# Hidden Lake
# Sockeye Salmon Enhancement
# Progress Report
# 2012

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**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 the harvest and sale of surplus fish.**

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# DISCLAIMER

The Cook Inlet Aquaculture Association (CIAA) 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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Our equal employment opportunity philosophy applies to all aspects of employment with CIAA including recruiting, hiring, training, transfer, promotion, job benefits, pay, dismissal, and educational assistance.

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# ACKNOWLEDGEMENTS

Many individuals contributed to the 2012 field season at the Hidden Lake Salmon Enhancement Project. Appreciation is extended to the Cook Inlet Aquaculture Association seasonal assistants and full-time staff who invested many hours in planning and executing this project. Exceptional appreciation is extended to the Cook Inlet Aquaculture Association Board of Directors, the Alaska Department of Fish and Game, Pacific Northwest National Lab, the U.S. Fish and Wildlife Service Kenai Field Office, and the Kenai National Wildlife Refuge.

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# TABLE OF CONTENTS

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# LIST OF FIGURES

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# LIST OF TABLES

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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 and in 1988 Cook Inlet Aquaculture Association (CIAA) began assisting with the enhancement project. Since 1991 CIAA has completed all field activities.

In 2012, ADF&G, CIAA and United States Fish and Wildlife Services (USFWS), Kenai Wildlife Refuge (KWR) conducted an assessment review of the Hidden Lake Project. Based on this review an Operational Plan was developed and agreed to by all parties and is in effect for the next five years (2012-2017).

To supplement the Hidden Lake sockeye salmon population, on 15 May and 16 May 2012, an estimated 948,000 unfed sockeye fry (average weight = 0.08 g) were released into Hidden Lake. All fry were released at the eastern basin of the lake near the north shore. This was a new release site in comparison to previous years and is part of the new Operational Plan (2012-2017).

The Hidden Lake smolt migration was enumerated from 17 May and continued daily until 08 July. During this time an estimated 312,100 (±11,000) sockeye (*O. nerka*) and 23,200 (±600) coho (*O. kisutch*) smolt migrated from the lake. The 10% sub-sampling procedure was used to estimate the smolt migration during peak run periods. Of the total smolt migration, 18% (±3%), or 54,800 (±10,733), sockeye smolt and 5% (±3%), or 1,180 (±600), coho smolt were sub-sampled.

Based on the sockeye otolith samples collected which were readable (n=545), 65% (±4.0%) of the migrating sockeye smolt were incubated at Trail Lakes Hatchery. An estimated 94.7% (±2.1%) were age 1 and 5.3% (±2.1%) were age 2. The average length and weight of the age 1 sockeye smolt were 122 mm (±0.7 mm) and 16.6 g (±0.6 g). The average length and weight of the age 2 sockeye smolt were 181 mm (±4.8 mm) and 53.5 g (±9.4 g).

Based on the coho scale samples which were readable (n=299), an estimated 38.8% (±5.5%) of

the migrating coho smolt were age 1. An estimated 61.2% (±5.5%) were age 2. The average length and weight of the age 1 coho smolt were 127 mm (±1.4 mm) and 21.1 g (±2.3 g). The average length and weight of the age 2 coho smolt were 139 mm (±2.2 mm) and 24.9 g (±0.8 g).

The Hidden Lake adult salmon escapement was enumerated from 15 July to 6 September 2012. During this time, an estimated 30,466 adult sockeye and 0 adult coho salmon returned to Hidden Creek.

Of the adult sockeyes returning to Hidden Creek, scale analysis (n=514) estimated 79.4% were age 1.2, 13.4% were age 1.3, and 7.2% were age 2.2. Forty-five percent were male with an average length of 515 mm (±31 mm) and 55% were female with an average length of 514 mm (±28.1 mm). Based on adult otolith samples (n=598), an estimated 53% (±3.9%) adult sockeye salmon were incubated at Trail Lakes Hatchery.

In order to enhance the Hidden Lake sockeye salmon population, 0.964 million eggs were collected and shipped to Trail Lakes Hatchery for fertilization, incubation, and rearing on 25 September to 26 September 2012. An estimated 93% (900,514) fertilized eggs survived to the eyed stage. The surviving unfed fry will be stocked at Hidden Lake in 2013.

In 2012, as part of the new Operational Plan, CIAA undertook three special studies. The first study was to collect otoliths from adult sockeye salmon at three locations on Hidden Lake in order to determine the ratio of hatchery to naturally produced fish in each area. A total of 17 samples were collected from the Eastern basin, 233 samples from Western basin-North side and 236 from the Western basin-South side. In the Eastern basin, 94.1% were estimated as being from hatchery origin, while 73% and 52% were detected in the Western basin-North side and Western basin-South side sampling areas respectively.

The second study was to search for hatchery-reared Hidden Lake adult sockeye suspected of straying into the surrounding Kenai and Skilak Lake system. CIAA staff attempted to collected otolith samples from adult sockeye carcasses from Skilak Lake-North shore, Skilak Lake-South shore, Skilak Lake-Dunes area and the Kenai River-Jim's Landing to Skilak Confluence.

However, flood events for much of September made it impossible to complete this task. Samples were collected at Skilak-North (n=69) and Skilak-Dunes (n=100). No hatchery-reared fish were detected.

The third study was to collect otoliths from those fish which may be remaining in the lake and not migrating to the ocean (.i.e. residual salmon or kokanee). A total of 48 smaller sized spawning fish were collected. Otoliths were read by two different readers. Reader 1 estimated that predominant age (79%) were from the age class 2.1, while Reader 2 estimated that the predominant age (56%) were from age class 3.0 followed by age class 2.1 (25%). Based on these conflicting results, otolith samples were sent for microchemistry analysis at Pacific Northwest National Laboratory. Results indicate that the suspected residual salmon had not gone to ocean at any point in their life cycle.

Water chemistry and zooplankton samples were collected five (5) times during 2012. ADF&G provided the analysis. Zooplankton analysis was updated for 2010 through 2012.

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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 (Barton & Barrett, 1973 and Bill, Namtvedt, & Davis, 1972). 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 (FREDD) 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, Litchfield, & Todd, 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. 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:

1. Annually collecting sockeye eggs and releasing sockeye fry to the lake to target an annual average adult return of 30,000;
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 the Hidden Lake Sockeye Salmon Enhancement Project Technical Review (Simpson & Edmundson, 1999). Concerns arose regarding the amount of sockeye salmon entering Hidden Lake. In 2000, CIAA took steps to alleviate this 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. Also based on the technical review, ADF&G recommended that two special studies be conducted. One study to determine if hatchery incubated fish released to Hidden Lake were straying into other Kenai River system spawning populations and a second study to determine the contribution of hatchery incubated fish to the sockeye population returning to Hidden Lake.

In 2012, ADF&G, United States Fish and Wildlife Services (USFWS), Kenai Wildlife Refuge and CIAA participated in a review of the Hidden Lake project. United States Fish and Wildlife Services, Kenai Wildlife Refuge voiced concerns over two conditions in the Special Use Permit which they wanted to address. These two concerns were (1) the ratio of hatchery to natural fish in the spawning population and (2) the straying study had yet to be completed with statistically valid numbers. Based on these concerns all three parties agreed to the following changes to take place starting in 2012:

1. Change the release of hatchery reared unfed fry to the eastern basin of the lake,
2. Change the location of broodstock and egg collection to the western basin-south side of the lake ,
3. Collect otoliths during spawning from three regions on the lake (Eastern Basin- new fry release, Western Basin-South Side - new brood and egg collection site and Western Basin-North Side).
4. Collect otoliths from Skilak Lake (North (n=220) and South (n=220) side), Skilak Lake - Dunes area (n=440) and Kenai River - Jim's Landing to Skilak Confluence (n=220).
5. Collect otoliths from n=250 residual salmon during egg collection activities.

Items 1, 2 and 3 are changes for 2012-2017, while items number 4 and 5 will be assessed at the end of the 2012 season to determine if further sampling is necessary. Details of the above changes can be found in the Hidden Lake Operational Plan 2012 (Cook Inlet Aquaculture Association, United States Fish and Wildlife Services, Kenai Wildlife Refuge, Alaska Department of Fish and Game, 2012).

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# 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).

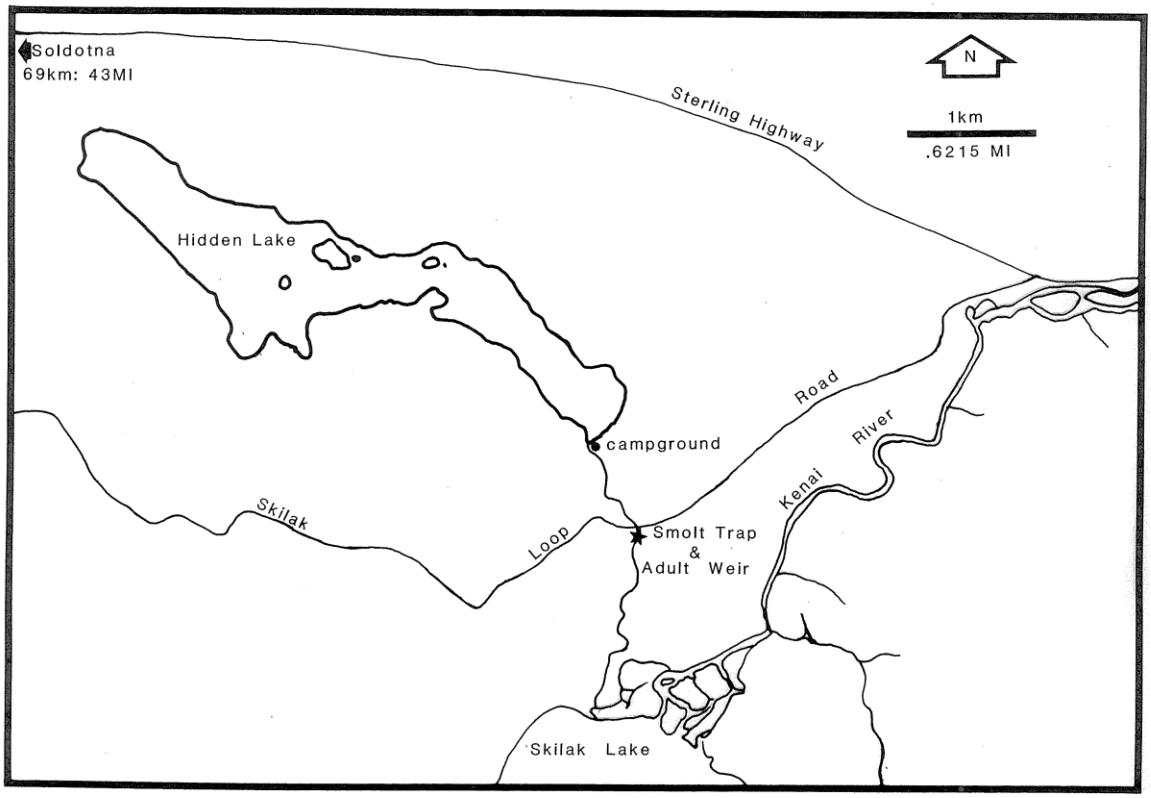



Figure 1. Area Map of Hidden Lake, Kenai Peninsula, Southcentral Alaska.

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.

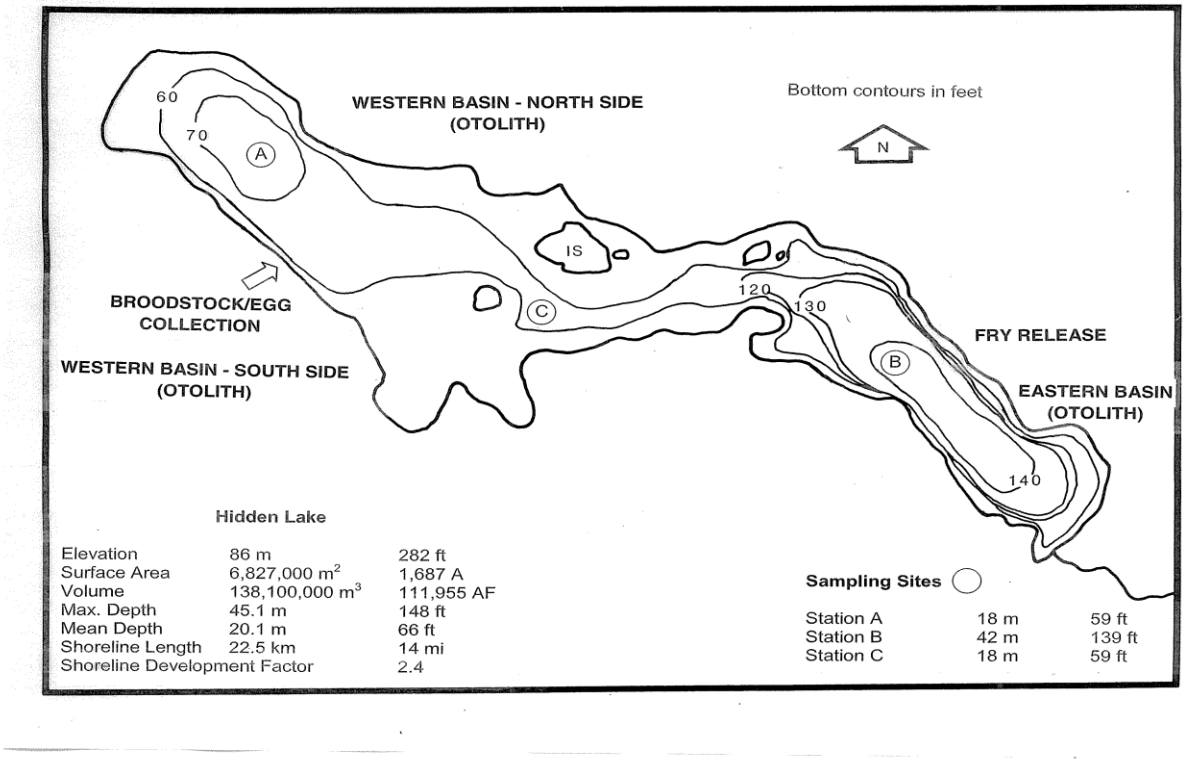



Figure 2. Morphometric map of Hidden Lake showing the two major basins.

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.

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. Historically, 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, Litchfield, & Todd,1990).

# METHODS

In general, Hidden Lake limnological sampling, salmon egg collection, hatchery incubation, fry rearing, smolt enumeration and adult escapement monitoring follow procedures recommended by ADF&G.

## Limnological Sampling and Environmental Conditions

During 2012, water quality samples were collected five times during the open water season in May, June, July, August and September. Due to weather conditions on September 20, 2012, only Site A and C were sampled.

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 horizontal Van Dorn beta sampler one meter below the surface and from the midhypolimnion. In addition to the two primary sites, one secondary site, Station C, was sampled (Figure 2). Measurements at the secondary site were limited to the zooplankton community and Secchi disk transparency.

CIAA followed water sample procedures described in the Limnology Field and Laboratory Manual: Methods for Assessing Aquatic Production (Koenings, Edmundson, Edumndson, & Kyle, 1986). Analysis was 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 day 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-sampling[1] 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:

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

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.

A detailed description of smolt enumeration procedures is available in CIAA's 2012 Hidden Lake Smolt Enumeration Procedures Manual.

**Smolt Characteristics and Enhanced Contribution**

During the smolt enumeration CIAA analyzed age, weight, and length characteristics of emigrating sockeye and coho salmon smolt. Additionally hatchery contribution was also assessed by collecting otolith samples from sockeye salmon smolt. No otolith sampling was conducted on any other species. However, scale samples were collected from the coho smolts. Since 1991, CIAA has marked the otolith of all sockeye salmon fry released to Hidden Lake with a thermal mark. The otolith mark is a hatchery induced thermal band produced by controlled temperature changes during incubation.

During the 2012 smolt migration, smolt samples were collected in proportion to the projected emigration. This was accomplished by attempting to collect every 500$^{th}$ sockeye smolt and every 30$^{th}$ coho smolt that was counted and passed through the smolt trap. In 2012, 0.2% of the migrating sockeye salmon were sampled (every 610th fish) and 13.0% of the migration coho salmon were sampled (every 76th coho). The numbering sequence began when the first fish passed through the trap and continued consecutively until the smolt migration was complete.

The fish were placed in a plastic container filled with a diluted solution of 99.5% pure Tricaine Methanesulfonate Finquel® MS-222® and water to anesthetize the fish during the sampling

event. Sockeye and coho smolt were first measured to the nearest millimeter for fork length[2] and then weighed to the nearest 0.1 gram. Up to ten scales were removed from the primary growth area[3] and mounted on a glass slide for subsequent age determination for coho salmon only. The otoliths from sockeye smolt were extracted following procedures by Glick and Shields (1993) and placed in a labeled one-dram vial. A dilute ethanol solution was added to the vial to cover the otoliths.

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 $h$, $\left(N = \sum N_h\right)$,

$n$ = total number of smolt sampled,

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

$a$ = total number of hatchery incubated smolt sampled,

$a_h$ = number of hatchery incubated smolt sampled in stratum $h$, $\left(a = \sum a_h\right)$,

$p_h = a_h / n_h$, 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 $h$, $\left(c_i = \sum c_{hi}\right)$,

$l_{hi} = c_{hi} / n_{hi}$, 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

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

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

Then, the proportion of hatchery incubated smolt, $\hat{P}$, is:

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

with a variance of:

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

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

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

with a variance of:

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

Since samples sizes 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:

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

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

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

with an approximate variance estimate of:

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

and 95% confidence interval estimates of:

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

**Adult Enumeration and Enhanced Contribution**

The 2012 Hidden Lake adult escapement was monitored to assess the returning fish population. To enumerate and sample returning salmon, two halves of the adult counting weir were temporarily installed in Hidden Creek. The weirs were 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. The weirs were erected perpendicular to the flow and positioned at an approximate distance of 5 yards of each other creating a trap between the two weirs. The double weir configuration comfortably held fish for a short period while field personnel safely operated the weir. During day time hours, field personnel passed fish upstream or downstream through both weirs. Personnel initially made hourly counts when the numbers of fish were few. As the number of fish ascending Hidden Creek increased, counts were made more frequently to prevent fish from accumulating behind the weir.

The returning adult population's characteristics were assessed by collecting a sample of the migrating sockeye adults to determine age, sex, and length characteristics. To obtain a representative sample for determining age, sex, and size of the returning adult sockeye population, samples were collected for every 50th adult sockeye which passed through the weir.

For 2012, 1.96% of the returning adult salmon were sampled (every 51st fish). Adult sockeye were captured at the weir, measured for standard fork length to the nearest millimeter, sex

determined, and a scale was removed from the primary growth area. The fish were unharmed and released upstream. Reading and statistical analysis of adult sockeye scales was conducted by the ADF&G.

Hatchery contribution was assessed by collecting otoliths from returning adult sockeye to identify the hatchery induced thermal band. CIAA attempted to collect a total of 600 readable otolith pairs for evaluation with equal number of samples (n=200) collected over the beginning, middle, and end of the escapement. For 2012, 598 otolith samples were collected. The otolith pairs were analyzed by CIAA staff to estimate hatchery contribution.

A detailed description of adult escapement enumeration procedures is available in the 2012 CIAA Hidden Lake Adult Enumeration Procedures Manual.

**Gamete Collection, Incubation and Rearing**

Gamete collection occurred on 25 and 26 September 2012. Adult sockeye were collected using a beach seine from the spawning area located in the western basin on the south shore, checked for ripeness and placed into net pens. This spawning location is different from previous years and is part of the changes implemented in 2012 to the Hidden Lake Operational Plan.

Gamete collection followed ADF&G Sockeye Salmon protocol. Equipment was disinfected between each fish. Single family delayed fertilization and water hardening disinfecting techniques were used. Iced coolers of eggs and milt in individual containers were transported to Trail Lakes Hatchery. Containers were disinfected prior to admission to the facility. Newly fertilized eggs were water hardened in iodophor solution for 2 hours before being placed into Kitoi incubators. Once eggs reached the eyed stage, eggs were shocked, picked and inventoried. Resulting live eggs were placed into Kitoi incubators for hatching and emergence. The sockeye eggs collected in 2012 are currently being incubated at Trail Lakes Hatchery. Incubation will follow standard hatchery procedures and water temperature will be regulated to thermally mark the otoliths of fish scheduled for release in 2013.

**Fish Transport and Stocking**

Prior to fish transport, fish samples were sent to ADF&G Pathology Lab for disease screening. The surviving unfed fry collected from adult sockeye in 2011 were measured for weight to the nearest 0.1 gram, transferred to fish transport tanks and transported to Hidden Lake. CIAA staff transported the sockeye fry via boat to the east basin of the lake and released the fry near the north shore. This location is different from previous years and is part of the changes implemented in 2012 to the Hidden Lake Operational Plan.

**Evaluation of Adult Sockeye Fidelity in Hidden Lake at Spawning**

Continuing with an evaluation on spawning fidelity by ADF&G (2008 through 2010), which indicated that the hatchery-reared fish have returned to their release location at a higher proportion than to other areas of the lake, CIAA attempted to collected 250 otoliths per location from the spawning population at three different locations. These three locations were the western basin at the (1) north (Western Basin-North Side) and (2) south side of the lake (Western Basin-South Side) and (3) an aggregate of the eastern basin (Eastern Basin). The south side of the western basin corresponds to the new broodstock/egg collection area while the aggregate of the eastern basis corresponds to the new fry release site. The north side of the western basin corresponds to the gamete collection site prior to 2012.

In 2012, otoliths were collected from 17, 233 and 236 fish from the Eastern Basin, Western Basin-North Side and Western Basin-South Side regions respectively. Spawning fish were collected via beach seine and were killed with a blow to the head and otoliths removed. Otoliths were analyzed for age structure and presence of thermal mark.

This study is new in 2012 and will continue for future years. Data collected from this study will be used to assess the changes that the egg collection and fry release location has on obtaining a 1:1 enhanced to natural ratio goal by 2017.

**Residual Salmon Monitoring**

It has been known for some time that a population of smaller sockeye salmon resides in Hidden Lake. It is believed that these fish do not migrate to the ocean at any point in their life cycle and hence are residual or Kokanee salmon. To assess the age structure and enhanced contribution of this population, CIAA staff attempted to collect 250 of the smaller sockeye salmon caught in the beach seine during egg collection activities to determine age structure and thermal mark. In 2012, 48 small sockeye salmon were collected and otoliths removed.

Two otolith samples from adult sockeye which were known to have entered and returned to seawater were sent to the Pacific Northwest National Laboratory along with four otolith samples collected from spawning sockeye believed to be from residual (kokanee) salmon captured in Hidden Lake. Samples were analyzed for isotopic composition namely the ratio of $^{87}Sr/^{86}Sr$ via laser aberration.

This study is new for 2012 and its continuation for the future is dependent on the results and discussions with USFWS, ADF&G and CIAA.

**Straying Study**

Based on the genetic mapping which was summarized in a ADF&G report (Barclay et al. 2010), three populations were identified as possible concerns for straying (1) Skilak Lake Outlet, (2) Kenai River between Skilak and Kenai Lakes and (3) Skilak Lake beach spawners (north and south side of the lake). CIAA, ADF&G and USWFS have agreed to analyze the straying rate of enhanced fish stocked into Hidden Lake based on the entire stock-complex (i.e. the entire Kenai River stock complex excluding Hidden Lake). The parameters under which this analysis will occur are: 2% overall stray rate at a precision of 35% with a 90% confidence interval. Due to the excessive samples that would be required to have statistical validation of these 3 key populations (1,100/population; 3,300 total samples), all parties agreed to monitor the aggregate of these populations, therefore requiring 1,100 samples to be collected in total, distributed among

the four areas. These four areas and number of samples to be collected are (1) Skilak Lake - South (n=220) , (2) Skilak Lake - North (n=220), (3) Kenai River - Jim's Landing to Skilak Lake confluence (n=220) and (4) Skilak - Dunes (n=440).

CIAA attempted to collect otoliths from carcasses found in each of these four areas on a weekly basis over the month of September. However, samples could only be collected in two of the areas through the second week of September before flood conditions made it impossible to complete the task safely and have representative data collected. Sixty-nine samples were collected from Skilak North and 100 from Skilak-Dunes.

# RESULTS AND DISCUSSION

## Limnology and Environmental Conditions

CIAA has completed limnology sampling at Hidden Lake since 1992. In 2012, water quality and zooplankton samples were collected five times (May, June, July, August and September). However, due to weather conditions on 20 September, water samples were collected from Station A and C only. No samples could be collected from Station B. Water quality analysis was completed by ADF&G and is summarized in Table 1. Zooplankton analysis was updated for 2010 through 2012 and was corrected for 2008 and 2009 due to spreadsheet formula errors.

Table 1. Average open water season water quality characteristics of Hidden Lake

| | AVERAGE WATER QUALITY - 1 METER | | | | | | | | | | 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) | EZD (m) | Secchi (m) | Zooplankton (mg/m2) | Sp. Cond (umhos/cm) | pH (SU) | Alk (mg/l) | Turb. (NTU) | TP (ug/l) | TKN (ug/l) | Chl a (ug/l) |
| 1980 | 145 | 7.8 | 66 | | 6.8 | 120 | 2.1 | | | | 146 | 7.8 | 69 | | 6.1 | 140 | 1.8 |
| 1981 | 117 | 7.0 | 73 | | 6.6 | 171 | 0.6 | | | 2,381 | 116 | 7.0 | 74 | | 6.5 | 175 | 0.5 |
| 1982 | 137 | 8.1 | 70 | | 8.6 | 174 | 0.4 | | | 1,619 | 136 | 8.0 | 71 | | 7.2 | 172 | 0.5 |
| 1983 | 144 | 8.1 | 72 | | 6.9 | 176 | 0.5 | | | 3,285 | 148 | 7.8 | 73 | | 9.2 | 193 | 0.8 |
| 1984 | 146 | 7.9 | 71 | | 6.7 | 172 | 0.7 | | | 2,248 | 149 | 7.7 | 72 | 0.6 | 6.3 | 168 | 0.6 |
| 1985 | 147 | 7.9 | 78 | 0.7 | 7.2 | 177 | 0.9 | | | 1,967 | 147 | 7.7 | 79 | 0.7 | 8.2 | 179 | 0.7 |
| 1986 | 144 | 7.8 | 72 | 0.4 | 7.5 | 185 | 0.3 | | | 2,420 | 146 | 7.7 | 71 | 0.3 | 7.6 | 180 | 0.3 |
| 1987 | 147 | 8.0 | 70 | 0.2 | 6.9 | 188 | 0.5 | | | 1,390 | 150 | 7.8 | 70 | 0.3 | 8.3 | 191 | 0.5 |
| 1988 | 146 | 7.8 | 67 | 0.6 | 6.8 | 197 | 0.6 | | | 2,466 | 150 | 7.6 | 67 | 0.4 | 7.0 | 195 | 0.6 |
| 1989 | 146 | 8.0 | 67 | 0.4 | 7.8 | 198 | 0.4 | | | 3,437 | 149 | 7.9 | 67 | 0.4 | 8.0 | 196 | 0.4 |
| 1990 | 147 | 8.0 | 73 | 0.4 | 7.8 | 193 | 0.8 | | | 2,258 | 148 | 7.8 | 73 | 0.4 | 8.5 | 187 | 0.7 |
| 1991 | 152 | 8.0 | 72 | 0.7 | 6.7 | 171 | 0.8 | 20.2 | 7.3 | 2,222 | 154 | 7.8 | 73 | 0.7 | 8.2 | 189 | 0.6 |
| 1992 | 145 | 8.0 | 66 | 0.7 | 7.4 | 231 | 1.3 | 15.2 | 5.0 | 1,030 | 147 | 7.7 | 69 | 0.6 | 9.5 | 218 | 1.1 |
| 1993 | 150 | 7.8 | 68 | 0.5 | 7.0 | 198 | 1.5 | 14.0 | 6.4 | 2,030 | 156 | 7.6 | 71 | 0.4 | 8.0 | 203 | 1.3 |
| 1994 | 156 | 7.8 | 70 | 0.5 | 7.4 | 210 | 1.6 | 19.6 | 6.7 | 847 | 157 | 7.6 | 70 | 0.6 | 7.3 | 188 | 0.9 |
| 1995 | 153 | 7.8 | 71 | 0.7 | 5.7 | 197 | 1.8 | 20.0 | 7.6 | 1,520 | 159 | 7.6 | 72 | 0.7 | 6.5 | 189 | 1.6 |
| 1996 | 152 | 7.8 | 71 | 0.7 | 5.6 | 188 | 0.9 | 19.6 | 8.4 | 1,338 | 159 | 7.7 | 73 | 0.7 | 6.3 | 190 | 2.6 |
| 1997 | 153 | 7.8 | 73 | 0.4 | 6.6 | 186 | 0.7 | 20.2 | 9.7 | 2,111 | 153 | 7.8 | 73 | 0.5 | 9.0 | 201 | 1.2 |
| 1998 | 150 | 8.0 | 72 | 0.8 | 6.4 | 205 | 0.8 | 21.0 | 7.2 | 2,358 | 153 | 7.8 | 72 | 0.1 | 6.6 | 194 | 0.6 |
| 1999 | 149 | 7.6 | 72 | 0.7 | 7.3 | 234 | 0.8 | 18.7 | 6.7 | 2,474 | 153 | 7.5 | 72 | 0.7 | 7.4 | 221 | 0.5 |
| 2000 | 150 | 7.8 | 69 | 0.8 | 7.2 | 234 | 1.6 | 20.4 | 8.7 | 3,896 | 151 | 7.7 | 70 | 0.7 | 7.9 | 245 | 1.5 |
| 2001 | 150 | 7.6 | 68 | 0.7 | 7.8 | 231 | 1.1 | 19.4 | 7.1 | 3,398 | 152 | 7.5 | 69 | 0.7 | 7.5 | 222 | 0.9 |
| 2002 | 147 | 7.7 | 73 | 0.4 | 8.6 | 257 | 1.1 | 17.9 | 5.9 | 2,447 | 150 | 7.6 | 73 | 0.5 | 9.1 | 239 | 0.7 |
| 2003 | 148 | 7.3 | 70 | 0.4 | 8.4 | 229 | 2.8 | 17.1 | 7.0 | 959 | 149 | 7.3 | 68 | 0.5 | 8.9 | 224 | 1.5 |
| 2004 | 141 | 7.5 | 70 | 0.3 | 11.7 | 286 | 1.0 | 17.1 | 6.6 | 1,450 | 151 | 7.7 | 71 | 0.5 | 13.1 | 302 | 1.0 |
| 2005 | 149 | 7.2 | 68 | 0.3 | 9.8 | 273 | 0.5 | 17.5 | 7.0 | 1,693 | 149 | 7.2 | 68 | 0.1 | 11.8 | 277 | 0.5 |
| 2006 | 147 | 7.3 | 67 | 0.1 | 8.2 | 237 | 0.5 | 23.4 | 8.0 | 1,445 | 148 | 7.4 | 68 | 0.2 | 8.5 | 216 | 0.6 |
| 2007 | 151 | 7.8 | 71 | 0.6 | 8.4 | 218 | 0.7 | 21.4 | 9.0 | 1,589 | 154 | 7.7 | 71 | 0.5 | 9.9 | 222 | 0.9 |
| 2008 | 149 | 7.4 | 68 | 0.3 | 12.4 | 217 | 0.6 | 20.6 | 7.8 | 1,373 | 152 | 7.3 | 69 | 0.2 | 8.8 | 202 | 0.5 |
| 2009 | 151 | 7.4 | 69 | 0.3 | 8.8 | 229 | 0.5 | 20.0 | 8.1 | 1,515 | 151 | 7.3 | 68 | 0.2 | 8.1 | 219 | 0.6 |
| 2010 | 154 | 7.5 | 66 | 0.2 | 7.7 | NA | 0.6 | 20.2 | 7.4 | 955 | 152 | 7.5 | 66 | 0.6 | 7.5 | NA | 0.9 |
| 2011 | 160 | 8.0 | 73 | 0.8 | 6.5 | NA | 0.9 | 24.0 | 8.5 | 1,313 | 162 | 7.9 | 72 | 0.3 | 12 | NA | 2.4 |
| 2012 | 160 | 7.9 | 69 | 0.4 | 6.5 | NA | 1.0 | 20.6 | 7.7 | 1,419 | 163 | 7.7 | 70 | 0.5 | 6.2 | NA | 1.0 |

Averages prior to 1992 compiled by ADF&G.
EZD and Secchi provided by CIAA.
Open water season only.
Zooplankton data was corrected for 2008 onward.

Environmental conditions during the Hidden Lake smolt migration were monitored from 17 May to 08 July 2012. Stream stage measurements declined over the course of the smolt migration with the exception of an increase in stage height in late May. The average change in stage height over this time period was -0.5 ft (±0.06 ft). During the period of smolt migration, stream temperatures averaged 12°C (±3°C). Air temperatures averaged 15°C (±5°C). Eleven percent of the days were clear, 9% had less than 50% cloud cover, 36% had more than 50% cloud cover, and 28% were completely overcast. Measurable rain was recorded on 23 days (43%) during the smolt migration. A total of 76 mm of rain fell during this period.

Environmental conditions during the Hidden Lake adult sockeye migration were monitored from 14 July to 06 September 2012. Stream stage measurements declined over the course of the adult migration. The average change in stage height over this time period was -0.11 ft (±0.07 ft). Stream temperatures averaged 16°C (±2°C) and air temperatures averaged 16°C (±3°C). Two percent of the days were clear, 27% had less than 50% cloud cover, 24% had more than 50% cloud cover, and 36% were completely overcast. Measurable rain was recorded on 36 days (65%) during the adult migration. A total of 71 mm of rain fell during this period.

**Smolt Enumeration**

The Hidden Lake smolt migration was enumerated from 17 May and continued daily until 08 July. During this time an estimated 312,100 (±11,000) sockeye and 23,200 (±600) coho smolt salmon migrated from the lake. Other fish counted included 60 rainbow trout (*O. mykiss*), and 28 dolly varden (*S. malma*). The 10% sub-sampling procedure was used to enumerate 18% of the total sockeye salmon smolt and 5% of the total coho salmon smolt.

In general, the pattern of the 2012 Hidden Lake sockeye salmon smolt migration was similar to the average smolt migrations observed over the last 4 years both in terms of total count and run timing.

**Smolt Characteristics and Enhanced Contribution**

Otolith, weight, and length measurements were collected and analyzed on 611 sockeye salmon

smolts. However, only 545 of these samples were readable. A number of the otoliths were identified as being "soft" in structure and therefore, difficult to grind and polish. Based on the otolith samples collected, 65% (±4.0%) of the migrating sockeye smolt were incubated at Trail Lakes Hatchery. An estimated 94.7% (±2.1%) were age 1 and 5.3% (±2.1%) were age 2. The average length and weight of the age 1 sockeye smolt were 122 mm (±0.7 mm) and 16.6 g (±0.61 g). The average length and weight of the age 2 sockeye smolt were 181 mm (±2.5 mm) and 53.5 g (±9.4 g).

Scale age, weight, and length measurements were made on 302 coho smolt, of which 299 samples were readable. Based on the scale samples collected, an estimated 38.8% (±5.5%) of the migrating coho smolt were age 1. An estimated 61.2% (±5.5%) were age 2. The average length and weight of the age 1 coho smolt were 127 mm (±1.4 mm) and 21.1 g (±2.3 g). The average length and weight of the age 2 coho smolt were 139 mm (±2.2 mm) and 25.0 g (±0.8 g).

The age structure, average length, and weight measurements of the sockeye and coho smolt were different in comparison to the previous three years with more age 1 fish being identified and the sockeye salmon being smaller in size but were comparable to the overall historic information (Table 2).

Prior to 1988, estimates of the enhanced contribution 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, Litchfield, & Todd, 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.

Table 2. Age structure, length and weight characteristics of Hidden Lake sockeye smolts, 1976 - 2012

| | | Age Class 1.0 | | | Age Class 2.0 | | | Mean Length (mm) | | | | Mean weight (g) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Smolt Year | # Live Migr. | % | 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 | 29,639 | 80 | | 23,711 | 20 | 5,928 | | 130 | | 146 | | NA | | NA | |
| 1977 | 17,670 | 83 | | 14,666 | 17 | 3,004 | | 144 | | 199 | | NA | | NA | |
| 1978 | 111,466 | 88 | | 98,090 | 12 | 13,376 | | 133 | | 190 | | 22.4 | | 79.3 | |
| 1979 | 94,347 | 85 | | 80,195 | 15 | 14,152 | | 145 | | 177 | | 30.7 | | 57.2 | |
| 1980 | 81,748 | 90 | | 73,573 | 10 | 8,175 | | 143 | | 200 | | 27.3 | | 83.9 | |
| 1981 | 161,522 | 98 | | 158,292 | 2 | 3,230 | | 144 | | 198 | | 28.5 | | 81.4 | |
| 1982 | 222,673 | 99 | | 220,446 | 1 | 2,227 | | 145 | | 174 | | 27.3 | | 55.3 | |
| 1983 | 235,233 | 94 | | 221,119 | 6 | 14,114 | | 132 | | 186 | | 21.3 | | 66.1 | |
| 1984 | 419,376 | 95 | | 398,407 | 5 | 20,969 | | 144 | | 170 | | 28.7 | | 49.2 | |
| 1985 | 396,000 | 97 | | 384,120 | 3 | 11,880 | | 141 | | 185 | | 26.3 | | 63.7 | |
| 1986 | 651,889 | 96 | | 625,813 | 4 | 26,076 | | 134 | | 180 | | 22.4 | | 55.6 | |
| 1987 | 68,980 | 81 | | 55,874 | 19 | 13,106 | | 143 | | 175 | | 28.0 | | 54.3 | |
| 1988 | 471,625 | 94 | | 443,328 | 6 | 28,298 | | 128 | | 179 | | 18.7 | | 59.1 | |
| 1989 | 719,527 | 94 | | 676,355 | 6 | 43,172 | | 126 | | 163 | | 17.6 | | 43.5 | |
| 1990 | 231,300 | 78 | | 180,414 | 21 | 48,573 | | 140 | | 191 | | 30.0 | | 71.6 | |
| 1991 | 208,500 | 93 | | 193,905 | 6 | 12,510 | | 140 | | 205 | | 25.4 | | 88.9 | |
| 1992 | 191,900 | 95 | | 182,305 | 5 | 9,595 | | 133 | | 172 | | 21.5 | | 47.1 | |
| 1993 | 388,500 | 89 | | 345,765 | 10 | 38,850 | | 130 | | 183 | | 20.4 | | 61.2 | |
| 1994 | 414,400 | 94 | | 389,536 | 6 | 24,864 | | 130 | | 179 | | 18.1 | | 49.8 | |
| 1995 | 293,700 | 86 | | 252,582 | 13 | 38,181 | | 128 | | 181 | | 18.3 | | 56.5 | |
| 1996 | 427,400 | 95 | (±2.1) | 406,030 | 5 | 21,370 | (±2.1) | 135 | (±0.5) | 190 | (±4.5) | 19.1 | (±0.3) | 59.4 | (±6.5) |
| 1997 | 228,400 | 96 | (±2.7) | 219,264 | 4 | 9,136 | (±2.7) | 123 | (±0.6) | 190 | (±15.9) | 15.9 | (±0.3) | 72.7 | (±19.7) |
| 1998 | 384,800 | 91 | (±2.9) | 350,168 | 9 | 34,632 | (±2.9) | 129 | (±0.7) | 203 | (±5.8) | 20.0 | (±0.4) | 82.3 | (±6.5) |
| 1999 | 312,644 | 86 | (±3.6) | 268,874 | 14 | 43,770 | (±3.6) | 132 | (±0.6) | 173 | (±5.1) | 23.0 | (±0.3) | 51.1 | (±4.8) |
| 2000 | 474,900 | 93 | (±2.2) | 441,657 | 8 | 37,992 | (±2.2) | 138 | (±0.5) | 182 | (±7.3) | 25.0 | (±0.3) | 64.0 | (±7.8) |
| 2001 | 324,400 | 94 | (±2.6) | 304,936 | 6 | 19,464 | (±2.5) | 134 | (±0.5) | 165 | (±8.6) | 22.3 | (±0.3) | 45.0 | (±8.0) |
| 2002 | 366,600 | 86 | (±2.2) | 315,276 | 13 | 47,658 | (±2.2) | 134 | (±0.8) | 165 | (±6.0) | 22.2 | (±0.4) | 45.0 | (±4.8) |
| 2003 | 308,500 | 94 | (±2.2) | 289,990 | 6 | 18,510 | (±2.2) | 140 | (±0.5) | 179 | (±0.8) | 24.7 | (±0.2) | 60.5 | (±6.5) |
| 2004 | 180,600 | 64 | (±3.7) | 115,584 | 36 | 65,016 | (±3.7) | 140 | (±0.8) | 179 | (±3.6) | 24.7 | (±0.8) | 60.5 | (±3.7) |
| 2005 | 289,300 | 91 | (±1.8) | 263,263 | 9 | 26,037 | (±1.9) | 140 | (±0.5) | 179 | (±3.6) | 24.7 | (±2.0) | 60.5 | (±3.7) |
| 2006 | 200,000 | 91 | (±2.4) | 182,000 | 9 | 18,000 | (±2.4) | 140 | (±0.9) | 179 | (±10.3) | 24.7 | (±0.5) | 60.4 | (±8.7) |
| 2007 | 216,000 | 86 | (±2.8) | 185,760 | 16 | 34,560 | (±3.0) | 135 | (±0.9) | 167 | (±3.1) | 24.7 | (±1.0) | 47.4 | (±4.8) |
| 2008 | 349,600 | 97 | (±1.8) | 339,112 | 3 | 10,488 | (±1.7) | 123 | (±0.9) | 170 | (±16.3) | 18.0 | (±0.3) | 49.5 | (±12.2) |
| 2009 | 315,200 | 88 | (±2.4) | 277,376 | 12 | 37,824 | (±2.4) | 131 | (±0.5) | 175 | (±3.0) | 22.9 | (±0.5) | 55.7 | (±3.7) |
| 2010 | 283,300 | 84 | (±3.4) | 237,972 | 16 | 45,328 | (±3.4) | 120 | (±7.0) | 188 | (±13.0) | 17.0 | (±2.5) | 67.8 | (±5.9) |
| 2011 | 298,700 | 70 | (±4.2) | 207,895 | 30 | 90,805 | (±4.2) | 137 | (±5.0) | 197 | (±2.5) | 24.5 | (±0.9) | 77.8 | (±2.9) |
| 2012 | 312,100 | 95 | (±2.1) | 296,495 | 5 | 15,605 | (±2.1) | 122 | (±0.7) | 181 | (±4.8) | 16.6 | (±0.6) | 53.5 | (±9.3) |
| Mean | | 89 | | | 10 | | | 135 | | 181 | | 21.7 | | 57.8 | |

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

In 2012, the proportion of hatchery-incubated salmon in the sockeye smolt migration was 65% (±4.0%) (Table 3). The 2012 hatchery contribution is slightly less than the 1993-2012 average of 66% but higher than the most recent 4 year average of 53%.

Table 3. The contribution of enhanced sockeye to the Hidden lake smolt migrations, 1976 - 2012

| Smolt Year | Total # Live Migr. | 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 | 414,400 | (±40,400) | 53,900 | 360,500 | 87 | (±3.9) |
| 1995 | 293,700 | (±33,400) | 79,300 | 214,400 | 73 | (±6.5) |
| 1996 | 427,400 | (±15,700) | 94,000 | 333,400 | 78 | (±3.6) |
| 1997 | 228,400 | (±0) | 66,200 | 162,200 | 71 | (±5.1) |
| 1998 | 384,800 | (±45,000) | 84,700 | 300,100 | 78 | (±3.7) |
| 1999 | 312,644 | (±13,400) | 93,800 | 218,900 | 70 | (±4.2) |
| 2000 | 474,900 | (±52,600) | 109,200 | 365,700 | 77 | (±3.2) |
| 2001 | 324,400 | (±0) | 94,100 | 230,300 | 71 | (±4.4) |
| 2002 | 366,600 | (±51,400) | 132,000 | 234,600 | 64 | (±4.4) |
| 2003 | 308,500 | (±17,300) | 64,800 | 243,700 | 79 | (±3.1) |
| 2004 | 180,600 | (±0) | 131,800 | 48,800 | 27 | (±3.9) |
| 2005 | 289,300 | (±15,500) | 69,400 | 219,900 | 76 | (±2.6) |
| 2006 | 200,000 | (±17,900) | 106,000 | 94,000 | 47 | (±3.6) |
| 2007 | 216,000 | (±70,700) | 64,800 | 151,200 | 70 | (±3.4) |
| 2008 | 349,600 | (±58,500) | 139,800 | 209,800 | 60 | (±4.3) |
| 2009 | 315,200 | (±9,000) | 154,400 | 160,800 | 51 | (±3.4) |
| 2010 | 283,300 | (±13,530) | 140,200 | 143,100 | 51 | (±4.1) |
| 2011 | 298,700 | (±17,639) | 157,400 | 141,300 | 47 | (±3.8) |
| 2012 | 312,100 | (±11,000) | 109,600 | 203,100 | 65 | (±4.0) |
| Mean | 318,500 | | 100,400 | 218,100 | 66 | |
| 4-year Mean | 302,300 | | 140,400 | 162,100 | 53 | |

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).
This summary is total migration minus the mortalities

## Adult Enumeration and Enhanced Contribution

The Hidden Lake adult salmon escapement was enumerated from 15 July to 06 September 2012. During this time, an estimated 30,500 adult sockeye salmon (*O. nerka*) and 0 adult coho salmon

(*O. kisutch*) returned to Hidden Creek. No other fish were reported. Personnel collected scales from 597 adult sockeye, of which 514 scales were readable. The percentage of adult male and adult female sockeye salmon returning to Hidden Lake was 45% and 55%, respectively. Male fish averaged 515 mm (±30.6 mm) in length and the females averaged 502 mm (±24.4 mm). An estimated 0.0% were age 1.1, 79.4% were age 1.2, 13.4% were age 1.3, 7.2% were age 2.2, and 0.0% were age 2.3.

To determine the contribution of hatchery incubated fish to the population of adult sockeye returning to Hidden Lake, CIAA staff collected 598 otolith pairs from Hidden Creek on 31 July, 14 August, and 23 August 2012, of which 583 pairs were readable. Based on otolith marks, an estimated 53% (±3.9%) adult sockeye salmon were incubated at Trail Lakes Hatchery. The 598 fish collected for otolith extraction were not included in the lake escapement.

Prior to 1999, adult hatchery contribution was not evaluated. The Hidden Lake adult hatchery contribution from 1999-2012 was 59%. Hatchery contribution was not included in the analysis in 2005 and 2006 due to inconsistency in daily escapement which created an unpredictable sampling technique and rendered statistically inconclusive results. Hatchery contribution decreased to 57% when looking at the most recent 4 year average hatchery return from 2009-2012. Table 4 summarizes historical sockeye escapements and major age classes based on calendar year while Table 5 summarizes the same information but on a brood year basis and for enhanced characteristics only. On a brood year basis, the enhanced characteristics of that year class of smolts are a good predictor of what the adult returns are for that same year class.

Table 4. Summary of Hidden Lake salmon escapement, age distribution and fish length, 1976 - 2012

| | | | | | | Major Age Classes | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Lake | Hatchery Return | | | | 1.2 | | | 1.3 | | | 2.2 | | |
| Year | Escapement | (%) | (C.I.) | Hatchery | Wild | (%) | # | Lth(mm) | (%) | # | Lth(mm) | (%) | # | Lth(mm) |
| 1976 | 4,860 | | | | | 79 | 3,839 | 540 | 1 | 49 | 530 | 20 | 972 | 550 |
| 1977 | 1,055 | | | | | 64 | 675 | 550 | 2 | 21 | 600 | 34 | 359 | 570 |
| 1978 | 4,647 | | | | | 88 | 4,089 | 530 | 10 | 465 | 540 | 2 | 93 | 540 |
| 1979 | 5,762 | | | | | 90 | 5,186 | 540 | 4 | 230 | 560 | 6 | 346 | 550 |
| 1980 | 27,488 | | | | | 92 | 25,289 | 530 | 1 | 275 | 560 | 1 | 275 | 530 |
| 1981 | 15,939 | | | | | 78 | 12,432 | 530 | 15 | 2,391 | 560 | 7 | 1,116 | 555 |
| 1982 | 9,790 | | | | | 70 | 6,853 | 520 | 23 | 2,252 | 560 | 4 | 392 | 520 |
| 1983 | 11,297 | | | | | 87 | 9,828 | 530 | 11 | 1,243 | 550 | 2 | 226 | 530 |
| 1984 | 27,784 | | | | | 92 | 25,561 | 520 | 3 | 834 | 570 | 5 | 1,389 | 550 |
| 1985 | 24,784 | | | | | 77 | 19,084 | 520 | 13 | 3,222 | 570 | 9 | 2,231 | 580 |
| 1986 | 17,530 | | | | | 85 | 14,901 | 530 | 9 | 1,578 | 570 | 6 | 1,052 | 540 |
| 1987 | 43,487 | | | | | 96 | 41,748 | 530 | 3 | 1,305 | 540 | 0 | 0 | 540 |
| 1988 | 50,907 | | | | | 94 | 47,853 | 540 | 4 | 2,036 | 570 | 2 | 1,018 | 570 |
| 1989 | 7,770 | | | | | 44 | 3,419 | 550 | 41 | 3,186 | 580 | 15 | 1,166 | 540 |
| 1990 | 77,959 | | | | | 86 | 67,045 | 507 | 2 | 1,559 | 565 | 12 | 9,355 | 516 |
| 1991 | 35,576 | | | | | 90 | 32,018 | 512 | 7 | 2,490 | 557 | 3 | 1,067 | 521 |
| 1992 | 32,912 | | | | | 82 | 26,988 | 505 | 13 | 4,279 | 551 | 5 | 1,646 | 513 |
| 1993 | 11,582 | | | | | 80 | 9,266 | 529 | 9 | 1,042 | 568 | 11 | 1,274 | 536 |
| 1994 | 6,086 | | | | | 60 | 3,652 | 493 | 31 | 1,887 | 557 | 6 | 365 | 507 |
| 1995 | 7,542 | | | | | 63 | 4,751 | 514 | 12 | 905 | 559 | 21 | 1,584 | 525 |
| 1996 | 55,526 | | | | | 83 | 46,087 | 539 | 7 | 3,887 | 587 | 9 | 4,997 | 540 |
| 1997 | 56,053 | | | | | 77 | 43,161 | 514 | 18 | 10,090 | 566 | 3 | 1,682 | 536 |
| 1998 | 67,727 | | | | | 83 | 56,213 | 510 | 14 | 9,482 | 556 | 3 | 2,032 | 516 |
| 1999 | 49,406 | 69% | (±3.7%) | 34,288 | 15,118 | 89 | 43,971 | 455 | 6 | 2,964 | 549 | 5 | 2,470 | 502 |
| 2000 | 45,685 | 62% | (±3.6%) | 28,325 | 17,360 | 82 | 37,462 | 519 | 9 | 4,112 | 560 | 8 | 3,655 | 530 |
| 2001 | 42,462 | 58% | (±4.0%) | 24,585 | 17,877 | 63 | 26,827 | 525 | 20 | 8,548 | 564 | 12 | 5,282 | 544 |
| 2002 | 71,983 | 62% | (±3.1%) | 44,629 | 27,354 | 73 | 52,548 | 537 | 18 | 12,957 | 582 | 7 | 5,039 | 544 |
| 2003 | 11,734 | 58% | (±5.2%) | 6,794 | 4,940 | 70 | 8,214 | 517 | 24 | 2,816 | 568 | 6 | 704 | 570 |
| 2004 | 18,172 | 77% | (±2.7%) | 13,956 | 4,216 | 67 | 12,175 | 521 | 19 | 3,453 | 568 | 12 | 2,181 | 540 |
| 2005 | 13,000 | ND | ND | ND | ND | 79 | 10,270 | ND | 12 | 1,560 | ND | 9 | 1,170 | ND |
| 2006 | 38,535 | ND | ND | ND | ND | 89 | 34,296 | 502 | 4 | 1,541 | 547 | 7 | 2,697 | 506 |
| 2007 | 16,735 | 57% | (±7.9%) | 9,489 | 7,246 | 63 | 10,618 | 537 | 23 | 3,864 | 562 | 11 | 1,888 | 520 |
| 2008 | 15,072 | 41% | (±1.5%) | 6,104 | 8,968 | 86 | 12,962 | 511 | 8 | 1,206 | 573 | 6 | 904 | 517 |
| 2009 | 11,002 | 67% | (±1.8%) | 7,338 | 3,664 | 65 | 7,151 | 518 | 21 | 2,310 | 553 | 8 | 880 | 518 |
| 2010 | 40,503 | 56% | (±1.7%) | 22,560 | 17,943 | 91 | 36,781 | 500 | 1 | 522 | 543 | 8 | 3,196 | 496 |
| 2011 | 17,771 | 51% | (±3.8%) | 9,117 | 8,654 | 84 | 14,887 | 506 | 8 | 1,441 | 546 | 7 | 1,290 | 496 |
| 2012 | 30,466 | 53% | (±3.9%) | 16,100 | 14,366 | 79 | 24,068 | 500 | 13 | 3,961 | 547 | 7 | 2,133 | 521 |
| Mean | 27,746 | 59% | | 18,607 | 12,309 | 79 | 23,731 | 520 | 12 | 3,661 | 561 | 8 | 2,392 | 533 |
| 4 Year Avg | 24,936 | 57% | | 13,779 | 11,157 | 80 | 20,722 | 506 | 11 | 2,059 | 547 | 8 | 1,875 | 508 |
| Min | 1,055 | 41% | | 6,104 | 3,664 | 44 | 7,151 | 455 | 1 | 522 | 530 | 0 | 704 | 496 |
| Max | 77,959 | 77% | | 44,629 | 27,354 | 96 | 52,548 | 550 | 41 | 12,957 | 600 | 34 | 5,282 | 580 |

Data prior to 1990 from Kyle, et al. 1990.
ND = No Data Collected or Calculated
Note: Total is escapment to the lake and not fish returning to weir (morts and sampled fish)
1991 - Total sockeye return to weir was 112,792. Personal use-dipnet fishery harvested 72,060. 5,156 were donated to charity
2005 - 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
2008 - Total estimated return includes 1,500 sockeye estimated due to high bear activity.

Table 5. Summary of enhanced contribution for smolt and adult migrations by brood year, (BY1991 - 2009)

| | Smolt Migration | | Adult Migration | |
|---|---|---|---|---|
| Brood Year | % Hatchery | % Wild | % Hatchery | % Wild |
| 1991 | 84 | 16 | Incomplete Brood Years | |
| 1992 | 86 | 14 | | |
| 1993 | 73 | 27 | | |
| 1994 | 78 | 22 | | |
| 1995 | 72 | 28 | 68 | 32 |
| 1996 | 77 | 23 | 61 | 39 |
| 1997 | 71 | 29 | 60 | 40 |
| 1998 | 77 | 23 | 62 | 38 |
| 1999 | 70 | 30 | 64 | 36 |
| 2000 | 65 | 35 | Incomplete Brood Years | |
| 2001 | 69 | 31 | | |
| 2002 | 36 | 64 | | |
| 2003 | 74 | 26 | 55 | 45 |
| 2004 | 51 | 49 | 46 | 54 |
| 2005 | 69 | 31 | 63 | 37 |
| 2006 | 59 | 41 | 56 | 44 |
| 2007 | 51 | 49 | 52 | 48 |
| 2008 | 50 | 50 | 53 | 47 |
| 2009 | 49 | 51 | | |
| 4 yr avg. | 52 | 48 | 56 | 44 |

*4 year average is for complete brood years only

The 2012 estimated commercial fishery harvest of Hidden Lake sockeye salmon (enhanced and wild) was 27,567 and personal use and sport fishery combined was estimated at 24,392 (M. Willette, 2012). Common property harvest was estimated to be 63% and escapement to Hidden Lake was 37%. Table 6 summarizes the common property harvest and escapement percentages since 1996.

Based on information collected from migrating sockeye smolts and returning sockeye adults, it is possible to provide an estimate of the survival of each brood year in the marine environment. This information is summarized below in Table 7.

Table 6. Historical common property harvests and escapement to Hidden Lake (1996 - 2012)

| Year | % Harvest | % Escapement |
|---|---|---|
| 1996 | 75% | 25% |
| 1997 | 55% | 45% |
| 1998 | 50% | 50% |
| 1999 | 50% | 50% |
| 2000 | 52% | 48% |
| 2001 | 71% | 29% |
| 2002 | 71% | 29% |
| 2003 | 69% | 31% |
| 2004 | 65% | 35% |
| 2005 | 72% | 28% |
| 2006 | 43% | 57% |
| 2007 | 67% | 33% |
| 2008 | 61% | 39% |
| 2009 | 58% | 42% |
| 2010 | 56% | 44% |
| 2011 | 51% | 49% |
| 2012 | 63% | 37% |
| Average | 61% | 39% |
| 4 yr avg. | 57% | 43% |

Table 7. Marine survival (BY) for returns to Hidden Lake, (BY1988 - 2007)

| BY | Marine Survival (%) |
|---|---|
| 1988 | 51.2% |
| 1989 | 23.0% |
| 1990 | 9.6% |
| 1991 | 13.7% |
| 1992 | 48.7% |
| 1993 | 45.1% |
| 1994 | 29.7% |
| 1995 | 42.6% |
| 1996 | 31.7% |
| 1997 | 50.1% |
| 1998 | 41.1% |
| 1999 | 10.6% |
| 2000 | 10.0% |
| 2001 | 12.8% |
| 2002 | 50.8% |
| 2003 | 13.8% |
| 2004 | 18.9% |
| 2005 | 13.1% |
| 2006 | 23.6% |
| 2007 | 14.5% |
| *2008* | *19.8%* |
| *2009* | *0.0%* |
| *2010* | *0.0%* |
| 4-year avg. | 17.5% |

*4 yr average is for complete brood years

**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, Tutka Bay Lagoon, Leisure (China Poot) Lake, Hazel Lake, and Kirschner Lake. To date, a total of 89,231,000 eggs have been collected for incubation at Crooked Creek, Big Lake, and Trail Lakes Hatcheries. Current egg incubation is taking place at Trail Lakes Hatchery. As of 2009, CIAA is no longer utilizing the Hidden Lake sockeye population to enhance systems other than Hidden Lake. The annual gamete collections conducted since 1976 are summarized in Table 8.

On 26 September and 27 September 2012, approximately 0.964 million eggs were collected from 370 female sockeye salmon and shipped to Trail Lakes Hatchery for fertilization. Fertilization involves mixing the eggs from each female with the milt from one male and activating the sperm with a 0.7% saline solution. An estimated 900,000 eggs (93%) have survived to the eyed stage.

The objective of the Hidden Lake Sockeye Salmon Enhancement Project is to achieve 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 (140,400 - Table 3), brood year average green egg-to-fry survival (87.1% - Table 8), fry-to-smolt survival (16.7% - Table 8), smolt-to-adult survival (17.5% - Table 7), and the average common property harvest rate (57.1% - Table 6). Based on these averages, to meet a projected adult return of 30,000 adult sockeye to Hidden Creek, CIAA projects 1,774,000 eggs must be collected in 2013 to supplement the Hidden Lake return.

<u>Calculations:</u>

*Equation 1: Natural Return (Total Fishery Return)*

4 yr avg natural smolt * smolt-to-adult survival = est. 2013 natural return (total fishery return)

$$140{,}400 * 17.5\% = 24{,}609$$

*Equation 2: Natural Return (Hidden Lake)*

2013 total fishery return (Equation 1) * (1 - Common Property %) = est. natural return to lake

24,609 * (1-0.517) = 10,567

*Equation 3: Enhanced Return (Hidden Lake)*

return goal – est. natural return to lake (Equation 2) = est. enhanced return to lake

30,000 - 10,567 = 19,433

*Equation 4: Enhanced Green Egg Collection Requirement*

est. enhanced return to lake/green-to-eyed surv./fry-to-smolt surv./smolt-to-adult surv/escape.%

19,433/0.871/0.167/0.175/0.430 = 1,774,000

Table 8. Summary of sockeye salmon gamete collection and fry releases at Hidden Lake, 1976 - 2012

| Brood Year | No. eggs taken | No. females used | Fecundity | Receiving hatchery | Egg-to-fry survival (%) | No. fry released Hidden Lk. | No. Hatchery Smolt Migrated | 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 | 59,076 | 17.89% | | | | |
| 1977 | 406,878 | 200 | | Big L. | 75.9% | 308,704 | 40,342 | 13.07% | | | | |
| 1978 | 311,808 | 100 | 3,118 | Crooked Cr. | 27.0% | 8,258 | 2,207 | 26.73% | | | | |
| 1979 | | | | | | | | | | | | |
| 1980 | | | | | | | | | | | | |
| 1981 | | | | | | | | | | | | |
| 1982 | | 576 | 2,741 | Trail L. | 68.8% | 1,086,000 | 250,633 | 23.08% | | | | |
| 1983 | 1,928,000 | 639 | 3,017 | Trail L. | 64.2% | 1,236,900 | 49,148 | 3.97% | | | | |
| 1984 | 3,766,000 | 1,310 | 2,875 | Trail L. | 47.9% | 1,805,792 | 488,134 | 27.03% | | | | |
| 1985 | 7,019,000 | 2,330 | 3,012 | Trail L. | | 0 | No otolith | | | | | |
| 1986 | 4,740,000 | 1,580 | 3,000 | Trail L. | 78.5% | 3,718,311 | No otolith | | | | | |
| 1987 | 7,000,184 | 2,434 | 2,876 | Trail L. | 86.9% | 6,085,307 | No otolith | | | | | |
| 1988 | 2,718,853 | 891 | 3,046 | Trail L. | 91.0% | 2,470,012 | No otolith | | | | | |
| 1989 | 2,220,467 | 647 | 2,669 | Trail L. | 79.0% | 1,747,900 | No otolith | | | | | |
| 1990 | 2,189,000 | 956 | 2,290 | Trail L. | 64.6% | 1,600,000 | No otolith | | | | | |
| 1991 | 2,652,000 | 1,119 | 2,370 | Trail L. | 64.7% | 1,716,000 | 317,634 | 18.51% | | | | |
| 1992 | 2,293,000 | 1,007 | 2,277 | Trail L. | 82.9% | 1,901,000 | 369,549 | 19.44% | | | | |
| 1993 | 2,200,000 | 934 | 2,355 | Trail L. | 81.8% | 1,800,000 | 201,475 | 11.19% | | | | |
| 1994 | 2,156,000 | 1,017 | 2,120 | Trail L. | 78.8% | 1,700,000 | 331,201 | 19.48% | | | | |
| 1995 | 1,893,000 | 849 | 2,230 | Trail L. | 84.5% | 1,600,000 | 182,930 | 11.43% | | | | |
| 1996 | 2,048,000 | 817 | 2,507 | Trail L. | 73.3% | 1,501,000 | 304,170 | 20.26% | | | | |
| 1997 | 2,166,000 | 936 | 2,314 | Trail L. | 47.8% | 1,035,000 | 217,783 | 21.04% | | | | |
| 1998 | 2,303,000 | 859 | 2,681 | Trail L. | 65.4% | 1,507,100 | 354,418 | 23.52% | | | | |
| 1999 | 2,297,000 | 954 | 2,408 | Trail L. | 54.1% | 1,242,000 | 247,614 | 19.94% | | | | |
| 2000 | 1,486,000 | 607 | 2,448 | Trail L. | 60.9% | 905,500 | 218,330 | 24.11% | | | | |
| 2001 | 1,326,000 | 504 | 2,631 | Trail L. | 73.9% | 980,200 | 249,711 | 25.48% | | | | |
| 2002 | 1,118,000 | 433 | 2,582 | Trail L. | 56.3% | 628,900 | 53,455 | 8.50% | | | | |
| 2003 | 893,000 | 371 | 2,481 | Trail L. | 89.4% | 646,000 | 210,499 | 32.58% | | 100,000 | 96,000 | 96.0 |
| 2004 | 5,445,000 | 2,045 | 2,663 | Trail L. | 89.5% | 573,000 | 111,447 | 19.45% | 4,126,000 | 284,000 | 260,000 | 91.5 |
| 2005 | 2,027,000 | 1,045 | 1,940 | Trail L. | 78.6% | 582,000 | 136,827 | 23.51% | 680,000 | 193,000 | 144,000 | 74.6 |
| 2006 | 5,640,000 | 2,340 | 2,450 | Trail L. | 89.9% | 658,000 | 223,452 | 33.96% | 3,980,000 | 570,000 | 483,000 | 84.7 |
| 2007 | 5,686,000 | 2,231 | 2,549 | Trail L. | 85.0% | 917,000 | 165,098 | 18.00% | 4,880,000 | 317,000 | 301,000 | 95.0 |
| 2008 | 4,004,000 | 1,543 | 2,595 | Trail L. | 90.4% | 911,000 | 164,166 | 18.02% | 2,411,000 | 290,000 | 278,000 | 95.9 |
| 2009 | 5,140,000 | 1,849 | 2,780 | Trail L. | 92.4% | 880,000 | 108,633 | 12.34% | 3,406,000 | 410,000 | 192,000 | 46.8 |
| 2010 | 1,241,000 | 500 | 2,517 | Trail L. | 84.1% | 1,044,000 | 193,092 | 18.50% | | | | |
| 2011 | 1,119,600 | 445 | 2,516 | Trail L. | 84.7% | 948,000 | | | | | | |
| 2012 | 964,000 | 370 | 2,606 | Trail L. | | | | | | | | |
| Total | 89,231,000 | 34,712 | | | | 44,073,000 | 5,251,000 | | | | | |
| Mean | | | 2,481 | | 76.8% | 1,228,901 | 218,074 | 19.96% | | | | |
| 4-yr Avg. | | | 2,605 | | 87.1% | 945,750 | 157,747 | 16.72% | | | | |

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.
2003-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

## Fish Transport and Stocking

On 15 & 16 May 2012, an estimated 948,000 unfed sockeye fry at approximately 0.08 g from gametes collected in 2011 were released into Hidden Lake. 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 east end of the lake (Figure 2) where they were released along the north shoreline. All fry were screened for diseases prior to release. There was no detection of infectious hematopoietic necrosis virus (IHN). 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: 2,1,2H]. Since 1977, over 44 million fry have been released to Hidden Lake (Table 8).

## Evaluation of Adult Sockeye Fidelity in Hidden Lake at Spawning

It is hypothesized that by imprinting hatchery reared sockeye salmon fry to the eastern basin of the lake where spawning conditions are marginal, returning F1 hatchery-origin adults will not be as successful spawning and subsequent egg and fry survival will be lower, thus decreasing the number of F2 smolts and adults. With reduced F1 hatchery adult influence at the two primary spawning areas located in the western basin of the lake, the number of hatchery produced fish spawning with naturally produced fish will be reduced.

On 26 September, otoliths were collected and analyzed for thermal marks from 17, 233 and 236 actively spawning adult sockeye salmon in the Eastern Basin, Western Basin-North Side and Western Basin-South Side sampling locations respectively. The number of samples in the Eastern basin is a reflection of the number of fish located in this area and not a lack of effort or inability to capture the fish. Table 9 summarizes the results. The Eastern Basin had the highest percentage of hatchery reared fish at 94.1%, followed by the Western Basin-North Side (73%) and Western Basin-South Side (52%).

Table 9. Distribution of hatchery and natural reared adult sockeye salmon in Hidden Lake, 2012

| Date | Location | No. of Samples | No. of Readable Samples | No. Readable Marked | Percent Hatchery Marked | Percent Wild |
|---|---|---|---|---|---|---|
| 26-Sep | Eastern | 17 | 17 | 16 | 94.1% | 5.9% |
| 26-Sep | Western-North | 233 | 233 | 170 | 73.0% | 27.0% |
| 26-Sep | Western-South | 236 | 232 | 120 | 51.7% | 48.3% |

It should be noted that the Western Basin-North Side sampling site was the fry release location before 2012. Therefore, based on the fidelity hypothesis, it was expected to see a higher percentage of hatchery reared fish in this area.

**Residual Salmon Monitoring**

A total of 48 smaller size sockeye salmon (in spawning colors) were caught during the egg collection procedures on 25 & 26 September. The number of fish sampled is once again a reflection of availability versus lack of effort or inability to capture the fish. Otoliths were analyzed for age and thermal mark characteristics. Thermal mark analysis indicated that nearly 88% (±9.4%) were of hatchery-origin while 12% (±9.4%) were from natural production (Table 10). However, there was controversy in determining whether these fish had migrated to the ocean. Reader 1 had the predominant age structure reported as age class 2.1 (79%) indicating that the fish had spent 2 years in the freshwater environment before spending one year in seawater (jacks), while Reader 2 had the predominant age structure being age class 3.0 (56%) (no ocean migration; kokanee), followed by 2.1 (jacks; 25%).

To confirm whether these fish had migrated to the ocean, four unknown (suspected residual salmon) and 2 known samples (known to have spent at least 2 years in the ocean) were sent to the Pacific Northwest National Lab in Richland, Washington for otolith microchemistry analysis. For the two known samples one was determined to be of hatchery origin while the other was wild. For the four unknown samples, all were determined to be of hatchery origin. The changes in chemical composition between the seawater and freshwater environment will be evident on a laser aberration analysis if the suspected residual salmon had any exposure to seawater during their life cycle.

The marine environment is known to have a stable iosotopic composition of $^{87}Sr/^{86}Sr$ equal to 0.7092, while the freshwater environment tends to have a lower ratio (less than 0.709) (Bacon et al. 2003) . If the salmon had spent any time in seawater the outer edges of the otolith would have an $^{87}Sr/^{86}Sr$ near 0.709.

Figure 3 demonstrates the scan from one of the sockeye salmon that was collected at the weir and therefore was known to have migrated from ocean. As the trace indicates, the outer edges of the otolith had $^{87}Sr/^{86}Sr$ values at 0.7092 indicating that part of their life cycle was spent in ocean. In contrast, Figure 4 shows the trace for two unknown samples sent for analysis (K42 and K15). As can be seen in this figure the outer edges have $^{87}Sr/^{86}Sr$ values below the known marine value of 0.7092 indicating that they had been residing in freshwater.

Of interest to note is the increase in $^{87}Sr/^{86}Sr$ that occurs in the middle of the trace. This increase corresponds to the middle of the otolith and therefore represents the maternal origins of the fish (Bacon et al, 2003; Miller and Kent, 2009). Based on this all three of traces (Figure 3 and 4) originated from parents that had gone to seawater (i.e. true sockeye). However, as Figure 5 indicates there was one known sockeye and two suspected residual samples in which the $^{87}Sr/^{86}Sr$ did not show the increase as in Figure 3 and 4 but rather stayed at the freshwater levels. While it is possible that it was missed in performing the analysis, it could also indicate that the origin of these three fish were from parents that had not gone to seawater (i.e. kokanee).

Based on these results a few conclusions can be made. Firstly, there is some discrepancy in how to age these fish. For example, of the four unknown samples sent to PNNL, none of the otoliths were aged correctly by either reader and only two of the samples was aged correctly by one of the readers.

Figure 3. Otolith trace of $^{87}Sr/^{86}Sr$ for Hidden Lake sockeye known to have gone to the ocean.

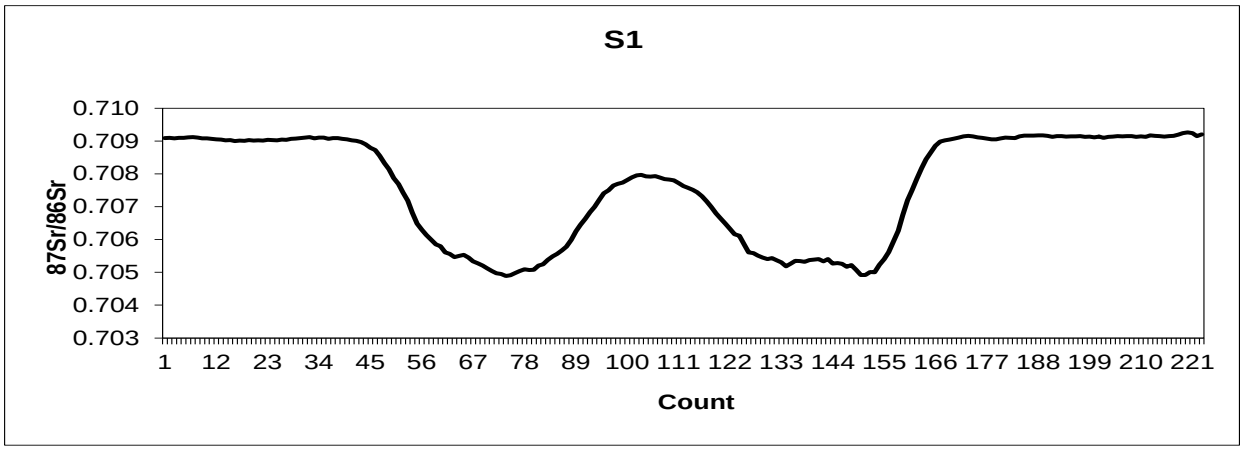
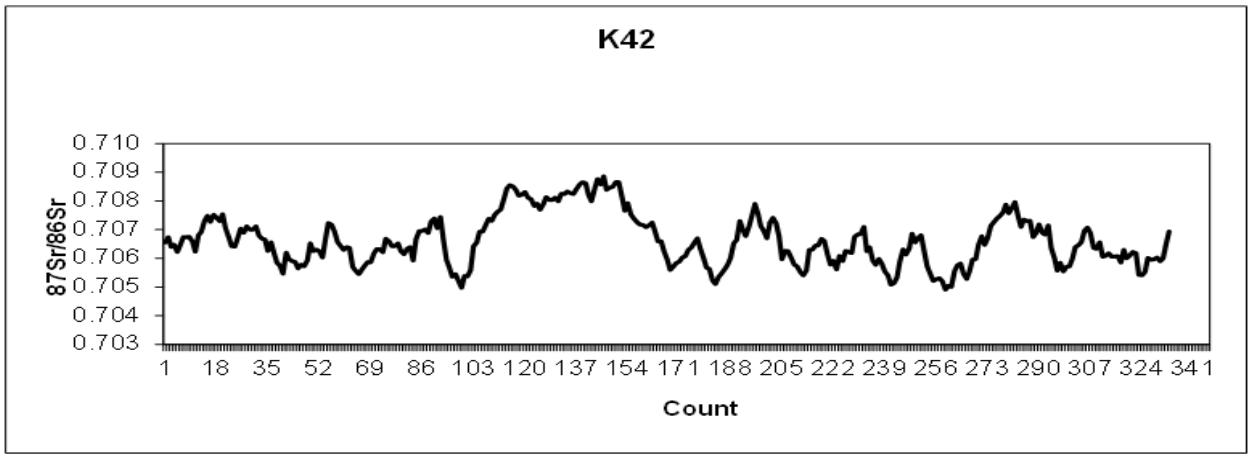



Figure 4. Otolith trace of $^{87}Sr/^{86}Sr$ for Hidden Lake sockeye believed to be residuals (kokanee)



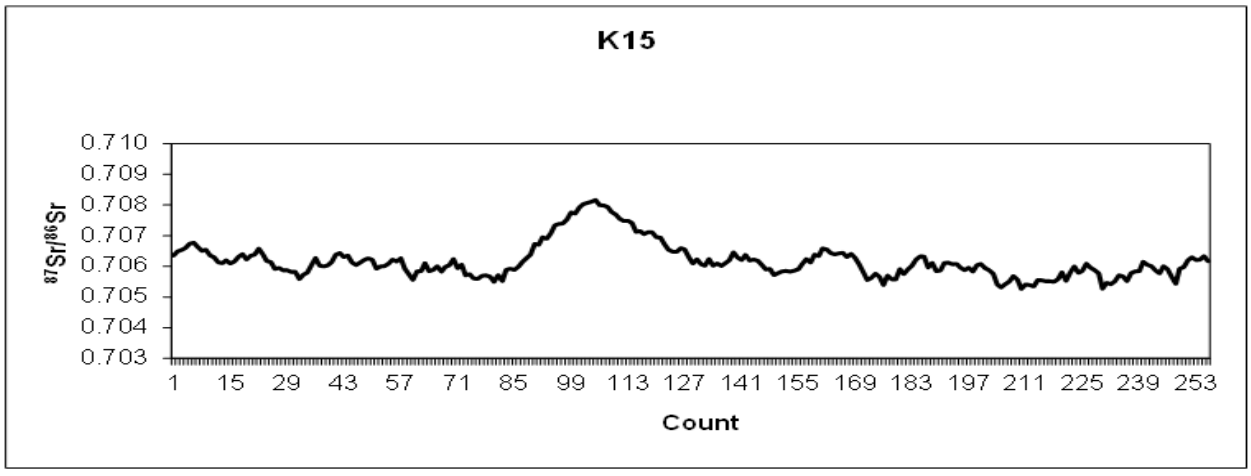
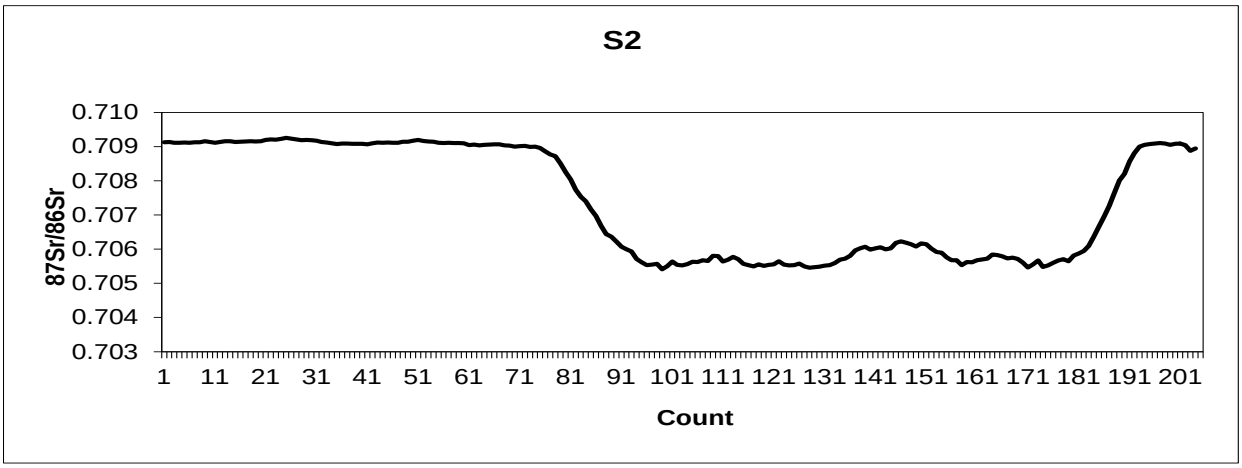
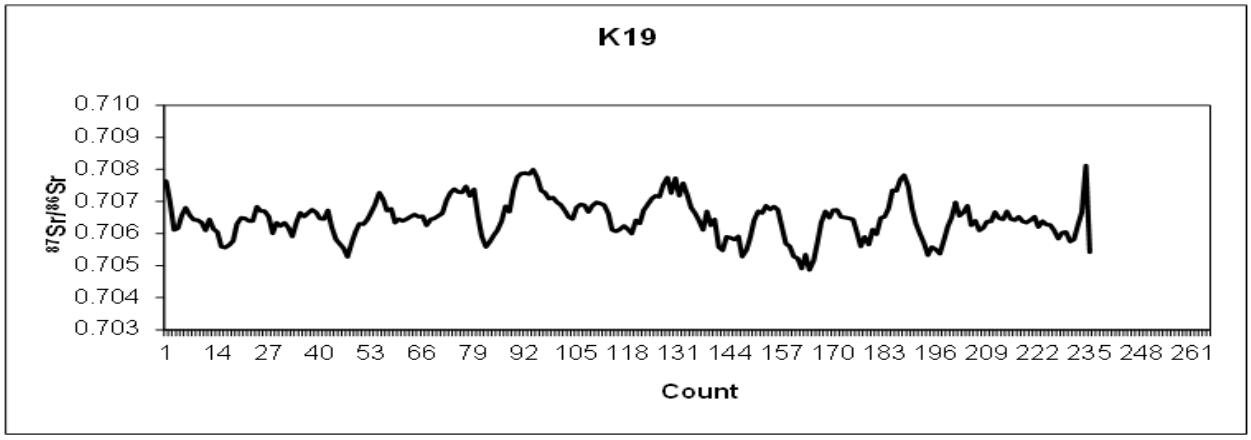
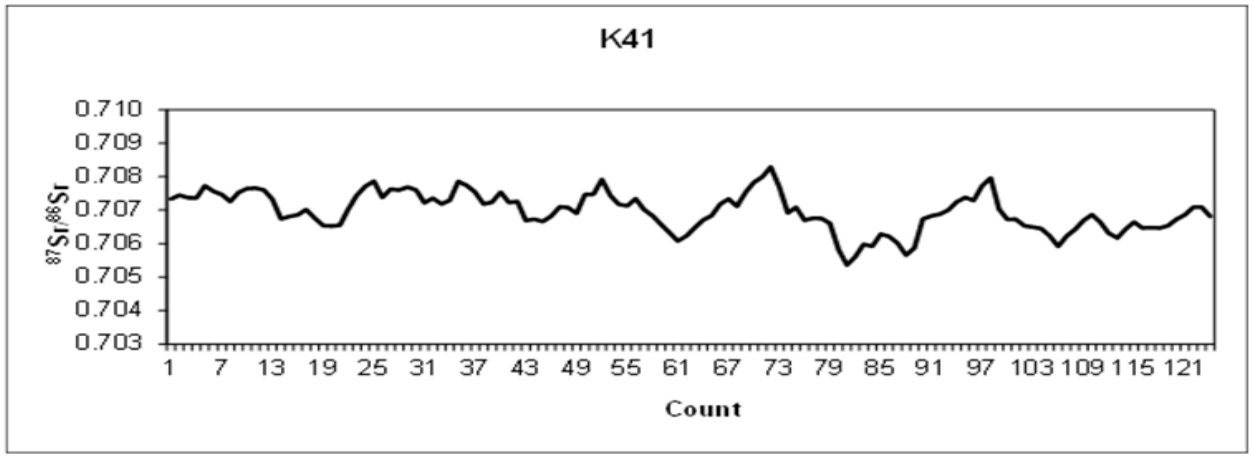



Figure 5. Otolith trace of $^{87}Sr/^{86}Sr$ for known and unknown Hidden Lake Sockeye



**Straying Study**

On 13 September, 69 and 100 samples were collected from Skilak-North and Skilak-Dunes respectively. Due to a number of heavy rainstorms to the area over a two week time period it was not possible to complete any further sampling as planned. Kenai River and surrounding areas were in flood stage and to complete any further sampling would have been unsafe for staff. In addition, due to the high water levels, carcass deposition could not be correlated to where the fish had actually spawned thus results would have been questionable. Discussions with USFWS, ADF&G and CIAA all concurred that this sampling study will be postponed until 2013 field season.

Based on the samples that were collected, no hatchery-reared fish were detected at either location.

# RECOMMENDATIONS

For the 2013 field season, in order to meet a projected adult return of 30,000 adult sockeye to Hidden Creek, CIAA projects 1,744,000 eggs must be collected to supplement the Hidden Lake return. The new fry release site and egg collection site should continue to be used in 2013. Fidelity monitoring and evaluation at Hidden Lake should also continue with the next field season. Future sampling of the supposed residual salmon in the lake will need to be assessed when the otolith microchemistry results are available to determine if these fish are truly kokanee or are jacks. In 2013, the straying study should be completed.

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# LITERATURE CITED

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# APPENDICES

# Appendix 1. Hidden Lake 2012 - Water Quality

## Nutrients and Primary Productivity

| Date | Sta | Depth (m) | TP (ug/l) | TFP (ug/l) | FRP (ug/l) | TKN (ug/l) | NH3+NH4 (ug/l) | NO2+NO3 (ug/l) | TN:TP | RSi (ug/l) | Org C (ug/l) | Chla (ug/l) | Phaeo (ug/l) | EZD (m) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 5/26/2012 | A | 1 | 7.6 | 3.3 | 1.9 | | 7.4 | 10.0 | | 3,215 | 267 | 1.64 | 0.34 | A | 21.3 |
| | A | 18 | 6.6 | 3.5 | 1.9 | | 3.7 | 9.0 | | 3,066 | 218 | 0.93 | 0.23 | B | 15.3 |
| | B | 1 | 6.8 | 4.0 | 1.7 | | 3.6 | 8.0 | | 3,167 | 230 | 1.69 | 0.39 | | |
| | B | 30 | 6.7 | 3.3 | 1.7 | | 10.1 | 22.0 | | 3,343 | 155 | 1.23 | 0.46 | | |
| 6/21/2012 | A | 1 | 5.5 | 3.2 | 1.9 | | 5.7 | 10.0 | | 3,091 | 155 | 0.63 | 0.12 | A | 24.0 |
| | A | 15 | 8.2 | 3.9 | 1.7 | | 4.5 | 9.0 | | 3,217 | 188 | 1.52 | 0.50 | B | 18.8 |
| | B | 1 | 9.2 | 3.3 | 1.6 | | 5.4 | 9.0 | | 3,151 | 179 | 0.57 | 0.16 | | |
| | B | 30 | 5.4 | 3.5 | 1.7 | | 5.3 | 43.0 | | 3,481 | 158 | 0.69 | 0.26 | | |
| 7/13/2012 | A | 1 | 5.8 | 3.3 | 1.6 | | 4.1 | 8.0 | | 3,197 | 166 | 0.82 | 0.28 | A | 23.2 |
| | A | 16 | 6.2 | 3.5 | 1.4 | | 3.9 | 8.0 | | 3,386 | 175 | 2.76 | 1.71 | B | 20.8 |
| | B | 1 | 5.6 | 3.5 | 1.6 | | 3.3 | 7.0 | | 3,194 | 124 | 0.93 | 0.27 | | |
| | B | 30 | 6.2 | 3.2 | 1.8 | | 4.0 | 38.0 | | 3,640 | 181 | 0.37 | 0.20 | | |
| 8/20/2012 | A | 1 | 5.7 | 3.2 | 1.7 | | 5.3 | 10.0 | | 3,541 | 181 | 1.02 | 0.25 | A | 19.1 |
| | A | 15 | 5.2 | 3.2 | 1.9 | | 4.9 | 8.0 | | 4,407 | 130 | 0.59 | 0.28 | B | 24.5 |
| | B | 1 | 5.9 | 4.2 | 1.7 | | 6.9 | 8.0 | | 3,567 | 109 | 0.63 | 0.23 | | |
| | B | 30 | 5.1 | 3.2 | 2.2 | | 6.6 | 36.0 | | 3,938 | 88 | 0.20 | 0.28 | | |
| 9/20/2012 | A | 1 | 6.8 | 4.4 | 1.9 | | 9.7 | 10.0 | | 3,560 | 163 | 1.21 | 0.48 | A | 18.3 |
| | A | 15 | 6.6 | 3.2 | 1.6 | | 7.5 | 7.0 | | 3,625 | 148 | 0.88 | 0.45 | | |
| Mean | 1 - Meter | | 6.5 | 3.6 | 1.7 | ND | 5.7 | 8.9 | ND | :1 | 3,298 | 175 | 1.0 | 0.3 | Mean | 20.6 |
| Min | | | 5.5 | 3.2 | 1.6 | 0 | 3.3 | 7.0 | ND | :1 | 3,091 | 109 | 0.6 | 0.1 | Min | 15.3 |
| Max | | | 9.2 | 4.4 | 1.9 | 0 | 9.7 | 10.0 | ND | :1 | 3,567 | 267 | 1.7 | 0.5 | Max | 24.5 |
| Mean | Hypolimnion | | 6.2 | 3.4 | 1.8 | ND | 5.4 | 21.6 | ND | :1 | 3,560 | 162 | 1.0 | 0.5 | | |
| Min | | | 5.1 | 3.2 | 1.4 | 0 | 3.7 | 8.0 | ND | :1 | 3,066 | 88 | 0.2 | 0.2 | | |
| Max | | | 8.2 | 3.9 | 2.2 | 0 | 10.1 | 43.0 | ND | :1 | 4,407 | 218 | 2.8 | 1.7 | | |

*Only Site A sampled on September 20, 2012 due to weather conditions.

## General Tests and Metals

| Date | Sta | Depth (m) | Sp. Cond (umhos/cm) | pH (SU) | Alk (mg/l) | Turb (NTU) | Color (Pt) | Ca (mg/l) | Mg (mg/l) | Fe (ug/l) | Secchi Sta | Secchi (meters) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 5/26/2012 | A | 1 | 153 | 7.8 | 69.0 | 0.3 | 10 | 23.7 | 3.0 | 6 | A | 7.00 |
| | A | 18 | 153 | 7.9 | 69.4 | 0.6 | 9 | 23.5 | 2.9 | 13 | B | 6.00 |
| | B | 1 | 156 | 7.8 | 70.6 | 0.3 | 8 | 23.7 | 2.9 | 6 | C | 6.00 |
| | B | 30 | 159 | 7.7 | 71.3 | 0.5 | 8 | 24.0 | 2.9 | 7 | | |
| 6/21/2012 | A | 1 | 163 | 7.9 | 69.7 | 0.4 | 9 | 23.8 | 2.8 | 9 | A | 8.25 |
| | A | 15 | 165 | 7.8 | 69.7 | 0.7 | 9 | 24.1 | 2.9 | 14 | B | 8.00 |
| | B | 1 | 164 | 7.9 | 69.0 | 0.4 | 9 | 23.8 | 3.0 | 9 | C | 9.00 |
| | B | 30 | 170 | 7.7 | 70.3 | 0.5 | 8 | 24.2 | 3.1 | 10 | | |
| 7/13/2012 | A | 1 | 160 | 7.9 | 69.6 | 0.6 | 10 | 24.4 | 2.7 | 19 | A | 7.50 |
| | A | 16 | 165 | 7.6 | 70.6 | 0.6 | 10 | 23.8 | 2.7 | 16 | B | 6.75 |
| | B | 1 | 163 | 7.9 | 69.6 | 0.4 | 9 | 23.8 | 2.9 | 20 | C | 6.50 |
| | B | 30 | 168 | 7.6 | 71.4 | 0.5 | 9 | 23.8 | 3.2 | 23 | | |
| 8/20/2012 | A | 1 | 160 | 7.9 | 69.2 | 0.4 | 11 | 24.2 | 2.8 | 11 | A | 7.50 |
| | A | 15 | 161 | 7.8 | 69.0 | 0.3 | 11 | 23.7 | 2.8 | 13 | B | 12.00 |
| | B | 1 | 162 | 7.9 | 69.3 | 0.3 | 10 | 23.7 | 2.8 | 7 | C | 8.50 |
| | B | 30 | 166 | 7.5 | 72.0 | 0.3 | 10 | 23.8 | 2.8 | 10 | | |
| 9/20/2012 | A | 1 | 162 | 7.7 | 68.7 | 0.4 | 8 | 23.8 | 2.8 | 13 | A | 7.00 |
| | A | 15 | 162 | 7.8 | 68.8 | 0.4 | 8 | 23.6 | 2.8 | 11 | | |
| Mean | 1 - Meter | | 160 | 7.9 | 69.4 | 0.4 | 9 | 23.9 | 2.9 | 11 | Mean | 7.7 |
| Min | | | 153 | 7.7 | 68.7 | 0.3 | 8 | 23.7 | 2.7 | 6 | Min | 6.0 |
| Max | | | 164 | 7.9 | 70.6 | 0.6 | 11 | 24.4 | 3.0 | 20 | Max | 12.0 |
| Mean | Hypolimnion | | 163 | 7.7 | 70.3 | 0.5 | 9 | 23.8 | 2.9 | 13 | | |
| Min | | | 153 | 7.5 | 68.8 | 0.3 | 8 | 23.5 | 2.7 | 7 | | |
| Max | | | 170 | 7.9 | 72.0 | 0.7 | 11 | 24.2 | 3.2 | 23 | | |

# Appendix 2. Hidden Lake 2012 - Zooplankton (Density)

Macrozooplankton Density - Site A - Depth 18m - 21m
(No/m2)

| | 26-May | 21-Jun | 13-Jul | 20-Aug | 20-Sep | Mean (No/m2) | Seasonal Mean (No/m2) |
|---|---|---|---|---|---|---|---|
| Ergasilus | | | | | | | |
| Ovig Ergasilus | | | | | | | |
| Epischura | 382 | 18,726 | 20,701 | 478 | 318 | 8,121 | 8,121 |
| Ovig Epischura | | | | | | | |
| Diaptomus | | | | | | | |
| Ovig Diaptomus | | | | | | | |
| Cyclops | 114,459 | 90,000 | 93,312 | 1,338 | 318 | 59,885 | 59,885 |
| Ovig. Cyclops | 764 | 1,720 | 1,274 | | | 1,253 | 752 |
| Bosmina | 1,146 | 9,172 | 399,045 | 2,484 | 6,115 | 83,592 | 83,592 |
| Ovig. Bosmina | 764 | 1,720 | 4,777 | 669 | 637 | 1,713 | 1,713 |
| Daphnia l. | 3,057 | 3,822 | 14,650 | 8,312 | 2,229 | 6,414 | 6,414 |
| Ovig. Daphnia l. | 764 | 764 | 6,688 | 191 | 32 | 1,688 | 1,688 |
| Daphnia g. | 573 | | 3,503 | 191 | 669 | 1,234 | 987 |
| Ovig. Daphnia g. | | | | | | | |
| Chydorinae | | | | 96 | | 96 | 19 |
| Polyphemus | | | | | | | |
| Total: | 121,909 | 125,924 | 543,950 | 13,759 | 10,318 | 163,997 | 163,172 |
| Ave: | 15,239 | 17,989 | 67,994 | 1,720 | | 18,222 | 18,130 |
| STDEV: | 40,100 | 32,380 | 137,157 | 2,781 | | 31,027 | 31,085 |

Macrozooplankton Density - Site B - Depth 38m - 40m
(No/m2)

| | 26-May | 21-Jun | 13-Jul | 20-Aug | | Mean (No/m2) | Seasonal Mean (No/m2) |
|---|---|---|---|---|---|---|---|
| Ergasilus | | | | | | | |
| Ovig Ergasilus | | | | | | | |
| Epischura | | 21,401 | 38,217 | 38,854 | | 32,824 | 19,694 |
| Ovig Epischura | | | | | | | |
| Diaptomus | | | | | | | |
| Ovig Diaptomus | | | | | | | |
| Cyclops | 725,096 | 740,382 | 812,739 | 768,153 | | 761,593 | 609,274 |
| Ovig. Cyclops | 1,019 | 9,172 | 21,019 | 6,369 | | | 7,516 |
| Bosmina | 10,701 | 83,057 | 176,433 | 110,191 | | 95,096 | 76,076 |
| Ovig. Bosmina | 1,783 | 5,605 | 1,911 | 1,274 | | 2,643 | 2,115 |
| Daphnia l. | 2,038 | 18,344 | 13,376 | 30,573 | | 16,083 | 12,866 |
| Ovig. Daphnia l. | | 2,038 | 4,459 | 4,459 | | 3,652 | 2,191 |
| Daphnia g. | 1,019 | 6,624 | 5,096 | 15,287 | | 7,007 | 5,605 |
| Ovig. Daphnia g. | | 1,019 | 1,274 | 3,822 | | 2,038 | 1,223 |
| Chydorinae | | | | | | | |
| Polyphemus | | | | | | | |
| Total: | 741,656 | 887,642 | 1,074,524 | 978,982 | 0 | 920,935 | 736,561 |
| Ave: | 123,609 | 98,627 | 119,392 | 108,776 | | 115,117 | 81,840 |
| STDEV: | 294,691 | 241,991 | 265,875 | 249,616 | | 263,075 | 199,178 |

Macrozooplankton Density - Site C - Depth 12m - 18m
(No/m2)

| | 26-May | 21-Jun | 13-Jul | 20-Aug | 20-Sep | Mean (No/m2) | Seasonal Mean (No/m2) |
|---|---|---|---|---|---|---|---|
| Ergasilus | | | | | | | |
| Ovig Ergasilus | | | | | | | |
| Epischura | | 47,898 | 9,936 | 19,299 | 1,815 | 19,737 | 15,790 |
| Ovig Epischura | | | | | | | |
| Diaptomus | | | | | | | |
| Ovig Diaptomus | | | | | | | |
| Cyclops | 163,185 | 130,191 | 40,127 | 7,261 | 5,828 | 69,318 | 69,318 |
| Ovig. Cyclops | 573 | 3,567 | 1,911 | 191 | | | 1,248 |
| Bosmina | 6,879 | 25,732 | 61,529 | 109,299 | 26,847 | 46,057 | 46,057 |
| Ovig. Bosmina | 955 | 1,274 | 2,293 | 20,255 | 1,529 | 5,261 | 5,261 |
| Daphnia l. | 1,720 | 6,879 | 7,643 | 18,153 | 11,465 | 9,172 | 9,172 |
| Ovig. Daphnia l. | 191 | 1,019 | 573 | 3,631 | 1,720 | 1,427 | 1,427 |
| Daphnia g. | | 510 | 3,057 | 7,452 | 4,204 | 3,806 | 3,045 |
| Ovig. Daphnia g. | | | 573 | 382 | 287 | 414 | 248.4 |
| Chydorinae | | | | | | | |
| Polyphemus | | | | | | | |
| Total: | 173,503 | 217,070 | 127,642 | 185,923 | 53,695 | 155,192 | 151,567 |
| Ave: | 28,917 | 27,134 | 14,182 | 20,658 | | 19,399 | 16,841 |
| STDEV: | 65,824 | 44,848 | 21,685 | 34,167 | | 25,167 | 24,361 |

# Appendix 3 Hidden Lake 2012 - Zooplankton (Size and Biomass)

| | Body Size - Site A - Depth 18m - 21m (mm) | | | | | Seasonal Means | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 26-May | 21-Jun | 13-Jul | 20-Aug | 20-Sep | Mean Length (mm) | Weighted Length (mm) | Biomass (mg/m2) | Weighted Biomass (mg/m2) | % by Species |
| Ergasilus | | | | | | | | | | |
| Ovig Ergasilus | | | | | | | | | | |
| Epischura | 0.53 | 1.26 | 1.44 | 1.09 | 1.24 | 1.11 | 1.34 | 49.4 | 84.4 | 16% |
| Ovig Epischura | | | | | | | | | | |
| Diaptomus | | | | | | | | | | |
| Ovig Diaptomus | | | | | | | | | | |
| Cyclops | 0.83 | 0.90 | 0.91 | 0.94 | 0.85 | 0.89 | 0.88 | 166 | 163 | 31% |
| Ovig. Cyclops | 1.26 | 1.22 | 1.28 | | | 1.25 | 1.25 | 4 | 4 | |
| Bosmina | 0.47 | 0.47 | 0.53 | 0.44 | 0.44 | 0.47 | 0.53 | 173 | 220 | 43% |
| Ovig. Bosmina | 0.58 | 0.70 | 0.61 | 0.45 | 0.58 | 0.58 | 0.61 | 6 | 6 | 1% |
| Daphnia l. | 0.78 | 0.82 | 0.99 | 0.76 | 0.73 | 0.82 | 0.87 | 19 | 22 | 4% |
| Ovig. Daphnia l. | 1.06 | 1.20 | 1.47 | 1.20 | 1.16 | 1.22 | 1.40 | 12 | 16 | 3% |
| Daphnia g. | 0.92 | | 0.94 | 0.78 | 0.97 | 0.90 | 0.94 | 2 | 2 | 0% |
| Ovig. Daphnia g. | | | | | | | | | | |
| Chydorinae | | | | 0.66 | | 0.66 | 0.66 | 0.08 | 0.08 | 0% |
| Polyphemus | | | | | | | | | | |
| TOTAL: | | | | | | | | 432 | 518 | 100% |

| | Body Size - Site B - Depth 38m - 40m (mm) | | | | Mean Length (mm) | Weighted Length (mm) | Biomass (mg/m2) | Weighted Biomass (mg/m2) | % by Species |
|---|---|---|---|---|---|---|---|---|---|
| | 26-May | 21-Jun | 13-Jul | 20-Aug | | | | | |
| Ergasilus | | | | | | | | | |
| Ovig Ergasilus | | | | | | | | | |
| Epischura | | 1.27 | 1.43 | 1.76 | 1.49 | 1.53 | 273 | 294 | 12% |
| Ovig Epischura | | | | | | | | | |
| Diaptomus | | | | | | | | | |
| Ovig Diaptomus | | | | | | | | | |
| Cyclops | 0.82 | 0.95 | 0.96 | 0.97 | 0.93 | 0.93 | 1,856 | 1,864 | 73% |
| Ovig. Cyclops | 1.24 | 1.28 | 1.25 | 1.19 | 1.24 | 1.25 | 43 | 43 | |
| Bosmina | 0.53 | 0.50 | 0.52 | 0.60 | 0.54 | 0.54 | 209 | 211 | 8% |
| Ovig. Bosmina | 0.62 | 0.69 | 0.62 | 0.69 | 0.66 | 0.67 | 9 | 9 | 0% |
| Daphnia l. | 0.82 | 0.90 | 1.00 | 1.05 | 0.94 | 0.99 | 52 | 58 | 2% |
| Ovig. Daphnia l. | | 1.10 | 1.55 | 1.55 | 1.40 | 1.47 | 21 | 23 | 1% |
| Daphnia g. | 0.96 | 1.08 | 1.10 | 1.30 | 1.11 | 1.20 | 20 | 26 | 1% |
| Ovig. Daphnia g. | | 1.35 | 1.71 | 1.83 | 1.63 | 1.73 | 15 | 19 | 1% |
| Chydorinae | | | | | | | | | |
| Polyphemus | | | | | | | | | |
| TOTAL: | | | | | | | 2,499 | 2,546 | 100% |

| | Body Size - Site C - Depth 12m - 18m (mm) | | | | | Mean Length (mm) | Weighted Length (mm) | Biomass (mg/m2) | Weighted Biomass (mg/m2) | % by Species |
|---|---|---|---|---|---|---|---|---|---|---|
| | 26-May | 21-Jun | 13-Jul | 20-Aug | 20-Sep | | | | | |
| Ergasilus | | | | | | | | | | |
| Ovig Ergasilus | | | | | | | | | | |
| Epischura | | 1.21 | 1.43 | 1.25 | 1.25 | 1.29 | 1.25 | 145 | 133 | 24% |
| Ovig Epischura | | | | | | | | | | |
| Diaptomus | | | | | | | | | | |
| Ovig Diaptomus | | | | | | | | | | |
| Cyclops | 0.83 | 0.94 | 0.93 | 0.98 | 0.91 | 0.92 | 0.89 | 208 | 193 | 35% |
| Ovig. Cyclops | 1.09 | 1.25 | 1.24 | 1.22 | | 1.20 | 1.23 | 7 | 7 | |
| Bosmina | 0.49 | 0.46 | 0.55 | 0.60 | 0.58 | 0.54 | 0.57 | 126 | 141 | 25% |
| Ovig. Bosmina | 0.70 | 0.79 | 0.68 | 0.66 | 0.62 | 0.69 | 0.67 | 25 | 23 | 4% |
| Daphnia l. | 0.76 | 0.86 | 0.97 | 0.96 | 0.83 | 0.88 | 0.91 | 32 | 34 | 6% |
| Ovig. Daphnia l. | 0.91 | 1.12 | 1.79 | 1.36 | 1.14 | 1.26 | 1.30 | 11 | 12 | 2% |
| Daphnia g. | | 0.96 | 1.09 | 1.12 | 1.04 | 1.05 | 1.09 | 9 | 10 | 2% |
| Ovig. Daphnia g. | | | 1.75 | 1.58 | 1.42 | 1.58 | 1.62 | 3 | 3 | 1% |
| Chydorinae | | | | | | | | | | |
| Polyphemus | | | | | | | | | | |
| TOTAL: | | | | | | | | 564 | 556 | 100% |

# Appendix 4. Hidden Lake 2012 - Environmental Conditions

Smolt Migration

| Date | Sky | Precip. (mm) | Stage (ft) | Stage Change (ft) | Water Temp. (°C) | Air Temp. (°C) |
|---|---|---|---|---|---|---|
| 17-May | 1 | 0 | 1 | 0 | 8 | 10 |
| 18-May | 1 | 0 | 0.99 | -0.01 | 8 | 10 |
| 19-May | 3 | 0 | 1.1 | 0.1 | 8 | 9 |
| 20-May | 3 | 0 | 1.1 | 0.1 | 8 | 9 |
| 21-May | 4 | 0 | 1 | 0 | 9 | 9 |
| 22-May | 5 | 0.25 | 0.95 | -0.05 | 9 | 9 |
| 23-May | 3 | 0 | 0.97 | -0.03 | 10 | 10 |
| 24-May | 3 | 0 | 0.98 | -0.02 | 10 | 9 |
| 25-May | 5 | 1 | 0.96 | -0.04 | 8 | 8 |
| 26-May | 3 | 0.5 | 0.98 | -0.02 | 8 | 8 |
| 27-May | 4 | 0 | 0.96 | -0.04 | 9 | 8 |
| 28-May | 2 | 0 | 0.98 | -0.02 | 11 | 14 |
| 29-May | 3 | 0 | 1.2 | 0.2 | 10 | 13 |
| 30-May | 4 | 3 | 0.94 | -0.06 | 9 | 11 |
| 31-May | 3 | 0 | 1 | 0 | 9 | 12 |
| 1-Jun | 3 | 5 | 0.98 | -0.02 | 10 | 13 |
| 2-Jun | 4 | 0 | 0.98 | -0.02 | 11 | 17 |
| 3-Jun | 5 | 9 | 0.95 | -0.05 | 9 | 12 |
| 4-Jun | 3 | 2 | 0.94 | -0.06 | 11 | 12 |
| 5-Jun | 3 | 0 | 0.97 | -0.03 | 13 | 16 |
| 6-Jun | 3 | 1.25 | 0.94 | -0.06 | 11 | 11 |
| 7-Jun | 4 | 1.25 | 0.95 | -0.05 | 12 | 13 |
| 8-Jun | 2 | 0.5 | 0.96 | -0.04 | 14 | 19 |
| 9-Jun | 4 | 0 | 0.9 | -0.1 | 11 | 12 |
| 10-Jun | 3 | 0 | 0.9 | -0.1 | 11 | 14 |
| 11-Jun | 4 | 1 | 0.9 | -0.1 | 13 | 16 |
| 12-Jun | 4 | 9 | 0.88 | -0.12 | 10 | 9 |
| 13-Jun | 4 | 12.5 | 0.98 | -0.02 | 11 | 14 |
| 14-Jun | 2 | 0.5 | 0.94 | -0.06 | 12 | 13 |
| 15-Jun | 2 | 0.25 | 0.94 | -0.06 | 12 | 11 |
| 16-Jun | 3 | 0 | 0.92 | -0.08 | 13 | 16 |
| 17-Jun | 3 | 0 | 0.92 | -0.08 | 15 | 23 |
| 18-Jun | 5 | 0.5 | 0.92 | -0.08 | 13 | 22 |
| 19-Jun | 5 | 0 | 0.9 | -0.1 | 16 | 20 |
| 20-Jun | 4 | 0.25 | 0.92 | -0.08 | 14 | 17 |
| 21-Jun | 1 | 0.8 | 0.94 | -0.06 | 17 | 22 |
| 22-Jun | 2 | 0 | 0.94 | -0.06 | 17 | 25 |
| 23-Jun | 1 | 0 | 0.92 | -0.08 | 19 | 27 |
| 24-Jun | 4 | 2.75 | 0.88 | -0.12 | 14 | 14 |
| 25-Jun | 5 | 3.75 | 0.9 | -0.1 | 14 | 12 |
| 26-Jun | 3 | 13 | 0.95 | -0.05 | 15 | 17 |
| 27-Jun | 5 | 3.5 | 0.95 | -0.05 | 15 | 17 |
| 28-Jun | 5 | 4 | 0.93 | -0.07 | 14 | 17 |
| 29-Jun | 1 | 0 | 0.9 | -0.1 | 15 | 18 |
| 30-Jun | 3 | 0 | 0.93 | -0.07 | 16 | 17 |
| 1-Jul | 3 | 0 | 0.93 | -0.07 | 15 | 21 |
| 2-Jul | 3 | 0 | 0.93 | -0.07 | 15 | 15 |
| 3-Jul | 4 | 0 | 0.93 | -0.07 | 15 | 18 |
| 4-Jul | 4 | 0 | 0.91 | -0.09 | 14 | 15 |
| 5-Jul | 4 | 0 | 0.9 | -0.1 | 14 | 16 |
| 6-Jul | 4 | 0 | 0.91 | -0.09 | 15 | 16 |
| 7-Jul | 3 | 0 | 0.91 | -0.09 | 15 | 17 |
| 8-Jul | 1 | 0 | 0.86 | -0.14 | 15 | 18 |
| Total | | 76 | | | | |
| Avg. | | 1.4 | 0.95 | -0.05 | 12.3 | 14.5 |
| Min. | | 0.0 | 0.86 | -0.14 | 8.0 | 8.0 |
| Max. | | 13.0 | 1.20 | 0.20 | 19.0 | 27.0 |
| SD | | 3.0 | 0.06 | 0.06 | 2.9 | 4.6 |

Adult Migration

| Date | Sky | Precip. (mm) | Stage (ft) | Stage Change (ft) | Water Temp. (°C) | Air Temp. (°C) |
|---|---|---|---|---|---|---|
| 14-Jul | 4 | 1.0 | 0.82 | 0.00 | 15 | 12 |
| 15-Jul | 4 | 1.5 | 0.80 | -0.02 | 13 | 12 |
| 16-Jul | 3 | 1.8 | 0.80 | -0.02 | 14 | 15 |
| 17-Jul | 2 | 0.8 | 0.81 | -0.01 | 18 | 21 |
| 18-Jul | 2 | 0.0 | 0.80 | -0.02 | 18 | 18 |
| 19-Jul | 2 | 0.0 | 0.81 | -0.01 | 19 | 24 |
| 20-Jul | 4 | 0.5 | 0.77 | -0.05 | 16 | 19 |
| 21-Jul | 5 | 12.0 | 0.78 | -0.04 | 12 | 12 |
| 22-Jul | 3 | 6.3 | 0.82 | 0.00 | 14 | 15 |
| 23-Jul | 4 | 0.6 | 0.80 | -0.02 | 14 | 15 |
| 24-Jul | 4 | 0.0 | 0.80 | -0.02 | 14 | 16 |
| 25-Jul | 2 | 0.0 | 0.79 | -0.03 | 17 | 17 |
| 26-Jul | 2 | 0.6 | 0.80 | -0.02 | 18 | 21 |
| 27-Jul | 2 | 0.0 | 0.81 | -0.01 | 19 | 21 |
| 28-Jul | 3 | 0.3 | 0.77 | -0.05 | 17 | 19 |
| 29-Jul | 2 | 0.0 | 0.75 | -0.07 | 16 | 17 |
| 30-Jul | 5 | 1.0 | 0.76 | -0.06 | 14 | 14 |
| 31-Jul | 3 | 0.4 | 0.76 | -0.06 | 17 | 18 |
| 1-Aug | 4 | 1.6 | 0.73 | -0.09 | 14 | 15 |
| 2-Aug | 4 | 0.5 | 0.77 | -0.05 | 13 | 13 |
| 3-Aug | 2 | 0.0 | 0.78 | -0.04 | 16 | 19 |
| 4-Aug | 4 | 0.0 | 0.74 | -0.08 | 14 | 13 |
| 5-Aug | 4 | 0.0 | 0.75 | -0.07 | 16 | 15 |
| 6-Aug | 3 | 0.5 | 0.75 | -0.07 | 16 | 16 |
| 7-Aug | 3 | 0.0 | 0.72 | -0.10 | 16 | 16 |
| 8-Aug | 3 | 0.3 | 0.70 | -0.12 | 16 | 18 |
| 9-Aug | 2 | 0.3 | 0.72 | -0.10 | 17 | 21 |
| 10-Aug | 4 | 0.0 | 0.75 | -0.07 | 15 | 15 |
| 11-Aug | 3 | 0.0 | 0.70 | -0.12 | 17 | 21 |
| 12-Aug | 2 | 0.0 | 0.68 | -0.14 | 17 | 21 |
| 13-Aug | 2 | 0.0 | 0.70 | -0.12 | 18 | 20 |
| 14-Aug | 3 | 0.0 | 0.62 | -0.20 | 18 | 20 |
| 15-Aug | 4 | 0.0 | 0.62 | -0.20 | 16 | 17 |
| 16-Aug | 3 | 0.0 | 0.68 | -0.14 | 16 | 16 |
| 17-Aug | 2 | 4.0 | 0.66 | -0.16 | 17 | 15 |
| 18-Aug | 5 | 0.3 | 0.65 | -0.17 | 15 | 12 |
| 19-Aug | 4 | 0.6 | 0.64 | -0.18 | 15 | 15 |
| 20-Aug | 3 | 1.3 | 0.65 | -0.17 | 14 | 13 |
| 21-Aug | 3 | 0.5 | 0.66 | -0.16 | 16 | 15 |
| 22-Aug | 2 | 0.0 | 0.68 | -0.14 | 16 | 19 |
| 23-Aug | 4 | 6.0 | 0.67 | -0.15 | 16 | 15 |
| 24-Aug | 4 | 0.3 | 0.65 | -0.17 | 15 | 15 |
| 25-Aug | 2 | 0.0 | 0.68 | -0.14 | 16 | 18 |
| 26-Aug | 4 | 2.8 | 0.64 | -0.18 | 16 | 15 |
| 27-Aug | 5 | 2.0 | 0.67 | -0.15 | 16 | 16 |
| 28-Aug | 1 | 0.8 | 0.65 | -0.17 | 16 | 17 |
| 29-Aug | 2 | 0.3 | 0.65 | -0.17 | 17 | 20 |
| 30-Aug | 4 | 0.5 | 0.65 | -0.17 | 14 | 13 |
| 31-Aug | 4 | 0.8 | 0.64 | -0.18 | 14 | 14 |
| 1-Sep | 5 | 9.0 | 0.66 | -0.16 | 14 | 12 |
| 2-Sep | 4 | 1.0 | 0.64 | -0.18 | 13 | 11 |
| 3-Sep | 4 | 0.5 | 0.62 | -0.20 | 14 | 14 |
| 4-Sep | 4 | 2.5 | 0.62 | -0.20 | 12 | 11 |
| 5-Sep | 5 | 7.8 | 0.62 | -0.20 | 12 | 11 |
| 6-Sep | 3 | 0.5 | 0.62 | -0.20 | 12 | 13 |
| Total | | 71 | | | | |
| Avg. | | 1.3 | 0.71 | -0.11 | 15.5 | 16.1 |
| Min. | | 0.0 | 0.62 | -0.20 | 12.0 | 11.0 |
| Max. | | 12.0 | 0.82 | 0.00 | 19.0 | 24.0 |
| SD | | 2.4 | 0.07 | 0.07 | 1.8 | 3.2 |

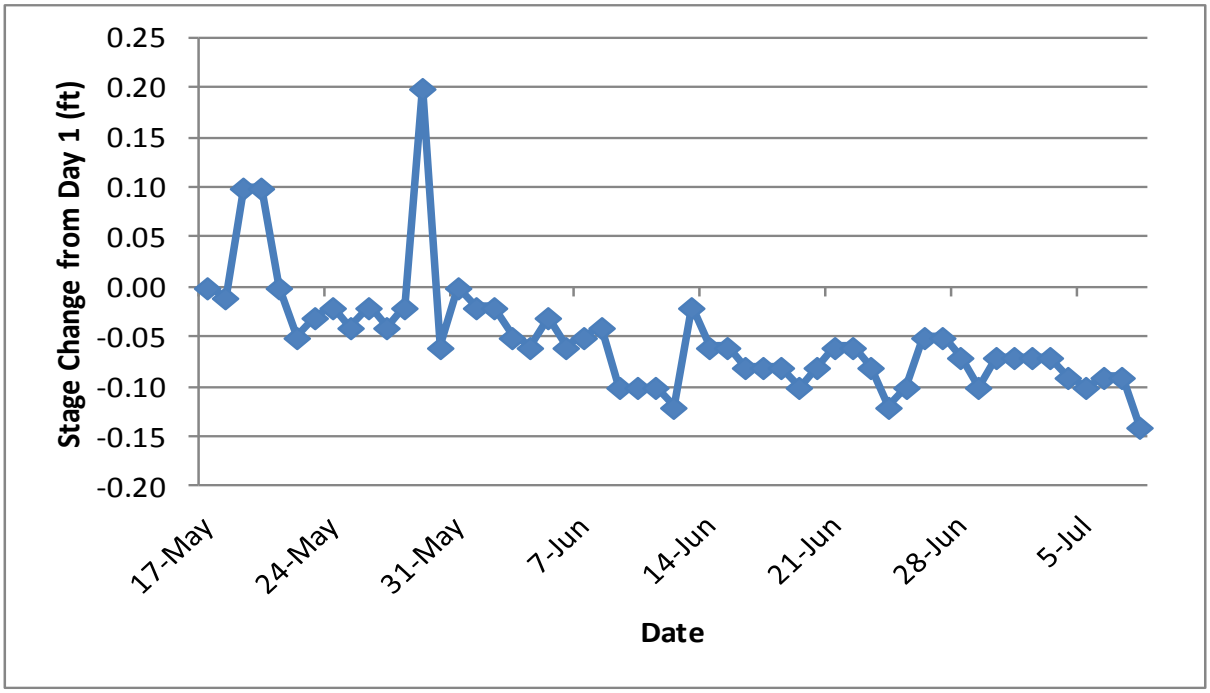
Summary of Cloud Cover - Percent of Days

| | No. Days | Meas. Rain | Rain | 100% Overcast | > 50% Overcast | <50% Overcast | Clear |
|---|---|---|---|---|---|---|---|
| Smolts | 53 | 43% | 15% | 28% | 36% | 9% | 11% |
| Adults | 55 | 65% | 11% | 36% | 24% | 27% | 2% |

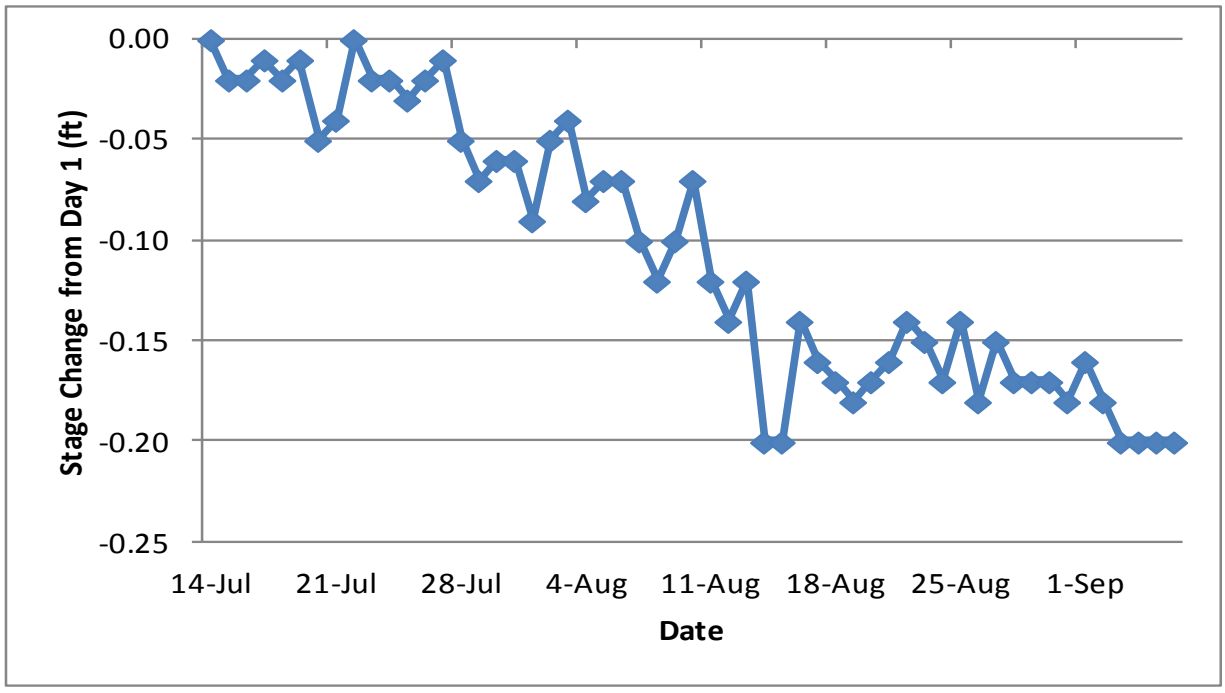
1 = Clear
2 = Cloud Cover < 50%
3 = Cloud Cover > 50%
4 = 100% Overcast
5 = Rain
ND = No Data

Appendix 5. Hidden Lake 2012 - Stage Height Changes

Smolt Migration




Adult Migration



# Appendix 6 Hidden Lake 2012 - Smolt Migration

| | Sockeye | | | | | Coho | | Rainbow | | Dolly Varden | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Date | Daily | Morts | Otoliths | Total | % Smpl | Daily | Total | Daily | Total | Daily | Total |
| 17-May | 0 | | | 0 | | 0 | 0 | 1 | 1 | 0 | 0 |
| 18-May | 0 | | | 0 | | 0 | 0 | 0 | 1 | 0 | 0 |
| 19-May | 0 | | | 0 | | 0 | 0 | 1 | 2 | 0 | 0 |
| 20-May | 0 | | | 0 | | 0 | 0 | 0 | 2 | 0 | 0 |
| 21-May | 1 | 0 | 0 | 1 | 0.00% | 0 | 0 | 1 | 3 | 0 | 0 |
| 22-May | 2 | 0 | 0 | 3 | 0.00% | 2 | 2 | 0 | 3 | 0 | 0 |
| 23-May | 244 | 0 | 0 | 247 | 0.00% | 4 | 6 | 4 | 7 | 0 | 0 |
| 24-May | 1,125 | 0 | 1 | 1,372 | 0.09% | 2 | 8 | 3 | 10 | 0 | 0 |
| 25-May | 727 | 0 | 0 | 2,099 | 0.00% | 8 | 16 | 2 | 12 | 0 | 0 |
| 26-May | 445 | 0 | 7 | 2,544 | 1.57% | 4 | 20 | 1 | 13 | 0 | 0 |
| 27-May | 168 | 0 | 0 | 2,712 | 0.00% | 21 | 41 | 1 | 14 | 0 | 0 |
| 28-May | 192 | 0 | 4 | 2,904 | 2.08% | 111 | 152 | 1 | 15 | 0 | 0 |
| 29-May | 61 | 0 | 2 | 2,965 | 3.28% | 164 | 316 | 0 | 15 | 0 | 0 |
| 30-May | 145 | 0 | 3 | 3,110 | 2.07% | 19 | 335 | 1 | 16 | 0 | 0 |
| 31-May | 290 | 0 | 0 | 3,400 | 0.00% | 136 | 471 | 1 | 17 | 0 | 0 |
| 1-Jun | 9,148 | 0 | 16 | 12,548 | 0.17% | 709 | 1,180 | 1 | 18 | 0 | 0 |
| 2-Jun | 2,971 | 0 | 8 | 15,519 | 0.27% | 1,493 | 2,673 | 0 | 18 | 0 | 0 |
| 3-Jun | 3,398 | 0 | 12 | 18,917 | 0.35% | 1,623 | 4,296 | 0 | 18 | 0 | 0 |
| 4-Jun | 30,675 | 0 | 15 | 49,592 | 0.05% | 1,329 | 5,625 | 0 | 18 | 0 | 0 |
| 5-Jun | 31,340 | 0 | 44 | 80,932 | 0.14% | 2,991 | 8,616 | 0 | 18 | 0 | 0 |
| 6-Jun | 13,763 | 0 | 47 | 94,695 | 0.34% | 1,063 | 9,679 | 1 | 19 | 0 | 0 |
| 7-Jun | 11,607 | 0 | 35 | 106,302 | 0.30% | 1,361 | 11,040 | 0 | 19 | 0 | 0 |
| 8-Jun | 16,770 | 0 | 32 | 123,072 | 0.19% | 1,418 | 12,458 | 0 | 19 | 0 | 0 |
| 9-Jun | 48,512 | 0 | 30 | 171,584 | 0.06% | 1,954 | 14,412 | 0 | 19 | 0 | 0 |
| 10-Jun | 38,441 | 0 | 95 | 210,025 | 0.25% | 1,762 | 16,174 | 0 | 19 | 0 | 0 |
| 11-Jun | 5,754 | 0 | 66 | 215,779 | 1.15% | 881 | 17,055 | 0 | 19 | 0 | 0 |
| 12-Jun | 850 | 0 | 13 | 216,629 | 1.53% | 300 | 17,355 | 0 | 19 | 0 | 0 |
| 13-Jun | 9,618 | 0 | 17 | 226,247 | 0.18% | 426 | 17,781 | 0 | 19 | 0 | 0 |
| 14-Jun | 13,795 | 0 | 35 | 240,042 | 0.25% | 1,311 | 19,092 | 3 | 22 | 0 | 0 |
| 15-Jun | 10,869 | 0 | 0 | 250,911 | 0.00% | 584 | 19,676 | 1 | 23 | 0 | 0 |
| 16-Jun | 9,070 | 0 | 0 | 259,981 | 0.00% | 433 | 20,109 | 1 | 24 | 0 | 0 |
| 17-Jun | 7,981 | 0 | 47 | 267,962 | 0.59% | 357 | 20,466 | 0 | 24 | 0 | 0 |
| 18-Jun | 9,254 | 0 | 19 | 277,216 | 0.21% | 389 | 20,855 | 5 | 29 | 0 | 0 |
| 19-Jun | 4,797 | 0 | 7 | 282,013 | 0.15% | 495 | 21,350 | 0 | 29 | 0 | 0 |
| 20-Jun | 3,024 | 0 | 19 | 285,037 | 0.63% | 311 | 21,661 | 3 | 32 | 0 | 0 |
| 21-Jun | 4,666 | 0 | 13 | 289,703 | 0.28% | 218 | 21,879 | 2 | 34 | 0 | 0 |
| 22-Jun | 4,850 | 0 | 0 | 294,553 | 0.00% | 193 | 22,072 | 18 | 52 | 0 | 0 |
| 23-Jun | 4,306 | 0 | 0 | 298,859 | 0.00% | 229 | 22,301 | 4 | 56 | 0 | 0 |
| 24-Jun | 2,683 | 0 | 5 | 301,542 | 0.19% | 123 | 22,424 | 3 | 59 | 0 | 0 |
| 25-Jun | 2,282 | 0 | 0 | 303,824 | 0.00% | 83 | 22,507 | 1 | 60 | 0 | 0 |
| 26-Jun | 599 | 0 | 0 | 304,423 | 0.00% | 44 | 22,551 | 0 | 60 | 0 | 0 |
| 27-Jun | 1,418 | 0 | 7 | 305,841 | 0.49% | 113 | 22,664 | 0 | 60 | 0 | 0 |
| 28-Jun | 1,343 | 0 | 4 | 307,184 | 0.30% | 239 | 22,903 | 0 | 60 | 0 | 0 |
| 29-Jun | 473 | 0 | 0 | 307,657 | 0.00% | 21 | 22,924 | 0 | 60 | 0 | 0 |
| 30-Jun | 608 | 0 | 0 | 308,265 | 0.00% | 18 | 22,942 | 0 | 60 | 0 | 0 |
| 1-Jul | 718 | 0 | 1 | 308,983 | 0.14% | 20 | 22,962 | 0 | 60 | 0 | 0 |
| 2-Jul | 691 | 0 | 1 | 309,674 | 0.14% | 32 | 22,994 | 0 | 60 | 0 | 0 |
| 3-Jul | 472 | 0 | 2 | 310,146 | 0.42% | 39 | 23,033 | 0 | 60 | 0 | 0 |
| 4-Jul | 479 | 0 | 0 | 310,625 | 0.00% | 19 | 23,052 | 0 | 60 | 0 | 0 |
| 5-Jul | 341 | 0 | 0 | 310,966 | 0.00% | 26 | 23,078 | 0 | 60 | 0 | 0 |
| 6-Jul | 511 | 0 | 0 | 311,477 | 0.00% | 21 | 23,099 | 0 | 60 | 0 | 0 |
| 7-Jul | 355 | 0 | 0 | 311,832 | 0.00% | 59 | 23,158 | 0 | 60 | 0 | 0 |
| 8-Jul | 262 | 0 | 4 | 312,094 | 1.53% | 5 | 23,163 | 0 | 60 | 0 | 0 |
| Total | 312,094 | 0 | 611 | 312,094 | 0.20% | | 23,163 | | 60 | | 0 |

# Appendix 7. Hidden Lake 2012 - Adult Migration

| | Sockeye | | | | Coho | | King | | Pink | | Chum | | Rainbow | | Dolly Varden | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Date | Daily | Otolith | Total | Lures | Daily | Total | Daily | Total | Daily | Total | Daily | Total | Daily | Total | Daily | Total |
| 15-Jul | 0 | | 0 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 16-Jul | 0 | | 0 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 17-Jul | 0 | | 0 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 18-Jul | 0 | | 0 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 19-Jul | 0 | | 0 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 20-Jul | 58 | | 58 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 21-Jul | 453 | | 511 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 22-Jul | 59 | | 570 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 23-Jul | 7 | | 577 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 24-Jul | 84 | | 661 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 25-Jul | 2,479 | | 3,140 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 26-Jul | 1,411 | | 4,551 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 27-Jul | 3 | | 4,554 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 28-Jul | 7 | | 4,561 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 29-Jul | 2 | | 4,563 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 30-Jul | 2 | | 4,565 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 31-Jul | 629 | 200 | 5,394 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1-Aug | 162 | | 5,556 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2-Aug | 5 | | 5,561 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 3-Aug | 4 | | 5,565 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 4-Aug | 343 | | 5,908 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 5-Aug | 2,663 | | 8,571 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 6-Aug | 1,162 | | 9,733 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7-Aug | 613 | | 10,346 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 8-Aug | 1 | | 10,347 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 9-Aug | 11 | | 10,358 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 10-Aug | 5,286 | | 15,644 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 11-Aug | 73 | | 15,717 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 12-Aug | 2,748 | | 18,465 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 13-Aug | 2,729 | | 21,194 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 14-Aug | 1,109 | 204 | 22,507 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 15-Aug | 9 | | 22,516 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 16-Aug | 51 | | 22,567 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 17-Aug | 615 | | 23,182 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 18-Aug | 8 | | 23,190 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 19-Aug | 2,842 | | 26,032 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 20-Aug | 24 | | 26,056 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 21-Aug | 35 | | 26,091 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 22-Aug | 30 | | 26,121 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 23-Aug | 0 | 194 | 26,315 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 24-Aug | 1 | | 26,316 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 25-Aug | 1,563 | | 27,879 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 26-Aug | 3 | | 27,882 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 27-Aug | 1,629 | | 29,511 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 28-Aug | 17 | | 29,528 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 29-Aug | 0 | | 29,528 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 30-Aug | 471 | | 29,999 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 31-Aug | 115 | | 30,114 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1-Sep | 0 | | 30,114 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2-Sep | 0 | | 30,114 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 3-Sep | 319 | | 30,433 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 4-Sep | 0 | | 30,433 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 5-Sep | 0 | | 30,433 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 6-Sep | 33 | | 30,466 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total | 29,868 | 598 | 30,466 | 0 | 0 | | 0 | | 0 | | 0 | | 0 | | 0 | |

Appendix 8. Hidden Lake 2012 Adult Sockeye Salmon Escapement Sex Ratio and Size Data, 2012

| | Age | | | | | | |
|---|---|---|---|---|---|---|---|
| | 1.1 | 1.2 | 1.3 | 2.1 | 2.2 | 2.3 | Total |
| Sample Period: | 20 July - 03 September | | | | | | |
| Males (No.) | 0 | 10,076 | 2,489 | 0 | 1,245 | 0 | 13,810 |
| Percent | 0.0% | 73.0% | 18.0% | 0.0% | 9.0% | 0.0% | 45.3% |
| Sample Size | 0 | 170 | 42 | 0 | 21 | 0 | 233 |
| Total Sample Size | | | | | | | 275 |
| Mean Length (mm) | | 504 | 554 | | 522 | | 515 |
| Std. Deviation | | 23.6 | 23.2 | | 27.3 | | 30.6 |
| Std. Error | | 1.8 | 3.6 | | 6.0 | | 1.8 |
| Females (No.) | 0 | 14,107 | 1,600 | 0 | 948 | 0 | 16,656 |
| Percent | 0.0% | 84.7% | 9.6% | 0.0% | 5.7% | 0.0% | 54.7% |
| Sample Size | 0 | 238 | 27 | 0 | 16 | 0 | 281 |
| Total Sample Size | | | | | | | 322 |
| Mean Length (mm) | | 498 | 536 | | 520 | | 502 |
| Std. Deviation | | 21.5 | 22.3 | | 17.3 | | 24.4 |
| Std. Error | | 1.4 | 4.3 | | 4.3 | | 1.4 |
| Both Sexes (No.) | 0 | 24,183 | 4,090 | 0 | 2,193 | 0 | 30,466 |
| Percent | 0.0% | 79.4% | 13.4% | 0.0% | 7.2% | 0.0% | 100.0% |
| Sample Size | 0 | 408 | 69 | 0 | 37 | 0 | 514 |
| Total Sample Size | | | | | | | 597 |
| Mean Length (mm) | | 500 | 547 | | 521 | | 508 |
| Std. Deviation | | 22.6 | 24.4 | | 23.2 | | 28.1 |
| Std. Error | | 1.1 | 2.9 | | 3.8 | | 1.1 |

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

# Appendix 9. Hidden Lake 2012 - Update

## Stocking & Misc. Activities

| | | |
|---|---|---|
| Ice-out: | NA | (approximate date) |
| Smolt crew on-site: | 17-May | |
| Smolt crew off-site: | 8-Jul | |
| Adult crew on-site: | 15-Jul | |
| Adult crew off-site: | 6-Sep | |
| Fry stocking: | 15-May & 16-May | 948,000 |
| Adult Otolith Collection | 3-Aug 13-Aug 30-Aug | |

## Egg Take

Dates: 26-Sep to 27-Sep

| | No. Female | No. Male |
|---|---|---|
| No. of broodstock used: | 370 | 371 |
| Green eggs: | 964,148 | |
| Fecundity: | 2,606 | |
| Eyed eggs: | 900,514 | |
| Survival | 93% | |

## Smolt Migration

Dates: 17-May to 8-Jul

| | No. | % |
|---|---|---|
| Sockeyes: | 312,100 | |
| Mortalities: | 0 | 0.00% |
| Age 1: | 296,500 | 95% |
| Age 2: | 15,600 | 5% |
| Hatchery: | 203,100 | 65% |
| Coho: | 23,163 | |
| Dolly Varden: | 0 | |
| Rainbow: | 60 | |

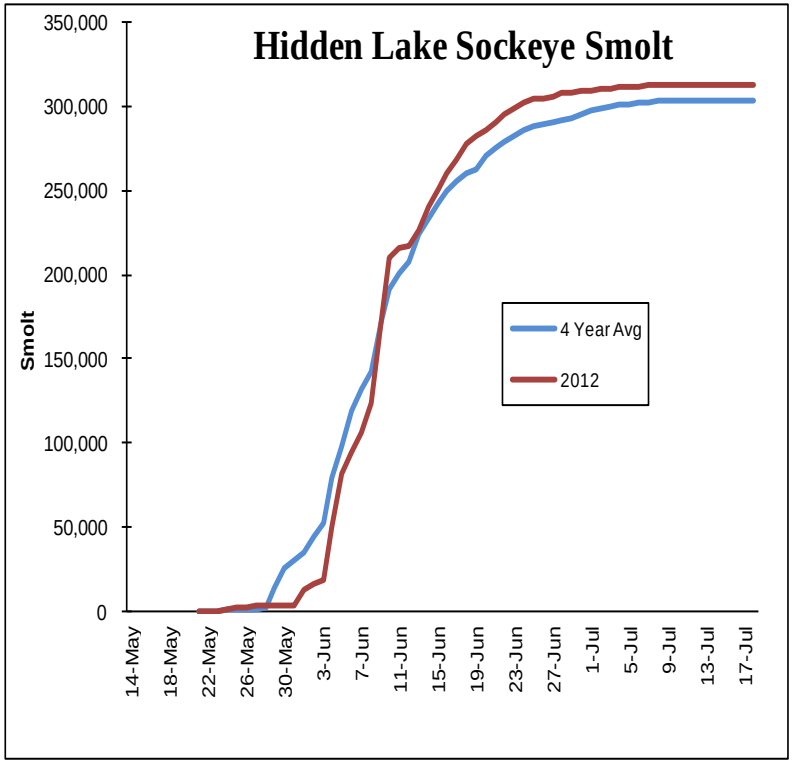
## Adult Migration

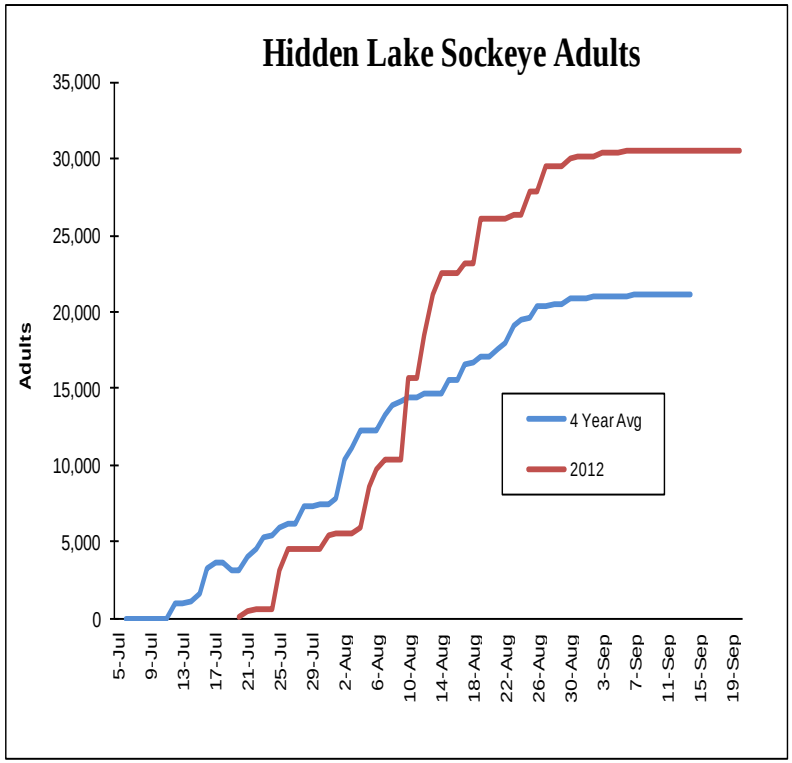
Dates: 16-Jul to 1-Sep

| | No. | % | |
|---|---|---|---|
| Sockeye total return: | 82,425 | | |
| Hidden Creek return: | 29,868 | 36.2% | Total |
| Commercial Harvest:* | 27,567 | 33.4% | C.P. |
| Personal Use/Sport Fish Harvest:* | 24,392 | 29.6% | Harvest |
| Otolith Collection: | 598 | 0.7% | 63.0% |
| Lake otolith collection: | 0 | | |
| Mortalites: | 0 | | |
| Lake Escapement: | | | |
| Hatchery broodstock: | 741 | | |
| Lake broodstock: | 29,127 | | |
| Lures: | - | | |
| Coho: | 0 | | |

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

Appendix 10. Hidden Lake Smolt and Adult Cumulative Migrations



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