THE OREGON PLAN *for Salmon and Watersheds*

Salmonid Life-Cycle Monitoring in Western Oregon Streams, 2003-2005.

Report Number: OPSW-ODFW-2006-2

Salmonid Life-Cycle Monitoring in Western Oregon Streams, 2003-2005

Oregon Plan for Salmon and Watersheds

Monitoring Report No. OPSW-ODFW-2006-2

April 2006

David B. Jepsen
Tim Dalton
Steven L. Johnson
Kevin A. Leader
Bruce A. Miller

Salmonid Life Cycle Monitoring Project
Western Oregon Research and Monitoring Program
Oregon Department of Fish and Wildlife
28655 Highway 34
Corvallis, OR 97333

Current funds provided in part by:
Oregon Department of Fish and Wildlife
Sport Fish and Wildlife Restoration Program administered by the U.S. Fish and Wildlife Service
Bureau of Land Management, Salem and Coos Bay Districts
Oregon Department of Forestry

Citation: Jepsen, D. B, T. Dalton, S. L. Johnson, K. A. Leader, and B. A. Miller. 2006. Salmonid Life Cycle Monitoring in Western Oregon streams, 2003-2005. Monitoring Program Report Number OPSW-ODFW-2006-2**,** Oregon Department of Fish and Wildlife, Salem.

TABLE OF CONTENTS

Page

LIST OF FIGURES

Page

LIST OF TABLES

Page

LIST OF APPENDICES

Page

EXECUTIVE SUMMARY

In 1997, as part of the Oregon Plan for Salmon and Watersheds, the Oregon Department of Fish and Wildlife (ODFW) began a 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.

- North Fork Scappoose Creek-Willamette River: The estimated number of coho spawners ranged between 7 (1999-2000) and 49 (2004-05) fish, with no detectable increase or decrease in numbers annually. Marine survival has been above 6% since the 1999 brood year. The annual number of out-migrating juvenile coho has declined since monitoring began, and freshwater survival has varied annually between 0.5 and 5.7% with no clear trend over the course of monitoring.

- North Fork Nehalem River: Estimates of wild adult spawners in the entire basin upstream of Waterhouse Falls were considerably lower in the first three years of monitoring than for the last four years. Numbers were lowest in 2000-2001 and highest in 2001-2002. Total estimated numbers of spawners (wild plus hatchery) was also lowest in 2000-2001 and greatest in 2002-2003 (N=4,899). Marine survival has increased in recent years, ranging from 2% (1996 brood) to 8% (2001 brood). The annual number of out-migrating juvenile coho varied annually, but there is a trend of decreased freshwater survival over the course of sampling, presumably related to density dependent effects.

- East Fork Trask River: An estimate of coho spawners for the first year of collection was 304 fish. The estimated number of coho out-migrants was 6,069 fish. Estimates of marine and freshwater survival will be available after the brood cycle is complete.

- Mill Creek-Siletz River: The number of adult coho salmon spawning each year has increased since return year 1997-98 (~50 fish) to > 1,000 spawners/year in the winters of 2002-03 and 2003-04. The number of adult spawners dropped to 430 fish in 2004-05. Increased marine survival has led to greater female returns, but not a corresponding increase in out-migrant production. As a result, freshwater survival estimates have decreased. Presumably, density dependent effects are influencing the freshwater rearing portion of the life cycle.

- Mill Creek-Yaquina River: The number of returning adult coho salmon spawners ranged between 64 and 138 for the winters of 1997-98 through 2000-01, increased to 624 spawners in the winter of 2001-02, and has been over 1,000 spawners from 2002-03 through 2004-05. The marine survival rate increased to > 10% for brood years 1998-

2001, resulting in large increases in subsequent adult numbers. Trends in female spawners and subsequent juvenile freshwater survival suggest density dependent effects are influencing the freshwater rearing portion of the life cycle.

- Cascade Creek-Alsea River: Total numbers of adult spawners ranged between 6 and 45 in return years 1997-98 through 2001-02, and increased to > 100 spawners annually in return years 2002-03 through 2004-05. Marine survival for the 1999-2001 broods ranged from 7% to 8%. Marine survival estimates for the 1997 and 1998 broods may be inaccurate, as the number of smolts leaving the stream was very low. Freshwater survival varied between 0.1% (1998 brood) and 10% (2001 brood).

- West Fork Smith River-Lower Umpqua River: The number of returning adult coho increased each year from 1998 to 2003, and then decreased in 2004, corresponding with changes in marine survival rates. Freshwater survival declined over the course of the monitoring due mostly to correlation with increases in adult spawners. Increased spawner levels corresponded to proportionate increases in fry migrants, suggesting that within the range of seeding levels observed, a proportion of fry produced from each female tends to move downstream, irrespective of fry abundance.

- Winchester Creek-South Slough, Coos Bay: The numbers of spawners generally increased since 1999, although marine survival rate has steadily declined. In fall 2000, precipitation and stream flows were very low until late December, and this factor likely influenced number of spawners for that brood year. The 2000 brood produced few smolts, and relatively few adults from this brood returned to spawn in 2003. Both marine and freshwater survival has decreased over the course of monitoring.

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 downstream migration of salmonid fishes (*Onchorhynchus spp*.) in select coastal basins. As part of this program the Salmonid Life-Cycle Monitoring Project developed three objectives; 1) estimate abundance of adult salmonids and downstream migrating juvenile salmonids, 2) estimate marine and freshwater survival rates for coho salmon (*Oncorhynchus kisutch*), and 3) evaluate effects of habitat modification on the abundance of juvenile salmonids in Cummins and Tenmile creeks, direct ocean tributaries on the Central Oregon coast. Research that addressed Objective 3 is complete (Johnson et al. 2005), and is not covered in this report. This report updates the estimates for the first two objectives by summarizing data collected at eight Life Cycle Monitoring sites (hereafter LCM sites) for adult salmonids (1997-1998 through 2004-2005 run-years) and out-migrating juveniles (1997 through 2005). Previous annual reports summarized LCM data up to year 2002 (Solazzi et al. 2000a, 2001, 2002, 2003), so this report includes previously unpublished data for the 2003-2005 sample years. At a later date we will prepare a synthesis report that compares inter-annual patterns in adult and juvenile data across LCM sites.

This report is organized into chapters for each LCM site from north to south along the Oregon Coast. LCM sites are located on North Fork (NF) Scappoose Creek (Willamette River basin), North Fork (NF) Nehalem River, East Fork (EF) Trask River, Mill Creek (Siletz River basin), Mill Creek (Yaquina River basin), Cascade Creek (Alsea River basin) West Fork (WF) Smith River (Umpqua River basin) and Winchester Creek (Coos River basin).

There are currently six 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 Little South Fork Kilchis River, Little North Fork Wilson River, East Fork Lobster and upper main Lobster creeks, Cummins Creek, and Tenmile Creek. Data collection began in 1998 at the Kilchis and Wilson river sites, in 1982 at the Lobster Creek sites, and in 1992 at the Cummins and Tenmile creek sites. These data are available by request as annual contract reports that have been submitted to funding partners, and on the website http://oregonstate.edu/Dept/ODFW/life-cycle/index.html. Data from these sites will be summarized as an aggregate data set in a separate composite report at a later date.

GENERAL METHODOLOGY

Site-specific details from this general methodology are provided within individual site chapters of this report, and in Solazzi et al. (2000a, 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.

Juvenile Salmonids

Rotary screw traps or rotating incline-plane traps were used to capture juvenile salmonids migrating downstream. Traps generally began fishing from early February to early March and fished continuously until catches diminished to low levels or low stream flows precluded further trap operation, usually by mid to late June. The traps were normally checked and cleared of fish and debris once a day, although, to ensure fish safety, visits were more frequent during storm events and periods of high debris. On days when traps could not be safely operated, primarily due to high flow events, catch was estimated based on the average of catch measured on days preceding and following the period that the trap was inoperable.

Fish were anesthetized with MS-222 and enumerated by species and age or size group (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 (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 mm FL. Many cutthroat >160 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 attributes.

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 upper caudal lobe, then releasing clipped fish upstream of the trap. Occasionally, more than 25 fish of a category were marked at some traps. Subsequent recaptures of marked fish were recorded and weekly estimates of out-migrants were made by expanding trap catches using the following equations:

$$N_m = c / e_m$$

and

$$e_m = r / m,$$

where:

N_m = weekly estimated out-migrants
c = number of fish captured
e_m = measured weekly trap efficiency

r = number of recaptured marked fish
m = number of marked fish released

Weekly estimates were summed for season totals. When recaptures were infrequent (< five recaptures/week), totals for an equal number of previous and following weeks were pooled to obtain at least five recaptures. Population estimates were generally not calculated if fewer than five marked fish of a particular category were recaptured over the season, in which case the actual number caught is reported. In some cases where < 5 marked coho salmon fry were recaptured, population estimates were made using the average trap efficiency for this category measured in other years.

A bootstrap procedure was used to estimate the variance and construct 95% confidence intervals for each population estimate (Thedinga et al. 1994; 1000 iterations used for each calculation). This procedure uses trap efficiency as one parameter in calculation of variance. Prior to 2005, trap efficiency was calculated as the season average (total number recaptured divided by total number marked during the trapping period). Beginning 2005, a weighted value for trap efficiency was used to calculate confidence intervals. Each weekly estimate of trap efficiency was weighted based on the proportion of total estimated migrants that each weekly estimate of migrants represented, using the equation:

$$e_w = e_m * (N_m / N_t),$$

where:
e_w = weighted weekly trap efficiency
e_m = measured weekly trap efficiency
N_m = weekly estimated migrants
N_t = season total migrants.

The sum of the weighted trap efficiencies was used in the confidence interval calculations.

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. The transformed life-history stage of juvenile lamprey was distinguished from ammocoetes. This stage is characterized by a fully formed eye, silver body coloration, sucking mouth parts, and adult fin morphology.

Adult Salmonids

Returning adult spawner populations were either directly counted, estimated by mark-recapture methodology, estimated by area-under-the-curve (AUC) calculation based on live fish counts on spawner surveys (Beidler and Nickelson 1980), or by the ratios between hatchery and wild fish caught in traps and observed on spawner surveys. 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, below.

Fish that entered traps were identified to species and sex, and distinguished as wild or hatchery-reared based on presence or absence of an adipose fin clip. In NF Nehalem River, many hatchery coho salmon were given coded wire tags in their snouts rather than adipose fin clips, and these tags could be identified with a metal detector. Jacks of coho salmon, winter steelhead (≤ 50 cm FL), and Chinook salmon (≤ 60 cm FL) were distinguished from adults. Fish in the traps 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 above-trap spawner population. Live fish were identified to species and observed for tag presence, color and number of tags, stage of maturity (jack or adult) and in some cases, presence of adipose fin clips (denoting hatchery fish). Carcasses were sampled to record species, sex, origin (wild or hatchery), color and number code of any tags, and to enumerate jacks (coho salmon ≤ 43 cm mid-eye to posterior scale insertion (MEPS), Chinook salmon ≤ 51 cm MEPS). Other opportunities to record mark disposition of spawners included fish that re-entered the adult traps, 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

Numbers of males and females proportioned within population estimates were calculated based on sex ratios among trap captures and carcasses observed on surveys.

For sites that used mark-recapture population estimates (traps < 100% efficient), variance and 95% confidence intervals were calculated with the bootstrap procedure (Thedinga et al. 1994; 1000 iterations used for each calculation). The exception was the estimate for coho salmon at WF Smith River, where catch efficiency is low in the fall. Leaf debris caused frequent submergence of the floating weir, thus it was not a complete barrier, and to compensate for low trap efficiency we increased the survey sample size (e.g. total number of observations). However, the bootstrap procedure does not account for sample size, so we used the relationship between the F and binomial distributions to estimate variance and confidence intervals for the population estimate. Briefly, we first calculated 95% confidence limits of the proportion of tagged fish in the population (R/C), then calculated the 95% confidence limits of tagged fish expected within the dataset, then calculated Peterson estimates 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 at WF Smith River was sufficiently high to apply the bootstrap procedure for variance estimates of steelhead spawners. The variance of other population estimates was adjusted as follows. Hatchery coho spawners in NF Nehalem River that were not independent of wild spawner estimates had variance calculated as for combined wild and hatchery origin populations, then the resulting confidence intervals were partitioned among the two groups. For the EF Trask River, variance was calculated based on variation among the AUC spawner estimates for the individual surveys.

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 adult fish are collected at the trap or observed upstream of the trap. Composed of Age-3 adults and Age-2 jacks (e.g. 1996 Brood Year adults and 1997 Brood Year jacks form the 1999-2000 Return Year).

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 1996-1997 Return Year. This brood will return as adults to form the 1999-2000 Return Year).

Sample Year:
- Juvenile salmonids; the year juvenile fish were collected at the juvenile trap.

Percent Freshwater (FW) Survival = the number of smolts produced from the estimated number of eggs deposited.

Percent Marine Survival = Estimate of the total wild adults returning to spawn, divided by the smolts produced from the corresponding brood year (minus smolt handling mortality).

RESULTS AND DISCUSSION

Chapter 1: North Fork Scappoose Creek (Lower Willamette River)

North Fork Scappoose Creek is a 3rd order tributary that joins South Fork Scappoose Creek before entering the Multnomah Channel of the Willamette River at rkm 3.25. Adult coho salmon, steelhead and cutthroat trout are captured in NF Scappoose Creek at a ladder/trap facility that provides passage around a waterfall 10.6 rkm upstream of the creek mouth. The waterfall is a complete barrier to upstream migration, so 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 rkm downstream of the waterfall and adult ladder/trap.

Coho Salmon

The number of adult and jack coho salmon caught at the NF Scappoose Creek trap and the number of coho salmon placed above the trap (estimated spawning population) are given in Table 1. The estimated number of spawners ranged between 7 (1999-2000) and 49 (2004-05) fish, with no apparent trend over the course of monitoring.

Table 1. The number of female (F), male (M), jack (J), salmonids captured at the NF Scappoose Creek adult trap, and the estimated spawning population in NF Scappoose Creek during the return years 1999-2000 through 2004-05.

Return Year and Species	Trap Catch						Estimated Spawning Population					
	Wild			Hatchery			Wild			Hatchery		
	F	M	J[b]	F	M	J	F	M	J	F	M	J
Coho												
99-00	6	2	15	0	1	1	6	1	15	0	1	1
00-01	17	24	14	0	0	1	17	24	14	0	0	1
01-02	4	8	3	0	3	0	4	8	3	0	3	0
02-03	19	30	18	0	0	0	19	30	18	0	0	0
03-04	8	11	21	0	0	1	8	11	21	0	0	1
04-05	15	21	3	0	0	0	15	21	3	0	0	0
Steelhead												
99-00	11	10	0	0	0	0	11	10	0	0	0	0
00-01	5	7	0	0	0	0	5	7	0	0	0	0
01-02	7	7	0	1	0	0	7	7	0	1	0	0
02-03	13	8	1	1	1	0	13	8	1	1	1	0
03-04	5	9	1	0	1	0	5	9	1	0	1	0
04-05	11	11	1	1	0	0	11	11	1	1	0	0
Cutthroat (≥250 mm)[a]												
99-00	13	24	25									
00-01	8	12	62									
01-02	2	8	39									
02-03	3	4	0									
03-04	1	5	18									
04-05	6	10	27									

[a] Trap catch does not include all adult cutthroat migrants because bar spacing of trap allows some adults to move through the trap.
[b] cutthroat in jack column are unsexed fish, not jacks

Estimates of the number of eggs, fry, smolts, and adult returns in NF Scappoose Creek are summarized by brood year in Table 2, and the annual patterns are plotted as bar charts in Figures 1a-d. Marine survival for the 1997-2000 brood years ranged from 2.8% to 9.3 %. Freshwater survival varied between 0.5 % (2000 brood) and 5.7% (2001 brood). The 1999 and 2001 brood years had the fewest spawning females (Table 1; N= 6 and 4, respectively), which resulted in subsequent higher freshwater survival rates of juveniles (4.1%, 1999 brood; 5.7%, 2001 brood).

The 2003 brood year produced an abnormally high number of fry in proportion to the estimated number of eggs deposited. This is most likely due to potential spawning in the 1.8 kms of stream above the adult trap and below the rotary screw trap site. Fry numbers may be underestimated for the 2004 brood year because in spring 2005, fallen trees just upstream of the rotary screw trap created a large debris jam, diverting the natural stream flow pattern away from the thalweg. An attempt to divert flow back to the trap failed. Confidence intervals for smolt estimates are provided in Table 3 and data on mean fish size and mean peak week are provided in Appendix 1. During the years of trap operation at NF Scappoose Creek, the data indicate that as the number of female spawners increases, the number of smolts produced per female decreases (Figure 2). Developing this relationship for NF Scappoose Creek has been difficult because of low spawner escapement. More years of data with higher adult spawning densities may clarify the relationship.

Fall Chinook Salmon

Fall Chinook salmon apparently do not migrate up to the NF Scappoose Creek traps. No adult or jack fall Chinook salmon were captured in the NF Scappoose Creek trap for the return years 1999-2000 through 2004-05, and no juvenile fall Chinook salmon migrated downstream past the rotary screw trap from 1999 through 2005.

Winter Steelhead

The numbers of adult and jack winter steelhead captured in the NF Scappoose adult trap and the number of fish placed above the trap to spawn in NF Scappoose Creek are given in Table 1. Estimates of the number of winter steelhead smolts leaving NF Scappoose each spring are in Table 3, and data on size, peak week and pre-smolts estimates are given in Appendix 2. 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.

Cutthroat Trout

The numbers of adult cutthroat trout captured in the NF Scappoose trap are given in Table 1. 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 that would have been of hatchery origin. Estimates of the number of cutthroat trout in the two largest size classes that migrated downstream and leave NF Scappoose Creek each spring 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.

Table 2. The estimated number of spawners, actual number of fry, smolts, and wild returning adults, and estimates of freshwater and marine survival rates of coho salmon in NF Scappoose Creek.

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						6	2		
1997					1,453	17	24		2.8
1998				339	134	4	8		9.0
1999	6	0	15,892	876	659	19	30	4.1	7.4
2000	17	0	44,071	2,649	205	8	11	0.5	9.3
2001	4	0	9,905	807	569	15	21	5.7	6.3
2002	19	0	48,483	8,640	275			0.6	
2003	8	0	21,599	18,786	416			1.9	
2004	15	0	40,206	9,573					

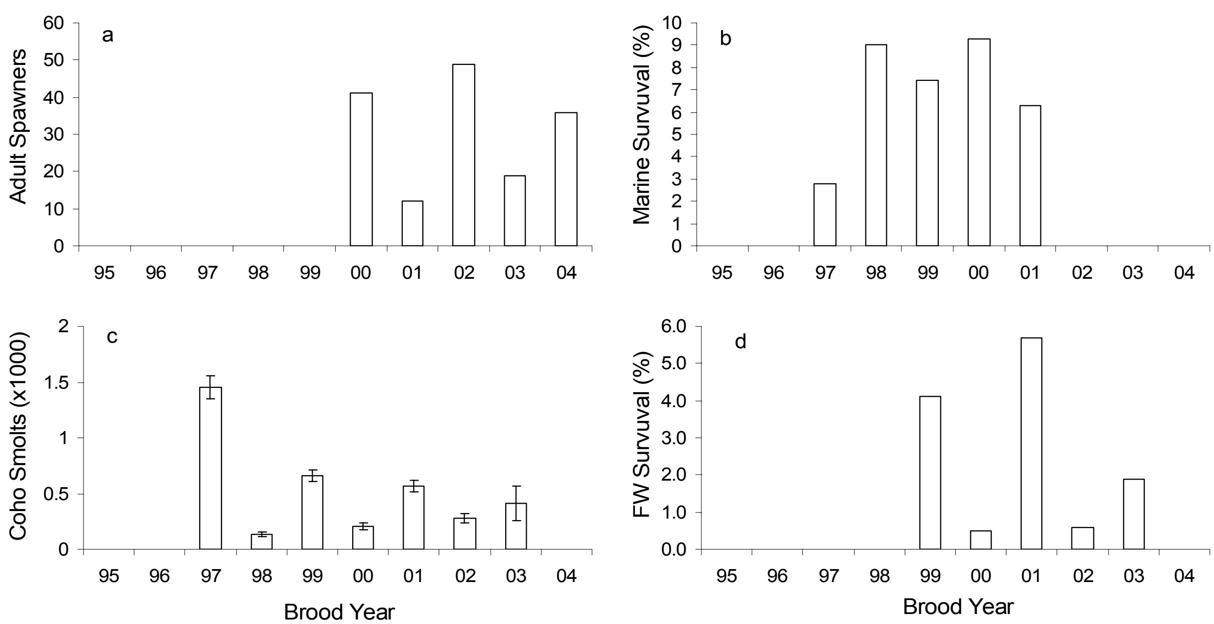

Figure 1. Annual trends in (a) the estimated number of adult spawners, (b) the percent marine survival, (c) number of smolts, and (d) percent freshwater survival for coho salmon in NF Scappoose Creek. The sample year of smolt out-migration is brood year +2 years and the calendar year of adult return for marine survival estimate is brood year + 3 years.

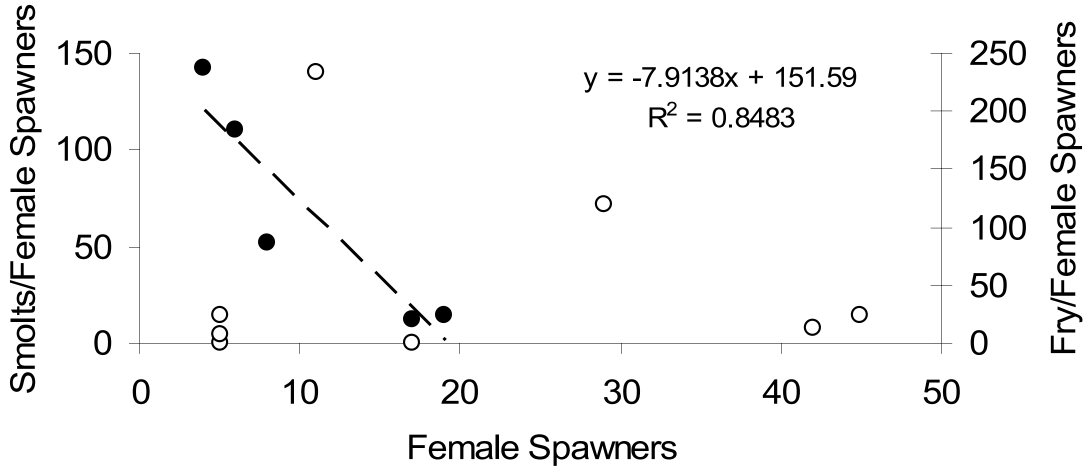

Figure 2. Relationship of coho smolt (solid symbol) and fry (clear symbol) migrants produced per female, to total female spawners in NF Scappoose Creek. The linear regression results for smolts are shown.

Table 3. Estimated number of juvenile salmonids (and 95% CI) migrating past the NF Scappoose Creek juvenile trap. Number of actual fish caught is reported (in parentheses) when trap efficiency could not be determined for a particular category. For cutthroat trout, only the 2 largest size classes are given. Additional out-migrant data are provided in appendices.

Sample Year	Coho smolts ± CI			Steelhead smolts ± CI ≥ 120 mm			Cutthroat migrants ± CI 160-249 mm			Cutthroat migrants ± CI 120-159 mm		
1999	1,453	±	102	407	±	180	346	±	114	142	±	43
2000	134	±	22	553	±	103	339	±	102	240	±	36
2001	659	±	55	841	±	137	375	±	76	344	±	66
2002	205	±	28	496	±	131	169	±	31	153	±	36
2003	569	±	49	717	±	779	245	±	84	259	±	81
2004	275	±	42	712	±	115	227	±	42	212	±	40
2005	416	±	156	(61)			486	±	561	(47)		

Chapter 2: North Fork Nehalem River (Nehalem River)

Life Cycle monitoring began on the North Fork (NF) Nehalem River in 1998, commencing with juvenile out-migration monitoring in the spring, followed by adult return and spawning monitoring in the fall and following spring. Waterhouse Falls defines the downstream extent of the basin being monitored, with an adult ladder/trap just upstream of the falls. A second falls ~ 6.5 km upstream of the lower falls has a second adult ladder/trap facility. Both falls are partial migration barriers. In spring, rotary screw traps placed near each ladder monitor juvenile salmonid out-migration. Juvenile monitoring at the upstream site began in spring 2000. For our monitoring and reporting, we've defined a lower sub-basin as the reach of river and tributaries between the two ladders, and an upper sub-basin as the area above the upstream falls and ladder.

The Nehalem Fish Hatchery (~ 2 km downstream of Waterhouse Falls), has two stocks of both coho salmon and winter steelhead. The "32" lower NF Nehalem River derived stocks have had some inputs from other streams or basins, but no wild inputs since the 1960's. The "99" stocks are derived only from wild fish from Fishhawk Creek, a tributary to the upper Nehalem River. Steelhead were taken from this creek to initiate the hatchery stock in 1982-1984, with no wild inputs thereafter. Both steelhead stocks are released as smolts and return as adults each year. The "99" coho salmon stock was initiated in 1978, and had further inputs from Fishhawk Creek in 1981 and 1984, the first two years that adults from the line returned. During the three year brood-cycle of coho salmon, "32" stock fish are released as smolts and return as adults in two years. The "99" stock are released as smolts and return as adults in one year.

Methods for salmonid species

We used a Petersen mark-recapture method to estimate the number of adult wild coho and fall Chinook salmon spawners, and total winter steelhead spawners (including jacks), for the basin area above Waterhouse Falls. In 2000-2002 no adjustments were made for tag loss, because fish tagged at the ladders were also given an opercle 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.

In this report, strays were designated as fish of hatchery origin that migrated upstream of the hatchery. In the 1998-1999 through 2001-2002 return years, stray coho salmon and steelhead were removed from the fish ladder at Waterhouse Falls. Hatchery coho salmon were killed and hatchery steelhead were either returned to the hatchery or released ("recycled") further downstream (near confluence with main Nehalem River). In 1998-1999 a small number of steelhead were released downstream of the ladder. All hatchery steelhead had adipose fin-clips, and some had additional marks. Until the spring of 2002, approximately 10-25% of hatchery coho salmon smolts were “double-indexed” (coded-wire tagged (CWT), no adipose fin-clip). When these fish returned as adults in 2003, tag presence was detected with a CWT wand. For the 1998-1999 through 2001-2002 return years, the estimated number of hatchery spawners passing (jumped) Waterhouse Falls were based on the estimated number of wild fish passing the falls (Peterson method) and the ratios between wild and hatchery fish among Waterhouse Falls captures and upstream recoveries. Beginning in fall 2002, hatchery fish were tagged and passed at Waterhouse Falls, allowing Petersen mark-recapture estimates for hatchery fish above the lower falls.

At the upstream ladder, all wild fish were passed upstream in all return years, as were hatchery fish during the 1998-1999 return year. For the 1999-2000 and 2000-2001 return years, fish with adipose fin-clips were killed and removed, but double-indexed fish were not differentiated from wild fish and were also passed upstream. The estimated number of double-indexed fish were based on the numbers of adipose fin-clipped fish captured, using the known ratio of adipose fin-clipped to double-indexed fish from the downstream ladder and the hatchery. In the 2001-2002 return year, a CWT wand was available for the upstream ladder, thus double-indexed fish were also killed and removed. Beginning with the 2002-2003 season, hatchery coho salmon were tagged and passed at the upstream ladder. Hatchery steelhead were always passed above the upstream ladder. Beginning in the 2000-2001 return year, wild coho and Chinook salmon, and wild and hatchery steelhead were tagged in the upstream ladder. We discontinued tagging hatchery steelhead after the 2002-2003 return year because too few recaptures were collected in previous years to obtain abundance estimates.

Spawner surveys were conducted each year on mainstem and tributary reaches 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 only tagged in the downstream ladder in 1998 and 1999, we did not allocate survey effort between the upper and lower sub-basins. In those years, surveys were more numerous in the lower sub-basin because spawners, particularly Chinook salmon, were more abundant in this reach. Beginning in 2000 more emphasis was placed on upper sub-basin surveys in order to find fish with upstream ladder tags, resulting in effort similar to the lower sub-basin. 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.

Live fish on surveys were identified as jacks or adults, and were observed for tags (all species) and adipose fin-clips (except Chinook salmon). Unless presence-absence of tags and adipose fin-clips was certain, surveyors recorded these attributes as unknown. Carcasses were sampled for sex, maturity (jack or adult), tags, opercle punches, and adipose fin-clips. To determine presence/absence of tags or other hatchery marks, we considered carcass condition in the body area where these marks would be found. In 2000, we took scale samples from some coho carcasses that lacked marks, for later identification of hatchery or wild growth patterns. In 2001, scale samples were taken from almost all unmarked fish, or else the snout was removed for later interrogation with a CWT wand. In 2002 and 2003, snouts of almost all unmarked fish 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.

Methods specific to coho salmon

During the 1999-2000 return year, we noted that a greater proportion hatchery fish spawned in the lower sub-basin, closer to the hatchery, while a greater proportion of wild spawners migrated into the upper sub-basin. Therefore, beginning in fall 2000 we obtained separate estimates for the number of wild and hatchery adult spawners in the two sub-basins by tagging wild fish trapped in both the upstream and downstream ladders. The resulting upper sub-basin estimates could then be subtracted from the entire basin estimates to yield lower sub-basin estimates. Juvenile migrants from the upper sub-basin were also trapped and estimated separately with the same goal.

To get separate spawner estimates for the two sub-basins for the 1999-2000 return year, we used an iterative procedure, described in Dalton et al. (unpublished manuscript). Sampling difficulties and insufficient recoveries precluded using the iterative procedure to make separate sub-basin estimates of adult spawners for the 1998-1999 or 2000-2001 return years. For the 2001-2002 return year, tag recoveries of wild adult coho spawners were sufficient to make a Petersen estimate of upper sub-basin. Upper sub-basin hatchery spawner numbers were then estimated based on this estimate and the wild/hatchery ratio among adults trapped in the upstream ladder. Subtraction of the upper sub-basin wild spawner estimate from the entire basin wild spawner estimate gave an estimate of wild adult spawners in the lower sub-basin. Lower sub-basin hatchery spawners were estimated from this lower sub-basin wild spawner estimate and the wild/hatchery ratio among lower sub-basin carcass recoveries. For the 2002-2003 return year, there were sufficient tag recoveries to make separate Petersen estimates of wild and hatchery adult spawners for both the entire basin and the upper sub-basin, and lower sub-basin estimates were made by subtraction of the upper sub-basin estimates from the entire basin estimates. For the 2003-2004 return year, Petersen estimates were made of entire basin wild and hatchery adults as well as upper sub-basin wild adults, and an upper sub-basin hatchery adult estimate was based on the latter estimate and the wild/hatchery ratio among upstream ladder captures. For the 2004-2005 return year, all estimates were made as they were in 2002-2003.

We estimated the weekly number of juvenile coho out-migrating past the two rotary screw traps for each week beginning of March to mid June. During some high flows the screw traps could not be operated safely, and in these cases the estimated number of out-migrants on each non-trapping day was interpolated from catch averages of the closest 4-5 days (preceding and following), during which the trap was actually operated. These high flow events occurred mostly in late February through March when smolt numbers were low relative to April and May; thus potential bias in the total season estimates were small. For example, in 2000 the upstream trap was not installed until the end of March, but trapping began on schedule (i.e., 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. This adjustment resulted in an increase of only 2.4%. The 2000 upper sub-basin total season estimate included the most non-trapping days of all the estimates.

Winter aquatic habitat was inventoried in all stream reaches accessible to coho salmon upstream of Waterhouse Falls in 2003 (T. Boswell, Lower Nehalem Watershed Council, unpublished data), and 2004 (ODFW Oregon Plan Aquatic Inventory Monitoring, unpublished data), using stream channel unit classifications and methodology described by Moore et al. (2005). The method yielded estimates of stream length accessible to anadromous fish in both sub-basins. These data were used in a Habitat Limiting Factors Model (HLFM, Nickelson 1998) to estimate smolt rearing capacity of each sub-basin. For the brood years for which separate sub-basin estimates of smolt numbers were made (1998-2003), we compared sub-basin estimates of wild spawner numbers, total female spawner density, percent of hatchery spawners, and smolt productivity (smolts/km of accessible stream, and smolts/estimated rearing capacity).

Finally, comparisons were made between smolt-to-adult survival rates of hatchery releases of the “99” and “32” stocks for the 1995-2000 brood years. Total adult survival was estimated by summing the estimates of strays with the returns to the hatchery, freshwater fisheries catch from punch-card data, and ocean fisheries catch from coded-wire tag data, and then dividing the sums by the numbers of smolts released from the hatchery (Mark Lewis, ODFW, pers. comm.). To account for annual variations in ocean survival conditions, these survival rates were indexed by dividing them by the annual return rate (marine survival) estimates for the wild population. This yielded an estimate of the proportion of the wild fish survival rate that was obtained by the hatchery population each year. No adjustment was made for “shaker” (hooking) mortality of double-indexed fish that anglers could not identify as being of hatchery origin and therefore had to release, but these constituted only about 10-25% of hatchery fish. Also, estimated hooking mortality impact rates were relatively small and varied little for these brood years, ranging from 7%-15% (Pacific Fishery Management Council 2005). In addition, the wild fish marine survival rates used to index the hatchery fish return rates had not been adjusted for hooking mortality impacts.

Coho Salmon

Coho salmon adults and smolts in the entire basin upstream of Waterhouse Falls

Coho salmon usually ascend the NF Nehalem River basin from mid September to early November. There was more annual variation in the number of hatchery versus wild adult coho, both for actual catch at Waterhouse Falls (Table 4) and for estimated numbers in the basin upstream of the falls (Table 5). Numbers of naturally spawning hatchery adults were relatively low for the first three years of sampling, particularly return year 2000-2001, increased in 2001-2002, and were most abundant in 2002-2003 (the first year that trapped hatchery fish were not killed), then declined in the 2003-2004 and 2004-2005 return years.

Actual catch of wild adult coho at Waterhouse Falls ranged from 227 (1998-1999) to 774 (2003-2004, Table 4). Estimates of wild adult spawners in the entire basin upstream of the falls were considerably lower for the first three years of monitoring than for the following four years, with the lowest and highest estimates in 2000-2001 and 2001-2002, respectively (Table 5). Total estimated spawners (wild and hatchery) were also lowest in 2000-2001 and greatest in 2002-2003, with tight confidence intervals for both of these estimates (Table 5, Fig. 3a).

Table 4. Number of wild and hatchery female (F), male (M) adult and jack (J) coho salmon captured at the NF Nehalem River downstream adult trap (at Waterhouse Falls) and the upstream adult trap.

Return Year	Lower Trap						Upper Trap					
	Wild			Hatchery			Wild			Hatchery		
	F	M	J	F	M	J	F	M	J	F	M	J
98-99[a]	104	123	53	77	81	125	13	17	4	0	4	23
99-00	227	234	4	345	307	13	75	78	5	8	15	0
00-01	147	127	17	24	31	21	34	30	5	1	1	2
01-02	181	202	7	311	284	49	155	195	0	13	24	6
02-03[ab]	189	217	5	474	541	46	152	215	2	153	224	2
03-04	384	390	38	159	210	6	138	178	12	24	36	0
04-05	282	214	14	89	111	91	153	179	17	11	31	22

[a] In the upper basin one wild fish was unsexed.

[b] In the lower basin one wild and one hatchery fish were unsexed

Table 5. Estimated number of wild and hatchery female (F) and male (M) adults and jack (J) coho salmon spawners in the NF Nehalem River (upstream of Waterhouse Falls). Jack abundance was not estimated ("na") when insufficient numbers of tagged fish were recovered.

Return Year	Total Adults ± CI	Wild: Total Adults ± CI	Wild: F	Wild: M	Wild: J	Hatchery: Total Adults ± CI	Hatchery: F	Hatchery: M	Hatchery: J
98-99	956 ± 229	657 ± 135	298	359	na	299 ± 94	142	157	na
99-00	1,137 ± 292	745 ± 121	369	376	na	392 ± 171	209	183	na
00-01	721 ± 127	612 ± 99	328	284	na	109 ± 56	51	58	na
01-02	4,093 ± 997	2,022 ± 427	937	1,085	na	2,071 ± 570	1,281	790	na
02-03	4,899 ± 554	1,567 ± 299	712	855	na	3,332 ± 467	1,574	1,758	na
03-04	2,321 ± 169	1672 ± 153	785	887	na	649 ± 73	283	366	na
04-05	2,463 ± 351	1816 ± 311	905	911	na	647 ± 136	257	390	233

We found no consistent relationship between the number of smolts released from the hatchery and the subsequent number of returning hatchery adults, or the percent of hatchery spawners among the naturally spawning population (Table 6). The number of hatchery smolt released declined over the years of monitoring, and two brood years with very similar smolt releases (1997 and 1999) produced, respectively, both the least and the greatest numbers of returning adults that were trapped at Waterhouse Falls and subsequently spawned above the falls. During the first four years of monitoring, hatchery strays were 17%-48% of estimated hatchery adult returns (Table 6), of which 22%-61% were trapped and killed at the Waterhouse Falls ladder/trap.

Table 6. Number of coho salmon smolts released from the Nehalem fish hatchery, total returning hatchery adults entering hatchery, percent that were strays (not entering hatchery), and percentage of strays among all adult spawners upstream of Waterhouse Falls.

		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	2,772	2,315	158	299	16.5	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]	209,652	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

[a] Strays from the 1995-1998 brood years trapped at Waterhouse Falls were killed.
[b] Trapped strays of the 1999-2001 brood years were passed.

At the out-migrant traps, accurate estimates of coho fry numbers was not possible in February and early March, due to hazardous working conditions and severe trap damage occurring with large storms and high flows at this time of year. Estimates of smolt out-migrants produced from the basin above Waterhouse Falls ranged from 20,804 -44,710 fish for the 2000 and 1999 broods, respectively (Table 7). Over the course of monitoring, out-migrant numbers usually peaked from early-mid April to mid May. The average fish length during weeks of peak migration was not correlated with when the peak week of migration occurred (Appendix 1).

In coastal Oregon, coho salmon have a three year life-cycle, with the majority of juvenile fish out-migrating to sea as age 1+ “smolts”, and returning after 1.5 years to spawn as three-year old adults. Therefore, three potential brood-lines exist from which adult spawners produce progeny that return as adults three years later. Our smolt abundance data over the eight years of monitoring show a three year pattern conforming to three potential brood-lines (Fig. 3c). Beginning with the 1996 brood year (spring of 1998 juvenile monitoring), smolt numbers for the three brood-lines were, relatively large, then relatively small for the 1997 brood, and then mid-range for the 1998 brood. This pattern was repeated in the 1999-2001 broods, and continued for the 2002 and 2003 broods. Spawner numbers fluctuated widely, with little apparent relationship with the subsequent number of smolts produced (Fig. 3a and c). Estimates of freshwater survival were much lower for the last three brood years, where spawner numbers increased without subsequent increases in smolt numbers (Table 7, Fig. 3d). As a result, smolts produced per female declined with an increase in female spawners (Fig. 4). Percent marine survival has varied annually from 2% (1996 brood) to 8% (2000 brood), with no consistent relationship between smolt numbers and subsequent adult returns. Over the six brood years for which we now have brood cycle data, the three highest marine survival estimates occurred in the last four years (Table 7, Fig. 3b).

Coho salmon adults and smolts in the upper and lower sub-basins

Wild adult coho greatly out-numbered hatchery adults among catches in the upstream ladder in all return years except 2002-2003, when they were trapped in almost equal numbers (Table 8). Sub-basin estimates of wild and hatchery adult spawners could be made for the 1999-2000 and 2001-2002 through 2004-2005 return years. Wild adult fish were the majority in the upper sub-basin, except in the 2002-2003 return year when there were slightly more hatchery adults. Confidence intervals for the upper sub-basin adult estimates were fairly narrow (Table 8, Fig. 5a). In the lower sub-basin, hatchery adults were more abundant than wild adults during the 2001-2002 and 2002-2003 return years, but wild adults out-numbered hatchery adults in all other return years (Table 8, Fig. b). 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. Lower sub-basin spawners, particularly hatchery fish, were more abundant than in the upper sub-basin in all return years except 2003-2004 (Fig. 5a and b). In all return years except 2002-2003, the estimated number of lower sub-basin wild and hatchery adults were more similar than in the upper sub-basin.

Hatchery adults were always more abundant in the lower sub-basin than in the upper sub-basin.

The number of juvenile coho out-migrating from the two sub-basins was similar for sample years 2001, 2002 and 2004, but greater in the upper sub-basin in 2000, 2003 and 2005 (Table 9). Lower sub-basin juvenile production varied over a wide range of female spawner numbers, while upper sub-basin production was less variable over a much narrower range of female spawners (Figure 6). In both sub-basins, juveniles per female decreased as the number of female spawners increased. The greater proportion of adult hatchery fish in the lower sub-basin relative to the upper sub-basin was always related to lower juvenile production in the lower sub-basin, and this occurred over a wide range of female densities as well as wild adult abundances (Table 10). The lower and upper sub-basins contained a total of 45.3 km and 32.1 km respectively, of stream reaches accessible to coho salmon. The HLFM yielded estimates of freshwater rearing capacity of 39,700 fish and 25,600 fish for the lower sub-basin and for the upper sub-basin, respectively. For all brood years the rearing capacity was much greater in the upper versus lower sub-basins (Figure 7). Female densities were mostly greater in the lower sub-basin, probably reflecting the influence of hatchery fish in that area (Table 10).

Wild coho salmon production

Over the years of monitoring, the annual number of returning wild adult coho salmon varied widely, reflecting large variation in marine survival rates. Estimates of wild fish have been similar the last three years (2002-2004), although smolt out-migrant estimates varied widely. Annual smolt production has had limited influence on subsequent adult returns, and this pattern is common in adult-to-smolt production of coho salmon. Smolt production is likely linked to density dependent factors in the freshwater realm (Bradford et al. 1997), except at very low spawner densities. Availability of winter habitat has been shown to influence smolt production (Brown and Hartman 1988; Nickelson et al. 1992, Beechie et al. 1994, and many others). We are currently investigating trends and relationships in the data that may help to explain the consistent differences in smolt productivity between the sub-basins, as well as the consistent patterns in smolt production among the brood-lines.

Table 7. The estimated number of spawners, actual number of fry, smolts, and wild returning adults, and estimates of freshwater and marine survival rates of coho salmon in NF Nehalem River.

Brood Year	Female Spawners		Egg Deposition	Fry	Smolts	Returning Adults (wild)		Percent Survival	
	Wild	Hatchery				F	M	FW	Marine
1996					42,267	369	376		1.8
1997					20,999	328	284		2.9
1998	298	142	1,158,208	na	31,677	937	1,085	2.7	6.4
1999	369	209	1,651,921	na	44,710	712	855	2.7	3.5
2000	328	51	1,061,026	na	20,804	785	887	2.0	8.1
2001	937	1,281	6,611,285	na	29,212	905	911	0.4	6.2
2002	712	1,574	7,234,089	na	40,013			0.6	
2003	785	283	2,965,756	na	24,587			0.8	
2004	905	257	3,374,021	na					

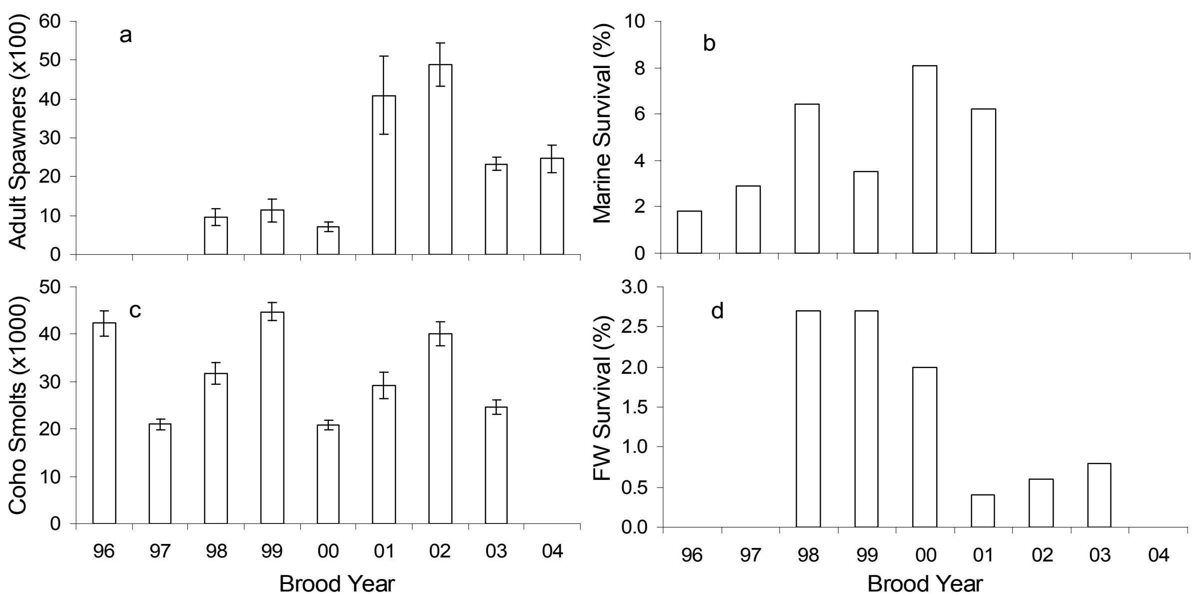

Figure 3. Annual trends in (a) the estimated number of adult spawners, (b) the percent marine survival, (c) number of smolts, and (d) percent freshwater survival for coho salmon in the NF Nehalem River.

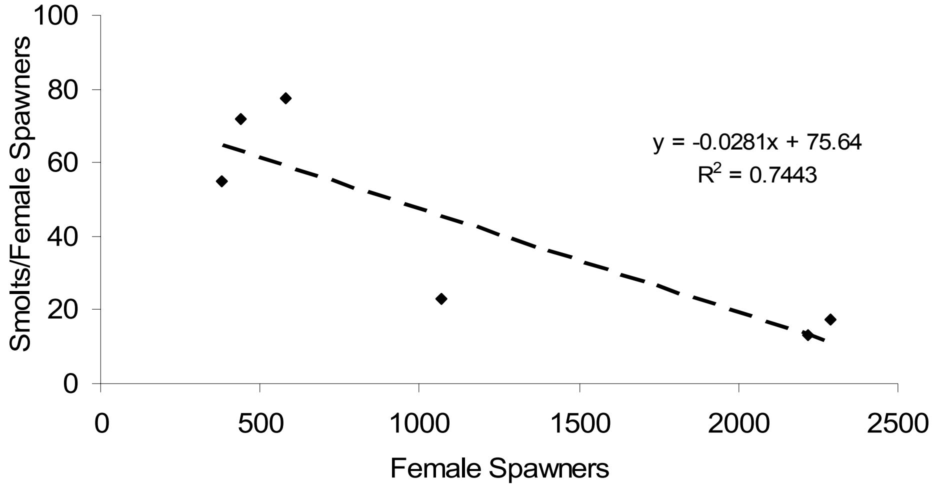

Figure 4. Relationship between smolts produced per female to total female spawners, in the NF Nehalem River entire basin upstream of Waterhouse Falls, 1998-2003 brood years.

Table 8. Estimated numbers of wild and hatchery female (F) and male (M) adult coho salmon spawners in the NF Nehalem River upper sub-basin (upstream of the upstream ladder trap), and lower sub-basin (between the downstream and upstream ladder traps) 1999-2000 and 2001-2002 through 2004-2005 return years. Jack abundances were not estimated (“na).

				Wild						Hatchery						
Return Year	Total Adults ± CI			Total Adults ± CI			F	M	J	Total Adults ± CI			F	M	J
Upper Sub-basin															
99-00	220	±	47	207	±	34	102	105	na	13	±	13	5	8	na
01-02	621	±	75	595	±	68	263	332	na	26	±	7	9	17	na
02-03	1,770	±	212	839	±	125	353	486	na	931	±	171	384	547	na
03-04	1,269	±	250	1,068	±	210	456	612	na	201	±	40	82	119	na
04-05	612	±	69	557	±	67	235	322	na	55	±	14	15	40	na
Lower Sub-basin															
99-00	917	±	142	538	±	50	267	271	na	379	±	92	204	175	na
01-02	3,472	±	1,000	1,427	±	411	674	753	na	2,045	±	589	1,272	773	na
02-03	3,129	±	593	728	±	324	359	369	na	2,401	±	498	1,190	1,211	na
03-04	1,052	±	302	604	±	173	329	275	na	448	±	129	201	247	na
04-05	1,851	±	358	1,259	±	318	670	589	na	592	±	163	242	350	na

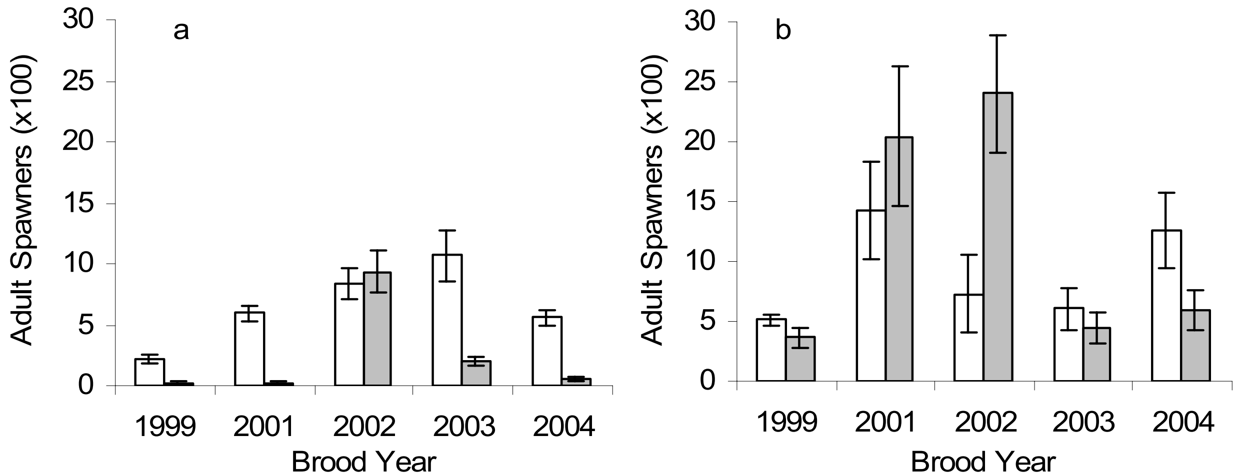

Figure 5. Estimated number of wild (clear bars) and hatchery (gray bars) adult coho salmon spawners in the a) upper sub-basin and b) lower sub-basins of the NF Nehalem River.

Table 9. Estimated number of coho salmon smolt migrants in the NF Nehalem River lower and upper sub-basins, 2000-2005. 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	8,129	±	3,134	23,548	±	2,089
2001	22,086	±	2,440	22,624	±	1,553
2002	9,252	±	1,940	11,452	±	1,664
2003	10,224	±	3,032	18,988	±	1,008
2004	18,351	±	2,761	21,662	±	1,113
2005	6,838	±	1,777	17,749	±	922

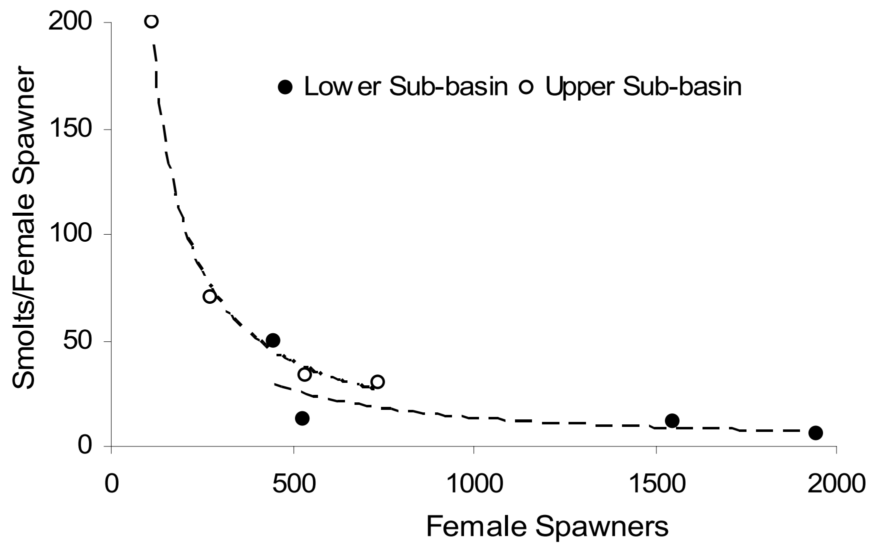

Figure 6. Relationship of coho salmon smolts produced to total female spawners in the lower sub-basin and upper sub-basin of the NF Nehalem River, for the 1999 and 2001-2004 brood years.

Table 10. Female coho spawners per km, proportion of hatchery spawners, smolts per smolt capacity productivity, smolts per km, and smolts per female spawners in the lower and upper sub-basins of the NF Nehalem River for the 1998-2003 brood years. Estimates not available are denoted by “na”.

Brood Year	Sub-basin	Females per km	Hatchery Spawners (%)	Smolts per Smolt Capacity (%)	Smolts per km	Smolts per female
1998	lower	na	na	20.5	180	na
	upper	na	na	92.0	733	na
1999	lower	10	41.3	55.6	488	47
	upper	3	5.9	88.4	704	211
2000	lower	na	na	23.6	204	na
	upper	na	na	44.7	356	na
2001	lower	43	58.9	25.6	226	5
	upper	8	4.2	74.2	591	70
2002	lower	34	76.7	46.2	405	12
	upper	23	52.6	84.6	674	29
2003	lower	12	42.6	17.2	151	13
	upper	17	15.8	69.6	552	33

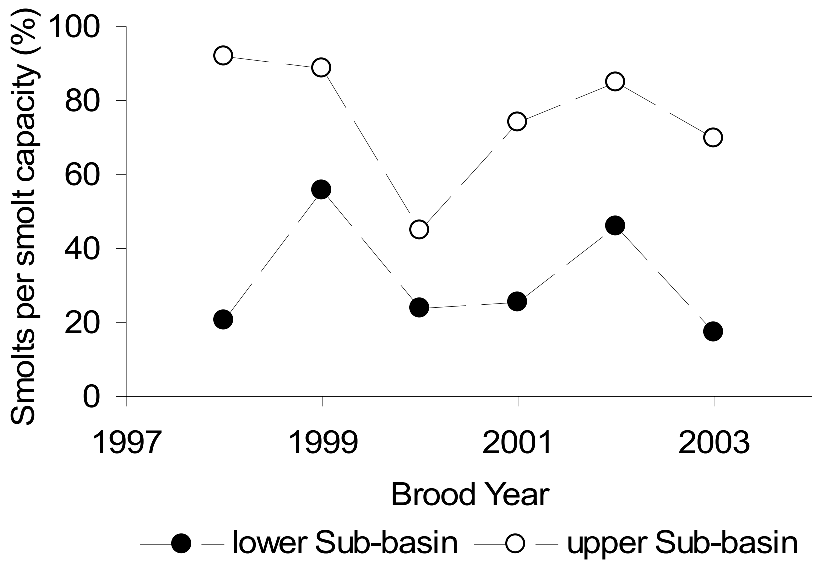

Figure 7. Relative production of coho smolts based on habitable stream distance for two sub-basins in the NF Nehalem River, brood years 1998-2003. Data are based on a HLF model.

Hatchery adult straying and survival rates

Straying rates for two brood years of the “99” stock (1996 and 1999), were 48% and 57%, respectively. For brood years of the “32” stock (1995, 1997, 1998, 2000 and 2001), straying rates were generally lower (35%, 19%, 29%, 28% and 31%, respectively; average = 26%). Stray rates might be related to 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 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. It should be noted that Soapstone Creek enters the river from the opposite bank near the hatchery, and contains large amounts of spawning and rearing habitat. Although we have no estimates of numbers of hatchery strays in this creek, annual spawner surveys indicate these numbers are substantial. It is possible that “32” stock fish, because they are mainly derived from lower river brood inputs, stray into this creek more often than do “99” stock fish, derived from upriver input. Differences between the stocks in straying rates into the Nehalem River or Foley Creek are unexamined.

The “99” stock averaged better adult return rates than the “32” stock. For two brood years of the “99” stock, total smolt-to-adult survival rates were 1% and 3%, respectively, and for four brood years of the "32" stock (1995, 1997, 1998, and 2000), adult survival rates were 0.5%, 0.4%, 6%, and 2%, respectively. Catch data were not yet available for the 2001 brood, but if catch rates were similar to the average for the other years, total survival would have been about 3%. The "99" stock hatchery population was 77% (1996 brood) and 93% (1999 brood) of wild survival. For the "32" stock brood years of 1997, 1998, and 2000, the hatchery population was 14%, 87% and 19%, respectively, of wild survival. A marine survival estimate for wild fish was not available for the 1995 brood, as juveniles of this brood migrated before monitoring began. If the 3% hatchery adult survival is accurate for the 2001 brood, then this brood would have had about 40% of wild survival. If higher numbers of "32" stock fish stray into Soapstone Creek, returns and survival rates for the "32" stock could be somewhat higher in comparison to the "99" stock survival rates reported here. Notably, the "99" stock returns in the same year as the wild brood-line associated with the highest average smolt production, as discussed in the previous section. However, there were also differences in juvenile abundance between the two brood-lines associated with the "32" stock. Future research and monitoring can examine differences in stock interactions and influences on the wild fish population.

Fall Chinook Salmon

Adult fall Chinook salmon usually ascend the NF Nehalem River in mid October, with more fish moving upstream with higher river flows. Chinook usually arrive at the lower trap in large numbers until mid to late November, with few new arrivals by the end of December. The Nehalem Fish hatchery does not release fall Chinook salmon, and strays have not been seen in most years. Adult catches at the Waterhouse Falls ladder/trap have ranged from 53 fish in the 2000-2001 return year to 339 fish in the 1999-2000 return year. Jacks were caught in small numbers in all years (Table 11). Estimated adult spawner numbers in the basin upstream of Waterhouse Falls decreased over the first three years of monitoring, then increased the following years (Table 11, Fig. 8a). Estimates varied between 138 fish in 2000-2001 to 1,187 fish in 2003-2004.

Low flows appear to influence the upstream migration of fall Chinook, particularly females. Males made up 80% of spawners in the monitored basin during low flows of the 2000-2001 return year. Males were also predominant in 2001-2002 (66%) and 2004-2005 (61%). The latter year had particularly low flows during most of November and early December. Spawning occurs extensively in the lower sub-basin NF Nehalem and in the lower gradient reaches of tributary confluences with the river. Relatively few fish migrate to the upper sub-basin (Table 11). Catches of adults fall Chinook salmon in the upstream ladder ranged from 4 (2004-2005) to 34 (2003-2004), with males predominating. Upper sub-basin adult spawner population estimates could be made for the 2002-2003 and 2003-2004 return years; however, 95% confidence intervals of these estimates were large. Jacks were caught only in the 2003-2004 return year, 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). Trap collections often peak sharply for short periods in March. The peak week of migration ranged from late in March until late in April, and usually occurred in early to mid April (Table 12). Estimated fry and fingerling abundance in the entire basin upstream of Waterhouse Falls was highest during the spring of 2004, and least in the spring of 2001. Total sub-yearling out-migration appears to be related with the number of female spawners (Figure 8b).

Table 11. Number of female (F) and male (M) adults and jack (J) fall Chinook salmon captured at the NF Nehalem River traps, and estimated numbers of spawners in the upper sub-basin (upstream of the upper trap), and estimated adult spawners in the entire basin upstream of the lower trap. Estimates were not made ("na") when few fish were captured in the ladders or recovered on surveys.

Return	Caught			Estimated Spawners					
Year	F	M	J	Total Adults ± CI[a]			F	M	J
Upper Trap and upper Sub-basin									
98-99	2	11	0	na	±	na	na	na	na
99-00	4	13	0	na		na	na	na	na
00-01	0	6	0	na		na	na	na	na
01-02	1	11	0	na		na	na	na	na
02-03	7	23	0	63	±	37	17	46	na
03-04	5	29	2	111	±	97.5	26	85	na
04-05	1	3	0	na		na	na	na	na
Lower Trap and Total basin									
98-99	90	74	3	633	±	211	325	308	na
99-00	194	145	10	484	±	47	265	219	na
00-01	10	43	3	138	±	66	28	110	na
01-02	61	133	10	644	±	172	220	424	na
02-03	70	50	3	876	±	512	461	415	na
03-04	88	93	14	1,187	±	475	497	690	na
04-05	69	100	15	522	±	146	201	321	na

[a] For years where adult spawner estimates were made, 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.

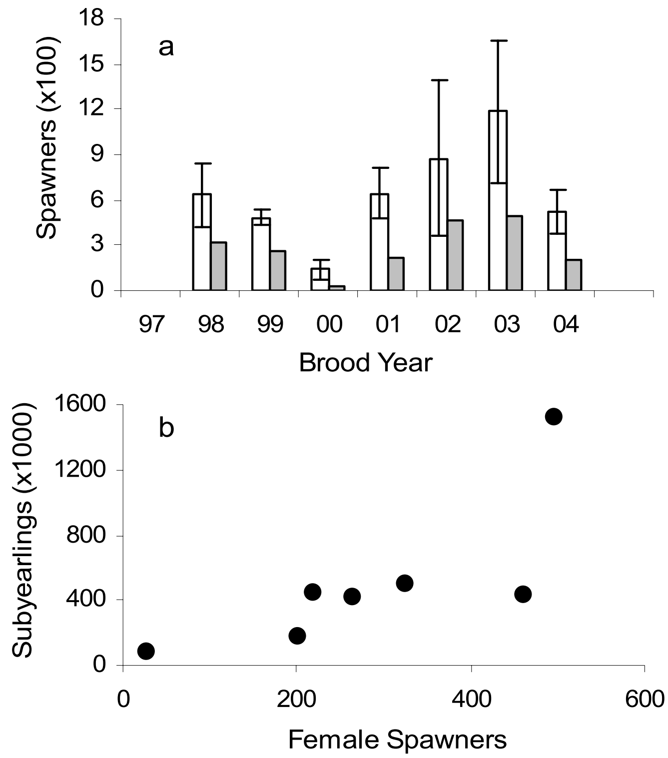

Figure 8. Estimated numbers of (a) total (clear bars) and female (shaded bars) fall Chinook salmon adult spawners, and (b) the relationship of migrant sub-yearling (fry and fingerling) numbers to female spawner numbers in the NF Nehalem River entire basin above Waterhouse Falls, 1997 through 2004 brood years.

Table 12. Estimated number of sub-yearling (fry and fingerling) fall Chinook salmon migrants, and week of peak migration, from the NF Nehalem River entire basin upstream of Waterhouse Falls.

Sample Year	Migrants ± CI			Peak week
1998	984,449	±	115,714	3/23-3/29
1999	496,371	±	57,271	4/05-4/11
2000	414,739	±	33,096	3/27-4/02
2001	81,753	±	4,946	4/23-4/29
2002	445,384	±	43,904	4/01-4/06
2003	427,584	±	133,232	4/14-4/20
2004	1,515,271	±	201,521	4/12-4/18
2005	177,812	±	28,537	4/04-4/10

Winter Steelhead

The majority of adult hatchery winter steelhead returned to the Nehalem River from mid December through January, with the remainder arriving by early March. Wild winter steelhead generally returned later and over a longer time period, in large numbers from mid January into April, and in small numbers into mid to late May. In the 1998-1999 return year the Waterhouse Falls ladder/trap caught more wild than hatchery steelhead (Table 13), while the converse was observed in 2003-2004. In the other years, numbers of wild and hatchery steelhead caught were somewhat similar. The lowest and highest estimate of wild steelhead spawners occurred in 2003-2004 and 2001-2002, respectively, with most other annual estimates nearer the lower value (Table 14). The estimates of hatchery spawners showed a wider range than wild spawner estimates. The lowest (2000-2001) and highest (2001-2002) return year estimate of hatchery spawners were years when fish trapped at Waterhouse Falls were recycled. The other annual estimates were all much nearer the lower value. Total spawner estimates ranged from 464 (2000-2001) to 2,436 (2001-2002) fish, with the other annual totals again being considerably closer to the low end of the range.

In all years, it appeared that a majority of returning hatchery steelhead entered the hatchery; the percentage that strayed to Waterhouse Falls was estimated to range from 18% in 2002-2003 to 38% in 2001-2002 (Table 15). Estimated straying rates were somewhat greater and more variable in the first four years of monitoring (20%-38%), when hatchery stray estimates were based upon wild spawner estimates. Hatchery stray estimates were lower in the last three years (18-19%), when they were calculated independent of wild fish estimates. The percentage of all hatchery steelhead strays trapped at Waterhouse Falls ranged from 13% (2001-2002) to 60% (1999-2000). During years when hatchery steelhead were recycled, the estimated proportion of hatchery strays among all spawners upstream of Waterhouse Falls ranged from 27%-64%. During the years when they were passed, hatchery steelhead proportions ranged from 34%-66%. It is also possible that significant numbers of hatchery steelhead strayed into Soapstone Creek, as noted above for coho.

Table 13. Number of wild and hatchery female (F), male (M) and unsexed (UA) adults and jack (J) winter steelhead captured at the NF Nehalem River downstream adult ladder trap at Waterhouse Falls for the return years 1998-1999 through 2004-2005.

	Wild				Hatchery			
Return Year	F	M	UA	J	F	M	UA	J
98-99	44	39	0	17	19	25	0	5
99-00	160	69	0	1	198	112	0	0
00-01	98	91	0	18	114	71	0	15
01-02	62	48	0	3	151	80	0	2
02-03	45	29	0	2	55	35	1	6
03-04	38	23	0	1	139	71	0	0
04-05	64	44	0	4	91	58	0	2

Table 14. Estimated number of wild and hatchery female (F) and male (M) adult winter steelhead spawners in the NF Nehalem River entire basin upstream of Waterhouse Falls. "Males" includes both adult males and jacks. Male and female ratios were based on male and female ratios of steelhead that entered the Nehalem hatchery.

Return Year	Total Adults ± CI			Wild Total Adults ± CI			Wild F	Wild M	Hatchery Total Adults ± CI			Hatchery F	Hatchery M
98-99	922	±	566	648		379	268	380	274	±	187	133	141
99-00	655	±	128	410	±	55	208	202	245	±	73	99	146
00-01	464	±	85	338		43	158	180	136	±	42	80	46
01-02	2,436	±	1,645	869	±	537	425	444	1,567	±	1,108	894	673
02-03	647	±	326	427	±	318	217	210	220	±	70	120	100
03-04	667	±	139	228	±	115	136	92	439	±	78	232	207
04-05	720	±	155	359	±	126	191	168	361	±	91	184	177

Table 15. Estimated numbers of returning hatchery winter steelhead (adults and jacks) that entered the hatchery, percent that were strays (not entering hatchery, and percentage 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
98-99[a]	1,595	1,272	49	274	20.3	15.2	29.7
99-00[a]	1,719	1,164	310	245	32.3	55.9	37.4
00-01[a]	1,000	674	200	126	32.6	61.3	27.2
01-02[a]	4,717	2,917	233	1567	38.2	12.9	64.3
02-03[b]	1,199	979	96	124	18.3	43.6	34.0
03-04[b]	2,332	1,893	210	229	18.8	47.8	65.8
04-05[b]	1,868	1,507	151	210	19.3	41.8	50.1

[a] Strays were returned to hatchery or released near confluence with mainstem Nehalem R.
[b] Strays were passed.

The estimated number of steelhead smolt migrants was highest in spring 2000 and lowest in the spring of 2002. The higher estimate was anomalous, as all other annual abundance estimates were < 8,090 fish (Table 16). Peak week of migration normally occurred by the beginning of April or early May (Appendix 2). Recapture of marked 90-119 mm parr migrants were usually sufficient to make annual abundance estimates. Mark recoveries of 60-89 mm parr were too few to make abundance estimates in all but three years (Appendix 2).

Table 16. Estimated number of trout (and 95% CI) migrating past the NF Nehalem River juvenile trap at Waterhouse Falls. Number of actual fish caught is reported (in parentheses) when trap efficiency could not be determined for a particular category. For cutthroat trout, only the 2 largest size classes are given. Additional out-migrant data are provided in appendices.

Sample Year	Steelhead smolts ± CI ≥ 120 mm			Cutthroat migrants ± CI 160-249 mm			Cutthroat migrants ± CI 120-159 mm		
1998	6,706	±	1,285	550	±	685	1,471	±	895
1999	4,572	±	498	658	±	157	1,987	±	323
2000	17,448	±	1,702	1,520	±	389	3,232	±	655
2001	8,090	±	714	592	±	126	3,444	±	556
2002	3,437	±	514	1,647	±	358	3,456	±	714
2003	5,380	±	1,470	1,041	±	809	1,886	±	1,820
2004	7,762	±	1,496	981	±	1,165	2,008	±	1,540
2005	4,613	±	1,293	322	±	180	1,527	±	629

Cutthroat Trout

Cutthroat trout caught in the Waterhouse Falls ladder trap were not tagged and no effort was made to estimate the numbers migrating upstream. Cutthroat trout ≥ 250 mm FL were classed as adults. In Table 17, we present only catch of adult cutthroat trout in the Waterhouse Falls ladder trap, and catch of adults in the out-migrant screwtrap at Waterhouse Falls in spring. Adult cutthroat were caught in the ladder mostly in fall, associated with rains, but catch varied widely among years. Relatively large numbers were sometimes caught as late as December, but few were caught afterwards. Spring catches in the out-migrant trap varied widely by month, and included resident fluvial fish, some of which may have been caught multiple times. Catch was greatest from as early as March to as late as June in different years, with the greatest catch most often in April.

Annual cutthroat trout catch in the out-migrant trap was usually small for the smallest size class (60-89 mm FL), and in most years abundance estimates were not possible (Appendix 3). Estimates were small and had large confidence intervals in the two years where estimates were possible (2000 and 2001), and low trapping efficiency for all the size classes resulted in large confidence intervals. In all years, fish 120-159 mm FL were most common, with those in the 60-249 mm size class usually the next most common (Table 16). Abundance estimates for the 90-119 mm size class were not possible in 2004 and 2005 due to low recapture rates (Appendix 3).

Table 17. Number of unsexed adult cutthroat trout (≥ 250 mm) captured in the NF Nehalem River ladder trap and the out-migrant screwtrap at Waterhouse Falls. Fish were caught October-June in the ladder trap, and in February-July in the screwtrap.

Return Year	Adult Ladder Trap[a]	Juvenile Screw Trap
97-98	Na	10
98-99	25	18
99-00	17	26
00-01	1	45
01-02	1	35
02-03	1	3
03-04	82	11
04-05	31	15

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

Chapter 3: East Fork Trask River (Trask River)

In 2004, the Oregon Department of Forestry (ODF) and ODFW began jointly operating an Oregon Plan Life Cycle monitoring site on the East Fork (EF) Trask River. The site is located at a dam that was built to supply water to an ODFW fish rearing facility. There are ~33.7 km of stream above the dam, and almost all the basin is under ODF ownership. The dam is a complete barrier to upstream anadromous migration. Adults swim up a ladder into the water intake structure where they are trapped and counted. The East Fork enters the South Fork Trask River ~0.8 km downstream of the dam. In the fall and winter of 2004-05, the reach between the dam and the South Fork confluence and three small spring-fed tributaries were surveyed approximately weekly for live adults and carcasses. Juveniles are captured using a rotary screw trap placed in the river in the spring about 300 m upstream of the confluence.

Coho Salmon

The estimated number of adults that spawned in the EF Trask River below the dam was 21 fish (AUC estimate ± CI). This estimate was allocated to males and females by their ratio among captures in the trap, and these numbers were then added to the number of adults trapped and passed above the dam (N=283, Table 18) to yield a total estimate of 304 spawners. The estimated number of coho salmon juvenile out-migrants was 6,069 ± 665 (Table 19), and the fry estimate was 42,474 ± 12,600 (Appendix 1). The peak week of smolt migration was from May 9-15, and the mean FL was 107.5 ± 3.1 mm.

Table 18. Actual number of wild adult female (F) male (M), unsexed (UA) and jack (J) salmonids captured at the EF Trask River adult trap and passed upriver (passed in parentheses if different), and estimated numbers of wild fish upriver of the trap for the 2004-2005 return year. The 95% CI's are based on spawner survey data for the total adult spawner estimate for (wild plus hatchery). For steelhead, total estimates of spawners are the same as the numbers passed.

	Actual Catch				Estimated Wild				
Return Year	F	M	UA	J	Total Adults ± CI	F	M	UA	J
Coho									
04-05	139	143	0	8	304 ± 7	149	154		9
Fall Chinook									
04-05	4	4	0	0	27 ± 7	13	14		1
Steelhead[a]									
04-05	47	37 (36)	4	1					

[a] Total estimates of steelhead spawners are the same as the numbers passed

Table 19. Estimated number of juvenile salmonids (and 95% CI) migrating past the EF Trask River juvenile trap. For cutthroat trout, only the 2 largest size classes are given. Additional out-migrant data are provided in appendices.

Sample Year	Coho smolts ± CI	Steelhead smolts ± CI ≥ 120 mm	Cutthroat migrants ± CI 160-249 mm	Cutthroat migrants ± CI 120-159 mm
2005	6069 ± 665	2588 ± 1015	551 ± 296	3,526 ± 616

Fall Chinook Salmon

Only eight adult fall Chinook salmon were caught in the EF Trask adult trap. AUC estimates and 95% confidence intervals of the number of spawners downstream of the dam were added to yield a total spawner estimate of 27 adults (Table 18). The estimate of sub-yearling fry and fingerlings migrating downstream was 37,073 ± 8,280, based on the overall trap efficiency for the season. Migration of fry and fingerlings peaked May 2-8.

Summer and Winter Steelhead

Both hatchery summer steelhead (N=23) and hatchery winter steelhead (N=37) were caught in the adult trap. All summer fish and all but four winter fish were passed upstream; one fish was recycled to the Wilson River, and three were released downriver at the ladder. Wild winter steelhead were caught in low numbers, and all but one fish, a mortality, was passed upriver (Table 18). No steelhead spawners were seen on surveys, thus the ladder trap captures constituted estimates of spawners. Among steelhead juvenile migrants, smolts >120 mm FL were most abundant with peak numbers in mid to late April (Table 19). The next most abundant were juveniles in the 90-119 mm category, followed by those in the 60-89 mm category (see Appendix 2).

Cutthroat Trout

The EF Trask River trap site was efficient at catching cutthroat trout, where 171 unsexed adults were caught. Over half were caught in October, and numbers decreased thereafter. Flows were very low in February, and no adults of any species were caught that month. It is uncertain whether the number of fish trapped constitutes a total estimate of the numbers that entered the ladder and passed upstream, as other Oregon Plan LCM sites do not collect all cutthroat trout that enter the traps. Twenty four cutthroat of $\geq$250 mm were caught in the screw trap from early March through mid-May, with most being caught in March. Some of these may have been caught multiple times.

Most juvenile cutthroat trout migrants estimated to have migrated were in the 120-159 mm size class, followed respectively by the 90-119 mm class, 160-249 mm class (Table 19, Appendix 3). Only 26 fish of the smallest category (60-99mm) were captured, and too few marked fish were recaptured to make an abundance estimate (Appendix 3).

Chapter 4: Mill Creek (Siletz River)

Mill Creek is a third order stream that enters the main-stem of the Siletz River at rkm 82. Mill Creek contains approximately 18 km of stream accessible to anadromous salmonids. Estimates of juvenile out-migrants at Mill Creek began in the spring of 1997, and have continued through the spring of 2005. Juveniles are captured using a rotary screw trap located just above a waterfall and fish ladder located 0.4 km upstream of the stream mouth. Estimates of adult salmon and steelhead entering the stream to spawn began in the winter of 1997-98, and have continued through the winter of 2004-05. Estimates of adult salmon spawners are made using a Petersen mark-recapture population estimate by tagging adult salmon with Floy tags at the ladder. Spawning surveys are completed each winter to determine the tagged:untagged ratio of adult salmon.

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 20. The number of adult coho salmon spawning each year in the late 1990's was approximately 50-150 fish, increased to 250-275 spawners in the winters of 2000-01 and 2001-02, and then jumped substantially to over 1,000 spawners/year in the winters of 2002-03 and 2003-04. The numbers of spawners dropped to 430 in the winter of 2004-05 (Table 20 and Figure 9a). No hatchery fish were observed during surveys.

Estimates of eggs, fry, smolts, adult returns, and survival rates are provided for each brood in Table 22, and additional juvenile data are summarized in Appendix 1. These data indicate that the increase in adult spawners in Mill Creek since 1997 has largely been the result of an increase in marine survival, with smolts from brood years 1998-2000 surviving to spawn at two to three times the rate of smolts from brood years 1995-1997 (Figure 9b). The 1995-97 broods also had fewer smolts migrating from Mill Creek than later broods (Figure 9c), which contributed to the low adult returns. When the number of female spawners in Mill Creek is under 100 fish, the smolt population appears to be directly correlated to the number of female spawners; however, as the number of female spawners continues to increase, the number of smolts produced in the stream levels off at approximately 17,000 to 20,000 smolts, suggesting the stream has reached it's capacity for rearing juvenile coho salmon. Freshwater survival (Figure 9d) was over 8% when the number of female spawners was low (Figure 9a; < 50 females) but was less than 2% when the number of female spawners was high (> 450 females). At higher abundance of spawners, more coho salmon fry left Mill Creek, and there was a significant relationship (P=0.008) between the number of fry/female and the number of female spawners (Figure 10). This relationship suggests that at high numbers of female spawners, more fry/female may be migrating because some habitats may be limited. However, other factors, particularly the number and intensity of spring freshets, can also influence fry migrant numbers. The relationship between fry/female and female spawners is driven primarily by the 2002 brood of female spawners and the resulting fry migrants in the spring of 2003. In March of 2003, there were two large high flow events that contributed to the large numbers of coho salmon fry caught in the downstream migrant trap that spring. Additional years of sampling are needed to understand this relationship.

Fall Chinook Salmon

The numbers of adult and jack fall Chinook salmon captured in the Mill Creek-Siletz trap are low (Table 20). All fall Chinook salmon were passed above the trap, and these numbers are believed to represent the total spawning population, as these fish are generally unable to jump the waterfall to gain access to Mill Creek above the falls. A series of small waterfalls near the mouth of Mill Creek often makes access to the stream difficult during October and early November, when adults are typically moving into tributaries to spawn. Therefore, fall Chinook salmon do not generally use Mill Creek as a primary spawning area in the Siletz watershed. The numbers of juvenile fall Chinook salmon migrants leaving Mill Creek in each spring are given in Table 23.

Table 20. Actual number of female (F), male (M) and jack (J) salmonids captured at Mill Creek-Siletz adult trap, and estimated number of wild spawners above the trap. Estimated the numbers of female and male spawners were based on the sex ratio observed at the trap.

Return Year and Species	Trap Catch						Estimated						
	Wild			Hatchery						Wild			
	F	M	J[b]	F	M	J	Total ± CI			F	M	J
Coho												
97-98	41	30	0	0	0	0	113	±	67	48	65	na
98-99	29	25	4	8	3	2	55	±	0	25	30	7
99-00	40	52	10	18	6	2	147	±	32	83	64	29
00-01	117	119	12	2	1	0	257	±	13	130	127	35
01-02	89	113	21	16	12	7	277	±	31	155	122	121
02-03	467	429	35	7	7	5	1,034	±	37	495	539	73
03-04	498	386	10	4	1	0	1,065	±	52	459	606	59
04-05	182	174	8	1	1	0	430	±	27	210	220	na
Fall Chinook												
97-98	0	0	0	0	0	0						
98-99	1	2	0	0	0	0						
99-00	1	0	1	0	0	0						
00-01	0	0	0	0	0	0						
01-02	20	36	3	0	0	0						
02-03	0	1	0	0	0	1						
03-04	0	1	0	0	0	0						
04-05	1	0	0	0	0	0						
Steelhead												
97-98	11	11	0	31	29	1						
98-99	6	5	1	56	40	1						
99-00	3	2	1	14	3	0						
00-01	7	6	0	13	6	0						
01-02	13	11	0	27	41	0						
02-03	13	15	0	20	24	1						
03-04	17	10	0	106	113	1						
04-05	4	7	0	81	61	0						
Cutthroat > 250 mm[a]												
97-98	0	1	3									
98-99	0	0	4									
99-00	0	0	4									
00-01	0	0	0									
01-02	0	2	0									
02-03	1	3	2									
03-04	1	1	1									
04-05	0	0	0									

[a] Trap catch does not include all adult cutthroat migrants because bar spacing of trap allows some adults to move through the trap.
[b] cutthroat in jack column are unsexed fish, not jacks

Table 21. The estimated number of spawners, actual number of fry, smolts, and wild returning adults, and estimates of freshwater and marine survival rates of coho salmon in Mill Creek-Siletz.

Brood Year	Female Spawners		Egg Deposition	Fry	Smolts	Returning Adults (wild)		Percent Survival	
	Wild	Hatchery				female	male	FW	Marine
1994						48	65		
1995					8,110	25	30		0.7
1996					9,547	83	64		1.5
1997	48	0	95,945	483	8,409	130	127	8.8	3.1
1998	25	0	52,716	100	4,311	155	122	8.2	6.6
1999	83	0	204,416	617	15,475	495	539	7.6	6.7
2000	130	0	330,551	2,143	17,305	481	624	5.2	6.4
2001	155	0	438,065	9,030	16,063	210	220	3.7	2.7
2002	495	0	1,450,177	62,727	18,300			1.3	
2003	459	0	1,188,228	24,166	20,717			1.7	
2004	210	0	596,809	11,196					

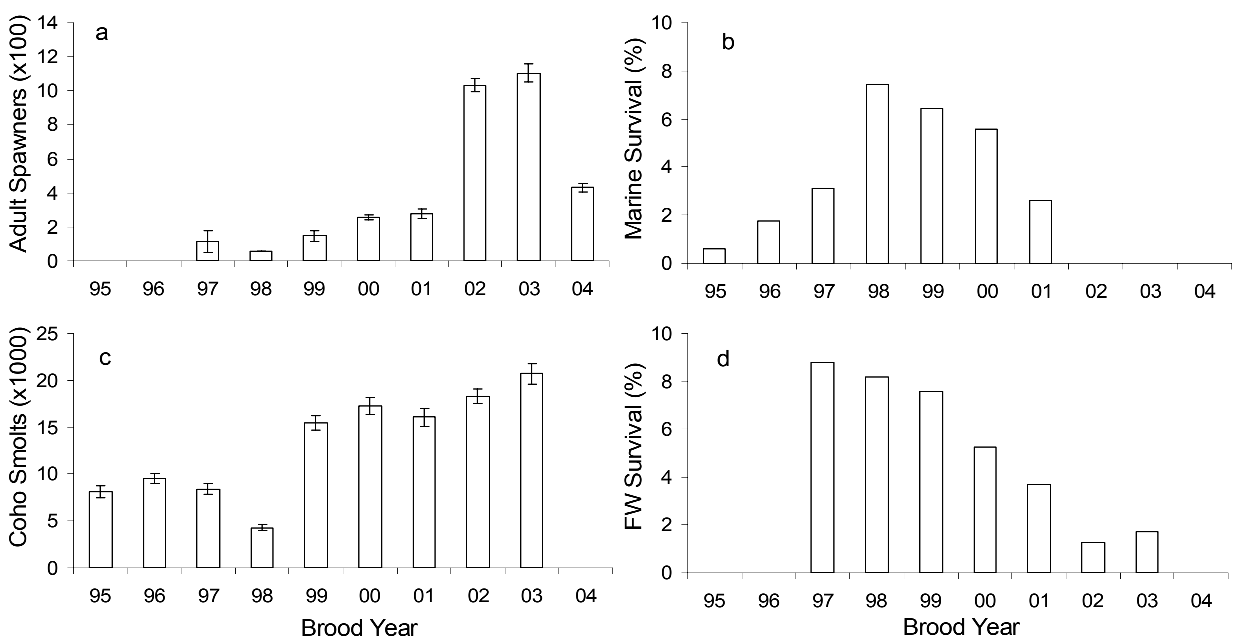

Figure 9. Annual trends in (a) the estimated number of adult spawners, (b) the percent marine survival, (c) number of smolts, and (d) percent freshwater survival for coho salmon in Mill Creek-Siletz River.

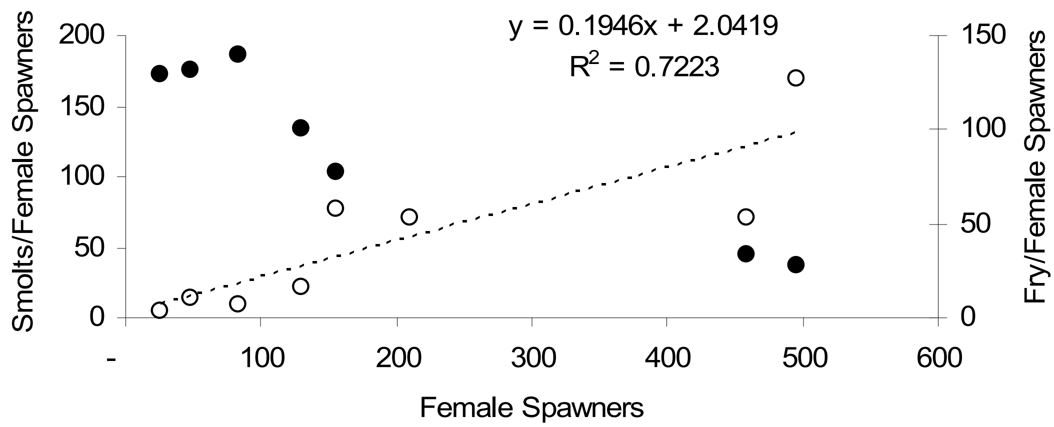

Figure 10. Relationship of smolt (solid symbol) and fry (clear symbol) migrants produced per female, to total female spawners in Mill Creek-Siletz River. The linear regression shown for fry is significant (P=0.008).

Table 22. Estimated number of juvenile salmonids (and 95% CI) migrating past the Mill Creek-Siletz juvenile trap. For cutthroat trout, only the 2 largest size classes are given. Additional out-migrant data are provided in appendices.

Sample Year	Coho smolts ± CI			Steelhead smolts ± CI ≥ 120 mm			Cutthroat migrants ± CI 160-249 mm			Cutthroat migrants ± CI 120-159 mm		
1997	8,110	±	616	241	±	131	449	±	173	1,521	±	233
1998	9,547	±	517	1,017	±	163	496	±	160	1,718	±	257
1999	8,409	±	558	240	±	64	674	±	243	1,790	±	396
2000	4,311	±	283	1,078	±	241	1,429	±	384	2,857	±	435
2001	15,475	±	731	1,137	±	192	1,604	±	462	2,493	±	380
2002	17,305	±	917	493	±	147	1,246	±	427	2,605	±	415
2003	16,063	±	986	202	±	66	1,348	±	309	1,975	±	388
2004	18,300	±	827	428	±	123	994	±	201	696	±	119
2005	20,717	±	1,114	784	±	206	1,324	±	396	2,031	±	312

Table 23. Number of fall Chinook salmon fry and fingerling migrants (± 95% CI) and week of peak migration in Mill Creek-Siletz River. Year of migration is the first year following egg deposition (e.g. the 1997 brood year was sampled in 1998).

Sample Year	N of fish ± CI			Peak Migration Week
1997	31,257	±	1,635	3/10-3/16
1998	0			
1999	52	±	74	3/15-3/21
2000	0			
2001	0			
2002	16,940	±	1,081	4/1-4/7
2003	0			
2004	0			
2005	0			

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 eight years of sampling (Table 20). Hatchery steelhead that stray into Mill Creek include both summer steelhead (Siletz stock, generally released in the mainstem Siletz River above the mouth of 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). Adult steelhead successfully jump the waterfall associated with the ladder and fish trap, thus trap catch is not a good estimate of the total spawning population of steelhead in Mill Creek. Although steelhead were tagged in the first several years of the study to obtain an estimate of total spawners, reliable estimates were difficult to obtain because of the low tag recovery rate on adult steelhead in subsequent spawning surveys. Therefore, adult steelhead are no longer tagged at this trap site.

The estimated number of juvenile steelhead defined as smolts are given in Table 22, 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 is usually about 150 mm. Analysis of scales from the spring of 1997 indicates steelhead smolts (≥ 120 mm) are predominately age-2 migrants, but also include some age-1 and age-3 migrants.

Cutthroat Trout

Trap catch of cutthroat trout 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 (Table 20). Adult cutthroat trout are not tagged, and no estimate of total spawners is available. No hatchery fish were observed on spawning surveys. The estimated numbers of cutthroat trout that migrate downstream and leave Mill Creek each spring are summarized in Table 22, with additional data in Appendix 3. The week of peak migration is typically in mid-April. Most migrants that are 90-159 mm in length show partial silvering in their appearance. Migrants of the 160-249 mm size class are either partially silvered or completely silvered when they migrate from the stream.

Chapter 5: Mill Creek (Yaquina River)

Mill Creek in the Yaquina River basin is a second order tributary that enters the Yaquina River at rkm 17.7. At the confluence, the main stem of the Yaquina River and first 1.5 km of Mill Creek are tidally influenced. The adult trap is located in the 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. Thus, live fish placed above the trap represent the total spawning population. There are approximately 4.2 km of stream above the reservoir for adult spawning. A motorized inclined plane trap is used immediately below the fish ladder and spillway of the dam to estimate juvenile migrant populations each spring.

Coho Salmon

Total numbers of adult and jack coho salmon caught at the Mill Creek trap (hereafter MC-Yaquina) and the number of coho salmon placed above the trap (estimated spawning population) are given in Table 24. Although some jacks are small enough to move through bars of the trap, most are collected at the upper end of the fish ladder. At this point, the head gate that controls flow into the fish ladder has been adjusted to act as a velocity barrier, impeding further upstream movement of fish until they are counted and placed in the reservoir above the fish ladder. Therefore, jack counts at this site represent total returns. The number of returning adult coho salmon spawners ranged between 64 and 138 for the winters of 1997-98 through 2000-01, increased to 624 spawners in the winter of 2001-02, and has been over 1,000 spawners from 2002-03 through 2004-05. Tissue samples were collected for genetic analysis on all wild adult and jack coho salmon returning to the adult trap site in the winters of 1999-2000 through 2003-04.

Table 24. The number of female (F), male (M) and jack (J) salmonids captured at the MC-Yaquina adult trap and the estimated spawning population in the Mill Creek watershed above Mill Creek Reservoir during return years 1997-98 through 2004-05.

Return Year and Species	Trap Catch						Estimated Spawning Population					
	Wild			Hatchery			Wild			Hatchery		
	F	M	J[b]	F	M	J	F	M	J	F	M	J
Coho												
97-98	36	56	13	9	16	0	36	53	13	6	13	0
98-99	80	58	19	9	37	1	77	57	16	0	0	0
99-00	43	49	49	0	0	0	43	43	43	0	0	0
00-01	40	24	258	0	0	0	40	24	252	0	0	0
01-02	377	247	204	3	2	0	375	245	197	0	0	0
02-03	549	498	245	7	2	0	549	497	244	0	0	0
03-04	602	613	183	1	1	0	602	612	181	0	0	0
04-05	527	628	55	0	1	0	527	628	54	0	0	0
Fall Chinook												
97-98	24	25	1	0	0	0	20	21	1	0	0	0
98-99	10	14	1	0	0	0	0	2	0	0	0	0
99-00	11	24	0	0	0	0	0	14	0	0	0	0
00-01	0	2	0	0	0	0	0	2	0	0	0	0
01-02	12	27	2	0	0	0	6	22	2	0	0	0
02-03	1	6	0	0	0	0	1	6	0	0	0	0
03-04	10	14	0	0	0	0	5	9	0	0	0	0
04-05	6	11	0	0	0	0	6	11	0	0	0	0
Steelhead												
97-98	18	24	0	2	4	0	18	24	0	2	3	0
98-99	28	24	2	3	3	0	28	24	2	0	0	0
99-00	30	21	0	4	8	0	30	21	0	0	0	0
00-01	21	9	2	0	1	1	21	9	3	0	1	1
01-02	33	37	3	2	3	0	33	37	3	2	3	0
02-03	36	37	6	3	3	0	36	37	6	3	3	0
03-04	42	47	0	6	10	1	42	47	0	5	10	1
04-05	10	10	1	1	4	0	10	10	1	1	4	0
Cutthroat > 250 mm[a]												
97-98	0	1	3									
98-99	0	0	0									
99-00	0	1	7									
00-01	2	4	0									
01-02	2	6	0									
02-03	0	3	1									
03-04	1	9	1									
04-05	3	7	7									

[a] Trap catch does not include all adult cutthroat migrants because bar spacing of trap allows some adults to move through the trap.
[b] cutthroat in jack column are unsexed fish, not jacks

Estimates of the number of eggs, fry, smolts, and adult returns are provided for each brood in Table 25. The marine survival rate of coho salmon at MC-Yaquina increased to over 10% for brood years 1998-2001, resulting in the large increase in adult spawners that returned in the winters of 2001-02 through 2004-05 (Table 25 and Figure 11). The large increase in female spawners in recent years has been followed by same brood increases in smolt out-migration (Table 25 and Figure 11a and c). For the 1997-2000 broods, when estimated number of female spawners ranged from 36-77, smolt populations ranged from 2,225 to 6,833. After female spawners increased to 375-602 for the 2001-2004 brood years, smolt populations ranged between 8,117 and 12,726. Estimates of freshwater survival (percent of eggs that survived to smolt) ranged between 2.2% and 6.5% when adult spawner populations were low, and < 1% for brood years with high spawner densities (Figure 11d). In the spring of 2005, smolt numbers were higher than previously observed; however, these smolts were significantly smaller than observed in earlier years, suggesting growth was limited by the higher rearing density in Mill Creek Reservoir (Appendix 1).

At a spawning population of less than 100 female spawners, fry migrants leaving Mill Creek Reservoir were less than 10,000, but increased to over 100,000 fry when female spawners ranged between 375 and 602 (Table 25, Figure 12a). However, the number of fry migrants/female spawner remained constant at 250-350 over a wide range of female spawners (Figure 12b). The presence of Mill Creek Reservoir acts as a large rearing area for fry dispersing from tributaries above the reservoir. The number of fry leaving the reservoir is often associated with the number and timing of freshets, and complicates any analysis that examines the relationship between fry migrants and fry rearing habitat.

Fall Chinook Salmon

In the Mill Creek-Yaquina the spawning population of fall Chinook salmon is often less than the trap catch because fall Chinook salmon have been collected at this site and used for hatchery brood stock in the Yaquina River (Table 24). The number of adults returning to the Mill Creek-Yaquina adult trap has ranged from 2 to 49 for return years 1997-98 through 2004-05. Most fall Chinook salmon spawn below Mill Creek Reservoir. In years with low flows during October and November, a higher percentage of adults spawn below the reservoir. Therefore, 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 27).

Table 25. Number of spawners, fry and smolt production, number of wild returning adults, and freshwater and marine survival rates for coho salmon at the Mill Creek-Yaquina site. Number of fry and smolts produced denotes total number that reached the trap site.

Brood Year	Female Spawners		Egg Deposition	Fry	Smolts	Returning Adults (wild)		% Survival	
	Wild	Hatchery				Female	Male	FW	Marine
1994						36	56		
1995					1,400	77	58		9.9
1996				46,732	6,698	43	49		1.4
1997	36	6	101,674	220	2,225	40	24	2.2	3.0
1998	77	0	206,935	2,565	5,601	375	247	2.7	11.1
1999	43	0	116,500	1,319	7,026	549	498	6.0	14.9
2000	40	0	105,800	9,376	6,833	602	613	6.5	17.8
2001	375	0	1,087,481	126,257	8,833	527	628	0.8	13.1
2002	549	0	1,694,355	108,554	8,117			0.5	
2003	602	0	1,646,034	127,136	12,726			0.8	
2004	527	0	1,512,987	152,815					

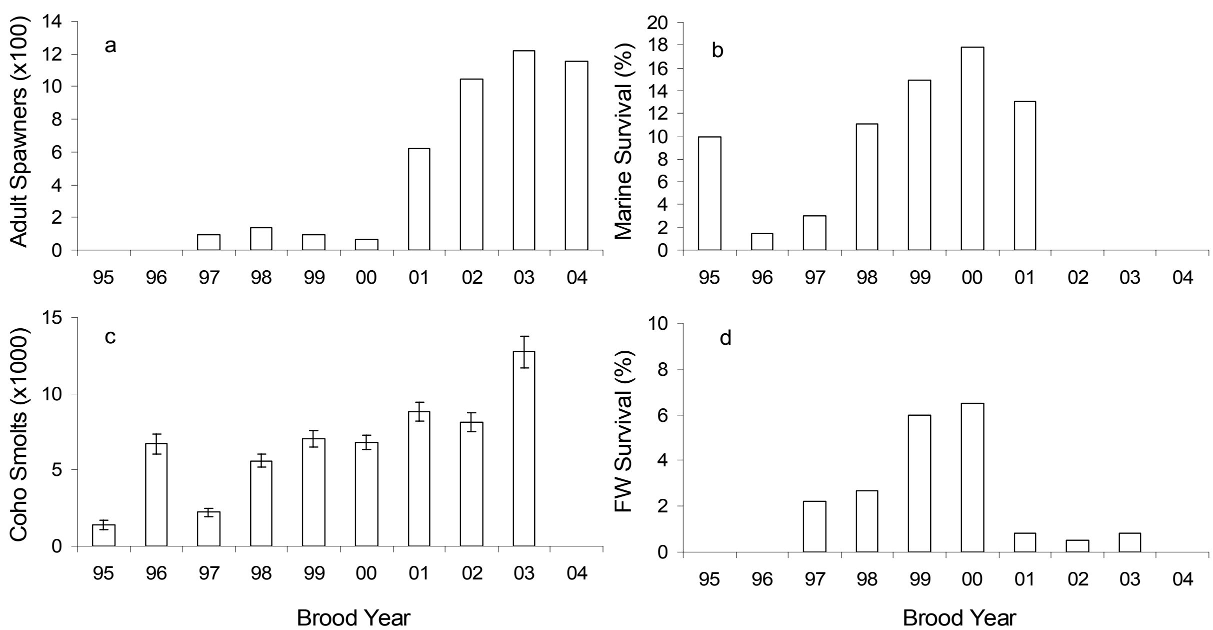

Figure 11. Annual trends in (a) the estimated number of adult spawners, (b) the percent marine survival, (c) number of smolts, and (d) percent freshwater survival for coho salmon in Mill Creek-Yaquina.

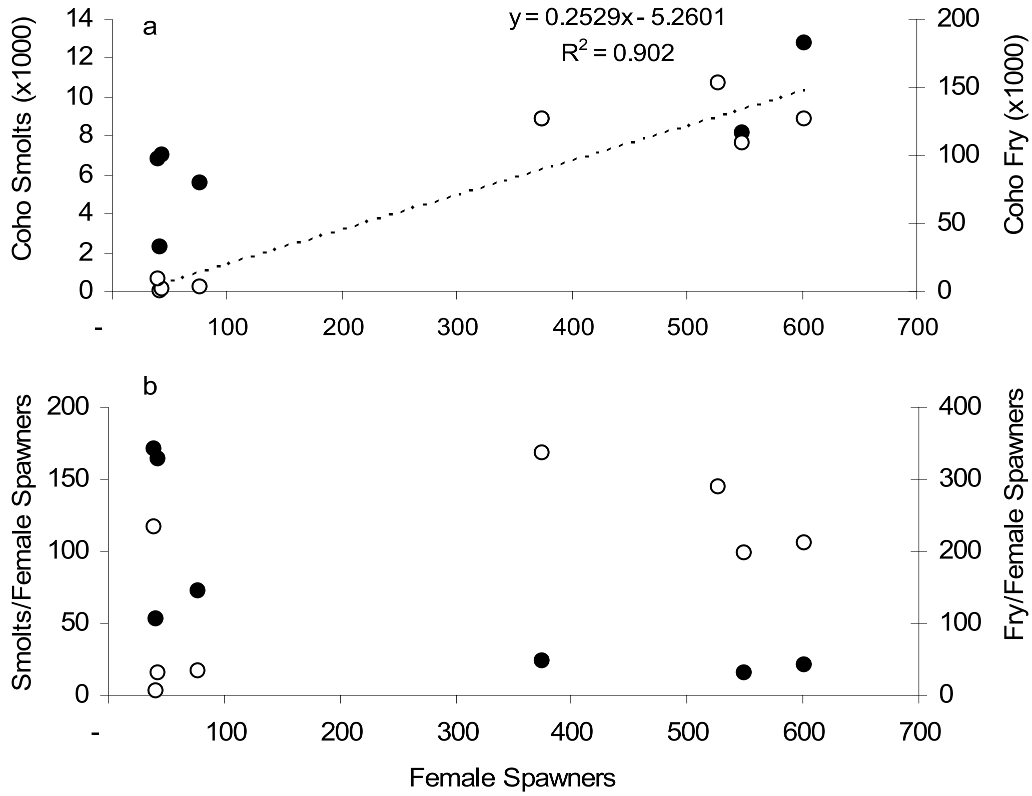

Figure 12. Relationship of (a) total smolt and fry migrants produced to total female spawners, and (b) relationship of smolt and fry migrants produced per female, to total female spawners at the Mill Creek-Yaquina site. Solid symbols are smolt data and clear symbols are fry data. The regression shown for fry is significant (*P*=0.0003).

Table 26. Estimated number of juvenile salmonids (and 95% CI) migrating past the Mill Creek-Yaquina juvenile trap. For cutthroat trout, only the 2 largest size classes are given. Additional out-migrant data are provided in appendices.

Sample Year	Coho smolts ± CI			Steelhead smolts ± CI ≥ 120 mm			Cutthroat migrants ± CI 160-249 mm			Cutthroat migrants ± CI 120-159 mm		
1997	1,400	±	286	(3)			(0)			(3)		
1998	6,698	±	638	(33)			(6)			(16)		
1999	2,225	±	283	374	±	181	32	±	23	(8)		
2000	5,601	±	427	280	±	79	64	±	28	41	±	55
2001	7,026	±	553	874	±	629	36	±	16	41	±	28
2002	6,833	±	463	679	±	462	(11)			87	±	15
2003	8,833	±	601	168	±	156	94	±	138	(14)		
2004	8,117	±	622	394	±	594	76	±	43	(11)		
2005	12,726	±	1,018	(19)			(14)			(16)		

Table 27. The number of fall Chinook salmon fry and fingerling migrants (± 95% CI) and week of peak migration in Mill Creek-Yaquina. Year of migration is the first year following egg deposition (e.g. the 1997 brood year was sampled in 1998).

Sample Year	Migrants ± CI			Peak week
1997	14,694	±	505	3/24-3/30
1998	7,348	±	571	3/23-3/29
1999	34	±	19	5/23-5/29
2000	(7)			
2001	(2)			
2002	2,923	±	316	4/8-4/14
2003	273	±	59	4/21-4/27
2004	1,120	±	112	4/12-4/18
2005	1,963	±	210	4/25-5/1

Winter Steelhead

The numbers of adult and jack winter steelhead captured in the MC-Yaquina trap and the number of fish placed above the trap to spawn in tributaries above Mill Creek Reservoir are given in Table 24. Beginning in the winter of 2000-01, tissue samples were collected on all winter steelhead entering the adult trap, and winter steelhead of both wild and of hatchery origin were allowed to spawn above the trap site. Tissue samples are being collected for Oregon State University researchers for genetic analysis.

Estimates of the number of juvenile winter steelhead migrants leaving Mill Creek Reservoir each spring are given in Table 26, and data on pre-smolts and peak week given in Appendix 2. The week of peak migration for smolts is typically in mid-April. The average size of smolts leaving the reservoir has ranged from 158.7 mm to 183.7 mm, which is generally larger than stream-reared smolts at other monitoring sites.

Cutthroat Trout

The numbers of adult cutthroat trout captured in the MC-Yaquina trap are given in Table 24. 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. The number of out-migrants is low, relative to some other LCM sites (Table 24, Appendix 3), and the week of peak out-migration is typically between late April and early May.

Chapter 6: Cascade Creek (Alsea River)

Cascade Creek is a 3rd order tributary that enters Five Rivers 8 km upstream of its confluence with the mainstem Alsea River. Five Rivers enters the main stem of Alsea River at rkm 34. Adult salmon, steelhead and cutthroat trout are captured in 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 just downstream of the waterfall and fish ladder.

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 28. Estimates of total numbers of coho salmon jacks may be low, because some jacks are small enough to move through the bars in the trap and continue upstream. Total numbers of adult spawners ranged between 6 and 45 in return years 1997-98 through 2001-02. The number of adult spawners increased to over 100 spawners each year in return years 2002-03 through 2004-05.

Estimates of eggs, fry, smolts, adult returns, and survival rates are provided for each brood in Table 29, and plotted in Figure 13. Marine survival for the 1999-2001 broods ranged from 7.2% to 7.6%. Estimates for the 1997 and 1998 broods may be inaccurate, as the number of smolts leaving the stream was very low, and are not plotted on Figure 13b. Freshwater survival varied between 0.1% (1998 brood) and 10.1% (2001 brood). During the three run-years in which only five females spawned, freshwater survival rates ranged from the lowest to highest values observed. 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. While the estimate for smolts for the 1998 brood is 13 migrants (resulting in a freshwater survival rate of 0.1%), it is probable that none of these smolts reared above the waterfall and adult trap. The juvenile migrant trap is located immediately below the waterfall, and it is likely that these few smolts originated below the trapping site on Cascade Creek, but moved upstream to the base of the waterfall during the winter and then were caught in the juvenile downstream migrant trap in the spring.

Table 28. The number of female (F), male (M) and jack (J) salmonids captured at the Cascade Creek adult trap and the estimated spawning population in the Cascade Creek watershed above the trap during the return years 1997-98 through 2004-05.

	Trap Catch						Estimated Spawning Population					
Return	Wild			Hatchery			Wild			Hatchery		
Year	F	M	J[b]	F	M	J	F	M	J	F	M	J
Coho												
97-98	16	14	0	1	9	0	16	11	0	1	9	0
98-99	5	1	8	3	13	3	5	1	7	0	0	0
99-00	5	4	0	0	7	0	5	4	0	0	0	0
00-01	11	34	10	0	0	0	11	34	10	0	0	0
01-02	5	17	21	1	4	1	5	17	19	0	0	0
02-03	45	62	20	1	1	0	45	62	19	0	0	0
03-04	42	86	13	0	0	0	42	86	13	0	0	0
04-05	30	86	24	0	1	0	29	83	23	0	0	0
Fall Chinook												
97-98	0	1	0	0	0	0	0	1	0	0	0	0
98-99	0	0	0	0	1	0	0	0	0	0	0	0
99-00	0	0	2	0	0	0	0	0	2	0	0	0
00-01	0	0	0	0	0	0	0	0	0	0	0	0
01-02	1	4	0	0	0	0	1	4	0	0	0	0
02-03	0	2	0	0	0	0	0	2	0	0	0	0
03-04	2	5	0	0	0	0	2	5	0	0	0	0
04-05	3	9	3	0	0	0	3	9	3	0	0	0
Steelhead												
97-98	3	3	0	1	3	0	3	3	0	1	3	0
98-99	3	2	0	1	0	1	3	2	0	0	0	0
99-00	3	8	0	1	2	0	3	8	0	0	0	0
00-01	9	9	7	7	11	1	9	9	7	0	0	0
01-02	2	1	0	0	1	1	2	1	0	0	0	0
02-03	3	4	0	1	0	0	3	4	0	0	0	0
03-04	9	12	0	5	6	0	9	12	0	0	0	0
04-05	2	3	0	7	6	2	2	3	0	0	0	0
Cutthroat > 250 mm[a]												
97-98	0	0	5	0	0	0						
98-99	0	0	50	0	0	0						
99-00	0	0	15	0	0	0						
00-01	1	5	2	0	0	0						
01-02	20	58	0	0	0	0						
02-03	8	23	51	0	0	0						
03-04	2	11	17	0	0	0						
04-05	10	14	15	0	0	0						

[a] Trap catch does not include all adult cutthroat migrants because bar spacing of trap allows some adults to move through the trap.
[b] cutthroat in jack column are unsexed fish, not jacks

The 2002 and 2003 broods had similar numbers of female spawners (45 and 42), but freshwater survival for the 2003 brood was 2.5 times higher than the 2002 brood. This resulted in an increase in smolt abundance from 3,058 (2002 brood) to 6,654 (2003 brood). Two factors may explain the difference in survival rate observed for these two brood years. Spawning timing of the female coho salmon differed between the two broods. For the 2002 brood, 73% of the females entered Cascade Creek to spawn prior to November 15, and only 11% entered the stream to spawn after December 15. Conversely, none of the female spawners for the 2003 brood entered Cascade Creek prior to November 15, and 69% entered the stream to spawn after December 15. Spawning timing has been observed to influence subsequent survival of juvenile coho salmon in other Oregon coastal streams (Nickelson et al. 1986) and may be partially responsible for the difference in freshwater survival observed for these two brood years in Cascade Creek. The other factor that may have increased the freshwater survival for the 2003 brood was the mild winter in 2004-05, when the juveniles of the 2003 brood were rearing before migrating in the spring of 2005. With fewer and less severe high flow conditions during the winter, over-winter survival for these pre-smolts probably increased.

Estimates of the number of coho salmon smolts leaving Cascade Creek each spring by sample year are summarized in Table 30. Additional data on smolt size and fry numbers are in Appendix 1. Peak migration of coho salmon smolts in Cascade Creek is typically in mid-April, and smolts have left the stream by mid-June. In the spring of 2005, the week of peak migration was earlier that had previously been observed (March 21-27). The large number of smolts leaving the stream that week was associated with a large freshet after an extended period of low stream flows in January, February, and early March. The mean FL of smolts during the week of peak migration was significantly smaller in 2005 than previous years (Appendix 1); however, the size of smolts migrating from the stream in mid-April to mid-May of 2005 was not significantly different than the size of smolts observed in April and May of previous years. Therefore the smaller size of smolts observed during the week of peak migration in 2005 may be more related to the timing of peak out-migration rather than a function of higher rearing densities restricting growth.

Over the range of female spawners observed to date, the relationship between number of spawning females and the number of smolt out-migrants has been variable (Figure 14). Developing this relationship for Cascade Creek has been hampered because of low spawning escapement for most brood years. More years of data over a wider range in female spawner numbers will be needed to understand the relationship.

Table 29. Number of spawners, fry and smolt production, number of wild returning adults, and freshwater and marine survival rates for coho salmon in Cascade Creek.

Brood Year	Female Spawners Wild	Female Spawners Hatchery	Egg Deposition	Fry	Smolts	Returning Adults (wild) Female	Returning Adults (wild) Male	% Survival FW	% Survival Marine
1994						16	14		
1995						5	1		
1996					1,404	5	4		0.6
1997	16	1	37,321	0	557	11	34	1.5	8.1[a]
1998	5	0	10,104	0	13	5	17	0.1	na[a]
1999	5	0	14,927	36	1,485	45	62	9.9	7.2
2000	11	0	28,471	2,578	1,761	42	86	6.2	7.3
2001	5	0	15,245	118	1,534	30	86	10.1	7.6
2002	45	0	120,657	1,113	3,058			2.5	
2003	42	0	105,631	517	6,654			6.3	
2004	29	0	81,396						

[a] rates are questionable due to low smolt out-migration

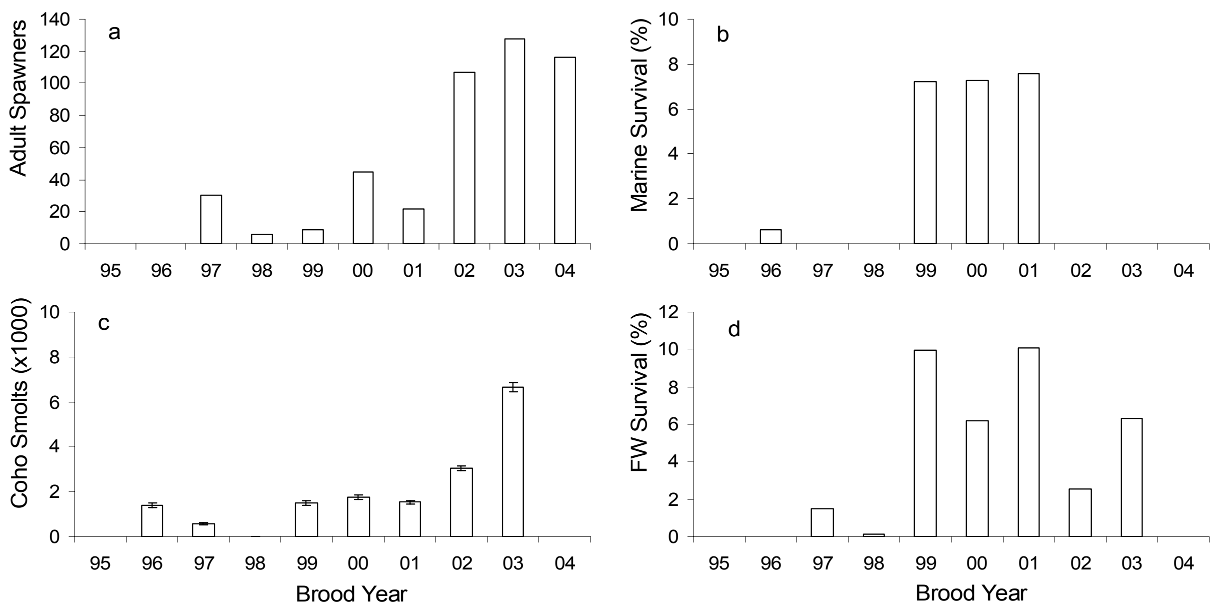

Figure 13. Annual trends in (a) the estimated number of adult spawners, (b) the percent marine survival, (c) number of smolts, and (d) percent freshwater survival for coho salmon in Cascade Creek.

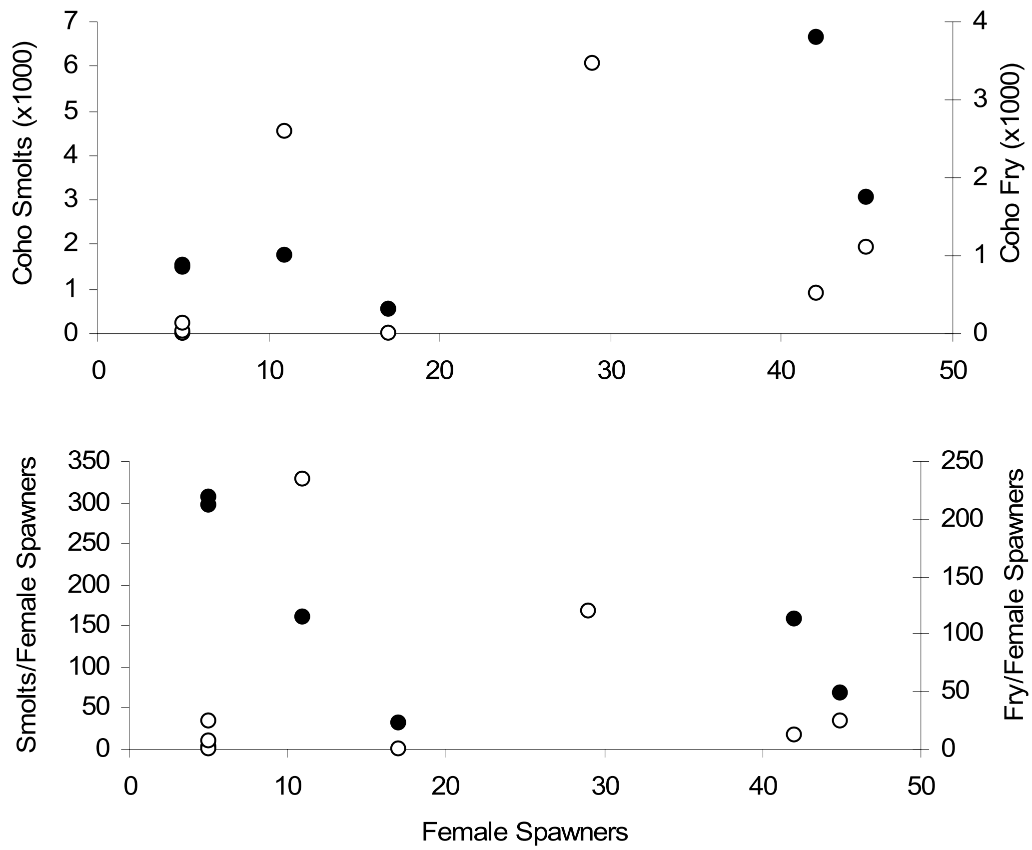

Figure 14. Relationship of total coho smolt and fry migrants produced to total female spawners (top panel), and relationship of smolt and fry migrants produced per female, to total female spawners (bottom panel) at the Cascade Creek site. Solid symbols are smolt data and clear symbols are fry data.

Table 30. Estimated number of juvenile salmonids (and 95% CI) migrating past the Cascade Creek juvenile trap. For cutthroat trout, only the 2 largest size classes are given. Additional out-migrant data are provided in appendices.

Sample Year	Coho smolts ± CI	Steelhead smolts ± CI ≥ 120 mm	Cutthroat migrants ± CI 160-249 mm	Cutthroat migrants ± CI 120-159 mm
1998	1,404 ± 98	110 ± 22	168 ± 31	662 ± 103
1999	557 ± 43	(10)	138 ± 44	592 ± 61
2000	13 ± 8	125 ± 30	272 ± 51	698 ± 69
2001	1,485 ± 102	138 ± 38	487 ± 99	1,328 ± 111
2002	1,761 ± 86	71 ± 40	260 ± 75	1,415 ± 110
2003	1,534 ± 81	(18)	268 ± 115	1,737 ± 164
2004	3,058 ± 109	(9)	276 ± 63	1,242 ± 105
2005	6,654 ± 221	54 ± 18	393 ± 75	2,112 ± 204

Fall Chinook Salmon

The numbers of adult and jack fall Chinook salmon captured in the Cascade Creek trap are given in Table 28. Fall Chinook salmon passed above the trap represents the total spawning population. Estimate of the number of fall Chinook salmon juveniles that migrated downstream past the rotary screw trap each spring are summarized in Table 36. 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 150 meters between the waterfall and the stream mouth. 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.

Table 31. Estimated number of out-migrant fall Chinook salmon fry and fingerling (± 95% CI) and week of peak out-migration in Cascade Creek. Year of out-migration 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	649	±	111	4/17-4/23
2001	(15)			
2002	1,152	±	187	3/25-3/31
2003	(2)			
2004	1,007	±	203	4/12-4/18
2005	69	±	30	5/30-6/5

Winter Steelhead

The numbers of adult and jack winter steelhead captured in the Cascade Creek trap are given in Table 28. Beginning in the winter of 1998-99, adult winter steelhead of hatchery origin were not passed above the waterfall and fish ladder. Estimates of the number of winter steelhead smolts and leaving Cascade Creek each spring are summarized in Table 30. Additional data on pre-smolts and average length of smolts during the week of peak migration are provided in Appendix 2. Peak migration of steelhead smolts is typically in late March to mid-April, and the average size of smolts is usually about 150 mm FL.

Cutthroat Trout

The numbers of adult cutthroat trout captured in the Cascade Creek trap are given in Table 28. 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. No hatchery fish were observed. Estimates of the number of cutthroat trout that migrant downstream and leave Cascade Creek each spring are given in Table 30, with addition out-migrant data given in Appendix 3. The week of peak migration is typically in mid-April. Most cutthroat migrants that are 90-159 mm FL show partial silvering in their appearance. Cutthroat migrants 160-249 mm FL are either partially silvered or completely silvered when they migrate from the stream.

Chapter 7: West Fork Smith River (Umpqua)

The West Fork (WF) Smith River forms a 6^{th} order tributary to the Smith River within the Umpqua River basin. The watershed includes approximately 297 km of stream network that drains an area of 69 km^2. Mean monthly stream flows range from <0.1 m^3/s in late summer to approximately 5 to 8 m^3/s during winter, with peak stream flows frequently exceeding 35 m^3/s. 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 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.

Coho Salmon

Trap catch and spawner population estimates for fish groups are given in Table 32. The total spawner population estimate with confidence intervals are given in Table 33. No hatchery coho were observed in most years. In 2001-02, 19 hatchery adults entered the trap, but the estimated hatchery component of the spawning population was only 2.4 percent. There is no hatchery program in the Smith Basin; hatchery fish were likely strays from the North Umpqua River. Number of returning adults increased each year from 1998 to 2003, then decreased in 2004, corresponding to changes in marine survival rates (Table 34 and Figures 15a and 15b).

The estimated number of coho salmon smolts out-migrating each year are summarized in Table 35, and data on peak week, smolt size, and fry abundance are summarized in Appendix 1. Annual trends in smolt number are shown in Figure 15c. Freshwater survival declined over the course of the monitoring (Figure 15d), due mostly to correlation with increases in adult spawners. There is a clear linear relationship between fry migrants and spawner abundance, with increased spawner levels corresponding to proportionate increases in fry migrants (Figure 16a). When the number of fry migrants per parent is plotted against the number of female spawners, there is relatively little variation in this parameter over a broad range of spawner levels (Figure 16b). This suggests that within the range of seeding levels observed, a proportion of fry produced from each female tends to move downstream, irrespective of fry abundance. One factor that may influence this relationship is stream flow, where high flow events may scour redds or distribute newly emerged fry downstream soon after emergence. The close correlation between fry migrants and spawners suggests these factors may not be significant at the basin scale.

Table 32. The number of female (F), male (M) and jack (J) salmonids captured at the WF Smith River adult trap and the estimated spawning population in the WF Smith River watershed above the trap during the return years 1997-98 through 2004-05. For coho, numbers of wild and hatchery female (F) and male (M) spawners were based on percent representation in spawned-out carcasses recovered on surveys.

	Trap Catch						Estimated Spawning Population					
	Wild			Hatchery			Wild			Hatchery		
Return Year	F	M	J	F	M	J	F	M	J	F	M	J
Coho												
98-99							72	73	na	0	0	0
99-00	38	58	1	0	0	0	130	163	na	0	0	0
00-01	46	56	23	0	0	0	271	279	na	0	0	0
01-02	49	57	6	8	11	0	707	729	189	15	20	0
02-03	100	173	12	3	0	0	1,520	1,924	114	4	3	0
03-04	56	110	2	0	0	0	1,787	1,940	101	0	0	0
04-05	30	32	0	0	0	0	417	561	na	0	0	0
Fall Chinook												
98-99		13										
99-00	3	13										
00-01	1	32	3									
01-02	5	34	2		1							
02-03	2	10										
03-04	2	20	2									
04-05	8	20	2	6	21	1						
Steelhead[a]												
98-99	54	48	4	3	2	0	178	172		10	7	
99-00	244	158	0	1	1	0	273	177		1	1	
00-01	141	118	7	1	2	0	175	155		1	2	
01-02	116	86	2	0	1	0	472	358		2	2	
02-03	45	72	0	0	0	0	144	231		0	0	
03-04	104	92	1	0	1	0	281	252		2	1	
04-05	78	79	2	1	3	0	120	121		2	5	

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

Table 33. Total estimated adult coho salmon spawners in the WF Smith River for the return years 1998-99 through 2004-05. Numbers of wild and hatchery female (F) and male (M) spawners were based on percent representation in spawned-out carcasses recovered on surveys. Jack (J) spawners were not estimated when insufficient numbers of tagged fish were recovered on surveys. Confidence intervals (in parentheses) were calculated using a relationship between the F distribution and the binomial distribution. The adult spawner population in 1998-99 was based on area-under-curve estimation from spawner survey data and the confidence interval was not calculated.

Return Year	Total Estimated Adult Spawners		Wild Female	Wild Male	Wild J	Hatchery F	Hatchery M	Hatchery J
98-99	145	na	72	73	na	0	0	0
99-00	293	(238-372)	130	163	na	0	0	0
00-01	550	(465-657)	271	279	na	0	0	0
01-02	1,471	(1,216-1,794)	707	729	189	15	20	0
02-03	3,451	(3,122-3,927)	1,520	1,924	114	4	3	0
03-04	3,727	(3,220-4,441)	1,787	1,940	101	0	0	0
04-05	978	(787-1,233)	417	561	na	0	0	0

Although numbers of spawners and fry migrants appear closely linked, this relationship may be influenced by distribution of spawning activity. The tributaries have extensive reaches with gravel suitable for spawning, and a broad range of habitat types that provide refuge during high stream flows. In contrast, the middle and lower reaches of the main stem are predominantly bedrock with little coarse sediment or large wood debris, and have little habitat providing hydraulic refuge for juvenile fish. Spawning habitat in the main stem has been enhanced in some reaches by boulder-weir projects, but this habitat is patchy and moderate in extent. Spawning surveys are not conducted randomly over the basin, precluding direct comparison of spawner densities between tributaries and the main stem, but most survey reaches are the same each year, allowing densities to be compared between years. Mainstem spawners represent a significant portion of total spawners in most years (Table 36). Because the main stem has low habitat complexity and little hydraulic refugia compared to the tributaries, fry derived from mainstem spawners are more likely displaced downstream during high flow events and comprise a higher percentage of fry measured at the trap.

There was no significant linear correlation between female spawners and smolt production (Figure 16a). In addition to seeding levels and egg to fry survival rates, smolt production is influenced by factors that determine survival of parr during summer and winter. These factors include summer water temperatures, winter stream flows, density of parr and competition between cohorts and other species, and level of parasite infestation (discussed below). Survival of a cohort is influenced by each variable to greater or lesser degrees each year, thus a linear relationship would not be expected.

Despite a lack of a clear correlation between number of smolts and spawners, smolt production shows relatively little variation over a broad range of spawners (Figure 16a). The highest production rates, in terms of smolts per female, occurs at low spawner densities (Figure 16b), suggesting 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.

Table 34. Estimated number of female spawners, egg deposition, fry and smolt production, number of wild returning adults, and freshwater and marine survival rates for coho salmon in the WF Smith River.

Brood Year	Female Spawners		Egg Deposition	Fry	Smolts	Returning Adults		Percent Survival	
	Wild	Hatchery				Female	Male	FW	Marine
1996					22,412	131	164		1.3
1997				2,527	10,866	273	280		5.1
1998	72	0	205,405	3,014	14,851	707	734	7.2	9.8
1999	130	0	376,545	3,605	20,091	1,521	1,926	5.5	17.3
2000	271	0	721,450	13,550	17,358	1,790	1,940	2.4	21.7
2001	707	15	2,044,536	35,851	15,849	417	561	0.8	6.2
2002	1,520	4	4,853,940	80,876	23,054			0.5	
2003	1,787	0	5,130,275	104,402	39,576			0.8	
2004	417	0	1,169,503	27,598					

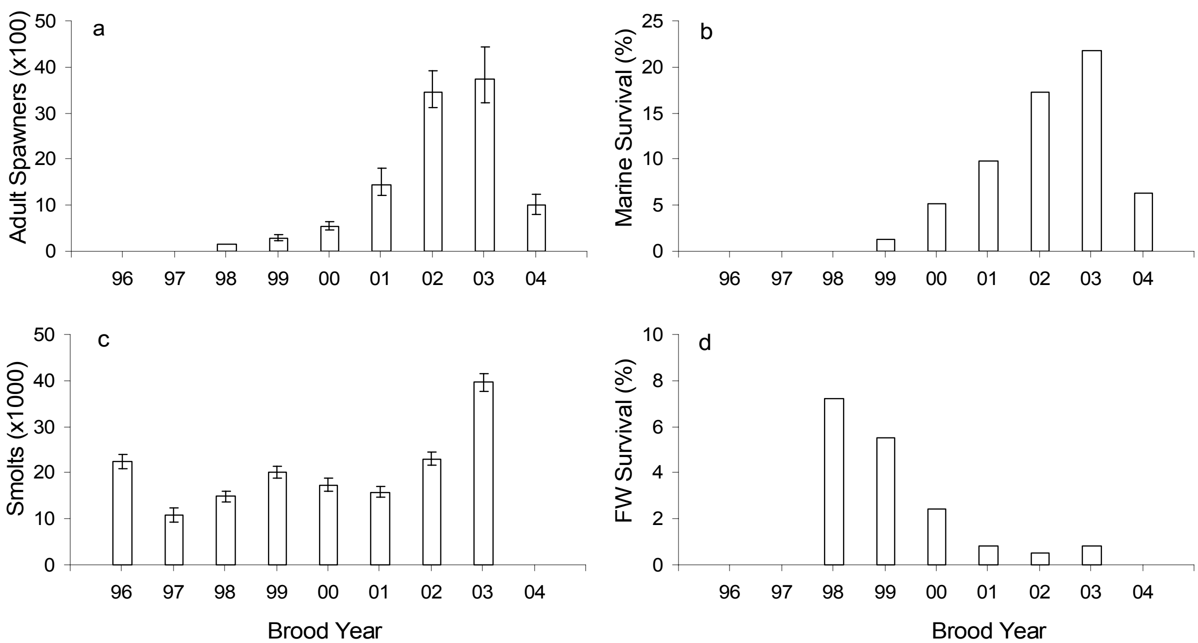

Figure 15. Annual trends in (a) the estimated number of adult spawners, (b) the percent marine survival, (c) number of smolts, and (d) percent freshwater survival for coho salmon in WF Smith River.

Table 35. Estimated number of juvenile salmonids (and 95% CI) migrating past the WF Smith River juvenile trap. For cutthroat trout, only the 2 largest size classes are given. Additional out-migrant data are provided in appendices.

Sample Year	Coho smolts ± CI	Steelhead smolts ± CI ≥ 120 mm	Cutthroat migrants ± CI 160-249 mm	Cutthroat migrants ± CI 120-159 mm
1998	22,412 ± 1,584	6,438 ± 1,286	(192)	(4)
1999	10,866 ± 1,465	2,688 ± 846		
2000	14,851 ± 1,088	2,836 ± 593	947 ± 581	1,148 ± 439
2001	20,091 ± 1,337	2,737 ± 1,338	901 ± 251	1,633 ± 377
2002	17,358 ± 1,460	4,681 ± 3,558	2,417 ± 982	2,748 ± 985
2003	15,849 ± 1,239	2,448 ± 4,306	1,235 ± 2,177	(70)
2004	23,054 ± 1,523	2,916 ± 1,847	713 ± 815	135 ± 136
2005	39,576 ± 2,038	4,333 ± 1,382	898 ± 646	724 ± 454

Summer rearing habitat decreases in extent and accessibility as stream flows diminish, thereby increasing competition for prey resources, increasing parasite infestation rates, and restricting movement of fish that may be seeking refuge from high water temperature. Surface flow in some tributaries (e.g. Coon, Crane and Moore creeks) becomes intermittent in dry summers, isolating fish in disconnected pools. Long reaches of the main stem are predominantly shallow bedrock with little habitat complexity, and during summer the average daily maximum (ADM) frequently exceeds 18 C^o over most of the middle and lower main stem and frequently exceeds 20 C^o in the lower reaches; tributaries usually remain below 18 C^o throughout summer (Cairns et al. 2005; Michael Cairns, US EPA, pers. comm). The metric of ADM is used by the State of Oregon as the temperature standard for water quality, with the value 18 C^o established as the recommended maximum for juvenile salmonids in coastal streams (DEQ 2004). Stress from high water temperature may have a direct impact on fish by reducing growth rate, resulting in smaller size (length or condition factor) at the end of summer (Poole et al. 2001). Summer water temperatures have also been correlated to infestation rate of black spot, the encysted metacercarial larval stage of a Neascus-type trematode parasite, in WF Smith River (Cairns et al. 2005). Higher rates of infestation were correlated with higher water temperatures, and fish with heavy parasite infestation had lower body condition factor (K, a length to body mass relationship) than fish with little or no black spot infestation. Highest water temperature and infestation rates were found in the main stem, thus the position of fish within the stream network may influence size and condition of fish at the end of summer, and subsequent survival during the winter period. There is a positive correlation between fall parr size and smolt size in spring (Ebersole et al. 2006), and a higher apparent over-winter survival rate for fish that were PIT-tagged in tributaries compared to those tagged in the main stem of WF Smith River (e.g. 12-13 % in three tributaries and one upper main stem reach, 9-10 % in other upper main stem reaches, and 4-6 % in the lower main stem).

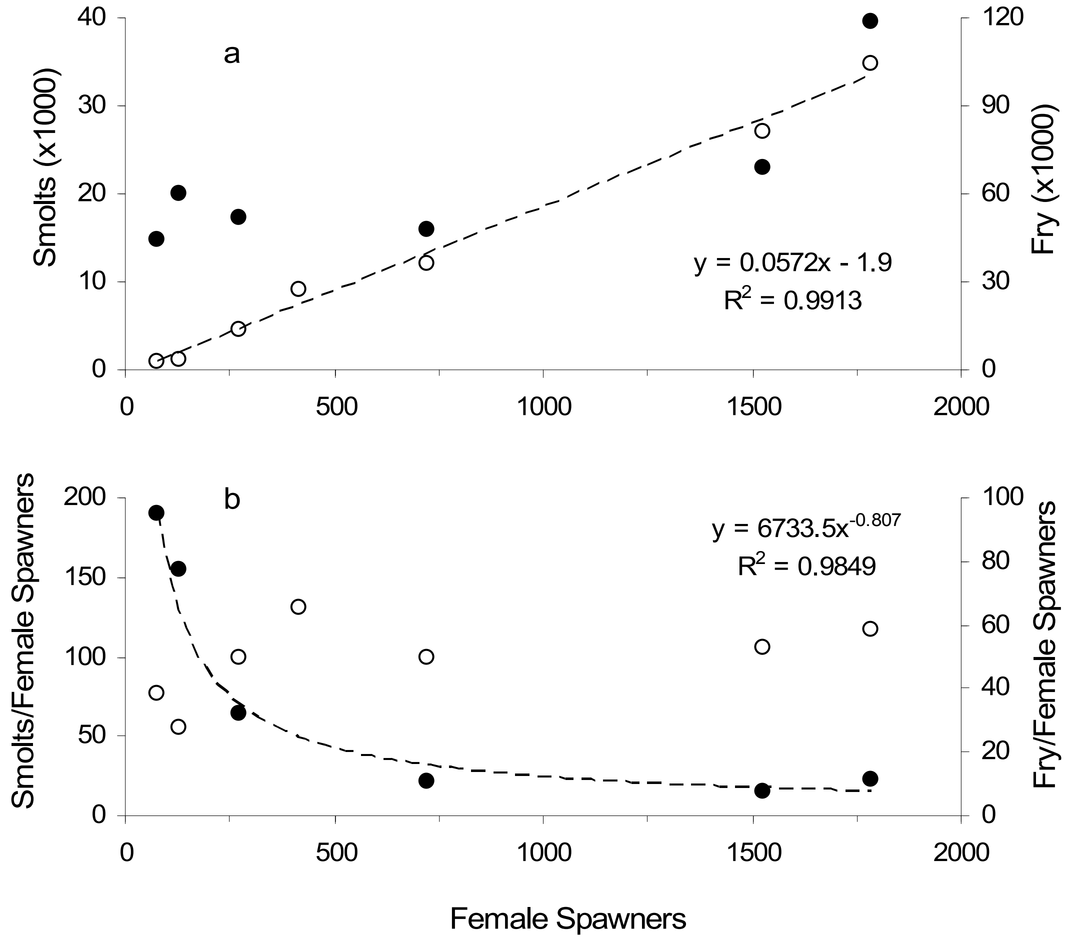

Figure 16. Relationship of total smolt and fry migrants produced to total female spawners (a), and relationship of smolt and fry migrants produced per female, to total female spawners (b) at the WFS River site. Solid symbols are smolt data and clear symbols are fry data. The linear regression shown for fry in (a) is significant (P<0.0001). The smolt/female to female relationship fit in (b) fits a power function (P =0.0003).

Table 36. Total coho salmon spawners based on area-under-calculation of spawner counts and spawner density (fish/km) in tributary and main stem survey reaches of WF Smith River for the return years 2001-02 to 2004-05.

	Tributary surveys		Mainstem surveys	
Year	Spawners	Fish / km	Spawners	Fish / km
2001-02	195	12.7	383	38.1
2002-03	830	54.1	616	56.7
2003-04	1000	68.7	380	33.5
2004-05	333	25.4	251	35.8

The type, amount, and distribution of in-stream and off-channel habitats that provide hydraulic refuge during winter are also likely major factors influencing survival. A history of splash damming in the WF Smith River below Beaver Creek eliminated large wood debris (LWD) and coarse sediments, and much of the main stem is still dominated by long reaches of bedrock. The US Bureau of Land Management has invested heavily in large-boulder weirs and other large wood projects to aggrade the stream channel and capture natural sources of wood debris. These projects have begun to convert bedrock-dominated reaches to alluvial channels, and spawner surveys show high levels of spawning activity at some boulder weirs. Boulder weir projects increased pool area, LWD, pool-forming LWD, and boulder abundance in treatment reaches of the WF Smith River (Roni et al. 2004). During the summer, densities of juvenile coho salmon and trout were also higher in treatment reaches compared to non-treatment reaches. While densities of juvenile fish were not evaluated during winter, increased habitat complexity resulting from boulder weir projects likely has a positive effect on over-winter survival rate.

These studies suggest that among the variables that influence fry to smolt survival in the WF Smith River, position within the stream network and water quality may be the most important. Initial position is a function of the distribution of spawning habitat and activity, and retention of fry within or near the natal reach. Remaining within (or swimming into) the tributaries allows fish to avoid thermal stress, and the tributaries provide complex habitats that serve as refugia during high stream flows. To some extent, fish distribution in WF Smith River appears to follow this model; in midsummer 2002, Ebersole et al. (2006) found highest densities of juvenile coho in the tributaries (mean density = 0.66 coho/m^2, SD = 0.3), intermediate densities in the main stem upstream of Moore Creek (mean = 0.34 coho/m^2, SD = 0.1) and lowest densities in the main stem downstream of Moore Creek (mean = 0.15 coho/m^2, SD = 0.02). Tributaries may be inaccessible from the main stem during low summer flows, but connectivity during the fall when stream flow rises is critical.

Water quality, specifically temperature, affects several factors that influence fry to smolt survival in the WF Smith River. Thermal stress may lead directly to smaller relative or absolute size, or body condition factor (*K*). High temperature also affects these metrics indirectly by increasing rates of black spot infestation. Numerous studies have shown positive correlations between size and survival rates for different life-history stages, including parr to smolts and smolts to adults. Thus, amount of (and accessibility to) habitats with ADM less than 18 C^o may be a major factor limiting smolt production in the WF Smith River.

Coho salmon parr that were PIT-tagged in late summer have shown apparent over-winter survival rates of 12 to 35% in the WF Smith River (Table 37), demonstrating that substantial mortality also occurs during this life-history stage (Ebersole et al. 2006; and J. Ebersole, pers. comm.). Insufficient habitats that provide refugia during winter flows, particularly in the main stem, may also be a factor limiting smolt production. Development of a model of carrying capacity for juvenile coho salmon in the WF Smith

River requires a comprehensive inventory of habitat throughout the basin, integrated with physical metrics such as temperature, and summer and winter stream flows. Winter habitat surveys were conducted throughout the WF Smith River basin during winter 2005, but these data have not been analyzed.

Table 37. Estimated apparent over-winter survival of juvenile coho salmon in the WF Smith River based on recoveries of PIT-tagged fish at the out-migrant trap. Parr were PIT-tagged in late summer in tributaries and adjacent main stem reaches by US EPA. The estimate is based on number of migrants at the trap and does not account for fish emigrating prior to trap installation in early February.

Brood Year	Number scanned	Number detected	Trap Effic.	Tagged smolts	Parr implanted	Parr survival	Total smolts	Estimated total parr
2001	4,146	152	0.33	459	3,734	0.12	15,849	128,846
2002	6,921	318	0.34	928	5,685	0.16	23,054	141,301
2003	14,726	830	0.39	2,142	6,173	0.35	39,576	114,028

Fall Chinook Salmon

Fall Chinook spawn in the WF 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 can not 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 32. In 2004, hatchery fish comprised 49.1% of adult fall Chinook trapped, and 31.8% of carcasses recovered (n=22). These hatchery strays were likely derived from a program that released juvenile hatchery fish at Buck Creek on the main stem of Smith River, and are from Smith River brood stock.

The number of age-0 fall Chinook migrants are shown in Table 38. Week of peak migration has varied considerably, from early March to late May. Catch of juvenile fall Chinook decreased in May in most years, but juveniles were usually still caught when the trap became inoperable due to low stream flows in early June, thus total migrants were underestimated.

Table 38. Estimated number of fall Chinook salmon fry and fingerling migrants (± 95% CI), and week of peak migration in the WF Smith River.

Sample Year	Migrants ± 95% CI			Peak Week
1998	127,726	±	6,488	3/02-3/08
1999	10,316	±	1,932	3/15-3/21
2000	3,789	±	553	4/03-4/09
2001	937	±	251	4/23-4/29
2002	18,726	±	2,284	4/08-4/14
2003	933	±	243	5/26-6/01
2004	15,527	±	2,036	4/05-4/11
2005	25,871	±	2,620	3/07-3/13

Winter Steelhead

The annual number of adult winter steelhead captured at the trap and spawner population estimates for each sex are listed in Table 32. Hatchery fish comprised a minor component of trap catch in most years. There is no hatchery program in the Smith Basin and hatchery strays are likely from the Siuslaw River.

The estimates of total spawners shown in Table 39 were adjusted to account for repeat spawners. A portion of fish that returned each year had tags implanted the previous year, and any yellow-tagged fish that bypassed the trap became part of the marked (M) population. It was assumed that repeat spawners were equally represented in trap catch and the population that bypassed the trap, thus the number marked was adjusted by the percentage of repeat spawners in the trap catch and the calculated percentage of total spawners that bypassed the trap. Because some tagged repeat spawners in trap catch had only one tag, the number of repeat spawners each year was also adjusted to account for tag loss. The percentage of combined male and female repeat spawners has ranged from 0.7% to 12.3% (Table 39). The highest percentage occurred in 2001, when an estimated 16.5% of females and 10.3% of males were repeat spawners.

Estimated numbers of juvenile steelhead smolts (fish > 120 mm) are summarized by size class in Table 35, and data on peak week of out migration and pre-smolt estimates are given in Appendix 2. Analysis of scales collected in 1998 and 1999 from steelhead smolts (≥ 120 mm FL) in the WF Smith River indicates juveniles may rear for two to three years before emigration as smolts. Juvenile steelhead may also move downstream prior to the smolt stage, and the number of pre-smolt migrants has varied considerably in the West Fork Smith River. Growth rate of juvenile steelhead likely varies between reaches (e.g. between tributary and main stem reaches) and between years, thus while fish in the 60-89mm size class may be predominantly age-1, fish in the larger size classes are more likely to be composed of more than one age class. Despite this uncertainty in aging based on size distribution, the 1999 brood year appeared to be a particularly strong year class, represented by 1,675 age-1 migrants in 2000, and some portion of the 3,883 migrants measured in the 90-119 mm size class in 2001 (Appendix 2). It is not known where pre-smolts rear after migrating past the juvenile trap, or whether some portion of these early migrants subsequently return to the WF Smith River to rear to the smolt stage.

Mean FL of steelhead smolts at week of peak migration appears to have decreased since 1998, but this apparent trend can be mostly attributed to variation in migration timing, with the largest mean sizes corresponding to years in which smolts migrated later in spring. A regression of mean FL against peak week of migration was linear, but not quite significant (P = 0.058; r^2 =0.48).

Cutthroat Trout

Picket spacing in the floating weir and adult trap in the WF Smith River is too wide to effectively retain adult cutthroat trout. Live adults and cutthroat trout redds are counted on spawner surveys, but counts are generally too low to make population estimates using area-under-the-curve calculation. Estimated numbers of juvenile cutthroat trout migrants in the 2 larges size classes are summarized by size class in Table 35, and data on peak week and smaller size classes are in Appendix 3. The predominant size classes are fish 120-159 mm and 160-249 mm FL, although there is considerable variation between years in each size class.

Table 39. Total estimated winter steelhead spawners in the WF Smith River for the return years 1998-1999 through 2004-2005, and percentage of combined males and females that were repeat spawners.

Return Year	Spawners ± 95% CI			Repeat Spawners (%)
98-99	366	±	128	na
99-00	453	±	21	na
00-01	334	±	17	0.7
01-02	834	±	216	12.3
02-03	375	±	114	4.8
03-04	536	±	111	2.0
04-05	247	±	36	1.8

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

Winchester Creek is a third 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, and mean monthly discharge ranges from ~ 0.1 m^3/s (late summer) to > 6 m^3/s (peak stream flow events in winter). The adult trap was constructed in 1999 and trapping 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. Juvenile fish are trapped using a rotary screw trap located at head of tide. Trapping for juvenile fish began in spring 1999. In most years the juvenile trap is operated fall through spring, and during periods of low flows, a motor is used to power the trap drum.

Coho Salmon

Trap catch and spawner population estimates by fish groups are summarized in Table 40. The total spawner estimate for coho (with confidence intervals) for each year is given in Table 41. Numbers of spawners have generally increased since 1999, although marine survival rate has steadily declined (Table 42 and Figure 17ab). In fall 2000, precipitation and stream flows were very low until late December, and this factor likely influenced number of spawners for that brood year. The 2000 brood produced few smolts, and relatively few adults from this brood returned to spawn in 2003.

Prior to 2004, hatchery fish comprised a significant portion of trap catch and, in some years, the spawning population. Hatchery fish that entered the trap were not passed, but during high stream-flows both wild and hatchery fish were able to bypass the trap. These hatchery fish were Coos River stock, and were acclimated and released at a small creek near the mouth of South Slough, the arm of Coos Bay into which Winchester Creek flows. This hatchery program ended in 2003.

Table 40. The number of female (F), male (M) and jack (J) coho captured at the Winchester Creek adult trap and the estimated spawning population in the Winchester Creek watershed above the trap during the return years 1999-2000 through 2004-05.

Return Year	Trap Catch						Estimated Spawning Population					
	Wild			Hatchery			Wild			Hatchery		
	F	M	J	F	M	J	F	M	J	F	M	J
99-00	5	10	5	2	3	1	10	20	na	4	6	na
00-01	3	2	73	0	0	1	3	2	na	0	0	na
01-02	140	101	20	46	57	1	151	109	72	2	3	3
02-03	27	25	6	8	4	3	148	137	38	36	18	16
03-04	10	12	14	5	4	0	20	24	75	6	5	0
04-05	44	48	17	0	0	0	179	195	201	0	0	0

Table 41. Total estimated coho salmon spawners in Winchester Creek for the return years 1999-2000 through 2004-2005.

Return Year	Spawners ± 95% CI		
99-00	40	±	26
00-01	5	±	0
01-02	265	±	11
02-03	339	±	349
03-04	55	±	47
04-05	374	±	167

Estimated numbers of smolts for a given brood year are given in Table 42, and summarized by out-migrant year (with confidence intervals) in Table 43. Data on peak week, size and fry abundance are summarized in Appendix 1. The annual trend in smolt abundance is shown in Figure 17c. The low numbers of the 2000 brood year migrants was due to the low number of spawners that produced that brood (described in the discussion of adult coho, above). In 2003 few adults returned from this small brood, and juveniles from this brood experienced low freshwater survival. As a consequence, the 2003 brood was also small. Subsequent broods produced on this three-year cycle will have to experience either higher than average freshwater survival rates or marine survival rates before adult returns will increase to the levels observed in alternate return years (Figure 17bd).

A low spawner levels, very few fry appeared at the trap site, but at high spawner levels, significant numbers of fry moved downstream (Figure 18ab). Observed spawner abundance has been limited to ≤ 26 and ≥153 females, thus spawner densities that may correspond to intermediate levels of fry movement can not be defined.

The juvenile trap in Winchester Creek is located near head of tide in a narrow, incised channel within a broad, flat flood plain. Flow dynamics allow operation of the trap through all stream flows, permitting monitoring during fall and winter. In most years, fish that moved downstream during fall and early winter formed a considerable percentage of total migrants, ranging from 13 % in 2001 and 2005, to 33 % in 2000 (Table 43). Previous research has shown that fall migrants in Winchester Creek used habitats below the trap site for extended periods and experienced growth rates higher than those observed in the upper watershed (Miller and Sadro 2003). Habitats used by fall migrants included reaches of the main channel (salinities < 10 ppt), the channels of non-spawning tributaries, a large beaver pond in a non-spawning tributary, and tidally flooded marsh channels adjacent to the main channel. Fish that migrated past the trap during fall and early winter had mean minimum residence times of 48 days and 64 days during the two year study period. It is not known what portion of pre-smolt migrants become smolts or how marine survival of early migrants compares to that of the more abundant spring smolts. Marine survival rates shown in Table 42 were calculated using numbers of spring (post-January) smolts only.

There was no clear correlation between female spawners and smolt production (Figure 18a). In addition to seeding level and egg to fry survival rate, several variables likely influence survival of parr during the summer and winter rearing periods, thus no linear correlation between smolt production and spawners is expected. Some variables that frequently influence survival in other systems are probably less important in Winchester Creek. Summer water temperatures in both headwater and lower reaches generally do not reach the average daily maximum (ADM) standard of 18 C^o for juvenile salmonids in coastal streams (DEQ 2004, Michael Cairns, US EPA, pers. comm.). In West Fork Winchester Creek, where most spawning activity occurs, ADM is approximately 16 C^o, and summer water temperatures usually range 12-14 C^o. In the main stem below the WF Smith, highest ADM measured has been 17.7 C^o. High stream flow events during winter are also not likely a major factor effecting survival. Beaver ponds form the predominant habitat in extensive reaches of the upper watershed and this habitat attenuates flows during high streamflow events. Large wood debris is also abundant over most of the basin, providing refuge during high flows. Infestation of black spot, the Neascus-type trematode parasite that causes a metacercarial cyst infestation in juvenile salmonids, is generally very low in juvenile coho sampled at the trap.

Factors that potentially have a strong influence on survival in Winchester Creek are beaver dams that restrict juvenile fish passage, very low summer stream flows, and predation. Beaver dams are typically built to the height of the stream channel, may persist for multiple years, and block juvenile fish passage during periods of low flow, but it is not clear whether beaver pond habitats have a positive or negative effect on survival in Winchester Creek. Movement of fish in reaches not impounded by beavers is also restricted during low summer flows, increasing competition and possibly predation in small pools.

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 are made.

Estimated numbers of the larger size classes of juvenile cutthroat trout migrants are summarized in Table 43, and data on smaller size classes are in Appendix 3. The predominant size class is fish in the 120-159 mm FL range. Other size classes show considerable variation between years. 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).

Table 42. Estimated number of spawners, fry and smolt production, number of wild returning adults, and freshwater and marine survival rates for coho salmon in Winchester Creek.

Brood Year	Female spawners Wild	Female spawners Hatchery	Egg deposition	Fry	Smolts	Returning adults (wild) female	Returning adults (wild) male	Percent Survival FW	Percent Survival Marine
1997					2,247	10	20		na[a]
1998				252	3,538	3	2		7.4
1999	10	4	34,929	656	5,035	151	109	14.4	5.7
2000	3	0	8,343	0	998	148	137	12.0	4.4
2001	151	2	446,900	50,426	11,468	20	24	2.6	3.3
2002	148	36	546,212	47,756	6,069	179	195	1.1	
2003	20	6	73,170	11	910			1.2	
2004	179	0	452,492	37,685					

[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.

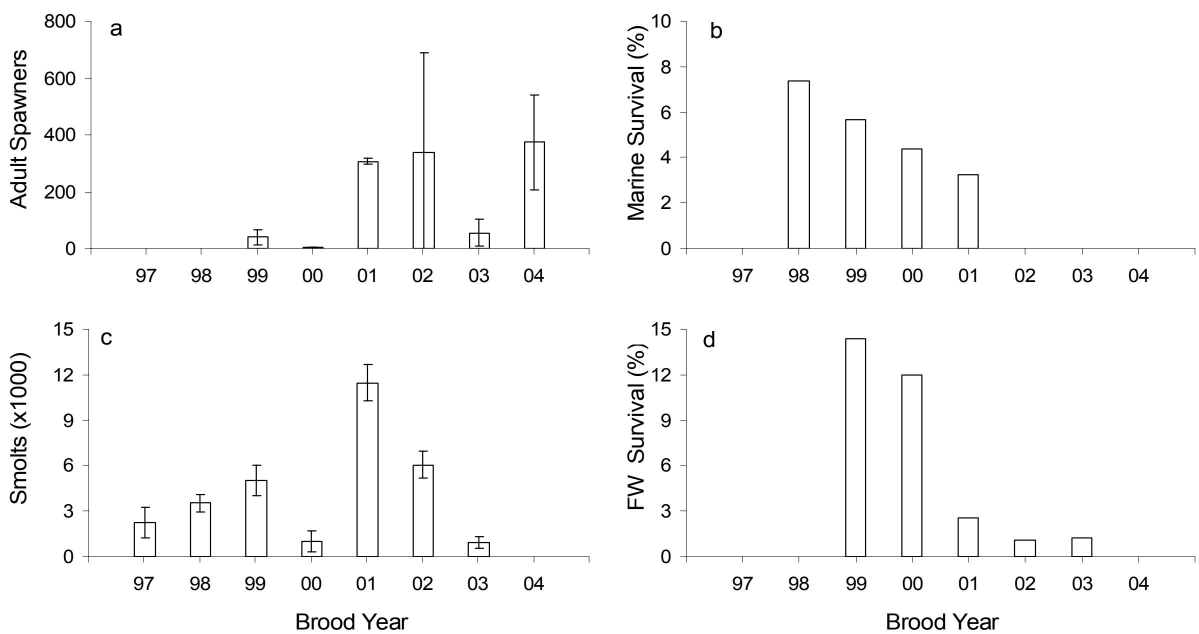

Figure 17. Annual trends in (a) the estimated number of adult spawners, (b) the percent marine survival, (c) number of smolts, and (d) percent freshwater survival for coho salmon in Winchester Creek. .

Table 43. Estimated number of juvenile salmonids (and 95% CI) migrating past the Winchester Creek juvenile trap. Coho pre-smolts were defined as fish trapped from November through January. For cutthroat trout, only the 2 largest size classes are given. Additional out-migrant data are provided in appendices.

Sample Year	Coho smolts ± CI			Coho pre-smolts ± CI			Cutthroat migrants ± CI 160-249 mm			Cutthroat migrants ± CI 120-159 mm		
1999	na	±		2,247	±	1,005	442	±	308	1,187	±	470
2000	1,720	±	957	3,538	±	574	74	±	74	961	±	366
2001	743	±	1,220	5,035	±	1,011	(16)			548	±	396
2002	0	±		998	±	668	259	±	139	976	±	539
2003	2,153	±	497	11,468	±	1,194	424	±	402	394	±	344
2004	2,302	±	575	6,069	±	881	129	±	137	1,216	±	1,478
2005	132	±	224	910	±	385	(28)			951	±	1,139

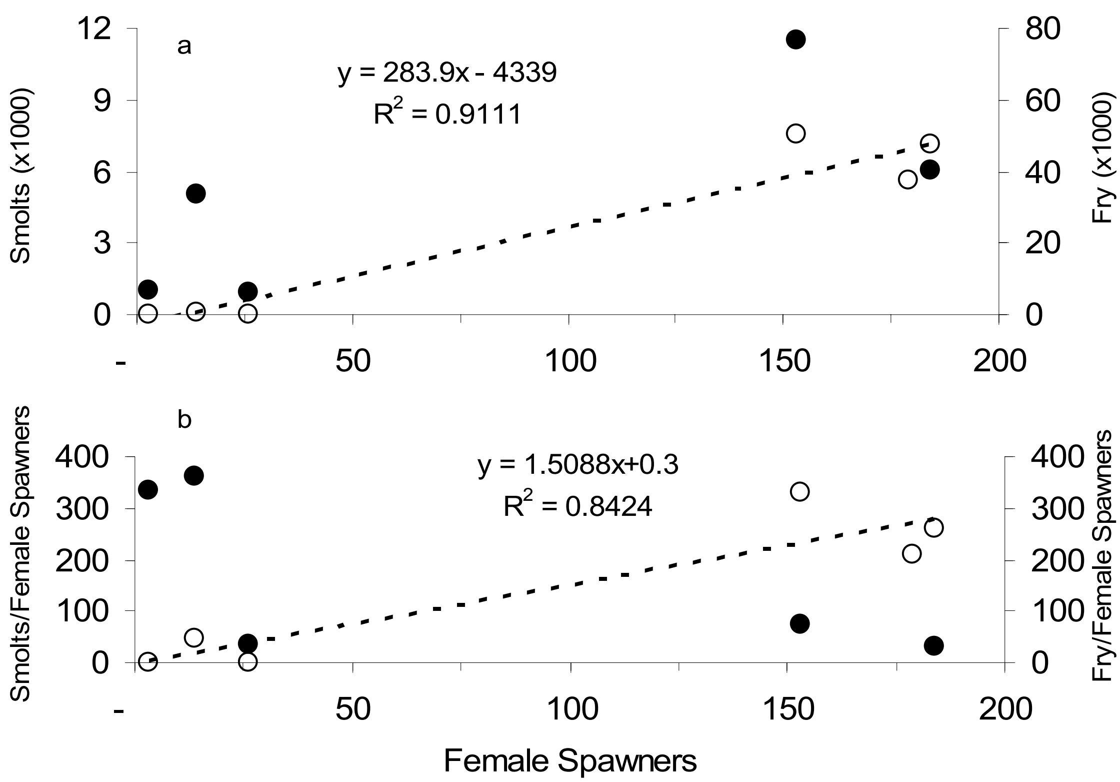

Figure 18. Relationship of total smolt (solid symbols) and fry (clear symbols) migrants produced to total female spawners (a), and relationship of smolt and fry migrants produced per female, to total female spawners (b) at the Winchester Creek site. Regression results (line shown) are significant for fry on female spawners (P = 0.0116) and fry/female on female spawners (P = 0.0098).

LITERATURE CITED

Beechie, T., E. Beamer, and L. Wasserman. 1994. Estimating coho salmon rearing habitat and smolt production losses in a large river basin, and implications for habitat restoration. N. Amer. J fish. Man. 14: 797-811.

Beidler, W. M., and T. E. Nickelson. 1980. An evaluation of the Oregon Department of Fish and Wildlife standard spawning fish survey system for coho salmon. Oregon Department of Fish and Wildlife, Information Report Series, Fisheries Number 80-9, Portland.

Bradford, M. J., G. C. Taylor, and J. A. Allan. 1997. Empirical review of coho salmon smolt abundance and the prediction of smolt production at the regional level. Tran. Amer. Fish. Soc. 126: 49-64.

Cairns, M. A., J. L. Ebersole, J. P. Baker, H. R. Lavigne, S. M. Davis, and P. J. Wigington. 2005 (in press). Influence of summer stream temperatures on black spot infestation of juvenile coho salmon in the Oregon Coast Range. Tran. Amer. Fish. Soc.

Caughely, G. 1977. Analysis of Vertebrate Populations. John Wiley and Sons, pp. 139-140.

DEQ (Oregon Department of Environmental Quality). 2004. Final temperature rule and other water quality standards (Division 41) and revisions. Oregon Department of Environmental`Quality.Salem,OR.http://www.deq.state.or.us/wq.wqrules/Divo41/OAR340Div041.pdf.

Ebersole, J. L., P. J. Wigington, J. P. Baker, M. A. Cairns, M. R. Church, J. E. Compton, S. Leibowitz, B. Hansen, and B. Miller. 2006 (In Review). Juvenile coho salmon growth and survival across stream network seasonal habitats. Tran. Amer. Fish. Soc

Johnson, S. L., J. D. Rodgers, M. F. Solazzi, and T. E. Nickelson. 2005. Effects of an increase in large wood on abundance and survival of juvenile salmonids (*Oncorhynchus* spp.) in an Oregon coastal stream. Can. J. Fish. Aquat. Sci. 62: 412-424.

Miller, B. A. and S. Sadro. 2003. Residence time and seasonal movements of juvenile coho salmon in the ecotone and lower estuary of Winchester Creek, South Slough, Oregon. Transactions of the American Fisheries Society 132: 546-559.

Moore, K., K. Jones, and J. Dambacher. 2005. Methods for Stream Habitat Surveys; Version 15.1, May 2005. ODFW. Aquatic Inventory Project.

Nickelson, T. E., M. F. Solazzi, and S. L. Johnson. 1986. Use of hatchery coho salmon (*Oncorhynchus kisutch*) pre-smolts to rebuild wild populations in Oregon coastal streams. Can. J. Fish. Aquat. Sci. 43: 2443-2449.

Nickelson, T. E., J. D. Rodgers, S. L. Johnson, and M. F. Solazzi. 1992. Seasonal changes in habitat use by juvenile coho salmon (*Oncorhynchus kisutch*) in Oregon coastal streams. Can. J. Fish. Aquat. Sci. 49: 783-789.

Nickelson, T. E. 1998. A habitat based assessment of coho salmon production potential and spawner escapement needs for Oregon coastal streams. Oreg. Dep. Fish Wildl., Fish Div. Info. Rep. 98-2, Portland, Oregon.

Northcote, T. G. 1997. Why sea-run? An exploration into the migratory/residency spectrum of coastal cutthroat trout. Pages 20-26 *in* J. D. Hall, P. A. Bisson, and R. E. Gresswell, editors. Sea-run cutthroat trout: biology, management and future conservation. Oregon Chapter, American Fisheries Society, Corvallis.

Pacific Fishery Management Council. 2005. Preseason Report I Stock Abundance Analysis for 2005 Ocean Salmon Fisheries. (Document prepared for the Council and its advisory entities.) Pacific Fishery Management Council, 7700 NE Ambassador Place, Suite 200, Portland, Oregon 97220-1384.

Poole, G., J. Dunham, M. Hicks, D. Keenan, J. Lockwood, E. Materna, D. McCullough, C. Mebane, J. Risley, S. Sauter, S. Spalding, and D. Sturdevant. 2001. Scientific issues relating to temperature criteria for salmon, trout, and charr native to the Pacific Northwest. U.S. Environmental Protection Agency, EPA 910-R-01-007, Seattle.

Ricker, W. E. 1975. Computation and Interpretation of Biological Statistics of Fish Populations. Department of the Environment Fisheries and Marine Service, Ottawa, Bulletin 191, p. 78.

Roni, P., T. Bennett, S. Morley, G. R. Pess, K. Hanson, D. Van Slyke, and P. Olmstead. 2004. Rehabilitation of bedrock stream channels: the effects of boulder weir placement on aquatic habitat and biota. Project Completion Report for Interagency Agreement HAI013001. Northwest Fisheries Science Center, Seattle, WA.

Solazzi, M. F., S. L. Johnson, B. Miller, and T. Dalton. 2000a. Salmonid Life-Cycle Monitoring Project 1998 and 1999. Monitoring Program Report Number OPSW-ODFW-2000-2, Oregon Department of Fish and Wildlife, Portland, Oregon.

Solazzi, M. F., T. E. Nickelson, S. L. Johnson, and J. D. Rodgers. 2000b. Effects of increasing winter rearing habitat on abundance of salmonids in two coastal Oregon streams. Can. J. Fish. Aquat. Sci. 57: 906-914.

Solazzi, M. F., S. L. Johnson, B. Miller, and T. Dalton. 2001. Salmonid Life-Cycle Monitoring Project 2000. Monitoring Program Report Number OPSW-ODFW-2001-2, Oregon Department of Fish and Wildlife, Portland, Oregon.

Solazzi, M. F., S. L. Johnson, B. Miller, and T. Dalton. 2002. Salmonid Life-Cycle Monitoring Project 2001. Monitoring Program Report Number OPSW-ODFW-2002-2, Oregon Department of Fish and Wildlife, Portland, Oregon.

Solazzi, M. F., S. L. Johnson, B. Miller, T. Dalton, and K. A. Leader. 2003. Salmonid Life-Cycle Monitoring Project 2002. Monitoring Program Report Number OPSW-ODFW-2003-2, Oregon Department of Fish and Wildlife, Portland, Oregon.

Thedinga, J. F., M. L. Murphy, S. W. Johnson, J. M. Lorenz, and K. V. Koski. 1994. Determination of salmonids smolt yield with rotary-screw traps in the Situk River, Alaska, to predict effects of glacial flooding. N. Am. J. Fish. Manage. 14: 837-851.

Trotter, P. C. 1997. Sea-run cutthroat trout: life history profile. Pages 7-15 *in* J. D. Hall, P. A. Bisson, and R. E. Gresswell, editors. Sea-run cutthroat trout: biology, management and future conservation. Oregon Chapter, American Fisheries Society, Corvallis.

Van de Wetering, S. J. 1998. Aspects of life history characteristics and physiological processes in smolting Pacific lamprey, Lampetra tridentate, in a central coast Oregon stream. MS Thesis, Oregon State University, Corvallis, Oregon.

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	Peak Week	Mean FL (mm) ± CI
NF Scappoose				
1999	1,453 ± 102	339 ± 578	5/17-5/23	129.1 ± 2.0
2000	134 ± 22	876 ± 500	4/24-4/30	139.7 ± 1.8
2001	659 ± 55	2,649 ± 822	5/17-5/13	141.7 ± 2.4
2002	205 ± 28	807 ± 320	5/13-5/19	136.0 ± 2.1
2003	569 ± 49	8,640 ± 3,065	5/19-5/25	142.3 ± 2.7
2004	275 ± 42	18,786 ± 2,553	5/3-5/9	131.2 ± 3.1
2005	416 ± 156	9,573 ± 13,823	5/2-5/8	127.7 ± 3.3
NF Nehalem[a]				
1998	42,267 ± 2,732		4/27-5/03	102.4 ± 4.5
1999	20,999 ± 1,137		5/10-5/16	115.4 ± 3.5
2000	31,677 ± 2,336		5/01-5/07	117.4 ± 3.4
2001	44,710 ± 1,882		4/23-4/29	105.4 ± 5.0
2002	20,804 ± 997		4/08-4/14	105.3 ± 4.1
2003	29,212 ± 2,859		4/28-5/04	112.2 ± 4.7
2004	40,013 ± 2,527		4/12-4/18	108.6 ± 4.5
2005	24,587 ± 1,519		5/02-5/08	103.3 ± 3.6
EF Trask				
2005	6,069 ± 665	42,474 12,600	5/09-5/15	107.5 ± 3.1
Mill Creek-Siletz				
1997	8,110 ± 616	na ±	4/28-5/4	98.4 ± 5.1
1998	9,547 ± 517	483 ± 177	4/20-4/26	94.3 ± 4.2
1999	8,409 ± 558	100 ± 152	5/10-5/16	100.9 ± 3.8
2000	4,311 ± 283	617 ± 971	5/1-5/7	112.9 ± 3.3
2001	15,475 ± 731	2,143 ± 363	5/14-5/20	105.4 ± 4.0
2002	17,305 ± 917	9,030 ± 716	4/8-4/14	87.8 ± 5.4
2003	16,063 ± 986	62,727 ± 4,674	4/28-5/4	100.0 ± 4.8
2004	18,300 ± 827	24,166 ± 1,369	4/26-5/2	100.4 ± 4.2
2005	20,717 ± 1,114	11,196 ± 1,131	5/2-5/8	103.9 ± 4.7
Mill Creek-Yaquina				
1997	1,400 ± 286	46,732 ± 6,693	4/28-5/4	123.5 ± 9.5
1998	6,698 ± 638	220 ± 94	4/27-5/3	123.9 ± 0.7
1999	2,225 ± 283	2,565 ± 542	5/3-5/9	145.9 ± 1.4
2000	5,601 ± 427	1,319 ± 227	4/24-4/30	141.5 ± 4.9

Sample Year and Site	Smolts ± CI			Fry ± CI			Peak Week	Mean FL (mm) ± CI		
2001	7,026	±	553	9,376	±	937	4/30-5/6	138.6	±	4.9
2002	6,833	±	463	126,257	±	5,781	4/29-5/5	126.4	±	2.2
2003	8,833	±	601	108,554	±	5,117	5/5-5/11	129.4	±	4.3
2004	8,117	±	622	127,136	±	3,820	5/10-5/16	133.0	±	3.4
2005	12,726	±	1,018	152,815	±	6,926	5/9-5/15	117.4	±	3.0
Cascade Creek										
1998	1,404	±	98	0			4/20-4/26	99.8	±	6.7
1999	557	±	43	0			4/19-4/25	102.9	±	4.5
2000	13	±	8	(6)						
2001	1,485	±	102	2,578	±	1,232	4/16-4/22	111.1	±	3.0
2002	1,761	±	86	(20)			4/29-5/5	94.7	±	4.0
2003	1,534	±	81	1,113	±	349	4/28-5/4	94.9	±	3.6
2004	3,058	±	109	517	±	281	4/5-4/11	95.7	±	2.7
2005	6,654	±	221	3,454	±	385	3/21-3/27	79.2	±	3.3
WF Smith River										
1998	22,412	±	1,584	2,527	±	1,224	4/11-5/17	104.6	±	4.2
1999	10,866	±	1,465	3,014	±	658	5/17-5/23	113.0	±	3.5
2000	14,851	±	1,088	3,605	±	752	4/10-4/16	103.0	±	4.4
2001	20,091	±	1,337	13,550	±	3,557	4/23-4/29	112.1	±	4.3
2002	17,358	±	1,460	35,851	±	5,628	5/06-5/12	112.5	±	2.8
2003	15,849	±	1,239	80,876	±	11,360	5/05-5/11	109.2	±	4.1
2004	23,054	±	1,523	104,402	±	7,963	4/12-4/18	105.4	±	3.8
2005	39,576	±	2,038	27,598	±	3,515	5/02-5/08	110.0	±	5.0
Winchester Creek[b]										
1999	2,247	±	1,005	252			4/26-5/02	120.7		2.7
2000	3,538	±	574	656			3/27-4/02	103.5		2.9
2001	5,035	±	1,011	0			3/19-3/25	92.8		1.6
2002	998	±	668	50,426	±	3,750	4/08-4/14	113.4		3.5
2003	11,468	±	1,194	47,455	±	6,873	4/21-4/27	99.5		4.1
2004	6,069	±	881	20			3/22-3/28	93.9		4.5
2005	910	±	385	37,685	±	11,215	3/14-3/20	97.5		6.9

[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			Pre-smolts	
	Estimate ± CI	Mean FL (mm) ± CI	Peak Week	90-119 mm	60-89 mm
NF Scappoose					
1999	407 ± 180	174.9 ± 6.2	5/10-5/16	(1)	0
2000	553 ± 103	164.7 ± 8.6	4/17-4/23	(7)	0
2001	841 ± 137	168.6 ± 8.1	4/23-4/29	(12)	(1)
2002	496 ± 131	171.9 ± 8.0	4/8-4/14	(1)	0
2003	717 ± 779	174.6 ± 9.8	5/12-5/18	(8)	2
2004	712 ± 115	170.1 ± 10.5	4/5-4/11	158	19
2005	(61)			(8)	(1)
NF Nehalem					
1998	6,706 ± 1,285	174.1 ± 7.3	4/27-5/03	200	(9)
1999	4,572 ± 498	178.2 ± 5.2	5/03-5/09	110	(9)
2000	17,448 ± 1,702	164.7 ± 9.2	4/24-4/30	1,863	372
2001	8,090 ± 714	161.8 ± 7.5	4/23-4/29	1,279	267
2002	3,437 ± 514	171.2 ± 7.0	4/08-4/14	(72)	103
2003	5,380 ± 1,470	167.2 ± 10.5	3/31-4/06	(73)	(4)
2004	7,762 ± 1,496	180.7 ± 10.7	4/05-4/11	652	(35)
2005	4,613 ± 1,293	170.2 ± 8.6	4/18-4/24	395	(29)
EF Trask					
2005	2,588 ± 1,015	175.0 ± 8.8	4/18-4/24	379	73
Mill Creek-Siletz					
1997	241 ± 131	144.6 ± 12.6	4/14-4/20	555	184
1998	1,017 ± 163	147.5 ± 8.3	4/20-4/26	405	68
1999	240 ± 64	158.0 ± 10.9	3/29-4/4	225	42
2000	1,078 ± 241	143.0 ± 8.0	4/10-4/16	1,254	104
2001	1,137 ± 192	150.0 ± 8.1	3/26-4/1	1,219	465
2002	493 ± 147	150.8 ± 8.3	4/8-4/14	152	203
2003	202 ± 66	154.0 ± 19.5	3/10-3/16	322	152
2004	428 ± 123	148.3 ± 10.3	4/12-4/18	167	73
2005	784 ± 206	158.2 ± 14.0	3/21-3/27	258	100
Mill Creek-Yaquina					
1997	(3)			9	(15)
1998	(33)			169	(22)
1999	374 ± 181	183.7 ± 4.5	4/29-5/2	(26)	(12)
2000	280 ± 79	179.8 ± 14.2	4/10-4/16	193	61
2001	874 ± 629	158.7 ± 6.1	4/23-4/29	169	270
2002	679 ± 462	169.8 ± 7.9	4/8-4/14	132	256
2003	168 ± 156	161.4 ± 24.9	4/28-5/4	175	314
2004	394 ± 594	177.9 ± 20.0	4/12-4/18	(20)	(12)
2005	(19)			(14)	(32)

Sample Year and Site	Smolts							Pre-smolts	
	Estimate ± CI			Mean FL (mm) ± CI			Peak Week	90-119 mm	60-89 mm
Cascade Creek									
1998	110	±	22	141.9	±	6.6	4/20-4/26	197	(5)
1999	(10)							(8)	0
2000	125	±	30	132.5	±	6.0	4/3-4/9	(16)	0
2001	138	±	38	137.1	±	4.9	3/26-4/1	345	37
2002	71	±	40	140.8	±	13.5	4/8-4/14	56	(13)
2003	(18)							23	(3)
2004	(9)							97	18
2005	54	±	18	149.1	±	22.1	3/21-3/27	114	94
WF Smith River									
1998	6,438	±	1,286	168.9	±	7.9	4/20-4/26	761	27
1999	2,688	±	846	160.9	±	6.8	5/03-5/09	66	(10)
2000	2,836	±	593	152.6	±	4.3	5/01-5/07	193	1675
2001	2,737	±	1,338	147.5	±	6.5	3/26-4/01	3,883	620
2002	4,681	±	3,558	148.8	±	7.5	4/08-4/14	769	(10)
2003	2,448	±	4,306	158.0	±	10.0	4/21-4/27	(75)	159
2004	2,916	±	1,847	153.7	±	8.3	4/12-4/18	1,138	236
2005	4,333	±	1,382	145.0	±	7.0	3/21-3/27	752	73

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		
NF Scappoose												
1999	346	±	114	142	±	43	63	±	43	(9)		
2000	339	±	102	240	±	36	62	±	32	(4)		
2001	375	±	76	344	±	66	373	±	79	(20)		
2002	169	±	31	153	±	36	27	±	36	0		
2003	245	±	84	259	±	81	205	±	111	(7)		
2004	227	±	42	212	±	40	171	±	56	(9)		
2005	486	±	561	(47)			(3)			(1)		
NF Nehalem												
1998	550	±	685	1,471	±	895	647	±	1,140	(4)		
1999	658	±	157	1,987	±	323	376	±	200	(1)		
2000	1,520	±	389	3,232	±	655	852	±	245	72	±	111
2001	592	±	126	3,444	±	556	1,304	±	326	230	±	155
2002	1,647	±	358	3,456	±	714	388	±	205	(9)		
2003	1,041	±	809	1,886	±	1,820	533	±	661	(7)		
2004	981	±	1,165	2,008	±	1,540	(26)			(1)		
2005	322	±	180	1,527	±	629	(55)			(3)		
EF Trask												
2005	551	±	296	3,526	±	616	889	±	439	(26)		
Mill Creek-Siletz												
1997	449	±	173	1,521	±	233	1,061	±	615	(5)		
1998	496	±	160	1,718	±	257	276	±	98	0		
1999	674	±	243	1,790	±	396	120	±	41	0		
2000	1,429	±	384	2,857	±	435	181	±	68	0		
2001	1,604	±	462	2,493	±	380	716	±	183	(17)		
2002	1,246	±	427	2,605	±	415	399	±	141	(4)		
2003	1,348	±	309	1,975	±	388	109	±	98	(3)		
2004	994	±	201	696	±	119	81	±	136	0		
2005	1,324	±	396	2,031	±	312	212	±	61	(3)		
Mill Creek-Yaquina												
1997	(0)			(3)			(2)			(2)		
1998	(6)			(16)			(4)			0		
1999	32	±	23	(8)			(8)			(1)		
2000	64	±	28	41	±	55	(7)			0		
2001	36	±	16	41	±	28	95	±	43	67	±	97
2002	(11)			87	±	151	(11)			0		
2003	94	±	138	(14)			(1)			(1)		
2004	76	±	43	(11)			(5)			0		
2005	(14)			(16)			(1)			(1)		
Cascade Creek												
1998	168	±	31	662	±	103	367	±	75	(3)		

Sample Year and Site	Estimate ± CI											
	160-249 mm			120-159 mm			90-119 mm			60-89 mm		
1999	138	±	44	592	±	61	59	±	15	(4)		
2000	272	±	51	698	±	69	145	±	39	(3)		
2001	487	±	99	1,328	±	111	430	±	64	33	±	38
2002	260	±	75	1,415	±	110	532	±	78	39	±	24
2003	268	±	115	1,737	±	164	778	±	99	75	±	32
2004	276	±	63	1,242	±	105	332	±	55	(11)		
2005	393	±	75	2,112	±	204	928	±	125	114	±	89
WF Smith River												
1998[a]	(192)			(4)			0			0		
1999[a]												
2000	947	±	581	1,148	±	439	(11)			(1)		
2001	901	±	251	1,633	±	377	472	±	406	(31)		
2002	2,417	±	982	2,748	±	985	(3)			(1)		
2003	1,235	±	2,177	(70)			(4)			(5)		
2004	713	±	815	135	±	136	(2)			(7)		
2005	898	±	646	724	±	454	(2)			0		
Winchester Creek												
1999	442	±	308	1,187	±	470	1,207	±	1,231	(8)		
2000	74	±	74	961	±	366	535	±	356	19	±	25
2001	(16)			548	±	396	(40)			(8)		
2002	259	±	139	976	±	539	(24)			(1)		
2003	424	±	402	394	±	344	(14)			(11)		
2004	129	±	137	1,216	±	1,478	813	±	501	185	±	327
2005	(28)			951	±	1,139	(38)			(3)		

[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.

Sample Year	Lamprey adults: Brook	Lamprey adults: Pacific	Lamprey juveniles: Amm.[a]	Lamprey juveniles: Eyed	Cottids	Dace: Dace[d]	Dace: Speckled	Dace: Umpqua	Redside Shiner	Largescale Sucker	Pike Minnow	Three-spine Stickleback
NF Scappoose Creek												
1999	49	24	156	0	50	624						
2000	50	2	58	0	85	1,220						
2001	37	8	329	0	67	1,494						
2002	47	18	282	0	94	600						
2003	32	6	41	0	54	542						
2004	26	10	192	0	52	1,233						
2005	3	3	232	0	30	245						
NF Nehalem River @ WH Falls[b]												
1998	7	5	61	na	0	0						
1999	55	7	106	na	13	0						
2000	73	19	362	na	281	0						
2001	197	14	232	na	600	0						
2002	54	35	118	na	414	0						
2003	74	1	47	na	244	0						
2004	28	9	23	na	78	0						
2005	29	3	16	14	57	0						
EF Trask River												
2005	0	2	11	7	7	0						
Mill Creek-Siletz												
1997	254	0	852	0	67	0						
1999	39	0	248	0	13	0						
2000	91	0	93	0	21	0						
2001	189	1	207	18	54	0						
2002	101	0	733	0	27	0						
2003	263	0	268	0	34	0						
2004	112	1	298	0	43	0						
2005	72	0	187	17	54	0						
Mill Creek-Yaquina												
1997	14	0	0	0	139	0						
1998	4	0	0	0	45	0						

Sample Year	Lamprey adults		Lamprey juveniles			Dace						
	Brook	Pacific	Amm.[a]	Eyed	Cottids	Dace[d]	Speckled	Umpqua	Redside Shiner	Largescale Sucker	Pike Minnow	Three-spine Stickleback
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	2	0	58	0						
2005	22	0	1	0	54	0						
Cascade Creek												
1998	79	22	402	0	85	477						
1999	58	10	1,186	0	38	169						
2000	229	6	860	0	91	1,045						
2001	156	6	1,544	14	75	785						
2002	216	6	2,246	0	105	1,444						
2003	134	5	2,874	0	68	543						
2004	139	2	794	0	38	700						
2005	151	4	4,262	33	67	744						
WF Smith River												
1998	22	585[c]				7,637			913	100	2	
1999	1	327[c]				2,975			265	97	0	
2000	21	648	32			2,440			322	85	0	
2001	54	144	114			5,194			271	167	0	
2002	4	300	17				2,298	45	379	50	4	
2003	0	216	7				2,830	52	200	10	4	
2004	4	309	8				4,292	71	974	35	1	
2005	7	749	81				4,879	103	1,117	21	2	
Winchester Creek[e]												
2002		43	343	14	883							60
2003			646	687	1,346							1,874
2004			667	382	1,529							384
2005		14	596	1,049	892							64

[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 previous year. Some species not listed; see text
[f] prior to 1994 non-salmonids were not recorded

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 sites 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 two years. In other Oregon coastal streams, these fish have been observed to migrate to the ocean in November and December during winter freshets (Van deWetering 1998). Typically, their seaward migration is complete by the time downstream trapping begins in March. The two years in which we observed the 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 also only occurred in 2001 and 2005.

- 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.

- 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.