

**Hidden Lake
Sockeye Salmon Enhancement
Progress Report
2007**

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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 Pacific Coast Salmon Recovery Fund.

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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 with the enhancement project in 1988; and, since 1991, has completed all the field activities.

On 20 May 2007, an estimated 658,000 unfed sockeye fry were released into Hidden Lake. All 658,000 fry were released at the west end of the lake and all the released fish were otolith marked.

During 2007, smolt migration monitoring began on 19 May and continued daily until 27 June. During this time an estimated 216,800 ($\pm 18,900$) sockeye (*O. nerka*) and 25,500 ($\pm 4,570$) coho (*O. kisutch*) smolts migrated from the lake.

Based on otolith marks, 67.9% ($\pm 3.4\%$) of the migrating sockeye smolts were incubated at Trail Lakes Hatchery. An estimated 86% ($\pm 2.8\%$) were age 1 and 16% ($\pm 3.0\%$) were age 2. The average length and weight of the age 1 sockeye smolt were 135 mm (± 0.9 mm) and 24.7 g (± 1.0 g). The average length and weight of the age 2 sockeye smolt were 167 mm (± 3.1 mm) and 44.4 g (± 4.8 g).

Of the migrating coho smolt, an estimated 19% ($\pm 0.5\%$) were age 1 and 81% ($\pm 2.6\%$) were age 2. The average length and weight of the age 1 coho smolt were 120 mm (± 2.4 mm) and 17.2 g (± 1.0 g). The average length and weight of the age 2 coho smolt were 133 mm (± 1.2 mm) and 23.3 g (± 0.6 g).

Adult sockeye salmon escapement was monitored from 10 July to 13 September 2007. During this time an estimated 16,879 adult sockeye salmon returned to Hidden Creek. The percentage of adult male and adult female fish was 45.8% and 54.2%, respectively. Male fish averaged 564 mm (22.2 in) in length and the females averaged 523 mm (20.6 in). An estimated 63.4% of the fish were age 1.2, 23.1% were age 1.3, 11.3% were age 2.2 and 2.2% were age 2.3

Otolith samples were collected from fish returning to the weir on Hidden Creek. Of the otolith samples collected 69.7% were from fish incubated at Trail Lakes Hatchery.

Between 19 September and 12 October 2007, 5.686 million eggs were collected and shipped to Trail Lakes Hatchery for fertilization and incubation. An estimated 5.083 million eggs (89.4%) have survived to the eyed stage.

Water chemistry and zooplankton samples were collected 4 times during 2007. ADF&G provided the analysis.

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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 could be 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 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 production of the maximum number of adult fish while maintaining the fry-rearing environment. To meet this objective, an average adult sockeye escapement of 30,000 fish was considered an appropriate management strategy 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. In 1989, CIAA, with assistance from ADF&G, also conducted the smolt migration and adult escapement monitoring; and, in 1991, 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 arose 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).

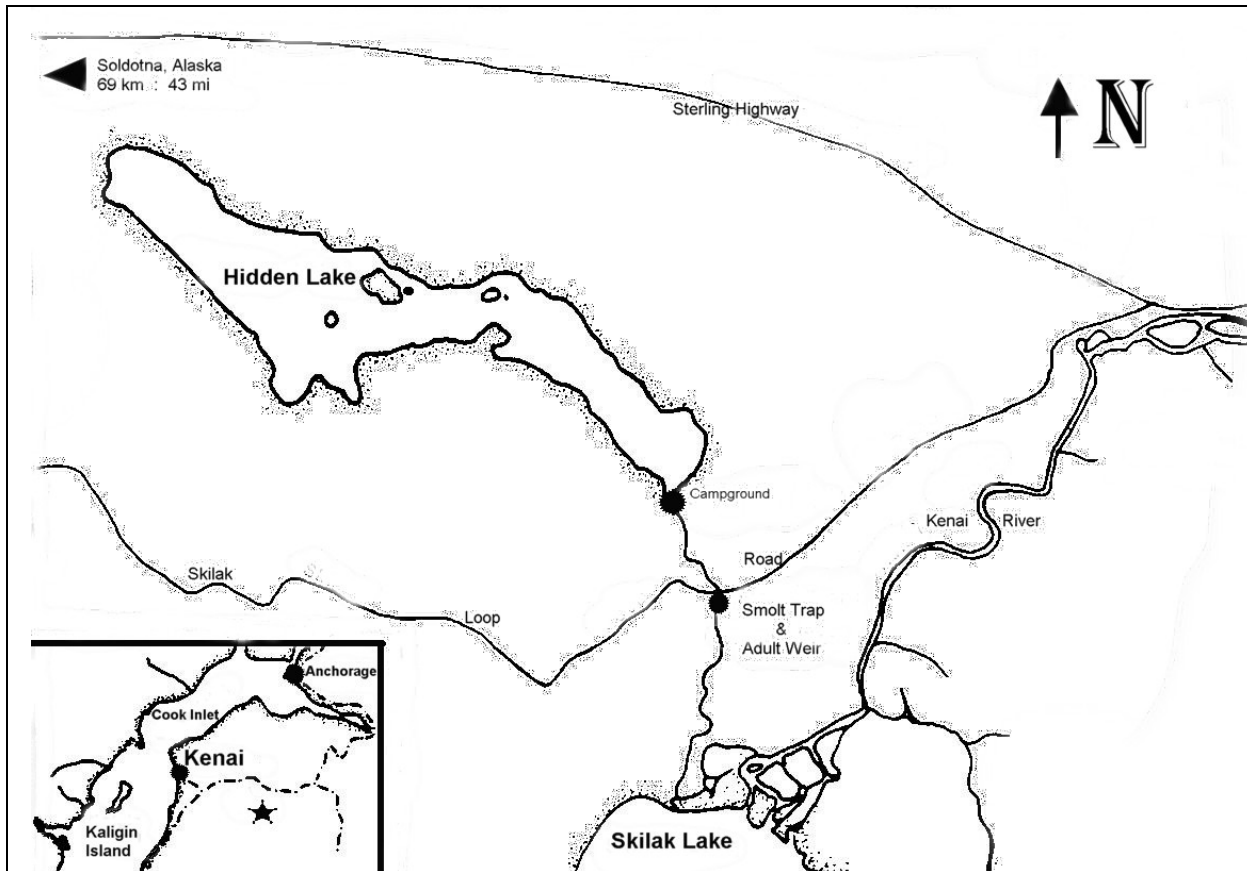


Figure 1. Area Map of Hidden Lake, Kenai Peninsula, Southcentral Alaska.

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 $138.1 \times 10^6 \text{ m}^3$. 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.

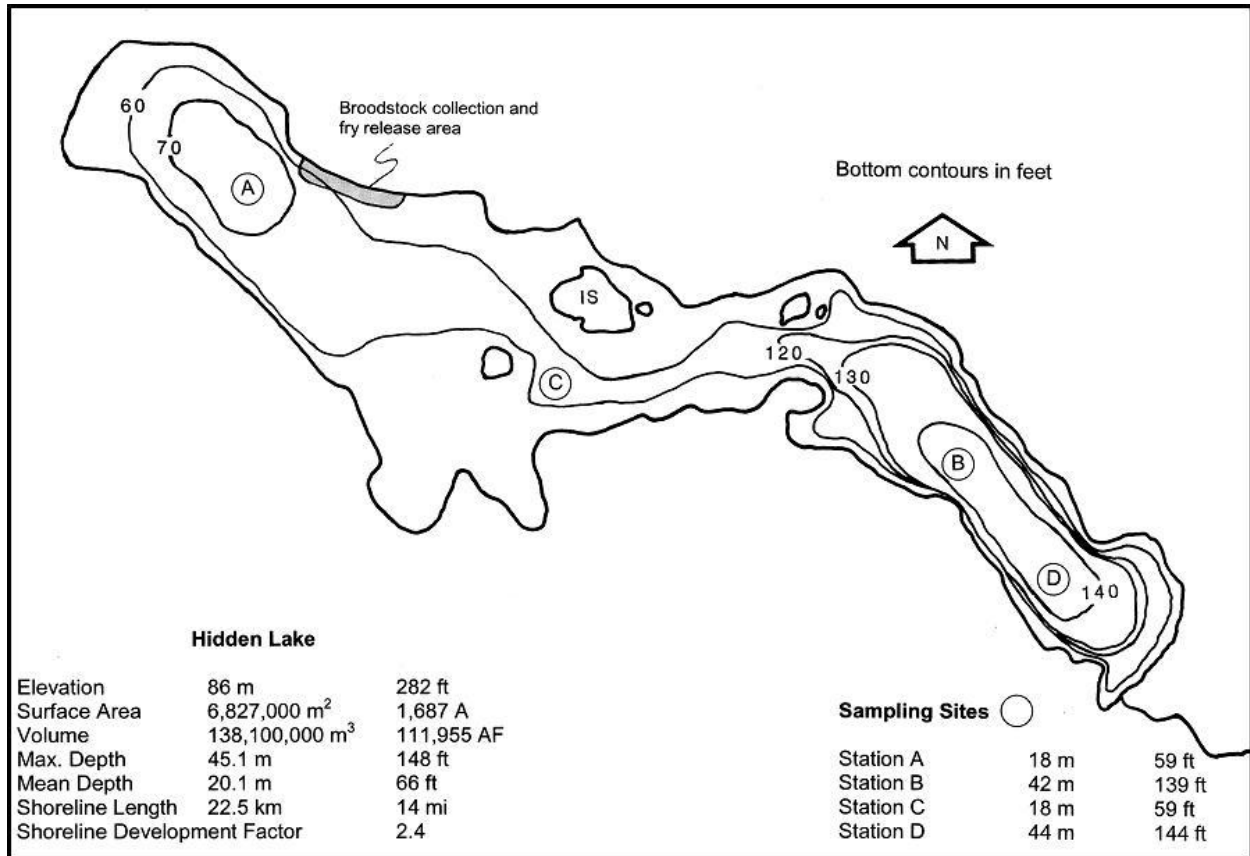


Figure 2. Morphometric map of Hidden lake showing the two major basins.

The lake's watershed area is 37.4 km² 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 (*Gasterosteus 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 2007, water quality samples were collected four times during the open water season from May through September. Two primary sites, Stations A and B, (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, one secondary site, Station C, was also sampled (Figure 2). Measurements at the secondary site were limited to the zooplankton community and Secchi disk transparency.

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

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 5:00 PM each day during the field monitoring activities.

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 smolt into the live-box. A swing gate remotely controlled by the trap operators directed smolt into one of two live-box compartments where they were enumerated and a smolt sample was collected.

A total count of smolt migrating from Hidden Lake was 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 smolt 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 smolt passed through the trap uncounted. To estimate the number of smolt 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-sampling¹ 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, the total smolt migration (\hat{T}) is:

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

¹ Predetermined random 2-minute sampling intervals assured random distribution within each 20-minute period.

with a variance of:

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

and 95% confidence limits of:

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

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

In 2007, migrating smolt were enumerated from 19 May through 27 June. The 10% sub-sampling procedure was used to enumerate 35% of the sockeye smolt and 37% of the coho smolt migrating in 2007.

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 smolt 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 mark². The purpose of this mark is to determine the contribution of released fish to the smolt population. In 2007, the otoliths of sockeye smolt collected for age, weight, and length measurements were removed and checked for a thermal mark. Otoliths were not collected from migrating coho smolts.

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

In 2007, smolt collected for measurement were collected in proportion to the daily smolt migration. This was accomplished by attempting to collect every 325th sockeye smolt and every 70th 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 and otoliths removed from 672 sockeye smolt. Age, weight, and length measurements were made on 394 coho smolt.

Each smolt collected for evaluation was first measured to the nearest millimeter for fork length³ and then weighed to the nearest 0.1 gram. Several scales were also removed from the primary growth area⁴ 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, staff at CIAA processed the otoliths and checked each for a hatchery mark following procedures described by Glick and Shields (1993). Field staff collected 672 pairs of sockeye otoliths, of which 657 were readable.

Sockeye smolt characteristics, the proportion of hatchery incubated 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 smolt,

N_h = number of smolt in stratum h , $N = \sum N_h$,

n = total number of smolt sampled,

n_h = number of smolt sampled in stratum h , $n = \sum n_h$,

a = total number of hatchery incubated smolt sampled,

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

⁴ 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.

$a_h =$ number of hatchery incubated smolt sampled in stratum h , $\hat{a} = \sum a_h$,

$p_h = a_h / n_h$, the proportion of hatchery incubated smolt in stratum h ,

$q_h = 1 - p_h$, the proportion of wild smolt in stratum h ,

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

$c_{hi} =$ number of age = i smolt sampled in stratum h , $\hat{c}_i = \sum c_{hi}$,

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

$m_{hi} = 1 - l_{hi}$, the proportion of other than age = i smolt 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 hatchery incubated smolt, \hat{P} , is:

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

with a variance of:

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

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

And, the total number of hatchery incubated smolt, \hat{A} , is:

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

with a variance of:

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

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:

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

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 smolt 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 smolt 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:

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

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:

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

and 95% confidence interval estimates of:

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

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 length⁵ of the returning population of fish. To determine the proportion of hatchery incubated fish in the adult population, CIAA has, in the past, collected otolith samples from returning fish. However, in

⁵Standard fork length was defined as the measurement from mid-eye to the fork of the tail.

2007, few fish were sacrificed for otolith collection because fewer adult fish returned than what was projected.

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 2007, adult escapement was monitored from 10 July to 13 September. After 13 September, the adult migration appeared complete and the counting weir was removed.

In 2007, it was assumed 23,600 adult fish would return to Hidden Creek during a six week period from approximately 15 July to 25 August. Based on this assumption, it was calculated that 120 fish needed to be sacrificed every 6th day to secure an otolith sample size adequate to assess the enhanced proportion, of the returning fish. However, the adult return was less than expected and CIAA did not implement this practice. As an alternative, CIAA staff collected otoliths for analysis from 48 fish on the 23 August 2007 and 95 fish on 4 September 2007.

To obtain representative scale samples for determining age, sex, and size of the returning population, up to 40 fish were collected daily, measured, sexed, a scale removed and the fish were released upstream.

In 2007, 143 otolith samples were collected and 550 adult sockeye salmon were sampled for age, sex, length and weight determination.

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 78,442,000 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.

Table 1. Summary of sockeye salmon gamete collection and fry releases at Hidden Lake, 1976 - 2007.

Brood Year	No. eggs taken	No. females used	Fecundity	Receiving hatchery	Egg-to-fry survival (%)	No. fry released Hidden Lk.	No. smolt produced in Hidden Lk	Fry-to-smolt survival (%)	No. fry Released LCI Lakes	No. fry Held for Smolt	No. Smolt Released Tutka Lagoon	Hatchery Fry-to-smolt survival (%)
1976	832,880	274	3,091	Crooked Cr.	39.6	330,228	58,800	17.8				
1977	406,878	200		Big L.	75.9	308,704	40,600	13.2				
1978	311,808	100	3,118	Crooked Cr.	2.7	8,258						
1979												
1980												
1981												
1982	1,579,188	576	2,741	Trail L.	68.8	1,086,000	231,300	21.3				
1983	1,928,000	639	3,017	Trail L.	64.2	1,236,900	289,100	23.4				
1984	3,766,000	1,310	2,875	Trail L.	47.9	1,805,792						
1985	7,019,000	2,330	3,012	Trail L.		0						
1986	4,740,000	1,580	3,000	Trail L.	78.5	3,718,311						
1987	7,000,184	2,434	2,876	Trail L.	86.9	6,085,307						
1988	2,718,853	891	3,046	Trail L.	91.0	2,470,012	194,400	7.9				
1989	2,220,467	647	2,669	Trail L.	79.0	1,747,900	203,800	11.7				
1990	2,189,000	956	2,290	Trail L.	64.6	1,600,000	214,100	13.4				
1991	2,652,000	1,119	2,370	Trail L.	64.7	1,716,000	330,200	19.2				
1992	2,293,000	1,007	2,277	Trail L.	82.9	1,901,000	365,300	19.2				
1993	2,200,000	934	2,355	Trail L.	81.8	1,800,000	195,000	10.8				
1994	2,156,000	1,017	2,120	Trail L.	78.8	1,700,000	326,600	19.2				
1995	1,893,000	849	2,230	Trail L.	84.5	1,600,000	184,700	11.5				
1996	2,048,000	817	2,507	Trail L.	73.3	1,501,000	305,300	20.3				
1997	2,166,000	936	2,314	Trail L.	47.8	1,035,000	182,900	17.7				
1998	2,303,000	859	2,681	Trail L.	65.4	1,507,100	352,300	23.4				
1999	2,297,000	954	2,408	Trail L.	54.1	1,242,000	254,600	20.5				
2000	1,486,000	607	2,448	Trail L.	60.9	905,500	220,000	24.3				
2001	1,326,000	504	2,631	Trail L.	73.9	980,200	257,800	26.3				
2002	1,118,000	433	2,582	Trail L.	56.3	628,900	46,700	7.4				
2003	893,000	371	2,481	Trail L.	89.4	646,000	214,700	33.2		100,000	96,000	96.0
2004	5,445,000	2,045	2,663	Trail L.	89.5	573,000	104,400	18.2	4,126,000	284,000	260,000	91.5
2005	2,027,000	1,045	1,940	Trail L.	78.6	582,000	136,600	23.5	680,000	193,000	144,000	74.6
2006	5,640,000	2,340	2,450	Trail L.	89.9	658,000			3,980,000	570,000		
2007	5,686,000	2,231	2,549	Trail L.								
Total	78,341,000	30,005				39,373,000	4,254,000					
Mean			2,450		74.0	1,304,927	240,525	17.9				
4-yr Avg.			2,400		86.9	614,750	155,900	21.3				

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 calculation is based on broodyear 1988 to present.

The number of smolt produced was derived from the recovery of marked fish.

*Survival from eyed egg to emergent fry was 89%. Only 646,000 fry released, 152,000 kept for smolt.

**Survival from eyed egg to emergent fry was 89%. Only 573,000 fry released to Hidden, 4,126,000 fry released to Lower Inlet Lakes, 174,000 kept for smolt

***Survival from eyed egg to emergent fry was 79%. Only 582,000 fry released to Hidden, 680,000 fry released to Lower Inlet Lakes, 193,000 kept for smolt

incomplete broodyear

In 2007, 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 19 September and 12 October 2007, approximately 5.735 million eggs were collected from 2,231 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 activating the sperm with a 0.7% saline solution completed fertilization. An estimated 5.639 million eggs (92.6%) have survived to the eyed stage.

The sockeye eggs collected in 2007 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 2008 and 2009.

The objective of the Hidden Lake Sockeye Salmon Enhancement Project is an average adult sockeye escapement of 30,000 fish. CIAA calculates the number of gametes to collect each year to meet this objective based on the most recent 4-year average natural sockeye smolt emigration (108,300 - Table 4), broodyear average green egg-to-fry survival (86.9% Table 1), fry-to-smolt survival (21.3% - Table 1), smolt-to-adult survival (18.6%), and the average common property harvest rate (62.0%). Based on these averages, to meet a projected adult return of 30,000 adult sockeye to Hidden Creek, CIAA projects 1,708,000 eggs must be collected to supplement the Hidden Lake return. CIAA plans to collect 1,299,000 eggs in 2008.

Fish Transport and Stocking

An estimated 658,000 of the 5,072,000 sockeye salmon fry produced from gametes collected from Hidden Lake in 2006 were released to Hidden Lake on 20 May 2007. Since 1977, over 39.3 million fry have been released to Hidden Lake (Table 1).

The unfed fry released to Hidden Lake 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: 2,2,2H; Rbr 1:1.2,2.2,3.2]. Otoliths samples were processed to document the marks and are on file at CIAA Headquarters.

An estimated 3,980,000 fry also produced from Hidden Lake gametes collected in 2006 were released to three lower Cook Inlet lakes on 27 and 28 June 2007– 2,315,000 to Leisure Lake, 1,411,000 to Hazel Lake and 254,000 to Kirschner Lake. The fish were thermally marked with the Hatch Code: 2,2H; Rbr 1:1.2,2.2.

In addition to the aforementioned fry releases, an estimated, 144,000 smolts produced from Hidden Lake gametes collected in 2005, were released to Tutka Bay Lagoon on 15 May 2007. The fish were thermally marked with the Hatch Code H3,1; Rbr 2:1.3,2 .1.

RESULTS AND DISCUSSION

Limnology and Environmental Conditions

Hidden Lake water chemistry and zooplankton have been monitored for several years. Water chemistry and zooplankton samples were collected in 2007; however, samples analysis has not been completed. Water chemistry from samples collected prior to 2007 is summarized in Table 2.

Environmental conditions during the Hidden Lake smolt migration were monitored from 19 May to 27 June 2007. Stream stage measurements averaged 0.68 feet and ranged from 0.60 to 0.72 feet. During the period of smolt migration, stream temperatures averaged 10.5°C and ranged from 5.0 to 17°C. Air temperatures averaged 14.8°C and ranged from 9.0 to 24.0°C. Fifteen percent of the days were clear, 40% were partly cloudy, and 18% were completely overcast. Measurable rain was recorded on 8 days during the smolt migration. A total of 9.5 mm of rain fell during this period (Appendix 2).

Environmental conditions during the Hidden Lake adult sockeye migration were monitored from 10 July to 13 September 2007. Stream stage measurements averaged 0.86 feet and ranged from 0.78 to 1.00 feet. Stream temperatures averaged 17.8°C and ranged from 12.0 to 22.0°C and air temperatures averaged 17.9°C and ranged from 12.0 to 27.0°C. Three percent of the days were clear, 18% were partly cloudy, and 32% were completely overcast. Rain was recorded on 26 days during the adult migration. A total of 71.7 mm of rain fell during this period (Appendix 2).

Table 2. Average open water season water quality characteristics of Hidden Lake

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
2004				NO DATA				17.1	6.6	1,450
2005	149	7.2	68	0.3	9.8	273	0.5	17.5	7.0	1,693
2006	147	7.3	67	0.1	8.2	237	0.5	23.4	8.0	1,445

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
2004				NO DATA			
2005	149	7.2	68	0.1	11.8	277	0.5
2006	148	7.4	68	0.2	8.5	216	0.6

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 2007 Hidden Lake sockeye smolt migration was similar to the smolt migrations observed prior to 2005. The smolt migrations observed in 2005 and 2006 were characterized by two peak periods of migratory activity. The 2007 smolt migration and migrations prior to 2005 were characterized by a single peak period of migratory activity. The peak of the 2007 smolt migration occurred between 10 and 15 June.

Only 74 moribund or dead sockeye smolt were observed during the 2007 smolt migration. A majority of the mortality occurred prior to the fish entering the trap. Not considering the 74 sockeye smolt lost during enumeration, the final 2007 Hidden Creek sockeye smolt migration was estimated at 216,800 ($\pm 18,900$). Other fish counted included 25,500 ($\pm 4,570$) coho smolt, 13 rainbow trout and 42 Dolly Varden char (Appendix 3).

Smolt Characteristics and Enhanced Contribution

In 2007, characteristics of the smolt population were evaluated from scale samples collected throughout the migration and from measurements of length and weight. Based on these samples and measurements, an estimated 86% ($\pm 2.8\%$) were age 1 and 16% ($\pm 3.0\%$) were age 2. The average length and weight of the age 1 sockeye smolt were 135 mm (± 0.9 mm) and 24.7 g (± 1.0 g). The average length and weight of the age 2 sockeye smolt were 167 mm (± 3.1 mm) and 44.4 g (± 4.8 g). There were no age 3 smolts (Table 3).

Of the migrating coho smolt, an estimated 19% ($\pm 0.5\%$) were age 1 and 81% ($\pm 2.6\%$) were age 2. The average length and weight of the age 1 coho smolt were 120 mm (± 2.4 mm) and 17.2 g (± 1.0 g). The average length and weight of the age 2 coho smolt were 133 mm (± 1.2 mm) and 23.3 g (± 0.6 g).

The age structure, average length, and weight measurements of the sockeye and coho smolt were similar to previous smolt migrations.

Table 3. Age structure, length and weight characteristics of Hidden Lake sockeye smolt, 1976 - 2007.

Smolt Year	Age Class (%)				Mean length (mm)				Mean weight (g)			
	Age 1.0	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	(±0.8)	24.7	(±0.2)	60.5	(±6.5)
2004	64	(±3.7)	36	(±3.7)	140	(±0.8)	179	(±3.6)	24.7	(±0.8)	60.5	(±3.7)
2005	91	(±1.8)	9	(±1.9)	140	(±0.5)	179	(±3.6)	24.7	(±2.0)	60.5	(±3.7)
2006	91	(±2.4)	9	(±2.4)	140	(±0.9)	179	(±10.3)	24.7	(±0.5)	60.4	(±8.7)
2007	86	(±2.8)	16	(±3.0)	135	(±0.9)	167	(±3.1)	24.7	(±1.0)	47.4	(±4.8)
Mean	90		10		136		181		22.0		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 smolt between wild and enhanced fish since 1993. In 2007, the proportion of hatchery-incubated salmon in the sockeye smolt migration was 67.9% (±3.4%) (Table 4). This proportion is approximately equal to the average estimate of the hatchery

contribution based on otolith thermal marks, but greater than the most recent 4-year average contribution.

Table 4. The contribution of enhanced sockeye to the Hidden Lake smolt migrations, 1976 - 2007.

Smolt Year	Total				% Hatchery	
	No.	95% C.I.	Wild	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	(±13,400)	94,300	218,800	70	(±4.2)
2000	475,600	(± 52,600)	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)
2004	192,800	(±0)	140,800	53,000	27	(±3.9)
2005	290,400	(±15,500)	70,300	220,100	76	(±2.6)
2006	200,800	(±17,900)	106,400	94,400	47	(±3.6)
2007	216,800	(±70,700)	151,100	65,700	70	(±3.4)
Mean	322,200		89,400	240,300	70	
4-year Mean	225,200		117,200	108,300	55	

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.

Mean calculated from 1993 to present.

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

Adult Escapement

Adult sockeye salmon return was monitored from 10 July to 13 September 2007 (Appendix 4). During this time an estimated 16,879 adult sockeye salmon returned to Hidden Creek. (Table 5).

Table 5. Summary of Hidden Lake salmon escapement, age distribution and fish length. 1976 - 2007.

Year	Escapement Number	Escapement Hatchery		Major Age Classes					
		(%)	(C.I.)	1.2 (%)	Lth(mm)	1.3 (%)	Lth(mm)	2.2 (%)	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*	35,576			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
2004	18,172	76.8	(±2.7)	67	521	19	568	12	540
2005**	13,000	ND		79	ND	12	ND	9	ND
2006***	38,535	47		89	502	4	547	7	506
2007***	16,734	56.7	(±7.9)	63	537	23	562	11	520
Mean	28,493	61.2		79	522	12	562	8	536
Min	1,055	47.0		44	455	1	530	0	502
Max	77,959	76.8		96	550	41	600	34	580

Data prior to 1990 from Kyle, et al. 1990.

Mean escapement from 2004 to 2007 = 21,610

Mean escapement from 1992 to 2007 = 34,071

ND = No Data Collected or Calculated

Note: Total escapement is Lake escapement and not fish returning to weir (morts and sampled fish)

*112,792 fish returned to the weir. 72,060 were harvested in a personal use-dipnet fishery and 5,156 were donated to charity

**A hole was detected in the weir, CIAA counted 6,745 sockeye salmon. 13,000 is based on prior counts and ADF&G fish wheel estimates

***Sample collection procedure incomplete. % hatchery estimate is not reliable.

The 2007 commercial fishery harvest was 27,265, the personal use fishery harvest was 3,646, and sport fishery harvest was 4,112 (ADF&G, personal communication).

The percentage of adult male and adult female sockeye salmon returning to Hidden Lake in 2007 was 45.8% and 54.2%, respectively (Table 6). Male fish averaged 564 mm (22.2 in) in length and the females averaged 523 mm (20.6 in). An estimated 63.4% of the fish were age 1.2, 23.1% were age 1.3, 11.3% were age 2.2 and 2.2% were age 2.3

Table 6. Hidden Lake sockeye salmon escapement sex ratio and size data, 2007.

	Age Group						Total
	1.1	1.2	1.3	2.2	2.3	3.2	
Males	0	4,473	2,435	517	243	0	7,668
Percent	0.00%	26.73%	14.55%	3.09%	1.45%	0.00%	45.82%
Sample Size	0	147	80	17	8	0	252
Mean Lth (mm)		563	570	536	569		564
Std. Error		32	3	7	7		18
Females	0	6,145	1,431	1,369	122	0	9,066
Percent	0.00%	36.72%	8.55%	8.18%	0.73%	0.00%	54.18%
Sample Size	0	202	47	45	4	0	298
Mean Lth (mm)		519	548	514	549		523
Std. Error		2	5	4	12		2
Both Sexes	0	10,618	3,866	1,886	365	0	16,734
Percent	0.00%	63.45%	23.09%	11.28%	2.18%	0.00%	100.00%
Sample Size	0	349	127	62	12	0	550
Mean Lth (mm)		537	562	520	562		542
Std. Error		13	3	3	6		8
* Large Freshwater		99%	77%				

* 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 were 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 2002 and no hatchery fish were 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 311 otolith samples were collected from this creek and its surrounding area. None were found to be of hatchery origin.

In addition, since 1999, the Trail Lakes Hatchery discharge has been checked for fish from Hidden Lake. It is believed returning fish may be attracted to the water they were incubated in; however, none have been observed at the discharge.

Typically to determine the contribution of hatchery incubated fish to the population of adult sockeye returning to Hidden Lake, CIAA annually attempts to collect otolith samples from approximately 120 fish every sixth day throughout the migration. In 2007, the adult return was less than expected and CIAA did not implement this practice. As an alternative, CIAA staff collected otoliths for analysis from 48 fish on the 23 August 2007 and 95 fish on 4 September 2007. Of the 143 otolith samples collected, 141 were readable and the hatchery contribution was 56.7% ($\pm 7.9\%$). Due to the sample collection procedure, the estimate of the hatchery contribution is not considered statistically valid.

RECOMMENDATIONS

CIAA should continue to monitor the Hidden lake smolt and adult migrations to Hidden Creek.

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APPENDICES

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Appendix 1. Hidden Lake 2007 – Macrozooplankton Density, Macrozooplankton Biomass and Water Quality.

The 2007 sample analysis is not complete.

Appendix 2. Hidden Lake 2007 – Environmental Conditions.

Smolt Migration							Adult Migration						
Date	Sky	Precip. (mm)	Stage (ft)	Flow	Water Temp. (°C)	Air Temp. (°C)	Date	Sky	Precip. (mm)	Stage (ft)	Flow	Water Temp. (°C)	Air Temp. (°C)
19-May	2	0.0	0.71	ND			10-Jul	3	1.2	1.00	ND	19	17
20-May	2	0.0	0.72	ND	10	20	11-Jul	4	0.7	1.00	ND	20	15
21-May	1	0.0	0.72	ND	10	16	12-Jul	4	0.5	1.00	ND	19	13
22-May	3	0.0	0.70	ND	7	15	13-Jul	3	0.3	1.00	ND	21	18
23-May	4	0.0	0.70	ND	5	10	14-Jul	3	0.1	1.00	ND	20	16
24-May	3	0.0	0.70	ND	8	15	15-Jul	3	0.0	1.00	ND	22	19
25-May	3	0.0	0.71	ND	6	10	16-Jul	2	0.0	1.00	ND	22	24
26-May	3	0.0	0.71	ND	6	11	17-Jul	3	0.0	1.00	ND	21	22
27-May	3	0.0	0.70	ND	7	14	18-Jul	4	0.0	1.00	ND	21	18
28-May	2	0.0	0.71	ND	6	9	19-Jul	3	0.0	0.90	ND	21	19
29-May	3	1.2	0.71	ND	9	11	20-Jul	3	0.0	0.90	ND	18	21
30-May	3	1.9	0.70	ND	7	13	21-Jul	2	0.3	0.90	ND	21	24
31-May	2	0.0	0.70	ND	8	13	22-Jul	5	0.8	0.90	ND	19	14
1-Jun	2	0.0	0.70	ND	6	11	23-Jul	4	2.8	0.90	ND	16	16
2-Jun	4	1.0	0.71	ND	8	11	24-Jul	4	0.3	0.90	ND	16	16
3-Jun	3	0.4	0.71	ND	10	15	25-Jul	4	0.0	0.90	ND	16	18
4-Jun	2	3.2	0.71	ND	11	18	26-Jul	4	0.0	0.90	ND	18	17
5-Jun	2	0.3	0.71	ND	8	14	27-Jul	4	0.6	0.90	ND	18	20
6-Jun	2	0.0	0.69	ND	8	11	28-Jul	2	0.0	0.90	ND	19	24
7-Jun	2	0.0	0.68	ND	8	9	29-Jul	3	0.0	0.90	ND	21	25
8-Jun	3	0.0	0.69	ND	9	10	30-Jul	3	17.4	0.90	ND	21	19
9-Jun	2	0.0	0.69	ND	10	12	31-Jul	3	0.5	0.90	ND	19	20
10-Jun	1	0.0	0.70	ND	11	20	1-Aug	4	0.0	0.90	ND	19	17
11-Jun	2	0.0	0.70	ND	13	18	2-Aug	4	0.1	0.90	ND	17	15
12-Jun	3	0.0	0.68	ND	12	15	3-Aug	4	0.9	0.90	ND	17	19
13-Jun	3	0.0	0.68	ND	11	14	4-Aug	4	1.4	0.90	ND	16	16
14-Jun	2	0.0	0.67	ND	15	19	5-Aug	3	0.4	0.90	ND	16	18
15-Jun	2	0.0	0.68	ND	16	23	6-Aug	2	0.2	0.90	ND	18	21
16-Jun	2	0.0	0.68	ND	17	24	7-Aug	2	2.4	0.90	ND	18	20
17-Jun	4	0.0	0.67	ND	12	15	8-Aug	2	0.4	0.86	ND	18	24
18-Jun	4	0.0	0.68	ND	14	14	9-Aug	2	0.1	0.86	ND	22	21
19-Jun	1	0.0	0.65	ND	17	21	10-Aug	2	0.0	0.86	ND	21	24
20-Jun	1	0.0	0.66	ND	17	22	11-Aug	2	0.0	0.84	ND	21	27
21-Jun	1	0.0	0.66	ND	16	19	12-Aug	3	0.0	0.84	ND	21	25
22-Jun	4	0.0	0.62	ND	11	12	13-Aug	2	0.0	0.84	ND	22	27
23-Jun	5	0.5	0.61	ND	11	11	14-Aug	5	0.0	0.84	ND	20	16
24-Jun	4	1.0	0.60	ND	10	10	15-Aug	3	7.0	0.84	ND	18	17
25-Jun	2	0.0	0.66	ND	11	12	16-Aug	3	0.7	0.84	ND	18	18
26-Jun	2	0.0	0.62	ND	14	18	17-Aug	4	2.6	0.82	ND	18	15
27-Jun	1	0.0	0.61	ND	16	21	18-Aug	4	0.6	0.80	ND	16	15
Total		9.5					19-Aug	4	0.8	0.80	ND	16	16
Avg.		0.2	0.68	ND	10.5	14.8	20-Aug	4	0.0	0.80	ND	16	16
Min.		0.0	0.60	ND	5.0	9.0	21-Aug	3	0.8	0.80	ND	16	16
Max.		3.2	0.72	ND	17.0	24.0	22-Aug	4	0.6	0.80	ND	16	15
							23-Aug	4	0.4	0.80	ND	16	15
							24-Aug	2	0.4	0.80	ND	18	19
							25-Aug	2	0.1	0.80	ND	18	14
							26-Aug	2	0.0	0.80	ND	18	17
							27-Aug	3	0.0	0.78	ND	18	16
							28-Aug	1	0.0	0.79	ND	16	20
							29-Aug	1	0.0	0.80	ND	18	22
							30-Aug	4	0.0	0.80	ND	18	18
							31-Aug	4	0.0	0.80	ND	18	20
							1-Sep	4	5.7	0.78	ND	18	12
							2-Sep	2	0.3	0.80	ND	17	15
							3-Sep	4	0.1	0.78	ND	14	14
							4-Sep	4	0.0	0.78	ND	16	15
							5-Sep	3	0.0	0.79	ND	14	15
							6-Sep	3	2.0	0.79	ND	16	16
							7-Sep	3	0.3	0.78	ND	15	15
							8-Sep	4	10.0	0.80	ND	15	15
							9-Sep	4	0.8	0.79	ND	14	15
							10-Sep	4	1.8	0.78	ND	14	15
							11-Sep	3	0.1	0.78	ND	14	14
							12-Sep	5	2.8	0.80	ND	13	13
							13-Sep	4	2.4	0.79	ND	12	12
Total		71.7											
Avg.		1.1	0.86	ND	17.8	17.9							
Min.		0.0	0.78	ND	12.0	12.0							
Max.		17.4	1.00	ND	22.0	27.0							

Ice out = ND					
Summary of Cloud Cover - Percent of Days					
	No. Days	Meas. Rain	Overcast	Partly Cloudy	Clear
Smolts	40	20%	18%	40%	15%
Adults	66	62%	45%	21%	3%

1.0 = Clear
2.0 = Cloud Cover <50%
3.0 = Cloud Cover >50%
4.0 = Overcast
5.0 = Rain

ND = No Data

Appendix 3. Hidden Lake 2007 – Smolt Migration.

Date	Sockeye			Coho			Rainbow		Dolly Varden	
	Daily	Mort.	Total	Daily	Mort.	Total	Daily	Total	Daily	Total
19-May	0	0	0	0	0	0	0	0	0	0
20-May	2	0	2	0	0	0	0	0	0	0
21-May	5	0	7	1	0	1	0	0	0	0
22-May	2	0	9	0	0	1	0	0	0	0
23-May	1	0	10	1	0	2	1	0	0	0
24-May	2	0	12	0	0	2	0	0	0	0
25-May	2	1	15	2	0	4	0	0	0	0
26-May	20	0	35	1	0	5	0	0	0	0
27-May	8	0	43	1	0	6	0	0	0	0
28-May	37	0	80	1	0	7	0	0	0	0
29-May	32	14	126	1	0	8	0	0	0	0
30-May	159	0	285	13	0	21	0	0	0	0
31-May	555	6	846	47	0	68	0	0	0	0
1-Jun	388	5	1,239	65	0	133	0	0	0	0
2-Jun	317	1	1,557	114	0	247	0	0	0	0
3-Jun	772	5	2,334	424	0	671	1	1	3	3
4-Jun	3,396	9	5,739	1,071	0	1,742	0	1	1	4
5-Jun	8,929	13	14,681	1,570	0	3,312	0	1	8	12
6-Jun	650	4	15,335	390	0	3,702	0	1	0	12
7-Jun	1,058	1	16,394	272	0	3,974	0	1	0	12
8-Jun	6,559	15	22,968	1,196	0	5,170	0	1	0	12
9-Jun	12,013	0	34,981	1,793	0	6,963	0	1	1	13
10-Jun	35,539	0	70,520	5,219	0	12,182	0	1	2	15
11-Jun	32,822	0	103,342	5,104	0	17,286	1	2	0	15
12-Jun	23,522	0	126,864	3,248	0	20,534	4	6	2	17
13-Jun	19,669	0	146,533	2,216	0	22,750	0	6	0	17
14-Jun	13,411	0	159,944	456	0	23,206	1	7	0	17
15-Jun	10,675	0	170,619	766	0	23,972	0	7	0	17
16-Jun	7,793	0	178,412	263	0	24,235	0	7	5	22
17-Jun	5,431	0	183,843	126	0	24,361	0	7	0	22
18-Jun	10,421	0	194,264	316	0	24,677	0	7	0	22
19-Jun	6,753	0	201,017	283	0	24,960	0	7	10	32
20-Jun	6,451	0	207,468	138	0	25,098	0	7	6	38
21-Jun	5,578	0	213,046	281	0	25,379	6	13	3	41
22-Jun	370	0	213,416	30	0	25,409	0	13	0	41
23-Jun	3,154	0	216,570	67	0	25,476	0	13	1	42
24-Jun	46	0	216,616	1	0	25,477	0	13	0	42
25-Jun	115	0	216,731	15	0	25,492	0	13	0	42
26-Jun	37	0	216,768	1	0	25,493	0	13	0	42
27-Jun	26	0	216,794	9	0	25,502	0	13	0	42
Total	216,720	74	216,794	25,502	0	25,502		13		42

Appendix 4. Hidden Lake 2007 – Adult Migration.

Date	Sockeye					Lures	Coho	
	Daily Escapement	Mortalities	Otolith Collection	Total Return	Daily Escapement		Total Return	
10-Jul	0	0	0	0	0	0	0	0
11-Jul	0	0	0	0	0	0	0	0
12-Jul	0	0	0	0	0	0	0	0
13-Jul	0	0	0	0	0	0	0	0
14-Jul	0	0	0	0	0	0	0	0
15-Jul	0	0	0	0	0	0	0	0
16-Jul	0	1	0	1	0	0	0	0
17-Jul	41	0	0	42	0	0	0	0
18-Jul	0	0	0	42	0	0	0	0
19-Jul	0	0	0	42	0	0	0	0
20-Jul	0	0	0	42	0	0	0	0
21-Jul	0	0	0	42	0	0	0	0
22-Jul	0	0	0	42	0	0	0	0
23-Jul	0	0	0	42	0	0	0	0
24-Jul	0	0	0	42	0	0	0	0
25-Jul	28	0	0	70	1	0	0	0
26-Jul	87	0	0	157	0	0	0	0
27-Jul	145	0	0	302	0	0	0	0
28-Jul	0	0	0	302	0	0	0	0
29-Jul	10	0	0	312	0	0	0	0
30-Jul	3	0	0	315	0	0	0	0
31-Jul	1,596	0	0	1,911	0	0	0	0
1-Aug	221	0	0	2,132	0	0	0	0
2-Aug	0	0	0	2,132	0	0	0	0
3-Aug	1,827	0	0	3,959	0	0	0	0
4-Aug	4	0	0	3,963	0	0	0	0
5-Aug	21	0	0	3,984	0	0	0	0
6-Aug	192	0	0	4,176	0	0	0	0
7-Aug	180	0	0	4,356	0	0	0	0
8-Aug	24	0	0	4,380	0	0	0	0
9-Aug	174	0	0	4,554	0	0	0	0
10-Aug	216	0	0	4,770	0	0	0	0
11-Aug	79	0	0	4,849	0	0	0	0
12-Aug	7	0	0	4,856	0	0	0	0
13-Aug	105	0	0	4,961	3	0	0	0
14-Aug	2,637	0	0	7,598	0	0	0	0
15-Aug	84	0	0	7,682	0	0	0	0
16-Aug	189	0	0	7,871	0	0	0	0
17-Aug	94	0	0	7,965	0	0	0	0
18-Aug	690	0	0	8,655	0	0	0	0
19-Aug	698	0	0	9,353	0	0	0	0
20-Aug	69	0	0	9,422	4	0	0	0
21-Aug	1,697	0	0	11,119	0	0	0	0
22-Aug	27	0	0	11,146	0	0	0	0
23-Aug	95	0	48	11,289	0	0	0	0
24-Aug	88	0	0	11,377	0	0	0	0
25-Aug	32	0	0	11,409	0	0	0	0
26-Aug	2,172	0	0	13,581	0	0	0	0
27-Aug	57	0	0	13,638	0	0	0	0
28-Aug	0	0	0	13,638	0	0	0	0
29-Aug	25	0	0	13,663	0	0	0	0
30-Aug	15	0	0	13,678	0	0	0	0
31-Aug	1,021	0	0	14,699	0	0	0	0
1-Sep	42	0	0	14,741	0	0	0	0
2-Sep	525	0	0	15,266	0	0	0	0
3-Sep	61	0	0	15,327	0	0	0	0
4-Sep	161	0	96	15,584	0	0	0	0
5-Sep	31	0	0	15,615	0	0	0	0
6-Sep	823	0	0	16,438	0	2	2	2
7-Sep	43	0	0	16,481	0	0	2	2
8-Sep	29	0	0	16,510	0	0	2	2
9-Sep	190	0	0	16,700	0	0	2	2
10-Sep	37	0	0	16,737	0	0	2	2
11-Sep	126	0	0	16,863	0	0	2	2
12-Sep	10	0	0	16,873	0	0	2	2
13-Sep	6	0	0	16,879	0	0	2	2
Total	16,734	1	144	16,879	8	2		

% of fish with lures 0.05

Appendix 5. Hidden Lake 2007 - Update.

2007 Hidden Lake Project Update

Stocking & Misc. Activities

Crew on-site:	19-May	
Ice-out:	NA	(approximate date)
Crew off-site:	13-Sep	
Fry stocking:	20-May	658,000
Adult Otolith Collection	23-Aug and 4-Sep	

Smolt Migration

Dates:	19-May to 27-Jun	
	No.	%
Sockeyes:	216,800	
Mortalities:	74	0.0%
Age 1:	186,400	86.0%
Age 2:	35,300	16.3%
Hatchery:	151,100	69.7%
Coho:	25,502	
Dolly Varden:	42	
Rainbow:	13	

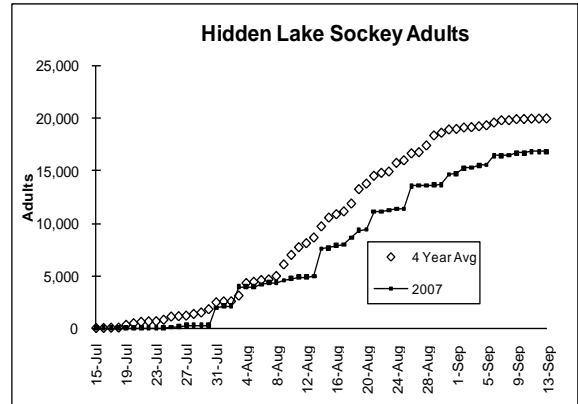
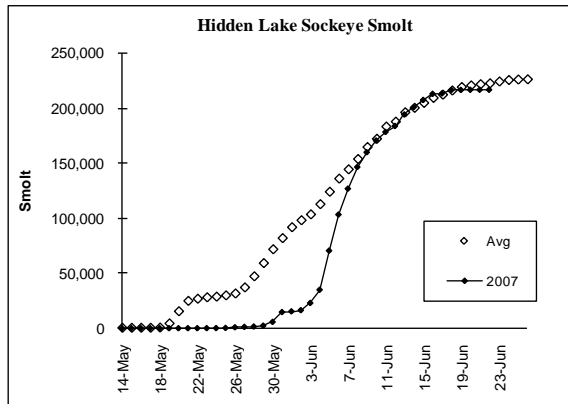
Egg Take

Dates:	19-Sep to 12-Oct	
No. of broodstock used:	2,231 ♀	2,199 ♂
Green eggs:	5,686,000	
Fecundity:	2,549	
Eyed eggs:	5,083,000	
Survival:	89.4%	

Adult Migration

Dates:	10-Jul to 13-Sep	
	No.	%
Sockeye total return:	51,902	
Hidden Creek return:	16,879	32.5%
Commercial Harvest:*	27,265	52.5%
Sportfish Harvest:*	4,112	7.9%
Personal Use Harvest:*	3,646	7.0%
Otolith Collection:	144	0.3%
Mortalities:	0	
Lake Escapement:		
Hatchery broodstock:	4,468	8.6%
Lake broodstock:		
Lures:	8	
Coho:	2	

* Commercial, sportfish and personal use harvests provided by ADF&G.



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