West Fork Smith River
Salmonid Life Cycle Monitoring Project

Annual Report: 2009-2010

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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.

This report summarizes monitoring activities within the West Fork Smith River basin, including population estimation for the 2009-10 run-year of returning adult fish and year 2010 out-migration of juvenile fish. A full description of sampling methods is provided in Solazzi et al. (2000) and Suring et al. (2009). These and other Life Cycle Monitoring Project reports are available on the ODFW Corvallis Research Lab website, http://nrimp.dfw.state.or.us/crl/

Adult Fish Trap Operation

The floating weir used as a passage barrier at the West Fork Smith River adult fish trap was dismantled and re-built during summer 2009. All PVC pickets were replaced and many aluminum and plastic parts were fabricated to replace damaged components. The bolts that fasten the head dam to the river bottom were found to be heavily corroded and most were replaced. One improvement to trap operation was fabrication of a moveable blocking weir that fits at the upstream end of the trap box and functions to prevent passed fish from impinging on the horizontal V-weir while they recover from handling stress.

The floating weir was installed September 16 and the first fish (both coho and chinook salmon) were trapped on October 26. Most coho salmon were trapped in November corresponding with higher streamflows (Figure 1). Following a period of lower flows in early December, another group of coho salmon were trapped during the third week of December. Run timing of winter steelhead extended from late December through April. Steelhead were trapped in several pulses that also generally corresponded with higher streamflows (Figure 1). Number of fish trapped is summarized in Table 1.

The floating weir was removed from the river and the adult trap decommissioned on May 5.

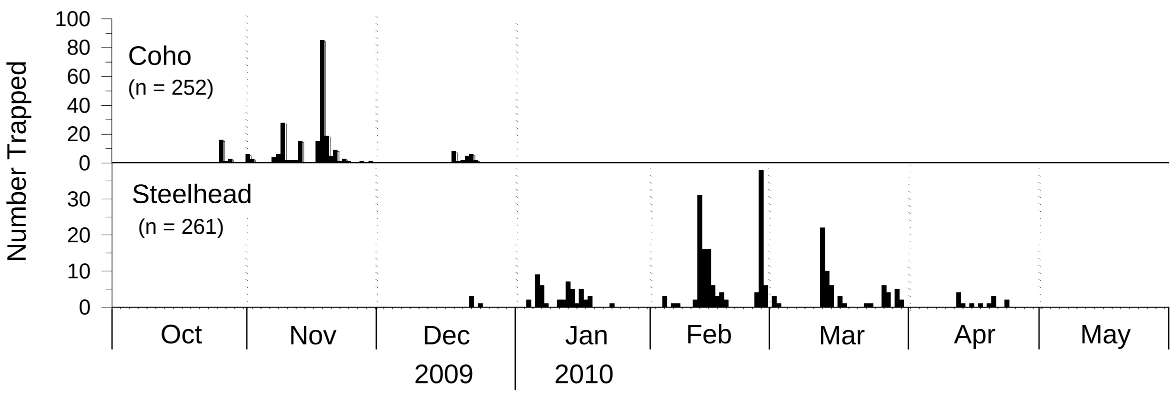

Figure 1. Timing of coho salmon and winter steelhead trapped in the West Fork Smith River during the 2009-10 run-year.

Table 1. Number of days the West Fork Smith River adult fish trap weir functioned as a passage barrier, and number of fish trapped during the 2009-10 run-year. Most mortalities were fish that stranded on the floating weir after being passed above the trap or after they bypassed the trap during high streamflows. Two of the female Chinook salmon trapped were provided to the Gardner STEP Program for use as broodstock.

			Wild			Hatchery			
Species	Month	Trap days	Female	Male	Jack	Female	Male	Jack	Mortalities
Coho	Oct	31	6	13	1				
	Nov	25	101	107					2
	Dec	27	17	7					
Chinook	Oct	31	1	9	2			1	3
	Nov	25	3	27	4			1	13
	Dec	27	1	2					
Steelhead	Dec	27	1	3					
	Jan	24	26	20					
	Feb	28	71	62	1				
	Mar	26	43	22					
	Apr	27	6	7					

Spawning Ground Surveys

Surveys that provided data for estimation of spawner populations of coho salmon and winter steelhead were conducted at approximately seven day intervals from October 28, 2009 to April 27, 2010. These included nine reaches on the five principal tributaries and nine mainstem reaches. In addition, we were able to make frequent observations of post-spawned steelhead that tended to gather in the pool above the head dam at the adult trap. Spawning activity for Pacific lamprey and cutthroat trout was also recorded for all surveys conducted.

Coho salmon spawning activity was widespread throughout all major tributaries (Table 2 and Figure 2). Redds were also observed in mainstem survey reaches but were not differentiated between coho and Chinook salmon spawners. Winter steelhead redds were observed in all tributaries except Coon Creek, but the majority of spawning within survey reaches was found in the mainstem (72.7% of redds observed; Table 3 and Figure 2).

We made a total of 19 observations of fall Chinook salmon spawners; all were seen in the mainstem. Table 3 also summarizes redd counts of cutthroat trout and Pacific lamprey. Few cutthroat or lamprey redds were seen, but this is likely due to the cessation of survey efforts before most spawning occurs.

Table 2. Peak live counts and redd counts for coho salmon, and total coho spawners in survey reaches based on area-under-curve (AUC) calculations from live counts in the West Fork Smith River during the period November 2009 to January 2010.

	Survey	Section	Length (km)	Peak Live	Peak Redds	Total AUC
Tributaries						
	Coon Cr.		1.11	22	26	53
	Crane Cr.	1	1.15	20	20	34
	Crane Cr.	2	1.54	14	23	35
	Moore Cr.	1	1.33	26	24	68
	Moore Cr.	2	1.99	25	18	76
	Beaver Cr.	1	2.11	28	40	66
	Beaver Cr.	2	1.17	87	81	192
	Gold Cr.	1	1.16	16	17	50
	Gold Cr.	2	1.86	44	24	119
Mainstem						
	Trib. B to Crane Cr.		1.71	27	16	63
	Moore Cr to Trib. D		2.55	21	10	46
	Trib. D to Trib. E		0.64	7	5	11
	Road X-ing to Trib. F		0.51	11	13	25
	Trib. F to Beaver Cr.		1.56	38	12	113
	Beaver to Gold Cr.		0.84	52	18	85
	Gold Cr to left trib.		1.78	72	25	190
	Headwaters	3	1.12	42	20	86
	Headwaters	4	1.36	43	19	99
Total			26.0			1,411

Estimated Spawner Populations

Estimates of spawners are made using an adjusted Peterson mark-recapture methodology, based on the number of fish tagged and passed at the adult trap, and number of tagged and untagged fish observed (live fish and spawned-out carcasses) on surveys (see Solazzi et al. 2000 and Suring et al. 2009 for methodology).

We made a total of 1,882 observations of live and dead coho salmon and 125 observations of winter steelhead. Tagged fish represented 11.1% of coho salmon and 69.6% of steelhead. Using these data, we estimate a returning spawning population of 2,225 coho salmon and 375 winter steelhead. Confidence intervals for these estimates are shown in Table 4.

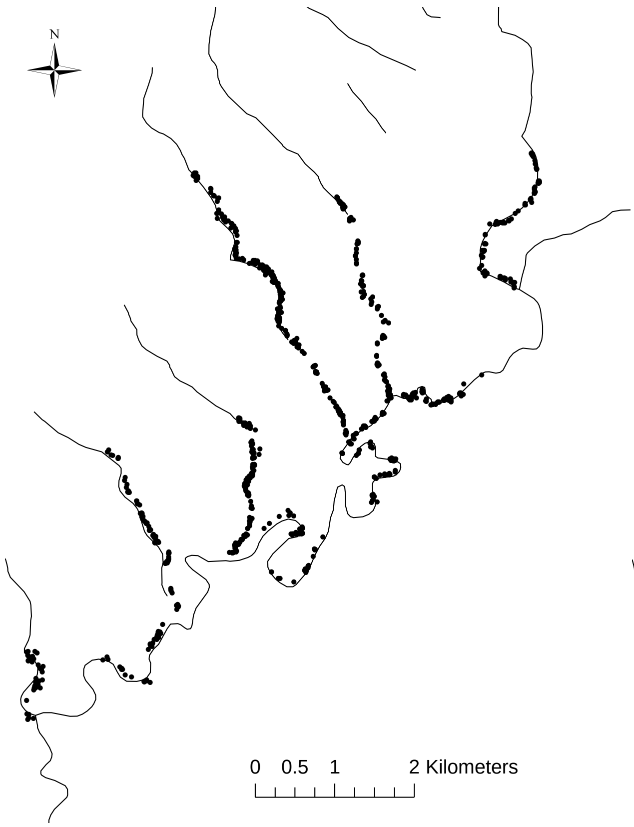

Figure 2. Redd distribution for coho and Chinook salmon (left) and winter steelhead (right) within survey reaches in West Fork Smith River during the 2009-2010 run-year. Tributary names (from south to north, Coon, Crane, Moore, Beaver, and Gold creeks) are omitted for clarity. Not all reaches of the mainstem or uppermost reaches of tributaries were surveyed.

Juvenile Out-Migrant Trap Operation

The juvenile out-migrant trap on the West Fork Smith River was installed on February 3 and operated until June 10. The trap functioned continuously except for 11 days when it was inoperable due to high stream flows or trap malfunction. High streamflows prevented trap operation for three days during the first week of June when we normally have difficulty operating the trap due to low flows.

Estimated numbers of out-migrants for each species and size class are shown in Table 5.

Table 3. Total redd counts for winter steelhead, cutthroat trout and Pacific lamprey on survey reaches in the West Fork Smith River for the period December 2009 to April 2010.

	Survey	Section	Length (km)	Steelhead	Cutthroat	Pacific Lamprey
Tributaries						
	Coon Cr.		1.11	0	0	0
	Crane Cr.	1	1.15	3	0	0
	Crane Cr.	2	1.54	3	0	2
	Moore Cr.	1	1.33	5	0	0
	Moore Cr.	2	1.99	9	0	0
	Beaver Cr.	1	2.11	5	0	0
	Gold Cr.	1	1.16	13	0	0
	Gold Cr.	2	1.86	7	0	0
Mainstem						
	Trib. B to Crane Cr.		1.71	16	0	0
	Moore Cr to Trib. D		2.55	17	1	0
	Trib D to Trib. E		0.64	5	0	0
	Road X-ing to Trib F		0.51	20	0	0
	Trib. F to Beaver Cr.		1.56	19	0	0
	Beaver to Gold Cr.		0.84	15	1	0
	Gold Cr to left trib.		1.78	10	2	0
	Headwaters	3	1.12	12	1	0
	Headwaters	4	1.36	6	0	0
Total				165	5	2

Table 4. Total spawner population estimates and confidence intervals (CI) for coho salmon and winter steelhead in the West Fork Smith River for run-years 1998-99 through 2009-10. The adult coho spawner population in 1998-99 and 2007-08 was based on area-under-curve estimation from spawner survey data; confidence intervals were not calculated. Calculated trap efficiency was based on the percentage of total estimated spawners that were trapped. Repeat steelhead spawners were determined from the percentage of fish that entered the adult trap with tags implanted in previous run years.

Return Year	Coho (95% CI)		Trap Effic. (%)	Steelhead (95% CI)		Trap Effic. (%)	Repeat Spawners (%)
98-99	155	na	na	366	(± 128)	na	na
99-00	293	(238-372)	32.0	453	(± 21)	89.3	0.7
00-01	549	(465-657)	18.3	334	(± 17)	91.2	12.6
01-02	1,471	(1,216-1,794)	7.5	834	(± 216)	28.2	4.9
02-03	3,451	(3,122-3,927)	7.9	375	(± 114)	33.0	2.6
03-04	3,728	(3,220-4,441)	4.5	536	(± 111)	38.8	2.0
04-05	978	(787-1,233)	6.3	247	(± 36)	66.4	1.9
05-06	1,818	(1,458-2,392)	2.8	425	(± 158)	28.8	5.8
06-07	1,154	(831-1,658)	3.5	385	(± 103)	35.4	0.8
07-08	335	na	na	308	(±122)	31.3	3.4
08-09	1,260	(1,000-1,653)	3.1	427	(±179)	24.3	2.1
09-10	2,225	(1,990-2,483)	11.1	375	(±41)	69.6	2.3

Table 5. Estimated out-migrants, calculated trap efficiencies and handling mortalities measured at the juvenile migrant trap on the West Fork Smith River from January 31 to June 12, 2010. Adult cutthroat trout (> 250mm) were not estimated using mark-recapture methodology; for this and other categories with insufficient mark recoveries, the number in parentheses denotes actual catch.

Species	Age (salmon) or size-class (FL, mm)	Estimated total migrants	Trap efficiency	Handling mortalities
Coho	smolts (age 1+)	41,142	0.27	46
	fry (age 0)	30,516	0.04	16
Chinook fry	age-0	1,195	0.26	7
Trout fry	< 60	(17)		10
Steelhead	> 120	5,652	0.04	1
	90 – 119	1,427	0.18	1
	< 60 – 89	279	0.21	0
Cutthroat	≥ 250	(12)		0
	160 – 249	3,930	0.04	1
	120 – 159	2,787	0.06	0
	90 – 119	(21)		0
	60 – 89	0		

West Fork Smith River Monitoring Summary: 1998-2010

Coho Salmon

Trap catch of coho and Chinook salmon, and estimated spawning populations of coho salmon are summarized in Table 6. Calculated freshwater and marine survival rates are summarized in Table 7, and trends in these parameters are shown in Figure 3.

Table 8 summarizes data collected on juvenile coho salmon sampled at the fish trap. Figure 4 displays juvenile production in the basin, specifically the relationship of the number of fry and smolt migrants to size of spawner stock, and the relationship of fry and smolt migrants produced per female to total female spawners. The latter relationship (Figure 4b) suggests smolt production is density dependent and that carrying capacity for the basin is approached in most years. This interpretation is supported by comparison of measured smolt production to the predicted smolt capacity of the basin based on the Habitat Factors Limiting Model (HFLM) (Nickelson et al. 1992; Anlauf et al. 2009). This model combines the inventory of winter habitat within fish distribution (type and quantity) with expected densities of fish by habitat type to develop a total basin capacity. The HFLM prediction for coho salmon smolts in West Fork Smith River (based on 2005 habitat surveys) is 39,040 fish. Measured smolt production has been within 5.4% of this predicted value in three of the past six smolt years (2005, 2009 and 2010). The upward trend in smolt production shown in Figure 3c (despite wide variation in spawner stock) suggests carrying capacity may be increasing.

Table 6. The number of female (F), male (M) and jack (J) coho and chinook salmon captured at the West Fork Smith River adult trap and the estimated spawning population above the trap during the return years 1998-1999 through 2009-2010. Numbers of wild female and male spawners were based on percent representation in spawned-out carcasses recovered on surveys and the adult trap weir. Coho salmon jacks are fish ≤510mm, and chinook salmon jacks are fish ≤600mm.

	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	na
99-00	38	58	1	0	0	0	130	163	na	0	0	na
00-01	46	56	23	0	0	0	271	279	na	0	0	na
01-02	49	57	6	8	11	0	707	729	189	15	20	na
02-03	100	173	12	3	0	0	1,520	1,924	114	4	3	na
03-04	56	110	2	0	0	0	1,787	1,940	101	0	0	na
04-05	30	32	0	0	0	0	417	561	na	0	0	na
05-06	17	34	0	0	0	0	723	1,095	na	0	0	na
06-07	17	16	0	2	1	0	464	688	na	2	1	na
07-08	7	6	0	0	0	0	137	198	na	0	0	na
08-09	16	23	5	0	0	0	501	759	na	0	0	na
09-10	124	127	1	0	1	0	1,094	1,131	na	0	0	na
Fall Chinook												
98-99	0	13	0	0	0	0						
99-00	3	13	0	0	0	0						
00-01	1	32	3	0	0	0						
01-02	5	34	2	0	1	0						
02-03	2	10	0	0	0	0						
03-04	2	20	2	0	0	0						
04-05	8	20	2	6	21	1						
05-06	2	9	4	1	4	0						
06-07	0	1	0	0	0	0						
07-08	2	7	0	0	0	0						
08-09	2	18	2	0	0	0						
09-10	8	47	7	0	0	2						

Table 7. Estimated number of female spawners, egg deposition, fry and smolt production, number of wild returning adults, and freshwater and marine survival rates (females) for coho salmon in the WF Smith River.

Brood	Female Spawners					Returning Adults		Percent Survival	
Year	Wild	Hatchery	Egg Deposition[a]	Fry	Smolts	Female	Male	FW	Marine
1996					22,412	131	164		1.2
1997				2,527	10,866	273	280		5.0
1998	72	0	205,405	3,014	14,851	707	734	7.1	9.6
1999	130	0	376,545	3,605	20,091	1,521	1,926	5.3	15.3
2000	271	0	721,450	13,550	17,358	1,790	1,940	2.4	20.9
2001	704	15	2,044,536	35,851	15,849	417	561	0.8	5.3
2002	1,520	4	4,853,940	80,876	23,054	723	1,095	0.5	6.3
2003	1,787	0	5,130,275	104,402	39,576	464	688	0.8	2.4
2004	417	0	1,184,220	27,598	23,242	137	198	2.0	1.2
2005	723	0	2,222,612	36,621	22,504	501	759	1.0	4.5
2006	464	0	1,376,200	30,471	31,017	1,096	1,134	2.3	7.1
2007	137	0	352,316	1,448	38,605			10.9	
2008	501	0	1,511,052	3,169	41,142			2.7	
2009	1,094	0	2,706,553	30,516					

[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).

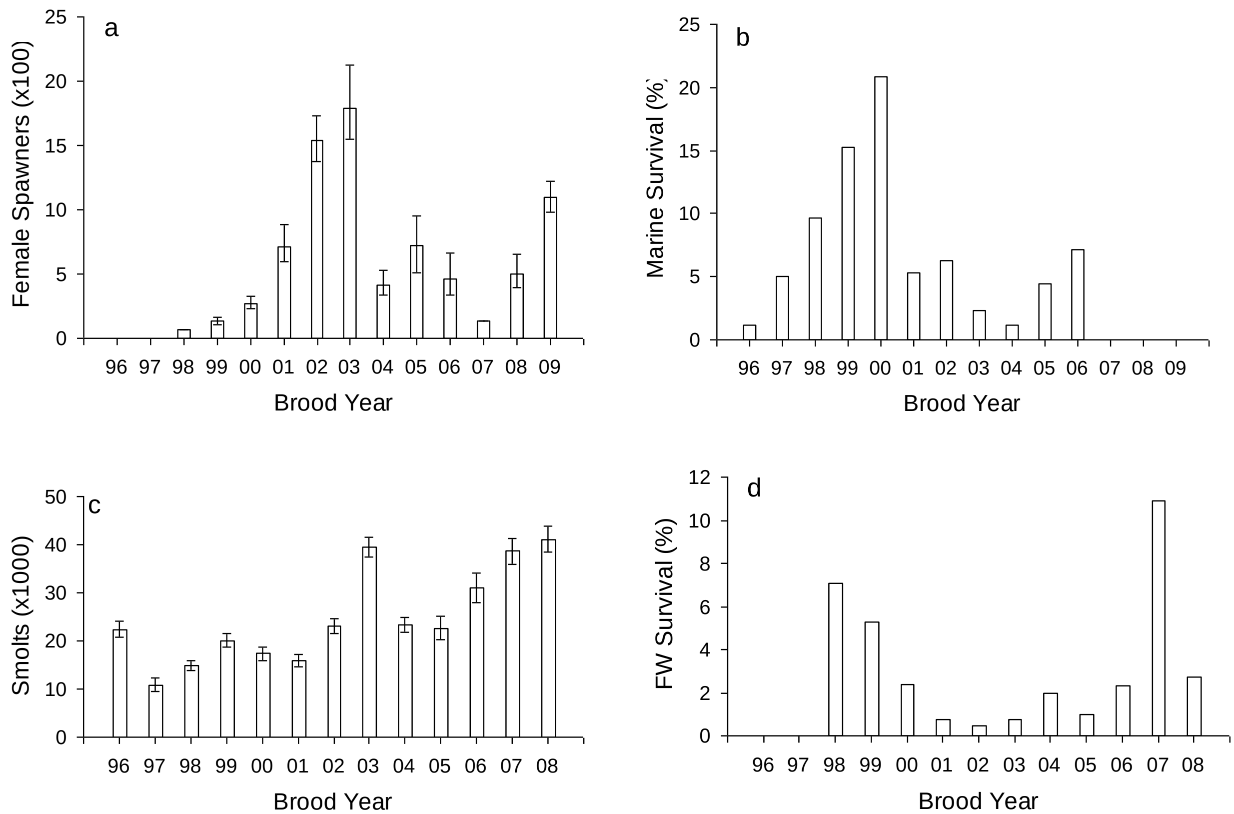

Figure 3. Trends in (a) estimated number of female spawners, (b) percent marine survival, (c) smolts, and (d) percent freshwater survival for coho salmon in the West Fork Smith River. Error bars show the 95% confidence interval. Marine survival estimates are for the total wild adults returning to spawn from smolts produced from the corresponding brood year. Calendar year of smolt out-migration is brood year +2 years. Calendar year of adult return for marine survival estimate is brood year + 3 years. Freshwater survival (egg to smolt) is based on the estimated number of eggs deposited from the parent spawner population. The 1998 and 2007 brood years were estimated using area-under-curve calculations; confidence intervals were not calculated.

Table 8. Estimated number of coho salmon smolt and fry migrants, week of peak migration for smolts, and mean fork length of smolts during week of peak migration in the West Fork Smith River. Data for smolts represents fish sampled in the second year following egg deposition (eg. 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) are shown.

Sample Year	Smolts ± CI			Fry ± CI			Peak Week	Mean FL (mm) ± CI		
1998	22,412	±	1,582	2,527	±	1,224	4/20-4/26	105	±	4.2
1999	10,866	±	1,420	3,014	±	641	5/17-5/23	113	±	3.5
2000	14,851	±	1,063	3,605	±	755	4/10-4/16	103	±	4.4
2001	20,091	±	1,325	13,550	±	3,626	4/23-4/29	112	±	4.3
2002	17,358	±	1,418	35,851	±	5,526	5/06-5/12	113	±	2.8
2003	15,849	±	1,166	80,876	±	9,319	5/05-5/11	109	±	4.1
2004	23,054	±	1,516	104,402	±	7,974	4/12-4/18	105	±	3.8
2005	39,576	±	2,038	27,598	±	3,515	5/02-5/08	110	±	4.8
2006	23,242	±	1,550	36,621	±	5,551	5/01-5/07	107	±	4.2
2007	22,504	±	2,375	30,471	±	13,585	4/23-4/29	112	±	3.0
2008	31,017	±	2,996	1,448	±	728	4/14-4/20	110	±	4.8
2009	38,605	±	2,664	3,169	±	2,149	4/27-5/3	106	±	1.9
2010	41,142	±	2,682	30,516	±	19,402	5/10-5/16	105	±	2.5

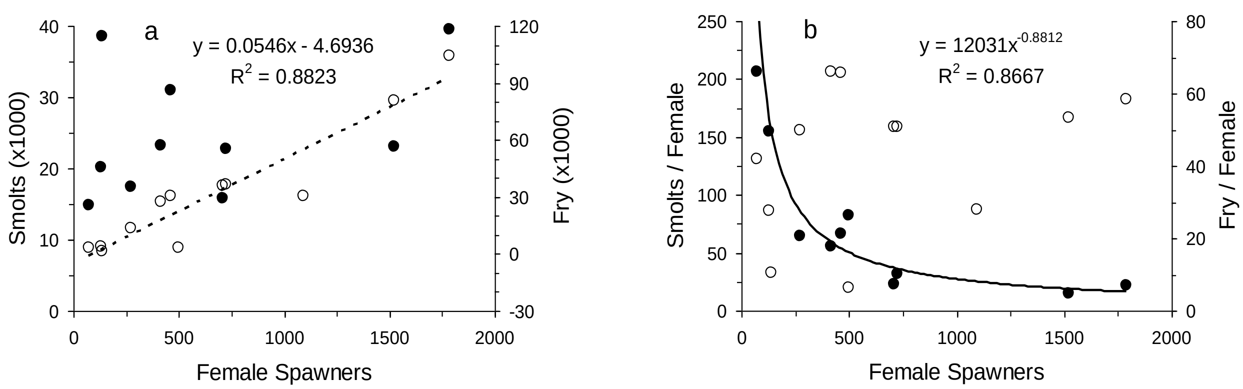

Figure 4. Relationship of number of fry and smolt migrants to size of spawner stock; (a) total smolt (solid symbol) and fry (clear symbol and dotted regression line; formula shown) migrants produced, to total female spawners; and (b) numbers of smolt (solid symbol and regression line, formula shown) and fry (clear symbol) migrants produced per female, to total female spawners.

Winter Steelhead

Trap catch and estimated spawning populations of winter steelhead are shown in Table 9. Estimated numbers of juvenile steelhead migrants are summarized by size class in Table 10.

Table 9. The number of female (F), male (M) and jack (J) winter steelhead captured at the West Fork Smith River adult trap and the estimated spawning population above the trap during the return years 1998-99 through 2009-10. Steelhead jacks are fish ≤510mm.

	Trap Catch						Estimated Spawning Population					
	Wild			Hatchery			Wild			Hatchery		
Return Year	F	M	J	F	M	J	F	M	J	F	M	J
98-99	54	48	4	3	2	0	179	173	na	10	7	na
99-00	244	158	0	1	1	0	275	177	na	1	1	na
00-01	141	118	7	1	2	0	175	155	na	1	2	na
01-02	116	86	2	0	1	0	472	362	na	2	2	na
02-03	45	72	0	0	0	0	145	233	na	0	0	na
03-04	104	92	1	0	1	0	281	252	na	2	1	na
04-05	78	79	2	1	3	0	122	121	na	2	5	na
05-06	56	43	0	4	1	0	229	176	na	16	4	na
06-07	58	74	2	0	1	0	164	210	na	0	3	na
07-08	31	57	2	0	0	0	108	200	na	0	0	na
08-09	50	45	0	0	1	0	223	200	na	2	2	na
09-10	147	114	1	0	0	0	211	164	na	0	0	na

Table 10. Estimated number of juvenile winter steelhead smolts (≥ 120mm fork length), week of peak smolt migration, mean fork length at peak week, and number of parr migrants (90-119mm and 60-89mm) in the West Fork Smith River. Number of fish caught is reported in parentheses when trap efficiency could not be determined for a particular category. Ninety five percent confidence intervals are shown.

Sample Year	Smolts ± CI			Peak week	Mean FL (mm) ± CI			Parr 90-119mm ± CI			Parr 60-89mm ± CI		
1998	6,438	±	1,286	4/20-4/26	169	±	8	761	±	225	27	±	26
1999	2,688	±	846	5/03-5/09	161	±	7	66	±	86	(10)		
2000	2,836	±	593	5/01-5/07	153	±	4	1,675	±	49	1,675	±	1,030
2001	7,678	±	1,338	3/26-4/01	148	±	7	3,883	±	507	620	±	131
2002	4,681	±	3,558	4/08-4/14	149	±	8	769	±	513	(10)		
2003	2,448	±	4,306	4/21-4/27	158	±	10	227			159	±	111
2004	2,916	±	1,847	4/12-4/18	154	±	8	1,138	±	410	236	±	158
2005	4,333	±	1,382	3/21-3/27	145	±	7	752	±	227	73	±	68
2006	3,840	±	1,504	4/10-4/16	160	±	8	582	±	213	96	±	163
2007	6,324	±	5,258	4/09-4/15	160	±	8	861	±	316	(28)		
2008	3,876	±	2,680	4/28-5/4	154	±	8	1,789	±	696	319	±	201
2009	4,433	±	3,800	4/27-5/3	162	±	9	1,475	±	374	278	±	104
2010	5,652	±	7,706	4/12-4/18	153	±	7	1,247		448	279	±	218

Winter Steelhead Scale Analysis

The out-migrating populations of juvenile winter steelhead display a broad range in fork length (Table 10). Juveniles >120mm FL are termed “smolts” based primarily on two attributes, 1) most fish above this threshold display a high degree of silvering characteristic of fish making the physiological transition to salt water, and 2) scale analysis shows that fish >120mm are predominantly age-2, whereas fish below this threshold are predominantly age-1. Although not considered smolts, many of the larger parr migrants, particularly 110-120mm FL, do display silvering. The proportion of 90-119mm parr migrants is also substantial in some years, ranging from 2.4 to 33.6 % of fish >90mm (mean = 19.1%; Table 10 and Figure 5). A relevant question is whether some parr migrants from West Fork Smith River move directly to the ocean and should be accounted for in estimation of smolt to adult survival. We addressed this question by analyzing scales from returning adult spawners for evidence of smolt size at ocean entry <120mm.

From 2008 to 2010, scales were collected from out-migrants ranging in size from 90 to >200mm FL. Scale radius was measured on scales projected by Microfiche and calibrated with a stage micrometer. Radius was measured along the primary axis and along two axes $\pm 15^0$ to account for variation in scale shape. The mean of the three measurements was used to develop a relationship of radius to fork length (Figure 6).

In 2009 and 2010, we collected scales from all steelhead spawners sampled at the adult fish trap or found on spawning surveys. On the adult scales, we assumed that the distinct transition in circuli spacing from that typical of riverine growth to wide spacing typical of ocean growth marked the point of ocean entry. The radius of the scale to the point of ocean entry was measured in the same manner as for juvenile scales. The regression formula developed for radius to fork length of juvenile fish was then used to back-calculate smolt size at ocean entrance for the adult fish.

Figure 7 shows the size distribution of smolts sampled at the juvenile trap and the calculated size at ocean entry for adult spawners. The mode displayed from the adult scales is strongly skewed to the right of the mode for measured juveniles, and in no case was the calculated size at ocean entrance <130mm. This suggests that parr migrants either do not move directly to the ocean in the same year as emigration from West Fork Smith River, or survival of smolts <120mm FL is very low.

Two factors may explain the misalignment of modes displayed in Figure 7, specifically, size-biased marine survival and sampling bias. The positive correlation of smolt size to smolt-to-adult survival has been well documented for a variety of anadromous fishes, including steelhead (Ward and Slaney 1988), thus we would expect a higher proportion of returning adults from larger smolts. Ward et al. (1989) also found a positive size-biased survival relationship for steelhead in the Keogh River, British Columbia, with the mode of smolt lengths back-calculated from adult scales being larger (9 to 25 mm) than the mode of measured smolts lengths for the smolt years that produced the adults. Traps in the Keogh River were highly efficient for juvenile steelhead, thus length distributions of sampled smolts were close to the population distribution. The size-biased survival observed was likely due to higher survival of larger smolts and not sampling bias

In West Fork Smith River, sampling bias may be a major factor accounting for the wide separation of length modes shown in Figure 7. Most of the returning adults were estimated to be from smolts >180mm, while relatively few smolts above that size are captured in the trap. Trap efficiency is low for steelhead smolts, ranging from 4 to 19 % (mean = 10%) and it appears the largest smolts are under-represented in trap catch. If true, mean size of smolts measured at the trap does not reflect the population mean.

Although the fate of parr migrants from West Fork Smith River remains unresolved, it is possible that parr may rear in the mainstem of Smith River for some period until stressed by elevated water temperatures, at which point they seek a tributary to continue rearing until the following spring. With this strategy, it is not clear that parr would ascend their natal stream. If not, then parr from West Fork Smith River may contribute to the smolt population from a non-natal tributary. If this strategy is common for the basin, it is possible that fish from other parts of Smith Basin may use the West Fork to overwinter and contribute to the local smolt population

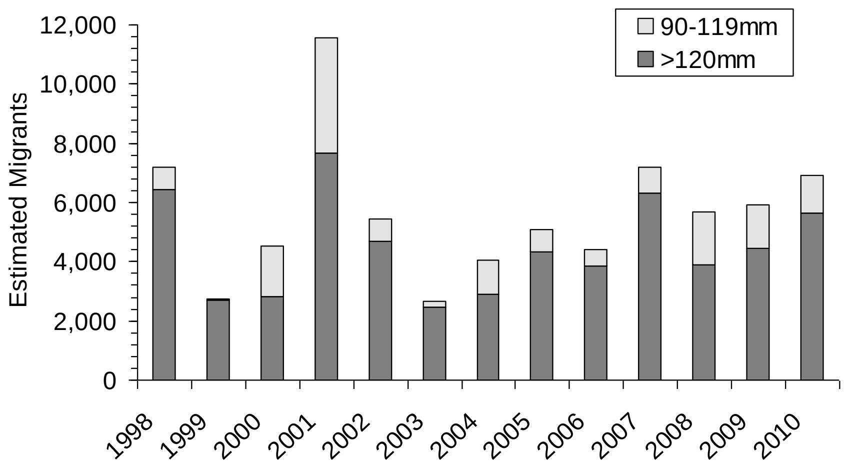

Figure 5. Estimated number of smolt (>120mm FL) and parr (90-119mm FL) out-migrants in West Fork Smith River.

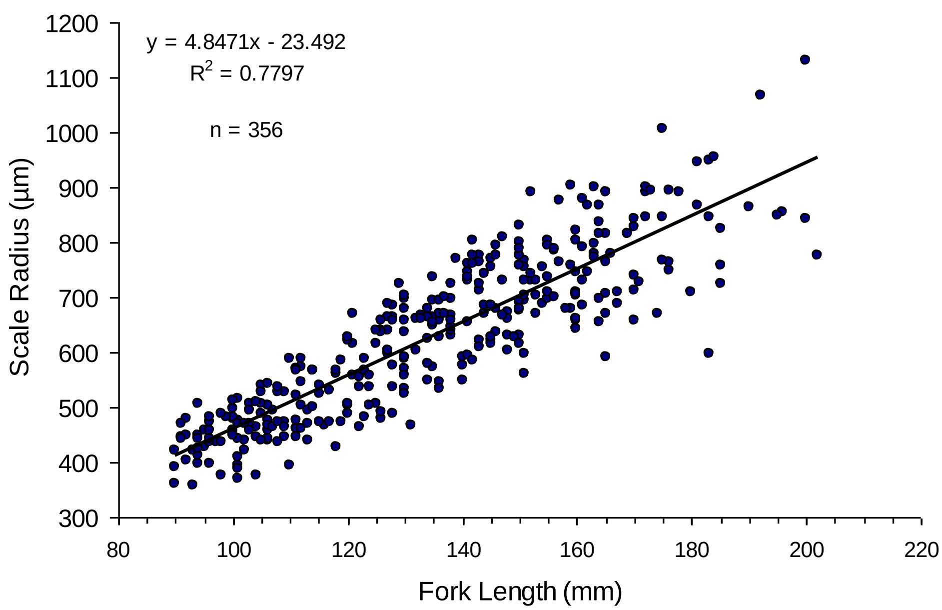

Figure 6. Linear regression of scale radius and fork length of juvenile winter steelhead sampled at the West Fork Smith juvenile fish trap. Data for 2008 (n=50), 2009 (n=196) and 2010 (n=110) combined.

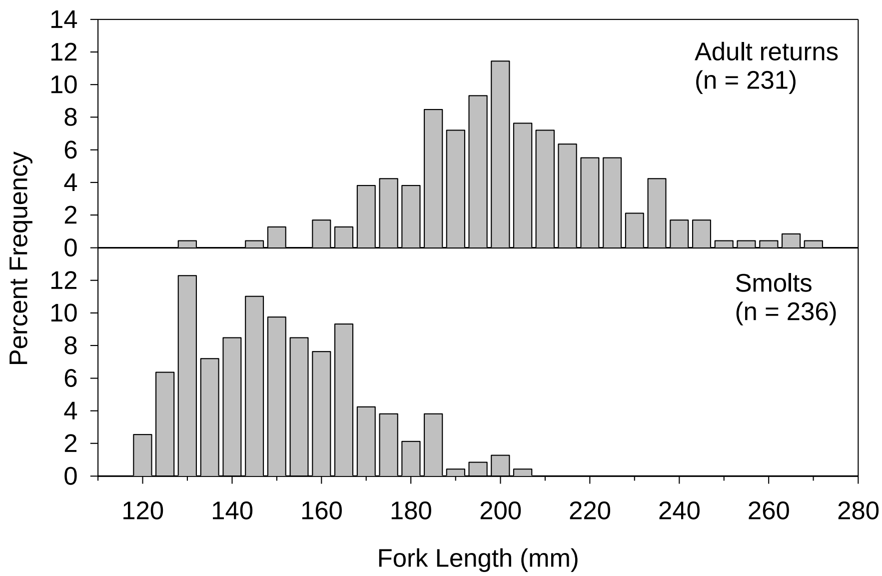

Figure 7. Calculated smolt size at ocean entrance for winter steelhead spawners (combined 2008-09 and 2009-10 return years) and size distribution of smolts (> 120mm FL, combined 2008, 2009, 2010 out-migration years) in West Fork Smith River. Size at ocean entrance for adults was calculated using the formula $x = y*4.85^{-1} + 4.85$, where x = fork length and y = radius of scale at point of ocean entrance.

Steelhead life history provides challenges for determining smolt to adult (marine) survival. Juveniles may spend from one to three years in the river before ocean entry, adults may have from one to five years of ocean rearing, and post-spawn adults may survive to spawn repeatedly over several years. Parameters for estimation of marine survival for maiden adults include numbers of smolts for a particular brood year, numbers of returning adults that can be assigned to the same brood year, and the proportion of returning adults that are repeat spawners. Our approach to calculating marine survival is to use scale analysis in conjunction with annual counts of smolt out-migrants and adult returns.

We determined age of smolts sampled in 2008, 2009 and 2010 and used these data to apportion the total smolt populations into respective brood years. For prior years when scales were not collected, we used the mean values of the proportion of age-1, age-2 and age-3 smolts from the 2008-2010 data (Table 11). Adult fish scales were analyzed to discern smolt age, number of years in the ocean, and number of times a fish had previously spawned. These data were used to apportion the total sampled population of returning adults into respective brood years. For years when adult scales were not collected, we used the mean values for the proportion of fish of different combinations of smolt age and ocean age (Table 11). We exclude repeat spawners because we are only estimating number of adults that survived, not total incidences of spawning. Repeat spawners were excluded by deducting the proportion of repeat spawners within each ocean age group (7.4% of ocean age-2, 58.6% of ocean age-3, 100% of ocean age-4+, representing mean values for 2009 and 2010 returns).

The combination of smolt and adult numbers assigned to specific brood years allowed us to estimate marine survival (Figure 8). The predominant smolt age is age-2, averaging 76% of smolts. The predominant age at return is four (age-2 smolt plus two ocean years) and averages 70% of spawners. The pattern of marine survival shown in Figure 8 is thus dominated by survival of the age-2 smolt year class and adults that return following two years of ocean growth.

An alternative view of marine survival, followed by Ward and Slaney (1988), is to consider survival of all smolts in a particular out-migration year, irrespective of smolt age. Because all smolts each year face similar ocean conditions, this view provides a measure of how variable ocean conditions may be as a factor influencing early survival. Marine survival by out-migration year is shown in Figure 9. The pattern is similar to the pattern displayed by brood year because survival of the same age-group (age-2 smolts plus two ocean years) accounts for most of the smolt to adult survival.

Continued scale analysis of both juvenile and adult populations should provide increased accuracy of marine survival estimates because out-migration and return year-specific age values can be used to apportion fish into brood years.

Table 11. Age composition of juvenile and adult winter steelhead in West Fork Smith River.

Juvenile Scales					Adult Scales					
							Percent			
OMY	n	Smolt age	Percent		Smolt age	Ocean years	2009	2010	Mean	St. Dev.
2008	50	1	18.0		1	1				
		2	80.0			2	3.5	4.1	3.8	0.37
		3	2.0			3	0.0	1.2	0.6	0.86
						4	0.0	0.8	0.4	0.57
2009	145	1	13.8			5			0.0	
		2	82.1							
		3	4.1		2	1	1.2	0.4	0.8	0.55
						2	75.3	64.4	69.8	7.72
2010	110	1	28.2			3	11.8	20.7	16.2	6.29
		2	65.5			4	3.5	1.2	2.4	1.64
		3	6.4			5	1.2	0.8	1.0	0.26
			mean	st. dev.	3	1			0.0	
		1	20.0	7.4		2	2.4	2.8	2.6	0.34
		2	75.8	9.1		3	2.4	3.2	2.8	0.63
		3	4.2	2.2		4	0.0	0.4	0.2	0.28
						5			0.0	
						n =	85	247		

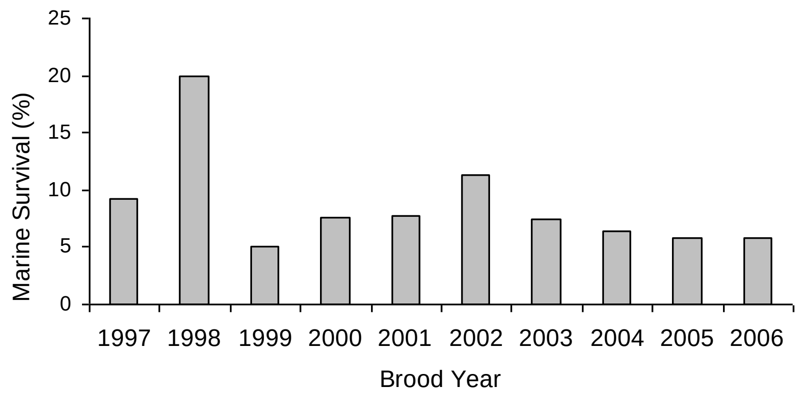

Figure 8. Calculated marine survival (smolt to adult) by brood year for winter steelhead in West Fork Smith River.

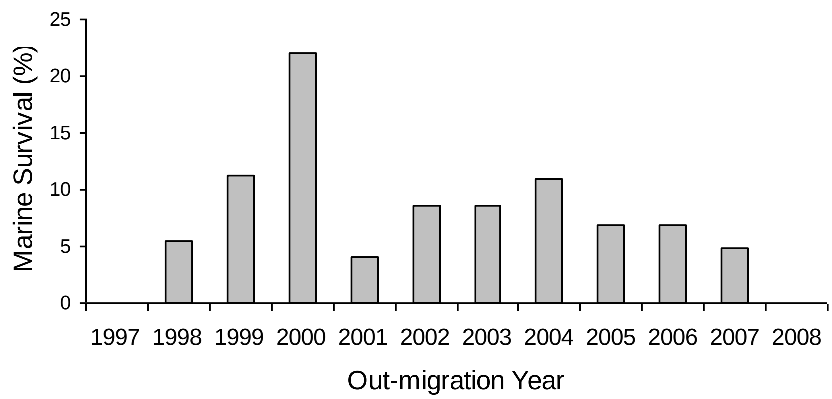

Figure 9. Calculated marine survival (smolt to adult) by smolt year for winter steelhead in West Fork Smith River.

Cutthroat Trout

Picket spacing in the floating weir and adult trap in the West Fork 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 are summarized by size class in Table 12. The predominant size classes are fish 120-159 mm and 160-249 mm fork length, although there is considerable variation between years in each size class.

Table 12. Estimated number of cutthroat trout downstream migrants by size class (± 95% CI) in the West Fork Smith River. Number of fish caught is reported in parentheses when trap efficiency could not be determined for a particular category. 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.

Sample year	Fork Length 160-249mm			120-159mm			90-119mm			60-89mm
1998	(192)			(4)			0			0
1999	--			--			--			--
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
2006	2,304	±	1,118	1,587	±	471	(8)			(1)
2007	(64)			945	±	1,615	(5)			(3)
2008	904	±	1,519	1,455	±	950	(14)			0
2009	1,845	±	1,140	1,636	±	566	587	±	890	0
2010	3,930	±	5,916	2,787	±	3,207	(21)			0

Other Species

Total number of select non-salmonid fishes trapped is shown in Table 13.

Speckled dace *Rhinichthys osculus* have a broad distribution in the Pacific Northwest and are the most abundant non-salmonid species within the fish assemblage found in West Fork Smith River. In 2002, 2003 and 2010 we used mark and recapture methodology to estimate the total out-migrant population of speckled dace. Measured trap efficiencies for speckled dace ranged from 0.30 to 0.45. The ratio of the trap efficiency values for speckled dace and coho salmon smolts ranged from 1.03 to 1.45. The mean of these ratio values (1.20) was used to calculate a proxy value for trap efficiency (for years when speckled dace were not marked) by multiplying respective trap efficiencies for coho smolts by 1.20. The proxy trap efficiencies were used to expand actual catch to estimate total migrants (Table 14).

Figure 10 shows migration timing for 2002, 2003 and 2010 when speckled dace were marked to estimate total migrants. As with salmonid fishes, the peak in migration timing varied between years.

Fork length of speckled dace was measured in 2004 and 2010 to characterize the migrating population. Length-frequency histograms (Figure 11) show that year-class strength can vary considerably. The mode centered between 35 and 50 mm represents sexually immature age-1 fish. Fish become sexually mature at age-2. Few speckled dace live beyond three years (Wydoski and Whitney, 2003). The two apparent modes at 60-70 mm and >75 mm seen in 2010 may represent age-2 and age-3+ fish, respectively (Figure 11). Most females sampled were gravid and females were more prevalent in the presumed age-3+ population. The peak spawning period for speckled dace is May or June and fish were likely moving downstream as part of a spawning migration. The spawning destination is not known but is likely mainstem reaches of Smith River. It is also not clear whether post-spawn fish return to their natal stream. If spawning does occur primarily in higher-order reaches of the basin, survival rate of age-0 fish and the number that ascend into tributaries (such as West Fork Smith River) to over-winter account for some of the numeric variation in the spring-migrating population (Table 14).

Table 13. Number of Pacifc and brook lamprey, speckled dace, Umpqua dace, redside shiner, largescale sucker and pikeminnow captured at the West Fork Smith River fish trap, river kilometer 1.6. Numbers represent actual catch; trap efficiency was not measured for these species. Eyed juvenile lamprey are Pacific lamprey that have completed metamorphosis to the life-history stage that is migrating seaward; eyed juveniles were not distinguished from ammoecoetes in 1998 and 1999. Western brook lamprey and eyed Pacific lamprey juveniles were not distinguished prior to 2003. Umpqua dace were not distinguished from speckled dace for the period 1998 through 2001.

	Pacific lamprey			Brook	Speck.	Umpq.	R.S.	L.S.	Pike-
Year	Adult	Amm.	Eyed	lamprey	dace	dace	shiner	sucker	minnow
1998	--	585[a]	--	22[b]	7,637[c]	--	913	100	2
1999	1	327[a]	--	--	2,975[c]	--	265	97	0
2000	--	648	--	42[b]	2,440[c]	--	322	85	0
2001	8	144	--	114[a]	5,194[c]	--	271	167	0
2002	4	300	--	17[a]	2,298	45	379	50	4
2003	0	216	7	45	2,830	52	200	10	4
2004	4	309	8	93	4,292	71	974	35	1
2005	7	749	81	74	4,879	103	1,117	21	2
2006	4	405	3	69	5,193	141	1,576	59	0
2007	1	219	0	142	5,133	65	517	71	0
2008	1	58	0	14	2,718	231	354	49	2
2009	2	36	0	7	4,265	70	1,297	128	0
2010	2	31	0	1	2,847	38	649	56	1

[a] may include eyed lamprey juveniles
[b] may include adult Pacific lamprey
[c] may include Umpqua dace

Speckled dace are found in West Fork Smith River year-round. The 13-year (1998-2010) mean population size of spring-migrating speckled dace in West Fork Smith River is 11,521 (SD = 4,963), representing a significant portion of juvenile fish biomass in the river. Preferred habitat differs somewhat from that used by salmonid fishes, but speckled dace are dependent on and competitors for the same prey food base. As such, speckled dace provide another indicator of basin carrying capacity and another opportunity to monitor basin productivity.

Table 14. Measured trap efficiencies (2002, 2003 and 2010), proxy trap efficiencies, and estimated speckled dace out-migrants in West Fork Smith River. The mean of the ratio of trap efficiencies measured for speckled dace and coho salmon smolts in 2002, 2003 and 2010 was used to calculate proxy values for trap efficiency for alternate years (see text, above).

Year	Measured trap efficiency	Ratio of dace to coho smolt trap efficiency	Proxy trap efficiency	Estimated total migrants
1998	na	(1.20)	.40	19,093
1999	na	(1.20)	.25	11,900
2000	na	(1.20)	.46	5,304
2001	na	(1.20)	.42	12,367
2002	0.45	1.45	--	5,165
2003	0.34	1.03	--	8,276
2004	na	(1.20)	.41	10,468
2005	na	(1.20)	.47	10,381
2006	na	(1.20)	.44	11,802
2007	na	(1.20)	.22	23,332
2008	na	(1.20)	.26	10,454
2009	na	(1.20)	.36	11,847
2010	0.30	1.11	--	9,380

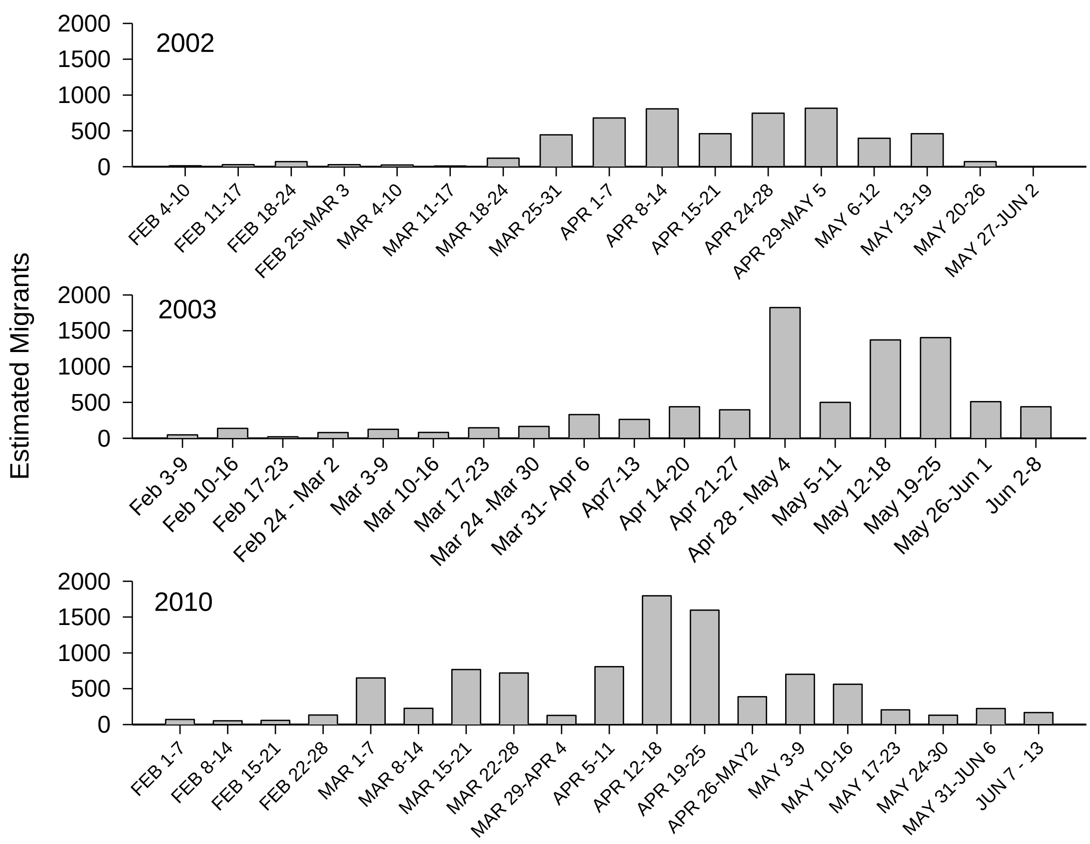

Figure 10. Migration timing of speckled dace sampled at the juvenile fish trap in West Fork Smith River.

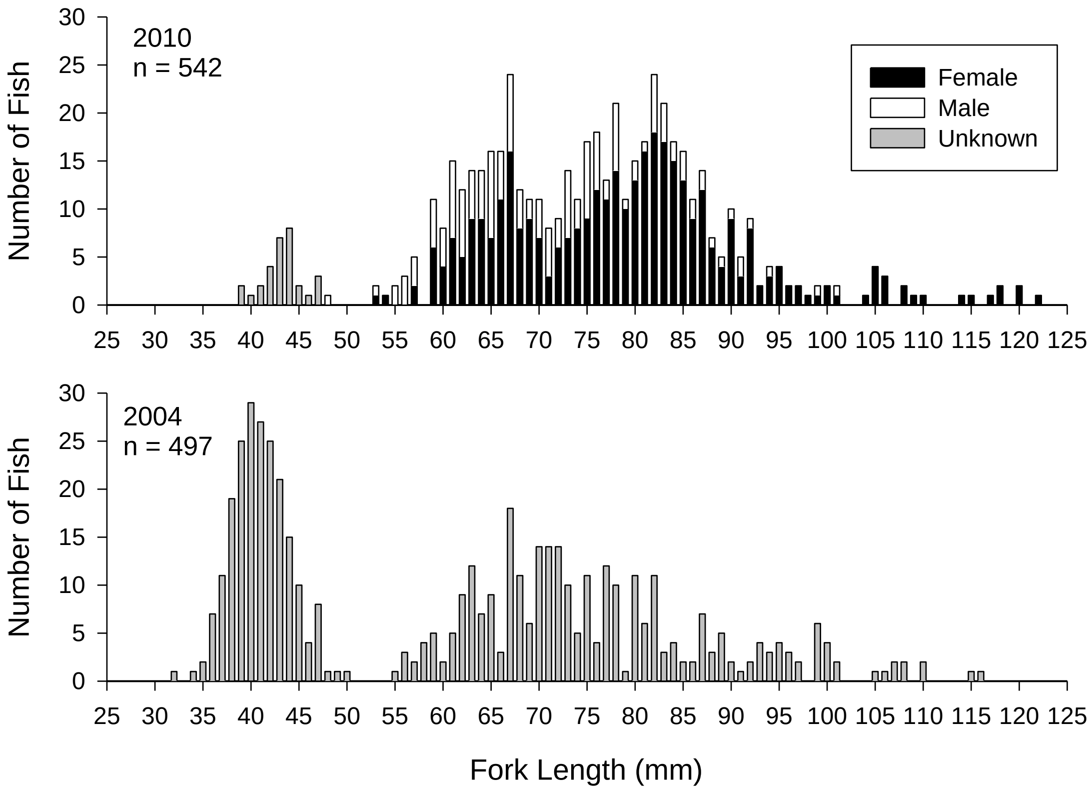

Figure 11. Length-frequency histograms of speckled dace sampled at the West Fork Smith River juvenile fish trap in 2004 and 2010. Sex was not determined in 2004.

Umpqua dace *Rhinichthys evermanni* are endemic to the Umpqua Basin. It is hypothesized that both Umpqua dace and Millicoma dace *Rhinichthys sp.* are derived from Columbia longnose dace *Rhinichthys cataractae* (Bisson and Reimers 1977). Millicoma dace are endemic to nearby Coos River, south of the Umpqua River. Recent genetic analyses by Mcphail and Taylor (2009) suggest that Umpqua and Millicoma dace form a coastal clade of sister taxa that differentiated from a longnose dace-type ancestor when the Umpqua River lost connection with the Columbia Basin during the early to mid-Pliocene. Their evidence further suggest that sometime during uplift of the Coast Range and formation of Coos River (late Pliocene or early Pleistocene), a connection between the Coos and Umpqua basins existed that allowed dispersal and subsequent divergence of Umpqua and Millicoma dace into allopatric sister species. Little is known of life-history and behavior for either species.

Relatively few Umpqua dace are found in the West Fork Smith River juvenile trap catch (Table 13). Umpqua dace migrate downstream throughout late winter and spring in West Fork Smith River, with no consistent peak in migration between years (Figure 12). The migrating population is primarily female and consists of larger fish with little evidence of an age-1 year class in the trap catch. (Figure 13). Females in the trap catch appear gravid, but no dissections have been conducted to confirm this observation.

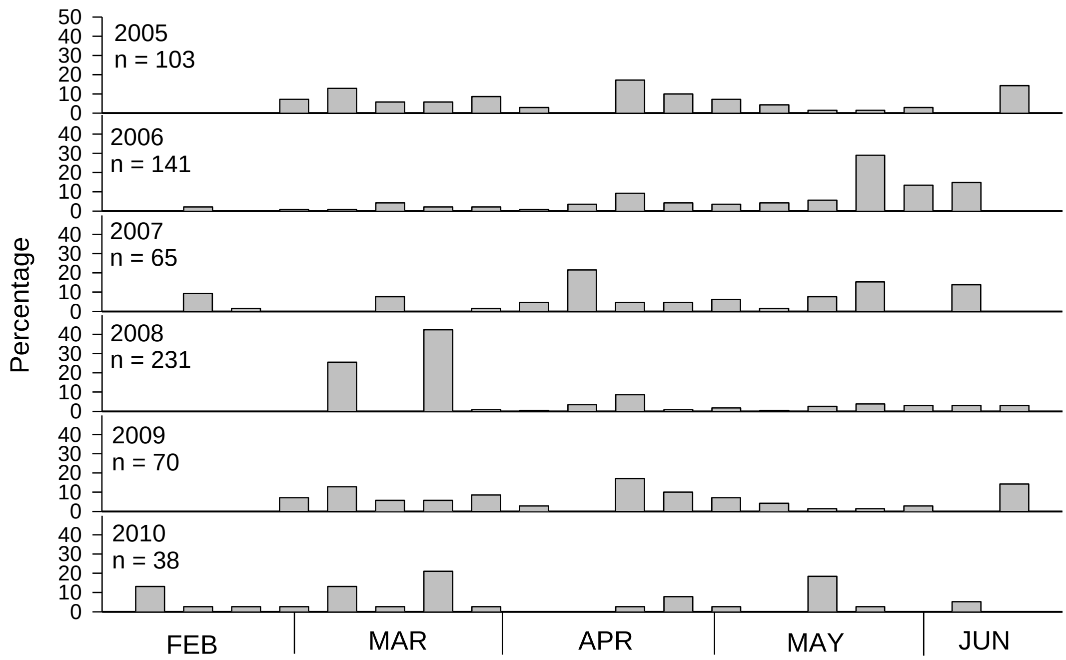

Figure 12. Migration timing of Umpqua dace sampled at the juvenile fish trap in West Fork Smith River for the period 2005 - 2010. Data shown are trap catch; trap efficiency was not determined for this species.

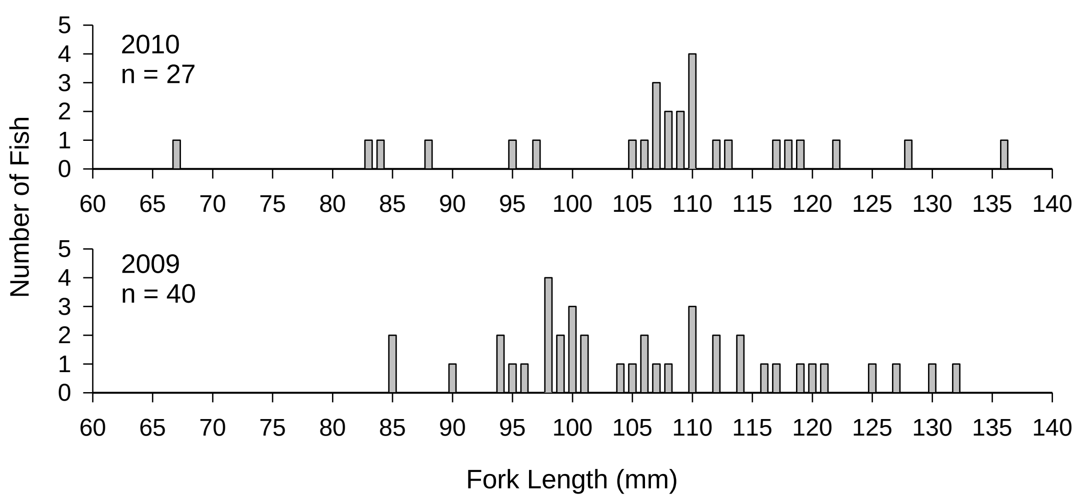

Figure 13. Length-frequency histograms of Umpqua dace sampled at the West Fork Smith River juvenile fish trap in 2009 and 2010.

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Acknowledgements

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