Run Size Forecast for Yakima River Adult Spring Chinook, 2010

Preliminary[1]

Prepared by:
Bill Bosch
Yakima Klickitat Fisheries Project
Yakama Nation Fisheries Resource Management
771 Pence Road
Yakima, Washington 98908

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[1] Some updates to 2009 age-at-return data are still pending. An updated forecast may be generated in February, 2010, but is not expected to differ substantially from this report.

Summary

In 2009 the forecast was for a return of 15,910 adult (age-4 and age-5) spring Chinook to the mouth of the Yakima River. The actual return in 2009 was estimated to be 7,470 adult spring Chinook. Because actual returns have been consistently and considerably less than preseason forecasts for most recent years, the method used to compute Yakima River spring Chinook forecasts for 2010 was again re-evaluated. Since 1997, projections have generally been based on examination of brood cohort relationships from 1982 to present projecting age-4 returns based on the return survival of age-3 fish in a given brood, and similarly projecting age-5 returns from age-4 returns. Over the past decade age-3 jack return abundance has been an increasingly unreliable predictor of age-4 return abundance. Yakima River biologists have been collaborating with other scientists from the region to see if parameters such as NOAA ocean condition rank[2], jack size or other variables can help explain and correct for ocean conditions or other factors that could be reducing the reliability of jacks as a predictor.

To produce the 2010 Yakima River forecast I evaluated output from at least seven different methods all of which used jack abundance in some combination with traditional cohort relationships, NOAA ocean condition rank, or jack size. These methods produced forecasts for 2010 age-4 and age-5 adult returns ranging from 22,000 to 34,000 spring Chinook. Given the increasing unreliability of jack-based predictor methods, I also evaluated a method which used Chandler smolt estimates, juvenile survival estimates for natural- and hatchery-origin fish from Roza to McNary Dams, and NOAA ocean rank as input variables to forecast combined age-4 and age-5 adult returns. These data are only available dating back to the 1997 brood year (1999 migration year). Results for this method were considered scientifically credible for natural-origin fish, but not for hatchery-origin fish. The hatchery-origin method was revised to include Chandler smolt estimates, juvenile survival estimates for natural- and hatchery-origin fish from Roza to McNary Dams, jacks and jack size as input variables. This method produces a forecast of 4,660 wild/natural and 11,910 hatchery-origin adult (age-4 and age-5) spring chinook returns to the Yakima Basin in 2010:

Stock	Age-4	Age-5	Total Adults
Upper Yakima Natural	3,490	60	3,550
Upper Yakima CESRF	11,800	110	11,910
Naches/American Wild	840	270	1,110
Total Run	**16,130**	**440**	**16,570**
Total Wild/Natural	**4,330**	**330**	**4,660**
Total CESRF	**11,800**	**110**	**11,910**

The total 2010 forecasted return of 16,570 adult spring Chinook is 160% of the recent 10-year (2000-2009) average adult return of 10,330 spring Chinook.

[2] see http://www.nwfsc.noaa.gov/research/divisions/fed/oeip/g-forecast.cfm

Review of 2009 Yakima River spring Chinook return

The estimated spring Chinook return to the Yakima River mouth in 2009 was 7,470 (3,510 CESRF) adults and 4,650 (3,530 CESRF) jacks for a total return of 12,120 spring Chinook (Table 1). The final Prosser Dam counts were estimated to be: 6,630 adults (3,040 CESRF), and 3,970 jacks (3,180 CESRF) for a total count of 10,600 spring Chinook (Table 2). The final Roza Dam counts were: 5,150 adults (2,860 CESRF), and 3,480 jacks (2,740 CESRF) for a total count of 8,630 spring Chinook (Table 3). Age information from all available sampling data is used to reconstruct the river mouth run components, and to produce brood cohort tables for the forecast. Since age data from scale samples do not always agree with jack counts based on video or physical observations, adjustments are typically made during run reconstruction resulting in slight discrepancies between adult and jack river mouth run size estimates compared to Prosser Dam and harvest below Prosser Dam estimates, and between Prosser and Roza Dam estimates. The reader may also notice some discrepancies in CESRF and wild/natural count estimates throughout this report due to inherent inaccuracies involved with video-based mark sampling.

Harvest was estimated at 1,190 adults and 1,080 jacks. Harvest consisted of approximately 560 wild/natural adults, 160 wild/natural jacks, 630 CESRF adults, and 920 CESRF jacks with about 930 adults and 590 jacks harvested in tribal fisheries below Prosser Dam (Table 4). The mark-selective, non-Indian recreational fishery in the Yakima River in 2009 harvested about 470 spring Chinook.

Estimated escapements were: 7,040 spring Chinook (2,960 jacks; approximately 64% of the total escapement was estimated to be returns from the CESRF) into the upper Yakima River subbasin, and 1,190 spring Chinook into the Naches River and its associated subbasins (Table 1). A total of about 1,530 redds were counted in the upper Yakima River subbasin and 480 redds were counted in the Naches River and its associated subbasins (Table 5).

Forecast for 2010 Yakima River spring Chinook return

Age-4:age-3 and age-5:age-4 cohort ratios and regression relationships for wild/natural fish in the upper Yakima and Naches subbasins independently and for the aggregate Yakima River return were reviewed for all brood years dating back to 1982 (Tables 6-8). Similar relationships were analyzed for the 1997-2005 brood CESRF returns (Table 9). Since most Yakima River spring Chinook return at age-4, the survival of age-3 fish (jacks) in the previous year are the primary driver in these forecasting techniques. As noted above, the method used to compute Yakima River spring Chinook forecasts for 2010 was changed from methods used in prior years. Chandler smolt estimates, juvenile survival estimates for natural- and hatchery-origin fish from Roza to McNary Dams, and NOAA ocean rank (for natural-origin fish) or jack counts and jack size (for hatchery-origin fish) were used as input variables to separate multiple linear regression functions (Tables 10 and 11). Age and stock specific regressions were then used to apportion these aggregate natural- and hatchery-origin forecasts into their component parts. Given these methods, **the forecasts for 2010 spring Chinook returns to the Yakima River mouth are: 16,130 age-4 and 440 age-5 fish for a total projected return of 16,570 adult spring Chinook.**

The forecast includes projected returns of 4,660 wild/natural adult (28%) and 11,910 CESRF adult (72%) spring Chinook.

On average since 1997, the data indicate that forecasting has been accurate to within about +/- 43% of the actual return (Table 12). Note also that a variety of factors can affect the Yakima River mouth return rate of CESRF fish relative to their natural counterparts. These factors include: year-to-year variances in release numbers (Table 13), mark-selective fisheries in the lower Columbia River which target adipose-fin-clipped fish (all CESRF fish are adipose-clipped), and variances in freshwater and ocean survival.

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Table 1. Yakima River Spring Chinook Run (CESRF and wild/natural, Adults and Jacks combined) Reconstruction, 1984-Present.

	River Mouth Run Size[1]			Harvest Below	Prosser	Harvest Above	Spawners Below	Roza	Roza	Est. Escapement		Redd Counts	
Year	Adults	Jacks	Total	Prosser	Count	Prosser	Roza[2]	Count	Removals[3]	Upper Y.R.[4]	Naches[5]	Upper Y.R.	Naches
1984	2,251	407	2,658	119	2,539	170	180	1,619	84	1,535	570	634	220
1985	4,109	451	4,560	321	4,239	544	247	2,428	97	2,331	1,020	860	427
1986	8,841	598	9,439	530	8,909	810	709	3,267	16	3,251	4,123	1,472	1,313
1987	4,187	256	4,443	359	4,084	158	269	1,928	194	1,734	1,729	903	677
1988	3,919	327	4,246	333	3,913	111	60	1,575	235	1,340	2,167	424	490
1989	4,640	274	4,914	560	4,354	187	135	2,515	184	2,331	1,517	915	541
1990	4,280	92	4,372	131	*2,255*	532	282	2,047	31	2,016	*1,380*	678	464
1991	2,802	104	2,906	27	2,879	5	131		40	*1,583*	*1,121*	582	460
1992	4,492	107	4,599	184	4,415	161	39	3,027	18	3,009	1,188	1,230	425
1993	3,800	119	3,919	44	3,875	85	56	1,869	0	1,869	1,865	637	554
1994	1,282	20	1,302	0	1,302	25	10	563	0	563	704	285	272
1995	526	140	666	0	666	79	9	355	0	355	223	114	104
1996	3,060	119	3,179	100	3,079	375	26	1,631	0	1,631	1,047	801	184
1997	3,092	81	3,173	0	3,173	575	20	1,445	261	1,184	1,133	413	339
1998	1,771	132	1,903	0	1,903	188	3	795	408	387	917	147	330
1999	1,513	1,268	2,781	8	2,773	596	55	1,704	738	966	418	212	186
2000	17,519	1,582	19,101	90	19,011	2,368	204	12,327	667	11,660	4,112	3,770	888
2001	21,225	2,040	23,265	1,793	21,472	2,838	286	12,516	718	11,798	5,832	3,260	1,192
2002	14,616	483	15,099	328	14,771	2,780	29	8,922	878	8,044	3,041	2,816	943
2003	4,868	2,089	6,957	59	6,898	381	83	3,842	584	3,258	2,592	868	935
2004	13,974	1,315	15,289	135	15,154	1,544	90	11,005	718	10,287	2,515	3,414	719
2005	8,059	699	8,758	34	8,724	440	28	6,352	667	5,685	1,904	2,009	576
2006	5,951	363	6,314	0	6,314	600	14	4,028	664	3,364	1,672	1,245	444
2007	2,968	1,335	4,303	10	4,293	269	13	3,025	716	2,309	986	722	314
2008	6,615	1,983	8,598	539	8,059	993	9	5,478	1,144	4,334	1,578	1,372	495
2009	7,472	4,648	12,120	1,517	10,603	758	18	8,633	1,595	7,038	1,194	1,527	478

1. River Mouth run size is the greater of the Prosser count plus lower river harvest or estimated escapement plus all known harvest and removals.
2. Estimated as the average number of fish per redd in the upper Yakima times the number of redds between the Naches confluence and Roza Dam.
3. Roza removals include harvest above Roza, hatchery removals, and/or natural broodstock removals.
4. Estimated escapement into the upper Yakima River is the Roza count less harvest or broodstock removals above Roza Dam except in 1991 when Upper Yakima River escapement is estimated as the (Prosser count - harvest above Prosser - Roza subtractions) times the proportion of redds counted in the upper Yakima.
5. Naches River escapement is estimated as the Prosser count less harvest above Prosser and the Roza counts, except in 1983 and 1990 when it is estimated as the upper Yakima fish/redd times the Naches redd count.

Table 2. Estimated Spring Chinook counts at Prosser Dam, 1982-Present.

	Adults			Jacks			Total Passage			Actual CESRF	Forecast CESRF
Year	CESRF	Wild/Nat.[2]	Total	CESRF	Wild/Nat.[2]	Total	Total	Wild/Nat.[2]	CESRF	Percent	Percent
1982			1,453			46	1,499				
1983			748			119	867				
1984			2,321			218	2,539				
1985			3,815			424	4,239				
1986			8,557			352	8,909				
1987			3,758			326	4,084				
1988			3,590			323	3,913				
1989			4,112			242	4,354				
1990			2,202			53	2,255				
1991			2,750			129	2,879				
1992			4,282			133	4,415				
1993			3,795			80	3,875				
1994			1,283			19	1,302				
1995			528			138	666				
1996			2,946			133	3,079				
1997			3,126			47	3,173				
1998			1,771			132	1,903				
1999			1,795			978	2,773				
2000	41[1]	17,381	17,422	741	848	1,589	19,011	18,229			
2001	7,803	11,960	19,763	1,087	622	1,709	21,472	12,582	8,890	41.4%	38.3%
2002	7,393	6,661	14,054	369	348	717	14,771	7,009	7,762	52.5%	56.6%
2003	1,257	3,742	4,999	989	910	1,899	6,898	4,652	2,246	32.6%	20.6%
2004	4,195	10,218	14,413	170	571	741	15,154	10,789	4,365	28.8%	41.2%
2005	737	7,160	7,897	540	287	827	8,724	7,447	1,277	14.6%	17.7%
2006	2,448	3,563	6,012	151	151	302	6,314	3,714	2,599	41.2%	31.3%
2007	823	2,044	2,867	866	560	1,426	4,293	2,604	1,689	39.3%	15.9%
2008	3,264	3,127	6,391	1,169	499	1,668	8,059	3,626	4,433	55.0%	48.3%
2009	3,039	3,590	6,629	3,183	791	3,974	10,603	4,381	6,222	58.7%	55.7%

1. There were no CESRF adults returning in 2000. These are marked fish, presumably out-of-basin strays.
2. All fish prior to 2000 are assumed to be wild.

Table 3. Estimated Spring Chinook counts at Roza Dam, 1982-Present.
(total counts including fish collected and removed for broodstock)

	Adults			Jacks			Total
Year	CESRF	Wild/Nat.[1]	Total	CESRF	Wild/Nat.[1]	Total	Passage
1982			1,057			89	1,146
1983			860			147	1,007
1984			1,371			248	1,619
1985			2,189			239	2,428
1986			2,979			288	3,267
1987			1,854			74	1,928
1988			1,467			108	1,575
1989			*2,375*			*141*	2,515
1990			2,007			40	2,047
1991			No counts available				
1992			2,965			62	3,027
1993			1,795			74	1,869
1994			554			9	563
1995			280			75	355
1996			1,576			55	1,631
1997			1,396			49	1,445
1998			740			55	795
1999			879			825	1,704
2000		11,109	11,109	688	530	1,218	12,327
2001	6,180	5,010	11,190	990	336	1,326	12,516
2002	6,298	2,405	8,703	86	133	219	8,922
2003	1,151	784	1,935	1,133	774	1,907	3,842
2004	2,985	7,093	10,078	216	711	927	11,005
2005	726	4,876	5,602	540	210	750	6,352
2006	1,851	1,906	3,757	127	144	271	4,028
2007	899	1,101	2,000	833	192	1,025	3,025
2008	2,678	1,419	4,097	1,123	258	1,381	5,478
2009	2,860	2,294	5,154	2,743	736	3,479	8,633

1. All fish prior to 2000 are assumed to be wild.

Table 4. Spring Chinook Harvest (adults and jacks combined) in the Yakima River Basin, 1982-Present.

	Tribal		Non-Tribal		River Totals			Harvest
Year	CESRF	Wild/Nat.	CESRF	Wild/Nat.	CESRF	Wild/Nat.	Total	Rate[1]
1982	0	434	0	0	0	434	434	23.8%
1983	0	84	0	0	0	84	84	5.8%
1984	0	289	0	0	0	289	289	10.9%
1985	0	865	0	0	0	865	865	19.0%
1986	0	1,340	0	0	0	1,340	1,340	14.2%
1987	0	517	0	0	0	517	517	11.6%
1988	0	444	0	0	0	444	444	10.5%
1989	0	747	0	0	0	747	747	15.2%
1990	0	663	0	0	0	663	663	15.2%
1991	0	32	0	0	0	32	32	1.1%
1992	0	345	0	0	0	345	345	7.5%
1993	0	129	0	0	0	129	129	3.3%
1994	0	25	0	0	0	25	25	1.9%
1995	0	79	0	0	0	79	79	11.9%
1996	0	475	0	0	0	475	475	14.9%
1997	0	575	0	0	0	575	575	18.1%
1998	0	188	0	0	0	188	188	9.9%
1999	0	604	0	0	0	604	604	21.7%
2000	53	2,305	0	100	53	2,405	2,458	12.9%
2001	572	2,034	1,252	772	1,825	2,806	4,630	19.9%
2002	1,373	1,207	492	36[2]	1,865	1,243	3,108	20.6%
2003	134	306	0	0	134	306	440	6.3%
2004	289	712	569	109[2]	858	820	1,679	11.0%
2005	46	428	0	0	46	428	474	5.4%
2006	246	354	0	0	246	354	600	9.5%
2007	123	156	0	0	123	156	279	6.5%
2008	521	414	586	11[2]	1,107	425	1,532	17.8%
2009	1,089	715	463	8[2]	1,552	722	2,275	18.8%

1. Harvest rate is the river total harvest as a percentage of the river mouth run size given in Table 1.
2. Estimate of post-release mortality of unmarked fish.

Table 5. Yakima Basin spring Chinook redd count summary, 1982 – present.

	Upper Yakima River System[1]				Naches River System				
Year	Mainstem[2]	Cle Elum	Teanaway	Total	American	Naches[2]	Bumping	Little Naches	Total
1982	610	30	0	640	11	25	6	12	54
1983	387	15	0	402	36	27	11	9	83
1984	677	31	0	708	72	81	26	41	220
1985	795	153	3	951	141	168	74	44	427
1986	1,716	77	0	1,793	464	543	196	110	1,313
1987	968	75	0	1,043	222	281	133	41	677
1988	369	74	0	443	187	145	111	47	490
1989	770	192	6	968	187	200	101	53	541
1990	727	46	0	773	143	159	111	51	464
1991	568	62	0	630	170	161	84	45	460
1992	1,082	164	0	1,246	120	155	99	51	425
1993	550	105	1	656	214	189	88	63	554
1994	226	64	0	290	89	93	70	20	272
1995	105	12	0	117	46	25	27	6	104
1996	711	100	3	814	28	102	29	25	184
1997	364	56	0	420	111	108	72	48	339
1998	123	24	1	148	149	104	54	23	330
1999	199	24	1	224	27	95	39	25	186
2000	3,349	466	21	3,836	54	483	278	73	888
2001	2,932	386	21	3,339	392	436	257	107	1,192
2002	2,441	275	110	2,826	366	226	262	89	943
2003	772	87	31	890	430	228	216	61	935
2004	2,985	330	129	3,444	91	348	205	75	719
2005	1,717	287	15	2,019	142	203	163	68	576
2006	1,092	100	58	1,250	133	163	115	33	444
2007	665	51	10	726	166	60	60	28	314
2008	1,191	137	47	1,375	158	165	102	70	495
2009	1,301	197	33	1,531	91	159	163	65	478
Mean	1,022	127	17	1,165	156	179	109	48	492

[1] Yakima River redd counts include redds between the Naches River confluence and Roza Dam. In some years, water conditions preclude accurate counts in this reach and the number of redds is estimated using historical proportions for this reach.

[2] Including minor tributaries.

Table 6. Brood Table for Upper Yakima wild/natural stock.

Brood Year	Estimated Spawners	Estimated Yakima R. Mouth Returns				Returns/ Spawner
		Age-3	Age-4	Age-5	Total	
1982	1,280	324	4,016	411	4,751	3.71
1983	1,125	408	1,882	204	2,494	2.22
1984	1,715	92	1,348	139	1,578	0.92
1985	2,578	114	2,746	105	2,965	1.15
1986	3,960	171	2,574	149	2,893	0.73
1987	2,003	53	1,571	109	1,733	0.87
1988	1,400	53	3,138	132	3,323	2.37
1989	2,466	68	1,779	9	1,856	0.75
1990	2,298	79	566	0	645	0.28
1991	1,713	9	326	22	358	0.21
1992	3,048	87	1,861	95	2,043	0.67
1993	1,925	66	1,606	57	1,729	0.90
1994	573	60	737	92	890	1.55
1995	364	59	1,036	129	1,224	3.36
1996	1,657	1,059	12,882	630	14,571	8.79
1997	1,204	621	5,837	155	6,613	5.49
1998	390	434	2,803	145	3,381	8.68
1999	1,021[1]	164	722	45	930	0.91
2000	11,864	856	7,689	127	8,672	0.73
2001	12,084	775	5,074	222	6,071	0.50
2002	8,073	224	1,875	148	2,247	0.28
2003	3,341[1]	158	1,036	63	1,257	0.38
2004	10,377	207	1,547	115	1,869	0.18
2005	5,713	293	2,583		2,875	0.50
2006	3,378	866				
2007	2,322					
2008	4,343					
2009	7,056[1]					

1. Approximately 45-50% of these fish were jacks.

Table 7. Brood Table for Naches/American wild stock.

Brood Year	Estimated Spawners	Estimated Yakima R. Mouth Returns					Returns/ Spawner
		Age-3	Age-4	Age-5	Age-6	Total	
1982	108	127	1,274	601	0	2,002	18.54
1983	232	190	1,257	1,257	8	2,713	11.68
1984	570	164	1,109	1,080	0	2,354	4.13
1985	1,020	213	667	931	0	1,811	1.77
1986	4,123	103	670	852	31	1,657	0.40
1987	1,729	39	231	400	0	669	0.39
1988	2,167	51	815	1,557	11	2,434	1.12
1989	1,517	39	332	371	0	741	0.49
1990	1,380	40	326	168	0	533	0.39
1991	1,121	10	32	144	127	314	0.28
1992	1,188	52	1,034	661	0	1,747	1.47
1993	1,865	53	603	817	17	1,489	0.80
1994	704	21	160	167	0	348	0.49
1995	223	73	201	498	0	771	3.46
1996	1,047	209	4,010	2,360	0	6,580	6.29
1997	1,133	220	4,645	1,377	0	6,242	5.51
1998	917	364	2,167	2,316	0	4,847	5.28
1999	418[1]	185	369	280	0	835	2.00
2000	4,112	131	2,296	346	0	2,773	0.67
2001	5,832	144	1,598	785	0	2,526	0.43
2002	3,041	78	975	443	0	1,496	0.49
2003	2,592	75	387	1,028	0	1,489	0.57
2004	2,515	227	514	631		1,372	0.55
2005	1,904	246	517				
2006	1,672	253					
2007	986						
2008	1,578						
2009	1,194						

1. Approximately 48% of these fish were jacks.

Table 8. Brood Table for Yakima River aggregate (wild/natural).

Brood Year	Estimated Spawners	Estimated Yakima R. Mouth Returns					Returns/ Spawner
		Age-3	Age-4	Age-5	Age-6	Total	
1982	1,388	451	5,290	1,012	0	6,753	4.86
1983	1,357	598	3,138	1,461	8	5,206	3.84
1984	2,285	256	2,457	1,219	0	3,932	1.72
1985	3,598	327	3,412	1,037	0	4,776	1.33
1986	8,083	274	3,244	1,000	31	4,550	0.56
1987	3,732	92	1,802	508	0	2,402	0.64
1988	3,567	104	3,953	1,689	11	5,757	1.61
1989	3,983	107	2,111	379	0	2,597	0.65
1990	3,678	119	892	168	0	1,178	0.32
1991	2,834	20	358	166	127	672	0.24
1992	4,236	140	2,894	756	0	3,790	0.89
1993	3,790	119	2,209	874	17	3,218	0.85
1994	1,277	81	897	260	0	1,238	0.97
1995	587	132	1,236	627	0	1,995	3.40
1996	2,704	1,268	16,892	2,990	0	21,151	7.82
1997	2,337	841	10,482	1,532	0	12,855	5.50
1998	1,307	798	4,970	2,460	0	8,228	6.30
1999	1,439[1]	349	1,091	325	0	1,765	1.23
2000	15,976	987	9,986	472	0	11,445	0.72
2001	17,916	919	6,671	1,007	0	8,597	0.48
2002	11,113	302	2,849	592	0	3,743	0.34
2003	5,933[2]	233	1,423	1,091	0	2,746	0.46
2004	12,893	434	2,061	746		3,241	0.25
2005	7,617	539	3,100				
2006	5,050	1,119					
2007	3,308[2]						
2008	5,922						
2009	8,250						

1. Approximately 48% of these fish were jacks.
2. Approximately 36% of these fish were jacks.

Table 9. Brood Table for Cle Elum SRF Spring Chinook.

Brood Year	Estimated Spawners[1]	Estimated Yakima R. Mouth Returns				Returns/ Spawner
		Age-3	Age-4	Age-5	Total	
1997	261	741	7,753	176	8,670	33.22
1998	408	1,242	7,939	602	9,782	23.98
1999	738[2]	134	714	16	864	1.17
2000	567	1,103	3,647	70	4,819	8.50
2001	595	396	845	9	1,251	2.10
2002	629	345	1,886	69	2,300	3.66
2003	441	121	800	12	932	2.11
2004	597	805	3,101	115	4,021	6.73
2005	510	1,305	3,019		4,324	8.48
2006	419	3,005				
2007	449					
2008	457					
2009	486					

1. These are the total number of natural fish collected at Roza Dam and taken to the CESRF for production brood stock.
2. 357 or 48% of these fish were jacks.

Table 10. Juvenile Survival Based Regression – Aggregate Wild/Natural Return.

JuvMigrYear	AdltRtnYr	Age4/5Adlts	SmoltsOut	Roza-McNSurv	NOAAOcn	Predicted Age4/5Adlts
1999	2001	13,472	277,087	0.6380	3.5	13,572
2000	2002	6,501	77,009	0.4172	3.2	6,030
2001	2003	3,552	105,422	0.2528	4.6	3,290
2002	2004	10,311	481,414	0.2622	4.3	10,758
2003	2005	7,144	261,707	0.2824	8.6	5,500
2004	2006	3,856	137,343	0.3470	8	4,423
2005	2007	2,014	157,057	0.2569	9.7	2,698
2006	2008	3,152	92,175	0.3175	6.9	3,405
2007	2009	3,846	130,263	0.2857	5.1	4,171
2008	2010		76,859	0.3230	2.4	***4,665***
2009	2011		107,263	0.4310		

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.981767
R Square	0.963866
Adjusted R Square	0.942186
Standard Error	912.409
Observations	9

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	3	1.11E+08	37010809	44.4579477	0.00049904
Residual	5	4162451	832490.27		
Total	8	1.15E+08			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	-1593.42	1811.092	-0.8798144	0.41923049	-6248.98459	3062.1352
X Variable 1	0.019172	0.002514	7.6249224	0.00061695	0.01270877	0.0256358
X Variable 2	17221.26	2973.765	5.7910617	0.00216219	9576.95161	24865.566
X Variable 3	-324.121	156.3901	-2.0725175	0.09294165	-726.134607	77.892306

Table 11. Juvenile Survival Based Regression – Hatchery-Origin Return.

JuvMigrYear	AdltRtnYr	Age4/5Adlts	SmoltsOut	Roza-McNSurv	Age-3 Returns	Age-3 Size@Rtn	Predicted Age4/5Adlts
1999	2001	7,753	97,844	0.4837	741	38.6	7,884
2000	2002	8,115	225,107	0.2474	1,242	40.3	7,417
2001	2003	1,316	450,570	0.2744	134	41.6	1,325
2002	2004	3,663	325,743	0.2100	1,103	42.2	4,403
2003	2005	915	112,077	0.2239	396	42.3	645
2004	2006	2,094	300,087	0.1504	397	41.8	1,471
2005	2007	953	230,665	0.2741	130	41.2	1,295
2006	2008	3,463	159,352	0.1628	901	41.4	3,960
2007	2009	3,626	325,348	0.5387	1,444	45.0	3,497
2008	2010		164,537	0.2573	3,530	44.7	***11,906***
2009	2011		176,489	0.3517			

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.983928
R Square	0.968115
Adjusted R Square	0.93623
Standard Error	687.666
Observations	9

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	4	57432010	14358003	30.3626	0.002985
Residual	4	1891538	472884.5		
Total	8	59323548			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	52239.86	6683.153	7.816649	0.001446	33684.45	70795.26
X Variable 1	0.002403	0.002461	0.976819	0.383969	-0.00443	0.009235
X Variable 2	3560.685	1923.757	1.850902	0.137845	-1780.52	8901.889
X Variable 3	4.52155	0.569129	7.944679	0.001359	2.941394	6.101706
X Variable 4	-1287.54	170.4704	-7.55284	0.001647	-1760.84	-814.234

Table 12. Forecasted versus Actual Return of Age-4 and Age-5 Fish.

Year	Forecast	Actual	Difference	AbsDiff
1997	3,300	3,090	6.8%	6.8%
1998	1,400	1,770	-20.9%	20.9%
1999	1,200	1,510	-20.5%	20.5%
2000	5,200	17,520	-70.3%	70.3%
2001	26,100	21,220	23.0%	23.0%
2002	21,780	14,620	49.0%	49.0%
2003	6,370	4,870	30.8%	30.8%
2004	19,160	13,970	37.2%	37.2%
2005	14,500	8,060	79.9%	79.9%
2006	6,670	5,950	12.1%	12.1%
2007	4,160	2,970	40.1%	40.1%
2008	10,060	6,610	52.2%	52.2%
2009	15,910	7,470	113.0%	113.0%
2010	16,570			
			Average Error in forecast:	42.7%

Table 13. CESRF Smolt Releases by Brood Year[1]

Brood Year	Migration Year	Total Release	Return Year for: Age-3 (jack)	Age-4	Age-5
1997	1999	386,048	2000	2001	2002
1998	2000	589,683	2001	2002	2003
1999	2001	758,789	2002	2003	2004
2000	2002	834,285	2003	2004	2005
2001[2]	2003	370,236	2004	2005	2006
2002	2004	836,904	2005	2006	2007
2003	2005	824,692	2006	2007	2008
2004	2006	785,448	2007	2008	2009
2005	2007	860,002	2008	2009	2010
2006	2008	642,795	2009	2010	2011
2007	2009	771,265	2010	2011	2012

1. Release target is 720,000 to 810,000 smolts, but was intentionally reduced in start-up years of 1997 and 1998.
2. Approximately ½ of production destroyed due to high presence of agents causing Bacterial Kidney Disease (BKD).