LAKE SAMMAMISH LATE-RUN KOKANEE
SPAWNING GROUND SURVEY SUMMARY AND ESCAPEMENT ESTIMATE

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INTRODUCTION

The Lake Washington-Sammamish Watershed is one of five watersheds in Washington (Baker, Whatcom, Wenatchee, and Chelan) that support native populations of kokanee *Oncorhynchus nerka* (Pfeifer 1995). There are three distinct kokanee populations within the Lake Washington-Sammamish Watershed, including the early, middle, and late-runs (Berge and Higgins 2003). Early-run kokanee rear in Lake Sammamish and were only known to spawn in Issaquah Creek. Middle-run kokanee are believed to rear in Lake Washington and spawn in tributaries to the Sammamish River, including Swamp, North, Bear, Little Bear, and Cottage Lake creeks. Late-run kokanee also rear in Lake Sammamish, but spawn in south Lake Sammamish tributaries, such as Lewis, Ebright, Laughing Jacobs, Vasa, and Pine Lake creeks.

Native kokanee within the Lake Sammamish Watershed were once very abundant. Anecdotal accounts from past Issaquah Salmon Hatchery staff and former University of Washington graduate student T.J. Berggren estimated escapement of early-run kokanee into Issaquah Creek ranged from 3,000-15,000. However, by the early 1980's fishery managers became alarmed over declines in Lake Sammamish kokanee abundance from historic levels (Pfeifer 1995). Special concern was given to the early-run population in Issaquah Creek. For nearly two decades (1973-2002), fishery managers conducted spawning ground surveys to assess early-run kokanee abundance in Issaquah Creek. Adult trapping was performed in the middle 1980's and again for two years in 2001 and 2002 to collect brood stock for hatchery supplementation. In the middle 1980's, early-run kokanee were collected, but efforts to raise fry at Issaquah Creek Salmon Hatchery failed. No early-run kokanee were collected in adult traps or observed in 2001 and 2002. Based on the 2001-2002 adult trapping efforts and spawning ground surveys, the Washington Department of Fish and Widlife (WDFW) classified the early-run kokanee population as functionally extinct. Middle-run kokanee are still observed in Sammamish River tributaries, however, recent genetic analysis indicates that the native genes appear to have been replaced by Baker Lake origin sockeye genes that primarily spawn in the Cedar and Sammamish watersheds (Young et. al. 2004). The only native kokanee population remaining in the watershed is the late-run component that spawns in south Lake Sammamish tributaries. Late-run kokanee abundance is declining and is the conservation focus of several natural resource entities.

Lake Washington-Sammamish Watershed kokanee have been petitioned twice for listing under the Endangered Species Act (ESA). The first petition was submitted in 2000 and requested that only the early-run kokanee population be listed under ESA. This petition was ultimately denied by the United States Fish and Wildlife Service (USFWS). In 2007, a group comprised of local jurisdictions and non-governmental organizations submitted another petition to list late-run kokanee as either threatened or endangered under ESA. The new petition requests that all three kokanee populations be listed under ESA and argues that the Lake Washington-Sammamish watershed should be its own distinct population segment. This petition is still under review and awaiting a decision by USFWS.

Since late-run kokanee appear to be the only remaining population segment in the Lake Washington-Sammamish Watershed, considerable attention has been given to learn more about the biology and ecology of this species. The WDFW Region 4 Fish Program, with assistance from King County Department of Natural Resources and Parks and volunteer stream walkers,

annually conducts spawning ground surveys for late-run kokanee within selected Lake Sammamish tributaries from November through January to estimate spawner escapement. During the 2009-10 spawning run, surveys began earlier in October and concluded later in February. Annual spawning ground surveys allow the WDFW and other interested entities to monitor late-run kokanee escapement trends.

METHODS

Selected Lake Sammamish tributary streams known to have late-run kokanee spawning were surveyed bi-weekly to daily from October through early February. For the 2009-10 late-run kokanee spawning run, a brood stock collection component was added to the spawning ground survey methodology. Survey frequency was largely dictated by brood stock collection goals identified in the hatchery supplementation plan. Escapement estimates provided below include brood stock that were removed from the spawning grounds. Tributaries surveyed included Lewis, Laughing Jacobs, Ebright, and Pine Lake creeks. Surveyors walked upstream in each tributary counting all live and dead fish observed. Dead fish encountered were processed for biological data. Biological data collected included fork length (mm), sex, otoliths, and a tissue sample for DNA analysis.

Escapement is estimated by using the area under the curve (AUC) methodology. AUC consists of graphing live fish counts (y-axis) over survey dates (x-axis) and then finding the area underneath that curve. The calculated AUC value, termed fish-days, is then divided by an average stream life value for spawning kokanee to determine total escapement. For the 2009/10 late-run kokanee spawning run, a stream life value of 10 days was used to estimate final escapement. This stream life value was selected based on stream life values for kokanee and sockeye identified in the literature, from field observations in the tributaries, and for comparison purposes a 10 day stream life has been used to estimate escapement in the past. However, since stream life for kokanee within south Lake Sammamish tributaries can be variable (between and within years), total fish-days was divided by four different stream life values (5, 7, 10, and 12 days) to provide a range of possible escapements.

Late-run kokanee escapement has been estimated annually in Lewis, Ebright, and Laughing Jacobs creeks since the 1996-97 spawning run. This dataset was summarized to assess spawner escapement trends in each tributary and as a single pooled stock. Additionally, a series of average escapements was calculated for each tributary and the pooled stock to compare with the 2009-10 spawning run. Averages calculated include a total dataset (1996-97 to 2009-10) average, a recent 4-year average (2005-07 to 2008-09), and an all years (1996-97-2008-09) average.

RESULTS

Lewis Creek:
Lewis Creek was surveyed 46 times from October 2nd, 2009 to February 4th, 2010. Survey frequency initially started at two days per week until kokanee were first observed and then increased to almost daily through November. From December through early February, spawning ground surveys were conducted 2-3 days per week until no more live kokanee were observed.

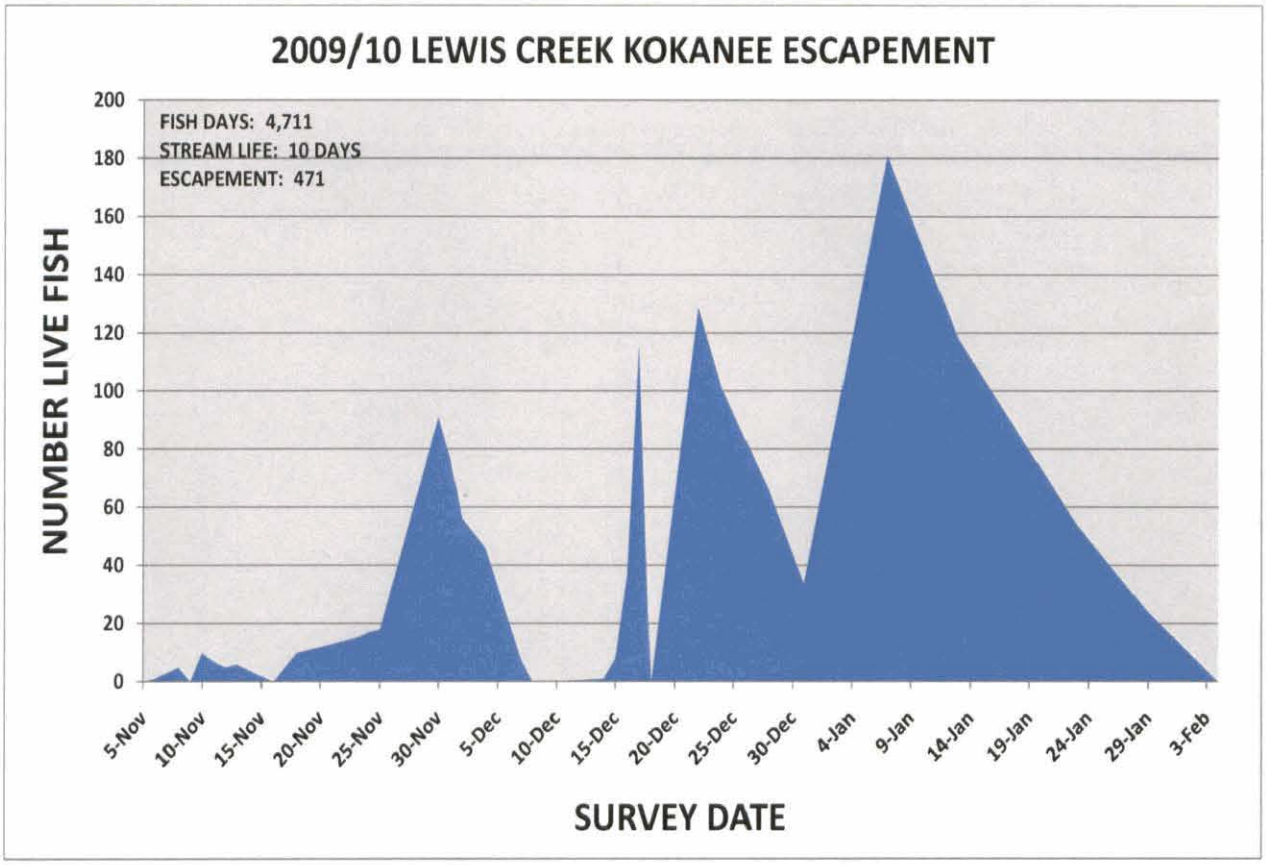
Late-run kokanee were first observed in Lewis Creek on November 6th and last seen on January 29th. Peak live counts occurred on January 7th when 181 live kokanee were observed in Lewis Creek. Total fish-days calculated from AUC is 4,711. Using a 10 day stream life, total escapement into Lewis Creek is estimated to be 471 fish. The 2009-10 escapement estimate was lower than the all years (1996-97 to 2008-09) average of 471 fish, but is about three times greater than the recent 4-year average of 172 fish. However, since stream life appeared to be variable during the spawning run, a series of stream life values (5, 7, 10, and 12 days) was used to estimate a possible range of total escapements. Based on these stream life values, late-run kokanee escapement could range between 393 to 942 fish. Table 1 and Figure 1 summarize both the spawning ground survey and escapement data.

A total of 21 carcasses were processed for biological data in Lewis Creek. All carcasses sampled came from brood stock collected from the spawning grounds and taken to Issaquah Creek Hatchery. Of the total, 10 females (47.6%) and 11 males (53.4%) were processed. Average fork length for female and male kokanee is nearly identical at 376mm and 375mm, respectively. Otoliths were extracted from all 21 carcasses. Otoliths have not been read to determine age structure of late-run kokanee. As soon as otoliths are read, data will be summarized and provided to Kokanee Work Group (KWG) for review.

Table 1. Lewis Creek late-run kokanee spawning ground survey summary and escapement estimate.

SURVEY DATES	TOTAL LIVE FISH	TOTAL DEAD FISH	FISH DAYS	SURVEY DATE	TOTAL LIVE FISH	TOTAL DEAD FISH	FISH DAYS
2-Oct	0	0	0	24-Nov	17	0	16
5-Oct	0	0	0	25-Nov	18	0	18
9-Oct	0	0	0	30-Nov	91	0	273
12-Oct	0	0	0	1-Dec	77	2	84
21-Oct	0	0	0	2-Dec	56	2	67
23-Oct	0	0	0	4-Dec	46	2	102
27-Oct	0	0	0	7-Dec	8	0	81
29-Oct	0	0	0	8-Dec	0	0	4
2-Nov	0	0	0	9-Dec	0	0	0
3-Nov	0	0	0	14-Dec	1	0	3
4-Nov	0	0	0	15-Dec	8	1	5
5-Nov	0	0	0	16-Dec	37	0	23
6-Nov	1	0	1	17-Dec	116	3	77
8-Nov	5	0	6	18-Dec	0	0	58
9-Nov	0	0	3	22-Dec	129	2	258
10-Nov	10	0	5	24-Dec	101	0	230
11-Nov	7	0	9	28-Dec	66	0	334
12-Nov	5	0	6	31-Dec	34	4	150
13-Nov	6	0	6	7-Jan	181	2	753
16-Nov	0	0	9	13-Jan	118	1	897
18-Nov	10	0	10	23-Jan	54	6	860
20-Nov	12	0	22	29-Jan	24	2	234
23-Nov	15	0	41	4-Feb	0	0	72
TOTALS:					**1,253**	**27**	**4,711**
ESC 5-DAY STREAM LIFE:							**942**
ESC 7-DAY STREAM LIFE:							**673**
ESC 10-DAY STREAM LIFE:							**471**
ESC 12-DAY STREAM LIFE:							**393**

Figure 1. Lewis Creek spawning ground survey summary.



Ebright Creek:

Ebright Creek was surveyed 42 times from October 2nd, 2009 to February 8th, 2010. Survey frequency initially started at two days per week until kokanee were first observed and then increased to almost daily through November. From December through early February, spawning ground surveys were conducted 2-3 days per week until no more live kokanee were observed. A single kokanee male was observed in Ebright Creek on October 27th, but not seen again until November 6th. The last live kokanee was observed on February 4th. Peak live counts occurred on November 30th when 239 live kokanee were observed in Ebright Creek. Total fish-days calculated from AUC is 11,228. Using a 10 day stream life, total escapement into Ebright Creek is estimated to be 1,123 fish. The 2009-10 escapement estimate is five times greater than the all years (1996-97 to 2008-09) average of 273 fish and approximately ten times greater than the recent 4-year average of 114 fish. However, since stream life appeared to be variable during the spawning run, a series of stream life values (5, 7, 10, and 12 days) was used to estimate a possible range of total escapements. Based on these stream life values, late-run kokanee escapement could range between 936 to 2,246 fish. Table 2 and Figure 2 summarize both the spawning ground survey and escapement data.

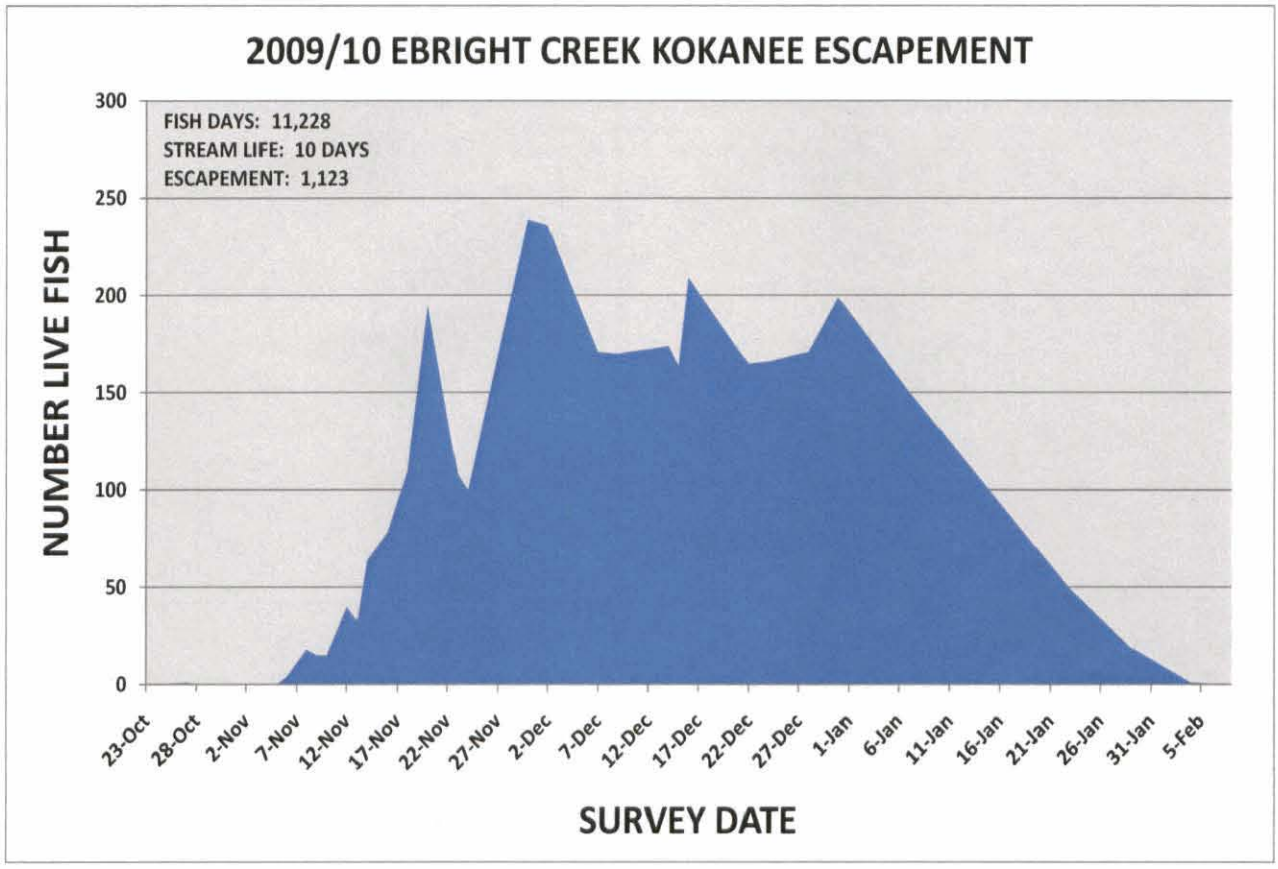
A total of 80 carcasses were processed for biological data in Ebright Creek. All carcasses sampled came from brood stock collected from the spawning grounds and taken to Issaquah

Creek Hatchery. Of the total, 52 females (65.0%) and 28 males (35.0%) were processed. Average fork length for female and male kokanee is 365mm and 376mm, respectively. Otoliths were extracted from all 80 carcasses. Otoliths have not been read to determine age structure of late-run kokanee. As soon as otoliths are read, data will be summarized and provided to the KWG for review.

Table 2. Ebright Creek late-run kokanee spawning ground survey summary and escapement estimate.

SURVEY DATES	TOTAL LIVE FISH	TOTAL DEAD FISH	FISH DAYS	SURVEY DATE	TOTAL LIVE FISH	TOTAL DEAD FISH	FISH DAYS
2-Oct	0	0	0	18-Nov	110	0	188
5-Oct	0	0	0	20-Nov	195	0	305
9-Oct	0	0	0	23-Nov	108	0	455
12-Oct	0	0	0	24-Nov	100	0	104
21-Oct	0	0	0	30-Nov	239	2	1,017
23-Oct	0	0	0	2-Dec	236	5	475
27-Oct	1	0	2	4-Dec	209	4	445
29-Oct	0	0	0	7-Dec	171	7	570
2-Nov	0	0	0	9-Dec	170	26	341
3-Nov	0	0	0	14-Dec	174	24	860
4-Nov	0	0	0	15-Dec	164	36	169
5-Nov	0	0	0	16-Dec	209	13	187
6-Nov	4	0	2	22-Dec	165	8	1,122
8-Nov	18	0	22	24-Dec	166	12	331
9-Nov	15	0	17	28-Dec	171	15	674
10-Nov	15	0	15	31-Dec	199	26	555
11-Nov	27	0	21	7-Jan	151	5	1,225
12-Nov	40	0	34	23-Jan	49	6	1,600
13-Nov	33	0	37	29-Jan	19	0	204
14-Nov	64	0	49	4-Feb	1	0	60
16-Nov	78	0	142	8-Feb	0	0	2
TOTALS:					**3,301**	**189**	**11,228**
ESC 5-DAY STREAM LIFE:							**2,246**
ESC 7-DAY STREAM LIFE:							**1,604**
ESC 10-DAY STREAM LIFE:							**1,123**
ESC 12-DAY STREAM LIFE:							**936**

Figure 2. Ebright Creek spawning ground survey summary.



Laughing Jacobs Creek:

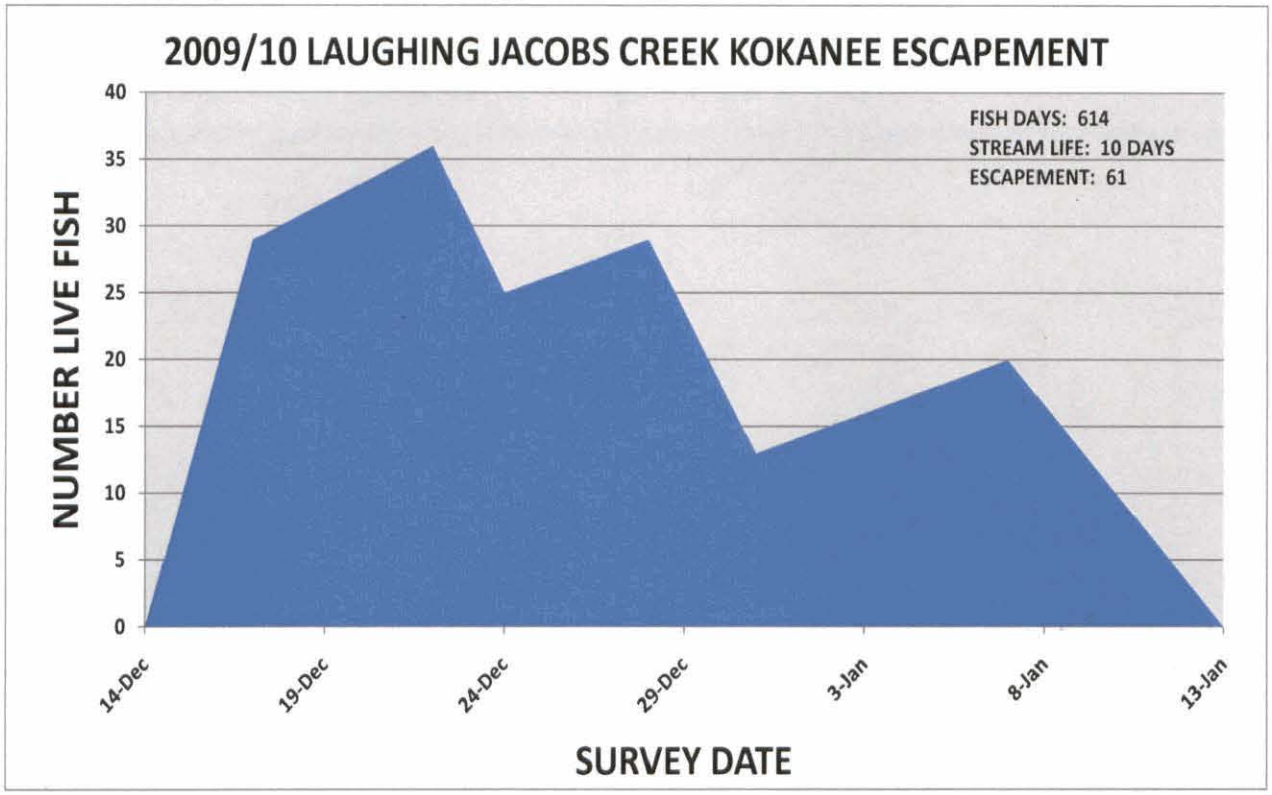
Lewis Creek was surveyed 35 times from October 2nd, 2009 to January 13th, 2010. However, due to time constraints associated with brood stock collection in Lewis and Ebright creeks, many of the early surveys were "spot checks" where only selected portions of the creek were checked for live fish. Spot check ceased and full spawning ground surveys were initiated once live kokanee were first observed in Laughing Jacobs Creek. Survey frequency initially started at two days per week until kokanee were first observed and then increased to almost daily through November. From December through early February, spawning ground surveys were conducted 2-3 days per week until no more live kokanee were observed. Late-run kokanee were first observed in Laughing Jacobs Creek on December 17th and last seen on January 7th. Peak live counts occurred on December 22nd when 36 live kokanee were observed in Laughing Jacobs Creek. Total fish-days calculated from AUC is 614. Using a 10 day stream life, total escapement into Laughing Jacobs Creek is estimated to be 61 fish. The 2009-10 escapement estimate is below the all years (1996-97 to 2008-09) estimate of 83 fish, but approximately twice the recent 4-year average of 31 fish. However, since stream life appeared to be variable during the spawning run, a series of stream life values (5, 7, 10, and 12 days) was used to estimate a possible range of total escapements. Based on these stream life values, late-run kokanee escapement could range between 51 to 123 fish. Table 3 and Figure 3 summarize both the

spawning ground survey and escapement data. No late-run kokanee carcasses were sampled for biological data from Laughing Jacobs Creek.

Table 3. Laughing Jacobs Creek late-run kokanee spawning ground survey summary and escapement estimate.

SURVEY DATES	TOTAL LIVE FISH	TOTAL DEAD FISH	FISH DAYS	SURVEY DATE	TOTAL LIVE FISH	TOTAL DEAD FISH	FISH DAYS
2-Oct	0	0	0	13-Nov	0	0	16
5-Oct	0	0	0	16-Nov	0	0	18
9-Oct	0	0	0	20-Nov	0	0	273
12-Oct	0	0	0	21-Nov	0	2	84
21-Oct	0	0	0	24-Nov	0	2	67
23-Oct	0	0	0	25-Nov	0	2	102
27-Oct	0	0	0	2-Dec	0	0	81
29-Oct	0	0	0	4-Dec	0	0	4
2-Nov	0	0	0	9-Dec	0	0	0
3-Nov	0	0	0	14-Dec	0	0	3
4-Nov	0	0	0	17-Dec	29	0	5
5-Nov	0	0	0	22-Dec	36	1	23
6-Nov	0	0	1	24-Dec	25	2	77
8-Nov	0	0	6	28-Dec	29	2	58
9-Nov	0	0	3	31-Dec	13	0	258
10-Nov	0	0	5	7-Jan	20	1	230
11-Nov	0	0	9	13-Jan	0	0	334
12-Nov	0	0	6				
TOTALS:					**152**	**6**	**614**
ESC 5-DAY STREAM LIFE:							**123**
ESC 7-DAY STREAM LIFE:							**88**
ESC 10-DAY STREAM LIFE:							**61**
ESC 12-DAY STREAM LIFE:							**51**

Figure 3. Laughing Jacobs Creek spawning ground survey summary.



Pine Lake Creek:

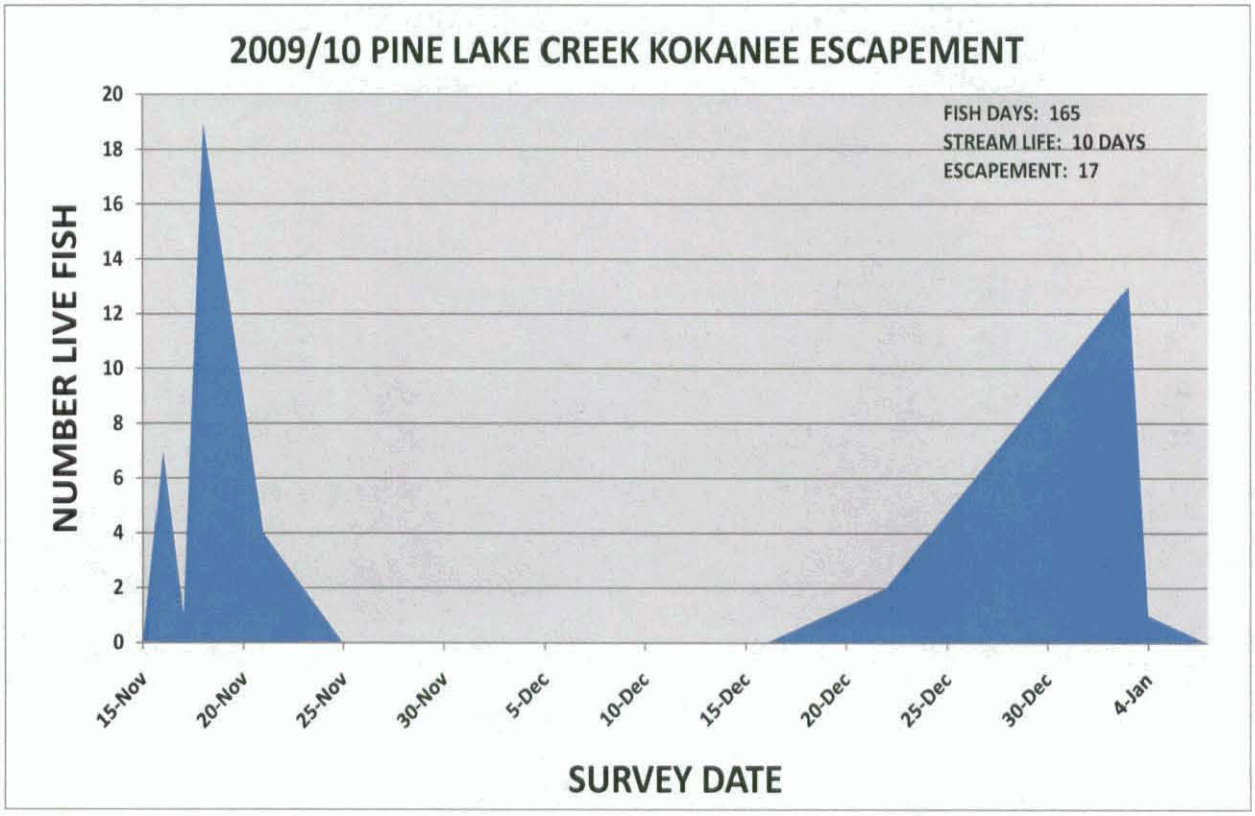
Pine Lake Creek was survweyed14 times from November 15th, 2009 to January 7th, 2010. Spawning ground surveys were conducted two days per week. Late-run kokanee were first observed in Pine Creek on November 16th and last seen on January 7th. Peak live counts occurred on November 18th when 19 live kokanee were observed in Pine Lake Creek. Total fish-days calculated from AUC is 165. Using a 10 day stream life, total escapement into Pine Lake Creek is estimated to be 16 fish. Table 4 and Figure 4 summarize both the spawning ground survey and escapement data. No late-run kokanee carcasses were sampled for biological data from Pine Lake Creek.

Table 4. Pine Lake Creek late-run kokanee spawning ground survey summary and escapement estimate.

SURVEY DATES	TOTAL LIVE FISH	TOTAL DEAD FISH	FISH DAYS	SURVEY DATE	TOTAL LIVE FISH	TOTAL DEAD FISH	FISH DAYS
15-Nov	0	0	0	5-Dec	0	0	0
16-Nov	7	0	4	12-Dec	0	0	0
17-Nov	1	1	4	16-Dec	0	0	0
18-Nov	19	0	10	22-Dec	2	0	6
21-Nov	4	1	35	3-Jan	13	1	90
25-Nov	0	0	8	4-Jan	1	0	7
3-Dec	0	0	0	7-Jan	0	0	2
TOTALS:					**47**	**3**	**165**
ESC 5-DAY STREAM LIFE:							**33**

ESC 7-DAY STREAM LIFE:	**24**
ESC 10-DAY STREAM LIFE:	**16**
ESC 12-DAY STREAM LIFE:	**14**

Figure 4. Pine Lake Creek spawning ground survey summary.



Late-Run Kokanee Escapement Trends:

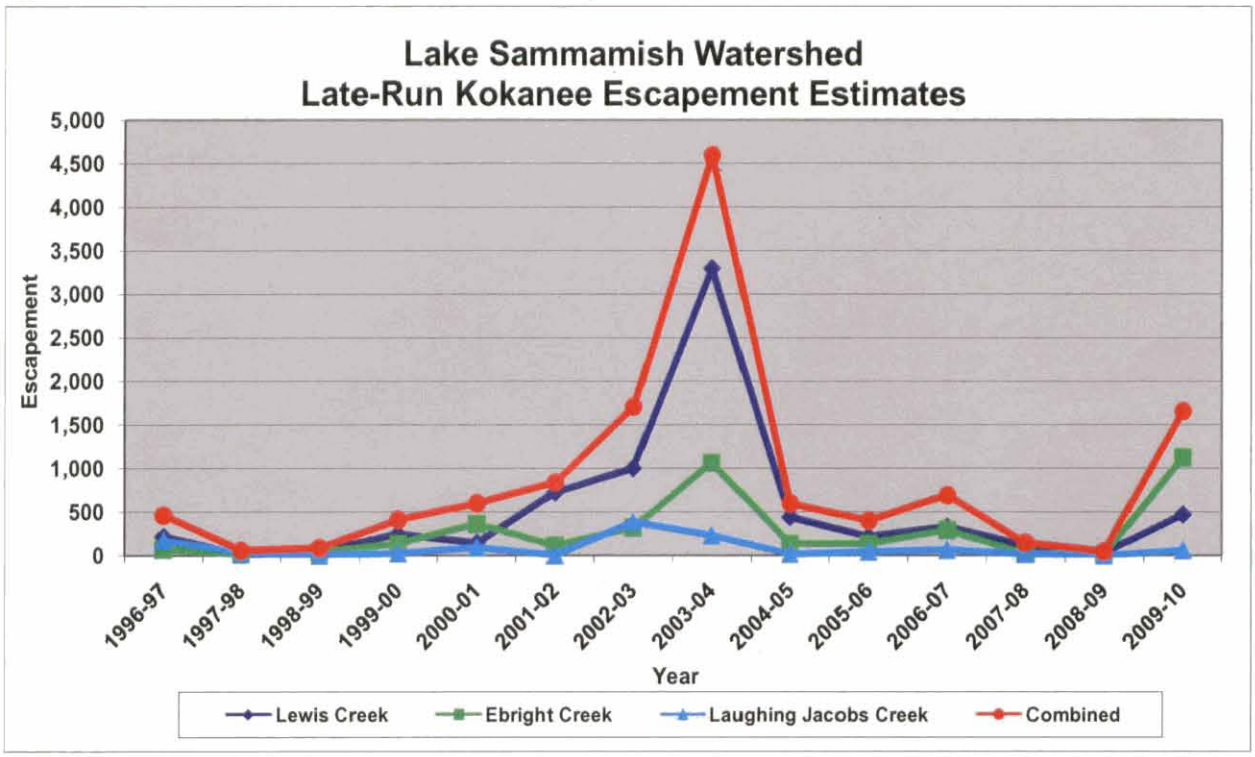
Total late-run kokanee escapement rebounded significantly from the past two years. The total combined late-run kokanee escapment estimate for Lewis, Ebright, and Laughing Jacobs creeks is 1,655 fish based on a 10-day stream life. Late-run kokanee escapment increases to 1,671 when Pine Lake Creek is included in the total estimate. However, when applying different stream life values (5, 7, 10, and 12 days) the pooled late-run kokanee escapement estimate could range from 1,380-3,311 fish. The 2009-10 escapement estimate is the third highest observed since records began in 1996. The 2009-10 late-run kokanee combined escapement estimated is more than double the all-years average of 815 fish and greater than five times the recent 4-year average of 317 fish. Table 5 and Figure 5 summarize late-run kokanee escapment trends and averages.

Table 5. Lake Sammamish late-run kokanee escapement trends.

YEAR	LEWIS	EBRIGHT	LAUGHING JACOBS	COMBINED
1996-97	219	70	170	459
1997-98	10	15	29	54
1998-99	43	40	0	83
1999-00	247	134	27	408
2000-01	143	362	92	597
2001-02	722	110	2	834

2002-03	1,002	319	384	1,705
2003-04	3,296	1,063	232	4,591
2004-05	442	134	18	594
2005-06	217	135	44	396
2006-07	330	292	65	687
2007-08	111	17	15	143
2008-09	29	12	1	42
2009-10	471	1,123	61	1,655
AVE (All Years):	**520**	**273**	**81**	**875**
AVE (96-08):	**524**	**208**	**83**	**815**
AVE (4-Year, 06-09):	**172**	**114**	**31**	**315**

Figure 5. Combined late-run kokanee spawner escapement trend.



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