

Lake Sammamish Late-Run Kokanee
2010-11 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 kokanee *Oncorhynchus nerka* (Pfeifer 1995). Three separate kokanee populations historically inhabited the Lake Washington-Sammamish Watershed: 1) Early-run kokanee, 2) Middle-run kokanee, and 3) Late-run kokanee (Berge and Higgins 2003). Early-run kokanee occurred in Lake Sammamish and were only known to spawn in Issaquah Creek. Middle-run kokanee rear in Lake Washington and spawn in tributaries of the Sammamish River, including Swamp, North, Bear, Little Bear, and Cottage Lake creeks. Late-run kokanee rear in Lake Sammamish and primarily spawn in Ebright, Lewis, and Laughing Jacobs Creeks, which flow into the south end of Lake Sammamish. Late-run kokanee adults have also been reported in other small Lake Sammamish tributaries (George Davis, Pine Lake, Vasa, and Zaccuse Creeks), but kokanee spawning has not been confirmed in these streams.

Native kokanee in the Lake Sammamish watershed were once abundant, and historically supported harvest fisheries with run sizes numbering in the tens of thousands. However, kokanee abundance levels in Lake Sammamish began to decline in the 1980s (Pfeifer 1995). Kokanee fisheries in Lake Sammamish were discontinued during the 1990s, as kokanee abundance continued to decline. Despite reductions in harvest, the early-run kokanee population that used Issaquah Creek for spawning continued to decline, ultimately reaching abundance levels so low that standard stream survey methods were not able to detect any returning fish during the spawning season. (Pfeifer 1995). Early-run kokanee spawning escapement is not currently monitored, and this population may have been extirpated. The middle-run kokanee population spawning in tributaries to the Sammamish River was likely affected or replaced by Baker Lake sockeye that were planted throughout the early 1900s (Young et al. 2004). Middle-run kokanee escapement is not currently monitored, and the relative size and health of this population is unknown. Late-run kokanee are currently the only detectable native kokanee population that still spawns and rears within the Lake Sammamish watershed.

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 late-run kokanee population be listed under ESA. This petition was ultimately denied by the United States Fish and Wildlife Service (USFWS). A group comprised of local

jurisdictions and non-governmental organizations submitted another petition to list kokanee as either threatened or endangered under ESA in 2007. 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 by the USFWS in Washington DC.

Late-run kokanee abundance has been highly variable, and the efforts of several local natural resource management agencies have focused on monitoring and recovering this population. Recently, the Lake Sammamish Kokanee Technical Workgroup (LSKWG) was formed by Washington Department of Fish and Wildlife (WDFW), King County Department of Natural Resources and Parks (KCDNRP), Save Lake Sammamish, Friends of Pine Lake Creek, Cities of Issaquah, Bellevue, Redmond, and Sammamish, and the USFWS. The goal of the LSKWG is to prevent extinction and improve the health of the native kokanee population such that it is viable and self-sustaining, and can support fishing opportunities. Conservation efforts of the LSKWG include public outreach and education, annual spawning ground surveys, and most recently, development of a supplementation program to increase spawning success of the population. The WDFW Region 4 Fish Program, KCDNRP, and local area volunteers survey selected Lake Sammamish tributaries annually for spawning late-run kokanee from October to February to estimate adult escapement.

The objective for this report is to summarize spawning ground surveys for late-run kokanee in primary spawning tributaries between October 2010 and January 2011, and to document wild broodstock collection activities associated with the supplementation program. Results of these monitoring activities will contribute to the index of late-run kokanee abundance in the Lake Sammamish watershed, and help evaluate the long-term success of conservation activities.

Methods

Spawning Ground Surveys and Adult Escapement: Regular surveys were conducted for kokanee spawning activity in Ebright Creek (RM 0.0 – RM 0.5), Lewis Creek (RM 0.0 – RM 1.0), and Laughing Jacobs Creek (RM 0.0 – 0.8). The upper reaches (upstream from surveyed areas) of these three streams are not accessible to fish migrating from Lake Sammamish, and surveys encompassed the entire spawning habitat available. Ebright, Lewis, and Laughing Jacobs creeks were monitored for spawning activity four to five days per week between November 2, 2010 and January 31, 2011 (Figure 1). Numbers of live fish, dead fish, and redds were recorded during each survey. Pine Lake Creek was surveyed 5 times per week from October through January by Mike Schmidt, a volunteer. Smaller tributaries known to support low levels of kokanee spawning in some years (i.e. Vasa Creek, Zacuse, and George Davis Creek) were not surveyed, but local landowners did provide occasional reports of fish sightings and spawning activity. Kokanee carcasses encountered during spawning ground surveys were processed for biological data including length, sex, otoliths, egg retention, and tissue samples for DNA analysis.

Adult escapement was estimated using the area under the curve index escapement (AUC; Ames 1984; Perrin and Irvine 1990). Live fish counts are combined for a stream system and plotted (y-axis) by date (x-axis). The first step is to calculate fish days (F) as

$$F_{t+1} = \left(\frac{C_t + C_{t+1}}{2} \right) \times (J_{t+1} - J_t), \quad \text{Equation 1}$$

where C_t is the live count for the first survey, C_{t+1} is the live count of the second survey, and J_t and J_{t+1} corresponds to the Julian Day of each of the live counts, respectively. AUC is then calculated as

$$AUC = \frac{\sum_t^{t_f} F}{V}, \quad \text{Equation 2}$$

where F represents fish days, V is the number of days a fish is susceptible to being counted by surveyors (stream life estimate), and t_f represents the last survey date. A stream life estimate (V) of 10 days was used to estimate total escapement for the 2010-11 spawning season. The stream life estimate of 10 days is likely higher than the actual stream life for Lake Sammamish kokanee (i.e. Spawning kokanee typically are present in Lake Sammamish spawning streams for less than a 10-day duration), but a 10-day value is used to be consistent with past escapement estimates. Broodstock removed from streams for use in the supplementation program were not included in the live fish counts because they were not permitted to spawn naturally, but were added into the final escapement estimate (total run size estimate) for each stream.



Figure 1. Lake Sammamish tributaries known to be used by late-run kokanee for spawning.

Brood Stock Collection: The kokanee supplementation program, initiated in 2008, is an important strategy in the overall effort to recover late-run kokanee in Lake Sammamish. Adult kokanee are collected for the supplementation program from Lewis, Ebright, and Laughing Jacobs creeks using dip-nets and a backpack electrofisher, and transported to Issaquah Hatchery for use as wild broodstock. Adult kokanee that are actively spawning, or that have initiated redd construction, are not collected and efforts are taken to avoid disrupting them. Broodstock collection efforts span the duration of the kokanee spawning season, and the number of wild fish taken for use in the supplementation program varies annually with the strength of the kokanee run (Table 1). Broodstock collection goals and spawning guidelines for the program are described in the Kokanee Supplementation Plan (LSKWG 2010).

	Size of Return/Escapement		
	Low	Medium	Good
Laughing Jacobs Creek	<50	50-100	>100
Collection goal (% of run)	75%	50%	25%
Lewis Creek	<50	50-200	>200
Collection goal (% of run)	75%	33%	15%
Ebright Creek	<50	50-100	>100
Collection goal (% of run)	75%	33%	15%

Table 1. Broodstock collection goals by tributary under different run size scenarios (Source: LSKWG 2010).

Results

Spawning Ground Surveys and Adult Escapement: Spawning ground surveys in Ebright, Lewis, and Laughing Jacobs Creeks began on November 2, 2010 and extended until January 31, 2011, after kokanee spawning activity was no longer observed. Surveys were typically conducted four to five days per week (Appendix A), although periods of extended rain and high stream flows precluded effective surveys during portions of the spawning season. A total of 38 surveys were conducted on Lewis Creek, 32 surveys on Laughing Jacobs Creek, and 40 surveys were conducted on Ebright Creek. Although Pine Lake Creek was surveyed over 36 days, no kokanee were observed.

Kokanee spawning escapement (AUC method with a 10-day stream life) was estimated at 13 fish in Ebright Creek, 4 fish in Laughing Jacobs Creek, and 1 fish in Lewis Creek during the 2010-11 spawning season (Table 2). In addition to the spawning escapement, 26 wild (16♂, 10♀) broodstock fish were collected from Ebright Creek, 9 wild (5♂, 4♀) broodstock were collected from Laughing Jacobs Creek, and 5 wild (4♂, 1♀) broodstock were collected from Lewis Creek. Total run size (spawning escapement plus broodstock) for 2010-11 kokanee spawning season was estimated at 39 fish in Ebright Creek, 13 fish in Laughing Jacobs Creek, and 6 fish in Lewis Creek (Table 2).

The kokanee spawning escapement estimate for 2010-11 is likely lower than the actual spawning escapement. Although the escapement estimate may not be accurate, the methods used to arrive at the estimate are consistent with those that have been used in past survey seasons, and this estimate can be compared with previous escapements that have been recorded. The primary reason this estimate may be low is that total fish days are divided by a stream life estimate of 10

days, rather than a stream life estimate of 1-3 days, which more accurately reflects the amount of time that adult fish were actually observed in the spawning streams. Adult kokanee were rarely observed in the spawning streams for more than 3 consecutive days, and were often observed for only a single day.

Stream	Surveys Conducted	Spawning Escapement	Broodstock Collected	Total Run Size	Redd Count
Lewis Creek	38	1	5	6	0
Laughing Jacobs Creek	32	4	9	13	12
Ebright Creek	40	13	26	39	13
Total		18	40	58	25

Table 2. Kokanee spawning escapement estimates redd counts, and broodstock collection totals for late-run Lake Sammamish kokanee in the 2010-11 spawning season.

Kokanee Age Distribution: Otoliths from 46 kokanee carcasses were assessed for age distribution in 2010-11. Kokanee otoliths were obtained from fish that had been spawned at the hatchery or taken from carcasses found during spawning ground surveys in November and December of 2010 (Appendix C). Most (78%) of the kokanee sampled during the 2010-11 spawning season were age-3 (2007 brood year), and the remaining 22% of the samples were age-4 fish (2006 brood year, Table 3). Most adult kokanee males and females were age-3 (71% ♂ and 86% ♀), with smaller numbers of age-4 fish (29% ♂ and 14% ♀, Table 4). The true age (from hatching to the time of sampling) of an age-3 fish is approximately 2-years, 9-months (hatched around February 2008, captured in November 2010), and the total age of an age-4 fish is 3-years, 9-months.

Collection Location	Return Year	Sample Size	Age-2 (%)	Age-3 (%)	Age-4 (%)	Age-5 (%)
Ebright Creek	2010-2011	24	0%	88%	13%	0%
Laughing Jacobs Creek	2010-2011	19	0%	79%	21%	0%
Lewis Creek	2010-2011	3	0%	0%	100%	0%
Total	2010-2011	46	0%	78%	22%	0%

Table 3: Age distribution of adult late-run kokanee collected from Lake Sammamish spawning tributaries during the 2010-11 spawning season.

Sex	Return Year	Sample Size	Age-2 (%)	Age-3 (%)	Age-4 (%)	Age-5 (%)
Male	2010-11	24	0%	71%	29%	0%
Female	2010-11	22	0%	86%	14%	0%
Total	2010-11	46	0%	78%	22%	0%

Table 4: Age distribution of male and female kokanee spawners collected from Lake Sammamish spawning tributaries during the 2010-11 spawning season.

Spawn Timing: Spawning activity was sporadic in all three streams and no fish were observed in any stream after December 20, 2010 (Figure 2). A total of 13 kokanee redds were observed in Ebright Creek, 12 redds were observed in Laughing Jacobs Creek, and no redds were observed in

Lewis Creek. Most spawning occurred in Ebright Creek in a series of three short events between early-November and December. Fish were present in Lewis Creek for approximately 15 days in December. Spawning in Laughing Jacobs Creek occurred between early-November and late-December (Appendix B). The 2010-11 kokanee spawning season produced the third lowest run size (N=58) on record since monitoring began in 1996-97 (Figure 3, Table 5).

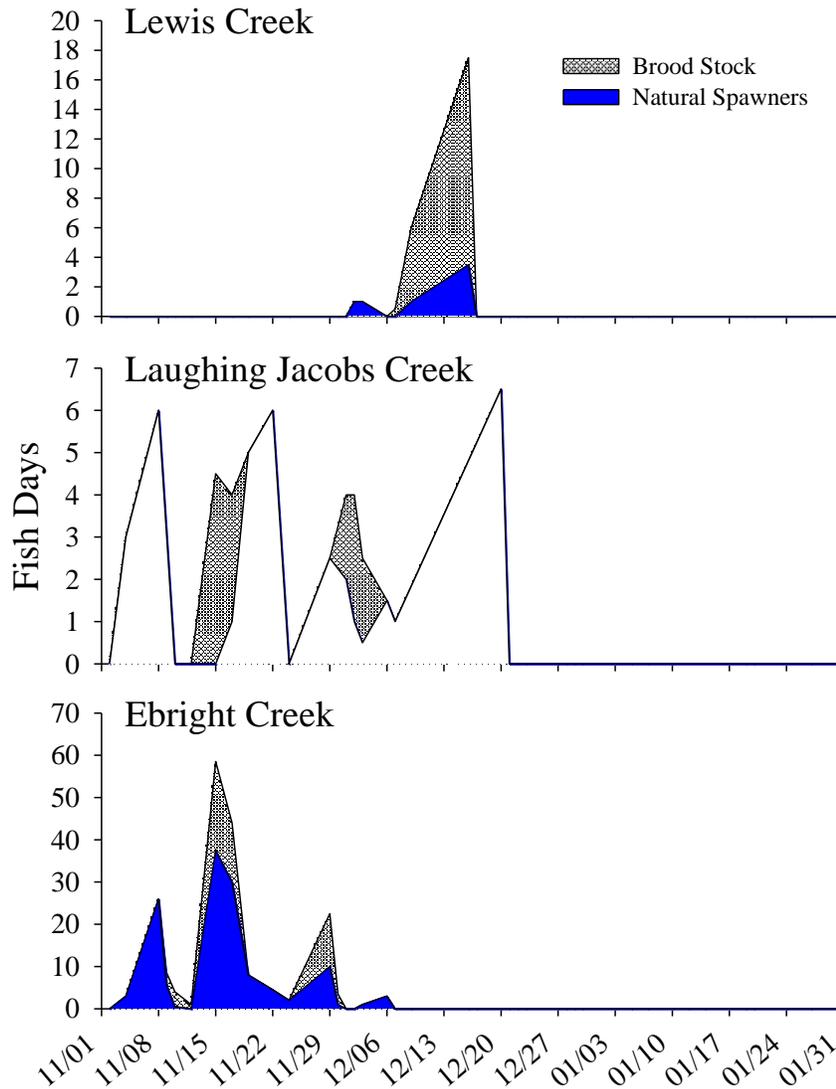


Figure 2. Spawn timing and broodstock collection dates (from live fish counts) of late-run kokanee during the 2010-11 spawning season.

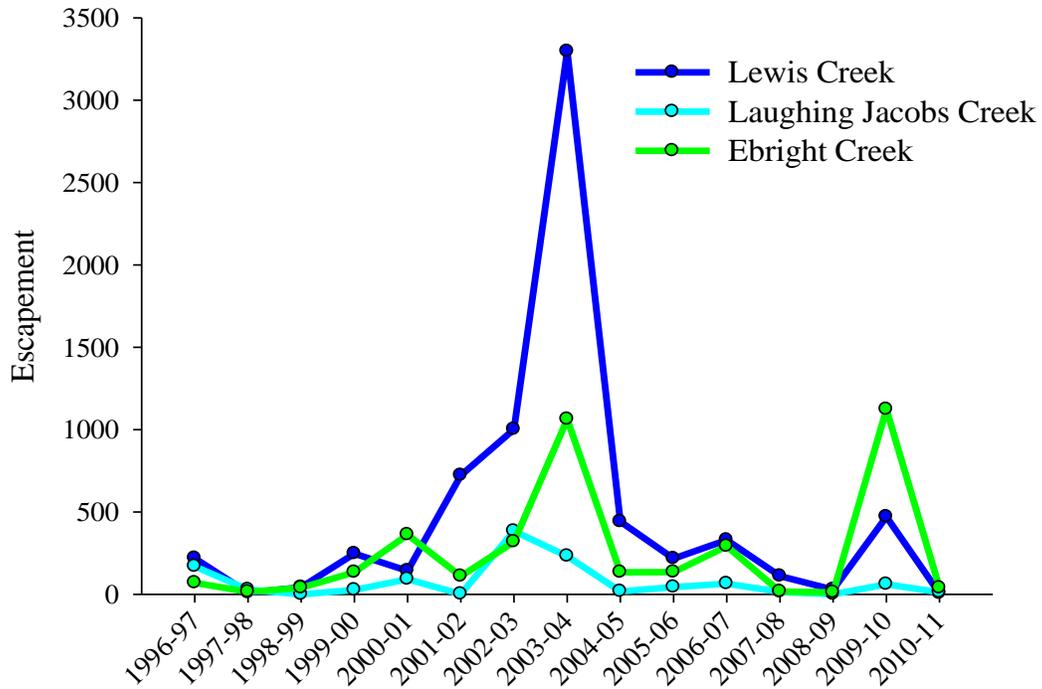


Figure 3. Late-run kokanee escapement (stream life = 10 days) in primary Lake Sammamish spawning tributaries from 1996-97 to 2010-11.

Year	Lewis	Ebright	Laughing Jacobs	Total
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
2010-11	6	39	13	58
Average (all years)	486	258	77	820

Table 5. Late-run kokanee escapement (stream life = 10 days) in primary Lake Sammamish spawning tributaries from 1996-97 to 2010-11.

Brood Stock Collection: Brood stock were collected from all three tributaries during the spawning period in 2010-11 (Table 6). A total of 25 males and 15 females were collected during the spawning season. Time periods when wild broodstock collections were made is shown in Figure 2. The collection goal for broodstock was met in Lewis Creek, but was not met in either Ebright Creek or Laughing Jacobs Creek. Average fecundity of kokanee females collected for the supplementation program in 2010-11 was approximately 1,100 eggs, and the number of fry released into each stream is cited in Table 6. Kokanee fry from the supplementation program were released in April of 2011.

Stream	Male Brood	Female Brood	Total Escapement	Collection Goal	Percent of Spawning Run Collected	Number of Kokanee Fry Released
Ebright Creek	16	10	39	75%	67%	10,579
Lewis Creek	4	1	6	75%	83%	795
Laughing Jacobs Creek	5	4	13	75%	69%	2,677

Table 6: Number of broodstock collected during the 2010-11 spawning season, and number of kokanee fry released through the kokanee supplementation program.

Genetic Assignments

Tissue samples were taken for genetic analysis from 51 kokanee adults (broodstock and carcasses) in 2010-11. Individual fish were assigned to kokanee and sockeye populations in the Lake Washington watershed and from different locations within Puget Sound using a population-origin-assignment-test (Appendix D; T. Kassler, WDFW, personal communication). All fish in 2010-11 (carcasses and broodstock) were assigned to populations from the Lake Washington basin, and no individuals assigned to kokanee populations outside of Lake Sammamish (Table 7, Appendix D). One individual, however, assigned to the Cedar River sockeye population.

Most (81%) kokanee collected from Ebright Creek assigned to the Ebright population while 11% assigned to the Lewis population, 0% assigned to the Laughing Jacobs population, 4% assigned to another location (this was the Cedar River sockeye), and 4% did not have a clear assignment (Table 7). Kokanee collected in Lewis Creek assigned to Ebright Creek (40%) or did not have a clear assignment (60%). Most kokanee collected from Laughing Jacobs Creek assigned to Ebright Creek (53%), while 37% assigned to Lewis Creek, 0% assigned to Laughing Jacobs Creek, and 11% did not have a clear assignment. Finally, one kokanee (carcass) collected in George Davis Creek assigned to Ebright Creek.

Location	Number Analyzed	Percent Assigned to Ebright	Percent Assigned to Lewis	Percent Assigned to Laughing Jacobs	Percent Assigned to Another Location	Percent with Uncertain Assignment
Ebright Creek	27	81%	11%	0%	4%	4%
Lewis Creek	5	40%	0%	0%	0%	60%
Laughing Jacobs	19	53%	37%	0%	0%	11%
Total	51	67%	20%	0%	2%	12%

Table 7. Genetic assignments for kokanee collected during the 2010-11 spawning season. Assignments to baseline kokanee populations were conducted using the MATLAB program.



Figure 4. Wild kokanee broodstock used in the supplementation program in 2010-11.



Figure 5. Wild kokanee broodstock in a holding tank at Issaquah Hatchery prior to spawning.

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Appendix A: Kokanee spawning ground survey data for three Lake Sammamish tributaries from November 2010 to January 2011.

Lewis Creek

Date	Live	Dead	Brood Stock	Fish Days	Date	Live	Dead	Brood Stock	Fish Days
11/02/10	0	0	0	0	12/17/10	0	0	0	0
11/04/10	0	0	0	0	12/20/10	0	0	0	0
11/08/10	0	0	0	0	12/21/10	0	0	0	0
11/09/10	0	0	0	0	12/22/10	0	0	0	0
11/10/10	0	0	0	0	12/23/10	0	0	0	0
11/12/10	0	0	0	0	12/27/10	0	0	0	0
11/15/10	0	0	0	0	12/28/10	0	0	0	0
11/17/10	0	0	0	0	12/29/10	0	0	0	0
11/19/10	0	0	0	0	12/30/10	0	0	0	0
11/22/10	0	0	0	0	01/03/11	0	0	0	0
11/24/10	0	0	0	0	01/05/11	0	0	0	0
11/29/10	0	0	0	0	01/07/11	0	0	0	0
11/30/10	0	0	0	0	01/10/11	0	0	0	0
12/01/10	0	0	0	0	01/19/11	0	0	0	0
12/02/10	2	0	0	1	01/20/11	0	0	0	0
12/03/10	0	0	0	1	01/24/11	0	0	0	0
12/06/10	0	0	0	0	01/27/11	0	0	0	0
12/07/10	1	0	1	0	01/31/11	0	0	0	0
12/09/10	5	0	4	1					
12/16/10	0	0	0	4	Total	8	0	5	7

Laughing Jacobs Creek

Date	Live	Dead	Brood Stock	Fish Days	Date	Live	Dead	Brood Stock	Fish Days
11/02/10	0	0	0	0	12/21/10	0	0	0	0
11/04/10	3	0	0	3	12/22/10	0	0	0	0
11/08/10	0	2	0	6	12/23/10	0	0	0	0
11/10/10	0	0	0	0	12/27/10	0	0	0	0
11/12/10	0	0	0	0	12/28/10	0	0	0	0
11/15/10	3	0	3	0	12/29/10	0	0	0	0
11/17/10	1	0	0	1	12/30/10	0	0	0	0
11/19/10	4	3	0	5	01/03/11	0	0	0	0
11/22/10	0	5	0	6	01/05/11	0	0	0	0
11/24/10	0	0	0	0	01/07/11	0	0	0	0
11/29/10	1	0	0	3	01/10/11	0	0	0	0
12/01/10	3	0	2	2	01/19/11	0	0	0	0
12/02/10	5	4	4	1	01/20/11	0	0	0	0
12/03/10	0	0	0	1	01/27/11	0	0	0	0
12/06/10	1	0	0	2	01/31/11	0	0	0	0
12/07/10	1	0	0	1					
12/20/10	0	0	0	7	Total	22	14	9	36

Ebright Creek

Date	Live	Dead	Brood Stock	Fish Days	Date	Live	Dead	Brood Stock	Fish Days
11/02/10	0	0	0	0	12/20/10	0	0	0	0
11/04/10	3	0	0	3	12/21/10	0	0	0	0
11/08/10	10	0	0	26	12/22/10	0	0	0	0
11/09/10	7	0	6	6	12/23/10	0	0	0	0
11/10/10	1	0	1	1	12/27/10	0	0	0	0
11/12/10	0	0	0	0	12/28/10	0	0	0	0
11/15/10	39	0	14	38	12/29/10	0	0	0	0
11/17/10	5	1	0	30	12/30/10	0	0	0	0
11/19/10	3	0	0	8	01/03/11	0	0	0	0
11/22/10	0	1	0	5	01/05/11	0	0	0	0
11/24/10	2	0	0	2	01/07/11	0	0	0	0
11/29/10	7	0	5	10	01/10/11	0	0	0	0
11/30/10	0	0	0	1	01/12/11	0	0	0	0
12/01/10	0	0	0	0	01/14/11	0	0	0	0
12/02/10	0	0	0	0	01/19/11	0	0	0	0
12/03/10	2	0	0	1	01/20/11	0	0	0	0
12/06/10	0	0	0	3	01/24/11	0	0	0	0
12/07/10	0	0	0	0	01/27/11	0	0	0	0
12/09/10	0	0	0	0	01/31/11	0	0	0	0
12/16/10	0	0	0	0					
12/17/10	0	0	0	0					
					Total	79	2	26	132

Appendix B: 2010-11 Lake Sammamish Kokanee Supplementation Project

End of Season Summary

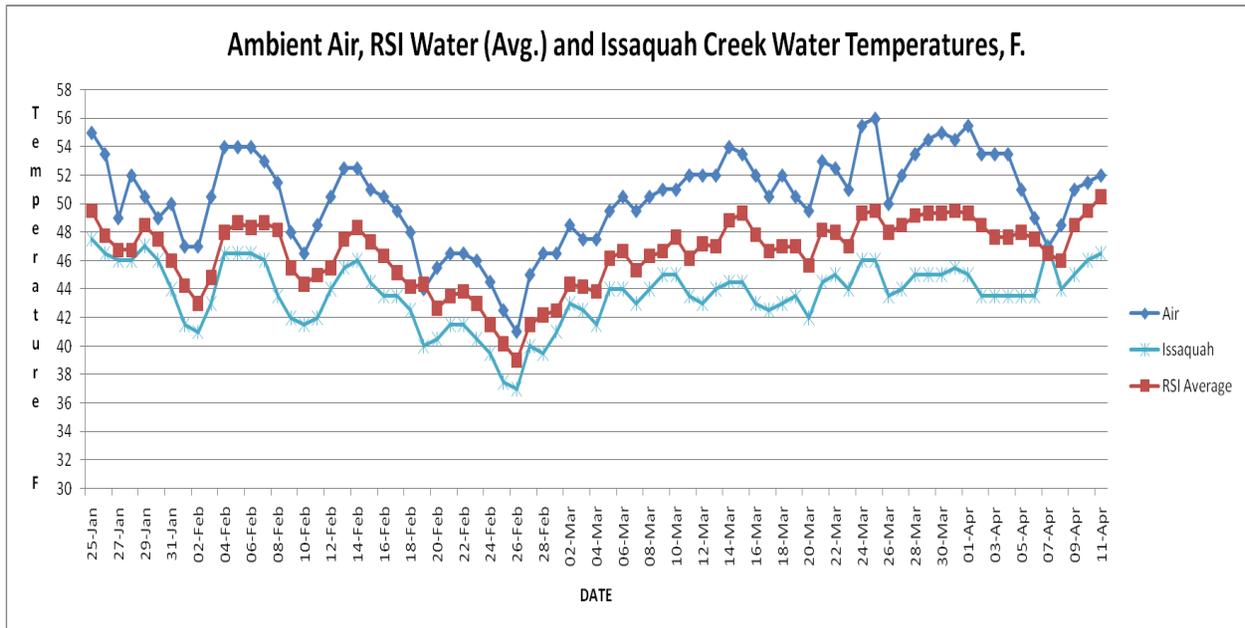
Darin Combs
Washington Department of Fish and Wildlife
Fish Hatchery Specialist 4

This was the first season of the project in which eggs were incubated at Issaquah Hatchery and Quilcene National Fish Hatchery. It was also the first time that an alternative incubation and rearing system, which we call an RSI, was used at Issaquah Hatchery.

The basic idea of a recirculating incubation system (RSI) is similar to that of a large aquarium. Water is pumped through a closed system and equipped with a filter to maintain clean water. The RSI would allow us to incubate eggs in their natal stream water, which would provide the natural imprinting that these fish will use when returning to spawn. The RSI's were assembled inside the incubation building at Issaquah Hatchery, utilizing existing deep troughs as the water reservoir. These troughs held stream water from the brood kokanee natal stream(s), which was used to incubate from the eyed-stage to swim-up stage. A submersible pump was used to constantly circulate this water through the incubation buckets. These buckets were a standard five gallon bucket modified with plumbing and screening. The circulating water enters the bucket from the bottom, below a perforated plate, and exits at the top of the bucket. The water exits into a second bucket which is lined with a fine mesh net. That water then exits below to the deep trough water reservoir. Each RSI is also equipped with an ultraviolet water treatment system to maintain a healthy rearing environment.

The initial start-up and operation of these RSI's showed that there was a problem with the water temperatures being too warm. Factors influencing the water temperature were ambient air temperature in the building, heat produced from the submersible pump, and heat from the UV light. It wasn't long before we had water temperatures in the mid-60's, which was 20 degrees warmer than the average water temperature of Issaquah Creek during that time. Each RSI was then modified in two ways: aquarium chillers were installed in the deep troughs, and heat exchange systems were constructed and placed inside the troughs. The heat exchange systems comprised of placing 200 feet of one inch coiled, plastic tubing the length of each trough at the bottom. One end of the tubing was plumbed to accept Issaquah Creek surface water and the other end exited the trough and entered the hatchery drain system. Issaquah Creek water was circulated through this tubing to act as a radiator, or heat exchanger, to reduce the water temperature in the RSI. Throughout the project, approximately 200 gallons of creek water was collected weekly and exchanged with the water in each RSI. The combination of these efforts successfully lowered the water temperatures to acceptable rearing conditions throughout the season (Figure 1.).

Figure1. RSI Temperatures



A total of 15 female kokanee were spawned this season for a total egg take of 16,106 eggs. Fertilized egg to eyed egg survival was 91% (Table 1.) All eyed eggs were thermally marked while at their respective hatchery, and those eggs at Quilcene were then transferred back to Issaquah Hatchery for the remainder of the season. Eyed eggs at Issaquah Hatchery were thermal marked using well water which was pumped from the Darigold plant, then chilled using water chillers. Once each group of eggs was marked, they were then placed in the RSI's where they eventually hatched and emerged from the incubation buckets as fry. Next, as each group of fry reached the point in development where they needed food, they were transferred to standard shallow troughs on Darigold well water and fed.

Table 1. 2010-11 Lake Sammamish Kokanee Program Percent Survival for various stages.

BROOD SOURCE	Total Egg Take	Total Eyed Eggs	% Survival to Eyed Egg	# Live Fry at Swim-Up (from RSI)	% Survival Eyed to swim-up	Number Released	Total % Survival
EBRIGHT CREEK	11,453	11,012	0.96	10,636	0.97	10,579	0.92
LAUGHING JACOBS CR.	3,468	2,753	0.79	2,699	0.98	2,677	0.77
LEWIS CREEK	1,185	851	0.72	799	0.94	795	0.67
PROGRAM TOTALS	16,106	14,616	0.91	14,134	0.97	14,051	0.87

Feeding went very well using the Darigold water due to its cleanliness and warm temperatures. The different groups of fry were then released back to their natal streams on April 18th and 25th (See Plant Report, page 4). Sizes at release varied depending on age and how long each group was fed prior to release. The largest was the 11/17 Ebright Creek group which averaged .77 grams in weight and 43 mm in length. The smallest were the 12/10 Lewis Creek fish at .14 grams and 25 mm. Survival from Eyed egg to release was very good at 97%. This included the time the kokanee were in the RSI's, and during feeding. Fry plants were conducted in the evening, after dark. Total fry released this season was 14,051, giving us a total survival of 87% from fertilization to release.

Next season, the biggest change to the program may be the decision to keep all eggs at Issaquah Hatchery. This will simplify the spawning process, reduce handling of gametes and reduce costs associated with transporting eggs. There is some fine tuning that will be done with the RSI's before next season as well. We will experiment with flow rates through the buckets, and possibly add a perforated screen at the surface of the water in the buckets to keep alevin from swimming-up and out of the incubation buckets too early. The first season of the Lake Sammamish Kokanee Supplementation Program was a great learning experience for everyone involved. While this season can be considered a success, if we use what we learned from this season, our results will improve.

Appendix C: Age, length, and recovery location data from late-run kokanee carcasses and broodstock collected from Lake Sammamish spawning tributaries in 2010-2011.

Otolith Sample Code	Collection Location	Sex (M/F)	Fork Length (mm)	POH Length (mm)	Age	Date
10HS0001	Ebright Creek	F	460	375	3	11/10/2010
10HS0004	Ebright Creek	F	420	340	3	11/17/2010
10HS0005	Ebright Creek	F	495	335	3	11/17/2010
10HS0007	Ebright Creek	F	410	330	3	11/17/2010
10HS0008	Ebright Creek	F	410	340	3	11/17/2010
10HS0009	Ebright Creek	F	396	328	3	11/17/2010
10HS0029	Ebright Creek	F	400	320	3	11/30/2010
10HS0030	Ebright Creek	F	396	328	3	11/30/2010
10HS0031	Ebright Creek	F	365	304	3	11/30/2010
10HS0006	Ebright Creek	F	390	320	4	11/17/2010
10HS0010	Ebright Creek	M	432	340	3	11/17/2010
10HS0011	Ebright Creek	M	375	300	3	11/17/2010
10HS0013	Ebright Creek	M	450	355	3	11/17/2010
10HS0014	Ebright Creek	M	370	295	3	11/17/2010
10HS0033	Ebright Creek	M	418	326	3	11/30/2010
10HS0034	Ebright Creek	M	391	311	3	11/30/2010
10HS0035	Ebright Creek	M	418	328	3	11/30/2010
10HS0036	Ebright Creek	M	434	357	3	11/30/2010
10HS0037	Ebright Creek	M	412	335	3	11/30/2010
10HS0039	Ebright creek	M	420	317	3	11/30/2010
10HS0040	Ebright creek	M	390	307	3	11/30/2010
10HS0041	Ebright creek	M	440	330	3	11/30/2010
10HS0012	Ebright Creek	M	431	337	4	11/17/2010
10HS0015	Ebright Creek	M	298	243	4	11/17/2010
10HS0032	Ebright Creek	M	330	263	NA [†]	11/30/2010
No Sample	Ebright Creek	M	415		NA	11/10/2010
No Sample	Ebright Creek	M	430		NA	11/10/2010
10HS0019	Ebright Creek	M	370	290	NA [†]	11/22/2010
10HS0161	George Davis Creek	M	361	273	NA [†]	1/14/2011
10HS0016	Laughing Jacobs	F	344	275	3	11/17/2010
10HS0020	Laughing Jacobs	F	410	330	3	11/22/2010
10HS0021	Laughing Jacobs	F	425	350	3	11/22/2010
10HS0022	Laughing Jacobs	F	425	350	3	11/22/2010
10HS0043	Laughing Jacobs	F	383	293	3	12/2/2010
10HS0044	Laughing Jacobs	F	370	310	3	12/2/2010
10HS0045	Laughing Jacobs	F	330	263	3	12/2/2010
10HS0049	Laughing Jacobs	F	374	290	3	12/2/2010
10HS0102	Laughing Jacobs	F	422	345	3	11/19/2010
10HS0104	Laughing Jacobs	F	404	331	3	11/19/2010
10HS0101	Laughing Jacobs	F	404	336	4	11/17/2010
10HS0023	Laughing Jacobs	M	400	325	3	11/22/2010
10HS0024	Laughing Jacobs	M			3	11/22/2010
10HS0042	Laughing Jacobs	M	432	343	3	11/30/2010
10HS0047	Laughing Jacobs	M	344	270	3	12/2/2010

10HS0048	Laughing Jacobs	M	385	315	3	12/2/2010
10HS0038	Laughing Jacobs	M			4	11/24/2010
10HS0046	Laughing Jacobs	M	460	350	4	12/2/2010
10HS0103	Laughing Jacobs	M	407	316	4	11/19/2010
No Sample	Laughing Jacobs	M	430		NA	11/17/2010
No Sample	Laughing Jacobs	M	430		NA	11/17/2010
No Sample	Laughing Jacobs	M			NA	12/2/2010
No Sample	Laughing Jacobs	M			NA	12/2/2010
10HS0151	Laughing Jacobs	M	400	312	NA [†]	12/7/2010
10HS0052	Lewis Creek	F	380	298	4	12/10/2010
10HS0053	Lewis Creek	M	395	300	4	12/10/2010
10HS0054	Lewis Creek	M	434	330	4	12/10/2010
No Sample	Lewis Creek	M	390	300	NA	12/16/2010
No Sample	Lewis Creek	M	370	290	NA	12/16/2010

[†] = Annuli on otolith were not identifiable.

Appendix D: Assignment of late-run kokanee collected from Lake Sammamish tributaries in 2010-2011. Assignments for individuals highlighted in red are inconclusive.

DNA Sample Code	Collection Location	Assignment #1	Mean Posterior Probability	Prob MaxAssign = Assignment #2	Assignment #2	Mean Posterior Probability
10HS0029	Ebright Creek	Lewis2	0.5285	0.000	Ebright2	0.088
10HS0011	Ebright Creek	Lewis2	0.7298	0.000	Ebright2	0.253
10HS0035	Ebright Creek	Lewis2	0.8678	0.000	Ebrig01	0.125
10HS0009	Ebright Creek	Lewis01	0.2273	0.604	Ebright2	0.213
10HS0039	Ebright creek	Ebright2	0.5985	0.000	Ebrig01	0.124
10HS0032	Ebright Creek	Ebright2	0.6182	0.000	Ebrig01	0.351
10HS0001	Ebright Creek	Ebright2	0.7528	0.000	Ebrig01	0.190
10HS0030	Ebright Creek	Ebright2	0.8571	0.000	Lewis2	0.034
10HS0019	Ebright Creek	Ebright2	0.9546	0.000	Ebrig01	0.033
10HS0033	Ebright Creek	Ebright2	0.9575	0.000	Lewis2	0.024
10HS0007	Ebright Creek	Ebright2	0.9652	0.000	Ebrig01	0.021
10HS0006	Ebright Creek	Ebright2	0.9811	0.000	Lewis2	0.009
10HS0031	Ebright Creek	Ebright2	0.9902	0.000	Ebrig01	0.009
10HS0002	Ebright Creek	Ebright2	0.9938	0.000	Lewis01	0.004
10HS0008	Ebright Creek	Ebright2	0.9954	0.000	Ebrig01	0.002
10HS0012	Ebright Creek	Ebright2	0.9989	0.000	Ebrig01	0.000
10HS0014	Ebright Creek	Ebright2	0.9996	0.000	Lewis2	0.000
10HS0010	Ebright Creek	Ebrig01	0.4094	0.000	Lewis2	0.164
10HS0040	Ebright creek	Ebrig01	0.5220	0.000	Ebright2	0.139
10HS0003	Ebright Creek	Ebrig01	0.6227	0.000	Lewis2	0.093
10HS0034	Ebright Creek	Ebrig01	0.6307	0.000	Ebright2	0.331
10HS0005	Ebright Creek	Ebrig01	0.6765	0.000	Lewis2	0.257
10HS0037	Ebright Creek	Ebrig01	0.7640	0.000	Lewis2	0.077
10HS0004	Ebright Creek	Ebrig01	0.9375	0.000	Lewis01	0.062
10HS0036	Ebright Creek	Ebrig01	0.9510	0.000	Lewis2	0.014
10HS0013	Ebright Creek	Ebrig01	0.9762	0.000	Lewis2	0.010
10HS0015	Ebright Creek	CedarSock1	0.8773	0.000	Lewis2	0.053
10HS0161	George Davis Creek	Ebrig01	0.9999	0.000	Lewis01	0.000
10HS0044	Laughing Jacobs	Lewis2	0.3869	0.000	Ebright2	0.180
10HS0046	Laughing Jacobs	Lewis2	0.4303	0.374	Ebright2	0.367
10HS0047	Laughing Jacobs	Lewis2	0.6991	0.000	Ebrig01	0.166
10HS0021	Laughing Jacobs	Lewis2	0.9807	0.000	Ebrig01	0.002
10HS0048	Laughing Jacobs	Lewis2	0.9883	0.000	Lewis01	0.008
10HS0042	Laughing Jacobs	Lewis01	0.1646	0.795	Lewis2	0.160
10HS0045	Laughing Jacobs	Lewis01	0.5308	0.000	Lewis2	0.123

10HS0018	Laughing Jacobs	Lewis01	0.7163	0.000	Lewis2	0.132
10HS0102	Laughing Jacobs	Lewis01	0.9607	0.000	Lewis2	0.027
10HS0020	Laughing Jacobs	Ebright2	0.8241	0.000	Lewis01	0.063
10HS0017	Laughing Jacobs	Ebright2	0.9575	0.000	Lewis2	0.024
10HS0023	Laughing Jacobs	Ebright2	0.9802	0.000	Ebrig01	0.013
10HS0049	Laughing Jacobs	Ebrig01	0.4518	0.000	Lewis2	0.074
10HS0103	Laughing Jacobs	Ebrig01	0.4980	0.000	Ebright2	0.163
10HS0043	Laughing Jacobs	Ebrig01	0.6456	0.001	Lewis01	0.342
10HS0022	Laughing Jacobs	Ebrig01	0.9613	0.000	Lewis01	0.023
10HS0101	Laughing Jacobs	Ebrig01	0.9695	0.000	Ebright2	0.005
10HS0051	Laughing Jacobs	Ebrig01	0.9945	0.000	Ebright2	0.004
10HS0104	Laughing Jacobs	Ebrig01	0.9970	0.000	Ebright2	0.003
10HS0054	Lewis Creek	Laughing1	0.1542	0.342	Ebright2	0.114
10HS0060	Lewis Creek	Ebright2	0.9853	0.000	Ebrig01	0.005
10HS0059	Lewis Creek	Ebrig01	0.3445	0.099	Lewis01	0.294
10HS0052	Lewis Creek	Ebrig01	0.4543	0.915	Lewis2	0.443
10HS0053	Lewis Creek	Ebrig01	0.9331	0.000	Ebright2	0.065