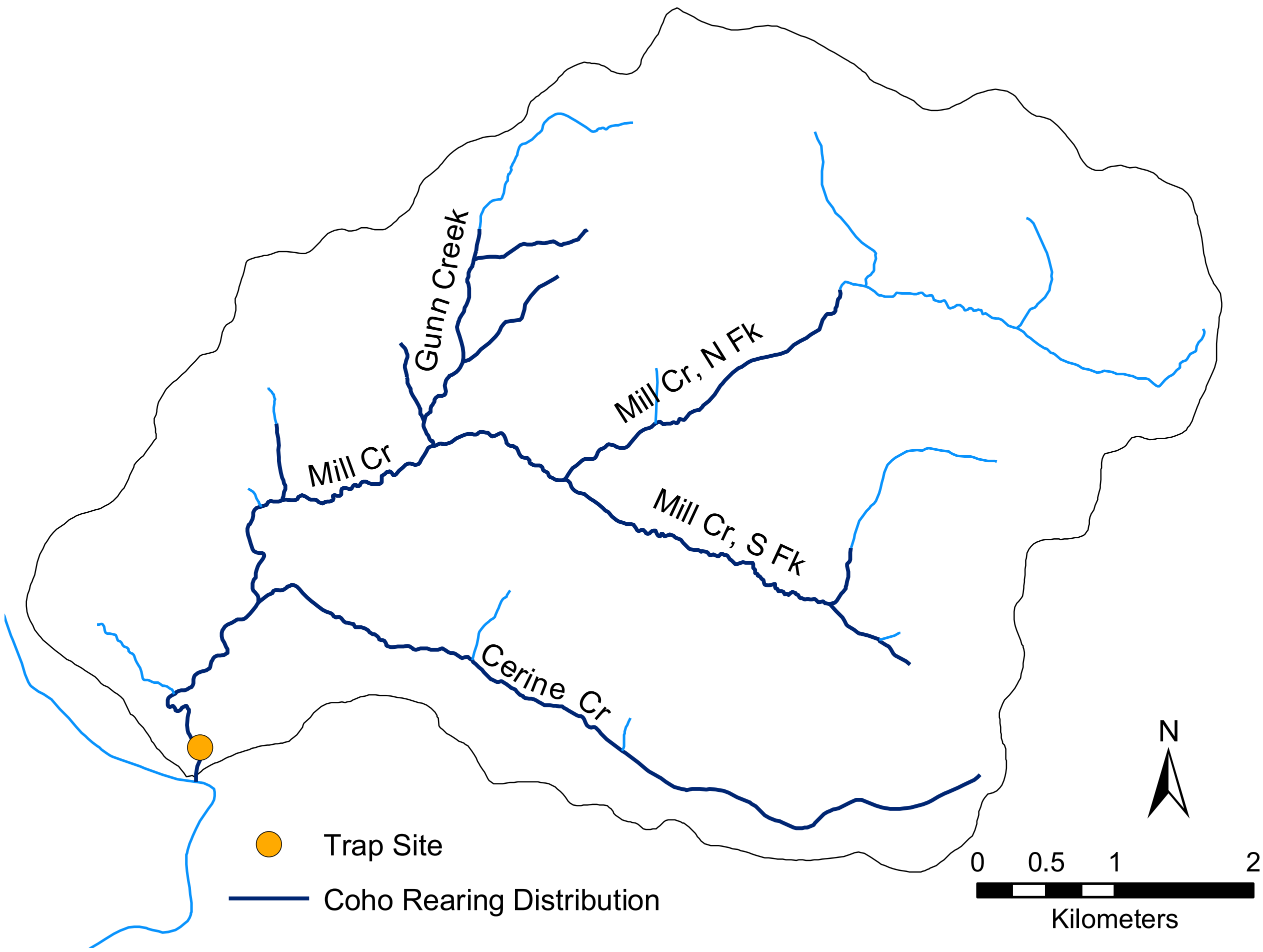

Figure 15. Mill Creek-Siletz showing the trap site and extent of coho rearing distribution.

Coho Salmon

The numbers of adult and jack coho salmon captured in the Mill Creek-Siletz trap and the estimated number of adult and jack coho salmon spawning in the watershed are given in Table 30. Mark-recapture population estimates for adult coho salmon were calculated based on the proportion of tagged fish among live fish observed on spawning surveys (2001 return year), or using a combination of live fish observations and carcass

Table 30. The number of female (F), male (M) and jack (J) coho salmon captured at the Mill Creek-Siletz adult trap and estimated spawning population above the trap. Estimated numbers of female and male spawners were based on the sex ratio observed at the trap.

	Trap Catch						Wild Spawning Population					
Return	Wild			Hatchery			Total ± CI			Sex		
Year	F	M	J	F	M	J				F	M	J
1997	30	41	0	0	0	0	113	±	67	48	65	na
1998	25	29	4	3	8	2	55	±	0	25	30	7
1999	52	40	10	6	18	2	147	±	32	83	64	29
2000	119	117	12	1	2	0	257	±	13	130	127	35
2001	113	89	21	12	16	7	277	±	31	155	122	121
2002	429	467	35	7	7	5	1,034	±	37	495	539	73
2003	386	498	10	1	4	0	1,065	±	52	459	606	59
2004	174	182	8	1	1	0	430	±	27	210	220	na
2005	251	269	5	0	2	0	616	±	32	297	319	na
2006	128	133	7	4	4	0	361	±	36	177	184	na
2007	86	96	7	1	0	0	237	±	25	112	125	35
2008	306	281	4	5	0	0	724	±	37	378	346	64
2009	244	318	1	0	0	0	1,077	±	106	468	609	na
2010	227	190	26	0	2	0	639	±	57	347	292	108
2011	442	496	7	0	0	0	1,067	±	35	503	564	na
2012	136	114	2	2	1	0	398	±	50	217	181	na
2013	132	143	32	0	0	0	364	±	32	175	189	160

recoveries during surveys (all other return years). Spawning surveys have always included the areas with highest spawner abundance, and have covered an increasing portion of the basin through time. During the past four coho spawning seasons, surveys were expanded to include 95-100% of the available spawning habitat as part of a survey calibration study. The number of male and female spawners was estimated based on the sex ratio of adults captured at the trap. In general, a high percentage of the adult coho salmon entering Mill Creek to spawn are captured in the trap, but the proportion of fish jumping the falls has varied considerably among years. Over the 17 years of monitoring, the percentage of spawners observed on surveys that were tagged averaged 76%, and ranged from 52% (2009 return year) to 100% (1998 return year). Bar spacing in the adult fish trap allows most jack coho salmon to pass through the ladder without being captured, and so the number of jacks tagged at the trap and subsequently observed on spawning surveys is usually low. As a result, jack estimates are not available for several years and all jack population estimates had wide confidence intervals. The proportion of hatchery coho caught in the trap is generally very low, these fish are removed, and no hatchery coho have been observed during spawning surveys. Therefore, our analyses assume that no hatchery coho bypass the trap.

Table 31. The estimated number of female spawners, egg deposition, fry, smolts, wild spawning adults, and freshwater and marine survival rates for coho salmon in Mill Creek-Siletz.

Brood	Female Spawners		Egg			Returning Adults (wild)		Percent Survival	
Year	Wild	Hatchery	Deposition	Fry	Smolts	F	M	FW	Marine
1994						48	65		
1995					8,099	25	30		0.6%
1996				21,437	9,626	83	64		1.7%
1997	48	0	95,945	812	8,417	130	127	8.8%	3.1%
1998	25	0	52,716	(21)	4,312	155	122	8.2%	7.4%
1999	83	0	204,416	1269	15,123	495	539	7.4%	6.6%
2000	130	0	330,551	5,716	17,717	481	623	5.4%	5.4%
2001	155	0	438,065	9,460	15,699	210	220	3.6%	2.7%
2002	495	0	1,450,177	62,064	17,821	297	319	1.2%	3.3%
2003	459	0	1,188,228	24,239	19,653	177	184	1.7%	1.8%
2004	210	0	596,331	10,373	13,124	112	125	2.2%	1.7%
2005	297	0	786,656	9,336	11,986	378	346	1.5%	6.3%
2006	177	0	518,152	16,999	13,288	468	609	2.6%	7.1%
2007	112	0	283,860	2,845	13,807	348	292	4.9%	5.1%
2008	378	0	1,101,050	67,055	18,718	503	565	1.7%	5.4%
2009	468	0	1,156,564	92,283	15,554	217	181	1.3%	2.8%
2010	347	0	1,010,216	24,028	12,841	175	189	1.3%	2.7%
2011	503	0	1,418,533	78,250	16,767			1.2%	
2012	217	0	516,133	23,704	16,627			3.2%	
2013	175	0	463,813	11,464					

Estimates of female coho spawners, egg deposition, fry and smolt out-migrants, adult returns, and freshwater and marine survival rates are provided for each brood in Table 31. Smolt estimates with confidence intervals are shown in Table 32 and additional juvenile data are summarized in Appendix 1. The estimated number of coho spawners in Mill Creek-Siletz has ranged from 55 adults in 1998 to 1,077 adults in 2009 (Table 30), with coho spawner abundance generally tracking trends in marine survival (Table 31 and Figure 16). Marine survival was very low (<1%) when monitoring began, and has exhibited a cyclical pattern since then, peaking at over 7% for the 1998 and 2006 broods. A decreasing trend in marine survival has been observed over the last four years (Table 31 and Figure 16).

Freshwater survival rates have varied from 1.2% to 8.8%, and have shown a strong negative relationship with adult spawner abundance (Table 31 and Figure 16). This relationship was particularly evident during the first six years of monitoring, as spawner abundance increased from <50 to nearly 500 adult females and freshwater survival dropped precipitously. Freshwater survival increased back to nearly 5% as the number of spawners declined between 2002 and 2007, but fell below 2% with increased spawner abundance in the 2008-2011 broods. The 2012 brood had significantly fewer

Table 32. The estimated number of juvenile salmonids migrating past the Mill Creek-Siletz juvenile trap. For cutthroat trout, only the two largest size classes are shown. Additional out-migrant data are provided in the appendices.

Sample Year	Coho smolts ± CI	Steelhead smolts ≥ 120 mm ± CI	Cutthroat migrants ± CI 160-249 mm	Cutthroat migrants ± CI 120-159 mm
1997	8,099 ± 686	342 ± 265	471 ± 402	1,595 ± 343
1998	9,626 ± 698	960 ± 357	482 ± 270	1,999 ± 710
1999	8,417 ± 594	312 ± 141	829 ± 519	1,717 ± 353
2000	4,312 ± 241	996 ± 280	1,513 ± 545	2,844 ± 443
2001	15,123 ± 853	1,199 ± 327	1,640 ± 615	2,592 ± 437
2002	17,717 ± 1,023	633 ± 515	2,233 ± 4,557	2,452 ± 447
2003	15,699 ± 1,145	280 ± 531	1,818 ± 1,439	1,824 ± 355
2004	17,821 ± 1,166	600 ± 276	914 ± 225	703 ± 129
2005	19,653 ± 1,174	801 ± 223	1,163 ± 314	2,120 ± 325
2006	13,124 ± 849	642 ± 208	1,179 ± 468	1,631 ± 329
2007	11,986 ± 1,825	349 ± 123	838 ± 302	2,081 ± 347
2008	13,288 ± 514	477 ± 98	728 ± 247	1,460 ± 270
2009	13,807 ± 641	814 ± 139	942 ± 312	1,964 ± 286
2010	18,718 ± 770	1,078 ± 321	1,279 ± 308	2,172 ± 406
2011	15,554 ± 970	782 ± 253	1,318 ± 343	2,050 ± 316
2012	12,841 ± 790	665 ± 341	1,545 ± 537	1,350 ± 276
2013	16,767 ± 831	1,086 ± 529	387 ± 139	1,071 ± 321
2014	16,627 ± 931	646 ± 308	477 ± 223	1,635 ± 329

spawners, and freshwater survival increased back up to 3.2%. The number of coho smolts migrating out of Mill Creek has generally increased as the number of female spawners increases, but the relationship appears to level off when spawner abundance is high (Figure 17a), suggesting that the stream had reached its capacity for rearing juvenile coho salmon. Consistent with the freshwater survival patterns discussed above, the number of smolts produced per female spawner decreased rapidly with increasing spawner abundance, (Figure 17b). The number of coho smolts produced per female spawner has ranged from a high of 182 (1999 brood year) to a low of 33 (2009 and 2011 brood years).

At higher spawner abundance more coho salmon fry left Mill Creek (Figure 17a), and there was a significant positive relationship between the number of fry per female and the number of female spawners (Figure 17b). These relationships suggest that rearing habitats can become limiting when spawner abundance is high. Other factors, particularly the frequency and intensity of spring freshets, also affect the number of fry migrants and may explain why there was substantial variation in the relationship between spawner abundance and the number of fry leaving Mill Creek.

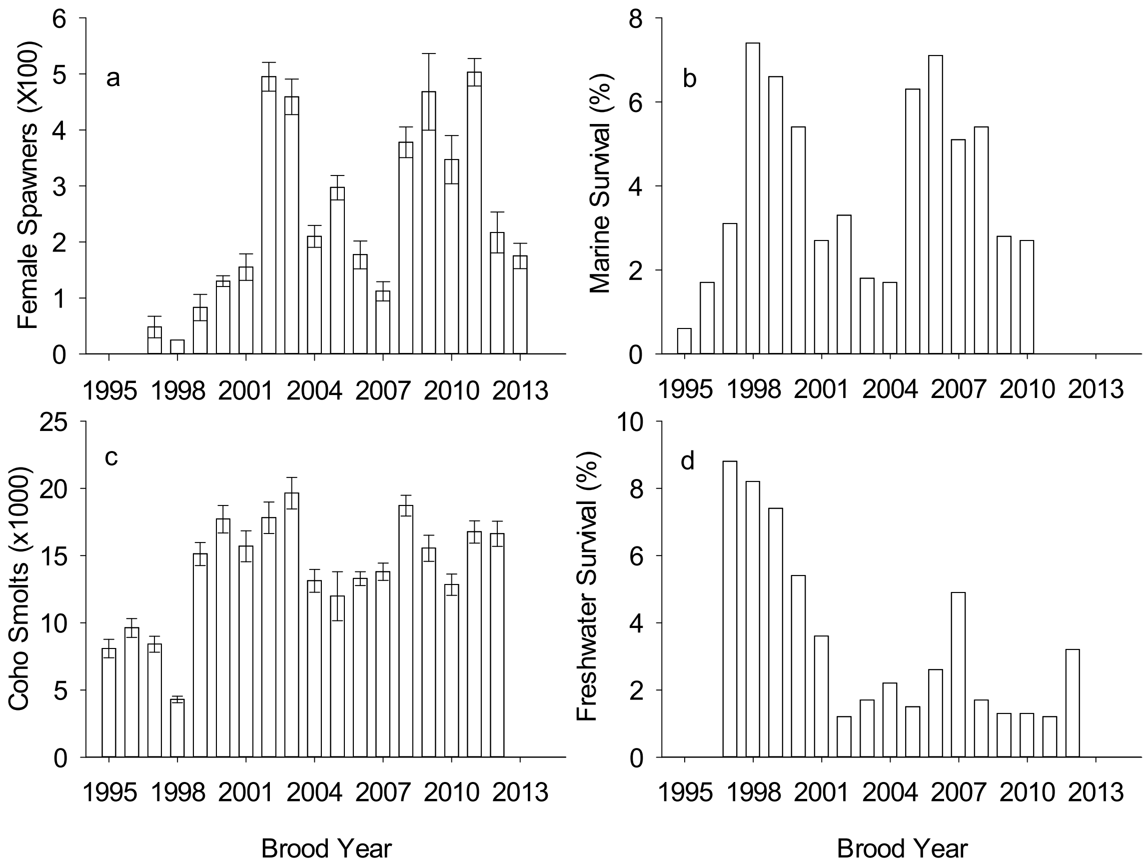

Figure 16. Annual trends in the (a) parental female spawner estimate, (b) percent marine survival, (c) smolt production estimate, and (d) percent freshwater survival for coho salmon in Mill Creek-Siletz.

Fall Chinook Salmon

The number of adult and jack fall Chinook salmon captured in the Mill Creek-Siletz trap has generally been low (Table 33), and very few Chinook salmon have been observed on spawning surveys. A series of small waterfalls near the mouth of Mill Creek often makes access to the stream difficult during October and early November, when adult Chinook are typically moving into tributaries to spawn. All fall Chinook salmon captured in the trap were passed upstream, but it is likely that many of these fish dropped out of Mill Creek to look for spawning opportunities elsewhere. In 2001, one untagged Chinook salmon was observed on the spawning grounds, indicating that Chinook salmon can jump the falls and avoid the trap. The numbers of juvenile fall Chinook salmon migrants leaving Mill Creek each spring are given in Table 34, and support our assumption that there is little or no Chinook spawning activity in Mill Creek in most years.

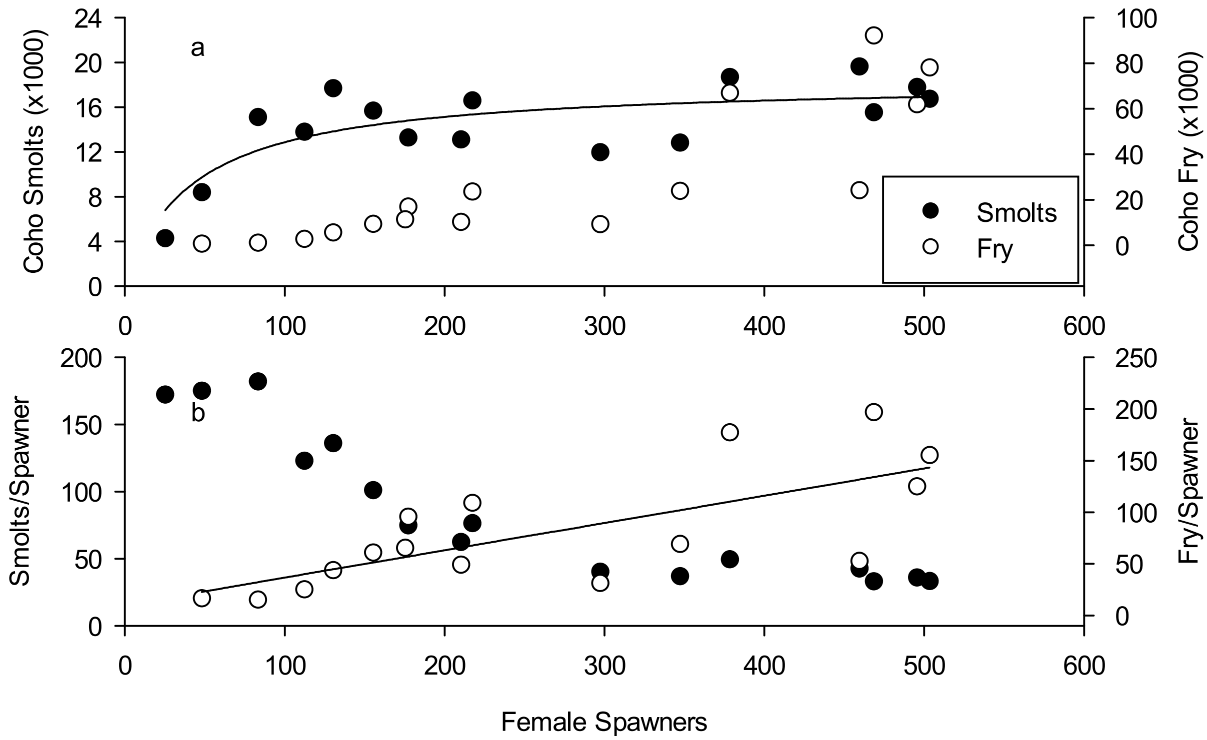

Figure 17. a) The relationship between coho smolt (solid symbols) and fry (clear symbols) migrants and female spawners in Mill Creek-Siletz. The solid line is the regression line between smolts and female spawners (R^2=0.63, p<0.001). b) The relationship between coho smolts/female (solid symbols) and fry/female (clear symbols) migrants with female spawners in Mill Creek-Siletz. The solid line is the regression line between fry/female and female spawners (R^2=0.52, p=0.002).

Winter Steelhead

The adult steelhead entering Mill Creek are predominately of hatchery origin, with the percentage of hatchery fish ranging between 59% and 93% over the 17 years of sampling (Table 33). Hatchery steelhead that stray into Mill Creek include both summer steelhead (Siletz stock, released in the mainstem Siletz River at several points upstream and downstream from Mill Creek) and winter steelhead (Siletz River stock, released from acclimation ponds in Palmer Creek, a Siletz River tributary 5.5 km above the mouth of Mill Creek). Summer steelhead typically account for less than 20% of the hatchery steelhead captured at the trap. Adult steelhead successfully jump the waterfall associated with the ladder and fish trap, so trap catch is not a good indicator of the spawning population of steelhead in Mill Creek. Steelhead were tagged in the first several years of monitoring to obtain a mark-recapture estimate of total spawners, and population estimates were made in 1998 and 1999. These estimates indicated that most steelhead (61% in 1998, 88% in 1999) avoid the trap by jumping the falls. In subsequent years, reliable estimates were difficult to obtain because of the low tag recovery rate for adult steelhead on spawning surveys. As a result, we have not tagged

Table 33. The number of female (F), male (M) and jack (J) Chinook salmon and steelhead trout captured at the Mill Creek-Siletz adult trap.

	Trap Catch					
	Wild			Hatchery		
Return Year	F	M	J	F	M	J
Fall Chinook						
1997	0	0	0	0	0	0
1998	1	2	0	0	0	0
1999	1	0	1	0	0	0
2000	0	0	0	0	0	0
2001	20	36	3	0	0	0
2002	0	1	0	0	0	1
2003	0	1	0	0	0	0
2004	1	0	0	0	0	0
2005	0	1	0	0	0	0
2006	2	2	0	0	0	0
2007	0	0	0	0	0	0
2008	0	0	0	0	0	0
2009	0	2	0	0	0	0
2010	0	2	0	0	0	0
2011	0	2	0	0	0	0
2012	2	2	0	0	0	0
2013	0	1	0	0	0	0
Steelhead						
1998	11	11	0	31	29	1
1999	6	5	1	56	40	1
2000	3	2	1	14	3	0
2001	7	6	0	13	6	0
2002	13	11	0	27	41	0
2003	13	15	0	20	24	1
2004	17	10	0	106	113	1
2005	4	7	0	81	61	0
2006	13	16	0	55	46	2
2007	7	6	0	49	68	1
2008	13	6	0	26	24	0
2009	9	6	0	32	25	0
2010	5	9	0	21	23	1
2011	11	18	0	24	29	0
2012	22	16	0	40	57	0
2013	5	10	0	30	58	0
2014	7	8	0	22	41	0

Table 34. The estimated number of sub-yearling (fry and fingerling) fall Chinook salmon migrants and week of peak out-migration in Mill Creek-Siletz. The out-migration year is the first year following egg deposition (e.g., the 1997 brood year was sampled in 1998).

Sample Year	Migrants ± 95% CI			Peak week
1997	30,531	±	7,505	3/10-3/16
1998	0			
1999	1,264	±	968	3/1-3/7
2000	0			
2001	0			
2002	17,416	±	2,642	4/1-4/7
2003-2014	0			

adult steelhead or attempted to estimate the number of adult steelhead spawners in Mill Creek since the 2002 return year.

The estimated numbers of juvenile steelhead defined as smolts are given in Table 32, with additional data on pre-smolts and peak week summarized in Appendix 2. Juvenile migrants are presumably progeny of both summer and winter steelhead adults, although winter steelhead would be expected to be the larger component based on adult counts at the trap. Peak migration of steelhead smolts is typically in late March to mid-April, and the average size of smolts during the peak week has ranged from 140.7 mm to 168.4 mm. Scale samples indicate that steelhead smolts (≥ 120 mm) are predominately age-2 migrants. Over the five years in which juvenile steelhead scale samples were collected and analyzed, age-1 migrants accounted for 17% of smolts, age-2 migrants accounted for 77% of smolts, and age-3 migrants accounted for 6% of smolts.

Cutthroat Trout

Trap catch of cutthroat trout does not include all adult migrants and is not a good index of abundance because the spacing of trap bars is wide enough for most adults to move through the trap (Table 35). Adult cutthroat trout are not tagged, and no estimate of total spawners is available. The estimated numbers of cutthroat trout that migrate downstream and leave Mill Creek each spring are summarized in Table 32, with additional data in Appendix 3. The week of peak migration typically occurs between mid-April and early May. Most migrants that are 90-159 mm in length show partial silvering in their appearance. Nearly all migrants in the 160-249 mm size class are either partially silvered or completely silvered when they migrate from the stream. Adult cutthroat trout (≥ 250 mm FL) are also captured each year at the smolt trap, typically in March and April. In most years, fewer than 15 cutthroat trout ≥ 250 mm FL are caught in the smolt trap, but as many as 50 adult cutthroat have been caught in a season (2005). Cutthroat trout ≥ 250 mm FL are not marked to make a population estimate, and smolt trap catch is probably not a good index of abundance due to differences in trapping conditions between years.

Table 35. The number of adult cutthroat trout (≥ 250 mm) captured in the Mill Creek-Siletz adult and out-migrant traps. Fish were caught October-June in the adult trap, and from February-July in the screw trap.

Return Year	Adult Ladder Trap[a]	Out-Migrant Screw Trap
1998	9	5
1999	4	2
2000	4	4
2001	0	25
2002	2	14
2003	6	4
2004	3	8
2005	0	50
2006	1	12
2007	0	10
2008	0	9
2009	3	22
2010	0	11
2011	1	25
2012	3	17
2013	0	10
2014	0	4

[a] Adult trap catch does not include all adult migrants entering the trap because the spacing of trap bars is wide enough for some adults to escape upstream.

Chapter 5: Mill Creek (Yaquina River)

Mill Creek in the Yaquina River basin is a third order tributary that enters the Yaquina River at river km 17.7. At the confluence the mainstem of the Yaquina River and first 1.5 km of Mill Creek are tidally influenced. The adult trap is located in a fish ladder that provides access to Mill Creek Reservoir, approximately 5 km upstream from the stream mouth. Mill Creek Reservoir has a surface area of 0.06 km^2 (15 acres). All adult fish must move through the fish ladder and trap to access two tributaries above the reservoir; live fish placed above the trap represent the total spawning population. A motorized inclined plane trap is used immediately below the fish ladder and spillway of the dam to estimate juvenile migrant populations each spring. Juvenile and adult trapping at this site began in 1997. There are approximately 4.2 km of stream above the reservoir for juvenile rearing (Figure 18).

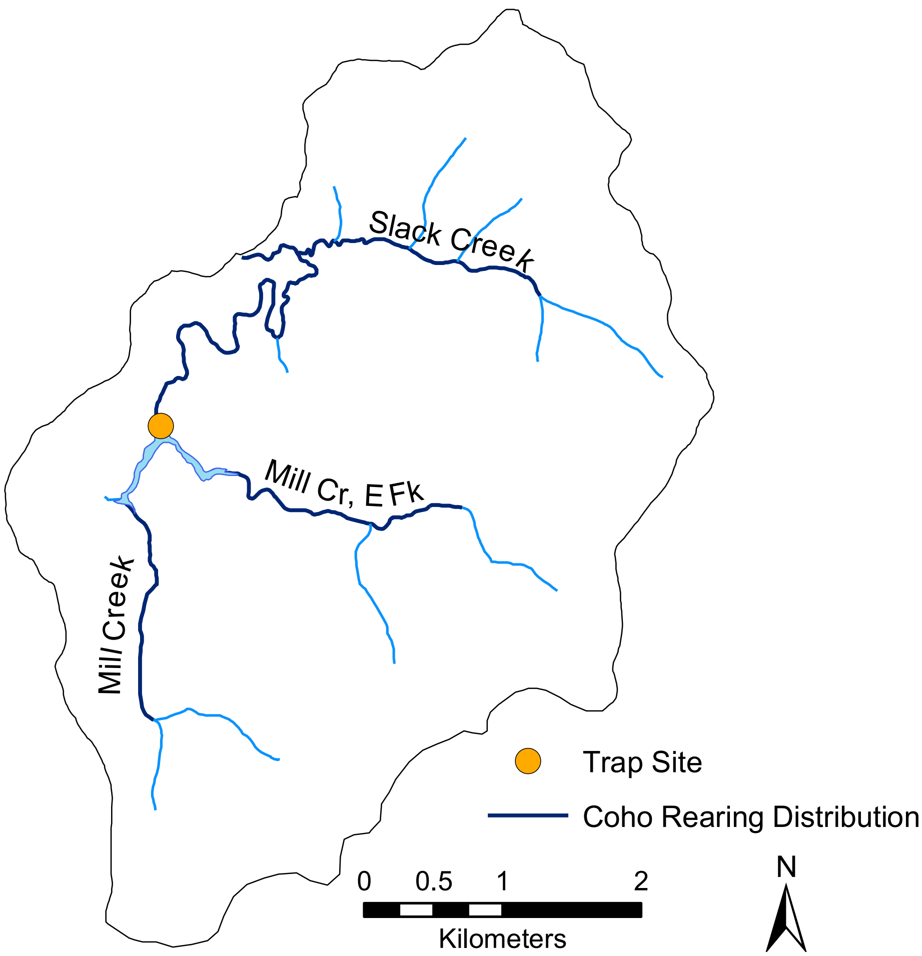

Figure 18. Mill Creek-Yaquina showing the trap site and extent of coho rearing distribution.

Coho Salmon

Total numbers of adult and jack coho salmon caught at the Mill Creek trap and the number of coho salmon placed above the trap (estimated spawning population) are given in Table 36. Differences between the trap catch and estimated spawning

Table 36. The number of female (F), male (M) and jack (J) coho salmon captured at the Mill Creek-Yaquina adult trap and the estimated spawning population in the Mill Creek watershed above Mill Creek Reservoir.

Return Year	Trap Catch						Spawning Population					
	Wild			Hatchery			Wild			Hatchery		
	F	M	J	F	M	J	F	M	J	F	M	J
1997	36	56	13	9	16	0	36	53	13	6	13	0
1998	80	58	19	9	37	1	77	57	16	0	0	0
1999	43	49	49	0	0	0	43	48	43	0	0	0
2000	40	24	258	0	0	0	40	24	252	0	0	0
2001	377	247	204	3	2	0	375	245	197	0	0	0
2002	549	498	245	7	2	0	549	497	244	0	0	0
2003	602	613	183	1	1	0	602	612	181	0	0	0
2004	527	628	55	0	1	0	527	627	55	0	0	0
2005	243	261	43	0	1	0	242	261	43	0	0	0
2006	228	264	25	5	4	0	228	263	25	0	0	0
2007	135	147	110	0	0	0	135	147	106	0	0	0
2008	429	355	171	1	0	0	429	353	169	0	0	0
2009	596	561	82	0	0	0	596	559	80	0	0	0
2010	699	572	170	2	0	0	699	571	169	0	0	0
2011	631	647	34	2	0	0	631	647	34	0	0	0
2012	164	158	98	1	0	0	163	157	98	0	0	0
2013	248	238	64	0	0	0	247	238	63	0	0	0

populations reflect unintentional mortality of wild fish and directed mortality of hatchery fish at the trap. Jack counts at this site represent total returns. Although some jacks are small enough to move through the bars of the trap, the hydraulics at the upper end of the ladder and the water velocity at the head gate ensures that jacks cannot move upstream to the reservoir without being captured and counted.

The number of female spawners, estimated egg deposition, fry and smolt production, adult returns and survival rates are provided for each brood in Table 37. Smolt estimates with confidence intervals are shown in Table 38 and additional juvenile data are summarized in Appendix 1. The number of coho spawners returning to Mill Creek-Yaquina has ranged from 64 to 1,278 adults. Spawner abundance has generally tracked trends in marine survival (Table 37 and Figure 19), but variation in coho smolt production has also had an important influence on subsequent adult returns (Table 37). Marine survival at Mill Creek-Yaquina has shown a cyclical trend similar to that observed at Mill Creek-Siletz, but with much greater variation through time (Figure 19). Estimated marine survival rates at Mill Creek-Yaquina are often 2-4 times higher than those at Mill Creek-Siletz, and in several years have been the highest observed among all of the coastal LCM sites.

Table 37. The estimated number of female spawners, egg deposition, fry, smolts, number of wild spawning adults, and freshwater and marine survival rates for coho salmon in Mill Creek-Yaquina.

Brood	Female Spawners		Egg			Returning Adults (wild)		Percent Survival	
Year	Wild	Hatchery	Deposition	Fry	Smolts	F	M	FW	Marine
1994						36	56		
1995					1,317	80	58		12.1%
1996				47,307	6,587	43	49		1.3%
1997	36	6	101,674	278	2,225	40	24	2.2%	3.7%
1998	77	0	206,935	2,565	5,434	377	247	2.6%	13.9%
1999	43	0	116,500	1,336	7,359	549	498	6.3%	14.9%
2000	40	0	107,202	7,920	6,593	602	613	6.2%	18.3%
2001	375	0	1,087,481	103,941	8,727	527	628	0.8%	12.1%
2002	549	0	1,694,355	99,451	8,102	243	261	0.5%	6.0%
2003	602	0	1,646,034	126,031	12,901	228	264	0.8%	3.5%
2004	527	0	1,512,987	147,895	10,224	135	147	0.7%	2.6%
2005	242	0	626,961	27,382	5,847	429	355	0.9%	14.8%
2006	228	0	651,126	29,575	5,290	596	561	0.8%	22.6%
2007	135	0	342,877	21,413	9,599	699	572	2.8%	14.6%
2008	429	0	1,246,653	91,587	3,330	631	647	0.3%	37.9%
2009	596	0	1,541,687	110,344	1,686	164	158	0.1%	19.5%
2010	699	0	2,040,334	157,068	4,758	248	238	0.2%	10.4%
2011	631	0	1,779,698	42,876	5,830			0.3%	
2012	163	0	399,242	30,074	8,430			2.1%	
2013	247	0	651,833	39,379					

High marine survival rates at Mill Creek-Yaquina relative to Mill Creek-Siletz and other LCM sites could be due to several factors, including the unusually large smolts that this site produces (Appendix 1), the short distance between the trap site and ocean entry relative to most other sites, and potential violations in our assumptions about the source of adult fish returns. In most years, substantial numbers of coho fry migrate downstream past the smolt trapping site in the spring (Table 37 and Appendix 1). The number of fry out-migrants was particularly large in years with high spawner abundance, often exceeded 100,000 fry (Figure 20). Some of these fry likely survive and rear in lower Mill Creek or in tidal marshes further downstream. If these fish returned to spawn above the reservoir, it would inflate marine survival estimates because they would not have been counted as smolts. An analysis of scale samples from coho smolts in the 1998 and 1999 broods and returning adult spawners in 2001 and 2002 indicated that nearly all returning adult coho salmon had reared in Mill Creek Reservoir as juveniles. Therefore, it did not appear that fry rearing in lower Mill Creek and adjacent marshes made a significant contribution to the adult spawner population above the reservoir in these years (Ray et al. 2006). The number of spring coho fry out-migrants was low in the 1998 and 1999 broods, however, and coho rearing downstream from the smolt trap may have had a stronger influence on marine survival estimates in other years. There

Table 38. The estimated number of juvenile salmonids migrating past the Mill Creek-Yaquina juvenile trap. For cutthroat trout, only the two largest size classes are shown. The number of actual fish caught is reported (in parentheses) when trap efficiency could not be determined for a particular size class. Additional out-migrant data are provided in the appendices.

Sample Year	Coho smolts ± CI	Steelhead smolts ≥ 120 mm ± CI	Cutthroat migrants ± CI 160-249 mm	Cutthroat migrants ± CI 120-159 mm
1997	1,317 ± 290	(3)	(1)	(2)
1998	6,587 ± 708	(33)	(6)	(16)
1999	2,225 ± 283	374 ± 181	32 ± 23	(8)
2000	5,434 ± 586	342 ± 196	71 ± 33	(15)
2001	7,359 ± 729	1,487 ± 1,031	116 ± 455	76 ± 53
2002	6,593 ± 553	797 ± 449	(11)	(21)
2003	8,727 ± 649	(39)	(18)	(14)
2004	8,102 ± 639	(47)	79 ± 61	(11)
2005	12,901 ± 1,054	(19)	(14)	(16)
2006	10,224 ± 455	(30)	(16)	(13)
2007	5,847 ± 388	(21)	31 ± 39	(8)
2008	5,290 ± 276	(13)	(4)	(10)
2009	9,599 ± 882	(42)	(11)	(11)
2010	3,330 ± 327	(15)	(3)	(4)
2011	1,686 ± 270	(6)	(1)	(1)
2012	4,758 ± 815	(6)	(6)	(1)
2013	5,830 ± 453	(32)	(6)	(2)
2014	8,430 ± 645	(13)	(3)	(8)

is no clear relationship between fry migrant abundance and brood years in which marine survival was particularly high at Mill Creek-Yaquina relative to other LCM sites.

The number of coho smolt out-migrants at Mill Creek-Yaquina generally followed trends in spawner abundance during the first 10 years of monitoring (Figure 19), but this relationship has not held over the last 6 brood years. Overall, there is no significant relationship between female spawner abundance and smolt production at this site (Figure 20). Freshwater survival has generally shown a negative relationship with adult spawner abundance at Mill Creek-Yaquina (Figure 19), though large differences in freshwater survival have been observed among brood years with similar numbers of spawners (Table 37). A period of extremely low freshwater survival was observed for the 2008-2011 broods, but lower spawner abundance and increased smolt production resulted in much higher freshwater survival for the 2012 brood. It is unclear what caused the steep drop in smolt production for the 2008-2009 brood years, which had relatively high spawner abundance, and why smolt abundance has steadily increased as adult abundance has declined more recently. The importance of the reservoir as a rearing habitat sets this site apart from other coastal LCM sites, and the wide variation in productivity we have observed at Mill Creek-Yaquina is likely due in large part to varying environmental conditions in the reservoir.

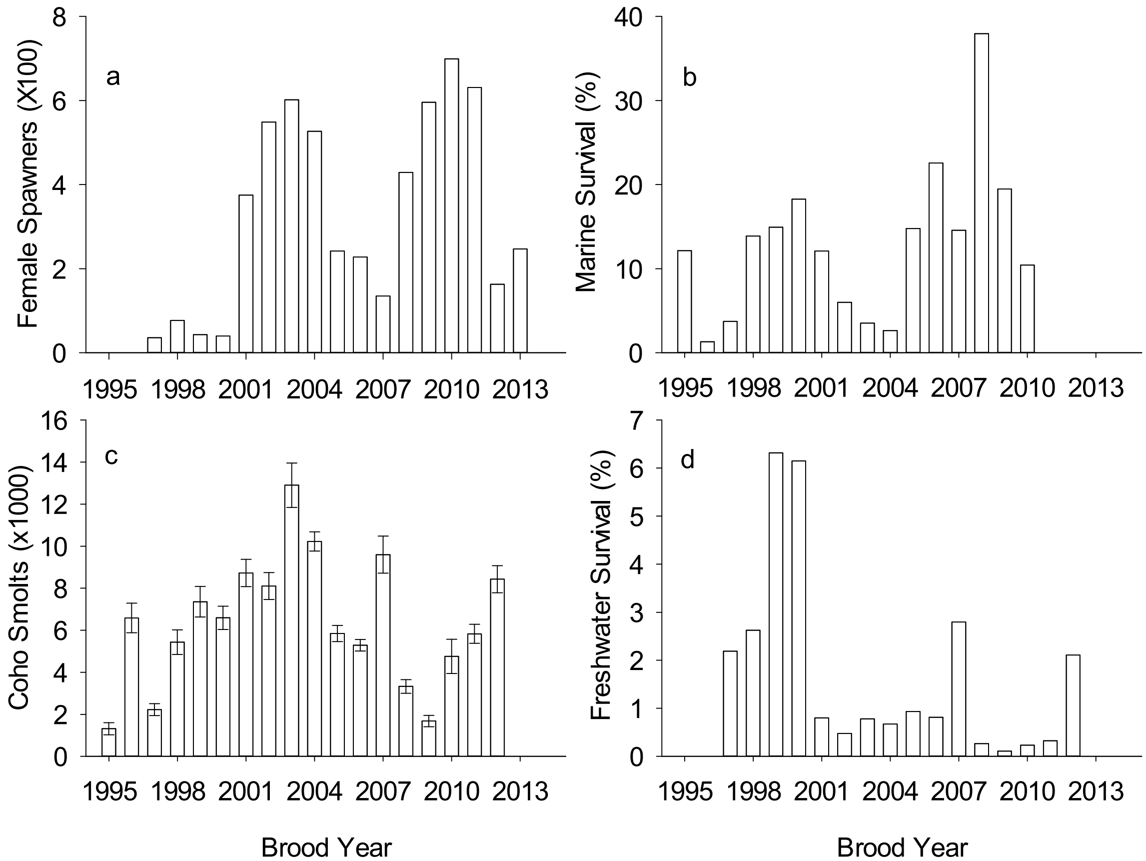

Figure 19. Annual trends in the (a) parental female spawner estimate, (b) percent marine survival, (c) smolt production estimate, and (d) percent freshwater survival for coho salmon in Mill Creek-Yaquina.

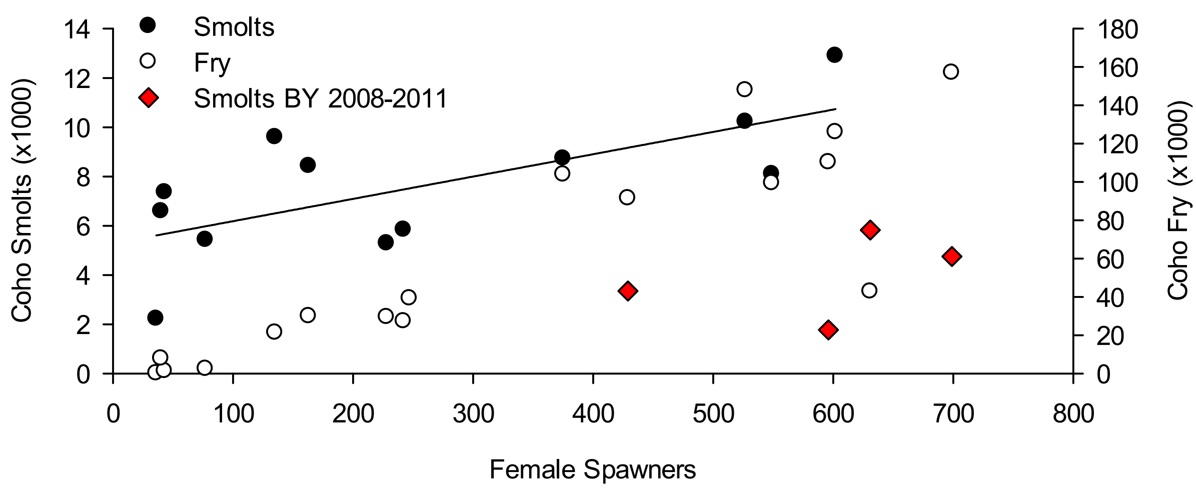

Figure 20. The relationship between coho smolt (solid symbols) and fry (clear symbols) migrants and female spawners in Mill Creek-Yaquina. The solid line is the regression line between smolts and female spawners, excluding the four most recent years of smolt production (R^2=0.48, p=0.013).

Fall Chinook Salmon

In Mill Creek-Yaquina, the spawning population of fall Chinook salmon has often been less than the trap catch because fall Chinook salmon were collected at this site and used for hatchery brood stock in the Yaquina River (Table 39). In recent years, however, all wild Chinook salmon captured at the trapped have been passed upstream to spawn in Mill Creek. The number of Chinook salmon spawners returning to the Mill Creek-Yaquina adult trap has ranged from 2 to 58 adults for return years 1997-2013, and male spawners have often far outnumbered female spawners. Most fall Chinook salmon entering Mill Creek to spawn do so below Mill Creek Reservoir. In years with low flows during October and November, a higher percentage of adults spawn below the reservoir, and so trap catch is not always a good index of total abundance for fall Chinook salmon in Mill Creek-Yaquina. Juveniles typically leave the reservoir as fry, with peak week of migration in late March to mid-April (Table 40).

Winter Steelhead

The numbers of adult and jack winter steelhead captured in the Mill Creek-Yaquina trap and the number of fish placed above the trap to spawn in tributaries above Mill Creek Reservoir are given in Table 39. Since the winter of 2001, tissue samples have been collected from all winter steelhead entering the adult trap and winter steelhead of both wild and of hatchery origin have been allowed to spawn above the trap site. Tissue samples are being archived for genetic analysis by Oregon State University researchers. The number of wild adult steelhead spawners returning to Mill Creek-Yaquina has ranged from a high of 89 in 2004 to a low of 20 in 2005, with an average of 47 spawners over the last 17 years. On average, hatchery fish have made up 14% of the total adult steelhead catch at the trap, with annual percentages ranging from 3% to 37%. Most of the hatchery steelhead captured appear to be within-basin strays from hatchery releases in Big Elk Creek, but out-of-basin strays are also common. In winter 2009-10, we began tagging adult steelhead passed at the trap with two floy tags to investigate the rate of repeat spawning at Mill Creek-Yaquina. Of the 150 untagged wild steelhead captured and Floy tagged at the trap from 2010 to 2013, 16 were recaptured the year following initial capture, and one female was captured on a third spawning run in 2014. No repeat spawners have been observed among hatchery steelhead tagged at the trap, most of which are males.

Estimates of the number of juvenile winter steelhead migrants leaving Mill Creek Reservoir each spring are given in Table 38, and data on pre-smolts and peak week are given in Appendix 2. The week of peak migration for smolts is typically in mid-April, and the average size of smolts leaving the reservoir has ranged from 158.7-180.0 mm. Due to the difficulty of capturing steelhead smolts with the inclined plane trap used at Mill Creek, steelhead smolt estimates generally have wide confidence intervals and recaptures were often insufficient to make population estimates.

Table 39. The number of female (F), male (M) and jack (J) Chinook salmon and steelhead trout captured at the Mill Creek-Yaquina adult trap and the estimated spawning population in the Mill Creek watershed above Mill Creek Reservoir.

Return Year & Species	Trap Catch						Spawning Population					
	Wild			Hatchery			Wild			Hatchery		
	F	M	J	F	M	J	F	M	J	F	M	J
Fall Chinook												
1997	24	25	1	0	0	0	20	21	1	0	0	0
1998	10	14	1	0	0	0	0	2	0	0	0	0
1999	11	24	0	0	0	0	0	14	0	0	0	0
2000	0	2	0	0	0	0	0	2	0	0	0	0
2001	12	27	2	0	0	0	6	22	2	0	0	0
2002	1	6	0	0	0	0	1	6	0	0	0	0
2003	10	14	0	0	0	0	5	9	0	0	0	0
2004	6	11	0	0	0	0	6	11	0	0	0	0
2005	4	15	0	0	6	0	4	7	0	0	4	0
2006	10	12	4	3	6	1	10	12	4	3	6	1
2007	6	2	1	0	0	0	4	1	1	0	0	0
2008	2	11	7	1	0	0	2	11	7	1	0	0
2009	3	21	1	0	0	0	3	21	1	0	0	0
2010	10	35	5	0	1	0	10	35	5	0	0	0
2011	9	14	2	0	1	0	9	14	2	0	0	0
2012	16	42	12	2	0	0	16	42	12	0	0	0
2013	5	11	2	1	2	0	5	11	2	0	0	0
Steelhead												
1998	18	24	0	2	4	0	18	24	0	2	3	0
1999	28	24	2	3	3	0	28	24	2	0	0	0
2000	30	21	0	4	8	0	30	21	0	0	0	0
2001	21	9	2	0	1	1	21	9	2	0	1	1
2002	33	37	3	2	3	0	33	37	3	2	3	0
2003	36	37	6	3	3	0	36	37	6	3	3	0
2004	42	47	0	5	10	1	42	47	0	5	10	1
2005	10	10	1	1	4	0	10	10	1	1	4	0
2006	30	35	6[a]	4	11	2	30	35	6[c]	4	11	2
2007	24	31	1	1	12	1	23	30	1	1	12	1
2008	12	15	0	0	6	2	12	15	0	0	6	2
2009	15	11	2	2	1	0	15	11	2	2	1	0
2010	18	11	2	3	0	0	18	11	2	3	0	0
2011	23	15	2	1	1	1	22	15	2	1	1	1
2012	31	35	2	2	6	0	31	35	2	2	6	0
2013	14	12	2	0	15	0	14	11	2	0	15	0
2014	24	20	1	2	9	1	24	20	1	2	9	1

[a] Includes one jenny

Table 40. The estimated number of sub-yearling (fry and fingerling) fall Chinook salmon migrants and week of peak out-migration in Mill Creek-Yaquina. The out-migration year is the first year following egg deposition (e.g., the 1997 brood year was sampled in 1998).

Sample Year	Migrants ± 95% CI			Peak week
1997	15,832	±	7,816	3/24-3/30
1998	7,770	±	1,650	3/23-3/29
1999	34	±	19	5/24-5/30
2000	(10)			
2001	(2)			
2002	2,901	±	733	4/08-4/14
2003	436	±	1,964	6/16-6/22
2004	1,104	±	112	4/12-4/18
2005	1,924	±	231	4/25-5/01
2006	1,142	±	153	3/20-3/26
2007	3,162	±	163	3/26-4/01
2008	26	±	41	5/19-5/25
2009	1,034	±	182	5/11-5/17
2010	2,372	±	423	3/22-3/28
2011	5,196	±	3,867	3/28-4/03
2012	1,199	±	163	4/23-4/29
2013	11,272	±	702	4/01-4/07
2014	1,547	±	249	3/31-4/06

Cutthroat Trout

The numbers of adult cutthroat trout captured in the Mill Creek-Yaquina trap are given in Table 41. Trap catch likely represents the total number of cutthroat ascending the ladder to spawn above the reservoir. The spacing of trap bars is wide enough for some adult cutthroat to move through the trap, but the design of the upper portion of the ladder would seem to present a barrier to further upstream movement, as discussed above for jack coho salmon. Due to low trap efficiency, we are seldom able to make population estimates for cutthroat trout out-migrants at this site (Table 38, Appendix 3). When population estimates have been made, they indicate that the number of cutthroat trout out-migrants at Mill Creek-Yaquina is low relative to other LCM sites.

Table 41. The number of adult cutthroat trout (≥ 250 mm) captured in the Mill Creek-Yaquina adult and out-migrant traps. Fish were caught October-June in the adult trap, and from February-July in the screw trap.

Return Year	Adult Ladder Trap	Out-Migrant Screw Trap
1998	3	0
1999	0	5
2000	8	5
2001	6	2
2002	8	0
2003	4	6
2004	19	13
2005	17	3
2006	3	1
2007	6	1
2008	9	1
2009	4	1
2010	6	1
2011	7	2
2012	5	0
2013	5	3
2014	6	1

Chapter 6: Cascade Creek (Alsea River)

Cascade Creek is a second order tributary that enters Five Rivers 8 km upstream from its confluence with the Alsea River. Five Rivers enters the Alsea River at river km 34. The Cascade Creek watershed encompasses an area of 14.5 km² with 15 km of stream accessible to anadromous salmonids (Figure 21). Adult salmon, steelhead and cutthroat trout are captured at Cascade Creek in a trap associated with a fish ladder that provides passage around a waterfall 0.15 km upstream of the mouth of the stream. The waterfall is a complete barrier to upstream migration, so the fish passed above the trap represent the total spawning population. Juveniles are captured using a rotary screw trap located 75 m downstream from the waterfall and fish ladder. Due to the small size of the stream and other characteristics of the trapping site, smolt trap efficiencies for coho salmon and other salmonid out-migrants are very high at Cascade Creek relative to other coastal LCM sites. Adult trapping began at this site in fall 1997, and juvenile trapping was initiated in spring 1998.

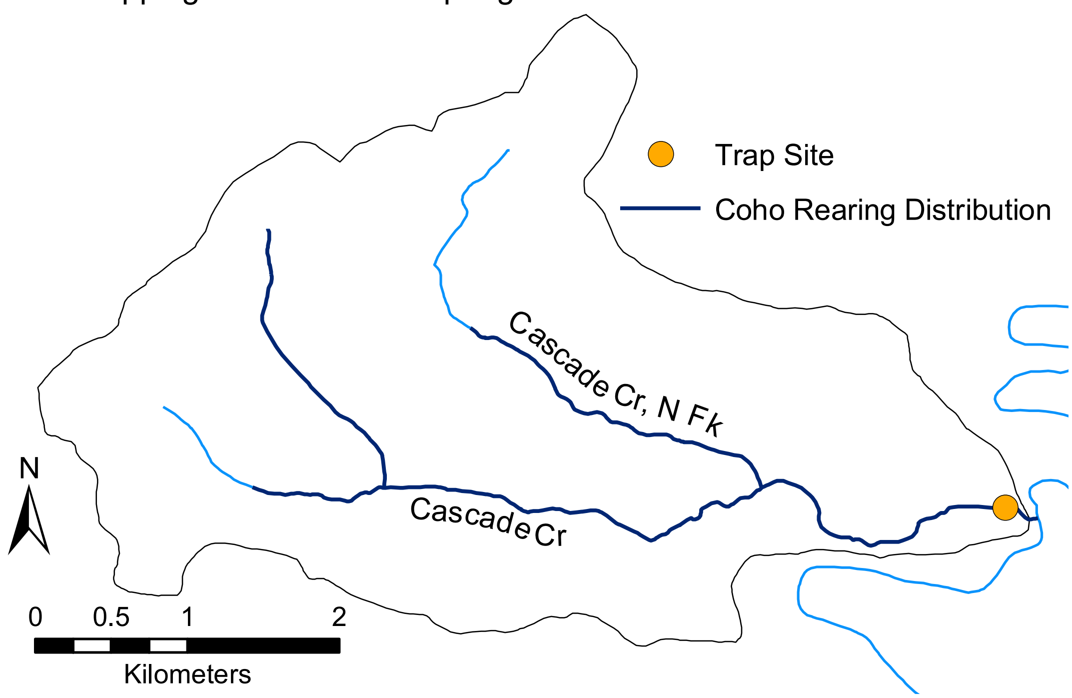

Figure 21. Cascade Creek showing the trap site and extent of coho rearing distribution.

Coho Salmon

Total numbers of adult and jack coho salmon caught at the Cascade Creek trap and the number of coho salmon placed above the trap (estimated spawning population) are given in Table 42. Differences between the trap catch and estimated spawning populations reflect unintentional mortality of wild fish and removal of hatchery fish at the trap. Some jack coho salmon are small enough to move through the bars in the trap, and so trap catch does not represent a complete count of coho jacks entering Cascade Creek to spawn and may not be a good index of abundance. The run timing of adult coho salmon at Cascade Creek is generally later than other LCM sites, with peak

Table 42. The number of female (F), male (M) and jack (J) coho salmon captured at the Cascade Creek adult trap and the estimated spawning population in the Cascade Creek watershed above the trap.

Return Year	Trap Catch						Spawning Population					
	Wild			Hatchery			Wild			Hatchery		
	F	M	J	F	M	J	F	M	J	F	M	J
1997	16	14	0	1	9	0	16	11	0	1	9	0
1998	5	1	8	3	13	3	5	1	7	0	0	0
1999	5	4	0	0	7	0	5	4	0	0	0	0
2000	11	34	10	0	0	0	11	34	10	0	0	0
2001	5	17	21	1	4	1	5	17	19	0	0	0
2002	45	62	20	1	1	0	45	62	19	0	0	0
2003	42	86	13	0	0	0	42	86	13	0	0	0
2004	30	86	24	1	0	0	30	85	23	0	0	0
2005	140	219	16	0	0	0	140	217	15	0	0	0
2006	42	82	11	2	3	0	42	82	10	0	0	0
2007	55	98	25	0	0	0	55	97	25	0	0	0
2008	160	234	17	0	0	0	160	233	17	0	0	0
2009	227	329	15	0	0	0	226	329	15	0	0	0
2010	115	117	19	0	0	0	115	117	19	0	0	0
2011	229	306	12	1	0	0	227	305	12	0	0	0
2012	173	273	10	0	0	0	172	268	10	0	0	0
2013	82	137	43	0	0	0	82	136	42	0	0	0

catches at the adult trap most often occurring in December. In some years, peak trap catches have not occurred until January, and the adult coho trapping season often extends into February. The sex ratio of returning adult coho has often been heavily skewed toward males at Cascade Creek (Table 42), but it is not clear why this is the case.

The number of female spawners, estimated egg deposition, fry and smolt production, adult returns, and survival rates are provided for each brood in Table 43, and plotted in Figure 22. Marine survival estimates for the 1997 brood may be inaccurate, as the number of smolts leaving the stream was very low, and so this estimate is not plotted in Figure 22. The number of coho spawners returning to Cascade Creek has ranged from 6 to 556 adults. Spawner abundance was very low during the first five years of monitoring at Cascade Creek, but a strong rebuilding trend was observed over the subsequent 10 years. All three brood lines showed increasing trends in adult spawner abundance during this period, and smolt production rose sharply as the number of coho spawners increased. Average annual smolt production for the 2002-2011 brood years was over 6 times higher than the average estimate during the 1997-2001 brood years. Since the 2003 brood year, smolt estimates have been more consistent and adult spawner abundance has generally tracked trends in marine survival (Figure 22). The adult coho return in 2013 was the smallest since 2007 due to relatively low marine survival (Table 43).

Table 43. The estimated number of female spawners, egg deposition, fry, smolts, wild spawning adults, and freshwater and marine survival rates for coho salmon in Cascade Creek. The number of actual fish caught is reported (in parentheses) when trap efficiency could not be determined for a particular size class.

Brood Year	Female Spawners Wild	Female Spawners Hatchery	Egg Deposition	Fry	Smolts	Returning Adults (wild) F	Returning Adults (wild) M	Percent Survival FW	Percent Survival Marine
1994						16	14		
1995						5	1		
1996					1,409	5	4		0.7%
1997	16	1	37,321	0	555	11	34	1.5%	4.0%
1998	5	0	10,104	0	(9)	5	17	na[a]	na[a]
1999	5	0	14,927	(6)	1,468	45	62	9.8%	6.1%
2000	11	0	28,471	3,224	1,754	42	86	6.2%	4.8%
2001	5	0	15,245	(21)	1,478	30	86	9.7%	4.1%
2002	45	0	120,657	1,707	3,053	140	219	2.5%	9.2%
2003	42	0	105,631	781	6,471	42	82	6.1%	1.3%
2004	30	0	83,832	3,614	5,218	55	98	6.2%	2.1%
2005	140	0	375,027	4,859	7,458	160	234	2.0%	4.3%
2006	42	0	114,183	1,912	6,201	227	329	5.4%	7.4%
2007	55	0	127,876	2,866	9,801	115	117	7.7%	2.4%
2008	160	0	445,935	49,127	7,902	229	306	1.8%	5.8%
2009	226	0	556,395	50,516	5,983	173	273	1.1%	5.8%
2010	115	0	331,301	33,858	7,577	82	137	2.3%	2.2%
2011	227	0	622,834	24,732	8,157			1.3%	
2012	172	0	404,025	47,845	9,648			2.4%	
2013	82	0	211,241	13,716					

[a] survival could not be estimated due to low smolt production

For years in which freshwater survival could be estimated, values have varied from 1.1% (2009 brood year) to 9.8% (1999 brood year). Freshwater survival has generally been lower in broods with higher spawner abundance, but large variation in freshwater survival has been observed among years with similar numbers of female spawners (Table 43). While low spawning density typically results in increased freshwater survival because of minimal density-dependent mortality, the females in the 1998 brood apparently failed to find and spawn with the one adult male and seven jacks that also returned in 1998, resulting in a failed year class. Although there were not enough recaptures to make a smolt estimate for the 1998 brood, it appeared that less than 15 coho smolts migrated past the trap site during the 2000 smolt trapping season. These fish likely originated below the waterfall and adult trap on Cascade Creek, and had moved upstream of the smolt trapping site during the winter. Interestingly, this brood line recovered over the next four brood cycles, and produced a total of 232 adult spawners in 2010 and 218 adult spawners in 2013.

Table 44. The estimated number of juvenile salmonids migrating past the Cascade Creek juvenile trap. For cutthroat trout, only the two largest size classes are shown. The number of actual fish caught is reported (in parentheses) when trap efficiency could not be determined for a particular size class. Additional out-migrant data are provided in the appendices.

Sample Year	Coho smolts ± CI	Steelhead smolts ≥ 120 mm ± CI	Cutthroat migrants ± CI 160-249 mm	Cutthroat migrants ± CI 120-159 mm
1998	1,409 ± 98	134 ± 114	197 ± 100	794 ± 265
1999	555 ± 73	(10)	188 ± 67	644 ± 125
2000	(9)	128 ± 37	374 ± 131	701 ± 82
2001	1,468 ± 96	147 ± 51	432 ± 94	1,312 ± 118
2002	1,754 ± 123	116 ± 84	399 ± 157	1,480 ± 163
2003	1,478 ± 108	(17)	295 ± 137	1,617 ± 165
2004	3,053 ± 120	(11)	304 ± 102	1,368 ± 157
2005	6,471 ± 247	63 ± 22	333 ± 67	1,989 ± 253
2006	5,218 ± 239	(24)	645 ± 118	1,474 ± 141
2007	7,458 ± 327	60 ± 59	320 ± 792	1,478 ± 1,303
2008	6,201 ± 243	(20)	417 ± 280	1,334 ± 112
2009	9,801 ± 347	(29)	465 ± 135	1,490 ± 110
2010	7,902 ± 288	(18)	360 ± 86	1,848 ± 235
2011	5,983 ± 208	(5)	399 ± 133	1,594 ± 178
2012	7,577 ± 384	(12)	391 ± 139	1,102 ± 229
2013	8,157 ± 223	(19)	444 ± 135	1,162 ± 139
2014	9,648 ± 384	(2)	212 ± 88	752 ± 118

Estimates of the number of coho salmon smolts leaving Cascade Creek each spring by sample year are summarized in Table 44 and Figure 22. Additional data on smolt size and fry numbers are in Appendix 1. Peak migration of coho salmon smolts in Cascade Creek typically occurs between mid-April and early May, and smolts have left the stream by mid-June. As noted above, coho smolt production has generally increased during the period of monitoring (Figure 22), and there is a positive relationship between number of spawning females and the number of smolt out-migrants (Figure 23a). This relationship appears to level off at higher spawner abundance levels, however, suggesting that the stream had reached its capacity for rearing juvenile coho salmon. Using the ODFW Habitat Limiting Factors Model (Anlauf et al. 2009) and winter habitat data collected at Cascade Creek in 2010, a smolt production capacity of 10,200 coho smolts is predicted for this site, which is very similar to the highest number of smolts we have observed. Excluding the 1998 brood year, the number of smolts per female spawner has ranged from 26 in the 2009 brood year to 296 in the 2001 brood year. The number of smolts per female spawner generally decreased with increasing spawner abundance (Figure 23b), consistent with observations on freshwater survival.

The number of coho fry out-migrants was very low during the first several years of monitoring, but has generally increased with increased spawner abundance (Figure

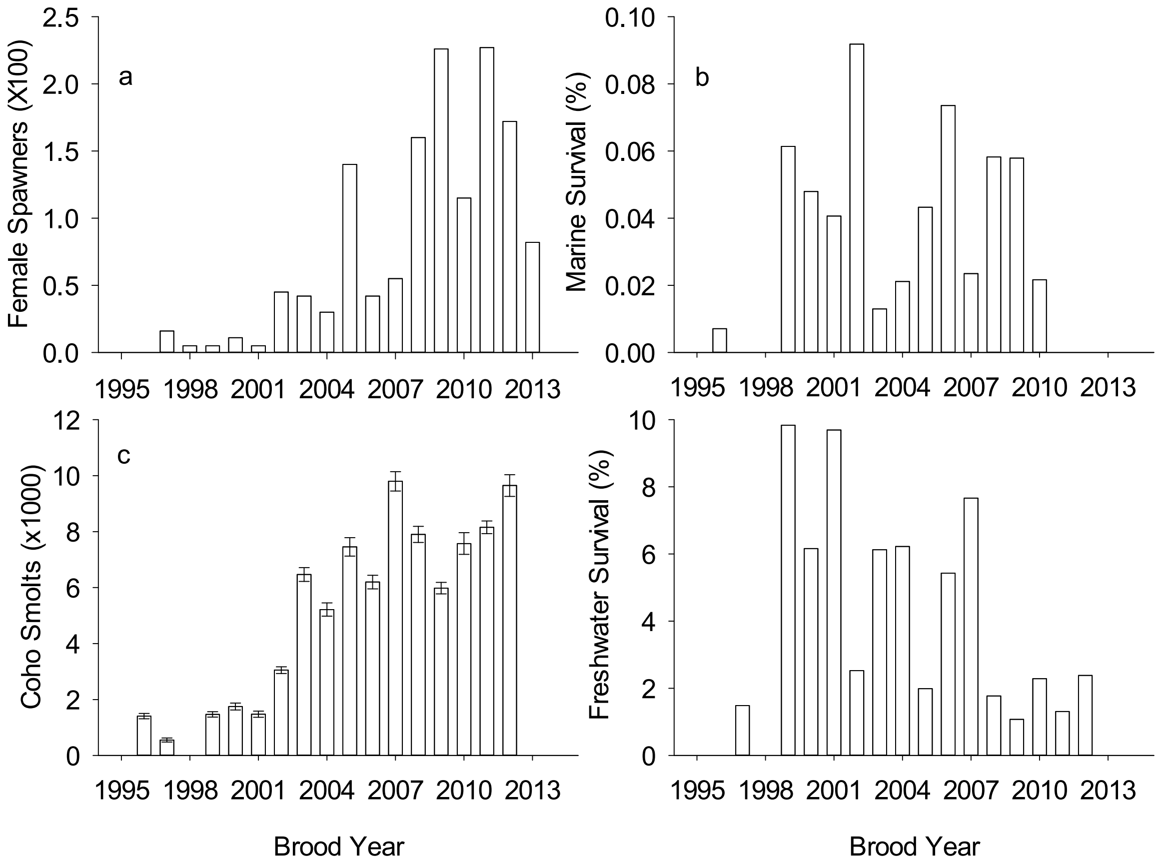

Figure 22. Annual trends in the (a) parental female spawner estimate, (b) percent marine survival, (c) smolt production estimate, and (d) percent freshwater survival for coho salmon in Cascade Creek.

23a) and has been much larger in recent years (Table 43). The number of fry produced per female has been highly variable, and is only weakly correlated with female spawner abundance. This suggests that spring flow conditions or other environmental factors may be as important as density dependent effects in determining the number of coho fry out-migrants.

Fall Chinook Salmon

The numbers of adult and jack fall Chinook salmon captured in the Cascade Creek trap are given in Table 45. Fall Chinook salmon passed above the trap represent the total spawning population above the waterfall. The number of fall Chinook captured at the trap is typically low and heavily weighted toward male spawners. Estimates of the number of fall Chinook salmon juveniles that migrated downstream past the rotary screw trap each spring are summarized in Table 46. Because the juvenile trap is located downstream of the waterfall and fish ladder, the estimate of downstream migrants may be influenced by adult fall Chinook salmon spawning in the short reach between the waterfall and the juvenile trapping site. Thus, estimates of juvenile abundance may not always reflect production of the few adults passed above the waterfall. Fall Chinook salmon juveniles leave Cascade Creek as fry, with peak week of migration typically in late March to mid-April.

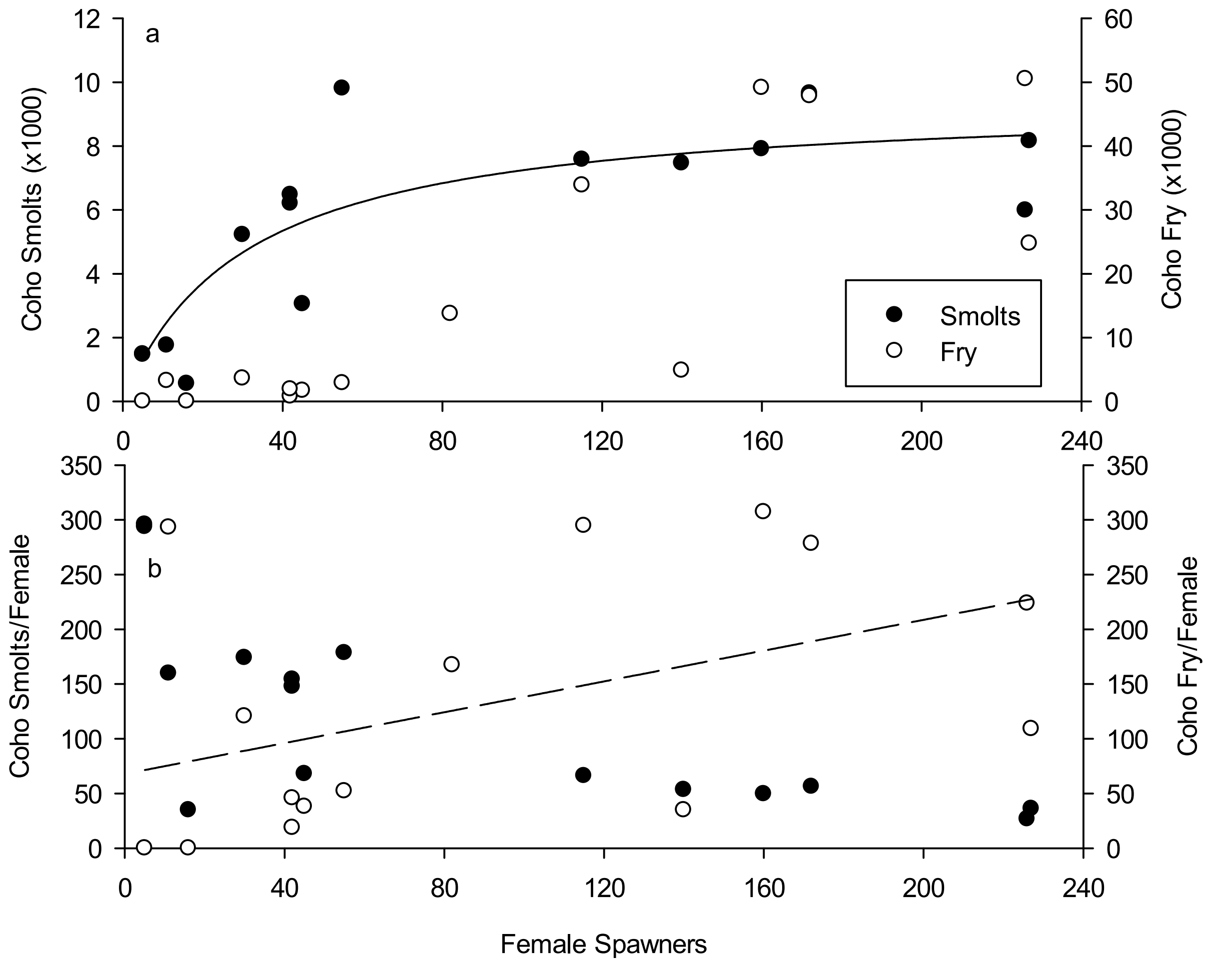

Figure 23. a) The relationship between coho smolt (solid symbols) and fry (clear symbols) migrants and female spawners in Cascade Creek. The solid line is the regression line between smolts and female spawners (R^2=0.72, p<0.001). b) The relationship between coho smolts/female (solid symbols) and fry/female (clear symbols) migrants and female spawners in Cascade Creek. The dashed line is the regression line between fry/female and female spawners (R^2=0.21, p=0.086).

Winter Steelhead

The numbers of adult and jack winter steelhead captured in the Cascade Creek trap are given in Table 45. Estimates of the number of winter steelhead smolts leaving Cascade Creek each spring are summarized in Table 44. Additional data on pre-smolts and average length of smolts during the week of peak migration are provided in Appendix 2. Steelhead smolt production and adult returns are generally very low at Cascade Creek. Adult winter steelhead of hatchery origin often constitute a substantial portion of the total catch at the trap (range 13-72%), but hatchery steelhead have not been passed at the trap since the first year of monitoring (Table 45). Many of the hatchery steelhead captured at Cascade Creek do not have marks applied to Alsea

Table 45. The number of female (F), male (M) and jack (J) Chinook salmon and steelhead trout captured at the Cascade Creek adult trap and the estimated spawning population in the Cascade Creek watershed.

Return Year & Species	Trap Catch						Spawning Population					
	Wild			Hatchery			Wild			Hatchery		
	F	M	J	F	M	J	F	M	J	F	M	J
Fall Chinook												
1997	0	1	0	0	0	0	0	1	0	0	0	0
1998	0	0	0	0	1	0	0	0	0	0	0	0
1999	0	0	2	0	0	0	0	0	2	0	0	0
2000	0	0	0	0	0	0	0	0	0	0	0	0
2001	1	4	0	0	0	0	1	4	0	0	0	0
2002	0	2	0	0	0	0	0	2	0	0	0	0
2003	2	5	0	0	0	0	2	5	0	0	0	0
2004	3	9	3	0	0	0	3	9	3	0	0	0
2005	7	19	0	0	0	0	7	19	0	0	0	0
2006	12	18	0	1	0	0	12	18	0	0	0	0
2007	1	0	0	0	0	0	1	0	0	0	0	0
2008	0	2	0	0	0	0	0	2	0	0	0	0
2009	1	4	1	0	0	0	1	4	1	0	0	0
2010	3	12	0	0	0	0	3	12	0	0	0	0
2011	13	23	1	0	0	0	13	23	1	0	0	0
2012	1	9	2	0	0	0	1	9	2	0	0	0
2013	1	3	0	0	0	0	1	3	0	0	0	0
Steelhead												
1998	3	3	0	1	3	0	3	3	0	1	3	0
1999	3	2	0	1	0	1	3	2	0	0	0	0
2000	3	8	0	1	2	0	3	8	0	0	0	0
2001	9	9	7	7	11	1	9	9	7	0	0	0
2002	2	1	0	0	1	1	2	1	0	0	0	0
2003	3	4	0	1	0	0	3	4	0	0	0	0
2004	9	12	0	5	6	0	9	12	0	0	0	0
2005	2	3	0	7	6	2	2	3	0	0	0	0
2006	7	12	1	6	9	7	7	12	1	0	0	0
2007	2	1	0	1	2	0	2	1	0	0	0	0
2008	4	2	0	1	0	0	4	2	0	0	0	0
2009	1	2	0	1	4	0	1	2	0	0	0	0
2010	6	5	0	1	3	0	6	5	0	0	0	0
2011	3	2	0	1	2	1	3	2	0	0	0	0
2012	2	4	0	3	2	0	2	4	0	0	0	0
2013	3	1	1	0	4	0	3	1	1	0	0	0
2014	4	0	0	2	1	0	4	0	0	0	0	0

Table 46. The estimated number of sub-yearling (fry and fingerling) fall Chinook salmon migrants and week of peak out-migration in Cascade Creek. The out-migration year is the first year following egg deposition (e.g., the 1997 brood year was sampled in 1998).

Sample Year	Migrants	±	95% CI	Peak week
1998	(8)			
1999	(1)			
2000	987	±	2,185	3/27-4/02
2001	(15)			
2002	1,163	±	400	4/01-4/07
2003	(2)			
2004	1,453	±	13,477	4/12-4/18
2005	110	±	76	5/30-6/05
2006	792	±	2,468	3/13-3/19
2007	19,024	±	2,356	4/02-4/08
2008	126	±	1,388	5/26-6/01
2009	-			
2010	(18)			
2011	3,016	±	7,062	4/11-4/17
2012	8,919	±	2,254	4/23-4/29
2013	(25)			
2014	(45)			

River hatchery stocks and appear to be out-of-basin strays. Peak migration of steelhead smolts is typically in late March to mid-April and the average size during the peak week is 139 mm.

Cutthroat Trout

The numbers of adult cutthroat trout captured in the Cascade Creek trap are given in Table 47. Trap catch does not include all adult migrants and is not a good index of abundance because the spacing of trap bars is wide enough for some adults to move through the trap. Estimates of the number of cutthroat trout that migrate downstream and leave Cascade Creek each spring are given in Table 44, with addition out-migrant data given in Appendix 3. The week of peak migration is typically in mid-April. Many cutthroat migrants that are 90-159 mm FL show partial silvering in their appearance. Nearly all cutthroat migrants 160-249 mm FL are either partially silvered or completely silvered when they migrate from the stream. Adult cutthroat trout (≥ 250 mm FL) are also captured each year at the smolt trap, with most fish caught in March and April. Trap catch typically ranges from 5-15 fish, but much higher numbers of adult cutthroat trout were captured in 2001 (47 cutthroat ≥ 250 mm FL) and 2005 (65 cutthroat ≥ 250 mm FL). Cutthroat trout ≥ 250 mm FL are not marked to make a population estimate, and smolt trap catch is probably not a good index of abundance due to differences in trapping conditions between years.

Table 47. The number of adult cutthroat trout (≥ 250 mm) captured in the Cascade Creek adult and out-migrant traps. Fish were caught October-June in the adult trap, and from February-June in the screw trap.

Return Year	Adult Ladder Trap[a]	Out-Migrant Screw Trap
1998	5	3
1999	50	7
2000	15	8
2001	8	47
2002	78	18
2003	82	6
2004	30	9
2005	39	65
2006	44	26
2007	23	16
2008	22	11
2009	20	15
2010	21	10
2011	12	1
2012	24	6
2013	6	23
2014	18	6

[a] Adult trap catch does not include all adult migrants entering the trap because the spacing of trap bars is wide enough for some adults to escape upstream.

Chapter 7: West Fork Smith River (Umpqua River)

The West Fork (WF) Smith River forms a 3rd order tributary to the Smith River within the Umpqua River basin. The watershed includes approximately 55.0 km of stream network that drains an area of 69 km^2. The WF Smith adult trap was constructed in 1998 and trapping for adult salmonids began in fall 1998. The adult trap uses a floating weir as a partial barrier to upstream migration, and a stream-side concrete trap box to retain fish. Trapping for juvenile fish began in spring 1998. The adult trap is located at river km 1.8 and the juvenile trap is located at river km 1.6 (Figure 24).

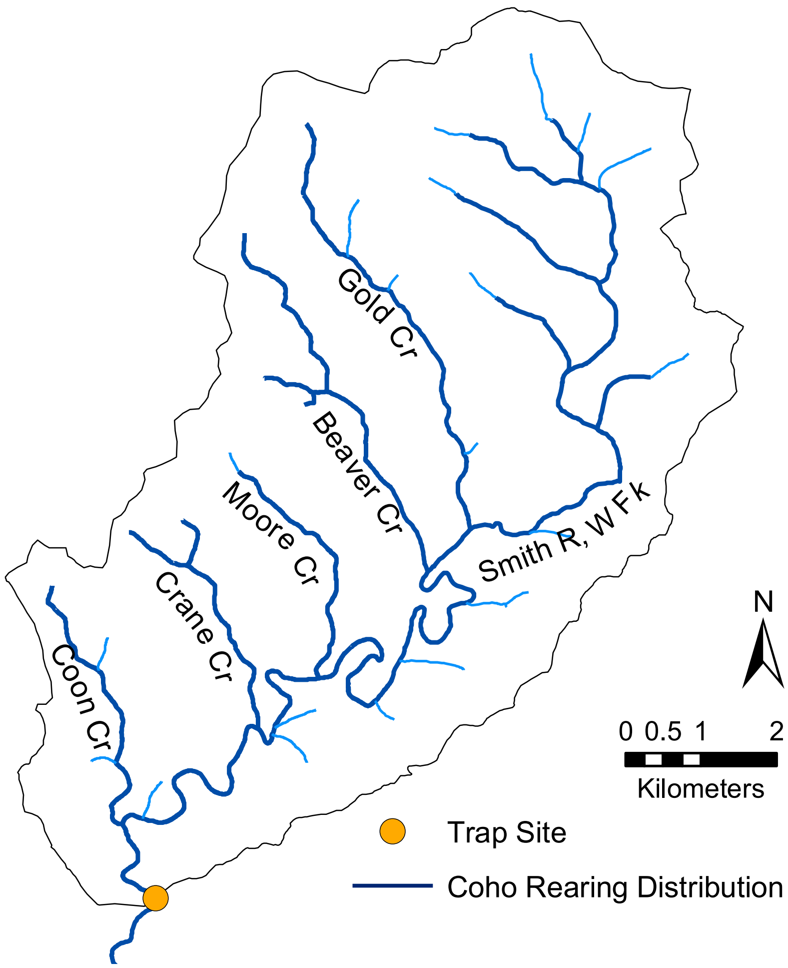

Figure 24. The West Fork Smith River showing the trap site and extent of coho rearing distribution.

Site specific methods

In most years coho salmon spawners are estimated using mark and recapture methodology as outlined in the general methods section, with estimates of female and male spawners based on percent representation in spawned-out carcasses recovered on surveys. In 1998, 2007 and 2010, too few fish were trapped and marked to use this method. As an alternative, spawners that returned in1998 and 2007 were estimated using area-under-curve (AUC) calculations for individual survey reaches and expanded for the entire basin. In 2010, we used mark and recapture methodology to estimate spawners but used only data collected from carcass recoveries. The low number of fish tagged in 2010, all within a short time frame, provided a limited opportunity to observe live fish for presence of tags. Carcasses persist in the system longer than live fish, providing a longer opportunity to determine the percentage of tagged fish in the spawner population.

Catch efficiency for coho salmon at WF Smith River is low in most years. Leaf debris causes frequent submergence of the floating weir, disabling the weir as a passage barrier. We compensate for low trap efficiency by increasing survey sample size (e.g. total number of observations). However, the bootstrap procedure does not account for sample size, so we use the relationship between the F and binomial distributions to estimate variance and confidence intervals for the population estimate. Briefly, we first calculate 95% confidence limits of the proportion of tagged fish in the population (R/C), then calculate the 95% confidence limits of tagged fish expected within the dataset. Peterson estimates are calculated at the new confidence limits to get 95% confidence intervals, where R in the Peterson equation is replaced by:

R_l (denominator for lower 95% CI) = $C*R/(R+(C-R+1) * F_{0.05}, v_1, v_2)$,
and
R_u (denominator for upper 95% CI) = $C * ((R + 1) * F_{0.05}, v'_1, v'_2) / (C – R + (R + 1) * F_{0.05}, v'_1, v'_2)$

where:
$v_1 = 2 (C-R+1)$
$v_2 = 2 R$
$v'_1 = 2 (R + 1)$
$v'_2 = 2 (C – R)$

Trap efficiency for steelhead spawners is sufficiently high to apply the bootstrap procedure for variance estimates.

Coho Salmon

Trap catch for wild and hatchery fish and spawner population estimates with 95% confidence intervals are shown in Table 48. There is no hatchery program in the Smith Basin; hatchery coho salmon trapped in some years were possibly strays from the North Umpqua River, which supports the only hatchery production of coho salmon within the basin. The largest hatchery returns were in 2001 when 35 hatchery fish were estimated to have made it to the spawning grounds (2.4% hatchery origin spawners).

Fry and smolt production and calculated freshwater and marine survival rates are summarized in Table 50, and trends in these parameters are shown in Figure 25. Smolt estimates with confidence intervals are shown in Table 51 and additional data on peak migration week, smolt size, and fry abundance are summarized in Appendix 1. Number of returning spawners has varied widely, a function of variation in marine survival rate. The trend in freshwater survival appears to be inversely correlated to number of spawners, with highest survival corresponding to low return years.

Table 48. The number of female (F), male (M) and jack (J) coho salmon captured at the WF Smith River adult trap and the estimated spawning population above the trap. Coho jack (J) spawners were not estimated (na) when insufficient numbers of tagged jacks were recovered on surveys.

Return Year	Trap Catch: Wild F	Wild M	Wild J	Hatchery F	Hatchery M	Wild Spawning Population: Total and 95% CI Range		Sex F	Sex M	Sex J
1998	0	0	0	0	0	155	na	72	83	na
1999	38	58	1	0	0	293	238-372	130	163	na
2000	46	56	23	0	0	550	465-657	271	279	na
2001	49	57	6	8	11	1,436	1,216-1,795	707	729	189
2002	100	173	12	3	0	3,444	3,122-3,927	1,520	1,924	114
2003	56	110	2	0	0	3,727	3,220-4,441	1,787	1,940	101
2004	30	32	0	0	0	978	787-1,233	417	561	na
2005	16	34	2	0	0	1,818	1,458-2,392	723	1,095	na
2006	17	16	0	2	1	1,151	831-1,658	464	687	na
2007	7	6	0	0	0	335	na	137	198	na
2008	16	23	4	0	0	1,260	1,000-1,653	501	759	na
2009	124	127	1	0	1	2,225	1,990-2,483	1,094	1,131	na
2010	19	23	2	0	0	2,909	1,655-5,830	1,583	1,326	na
2011	49	88	4	1	1	1,538	1,359-1,776	705	833	22
2012	22	21	4	0	0	561	416-776	235	326	40
2013	62	51	10	0	0	1,775	1,522-2,090	753	1,022	122

Figure 26a shows the relationship of number of coho fry and smolt migrants to size of spawner stock. The relationship of fry migrants to spawners displays a linear correlation, with increased spawner levels corresponding to proportionate increases in fry migrants (R^2=0.83, p<0.0001). There is little variation in this parameter except at low spawner levels (Figure 26b). This suggests that above a spawner abundance threshold a fixed number of fry produced from each female tends to move downstream irrespective of seeding level.

The linear correlation of smolt production to female spawners is less strong (R^2=0.45, p=0.049). The relationship between smolts produced and spawners can also be explained by a power-function regression of smolts per female and size of spawner stock (Figure 26b, R^2=0.74, p<0.0003). Highest production rates were found at low spawner densities. This suggests survival of one or more life-history stages may be density dependent, and by inference, habitats essential to specific life-history stages may be limited.

While there is evidence that rearing habitat quantity and quality in the basin is limiting smolt production, the increasing trend in coho smolts produced (Figure 25c) suggests carrying capacity may be increasing. For the period of monitoring presented here, mean smolt population size has almost doubled from 17,783 for the period 1998-2004 to 32,461 for the period 2005-2011 (SD=4,376 and 7,656, respectively).

Table 49. The estimated number of female spawners, egg deposition, fry, smolts, wild spawning adults, and freshwater and marine survival rates for coho salmon in the WF Smith River. The number of actual fish caught is reported (in parentheses) when trap efficiency could not be determined for a particular size class.

Brood	Female Spawners		Egg			Returning Adults (wild)		Percent Survival	
Year	Wild	Hatchery	Deposition	Fry	Smolts	F	M	FW	Marine
1996					22,143	131	164		1.2%
1997				4,070	11,223	273	280		4.9%
1998	72	0	205,405	2,867	16,199	707	734	7.9%	8.7%
1999	131	0	376,545	6,490	20,340	1,521	1,926	5.4%	15.0%
2000	273	0	721,450	18,200	18,355	1,790	1,940	2.5%	19.5%
2001	707	15	2,044,536	33,069	16,519	417	561	0.8%	5.0%
2002	1521	4	4,853,940	100,747	24,810	723	1,095	0.5%	5.8%
2003	1790	0	5,130,275	115,078	43,224	464	688	0.8%	2.1%
2004	417	0	1,184,220	33,285	23,804	137	198	2.0%	1.2%
2005	723	0	2,222,612	58,280	26,697	501	759	1.2%	3.8%
2006	464	0	1,376,200	32,513	29,783	1,096	1,134	2.2%	7.4%
2007	137	0	352,316	3,279	42,117	1,583	1,326	12.0%	7.5%
2008	501	0	1,511,052	4,412	41,627	705	833	2.8%	3.4%
2009	1096	0	2,706,553	32,524	30,403	235	326	1.1%	1.5%
2010	1583	0	4,830,255	(4,134)	35,075	753	1,775	0.7%	4.3%
2011	705	0	1,924,663	(238)	36,872			1.9%	
2012	235	0	574,217	8,163	40,968			7.1%	
2013	753	0	2,011,293	9,806					

Fall Chinook Salmon

Fall Chinook salmon spawn in the West Fork Smith River, but we have not been able to estimate spawner populations using mark-recapture methodology. Many of the fall Chinook that get trapped and passed upstream or that bypass the trap when the weir is submerged subsequently move downstream of the trap. Because of this behavior the tagged population above the trap cannot be determined accurately. Fall Chinook spawn in main stem reaches almost exclusively. Spawners are counted on surveys, but counts are generally too low to make population estimates using area-under-the-curve calculation. Trap catch for adult fall Chinook is shown in Table 52.

The numbers of juvenile fall Chinook salmon migrants have varied widely from fewer than 1,000 in two years to over 100,000 in two other years (Table 53). Week of peak migration has also varied considerably, from early March to late May. Migrants are underestimated most years because while catch of juvenile fall Chinook decreases in May in most years, juveniles are usually still being caught when the trap becomes inoperable due to low stream flows in June.

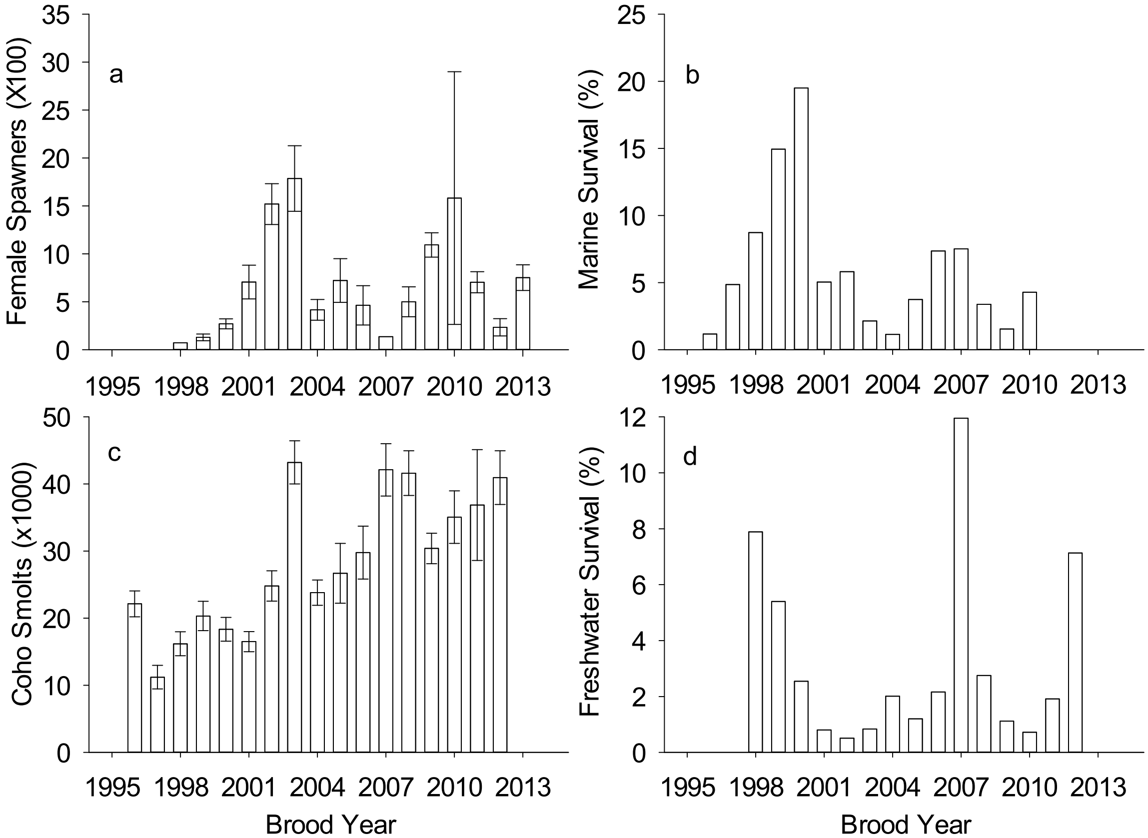

Figure 25. Annual trends in the (a) parental female spawner estimate, (b) percent marine survival, (c) smolt production estimate, and (d) percent freshwater survival for coho salmon in the WF Smith River.

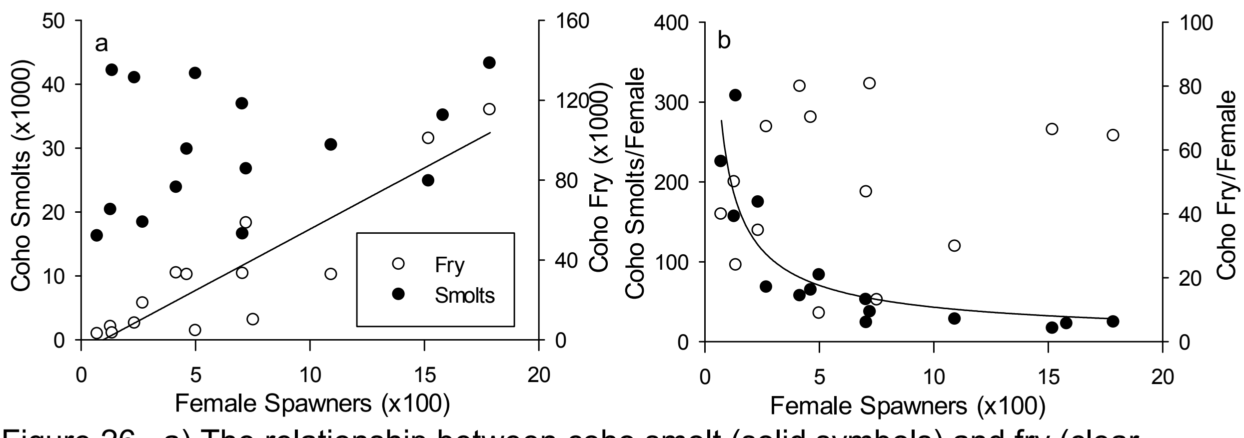

Figure 26. a) The relationship between coho smolt (solid symbols) and fry (clear symbols) migrants and female spawners in the WF Smith River. The solid line is the regression line between fry and female spawners (R^2=0.64, p<0.001). b) The relationship between coho smolts/female (solid symbols) and fry/female (clear symbols) migrants and female spawners in the West Fork Smith River. The solid line is the regression line between smolts/female and female spawners (R^2=0.74, p<0.001).

Table 50. The estimated number of juvenile salmonids that migrated past the WF Smith River juvenile trap. For cutthroat trout, only the two largest size classes are shown. The number of actual fish caught is reported (in parentheses) when trap efficiency could not be determined for a particular size class. Additional out-migrant data are provided in the appendices.

Sample Year	Coho smolts ± CI	Steelhead smolts (≥ 120 mm) ± CI	Cutthroat migrants ± CI 160-249 mm	Cutthroat migrants ± CI 120-159 mm
1998	22,143 ± 1,940	6,552 ± 1,319	(194)	(4)
1999	11,223 ± 1,756	3,171 ± 1,094	(149)	2,412 ± 1,566
2000	16,199 ± 1,776	3,335 ± 1,017	(0)	1,547 ± 564
2001	20,340 ± 2,191	7,851 ± 1,727	(9)	1,876 ± 615
2002	18,355 ± 1,774	7,346 ± 4,316	(0)	2,875 ± 1,021
2003	16,519 ± 1,497	(158)	(101)	(82)
2004	24,810 ± 2,262	3,186 ± 1,766	(90)	(36)
2005	43,224 ± 3,207	5,568 ± 1,980	1,438 ± 772	938 ± 480
2006	23,804 ± 1,884	4,533 ± 1,764	2,257 ± 1,041	1,743 ± 582
2007	26,697 ± 4,467	10,995 ± 7,524	(63)	(77)
2008	29,783 ± 3,949	4,002 ± 2,248	(74)	1,479 ± 645
2009	42,117 ± 3,900	6,974 ± 4,588	2,639 ± 1,468	2,161 ± 839
2010	41,627 ± 3,328	(234)	(158)	(176)
2011	30,403 ± 2,262	7,521 ± 3,994	3,525 ± 1,784	2,576 ± 915
2012	35,075 ± 3,906	(235)	2,450 ± 1,680	2,599 ± 1,825
2013	36,872 ± 8,244	6,338 ± 2,066	(151)	1,549 ± 721
2014	40,968 ± 4,000	(277)	2,201 ± 1,352	3,242 ± 1,394

Winter Steelhead

Trap catch and spawner population estimates for winter steelhead are summarized in Table 52 and total spawner population estimates with confidence intervals are shown in Table 54. There is no hatchery program in the Smith Basin and the few hatchery fish trapped in some years are possibly strays from the Siuslaw River, the closest basin with a steelhead hatchery program. The mark/recapture estimates of total spawners are adjusted to account for repeat spawners. A portion of fish that return each year have tags implanted the previous year, and any yellow-tagged fish that bypass the trap become part of the marked (M) population. It is assumed that repeat spawners are equally represented in trap catch and the population that bypasses the trap, thus the number marked is adjusted by the percentage of repeat spawners in the trap catch and the calculated percentage of total spawners that bypass the trap. Because some tagged repeat spawners in trap catch have only one tag, the number of repeat spawners each year is also adjusted to account for tag loss.

Estimated numbers of winter steelhead smolts (FL ≥ 120mm) are summarized in Table 51, and data on peak week of migration and pre-smolt migrants are given in Appendix 2.

Table 51. The number of female (F), male (M) and jack (J) Chinook salmon and steelhead trout captured at the WF Smith River adult trap and the estimated spawning population upstream of the trap.

Return Year & Species	Trap Catch						Spawning Population					
	Wild			Hatchery			Wild			Hatchery		
	F	M	J[b]	F	M	J	F	M	J	F	M	J
Fall Chinook												
1998	0	13	0	0	0	0						
1999	3	12	1	0	0	0						
2000	1	25	7	0	0	0						
2001	5	33	3	0	1	0						
2002	2	12	0	0	0	0						
2003	2	20	2	0	0	0						
2004	8	21	2	6	21	1						
2005	2	14	4	1	4	0						
2006	0	1	0	0	0	0						
2007	2	6	1	0	0	0						
2008	2	16	3	0	1	0						
2009	8	49	7	0	0	2						
2010	2	24	3	1	1	0						
2011	12	51	16	0	0	1						
2012	8	39	11	0	1	2						
2013	13	48	2	0	0	0						
Steelhead[a]												
1999	54	52	4	3	2		178	172	0	10	7	0
2000	244	158	1	1	1		273	177	0	1	1	0
2001	141	125	7	1	2		175	155	0	1	2	0
2002	116	88	2	0	1		472	358	0	2	2	0
2003	45	72	0	0	0		144	231	0	0	0	0
2004	104	93	1	0	1		281	252	0	2	1	0
2005	78	79	2	1	3		120	121	0	2	5	0
2006	56	43	0	4	1		229	176	0	16	4	0
2007	58	74	2	0	1		168	214	0	0	3	0
2008	31	57	2	0	0		109	200	0	0	0	0
2009	50	45	0	0	1		223	200	0	0	4	0
2010	147	114	1	0	0		211	164	0	0	0	0
2011	71	72	0	2	0		229	233	0	6	0	0
2012	58	42	0	1	1		315	228	0	5	5	0
2013	200	187	5	4	2		245	229	0	5	2	0
2014	84	68	0	2	6		150	122	0	4	11	0

[a] separate mark-recapture estimates for adult males and jacks were not made; estimated number of male spawners includes jacks.

Table 52. The estimated number of sub-yearling (fry and fingerling) fall Chinook salmon migrants and week of peak out-migration in the WF Smith River. The out-migration year is the first year following egg deposition (e.g., the 1997 brood year was sampled in 1998). The number of actual fish caught is reported (in parentheses) when trap efficiency could not be determined for a particular size class.

Sample Year	Migrants	±	95% CI	Peak Week
1998	129,959	±	13,250	3/2/1998
1999	10,869	±	1,801	3/15/1999
2000	4,746	±	1,162	4/10/2000
2001	1,195	±	1,127	4/23/2001
2002	17,551	±	7,693	4/8/2002
2003	4,487	±	2,497	4/28/2003
2004	13,639	±	3,379	4/5/2004
2005	27,973	±	14,694	3/7/2005
2006	101,929	±	16,327	3/27/2006
2007	39,901	±	5,288	3/26/2007
2008	4,681	±	1,529	3/10/2008
2009	9,819		5,904	4/27/2009
2010	4,767		11,390	3/22/2010
2011	(1,230)			
2012	1,492	±	1,168	5/14/2012
2013	48,728	±	9,234	3/11/2013
2014	19,979	±	9,769	4/21/2014

Winter Steelhead

Trap catch and spawner population estimates for winter steelhead are summarized in Table 52 and total spawner population estimates with confidence intervals are shown in Table 54. There is no hatchery program in the Smith Basin and the few hatchery fish trapped in some years are possibly strays from the Siuslaw River, the closest basin with a steelhead hatchery program. The mark/recapture estimates of total spawners are adjusted to account for repeat spawners. A portion of fish that return each year have tags implanted the previous year, and any yellow-tagged fish that bypass the trap become part of the marked (M) population. It is assumed that repeat spawners are equally represented in trap catch and the population that bypasses the trap, thus the number marked is adjusted by the percentage of repeat spawners in the trap catch and the calculated percentage of total spawners that bypass the trap. Because some tagged repeat spawners in trap catch have only one tag, the number of repeat spawners each year is also adjusted to account for tag loss.

Estimated numbers of winter steelhead smolts (FL ≥ 120mm) are summarized in Table 51, and data on peak week of migration and pre-smolt migrants are given in Appendix 2.

Table 53. The estimated number of winter steelhead spawners in the WF Smith River upstream of the trap. Repeat spawners are the percentage of both males and females that entered the trap with tags implanted in previous years.

Return Year	Winter Steelhead Spawners ± 95% CI			Repeat Spawners (%)
1999	366	±	128	na
2000	453	±	21	0.7
2001	334	±	17	12.6
2002	834	±	216	4.9
2003	375	±	114	2.6
2004	536	±	111	2.0
2005	247	±	36	1.9
2006	425	±	158	5.8
2007	385	±	103	0.8
2008	308	±	122	3.4
2009	427	±	179	2.1
2010	375	±	41	2.3
2011	468	±	133	1.4
2012	554	±	268	5.9
2013	481	±	30	3.3
2014	286	±	50	8.8

Cutthroat Trout

Trap catch of cutthroat trout does not include all adult migrants as picket spacing in the floating weir and adult trap in the WF Smith River is too wide to effectively retain adult cutthroat trout (Table 54). Live adults and cutthroat trout redds are counted on spawner surveys, but counts are generally too low to make population estimates using area-under-curve calculation. Estimated numbers of juvenile cutthroat trout migrants in the two largest size classes are shown in Table 51. There is considerable variation between years in the relative proportion of each size class. Adult cutthroat trout (≥ 250 mm FL) are also captured each year at the smolt trap (Table 54) Cutthroat trout ≥ 250 mm FL are not marked to make a population estimate, and smolt trap catch is probably not a good index of abundance due to differences in trapping conditions between years. Appendix 3 provides additional data on peak migration week and numbers of cutthroat trout migrants smaller than 120mm FL.

Table 54. The number of adult cutthroat trout (≥ 250 mm) captured in the West Fork Smith River adult and out-migrant traps. Fish were caught October-June in the adult trap, and from February-June in the screw trap.

Return Year	Adult Ladder Trap[a]	Out-Migrant Screw Trap
1998	0	0
1999	0	0
2000	0	10
2001	0	17
2002	0	3
2003	0	1
2004	0	9
2005	0	10
2006	0	8
2007	0	10
2008	0	13
2009	0	5
2010	0	8
2011	0	34
2012	0	13
2013	0	19
2014	0	18

[a] Adult trap catch does not include all adult migrants entering the trap because the spacing of trap bars is wide enough for some adults to escape upstream.

Chapter 8: Winchester Creek (South Slough, Coos Bay)

Winchester Creek is a 2nd order stream that forms the principal drainage of South Slough, a major estuarine arm of Coos Bay. The watershed drains a basin area of 24 km^2 with approximately 19.1 km of stream accessible to anadromous fish (Figure 27). The adult trap was constructed in 1999 and trapping for adult salmonids began in fall 1999. The adult trap is located within tidal influence approximately 0.5 km below head of tide (≤ 1 m tidal exchange), and uses a V-shaped weir consisting of vertical steel pickets as a barrier to upstream migration. The weir is a total migration barrier for adult fish except when high stream flows coincide with high spring-series tides. Juvenile fish are trapped using a rotary screw trap located at head of tide. Trapping for juvenile fish began in spring 1999. The juvenile trap was also operated in the fall from 2000-2011.

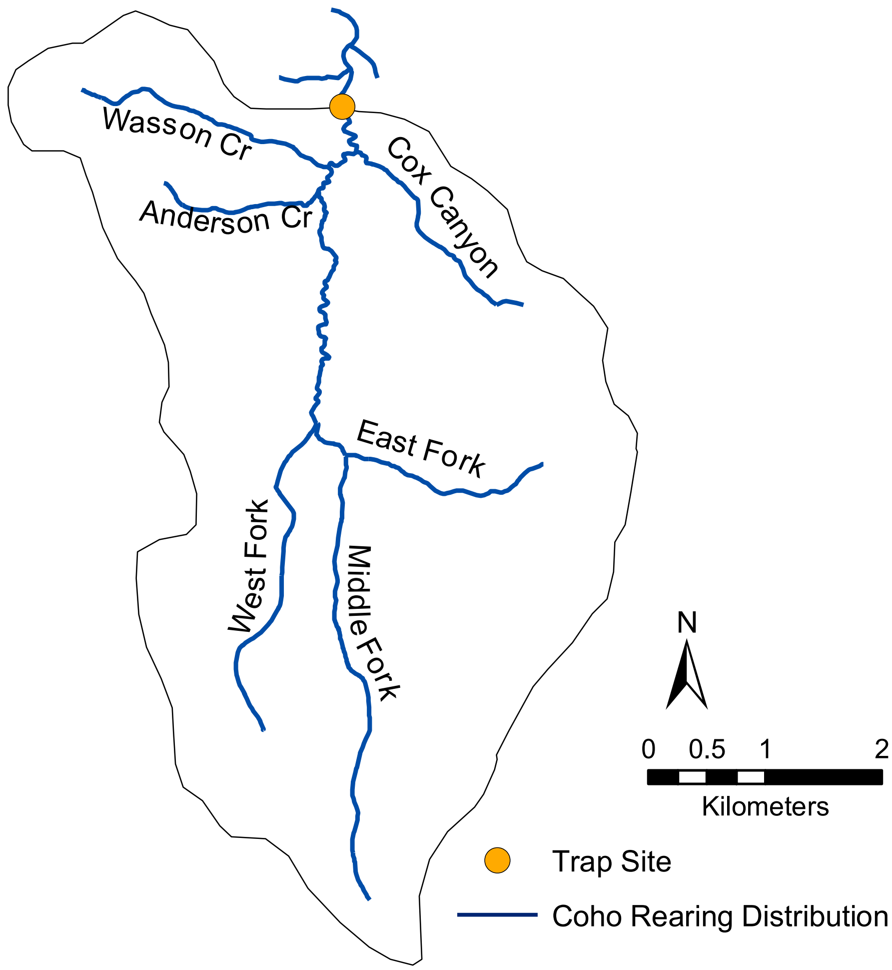

Figure 27. Winchester Creek showing the trap site and extent of coho rearing distribution.

Coho Salmon

Trap catch for wild and hatchery fish and spawner population estimates with 95% confidence intervals are shown in Table 55. Total spawners, fry and smolt production, and freshwater and marine survival rates are summarized in Table 54, and smolt numbers with confidence intervals are shown in Table 55. Trends in these parameters are shown in Figure 28. Data on peak migration week, size and fry abundance are summarized in Appendix 1. In the first years of monitoring hatchery fish made up a significant portion of returns, with a peak of 54 hatchery origin spawners in 2002 (15.9% hatchery origin spawners). Coho releases in the Coos Basin have been discontinued and only one hatchery coho has been trapped since 2006.

The number of smolts produced increased linearly as with the number of spawners (Figure 29a, R^2=0.70, p=0.001); the smolts per female decreased as the number of spawners increased, ranging from 33-360 smolts/female (Figure 29b, p=0.036), which suggests freshwater density dependent effects limits smolt production. The number of migrant fry/spawner increased as the number of spawners increased (Figure 29b, R^2=0.76, p<0.001) which suggests that rearing habitat is limiting.

Table 55. The number of female (F), male (M) and jack (J) coho salmon captured at the Winchester Creek adult trap and estimated spawning population above the trap. Estimated numbers of female and male spawners were based on the sex ratio observed at the trap.

	Trap Catch						Wild Spawning Population				
	Wild			Hatchery					Sex		
Return Year	F	M	J	F	M	J	Total ± CI		F	M	J
1999	5	10	5	2	3	1	30 ±	26	10	20	na
2000	3	2	73	0	0	1	5		3	2	na
2001	140	101	20	46	57	1	301 ±	11	175	126	72
2002	27	25	6	8	4	3	285 ±	349	148	137	38
2003	10	12	14	5	4	0	44 ±	47	20	24	75
2004	44	48	17	0	0	0	374 ±	167	179	195	201
2005	90	66	8	1	1	0	149 ±	24	74	75	33
2006	6	1	1	5	2	0	36 ±	25	19	17	na
2007	6	7	1	0	0	0	13		6	7	na
2008	13	8	2	0	1	0	21		13	8	na
2009	13	12	2	0	0	0	96 ±	157	51	45	na
2010	6	4	0	0	0	0	26 ±	45	16	10	na
2011	18	10	1	0	0	0	108 ±	127	69	39	na
2012	12	3	5	0	0	0	79 ±	92	63	16	90
2013	10	7	4	0	0	0	21	0	13	8	na

Table 56. The estimated number of female spawners, egg deposition, fry, smolts, wild spawning adults, and freshwater and marine survival rates for coho salmon in Winchester Creek. The number of actual fish caught is reported (in parentheses) when trap efficiency could not be determined for a particular category.

Brood Year	Female Spawners Wild	Female Spawners Hatchery	Egg Deposition	Fry	Smolts	Returning Adults (wild) F	Returning Adults (wild) M	Percent Survival FW	Percent Survival Marine
1996						10	20		
1997					2,464	3	2		na[a]
1998				(68)	4,002	175	128		8.8%
1999	10	4	34,928	(27)	6,176	148	137	17.7%	4.8%
2000	3	0	8,343	(0)	1,083	20	24	13.0%	3.7%
2001	175	2	517,326	36,172	11,248	179	195	2.2%	3.2%
2002	148	36	546,212	51,268	5,685	74	58	1.0%	2.6%
2003	20	6	73,170	(3)	1,468	19	17	2.0%	2.6%
2004	179	0	452,492	45,805	8,944	6	7	2.0%	0.1%
2005	74	0	187,476	5,063	6,301	14	8	3.4%	0.4%
2006	19	0	51,156	3,278	3,336	52	47	6.5%	3.1%
2007	6	0	14,260	(5)	1,539	16	11	10.8%	2.1%
2008	13	0	35,628	(24)	3,966	69	39	11.1%	3.5%
2009	51	0	138,236	(48)	2,206	63	16	1.6%	5.7%
2010	16	0	43,217	(109)	(51)	13	8	na[b]	na[b]
2011	69	0	186,328	7,836	3,456			1.9%	
2012	63	0	147,652	33,287	2,631			1.8%	
2013	13	0	36,224	(77)					

[a] number of spawners in 2000 was likely influenced by very low precipitation and stream flow, thus marine survival of the 1997 brood was not calculated.

[b] survival could not be estimated due to low smolt production

Cutthroat Trout

Picket spacing is too wide in the trap weir to effectively trap and retain adult cutthroat trout. The adult trap is not operated and spawning surveys are not conducted after the coho salmon spawning period, thus no data are collected on cutthroat trout spawners after early January. No estimates of adult cutthroat trout spawners are made. Estimated numbers of the two larger size classes of juvenile cutthroat trout migrants are summarized in Table 55 and data on smaller size classes are found in Appendix 3. Fish that are 120-159mm FL are the predominant size class of downstream migrants, although there is considerable annual variation in migrant numbers for all size classes. Within each size class there is also much variation in degree of silvering, ranging from coloration typical of a fluvial form, to strong silvering typical of an anadromous form. This suggests cutthroat trout in Winchester Creek may display a variety of life-history strategies (see Trotter 1997; Northcote 1997).

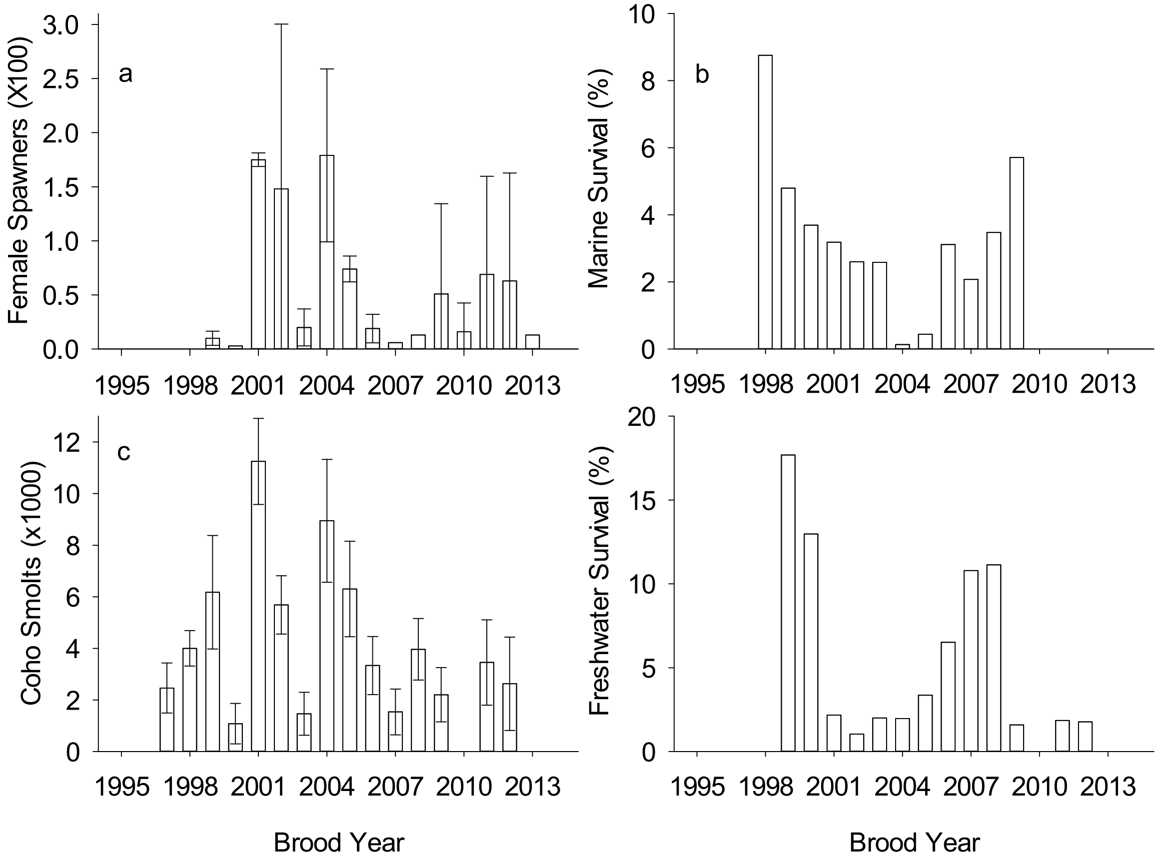

Figure 28. Annual trends in the (a) parental female spawner estimate, (b) percent marine survival, (c) smolt production estimate, and (d) percent freshwater survival for coho salmon in Winchester Creek.

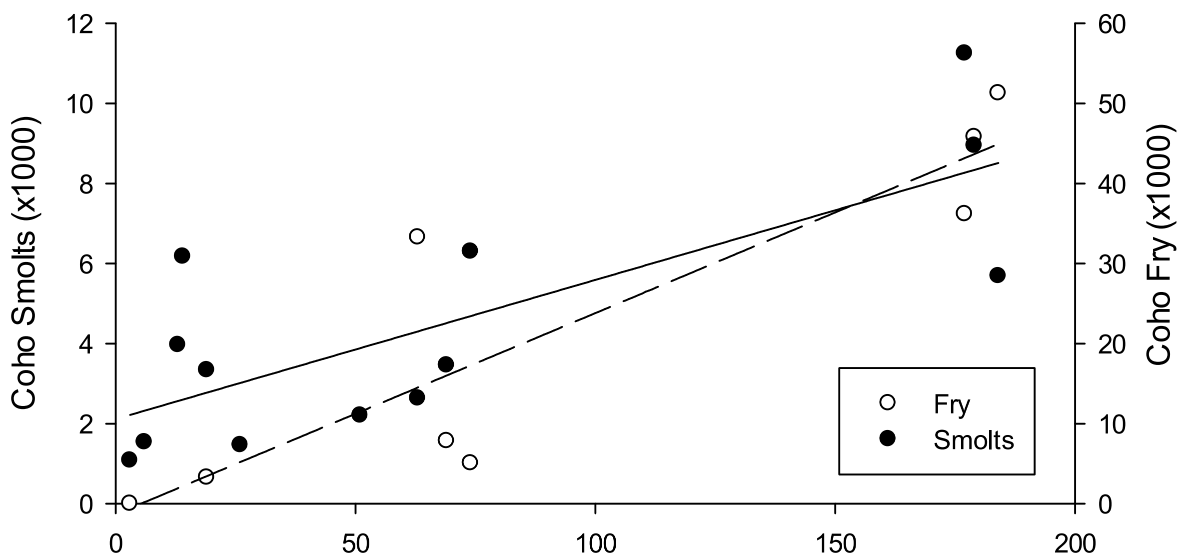

Figure 29. The relationship between coho smolt (solid symbols) and fry (clear symbols) migrants and female spawners in Winchester Creek. The solid line is the regression line between female spawners and smolts (R^2=0.60, p=0.002). The dashed line is the regression line between female spawners and fry (R^2=0.78, p=0.003).

Table 57. The estimated number of juvenile salmonids that migrated to the Winchester Creek juvenile trap. Coho pre-smolts were defined as fish trapped from November through JanuaryThe number of actual fish caught is reported (in parentheses) when trap efficiency could not be determined for a particular size class. Additional out-migrant data are provided in the appendices.

Sample Year	Coho smolts ± CI			Coho pre-smolts ± CI			Cutthroat migrants ± CI 160-249 mm			120-159 mm		
1999	2,464	±	968	na			607	±	429	1,459	±	631
2000	4,002	±	686	1,720	±	957	(22)			1,380	±	621
2001	6,176	±	2,197	751	±	1,220	(17)			565	±	368
2002	1,083	±	784	0			1,339	±	3,940	1,035	±	549
2003	11,248	±	1,670	3,133	±	607	(55)			(57)		
2004	5,685	±	1,129	2,302	±	575	(25)			(76)		
2005	1,468	±	831	132	±	224	(29)			(98)		
2006	8,944	±	2,383	1,515	±	500	(39)			(93)		
2007	6,301	±	1,850	283	±	356	(7)			(34)		
2008	3,336	±	1,123	na			(11)			(47)		
2009	1,539	±	888	na			(17)			(40)		
2010	3,966	±	1,194	181	±	103	(17)			1,191	±	762
2011	2,206	±	1,051	523	±	313	(3)			(44)		
2012	(51)			na			(3)			(13)		
2013	3,456	±	1,652	na			(5)			(36)		
2014	2,631	±	1,809	na			(2)			(38)		

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APPENDICES

Appendix 1. Estimated number of coho salmon smolt and fry migrants, week of peak smolt migration, and mean FL of smolts during week of peak migration at Life Cycle Monitoring sites in western Oregon streams. Data for smolts represents fish sampled in the second year following egg deposition (e.g. fish sampled in 1998 were the 1996 brood year). Data for fry represents fish sampled the first year following egg deposition. Ninety-five percent confidence intervals (CI) were calculated using a bootstrap procedure unless otherwise noted.

Sample Year and Site	Smolts ± CI			Fry ± CI			Smolt Peak Week	Smolt Mean FL (mm) ± CI		
NF Scappoose										
1999	1,409	±	149	(30)			5/17-5/23	129.1	±	2.1
2000	201	±	120	(101)			4/24-4/30	139.7	±	1.9
2001	679	±	359	3,075	±	1,166	5/7-5/13	141.7	±	2.5
2002	242	±	149	1,261	±	686	5/13-5/19	136.0	±	2.1
2003	574	±	53	7,866	±	3,148	5/19-5/25	142.3	±	2.8
2004	310	±	151	18,137	±	4,118	5/3-5/9	130.2	±	3.4
2005	589	±	253	(358)			5/2-5/8	127.7	±	3.4
2006	1,207	±	921	10,967	±	8,710	5/15-5/21	130.1	±	3.6
2007	(7)			39,133	±	21,915				
2008	689	±	98	4,145	±	776	5/19-5/25	127.2	±	3.3
2009	2,129	±	794	2,760	±	1,278	5/18-5/24	127.5	±	3.5
2010	(24)			67,630	±	26,611				
2011	1,612	±	251	30,947	±	8,834	5/9-5/15	126.3	±	2.1
2012	3,468	±	502	(58)			5/14-5/20	120.6	±	2.9
2013	632	±	367	15,521	±	7,424	5/6-5/12	137.7	±	3.4
2014	1,491	±	361	(88)			5/5-5/11	132.0	±	3.1
NF Nehalem[a]										
1998	43,260	±	3,552				4/27-5/03	103.7	±	4.5
1999	20,194	±	1,158				5/10-5/16	115.4	±	3.5
2000	30,951	±	2,432				5/01-5/07	117.4	±	3.5
2001	43,160	±	2,675				4/23-4/29	105.4	±	5.1
2002	19,603	±	1,944				4/29-5/05	113.8	±	3.1
2003	29,945	±	2,085				4/28-5/04	112.2	±	4.7
2004	39,019	±	2,956				4/12-4/18	108.6	±	4.6
2005	24,158	±	1,858				5/02-5/08	103.3	±	3.7
2006	26,905	±	1,799				5/15-5/21	106.2	±	3.8
2007	22,317	±	1,574				5/07-5/13	109.7	±	5.0
2008	20,830	±	1,311				5/12-5/18	112.5	±	3.1
2009	29,044	±	2,080				4/27-5/03	101.0	±	5.1
2010	27,106	±	2,134				5/10-5/16	113.3	±	4.0
2011	20,553	±	1,805				5/02-5/08	105.6	±	3.7
2012	37,852	±	3,830				4/23-4/29	98.9	±	4.9
2013	30,035	±	1,878				5/06-5/12	104.4	±	4.4
2014	19,228	±	1,482				5/05-5/11	106.4	±	3.7

Sample Year and Site	Smolts ± CI			Fry ± CI			Smolt Peak Week	Smolt Mean FL (mm) ± CI		
EF Trask										
2005	6,441	±	1,143	41,134	±	11,145	5/09-5/15	107.5	±	3.2
2006	2,006	±	237	34,405	±	26,907	5/15-5/21	118.4	±	2.8
2007	3,375	±	414	122,015	±	84,599	5/07-5/13	113.6	±	3.8
2008	2,769	±	302	4,649	±	2,321	5/26-6/01	112.6	±	2.6
2009	1,725	±	253	87,207	±	13,679	4/27-5/03	100.7	±	4.6
2010	4,508	±	476	53,273	±	10,359	5/10-5/16	107.7	±	4.4
2011	4,407	±	406	54,642	±	15,954	5/23-5/29	111.8	±	3.3
2012	4,077	±	466	107,480	±	19,155	5/07-5/13	107.3	±	2.9
2013	5,156	±	480	26,567	±	11,558	5/06-5/12	116.2	±	3.1
2014	5,940	±	521	13,725	±	8,495	5/19-5/25	109.8	±	2.9
Mill Creek-Siletz										
1997	8,099	±	686	21,437	±	14,349	4/28-5/4	98.2	±	5.3
1998	9,626	±	698	812	±	1,135	4/20-4/26	94.3	±	4.3
1999	8,417	±	594	(21)			5/10-5/16	100.9	±	3.9
2000	4,312	±	241	(59)			5/1-5/7	112.9	±	3.4
2001	15,123	±	853	5,716	±	6,938	5/14-5/20	105.4	±	4.1
2002	17,717	±	1,023	9,460	±	3,646	4/8-4/14	87.8	±	5.5
2003	15,699	±	1,145	62,064	±	7,130	4/28-5/4	100.0	±	4.9
2004	17,821	±	1,166	24,239	±	2,150	4/26-5/2	100.4	±	4.3
2005	19,653	±	1,174	10,373	±	1,399	5/2-5/8	103.9	±	4.8
2006	13,124	±	849	9,336	±	2,560	5/8-5/14	102.0	±	4.4
2007	11,986	±	1,825	16,999	±	2,566	5/14-5/20	97.6	±	2.8
2008	13,288	±	514	2,845	±	976	5/12-5/18	102.6	±	3.9
2009	13,807	±	641	67,055	±	64,690	4/27-5/3	99.7	±	4.4
2010	18,718	±	770	92,283	±	25,549	5/3-5/9	105.8	±	4.4
2011	15,554	±	970	24,028	±	19,608	5/2-5/8	96.9	±	5.3
2012	12,841	±	790	78,250	±	89,376	4/23-4/29	102.2	±	6.4
2013	16,767	±	831	23,704	±	13,210	4/1-4/7	96.3	±	6.3
2014	16,627	±	931	11,464	±	3,379	4/28-5/4	98.0	±	6.8
Mill Creek-Yaquina										
1997	1,317	±	290	47,307	±	12,885	5/5-5/11	132.8	±	7.9
1998	6,587	±	708	278	±	145	4/27-5/3	123.9	±	2.4
1999	2,225	±	283	2,565	±	542	5/3-5/9	145.9	±	1.4
2000	5,434	±	586	1,336	±	492	5/1-5/7	146.4	±	4.9
2001	7,359	±	729	7,920	±	2,552	4/30-5/6	138.6	±	5.0
2002	6,593	±	553	103,941	±	11,586	4/29-5/5	126.4	±	2.3
2003	8,727	±	649	99,451	±	19,694	5/5-5/11	129.4	±	4.4
2004	8,102	±	639	126,031	±	9,788	5/10-5/16	133.0	±	3.4
2005	12,901	±	1,054	147,895	±	15,261	5/9-5/15	117.4	±	3.0
2006	10,224	±	455	27,382	±	1,360	5/15-5/21	120.4	±	2.3
2007	5,847	±	388	29,575	±	2,568	5/7-5/13	135.6	±	5.7
2008	5,290	±	276	21,413	±	1,041	5/12-5/18	128.9	±	2.8
2009	9,599	±	882	91,587	±	5,837	5/4-5/10	130.0	±	2.9

Sample Year and Site	Smolts ± CI			Fry ± CI			Smolt Peak Week	Smolt Mean FL (mm) ± CI		
2010	3,330	±	327	110,344	±	7,511	5/17-5/23	125.3	±	5.6
2011	1,686	±	270	157,068	±	20,408	5/16-5/22	132.0	±	2.5
2012	4,758	±	815	42,876	±	5,770	4/30-5/6	133.5	±	2.3
2013	5,830	±	453	30,074	±	2,082	5/20-5/26	125.0	±	2.0
2014	8,430	±	645	39,379	±	3,704	4/21-4/27	128.0	±	4.5
Cascade Creek										
1998	1,409	±	98	0			4/20-4/26	99.8	±	6.9
1999	555	±	73	0			5/10-5/16	102.6	±	4.5
2000	(9)			(6)						
2001	1,468	±	96	3,224	±	1,972	4/16-4/22	111.1	±	3.1
2002	1,754	±	123	-21			4/8-4/14	88.8	±	3.8
2003	1,478	±	108	1,707	±	935	4/28-5/4	94.9	±	3.7
2004	3,053	±	120	781	±	455	4/5-4/11	95.7	±	2.8
2005	6,471	±	247	3,614	±	755	3/21-3/27	79.2	±	3.4
2006	5,218	±	239	4,859	±	945	4/24-4/30	99.3	±	4.8
2007	7,458	±	327	1,912	±	725	4/23-4/29	96.8	±	7.1
2008	6,201	±	243	2,866	±	1,049	4/28-5/4	91.7	±	3.6
2009	9,801	±	347	49,127	±	3,981	4/20-4/26	89.5	±	4.6
2010	7,902	±	288	50,516	±	6,919	4/12-4/18	83.5	±	3.3
2011	5,983	±	208	33,858	±	24,504	5/2-5/8	89.2	±	4.4
2012	7,577	±	384	24,732	±	3,354	4/16-4/22	85.2	±	4.4
2013	8,157	±	223	47,845	±	2,689	4/1-4/7	82.0	±	3.4
2014	9,648	±	384	13,716	±	1,141	4/7-4/13	85.9	±	3.5
WF Smith River										
1998	22,143	±	1,940	4,070	±	2,552	4/20-4/26	104.6	±	4.3
1999	11,223	±	1,756	2,867	±	737	5/17-5/23	113.1	±	3.5
2000	16,199	±	1,776	6,490	±	2,564	4/10-4/16	103.4	±	4.4
2001	20,340	±	2,191	18,200	±	6,625	4/23-4/29	112.1	±	4.4
2002	18,355	±	1,774	33,069	±	6,192	5/6-5/12	112.5	±	2.8
2003	16,519	±	1,497	100,747	±	48,292	5/5-5/11	109.4	±	3.8
2004	24,810	±	2,262	115,078	±	16,041	4/12-4/18	105.4	±	3.9
2005	43,224	±	3,207	33,285	±	8,544	5/2-5/8	110.3	±	4.8
2006	23,804	±	1,884	58,280	±	35,843	5/1-5/7	106.5	±	4.3
2007	26,697	±	4,467	32,513	±	13,990	5/14-5/20	108.9	±	3.1
2008	29,783	±	3,949	3,279	±	4,375	5/12-5/18	110.3	±	3.8
2009	42,117	±	3,900	4,412	±	2,907	4/20-4/26	103.1	±	2.0
2010	41,627	±	3,328	32,524	±	20,302	5/10-5/16	104.4	±	2.7
2011	30,403	±	2,262	(4,134)			5/9-5/15	110.0	±	2.1
2012	35,075	±	3,906	(238)			5/14-5/20	103.1	±	2.2
2013	36,872	±	8,244	8,163	±	4,530	4/29-5/5	104.7	±	3.2
2014	40,968	±	4,000	9,806	±	7,677	4/21-4/27	105.9	±	4.2
Winchester Creek[b]										
1999	2,464	±	968	(68)			4/26-5/2	120.3	±	2.7
2000	4,002	±	686	(26)			4/10-4/16	107.9	±	2.4

Sample Year and Site	Smolts ± CI			Fry ± CI			Smolt Peak Week	Smolt Mean FL (mm) ± CI		
2001	6,176	±	2,197	0			3/19-3/25	92.8	±	1.6
2002	1,083	±	784	36,194	±	3,810	4/8-4/14	112.3	±	3.8
2003	11,248	±	1,670	51,297	±	17,240	4/21-4/27	99.5	±	4.2
2004	5,685	±	1,129	(3)			3/22-3/28	93.9	±	4.6
2005	1,468	±	831	45,812	±	17,172	3/21-3/27	97.0	±	6.0
2006	8,944	±	2,383	5,082	±	1,854	4/24-4/30	108.1	±	4.2
2007	6,301	±	1,850	3,278	±	2,673	3/19-3/25	89.8	±	3.6
2008	3,336	±	1,123	(5)			3/17-3/23	89.1	±	4.0
2009	1,539	±	888	(24)			4/13-4/19	103.4	±	3.9
2010	3,966	±	1,194	(48)			4/19-4/25	102.5	±	2.7
2011	2,206	±	1,051	(107)			4/25-5/1	109.9	±	4.6
2012	(51)			7,837	±	55,680	-			
2013	3,456	±	1,652	33,299	±	13,338	4/1-4/7	93.9	±	4.1
2014	2,631	±	1,809	(77)			2/24-3/2	81.8	±	2.5

[a] fry data not available

[b] does not include pre-smolts, see chapter text

Appendix 2. Estimated number of juvenile winter steelhead smolts (≥ 120mm FL), week of peak smolt migration, and number of pre-smolt migrants collected at Life Cycle Monitoring sites in western Oregon streams. Number of fish caught is reported (in parentheses) when trap efficiency could not be determined for a particular category. Ninety-five percent confidence intervals (CI) were calculated using a bootstrap procedure unless otherwise noted.

Sample Year and Site	Smolts Estimate ± CI	Smolts Mean FL (mm) ± CI	Smolts Peak Week	Pre-smolts 90-119 mm	Pre-smolts 60-89 mm
NF Scappoose					
1999	416 ± 163	168.4 ± 5.4	5/17-5/23	(1)	0
2000	699 ± 202	168.4 ± 5.9	5/1-5/7	(7)	0
2001	814 ± 176	168.6 ± 8.3	4/23-4/29	(12)	(1)
2002	487 ± 159	177.7 ± 6.3	4/29-5/5	(1)	0
2003	(87)			(8)	(2)
2004	646 ± 139	171.9 ± 9.5	4/26-5/2	163	(12)
2005	(75)			(9)	(1)
2006	167 ± 186	180.0 ± 14.7	5/1-5/7	(2)	(1)
2007	660 ± 204	183.6 ± 6.3	4/23-4/29	(24)	(0)
2008	498 ± 353	174.6 ± 7.6	5/12-5/18	(4)	(6)
2009	730 ± 333	169.2 ± 6.6	5/11-5/17	(16)	0
2010	(50)			(2)	(1)
2011	434 ± 204	168.6 ± 10.5	5/2-5/8	(14)	(5)
2012	261 ± 182	159.0 ± 4.7	4/23-4/29	(12)	(4)
2013	(33)			(5)	(3)
2014	601 ± 270	169.1 ± 5.6	4/21-4/27	(9)	0
NF Nehalem					
1998	6,080 ± 1,103	174.1 ± 7.5	4/27-5/03	(21)	(9)
1999	4,216 ± 949	178.2 ± 5.4	5/03-5/09	(29)	(9)
2000	7,876 ± 925	169.8 ± 11.8	4/17-4/23	1,662	499
2001	7,764 ± 745	161.8 ± 7.6	4/23-4/29	1,194	300
2002	3,635 ± 733	174.1 ± 7.4	4/22-4/28	(70)	(35)
2003	4,673 ± 1,376	182.5 ± 9.3	4/21-4/27	(71)	(4)
2004	6,772 ± 1,670	180.7 ± 11.0	4/05-4/11	618	(37)
2005	4,765 ± 1,184	170.3 ± 8.7	4/18-4/24	(73)	(36)
2006	4,723 ± 1,223	176.8 ± 7.8	4/24-4/30	513	(10)
2007	4,076 ± 862	173.6 ± 7.8	4/23-4/29	372	(19)
2008	3,632 ± 1,019	157.4 ± 6.6	4/28-5/04	1,472	(56)
2009	6,979 ± 2,372	169.1 ± 5.9	4/13-4/19	811	(42)
2010	4,459 ± 1,435	173.6 ± 7.4	4/12-4/18	(52)	(22)
2011	3,623 ± 1,333	166.4 ± 5.6	4/25-5/01	(35)	(19)
2012	4,555 ± 1,431	165.2 ± 5.6	4/23-4/29	656	(88)
2013	4,576 ± 1,339	172.4 ± 5.8	4/15-4/21	1,363	(36)
2014	4,745 ± 1,458	168.7 ± 6.6	4/07-4/13	459	(17)
EF Trask					
2005	2,308 ± 921	175.0 ± 9.0	4/18-4/24	449	(24)
2006	2,504 ± 727	176.9 ± 7.0	5/08-5/14	(30)	(39)
2007	8,020 ± 4,089	188.0 ± 7.6	4/23-4/29	(45)	(29)

Sample Year and Site	Smolts Estimate ± CI	Smolts Mean FL (mm) ± CI	Smolts Peak Week	Pre-smolts 90-119 mm	Pre-smolts 60-89 mm
2008	3,148 ± 1,499	169.6 ± 7.4	4/21-4/27	(6)	(10)
2009	5,874 ± 4,006	176.4 ± 6.2	4/27-5/03	(60)	304
2010	9,404 ± 2,989	179.0 ± 5.5	4/26-5/02	506	(46)
2011	4,847 ± 1,278	168.0 ± 7.1	5/02-5/08	(17)	(38)
2012	2,484 ± 623	165.6 ± 5.5	4/23-4/29	(33)	436
2013	11,699 ± 4,522	180.4 ± 7.1	4/29-5/05	632	(71)
2014	4,488 ± 1,507	173.0 ± 4.7	4/28-5/04	(24)	(9)
Mill Creek-Siletz					
1997	342 ± 265	144.6 ± 13.2	4/14-4/20	571	259
1998	960 ± 357	147.5 ± 8.5	4/20-4/26	403	(23)
1999	312 ± 141	158.0 ± 11.1	3/29-4/4	338	(22)
2000	996 ± 280	143.0 ± 8.2	4/10-4/16	1,273	132
2001	1,199 ± 327	140.7 ± 6.2	3/19-3/25	1,055	468
2002	633 ± 515	150.8 ± 8.5	4/8-4/14	168	281
2003	280 ± 531	144.3 ± 39.6	3/31-4/6	555	243
2004	600 ± 276	154.1 ± 10.5	4/5-4/11	271	94
2005	801 ± 223	161.6 ± 8.2	4/11-4/17	299	100
2006	642 ± 208	168.4 ± 10.0	4/10-4/16	229	94
2007	349 ± 123	154.3 ± 10.8	4/9-4/15	178	73
2008	477 ± 98	150.1 ± 8.1	3/10-3/16	398	258
2009	814 ± 139	153.8 ± 9.2	3/16-3/22	457	238
2010	1,078 ± 321	154.3 ± 10.3	3/22-3/28	267	(20)
2011	782 ± 253	164.2 ± 11.4	3/28-4/3	133	174
2012	665 ± 341	145.8 ± 10.9	4/9-4/15	610	716
2013	1,086 ± 529	146.0 ± 7.8	4/1-4/7	574	263
2014	646 ± 308	143.1 ± 7.0	3/24-3/30	321	130
Mill Creek-Yaquina					
1997	(3)			(8)	(15)
1998	(33)			481	(22)
1999	342 ± 196	180.0 ± 14.5	4/10-4/16	241	(24)
2000	1,487 ± 1,031	158.7 ± 6.3	4/23-4/29	(38)	277
2001	797 ± 449	169.8 ± 8.0	4/8-4/14	(34)	421
2002	(39)			250	389
2003	(47)			(20)	(12)
2004	(19)			(15)	(38)
2005	(30)			(12)	(10)
2006	(21)			123	129
2007	(13)			(43)	310
2008	(42)			(20)	(27)
2009	(15)			(4)	(2)
2010	(6)			(5)	84
2011	(6)			(11)	394
2012	(32)			(34)	(23)
2013	(13)			(24)	(24)
2014	(3)			(8)	(15)
Cascade Creek					
1998	134 ± 114	141.9 ± 6.8	4/20-4/26	187	(5)

Sample Year and Site	Smolts Estimate	±	CI	Mean FL (mm)	±	CI	Peak Week	Pre-smolts 90-119 mm	60-89 mm
1999	(10)							(8)	0
2000	128	±	37	132.5	±	6.2	4/3-4/9	(16)	0
2001	147	±	51	137.1	±	5.0	3/26-4/1	366	83
2002	116	±	84	140.8	±	14.3	4/8-4/14	88	(13)
2003	(17)							(14)	(3)
2004	(11)							215	(13)
2005	63	±	22	149.1	±	23.6	3/21-3/27	153	100
2006	(24)							(21)	(1)
2007	60	±	59	132.0	±		2/26-3/4	84	47
2008	(20)							(6)	0
2009	(29)							(9)	(3)
2010	(18)							(14)	(2)
2011	(5)							52	(17)
2012	(12)							(9)	(8)
2013	(19)							(8)	(2)
2014	(2)							(3)	(0)
WF Smith River									
1998	6,552	±	1,319	168.9	±	8.0	4/20-4/26	505	(16)
1999	3,171	±	1,094		±		5/3-5/9	(32)	(15)
2000	3,335	±	1,017	151.4	±	8.8	4/10-4/16	1,887	251
2001	7,851	±	1,727	147.5	±	6.7	3/26-4/1	4,944	614
2002	7,346	±	4,316	148.8	±	7.6	4/8-4/14	757	(10)
2003	(158)							(77)	329
2004	3,186	±	1,766	153.7	±	8.3	4/12-4/18	1,309	472
2005	5,568	±	1,980	144.8	±	7.2	3/21-3/27	855	(28)
2006	4,533	±	1,764	159.9	±	7.5	4/10-4/16	678	(23)
2007	10,995	±	7,524	156.4	±	8.1	4/9-4/15	934	(29)
2008	4,002	±	2,248	154.1	±	8.7	4/28-5/4	2,192	443
2009	6,974	±	4,588	131.7	±	12.5	2/23-3/1	1,406	264
2010	(234)							1,402	310
2011	7,521	±	3,994	167.8	±	7.6	4/25-5/1	1,574	(43)
2012	(235)							1,245	825
2013	6,338	±	2,066	154.1	±	7.7	4/1-4/7	2,309	355
2014	(277)							1,920	256

Appendix 3. Estimated number of cutthroat trout out-migrants within four size categories collected at Life Cycle Monitoring sites in western Oregon streams. Number of fish caught is reported in parentheses when trap efficiency could not be determined for a particular category. Ninety-five percent confidence intervals (CI) were calculated using a bootstrap procedure unless otherwise noted.

Sample Year and Site	Estimate ± CI 160-249 mm			120-159 mm			90-119 mm			60-89 mm		
N Scappoose												
1999	439	±	184	192	±	90	83	±	61	(9)		
2000	325	±	125	329	±	169	93	±	49	(4)		
2001	379	±	82	353	±	94	393	±	94	(20)		
2002	229	±	69	171	±	49	(12)			(0)		
2003	274	±	96	288	±	100	266	±	145	(7)		
2004	243	±	47	227	±	51	198	±	71	(9)		
2005	466	±	298	(68)			(34)			(1)		
2006	428	±	237	311	±	125	(25)			(3)		
2007	405	±	172	412	±	110	204	±	114	(6)		
2008	184	±	157	260	±	176	(16)			(2)		
2009	310	±	127	359	±	241	(34)			(10)		
2010	(67)			(68)			(20)			(10)		
2011	(54)			1,234	±	780	(59)			(13)		
2012	(36)			2,093	±	1,590	(38)			(1)		
2013	(31)			(58)			(16)			(1)		
2014	352	±	172	323	±	98	333	±	74	175	±	96
NF Nehalem												
1998	(75)			1,787	±	1,113	(64)			(4)		
1999	897	±	384	2,044	±	376	475	±	249	(17)		
2000	2,344	±	1,084	3,118	±	615	1,069	±	333	(24)		
2001	777	±	290	3,375	±	549	1,277	±	312	286	±	123
2002	1,436	±	819	2,831	±	606	569	±	255	(12)		
2003	(96)			2,098	±	1,362	(75)			(7)		
2004	(102)			2,541	±	1,337	(26)			(1)		
2005	374	±	269	1,609	±	617	(57)			(3)		
2006	3,412	±	2,054	4,221	±	1,307	579	±	355	(32)		
2007	1,000	±	529	3,385	±	880	544	±	345	(5)		
2008	367	±	253	2,954	±	715	1,207	±	804	(5)		
2009	756	±	376	6,144	±	1,691	1,497	±	786	(22)		
2010	(74)			2,996	±	1,105	1,009	±	659	(18)		
2011	(96)			2,607	±	766	845	±	390	(29)		
2012	(77)			3,523	±	976	1,183	±	674	(44)		
2013	(52)			3,111	±	962	385	±	171	(48)		
2014	(34)			4,754	±	1,872	807	±	286	(38)		
EF Trask												
2005	568	±	255	3,755	±	808	2,162	±	2,091	(23)		
2006	1,289	±	692	3,646	±	719	665	±	319	(17)		
2007	(104)			4,517	±	1,419	2,079	±	1,368	(51)		
2008	(32)			2,148	±	878	1,307	±	1,241	(25)		
2009	(115)			6,247	±	1,725	1,660	±	831	(40)		

Sample Year and Site	Estimate ± CI 160-249 mm	120-159 mm	90-119 mm	60-89 mm
2010	1,133 ± 682	6,270 ± 2,448	727 ± 370	(18)
2011	(106)	4,186 ± 1,543	(71)	(5)
2012	610 ± 231	3,799 ± 733	867 ± 627	(19)
2013	2,196 ± 1,049	4,166 ± 780	(70)	(7)
2014	621 ± 355	3,711 ± 1,141	(65)	(17)
Mill Creek-Siletz				
1997	471 ± 402	1,595 ± 343	1,040 ± 480	(5)
1998	482 ± 270	1,999 ± 710	370 ± 241	0
1999	829 ± 519	1,717 ± 353	181 ± 112	0
2000	1,513 ± 545	2,844 ± 443	208 ± 74	0
2001	1,640 ± 615	2,592 ± 437	646 ± 231	(17)
2002	2,233 ± 4,557	2,452 ± 447	520 ± 192	(4)
2003	1,818 ± 1,439	1,824 ± 355	(33)	(3)
2004	914 ± 225	703 ± 129	(21)	0
2005	1,163 ± 314	2,120 ± 325	252 ± 88	(3)
2006	1,179 ± 468	1,631 ± 329	80 ± 33	(1)
2007	838 ± 302	2,081 ± 347	129 ± 53	(4)
2008	728 ± 247	1,460 ± 270	387 ± 145	(1)
2009	942 ± 312	1,964 ± 286	328 ± 151	(4)
2010	1,279 ± 308	2,172 ± 406	209 ± 120	0
2011	1,318 ± 343	2,050 ± 316	235 ± 67	(1)
2012	1,545 ± 537	1,350 ± 276	(39)	0
2013	387 ± 139	1,071 ± 321	(31)	(6)
2014	477 ± 223	1,635 ± 329	341 ± 145	(14)
Mill Creek-Yaquina				
1997	(1)	(2)	(2)	(2)
1998	(6)	(16)	(4)	0
1999	71 ± 33	(15)	(8)	0
2000	116 455	76 ± 53	146 ± 772	(19)
2001	(11)	(21)	(11)	0
2002	(18)	(14)	(1)	(1)
2003	79 ± 61	(11)	(5)	0
2004	(14)	(16)	(1)	(1)
2005	(16)	(13)	(7)	(1)
2006	31 ± 39	(8)	(6)	(10)
2007	(4)	(10)	(2)	0
2008	(11)	(11)	(6)	(2)
2009	(3)	(4)	(2)	0
2010	(1)	(1)	(4)	0
2011	(6)	(1)	(4)	(2)
2012	(6)	(2)	(1)	0
2013	(3)	(8)	(3)	(2)
2014	(1)	(2)	(2)	(2)
Cascade Creek				
1998	197 ± 100	794 ± 265	525 ± 214	(3)
1999	188 ± 67	644 ± 125	87 ± 55	(4)
2000	374 ± 131	701 ± 82	138 ± 43	(3)

Sample Year and Site	Estimate ± CI			
	160-249 mm	120-159 mm	90-119 mm	60-89 mm
2001	432 ± 94	1,312 ± 118	432 ± 92	(14)
2002	399 ± 157	1,480 ± 163	528 ± 98	51 ± 37
2003	295 ± 137	1,617 ± 165	790 ± 163	142 ± 125
2004	304 ± 102	1,368 ± 157	361 ± 71	(10)
2005	333 ± 67	1,989 ± 253	860 ± 143	(37)
2006	645 ± 118	1,474 ± 141	404 ± 63	(10)
2007	320 ± 792	1,478 ± 1,303	305 ± 74	(21)
2008	417 ± 280	1,334 ± 112	353 ± 63	(3)
2009	465 ± 135	1,490 ± 110	519 ± 69	178 ± 67
2010	360 ± 86	1,848 ± 235	353 ± 94	(9)
2011	399 ± 133	1,594 ± 178	373 ± 74	(27)
2012	391 ± 139	1,102 ± 229	312 ± 141	(14)
2013	444 ± 135	1,162 ± 139	205 ± 149	(8)
2014	212 ± 88	752 ± 118	340 ± 67	168 ± 96
WF Smith River				
1998[a]				
1999[a]				
2000	(135)	1,547 ± 564	(12)	(1)
2001	(232)	1,876 ± 615	937 ± 680	(32)
2002	(265)	2,875 ± 1,021	(3)	(2)
2003	(101)	(82)	(4)	(9)
2004	(90)	(36)	(2)	(9)
2005	1,438 ± 772	938 ± 480	(4)	(0)
2006	2,257 ± 1,041	1,743 ± 582	(8)	(1)
2007	(63)	(77)	(5)	(2)
2008	(74)	1,479 ± 645	(16)	(0)
2009	2,639 ± 1,468	2,161 ± 839	(51)	(0)
2010	(158)	(176)	(22)	(0)
2011	3,525 ± 1,784	2,576 ± 915	(10)	(2)
2012	2,450 ± 1,680	2,599 ± 1,825	(15)	(9)
2013	(151)	1,549 ± 721	(15)	(1)
2014	2,201 ± 1,352	3,242 ± 1,394	(36)	(3)
Winchester Creek				
1999	607 ± 429	1,459 ± 631	(118)	(8)
2000	(22)	1,380 ± 621	724 ± 414	(10)
2001	(17)	565 ± 368	(42)	(9)
2002	1,339 ± 3,940	1,035 ± 549	(24)	(1)
2003	(55)	(57)	(14)	(13)
2004	(25)	(76)	658 ± 365	(28)
2005	(29)	(98)	(47)	(3)
2006	(39)	(93)	(63)	(3)
2007	(7)	(34)	(24)	(10)
2008	(11)	(47)	(49)	(10)
2009	(17)	(40)	(22)	(13)
2010	(17)	1,191 ± 762	(46)	(20)
2011	(3)	(44)	228 ± 137	(9)

Sample Year and Site	Estimate ± CI			
	160-249 mm	120-159 mm	90-119 mm	60-89 mm
2012	(3)	(13)	(11)	(4)
2013	(5)	(36)	(53)	(20)
2014	(2)	(38)	(57)	670 ± 470

[a] No estimates were made in 1998 and 1999 when cutthroat trout in the Umpqua basin were listed as a threatened species under federal 4(d) rules

Appendix 4. Number of non-salmonid fish species collected at ODFW Life Cycle Monitoring sites. Numbers represent actual catch and are not adjusted for trap efficiency. Eyed juvenile lamprey are Pacific lamprey that have completed metamorphosis to the life-history stage that is migrating seaward.

	Lamprey adults		Lamprey juveniles			Dace						
Sample Year	Brook	Pacific	Amm.[a]	Eyed	Cottids	Dace[d]	Speckled	Umpqua	Redside Shiner	Largescale Sucker	Pike Minnow	Three-spine Stickleback
NF Scappoose Creek												
1999	49	24	201	0	57	756						
2000	57	2	58	0	85	1220						
2001	37	8	329	0	67	1494						
2002	46	18	306	0	57	600						
2003	32	6	57	13	54	542						
2004	26	10	201	0	52	1233						
2005	18	3	233	0	34	279						
2006	9	14	50	0	14	439						
2007	8	3	119	0	28	1094						
2008	212	14	150	7	79	439						
2009	66	6	72	0	11	327						
2010	63	12	37	8	24	54						
2011	135	11	271	14	30	24						
2012	21	0	126	0	14	65						
2013	23	8	79	3	9	398						
2014	9	9	185	2	28	333						
NF Nehalem River @ WH Falls[b]												
1998	7	5	60	na	0	0						
1999	55	7	106	na	13	0						
2000	73	5	361	na	281	0						
2001	197	14	230	na	600	0						
2002	54	35	118	na	414	0						
2003	74	1	56	na	244	0						
2004	28	9	23	na	78	0						
2005	29	3	16	14	57	0						
2006	4	0	16	1	107	0						
2007	14	1	39	0	30	0						
2008	22	0	20	0	60	0						

Sample Year	Lamprey adults		Lamprey juveniles		Cottids	Dace			Redside Shiner	Largescale Sucker	Pike Minnow	Three-spine Stickleback
	Brook	Pacific	Amm.[a]	Eyed		Dace[d]	Speckled	Umpqua				
2009	4	1	58	0	17	0						
2010	4	1	31	0	26	0						
2011	6	0	54	0	13	0						
2012	18	0	216	0	119	0						
2013	11	2	52	0	35	0						
2014	4	0	90	0	81	0						
EF Trask River												
2005	0	2	11	7	7	0						
2006	0	0	14	0	23	0						
2007	0	3	2	1	39	0						
2008	0	0	4	3	13	0						
2009	0	1	7	0	5	0						
2010	0	0	2	0	15	0						
2011	0	1	4	0	25	0						
2012	0	1	4	0	32	0						
2013	0	2	7	0	31	0						
2014	0	2	10	0	15	0						
Mill Creek-Siletz												
1997	255	0	914	0	109	0						
1999	51	2	245	0	51	0						
2000	39	0	295	0	17	0						
2001	91	0	96	0	21	0						
2002	189	1	226	18	55	0						
2003	101	0	733	0	27	0						
2004	263	0	268	0	34	0						
2005	112	1	307	0	43	0						
2006	72	0	198	17	54	0						
2007	115	0	197	0	41	0						
2008	135	0	156	0	20	0						
2009	147	0	274	0	41	0						
2010	110	0	93	0	42	0						
2011	130	0	99	0	46	0						
2012	224	0	217	0	51	0						

Sample Year	Lamprey adults		Lamprey juveniles		Cottids	Dace			Redside Shiner	Largescale Sucker	Pike Minnow	Three-spine Stickleback
	Brook	Pacific	Amm.[a]	Eyed		Dace[d]	Speckled	Umpqua				
2013	144	0	196	0	47	0						
2014	173	0	77	0	56	0						
Mill Creek-Yaquina												
1997	14	0	0	0	105	0						
1998	4	0	0	0	45	0						
1999	0	0	0	0	0	0						
2000	2	0	0	0	38	0						
2001	0	0	0	0	150	0						
2002	3	0	0	0	31	0						
2003	10	0	0	0	679	0						
2004	26	0	1	0	58	0						
2005	22	0	0	0	54	0						
2006	25	0	0	0	164	0						
2007	17	0	0	0	160	0						
2008	72	0	0	0	11	0						
2009	15	0	0	0	118	0						
2010	30	0	0	0	5	0						
2011	16	0	0	0	143	0						
2012	9	0	1	0	52	0						
2013	58	0	0	0	113	0						
2014	26	0	1	0	235	0						
Cascade Creek												
1998	79	20	414	0	85	477						
1999	58	10	1,264	0	40	169						
2000	229	6	896	0	91	1,045						
2001	156	6	1,572	14	75	785						
2002	216	6	2,274	0	105	1,444						
2003	134	5	3,090	0	68	543						
2004	139	2	832	0	38	700						
2005	151	4	4,335	33	67	744						
2006	107	4	682	0	144	719						
2007	97	3	486	0	107	534						
2008	351	3	856	0	54	480						

	Lamprey adults		Lamprey juveniles			Dace						
Sample Year	Brook	Pacific	Amm.[a]	Eyed	Cottids	Dace[d]	Speckled	Umpqua	Redside Shiner	Largescale Sucker	Pike Minnow	Three-spine Stickleback
2009	198	5	721	0	44	437						
2010	206	2	919	1	61	447						
2011	258	5	966	0	55	245						
2012	160	12	1,130	0	68	109						
2013	347	6	598	0	132	149						
2014	152	5	2,518	0	84	207						
WF Smith River												
1998	0	22	592	0	38	7,541			908	100	2	
1999	0	1	405	0	25	3,520			308	116	0	
2000	0	50	696	32	31	2,720			379	92	0	
2001	0	8	148	160	18	2,294			424	185	0	
2002	0	4	337	17	29		2,238		379	50	4	
2003	129	0	234	7	24		2,724	46	321	29	4	
2004	95	4	395	8	26		4,205	64	1,077	43	2	
2005	73	12	653	62	12		4,783	104	1,257	26	3	
2006	56	4	393	3	51		3,995	109	1,403	57	0	
2007	92	1	206	0	26		4,848	66	521	81	0	
2008	14	1	64	0	19		2,718	231	354	46	2	
2009	4	1	25	0	9		3,997	52	1,185	96	0	
2010	1	2	34	0	2		2,680	33	629	42	0	
2011	0	2	78	0	11		3,482	51	1,243	44	0	
2012	4	0	192	0	18		2,290	51	417	66	0	
2013	29	7	60	0	37		6,209	114	512	25	0	
2014	27	5	60	0	29		5,884	145	678	38	0	
Winchester Creek[e]												
2002	0	42	335	14	0							60
2003	4	42	390	8	1,086							1,866
2004	0	15	372	37	1,219							357
2005	0	14	418	117	612							61
2006	0	1	277	0	778							78
2007	1	1	157	2	515							363
2008	3	4	59	3	728							308
2009	0	2	94	14	378							153

Sample Year	Lamprey adults		Lamprey juveniles		Cottids	Dace			Redside Shiner	Largescale Sucker	Pike Minnow	Three-spine Stickleback
	Brook	Pacific	Amm.[a]	Eyed		Dace[d]	Speckled	Umpqua				
2010	0	20	20	4	662							72
2011	0	3	21	0	418							68
2012	0	2	56	21	320							741
2013	0	1	124	13	1,026							57
2014	0	10	132	0	843							48

[a] Lamprey ammocoete counts may include both western brook (*L. richardsoni*) and Pacific lamprey (*L. tridentata*)
[b] prior to 2005,eyed “transforming” juvenile lamprey were not recorded separately from ammocoetes (“na”)
[c] May include some “eyed” juvenile lamprey
[d] undifferentiated to Dace species
[e] sample year starts in fall of previous year for the 2003-2006 sample years. Some species not listed; see text
[f] prior to 1994 non-salmonids were not recorded
[g] Most eyed juvenile pacific lamprey were caught during the fall corresponding to the first increase in streamflow.

Incidental Species

- At the NF Scappoose trap in 2005, the low number of brook lamprey caught may have been attributed to flow abnormalities caused by a debris jam located just upstream of the trap. As sculpins usually remain close to the substrate, they were collected mostly when flows were low and the screw trap cone was near the bottom.

- At both NF Nehalem traps, adult brook lamprey were more prevalent than Pacific lamprey, and most were likely post-spawned adults. Sculpin (Cottus spp.) were also collected.

- In Cascade Creek, eyed juvenile Pacific lamprey were observed in only three years. In other Oregon coastal streams, these fish have been observed to migrate to the ocean in November and December during winter freshets (Van de Wetering 1998). Typically, their seaward migration is complete by the time downstream trapping begins in March. The two years in which we observed the most transformed juveniles followed winters that were unusually dry (2001 and 2005), suggesting that the timing of seaward migration was extended or delayed in these years with low rainfall. At the Mill Creek-Siletz site, observations of transformed juvenile lampreys only occurred in 2001 and 2005.

- At the WF Smith trap, non-salmonid fish species included speckled dace (*Rhinichthys osculus*), Umpqua dace (*R. evermanni*), redside shiner (*Richardsonius balteatus*), largescale sucker (*Catostomus macrocheilus*), Umpqua pikeminnow (Ptychocheilus umpquae), Pacific lamprey (*L. tridentata*), western brook lamprey (*Lampetra richardsoni*), and sculpin (*Cottus* spp.). Pacific lamprey captured included both pre- and post-spawned adults.

- Prior to the 2001-02 trapping period, the Winchester juvenile trap was located approximately 1 km below head of tide and catch included species found in brackish water. The trap was moved to head of tide in fall 2001. Non-salmonid fish species encountered at the trap since fall 2001 include Pacific lamprey (*L. tridentata*), western brook lamprey (*L. richardsoni*), prickly sculpin (*Cottus asper*), three-spine stickleback (*Gasterosteus aculeatus*) and longfin smelt (*Spirinchus thaleichthys*). All adult Pacific lamprey captured appeared to be in a pre-spawn phase. The largest catches of eyed juvenile Pacific lamprey occurred during December in association with strong streamflow events. Migrations of juvenile Pacific lamprey in December were of short duration, generally occurring over a two to three day period. This life-history stage was also observed during the spring trapping period, but in lower numbers. Few western brook lamprey were caught and all were post-spawned adults. Longfin smelt were captured in low numbers and were not encountered every year. All longfin smelt captured were sexually mature. Catch of three-spine stickleback was high in spring 2003, but most of these fish were age-0 juveniles.