West Fork Smith River
Salmonid Life-Cycle Monitoring

Final Report: 2004-2005

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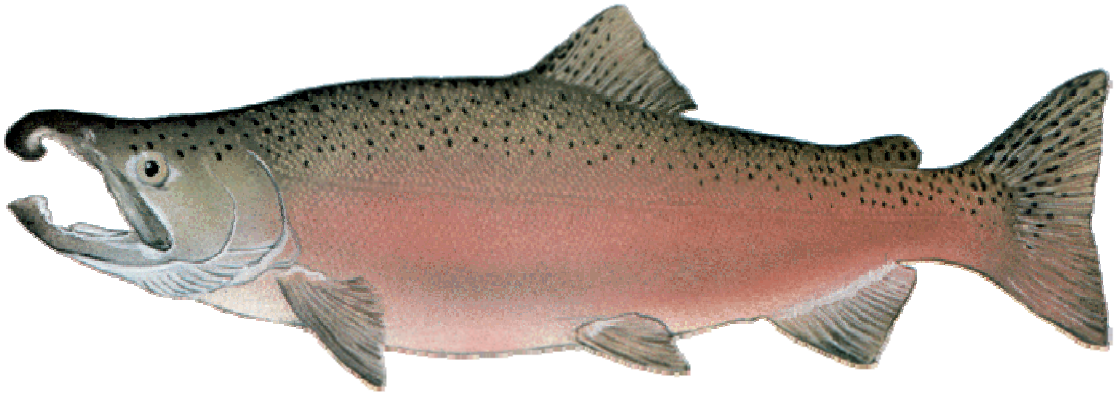

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Introduction

The Salmonid Life-Cycle Monitoring Project of the Oregon Department of Fish and Wildlife (ODFW) has guided monitoring of juvenile and adult salmonid fishes (*Oncorhynchus spp*.) in the West Fork Smith River (Umpqua basin) since 1998. These activities are coordinated under the Oregon Plan for Salmon and Watersheds and are part of a broader effort to monitor populations of salmonids in select Oregon coastal streams. Two objectives of this program are to estimate the abundance of returning adult salmonids and downstream-migrating juvenile salmonids, and estimate the marine and freshwater survival rates for coho salmon. Documenting long-term trends in these parameters is essential for the development of models that describe fish population response to variables at both the large scale (eg. climate) and smaller scale (eg. within-basin fish habitat enhancement or changes in land-use practices).

This report summarizes monitoring activities for the 2004-2005 run-year of returning adult fish and year 2005 out-migration of juvenile fish in the West Fork Smith River. A full description of sampling methods is provided in Solazzi et al. (2000). A more comprehensive report of monitoring activities in the West Fork Smith River is in preparation and will provide additional data analyses. Life-Cycle Monitoring Project progress reports are available on the Oregon Department of Fish and Wildlife website, http://www.dfw.state.or.us/.

Adult Fish Trap Operation

During summer 2004 the floating weir for the adult trap was completely rebuilt, and repairs were made to several trap components. The floating weir was installed and the trap made operational on September 15, 2004.

The first increase in stream flow occurred in mid-October. Stream flow remained low to moderate through November, and the first high streamflow event occurred December 7. During the trapping period, suspended debris caused the weir to submerge for a total of two days in November, five days in December, four days in January, and four days in March. Precipitation and stream flows were very low all of February and most of March. The last fish (winter steelhead) entered the trap on April 29, and the trap was decommissioned on May 5.

Total numbers of adult salmonids trapped are shown in Table 1. All wild coho salmon and both wild and hatchery winter steelhead were tagged with two yellow Floy tags and passed above the trap.

Run timing generally corresponded with timing of high streamflow events. Most fish bypassed the trap during high stream flows when the floating weir was submerged, thus timing of fish that entered the adult trap was only an approximation of run timing (Figure 1).

Spawning Ground Surveys

Coho salmon spawned throughout the basin. Among the major tributaries, Moore and Beaver creeks received the most spawning activity, while in the main stem, spawning was widespread over most reaches (Table 2). Spawning activity of winter steelhead was also widespread, but most activity occurred in the lower to middle reaches of the main stem (Table 2). Few fall Chinook salmon spawners were observed on surveys, and all were found on two lower main stem reaches (downstream of Crane Creek and just upstream of Moore Creek), and in the lower reach of Moore Creek.

Table 1. Number of fish trapped at West Fork Smith adult fish trap during the period October 2004 through April 2005.

		Wild			Hatchery			
Species	Month	Female	Male	Jack	Female	Male	Jack	Mortalities
Coho	Oct	2	3	0	0	0	0	0
	Nov	3	9	0	0	0	0	0
	Dec	13	12	0	0	0	0	0
	Jan	12	8	0	0	0	0	0
	Subtotal	30	32	0	0	0	0	0
Chinook	Oct	2	13	1	2	20	1	7 [a]
	Nov	3	7	0	4	1	0	0
	Dec	3	1	0	0	0	0	0
	Subtotal	8	21	1	6	21	1	0
Steelhead	Dec	1	0		0	0	0	0
	Jan	12	22		0	1	0	2 [b]
	Feb	3	6		0	0	0	0
	Mar	60	45		1	2	0	2 [c]
	Apr	2	8					
	Subtotal	78	81		1	3	0	0

[a] four hatchery jacks, two hatchery adult males, and one wild adult male pre-spawn mortalities on weir
[b] one female gilled in trap fyke, one female found as a tagged pre-spawn mortality below trap.
[c] one female gilled in trap fyke; one male pre-spawn mortality on weir

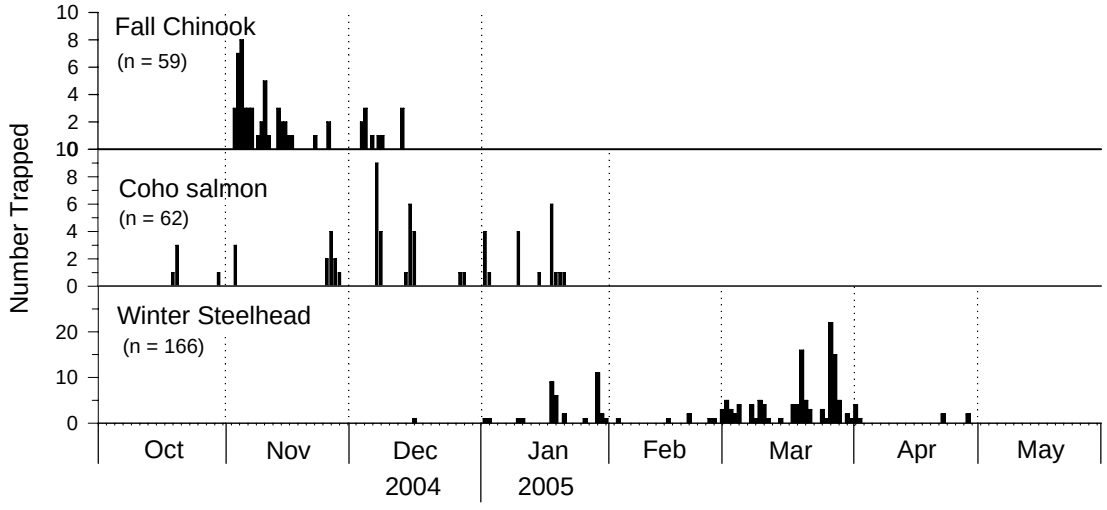

Figure 1. Timing of adult fall Chinook salmon, coho salmon, and winter steelhead trapped in the West Fork Smith River during the 2004-2005 run-year.

Table 2. Peak live counts and redd counts for coho salmon, total coho salmon spawners (based on area-under-curve calculations from survey counts), and season-total counts of winter steelhead redds on survey reaches in the West Fork Smith River during the period November 2004 to May 2005. Survey reaches of the main stem between tributaries E and F, and section 5 of the headwaters were not surveyed for coho salmon.

		Coho			Steelhead
Survey reach	Length (km)	Peak live	Peak redds	Total AUC	Total redds
Tributaries					
Coon Cr.	1.11	19	12	24	0
Crane Cr., lower	1.15	6	11	5	5
Crane Cr, upper	1.54	20	26	18	1
Moore Cr, lower	1.33	22	25	30	12
Moore Cr, upper	1.99	18	16	24	4
Beaver Cr, lower	2.11	19	15	26	9
Beaver Cr, upper	1.17	26	19	35	8
Gold Cr, lower	1.26	10	11	24	7
Gold Cr, upper	1.86	7	13	9	5
Main stem					
Trib. B to Crane Cr.	1.71	23	14	44	17
Moore Cr to Trib. D	2.50	58	14	102	22
Trib. E to Trib. F	1.50	na	na	na	13
Trib. F to Beaver Cr.	1.56	18	9	35	18
Beaver to Gold Cr.	0.84	29	12	59	17
Gold Cr. to left tributary	1.78	54	28	78	30
Headwaters, Section 3	1.12	21	10	33	8
Headwaters, Section 4	1.36	25	17	32	9
Headwaters, Section 5	na	na	na	na	2
Total					187

Estimation of Spawner Escapement

Coho salmon

The estimated number of coho salmon spawners was based on the number of fish that were tagged and passed at the West Fork Smith trap, and number of tagged and untagged fish observed (live fish and spawned-out carcasses) on surveys. An estimate of adult coho salmon spawners was made using the adjusted Peterson mark-recapture methodology:

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

where:

N = estimated population above the West Fork Smith River adult trap
M = 61, the number of adult coho salmon marked with two yellow Floy tags
C = 1136, the number of adult coho salmon observed for presence of yellow tags on spawning surveys (901 live fish observations, plus 235 carcass recoveries), excluding fish for which presence of tag could not be determined

R = 71, the number of yellow tagged fish observed (50 live fish, plus 21 carcass recoveries)
$p^2 = 6.15^{-4}$, the probability that a fish lost both yellow tags before being observed

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

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

where:

n_1 = (3) the number of fish observed with one yellow tag
n_2 = (59) the number of fish observed with two tags

Using this methodology and adjusting for tag loss, the population estimate of adult coho salmon spawners (N) was 978 fish during the 2004-05 run-year. Variance for the estimate was calculated using a relationship between the F distribution and the binomial distribution, providing a 95% confidence interval of 787 to1233 spawners. The calculated trap efficiency (percent of total run marked) was 6.3 percent. Based on the sex ratio of spawned-out fish recovered on surveys and on the trap weir, the population estimate included 417 females. Because no pre-spawn mortalities were observed, the spawner estimate of 978 fish represents the total return for this brood. Based on the estimated number of coho salmon smolts that migrated from the West Fork Smith River during spring 2003 (15,827), the 2004 return represents a marine survival rate of 6.2 % for total adults, and 5.3 % for females.

Fall Chinook Salmon

We have not been able to estimate spawner populations of fall Chinook salmon in the West Fork Smith River using mark and recapture methodology. Many of the fall Chinook salmon 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 salmon spawn in mainstem reaches almost exclusively. Spawners are counted on surveys, but counts are generally too low to make a population estimate using an area-under-the-curve calculation.

In 2004, hatchery fish comprised 49.1% of adult fall Chinook salmon 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 (Smith River brood stock) on the main stem of Smith River.

Winter Steelhead

A population estimate of winter steelhead spawners was made using the same mark/recapture methodology as above for coho, where:

M = (159) the number of fish yellow-tagged and passed above the trap
C = (218) the number of fish observed (live counts + carcass recoveries) for tags
R = (144) the number of fish with yellow tags
p^2 = the probability that a fish lost both yellow tags before being observed

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

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

where:

n_1 = (9) the number of fish observed with one yellow tag
n_2 = (135) the number of fish observed with two tags

Using this methodology, the estimated number of steelhead spawners (N) was 242 (95% CI = 230 – 254), and calculated percent trap efficiency was 66.1%. Based on the sex ratio of fish in the West Fork Smith River adult trap, 117 females spawned above the trap.

This estimate includes a further adjustment to account for repeat spawners that were tagged prior to the current run-year but that bypassed the trap, becoming part of the marked population observed for tags (M) but not part of the number tagged at the trap in 2004-05. Tagged repeat spawners comprised 1.8% of fish that entered the trap. The number tagged (M) was adjusted by assuming that 1.8% of fish that bypassed the trap (an estimated 34% of total spawners) were previously tagged. This adjustment increased "M", the tagged population, by two fish to a total of 161 fish.

The 2004-05 estimate of 244 steelhead spawners is the lowest since monitoring began in the West Fork Smith River (Table 5 in Summary of Findings, below).

Juvenile Out-Migrant Trap Operation

The juvenile out-migrant trap was installed in the West Fork Smith River on February 2 and removed on June 15 when low stream-flows precluded further operation. The trap operated continuously until March 13, when it stopped turning due to low stream flows. The trap was motorized from March 14-20, using 12-volt batteries and a photo-switch to turn the motor off during day-light hours when smolt downstream movement was thought to be low. The motor was disconnected on March 21 when increased stream flows allowed the trap to turn on its own. A strong streamflow event at the end of March caused the trap to partially submerge and the trap was pulled to the bank for three days to avoid damage and possible fish mortality. Catch for the days not sampled was estimated by using the mean of catch for the two two-day periods prior to and following the days the trap was not operated.

Capture efficiency of 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 on the caudal fin, then releasing upstream of the trap. 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 number caught is reported.

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, and N_t = season total migrants. The sum of the weighted trap efficiencies was used in the confidence interval calculations.

Estimated numbers of out-migrants for each species and size class are shown in Table 3. Recoveries of fish tagged with passive integrated transponders (PIT-tags) are also shown. Juvenile coho salmon were tagged by US Environmental Protection Agency (US EPA) as part of an evaluation of watershed-scale variation in juvenile salmonid survival and growth (see Ebersole et. al., in review). Juvenile cutthroat trout and winter steelhead, and small numbers of juvenile coho salmon, were also PIT-tagged by US Forest Service (USFS) as part of an evaluation of road culverts as potential barriers to juvenile fish movement. These agencies monitored movement and growth of tagged fish upstream of the juvenile trap. Sampling at the juvenile trap provided the last opportunity to monitor movement and growth of tagged coho salmon smolts and juvenile steelhead and cutthroat trout before emigration from the West Fork Smith River, and it provided a supplemental opportunity to monitor cutthroat trout that did not emigrate. For coho salmon, these combined sampling efforts have provided a relatively comprehensive evaluation of within-basin movement, growth and survival (fry to smolt and summer parr to smolt) for the 2001-03 brood years. The 2004 brood year of coho salmon was PIT-tagged by US EPA in summer 2005, and sampling for tagged fish at the juvenile trap is planned for 2006.

Summary of Findings: 1998 to 2005

The 1998 brood year of coho salmon was the first brood for which the size of the parent stock and number of eggs deposited was estimated in the West Fork Smith River, and thus represents the first brood for which freshwater survival rate could be calculated. Adult coho salmon that returned to the West Fork Smith River in fall 1999 (1996 brood year) represent the first spawners for which the number of smolts that produced these adults was estimated, providing the first opportunity to calculate marine survival rate for this stock. For these and subsequent broods sampled in West Fork Smith River, calculated freshwater and marine survival rates are shown in Table 4.

Returns of winter steelhead spawners have been determined annually since the 1998-99 run year and are shown in Table 5. Data for winter steelhead is presented by run year because adults return at more than one age, and may return to spawn multiple times, thus returning adults can not be assigned to brood year without knowing the age of each fish. Some numbers in Table 5 differ from those reported previously because in this report the estimates have been adjusted to account for repeat spawners. A portion of fish that returned each year had tags implanted the previous years, 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 had only one tag, the number of repeat spawners that entered the trap 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 5). The highest percentage occurred in 2001, when an estimated 16.5% of females and 10.3% of males were repeat spawners.

Table 3. Estimated number of out-migrants in age or size categories, recoveries of PIT-tagged fish, calculated trap efficiencies, and handling mortalities measured at the juvenile migrant trap at river kilometer 1.6 on the West Fork Smith River for the period February 2 – June 15, 2005. Adult cutthroat trout (> 250mm) were not estimated using mark-recapture methodology; for this and other categories with insufficient mark recoveries, number in parentheses denotes actual catch.

Species	Age (salmon) or size (trout, FL, mm) class	Estimated total migrants	PIT-tags		Trap Efficiency	Handling mortalities[b]
			N Fish scanned	N tagged[a]		
Coho	smolts (age 1+)	39,576	14,726	830	0.39	66
	fry (age 0)	27,598			0.16	61
Chinook fry	age-0	25,871			0.23	77
Trout fry	< 60	(94)				1
Steelhead	> 120	4,333	466	13	0.12	4
	90 – 119	752	160	3	0.25	1
	< 60 - 89	73	20	0	0.43	0
Cutthroat	≥ 250	(9)	9	0		1
	160 – 249	898	126	8	0.12	2
	120 – 159	724	127	6	0.15	0
	90 - 119	(2)				
	60 - 89	0				

[a] recoveries of fish PIT-tagged by US EPA and USFS

[b] handling mortalities only; an additional 40 fish were sacrificed for US EPA for isotope analysis and parasite identification

Trends in numbers of downstream-migrating juvenile coho salmon, winter steelhead and fall Chinook salmon are shown in Figure 2, and the trend in mean length of coho salmon and steelhead smolts during the two-week period of peak migration is shown in Figure 3.

Table 4. Estimated number of female spawners, egg deposition, fry and smolt production, number of wild returning adults, and freshwater (FW) and marine survival rates for coho salmon in the West Fork Smith River. Brood year represents the first year that eggs were deposited for a return year (eg. the 1996 brood year was derived from the 1996-1997 return year, and this brood returned as adults in 1999-2000). Percent freshwater survival represents the number of smolts produced from the estimated number of eggs deposited. Percent marine survival was calculated using number of smolts produced minus handling mortalities.

Brood	Female spawners		Egg			Returning adults (wild)		Percent survival	
year	Wild	Hatchery	deposition [a]	Fry	Smolts	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					

[a] the number of eggs deposited by each female was estimated using the formula: $\sum 7.96$ * (fork length of female in mm) – 2854. This formula is based on the relationship between length of female coho salmon and fecundity developed from hatchery fish returning to Fall Creek hatchery in the Alsea basin (Johnson 1988).

Table 5. Estimated number of winter steelhead spawners, percent repeat spawners (combined male and female), and calculated trap efficiency in the West Fork Smith River.

	Wild		Hatchery		Repeat	Trap
Return Year	Female	Male	Female	Male	Spawners (%)	efficiency (%)
1999-00	178	172	10	7	na	89.3
2000-01	271	176	1	1	0.7	91.2
2001-02	156	138	1	2	12.3	28.2
2002-03	459	348	2	2	4.8	33.0
2003-04	141	226	0	0	2.0	38.8
2004-05	117	119	2	4	1.8	66.4

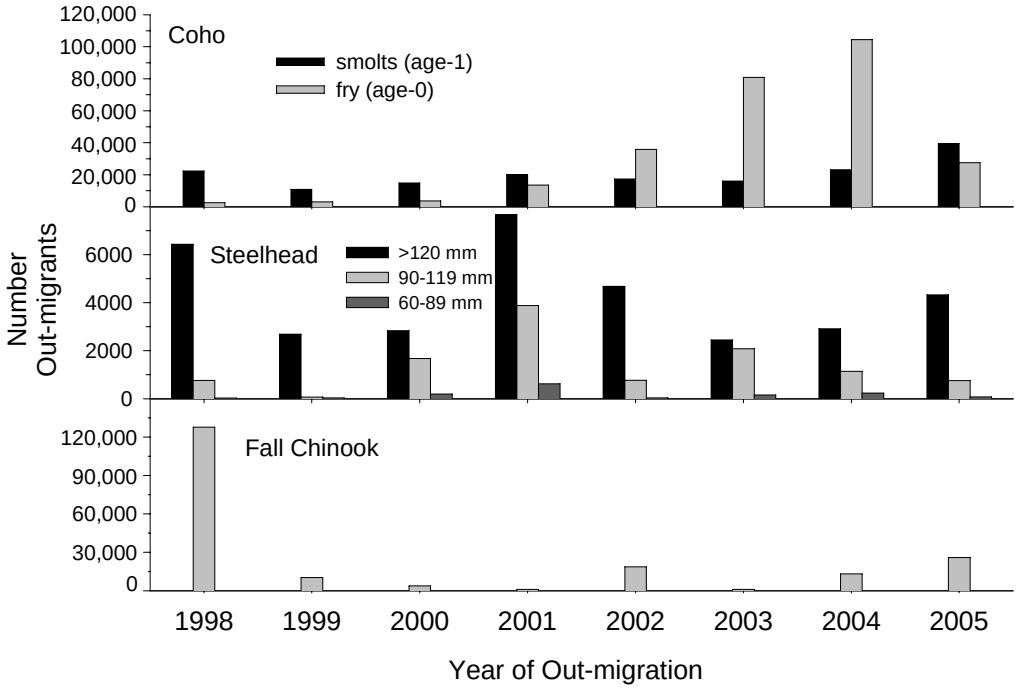

Figure 2. Number of downstream-migrating juvenile coho salmon, winter steelhead, and Chinook salmon measured at river kilometer 1.6 in the West Fork Smith River, Oregon, for the period 1998 through 2005.

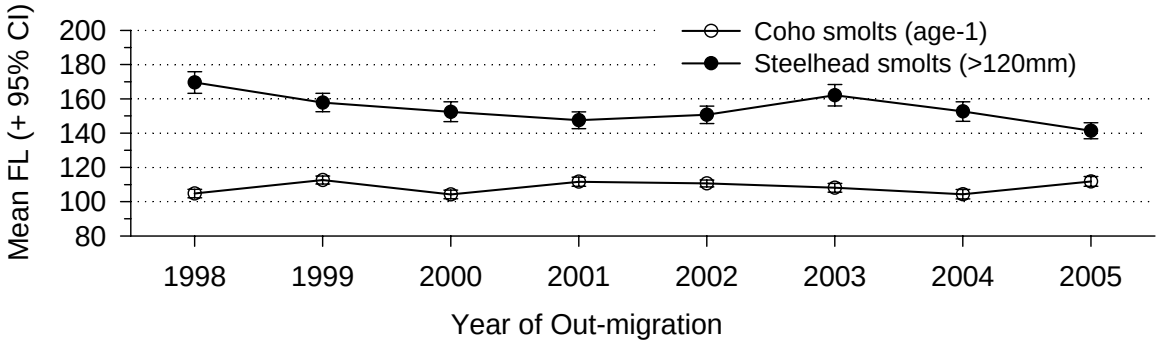

Figure 3. Mean fork length (mm ± 95% CI) of coho salmon and winter steelhead smolts during the two-week period of peak out-migration in the West Fork Smith River for the period 1998 to 2005.

Acknowledgements

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