

**Bear Lake  
Salmon Enhancement  
Progress Report  
2006**

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**This year's operation of the Bear Lake Sockeye and Coho Enhancement Project was made possible through enhancement taxes paid by the commercial fishermen in Area H, Cook Inlet and associated waters, through the harvest and sale of surplus fish, through a grant from the Seward Chamber of Commerce and a grant administered by the National Oceanic and Atmospheric Administration and the Alaska Department of Fish and Game provided by Senator Ted Stevens.**

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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 2006 Bear Lake smolt migration, fry release, adult count, and gamete collection exercise were conducted by the Cook Inlet Aquaculture Association (CIAA). Appreciation is extended to the full-time and seasonal staff at Bear Lake Weir and Trail Lakes Hatchery.

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# TABLE OF CONTENTS

DISCLAIMER.....	iii
ACKNOWLEDGEMENTS.....	v
TABLE OF CONTENTS .....	vii
LIST OF FIGURES .....	ix
LIST OF TABLES.....	xi
ABSTRACT .....	xiii
INTRODUCTION AND PURPOSE.....	15
PROJECT AREA .....	17
METHODS.....	19
Limnological Sampling and Environmental Conditions.....	19
Lake Nutrient Enrichment .....	19
Smolt Enumeration .....	20
Smolt Characteristics and Enhanced Contribution .....	22
Adult Escapement.....	24
Gamete Collection, Incubation and Rearing - Sockeye.....	25
Gamete Collection, Incubation, and Rearing - Coho.....	26
Fish Transport and Stocking.....	26
RESULTS AND DISCUSSION.....	29
Limnology, Environmental Conditions and Lake Fertilization .....	29
Smolt Enumeration - Sockeye .....	32
Smolt Enumeration - Coho .....	33
Adult Escapement - Sockeye .....	34
Adult Escapement - Coho.....	35
Hatchery Activities .....	36
RECOMMENDATIONS.....	40
LITERATURE CITED.....	43
APPENDICES .....	45

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## LIST OF FIGURES

Figure 1. Map showing location of Bear Lake near Seward, Alaska.....	17
Figure 2. Bear Lake near Seward, Alaska .....	18
Figure 3. The Bear Creek weir, smolt trap and adult counting complex (Top View).....	20

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## LIST OF TABLES

Table 1. Water quality characteristics of Bear Lake at 1 meter, 1979 to 2006. ....	29
Table 2. Water quality characteristics of Bear Lake in the hypolimnion, 1979 to 2006. ....	30
Table 3. Environmental conditions observed at Bear Lake, 1990 to 2006. ....	31
Table 4. Fertilizer application at Bear Lake, 1981 to 2006. ....	32
Table 5. Sockeye smolt migrations: mean length and weight, by age class, for Bear Lake, 1980 to 2006. ....	33
Table 6. Coho smolt migrations: mean length and weight, by age class, for Bear Lake, 1980 to 2006. ....	34
Table 7. Historic returns of Coho and Sockeye Salmon to Bear Lake weir, 1980 to 2006. ....	35
Table 8. Coho and sockeye salmon releases at Bear Lake, 1986 to 2006. ....	37
Table 9. Eggs collected for Bear Lake enhancement, 1989 to 2006. ....	38
Table 10. Bear Lake smolt production by brood years. ....	39
Table 11. Marine survival for sockeye at Bear Lake (BY1989 to BY2004). ....	39

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## ABSTRACT

The Cook Inlet Aquaculture Association (CIAA) 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 2006, 2.414 million sockeye fry (BY05) and 447,000 coho fry (BY05) were released into Bear Lake. At the time of release, the sockeye fry averaged 0.52 grams and the coho fry averaged 0.84 grams. All released fry were of Bear Lake origin. Approximately 979,000 sockeye smolts (BY04) and 115,000 coho smolts (BY04) were released into Bear Lake/Creek (average 10.0 and 10.8 gm respectively). An additional 146,000 coho smolts were released into Lowell Creek.

Smolt migration monitoring began on 21 May and continued daily until 30 June. During this time a total of 1,962,415 sockeye and 49,980 coho smolts migrated from the lake.

Based on otolith marks, 94.3% ( $\pm 1.0\%$ ) of the emigrating sockeye smolts were enhanced. An estimated 86.3% smolts were age 1 and 7.3% were age 2. The average length and weight of the age 1 sockeye smolts was 85 mm ( $\pm 0.5$  mm) and 5.7 g ( $\pm 0.2$  g) respectively. The age 2 sockeye smolts were 105 mm ( $\pm 1.2$  mm) and 11.1 g ( $\pm 0.6$  g).

Based on otolith marks, 88.3% ( $\pm 3.7\%$ ) of the emigrating coho smolts were enhanced. An estimated 72.5% of coho smolt were age 1 and 23.8% were age 2. The average length and weight of the age 1 coho smolts was 93 mm ( $\pm 2.2$  mm) and 8.4 g ( $\pm 0.9$  g) and the age 2 coho smolts were 128 mm ( $\pm 2.6$  mm) and 21.7 g ( $\pm 1.4$  g).

A total of 43,069 adult sockeye returned to Bear Creek in 2006. The returning sockeye salmon were age 1.2 (12%) or age 1.3 (81.3%). A total of 12,398 were passed into the lake, while the remaining 30,651 were harvested at the weir for cost recovery. An additional 4,004 were harvested in Resurrection Bay in cost recovery. In the common property, 27,500 were harvested and an estimated 5,000 fish were caught in the sport fishery. Total return of sockeye to Resurrection Bay was 79,597.

A total of 2,089 adult coho returned to Bear Creek weir in 2006. The returning fish were age 1.1 (50.6%), age 2.1 (45.6%) or 3.1 (3.8%). Of the adult coho returning, 681 were harvested and sold for cost recovery or donated, 892 were held and used as hatchery broodstock, and 516 were passed into Bear Lake.

From 26 July to 18 August 2006, 6,087,000 sockeye salmon eggs were collected for incubation, rearing, and release to Bear Lake. The eggs were obtained from Bear Lake broodstock, shipped to CIAA's Trail Lakes Hatchery, and fertilized using a delayed fertilization technique. Eggs from 2,008 females were fertilized with milt from 2,052 males.

From 5 October to 17 October 2006, 1,084,000 coho eggs were collected from 359 females and

fertilized with milt from 245 males. In addition, the Alaska Department of Fish and Game (ADF&G) collected 343,000 coho salmon eggs.

A total of 1,200 gallons of fertilizer was applied to Bear Lake in 2006. Limnological samples were collected monthly throughout the open-water season.

## INTRODUCTION AND PURPOSE

Bear Lake is located on Alaska's Kenai Peninsula near the community of Seward, Alaska 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<sup>1</sup>.

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 now target both sockeye and coho salmon with control of predator and competitor species. The objectives are to create a commercial sockeye fishery and to maintain the coho sport fishery enhancement program. To accomplish the objectives CIAA will:

- 1) Maintain the level of coho salmon production;
- 2) Maintain sockeye and coho lake spawning escapement goals;
- 3) Annually describe the timing, abundance, size, and percent of wild and enhanced sockeye and coho 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 adult migrations and evaluate the success of enhancement through the recovery of marked fish.

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<sup>1</sup> 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, Alaska. It is the largest clear water lake in the Resurrection Bay drainage.

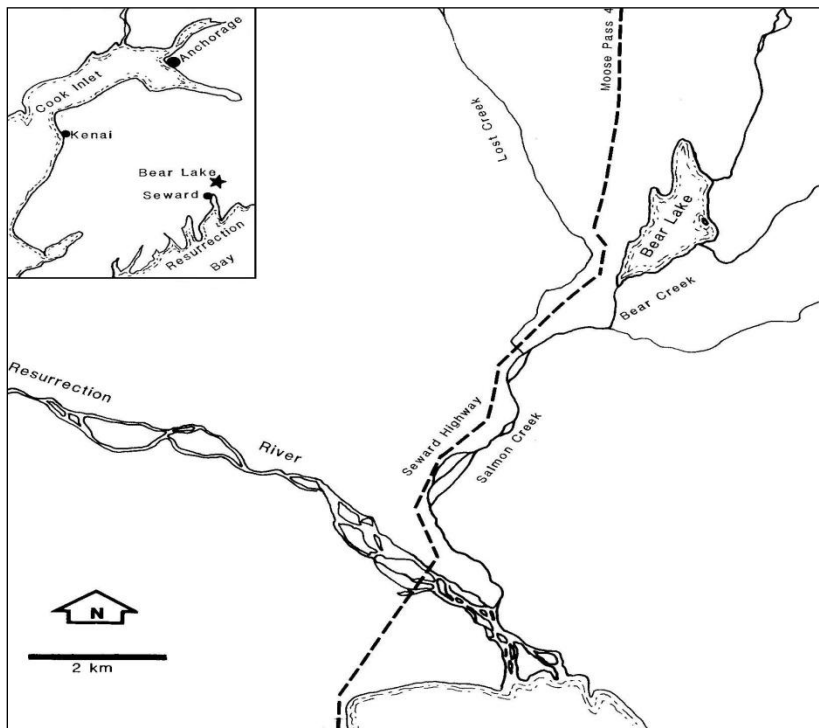


Figure 1. Map showing location of Bear Lake near Seward, Alaska.

Bear Lake has a watershed area of 15 km<sup>2</sup> and one outlet, which drains into Resurrection Bay through Bear Creek, Salmon Creek and the Resurrection River. 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 (Figure 1).

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  $18.7 \times 10^6 \text{ m}^3$  and a water residence time of 0.75 years. 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.

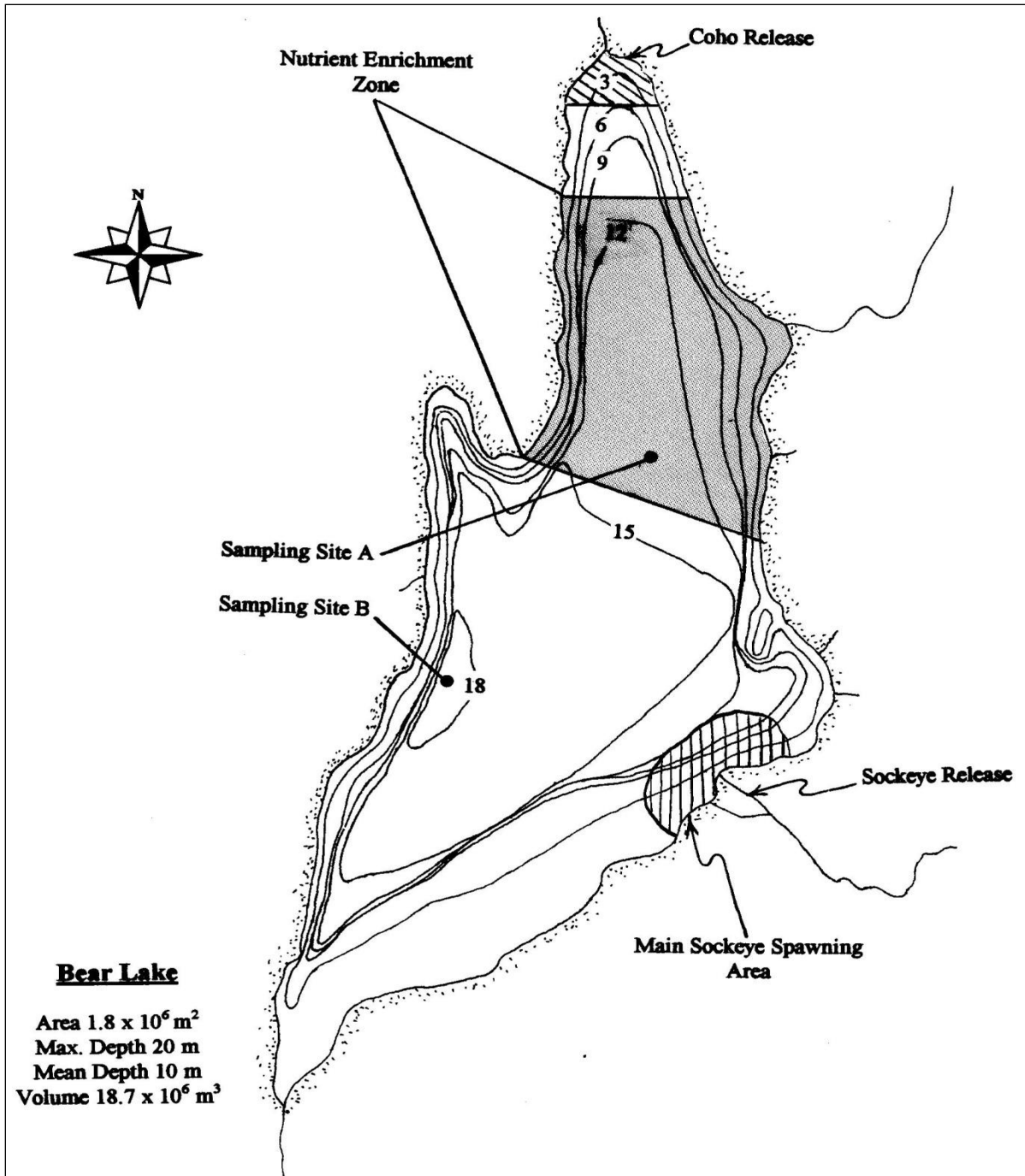


Figure 2. Bear Lake near Seward, Alaska

## **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.

### **Limnological Sampling and Environmental Conditions**

The limnological sampling and analysis procedures used in 2006 were consistent with previous limnological sampling activities. These procedures are described by Koenings, et al. (1986).

During 2006, assessments of water quality were conducted 3 times (May, August, September) throughout the open water season of May through October. One 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 with a Kemmerer sampler 1 meter below the surface and from the hypolimnion. One 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 completed by ADF&G.

In addition to the water chemistry analysis, daily observations of other environmental conditions at Bear Lake were made. These observations, completed at 5:00 P.M. throughout the summer field season, included percent cloud cover, precipitation to the nearest millimeter, air temperature, Bear Creek water temperature and Bear Creek stage.

### **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. Fertilizer was

applied from 01 July to 21 August.

### 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 2006 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.

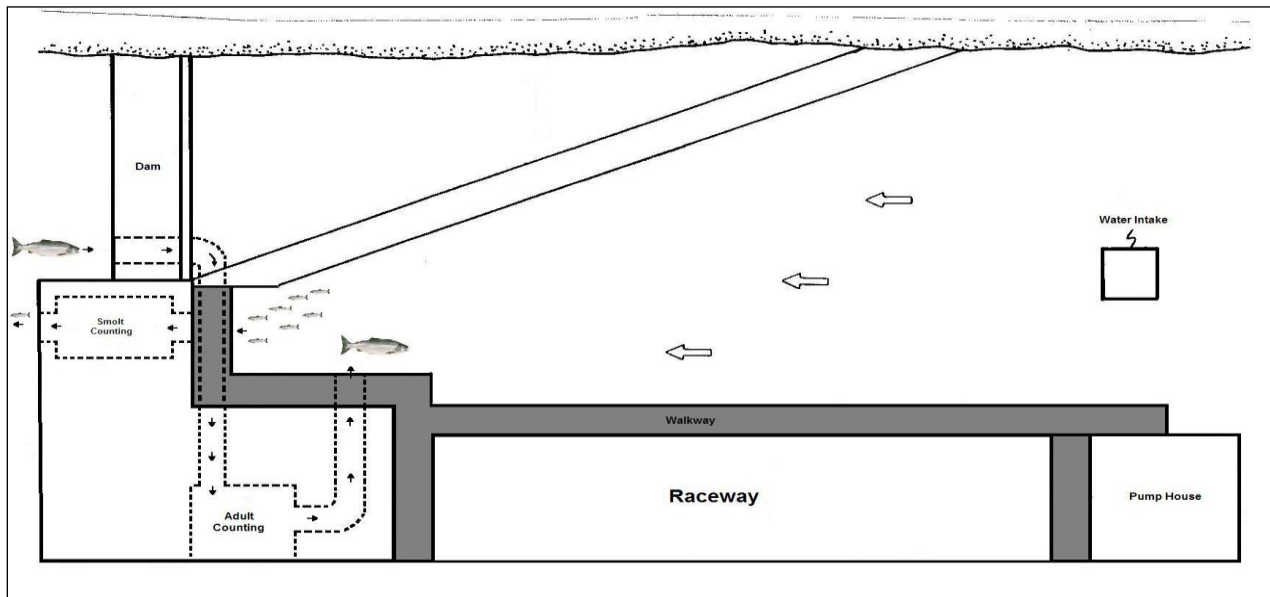


Figure 3. The Bear Creek weir, smolt trap and adult counting complex (Top View).

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 two minutes and then counted. During the remaining 18 minutes, migrating

smolts were passed through the weir structure uncounted. The two-minute smolt count was multiplied by 10 to estimate the number of smolts migrating during the twenty minute interval.

Assuming the two minute sub-sampling intervals were randomly distributed throughout sub-sampling<sup>2</sup> 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,

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

And:

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

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.

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<sup>2</sup> Predetermined randomly selected 2 minute subsampling intervals assured random distribution within each 20 minute period.

## Smolt Characteristics and Enhanced Contribution

CIAA has released sockeye and coho salmon fry to Bear Lake since 1990. To evaluate this enhancement procedure, CIAA has collected a sample of sockeye and coho 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<sup>3</sup>. The purpose of this mark is to determine the contribution of released hatchery fish to the Bear Lake smolt population.

In 2006, smolts collected for measurement, age determination, and otolith removal were sampled in proportion to the daily smolt migration. This was accomplished by collecting every 1,000<sup>th</sup> sockeye smolt and every 170<sup>th</sup> coho 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 taken on 1,995 sockeye smolts and 273 coho smolts.

Each smolt collected for evaluation was first measured to the nearest millimeter for fork length<sup>4</sup> and weighed to the nearest 0.1 gram. Several scales were then removed from the primary growth area<sup>5</sup> and mounted on a glass slide for subsequent age determination. Finally, otoliths were removed and placed in a labeled one dram vial filled with a 10% ethanol solution. At CIAA office, each otolith was checked for a hatchery mark following procedures described by Glick and Shields (1993).

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

If:

$N$  = total number of migrating smolts,

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

<sup>4</sup> Standard fork length was measured from the tip of the snout to the fork of the tail.

<sup>5</sup> The primary growth area is located above the lateral line on a diagonal from the posterior insertion of the dorsal fin to the anterior insertion of the anal fin.

$N_h$  = number of smolts in stratum h, ( $N = \sum N_h$ ),  
 $n$  = total number of smolts sampled,  
 $n_h$  = number of smolts sampled in stratum h, ( $n = \sum n_h$ ),  
 $a$  = total number of enhanced smolts sampled,  
 $a_h$  = number of enhanced smolts sampled in stratum h, ( $a = \sum a_h$ ),  
 $p_h = a_h / n_h$ , 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, ( $c_i = \sum c_{hi}$ ),  
 $l_{hi} = c_{hi} / n_{hi}$ , 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:

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

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:

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

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:

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

and, the relative error is:

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

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

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

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

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

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

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

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:

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

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 standard fork length<sup>6</sup> of the returning population of fish.

To enumerate the adult migration, fish attempting to migrate upstream were directed by the weir

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<sup>6</sup> Standard fork length was defined as the measurement from mid-eye to the fork of the tail.



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).

To assess the sex, age and length of the returning populations, every 75<sup>th</sup> adult sockeye and 12<sup>th</sup> adult coho were sampled. In 2006, measurements were collected from 574 sockeye (1.33%) and 169 coho (8.24%).

### **Gamete Collection, Incubation and Rearing - Sockeye**

Since 1989, egg collection, incubation and rearing of sockeye salmon have been done to develop a Bear Lake sockeye 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 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 gametes collected for the Bear Lake stocking program were collected from adults returning to Bear Lake.

Originally, it was believed returning adult sockeye 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 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, several methods have been employed 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 gill netting 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.

Male and female adult sockeye salmon from the spawning areas were killed and stripped of their gametes. The gametes were shipped to Trail Lakes Hatchery for fertilization, incubation and rearing. Fertilization was completed by mixing the eggs from each female with a portion of the milt from 8 to 10 males and activating the sperm with a 0.7% saline solution. The sockeye 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 - 4,2H; Smolt - 1,3H).

### **Gamete Collection, Incubation, and Rearing - Coho**

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 both males and females had a small section of kidney removed for screening of *Renibacterium salmoninarum*, the causative pathogen for Bacterial Kidney Disease (BKD). Eggs were fertilized and mating crosses were recorded. Each mating cross was placed into a vertical health stack incubator. Once the eggs reached the eyed stage and the BKD pathology results were received any crosses which had a high prevalence of BKD were culled. The coho eggs were incubated at ambient Trail Lakes Hatchery water temperature in 3 distinct lots for fry and smolt stocking. Incubation followed standard hatchery procedures and water temperature was regulated to thermally mark the 3 different lots (Fry - H2,2,2; Smolt - H3,2; Homer-Seldovia Smolt - H1,4). Coho salmon eggs were also collected by ADF&G Ft. Richardson Hatchery staff.

### **Fish Transport and Stocking**

Sockeye fry have been stocked into Bear Lake since 1990. For stocking, all fry were transported by truck from Trail Lakes Hatchery to Bear Lake in oxygenated transport tanks. In 2006, fry

were transported by truck in oxygenated tanks to a small tributary stream, 0.5 kilometers from Bear Lake (Figure 2). Fry were held in large containers and supplied with creek water for four hours to imprint them to the stream. After imprinting the fry were released into the tributary.

Coho fry have been stocked into Bear Lake since 1986. For stocking, all coho 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 contrast, all coho smolts were transported by truck in oxygenated tanks and placed into raceways at the weir for imprinting. Some smolts were transported and released directly into Lowell Creek (Seward, AK; Resurrection Bay).

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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 2006 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 2006.

Year	1 meter depth											
	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/m <sup>2</sup> )
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												
1989												
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	485
1999	82	7.2	30	1.2	5.6	126	9.0	53 :1	0.9	9.7	5.6	698
2000	80	7.0	28	2.2	6.8	125	3.4	42 :1	3.4	8.9	4.6	711
2001	79	7.1	27	1.2	6.0	124	4.0	35 :1	2.0	9.2	5.0	896
2002	78	7.1	29	0.7	7.0	117	12.4	42 :1	2.4	10.4	5.0	1,271
2003	74	6.7	26	0.6	6.7	124	6.8	44 :1	2.1	11.0	6.4	345
2004*	72	6.8	27	1.0	7.3	176	26.5	38 :1	1.5	9.2	3.8	NA
2005*	81	6.7	27	0.4	8.6	137	22.7	41 :1	0.9	9.2	5.4	NA
2006*	82	6.6	28	1.2	12.3	158	8.5	30 :1	2.5	8.3	3.2	NA

Averages prior to 1992 compiled by ADF&G.

EZD, Secchi and atomic ratio provided by CIAA.

Open water season only.

\*2004 - 2006 - zooplankton data analysis is incomplete.

Table 2. Water quality characteristics of Bear Lake in the hypolimnion, 1979 to 2006.

Year	Hypolimnion								
	Sp. Cond (umhos/cm)	pH (SU)	Alk (mg/l)	Turb. (NTU)	TP (ug/l)	TKN (ug/l)	NO <sub>2</sub> +NO <sub>3</sub> (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									
1989									
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

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)

The environmental conditions recorded in 2006 are presented in Appendix 2. Between 01 May and 30 June, the average air temperature was 12.5°C (± 6.1°C) while water temperature averaged 8.9°C (± 3.7°C). Average stage height below the weir was 0.91 ft (±0.1 ft) and above the weir it was 1.49 ft (± 0.1 ft) for the same time period. Between 01 July and 29 October, the average air temperature was 11.1°C (± 4.6°C) while water temperature averaged 11.6°C (± 3.0°C). Average stage height below the weir was 0.64 ft (± 0.2 ft) and above the weir it was 1.95 ft (± 1.2 ft). The environmental conditions observed in 2006 are compared to other years in Table 3.

Table 3. Environmental conditions observed at Bear Lake, 1990 to 2006.

Year	May thru June 30											
	Total Days	Clear	No. of Days			Rain	Days Meas. Precip	Precip (mm)	Temperature (C)			
			<50% Cloud Cover	>50% Cloud Cover	100% Overcast				Avg	Air Range	Avg	Water 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)

Year	July thru Sept/Oct/Nov											
	Total Days	Clear	No. of Days			Rain	Days Meas. Precip	Precip (mm)	Temperature (C)			
			<50% Cloud Cover	>50% Cloud Cover	100% Overcast				Avg	Air Range	Avg	Water 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	1084	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)

\*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.

Liquid fertilizer has been applied to Bear Lake in 19 of the last 26 years. It was not applied in 1987-1989, 1994, 1995, and 2001. Applications levels are presented in Table 4.

Table 4. Fertilizer application at Bear Lake, 1981 to 2006

Year	32-0-0 (gal)	27-7-0 (gal)	20-5-0 (gal)	N (Kg)	P (Kg)	Dates	Comments
1981	2,760			4,441		9/01 - 10/31	Every 10 days
1982	3,240			5,213		7/15 - 10/31	Every 10 days
1983	4,080			6,565		6/01 - 10/04	Every 3 days
1984	1,960	1,120		4,760	181	6/01 - 9/15	Every 3 days
1985	2,800			4,505		6/01 - 9/15	Every 3 days
1986	1,680	1,120		4,309	181	7/01 - 9/15	Every 3 days
1987							No application
1988							No application
1989							No application
1990	2,640		420	4,644	43	6/05 - 8/28	Every 2 days, 20-5-0 first
1991	2,340		390	4,133	40	5/30 - 8/14	Daily, 20-5-0 first
1992	3,264		390	5,620	40	6/04 - 8/09	4 to 6 times/week
1993			960	905	98	5/25 - 8/07	3 times/week
1994							No application
1995							No Application
1996	2,280		600	4,234	61	6/03 - 9/01	Daily, 20-5-0 mid-summer
1997	1,620		540	3,116	55	6/01 - 8/4	2 bbl. a day 4 times a wk.
1998			990	934	101	6/24 - 8/10	Every day
1999			1,050	990	107	6/17 - 8/25	Every other day
2000			840	792	86	6/12 - 8/26	Every other day
2001							No application
2002			900	849	92	6/27 - 8/18	Every other day
2003			1,050	990	107	6/26 - 8/8	Mon, Wed, Fri
2004			1,260	1,188	129	6/22 - 8/20	Every other day
2005			1,050	990	107	6/16 - 8/6	3 times/ week
2006			1,200	1,132	122	7/1 - 8/21	2 to 3 times/ week

### Smolt Enumeration - Sockeye

Enumeration of Bear Lake sockeye smolts occurred between May 21 - June 30. A total of 1,962,415 sockeye smolts migrated from Bear Lake in 2006 (Appendix 3). The 10% sub-sampling procedure was used to count 80.3% of the migrating sockeye salmon.

The age 1.0 smolts averaged 85 mm ( $\pm 0.5$  mm) in length and 5.7 g ( $\pm 0.2$  g) in weight. The age 2.0 smolts averaged 105 mm ( $\pm 1.2$  mm) in length and 11.1 g ( $\pm 0.6$  g) in weight (Table 5). Based on the presence of hatchery induced thermal marks in the otoliths of 1,995 smolts, it was estimated that 94.3% ( $\pm 1.0\%$ ) of the sockeye smolts were of hatchery origin.



Table 5. Sockeye smolt migrations: mean length and weight, by age class, for Bear Lake, 1980 to 2006.

Year	Number	95%CI	% Hatch.			Age Composition						Average Length (mm) <sup>5</sup>				Average Weight (g) <sup>6</sup>										
			95%CI	No. Wild		0.0	95% CI	1.0	95% CI	2.0	95% CI	3.0	95% CI	0.0	1.0	CI	2.0	CI	0.0	1.0	CI	2.0	CI			
1980	3,400							3,400		20						119		187				NA		NA		
1981	3,500							2,800		700						117		158				16.2		41.6		
1982	46,300							46,100		100						110		144				14.0		29.7		
1983	13,000							11,000		2,000						112		149				13.5		32.9		
1984	10,500							7,700		2,500						116		153				15.4		35.8		
1985	1,600							1,300		300						126		176				20.2		51.4		
1986	1,000							800		100						123		167				18.3		47.2		
1987	18,200							17,800		300						112		172				12.8		46.5		
1988	9,100							7,200		1,900						120		155				16.0		34.9		
1989	5,100							3,700		1,300						122		152				18.8		35.6		
1990 <sup>1</sup>	53,400						52,500	800		30					NA	113		125			NA	15.2		28.4		
1991 <sup>2</sup>	122,000							119,900		1,600						125		164				18.7		40.4		
1992 <sup>3</sup>	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					115	123		152		18.1		18.7		35.3		
1994	253,900						700	228,600		21,200					102	121		154		11.0		17.4		37.0		
1995	73,500	1,900	70.2	8	21,903			6,800	1,600	4,800	1,000					122		156				17.9		37.2		
1996	156,000	9,600	64.2	3.5	55,848			149,400	9,400	6,400	2,100					117	0.6	120	2.1			11.8		16.2		
1997	276,000	64,000	74.6	3.6	70,104			270,500	64,000	5,500	3,500					104	0.5	143	7.6			10.1	0.2	26.7	4.4	
1998	107,800	15,500	72.2	5.8	29,968			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	19,329			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	175,000	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	45,725			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	76,755			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	100,814			1,306,200	22,000	23,000	10,000					92	0.8	140	7.7			7.5	0.2	30.4	4.9	
2004	123,200		96.2	2.4	4,682			76,500	7,800	46,700	7,800					115	1.3	139	0.8			14.2	1.4	26.1	1.2	
2005	1,420,428	412,108	97.4	0.9	36,931			1,388,388	12,537	29,904	12,044					88	0.5	88				6.4	0.0	6.1		
2006	1,962,415	147,058	94.3	1	111,858			1,692,890	34,472	182,962	28,907					85	0.5	105.1	1.2			5.7	0.2	11.1	0.6	
Avg. <sup>4</sup>	384,400	57,700	75.9	3.8	45,700	11,400	5,600	355,426	15,800	20,700	6,000	3,800	2,300	119	111	0.9	141	4.6	17		12.8	1.2	30.2	4.7		
Total <sup>5</sup>	7,211,943					157,600		6,417,178		463,016		21,923														

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

<sup>1</sup>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.

<sup>2</sup>In 1991 smolt migration monitoring may have terminated before age 0.0 smolt migration.

<sup>3</sup>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

<sup>4</sup>Average values calculated from smolt year 1995 to 2005.

<sup>5</sup>Total values calculated from 1980 to 2006.

<sup>6</sup>1980 thru 1992 averages are arithmetic, 1993 and later are weighted averages.

## Smolt Enumeration - Coho

A total of 49,980 coho salmon smolts migrated from Bear Lake in 2006 (Appendix 3) between 21 May and 30 June. The 10% sub-sampling procedure was used to count 49.8% of the migrating coho smolts.

The average size (Table 6) of the age 1.0 coho smolts was 93 mm ( $\pm 2.2$  mm) and 8.4 g ( $\pm 0.9$  g). Age 2.0 smolts were 128 mm ( $\pm 2.6$  mm) and 21.7 g ( $\pm 1.4$  g). Based on the presence of hatchery induced thermal marks in the otoliths of 273 coho smolt, it was estimated that 88.3% ( $\pm 3.7\%$ ) of the coho smolts were of hatchery origin.

Table 6. Coho smolt migrations: mean length and weight, by age class, for Bear Lake, 1980 to 2006.

Year	Number		%		Age Composition								Average Length (mm) <sup>4</sup>						Average Weight (g) <sup>4</sup>									
	Number	95% CI	Hatch.	95% CI	1.0	95% CI	2.0	95% CI	3.0	95% CI	4.0	95% CI	1.0	95% CI	2.0	95% CI	3.0	95% CI	4.0	95% CI	1.0	95% CI	2.0	95% CI	3.0	95% CI	4.0	95% CI
1980	75,000				54,600		20,300		100				122		135						19.3		24.0					
1981	72,900				10,900		61,800		200				122		127						18.4		19.8					
1982	143,700				134,000		9,600		100				116		127						15.0		20.4					
1983	108,400				100,400		7,900		100				115		129						14.3		20.2					
1984	93,800				78,300		15,200		300				116		134						15.0		22.4					
1985	105,900				104,300		1,600		0				125		168						18.1		41.5					
1986	72,700				60,900		11,500		300				126		137						19.5		24.9					
1987	80,200				61,200		18,700		250				109		145						11.6		27.9					
1988	63,800				50,500		13,300		0				118		133						16.4		22.3					
1989	99,400				96,200		3,200		0				116		134						18.8		23.0					
1990	83,400				67,500		14,800		1,000				119		139						15.7		24.1					
1991	97,600				86,500		10,600		500				121		138						18.0		25.5					
1992	112,900				107,500		4,700		600				120		137						17.1		25.7					
1993	53,500				42,300		10,400		0				124		137						19.5		25.8					
1994	54,400				6,000		43,700		0				115		128						14.4		20.7					
1995	88,200	4,000			3,500	1,000	86,000	3,800	500	400	100	150	103		121						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			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			109		128		144				13.0		20.4		28.9			
2001 <sup>1</sup>	101,400	12,600	91.8	2.2	80,200	11,800	19,900	4,100	1,300	900			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			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			109		119		137.6				11.9		16.3		26.5			
2004	73,400		92.2	2.6	54,000	3,500	19,100	3,500					103	1.2	128	1.6					11.5	0.8	22.1	1.2				
2005	65,448	3,675	96.6	1.5	56,448	2,005	8,889	2,005					97	1.0	121	2.3					9.5	0.5	18.2	1.5				
2006	49,980	4,263	88.3	3.7	36,249	2,862	11,900	2,636					93	2.2	128	2.6					8.4	0.9	21.7	1.4				
Avg <sup>2</sup>	95,702	10,600	90	2	62,800	5,200	29,600	6,900	3,200	2,900	500	600	112		129		135		157		14.3		21.3		25.3		35.6	
Total <sup>3</sup>	2,538,228				1,669,398		782,589		76,750		1,900																	

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 rounded to nearest 0.1 g. All other figures have been rounded to nearest 100 fish.

<sup>1</sup>Percent Hatchery calculated for Age 1.0 smolts only

<sup>2</sup>Average values calculated from smolt year 1980 to 2005.

<sup>3</sup>Total values calculated from 1980 to 2006.

<sup>4</sup>1980 thru 1992 averages are arithmetic, 1993 and later are weighted averages.

## Adult Escapement - Sockeye

Adult sockeye salmon began arriving at the weir on 26 May 2006 and continued to migrate until 7 August 2006 (Appendix 4). During this time, 43,069 adults were captured and counted at the weir (Table 7). The returning major age groups for adult sockeye included ages 1.2 (12.0%), 1.3 (81.3%), 2.2 (5.2%) and 2.3 (1.6%). Of the 43,069 adult sockeye that migrated to Bear Creek in 2006, 30,651 were harvested for cost recovery and 12,398 were passed to the lake. Mortalities at the weir were 20 fish. An additional 27,500 fish were harvested in the seine fishery and an

additional 4,004 fish in the saltwater cost recovery harvest. It was estimated that 5,000 fish were harvested in the sport fishery for a total return to Resurrection Bay of 79,577 sockeye salmon.

A summary of mean age and weight, by age class, for adult sockeye salmon escapement to the Bear Creek weir site for 2006 is presented in Appendix 6.

Table 7. Historic returns of Coho and Sockeye Salmon to Bear Lake weir, 1980 to 2006.

Year	Coho Salmon				Sockeye Salmon											
	Weir Return Total	Age Composition			Weir Return Total	Age Composition										
		1.1	2.1	3.1		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	15	0	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
Avg <sup>1</sup>	4,137	1,392	2,623	122	22,183	343	194	493	9,728	12	9,802	6	1,186	412	4	2
% of Avg	100%	33.7%	63.4%	2.9%	100%	1.5%	0.9%	2.2%	43.9%	0.1%	44.2%	0.03%	5.3%	1.9%	0.02%	0.1%

<sup>1</sup> Average calculation is based on 1994 data onward.

### Adult Escapement - Coho

Adult coho salmon began arriving at the weir on 20 August 2006 and continued to migrate until 24 October (Appendix 5). During this time, 2,089 adults were captured and counted at the weir (Table 7). The returning major age groups for adult coho included ages 1.1 (50.6%), 2.1 (45.6%), and 3.1 (3%).

Of the 2,089 adult coho that were counted at the Bear Creek weir site, 681 were harvested, 892 were held for broodstock purposes and 516 were passed into the lake.

A summary of mean age and weight, by age class for adult salmon escapement to the Bear Creek weir site for 2006 is presented in Appendix 7.

## **Hatchery Activities**

### Stocking

In 2006, 2.414 million sockeye fry (BY05; 6H) and 447,000 coho fry (BY05; H3,3) were released into Bear Lake. These fish will migrate in 2007/2008 as smolts. At the time of release, the sockeye fry averaged 0.52 gm and the coho fry averaged 0.84 gm.

Approximately, 979,000 sockeye smolts (BY04; 3,3H,3) and 115,000 coho smolts (BY04: 3,3H2) were released into Bear Lake/Bear Creek. Average weight was 10.0 and 10.8 gm respectively. An additional 146,000 coho smolts (BY04; 3,3H2) were released into Lowell Creek. A summary of releases are provide in Table 8.

### Eggtake

Between 26 July and 18 August 2006, a total of 6,087,000 sockeye salmon eggs were collected. A total of 4,060 broodfish were used (2,008 females; 2,052 males) providing an average fecundity of 3,115 eggs/female.

From 5 October to 17 October 2006, a total of 1,084,000 coho eggs were collected from 359 females and fertilized with milt from 245 males. Average fecundity was 3,019 eggs/female. An additional 343,000 coho eggs were collected by ADF&G Fort Richardson Hatchery.

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

Table 8. Coho and sockeye salmon releases at Bear Lake, 1986 to 2006.

Release Year	Coho				Sockeye					
	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 <sup>1</sup>	450,000	0.30			47,000	0.15				
1993 <sup>2</sup>	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 <sup>3</sup>	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 <sup>4</sup>	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 <sup>5</sup>	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
Total	8,110,800		2,228,330		24,170,000		2,009,000		2,514,200	
Ave	368,673	0.91	159,166	11.4	1,342,778	0.47	702,500	3.96	307,040	7.76

<sup>1</sup> Released into Bear Lake

<sup>2</sup> Extra Fry Released into Bear Creek

<sup>3</sup> sockeye fry release, 445, 300 @ .36g & 335,300 @ .38g

<sup>4</sup> sockeye fry release, 1,573,000 @ (.35-.45 g) & 223,000 @2.7 g

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

Table 9. Eggs collected for Bear Lake enhancement, 1989 to 2006.

Brood Year	Brood Stock	Coho			Brood Stock	Sockeye		
		Green Eggs	Eyed Eggs	%		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	1,414,791	1,252,814	88.6	Bear L	4,002,000	3,618,000	90.4
2006	Bear L	1,084,000	990,000	91.33	Bear L	6,087,000	5,444,000	89.44
Total		17,688,963	15,265,806			61,139,600	51,218,400	
Ave				85.9				80.7

### Fry-to-Smolt Survival

Migrating smolts in 2006 were stocked either as fry in 2004 (BY03 - Age 2) and 2005 (BY04 - Age 1) or as smolts (2006). Assuming that all smolts migrated out (ie. no residuals stayed in the lake) and based on age classification from otoliths/scales, the fry-to-smolt survival for each brood year of fry stocking can be determined. This information is summarized in Table 10.

### Marine Survival

Based on information collected from migrating sockeye smolts and returning sockeye adults (total return), it is possible to provide an estimate of the survival of hatchery fish in the marine

environment. This information is summarized below in Table 11.

Table 10. Bear Lake smolt production by brood years.

Brood Year	Coho						Brood Year	Sockeye					
	Escap.	No. Fry Stocked	Size (g)	No. Smolt	Hatch Smolt	% Hatch. Survival		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	69,100	47,600	28.0
1994	475	509,000	0.75	204,100			1994	8,430	330,000	0.37	155,400	100,400	30.4
1995	444	350,000	0.70	84,600			1995	8,334	781,000	0.37	296,700	220,700	28.3
1996	380	448,700	0.63	64,500			1996	8,012	788,000	0.34	101,400	73,800	9.4
1997	276	409,000	0.66	57,700			1997	7,945	265,000	0.56	92,500	71,100	26.8
1998	350	306,000	0.82	74,827			1998	8,427	1,380,000	0.25	168,500	132,014	9.6
1999	368	316,100	0.94	100,200	90,700	28.7	1999	7,815	1,796,400	0.80	378,900	311,700	17.4
2000	429	311,000	0.99	114,300	97,300	31.3	2000	11,828	144,500	0.30	105,400	42,900	29.7
2001	495	405,000	1.04	186,900	163,400	40.3	2001	12,801	3,209,000	0.49	1,352,800	917,788	28.6
2002	875	405,000	1.37	62,900	58,400	14.4	2002 *	12,504	1,467,000	0.42	106,500	102,800	7.0
2003 *	395	406,000	1.07	86,100	80,716	19.9	2003 *	13,233	3,012,000	0.63	1,571,350	1,122,823	37.3
2004 *	572	405,000	1.30	62,800	55,452	13.6919	2004 *	8,061	3,020,000	1.17	1,692,890	1,596,395	
2005 *	546	447,000	0.84				2005 *	10,285	2,414,000	0.52			
2006 *	500						2006 *	8,338					
Ave <sup>1</sup>	476	388,700	0.87	96,811	90,995	24.7	Ave <sup>1</sup>	9,361	1,444,400	0.49	507,620	395,002	22.9

\* Incomplete broodyear

<sup>1</sup>Average data is for 1993 onward.

Smolt numbers are rounded to the nearest 100 fish.

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

\* Incomplete broodyear

<sup>1</sup>Average data is for 1993 to 2000

Smolt numbers are rounded to the nearest 100 fish.

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

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

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

Table 11. Marine survival for sockeye at Bear Lake (BY1989 to BY2004)

BY	Marine Survival
1989	5.0
1990	24.9
1991	5.4
1992	15.5
1993	18.6
1994	34.2
1995	16.1
1996	15.4
1997	14.5
1998	20.1
1999	8.1
2000	17.6
2001	9.6
2002	8.9
2003	0.0
2004	0.0
AVE	16.2

Red/italics indicates incomplete brood year.

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## **RECOMMENDATIONS**

Due to the high incidence of Bacterial Kidney Disease (BKD) in the coho, family tracking should continue during the coho eggtake. There are no other changes recommended for the Bear Lake Enhancement Project.

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## **APPENDICES**

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## Appendix 1. Bear Lake 2006 - 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)
5/31/2006	1	11.3	3.3	2.8	149	4.1	17.4	33 :1	2555	544	2.52	0.38	8.4
	12	10.6	3.3	2.5	125	3.7	12.3	29 :1	2599	544	2.75	1.26	
8/30/2006	1	11.4	5.0	3.5	161	19.2	4.1	32 :1	2445	602	2.53	1.60	9.3
	15	14.2	5.2	3.3	174	8.3	4.1	28 :1	2371	599	2.57	0.20	
9/29/2006	1	14.2	5.0	3.8	165	8.4	4.1	26 :1	2578	582	2.34	0.52	7.3
	14	12.8	8.1	4.5	148	7.8	4.1	26 :1	2659	585	1.90	0.67	
Mean		12.4	5.0	3.4	153.6	8.6	7.7	29 :1	2535	576	2.4	0.8	8.3
Min		10.6	3.3	2.5	124.5	3.7	4.1	26 :1	2371	544	1.9	0.2	7.3
Max		14.2	8.1	4.5	174.3	19.2	17.4	33 :1	2659	602	2.8	1.6	9.3
1m Ave		12.3	4.4	3.4	158.4	10.6	8.5	30.4 :1	2526	576	2.5	0.8	8.3
Hypo Ave		12.5	5.5	3.4	148.8	6.6	6.8	27.6 :1	2543	576	2.4	0.7	

\* Possible contamination of hypolimnion sample.

### 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)
5/31/2006	B	1	82	6.6	28.6	1.0	6	13.2	0.2	45	3.0
	B	12	83	6.6	28.6	1.0	5	12.9	0.2	40	
8/30/2006	B	1	82	6.7	27.8	0.8	5	13.4	0.2	14	4.0
	B	15	82	6.8	27.8	1.4	5	13.4	0.2	17	
9/29/2006	B	1	82	6.6	28.0	1.8	6	13.1	0.2	35	2.5
	B	14	84	6.6	27.8	4.0	6	13.1	0.2	29	
Mean			83	6.7	28.1	1.7	5.5	13.2	0.2	30.0	3.2
Min			82	6.6	27.8	0.8	5.0	12.9	0.2	14.0	2.5
Max			84	6.8	28.6	4.0	6.0	13.4	0.2	45.0	4.0
1m Ave			82.0	6.6	28.1	1.2	5.7	13.2	0.2	31.3	3.2
Hypo Ave			83.0	6.7	28.1	2.1	5.3	13.1	0.2	28.7	

Appendix 1. (continued) Bear Lake 2006 - Zooplankton Analysis

Zooplankton data analysis is incomplete. This section will need to be completed at a later date.



## Appendix 2. Bear Lake 2006 - Environmental Conditions

Date	Sky	Precip. (mm)	Lower Gauge (ft)	Upper Gauge (ft)	Water Temp (oC)	Air Temp (oC)	Date	Sky	Precip. (mm)	Lower Gauge (ft)	Upper Gauge (ft)	Water Temp (oC)	Air Temp (oC)
1-May	4	0		1.29	4	5	1-Jun	1	0	1.1	1.58	11	19
2-May	3	0		1.29	4	6	2-Jun	1	0	1.1	1.59	12	21
3-May	2	0		1.29	4	6	3-Jun	2	0	0.98	1.55	12	21
4-May	5	10		1.3	4	4	4-Jun	2	0	0.98	1.56	12	26
5-May	4	8		1.3	4	4	5-Jun	3	0	0.99	1.56	12	24
6-May	4	2	0.72	1.32	4	5	6-Jun	3	0	0.99	1.56	12	12
7-May	4	5	0.72	1.32	4	5	7-Jun	5	0	0.92	1.48	11	9
8-May	5	4.6	0.74	1.36	4	3	8-Jun	4	0	0.92	1.48	11	9
9-May	5	2.4	0.76	1.37	4	3	9-Jun	5	22.5	0.99	1.6	11	11
10-May	4	1.2	0.8	1.37	4	4	10-Jun	4	2.2	0.9	1.6	11	9
11-May	3	0	0.82	1.38	4	5	11-Jun	4	0.6	0.88	1.59	11	11
12-May	5	0	0.86	1.4	4	7	12-Jun	5	2.6	0.99	1.59	12	11
13-May	1	0	0.92	1.41	4	10	13-Jun	4	0.11	0.88	1.52	12	14
14-May	4	0	0.95	1.43	4	5	14-Jun	4	0.02	0.8	1.52	12	12
15-May	4	5.4	1.03	1.46	5	7	15-Jun	4	0	0.86	1.51	12	13
16-May	4	0	1.03	1.46	5	7	16-Jun	4	2	0.86	1.5	12	14
17-May	4	2	1.03	1.46	5	7	17-Jun	4	0.98	0.86	1.52	12	11
18-May	4	1.2	1.03	1.46	5	7	18-Jun	4	2.6	0.99	1.52	11	10
19-May	4	0	1.04	1.46	5	11	19-Jun	3	2.1	0.97	1.52	12	11
20-May	5	4	1.04	1.46	5	8	20-Jun	3	6	0.94	1.52	12	15
21-May	1	6.2	1.01	1.46	5	15	21-Jun	3	6	0.92	1.52	12	15
22-May	1	0	1.01	1.52	7	17	22-Jun	4	2.2	0.92	1.52	12	16
23-May	3	0	1	1.46	9	22	23-Jun	4	0	0.9	1.51	13	17
24-May	4	0	0.92	1.5	8.5	18	24-Jun	3	0	0.89	1.49	13	16
25-May	1	0	1	1.6	10	22	25-Jun	4	0	0.89	1.48	14	13
26-May	1	0	0.99	1.6	9	22	26-Jun	4	3.4	0.88	1.48	14	13
27-May	1	0	0.93	1.64	10	22	27-Jun	1	0	0.88	1.48	14	18
28-May	1	0	0.92	1.67	10	20	28-Jun	1	0	0.88	1.48	14	20
29-May	1	0	0.9	1.66	9	19	29-Jun	4	0	0.88	1.47	14	11
30-May	4	0	0.9	1.66	7.5	17	30-Jun	3	0	0.88	1.47	14	12
31-May	4	0	0.1	1.66	7	18							

### 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 2006 - Environmental Conditions

Date	Sky	Precip. (mm)	Lower Gauge (ft)	Upper Gauge (ft)	Water Temp (oC)	Air Temp (oC)	Date	Sky	Precip. (mm)	Lower Gauge (ft)	Upper Gauge (ft)	Water Temp (oC)	Air Temp (oC)
1-Jul	1	0	0.94	1.44	14	14	1-Aug	3	5	0.68	1.37	15	14
2-Jul	3	0	0.96	1.45	14	12	2-Aug	4	1.5	0.67	1.35	14	13
3-Jul	2	0	0.96	1.45	14	16	3-Aug	5	7.5	0.7	1.39	13	9
4-Jul	4	0	0.8	1.47	14	16	4-Aug	5	6.2	0.47	1.47	13	11
5-Jul	3	0	0.8	1.47	14	19	5-Aug	2	2.2	0.45	1.46	14	11
6-Jul	4	0	0.8	1.47	14	14	6-Aug	3	0	0.44	1.43	14	14
7-Jul	4	0	0.8	1.46	14	13	7-Aug	2	0	0.42	1.43	14	15
8-Jul	4	0	0.78	1.46	14	14	8-Aug	2	0	0.42	1.43	15	19
9-Jul	3	0	0.78	1.44	14	12	9-Aug	4	0	0.39	1.38	14	14
10-Jul	4	0	0.76	1.44	14	12	10-Aug	4	0	0.39	1.37	14	14
11-Jul	4	0	0.74	1.4	14	12	11-Aug	4	8.1	0.39	1.37	14	14
12-Jul	1	0	0.74	1.4	15	30	12-Aug	3	7.9	0.38	1.37	14	16
13-Jul	1	0	0.72	1.38	16	29	13-Aug	4	7.3	0.39	1.39	14	13
14-Jul	4	0	0.72	1.38	16	12	14-Aug	5	7.1	0.4	1.39	13	11
15-Jul	4	0	0.7	1.34	16	9	15-Aug	5	12.5	0.42	1.4	14	11
16-Jul	5	26	0.68	1.34	16	9	16-Aug	5	4.2	0.43	1.42	14	11
17-Jul	3	0	0.69	1.35	13	15	17-Aug	2	3.5	0.43	1.42	14	14
18-Jul	4	0	0.68	1.33	14	12	18-Aug	5	5.2	0.46	1.44	14	13
19-Jul	2	0	0.67	1.3	14	16	19-Aug	3	29	0.49	1.49	13	12
20-Jul	3	0	0.67	1.29	14	15	20-Aug	5	16	0.49	1.49	13	12
21-Jul	4	0	0.68	1.3	14	15	21-Aug	2	0	0.49	1.49	13	16
22-Jul	4	0	0.69	1.36	14	14	22-Aug	5	7.5	0.51	1.51	13	9
23-Jul	4	12.5	0.7	1.36	13	14	23-Aug	2	2.6	0.51	1.51	13	14
24-Jul	5	21	0.78	1.42	15	11	24-Aug	5	10	0.52	1.51	13	12
25-Jul	5	10.5	0.81	1.47	14	11	25-Aug	5	3.7	0.52	1.51	13	12
26-Jul	3	1.2	0.75	1.43	15	11	26-Aug	4	2.1	0.52	1.51	13	12
27-Jul	1	0	0.7	1.4	17	16	27-Aug	2	1.6	0.52	1.51	13	16
28-Jul	2	0	0.7	1.4	16	16	28-Aug	2	0.66	0.48	1.48	14	15
29-Jul	3	0	0.69	1.38	16	16	29-Aug	2	0.21	0.48	1.48	14	15
30-Jul	5	10.2	0.72	1.4	15	11	30-Aug	5	4	0.48	1.48	14	14
31-Jul	2	0	0.7	1.4	15	15	31-Aug	5	30.1	0.48	1.48	13	12

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 2006 - Environmental Conditions

Date	Sky	Precip. (mm)	Lower Gauge (ft)	Upper Gauge (ft)	Water Temp (oC)	Air Temp (oC)	Date	Sky	Precip. (mm)	Lower Gauge (ft)	Upper Gauge (ft)	Water Temp (oC)	Air Temp (oC)
1-Sep	3	4.2	0.48	1.48	13	13	1-Oct	5	2	0.72	1.54	9	8
2-Sep	5	7.2	0.49	1.49	12	12	2-Oct	5	30	0.76	1.58	9	8
3-Sep	2	0	0.49	1.49	12	14	3-Oct	5	27	0.74	2.6	9	11
4-Sep	5	3.6	0.49	1.47	12	12	4-Oct	5	12.6	0.72	2.62	9	7
5-Sep	2	0	0.67	1.47	11	12	5-Oct	3	16	0.58	3.73	9	6
6-Sep	5	30.2	46	1.49	11	11	6-Oct	4	27	0.61	4.78	9	6
7-Sep	4	12.5	0.5	1.49	11	11	7-Oct	5	37.4	0.78	4.78	9	8
8-Sep	4	7.2	0.55	1.5	11	12	8-Oct	5	27.6	0.79	4.58	9	9
9-Sep	3	6.3	0.62	1.51	11	12	9-Oct	5	100		4.59	9	9
10-Sep	4	0	0.69	1.51	11	12	10-Oct	4	32.5		5.5	9	8
11-Sep	1	3.5	0.7	1.52	11	13	11-Oct	4	24.5		4.78	9	8
12-Sep	1	0	0.7	1.52	12	16	12-Oct	4	12.6		4.58	8	6
13-Sep	1	0	0.64	1.53	12	16	13-Oct	2	0		3.99	8	7
14-Sep	5	3.6	0.66	1.59	11	12	14-Oct	4	0		3.9	8	8
15-Sep	5	38	0.76	1.59	11	10	15-Oct	4	0		3.5	8	7
16-Sep	5	2.6	0.76	1.59	10	10	16-Oct	5	4		3.35	8	8
17-Sep	4	1	0.76	1.59	10	8	17-Oct	4	6		2.94	8	2
18-Sep	5	0	0.76	1.59	10	8	18-Oct	5	18.5		2.78	7	5
19-Sep	5	0	0.75	1.57	10	9	19-Oct	5	0.5		2.73	7	5
20-Sep	3	2.6	0.75	1.56	10	10	20-Oct	4	0.1		2.7	7	5
21-Sep	3	22.5	0.8	1.66	10	9	21-Oct	2	0		2.66	7	5
22-Sep	4	12.5	0.8	1.66	10	9	22-Oct	4	0.1		2.65	6	4
23-Sep	4	1.6	0.8	1.66	10	8	23-Oct	4	0		2.63	6	4
24-Sep	3	0	0.78	1.64	10	9	24-Oct	5	1		2	6	3
25-Sep	4	0	0.76	1.63	10	9	25-Oct	3	2		1.8	6	2
26-Sep	5	10	0.76	1.63	10	9	26-Oct	2	0		1.76	5	3
27-Sep	5	13.5	0.78	1.65	9	8	27-Oct	5	1		1.32	5	3
28-Sep	5	6	0.78	1.65	9	9	28-Oct	4	0		1.2	5	3
29-Sep	3	6	0.72	1.65	9	6	29-Oct	4	1		8	5	2
30-Sep	4	12.5	0.74	1.66	9	8	29-Oct	3	6.2		7.7	5	2
							29-Oct	1	0	0	1.75	4	1

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 2006 - Smolt Migration.

Date	Sockeye		Coho		Dolly Varden		Rainbow Trout	
	Daily	Cumm	Daily	Cumm	Daily	Cumm	Daily	Cumm
01-May		0		0		0		0
02-May		0		0		0		0
03-May		0		0		0		0
04-May		0		0		0		0
05-May		0		0		0		0
06-May		0		0		0		0
07-May		0		0		0		0
08-May		0		0		0		0
09-May		0		0		0		0
10-May		0		0		0		0
11-May		0		0		0		0
12-May		0		0		0		0
13-May		0		0		0		0
14-May		0		0		0		0
15-May		0		0		0		0
16-May		0		0		0		0
17-May	0	0	0	0	0	0		0
18-May	0	0	0	0	0	0		0
19-May	0	0	0	0	0	0		0
20-May	0	0	0	0	0	0		0
21-May	1,925	1,925	20	20	0	0		0
22-May	9,281	11,206	105	125	0	0		0
23-May	25,902	37,108	240	365	0	0		0
24-May	31,401	68,509	601	966	0	0		0
25-May	122,373	190,882	949	1,915	1	1		0
26-May	123,958	314,840	1,399	3,314	20	21		0
27-May	73,449	388,289	2,460	5,774	20	41		0
28-May	59,122	447,411	1,719	7,493	30	71		0
29-May	124,460	571,871	2,099	9,592	0	71		0
30-May	79,947	651,818	3,443	13,035	1	72		0
31-May	93,498	745,316	1,475	14,510	0	72		0
01-Jun	149,137	894,453	1,940	16,450	0	72		0
02-Jun	154,101	1,048,554	2,305	18,755	0	72		0
03-Jun	188,632	1,237,186	3,631	22,386	11	83		0
04-Jun	161,735	1,398,921	1,833	24,219	0	83		0
05-Jun	103,040	1,501,961	2,960	27,179	10	93		0
06-Jun	105,000	1,606,961	2,260	29,439	0	93		0
07-Jun	40,420	1,647,381	1,070	30,509	0	93		0
08-Jun	68,560	1,715,941	784	31,293	0	93		0
09-Jun	91,893	1,807,834	989	32,282	1	94		0
10-Jun	56,298	1,864,132	2,420	34,702	0	94		0
11-Jun	6,076	1,870,208	2,065	36,767	0	94		0
12-Jun	13,621	1,883,829	1,460	38,227	0	94		0
13-Jun	10,381	1,894,210	857	39,084	0	94		0
14-Jun	10,050	1,904,260	605	39,689	0	94		0
15-Jun	12,698	1,916,958	1,027	40,716	0	94		0
16-Jun	3,400	1,920,358	425	41,141	0	94		0
17-Jun	4,202	1,924,560	1,973	43,114	0	94		0
18-Jun	13,965	1,938,525	3,007	46,121	0	94		0
19-Jun	7,049	1,945,574	1,571	47,692	0	94		0
20-Jun	4,041	1,949,615	995	48,687	0	94		0
21-Jun	3,412	1,953,027	439	49,126	0	94		0
22-Jun	420	1,953,447	80	49,206	0	94		0
23-Jun	218	1,953,665	65	49,271	0	94		0
24-Jun	0	1,953,665	0	49,271	0	94		0
25-Jun	362	1,954,027	119	49,390	0	94		0
26-Jun	2,718	1,956,745	176	49,566	0	94		0
27-Jun	2,923	1,959,668	168	49,734	0	94		0
28-Jun	1,227	1,960,895	157	49,891	0	94		0
29-Jun	1,112	1,962,007	65	49,956	0	94		0
30-Jun	408	1,962,415	24	49,980	1	95		0
01-Jul								0
02-Jul								0
03-Jul								0
04-Jul								0
05-Jul								0
06-Jul								0
07-Jul								0
08-Jul								0
09-Jul								0
10-Jul								0
11-Jul								0
Totals		1,962,415		49,980		95		0

Appendix 4. Bear Lake 2006 - Adult Sockeye Salmon Migration.

Date	Lake Escapement			Dodate & Harvest	Morts	Daily Total	Cummm. Total
	Males	Females	Combined				
20-May	0	0	0	0	0	0	0
21-May	0	0	0	0	0	0	0
22-May	0	0	0	0	0	0	0
23-May	0	0	0	0	0	0	0
24-May	0	0	0	0	0	0	0
25-May	0	0	0	0	0	0	0
26-May	0	1	1	0	0	1	1
27-May	0	0	0	0	0	0	1
28-May	0	1	1	0	0	1	2
29-May	0	0	0	0	0	0	2
30-May	0	0	0	0	0	0	2
31-May	0	0	0	0	0	0	2
01-Jun	0	2	2	0	0	2	4
02-Jun	77	40	117	0	0	117	121
03-Jun	118	26	144	0	0	144	265
04-Jun	154	30	184	0	0	184	449
05-Jun	217	39	256	0	0	256	705
06-Jun	166	77	243	0	0	243	948
07-Jun	298	61	359	0	0	359	1,307
08-Jun	198	36	234	0	0	234	1,541
09-Jun	303	117	420	0	3	423	1,964
10-Jun	319	170	489	0	0	489	2,453
11-Jun	295	215	510	0	0	510	2,963
12-Jun	241	92	333	0	0	333	3,296
13-Jun	203	124	327	0	0	327	3,623
14-Jun	431	267	698	0	2	700	4,323
15-Jun	273	180	453	0	0	453	4,776
16-Jun	280	431	711	0	0	711	5,487
17-Jun	373	391	764	0	3	767	6,254
18-Jun	384	438	822	0	0	822	7,076
19-Jun	420	400	820	0	0	820	7,896
20-Jun	90	423	513	0	0	513	8,409
21-Jun	15	172	187	169	0	356	8,765
22-Jun	41	170	211	0	2	213	8,978
23-Jun	57	623	680	220	0	900	9,878
24-Jun	51	600	651	0	0	651	10,529
25-Jun	2	91	93	1,353	0	1,446	11,975
26-Jun	109	124	233	2,716	5	2,954	14,929
27-Jun	87	132	219	2,156	0	2,375	17,304
28-Jun	0	0	0	2,957	2	2,959	20,263
29-Jun	0	0	0	1,789	0	1,789	22,052
30-Jun	0	0	0	3,113	0	3,113	25,165
01-Jul	0	0	0	3,348	3	3,351	28,516
02-Jul	0	0	0	1,290	0	1,290	29,806
03-Jul	0	0	0	563	0	563	30,369
04-Jul	51	103	154	0	0	154	30,523
05-Jul	0	0	0	1,492	0	1,492	32,015
06-Jul	102	100	202	687	0	889	32,904
07-Jul	0	0	0	1,204	0	1,204	34,108
08-Jul	0	0	0	460	0	460	34,568
09-Jul	74	86	160	0	0	160	34,728
10-Jul	0	0	0	714	0	714	35,442
11-Jul	104	128	232	780	0	1,012	36,454
12-Jul	86	98	184	0	0	184	36,638
13-Jul	0	0	0	643	0	643	37,281
14-Jul	0	0	0	1,089	0	1,089	38,370
15-Jul	267	110	377	0	0	377	38,747
16-Jul	124	72	196	672	0	868	39,615
17-Jul	0	0	0	578	0	578	40,193
18-Jul	0	0	0	385	0	385	40,578
19-Jul	0	0	0	47	0	47	40,625
20-Jul	0	0	0	592	0	592	41,217
21-Jul	0	0	0	0	0	0	41,217
22-Jul	0	0	0	391	0	391	41,608
23-Jul	0	0	0	0	0	0	41,608
24-Jul	0	0	0	153	0	153	41,761
25-Jul	0	0	0	30	0	30	41,791
26-Jul	0	0	0	101	0	101	41,892
27-Jul	0	0	0	0	0	0	41,892
28-Jul	0	0	0	20	0	20	41,912
29-Jul	0	0	0	515	0	515	42,427
30-Jul	0	0	0	7	0	7	42,434
31-Jul	0	0	0	24	0	24	42,458
01-Aug	53	13	66	351	0	417	42,875
02-Aug	49	26	75	0	0	75	42,950
03-Aug	0	0	0	0	0	0	42,950
04-Aug	21	37	58	42	0	100	43,050
05-Aug	0	0	0	0	0	0	43,050
06-Aug	0	0	0	0	0	0	43,050
07-Aug	5	14	19	0	0	19	43,069
08-Aug	0	0	0	0	0	0	43,069
Total	6,138	6,260	12,398	30,651	20	43,069	

### Appendix 5. Bear Lake 2006 - Adult Coho Salmon Migration.

Date	Lake Escapement			Broodstock			Harvest *			Total		Raceway Morts	Daily Total	Cumm Total
	Males	Females	Combined	Males	Females	Combined	Males	Females	Combined	Males	Females			
20-Aug	1	0	1	0	0	0	0	0	0	1	0	0	1	1
21-Aug	0	0	0	0	0	0	0	0	0	0	0	0	0	1
22-Aug	0	0	0	0	0	0	0	0	0	0	0	0	0	1
23-Aug	0	0	0	0	0	0	0	0	0	0	0	0	0	1
24-Aug	0	0	0	0	0	0	0	0	0	0	0	0	0	1
25-Aug	0	0	0	0	0	0	0	0	0	0	0	0	0	1
26-Aug	0	0	0	0	0	0	0	0	0	0	0	0	0	1
27-Aug	0	0	0	0	0	0	0	0	0	0	0	0	0	1
28-Aug	0	0	0	0	0	0	0	0	0	0	0	0	0	1
29-Aug	0	0	0	0	0	0	0	0	0	0	0	0	0	1
30-Aug	0	0	0	0	0	0	0	0	0	0	0	0	0	1
31-Aug	0	0	0	0	0	0	0	0	0	0	0	0	0	1
01-Sep	0	0	0	0	0	0	0	0	0	0	0	0	0	1
02-Sep	0	0	0	0	0	0	0	0	0	0	0	0	0	1
03-Sep	0	0	0	0	0	0	0	0	0	0	0	0	0	1
04-Sep	0	0	0	0	0	0	0	0	0	0	0	0	0	1
05-Sep	0	0	0	0	0	0	0	0	0	0	0	0	0	1
06-Sep	0	0	0	0	0	0	0	0	0	0	0	0	0	1
07-Sep	0	0	0	0	0	0	0	0	0	0	0	0	0	1
08-Sep	0	1	1	0	0	0	0	0	0	0	1	0	1	2
09-Sep	0	0	0	0	0	0	0	0	0	0	0	0	0	2
10-Sep	0	0	0	0	0	0	0	0	0	0	0	0	0	2
11-Sep	6	1	7	0	0	0	0	0	0	6	1	0	7	9
12-Sep	26	1	27	0	0	0	0	0	0	26	1	0	27	36
13-Sep	10	2	12	0	0	0	0	0	0	10	2	0	12	48
14-Sep	25	2	27	0	0	0	0	0	0	25	2	0	27	75
15-Sep	7	4	11	0	0	0	0	0	0	7	4	0	11	86
16-Sep	3	6	9	0	0	0	0	0	0	3	6	0	9	95
17-Sep	12	1	13	0	0	0	0	0	0	12	1	0	13	108
18-Sep	11	6	17	0	0	0	0	0	0	11	6	0	17	125
19-Sep	19	6	25	0	0	0	0	0	0	19	6	0	25	150
20-Sep	22	2	24	0	0	0	0	0	0	22	2	0	24	174
21-Sep	39	7	46	0	0	0	0	0	0	39	7	0	46	220
22-Sep	21	16	37	0	0	0	0	0	0	21	16	0	37	257
23-Sep	14	7	21	0	0	0	0	0	0	14	7	0	21	278
24-Sep	9	11	20	0	0	0	0	0	0	9	11	0	20	298
25-Sep	17	19	36	0	0	0	0	0	0	17	19	0	36	334
26-Sep	21	12	33	0	0	0	0	0	0	21	12	0	33	367
27-Sep	12	36	48	0	0	0	0	0	0	12	36	0	48	415
28-Sep	0	6	6	67	3	70	0	0	0	67	9	0	76	491
29-Sep	0	13	13	124	3	127	0	0	0	124	16	0	140	631
30-Sep	0	16	16	50	2	52	0	0	0	50	18	0	68	699
01-Oct	0	0	0	45	14	59	0	0	0	45	14	0	59	758
02-Oct	0	10	10	62	40	102	0	0	0	62	50	0	112	870
03-Oct	0	14	14	0	93	93	99	0	99	99	107	0	206	1,076
04-Oct	0	4	4	0	20	20	12	0	12	12	24	0	36	1,112
05-Oct	0	2	2	0	20	20	0	0	0	0	22	0	22	1,134
06-Oct	0	28	28	0	107	107	150	0	150	150	135	0	285	1,419
07-Oct	0	8	8	0	72	72	127	0	127	127	80	0	207	1,626
08-Oct	0	0	0	0	0	0	0	0	0	0	0	0	0	1,626
09-Oct	0	0	0	0	0	0	94	0	94	94	0	0	94	1,720
10-Oct	0	0	0	0	0	0	15	0	15	15	0	0	15	1,735
11-Oct	0	0	0	0	0	0	145	0	145	145	0	0	145	1,880
12-Oct	0	0	0	51	52	103	0	0	0	51	52	0	103	1,983
13-Oct	0	0	0	0	0	0	0	0	0	0	0	0	0	1,983
14-Oct	0	0	0	0	0	0	0	0	0	0	0	0	0	1,983
15-Oct	0	0	0	29	16	45	0	0	0	29	16	0	45	2,028
16-Oct	0	0	0	11	11	22	0	0	0	11	11	0	22	2,050
17-Oct	0	0	0	0	0	0	0	0	0	0	0	0	0	2,050
18-Oct	0	0	0	0	0	0	0	0	0	0	0	0	0	2,050
19-Oct	0	0	0	0	0	0	0	0	0	0	0	0	0	2,050
20-Oct	0	0	0	0	0	0	0	0	0	0	0	0	0	2,050
21-Oct	0	0	0	0	0	0	0	0	0	0	0	0	0	2,050
22-Oct	0	0	0	0	0	0	0	0	0	0	0	0	0	2,050
23-Oct	0	0	0	0	0	0	0	0	0	0	0	0	0	2,050
24-Oct	0	0	0	0	0	0	39	0	39	39	0	0	39	2,089
25-Oct	0	0	0	0	0	0	0	0	0	0	0	0	0	2,089
26-Oct	0	0	0	0	0	0	0	0	0	0	0	0	0	2,089
27-Oct	0	0	0	0	0	0	0	0	0	0	0	0	0	2,089
28-Oct	0	0	0	0	0	0	0	0	0	0	0	0	0	2,089
29-Oct	0	0	0	0	0	0	0	0	0	0	0	0	0	2,089
30-Oct	0	0	0	0	0	0	0	0	0	0	0	0	0	2,089
31-Oct	0	0	0	0	0	0	0	0	0	0	0	0	0	2,089
Total	275	241	516	439	453	892	681	0	681	1,395	694	0	2,089	

Appendix 6. Bear Lake 2006 – Adult Sockeye Age and Sex Characteristics

	Age						Total
	1.1	1.2	1.3	2.1	2.2	2.3	
Sample Period:	3 June through 20 July						
Males (No.)	0	3,403	17,597	0	1,750	389	23,139
Percent	0.0%	14.7%	76.1%	0.0%	7.6%	1.7%	53.7%
Sample Size	0	35	181	0	18	4	238
Total Sample Size							309
Mean Length (mm)		509	547		499	588	536
Std. Deviation		46.6	27.9		34.1	11.1	42.8
Std. Error		7.9	2.1		8.0	5.5	2.4
Mean Weight (kg)		2.08	2.52		1.94	3.06	2.38
Std. Deviation		0.49	0.46		0.42	0.07	0.55
Std. Error		0.08	0.03		0.10	0.03	0.03
Females (No.)	0	1,653	17,014	0	486	292	19,444
Percent	0.0%	8.5%	87.5%	0.0%	2.5%	1.5%	45.1%
Sample Size	0	17	175	0	5	3	200
Total Sample Size							257
Mean Length (mm)		525	536		493	504	532
Std. Deviation		33.4	25.6		31.8	26.8	29.2
Std. Error		8.1	1.9		14.2	15.5	1.8
Mean Weight (kg)		2.09	2.22		1.74	1.93	2.18
Std. Deviation		0.42	0.30		0.28	0.24	0.33
Std. Error		0.10	0.02		0.13	0.14	0.02
Both Sexes (No.)	0	5,153	35,000	0	2,236	681	43,069
Percent	0.0%	12.0%	81.3%	0.0%	5.2%	1.6%	100.0%
Sample Size	0	53	360	0	23	7	443
Total Sample Size							566
Mean Length (mm)		513	542		497	552	534
Std. Deviation		43.4	27.4		33.0	48.1	37.4
Std. Error		6.0	1.4		6.9	18.2	1.6
Mean Weight (kg)		2.07	2.37		1.89	2.57	2.29
Std. Deviation		0.47	0.41		0.40	0.62	0.47
Std. Error		0.07	0.02		0.08	0.23	0.02

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

Appendix 7. Bear Lake 2006 – Adult Coho Age and Sex Characteristics

	Age			Total
	1.1	2.1	3.1	
Sample Period:	14 Sep through 17 Oct			
Males (No.)	502	436	53	992
Percent	50.7%	44.0%	5.3%	47.5%
Sample Size	38	33	4	75
Total Sample Size				93
Mean Length (mm)	505	554	633	536
Std. Deviation	61.0	53.1	40.8	62.6
Std. Error	9.9	9.2	20.4	6.5
Mean Weight (kg)	2.09	2.72	3.99	2.48
Std. Deviation	0.79	0.80	0.88	0.90
Std. Error	0.13	0.14	0.44	0.09
Females (No.)	42	39	2	83
Percent	50.6%	47.0%	2.4%	4.0%
Sample Size	42	39	2	83
Total Sample Size				89
Mean Length (mm)	562	587	645	575
Std. Deviation	42.7	38.5	7.1	43.5
Std. Error	6.6	6.2	5.0	4.6
Mean Weight (kg)	2.86	3.22	4.40	3.06
Std. Deviation	0.70	0.72	0.28	0.76
Std. Error	0.11	0.12	0.20	0.08
Both Sexes (No.)	1,058	952	79	2,089
Percent	50.6%	45.6%	3.8%	100.0%
Sample Size	80	72	6	158
Total Sample Size				182
Mean Length (mm)	535	572	637	555
Std. Deviation	59.3	48.4	32.4	57.5
Std. Error	6.6	5.7	13.2	4.3
Mean Weight (kg)	2.49	2.99	4.12	2.77
Std. Deviation	0.84	0.79	0.72	0.88
Std. Error	0.09	0.09	0.30	0.07

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



## Appendix 8. Bear Lake 2006 – Project Updates

### Sockeye Salmon Project

#### Stocking & Misc. Activities

Crew on-site:	1-May		
Ice-out:	NA		
Crew off-site:	29-Oct		
Fry stocking:	21-Jun	2,414,000	0.52 g
PreSmolt stocking:			
Smolt stocking:	9-Jun	979,000	10.0 g
Fertilizer application:	1-Jul to 21-Aug	1200	gallon

#### Smolt Migration

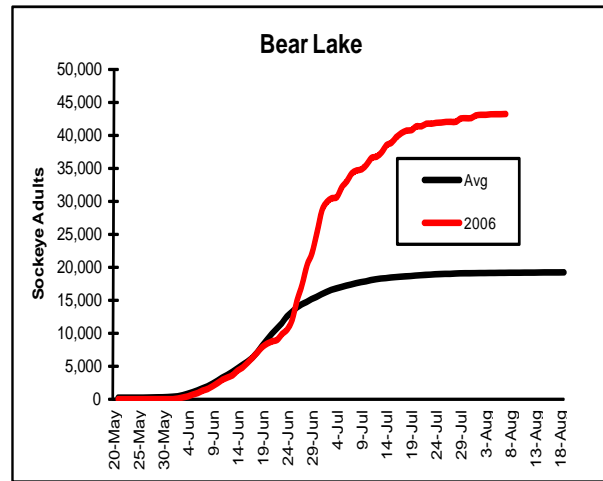
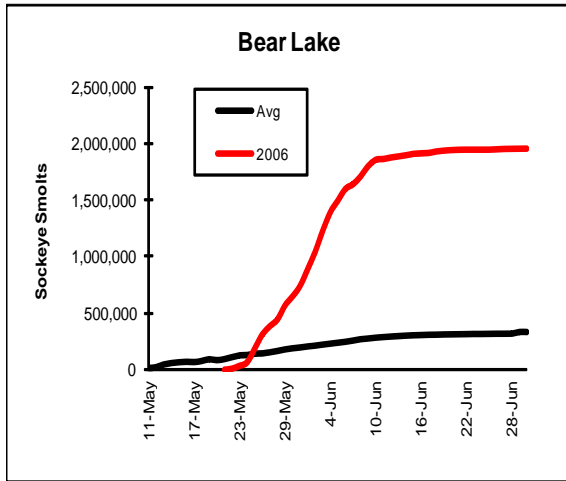
Dates:	21-May to 30-Jun	
Sockeyes:		1,962,415
Percent age 1:		86.3%
Percent age 2:		9.3%
Percent age 3:		0.0%
Percent hatchery:		94.3%
Dolly Varden:		95

#### Egg Take

Dates:	26-Jul to 18-Aug	
No. of broodstock used:		4,060
Green eggs:		6,087,000
Fecundity:		3,115
Eyed eggs:		5,444,000
% Survival		89.4%

#### Adult Migration

Dates:	26-May to 7-Aug	
Total return:		79,577
Commercial & Sport Fish harvest:		32,500 41%
Creek return:		43,069 54%
C.R. harvest:		34,655 44%
Mortalities:		0 0%
Lake:		12,398 16%
Hatchery broodstock:		4,060 5%
Lake broodstock:		8,338 10%



Appendix 8 (continued). Bear Lake 2006 – Project Updates

**Coho Salmon Project**

**Stocking & Misc. Activities**

Crew on-site:	1-May		
Ice-out:	NA		
Crew off-site:	29-Oct		
Fry stocking:	20-Jun	447,000	0.84 g
Smolt stocking Bear Cr.	30-May	115,000	10.8 g
Smolt stocking Lowell Cr	16-Jun	146,000	10.5 g
Fertilizer application:	1-Jul to 21-Aug	1200	gallon

**Egg Take**

Dates:	5-Oct to 17-Oct	
No. of females used:		359
Green eggs:		1,084,000
Fecundity:		3,019
Eyed eggs:		990,000
% Survival		91.3%

**Smolt Migration**

Dates:	21-May to 30-Jun	
Cohos:		49,980
Percent age 1:		72.5%
Percent age 2:		23.8%
Percent age 3:		0.0%
Percent hatchery:		88.3%
Dolly Varden:		95

**Adult Migration**

Dates:	20-Aug to 24-Oct		
Coho total creek return:		2,089	
Weir return:		2,089	100%
C.R. harvest:		681	33%
Lake:		516	25%
Hatchery broodstock:		892	43%
Est. Remaining in Bear Ck:		0	0%
Est. Remaining in Salmon Ck:		0	0%

