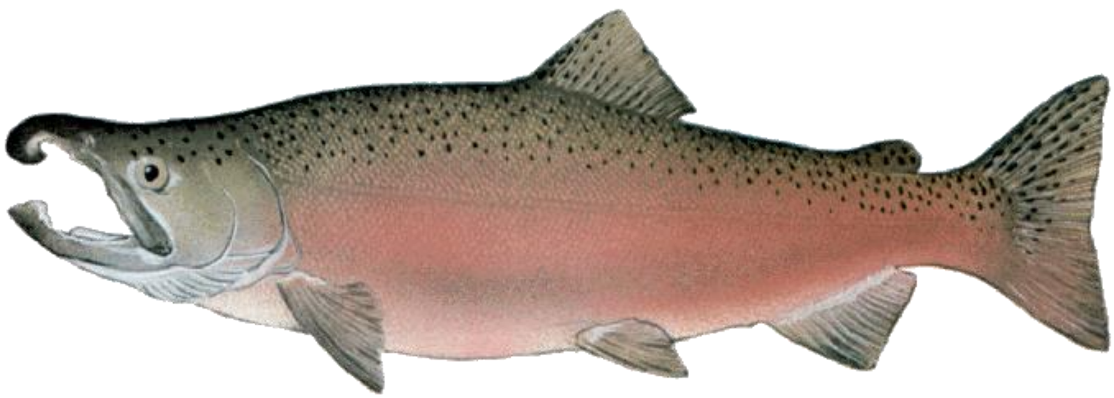
Summary of Habitat and Fish Monitoring Data from East Fork and Upper Mainstem Lobster Creeks: 1988-2018



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Western Oregon Research & Monitoring Program

Oregon Department of Fish and Wildlife

for the Bureau of Land Management

Summary of Habitat and Fish Monitoring Data from East Fork and Upper Mainstem Lobster Creeks: 1988-2018

Since 1988, the Oregon Department of Fish and Wildlife (ODFW) has monitored juvenile salmonid summer abundance, smolt abundance, adult spawner abundance, and stream habitat parameters in East Fork and Upper Mainstem Lobster Creeks of the Alsea watershed (Figure 1). The primary purpose of this monitoring is to study the effects of stream habitat modification on the freshwater survival and abundance of coho salmon (*Oncorhynchus kisutch*). This work has been partially funded by the Bureau of Land Management's (BLM) Salem District Office since 1996. The purpose of this report is to provide the BLM with an update of ODFW's sampling in East Fork Lobster Creek (East Fork) and Upper Mainstem Lobster Creek (Upper Mainstem) during the 2017-18 sampling season and to put these data in context with past data collected by ODFW.

The watershed characteristics of the two study streams are shown in Table 1. In 1991, extensive in-stream habitat modification was conducted by the BLM in Upper Mainstem as part of a before-after-control-impact (BACI) study to determine the effect of habitat modification on the survival rate and smolt abundance of juvenile salmonids. East Fork acted as the control stream during this study, which lasted from 1988 through 1995. A detailed description of this study is in Solazzi et al. (2000). During a February 1996 flood, a number of large debris torrents entered Upper Mainstem and significantly impacted the habitat structures, resulting in the loss of considerable overwinter habitat for juvenile coho salmon. Similar high stream flows in the winter of 1998-99 caused significant channel changes in East Fork. In the summer of 1999, the BLM used 65 pieces of large wood with a total volume of 265m^3 to create seven in-channel debris jams in East Fork.

Table 1. Watershed characteristics of East Fork and Upper Mainstem Lobster Creeks.

Stream	Basin area (km^2)	Anadromous fish habitat (km)	Mean summer wetted width (m)	Average gradient (%)
East Fork Lobster Cr.	14.2	3.5	3.3	4.0
Upper Mainstem Lobster Cr.	12.4	4.7	3.4	2.6

Habitat Inventory

From 1988-2002 and in 2006, we completed physical habitat surveys during late summer (late August – early September) using the methods of Hankin and Reeves (1988). Summer habitat inventory results are summarized in Table 2 and Table 4 for East Fork and Upper Mainstem, respectively. No physical habitat surveys were completed in the summers of 2003-2005, or 2007-2018 because Hankin-Reeves survey methods were no longer used to estimate summer rearing populations. Habitat surveys were also conducted during the winters of 1990-91, 1991-92, 1995-96, 1996-97 and 2004-05 in East Fork and Upper Mainstem. An additional winter habitat survey was completed in Upper Mainstem in the winter of 1993-94. Winter habitat inventory results are summarized in Table 3 and Table 5 for East Fork and Upper Mainstem, respectively. Further details about sampling methods used in the physical habitat surveys may be found in Solazzi et al. (2000) and Solazzi and Johnson (2002).

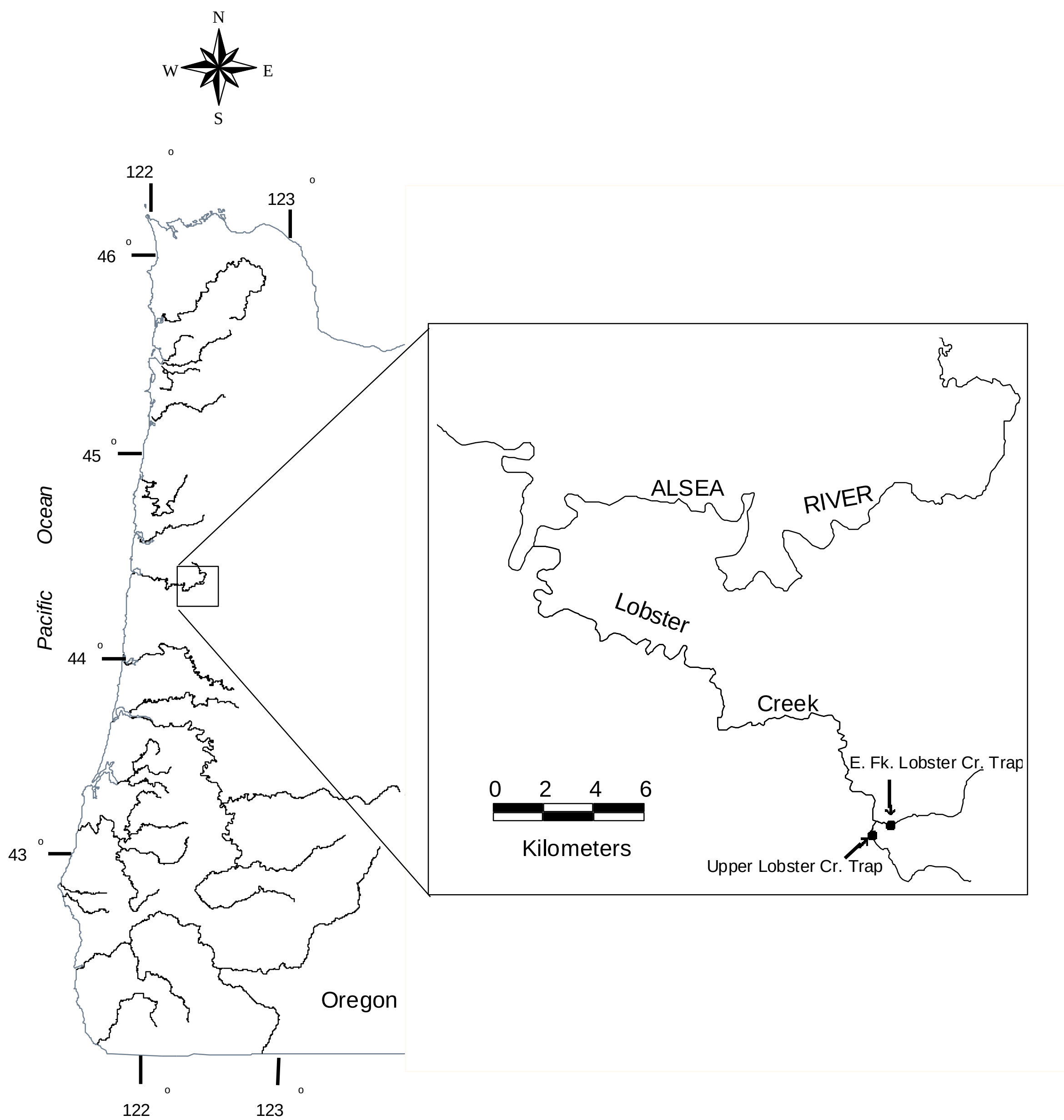


Figure 1. Locations of traps in East Fork and Upper Mainstem Lobster Creeks in the Alsea Basin.

Table 2. Summer habitat survey results for East Fork Lobster Creek, 1988-2002 and 2006.

Year	Average Width (m)	Lateral & Straight Scour Pools (m²)	Alcove Pools (m²)	Beaver Dam Pools (m²)	Dam Pools (m²)	Other Pools (m²)	Glide (m²)	Rapid (m²)	Riffle (m²)
1988	N/A	3,459	166	2,885	1,673	585	1,252	1,965	3,257
1989	3.3	3,650	12	1,759	1,273	1,082	2,108	1,948	2,428
1990	3.3	4,371	0	687	168	1,171	2,737	4,398	1,847
1991	3.5	5,502	91	1,081	170	656	1,474	4,723	1,849
1992	3.2	4,646	281	1,160	145	647	912	3,933	1,662
1993	3.9	5,303	270	1,622	354	775	1,842	6,132	3,046
1994	3.0	4,099	28	991	211	451	1,144	2,678	3,900
1995	3.2	3,207	11	263	0	469	1,635	1,915	5,479
1996	3.2	3,364	10	273	82	358	1,801	1,433	4,392
1997	3.4	4,725	0	463	25	350	1,259	6,187	2,860
1998	3.5	5,132	0	458	0	364	781	4,756	4,532
1999	3.2	3,660	0	369	169	224	735	5,445	2,707
2000	3.7	3,176	0	430	115	285	804	3,350	6,143
2001	3.2	4,221	0	0	0	181	787	6,919	2,562
2002	3.0	3,316	0	72	0	371	834	4,201	1,997
2006	3.6	4,534	0	180	0	235	1,091	5,549	2,458
Average	3.3	4,148	54	793	274	513	1,325	4,096	3,195

Table 3. Winter habitat survey results for East Fork Lobster Creek in select years between 1990-91 and 2004-05.

Year	Average Width (m)	Lateral & Straight Scour Pools (m²)	Alcove Pools (m²)	Beaver Dam Pools (m²)	Dam Pools (m²)	Other Pools (m²)	Glide (m²)	Rapid (m²)	Riffle (m²)
1990-91	N/A	5,526	0	558	1,048	1,777	1,911	10,307	6,223
1991-92	5.3	4,857	26	673	841	1,286	3,558	5,857	7,392
1995-96	6.1	4,627	251	357	246	981	631	6,907	12,734
1996-97	6.0	5,177	0	0	0	571	274	10,263	10,783
2004-05	6.0	5,011	0	161	484	319	594	9,333	6,882
Average	5.9	5,040	55	350	524	987	1,394	8,533	8,803

Table 4. Summer habitat survey results for Upper Mainstem Lobster Creek, 1988-2002 and 2006.

Year	Average Width (m)	Lateral & Straight Scour Pools (m^2)	Alcove Pools (m^2)	Beaver Dam Pools (m^2)	Dam Pools (m^2)	Other Pools (m^2)	Glide (m^2)	Rapid (m^2)	Riffle (m^2)
1988	N/A	4,976	175	0	2,506	924	1,442	1,168	6,610
1989	3	5,599	0	4,946	384	1,231	2,522	2,072	4,892
1990	N/A	3,891	0	992	1,411	2,154	2,320	4,726	5,134
1991	3.3	4,706	1,072	1,564	6,931	1,704	2,041	1,552	3,063
1992	3.1	4,594	847	2,548	6,784	1,363	1,590	1,552	3,414
1993	3.9	6,137	1,108	1,968	6,445	1,116	2,592	1,814	4,498
1994	3.1	4,865	731	1,928	5,165	966	3,086	1,213	3,800
1995	3.4	4,005	834	1,792	4,410	1,362	3,209	1,232	5,528
1996	N/A	8,331	118	558	1,277	1,193	2,334	2,407	8,574
1997	N/A	N/A	N/A	N/A	N/A	0	N/A	N/A	N/A
1998	3.3	7,969	131	243	0	707	2,339	5,929	4,214
1999	3.7	8,254	245	127	0	930	1,182	7,795	3,744
2000	3.8	9,162	222	412	283	445	1,146	6,643	4,706
2001	3.5	7,496	108	947	286	397	1,467	2,722	7,230
2002	3.4	7,413	204	771	274	542	1,070	5,553	3,627
2006	3.7	8,469	78	0	509	742	1,081	6,349	3,379
Average	3.4	6,391	392	1,253	2,444	986	1,961	3,515	4,828

Table 5. Winter habitat survey results for Upper Mainstem Lobster Creek in select years between 1990-91 and 2004-05.

Year	Average Width (m)	Lateral & Straight Scour Pools (m^2)	Alcove Pools (m^2)	Beaver Dam Pools (m^2)	Dam Pools (m^2)	Other Pools (m^2)	Glide (m^2)	Rapid (m^2)	Riffle (m^2)
1990-91	N/A	5,618	0	24	1,347	1,848	4,538	9,299	7,816
1991-92	5.0	4,491	892	1,670	8,032	1,517	2,412	4,461	7,001
1993-94	5.4	4,702	997	1,321	5,943	1,268	2,146	1,535	8,733
1995-96	6.6	7,931	1,124	173	5,603	3,152	804	5,526	12,644
1996-97	6.4	7,633	0	0	850	1,466	752	8,298	14,097
2004-05	5.7	9,958	73	0	80	1,054	219	5,784	14,847
Average	5.8	6,722	514	531	3,643	1,718	1,812	5,817	10,856

Juvenile Salmonid Summer Population Estimates

The estimated summer rearing populations of juvenile salmonids from 1988 through 2018 are shown in Table 6 for both streams. Each summer from 1988-2002, we estimated the number of young-of-the-year coho salmon, young-of-the-year trout (steelhead and cutthroat combined), age 1+ steelhead, and age 1+ cutthroat trout. To estimate the number of fish rearing in the pools, a diver counted the number of each species and age class in every third pool. These counts were adjusted for each species by a calibration factor derived from electrofishing population estimates in a subset of the snorkeled pools. Finally, the mean of the adjusted values was multiplied by the total number of pools in each stream (Hankin and Reeves 1988). Snorkel estimates were impractical in habitat with shallow depths; therefore, we estimated the mean density of fish for a subset of glide, riffle, and rapid habitats by electrofishing, employing a removal population estimate with two or more passes (Serber and Lecren 1967). For each habitat type, we then multiplied the mean density by the surface area of the habitat type in the entire stream (Hankin 1984).

In the summers of 2003-2018, as in previous years, we completed dive counts in every third pool; however, we did not use electrofishing equipment to calibrate the diver counts or to estimate population size of juvenile salmonids in fast water habitat. In order to make comparable estimates to the number of juvenile salmonids rearing in each stream from past years, we applied the 2003-2018 uncalibrated diver estimates in pool habitat to the regression of total population estimate for all habitat units (derived from Hankin-Reeves survey methods) on uncalibrated diver counts in pool habitat (Table 7). Data collected from the summer of 1991-2002 on each stream were used to develop the regression equations. The relationship between uncalibrated diver counts in pool habitat and the Hankin-Reeves population estimate (all habitat types) was significant for coho salmon and age 0 trout for both streams. Thus, we used the regression equations in Table 7 to obtain the Hankin-Reeves population estimates given in Table 6 for coho salmon in summers 2003-18. Population estimates were also made for age 0 trout in summers 2003-07, but not in subsequent years due to concerns about variability in counts among observers and the relatively weak relationship between the Hankin-Reeves population estimates and dive counts in East Fork (Table 7). For steelhead and cutthroat trout (≥90mm), relationships between pool dive counts and the Hankin-Reeves population estimates were generally very poor (Table 7). Therefore, no estimates of summer population size are provided for steelhead or cutthroat trout (≥90mm) in 2003-2018.

In 2018, we estimated the summer rearing population of juvenile coho salmon to be 4,915 parr in East Fork and 11,888 parr in Upper Mainstem. The Upper Main estimate was similar to the average abundance but the East Fork estimate was well below average (Table 6). Both streams had similar average rearing density in pools but the pool count in East Fork was low and pool surface area was the lowest observed in the last 16 years. Pool habitat in East Fork has declined considerably in recent years as several large log jams (including natural jams and placed structures) have broken up or been bypassed by the primary channel.

Table 6. Juvenile salmonid summer population estimates in East Fork Lobster and Upper Mainstem Lobster creeks, 1988-2018.

	East Fork Lobster Creek				Upper Mainstem Lobster Creek			
Sample Year	Coho	Trout <90mm	Steelhead ≥90mm	Cutthroat ≥90mm	Coho	Trout <90mm	Steelhead ≥90mm	Cutthroat ≥90mm
1988	11,462	5,098	530	368	10,667	2,916	437	338
1989	13,694	2,279	792	961	6,406	3,242	248	596
1990	19,278	2,837	474	1,811	18,161	2,288	766	792
1991	9,964	3,490	543	686	7,633	1,776	235	525
1992	7,716	3,096	363	1,255	8,819	2,951	216	1,268
1993	15,842	2,298	672	2,793	23,012	1,327	148	3,337
1994	6,432	2,278	468	998	15,486	2,562	150	729
1995	8,085	2,884	803	583	9,619	3,357	112	1,288
1996	3,767	2,355	412	592	940	2,501	520	893
1997	11,055	4,619	133	444	n/a	n/a	n/a	n/a
1998	4,863	3,516	667	827	6,842	3,153	909	1,018
1999	2,358	5,012	578	917	1,690	10,346	806	2,296
2000	8,011	5,478	800	488	9,385	4,815	1,300	788
2001	10,280	3,288	667	682	17,086	1,772	778	1,165
2002	10,954	4,121	276	1,315	14,247	3,053	127	1,579
2003	10,047	3,437	--	--	21,751	4,580	--	--
2004	10,937	3,686	--	--	14,842	2,431	--	--
2005	8,017	3,400	--	--	10,843	1,879	--	--
2006	11,456	2,100	--	--	15,434	1,589	--	--
2007	3,672	3,890	--	--	11,093	1,130	--	--
2008	8,370	--	--	--	12,806	--	--	--
2009	11,002	--	--	--	16,039	--	--	--
2010	6,673	--	--	--	10,887	--	--	--
2011	8,460	--	--	--	11,913	--	--	--
2012	7,176	--	--	--	10,421	--	--	--
2013	9,511	--	--	--	11,702	--	--	--
2014	5,065	--	--	--	9,150	--	--	--
2015	7,355	--	--	--	10,048	--	--	--
2016	6,141	--	--	--	10,235	--	--	--
2017	5,296	--	--	--	8,719	--	--	--
2018	4,915	--	--	--	11,888	--	--	--
Average	8,640	3,458	545	981	11,592	3,035	482	1,187

Table 7. Regression of Hankin-Reeves population estimate (y) on pool dive count (x) of juvenile salmonids in East Fork Lobster and Upper Mainstem Lobster creeks. Data collected from 1991-2002 were used for the regression analysis.

Stream	Species	Regression Equation	N	R^2	p value
East Fork	Coho	y =1.35356x + 614.296	12	0.736	0.0004
East Fork	0+ trout	y =2.51335x + 1439.24	12	0.424	0.022
East Fork	Steelhead ≥90mm	y =1.33392x + 311.81	12	0.299	0.066
East Fork	Cutthroat ≥90mm	y =2.22139x + 670.77	12	0.076	0.387
Upper Mainstem	Coho	y =1.63557x – 741.6	11	0.942	0.0000007
Upper Mainstem	0+ trout	y =4.09322x – 49.081	11	0.818	0.00013
Upper Mainstem	Steelhead ≥90mm	y =1.91800x + 29.61	11	0.372	0.0462
Upper Mainstem	Cutthroat ≥90mm	y =1.23459x + 1075.26	11	0.015	0.72

Downstream Migrant Juvenile Sampling

In the spring, a motorized inclined plane trap is operated in each study stream to estimate the number of juvenile fish emigrating downstream. A detailed description of the methods used to operate these traps can be found in Solazzi et al. (2000). Out-migrant population estimates for each species and age class are made by summing weekly estimates based on trap catch and efficiency. From 1988-2013, these calculations were made using a spreadsheet, with data interpolation used to fill in gaps when the traps were not operating. In recent years, we have taken a different approach using a Bayesian framework implemented in the program R (R Core Team 2015) with the BTSPAS Package (Bonner and Schwarz 2014). This approach uses a Bayesian P-spline model to estimate population size from mark-recapture data (Bonner and Schwarz 2011). Population estimates using the two approaches are generally quite similar, but the BTSPAS approach better incorporates uncertainty during trap stoppages and periods of low trap efficiency, and therefore produces more realistic confidence intervals for the estimates. All juvenile out-migrant population estimates presented below from 2014-2018 were made using BTSPAS in program R. To facilitate comparisons between years, we also re-ran all estimates for coho smolts and fry from 1988-2013 using BTSPAS. To accomplish this, data from 1994-2013 had to be transferred from the original spreadsheets to a database and 1988-1993 data had to be entered directly into the database from the original paper data sheets. All fork length measurements collected from juvenile coho salmon captured at the traps from 1988-2018 have been placed in the same database. Housing all of the coho salmon out-migrant data in a single database will facilitate future analyses and provide a more stable digital archive for this unusually long-term data set.

In spring 2018, the inclined plane traps were fished from the beginning of March to the end of May, when the coho smolt out-migration period appeared to end. Streamflow was moderate throughout the first half of the season, with only a single storm event that prevented fishing the traps for one day. Streamflow in the last half of the season was below average, with extremely low flows and fish numbers in the last half of May. The estimated numbers of juvenile salmonids migrating downstream in East Fork in the spring of 2018 are shown in Table 8. The population estimate of age 1+ coho salmon migrants (coho smolts) in East Fork in 2018 was 2,168 fish, which is average over the monitoring period. It is slightly higher than expected given the number of spawners but well within previous levels of observed freshwater survival (figure 2a). The week of peak migration and average smolt size were typical for this site (Table 8).

At Upper Mainstem Lobster, an estimated 2,870 smolts migrated downstream past the trap in spring 2018 (Table 9). The 2018 smolt estimate at Upper Mainstem was below the long-term average but within the observed range of production at similar spawner abundance (Figure 2a). The week of peak migration for coho smolts in 2018 at Upper Mainstem was April 2-8, and the mean fork length of coho smolts (86.2 mm) was similar to the long-term average for this site (Table 9).

The number of coho fry migrants in spring 2018 was lower than average at both sites, with an estimated 62,937 coho fry migrating out of East Fork (Table 8) and 46,124 coho fry migrating out of Upper Mainstem (Table 9). Both estimates were within the observed range compared to previous years with similar spawner abundance (Figure 2b). As is often the case, the abundance of fry migrants relative to the number of adult coho spawners was much higher at East Fork than at Upper Mainstem (Figure 2b).

Adult Chinook salmon were again present in the fall of 2017 (Table 10), though in lower numbers in East Fork than in 2016 and very low numbers in Upper Mainstem. Juvenile Chinook salmon production was observed at both sites with very low production in Upper Mainstem (Table 8 and 9). The estimated number of cutthroat trout (≥90mm) migrants was similar to the long-term average at East Fork (Table 8), and Upper Mainstem (Table 9). We were not able to estimate the number of steelhead (≥90mm) migrants at either site due to low trap efficiency and a lack of recaptures, as is often the case at these traps.

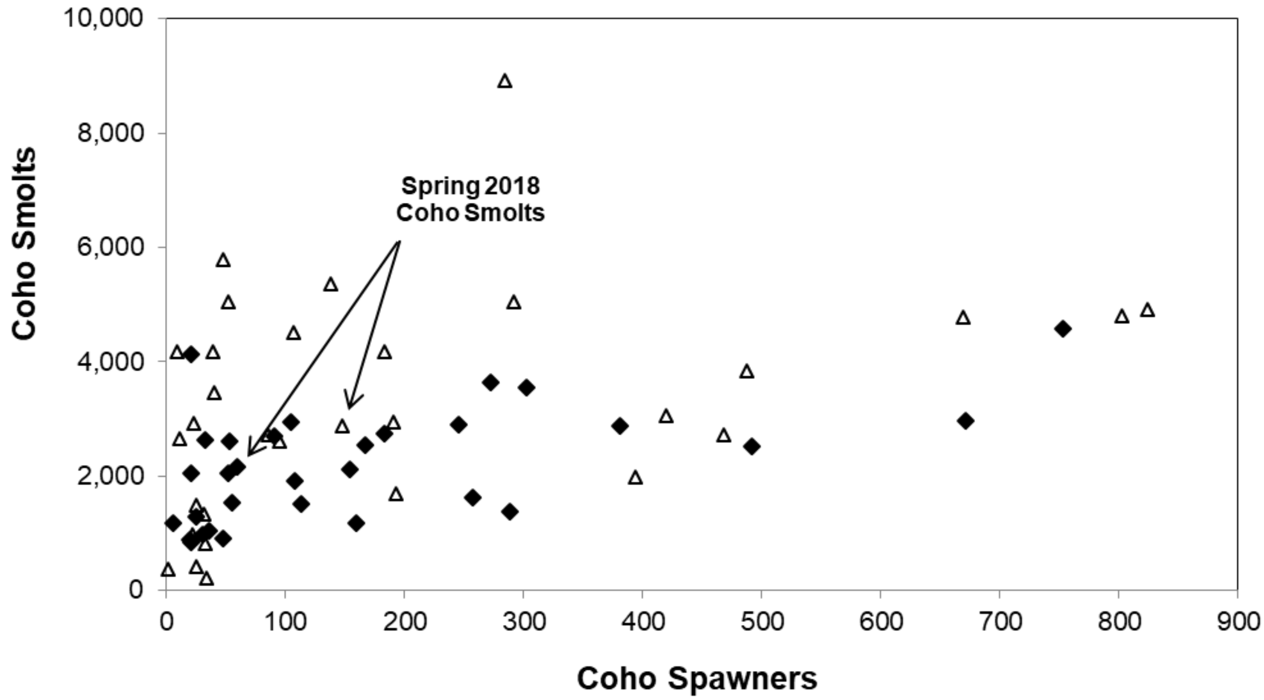
Table 8. The estimated number of juvenile salmonids migrating downstream each spring in East Fork Lobster Creek, and the peak week of migration and mean fork length of coho smolts, 1988-2018.

Trap Year	Trap Start Date	Coho (1+) Smolts	±	CI	Peak Week	Mean FL (mm)	Coho Fry	Chinook Fry	Steelhead ≥90mm	Cutthroat ≥90mm
1988	9-Mar-88	1,127	±	143	3/21-3/27	74.9	19,233	2,130	15[a]	15[a]
1989	1-Mar-89	2,593	±	284	3/20-3/26	79.2	49,252	264,733	1[a]	268
1990	5-Feb-90	3,245	±	259	4/23-4/29	80.0	23,325	0	32	110
1991	4-Feb-91	2,027	±	145	5/6-5/12	83.6	7,892	0	45	296
1992	4-Feb-92	2,535	±	190	4/6-4/12	80.4	6,413	0	49	251
1993	3-Feb-93	1,966	±	245	4/19-4/25	88.1	49,923	0	117	699
1994	1-Feb-94	3,434	±	253	5/2-5/8	81.9	4,675	0	26	738
1995	1-Feb-95	945	±	231	3/6-3/12	89.1	7,701	0	21	187
1996	12-Feb-96	1032	±	243	2/12-2/18	82.8	8,635	0	3[a]	7[a]
1997	3-Mar-97	988	±	237	4/21-4/27	87.7	38,922	0	14[a]	5[a]
1998	2-Mar-98	1,307	±	196	4/27-5/3	87.8	23,757	0	455	523
1999	1-Mar-99	871	±	116	3/15-3/21	81.7	6,163	228	169	839
2000	28-Feb-00	1,172	±	163	4/10-4/16	89.9	15,945	0	714	691
2001	28-Feb-01	4,103	±	276	4/23-4/29	85.7	43,605	0	1,371	999
2002	26-Feb-02	2,987	±	196	4/8-4/14	78.6	31,771	0	147	1,231
2003	28-Feb-03	1,982	±	270	4/14-4/20	82.2	311,926	5,951	76	842
2004	1-Mar-04	2,495	±	223	4/12-4/18	83.7	275,139	0	762	1,454
2005	27-Feb-05	4,605	±	359	3/21-3/27	83.3	116,546	0	422	802
2006	26-Feb-06	2,535	±	231	4/24-4/30	90.9	84,314	0	332	1,902
2007	1-Mar-07	2,721	±	580	5/7-5/13	81.3	5,205	32,175	28[a]	1,723
2008	29-Feb-08	795	±	135	5/12-5/18	95.7	44,590	0	28[a]	835
2009	28-Feb-09	2,503	±	269	4/6-4/12	78.7	153,235	0	43[a]	1,014
2010	27-Feb-10	2,971	±	339	3/22-3/28	80.9	234,603	0	211	1,092
2011	2-Mar-11	1,598	±	180	3/28-4/3	84.4	139,115	0	63	993
2012	1-Mar-12	1,765	±	361	3/5-3/11	81.6	57,298	0	6[a]	754
2013	28-Feb-13	2,880	±	276	4/1-4/7	85.7	103,984	0	692	841
2014	2-Mar-14	2,737	±	212	4/7-4/13	86.8	114,815	0	48[a]	1,024
2015	3-Mar-15	1,922	±	184	4/27-5/3	88.5	199,146	0	477	2,119
2016	29-Feb-16	1,384	±	229	4/4-4/10	83.0	24,455	0	399	1,182
2017	28-Feb-17	1,540	±	212	4/17-4/23	86.7	60,234	57,249	45[a]	980
2018	1-Mar-18	2,168	±	227	4/2-4/8	85.1	62,937	20,601	59[a]	1,167
Average		2,159				84.2	74,992		329[b]	903[b]

[a]Few marked fish recaptured, thus trap efficiency is not available. Number shown is total fish captured, not an expanded estimate of total migrants using trap efficiency.

[b]Average only includes years for which trap efficiency estimates are available.

a



b

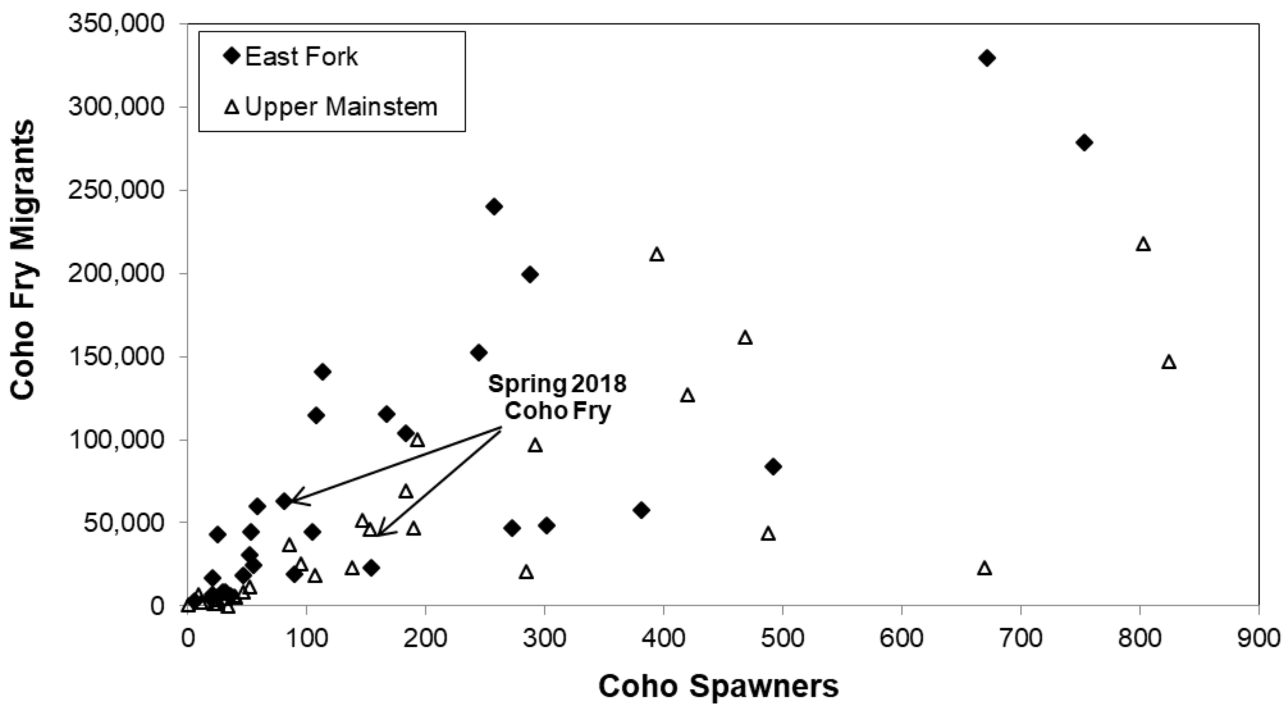


Figure 2. Estimated number of (a) coho smolts and (b) coho fry migrants in relation to the number of adult coho spawners for the 1986-2016 brood years in East Fork and Upper Mainstem Lobster Creek.

Table 9. The estimated number of juvenile salmonids migrating downstream each spring in Upper Mainstem Lobster Creek, and the peak week of migration and mean fork length of coho smolts, 1988-2018.

Trap Year	Trap Start Date	Coho (1+) Smolts	±	CI	Peak Week	Mean FL (mm)	Coho Fry	Chinook Fry	Steelhead ≥90mm	Cutthroat ≥90mm
1988	9-Mar-88	1,335	±	237	4/4-4/10	86.5	3,898	1[a]	2[a]	21[a]
1989	1-Mar-89	775	±	284	4/24-4/30	72.3	2,953	1[a]	0	22
1990	5-Feb-90	922	±	129	4/23-4/29	92.9	5,274	0	14	55
1991	4-Feb-91	3,459	±	194	4/15-4/21	80.9	6,297	0	36	319
1992	4-Feb-92	3,553	±	210	4/6-4/12	96.8	2,343	0	284	762
1993	3-Feb-93	2,598	±	186	4/19-4/25	92.4	19,352	0	209	382
1994	1-Feb-94	8,884	±	404	3/28-4/3	81.9	8,012	0	101	579
1995	1-Feb-95	5,767	±	298	4/24-4/30	91.5	241[a]	0	10[a]	606
1996	12-Feb-96	523	±	649	4/29-5/5	88.8	0	0	2[a]	73
1997	3-Mar-97	41[a]			n/a	n/a	117[a]	0	6[a]	7[a]
1998	2-Mar-98	2,759	±	382	4/20-4/26	88.8	4,091	0	484	1,391
1999	1-Mar-99	1,504	±	233	5/3-5/9	88.1	46[a]	0	147	398
2000	28-Feb-00	517	±	239	5/1-5/7	101.3	6,020	0	494	645
2001	28-Feb-01	4,045	±	459	3/26-4/1	86.2	19,360	0	347	1,134
2002	26-Feb-02	4,539	±	351	4/8-4/14	84.2	11,412	0	196	761
2003	28-Feb-03	5,080	±	343	4/7-4/13	86.2	215,881	3,439	21[a]	1,459
2004	1-Mar-04	4,424	±	341	4/5-4/11	86.5	148,748	0	23[a]	1,514
2005	27-Feb-05	4,813	±	419	3/28-4/3	82.3	69,939	0	46	1,647
2006	26-Feb-06	4,120	±	249	5/15-5/21	93.3	44,019	0	20[a]	1,556
2007	1-Mar-07	3,802	±	269	4/9-4/15	84.0	36,650	67,068	14[a]	2,463
2008	29-Feb-08	2,684	±	176	4/28-5/4	90.8	23,245	0	14[a]	1,909
2009	28-Feb-09	5,229	±	308	4/27-5/3	80.8	97,624	0	6[a]	1,854
2010	27-Feb-10	4,943	±	318	4/12-4/18	84.3	159,959	0	5[a]	1,857
2011	2-Mar-11	2,668	±	208	4/25-5/1	86.3	101,256	0	2[a]	1,818
2012	1-Mar-12	1,755	±	169	4/16-4/22	86.1	23,707	0	2[a]	737
2013	28-Feb-13	4,781	±	429	4/1-4/7	87.9	127,072	0	32[a]	1,177
2014	2-Mar-14	3,062	±	243	4/21-4/27	88.4	46,877	0	6[a]	813
2015	2-Mar-15	2,952	±	249	4/27-5/3	89.6	212,002	0	4[a]	1,266
2016	29-Feb-16	1,988	±	210	4/11-4/17	88.0	25,573	0	12[a]	474
2017	28-Feb-17	2,613	±	208	4/17-4/23	86.6	51,561	43,740	11[a]	781
2018	1-Mar-18	2,870	±	202	4/2-4/8	86.2	46,124	589	16[a]	970
Average		3,299				87.3	56,659[b]		197[b]	1,016[b]

[a]Few marked fish recaptured, thus trap efficiency is not available. Number shown is total fish captured, not an expanded estimate of total migrants using trap efficiency.

[b]Average only includes years for which trap efficiency estimates are available.

Overwinter Survival

The overwinter survival rate for juvenile coho salmon is calculated by dividing the estimated number of downstream migrating 1+ coho salmon in the spring by the rearing population of coho parr the previous summer. The 2017-18 overwinter survival rate estimates for juvenile coho salmon (2016 brood year) were 40.9% in East Fork and 32.9% in Upper Mainstem (Figure 3). Survival at Upper Mainstem was slightly higher than average and survival at East Fork was higher than average, similar to the 2011 and 2013 brood years. Over the past 13 years, overwinter survival trends at the two sites have been strongly correlated, a pattern that was not as evident during the first 17 years of monitoring. The lack of correspondence in the past appears to be linked to habitat modification projects at Upper Mainstem in 1990 and at East Fork in 1999, which had strong short-term effects on overwinter survival relative to the adjacent stream. These effects seem to have attenuated over time, however, and overwinter survival rates at the two sites are now tracking more closely from year to year (Figure 3).

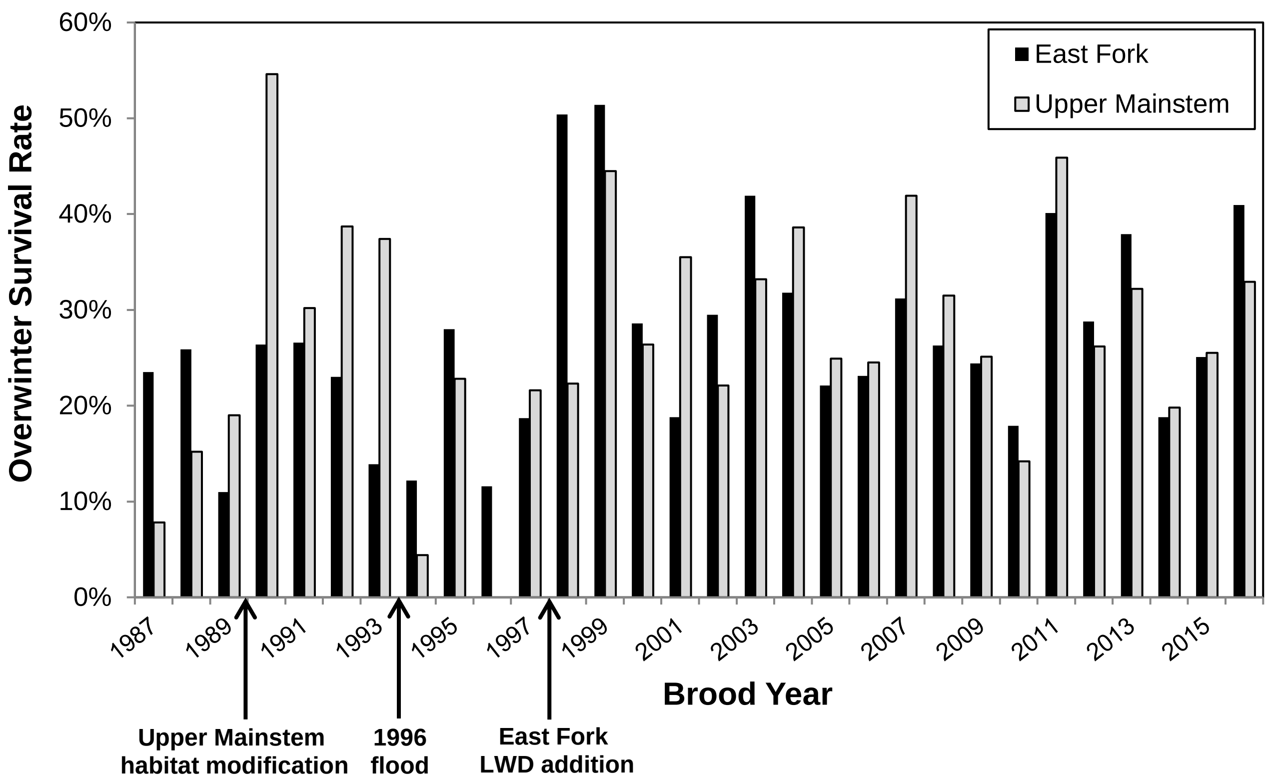


Figure 3. The estimated overwinter survival rate of juvenile coho salmon in East Fork Lobster and Upper Mainstem Lobster creeks. Arrows indicate the timing of events that had a significant effect on stream habitat at one or both sites.

Spawning Adult Surveys

From October 25, 2017 through January 31, 2018 we conducted spawning ground surveys to count adult salmon and steelhead in each stream. A single observer walking the entire salmon-bearing length of each study stream counted the number of redds and the number of live and dead salmon and steelhead. Area-under-the-curve (AUC) extrapolation techniques (Biedler and Nickelson 1980; Neilson and Geen 1981; Solazzi 1984) were used to estimate the total number of spawning salmon from the survey data.

High flows in November made survey conditions challenging but we were able to keep all surveys in rotation and meet the timing requirements necessary to make AUC population estimates for adult coho and Chinook salmon. The AUC estimates for adult coho salmon abundance in winter 2017-18 were 81 adult coho spawners at East Fork and 153 adult coho spawners at Upper Mainstem (Table 10). Spawner estimates were higher than in 2016-17, particularly at East Fork, but still fell well below long-term averages for these sites. As has been the case for the last 11 years, the number of adult spawners in Upper Mainstem was significantly higher than in East Fork. This pattern is generally consistent with the larger number of smolts that Upper Mainstem has produced in the broods corresponding to these adult returns.

AUC estimates of adult Chinook salmon spawner abundance in fall 2017 were 22 spawners in East Fork and 3 spawners in Upper Mainstem (Table 10). As in fall 2016 high stream flows in October allowed Chinook access to these small streams during a period when stream flows are typically much lower. The October storms were earlier in 2016, with high flows on October 13th, than in 2017, when flows rose on October 22nd. This difference in timing was likely the primary factor explaining the lower number of Chinook salmon observed on our surveys in 2017, but overall abundance of Chinook salmon returning to the Alsea basin was lower in 2017, as well.

Coho Salmon Freshwater and Marine Survival Rates

One of the primary goals of the ODFW Life Cycle Monitoring (LCM) Project is to estimate freshwater and marine survival rates for coho salmon in selected coastal monitoring sites (Suring et al. 2015). LCM sites are generally located in basins where a complete or partial barrier allows adult spawners to be trapped and enumerated. The number of coho smolts migrating out of these basins is estimated each spring using a rotary screw trap or motorized inclined plane trap. Freshwater survival rates at LCM sites are calculated by dividing the number of coho smolt out-migrants by the estimated egg deposition by female spawners in the corresponding brood year. Marine survival rates are determined by dividing the number of female spawners by the half the number of coho smolt out-migrants for a given brood year, assuming an equal sex ratio among smolt out-migrants (Suring et al. 2015).

Table 10. Area-under-the-curve (AUC) estimates of the number of adult coho and Chinook salmon spawning in East Fork and Upper Mainstem, 1986-2017 return years.

Return Year	East Fork Lobster Cr.		Upper Mainstem Lobster Cr.	
	Coho	Chinook	Coho	Chinook
1986	159	14	31	0
1987	90	8	32	0
1988	302	112	22	0
1989	154	0	40	0
1990	32	0	9	0
1991	21	0	11	0
1992	272	0	284	0
1993	20	0	47	0
1994	30	0	25	0
1995	36	0	34	0
1996	25	0	23	0
1997	47	0	25	0
1998	6	0	1	0
1999	21	1	39	0
2000	105	0	107	0
2001	52	53	52	0
2002	671	7	802	0
2003	753	1	824	1
2004	167	0	183	0
2005	492	0	487	1
2006	21	37	85	78
2007	53	0	138	0
2008	245	0	292	0
2009	257	0	468	1
2010	113	0	193	0
2011	381[a]	1	669[a]	0
2012	183	0	420	0
2013	108	0	190	0
2014	288	0	394	0
2015	55	0	95[a]	0
2016	59	53	147	42
2017	81	22	153	3
Average	166		198	

[a]Best available estimate. Surveys could not be completed during extended periods due to high water and thus did not meet standard requirements for AUC estimation.

Although we do not operate adult fish traps at East Fork or Upper Mainstem, annual estimates of adult coho abundance from spawning surveys and juvenile out-migrant numbers from the smolt traps allow us to make comparable survival rate estimates for coho salmon with some minor modifications. Egg deposition estimates at LCM sites are made based on the number of female spawners, as well as the average size of females captured and measured at fish traps. Fish observed on spawning surveys at East Fork and Upper Mainstem are not generally identified by sex and in most years we find relatively few carcasses, and so we do not have robust, consistent data on the total number or average size of female spawners at these sites. Therefore, to estimate egg deposition at East Fork and Upper Mainstem we divided AUC estimates in half, assuming an equal sex ratio among adult spawners, and multiplied by an average fecundity of 2,500 eggs per female. This fecundity estimate corresponds to an average female fork length of approximately 675 mm, which is very similar to the long-term average at the nearby Cascade Creek LCM site. Due to the lack of data on the sex ratio of adult coho spawners, marine survival estimates for coho salmon at East Fork and Upper Mainstem are calculated by dividing the total adult spawner AUC estimate by the number of coho smolt out-migrants for a given brood year.

Freshwater survival estimates for coho salmon have varied from 0.4% to 15.9% at East Fork and from 0.4% to 33.4% at Upper Mainstem, and show a negative power relationship with adult spawner abundance (Figure 4). Density-dependent factors appear to have a strong influence on survival of coho salmon in these streams, and egg-to-smolt survival can be very high at low spawner abundance. Substantial variability in survival has been observed among broods with similar spawner abundance, particularly when spawner abundance was low. Temporal changes in stream habitat and inter-annual variation in environmental conditions likely contributed to differences among brood years, and depensation may have been a factor in some years when very few adults were present on the spawning grounds. Our assumptions about the sex ratio of spawners may be a factor as well, because egg deposition would change significantly if the actual number of females was slightly higher or lower.

In brood years with relatively high spawner abundance, freshwater survival was uniformly low at both sites (Figure 4) because smolt production tended to be fairly consistent across a wide range of spawner abundance (Figure 2a). The number of coho fry migrants, in contrast, was highly variable and tended to increase with spawner abundance (Figure 2b). There is abundant rearing habitat in Lobster Creek below the smolt trapping sites, and although fry migrants would have to compete with locally emerging fry for this habitat, it is likely that many of them survive to out-migrate as smolts. Likewise, coho parr rearing above the smolt trapping site in summer may overwinter further downstream in Lobster Creek, and would not be counted as smolts in the spring. We do not know how juvenile coho movement affects overall smolt production in Lobster Creek, but it likely results in higher egg-to-smolt survival rate for coho salmon eggs deposited above the trapping sites than our freshwater survival estimates would suggest.

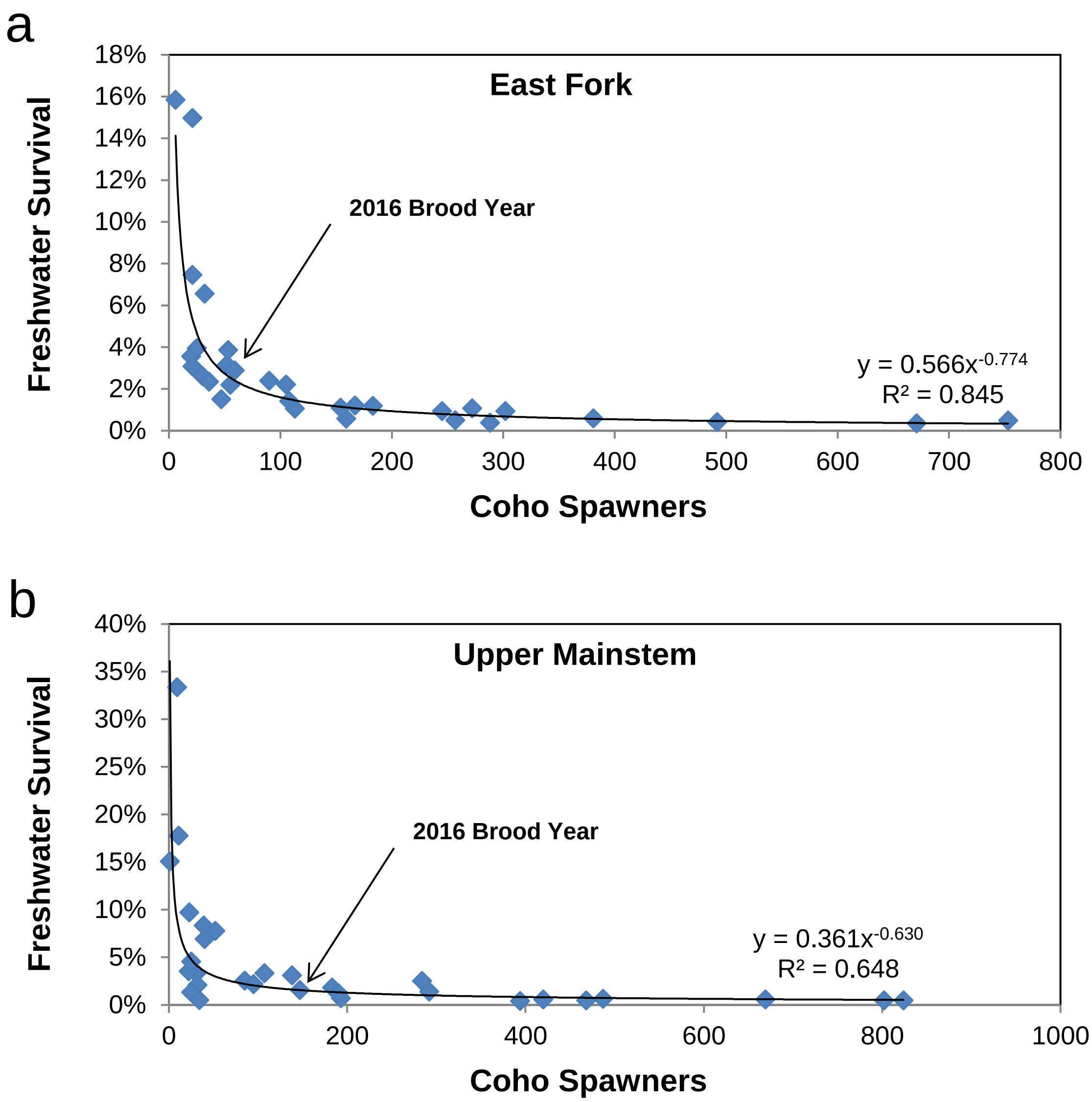


Figure 4. Estimated freshwater survival rate (egg-to-smolt survival) of coho salmon in relation to the number of adult coho spawners for the 1986-2016 brood years at (a) East Fork Lobster Creek and (b) Upper Mainstem Lobster Creek.

The relationship between adult coho spawner abundance and subsequent freshwater survival at East Fork and Upper Mainstem is very similar to that observed at other ODFW LCM sites (Suring et al. 2015), including nearby Cascade Creek. An important difference is that these other LCM sites generally have poorer rearing habitat downstream from the smolt trapping sites and produce fewer fry migrants relative to the number of smolts. As a result, the smolt estimates at our other LCM sites more closely represent total production from a given brood, the assumption underpinning our freshwater survival estimate. The situation is more complicated at the Lobster Creek sites, where smolt traps are located downstream from high quality spawning habitat and upstream from abundant rearing habitat. Despite these caveats, the long period of monitoring and consistency of methods over this period allow us to make valuable survival rate comparisons over time at the Lobster Creek sites. The freshwater survival estimate for the 2016 brood that out-migrated as smolts in spring 2018 was 2.9% at East Fork and 1.6% at Upper Mainstem, typical values for these sites based on the number of spawners in this brood year.

Marine survival estimates for coho salmon have ranged from 0.5% to 30.3% in East Fork and from 0.4% to 19.2% at Upper Mainstem over the last 29 brood years (Figure 5). As would be expected given the close proximity of the sites, marine survival estimates have been significantly correlated between the two sites during this period ($r^2 = 0.70$, $p < 0.001$ for logit-transformed data). Marine survival estimates for coho smolts from the 2014 brood that returned to spawn in 2017-18 were 5.9% in East Fork and 7.7% in Upper Mainstem. These values are an increase from the previous year and are similar to average values. Marine survival at the ODFW coastal LCM sites also increased from the 2013 to 2014 brood but generally were below the average observed survival.

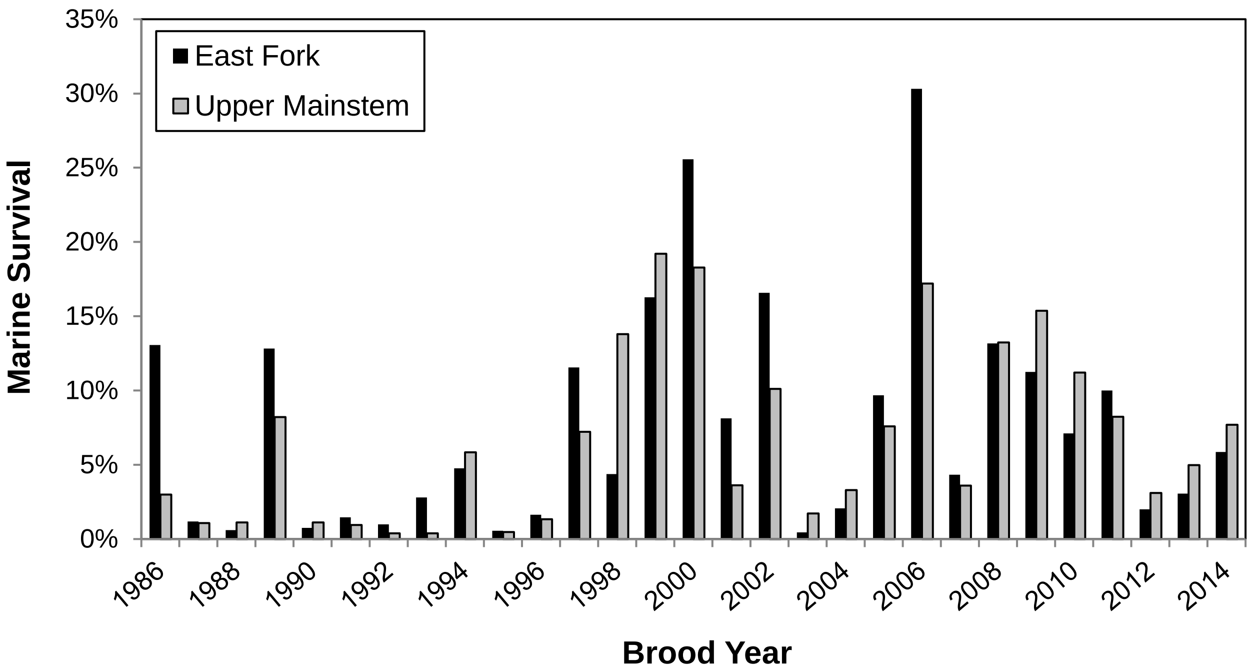


Figure 5. Estimated marine survival rate (smolt-to-adult survival) of coho salmon in East Fork and Upper Mainstem Lobster Creek, 1986-2013 brood years.

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