

**Yale Reservoir Kokanee (*Oncorhynchus nerka*)
Escapement Report**

2015



North Fork Lewis River Hydroelectric Project
Yale, FERC No. 2071

1.0 INTRODUCTION

This report presents results of kokanee spawner surveys conducted on Cougar Creek in 2015, Per Article 402(b) of the Yale and Swift Federal Energy Regulatory Commission (FERC) operating licenses and Article 402(c) of the Merwin FERC operating license.

2.0 COUGAR CREEK

As in previous years, Cougar Creek was surveyed on foot with two surveyors. Kokanee were enumerated from the stream mouth upstream to its origin, a distance of approximately 2,100 meters. Peak kokanee escapement estimates decreased from 2014 (33,626) to 2015 (20,942). The 2015 spawning estimate of 20,942 fish is well below the latest ten-year average of 28,483. The population continues to remain below the running average of approximately 61,008 kokanee (1978-2015).

For survey purposes, the accessible anadromous fish habitat in Cougar Creek is broken into five survey reaches. There are a series of three major log jams in Reach 3 of Cougar Creek. In 2015, the upper extent of kokanee spawning occurred just above the first downstream log jam in Reach 3.

Cougar Creek was surveyed for kokanee four times in 2015 (*Table 1*). Survey conditions during the sampling time period (Sep – Oct) were ideal, with stable flows and extremely good water clarity.

2.1 Distribution and Timing

The peak kokanee count was recorded on October 29 (*Table 1*). This peak timing of kokanee abundance in 2015 is the latest on record (1978-2015) and most likely was due to drought conditions experienced in the area that caused all watersheds in the basin to run at historical lows. Most kokanee were observed in Reach 2, which is consistent with prior years. This largest concentration of kokanee occurs just below the first log jam kokanee encounter on their travel upstream.

Table 1. Distribution and peak counts of kokanee in Cougar Creek in 2015

* Estimate uses a 2.3 multiplier of the peak count (Graves unpublished data, 1982)

Reach	Kokanee Escapement Recruiting to Cougar Creek 2015			
	Sept 22	Oct 5	Oct 12	Oct 29
1	340	2,640	2,990	2,750
2	500	3,730	5,680	5,805
3	0	0	10	460
4	0	0	0	0
5	0	0	0	0
<i>Spawning Estimate</i>	1,932	14,651	19,941	20,942

2.2 Escapement

The kokanee spawning escapement in 2015 is estimated at 20,942 (*Figure 1*). This is a decrease from the peak observed in 2014 (33,626), and remains well below the annual historical running average of 63,981. Kokanee escapement into Cougar Creek has been below this historical running average since 2003 (Table 3). This year's estimate is also well below the ten-year average of 28,483. Mean fork length of kokanee observed in 2015 (289 millimeters) was larger than what was observed during 2014 (269 millimeters). Historically, mean fork length is a general indicator of number of spawners. The larger the fish, the less spawners observed; conversely, the smaller the mean fork length of spawners, the higher the spawner escapement.

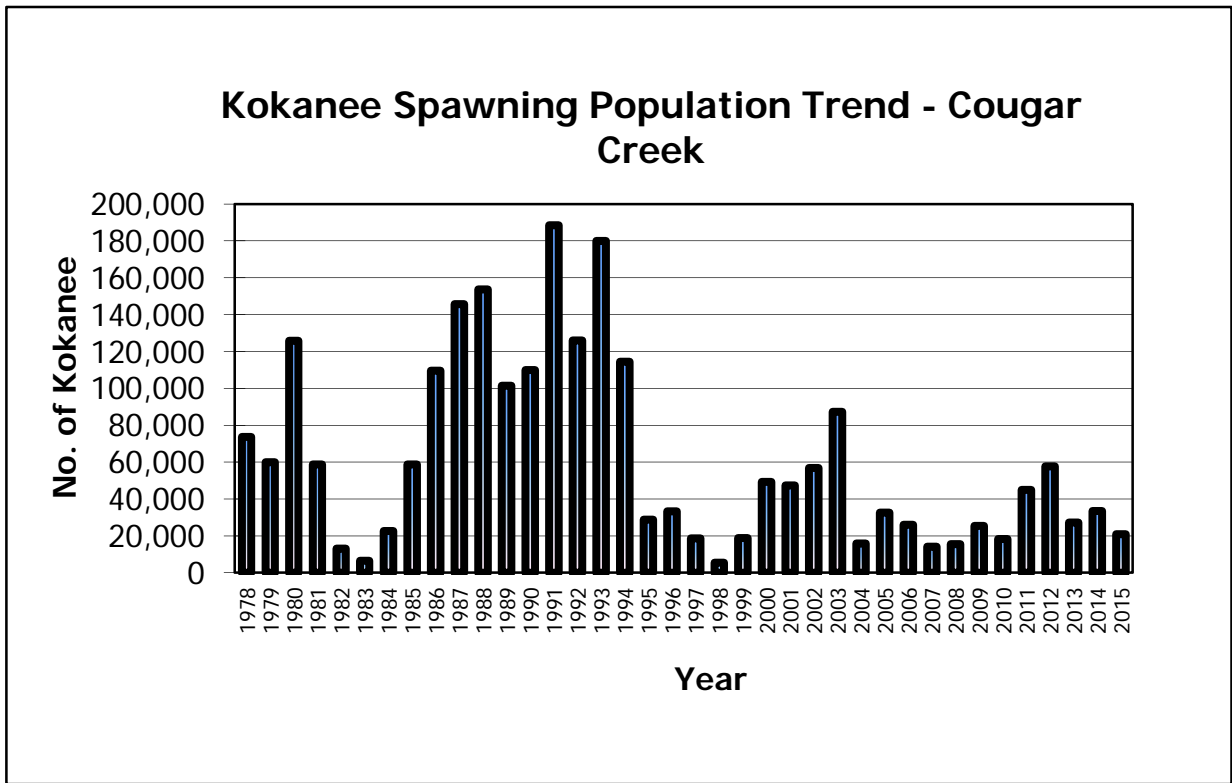


Figure 1. Kokanee spawning estimates for Cougar Creek, 1978-2015

2.3 Length Distribution

Lengths were measured from 21 male and 28 female kokanee (*Figure 2*). The average lengths of male and female kokanee this year were 309 and 289 mm, respectively.

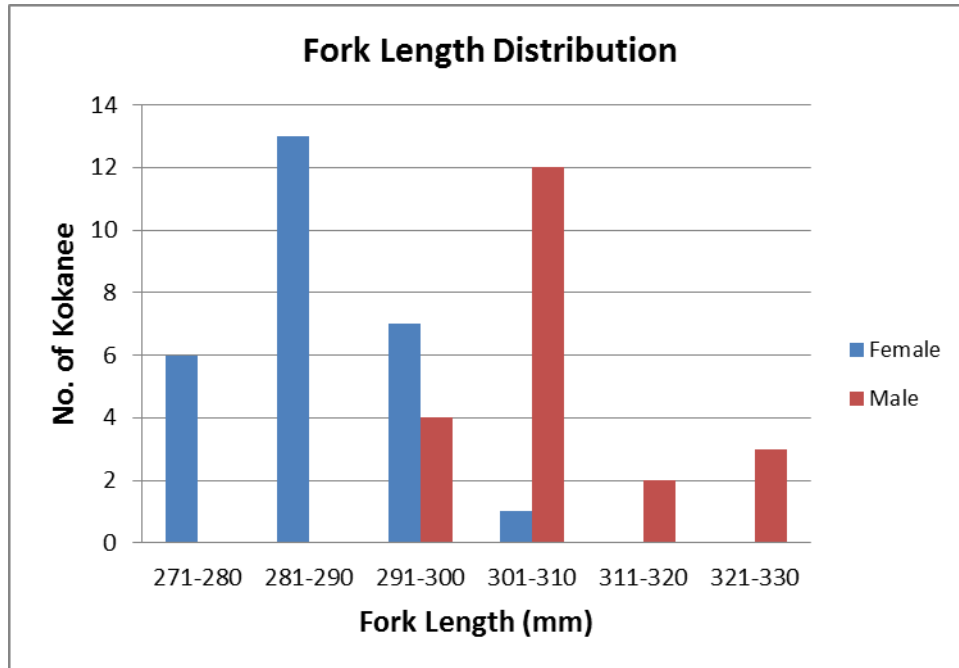


Figure 2. Length frequency histogram of male (n=21) and female (n=28) kokanee lengths (FL) sampled in Cougar Creek, Washington – 2015

The average length of this year's female kokanee (289 mm) is larger than the average female length observed in 2014 (268 mm). The average female fork length in 2015 is greater than the historical running average of 287 mm (1978-2015).

With the regression line established in *figure 3*, the average fork length size for females in 2015 is over-estimated from the equation by only four percent. The fitted line suggests that given the spawning population estimate the female average length should be 302 mm, instead of the observed average of 289 mm, an overestimate of 13 mm. This observed difference in estimation of four percent is negligible and may indicate that during the reservoir life-cycle of this brood year that productivity was ideal for proper fish growth and development.

The size at spawning estimate may be a good indication of reservoir production in terms of food availability and fish growth. When kokanee are smaller than anticipated (based on size at spawning and spawning escapement) it may be an indication that reservoir productivity was limited at some point during their residency in Yale Reservoir.

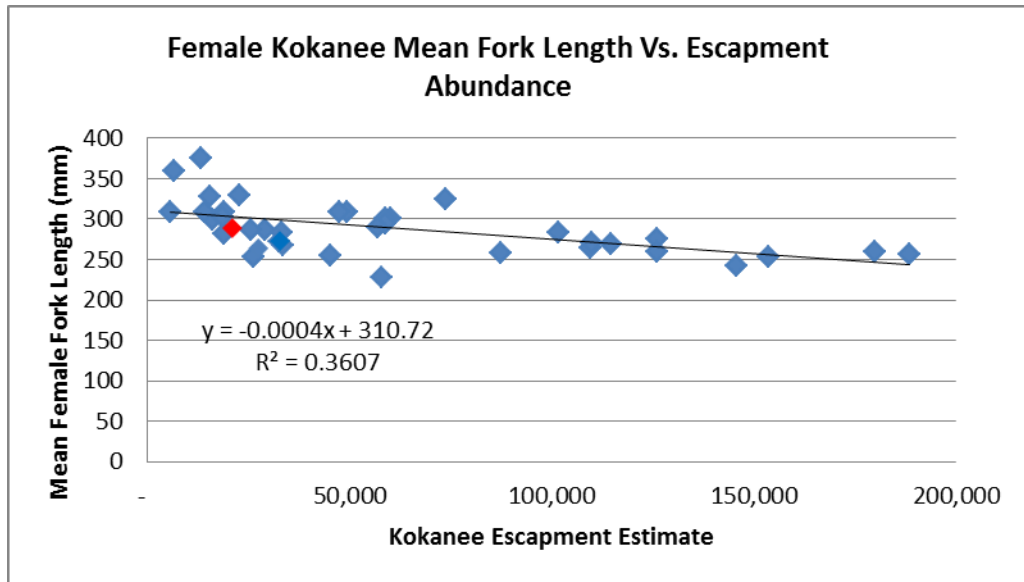


Figure 3. Relationship between mean kokanee fork length (female) and spawning escapement in Cougar Creek (1978-2015). Red dot represents 2015.

4.0 CONCLUSION

Kokanee spawning numbers in Cougar Creek remain below the long-term, 37 year historical average. In the past, decreases in the trend-line (especially due to stochastic events¹) were quickly followed (within 2 to 3yrs.) by years of higher production as female size and fecundity increased, presumably due to lack of competition. The spawner escapement numbers from 2005-2015 do not seem to be following this trend, as estimates remain below the long-term running average. However, the trend line established during this more recent time-frame has been stable, especially when compared to the 30 year long-term trend line.

There are a number of factors that may be limiting Yale Reservoir kokanee escapement including, but not limited to: predation, low reservoir productivity from water turbidity or hydroelectric operations, lack of access to quality spawning habitat in Cougar Creek due to the numerous logjams, harvest, disease, and competition. It is difficult to quantify each factor and its specific effect on kokanee escapement; however, it is clear that kokanee escapement is much lower in Cougar Creek in recent years, especially when compared to historical records. The exact cause(s) are yet to be determined.

¹ Mt. St. Helen's eruption in 1980 affecting the spawner escapement in 1982/1983 and the 100-year flood event in 1996 affecting the spawner escapement in 1998

Table 3. Summary of data collected from Cougar Creek kokanee surveys from 1978 to 2015.

Spawn Year	Peak Count	Date	Estimated Escapement*	Moving Average	Number of Females**	Mean Length (mm) Females	Mean Fecundity+	Total Eggs	Egg-to-Adult % Survival^
1978	32,064		73,747	35,930	36,874	325	582	21,468,547	
1979	26,136		60,113	66,930	30,056	300	515	15,485,658	
1980	54,782		125,999	86,620	62,999	275	448	28,237,546	
1981	25,614		58,912	79,693	29,456	300	515	15,176,372	0.27
1982	5,750		13,225	66,399	6,613	375	716	4,736,005	0.09
1983	2,875		6,613	56,435	3,306	359	673	2,226,230	0.02
1984	9,915		22,805	51,630	11,402	329	593	6,760,850	0.15
1985	25,623	25-Sep-85	58,933	52,543	29,466	294	499	14,707,884	1.24
1986	47,680	10-Oct-86	109,664	58,890	54,832	264	419	22,960,352	4.93
1987	63,406	30-Sep-87	145,834	67,584	72,917	242	360	26,234,042	2.16
1988	66,865	3-Oct-88	153,790	75,421	76,895	254	392	30,138,128	1.05
1989	44,199	11-Oct-89	101,658	77,608	50,829	284	472	24,008,499	0.44
1990	47,859	9-Oct-90	110,076	80,105	55,038	270	435	23,931,558	0.42
1991	81,993	7-Oct-91	188,584	87,854	94,292	256	397	37,462,192	0.63
1992	54,801	2-Oct-92	126,042	90,400	63,021	260	408	25,713,890	0.52
1993	78,260	6-Oct-93	179,998	95,999	89,999	259	405	36,480,195	0.75
1994	49,830	21-Sep-94	114,609	97,094	57,305	269	432	24,763,567	0.31
1995	12,590	12-Oct-95	28,957	93,309	14,479	287	480	6,955,182	0.11
1996	14,508	9-Oct-96	33,368	90,154	16,684	284	472	7,880,615	0.09
1997	8,169	23-Oct-97	18,789	86,586	9,394	308	537	5,041,572	0.08
1998	2,435	6-Oct-98	5,601	82,729	2,800	308	537	1,502,782	0.08
1999	8,260	22-Oct-00	18,998	79,832	9,499	281	464	4,410,386	0.24
2000	21,495	13-Oct-00	49,439	78,511	24,719	308	537	13,265,833	0.98
2001	20,611	24-Sep-01	47,405	77,215	23,703	309	539	12,783,787	3.15
2002	24,750	17-Oct-02	56,925	76,403	28,463	290	488	13,901,654	1.29
2003	38,004	9-Oct-03	87,409	76,827	43,705	258	403	17,598,094	0.66
2004	6,964	8-Oct-04	16,017	74,574	8,009	299	513	4,104,728	0.13
2005	14,226	7-Oct-05	32,720	73,080	16,360	273	443	7,245,145	0.24
2006	11,383	23-Oct-06	26,181	71,462	13,090	254	392	5,130,671	0.15
2007	6,175	17-Oct-07	14,203	69,554	7,101	308	537	3,810,957	0.35
2008	6,780	3-Oct-08	15,594	67,813	7,797	328	590	4,602,257	0.22
2009	11,075	29-Sep-09	25,473	66,490	12,736	286	478	6,084,107	0.50
2010	8,030	4-Oct-10	18,469	65,035	9,235	303	523	4,832,044	0.48
2011	19,610	10/11/2011	45,103	64,449	22,552	254.9	394	8,893,229	0.98
2012	25,150	10/8/2012	57,845	64,260	28,923	227	320	9,243,053	0.95
2013	11,910	10/14/2013	27,393	63,236	13,697	264	419	5,735,272	0.57
2014	14,620	10/3/2014	33,626	62,435	16,813	269	432	7,265,570	0.38
2015	9,105	10/29/2015	20,942	61,008	10,471	289	486	5,086,062	0.23
MEAN	26,671		61,344	73,273	30,672	287	488	13,804,823	

*Peak Count x 2.3 (Graves unpublished data, 1983)

**Assuming a 1:1 ratio

+ From the model: Fecundity = -288.78 + 2.68 x Length of Females (Graves unpublished data, 1983)

^ Estimated Escapement of Adults (3 year-olds) / estimated number of eggs