Bear Lake
Salmon Enhancement
Progress Report
2014

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The 2014 operation of the Bear Lake Sockeye and Coho Salmon Enhancement Project was made possible through enhancement taxes paid by the commercial fishermen in Area H, Cook Inlet and associated waters and through Cook Inlet Aquaculture Association Special Harvest Area Access licensing fees.

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DISCLAIMER

The Cook Inlet Aquaculture Association conducts salmon enhancement and restoration projects in Area H, Cook Inlet and associated waters. As an integral part of these projects a variety of monitoring and evaluation studies are conducted. The following progress report is a synopsis of the monitoring and evaluation studies conducted for the Bear Lake salmon enhancement project.

The purpose of the progress report is to provide a vehicle to distribute the information produced by the monitoring and evaluation studies. Data collected each year are presented with a summary of the information previously collected for comparative purposes. These reports are intended to provide a general description of project activity and are not an exhaustive evaluation of any restoration or enhancement project. The information presented in this report has not undergone an extensive review. As reviews are completed, the information may be updated and presented in later progress reports.

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ACKNOWLEDGEMENTS

The 2014 Bear Lake smolt migration, fry release, adult count, and gamete collection exercises were conducted by the Cook Inlet Aquaculture Association. Appreciation is extended to the full-time and seasonal staff at Bear Lake Weir and Trail Lakes Hatchery. Appreciation is extended to Copper River Seafoods for the collection of sockeye salmon otoliths from the cost recovery harvests in Resurrection Bay.

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ABSTRACT

The Cook Inlet Aquaculture Association has been conducting sockeye salmon (*Oncorhynchus nerka*) and coho salmon (*Oncorhynchus kisutch*) enhancement activities at Bear Lake since 1988. Enhancement efforts have focused on sockeye and coho fry stocking and improvements to the fry rearing environment through nutrient enrichment. Associated assessment activities have involved smolt and adult enumeration and limnological sampling.

In 2014, both sockeye (BY13; 2,405,000; 0.43 g) and coho salmon fry (BY13; 468,000; 0.95 g) were released into Bear Lake as well as sockeye salmon smolt into Resurrection Bay (BY12; 1,742,000; 14.5 g) and coho salmon smolt (BY12; 55,000; 12.2 g) to Bear Creek. Smolt migration began on 13 May and continued until 08 July. During this time period, 393,500 (± 25,300) sockeye and 21,100 (± 1,100) coho salmon smolts migrated from the lake. For the migrating sockeye smolt, 96.7% (± 1.8%) were of hatchery origin and theage-1 smolt was the dominant age class at 79% (± 4.3%). For the coho smolt, 95.8% (± 3.8%) were of hatchery origin and theage-2 smolts was the dominant age class at 57.3% (± 11.2%).

A total of 28,774 adult sockeye salmon returned to Bear Lake for escapement, broodstock, and harvest. An additional 112,043 fish were harvested in the saltwater component of the cost recovery harvest and 5,306 were harvested in the commercial seine fishery. The sport fish harvest was estimated at 20,000 fish and there were 115 mortalities at the weir, bringing the total sockeye salmon return to 166,323 fish. For the adult coho salmon return to Bear Lake, 1,772 fish were counted at the weir for escapement, broodstock, and harvest. The sport fish harvest was estimated at 5,400 fish bringing the total return of coho salmon to 7,172 fish.

Between 27 July and 15 August, 5,292,800 sockeye salmon eggs were collected and transported to Trail Lakes Hatchery for fertilization, incubation, and rearing. On three occasions between 30 September and 07 October, 581,000 coho eggs were collected and transported to Trail Lakes Hatchery for incubation and rearing.

Based on the 2013 fall water quality samples, it was determined that no fertilizer was necessary

in 2014. Limnology samples were collected in June, July, August, and September.

INTRODUCTION AND PURPOSE

Bear Lake is located on Alaska's Kenai Peninsula near the community of Seward and has been the site of salmon enhancement activities since 1962. Initial enhancement activities, conducted by the Alaska Department of Fish and Game (ADF&G) Sport Fish Division, focused on coho salmon (*Oncorhynchus kisutch*) and the control of predator and competitor species.[1]

In 1988, the Alaska Board of Fisheries revised the management plan for Bear Lake. The revision allowed for the enhancement of sockeye salmon (*Oncorhynchus nerka*).

The revised Bear Lake management plan developed in 1988 was soon followed by a cooperative agreement between ADF&G, Sport Fish Division, ADF&G Fisheries Rehabilitation, Enhancement and Development (FRED) Division, and the Cook Inlet Aquaculture Association (CIAA). The cooperative agreement, which became effective in August 1989, allowed CIAA to operate and maintain the Bear Lake coho salmon enhancement project and to begin sockeye enhancement activities in the lake. The agreement also provided CIAA with the responsibility of operating and maintaining the Bear Creek weir site.

Current enhancement activities at Bear Lake target both sockeye and coho salmon with control of predator and competitor species. The objectives are to create a commercial sockeye salmon fishery and to maintain the coho salmon sport fishery enhancement program. To accomplish the objectives CIAA does the following:

1) Maintain the level of coho salmon production.
2) Maintain sockeye and coho salmon lake spawning escapement goals.
3) Annually describe the timing, abundance, size, and percent of wild and enhanced sockeye and coho salmon in smolt migrations.
4) Annually describe the timing, abundance, and size of sockeye and coho salmon in adult migrations.
5) Monitor the number of marked fish resulting from fry, pre-smolt, and smolt releases in sockeye and coho salmon adult migrations and evaluate the success of enhancement through the recovery of marked fish.

1 ADF&G enhancement activities conducted prior to 1987 are reported by Vincent-Lang (1987).

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PROJECT AREA

Bear Lake is located on Alaska's Kenai Peninsula 9 km north of Seward. It is the largest clear water lake in the Resurrection Bay drainage.

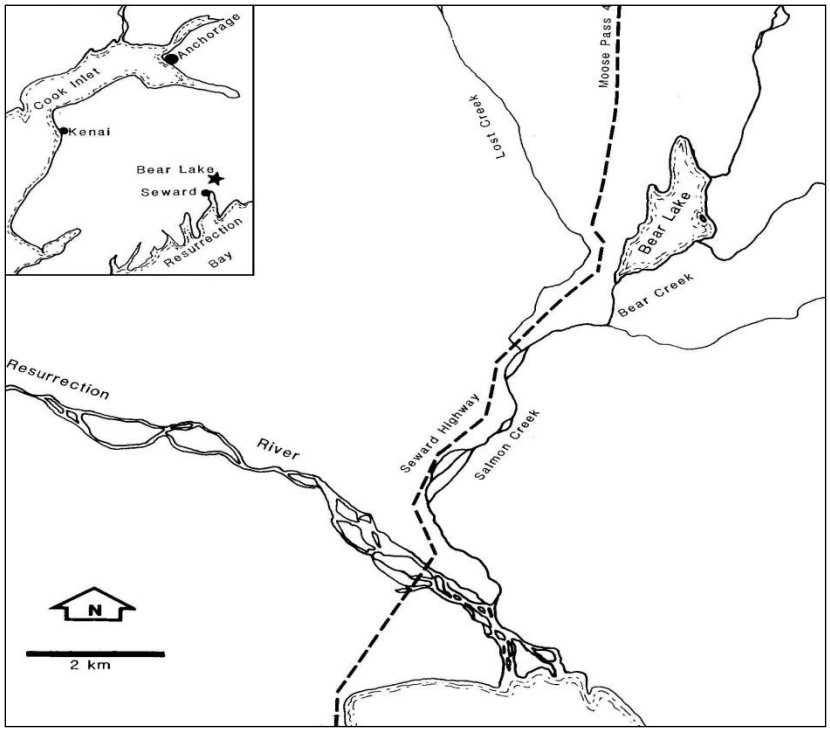

Figure 1. Map showing location of Bear Lake near Seward, Alaska.

Bear Lake has a watershed area of 15 km^2 and one outlet, which drains into Resurrection Bay through Bear Creek, Salmon Creek and the Resurrection River (Figure 1). A weir and fish passage complex, located 0.5 km downstream of the lake, provide a barrier to fish migration and allow for complete control of fish movements into or out of the lake.

Bear Lake (Figure 2) is oligotrophic with a surface area of 180 hectares. It has a mean depth of 10 meters, a maximum depth of 20 meters, a lake volume of 18.7 X 10^6 m^3 and a water residence time of 0.75 years (Koenings et al., 1987). There is one small island located along the east shore. The shoreline is heavily wooded and shoreline substrates vary from exposed bedrock, to large cobble, sand and organic muck.

In the fall of 2012, the small tributary stream used for acclimation of sockeye salmon fry and the main spawning area, changed course during a flood event. The amount of water flowing through this creek channel decreased substantially in comparison to previous years. The location now used for acclimation of fry and broodstock collection correspondingly has changed to the new stream discharge starting in 2013.

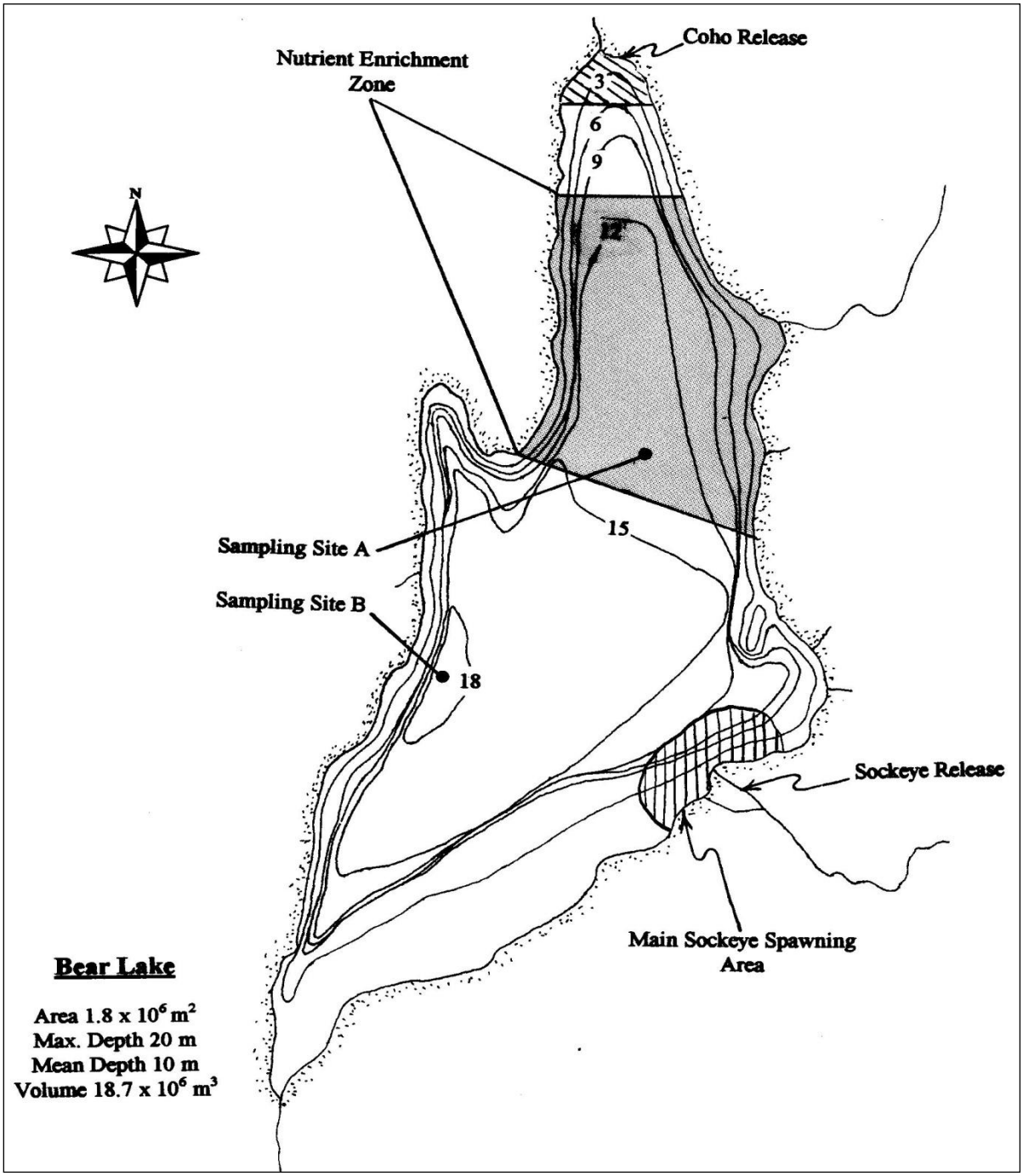

Figure 2. Bear Lake near Seward, Alaska

METHODS

In general, Bear Lake limnological sampling, salmon egg takes, hatchery incubation, fry rearing, smolt enumeration, and adult escapement monitoring follow procedures recommended by ADF&G. Greater detail of the methods can be found in the Smolt and Adult Procedure Manual for Bear Lake (CIAA, 2014).

Limnological Sampling and Environmental Conditions

During 2014, assessments of water quality were conducted 4 times (June, July, August, September) throughout the open water season using a Van Dorn water sampler. Sampling and analysis followed the procedures described by Koening et al. (1986). A primary site, site B (Figure 2) was sampled for dissolved oxygen, temperature and light transmission profiles, Secchi disk transparency, and zooplankton densities. Samples for analysis of phosphorus, carbon, chlorophyll a, phaeophytin a, nitrogen, calcium, magnesium, iron, conductivity, pH, alkalinity, turbidity, and color were also collected 1 meter below the surface and from the hypolimnion. A secondary site, site A, (Figure 2) was also sampled for Secchi disk transparency and zooplankton densities. All water samples were collected by CIAA and analyses were completed by ADF&G. Due to equipment failure, total nitrogen could not be analyzed. Zooplankton identification and quantification was conducted by ADF&G.

In addition to the water chemistry analysis, CIAA staff made daily observations of other environmental conditions at Bear Lake. These observations, completed at 5:00 P.M. throughout the summer field season, included percent cloud cover, precipitation to the nearest millimeter, and Bear Creek stage. Bear Creek stage height was recorded in 2 different locations. The upper gauge was used to monitor pool height above the weir while the lower gauge monitored the water level below the weir. Both heights were dependent on the addition or removal of dam boards. Air and water temperature were recorded every 2 hours using a Hobo® data logger. All recordings in a 24-hour period were averaged to provide a daily average air and water temperature. Unfortunately between the end of adult sockeye migration and the start of the adult coho migration (25 July–24 August), staff mistakenly stopped recording all of the environmental conditions at the weir except for air and water temperatures. For summary purposes, the percent

cloud cover, precipitation, and Bear Creek stage height excludes the time period of 25 July to 24 August where no data was recorded.

Lake Nutrient Enrichment

The purpose of fertilizer application, applied throughout the growing season to the pelagic area of the lake, is to stimulate algae growth and increase the zooplankton community. Using the mean fall total phosphorus concentration recorded in 2013 and a lake nutrient model supplied by ADF&G, it was determined that no fertilization of Bear Lake was necessary in 2014.

Smolt Enumeration

A permanently installed weir, located approximately 0.5 km downstream of Bear Lake prevents the uncontrolled migration of fish into or out of Bear Lake. This structure (Figure 3) was used in 2014 to identify, count, and control the migration of all fish moving into or out of Bear Lake.

For smolt enumeration, fish migrating downstream were directed by the weir into a live box where they were captured, temporarily held, identified to species, counted, and released downstream. Total counts of smolts migrating from the lake were made until the migration of fish exceeded 2,000 to 3,000 fish per hour. When this occurred, a 10% sub-sampling procedure was used to enumerate the migrating smolts.

To enumerate migrating smolts with the 10% sub-sampling procedure, the counting period was divided into 20-minute intervals. During each 20 minute interval, migrating fish were directed into the live-box for 2 minutes and then counted. During the remaining 18 minutes, migrating smolts were passed through the weir structure uncounted. The 2-minute smolt count was multiplied by 10 to estimate the number of smolts migrating during the 20-minute interval.

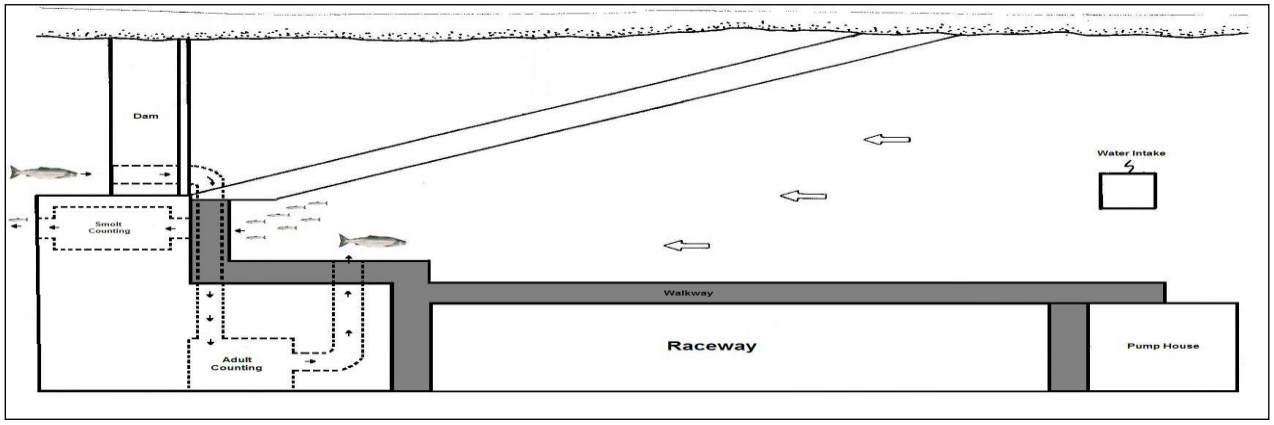

Figure 3. The Bear Creek weir, smolt trap and adult counting complex (top view).

Assuming the 2-minute sub-sampling intervals were randomly distributed throughout sub-sampling[2] and smolt moved through the weir randomly, the total smolt migration was estimated as follows:

If:

T_c = number of fish counted with the total count procedure,

$\hat{T}_s$ = number of fish counted with the 10% sub-sampling procedure,

$\hat{T}$ = the total smolt migration,

y = the number of fish counted in each two minute sub-sampling interval,

n = the number of two minute sub-sampling intervals sampled, and

N = the number of possible two minute sub-sampling intervals,

Then:

$$\hat{T} = T_c + \hat{T}_s$$

and the variance is,

$$v\left(\hat{T}_s\right) = N^2\left(\left(N-n\right)/N\right)\sum\left(y_i - \bar{y}\right)^2 / \left(n\left(n-1\right)\right)$$

And:

$$C.I._{\alpha=95\%} \text{ for } \hat{T}_s = \pm 2\sqrt{v\left(\hat{T}_s\right)}$$

2 Predetermined randomly selected 2 minute subsampling intervals assured random distribution within each 20 minute period.

The variance about the estimated smolt migration, $\hat{T}$ is equal to the variance about $\hat{T}_s$, because T_c is a total count with 0 variance.

Based on the unique thermal mark applied to the otolith for each species, it was noted that staff incorrectly identified the fish species (10.7% of 392 samples and 19.8% of 141 samples were incorrectly identified for sockeye and coho salmon respectively). Assuming this species misidentification also occurred while performing counts, caution should be taken when using the count data.

Smolt Characteristics and Enhanced Contribution

Since 1990, CIAA has been releasing sockeye and coho salmon fry into Bear Lake. To evaluate this enhancement procedure, CIAA has collected a sample of sockeye and coho salmon smolts migrating each year to determine age, weight, and length characteristics of the migrating populations. Since 1993, CIAA has also marked the otolith of all salmon fry released to Bear Lake with a thermal mark.[3] The purpose of this mark is to determine the contribution of released hatchery fish to the Bear Lake smolt population.

In 2014, smolts collected for measurement, age determination, and otolith removal were sampled in proportion to the daily smolt migration. This was accomplished by collecting every 1,000th sockeye salmon smolt and every 150th coho salmon smolt that passed through the smolt trap. The numbering sequence began when the first fish passed through the trap and continued consecutively until the smolt migration was complete. Age, weight, and length measurements were collected from 392 sockeye salmon smolt (0.10%) and 141 coho salmon smolt (0.67%). A number of samples were incorrectly identified and data had to be discarded, leaving 338 and 105 correctly identified samples respectively for sockeye and coho salmon.

Each smolt collected for evaluation was first measured to the nearest millimeter for fork length[4] and weighed to the nearest 0.1 g. Otoliths were removed and placed in a labeled one dram vial

3 The otolith mark is a hatchery induced thermal band produced by controlled temperature changes during incubation.

4 Standard fork length was measured from the tip of the snout to the fork of the tail.

filled with a 10% ethanol solution. Each otolith was checked for a hatchery mark and aged following procedures described by Glick and Shields (1993).

Sockeye salmon smolt characteristics, the proportion of enhanced sockeye smolt and the proportion of age- 1 and age-2 sockeye salmon smolt in the migrating population, were estimated with the following notations and formulas provided by ADF&G.

If:

N = total number of migrating smolts,

N_h = number of smolts in stratum h, $\left(N = \sum N_h\right)$,

n = total number of smolts sampled,

n_h = number of smolts sampled in stratum h, $\left(n = \sum n_h\right)$,

a = total number of enhanced smolts sampled,

a_h = number of enhanced smolts sampled in stratum h, $\left(a = \sum a_h\right)$,

$p_h = a_h / n_h$, The proportion of enhanced smolts in stratum h,

$q_h = 1 - p_h$, The proportion of wild smolts in stratum h,

c_i = number of age $= i$ smolts sampled,

c_{hi} = number of age $= i$ smolts sampled in stratum h, $\left(c_i = \sum c_{hi}\right)$,

$l_{hi} = c_{hi} / n_{hi}$, The proportion of age $= i$ smolts in stratum h,

$m_{hi} = 1 - l_{hi}$, The proportion of other than age $= i$ smolts in stratum h,

$f = n / N$, The sampling fraction (assumed equal in all strata),

$W_h = N_h / N$, The stratum weight, and,

$y =$ the weight or length of the smolt.

Then the proportion of enhanced smolts, $\hat{P}$, was estimated as:

$$\hat{P} = a / n; \quad \text{with a variance of} \quad v\left(\hat{P}\right) = \left(1 - f\right)(1/n)\sum W_h p_h q_h;$$

which, under proportional allocation, is like the usual simple random sample estimate.

The total number of enhanced smolts, $\hat{A}$, was also estimated as:

$$\hat{A} = N(a / n) = N\hat{P};$$

with a variance of:

$$v\left(\hat{A}\right) = N^2\left(1-f\right)(1/n)\sum W_h p_h q_h = N^2 v\left(\hat{P}\right).$$

Since samples sizes were fairly large and $\hat{P}$ was not extreme, the normal approximation, without a correction for continuity, could be used to develop the relative error. Thus, the 95% confidence interval estimate for $\hat{P}$ and $\hat{A}$ is:

$$\hat{P} \pm 1.96\sqrt{v\left(\hat{P}\right)} \quad \text{and} \quad \hat{A} \pm 1.96\sqrt{v\left(\hat{A}\right)};$$

and, the relative error is:

$$R.E. = \left(1.96\sqrt{v\left(\hat{P}\right)} \Big/ \left(\hat{P}\right)\right)100 \quad \text{and} \quad R.E. = \left(1.96\sqrt{v\left(\hat{A}\right)} \Big/ \left(\hat{A}\right)\right)100.$$

The proportion of age $= i$ smolt in the smolt migration was also estimated as:

$$\hat{L}_i = c_i \Big/ n; \qquad \text{with a variance of} \qquad v(\hat{L}_i) = (1-f)\frac{1}{n}\sum_h W_h l_{hi} m_{hi};$$

and, the total number of age $= i$ smolts was estimated as:

$$\hat{C}_i = N(\hat{L}_i); \qquad \text{with a variance of} \qquad v(\hat{C}_i) = N^2 v(\hat{L}_i).$$

Confidence interval (95%) estimates for age-class proportion and abundance, assuming 2 age-classes, are:

$$\hat{L}_i \pm 2.24\left(\sqrt{v(\hat{L}_i)}\right) \qquad \text{and} \qquad \hat{C}_i \pm 2.24\left(\sqrt{v(\hat{C}_i)}\right).$$

Mean weight or length of age $= i$ smolt was also estimated as:

$$\bar{y}_i = \frac{\sum_h \sum_j y_{hij}}{c_i};$$

with an approximate variance estimate of:

$$v(\bar{y}_i) \cong \frac{1}{\hat{C}_i^2}\sum_h \frac{N_h^2(1-f)}{n_h(n_h-1)}\left[\sum_j (y_{hij} - \bar{y}_{hi})^2 + c_{hi}(1 - c_{hi} \Big/ n_h)(\bar{y}_{hi} - \bar{y}_i)^2\right].$$

The confidence interval (95%) estimate for the mean weight and length is:

$$\bar{y}_i \pm 1.96\left(\sqrt{v(\bar{y}_i)}\right).$$

Adult Escapement

The weir structure that was used for enumerating the smolt migration was also used to identify, count, and control the migration of adult fish returning to Bear Lake. The escapement

enumeration included the assessment of the sex, age, and weight of the returning population of fish.

To enumerate the adult migration, fish attempting to migrate upstream were directed by the weir into a live box attached to a mechanical lift. Once in the live box, the fish were lifted above the weir, identified, and counted. Counted fish were either passed into the Bear Lake system or collected for other uses (harvest, hatchery broodstock).

All female sockeye salmon that were passed into the lake received an erythromycin injection (0.17–0.20 mg/kg fish weight) to reduce the prevalence of Bacterial Kidney Disease (BKD) at the spawning ground.

Every 30th sockeye salmon was sampled to assess sex, age (via scale analysis), and weight. For the coho adult migration, every 18th coho salmon was sampled. In 2014, measurements were collected from 963 sockeye salmon (3.3%) of which 609 were readable and 97 coho salmon (5.5%) of which 66 were readable. Scales that were not readable were either regenerated or incorrectly mounted (inverted).

Gamete Collection, Incubation and Rearing – Sockeye Salmon

Since 1989, egg collection, incubation, and rearing of sockeye salmon have been done to develop a Bear Lake sockeye salmon fishery. Prior to 1993, sockeye salmon returning to the Big River Lakes area on the west side of Cook Inlet or to Upper Russian Lake on the Kenai Peninsula served as broodstock for the Bear Lake sockeye salmon stocking program. Fry from eggs collected from one or both of these broodstocks were released into Bear Lake each spring from 1990 through 1993. In 1993, adults resulting from the Bear Lake stocking program returned to Bear Lake in numbers large enough (>5,000) to provide broodstock for the hatchery. Since 1993, all sockeye salmon gametes collected for the Bear Lake stocking program were collected from adults returning to Bear Lake.

Originally, it was believed returning adult sockeye salmon would congregate in the spawning

area identified on Figure 2 and be susceptible to capture by beach seine. In 1993, fish were captured here, but most of the returning sockeye salmon were found spawning at a depth of 40 feet or greater and were not susceptible to beach seining. In 1993, the egg collection goal was not met primarily because of the difficulty in capturing broodstock.

Since 1993, CIAA has employed several methods to collect fish for hatchery broodstock. Efforts included capturing fish at the weir and holding them in raceways or deepwater net pens for ripening and purse seining or gillnetting the fish from the deepwater spawning areas. Although the number of eggs collected has increased, none of the fish capture methods has worked well. In 1995, fry were released directly to a small tributary stream where it was expected returning adults could be easily captured. Since 1999, adults have returned to this area and broodstock collections have improved. However, flood conditions in the fall of 2012 dramatically changed the flow of water in this small tributary stream. In 2014, the broodstock collection area was changed to where the creek was now entering the lake after the 2012 flood event.

Male and female adult sockeye salmon from the spawning areas were harvested and stripped of their gametes. The gametes were shipped to Trail Lakes Hatchery for fertilization, incubation and rearing. The sockeye salmon eggs were incubated at ambient Trail Lakes Hatchery water temperature in 2 different lots. Incubation followed standard hatchery procedures and water temperature was regulated to thermally mark the 2 different lots (fry – 3,2H; smolt – 1,3H).

Gamete Collection, Incubation, and Rearing – Coho Salmon

Coho salmon eggs were collected by capturing adult fish as they attempted to migrate past the weir. The fish were held in the raceways at the weir (Figure 3) until the females' eggs matured. Gametes were collected and transported to Trail Lakes Hatchery. At the weir, all females used for gamete collection had a small section of kidney removed for screening of *Renibacterium. salmoninarum*, the causative pathogen for BKD. Eggs were fertilized and mating crosses were recorded. Each mating cross was placed into a vertical heath stack incubator. Once the eggs reached the eyed stage and the BKD pathology results were received any crosses that had a high prevalence of BKD were culled. The coho salmon eggs were incubated at ambient Trail Lakes

Hatchery water temperature in 2 different lots. Incubation followed standard hatchery procedures and water temperature was regulated to thermally mark the 2 different lots (fry – 2,6H, smolt – 4,4H). Coho salmon eggs were also collected by ADF&G staff for their stocking programs as well as for the Salmon in the Classroom program.[5]

Fish Transport and Stocking

Sockeye salmon fry have been stocked into Bear Lake since 1990. For stocking, the fry were transported by truck in oxygenated tanks to the public access area near the lake outlet. Fish were then transferred to a 150 gallon tank placed in a boat. The boat then transported the fry to the area where the main tributary now enters the lake. From the tank, fish were released into a small holding pen for acclimation and imprinting purposes. Staff from CIAA made multiple trips throughout the day. At the end of each day, the pen was emptied into the lake. In addition to the fry stocking, sockeye salmon smolt were stocked into net pens located in Resurrection Bay for short-term rearing before release.

Coho salmon fry have been stocked into Bear Lake since 1986. For stocking, the fry were transported by truck in oxygenated transport tanks, transferred to a boat, and motored to the north end of the lake where they were released in the littoral zone (Figure 2). In addition to the coho salmon fry stocking, coho salmon smolts were transported to Bear Creek weir by truck where they were put into raceways for a week to acclimate and imprint before being released to Bear Creek.

Otolith Collection in Resurrection Bay

With the stocking of sockeye salmon smolt into net pens in Resurrection Bay instead of Bear Lake, it became necessary to collect otoliths from fish harvested in Resurrection Bay (cost recovery and commercial harvests) in order to determine the percentage of return attributable to lake production versus net pen production (fry versus smolt production). In 2010 and 2011, the Alaska SeaLife Center (ASLC) performed this sampling as part of their salmon project

5 http://www.adfg.alaska.gov/index.cfm?adfg=educators.salmonclassroom

requirements. Fish heads were collected on a weekly basis at the fish processing plant (Icicle Seafoods) and otoliths were removed. Otoliths were sent to the ADF&G Mark Lab for analysis. Starting in 2012, CIAA staff performed this sampling following the same procedures and the otoliths were analyzed by CIAA staff. In 2014, fish heads were collected from Copper River Seafoods' processing plant in Kenai.

The proportion of adult sockeye belonging to each age class/program designation (BY08; BY09; BY10; and wild, fry, smolt) were estimated using the following notations and formulas.
If:

N = total number of adults captured in fishery (from fish tickets),
n = total number of adults captured in fishery that were sampled,
a = total number of adults captured in fishery from each age class/program designation,
p = the proportion of adults captured in fishery from each age class/program designation,

Then the proportion of adults from each age class/program designation, $\hat{P}$, was estimated as:

$$\hat{P} = a/n; \text{ with a variance of } v\left(\hat{P}\right) = (a/n)(1-a/n)/n-1$$

The total number of adults from each age class/program designation, $\hat{A}$, was also estimated as:

$$\hat{A} = N(a/n) = N\hat{P}; \text{ with a variance of: } v\left(\hat{A}\right) = v\left(\hat{P}\right)N^2.$$

Thus the 95% confidence interval estimate for

$$\hat{A} = 1.96\sqrt{v\left(\hat{A}\right)}$$

In 2014, 100 fish were sampled for otolith analysis for each harvest date. A total of 13 different harvests (112,043 fish) occurred of which 10 were sampled (105,187 fish). In total, 1,000 samples were obtained. For statistical analysis, the samples collected were then randomly

selected in proportion to the harvest number for that day. Approximately 0.5% of each day's harvest was analyzed.

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RESULTS AND DISCUSSION

Limnology, Environmental Conditions and Lake Fertilization

Bear Lake's limnological characteristics have been monitored for several years. The 2014 limnological data are presented in Appendix 1. This information has been summarized and is presented as open water seasonal average concentrations in Table 1 (1 meter) and Table 2 (hypolimnion).

Table 1. Water quality characteristics of Bear Lake at 1 meter, 1979 to 2014.

Year	Sp. Cond (umhos/cm)	pH (SU)	Alk (mg/l)	Turb. (NTU)	TP (ug/l)	TKN (ug/l)	NO2+NO3 (ug/l)	TN:TP	Chl a (ug/l)	EZD (m)	Secchi (m)	Zooplankton (mg/m2)
1979	76	7.4	30		8.0		8.3					
1980	74	7.3	29		7.7	138	9.8	42 :1	3.4			
1981	68	6.3	28		7.2	101	14.0	35 :1	3.4			734
1982	77	7.6	29		9.9	149	47.0	44 :1	1.9			704
1983	86	7.6	32		8.7	175	41.6	55 :1	2.0			914
1984	88	7.4	32	2.5	10.6	204	24.0	48 :1	3.6			836
1985	87	7.2	36	1.7	11.3	177	89.7	52 :1	2.6			429
1986	82	7.3	32	2.3	12.3	188	12.4	36 :1	2.9			583
1987	81	7.4	29	1.3	9.7	135	2.1	31 :1	1.6			401
1988						No analysis						
1989						No analysis						
1990	78	7.4	29	1.6	6.5	170	54.1	76 :1	1.9	11.2	3.6	1,134
1991	84	7.6	28	2.4	8.5	183	52.1	67 :1	2.8	7.4	3.2	467
1992	80	7.2	26	1.7	7.5	166	89.1	85 :1	1.7	9.0	3.8	395
1993	82	7.1	27	1.2	7.3	134	37.4	58 :1	1.9	8.7	4.4	804
1994	88	6.9	27	1.8	7.8	132	14.9	45 :1	2.1	11.4	5.0	743
1995	80	7.2	27	1.9	7.6	116	12.0	37 :1	2.7	10.1	4.4	377
1996	86	7.3	30	2.3	6.3	191	7.5	70 :1	3.1	9.0	3.8	949
1997	89	7.5	33	2.3	7.4	161	17.8	56 :1	3.0	8.2	4.4	556
1998	79	7.2	29	1.2	7.6	176	18.7	66 :1	0.6	8.5	5.3	515
1999	82	7.2	30	1.2	5.6	126	9.0	53 :1	0.9	9.7	5.6	771
2000	80	7.0	28	2.2	6.8	125	3.4	42 :1	3.4	8.9	4.6	356
2001	79	7.1	27	1.2	6.0	124	4.0	35 :1	2.0	9.2	5.0	288
2002	78	7.1	29	0.7	7.0	117	12.4	42 :1	2.4	10.4	5.0	525
2003	74	6.7	26	0.6	6.7	124	6.8	44 :1	2.1	11.0	6.4	333
2004	72	6.8	27	1.0	7.3	176	26.5	38 :1	1.5	9.2	3.8	107
2005	81	6.7	27	0.4	8.6	137	22.7	41 :1	0.9	9.2	5.4	698
2006	82	6.6	28	1.2	12.3	158	8.5	30 :1	2.5	8.3	3.2	412
2007	81	6.7	30	1.2	8.1	121	9.3	37 :1	1.6	11.9	4.3	322
2008	79	7.1	28	1.5	12.7	106	4.1	16 :1	2.6	8.9	4.0	292
2009	81	7.2	30	1.0	7.6	151	4.1	35 :1	1.2	8.4	4.5	407
2010	82	7.0	27	1.3	5.5	NA	4.1	NA :1	2.0	9.2	4.2	768
2011	85	7.6	30	1.4	15.2	NA	4.1	NA :1	3.2	8.6	4.4	658
2012	82	7.3	29	1.0	6.4	NA	25.3	NA :1	1.6	11.8	5.1	222
2013	76	7.3	25	0.9	9.6	NA	4.1	NA :1	1.9	9.0	4.1	247
2014	78	7.2	29	0.3	9.1	NA	1.5	NA :1	1.1	10.6	4.3	246

Averages prior to 1992 compiled by ADF&G. EZD, Secchi and atomic ration provided by CIAA. Open water season only.
2010 data is a combination of both Site A & B
NA-not available. 2010, 2011, 2012, 2013, 2014 TKN analysis is not complete due to equipment failure

Table 2. Water quality characteristics of Bear Lake in the hypolimnion, 1979 to 2014.

Year	Sp. Cond (umhos/cm)	pH (SU)	Alk (mg/l)	Turb. (NTU)	TP (ug/l)	TKN (ug/l)	NO2+NO3 (ug/l)	TN:TP	Chl a (ug/l)
1979	79	7.3	30		18.3		16.2		
1980	81	7.2	31		13.9	168	14.3	29 :1	8.8
1981	69	6.3	29		11.3	124	19.3	28 :1	5.5
1982	78	7.4	28		16.6	177	37.6	29 :1	5.8
1983	88	7.3	32		14.7	259	43.1	46 :1	6.8
1984	96	7.1	34	6.3	13.9	269	29.9	48 :1	7.7
1985	90	6.9	36	2.8	11.6	253	76.6	63 :1	4.1
1986	89	6.7	32	4.1	14.4	244	34.1	43 :1	3.9
1987	85	7.1	29	2.1	15.2	222	20.8	35 :1	
1988					No analysis				
1989					No analysis				
1990	83	7.1	29	2.9	11.2	248	47.4	58 :1	5.4
1991	88	7.1	29	3.3	10.6	203	55.9	55 :1	3.4
1992	84	7.0	26	2.9	8.1	194	82.7	83 :1	3.2
1993	88	7.0	29	1.9	8.8	140	65.6	62 :1	1.1
1994	88	6.9	29	1.9	13.6	185	17.7	34 :1	5.6
1995	83	7.0	28	4.7	12.8	202	8.3	36 :1	8.1
1996	87	7.0	30	4.6	12.4	273	1.9	49 :1	7.6
1997	93	7.3	34	8.3	17.1	332	4.3	44 :1	9.7
1998	89	7.1	32	2.9	8.5	188	34.5	63 :1	1.6
1999	86	6.9	30	4.2	14.7	222	12.2	38 :1	3.8
2000	81	7.2	28	1.9	6.9	127	3.0	41 :1	4.6
2001	80	7.0	27	1.9	5.8	137	3.9	37 :1	3.2
2002	80	7.0	31	0.9	10.1	127	15.2	32 :1	2.4
2003	73	6.8	26	0.7	6.7	116	7.1	41 :1	2.2
2004*	74	6.7	27	0.9	28.1	275	78.9	32 :1	1.7
2005	79	6.7	27	0.2	8.9	135	16.3	38 :1	0.9
2006	83	6.7	28	2.1	12.5	149	6.8	28 :1	2.4
2007	82	6.5	29	1.8	15.0	169	21.5	29 :1	3.2
2008	81	6.7	28	3.0	13.0	148	23.4	31 :1	2.2
2009	84	6.8	29	4.0	17.2	222	5.2	29 :1	4.8
2010	86	6.7	28	4.1	23.0	NA	8.0	NA :1	8.9
2011	92	7.1	32	2.6	17.0	NA	5.3	NA :1	5.4
2012	83	6.8	28	1.8	12.3	NA	47.3	NA :1	2.9
2013	81	6.9	25	2.5	17.3	NA	6.6	NA :1	4.2
2014	82	6.8	29	0.8	11.5	NA	2.1	NA :1	3.0

Averages prior to 1992 compiled by ADF&G. EZD, Secchi and atomic ratio provided by CIAA. Open water season only.

*2004 - possible contamination of hypolimnion sample (7/14/2004)

2010 data is combination of both Site A and B.

NA-not available. 2010, 2011, 2012, 2013, 2014 TKN analysis is not complete due to equipment failure.

The environmental conditions recorded in 2014 are presented in Appendix 2. Between 13 May and 30 June, the average air temperature was 11.4°C (± 1.9°C) [mean ± standard deviation] and the water temperature averaged 11.7°C (± 1.8°C). Average stage height below the weir was 1.4 ft (± 0.09 ft) and above the weir it was 0.9 ft (± 0.05 ft) for the same time period. Between 01 July and 10 October, the average air temperature was 11.5°C (± 3.8°C) and the water temperature averaged 13.7°C (± 3.2°C). Between 01 July and 24 July and 25 August and 14 October, average stage height below the weir was 1.53 ft (± 0.14 ft) and above the weir it was 0.9 ft (± 0.25 ft). However, due to the gap in data collection (25 July to 24 August), data cannot be compared with other years (see tables 3 and 4) for total days, percent cloud cover, and precipitation. Comparison can be made with air and water temperature as these data were collected for the entire time period.

Table 3. Environmental conditions observed at Bear Lake during smolt migration, 1990 to 2014.

	No. of Days								Temperature (C)			
			<50%	>50%			Days		Air		Water	
Year	Total Days	Clear	Cloud Cover	Cloud Cover	100% Overcast	Rain	Meas. Precip	Precip (mm)	Avg	Range	Avg	Range
1990	44	ND	ND	ND	ND	ND	ND	ND	ND	ND	10	(3-15)
1991	47	ND	ND	ND	ND	ND	ND	ND	ND	ND	7	(2-15)
1992	44	13	11	7	13	11	11	48	IC	IC	9	(3-14)
1993	42	5	13	11	7	6	16	ND	14	(8-20)	13	(7-17)
1994	47	8	8	11	5	15	18	38	12	(5-22)	11	(5-16)
1995	38	5	5	17	6	5	19	185	12	(6-22)	10	(6-14)
1996	45	9	7	11	6	12	17	102	11	(5-16)	12	(8-15)
1997	42	28	1	5	2	6	11	40	15	(9-22)	12	(5-20)
1998	29	6	11	3	3	6	14	5	15	(8-24)	7	(4-14)
1999	44	12	5	4	18	5	13	35	11	(4-20)	7	(0-14)
2000	46	15	5	6	17	3	8	44	11	(2-16)	7	(2-12)
2001	58	14	9	11	20	4	11	15	10	(1-18)	8	(0-15)
2002	54	18	2	7	9	18	27	58	12	(6-24)	8	(1-16)
2003	61	12	3	9	17	20	27	172	13	(6-23)	11	(1-16)
2004	61	19	2	12	14	14	17	218	15	(8-22)	9	(2-17)
2005	53	5	13	16	10	9	19	133	15	(10-23)	13	(7-17)
2006	61	12	3	10	28	8	26	105	13	(3-26)	9	(4-14)
2007	61	9	12	10	13	17	28	157	11	(5-22)	7	(1-15)
2008	61	7	8	11	11	9	19	64	12	(4-18)	8	(3-13)
2009	61	21	6	8	19	7	14	102	12	(2-18)	9	(2-14)
2010	46	8	11	8	11	8	14	70	12	(7-20)	11	(4-14)
2011	47	7	2	4	23	10	23	111	10	(3-17)	9	(4-14)
2012	46	11	7	7	13	8	25	149	12	(6-20)	6	(2-12)
2013	43	19	7	6	9	2	13	42	13	(3-21)	9	(2-15)
2014	49	15	13	10	6	5	20	6	12	(8-17)	11	(7-16)

ND-no data

Table 4. Environmental conditions observed at Bear Lake during adult migration, 1990 to 2014.

	No. of Days								Temperature (C)			
			<50%	>50%			Days		Air		Water	
	Total		Cloud	Cloud	100%		Meas.	Precip				
Year	Days	Clear	Cover	Cover	Overcast	Rain	Precip	(mm)	Avg	Range	Avg	Range
1990	119	ND	ND	ND	ND	ND	ND	ND	ND	ND	10	(3-15)
1991	100	ND	ND	ND	ND	ND	ND	ND	ND	ND	7	(2-15)
1992	92	17	22	16	48	38	38	345	IC	IC	IC	IC
1993	109	15	25	12	17	30	38	ND	14	(6-24)	15	(8-20)
1994	68	IC	IC	IC	IC	IC	IC	IC	IC	IC	IC	IC
1995	105	24	17	26	12	26	65	728	13	(3-20)	13	(6-16)
1996	101	17	11	31	23	19	50	308	10	(4-16)	14	(6-16)
1997	107	32	13	25	6	31	48	616	14	(5-21)	15	(6-20)
1998	117	24	19	13	39	31	72	627	12	(3-30)	11	(3-21)
1999	113	25	13	10	38	27	44	509	12	(3-25)	10	(2-16)
2000	125	19	25	14	36	31	56	443	9	(0-18)	10	(1-16)
2001	121	8	18	18	34	43	79	718	11	(-3-19)	12	(1-18)
2002	130	12	14	25	34	45	75	1,084	12	(3-26)	11	(6-18)
2003	123	19	21	22	30	30	56	661	14	(3-28)	13	(5-19)
2004	122	26	20	18	30	27	40	427	15	(3-32)	14	(6-19)
2005	123	25	16	19	36	27	65	416	13	(-1-25)	14	(4-19)
2006	122	7	18	20	38	39	75	864	11	(2-30)	12	(5-17)
2007	131	17	11	25	39	39	77	601	12	(-4-28)	12	(3-17)
2008	123	22	4	12	53	32	57	813	9	(0-22)	11	(3-15)
2009	110	23	5	16	42	24	55	761	12	(6-27)	13	(7-18)
2010	111	25	5	14	46	21	39	678	11	(2-18)	13	(7-16)
2011	93	18	6	16	32	21	44	671	10	(1-22)	13	(6-18)
2012	102	18	7	5	40	32	51	1,083	10	(2-18)	11	(5-15)
2013	102	28	5	10	40	19	32	607	14	(5-26)	14	(9-19)
2014	75	25	11	5	16	18	40	66	14	(5-17)	12	(0-17)

ND-no data. IC-incomplete data

*Sky condition data is calculated differently from 1997 onward. Rain days are counted as days with measurable precipitation and 100% overcast is measured as those days indicated as 100% overcast with or without measurable precipitation.

For 2014 - staff stopped recording sky condition and rainfall from July 25 - August 25. However, water and air temperatures were recorded for the entire time period.

Smolt Enumeration - Sockeye

Enumeration of Bear Lake sockeye smolt occurred between 13 May and 08 July. A total of 393,500 (± 25,300) sockeye salmon smolt migrated from Bear Lake in 2014 (Appendix 3). The 10% sub-sampling procedure was used to count 35.3% of the migrating sockeye salmon.

An estimated 79.0% (± 4.3%) smolt were age-1 and 21.0% (± 4.3%) were age-2. The age 1.0 smolt averaged 87 mm (± 0.7 mm) [mean ± confidence interval] in length and 6.3 g(± 0.5 g) in weight. The age 2.0 smolt averaged 105 mm (± 0.6 mm) in length and 11.2 g (± 0.9 g) in weight (Table 5). Based on the presence of hatchery induced thermal marks in the otoliths of 338 smolt, it was estimated that 96.7% (± 1.8%) of the sockeye salmon smolt were of hatchery origin.

As noted in the methods section, while analyzing the otoliths for age and mark, it was noted that staff had misidentified a number of samples for species (i.e., fish were sampled as sockeye salmon but were actually coho salmon). For the sockeye salmon sampling, 10.7% of the 392 samples were incorrectly identified. Due to the high percentage and assuming that the same error was occurring during counts, caution should be taken when using the smolt count number.

Smolt Enumeration – Coho Salmon

A total of 21,100 (± 1,100) coho salmon smolt migrated from Bear Lake in 2014 (Appendix 3) between 13 May and 08 July. The 10% sub-sampling procedure was used to count 21.5% of the migrating coho salmon smolt.

An estimated 42.7% (± 11.2%) [mean ± confidence interval] smolt were age 1, and 57.3% (± 11.2%) were age 2. The age 1.0 smolt averaged 81 mm (± 2.3 mm) in length and 6.6 g (± 1.5 g) in weight. The age 2.0 smolt averaged 111 mm (± 0.6 mm) in length and 15.2 g (± 0.6 g)in weight (Table 5). Based on the presence of hatchery induced thermal marks in the otoliths of 97 smolts, it was estimated that 95.8% (± 3.8%) of the coho salmon smolt were of hatchery origin.

As noted in the methods section, while analyzing the otoliths for age and mark, it was noted that staff had misidentified a number of samples for species (i.e., fish were identified as coho salmoncoho but were actually sockeye salmon). For the coho salmon sampling, 19.8% of the 141 samples were incorrectly identified. Due to the high percentage and assuming that the same error was occurring during counts, caution should be taken when using the smolt count number.

Adult Escapement – Sockeye Salmon

Adult sockeye salmon began arriving at the weir on 22 May 2014 and continued to migrate until 24 July 2014 (Appendix 4). During this time, 28,774 adults were captured and counted at the weir (Table 7). The returning major age groups (via scale samples) for adult sockeye salmon included ages 1.2 (37.8%), 1.3 (58.0%), 2.2 (3.1%) and 2.3 (1.1%). Of the 28,774 adult sockeye

that migrated to Bear Creek in 2014, 13,928 were harvested for cost recovery, 1,641 were donated to the Senior Center and Food Bank and 13,090 were passed to the lake. There were 115 mortalities at the weir. In the common property seine fishery a total of 5,306 were harvested and 112,043 fish were harvested in the saltwater cost recovery harvest. The number of fish caught in sport fishery is estimated at 20,000 based on personal communication with property owner in which most of the sport fishery occurs. An additional 115 were counted as mortalities at the weir. The total return to Resurrection Bay was estimated to be 166,323 sockeye salmon.

A summary of mean age and weight, by age class, for adult sockeye salmon escapement to the Bear Creek weir site for 2014 is presented in Appendix 6.

Adult Escapement – Coho Salmon

Adult coho salmon began arriving at the weir on 25 August 2014 and continued to migrate until 14 October (Appendix 5). During this time, 1,772 adults were captured and counted at the weir (Table 7). The returning major age groups for adult coho included ages 1.1 (22.7%), and 2.1 (77.3%).

Of the 1,772 adult coho that were counted at the Bear Creek weir site, 671 were harvested and donated, 383 were held for broodstock purposes and 534 were passed into the lake. Also an additional 184 fish were used for ADF&G eggtake and the Salmon in the Classroom program. Sport fish harvest is estimated at 5,400 fish, bringing the total return of adult coho salmon to 7,172. The adult return in 2014 was from smolts which migrated in 2013 (total 36,200). With the total return of 7,172, the smolt-to-adult survival is calculated at 19.8%.

A summary of mean age and weight, by age class for adult salmon escapement to the Bear Creek weir site for 2014 is presented in Appendix 7.

Table 5. Sockeye salmon smolt migrations: mean length and weight, by age class, for Bear Lake, 1980 to 2014.

						Age Composition								Average Length (mm)[6]					Average Weight (g)[6]				
Year	Number	*CI	% Hatch.	CI	No. Wild	0.0	CI	1.0	CI	2.0	CI	3.0	CI	0.0	1.0	CI	2.0	CI	0.0	1.0	CI	2.0	CI
1980	3,400					0		3,400		20		20			119		187			NA		NA	
1981	3,500					0		2,800		700		0			117		158			16.2		41.6	
1982	46,300					0		46,100		100		0			110		144			14.0		29.7	
1983	13,000					0		11,000		2,000		40			112		149			13.5		32.9	
1984	10,500					0		7,700		2,500		300			116		153			15.4		35.8	
1985	1,600					0		1,300		300		30			126		176			20.2		51.4	
1986	1,000					0		800		100		0			123		167			18.3		47.2	
1987	18,200					0		17,800		300		100			112		172			12.8		46.5	
1988	9,100					0		7,200		1,900		30			120		155			16.0		34.9	
1989	5,100					0		3,700		1,300		200			122		152			18.8		35.6	
1990[1]	53,400					52,500		800		30		3			113		125			15.2		28.4	
1991[2]	122,000					0		119,900		1,600		600			125		164			18.7		40.4	
1992[3]	133,800					38,400		78,000		15,800		1,600		110	118		170		15.4	16.7		49.4	
1993	345,800					54,600		285,500		4,900		0		115	123		152		18.1	18.7		35.3	
1994	253,900					700		228,600		21,200		0		102	121		154		11.0	17.4		37.0	
1995	73,500	1,900	70.2	8.0	21,900	0		68,000	1,600	5,500	1,000	0			122		156			17.9		37.2	
1996	156,000	9,600	64.2	3.5	55,400	0		149,400	9,400	6,400	2,100	0			117	0.6	120	2.1		11.8	*NA*	16.2	*NA*
1997	276,000	64,000	74.6	3.6	70,100	0		270,500	64,000	5,500	3,500	0			104	0.5	143	7.6		10.1	0.2	26.7	4.4
1998	107,800	15,500	72.2	5.8	30,000	0		81,800	13,600	25,500	7,200	500	1,400		115	1.1	151	3.6		13.1	0.5	35.2	2.5
1999	75,800	6,800	74.5	5.5	19,300	0		59,800	5,400	15,400	4,000	700	900		132	1.2	163	6.3		20.3	0.6	31.4	2.1
2000	162,500	20,600	76.8	5.2	40,600	11,400	5,600	138,600	18,000	20,700	7,500	4,300	3,400	119	114	1.6	172	11.1	16.8	14.0	0.7	59.0	9.8
2001	387,500	15,700	88.2	2.2	45,700	0		346,600	12,900	28,600	7,400	12,200	4,900		103	0.8	131	0.4		10.1	6.5	28.9	11.9
2002	107,200	7,100	28.4	3.2	76,800	0		85,100	6,300	20,800	3,300	1,300	800		115	0.6	146	1.5		15.1	0.7	35.1	1.0
2003	1,326,500	24,100	92.4	1.7	100,800	0		1,306,200	22,000	23,000	10,000	0			92	0.8	140	7.7		7.5	0.2	30.4	4.9
2004	123,200		96.2	2.4	4,700	0		76,500	7,800	46,700	7,800	0			115	1.3	139	0.8		14.2	1.4	26.1	1.2
2005	1,420,400	412,100	97.4	0.9	36,900	0		1,388,400	12,500	29,900	12,000	0			88	0.5	88	*NA*		6.4	*NA*	6.1	*NA*
2006	1,962,400	147,000	94.3	1.0	111,900	0		1,692,900	34,500	183,000	28,900	0			85	0.5	105	1.2		5.7	0.2	11.1	0.6
2007	1,347,900	88,300	96.4	1.0	48,500	0		1,262,900	20,000	84,900	20,000	0			89	0.6	92	2.3		6.6	0.1	7.0	0.5
2008	308,500	19,000	94.5	2.4	17,000	0		281,900	94,000	26,600	9,400	0			88	0.4	96	1.1		6.2	0.2	8.3	0.5
2009	241,100	29,500	97.1	1.6	7,000	0		235,400	3,900	5,700	9,400	0			91	0.6	126	*NA*		6.7	0.1	17.6	*NA*
2010	598,900	47,500	93.9	1.8	36,500	0		544,800	14,000	53,300	14,100	0			88	0.5	124	1.4		5.9	0.2	16.7	0.8
2011[7]	477,800	52,300	96.8	1.8	15,300	0		442,000	13,700	35,800	13,700	0			94	0.9	126	2.6		7.3	0.2	17.7	1.0
2012	467,000	28,700	99.3	0.8	3,600	0		454,800	8,100	12,200	8,100	0			93	0.8	132	6.3		6.9	0.2	20.7	2.4
2013	791,700	79,800	99.2	0.6	4,900	0		740,700	15,500	51,000	15,500	0			82	0.3	100	1.5		4.7	0.1	9.0	0.5
2014	393,500	25,300	96.7	1.8	7,100	0		310,900	17,000	82,600	17,000	0			87	0.7	105	0.6		6.3	0.5	11.2	0.9
Avg.[4]	540,300	57,600	85.2	2.7	37,700	600	5,600	496,860	19,700	38,200	10,100	1,000	2,300	119	101	0.8	128	3.4	17	9.8	0.7	22.6	2.8
Total[5]	11,825,800					157,600		10,751,800		815,850		21,923											

*CI-confidence interval = 95%. NA-not available.

Average Length rounded to nearest mm, Average Weight rouinded to nearset 0.1 g. All other figures have been rounded to nearest 100 fish.

[1]In 1990, the migration of juvenile sockeye salmon consisted of three groups of fish: 870 wild smolts of age 1.0 or older, 227,906 age 0.0 fingerlings and 52, 491 age 0.0 smolts. Age, length and weight data for age 0.0 smolts have been lost. Summary statistics are based on the wild smolt migration.

[2]In 1991 smolt migration monitoring may have terminated before age 0.0 smolt migration.

[3]In 1992, an additional 68,505 sockeye fingerlings migrated from Bear Lake. These small fingerlings were expected to have low survivals and AWL data was not collected

[4]Average values calculated from smolt year 1995 to 2012.

[5]Total values calculated from 1980 to 2013.

[6]1980 thru 1992 averages are arithmetic, 1993 and later are weighted averages.

[7]Due to vandalism at the weir, some samples (68) (scales/otoliths) were missing or destroyed. For the samples that are missing length/weight as well enhanced and age characteristics were not used for calculations.

Table 6. Coho salmon smolt migrations: mean length and weight, by age class, for Bear Lake, 1980 to 2014.

					Age Composition								Average Length (mm)[4]								Average Weight (g)[4]							
Year	Number	*CI	% Hatch.	CI	1.0	CI	2.0	CI	3.0	CI	4.0	CI	1.0	CI	2.0	CI	3.0	CI	4.0	CI	1.0	CI	2.0	CI	3.0	CI	4.0	CI
1980	75,000				54,600		20,300		100		0		122		135						19.3		24.0					
1981	72,900				10,900		61,800		200		0		122		127						18.4		19.8					
1982	143,700				134,000		9,600		100		0		116		127						15.0		20.4					
1983	108,400				100,400		7,900		100		0		115		129						14.3		20.2					
1984	93,800				78,300		15,200		300		0		116		134						15.0		22.4					
1985	105,900				104,300		1,600		0		0		125		168						18.1		41.5					
1986	72,700				60,900		11,500		300		0		126		137						19.5		24.9					
1987	80,200				61,200		18,700		250		0		109		145						11.6		27.9					
1988	63,800				50,500		13,300		0		0		118		133						16.4		22.3					
1989	99,400				96,200		3,200		0		0		116		134						18.8		23.0					
1990	83,400				67,500		14,800		1,000		0		119		139						15.7		24.1					
1991	97,600				86,500		10,600		500		0		121		138						18.0		25.5					
1992	112,900				107,500		4,700		600		0		120		137						17.1		25.7					
1993	53,500				42,300		10,400		0		0		124		137						19.5		25.8					
1994	54,400				6,000		43,700		0		0		115		128						14.4		20.7					
1995	89,200	4,000			3,500	1,000	85,000	3,800	500	400	100	150	103		121				*NA*		11.4		18.0					
1996	154,900	15,300			16,100	4,700	137,300	14,400	1,400	1,400	0		95		112						8.4		13.5					
1997	114,100	24,100			3,500	1,900	68,800	20,500	40,600	12,600	1,200	1,000	100		109		124		146		9.7		12.9		19.2		30.7	
1998	92,200	7,200			8,200	2,500	73,000	6,000	10,900	2,800	600	700	100		114		140		168		8.4		13.6		26.2		40.5	
1999	106,800	11,700			44,300	7,400	54,500	8,600	8,000	2,600	0		113		123		128				13.5		18.3		19.4			
2000	70,900	4,600			55,600	3,300	13,500	2,900	1,800	1,200	0		109		128		144				13.0		20.4		28.9			
2001[1]	101,400	12,600	91.8	2.2	80,200	11,800	19,900	4,100	1,300	900	0		104		117		125				11.6		17.0		20.5			
2002	94,200	11,700	84.5	3.0	82,400	11,300	11,500	3,000	300	500	0		109		119		148				11.9		16.2		36.5			
2003	208,100	10,900	86.9	3.1	167,800	7,700	31,900	6,700	8,500	3,700	0		109		119		138				11.9		16.3		26.5			
2004	73,400	*NA*	92.4	2.6	54,200	3,500	19,200	3,500	0		0		103	1.2	128	1.6					11.5	0.8	22.1	1.2				
2005	65,400	3,700	96.4	1.5	56,500	2,000	9,000	2,000	0		0		97	1.0	121	2.3					9.5	0.5	18.2	1.5				
2006	50,000	4,300	92.1	3.1	37,300	2,900	12,700	2,600	0		0		93	2.2	128	2.6					8.4	0.9	21.7	1.4				
2007	79,000	2,500	93.2	2.8	43,100	5,200	35,900	5,200	0		0		86	1.8	112	0.8					6.0	2.2	14.7	1.1				
2008	63,900	3,800	97.4	1.5	34,800	3,400	29,200	3,400	0		0		95	1.1	117	0.4					8.6	1.3	16.9	0.8				
2009	54,800	4,100	98.1	1.2	33,000	2,500	21,900	2,500	0		0		98	1.4	115	0.7					9.6	1.2	15.8	0.7				
2010	48,900	2,700	98.4	1.3	21,000	3,000	27,900	3,000	0		0		101	2.5	124	0.6					10.9	2.4	20.1	1.03				
2011[5]	40,400	3,800	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*					*NA*	*NA*	*NA*	*NA*				
2012	45,900	970	98.1	1.5	16,500	2,700	29,400	2,700	0		0		101	2.4	122	0.5					8.1	2.7	19.6	0.9				
2013	36,200	3,200	96.2	2.4	13,900	1,300	21,500	1,500	800	300	0		98	4.1	121	1.0	135	13.6			9.9	3.5	17.3	0.9	23.6	7.2		
2014	21,100	1,100	95.8	3.8	9,000	2,400	12,100	2,400	0		0		81	3.9	111	1.0					6.6	2.5	15.2	0.9				
Avg[2]	83,669	7,000	93.9	2.3	54,200	4,200	27,500	5,200	2,400	2,600	100	600	108		127		135		157		12.9		20.5		25.1		35.6	
Total[3]	2,928,400				1,842,000		961,500		77,550		1,900																	

*CI-confidence interval=95%. NA-not available.

Note: Averages for age 3.0 and 4.0 smolts are based on a small sample size.

Average Length rounded to nearest mm, Average Weight rouinded to nearset 0.1 g. All other figures have been rounded to nearest 100 fish.

[1]Percent Hatchery calculated for Age 1.0 smolts only

[2]Average values calculated from smolt year 1980 to 2012.

[3]Total values calculated from 1980 to 2013.

[4]1980 thru 1992 averages are arithmetic, 1993 and later are weighted averages.

[5]Due to vandalism at the weir nearly all (184) of the 249 samples collected (scales/otoliths) were destroyed or missing therefore it is impossible to provide statistical validation to enhanced contribution, age contribution and length/weight information

Table 7. Historical returns of Coho and Sockeye Salmon to Bear Lake weir, 1980 to 2014.

	Weir	Coho Salmon			Weir	Sockeye Salmon										
	Retun	Age Composition			Retun	Age Composition										
Year	Total	1.1	2.1	3.1	Total	0.2	1.1	0.3	1.2	0.4	1.3	2.1	2.2	2.3	3.2	3.3
1980	4,520	*NA*	*NA*	*NA*	1,462	0	0	0	1,447	0	0	0	15	0	0	0
1981	3,924	2,252	1,627	45	704	0	0	0	5	0	631	0	63	5	0	0
1982	2,122	*NA*	*NA*	*NA*	472	0	0	0	407	0	26	0	6	28	0	0
1983	5,797	5,261	510	25	627	0	0	0	275	0	316	0	25	11	0	0
1984	3,375	3,969	401	5	3,552	0	0	0	3,432	0	74	0	31	10	0	0
1985	4,825	4,222	603	0	1,235	0	0	0	245	0	935	0	52	3	0	0
1986	5,479	5,384	95	0	830	0	0	0	356	0	425	0	44	6	0	0
1987	6,021	5,888	133	0	212	0	0	0	75	0	102	0	26	5	0	0
1988	2,174	1,818	356	0	106	0	0	0	51	0	44	0	3	8	0	0
1989	5,106	4,174	932	0	185	0	0	0	174	0	11	0	0	0	0	0
1990	7,525	7,179	346	0	1,071	0	0	0	390	0	627	0	---11---		0	0
1991	7,331	6,328	1,003	0	741	0	0	0	232	0	409	0	90	5	0	0
1992	3,055	2,444	611	0	1,925	1,398	33	0	246	0	225	0	17	6	0	0
1993	8,671	8,136	535	0	6,708	84	17	4,068	2,336	0	135	0	17	17	0	0
1994	5,995	4,643	1,352	0	16,752	4,399	149	196	4,813	44	6,198	0	802	129	20	0
1995	3,295	883	2,346	66	29,203	29	380	4,877	4,877	117	17,317	29	876	672	0	0
1996	1,711	495	1,216	0	15,957	34	101	1,280	7,002	0	5,555	0	1,919	67	0	0
1997	3,569	618	2,883	68	17,965	0	663	26	4,849	0	10,080	0	1,123	1,174	26	26
1998	11,023	935	9,531	557	29,447	0	49	25	24,613	0	4,245	0	344	172	0	0
1999	3,811	529	2,991	291	17,439	0	0	0	9,004	0	6,802	25	1,534	74	0	0
2000	6,765	1,172	5,465	129	13,716	0	136	0	2,139	0	10,253	0	917	272	0	0
2001	2,913	1,515	1,265	133	16,364	0	0	0	5,187	0	9,705	0	736	736	0	0
2002	3,484	1,475	1,884	124	15,227	0	0	0	11,235	0	3,064	0	859	70	0	0
2003	3,506	2,727	752	27	16,010	0	58	0	7,219	0	6,404	0	1,921	408	0	0
2004	2,672	1,255	1,369	49	11,923	0	992	0	2,639	0	6,904	20	1,131	238	0	0
2005	2,947	795	2,095	58	45,312	0	0	0	37,729	0	5,898	0	1,026	659	0	0
2006	2,089	1,058	952	79	43,069	0	0	0	5,153	0	35,000	0	2,236	681	0	0
2007	1,113	596	517	0	20,090	0	0	0	10,472	0	8,121	0	321	1,175	0	0
2008	1,467	489	960	18	17,142	0	61	0	5,896	0	10,030	0	912	243	0	0
2009	1,245	392	819	34	45,859	0	0	0	1,663	0	43,017	0	151	1,028	0	0
2010	1,230	805	395	30	15,864	0	18	0	12,323	0	2,095	0	1,369	59	0	0
2011	850	198	629	23	18,116	0	25	0	6,576	0	11,187	25	151	151	0	0
2012	924	72	794	58	14,381	0	27	0	6,129	0	6,235	0	2,229	212	0	0
2013	3,122	1,561	1,416	145	15,820	0	62	0	7,290	0	7,103	217	1,086	62	0	0
2014	1,772	403	1,369	0	28,774	0	0	10,867	0	0	16,679	0	898	331	0	0
Avg[1]	3,119	1,077	1,952	90	22,116	212	130	822	8,419	8	11,042	15	1,073	410	2	1
% of Avg	100%	34.5%	62.6%	2.9%	100%	1.0%	0.6%	3.7%	38.1%	0.0%	49.9%	0.07%	4.9%	1.9%	0.01%	0.1%

NA-not available

[1] Average calculation is based on 1994 data onward.

Hatchery Activities

Stocking

In 2014, 2.405 million sockeye salmon fry (BY13; Hatch Code - 4H) and 468,000 coho salmon fry (BY13; Hatch Code - 4,3H) were released into Bear Lake. These fish will migrate in 2015/2016 as smolts. At the time of release, the sockeye salmon fry averaged 0.43 g and the coho salmon fry averaged 0.95 g.

In addition to the fry stocking, 1.742 million sockeye salmon smolt (BY12; Hatch Code - 3,3,2H) were short-term reared in net pens located in Resurrection Bay before being released. At the time of release, the sockeye salmon smolts averaged 14.5 g. A summary of releases are provided in Table 8. An additional 55,000 coho smolts (BY12; Hatch Code - 3,2H) were released into Bear Creek after a 1-week acclimation in raceways located at Bear Creek weir.

Eggtake

Between 27 July and 15 August 2014, a total of 5,292,800 sockeye salmon eggs were collected. A total of 3,857 broodfish (includes broodstock, mortalities, and inviable) were used providing an average fecundity of 2,999 eggs/female.

On 3 occasions between 30 September and 07 October 2014, a total of 581,300 coho salmon eggs were collected from 144 females and fertilized with milt from 96 males. Average fecundity was 4,272 eggs/female. An additional 330,000 coho salmon eggs were collected by ADF&G. Of the 144 females sampled for disease screening, no fish was identified as being positive for *Renibacterium salmoninarum.*

Table 9 provides an overview of egg collection activities for enhancement at Bear Lake since 1989.

Fry-to-Smolt Survival

Migrating smolts in 2014 were stocked either as fry in 2012 (BY11 - Age 2) and 2013 (BY12 - Age 1). Based on age classification from otoliths/scales, the fry-to-smolt survival for each brood year of fry stocking can be determined. Total smolt migration count (count plus fish sampled for otolith and mortalities) was used to determine fry to smolt survival. In 2014, the fry-to-smolt survival for sockeye salmon from BY10 was finalized at 20.3%,BY11 is at 29.8% (incomplete data), and BY12 is at 14.4% (incomplete data). For coho salmon, the fry-to-smolt survival is estimated at 8.5% for BY10, 11.0% for BY11 (incomplete data), and 2.3% for BY12 (incomplete data). This information is summarized in Table 10.

Resurrection Bay Fishery Otolith Analysis

Otolith analysis of adult sockeye salmon (n=501) sampled in proportion to the daily harvest during the Resurrection Bay fishery (28 May to 15 June) indicated that 0.4% (± 0.6%) [mean ± confidence interval] were from BY08-Wild, 17.0% (± 3.3%) were BY09-Fry, 1.0% (± 0.9%) were BY09-Wild, 15.0% (± 3.1%) were BY10-Fry, 60.1% (± 4.33%) were BY10-Smolt and 0.6% (± 0.7%) were BY10-Wild. As expected, there were no fish identified as BY09-Smolt as these fish were culled prior to stocking due to an IHN outbreak.

Marine Survival

Based on information collected from migrating sockeye salmon smolt and returning adults (total return), it is possible to provide an estimate of the survival of hatchery fish in the marine environment. Using otolith data collected by the ASLC (2010 and 2011) and by CIAA (2012 onward), the percentage of the total return attributable to the lake production (fry stocking program) and the net pen production (smolt stocking program) can be calculated (BY06 onward). This information is summarized below in Table 11. Caution should be used in interpreting the results for BY05 through BY07. Due to poor thermal marking, there are a number of different variations of the thermal mark making it very difficult to determine the program (fry or smolt) contribution to the total return. Steps have been taken to correct this problem.

For the return in 2014, age composition as determined by otolith collection in the Resurrection Bay fishery is applied only to the commercial and saltwater cost recovery harvests. Age composition for sport fishery, escapement, broodstock, and freshwater cost recovery harvest uses the information provided by scale analysis at the weir.

Table 8. Coho and sockeye salmon releases at Bear Lake, 1986 to 2014.

	Coho				Sockeye					
Release Year	Fry	Size (g)	Smolt	Size (g)	Fry	Size (g)	Pre-Smolt	Size (g)	Smolt	Size (g)
1986	445,700	1.64								
1987	226,300	1.46								
1988	347,200	1.00								
1989	491,300	0.75								
1990	333,200	1.30	93,700	20.0	2,260,200	0.80			158,800	7.1
1991	390,000	1.42			1,533,800	0.35			74,900	3.9
1992	203,800	0.49	51,730	10.1	1,795,500	0.72			565,500	4.4
1993[1]	450,000	0.30			47,000	0.15				
1993[2]	170,600	0.30			1,765,900	0.38				
1994	335,000	0.22			170,000	0.35				
1995	509,000	0.75	7,400	6.5	330,000	0.37				
1996[3]	350,000	0.70	75,000	11.2	780,600	0.37				
1997	448,700	0.63	153,000	8.0	788,000	0.34				
1998	409,000	0.66	117,000	8.3	265,000	0.56				
1999	306,000	0.82	51,000	7.8	1,380,000	0.26				
2000[4]	316,000	0.94	102,000	12.8	1,796,000	0.69				
2001	311,000	0.99	120,500	12.8	145,000	0.30				
2002	405,000	1.04	124,000	13.6	2,407,000	0.49	802,000	4.50		
2003[5]	405,000	1.37	253,000	13.7	1,467,000	0.42			334,000	11.8
2004	406,000	1.07	477,000	11.51	2,409,000	0.63	603,000	4.50		
2005	405,000	1.30	488,000	12.40	2,416,000	0.74	604,000	2.87	402,000	11.6
2006	447,000	0.84	115,000	10.8	2,414,000	0.52			979,000	10.0
2007	521,000	1.00	237,000	8.86	2,437,000	0.65			619,000	9.9
2008[6]	360,000	1.40	142,000	12.5	2,400,000	0.60			1,600,000	10.4
2009[6]	270,000	1.30	68,000	13.5	2,543,000	0.50			1,675,000	13.2
2010[6]	435,000	1.20			2,200,000	0.65			1,650,000	13.6
2011[7]	437,000	1.01			2,488,000	0.60				
2012	222,000	1.68	93,000	12.3	2,490,000	0.61			1,305,000	10.8
2013	405,000	1.00			2,548,000	0.49			2,090,000	14.7
2014	468,000	0.95	55,000	12.2	2,405,000	0.43			1,742,000	14.5
Total	11,228,800		2,823,330		43,681,000		2,009,000		13,195,200	
Ave	374,293	0.98	148,596	11.5	1,680,038	0.50	669,667	3.96	1,015,015	10.45

[1] Released into Bear Lake

[2] Extra Fry Released into Bear Creek

[3] sockeye fry relase, 445, 300 @ .36g & 335,300 @ .38g

[4] sockeye fry release, 1,573,000 @ (.35-.45 g) & 223,000 @2.7 g

[5] An additional 103,000 coho smolts @ 12.7g (Bear Lake brood year 2001) were released at the Homer Spit.

[6] Sockeye smolt stocking was into net pens at Resurrection Bay not Bear Lake

[7] No smolts into Resurrection Bay in 2011 due to IHN outbreak at hatchery. All smolts destroyed (BY09).

Table 9. Eggs collected for Bear Lake enhancement, 1989 to 2014.

	Coho				Sockeye			
Brood Year	Brood Stock	Green Eggs	Eyed Eggs	%	Brood Stock	Green Eggs	Eyed Eggs	%
1989	Bear L	932,300	711,800	76.3	SF Big R	3,119,300	2,713,700	87.0
					U Russian L	57,400	47,700	83.1
1990	Bear L	798,200	669,300	83.9	SF Big R	134,000	100,700	75.1
					U Russian L	2,602,800	1,721,500	66.1
1991	Bear L	695,600	533,400	76.7	SF Big R	2,534,500	1,794,500	70.8
					U Russian L	1,441,800	974,400	67.6
1992	Bear L	802,700	749,900	93.4	SF Big R	3,428,100	2,976,000	86.8
					Bear L	47,000	45,100	96.0
1993	Bear L	735,500	696,000	94.6	Bear L	276,700	172,800	62.5
1994	Bear L	847,000	739,600	87.3	Bear L	530,000	420,000	79.2
1995	Bear L	867,500	737,600	85.0	Bear L	2,040,000	1,672,000	82.0
1996	Bear L	968,000	829,000	85.6	Bear L	1,481,000	1,039,000	70.2
1997	Bear L	687,000	606,000	88.2	Bear L	502,000	363,000	72.3
1998	Bear L	805,000	727,000	90.3	Bear L	2,645,000	2,377,000	89.9
1999	Bear L	867,000	637,000	73.5	Bear L	2,436,000	1,902,000	78.1
2000	Bear L	972,300	785,800	80.8	Bear L	5,093,000	4,402,000	86.4
2001	Bear L	1,052,000	864,000	82.1	Bear L	6,017,000	5,127,000	85.2
2002	Bear L	1,237,500	1,085,700	87.7	Bear L	6,004,000	4,921,000	82.0
2003	Bear L	1,249,572	1,093,892	87.5	Bear L	5,000,000	4,398,000	88.0
2004	Bear L	1,673,000	1,557,000	93.1	Bear L	5,661,000	4,989,000	88.1
2005	Bear L	1,414,800	1,252,800	88.5	Bear L	4,002,000	3,618,000	90.4
2006	Bear L	1,084,000	990,000	91.3	Bear L	6,087,000	5,444,000	89.4
2007	Bear L	748,000	581,000	77.7	Bear L	6,071,000	5,398,000	88.9
2008	Bear L	574,000	283,000	49.3	Bear L	6,033,000	5,531,000	91.7
2009	Bear L	545,000	462,000	84.8	Bear L	5,009,000	4,531,000	90.5
2010	Bear L	647,000	501,000	77.4	Bear L	5,400,000	4,810,000	89.1
2011	Bear L	577,700	312,400	54.1	Bear L	5,984,100	5,586,600	93.4
2012	Bear L	638,600	518,300	81.2	Bear L	6,041,114	5,611,491	92.9
2013	Bear L	630,000	577,000	91.6	Bear L	5,325,100	4,774,200	89.7
2014	Bear L	581,279	547,422	94.2	Bear L	5,292,800	4,656,248	88.0
Total		22,630,551	19,047,914			106,295,714	92,116,939	
Ave				82.9				83.3

Table 10. Bear Lake smolt production by brood years.

Brood Year		Coho Escap.	No. Fry Stocked	Size (g)	No. Smolt	Hatch Smolt	% Hatch. Survival	Brood Year		Sockeye Escap.	No. Fry Stocked	Size (g)	No. Smolt	Hatch. Smolt	% Hatch. Survival
1985		4,421	445,700	1.64	74,520			1985		1,235			19,740		
1986		5,115	226,300	1.46	54,700			1986		830			8,450		
1987		5,653	347,200	1.00	111,570			1987		212			4,320		
1988		1,640	491,300	0.75	78,680			1988		106			4,030		
1989		475	333,200	1.30	91,280			1989		185	2,260,000	0.80	345,000		
1990		919	390,600	1.42	118,000			1990		1,071	1,530,000	0.35	157,800		
1991		227	203,800	0.49	86,470			1991		741	1,796,000	0.72	910,600		
1992		332	450,000	0.30	91,950			1992		1,925	1,813,000	0.38	288,200		
1993		560	335,000	0.22	62,800			1993		5,045	170,000	0.15	74,400	51,800	30.5
1994		475	509,000	0.75	204,100			1994		8,430	330,000	0.37	154,900	100,000	30.3
1995		444	350,000	0.70	84,600			1995		8,334	781,000	0.37	296,500	220,600	28.2
1996		380	448,700	0.63	64,500			1996		8,012	788,000	0.34	97,900	71,100	9.0
1997		276	409,000	0.66	57,700			1997		7,945	265,000	0.56	84,800	64,200	24.2
1998		350	306,000	0.82	74,827			1998		8,427	1,380,000	0.25	179,400	135,100	9.8
1999		368	316,100	0.94	100,200	83,300	26.4	1999		7,815	1,796,400	0.80	368,700	312,800	17.4
2000		429	311,000	0.99	114,300	97,300	31.3	2000		11,828	144,500	0.30	108,100	45,400	31.4
2001		495	405,000	1.04	187,000	163,600	40.4	2001		12,801	3,209,000	0.49	1,352,900	917,900	28.6
2002		875	405,000	1.37	63,200	58,800	14.5	2002		12,504	1,467,000	0.42	106,400	102,800	7.0
2003		395	406,000	1.07	69,200	66,200	16.3	2003		13,233	3,012,000	0.63	1,571,400	1,122,900	37.3
2004		572	405,000	1.30	73,200	67,800	16.7	2004		8,061	3,020,000	1.17	1,777,800	699,200	23.2
2005		546	447,000	0.84	72,300	68,600	15.3	2005		10,285	2,414,000	0.52	1,289,500	623,600	25.8
2006		500	521,000	1.00	56,700	55,400	10.6	2006		8,338	2,437,000	0.65	287,600	271,900	11.2
2007		386	360,000	1.40	60,900	59,900	16.6	2007		8,420	2,400,000	0.60	288,700	278,600	11.6
2008		368	270,000	1.30	IC	IC	IC	2008		8,992	2,543,000	0.50	580,600	546,200	21.5
2009		535	435,000	1.20	IC	IC	IC	2009		9,977	2,200,000	0.65	454,200	440,000	20.0
2010		492	437,000	1.00	38,300	37,100	8.5	2010		8,564	2,488,000	0.60	503,700	505,032	20.3
2011	*	359	222,000	1.68	*25,400*	*24,435*	*11.0*	2011	*	9,389	2,490,000	0.61	*750,100*	*743,000*	*29.8*
2012	*	315	405,000	1.00	*9,600*	*9,235*	*2.3*	2012	*	8,031	2,548,000	0.49	*381,700*	*367,200*	*14.4*
2013	*	300	468,000	0.95				2013	*	8,999	2,405,000	0.43			
2014	*	534						2014	*	9,233					
Ave[1]		452	389,100	0.99	86,489	75,800	19.7	Ave[1]		9,212	1,823,200	0.52	532,100	361,600	21.5

IC-incomplete data

* Incomplete broodyear

[1]Average data is for 1993 onward. For # Smolt, Hatchery Smolt and % Survival only includes completed years only.

Smolt numbers are rounded to the nearest 100 fish.

Note: Number of Hatchery Smolt is based on otolith mark data.

IC-incomplete data

* Incomplete broodyear

[1]Average data is for 1993 onward. For # Smolts, Hatchery Smolt and % Survival includes completed years only

Smolt numbers are rounded to the nearest 100 fish.

Note: Number of Hachery Smolt is based on otolith mark data.

BY2001, 2003, 2004 fry stocked includes those stocked as fry and as presmolts

BY2001, BY2003, BY2004, BY2005 hatchery smolt do not include the number that were stocked as smolts into Beak Lake

BY2006 - BY2012 hatchery smolt is from fry stocking only. Smolt stocking went to Resurrection Bay

Table 11. Marine survival for sockeye at Bear Lake.

BY	Lake (Fry) Marine Survival	NetPen (Smolt) Marine Survival
1989[a]	5.0	
1990	24.9	
1991	5.4	
1992	15.5	
1993	17.3	
1994	34.4	
1995	16.2	
1996	15.9	
1997	15.9	
1998	18.9	
1999	8.4	
2000	17.3	
2001	9.8	
2002	26.6	
2003	6.1	
2004	11.1	
2005 [b]	*1.2*	
2006[c,d]	60.6	0.1
2007[d]	48.3	3.4
2008	13.1	0.9
2009	*9.1*	*NA*
2010	*3.3*	*5.2*
AVE	19.5	1.4

[a]1989-2005 Lake survival includes enhanced + wild returns

[b]2005 cannot be complete since sampling methodology changed between the 2 and 3 yr old returns.

[c]2006 - 2010 Lake survival uses enhanced returns only but since the number of wild returns are low <1% this is a good estimate for the entire lake return.

Numbers in red and italicized are incomplete broodyears and are not included in calculation of the average.

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RECOMMENDATIONS

Based on the sampling errors that occurred throughout the season, better training and staff oversight is necessary. Steps are being taken to rectify this problem for the 2015 sampling season.

A more in-depth examination is required to determine the possible reasons for the decline in coho salmon smolt production and the adult returns to Bear Lake. In order to assess the marine survival for coho salmon, an assessment on the number of fish harvested in the sport fishery is necessary—CIAA and ADF&G should collaborate on performing this assessment.

The number of fish caught in the sport fishery for both sockeye and coho salmon is an estimate. Sport fish harvest is based on the mail-in Statewide Sport Fish Survey.[6] These numbers are not available until the summer after the fish had been caught. It has been some time since a creel survey has been performed to validate the Statewide Sport Fish Survey results. An assessment on the number of fish harvested and their age composition in the Resurrection Bay sport fishery is necessary—CIAA and ADF&G should collaborate on performing this assessment.

An evaluation to compare the methods of aging (otolith and scale samples) should be performed to determine if there is sufficient correlation between the methods.

An evaluation of the Trail Lakes Hatchery marking program should be performed to ensure tothat the different thermal marks are easily distinguishable and of high quality.

The erythromycin injection project is working and should be continued until 2015. In 2015, all returns (2 and 3 year old) will be from broodstock that were injected with erythromycin and should therefore have a lower incidence of BKD. In 2015, an assessment of the BKD incidence for injected and non-injected fish should be performed.

6 https://www.adfg.alaska.gov/sf/sportfishingsurvey/.

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APPENDICES

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Appendix 1. Bear Lake 2014 - Water Chemistry Analysis

Nutrients and Primary Productivity

Date	Sta	Depth (m)	TP (ug/l)	TFP (ug/l)	FRP (ug/l)	TKN (ug/l)	NH3+NH4 (ug/l)	NO2+NO3 (ug/l)	TN:TP	RSi (ug/l)	Carbon (ug/l)	Chla (ug/l)	Phaeo (ug/l)	EZD (m)
6/11/2014	B	1	6.2	2.5	1.9	NA	1.6	2.4	NA :1	2,914	511	1.26	0.26	
		10	14.5	2.5	2.2	NA	4.6	1.1	NA :1	3,095	582	5.27	0.71	8.0
7/16/2014	B	1	4.0	2.4	2.9	NA	1.7	0.8	NA :1	2,993	187	0.49	0.20	
		14	14.2	3.5	2.9	NA	1.9	1.3	NA :1	3,392	579	3.57	0.43	12.2
8/13/2014	B	1	20.1	2.6	1.2	NA	89.3	1.1	NA :1	2,838	184	1.66	0.55	
		13	5.2	6.1	3.7	NA	1.0	3.4	NA :1	3,586	374	1.77	0.66	11.9
9/11/2014	B	1	5.9	2.8	1.5	NA	7.1	1.6	NA :1	3,076	288	1.18	0.33	
		12	12.0	3.5	1.8	NA	5.3	2.4	NA :1	3,643	279	1.52	0.43	10.4
Mean			10.3	3.2	2.3	NA	3.3	1.8	NA :1	3,192	373	2.1	0.4	10.6
Min			4.0	2.4	1.2	0.0	1.0	0.8	NA :1	2,838	184	0.5	0.2	8.0
Max			20.1	6.1	3.7	0.0	89.3	3.4	NA :1	3,643	582	5.3	0.7	12.2
1m Ave			9.1	2.6	1.9	NA	24.9	1.5	NA :1	2,955	293	1.1	0.3	10.6
Hypo Ave			11.5	3.9	2.7	NA	3.2	2.1	NA :1	3,429	454	3.0	0.6	

NH3+NH4 average does not include highlight number. Out of range-sample contamination

NA-not available due to equipment failure.

General Tests and Metals

Date	Sta	Depth (m)	Sp. Cond (umhos/cm)	pH (SU)	Alk (mg/l)	Turb (NTU)	Color (Pt)	Ca (mg/l)	Mg (mg/l)	Fe (ug/l)	Secchi (meters)
6/11/2014	B	1	74	7.1	27.5	0.1	5	12.3	0.2	19	3.5
		10	76	6.8	27.9	0.2	5	11.9	0.2	36	3.5
7/16/2014	B	1	80	7.2	28.0	0.4	4	11.8	0.3	4	4.0
		14	83	6.6	29.4	0.5	5	12.4	0.2	65	4.5
8/13/2014	B	1	79	7.2	31.4	0.3	6	12.3	0.2	33	5.0
		13	84	7.1	30.3	1.3	8	12.7	0.2	257	4.5
9/11/2014	B	1	79	7.2	28.8	0.4	5	12.2	0.2	12	4.5
		12	84	6.6	29.6	1.1	5	12.9	0.2	80	4.8
Mean			80	7.0	29.1	0.5	5.4	12.3	0.2	35.3	4.3
Min			74	6.6	27.5	0.1	4.0	11.8	0.2	3.7	3.5
Max			84	7.2	31.4	1.3	8.0	12.9	0.3	257	5.0
1m Ave			78.1	7.2	28.9	0.3	5.0	12.2	0.2	16.9	4.3
Hypo Ave			81.5	6.8	29.3	0.8	5.8	12.5	0.2	109.2	

Fe average does not include higlighted number. Out of range-sample contamination

Appendix 1. (continued) Bear Lake 2014 - Zooplankton Analysis

Macrozooplankton Density - Site A - Depth 12.5m - 14m
(No/m2)

	11-Jun	16-Jul	13-Aug	11-Sep	Mean (No/m2)	Seasonal Mean (No/m2)
Ergasilus						
Ovig Ergasilus						
Epischura		8,790	1,433	669	3,631	2,723
Ovig Epischura						
Diaptomus	637	955	2,070	446	1,027	1,027
Ovig Diaptomus						
Cyclops	27,516	22,548	9,395	15,828	18,822	18,822
Ovig. Cyclops	127	764			446	223
Bosmina	2,803	117,325	99,204	46,815	66,537	66,537
Ovig. Bosmina	2,038	20,064	9,395	5,350	9,212	9,212
Daphnia l.	69,554	105,669	60,032	189,045	106,075	106,075
Ovig. Daphnia l.	21,401	13,758	19,427	45,478	25,016	25,016
Daphnia g.						
Chydorinae	127		2,229	446	934	701
Ovig. Chydorinae						
Scapholeberis				223	223	56
Total:	124,203	289,873	203,185	304,300	231,921	230,390
Ave:	15,525	36,234	25,398	33,811	23,192	23,039
STDEV:	24,311	47,218	35,557	61,226	35,560	35,660

Macrozooplankton Density - Site B - Depth 16m - 18m
(No/m2)

	11-Jun	16-Jul	13-Aug	11-Sep	Mean (No/m2)	Seasonal Mean (No/m2)
Ergasilus						
Ovig Ergasilus						
Epischura	478	3,822			2,150	1,075
Ovig Epischura						
Diaptomus	1,115	478	2,803	1,146	1,386	1,386
Ovig Diaptomus			255			
Cyclops	36,624	4,140	33,885	20,446	23,774	23,774
Ovig. Cyclops	159		2,548		1,354	677
Bosmina	6,051	69,586	160,510	29,236	66,346	66,346
Ovig. Bosmina	3,503	15,605	52,484	10,701	20,573	20,573
Daphnia l.	42,834	95,541	98,599	152,675	97,412	97,412
Ovig. Daphnia l.	19,108	9,554	52,739	25,223	26,656	26,656
Daphnia g.						
Chydorinae	159	159	764	382	366	366
Ovig. Chydorinae						
Scapholeberis				191	191	48
Total:	110,031	198,885	404,587	240,000	240,207	238,312
Ave:	12,226	24,861	44,954	30,000	24,021	23,831
STDEV:	16,757	36,631	54,768	50,899	33,046	33,190

Appendix 1. (continued) Bear Lake 2014 - Zooplankton Analysis

	Body Size - Site A - Depth 12.5m - 14m (mm)				Seasonal Means				
	11-Jun	**16-Jul**	**13-Aug**	**11-Sep**	Mean Length (mm)	Weighted Length (mm)	Biomass (mg/m2)	Weighted Biomass (mg/m2)	% by Species
Ergasilus									
Ovig Ergasilus									
Epischura		0.86	1.16	0.65	0.89	0.89	8.8	8.7	2%
Ovig Epischura									
Diaptomus	0.93	1.00	0.96	0.95	0.96	0.96	3.9	4.0	1%
Ovig Diaptomus									
Cyclops	0.83	0.89	0.68	0.70	0.78	0.80	39.3	42.2	10%
Ovig. Cyclops	1.20	1.27			1.24	1.26	1.3	1.3	0%
Bosmina	0.35	0.37	0.37	0.38	0.37	0.37	82.1	84.0	20%
Ovig. Bosmina	0.48	0.41	0.40	0.41	0.43	0.41	15.4	14.4	3%
Daphnia l.	0.68	0.78	0.64	0.62	0.68	0.67	211.3	206.3	49%
Ovig. Daphnia l.	0.85	0.85	0.76	0.69	0.79	0.76	68.5	63.4	15%
Daphnia g.									
Chydorinae	0.29		0.34	0.31	0.31	0.33	0.2	0.2	0%
Ovig. Chydorinae			0.36		0.36	0.36	0.6	0.6	0%
Scapholeberis				0.54	0.54	0.33	0.1	0.1	0%
TOTAL:							431.5	425.2	100%

	Body Size - Site B - Depth 16m - 18m (mm)				Mean Length (mm)	Weighted Length (mm)	Biomass (mg/m2)	Weighted Biomass (mg/m2)	% by Species
	11-Jun	**16-Jul**	**13-Aug**	**11-Sep**					
Ergasilus									
Ovig Ergasilus									
Epischura	1.00	0.82			0.91	0.84	3.7	2.9	1%
Ovig Epischura									
Diaptomus	0.93	1.13	1.21	1.10	1.09	1.12	7.6	8.3	2%
Ovig Diaptomus			1.26		1.26	1.26	0.5	0.5	
Cyclops	0.93	0.93	0.82	0.69	0.84	0.84	59.3	58.8	14%
Ovig. Cyclops			1.25		1.22	1.25	3.7	3.9	1%
Bosmina	0.31	0.41	0.38	0.40	0.38	0.39	85.4	92.0	22%
Ovig. Bosmina	0.42	0.42	0.41	0.42	0.42	0.41	33.2	32.6	8%
Daphnia l.	0.66	0.75	0.69	0.63	0.68	0.68	195.6	192.8	45%
Ovig. Daphnia l.	0.83	0.88	0.82	0.66	0.80	0.79	75.0	73.4	17%
Daphnia g.									
Chydorinae	0.32	0.30	0.33	0.31	0.32	0.32	0.3	0.3	0%
Ovig. Chydorinae									0%
Scapholeberis				0.52	0.52	0.52	0.1	0.1	0%
TOTAL:							464.4	465.6	100%

Appendix 2. Bear Lake 2014 - Environmental Conditions

Date	Sky	Precip. (mm)	Upper Gauge (ft)	Lower Gauge (ft)	Water Temp (oC)	Air Temp (oC)
1-May						
2-May						
3-May						
4-May						
5-May						
6-May						
7-May						
8-May						
9-May						
10-May						
11-May						
12-May						
13-May	1	0.00	0.93	1.53	7.18	15.84
14-May	1	0.00	0.98	1.38	7.73	12.03
15-May	2	0.00	0.98	1.56	7.56	10.16
16-May	1	0.00	0.98	1.55	7.55	11.63
17-May	1	0.00	1.00	1.48	8.76	14.59
18-May	1	0.00	0.91	1.47	10.21	13.03
19-May	3	0.00	0.93	1.48	10.63	10.41
20-May	1	0.00	0.91	1.40	10.98	11.86
21-May	2	0.00	0.90	1.50	10.26	10.39
22-May	2	0.00	0.90	1.40	10.74	12.18
23-May	1	0.00	0.89	1.40	11.62	11.52
24-May	3	0.00	0.94	1.40	10.07	9.98
25-May	2	0.00	0.94	1.38	10.18	10.23
26-May	3	0.00	0.92	1.35	10.78	10.86
27-May	5	0.05	0.92	1.35	10.60	9.67
28-May	4	0.07	0.91	1.33	11.33	9.33
29-May	5	0.08	0.91	1.30	11.24	8.90
30-May	5	0.40	0.98	1.35	11.22	9.20
31-May	4	1.60	1.16	1.42	10.80	8.74

Date	Sky	Precip. (mm)	Upper Gauge (ft)	Lower Gauge (ft)	Water Temp (oC)	Air Temp (oC)
1-Jun	4	0.10	1.05	1.50	10.70	7.67
2-Jun	2	0.30	1.10	1.55	11.05	10.18
3-Jun	1	0.00	1.00	1.43	12.22	12.31
4-Jun	1	0.00	0.92	1.45	12.11	12.81
5-Jun	2	0.00	0.90	1.45	11.64	11.92
6-Jun	1	0.00	0.90	1.45	12.06	10.51
7-Jun	3	0.00	0.95	1.45	12.79	12.49
8-Jun	4	0.05	0.92	1.45	13.27	12.22
9-Jun	2	0.00	0.90	1.44	12.32	10.04
10-Jun	4	0.06	0.96	1.48	12.59	10.23
11-Jun	2	0.00	0.92	1.45	12.45	10.59
12-Jun	3	0.00	0.90	1.40	12.09	8.70
13-Jun	5	0.31	1.20	1.55	12.38	8.97
14-Jun	2	0.17	0.90	1.40	12.19	11.55
15-Jun	3	0.06	0.89	1.40	13.04	12.70
16-Jun	4	0.05	1.00	1.38	12.33	9.75
17-Jun	3	1.40	1.10	1.50	12.31	9.63
18-Jun	1	0.13	1.06	1.50	12.55	10.88
19-Jun	2	0.03	1.08	1.48	12.79	11.39
20-Jun	1	0.00	1.06	1.48	13.16	13.87
21-Jun	5	0.42	1.08	1.50	13.11	10.61
22-Jun	2	0.29	1.08	1.50	13.43	13.08
23-Jun	1	0.00	1.60	1.50	13.74	13.26
24-Jun	1	0.00	1.00	1.50	14.02	13.83
25-Jun	3	0.07	0.98	1.50	13.04	10.89
26-Jun	3	0.30	0.98	1.50	13.41	11.10
27-Jun	2	0.00	0.98	1.00	13.95	13.35
28-Jun	2	0.00	0.98	1.45	14.24	15.71
29-Jun	1	0.00	0.94	1.45	14.98	14.34
30-Jun	3	0.00	0.94	1.45	14.15	13.43

Sky Conditions

1 = clear

2 = less than 50% cloud cover

3 = more than 50% cloud cover

4 = 100% overcast

5 = rain

.

Appendix 2 (continued). Bear Lake 2014 - Environmental Conditions

Date	Sky	Precip. (mm)	Upper Gauge (ft)	Lower Gauge (ft)	Water Temp (oC)	Air Temp (oC)
1-Jul	1	0.00	0.95	1.45	14.59	14.01
2-Jul	2	0.00	0.98	1.45	15.11	16.99
3-Jul	1	0.00	0.90	1.40	16.10	17.24
4-Jul	2	0.00	1.04	1.45	16.20	17.41
5-Jul	3	0.00	0.88	1.45	15.58	14.74
6-Jul	2	0.00	1.00	1.40	15.96	15.31
7-Jul	4	0.40	1.04	1.45	15.89	13.46
8-Jul	2	0.04	1.06	1.45	16.12	15.04
9-Jul	4	0.00	1.00	1.42	15.58	12.62
10-Jul	5	0.62	0.96	1.45	15.23	12.03
11-Jul	4	1.65	1.20	1.60	15.51	13.26
12-Jul	4	0.18	1.22	1.60	15.70	13.52
13-Jul	4	0.05	1.12	1.60	15.56	13.03
14-Jul	1	0.04	1.00	1.60	15.90	14.17
15-Jul	1	0.00	1.08	1.57	15.81	14.96
16-Jul	4	0.00	1.05	1.52	16.21	14.64
17-Jul	4	0.00	1.04	1.50	15.86	14.08
18-Jul	3	0.00	0.98	1.45	16.35	16.14
19-Jul	5	0.00	1.00	1.45	16.37	15.30
20-Jul	4	0.06	1.00	1.45	15.88	14.65
21-Jul	1	0.00	1.00	1.43	16.02	16.28
22-Jul	2	0.00	1.00	1.43	16.47	14.29
23-Jul	4	0.03	0.93	1.43	16.28	14.92
24-Jul	1	0.02	0.92	1.43	16.54	15.12
25-Jul					16.23	13.60
26-Jul					16.26	13.62
27-Jul					16.54	14.60
28-Jul					16.20	14.28
29-Jul					16.35	14.79
30-Jul					16.82	15.88
31-Jul					16.77	14.66

Date	Sky	Precip. (mm)	Upper Gauge (ft)	Lower Gauge (ft)	Water Temp (oC)	Air Temp (oC)
1-Aug					16.86	15.68
2-Aug					16.90	14.64
3-Aug					16.90	14.81
4-Aug					16.34	13.08
5-Aug					16.01	14.25
6-Aug					16.52	14.76
7-Aug					16.27	12.80
8-Aug					16.01	13.06
9-Aug					16.06	13.77
10-Aug					16.27	15.02
11-Aug					16.26	14.13
12-Aug					15.99	14.76
13-Aug					15.81	13.41
14-Aug					15.72	13.10
15-Aug					15.49	12.13
16-Aug					15.35	12.23
17-Aug					15.35	13.35
18-Aug					15.51	13.03
19-Aug					15.37	12.96
20-Aug					15.38	13.44
21-Aug					15.39	13.08
22-Aug					15.62	13.70
23-Aug					15.17	12.20
24-Aug					14.88	11.63
25-Aug	5		0.95	1.50	14.55	11.03
26-Aug	1	0.05	0.95	1.55	14.71	10.59
27-Aug	5	0.00	1.10	1.65	14.59	11.71
28-Aug	5	0.99	1.15	1.60	14.40	11.84
29-Aug	2	0.24	1.16	1.60	14.31	12.27
30-Aug	2	0.00	0.98	1.55	14.01	10.91
31-Aug	1	0.03	1.00	1.55	14.13	11.03

Sky Conditions

1 = clear
2 = less than 50% cloud cover
3 = more than 50% cloud cover
4 = 100% overcast
5 = rain

*Dam boards were removed from the weir on August 1, 2012. No difference in upper and lower staff gauge

Appendix 2 (continued). Bear Lake 2014 - Environmental Conditions

Date	Sky	Precip. (mm)	Upper Gauge (ft)	Lower Gauge (ft)	Water Temp (oC)	Air Temp (oC)
1-Sep	1	0.03	0.98	1.50	13.71	10.91
2-Sep	1	0.00	0.90	1.50	13.78	11.26
3-Sep	2	0.00	0.95	1.45	14.17	12.96
4-Sep	5	0.00	0.96	1.45	14.00	11.88
5-Sep	5	13.50	0.94	1.45	13.87	12.18
6-Sep	2	0.00	0.94	1.45	14.19	12.94
7-Sep	1	1.30	0.98	1.45	13.82	11.54
8-Sep	1	0.00	0.96	1.40	13.69	11.56
9-Sep	4	0.00	0.95	1.40	13.72	11.72
10-Sep	5	11.40	0.98	1.40	13.65	11.51
11-Sep	1	9.20	0.96	1.40	13.56	10.18
12-Sep	4	0.12	0.95	1.40	13.62	12.42
13-Sep	5	2.50	1.15	1.55	13.83	12.71
14-Sep	3	3.00	1.20	1.60	13.53	10.17
15-Sep	5	10.00	1.20	1.65	13.25	9.93
16-Sep	3	1.70	1.05	1.65	13.23	10.35
17-Sep	5	1.10	1.08	1.75	12.89	9.15
18-Sep	5	3.00	1.15	1.80	12.34	9.83
19-Sep	5	2.50	1.20	1.80	12.13	9.95
20-Sep	4	0.54	0.90	2.00	12.54	9.83
21-Sep	4	0.04	0.85	2.00	12.31	9.78
22-Sep	1	0.00	1.18	1.90	11.50	8.23
23-Sep	1	0.03	0.98	1.85	11.89	7.41
24-Sep	1	0.02	0.90	1.75	10.91	8.12
25-Sep	1	0.00	0.82	1.70	10.27	6.72
26-Sep	1	0.00	0.76	1.65	10.53	4.65
27-Sep	4	0.06	0.82	1.65	10.19	10.32
28-Sep	1	0.04	0.76	1.55	10.43	9.54
29-Sep	1	0.02	0.78	1.50	9.40	7.17
30-Sep	1	0.00	0.95	1.45	8.12	6.30

*Dam boards in for adult coho migration

Date	Sky	Precip. (mm)	Upper Gauge (ft)	Lower Gauge (ft)	Water Temp (oC)	Air Temp (oC)
1-Oct	1	0.00	1.00	1.50	8.06	3.15
2-Oct	2	0.00	0.95	1.50	8.61	5.61
3-Oct	4	0.00	0.45	1.55	7.99	5.86
4-Oct	5	0.25	0.40	1.40	7.48	2.15
5-Oct	4	0.16	0.40	1.40	7.27	2.56
6-Oct	1	0.00	0.40	1.45	6.66	0.78
7-Oct	2	0.00	0.40	1.40	5.46	0.34
8-Oct	3	0.00	0.35	1.35	5.37	0.16
9-Oct	5	0.00	0.35	1.45	5.33	4.26
10-Oct	5	0.36	0.30	1.40	6.47	5.32
11-Oct	5	0.32	0.35	1.45	7.40	6.58
12-Oct	5	0.22	0.40	1.45	7.32	5.86
13-Oct	1	0.08	0.40	1.45	7.33	6.80
14-Oct	1	0.00	0.40	1.45	8.23	6.76
15-Oct						
16-Oct						
17-Oct						
18-Oct						
19-Oct						
20-Oct						
21-Oct						
22-Oct						
23-Oct						
24-Oct						
25-Oct						
26-Oct						
27-Oct						
28-Oct						
29-Oct						
30-Oct						
31-Oct						

Sky Conditions

1 = clear
2 = less than 50% cloud cover
3 = more than 50% cloud cover
4 = 100% overcast
5 = rain

Appendix 3. Bear Lake 2014 - Smolt Migration.

	Sockeye				Coho				Dolly Varden		Rainbow Trout	
Date	Daily	Otoliths	Cumm	% Smpl	Daily	Otoliths	Cumm	% Smpl	Daily	Cumm	Daily	Cumm
13-May	1,042	1	1,042	0.10%	14	0	14	0.00%	2	2		0
14-May	19,482	19	20,524	0.10%	176	1	190	0.57%	2	4		0
15-May	13,645	14	34,169	0.10%	140	1	330	0.71%	2	6		0
16-May	8,433	8	42,602	0.09%	145	1	475	0.69%	19	25		0
17-May	14,663	9	57,265	0.06%	338	1	813	0.30%	7	32		0
18-May	27,687	33	84,952	0.12%	530	4	1,343	0.75%	15	47	10	10
19-May	24,377	25	109,329	0.10%	612	5	1,955	0.82%	2	49		10
20-May	12,351	13	121,680	0.11%	532	3	2,487	0.56%	3	52		10
21-May	17,681	17	139,361	0.10%	1,197	8	3,684	0.67%	1	53		10
22-May	10,655	11	150,016	0.10%	1,164	8	4,848	0.69%	4	57		10
23-May	18,154	18	168,170	0.10%	1,509	10	6,357	0.66%	9	66		10
24-May	19,542	19	187,712	0.10%	2,342	16	8,699	0.68%	9	75	1	11
25-May	8,636	10	196,348	0.12%	2,027	14	10,726	0.69%	11	86		11
26-May	18,229	17	214,577	0.09%	2,724	17	13,450	0.62%	11	97		11
27-May	10,393	11	224,970	0.11%	1,547	10	14,997	0.65%	8	105		11
28-May	4,515	4	229,485	0.09%	1,087	8	16,084	0.74%	5	110		11
29-May	7,322	8	236,807	0.11%	810	6	16,894	0.74%	2	112		11
30-May	6,127	6	242,934	0.10%	528	3	17,422	0.57%	3	115	2	13
31-May	24,253	24	267,187	0.10%	1,024	7	18,446	0.68%	14	129		13
01-Jun	4,119	4	271,306	0.10%	497	3	18,943	0.60%	8	137		13
02-Jun	6,910	7	278,216	0.10%	298	2	19,241	0.67%	13	150	1	14
03-Jun	14,630	15	292,846	0.10%	224	2	19,465	0.89%	13	163		14
04-Jun	7,600	7	300,446	0.09%	131	1	19,596	0.76%	8	171	1	15
05-Jun	1,693	2	302,139	0.12%	51	1	19,647	1.96%	1	172		15
06-Jun	2,194	2	304,333	0.09%	44	0	19,691	0.00%	0	172	1	16
07-Jun	1,206	1	305,539	0.08%	33	0	19,724	0.00%	0	172		16
08-Jun	2,071	2	307,610	0.10%	27	0	19,751	0.00%	0	172	2	18
09-Jun	6,003	6	313,613	0.10%	66	0	19,817	0.00%	1	173		18
10-Jun	3,919	4	317,532	0.10%	85	0	19,902	0.00%	0	173		18
11-Jun	4,981	5	322,513	0.10%	37	0	19,939	0.00%	0	173		18
12-Jun	5,234	5	327,747	0.10%	31	1	19,970	3.23%	2	175		18
13-Jun	7,917	8	335,664	0.10%	46	0	20,016	0.00%	2	177		18
14-Jun	4,630	5	340,294	0.11%	32	0	20,048	0.00%	0	177		18
15-Jun	7,019	7	347,313	0.10%	17	0	20,065	0.00%	2	179		18
16-Jun	1,865	2	349,178	0.11%	12	0	20,077	0.00%	3	182		18
17-Jun	7,491	7	356,669	0.09%	56	1	20,133	1.79%	0	182		18
18-Jun	4,201	5	360,870	0.12%	11	0	20,144	0.00%	2	184		18
19-Jun	3,943	3	364,813	0.08%	20	0	20,164	0.00%	1	185		18
20-Jun	3,284	4	368,097	0.12%	9	0	20,173	0.00%	0	185		18
21-Jun	1,208	1	369,305	0.08%	6	0	20,179	0.00%	0	185		18
22-Jun	2,776	3	372,081	0.11%	7	0	20,186	0.00%	1	186		18
23-Jun	998	1	373,079	0.10%	6	1	20,192	16.67%	1	187	1	19
24-Jun	2,986	3	376,065	0.10%	19	0	20,211	0.00%	0	187		19
25-Jun	2,022	2	378,087	0.10%	4	0	20,215	0.00%	0	187		19
26-Jun	2,950	3	381,037	0.10%	7	0	20,222	0.00%	0	187		19
27-Jun	2,258	2	383,295	0.09%	12	0	20,234	0.00%	1	188		19
28-Jun	2,331	3	385,626	0.13%	4	0	20,238	0.00%	1	189		19
29-Jun	1,272	1	386,898	0.08%	7	0	20,245	0.00%	0	189		19
30-Jun	1,328	1	388,226	0.08%	3	0	20,248	0.00%	0	189		19
01-Jul	983	1	389,209	0.10%	5	1	20,253	20.00%	0	189		19
02-Jul	1,359	1	390,568	0.07%	4	0	20,257	0.00%	0	189		19
03-Jul	825	0	391,393	0.00%	3	0	20,260	0.00%	1	190		19
04-Jul	197	0	391,590	0.00%	1	0	20,261	0.00%	0	190		19
05-Jul	482	0	392,072	0.00%	137	0	20,398	0.00%	0	190		19
06-Jul	390	1	392,462	0.26%	235	1	20,633	0.43%	0	190		19
07-Jul	709	0	393,171	0.00%	239	2	20,872	0.84%	1	191		19
08-Jul	382	1	393,553	0.26%	261	2	21,133	0.77%	0	191		19
09-Jul			393,553				21,133			191		19
Totals	393,553	392	393,553	0.10%	21,133	141	21,133	0.67%	191	191	19	19

Appendix 4. Bear Lake 2014 - Adult Sockeye Salmon Migration.

	Lake Escapement			Donate &		Daily	Cumm.
Date	Females	Males	Combined	Harvest	Morts	Total	Total
17-May	0	1	1	0	0	1	1
18-May	0	0	0	0	0	0	1
19-May	0	0	0	0	0	0	1
20-May	0	0	0	0	0	0	1
21-May	0	0	0	0	0	0	1
22-May	1	1	2	0	0	2	3
23-May	3	1	4	0	0	4	7
24-May	9	7	16	0	0	16	23
25-May	3	11	14	0	0	14	37
26-May	3	5	8	0	0	8	45
27-May	2	11	13	0	0	13	58
28-May	65	103	168	0	0	168	226
29-May	219	350	569	0	0	569	795
30-May	305	391	696	0	0	696	1,491
31-May	98	245	343	0	0	343	1,834
1-Jun	127	262	389	0	0	389	2,223
2-Jun	15	44	59	0	0	59	2,282
3-Jun	45	109	154	0	0	154	2,436
4-Jun	102	216	318	0	0	318	2,754
5-Jun	72	182	254	0	1	255	3,009
6-Jun	244	708	952	0	0	952	3,961
7-Jun	326	927	1,253	0	1	1,254	5,215
8-Jun	305	990	1,295	0	3	1,298	6,513
9-Jun	247	848	1,095	0	0	1,095	7,608
10-Jun	290	244	534	897	1	1,432	9,040
11-Jun	235	308	543	856	3	1,402	10,442
12-Jun	402	135	537	732	1	1,270	11,712
13-Jun	193	104	297	524	4	825	12,537
14-Jun	161	35	196	390	0	586	13,123
15-Jun	110	2	112	170	1	283	13,406
16-Jun	351	60	411	346	1	758	14,164
17-Jun	230	97	327	0	0	327	14,491
18-Jun	213	28	241	341	1	583	15,074
19-Jun	326	45	371	0	0	371	15,445
20-Jun	521	76	597	595	3	1,195	16,640
21-Jun	587	61	648	0	3	651	17,291
22-Jun	510	48	558	1,328	0	1,886	19,177
23-Jun	86	29	115	715	3	833	20,010
24-Jun	0	0	0	1,241	5	1,246	21,256
25-Jun	0	0	0	926	5	931	22,187
26-Jun	0	0	0	543	2	545	22,732
27-Jun	0	0	0	12	3	15	22,747
28-Jun	0	0	0	873	3	876	23,623
29-Jun	0	0	0	0	7	7	23,630
30-Jun	0	0	0	954	3	957	24,587
1-Jul	0	0	0	0	3	3	24,590
2-Jul	0	0	0	710	6	716	25,306
3-Jul	0	0	0	30	4	34	25,340
4-Jul	0	0	0	475	5	480	25,820
5-Jul	0	0	0	0	5	5	25,825
6-Jul	0	0	0	484	4	488	26,313
7-Jul	0	0	0	0	3	3	26,316
8-Jul	0	0	0	0	4	4	26,320
9-Jul	0	0	0	408	0	408	26,728
10-Jul	0	0	0	0	2	2	26,730
11-Jul	0	0	0	0	2	2	26,732
12-Jul	0	0	0	0	7	7	26,739
13-Jul	0	0	0	0	4	4	26,743
14-Jul	0	0	0	268	4	272	27,015
15-Jul	0	0	0	864	0	864	27,879
16-Jul	0	0	0	251	2	253	28,132
17-Jul	0	0	0	124	1	125	28,257
18-Jul	0	0	0	167	2	169	28,426
19-Jul	0	0	0	76	2	78	28,504
20-Jul	0	0	0	56	0	56	28,560
21-Jul	0	0	0	89	1	90	28,650
22-Jul	0	0	0	56	0	56	28,706
23-Jul	0	0	0	0	0	0	28,706
24-Jul	0	0	0	68	0	68	28,774
25-Jul		0	0			0	28,774
Total	6,406	6,684	13,090	15,569	115	28,774	28,774

Appendix 5. Bear Lake 2014 - Adult Coho Salmon Migration.

	Lake Escapement			Broodstock			Harvest *			Total		Raceway	Daily	Cumm
Date	Female	Males	Combined	Female	Males	Combined	Females	Males	Combined	Females	Males	Morts	Total	Total
24-Aug			0			0			0	0	0		0	0
25-Aug	3	19	22			0			0	3	19		22	22
26-Aug	1	21	22			0			0	1	21		22	44
27-Aug	0	8	8			0			0	0	8		8	52
28-Aug	0	5	5			0			0	0	5		5	57
29-Aug	1	0	1			0			0	1	0		1	58
30-Aug	2	2	4			0			0	2	2		4	62
31-Aug	2	4	6			0			0	2	4		6	68
01-Sep	0	0	0			0			0	0	0		0	68
02-Sep	1	0	1			0			0	1	0		1	69
03-Sep	0	0	0			0			0	0	0		0	69
04-Sep	1	0	1			0			0	1	0		1	70
05-Sep	2	3	5			0			0	2	3		5	75
06-Sep	4	6	10			0			0	4	6		10	85
07-Sep	1	7	8			0			0	1	7		8	93
08-Sep	1	4	5			0			0	1	4		5	98
09-Sep	1	2	3			0			0	1	2		3	101
10-Sep	0	0	0			0			0	0	0		0	101
11-Sep	4	9	13	32	96	128			0	36	105		141	242
12-Sep	0	0	0	37	68	105			0	37	68		105	347
13-Sep	0	64	64	107	133	240			0	107	197		304	651
14-Sep	0	0	0	80	1	81			0	80	1		81	732
15-Sep	46	17	63	52	0	52	0	157	157	98	174		272	1,004
16-Sep	70	0	70	0	0	0	0	66	66	70	66		136	1,140
17-Sep	10	0	10	15	0	15	0	0	0	25	0		25	1,165
18-Sep	0	0	0	0	0	0	0	0	0	0	0		0	1,165
19-Sep	0	0	0	0	0	0	94	107	201	94	107		201	1,366
20-Sep	0	0	0	0	0	0	12	3	15	12	3		15	1,381
21-Sep	0	0	0	0	0	0	3	0	3	3	0		3	1,384
22-Sep	0	0	0	0	0	0	100	107	207	100	107		207	1,591
23-Sep	0	0	0	0	0	0	5	7	12	5	7		12	1,603
24-Sep	0	0	0	14	15	29	0	0	0	14	15	14	29	1,632
25-Sep	0	0	0	2	0	2	0	0	0	2	0	0	2	1,634
26-Sep	0	0	0	0	0	0	2	3	5	2	3	0	5	1,639
27-Sep	0	0	0	4	4	8	1	4	5	5	8	17	13	1,652
28-Sep	0	0	0	8	0	8	0	0	0	8	0	7	8	1,660
29-Sep	0	0	0	3	1	4	0	0	0	3	1	11	4	1,664
30-Sep	0	0	0	0	0	0	0	0	0	0	0	0	0	1,664
01-Oct	0	0	0	2	3	5	0	0	0	2	3	5	5	1,669
02-Oct	0	0	0	0	0	0	0	0	0	0	0	0	0	1,669
03-Oct	0	0	0	3	1	4	0	0	0	3	1	4	4	1,673
04-Oct	0	0	0	1	1	2	0	0	0	1	1	2	2	1,675
05-Oct	0	0	0	0	0	0	0	0	0	0	0	0	0	1,675
06-Oct	0	0	0	0	0	0	0	0	0	0	0	0	0	1,675
07-Oct	0	0	0	2	1	3	0	0	0	2	1	3	3	1,678
08-Oct	0	0	0	0	0	0	0	0	0	0	0	0	0	1,678
09-Oct	0	0	0	0	1	1	0	0	0	0	1	1	1	1,679
10-Oct	0	0	0	5	3	8	0	0	0	5	3	8	8	1,687
11-Oct	0	0	0	7	9	16	0	0	0	7	9	16	16	1,703
12-Oct	0	0	0	19	10	29	0	0	0	19	10	29	29	1,732
13-Oct	72	130	202	(51)	(122)	(173)			0	21	8	29	29	1,761
14-Oct	7	4	11	0	0	0			0	7	4	11	11	1,772
Total	229	305	534	342	225	567	217	454	671	788	984	157	1,772	

Appendix 6. Bear Lake 2014 – Adult Sockeye Age and Sex Characteristics

	Age						
	1.1	1.2	1.3	2.1	2.2	2.3	Total
Sample Period:		May 28 - June 23					
Males (No.)	0	8,221	10,111	0	661	283	19,277
Percent	0.0%	42.6%	52.5%	0.0%	3.4%	1.5%	67.0%
Sample Size	0	174	214	0	14	6	408
Total Sample Size							641
Mean Weight (kg)		2.33	3.15		2.80	3.83	2.77
Std. Deviation		0.48	0.55		0.49	0.44	0.70
Std. Error		0.04	0.04		0.13	0.18	0.03
Females (No.)	0	2,646	6,567	0	236	47	9,497
Percent	0.0%	27.9%	69.2%	0.0%	2.5%	0.5%	33.0%
Sample Size	0	56	139	0	5	1	201
Total Sample Size							322
Mean Weight (kg)		2.27	2.95		2.86	3.30	2.67
Std. Deviation		0.44	0.44		0.51		0.55
Std. Error		0.06	0.04		0.23		0.03
Both Sexes (No.)	0	10,867	16,679	0	898	331	28,774
Percent	0.0%	37.8%	58.0%	0.0%	3.1%	1.1%	100.0%
Sample Size	0	230	353	0	19	7	609
Total Sample Size							963
Mean Weight (kg)		2.32	3.07		2.81	3.76	2.74
Std. Deviation		0.47	0.52		0.48	0.45	0.65
Std. Error		0.03	0.03		0.11	0.17	0.02

Total means for males, females and both sexes are generated from the total sample size

Appendix 7. Bear Lake 2014 – Adult Coho Age and Sex Characteristics

	Age			
	1.1	2.1	3.1	Total
Sample Period:	Sept 15 - Oct 1, 2014			
Males (No.)	268	725	0	993
Percent	27.0%	73.0%	0.0%	56.1%
Sample Size	10	27	0	37
Total Sample Size				53
Mean Weight (kg)	2.20	3.23		2.87
Std. Deviation	0.47	0.79		0.80
Std. Error	0.15	0.15		0.11
Females (No.)	134	644	0	779
Percent	17.2%	82.8%	0.0%	43.9%
Sample Size	5	24	0	29
Total Sample Size				44
Mean Weight (kg)	3.45	3.79		3.65
Std. Deviation	0.63	0.44		0.56
Std. Error	0.28	0.09		0.08
Both Sexes (No.)	403	1,369	0	1,772
Percent	22.7%	77.3%	0.0%	100.0%
Sample Size	15	51	0	66
Total Sample Size				97
Mean Weight (kg)	2.62	3.49		3.22
Std. Deviation	0.79	0.70		0.80
Std. Error	0.20	0.10		0.08

Total means for males, females and both sexes are generated from the total sample size

Appendix 8. Bear Lake 2014 – Project Updates

Sockeye Salmon Project

Stocking & Misc. Activities

Crew on-site:	13-May			
Ice-out:	NA			
Crew off-site:	14-Oct			
Fry stocking:	5-Jun		2,405,000	0.43
PreSmolt stocking:				
Smolt stocking:(Res Bay)	5-Jun		1,742,000	14.5
Fertilizer application:	NA	to NA	NA	

Egg Take

Dates:	27-Jul to 15-Aug		
No. of broodstock used*:		3,857	
Green eggs:		5,292,800	
Fecundity:		2,999	
Eyed eggs:		4,656,248	
% Survival		88.0%	

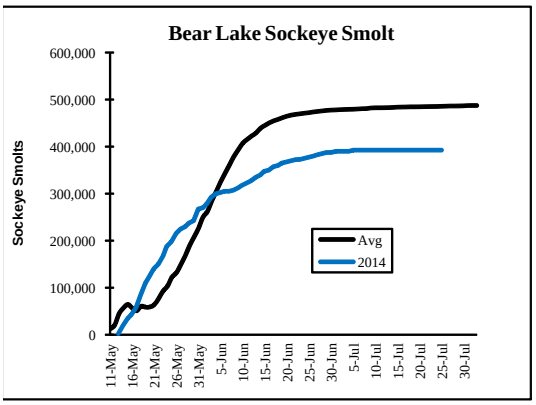
Smolt Migration

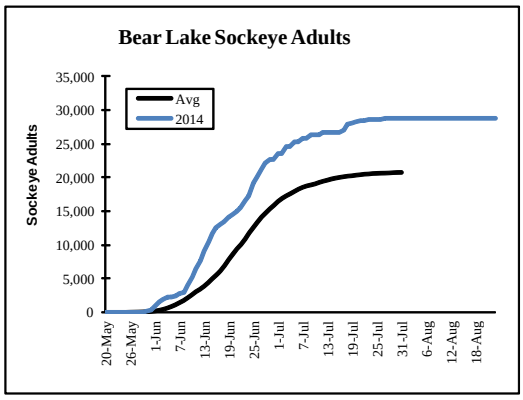
Dates:	13-May to 8-Jul		
Sockeyes:		**393,500**	
Percent age 1:		310,900	79.0%
Percent age 2:		82,600	21.0%
Percent age 3:		0	0.0%
Percent hatchery:		380,700	96.7%
Dolly Varden:			

Adult Migration

Dates:	22-May to 24-Jul		
Total return:		**166,323**	
Commercial & Sport Fish harvest:		25,306	15.2%
C.R. harvest(FW & SW):		125,966	75.7%
Lake:		**13,090**	7.9%
Donated		1,641	
Hatchery broodstock*:		3,972	
Lake broodstock:		9,233	

*Includes mortalities and inviables





Coho Salmon Project

Stocking & Misc. Activities

Crew on-site:	13-May		
Ice-out:	NA		
Crew off-site:	14-Oct		
Fry stocking:	5-Jun	2,405,000	0.43
PreSmolt stocking:			
Smolt stocking:(Res Bay)	5-Jun	1,742,000	14.5
Fertilizer application:	NA to NA	NA	

Egg Take

Dates:	30-Sep to 7-Oct	
No. of broodstock used:		383
Green eggs:		581,279
Fecundity:		4,272
Eyed eggs:		547,422
% Survival		94.2%

*Includes broodstock for ADFG and CIAA but green eggs are CIAA only.

Smolt Migration

Dates:	13-May to 8-Jul		
Cohos:		**21,100**	
Percent age 1:		9,000	42.7%
Percent age 2:		12,100	57.3%
Percent age 3:		0	0.0%
Percent hatchery:		20,300	96.2%

Adult Migration

Dates:	30-Aug to 10-Oct		
Coho total creek return:		**7,172**	
Weir return:		1,772	25%
Donated		671	9%
Lake:		534	7%
Hatchery broodstock:		383	5%
Est. Remaining in Bear Ck:		0	0%
Est. Remaining in Salmon Ck:		0	0%

CR Harvest = donations