Hidden Lake
Sockeye Salmon Enhancement
Progress Report
2003

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This year's operation of the Hidden Lake Sockeye Salmon Enhancement Project was made possible through enhancement taxes paid by the commercial fishermen in Area H, Cook Inlet and associated waters and through a grant from the U.S. Fish and Wildlife Service.

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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 Hidden Lake sockeye 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

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ABSTRACT

Hidden Lake, located on the Kenai Peninsula 69 Kilometers east of Soldotna, Alaska, has been managed by the Alaska Department of Fish and Game (ADF&G) for sockeye salmon (*Oncorhynchus nerka*) enhancement since 1976. Initial salmon enhancement activities were conducted by ADF&G. The Cook Inlet Aquaculture Association (CIAA) began assisting ADF&G in the enhancement project in 1988; and, since 1991, has completed all the field activities.

On 8 May 2003, an estimated 628,900 unfed sockeye fry were released into Hidden Lake. All 628,900 fry were released at the west end of the lake and all the released fish were otolith marked.

During 2003, smolt migration monitoring began on 26 May and continued daily until 1 July. During this time a total of 310,861 sockeye (*O. nerka*) and 42,114 coho (*O. kisutch*) smolts migrated from the lake.

Based on otolith marks, 79.4% (±3.1%) of the migrating sockeye smolts were enhanced. An estimated 93.5% (±2.2%) were age 1 and 6.5% (±2.2%) were age 2. The average length and weight of the age 1 sockeye smolts was 140 mm (±0.5 mm) and 24.7 g (±0.2 g). The age 2 sockeye smolts were 179 mm (±8.3 mm) and 60.0 g (±6.5 g).

Of the migrating coho smolts, an estimated 55.2% (±1.7%) were age 1, 38.7% (±1.7%) were age 2 and 6.1% (±0.8%) were age 3. The average length and weight of the age 1 coho smolts was 125 mm (±0.7 mm) and 17.9 g (±0.2 g). The age 2 coho smolts were 139 mm (±0.8 mm) and 24.3 g (±0.3 g) and the age 3 coho smolts were 153 mm (±3.0 mm) and 33.6 g (±1.9 g).

Adult sockeye salmon escapement was monitored from 12 July to 22 August 2003. During this time a total of 12,083 adult sockeye salmon returned to Hidden Creek. The percentage of adult male and adult female fish was 49.0% and 51.0%, respectively. Male fish averaged 546 mm (24.2in) in length and the females averaged 516 mm (22.9 in). An estimated 69.8% of the fish were age 1.2, 23.9% were age 1.3, 7.1% were 2.2, and 5.6% were 2.3. Angling lures were observed on 32 adult fish as they passed the counting weir.

In addition to enumerating the adult migration, adults returning to Hidden Lake were sampled for otolith marks. An estimated 57.9% (±5.2%) of the fish returning to Hidden Lake were marked. Otolith samples were also collected from sockeye salmon returning to a small creek at the East end of Skilak Lake. None of the fish returning to the creek were marked and no fish were observed at the Trail Lakes Hatchery discharge.

Between 18 September and 2 October 2003, 0.893 million eggs were collected and shipped to Trail Lakes Hatchery for fertilization and incubation. An estimated 0.824 million eggs (92.2%) have survived to the eyed stage.
Sampling for water chemistry and zooplankton analyses was completed 5 times during 2003. In

general, Hidden Lake's water chemistry in 2003 was comparable to the water chemistry of years previous. However, zooplankton biomass was lower than it was during the previous four years.

INTRODUCTION AND PURPOSE

In 1972 and 1973, the Commercial Fisheries Division of the Alaska Department of Fish and Game (ADF&G) conducted biological, chemical, and physical inventories of numerous lakes throughout the Cook Inlet basin (Bill, et al. 1972; Barton and Barrett, 1973). Based on these investigations it appeared that Hidden Lake had the potential for increased production of sockeye salmon (*Oncorhynchus nerka*).

In 1976, activities to enhance the production of sockeye salmon in Hidden Lake were initiated by the Fisheries Rehabilitation, Enhancement and Development Division (FRED) of ADF&G. Initial enhancement activities involved the collection of basic fisheries and limnological data and the gathering of a small number of sockeye salmon eggs to evaluate incubation and fry rearing procedures (Kyle, et al. 1990).

Between 1976 and 1989, ADF&G collected more information on Hidden Lake. Based on this information, ADF&G was able to conclude that at an adult escapement of 10,000 sockeye, wild smolt production leveled off because the natural spawning area was limited and/or egg to fry survival was poor (Kyle, et al. 1990). ADF&G also concluded the lake's zooplankton community was being underutilized by sockeye salmon fry rearing in the lake. Thus, more sockeye fry could rear in the lake than that produced by natural spawning

Since 1976 Hidden Lake has been enhanced by annually collecting eggs from adult sockeye returning to the lake and releasing the resulting fry back to the lake. Enhancement by collecting eggs and releasing fry back to Hidden Lake bypasses some of the critical life stages that occur in the lake and takes advantage of the lake's underutilized zooplankton community.

As the Hidden Lake enhancement project was being developed, it was feared salmon enhancement itself could be detrimental to the fry-rearing environment. The escapement of large numbers of enhanced fish may, by increasing the available nutrients, alter the level of primary productivity and shift the zooplankton community to species not utilized by rearing sockeye fry.

Based on the potential of Hidden Lake to rear sockeye fry and the limitations imposed by large adult escapements, the project objective became the maximum production of adult fish while maintaining the fry-rearing environment. An average adult sockeye escapement of 30,000 fish was considered an appropriate management objective and could be accomplished by the following goals:

1. Annually collecting up to 2.3 million eggs and releasing up to 2 million sockeye fry to the lake;
2. Monitoring lake water quality through the collection and analysis of representative samples;
3. Enumerating smolt migration from the lake, and;
4. Enumerating adult escapement to the lake.

In 1988, the Cook Inlet Aquaculture Association (CIAA) became involved in the Hidden Lake Enhancement Project by conducting the gamete collection, incubation, and fry release activities. Since 1989, CIAA, with assistance from ADF&G, also conducted the smolt migration and adult escapement monitoring; beginning in 1991, CIAA assumed responsibility for conducting the limnological sampling. For data consistency, ADF&G has completed and will continue to complete the water chemistry, plankton and adult scale analyses.

In March 1999, ADF&G conducted a technical review of the Hidden Lake Sockeye Salmon Enhancement Project (Simpson and Edmundson, 1999). Concerns arouse regarding the amount of sockeye salmon entering Hidden Lake. In 2000, CIAA took steps to alleviate concern by utilizing four year floating averages of survival rates (egg to fry, fry to smolt, and smolt to adult) and ADF&G estimated harvests to calculate a stocking rate that would best allow for an annual target escapement of 30,000 sockeye salmon into Hidden Lake.

PROJECT AREA

Hidden Lake is located on the Kenai Peninsula 69 kilometers east of Soldotna, Alaska and lies entirely within the Kenai National Wildlife Refuge. The lake is accessible by the Sterling Highway and the Skilak Lake Loop Road (Figure 1).

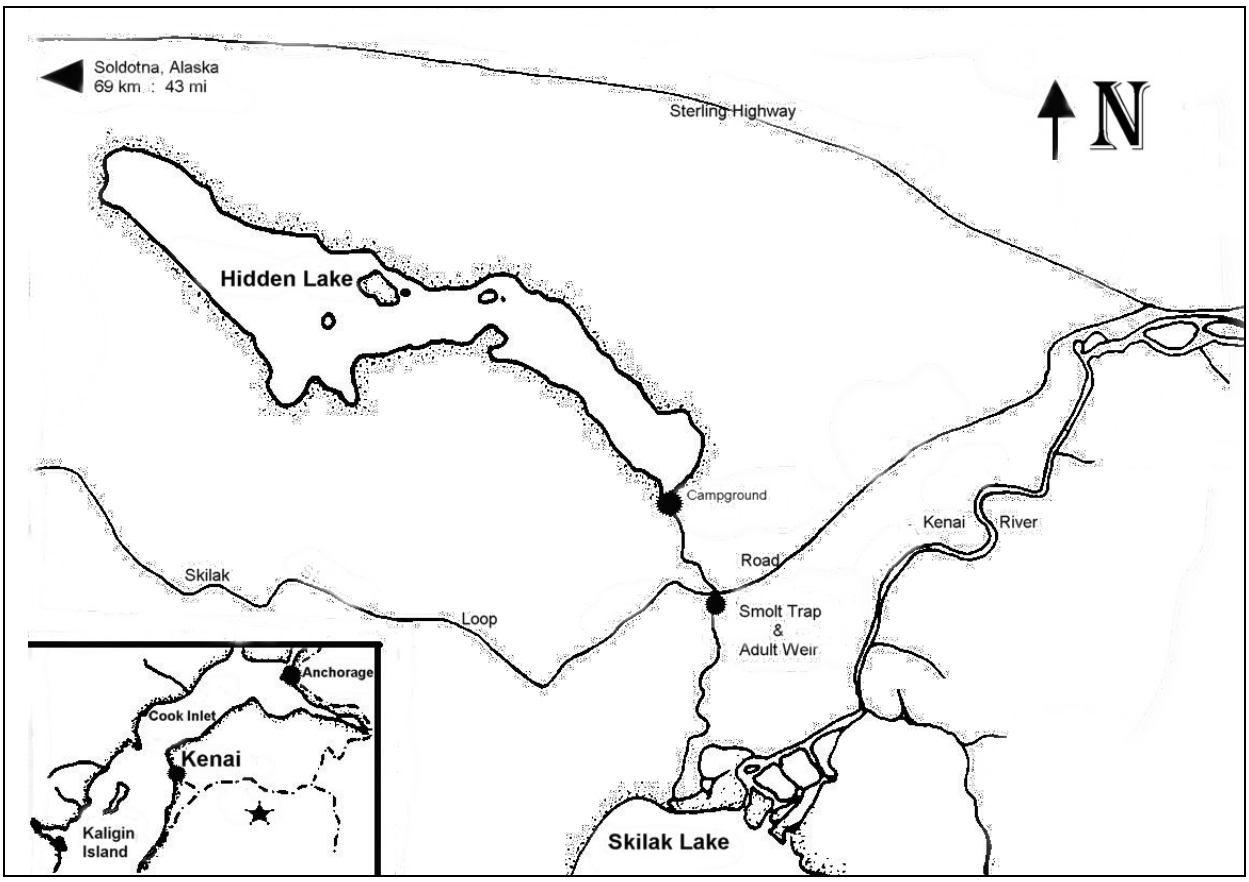

Figure 1. Area Map of Hidden Lake, Kenai Peninsula, Southcentral Alaska.

Hidden Lake (Figure 2) is steep sided with two major basins. It has a surface area of 6.8 km^2, a mean depth of 20.1 m, a maximum depth of 45.1 m, and a volume of 138.1 X 10^6 m^3. The mean depth of the euphotic zone is 20 m. There is one outlet, Hidden Creek, which flows 5 km to Skilak Lake, the Kenai River and Cook Inlet.

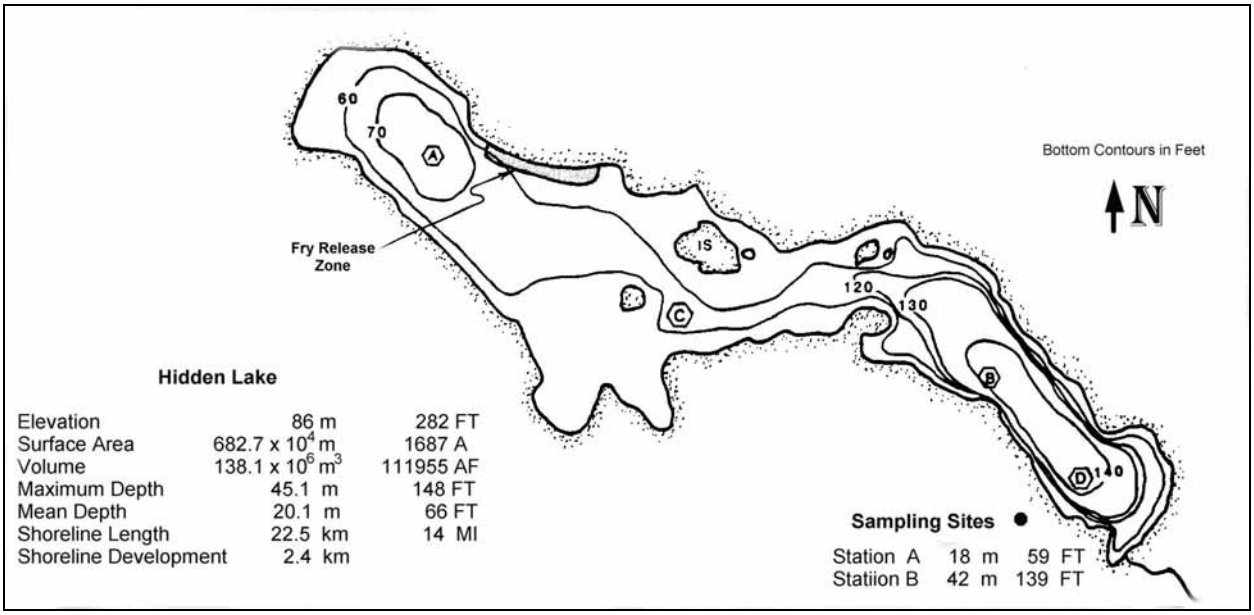

Figure 2. Morphometric map of Hidden lake showing the two major basins.

The lake's watershed area is 37.4 km^2 and has an average annual precipitation of 44 cm. The estimated water residence time is 11.7 years. During the open water season the total phosphorus concentration averages 7 μg/l, the total nitrogen concentration is 178 μg/l and the chlorophyll *a* concentration is 0.6 μg/l. Based on these concentrations, Hidden Lake is considered an oligotrophic-mesotrophic system (Kyle, et al. 1990).

Two cladocerans, (*Bosmina longirostris* and *Daphnia longiremus*), three copepoda (*Diaptomus pribolofensis, Epischura nevadensis*, and *Cyclops columbians*), and numerous species of rotifers make up the zooplankton community of Hidden Lake. Fish present in the lake include five species of Pacific salmon (*O. nerka, O. kisutch, O. tshawytscha, O. gorbuscha,* and *O. mykiss*), lake trout (*Salvelinus namaycush*), Dolly Varden char (*S. malma*), threespine stickleback (*Gaserosteus aculeatus*), and coastrange sculpin (*Cottus aleuticus*) (Kyle, et al. 1990).

METHODS

In general, Hidden 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

During 2003, assessments of water quality were conducted five times during the open water season from May through October. Two primary sites (Figure 2) were 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 one meter below the surface and from the midhypolimnion. In addition to the two primary sites, two secondary sites were also sampled (Figure 2). Measurements at the secondary sites were limited to the zooplankton community and Secchi disk transparency.

Water samples were collected by CIAA and water analysis completed by ADF&G. Sample collection and analysis procedures are described by Koenings, et al. (1986).

In addition to the limnological samples collected from Hidden Lake, percent cloud cover was estimated, precipitation measured to the nearest millimeter and Hidden Creek water and air temperatures were recorded at 4:00 PM each day.

Smolt Enumeration

To enumerate the smolt migration, a smolt trap was temporarily placed in Hidden Creek approximately 100 meters downstream of Skilak Lake Loop road. The smolt trap consisted of a

modified fyke net with nylon mesh leads and a double compartment live-box. The leads and fyke net funneled migrating smolts into the live-box. A swing gate remotely controlled by the trap operators directed smolts into one of two live-box compartments where they were counted and released downstream, momentarily held for a sub-sample count, or passed through the trap system uncounted.

Total counts of smolts migrating from Hidden Lake were made until the migration of fish exceeded 1,000 to 2,000 fish per hour. At migrations rates greater than 2,000 fish per hour, fish densities in the trap become too great and the fish become stressed. To avoid stressing the fish during periods of peak migration, a 10% sub-sampling procedure was used to enumerate the fish.

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 counted. During the remaining 18 minutes, migrating smolts passed through the trap uncounted. To estimate the number of smolts migrating during the 20-minute interval, the two-minute smolt count was multiplied by 10.

Assuming the two-minute sub-sampling intervals were randomly distributed throughout sub-sampling[1] and smolts 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,

[1] Predetermined randomly selected 2-minute sub-sampling intervals assured random distribution within each 20-minute period.

Then, the total smolt migration ($\hat{T}$) is:

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

with a variance of:

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

and 95% confidence limits of:

$$\hat{T}_s \pm 2\sqrt{v\left(\hat{T}_s\right)}.$$

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.

In 2003, migrating smolts were enumerated from 26 May through 1 July. The 10% sub-sampling procedure was used to enumerate 28% of the sockeye smolt and 15% of the coho smolt migrating in 2003.

A detailed description of smolt enumeration procedures is available in CIAA's Hidden Lake Enhancement Project procedure manual (CIAA, 2002).

Smolt Characteristics and Enhanced Contribution

CIAA has released sockeye salmon fry to Hidden Lake since 1989. To evaluate this enhancement procedure, CIAA collects a sample of the sockeye and coho smolts migrating each year to determine age, weight, and length characteristics of the migrating populations.

Since 1991, CIAA has marked the otolith of all salmon fry released to Hidden Lake with a thermal mark[2]. The purpose of this mark is to determine the contribution of released fish to the smolt population. In 2003, the otoliths of sockeye smolts collected for age, weight and length

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

measurements were removed and checked for a thermal mark. Otoliths were not collected from migrating coho smolts.

In 2003, smolts collected for measurement and otolith removal were sampled in proportion to the daily smolt migration. This was accomplished by collecting approximately every 460th sockeye smolt and every approximately 50th coho smolt that was counted and 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 made on and otoliths removed from 667 sockeye smolts. Age, weight and length measurements were made on 826 coho smolts.

Each smolt collected for evaluation was first measured to the nearest millimeter for fork length[3] and then weighed to the nearest 0.1 gram. Several scales were also removed from the primary growth area[4] and mounted on a glass slide for subsequent age determination. The otoliths were then removed and placed in a labeled one-dram vial. A dilute ethanol solution was added to the vial to cover the otoliths.

After the smolt migration was complete, the otoliths were shipped to Trail Lakes Hatchery. Staff at Trail Lakes Hatchery processed the otoliths and checked each for a hatchery mark following procedures described by Glick and Shields (1993). Of the 667 sockeye otoliths collected, 630 were readable.

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,

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

[3] Standard fork length was measured from the tip of the snout to the fork of the tail.

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, $\hat{P}$, is:

$$\hat{P} = a / n;$$

with a variance of:

$$v\left(\hat{P}\right) = \left(1 - f\right)(1/n)\sum W_h p_h q_h;$$

which, under proportional allocation, is like the usual simple random sample estimate. And, the total number of enhanced smolts, $\hat{A}$, is:

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

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 are large and $\hat{P}$ is not extreme, the normal approximation without a correction for continuity, can be used to develop the relative error. Thus, the 95% confidence interval estimates for $\hat{P}$ and $\hat{A}$ are:

[4] The primary growth area is located above the lateral line on a diagonal from the posterior insertion of the dorsal fin

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

with relative errors of:

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

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

$$\hat{L}_i = c_i/n;$$

with a variance of:

$$v(\hat{L}_i) = (1-f)\frac{1}{n}\sum_h W_h l_{hi} m_{hi};$$

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

$$\hat{C}_i = N(\hat{L}_i);$$

with a variance of:

$$v(\hat{C}_i) = N^2 v(\hat{L}_i).$$

Confidence intervals (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:

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

and 95% confidence interval estimates of:

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

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to the anterior insertion of the anal fin.

Adult Escapement

Each year CIAA enumerates the escapement of adult fish to Hidden Lake. The escapement enumeration includes an assessment of the sex, age, and standard fork length[5] of the returning population of fish. In 2003, a sample of the returning fish was also collected to determine the proportion of enhanced fish in the adult population.

To enumerate returning salmon, sample and collect sex, age, and length information, a "V" shaped adult counting weir was temporarily installed in Hidden Creek. The weir was constructed of 1.9 cm galvanized pipe and 7.6 cm aluminum channel. The galvanized pipe was picketed through 1.9 cm holes in the aluminum channel spaced 2.54 cm apart.

By removing one or two pickets fish were permitted to pass through the weir. Field personnel counted the adult fish as they ascended Hidden Creek. Initially counts were made at least twice a day. As the number of fish ascending Hidden Creek increased, counts were made more frequently to prevent fish from accumulating behind the weir.

In 2003, adult escapement was monitored from 12 July to 23 August. After 23 August, the adult migration appeared complete and the counting weir was removed.

In 2003, it was assumed 35,850 adult fish would return to Hidden Creek during a six week period from 12 July to 23 August. Based on this assumption, it was calculated that 120 fish needed to be collected every 6th day to secure a sample size adequate to assess the enhanced proportion, of the returning fish. To obtain an adequate sample size for determining age, sex, and size, a daily sample was taken on approximately every 35th fish counted upstream. However, the adult return was less than projected and fewer fish were collected for measurement than expected.

[5]Standard fork length was defined as the measurement from mideye to the fork of the tail.

In 2003, 349 fish were collected on 29 July, 5 and 10, August. For each fish collected the otoliths were extracted. All the fish were removed from Hidden Creek and sold or donated to a local charity after the otoliths were extracted. 160 adult sockeye salmon were also sampled for age, length and weight.

A detailed description of adult escapement enumeration procedures is available in the Hidden Lake Enhancement Project procedure manual (CIAA, 2002).

Gamete Collection, Incubation and Rearing

Since 1976, the collection of sockeye gametes and the release of hatchery incubated fry have been used to enhance the sockeye population in Hidden Lake. To date, a total of 59,558,000 eggs have been collected for incubation at Crooked Creek, Big Lake and Trail Lakes Hatcheries. The annual gamete collections conducted since 1976 are summarized in Table 1.

In 2003, male and female adult sockeye salmon in spawning areas were collected by beach seine and artificially spawned. Gametes were collected, transported and fertilized using a delayed fertilization technique. Gamete collection procedures are described in CIAA's "Egg-Take Procedures" manual (CIAA, 1993b).

Between 18 September and 2 October 2003, 0.893 million eggs were collected from 371 female salmon and shipped to Trail Lakes Hatchery for fertilization. Mixing the eggs from each female with a portion of the milt from eight to ten males and then activating the sperm with a 0.7% saline solution completed fertilization. An estimated 0.824 million eggs (92.2%) have survived to the eyed stage.

The sockeye eggs collected in 2003 are currently being incubated at Trail Lakes Hatchery. Incubation will follow standard hatchery procedures (Wilson and Hetrick, 1992) and water temperature will be regulated to thermally mark the otoliths of fish scheduled for release in 2004.

Table 1. Summary of sockeye salmon gamete collection and fry releases at Hidden Lake, 1976 - 2003.

Brood Year	No. eggs taken	No. females used	Fecundity	Receiving hatchery	No. fry released	Egg-to-fry survival (%)	No. smolt produced	Fry-to-smolt survival (%)
1976	832,880	274	3,091	Crooked Cr.	330,228	39.6	58,800	17.8
1977	406,878	200		Big L.	308,704	75.9	40,600	13.2
1978	311,808	100	3,118	Crooked Cr.	8,258	2.7		
1979								
1980								
1981								
1982	1,579,188	576	2,741	Trail L.	1,086,000	68.8	231,300	21.3
1983	1,928,000	639	3,017	Trail L.	1,236,900	64.2	289,100	23.4
1984	3,766,000	1,310	2,875	Trail L.	1,805,792	47.9		
1985	7,019,000	2,330	3,012	Trail L.	0			
1986	4,740,000	1,580	3,000	Trail L.	3,718,311	78.5		
1987	7,000,184	2,434	2,876	Trail L.	6,085,307	86.9		
1988	2,718,853	891	3,046	Trail L.	2,470,012	91.0	194,400	7.9
1989	2,220,467	647	2,669	Trail L.	1,747,900	79.0	203,800	11.7
1990	2,189,000	956	2,290	Trail L.	1,600,000	64.6	214,100	13.4
1991	2,652,000	1,119	2,370	Trail L.	1,716,000	64.7	330,200	19.2
1992	2,293,000	1,007	2,277	Trail L.	1,901,000	82.9	365,300	19.2
1993	2,200,000	934	2,355	Trail L.	1,800,000	81.8	195,000	10.8
1994	2,156,000	1,017	2,120	Trail L.	1,700,000	78.8	326,600	19.2
1995	1,893,000	849	2,230	Trail L.	1,600,000	84.5	184,700	11.5
1996	2,048,000	817	2,507	Trail L.	1,501,000	73.3	305,300	20.3
1997	2,166,000	936	2,314	Trail L.	1,035,000	47.8	182,900	17.7
1998	2,303,000	859	2,681	Trail L.	1,507,100	65.4	352,300	23.4
1999	2,297,000	954	2,408	Trail L.	1,242,000	54.1	284,200	22.9
2000	1,486,000	607	2,448	Trail L.	905,500	60.9	218,000	24.1
2001	1,326,000	504	2,631	Trail L.	980,200	73.9	230,600	23.5
2002	1,118,000	433	2,582	Trail L.	628,900	56.3		
2003	893,000	371	2,407	Trail L.				
Total	59,543,000	22,344			36,914,000		4,207,000	
Mean			2,458			70.6		17.5

The 1977 sockeye salmon were taken from anadromous and residual fish.
BY 1978 eggs suffered high mortality due to complications with the hatchery source water.
The 1985 hatchery broodstock (fry) became infected with IHN virus and were destroyed.
Egg collection data prior to 1989 is from on Kyle, et al. 1990.
Mean caculation is based on broodyear 1988 to present.
The number of smolt produced was derived from the recovery of marked fish.

incomplete broodyear

Fish Transport and Stocking

Approximately 628,900 of the 921,900 sockeye salmon fry produced from gametes collected from Hidden Lake in 2002 were released to Hidden Lake on 8 May 2003. The unfed fry were transported by truck in oxygenated tanks from Trail Lakes Hatchery to Hidden Lake, transferred to oxygenated fish transport tanks on board a small skiff, motored to the west end of the lake and released near historic spawning areas (Figure 2). All the fry appeared healthy at the time of release. None of the released fry were externally marked or tagged; however, the otoliths of all

the released fry were marked with thermal bands [Hatch Code: 4, 2H; Rbr 1:1.4, 2.2]. Otoliths samples were processed to document the marks and are on file at Trail Lakes Hatchery.

The remaining 293,000 fry were destroyed.

Since 1977, over 36.9 million fry have been released to Hidden Lake (Table 1).

RESULTS AND DISCUSSION

Limnology and Environmental Conditions

Hidden Lake limnological characteristics have been monitored for several years. Water chemistry and zooplankton data from 2003 are presented in Appendix 1. Historic limnological data presented as open-water season means are presented in Table 2. In general, Hidden Lake's water chemistry in 2003 was comparable to the water chemistry of previous years, zooplankton biomass, however, was lower than previous years.

Environmental conditions during the Hidden Lake smolt migration were monitored from 27 May to 29 June 2003. Stream stage measurements averaged 0.62 feet and ranged from 0.30 to 1.60 feet (a beaver damn upstream from the trap was removed by and caused an abnormal increased flow of water). During the period of smolt migration, stream temperatures averaged 12.6°C and ranged from 10 to 17°C. Air temperatures averaged 14.7°C and ranged from 11 to 22°C. Sixty-five percent of the days were partly cloudy, 35% were completely overcast, while there were no clear days recorded. Rain was recorded on 5 of the days during the smolt migration. A total of 160 mm of rain fell during this period (Appendix 2).

Environmental conditions during the Hidden Lake adult sockeye migration were monitored from 12 July to 22 August 2003. Stream stage measurements averaged 0.81 feet and ranged from 0.24 to 1.28 feet. Stream temperatures averaged 16.0°C and ranged from 10.0 to 20.0°C and air temperatures averaged 14.7°C and ranged from 11.0 to 22.0°C. Ten percent of the days were clear, 38% were partly cloudy, and 52% were completely overcast. Rain was recorded on 8 of the days during the adult migration. A total of 21 mm of rain fell during this period (Appendix 2).

Table 2. Average open water season water quality characteristics of Hidden Lake, 1980 - 2003.

AVERAGE WATER QUALITY - 1 METER

Year	Sp. Cond (umhos/cm)	pH (SU)	Alk (mg/l)	Turb. (NTU)	TP (ug/l)	TKN (ug/l)	Chl a (ug/l)	EZD (m)	Secchi (m)	Zooplankton (mg/m2)
1980	145	7.8	66		6.8	120	2.1			
1981	117	7.0	73		6.6	171	0.6			2,381
1982	137	8.1	70		8.6	174	0.4			1,619
1983	144	8.1	72		6.9	176	0.5			3,285
1984	146	7.9	71		6.7	172	0.7			2,248
1985	147	7.9	78	0.7	7.2	177	0.9			1,967
1986	144	7.8	72	0.4	7.5	185	0.3			2,420
1987	147	8.0	70	0.2	6.9	188	0.5			1,390
1988	146	7.8	67	0.6	6.8	197	0.6			2,466
1989	146	8.0	67	0.4	7.8	198	0.4			3,437
1990	147	8.0	73	0.4	7.8	193	0.8			2,258
1991	152	8.0	72	0.7	6.7	171	0.8	20.2	7.3	2,222
1992	145	8.0	66	0.7	7.4	231	1.3	15.2	5.0	1,030
1993	150	7.8	68	0.5	7.0	198	1.5	14.0	6.4	2,030
1994	156	7.8	70	0.5	7.4	210	1.6	19.6	6.7	847
1995	153	7.8	71	0.7	5.7	197	1.8	20.0	7.6	1,520
1996	152	7.8	71	0.7	5.6	188	0.9	19.6	8.4	1,338
1997	153	7.8	73	0.4	6.6	186	0.7	20.2	9.7	2,111
1998	150	8.0	72	0.8	6.4	205	0.8	21.0	7.2	2,358
1999	149	7.6	72	0.7	7.3	234	0.8	18.7	6.7	2,474
2000	150	7.8	69	0.8	7.2	234	1.6	20.4	8.7	3,896
2001	150	7.6	68	0.7	7.8	231	1.1	19.4	7.1	3,398
2002	147	7.7	73	0.4	8.6	257	1.1	17.9	5.9	2,447
2003	148	7.3	70	0.4	8.4	229	2.8	17.1	7.0	959

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

AVERAGE WATER QUALITY - HYPOLIMNION

Year	Sp. Cond (umhos/cm)	pH (SU)	Alk (mg/l)	Turb. (NTU)	TP (ug/l)	TKN (ug/l)	Chl a (ug/l)
1980	146	7.8	69		6.1	140	1.8
1981	116	7.0	74		6.5	175	0.5
1982	136	8.0	71		7.2	172	0.5
1983	148	7.8	73		9.2	193	0.8
1984	149	7.7	72	0.6	6.3	168	0.6
1985	147	7.7	79	0.7	8.2	179	0.7
1986	146	7.7	71	0.3	7.6	180	0.3
1987	150	7.8	70	0.3	8.3	191	0.5
1988	150	7.6	67	0.4	7.0	195	0.6
1989	149	7.9	67	0.4	8.0	196	0.4
1990	148	7.8	73	0.4	8.5	187	0.7
1991	154	7.8	73	0.7	8.2	189	0.6
1992	147	7.7	69	0.6	9.5	218	1.1
1993	156	7.6	71	0.4	8.0	203	1.3
1994	157	7.6	70	0.6	7.3	188	0.9
1995	159	7.6	72	0.7	6.5	189	1.6
1996	159	7.7	73	0.7	6.3	190	2.6
1997	153	7.8	73	0.5	9.0	201	1.2
1998	153	7.8	72	0.1	6.6	194	0.6
1999	153	7.5	72	0.7	7.4	221	0.5
2000	151	7.7	70	0.7	7.9	245	1.5
2001	152	7.5	69	0.7	7.5	222	0.9
2002	150	7.6	73	0.5	9.1	239	0.7
2003	149	7.3	68	0.5	8.9	224	1.5

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

Smolt Enumeration

In general, the pattern of the 2003 Hidden Lake sockeye smolt migration was similar to previous smolt migrations. The peak of the 2003 smolt migration occurred about 12 & 13 June.

One thousand six hundred eighty-one moribund or dead sockeye smolts were observed during the 2003 smolt migration. A majority of the mortality occurred during the peak day of the migration when conditions within the smolt trap became congested.

Considering the 1,681 sockeye smolts lost during enumeration, the final 2003 Hidden Creek sockeye smolt migration was 309,800). Other fish counted included 42,100 (±19,700) coho smolts, 156 Dolly Varden and 22 rainbow trout (Appendix 3).

Smolt Characteristics and Enhanced Contribution

In 2003, characteristics of the smolt migration were evaluated from scale samples collected throughout the migration and from measurements of length and weight. Based on these samples and measurements, an estimated 93.5% (±2.2%) of the sockeye smolts were age 1 and 6.5% (±2.2%) were age 2. The average length and weight of the age 1 sockeye smolts were 140 mm (±0.5 mm) and 24.7 g (±0.2 g). The age 2 sockeye smolts were 179 mm (±8.3 mm) and 60.5 g (±6.5g). There were no age 3 smolts (Table 3).

Of the migrating coho smolts, an estimated 55.2% (±1.7%) were age 1, 38.7% (±1.7%) were age 2 and 6.1% (±0.8%) were age 3. The average length and weight of the age 1 coho smolts was 125 mm (±0.7 mm) and 17.9 g (±0.2 g), the age 2 coho smolts were 139 mm (±0.8 mm) and 24.3 g (±0.3 g) and the age 3 coho smolts were 153 mm (±3.0 mm) and 33.6 g (±1.9 g).

The age structure, average length, and weight measurements of the sockeye smolts were similar to previous sockeye smolt migrations. Although average length and weight measurements of the coho smolts were similar to previous years, the age structure showed age-1 smolts to be the dominate age class of the coho smolt migration

Table 3. Age structure, length and weight characteristics of Hidden Lake sockeye smolt, 1976 - 2003.

	Age Class (%)				Mean length (mm)				Mean weight (g)			
Smolt Year	Age 1	95% C.I.	Age 2.0	95% C.I.	Age 1.0	95% C.I.	Age 2.0	95% C.I.	Age 1.0	95% C.I.	Age 2.0	95% C.I.
1976	80		20		130		146		NA		NA	
1977	83		17		144		199		NA		NA	
1978	88		12		133		190		22.4		79.3	
1979	85		15		145		177		30.7		57.2	
1980	90		10		143		200		27.3		83.9	
1981	98		2		144		198		28.5		81.4	
1982	99		1		145		174		27.3		55.3	
1983	94		6		132		186		21.3		66.1	
1984	95		5		144		170		28.7		49.2	
1985	97		3		141		185		26.3		63.7	
1986	96		4		134		180		22.4		55.6	
1987	81		19		143		175		28.0		54.3	
1988	94		6		128		179		18.7		59.1	
1989	94		6		126		163		17.6		43.5	
1990	78		21		140		191		30.0		71.6	
1991	93		6		140		205		25.4		88.9	
1992	95		5		133		172		21.5		47.1	
1993	89		10		130		183		20.4		61.2	
1994	94		6		130		179		18.1		49.8	
1995	86		13		128		181		18.3		56.5	
1996	95	(±2.1)	5	(±2.1)	135	(±0.5)	190	(±4.5)	19.1	(±0.3)	59.4	(±6.5)
1997	96	(±2.7)	4	(±2.7)	123	(±0.6)	190	(±15.9)	15.9	(±0.3)	72.7	(±19.7)
1998	91	(±2.9)	9	(±2.9)	129	(±0.7)	203	(±5.8)	20.0	(±0.4)	82.3	(±6.5)
1999	86	(±3.6)	14	(±3.6)	132	(±0.6)	173	(±5.1)	23.0	(±0.3)	51.1	(±4.8)
2000	93	(±2.2)	8	(±2.2)	138	(±0.5)	182	(±7.3)	25.0	(±0.3)	64.0	(±7.8)
2001	94	(±2.6)	6	(±2.5)	134	(±0.5)	165	(±8.6)	22.3	(±0.3)	45.0	(±8.0)
2002	86	(±2.2)	13	(±2.2)	134	(±0.8)	165	(±6.0)	22.2	(±0.4)	45.0	(±4.8)
2003	94	(±2.2)	6	(±2.2)	140	(±0.5)	179	(±8.3)	24.7	(±0.2)	60.5	(±6.5)
Mean	91		9		136		181		21.6		57.3	

Prior to 1990, data summary is from Kyle et al. (1990).

Prior to 1988, estimates of the enhanced contribution of sockeye to the Hidden Lake sockeye smolt migration were based on coded wire tag studies. Estimates of the proportion of hatchery fish ranged from 3 to 78% (Kyle, et al. 1990). Since 1991, the otoliths of all hatchery-incubated fry released to Hidden Lake were thermally marked. These hatchery marks have been used to apportion migrating sockeye smolts between wild and enhanced fish since 1993. In 2003, the proportion of hatchery-incubated salmon in the sockeye smolt migration was 79.4% (±3.1%)

(Table 4). This proportion is, greater, but similar to previous estimates of the hatchery contribution based on otolith thermal marks.

Table 4. The contribution of enhanced sockeye to the Hidden Lake smolt migrations, 1976 - 2003.

Smolt Year	Total No.	95% C.I.	Wild	Hatchery	% Hatchery %	95% C.I.
1976	29,639		29,639	0	0	
1977	17,670		17,670	0	0	
1978	111,466		52,745	58,721	53	
1979	94,347		46,828	47,519	50	
1980	81,748		79,458	2,290	3	
1981	161,522		161,522	0	0	
1982	222,673		222,673	0	0	
1983	235,233		235,233	0	0	
1984	419,376		175,876	243,500	58	
1985	396,000		98,000	298,000	75	
1986	651,889		140,965	510,924	78	
1987	68,980		68,980	0	0	
1988	471,625					
1989	719,527					
1990	231,300					
1991	208,500					
1992	191,900					
1993	388,500	(±21,100)	62,200	326,300	84	(+4.8)
1994	414,700	(±40,400)	53,900	360,800	87	(+3.9)
1995	293,700	(±33,400)	79,300	214,400	73	(+6.5)
1996	428,100	(±15,700)	94,200	333,900	78	(+3.6)
1997	228,800	(±0)	65,000	163,000	71	(+5.1)
1998	385,300	(±45,000)	85,600	299,700	78	(+3.7)
1999	313,100	(±13,390)	94,300	218,800	70	(+4.2)
2000	475,600	(± 52,609)	108,500	367,100	77	(+3.2)
2001	324,900	(±0)	94,000	230,900	71	(+4.4)
2002	369,900	(±51,400)	133,200	236,700	64	(+4.4)
2003	309,180	(±17,300)	63,800	245,400	79	(+3.1)
Mean	357,400		84,900	279,400	76	

Prior to 1993, estimates of smolts originating from hatchery fry releases based on CWT studies.
Since 1993, estimates of smolts originating from hatchery fry releases based on otolith thermal marks.
The mean percent hatchery contribution excludes the 1980 smolt, years when hatchery smolt were not released, and years when no estimate of hatchery smolt was made.
Mean calculated from 1993 to 2003.
Prior to 1990, data summary is from Kyle et al. (1990).

Adult Escapement

Adult sockeye salmon return was monitored from 10 July to 23 August 2003 (Appendix 4). During this time a total of 12,803 adult sockeye salmon returned to Hidden Creek. However, 349

adult sockeye salmon were collected for age, weight, length and hatchery mark samples. Therefore, the Hidden Lake escapement consisted of 11,734 adult sockeye salmon (Table 5).

Table 5. Summary of Hidden Lake salmon escapement, age distribution and fish length. 1976 - 2003.

	Escapement			Major Age Classes					
		Hatchery		1.2		1.3		2.2	
Year	Number	(%)	(C.I.)	(%)	Lth(mm)	(%)	Lth(mm)	(%)	Lth(mm)
1976	4,860			79	540	1	530	20	550
1977	1,055			64	550	2	600	34	570
1978	4,647			88	530	10	540	2	540
1979	5,762			90	540	4	560	6	550
1980	27,488			92	530	1	560	1	530
1981	15,939			78	530	15	560	7	555
1982	9,790			70	520	23	560	4	520
1983	11,297			87	530	11	550	2	530
1984	27,784			92	520	3	570	5	550
1985	24,784			77	520	13	570	9	580
1986	17,530			85	530	9	570	6	540
1987	43,487			96	530	3	540	0	540
1988	50,907			94	540	4	570	2	570
1989	7,770			44	550	41	580	15	540
1990	77,959			86	507	2	565	12	516
1991	112,792			90	512	7	557	3	521
1992	32,912			82	505	13	551	5	513
1993	11,582			80	529	9	568	11	536
1994	6,086			60	493	31	557	6	507
1995	7,542			63	514	12	559	21	525
1996	55,526			83	539	7	587	9	540
1997	56,053			77	514	18	566	3	536
1998	67,727			83	510	14	556	3	516
1999	49,406	69.4	(±3.7)	89	455	6	549	5	502
2000	45,685	62.0	(±3.6)	82	519	9	560	8	530
2001	42,462	57.9	(±4.0)	63	525	20	564	12	544
2002	71,983	62.0	(±3.1)	73	537	18	582	7	544
2003	11,734	57.9	(±5.2)	70	517	24	568	6	570
Mean	32,234	61.8		79	523	12	562	8	538
Min	1,055	57.9		44	455	1	530	0	502
Max	112,792	69.4		96	550	41	600	34	580

Data prior to 1990 from Kyle, et al. 1990.
Mean escapement from 1999 to 2003 = 44,254
Mean escapement from 1992 to 2003 = 38,225

In 2003, the commercial fishery harvest rate was estimated to be 55%, the personal use fishery harvest rate was estimated to be 6% and sport fishery harvest rate was 8% (ADF&G, personal communication). Thus, the estimated total common property harvest rate was 69%. Based on these harvest rates the total number of Hidden Lake fish returning to Cook Inlet was estimated to be 38,515 (Appendix 5).

The percentage of adult male and adult female sockeye salmon returning to Hidden Lake in 2003 was 49.0% and 51.0%, respectively (Table 6). Male fish averaged 546 mm (24.2in) in length

and the females averaged 516 mm (22.9 in). An estimated 69.8% of the fish were age 1.2, 23.9% were age 1.3, 7.1% were 2.2, and 5.6% were 2.3. Angling lures were observed on 32 adult fish as they passed the counting weir.

Table 6. Hidden Lake sockeye salmon escapement and age composition based on scale growth patterns, 2003.

	Age Group						
	1.1	1.2	1.3	2.2	2.3	3.2	Total
Males	0	3,800	1,825	228	0	11	5,864
Percent	0	31.45	15.10	1.89	0.00	0.09	49
Sample Size	0	50	24	3	0	1	78
Mean Lth (mm)	0	532	575	537	0	617	546
Std. Error		4	6	4	0		1
Sample Size	0	50	24	3	0	1	78
Females	0	4,636	1,065	456	76	0	6,162
Percent	0	38.37	8.81	3.77	0.63	0.00	51
Sample Size	0	61	14	6	1	0	82
Mean Lth (mm)	0	504	555	530	570	0	516
Std. Error		3	9	8			1
Sample Size	0	61	14	6	1	0	82
Both Sexes	0	8,436	2,889	684	76	11	12,083
Percent	0	69.81	23.90	5.66	0.63	0.09	100
Sample Size	0	111	38	9	1	1	160
Mean Lth (mm)	0	517	568	532	570	617	530
Std. Error		2	5	5			1
Sample Size	0	111	38	9	1	1	160
* Large Freshwater		85.0%	92.0%				

* Hidden Lake sockeye typically have a very distinctive large freshwater growth pattern on their scales. Fish without this pattern may be from another population.

Special Studies – Adults

In March 1999, ADF&G conducted a technical review of the Hidden Lake Sockeye Salmon Enhancement Project (Simpson and Edmundson, 1999). Based on this review, ADF&G recommended that two special studies be conducted. One study was to determine if hatchery incubated fish released to Hidden Lake are straying into other Kenai River system spawning

populations and the other was to determine the contribution of hatchery incubated fish to the sockeye population returning to Hidden Lake.

To determine if hatchery incubated fish were straying into other Kenai River spawning populations; late run adult sockeye salmon returning to the Russian River and the Trail Lakes Hatchery discharge were checked for hatchery incubated fish. The Russian River was checked for fish from Hidden Lake because the Russian River is upstream of Hidden Lake and fish returning to the Russian River migrate up the Kenai River with fish bound for Hidden Lake. Sockeye Salmon have been sampled every year from 1999 to 2000 and no hatchery fish have been detected in the Russian River. Thus, 2002 was the last year Russian River sockeye salmon were sampled for hatchery marks.

To continue monitoring for possible straying sockeye salmon in 2003, a small creek on the southeast side of Skilak Lake was sampled for hatchery marked sockeye salmon. Over the next three years a total of 300 otolith samples will be collected from this creek and its surrounding area. In addition, the hatchery discharge was checked for fish from Hidden Lake because it is believed returning fish may be attracted to the water they were incubated in.

In 2003, 53 otolith samples were collected from sockeye salmon within the small creek on Skilak Lake. Of the 53 otolith samples collected, 47 were readable and none showed a hatchery mark. No hatchery incubated fish were observed.

To determine the contribution of hatchery incubated fish to the population of adult sockeye returning to Hidden Lake, CIAA attempted to collect otolith samples from approximately 120 fish every sixth day throughout the migration. However, due to the sporadic nature of the adult migration, collections only occurred on 29 July, 5, and 10 August. The otoliths from each fish were removed and processed to identify hatchery incubated fish by a hatchery induced thermal mark. Of the 349 otolith samples collected, 335 were readable (Table 7).

The proportion of hatchery incubated fish in the adult migration was determined using a stratified sampling method described by David Evans (ADF&G). This statistical method utilizes weekly escapement values and was chosen instead of a daily method because variability in escapement could potentially be caused by the capture method on each sampling day. The proportion of hatchery incubated fish was 57.9% (±5.2%) and all hatchery marks were from the Hidden Lake stock (Table 7).

Table 7. Hidden Lake adult otolith sampling, 2003.

Date	No. of adults	No. of Samples	No. of Readable Samples	No. Readable Marked	Percent Hatchery Marked	Percent Wild
29-Jul	5,536	119	115	59	51.3	48.7
5-Aug	5,287	123	117	64	54.7	45.3
10-Aug	911	107	103	71	68.9	31.1
Total	11,734	349	335	194	57.9	42.1

In 2003, 69.8% of the adult fish returning to Hidden Lake were age 1.2 (Table 6) and migrated from Hidden Lake as smolt in 2001. In 2001, 94% (±2.6%) of the smolts migrating from Hidden Lake were age 1 smolt (Table 3). In 2003, 57.9% (±5.2%) of the adult fish returning to Hidden Lake were hatchery incubated fish (Table 5). In 2001, 71% (±4.4%) of the smolts migrating from Hidden Lake were hatchery incubated smolt (Table 4). The proportion of the hatchery fish in the 2003 adult return was lower than expected based on the proportion of hatchery incubated fish in the 2001 smolt migration.

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RECOMMENDATIONS

No changes or alterations to the Hidden Lake Sockeye Salmon Enhancement Project are recommended.

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APPENDICES

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Appendix 1. Hidden Lake 2002 – Macrozooplankton Density.

Site A - Depth 21 - 20 m

Date	Density (No/m^2) 21-May	26-Jun	29-Jul	27-Aug	29-Sep	Mean (No/m^2)	Seasonal Mean (No/m^2)
Epischura		849	3,715	1,943	1,624	1,626	1,626
Cyclops	59,448	24,204	31,316	1,847	1,274	23,618	23,618
Ovig .*Cyclops*	212	637	2,123	191		633	633
Bosmina	11,465	425	14,862	1,815	2,293	6,172	6,172
Ovig. *Bosmina*	1,062	0		159	2,357	716	716
Daphnia l.	31,210	2,972	122,611	3,185	1,019	32,199	32,199
Ovig. *Daphnia l.*	637	849	29,193	2,038	478	6,639	6,639
Daphnia g.							
Ovig. *Daphnia g.*							
Total:						71,603	71,603

Site B - Depth 39 - 42 m

Date	Density (No/m^2) 21-May	26-Jun	29-Jul	27-Aug	29-Sep	Mean (No/m^2)	Seasonal Mean (No/m^2)
Epischura		1,327	0	6,635	5,308	2,654	2,654
Cyclops	289,278	337,049	323,779	322,452	218,153	298,142	298,142
Ovig. *Cyclops*		11,943	31,847	17,251	3,182	12,845	12,845
Bosmina	10,616	3,981	53,079	106,157	12,739	37,314	37,314
Ovig. *Bosmina*	8,493	1,327	2,654		3,715	3,238	3,238
Daphnia l.	33,970	65,021	764,331	103,503	16,985	196,762	196,762
Ovig. *Daphnia l.*	7,962	30,520	63,694	37,155	8,493	29,565	29,565
Daphnia g	0					0	0
Ovig. *Daphnia g.*	531	0				106	106
Total:						580,626	580,626

Site C - Depth 17- 19 m

Date	Density (No/m^2) 21-May	26-Jun	29-Jul	27-Aug	29-Sep	Mean (No/m^2)	Seasonal Mean (No/m^2)
Epischura		1,274	3,185	2,123	297	1,376	1,376
Cyclops	16,136	13,800	0	849	329	6,223	6,223
Ovig. *Cyclops*		849	1,062			382	382
Bosmina	2,760	2,972	16,985	1,486	478	4,936	4,936
Ovig. *Bosmina*	0	1,274			382	331	331
Daphnia l.	16,561	19,533	194,268	9,342	287	47,998	47,998
Ovig. *Daphnia l.*	637	4,246	8,493	2,123	138	3,127	3,127
Daphnia g	425	0					
Ovig. *Daphnia g.*	212	212					
Total:						64,374	64,374

Site D - Depth 40 - 43 m

Date	Density (No/m^2) 21-May	26-Jun	29-Jul	27-Aug	29-Sep	Mean (No/m^2)	Seasonal Mean (No/m^2)
Epischura		2,654	0	9,554	10,191	4,480	4,480
Cyclops	242,887	205,679	117,834	280,255	231,847	215,700	215,700
Ovig. *Cyclops*		5,308	6,369	20,701	11,890	8,854	8,854
Bosmina	9,342	17,251	38,217	227,707	28,025	64,108	64,108
Ovig. *Bosmina*	849	3,981	1,592	1,592	1,699	1,943	1,943
Daphnia l.	19,533	176,486	646,497	113,057	47,558	200,626	200,626
Ovig *Daphnia l.*	2,548	84,926	25,478	12,739	20,382	29,215	29,215
Daphnia g.			0		0		
Ovig. *Daphnia g.*					849		
Total:						524,926	524,926

Appendix 1. (cont'd) Hidden Lake 2003 – Macrozooplankton Biomass.

Site A - Depth 20 - 21 m

	Body Size (mm)					Body Size (mm)		Biomass (mg/m^2)	
							Seasonal Weighted		Seasonal Weighted
Date	21-May	26-Jun	29-Jul	27-Aug	29-Sep	Mean	Mean	Mean	Mean
Epischura			0.87		0.92	0.90	0.89	5	5
Cyclops	0.87	0.97	1.08	0.95	1.03	0.98	0.95	81	76
Ovig .*Cyclops*		1.28	1.31	1.24		1.28	1.30	4	4
Bosmina	0.46	0.63	0.48	0.38	0.32	0.45	0.46	12	12
Ovig. *Bosmina*	0.69	0.62		0.56	0.32	0.55	0.44	2	1
Daphnia l.	0.69	0.61	0.63	0.60	0.56	0.62	0.64	52	56
Ovig. *Daphnia l.*	1.11	0.96	1.09	0.70	0.65	0.90	1.06	24	34
Daphnia g.									
Ovig. *Daphnia g.*									
Total:								181	189

Body Size - Site B - Depth 49 - 42 m

	Body Size (mm)					Body Size (mm)		Biomass (mg/m^2)	
							Seasonal Weighted		Seasonal Weighted
Date	21-May	26-Jun	29-Jul	27-Aug	29-Sep	Mean	Mean	Mean	Mean
Epischura		1.60	1.50	1.32	1.37	1.45	1.37	34	29
Cyclops	0.91	1.05	1.03	1.10	1.10	1.04	1.04	1,162	1,159
Ovig .*Cyclops*		1.33	1.29	1.34	1.24	1.30	1.31	81	82
Bosmina	0.45	0.56	0.52	0.44	0.47	0.49	0.47	84	77
Ovig. *Bosmina*	0.69	0.63	0.69	0.62	0.58	0.64	0.66	13	14
Daphnia l.	0.70	0.63	0.57	0.80	0.64	0.67	0.60	377	303
Ovig. *Daphnia l.*	1.06	0.90	0.89		1.02	0.97	0.91	127	112
Daphnia g.									
Ovig. *Daphnia g.*		1.40				1.40	1.40	0.809	0.809
Total:								1,879	1,777

Body Size - Site C - Depth 17 - 19m

	Body Size (mm)					Body Size (mm)		Biomass (mg/m^2)	
							Seasonal Weighted		Seasonal Weighted
Date	21-May	26-Jun	29-Jul	27-Aug	29-Sep	Mean	Mean	Mean	Mean
Epischura		1.02		0.83	0.95	0.93	0.91	5	5
Cyclops	0.94	0.93	1.10	0.86	1.07	0.98	0.93	21	19
Ovig .*Cyclops*		1.30	1.27			1.29	1.28	2	
Bosmina	0.44	0.50	0.58	0.37	0.32	0.44	0.54	9	14
Ovig. *Bosmina*	0.67	0.64	0.59	0.42	0.35	0.53	0.57	1	
Daphnia l.	0.65	0.57	0.84	0.56	0.61	0.65	0.79	86	134
Ovig. *Daphnia l.*	1.07	0.93		0.69	0.61	0.83	0.86	9	
Daphnia g.	1.22					1.22	1.22	0.41	0.41
Ovig. *Daphnia g.*	1.19	1.32				1.26	1.26	0.45	0.45
Total:								135	172

Body Size - Site D - Depth 40 - 43m

	Body Size (mm)					Body Size (mm)		Biomass (mg/m^2)	
							Seasonal Weighted		Seasonal Weighted
Date	21-May	26-Jun	29-Jul	27-Aug	29-Sep	Mean	Mean	Mean	Mean
Epischura		1.20	1.53	1.51	1.50	1.44	1.47	56	60
Cyclops	1.04	1.06	1.09	1.14	1.09	1.08	1.09	923	926
Ovig .*Cyclops*			1.32	1.36	1.28	1.32	1.33	58	59
Bosmina	0.50	0.53	0.46	0.46	0.53	0.50	0.47	149	134
Ovig. *Bosmina*		0.67		0.54	0.56	0.59	0.62	7	7
Daphnia l.	0.80	0.59	0.68	0.67	0.59	0.67	0.66	382	376
Ovig. *Daphnia l.*	1.05	1.04	1.01	0.83	0.91	0.97	1.00	125	134
Daphnia g.			1.12			1.12	1.12	0.00	0.00
Ovig. *Daphnia g.*					1.29	1.29	1.29	0.99	0.99
Total:								1,700	1,697

Appendix 1. (cont'd) Hidden Lake 2003 – Water Quality.

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)	Org C (ug/l)	Chla (ug/l)	Phaeo (ug/l)	EZD (m)
21-May	A	1	7.2	4.2	2.2	212	10.5	8.0	68 :1	2732	ND	8.62	0.48	13.7
	A	19	7.2	4.7	2.5	219	2.7	7.4	70 :1	2800	ND	8.33	1.23	
	B	1	7.2	3.5	1.6	231	5.3	7.0	73 :1	2733	ND	8.42	2.08	13.7
	B	30	7.2	3.9	1.9	202	23.5	37.6	74 :1	2833	ND	0.91	0.66	
26-Jun	A	1	9.1	4.2	1.9	245	8.8	8.3	62 :1	2621	ND	1.83	0.54	16.4
	A	19	9.6	4.8	2.4	246	14.5	23.7	62 :1	2913	ND	0.63	0.44	
	B	1	6.9	3.8	1.9	230	11.9	8.1	77 :1	2735	ND	1.03	0.61	18.2
	B	30	8.2	4.4	2.4	212	11.6	37.3	67 :1	2785	ND	0.44	0.43	
29-Jul	A	1	10.7	5.2	2.2	247	7.0	7.7	53 :1	2626	ND	1.62	0.41	25.8
	A	20	10.0	4.7	1.9	261	5.7	7.8	59 :1	2662	ND	1.67	0.28	
	B	1	7.4	4.2	1.8	235	6.2	7.7	73 :1	2645	ND	0.95	0.41	ND
	B	30	7.7	4.1	1.9	225	5.8	8.0	67 :1	2610	ND	0.71	0.17	
27-Aug	A	1	8.6	4.8	2.5	227	7.0	7.2	60 :1	2611	ND	1.67	0.08	16.0
	A	20	9.7	4.7	2.6	202	14.0	22.7	51 :1	3482	ND	0.48	0.33	
	B	1	7.1	4.7	2.2	201	8.8	10.4	66 :1	2639	ND	1.49	0.48	17.4
	B	30	6.9	4.7	3.5	186	8.4	50.0	76 :1	2905	ND	0.03	0.05	
29-Sep	A	1	12.3	5.8	2.8	253	6.3	10.2	47 :1	2866	ND	1.21	0.35	14.7
	A	15	12.7	2.6	2.5	255	5.7	7.1	46 :1	2818	ND	0.92	0.30	
	B	1	7.8	4.5	2.3	212	8.4	8.0	62 :1	2758	ND	1.09	0.30	18.1
	B	30	9.7	4.7	2.5	237	14.3	9.7	56 :1	2718	ND	0.62	0.23	
Mean			8.7	4.4	2.3	226.9	7.9	14.7	62 :1	2,775	ND	2.13	0.49	17.1
Min			6.9	2.6	1.6	185.6	2.7	7.0	46 :1	2,610	ND	0.03	0.05	14.7
Max			12.7	5.8	3.5	260.9	23.5	50.0	77 :1	3,482	ND	8.62	2.08	25.8

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)
21-May	A	1	150	7.3	65.8	0.4	11	ND		9	4.00
	A	19	150	7.3	69.5	0.5	14	ND	ND	10	
	B	1	149	7.3	74.0	0.3	11	ND	ND	8	4.25
	B	30	149	7.2	69.7	0.3	14	ND	ND	6	
26-Jun	A	1	147	7.4	70.3	0.5	14	ND	ND	7	6.00
	A	19	147	7.3	67.1	0.3	11	ND	ND	8	
	B	1	149	7.3	71.2	0.3	11	ND	ND	7	6.25
	B	30	148	7.3	67.0	0.3	15	ND	ND	7	
29-Jul	A	1	146	7.3	71.3	0.4	9	ND	ND	6	6.00
	A	20	146	7.5	67.6	0.3	9	ND	ND	6	
	B	1	147	7.4	69.8	0.3	9	ND	ND	8	9.00
	B	30	146	7.5	67.7	0.2	11	ND	ND	7	
27-Aug	A	1	147	7.4	70.3	0.1	10	ND	ND	7	7.00
	A	20	149	6.9	68.4	0.5	10	ND	ND	39	
	B	1	147	7.4	67.7	0.5	11	ND	ND	5	6.00
	B	30	149	7.1	69.7	0.2	9	ND	ND	7	
29-Sep	A	1	151	7.3	68.5	0.3	9	ND	ND	13	5.50
	A	15	152	7.2	70.1	1.4	8	ND	ND	15	
	B	1	151	7.3	66.7	0.5	10	ND	ND	7	7.00
	B	30	151	7.3	66.3	0.6	11	ND	ND	7	
Mean			149	7.3	68.9	0.4	11	ND	ND	9	6.10
Min			146	6.9	65.8	0.1	8	ND	ND	5	4.00
Max			152	7.5	74.0	1.4	15	ND	ND	39	9.00

Appendix 2. Hidden Lake 2003 – Environmental Conditions.

Smolts Date	Sky	Precip. (mm)	Stage (ft)	Flow	Water Temp. (°C)	Air Temp. (°C)
27-May	3	0	0.52	ND	11	12
28-May	2	0	0.5	ND	11	15
29-May	3	0	0.48	ND	12	16
30-May	4	0	0.72	ND	10	14
31-May	3	0	1.2	ND	10	12
1-Jun	3	0	1.18	ND	10	11
2-Jun	3	0	0.6	ND	10	13
3-Jun	2	0	0.6	ND	12	16
4-Jun	4	0	0.48	ND	12	16
5-Jun	3	0	0.48	ND	11	12
6-Jun	4	152	0.46	ND	11	11
7-Jun	2	0	0.4	ND	12	16
8-Jun	3	0	0.4	ND	12	15
9-Jun	5	0	0.5	ND	12	15
10-Jun	5	0	0.5	ND	12	12
11-Jun	4	2	0.48	ND	13	15
12-Jun	2	0	0.49	ND	15	20
13-Jun	2	1	0.49	ND	17	22
14-Jun	2	0	0.49	ND	14	15
15-Jun	3	0	0.5	ND	12	14
16-Jun	3	0	0.44	ND	12	15
17-Jun	4	0	0.46	ND	12	15
18-Jun	3	0	0.46	ND	14	15
19-Jun	4	3	0.48	ND	14	15
20-Jun	2	0	0.48	ND	14	18
21-Jun	4	2	0.54	ND	14	14
22-Jun	2	0	0.66	ND	15	17
23-Jun	3	0	0.56	ND	15	12
24-Jun	4	0	0.54	ND	12	13
25-Jun	4	0	0.52	ND	12	12
26-Jun	4	0	0.3	ND	12	11
27-Jun	3	0	1.58	ND	12	15
28-Jun	2	0	1.6	ND	14	16
29-Jun	2	0	0.88	ND	16	21
Total		160				

Adults Date	Sky	Precip. (mm)	Stage (ft)	Flow	Water Temp. (°C)	Air Temp. (°C)
12-Jul	2	0	0.26	ND	18	21
13-Jul	1	0	0.24	ND	15	24
14-Jul	2	0	0.24	ND	20	26
15-Jul	1	0	0.24	ND	16	21
16-Jul	4	0	0.38	ND	16	16
17-Jul	2	0	0.36	ND	16	19
18-Jul	2	0	0.38	ND	16	19
19-Jul	2	0	0.38	ND	16	20
20-Jul	4	0	1.2	ND	17	19
21-Jul	5	0	1.18	ND	17	18
22-Jul	4	2	1.14	ND	10	16
23-Jul	4	0	1.28	ND	16	19
24-Jul	5	0	1.26	ND	16	15
25-Jul	4	0	1.24	ND	15	14
26-Jul	4	3	1.18	ND	15	15
27-Jul	4	0	1.1	ND	16	16
28-Jul	4	0	1.1	ND	15	15
29-Jul	3	0	1.1	ND	15	16
30-Jul	4	0	1.06	ND	14	14
31-Jul	3	0	0.98	ND	16	17
1-Aug	2	0	0.96	ND	16	18
2-Aug	2	0	0.96	ND	17	17
3-Aug	4	0	0.9	ND	16	16
4-Aug	2	0	0.88	ND	17	18
5-Aug	1	0	0.88	ND	18	20
6-Aug	1	0	0.86	ND	18	21
7-Aug	3	0	0.86	ND	18	20
8-Aug	2	0	0.82	ND	19	26
9-Aug	2	0	0.78	ND	20	25
10-Aug	2	0	0.78	ND	18	22
11-Aug	4	0	0.76	ND	15	15
12-Aug	4	1	0.76	ND	14	15
13-Aug	4	1	0.76	ND	15	16
14-Aug	5	3	0.76	ND	16	14
15-Aug	5	1	0.74	ND	15	13
16-Aug	5	8	0.74	ND	15	15
17-Aug	3	2	0.74	ND	16	17
18-Aug	5	0	0.74	ND	15	13
19-Aug	4	0	0.72	ND	15	14
20-Aug	5	0	0.72	ND	15	15
21-Aug	4	0	0.72	ND	15	12
22-Aug	2	0	0.68	ND	16	9
Total		21				

		Precip	Stage	Flow	Water Temp	Air Temp
Smolts	Avg.	4.71	0.62	ND	12.6	14.7
	Min.	0	0.30	ND	10	11
	Max.	160	1.60	ND	17	22
Adults	Avg.	0.50	0.81	ND	16.0	17.4
	Min.	0	0.24	ND	10	9
	Max.	8	1.28	ND	20	26

	Cloud Cover - No. of Days				
	Meas. Rain	100%	<100% >50%	<50% >0%	Clear
Smolts	5	12	12	10	0
Adults	8	22	4	12	4

ND = No Data

1 = Clear
2 =Cloud Cover <50%
3 =Cloud Cover>50%
4 =Overcast
5 =Rain

Ice out = April 20

Appendix 3. Hidden Lake 2003 – Smolt Migration.

	Sockeye			Coho		Rainbow		Dolly Varden	
Date	Daily	Mort.	Total	Daily	Total	Daily	Total	Daily	Total
26-May			0	71	71		0		0
27-May	0	0	0	149	220	2	2	6	6
28-May	2	0	2	149	369	0	2	3	9
29-May	38	0	40	22	391	2	4	10	19
30-May	86	0	126	79	470	0	4	2	21
31-May	218	0	344	11	481	1	5	0	21
1-Jun	260	0	604	106	587	0	5	4	25
2-Jun	208	0	812	200	787	0	5	2	27
3-Jun	222	0	1,034	420	1,207	0	5	2	29
4-Jun	443	0	1,477	523	1,730	1	6	6	35
5-Jun	402	0	1,879	1,094	2,824	1	7	6	41
6-Jun	727	0	2,606	763	3,587	1	8	1	42
7-Jun	1,116	0	3,722	2,415	6,002	1	9	3	45
8-Jun	3,052	0	6,774	1,813	7,815	2	11	18	63
9-Jun	2,642	0	9,416	4,099	11,914	0	11	12	75
10-Jun	1,557	0	10,973	1,234	13,148	1	12	9	84
11-Jun	5,950	0	16,923	2,018	15,166	1	13	28	112
12-Jun	77,539	1,200	95,662	16,874	32,040	2	15	14	126
13-Jun	66,837	0	162,499	2,740	34,780	0	15	12	138
14-Jun	14,644	0	177,143	631	35,411	0	15	3	141
15-Jun	17,911	0	195,054	2,301	37,712	0	15	9	150
16-Jun	21,784	0	216,838	2,261	39,973	1	16	1	151
17-Jun	10,260	0	227,098	157	40,130	0	16	1	152
18-Jun	8,936	0	236,034	718	40,848	0	16	3	155
19-Jun	20,086	100	256,220	225	41,073	0	16	2	157
20-Jun	13,518	7	269,745	451	41,524	0	16	2	159
21-Jun	10,356	0	280,101	77	41,601	0	16	7	166
22-Jun	13,994	0	294,095	343	41,944	0	16	3	169
23-Jun	3,909	8	298,012	80	42,024	0	16	1	170
24-Jun	2,348	0	300,360	48	42,072	0	16	1	171
25-Jun	564	0	300,924	11	42,083	0	16	1	172
26-Jun	2,684	50	303,658	10	42,093	0	16	0	172
27-Jun	1,216	264	305,138	18	42,111	0	16	0	172
28-Jun	2,582	52	307,772	3	42,114	0	16	0	172
29-Jun	1,540	0	309,312	0	42,114	0	16	0	172
30-Jun	1,056	0	310,368	0	42,114	0	16	0	172
1-Jul	493	0	310,861		42,114		16		172
2-Jul			310,861		42,114		16		172
3-Jul			310,861		42,114		16		172
4-Jul			310,861		42,114		16		172
5-Jul			310,861		42,114		16		172
6-Jul			310,861		42,114		16		172
7-Jul			310,861		42,114		16		172
8-Jul			310,861		42,114		16		172
9-Jul			310,861		42,114		16		172
Total	309,180	1,681	310,861		42,114		16		172

Appendix 4. Hidden Lake 2003 – Adult Migration.

	Sockeye			Coho	Otolith	
Date	Daily	Total	Lures	Daily	Collection	Mortalites
12-Jul	0	0		0		
13-Jul	0	0		0		
14-Jul	0	0		0		
15-Jul	0	0		0		
16-Jul	0	0		0		
17-Jul	0	0		0		
18-Jul	8	8		0		
19-Jul	23	31		0		
20-Jul	0	31		0		
21-Jul	18	49		0		
22-Jul	0	49		0		
23-Jul	3,917	3,966	19	0		
24-Jul	0	3,966		0		
25-Jul	1,054	5,020	3	0		
26-Jul	5	5,025		0		
27-Jul	0	5,025		0		
28-Jul	3	5,028		0		
29-Jul	508	5,536	1	0	119	
30-Jul	276	5,812	1	0		
31-Jul	134	5,946		0		
1-Aug	1	5,947		0		
2-Aug	2,109	8,056	2	0		
3-Aug	0	8,056		0		
4-Aug	2	8,058		0		
5-Aug	2,765	10,823	6	0	123	
6-Aug	30	10,853		0		
7-Aug	145	10,998		0		
8-Aug	22	11,020		0		
9-Aug	20	11,040		0		
10-Aug	254	11,294		0	107	
11-Aug	0	11,294		0		
12-Aug	361	11,655		0		
13-Aug	0	11,655		0		
14-Aug	13	11,668		0		
15-Aug	66	11,734		0		
16-Aug	0	11,734		0		
17-Aug	0	11,734		0		
18-Aug	0	11,734		0		
19-Aug	0	11,734		0		
20-Aug	0	11,734		0		
21-Aug	0	11,734		0		
22-Aug	0	11,734		0		
	11,734		32	0	349	0
Total	12,083					

% of fish with lures 27%

Appendix 5. Hidden Lake 2003 - Project Update.

Stocking & Misc. Activities

Crew on-site:	26-May	
Ice-out:	20-Apr	(approximate date)
Crew off-site:	22-Aug	
Fry stocking:	8-May	628,900 unfed fry
Adult Otolith Collection	29-Jul 10-Aug	

Egg Take

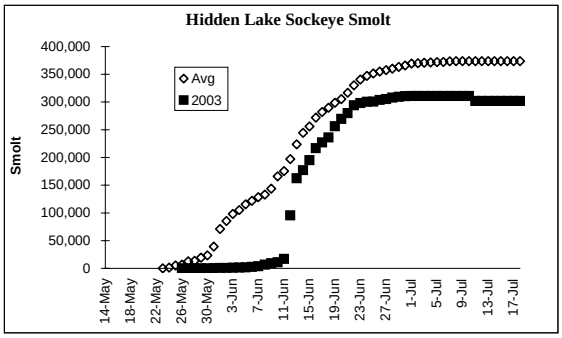
Dates:	18-Sep to 2-Oct	
No. of broodstock used:		742
Green eggs:		892,757
Fecundity:		2,481
Eyed eggs:		823,251
Survival		92.2%

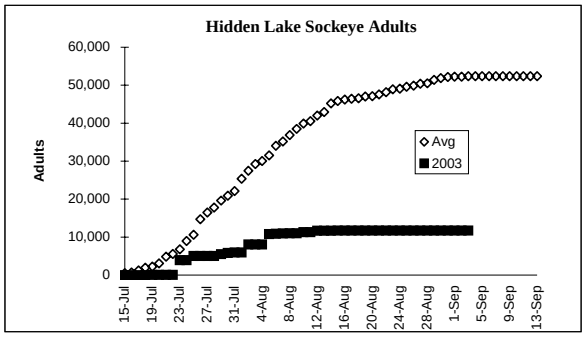
Smolt Migration

Dates:	26-May to 1-Jul			
Sockeyes:			310,861	±17,300
Mortalities:			1,681	
Percent age 1:	94%	±2.2%	290,800	±16,400
Percent age 2:	6%	±2.2%	19,000	±5,700
Percent hatchery:	79%	±3.1%		
Coho:			42,114	±19,700
Dolly Varden:			175	
Rainbow:			16	

Adult Migration

Dates:	12-Jul to 23-Aug		
Sockeye total return:		38,515	(est.)
Hidden Creek return:		12,083	31%
Commercial Harvest		21,066	55%
Sportfish Harvest		2,898	8%
Personal Use Harvest		2,468	6%
Otolith Collection		349	
Mortalites		0	
Lake Escapement:		11,734	
Hatchery broodstock:		742	
Lake broodstock:		10,992	
Lures:		32	
Coho		0	





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