Tustumena Lake
Sockeye Salmon Enhancement
Progress Report
2003

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December 2003

This year's operation of the Tustumena 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 grants received from the United States Fish and Wildlife Service.

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DISCLAIMER

The Cook Inlet Aquaculture Association conducts salmon enhancement and restoration projects in Area H, Cook Inlet and associated waters. As an integral part of these projects a variety of monitoring and evaluation studies are conducted.

The purpose of these progress reports is to provide a vehicle to distribute the information produced by the monitoring and evaluation activities. 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 fisheries project. The information presented in each report has not undergone an extensive review. As reviews are completed, the information may be updated and presented in later progress reports.

The following progress report is a synopsis of the monitoring and evaluation activities conducted for the Tustumena Lake sockeye salmon project.

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ACKNOWLEDGEMENTS

The 2003 Tustumena Lake smolt migration and Bear Creek sockeye fry release, adult count and gamete collection exercise were conducted by the Cook Inlet Aquaculture Association (CIAA). Smolt migration equipment was provided courtesy of the Alaska Department of Fish and Game, (ADF&G). Special appreciation is extended to Gary Fandrei, CIAA Executive director, whose leadership and guidance throughout this project was invaluable. CIAA seasonal employees Andrew Sheets, Alger Aleck, Aaron Fergola, and Mike Christiansen spent many hours in the field assisting with the 2003 field activities. Their efforts are greatly appreciated. Ronald Carlson, CIAA Project Technician, and Mark Thomas, Assistant Manager at Trail Lakes Hatchery, are also recognized for field assistance.

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ABSTRACT

The Alaska Department of Fish and Game (ADF&G) began the Tustumena Lake sockeye enhancement program in 1974. In 1976, the first fry resulting from egg collections were released to Tustumena Lake. During the project, eggs were collected from Bear Creek, Glacier Flats Creek, and Seepage Creek in varying combinations. As the project progressed, as many as 23.6 million eggs were collected and as many as 17.1 million fry were released into Tustumena Lake; and up to eight other lakes were stocked with fry of Tustumena origin. Currently 12 million eggs are collected from Bear Creek and 6 million are released to Tustumena Lake and 3.4 million to three lower Cook Inlet lakes.

In 1993, CIAA assumed operation of the Tustumena Lake sockeye enhancement program from ADF&G. Initially, ADF&G maintained the responsibility of conducting the Tustumena Lake limnological sampling, smolt migration and adult escapement and CIAA accepted the responsibility of enumerating the spawning population at the Bear Creek gamete collection site, collecting gametes for the enhancement program, incubating, rearing and releasing the resulting fish. In 1998, CIAA assumed the responsibility of enumerating the smolt migration and conducting the limnological sampling.

This report summarizes the 2003 Bear Creek fry release, the Tustumena Lake smolt migration, the Bear Creek adult enumeration and gamete collection activities, otolith collection activities, and the limnological sampling.

Brood year 2002 sockeye salmon fry from Bear Creek broodstock were released to Bear Creek between 28 and 31 May 2003. The 6.022 million fry were transported by fixed-wing float-equipped aircraft to the mouth of Bear Creek, held for four hours in Bear Creek water, and then released to Bear Creek 150 to 200 meters upstream. All fry were thermally marked prior to release. In addition to the fish released to Bear Creek, fry of the same brood year and stock were released to Leisure Lake (2.240 million), Hazel Lake (1.547 million), and Kirschner Lake (.298 million).

The enumeration of sockeye salmon smolts migrating from Tustumena Lake was conducted at mile 6.3 of the Kasilof River from 18 May to 5 July using a mark/recapture technique developed by ADF&G. The smolt migration totaled 12.95 million (± 2,26 million) fish and was composed of 74.2% (± 16.2%) age 1 smolts, 24.8% age 2 smolts, and 1.0% (± 0.8%) age 3 smolts. The age 1 smolts averaged 74.8 mm (± 0.42 mm) in length and 4.80 g (± 0.07 g) in weight; the age 2 smolts averaged 90.5 mm (± 0.15 mm) in length and 7.20 g (± 0.15 g) in weight. Age 3 smolts averaged 104.2 mm (± 3.65 mm) in length and 10.2 g (± 0.55 g). Smolts in 2003 weighed 30% more than smolts from 1997 to 2002. Smolts resulting from fry released by CIAA made up 18.0% (± 4.6%) of the migration. All smolts of hatchery origin were age 1.

An adult counting weir was placed in Bear Creek on 23 July 2003, and adult escapement was monitored from 23 July to 2 September 2003. The counting weir was also used to capture fish for gamete collection between 4 August and 28 August 2003. Adult sockeye in Bear Creek prior

to placement of the counting weir, were estimated by a ground survey conducted on 23 July.

Based on the ground survey count (7,300 fish) and counts at the weir (21,347), 28,647 adult sockeye migrated upstream prior to the collection of gametes. Fish counted through the weir during gamete collection totaled 29,703 and after gamete collection 3,053. The total Bear Creek sockeye spawning population was estimated at 61,403. An additional 10,251 adult sockeye also migrated to Bear Creek, but were sacrificed for gamete collection. Four hundred fifty-five dead or moribund sockeye salmon adults were also observed in Bear Creek. The total adult sockeye return to Bear Creek was estimated at 72,109.

Gamete collection at Bear Creek occurred between 4 August and 28 August. Eggs were removed from 5003 females, and milt removed from 4,994 males following ADF&G sockeye protocols for delayed fertilization. Holding mortalities and gametes not suitable for fertilization occurred in 254 fish. All carcasses were disposed of at least 100 meters offshore. The 10.936 million eggs collected were shipped to Trail Lakes Hatchery for fertilization and incubation. An estimated 9.600 million (87.8%) have survived to the eyed stage and are being thermally marked for later identification. ADF&G pathology protocols were followed for gamete collection and incubation.

Otoliths were collected from adult sockeye returning to Bear, Moose, Nicolai, and Glacier Creek, tributaries of Tustumena Lake. This is the fifth year in which this protocol was conducted to assess the incidence of straying in hatchery fish. The percent of hatchery fish identified in each of the tributaries was 2.0%, 2.4%, 0.0%, 0.0%, for Bear, Moose, Nicolai, and Glacier Creeks, respectively. All hatchery fish identified were of Tustumena Lake origin.

CIAA also sampled the hatchery outfall for hatchery-reared Tustumena stock adults returning to the hatchery. There were no adult sockeye observed at the Trail Lakes Hatchery outfall in 2003.

INTRODUCTION AND PURPOSE

In July 1993, the Alaska Department of Fish and Game (ADF&G) transferred operation of its Crooked Creek Salmon Hatchery to the Cook Inlet Aquaculture Association (CIAA). Prior to the transfer of hatchery operations to CIAA, Crooked Creek Hatchery incubated and reared sockeye (*Onchorynchus nerka*), coho (*O. kisutch*) and Chinook (*O. tshawytscha*) salmon and steelhead trout (*O. mykiss*) for release into various water bodies throughout the central and lower Cook Inlet drainage. While under CIAA management, the hatchery's stocking programs focused on sockeye salmon releases to Tustumena Lake, several lower Cook Inlet Lakes and Resurrection Bay.

In 1993, when CIAA began operating Crooked Creek Hatchery, ADF&G maintained the responsibility of monitoring the Tustumena Lake sockeye salmon smolt migration and adult escapement. CIAA accepted the responsibility of collecting the gametes (eggs and milt), incubating the eggs, rearing the fry and releasing the resulting fish to the designated water bodies.

In November 1996, CIAA terminated operations at Crooked Creek Hatchery, suspended stocking activities at five lower Cook Inlet Lakes, and transferred the remaining stocking programs to its Trail Lakes and Eklutna hatcheries.

In 1997, the Bear Creek gamete collection procedure and the Tustumena Lake fry stocking program were reviewed by the U.S. Fish and Wildlife Service. The U.S. Fish and Wildlife Service recommended several changes to these activities, which have been incorporated into the program.

In 1998, operations at Eklutna Hatchery were suspended, and the hatchery's Tustumena Lake egg incubation and fry rearing activities were transferred to Trail Lakes Hatchery. During 1998, CIAA also assumed the responsibility of conducting the limnological sampling; and, thus became responsible for conducting all project activities, except the adult escapement monitoring,

which is conducted by ADF&G. Under the current program, approximately twelve million eggs are collected to provide six million fry for rearing in Tustumena Lake and approximately 3.5 million for rearing in three Lower Cook Inlet lakes.

This report summarizes the 2003 project activities conducted by CIAA. It includes the Bear Creek fry release, the Kasilof River smolt enumeration, the Bear Creek adult enumeration, adult otolith analysis, gamete collection activities, the release of Tustumena Lake origin fish to three lower Cook Inlet lakes and results of the analysis of the limnology samples collected during the 2003 open water season.

The Tustumena Lake adult sockeye migration was completed by ADF&G and is reported separately by ADF&G.

PROJECT AREA

Tustumena Lake is located on the Kenai Peninsula in South-central Alaska (Figure 1). It is the largest lake on the Kenai Peninsula and the fifth largest lake in the State of Alaska. It is a glacial lake with a surface area of 294.5 km^2. The mean depth is 24 m, and the maximum depth is 320 m. The lake is fed by several clear-water streams and two glacial streams, which originate in the Harding Icefield (Kyle, 1992).

Tustumena Lake is oligotrophic with mean open-water season total phosphorus, total Kjeldahl nitrogen and chlorophyll a concentrations of 3.7 μ/L, 155 μ/L, and 0.45 μ/L, respectively. The lake is turbid with glacial silt and light penetration is limited to the upper two meters (Kyle, 1992).

The zooplankton community consists of two copepods, *Diaptomus pribilofensis* and *Cyclops columbianus.* All five species of Pacific salmon, *O. nerka*, *O. keta*, *O. gorbuscha*, *O. tshawytscha*, and *O. kisutch*, are found in the Tustumena Lake system; however, it is mainly sockeye that utilize the limnetic area of the lake. Resident fish species include rainbow trout (*O. mykiss*), lake trout (*Salvelinus namaycush*), Dolly Varden char (*S. malma*), threespine stickleback (*Gasterosteus aculeatus*), coastrange and slimy sculpin (*Cottus aleuticus* and *C. cognatus*) and round whitefish (*Prosopium cylindraceum*) (Kyle, 1992)

The Kasilof River, which flows 17.4 miles to Cook Inlet, forms the outlet. The smolt migration and the enumeration of the adult escapement occur in the Kasilof River.

Bear Creek, a tributary of Tustumena Lake (Figure 1), is the site of the fry release and gamete collection. It is a moderately sized stream approximately 16 miles long with an average gradient of 185 feet/mile. The stream lies northeast of the lake and begins in the Kenai Mountains above tree line at an elevation of approximately 3,100 feet. The upper section of the creek flows with an average gradient of 260 feet/mile for 4.25 miles. At the tree line it enters a narrow canyon. The canyon dominates the middle section of the stream as it flows for the next 8.25 miles with an

average gradient of 180 feet/mile. As the stream leaves the canyon, the gradient over the lower 3.75 miles decreases to approximately 105 feet/mile. The fry release and gamete collection site is located in the lower section of Bear Creek approximately 150 meters upstream of its confluence with Tustumena Lake. The site is in an area with a stable stream bottom and banks and is upstream of any lake influence.

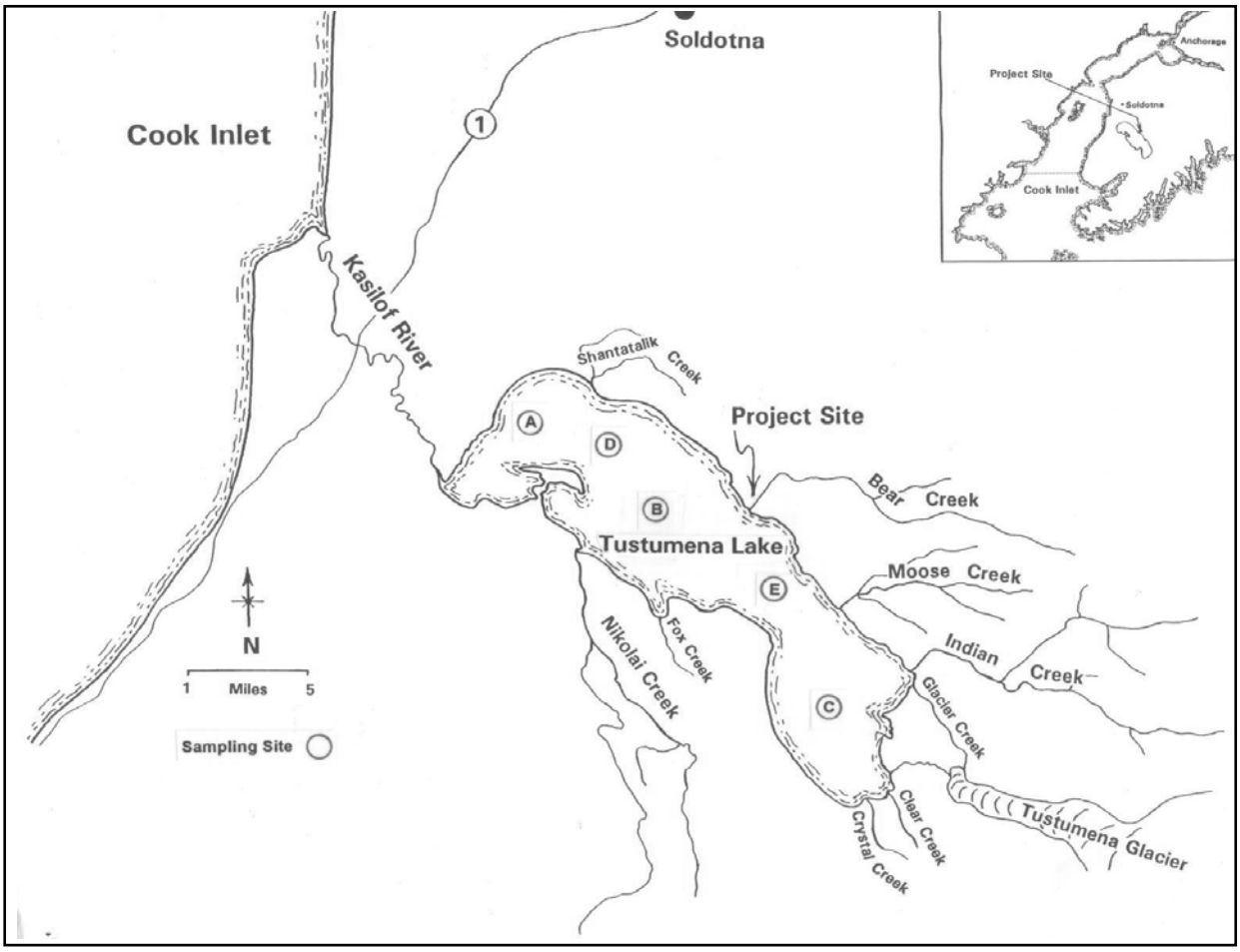

Figure 1. Area Map of Bear Creek, a tributary to Tustumena Lake, near Soldotna, Alaska.

METHODS

CIAA's 2003 Tustumena Lake fishery enhancement activities involved the collection of limnological samples, the enumeration of the smolt migration, the enumeration of the Bear Creek adult return, the collection of gametes, the release of fry at Bear Creek and to three Lower Cook Inlet lakes, and the collection of adult otolith samples. The procedures used to release the fry, enumerate the smolt migration and adult migrations and collect the gametes and otoliths are described below. In general, all procedures follow ADF&G recommendations.

Limnological Sampling and Environmental Conditions

During 2003, limnological samples were collected once each month during the open water season from June through September. Five sites (Figure 1) were sampled for light transmission profiles, Secchi disk transparency and zooplankton densities. All samples were collected by CIAA and water analyses completed by ADF&G. Sample collection and analysis procedures are described by Koenings, et al. (1986).

Smolt Enumeration

This was the sixth year CIAA was responsible for enumerating the smolt migration from Tustumena Lake. The smolt migration was estimated by enumerating a known proportion of the migration following procedures developed by ADF&G. The following is a general description of the procedures.

One inclined-plane smolt trap (Todd 1994) was placed in the Kasilof River near river mile 6.3 to capture a portion of the migrating smolts. The trap was operated from 18 May through 5 July 2003. It consisted of an inclined plane lead, a live box, and a floating support structure; and measured 1.5 m in width, 1 m in height, and 3.8 m in length.

Each day, the number of smolts captured by the trap was determined by individually counting and releasing each fish; or, when the daily smolt numbers exceeded 15,000 fish, the number of smolts captured was estimated using a biomass technique. To estimate the number of smolts captured by the biomass technique, the average weight of a sample of at least 50 smolts caught that day was divided into the total weight of all smolts captured (Todd and Kyle, 1996). Debris accumulating in the trap was also removed when the trap was checked for fish.

The total number of sockeye smolts migrating from Tustumena Lake was estimated using weekly trap capture efficiencies determined by the recapture of marked fish. For the mark-and-recapture procedure, each week approximately 1,000 sockeye smolts were dyed[1] and released upstream near river mile 7.1. The number of smolts recaptured was then used to estimate the proportion of migrating smolts captured (the trap capture efficiency) and the total smolt migration.

Statistical procedures for estimating the population of migrating smolts (N) followed the *simple stratified M-R design* for One-Site sampling experiments described by Carlson et al. (1998) where:

U = total unmarked population size;
N = total population size;
N_h = total population size in stratum h;
u_h = total number of unmarked smolts captured in stratum h;
M_h = number of marked smolts released in stratum h;
m_h = number of marked smolts recaptured in stratum h;
L = number of strata or periods; and

$$\hat{U} = \sum_{h=1}^{L} \hat{N}_h - M_h = \sum_{h=1}^{L} \frac{u_h (M_h + 1)}{m_h + 1}$$

The variance of the population estimate $v(N)$ and the 95% confidence interval (CI) were estimated as:

$$v(\hat{N}) = \sum_{h=1}^{L} v(\hat{N}_h) = \sum_{h=1}^{L} \frac{(M_h + 1)(n_h + 1)(M_h - m_h)(n_h - m_h)}{(m_h + 1)^2 (m_h + 2)}; \text{ and}$$

$$(CI) = \hat{N} \pm 1.96\sqrt{v(\hat{N})}\ .$$

This method assumes:

- All marked fish released upstream pass the trap before the next release of marked fish;
- The probability that a dyed or unmarked fish enters the trap equals the trap efficiency for all dyed or marked fish;
- Fish are captured or not captured in the trap independently of the fate of other fish;
- All fish entering the trap are counted, and;
- Trap efficiencies do not change significantly during the smolt migration.

The daily migration of sockeye smolts is presented in Appendix 3.

The proportions of age 1, age 2, and age 3 smolts were calculated using the data computed from the aforementioned notations and formulas with the following notations and formulas:

U_i = total unmarked population size for age class = i;
U_h = total unmarked population size for stratum = h;
U_{hi}= total unmarked population size for age class i, in stratum = h;
P_i = proportion of unmarked smolt for age class = i;
P_h = proportion of unmarked smolt for stratum = h;
P_{hi}= proportion of unmarked smolt for age class = i, in stratum = h;
a_i = total number of samples of age class = i;

The estimated number of migrating age = i smolts was calculated as:

$$U_i = \sum U_h P_{hi}$$

Proportion of age = i smolts was calculated as:

$$P_i = \frac{1}{U}\sum U_h P_{hi}$$

The variance of the proportion of age = i smolts in stratum = h was calculated as:

$$v(P_{hi}) = \frac{P_{hi}(1-P_{hi})}{a_h - 1}$$

The variance of the number of age = i smolts in stratum = h was calculated as:

[1] Fish were marked by placing them in a Bismark Brown Y dye bath (1.0g dye dissolved in 30 liters water) for 30 minutes before being reintroduced into the river.

$$v(U_{hi}) = U_h^2 v(P_{hi}) + P_{hi}{}^2 (U_h) - v(U_h)(P_{hi})$$

Therefore, the variance of the estimated number of age = i smolts was calculated as:

$$v(U_i) = \sum v(U_{hi})$$

Confidence intervals (95%) estimates for number of age = i smolts are:

$$U_i \pm 1.96\sqrt{v(U_i)}$$

Since 1976, ADF&G or CIAA has released sockeye salmon fry directly to Tustumena Lake or to Bear Creek, a tributary of Tustumena Lake, for rearing in Tustumena Lake. Since 1996, CIAA has marked the otoliths of all sockeye fry rearing in Tustumena Lake with a thermal band[2]. The purpose of the thermal band was to identify released fish in the population of smolt migrating from Tustumena Lake or adults migrating back to the lake.

In 2003, to assess the enhancement program, CIAA collected a sample of sockeye smolts migrating from the lake to determine age, weight, and length characteristics of the migrating population and to estimate the proportion of enhanced fish in the smolt migration. Smolts collected for evaluation, were collected daily in proportion to the number of smolts captured by the inclined-plane trap. This was accomplished by collecting a sample of migrating smolts approximately equal to 0.3% of the fish captured. Each sockeye smolt collected for evaluation was first measured to the nearest millimeter for fork length[3] and then weighed to the nearest 0.1 gram. Several scales were removed from the primary growth area[4] and mounted on a glass slide

[2]The otolith mark is a series of hatchery induced bands produced by controlled temperature changes during incubation.

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

[4]Located above the lateral line on a diagonal from the posterior insertion of the dorsal fin to the anterior insertion of the anal fin.

for subsequent age determination. The otoliths of the collected smolts were removed and placed in a labeled 1dram vial. Ethanol was added to the vial to cover the otoliths; and, after the smolt migration was complete, the otoliths were shipped to Trail Lakes Hatchery. Staff at Trail Lakes Hatchery processed the otoliths and checked each for a hatchery thermal mark following procedures described by Glick and Shields (1993).

In 2003, 1,100 otoliths were processed and readable. The enhancement contribution of the migrating smolts was calculated using the same notations and formulas as reported above, but with following exception: i = hatchery or wild.

Sockeye smolt characteristics (average weight and length) for captured smolts were estimated with the following notations and formulas.

If:

y = weight or length of fish
c_i = number of age = i smolts sample

Mean weight or length was calculated as:

$$\bar{y}_i = \frac{\sum y_i}{c_i}$$

The standard deviation for weight and length of each age class was calculated as:

$$\sigma_{y_i} = \sqrt{\frac{c_i \sum y_i - \left(\sum y_i\right)^2}{c_i\left(c_i - 1\right)}}$$

Confidence intervals (95%) for the mean weight and length are, therefore:

$$\bar{y}_i = \pm 1.96\left(\frac{\sigma_{y_i}}{\sqrt{c_i}}\right)$$

Adult Escapement

Monitoring of the 2003 Tustumena Lake adult sockeye escapement was completed by ADF&G. Based on preliminary information developed by ADF&G, the total estimated 2003 Tustumena Lake sockeye return was 996,483 fish; with a commercial harvest of 568,850, personal use harvest of 63,000, a sport fish harvest of 6,600, and a lake escapement of 258,033. The 2003 adult return data will be finalized and reported by ADF&G.

Adult escapement monitoring at Bear Creek began on 23 July 2003 when a picket weir was placed in the Creek. A ground survey was used to estimate the number of fish that had migrated upstream prior to placement of the picket weir. The picket weir was used to enumerate fish migrating into Bear Creek after the weir was in place.

The ground survey to enumerate sockeye salmon upstream of the weir was accomplished on 23 July by four CIAA staff members walking the lower seven kilometers (4.3 miles) of the stream. Two of the four stream surveyors maintained a constant watch for bears while the other surveyors counted fish. The survey was terminated when the number of fish/kilometer declined substantially. An estimate of the fish remaining uncounted was made based on the recorded stream count and the remaining length of stream historically known to contain spawning fish.

The picket weir used to enumerate sockeye salmon entering Bear Creek after 23 July was a commercially available steel and aluminum weir (Rack Master®). The weir was placed approximately 150 meters from the stream mouth and prevented the uncontrolled migration of adult fish upstream. Fish approaching the weir were either, held for broodstock or, based on broodstock needs, counted and passed upstream by removing one or two pickets.

Gamete Collection, Incubation and Rearing

In 2003, gamete collection at Bear Creek began on 4 August. Gamete collection continued until 28 August.

To capture fish (broodstock) for gamete collection, adult sockeye were allowed to accumulate below the weir. Broodstock were herded or dip netted into holding pens. The fish were immediately checked for gamete development. Green (sexually immature) fish were returned to Bear Creek, ripe (sexually mature) fish were held in the net pens for gamete removal. Adult fish were captured at random and selected for gamete removal based solely on gamete development (maturity). CIAA attempted to collect fish for broodstock in approximate proportion to the stream entry timing of fish returning to Bear Creek (Appendix 5).

The delayed fertilization technique (gametes are collected and sent separately to the hatchery for fertilization) was used at Bear Creek. In 2003, 10,251 fish were sacrificed for gamete collection. Holding mortalities and gametes not suitable for fertilization occurred in 254 fish. The remaining fish (5,003 females and 4,994 males) were stripped of their gametes and the gametes were shipped to Trail Lakes by floatplane. All spawned-out carcasses were removed from the creek and disposed into Tustumena Lake, at least 100 meters or more offshore each day.

When the gametes arrived at the hatchery, they were again inspected for quality. Eggs that were water hardened, or of very poor quality were culled. In 2003, no eggs were culled at the hatchery. It was estimated that 10.936 million eggs were collected and placed in Trail Lakes Hatchery; 9.600 million (89.9%) survived to the eyed stage. Low fecundity in the female broodstock had caused CIAA to reach the maximum allowed broodstock; therefore, the egg collection was terminated early, and, the egg collection goal was not realized.

The ADF&G pathology protocol for collecting and processing gametes (McDaniel, et al. 1994) was followed for all eggs collected at Bear Creek. Specific gamete collection procedures are presented in CIAA's egg take procedures manual (CIAA, 1993).

Fish Transport and Stocking

In 2003, all fry were transported by truck in oxygenated transport tanks from Trail Lake Hatchery to Trail Lakes, transferred to a fixed-wing float-equipped aircraft, and flown to the mouth of Bear Creek. Upon arrival, the fry were transferred to seven small holding tanks fitted with an oxygen delivery system and a continuous fresh water exchange. The fresh water was obtained from Bear Creek and gravity fed via a temporary pipe system to the holding tanks. The fry were held in the holding tanks between 4.0 and 11.3 hours for imprinting to Bear Creek. After imprinting, the fry were carried in buckets 150 to 200 meters upstream and released to the creek at the gamete collection site. Many fish immediately drifted downstream to the lake; however, some remained in the creek and were observed holding in small pools and eddies.

Fry of the same brood year and stock were also transported via fixed-wing float-equipped aircraft to Leisure Lake, Hazel Lake, and Kirschner Lake. The fry were gravity fed from the aircraft's holding tank directly to the Lake.

All fry from brood year 2002 and of Bear Creek broodstock were not externally marked or tagged upon release; however, the otoliths of these fry were marked with thermal bands [Rbr 1:1.3]. Otolith samples were processed to document the marks and are on file at Trail Lakes Hatchery.

Adult Otolith Collection

Beginning in 1996, CIAA thermally marked all fry released directly into Tustumena Lake or released into Bear Creek for rearing in Tustumena Lake. During the 2003 season, CIAA began the fifth year of a project to assess the incidence of straying in hatchery fish. This study has been conducted by collecting otoliths from post-spawn fish found in four creeks flowing into Tustumena Lake and by sampling the hatchery outfall for hatchery reared Tustumena stock adults returning to the hatchery. The creeks included Bear, Moose, Glacier, and Nikolai Creeks.

From 3 August to 27 August, adult fish were sampled from each creek and otoliths taken. Otoliths were sent to Trail Lakes Hatchery for analysis.

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RESULTS AND DISCUSSION

Limnology and Environmental Conditions

During 2003, water sampling and measurements were conducted five times; once each month from May through October. Five sites (Figure 1) were sampled for light transmission profiles, Secchi disk transparency and zooplankton densities. Secchi disk results and euphotic zone depth results are shown in Table 1. Average results of all limnological measurements collected by CIAA and the zooplankton analysis conducted by the Alaskan Department of Fish and Game are presented in Appendix 1. No unusual limnological measurements were observed; however, this was the second year higher than average plankton biomass and density was observed.

Table 1. Tustumena Lake Secchi Depth and EDZ 2003.

	Secchi Depth (cm)				
Date	A	B	C	D	E
28-May	39	34	33	36	37
28-Jun	39	37	32	37	33
5-Sep	40	36	41	35	45
5-Aug	57	39	56	48	50
8-Oct	31	43	42	41	32

	Euphotic Zone Depth (m)				
Date	A	B	C	D	E
28-May	1.8	1.8	1.7	1.9	1.8
28-Jun	2.2	2.1	1.9	2.0	2.1
5-Sep	1.6	1.4	2.6	2.0	1.8
5-Aug	2.4	2.1	3.6	2.0	1.9
8-Oct	1.9	1.7	1.8	1.8	1.6

Environmental conditions during the Kasilof River smolt migration were monitored from 18 May to 5 July 2003. Stream Stage measurements averaged 1.07 feet and ranged from 0.54 to 3.90 feet. During the period of the smolt migration, river temperatures averaged 10.6°C and ranged from 7 to 15°C. Air temperatures averaged 10.4°C and ranged from 4 to 18°C. Sixteen percent of the days were clear, 50% were partly cloudy, and 24% were completely overcast. A total of 5 mm of rain fell during this period. (Appendix 2)

Smolt Enumeration

Based on the statistical analysis a total of 12.95 million (± 2.438 million) sockeye smolts migrated from Tustumena Lake (Table 2) in 2003. Smolts resulting in fry released by CIAA made up 18.0% (±4.6%) of the migration.

Table 2. Tustumena Lake smolt migrations – 1998 to 2003.

Smolt Year	Total (million)	95% C.I.	Wild	Hatchery	% Hatchery	95% C.I.
1998	4.6	(±395,000)	3,872,000	727,000	15.8	(±2.2)
1999	4.5	(±461,000)	3,555,000	945,000	21.0	(±2.5)
2000	4.3	(±526,000)	3,986,000	316,000	7.4	(±1.8)
2001	5.3	(±612,000)	5,155,000	105,000	1.9	(±1.0)
2002	3.5	(±618,000)	3,474,000	0	0	0
2003	12.9	(±2,437,000)	10,619,000	2,329,000	18.0	(±4.6)
Average	5.8		5,110,167	737,000	10.7	

The smolt migration was composed of 74.2% (± 16.2%) age 1 smolts, 24.8% age 2 smolts, and 1.0% (± 0.8%) age 3 smolts. The age 1 smolts averaged 74.8 mm (± 0.42 mm) in length and 4.80 g (± 0.07 g) in weight; the age 2 smolts averaged 90.5 mm (± 0.15 mm) in length and 7.20 g (± 0.15 g) in weight (Table 3). . Age 3 smolts averaged 104.2 mm (± 3.65 mm) in length and 10.2 g (± 0.55 g). Age 1 Smolts from 2003 weighed 25% more than smolts from 1997 to 2002, while Age 2 smolts weighed 3o% more than smolts from 1997 to 2002.

Table 3. Tustumena Lake smolt characteristics – 1997 to 2003.

	Age Class (%)				Mean length (mm)				Mean weight (g)			
Smolt Year	Age 1.0	95% C.I.	Age 2.0	95% C.I.	Age 1.0	95% C.I.	Age 2.0	95% C.I.	Age 1.0	95% C.I.	Age 2.0	95% C.I.
1997	64.7		35.3		76.9		86.6		3.90		5.20	
1998	79.5		20.5		74.5	(±0.36)	84.9	(±1.03)	3.75	(±0.05)	5.43	(±0.16)
1999	77.7	(±9.6%)	22.3	(±3.8%)	76.8	(±0.34)	88.6	(±0.66)	3.85	(±0.05)	5.77	(±0.13)
2000	81.3	(±11.5%)	18.7	(±4.2%)	73.4	(±0.32)	86.0	(±0.73)	3.20	(±0.05)	5.01	(±0.12)
2001	60.7	(±9.5%)	38.2	(±6.3%)	72.3	(±0.39)	83.7	(±0.53)	3.26	(±0.05)	5.07	(±0.08)
2002	39.4	(±24.1%)	60.9	(±24.8%)	74.4	(±0.42)	81.9	(±0.64)	3.66	(±0.06)	5.16	(±0.11)
2003	74.2	(±16.2%)	24.8	(±6.4%)	77.8	(±0.42)	90.5	(±0.15)	4.80	(±0.07)	7.20	(±0.15)
Ave	68.2		31.5		75.2		86.0		3.8		5.5	

Note: 2001 smolt migration inclueded 1.1% (±0.07%) age class 3 smolt
Note: 2003 smolt migration inclueded 1% (±0.8%) age class 3 smolt

Adult Escapement

In October of 2002, Bear Creek experienced substantial flooding, and much of the creek was filled in with sand and gravel. In addition, significant amounts of established riparian habitat was destroyed and replaced with new sand, gravel, and cobble. Because of these conditions several areas within the project area had water levels of only 1 to 2 inches. High air temperatures were also observed in early August. Due to the low water, most of the bodies, including the head and mandible, of migrating sockeye salmon were sticking out of the water exposing them to the warmer air. These fish were observed resting in large line-forming groups and within these groups dead or moribund sockeye salmon were observed.

The ground survey team estimated 7,300 sockeye salmon had migrated upstream before the installation of the weir. An additional 21,347 fish were counted and passed upstream prior to gamete collection. During the gamete collection phase of the project, 10,251 fish were captured for gamete collection and 29,703 fish were passed upstream. After the gamete collection exercise, 3,053 fish were counted at the weir and migrated up Bear Creek. In addition, 455 dead fish were observed in Bear Creek during the migration. The total estimated return of sockeye salmon to Bear Creek was 72,109 (Appendix 4).

The unstable conditions of the creek substrate compromised the integrity of the weir on 12 and 26 August and fish were observed passing upstream freely. These problems were addressed and the number of fish that passed was estimated to be 5,000 on 12 August and 6,000 on 26 August (Appendix 4). Suspected escapes occurred on 10, 11, 13, 14, 16, and 17 August. Though no fish were observed moving upstream through the weir, several damaged areas where fish could pass freely were located. The data recorded on these dates are considered suspect.

The number of sockeye salmon returning to Bear Creek was slightly below the average for returns observed at Bear Creek since 1991 years (Table 4).

Table 4. Sockeye salmon escapement to Bear Creek – 1991 to 2003.

Year	Upstream Spawners	Hatchery Broodstock	Total
1991	60,400	8,500	68,900
1992	37,500	6,600	44,100
1993	36,000	9,113	45,100
1994	39,100	13,600	52,700
1995	29,000	12,846	41,800
1996	47,000	11,672	58,700
1997	73,700	8,289	82,000
1998	103,600	9,963	113,600
1999	68,300	9,914	78,300
2000	76,300	8,717	85,000
2001	101,440	8,724	110,164
2002	88,252	9,442	97,694
2003	61,403	10,251	71,654

Fish Transport and Stocking

Prior to 1996, all releases of sockeye fry by CIAA to Tustumena Lake were made by aerial drop. Fry were transported and released from fixed-wing aircraft from an altitude of approximately 300 feet near the lake's shoreline. In 1996, fry transport and release methods were modified. Fry were transported by skiff to the mouth of Bear Creek and released directly into the creek as it entered the lake.

In 1997, the fry transport and release methods were again modified. The fry were flown to the mouth of Bear Creek by fixed-wing float-equipped aircraft, transferred to several small holding tanks fitted with an oxygen delivery system and a continuous exchange of fresh water and then carried 150 to 200 meters upstream for release. Although, this transport and release procedure was developed to improve the ability of adult fish to migrate back to Bear Creek, it also provided CIAA with a better opportunity to estimate fry transport mortality (Table 5) and to evaluate the condition of the fry at the time of release. The release method has been consistent since 1997.

In 2003, 6.022 million fry were transported to Bear Creek. An estimated 16,850 sockeye fry died during transport. The remaining 6.020 fry were released between 28 May and 31 June (Table 5).

Table 5. 2003 summary of fry transport, imprinting and release activities at Bear Creek.

Load No.	Date	Transport		Holding		Start Imprint	Release Time	Hours Imprinted	Estimated Mortality	No. of Fry Released	No. of Fry Released Daily
		Weight (kg)	Fry/kg	No. of Fry	D.O (mg/l)						
1	28-May-03	78.2	2,475	193,545	ND	10:00	14:15	4:15	100	193,445	
2		115.9	2,475	286,853	ND	10:15	14:30	4:15	100	286,753	
3		109.6	2,445	267,972	ND	12:00	16:10	4:10	100	267,872	
4		80.5	2,591	208,576	ND	14:45	18:45	4:00	100	208,476	
5		85.3	2,695	229,884	ND	17:00	21:00	4:00	100	229,784	
6		109.4	2,695	294,833	ND	18:15	22:15	4:00	100	294,733	
7		82.8	3,086	255,521	ND	19:35	23:35	4:00	100	255,421	
8		118.2	3,020	356,964	ND	19:45	0:00 (5/29)	4:00	100	356,864	2,093,346
1	29-May-03	89.1	3,058	272,468	ND	8:55	20:15	11:20	100	272,368	
2		118.8	3,062	363,766	ND	10:23	19:50	9:27	100	363,766	
3		84.2	2,874	241,991	ND	11:10	17:30	6:20	7,500	241,991	
4		116.9	2,874	335,971	ND	12:55	16:55	4:00	7,500	335,971	1,214,095
1	30-May-03	83.5	3,876	323,646	ND	9:00	13:00	4:00	100	323,546	
2		119.3	3,756	448,091	ND	10:15	14:30	4:15	100	447,991	
3		85.6	3,610	309,016	ND	11:15	15:15	4:00	100	308,916	
4		126.6	3,212	406,639	ND	12:05	16:05	4:00	100	406,539	
5		85	3,125	265,625	ND	13:35	17:35	4:00	150	265,475	
6		116.3	3,086	358,902	ND	14:45	18:45	4:00	100	358,802	
7		118.1	2,933	346,387	ND	16:30	20:30	4:00	100	346,287	2,457,556
1	31-May-03	87.1	2,933	255,464	ND	9:30	13:30	4:00	100	255,364	255,364
	Total	2,010	59,881	6,022,000					16,850	6,020,000	
	Ave:	100.5	2,994.1	573,529				4:48	842.5		

Note: Although Dissolved Oxygen (DO) was not recorded, it was monitored and kept between 7 to 12 mg/l; during the last .5 hours of holding the DO was increased to 20 mg/l

Fry from brood year 2002 that were also stocked into Lower Cook Inlet lakes are presented in Table 6.

Table 6. A summary of sockeye and smolt releases of Bear Creek broodstock – 1994 to 2003

Release Year	BY	Fry Releases								Age 1 Smolt Releases		
		Release to Tustumena L.	Release to Other Areas									
			Leisure L.	*Chenik L.	*Paint River. L.	Kirschner L.	Hazel L.	*Bruin L.	*Ursus L.	BY	*Coal Ck.	*Grouse L.
1994	1993	0	0	0	0	208,000	0	0	0	1992	0	0
1995	1994	6,000,000	1,632,000	1,129,000	588,000	251,000	1,061,000	251,000	252,000	1993	146,000	83,000
1996	1995	6,136,000	1,490,000	951,000	500,000	250,000	1,030,000	250,000	250,000	1994	0	218,000
1997	1996	5,981,000	2,000,000	0	0	250,000	1,000,000	0	0	1995	0	761,000
1998	1997	4,558,000	1,877,000	0	0	234,000	1,218,000	0	0	1996	0	1,186,000
1999	1998	5,945,000	26,500	0	0	172,700	453,100	0	0	1997	0	0
2000	1999	5,431,600	1,707,500	0	0	248,500	1,248,000	0	0	1998	0	0
2001	2000	0	88,700	0	0	0	0	0	0	1999	0	0
2002	2001	6,052,000	2,246,000	0	509,000	302,000	1,200,000	0	0	2000	0	0
2003	2002	6,020,000	2,240,000	0	0	298,400	1,547,100	0	0	2001	0	0

*Project Not Active

Adult Otolith Collection

Intermittently, from 3 August to 11 September 2003, CIAA collected otoliths from post-spawn fish found in the Tustumena Lake tributaries of Bear, Moose, Nikolai, and Glacier Creeks. To

avoid conflicts with a bear study being conducted at Glacier Creek, CIAA opted to collect otoliths samples later than usual. Unfortunately, only 4 sockeye carcasses were recovered. Of the 912 samples collected, 889 were readable. Hatchery fish comprised 2.0%, 2.4%, 0.0%, and 0.0% of the samples collected at Bear, Moose, Nicolai, and Glacier Creeks, respectively (Table 7). All hatchery fish were of Tustumena Lake (Bear Creek) broodstock.

Table 7. Tustumena adult sockeye salmon otolith monitoring, 2003

Site	Sample Dates	# Collected	# Readable	# Hatchery	# Wild	%Hatchery
Bear	13,14,18,20 Aug	304	294	6	288	2.0%
Moose	3,15 Aug	304	297	7	290	2.4%
Nicolai	17,21 Aug	300	294	0	274	0.0%
Glacier	11-Sep	4	4	0	4	0%
Totals		912	889	13	856	1%

CIAA began this evaluation in 1999. Table 8 displays the historical comparisons.

Table 8. Historical results of Tustumena adult sockeye salmon otolith monitoring

	Bear Creek	Moose Creek	Nicolai Creek	Glacier Creek	Total
1999	0.0%	0.0%	0.0%	0.0%	0.0%
2000	5.8%	2.3%	0.7%	0.3%	2.3%
2001	13.2%	10.9%	11.3%	0.0%	9.0%
2002	30.6%	6.5%	0.0%	0.0%	9.0%
2003	2.0%	2.4%	0.0%	0.0%	1.0%
Average	10.3%	4.4%	2.4%	0.1%	4.3%

Gamete Collection

The number of sockeye salmon eggs collected for brood years 1993 through 2003 are presented in Table 9. Since 1993, the delayed fertilization technique and ADF&G pathology protocols have been followed for all gamete collections.

Table 9. Sockeye salmon gamete collections at Bear Creek – 1993 to 2003.

Year	Eggs Collected	Female Broodstock	Estimated Fecundity
1993	14,249,000	5,458	2,610
1994	15,181,000	6,800	2,230
1995	13,132,000	6,226	2,110
1996	16,105,000	5,587	2,880
1997	10,890,000	4,018	2,710
1998	13,382,000	4,869	2,750
1999	14,984,000	4,945	3,030
2000	11,810,000	4,245	2,782
2001	12,037,000	4,084	2,947
2002	11,721,690	4557	2,572
2003	10,936,267	5003	2,186
Ave:	13,129,814	5,072	2,619

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RECOMMENDATIONS

The fry release and enumeration of the smolt migration as conducted in 2003 was successful. However, the gamete collection goal was not met due to the altered conditions of Bear Creek and the low fecundity of early spawning broodstock; and the upstream count was compromised when unstable substrate allowed fish to bypass the weir on several occasions. It is recommended that the site conditions at Bear Creek be reevaluated and updated to the 2004 progress report. Additionally, environmental conditions (rain fall, creek depth, water and air temperature, etc.) should be gathered during the Bear Creek sockeye salmon migration.

Recommendations concerning the Kasilof Smolt migration are directed toward obtaining better data during trap catch efficiencies. The method of dying, transporting and holding smolts should be reevaluated. Equipment should also be evaluated and updated to ensure safe transport and holding of smolts. Staff gauge readings on the Kasilof River should be taken everyday in conjunction with all other environmental readings.

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APPENDICES

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Appendix 1. Tustumena Lake 2003 - Zooplankton Density and Biomass Averages.

SITE A

	Density Seasonal Mean (No/m^2)	Mean Length (mm)	Weighted Length (mm)	Biomass (mg/m^2)	Weighted Biomass (mg/m^2)
Diaptomus	7,930	0.96	0.85	30	22
Ovig. *Diaptomus*	85	1.09	1.09	0	0
Cyclops	41,951	0.92	0.92	125	127
Ovig. *Cyclops*	1,070	1.21	1.21	6	6

SITE B

	Density Seasonal Mean (No/m^2)	Mean Length (mm)	Weighted Length (mm)	Biomass (mg/m^2)	Weighted Biomass (mg/m^2)
Diaptomus	17,087	0.90	0.80	55	39
Ovig. *Diaptomus*	0	1.04	1.04	0	0
Cyclops	102,989	0.86	0.85	270	261
Ovig. *Cyclops*	658	1.20	1.20	4	3

SITE C

	Density Seasonal Mean (No/m^2)	Mean Length (mm)	Weighted Length (mm)	Biomass (mg/m^2)	Weighted Biomass (mg/m^2)
Diaptomus	30,107	0.89	0.89	92	94
Ovig. *Diaptomus*	955	1.11	1.11	5	6
Cyclops	50,951	0.90	0.91	146	151
Ovig. *Cyclops*	832	1.20	1.18	4	4

SITE D

	Density Seasonal Mean (No/m^2)	Mean Length (mm)	Weighted Length (mm)	Biomass (mg/m^2)	Weighted Biomass (mg/m^2)
Diaptomus	3,727	1.01	0.95	17	14
Ovig. *Diaptomus*	43	1.05	1.06	0.21	0.22
Cyclops	82,807	0.88	0.88	225	225
Ovig. *Cyclops*	509	1.20	1.20	3	3

SITE E

	Density Seasonal Mean (No/m^2)	Mean Length (mm)	Weighted Length (mm)	Biomass (mg/m^2)	Weighted Biomass (mg/m^2)
Diaptomus	10,108	0.84	0.77	27	21
Ovig. *Diaptomus*	212	1.08	1.08	1	1
Cyclops	111,717	0.88	0.86	302	294
Ovig. *Cyclops*	679	1.20	1.19	4	4

Appendix 1 (continued). Tustumena Lake 2003 – Historical Zooplankton

Station A

	Diaptomus		*Cyclops*		*Diaptomus*	*Cyclops*	Totals	
	Density	Biomass	Density	Biomass	Size	Size	Density	Biomass
Year	no/m2	mg/m2	no/m2	mg/m2	mm	mm	no/m2	mg/m2
1980	10,153	na	31,414	na	na	na	41,567	0
1981	10,850	34	23,586	77	0.90	0.95	34,435	111
1982	1,408	11	41,405	99	1.25	0.83	42,813	110
1983	11,411	79	25,261	74	1.18	0.91	36,673	153
1984	11,730	33	24,942	48	0.86	0.74	36,672	81
1985	1,656	15	47,836	93	1.31	0.75	49,492	108
1986	6,835	27	31,615	70	0.97	0.79	38,449	96
1987	5,606	39	44,516	107	1.19	0.83	50,123	146
1988	8,551	36	20,028	55	0.99	0.88	28,579	91
1989	4,898	38	24,208	53	1.18	0.74	29,106	91
1990	3,253	21	28,814	61	1.15	0.78	32,067	82
1991	16,252	79	50,815	133	1.04	0.86	67,067	212
1992	3,427	15	31,381	87	1.01	0.89	34,808	102
1993	15,689	94	49,390	116	1.13	0.82	65,079	210
1994	29,012	116	30,256	86	0.97	0.89	59,268	202
1995	12,415	61	22,325	73	1.04	0.96	34,740	134
1996	11,237	50	15,963	42	1.02	0.86	27,200	92
1997	5,282	22	28,568	75	1.00	0.86	33,850	97
1998	20,074	127	13,783	33	1.15	0.82	33,857	160
1999	6,252	23	30,674	71	0.95	0.81	36,926	94
2000	14,211	69	29,217	83	1.04	0.89	43,428	152
2001	7,017	24	25,040	57	0.92	0.80	32,057	81
2002	6,215	64	74,892	200	1.29	0.83	81,107	264
2003	8,015	22	43,021	133	0.85	0.92	51,036	155
	9,644	48	32,873	84	1.06	0.84	42,517	126

Station B

	Diaptomus		*Cyclops*		*Diaptomus*	*Cyclops*	Totals	
	Density	Biomass	Density	Biomass	Size	Size	Density	Biomass
Year	no/m2	mg/m2	no/m2	mg/m2	mm	mm	no/m2	mg/m2
1980	8,750	na	25,681	na	na	na	34,431	0
1981	30,078	90	20,858	56	0.88	0.87	50,936	146
1982	722	5	53,737	115	1.21	0.78	54,459	120
1983	5,871	30	37,448	111	1.07	0.91	43,320	141
1984	22,818	56	37,466	83	0.82	0.80	60,284	140
1985	1,582	9	27,700	47	1.13	0.70	29,282	57
1986	5,683	22	39,135	89	0.97	0.81	44,817	111
1987	1,577	11	30,004	63	1.20	0.78	31,581	74
1988	5,701	16	25,016	61	0.87	0.83	30,717	77
1989	2,855	22	22,813	46	1.24	0.76	25,667	68
1990	4,086	16	23,423	49	0.96	0.78	27,509	65
1991	12,764	69	64,626	129	1.09	0.76	77,390	198
1992	7,678	45	27,236	67	1.12	0.84	34,914	113
1993	6,352	38	41,450	97	1.12	0.82	47,802	134
1994	12,980	44	31,224	79	0.92	0.84	44,204	123
1995	10,639	49	24,478	71	1.02	0.91	35,117	120
1996	27,008	91	28,661	72	0.91	0.84	55,669	163
1997	12,122	40	20,756	58	0.91	0.89	32,878	98
1998	5,647	35	20,040	47	1.13	0.82	25,687	82
1999	33,921	107	36,145	70	0.89	0.75	70,066	177
2000	5,899	42	25,000	68	1.19	0.88	30,899	110
2001	11,230	32	19,640	49	0.87	0.84	30,870	81
2002	8,103	55	81,460	179	1.08	0.79	89,563	234
2003	17,087	39	103,647	264	0.80	0.85	120,734	303
	10,881	42	36,152	86	1.02	0.82	47,033	122

Appendix 1 (continued). Tustumena Lake 2003 – Historical Zooplankton.

Station C

	Diaptomus		*Cyclops*		*Diaptomus*	*Cyclops*	Totals	
	Density	Biomass	Density	Biomass	Size	Size	Density	Biomass
Year	no/m2	mg/m2	no/m2	mg/m2	mm	mm	no/m2	mg/m2
1980	6,883	na	33,029	na	na	na	39,912	0
1981	6,828	23	23,837	61	0.91	0.85	30,665	83
1982	1,044	5	43,156	102	1.06	0.82	44,200	107
1983	7,270	47	59,814	172	1.16	0.90	67,084	219
1984	4,275	6	26,868	59	0.67	0.79	31,143	65
1985	2,087	6	28,500	59	0.87	0.77	30,587	65
1986	2,135	6	56,231	136	0.85	0.83	58,365	142
1987	1,668	10	33,214	74	1.13	0.80	34,882	84
1988	2,620	7	19,485	51	0.85	0.86	22,105	58
1989	10,167	76	26,830	50	1.22	0.74	36,997	126
1990	13,303	26	29,504	63	0.76	0.78	42,808	89
1991	4,840	34	42,731	88	1.20	0.77	47,571	122
1992	13,224	35	39,414	103	0.85	0.86	52,637	139
1993	8,223	48	66,640	143	1.12	0.79	74,863	191
1994	33,395	112	26,240	67	0.91	0.85	59,635	179
1995	6,236	24	15,874	43	0.95	0.88	22,110	67
1996	6,864	22	23,250	58	0.91	0.84	30,114	80
1997	4,092	8	17,906	41	0.75	0.79	21,998	49
1998	8,547	48	16,774	44	1.09	0.86	25,321	92
1999	22,618	72	45,535	101	0.90	0.78	68,153	173
2000	4,979	34	24,643	73	1.17	0.91	29,622	107
2001	5,191	16	4,386	11	0.88	1.19	9,577	27
2002	4,602	53	40,893	104	1.41	0.82	45,495	157
2003	31,062	100	51,783	155	0.89	0.91	82,845	255
	8,840	36	33,189	81	0.98	0.84	42,029	112

Station D

	Diaptomus		*Cyclops*		*Diaptomus*	*Cyclops*	Totals	
	Density	Biomass	Density	Biomass	Size	Size	Density	Biomass
Year	no/m2	mg/m2	no/m2	mg/m2	mm	mm	no/m2	mg/m2
1980	na	na	na	na	na	na	na	na
1981	na	na	na	na	na	na	na	na
1982	na	na	na	na	na	na	na	na
1983	na	na	na	na	na	na	na	na
1984	na	na	na	na	na	na	na	na
1985	na	na	na	na	na	na	na	na
1986	na	na	na	na	na	na	na	na
1987	na	na	na	na	na	na	na	na
1988	na	na	na	na	na	na	na	na
1989	na	na	na	na	na	na	na	na
1990	4,916	27	28,205	47	1.10	0.70	33,121	75
1991	8,204	52	57,547	115	1.14	0.76	65,751	167
1992	4,688	22	29,059	67	1.04	0.81	33,746	90
1993	24,057	134	72,367	172	1.10	0.82	96,424	307
1994	41,034	116	57,735	174	0.86	0.92	98,769	290
1995	17,653	91	29,798	83	1.06	0.86	47,451	174
1996	8,465	35	27,857	70	0.98	0.85	36,322	105
1997	3,181	17	22,503	58	1.08	0.85	25,684	75
1998	16,806	105	18,929	51	1.14	0.87	35,735	156
1999	19,107	66	25,675	60	0.92	0.81	44,782	126
2000	10,633	67	39,769	100	1.14	0.85	50,402	167
2001	58,719	174	16,807	40	0.88	1.19	75,526	214
2002	10,511	77	77,778	166	1.14	0.75	88,289	243
2003	3,770	14	83,316	228	0.95	0.88	87,086	242
	16,553	71	41,953	102	1.04	0.85	56,308	168

Appendix 1 (continued). Tustumena Lake 2003 - Historical Zooplankton.

Station E

	Diaptomus		*Cyclops*		*Diaptomus*	*Cyclops*	Totals	
	Density	Biomass	Density	Biomass	Size	Size	Density	Biomass
Year	no/m2	mg/m2	no/m2	mg/m2	mm	mm	no/m2	mg/m2
1980	na	na	na	na	na	na	na	na
1981	na	na	na	na	na	na	na	na
1982	na	na	na	na	na	na	na	na
1983	na	na	na	na	na	na	na	na
1984	na	na	na	na	na	na	na	na
1985	na	na	na	na	na	na	na	na
1986	na	na	na	na	na	na	na	na
1987	na	na	na	na	na	na	na	na
1988	na	na	na	na	na	na	na	na
1989	na	na	na	na	na	na	na	na
1990	5,808	21	23,145	40	0.94	0.71	28,952	61
1991	7,678	55	53,102	155	1.20	0.91	60,779	210
1992	7,763	25	29,625	70	0.91	0.82	37,388	96
1993	11,075	73	44,713	106	1.17	0.82	55,787	179
1994	12,186	50	38,321	113	0.98	0.91	50,507	163
1995	12,552	61	23,442	69	1.04	0.90	35,994	130
1996	31,999	103	32,626	70	0.89	0.78	64,625	173
1997	4,536	21	20,864	46	1.02	0.79	25,400	67
1998	10,839	60	22,832	56	1.09	0.84	33,671	116
1999	11,503	44	29,190	61	0.96	0.77	40,693	105
2000	6,661	53	28,828	97	1.25	0.97	35,489	150
2001	6,802	18	11,542	32	0.84	0.89	18,344	50
2002	1,596	16	44,782	98	1.29	0.78	46,378	114
2003	10,320	22	112,396	298	0.77	0.86	122,716	320
	10,094	44	36,815	94	1.03	0.84	41,078	124

Appendix 2. Kasilof River 2003 - Environmental Conditions

Smolts Date	Sky	Precip. (mm)	Stage (ft)	Flow	Water Temp. (°C)	Air Temp. (°C)
18-May	1	0	0.54	ND	8	18
19-May	1	0	ND	ND	7	10
20-May	1	0	ND	ND	8	5
21-May	1	0	ND	ND	8	4.5
22-May	2	0	ND	ND	9	8
23-May	2	0	ND	ND	10	10
24-May	2	0	ND	ND	9	8
25-May	2	0	ND	ND	9	11
26-May	3	0	0.54	ND	10	16
27-May	3	0	ND	ND	8	10
28-May	2	0	ND	ND	9	10
29-May	1	0	0.65	ND	11	13
30-May	5	1	ND	ND	11	8
31-May	2	0	ND	ND	11	13
1-Jun	3	0	0.72	ND	10	12
2-Jun	2	1	0.73	ND	11	11
3-Jun	3	0	0.78	ND	10	12
4-Jun	1	0	0.78	ND	11	13
5-Jun	5	0	0.79	ND	11	8
6-Jun	3	0	0.85	ND	10	9
7-Jun	1	1	ND	ND	10	8
8-Jun	3	0	ND	ND	11	8
9-Jun	5	0	ND	ND	10	8
10-Jun	3	0	0.99	ND	10	8
11-Jun	5	1	1	ND	11	12
12-Jun	4	1	ND	ND	13	10
13-Jun	3	0	ND	ND	12	7
14-Jun	4	0	ND	ND	13	10
15-Jun	3	0	ND	ND	ND	9
16-Jun	2	0	ND	ND	12	4
17-Jun	3	0	3.9	ND	13	5
18-Jun	5	0	ND	ND	14	10
19-Jun	2	0	ND	ND	15	8
20-Jun	2	0	ND	ND	14	10
21-Jun	4	0	ND	ND	10	9
22-Jun	3	0	ND	ND	14	7
23-Jun	2	ND	ND	ND	10	12
24-Jun	3	ND	1.7	ND	10	12
25-Jun	4	0	ND	ND	12	13
26-Jun	3	0	ND	ND	10	10
27-Jun	3	0	ND	ND	11	12
28-Jun	2	0	ND	ND	12	15
29-Jun	2	0	ND	ND	11	18
30-Jun	2	0	ND	ND	9	14
1-Jul	5	ND	ND	ND	12	4
2-Jul	5	1	ND	ND	12	12
3-Jul	2	0	ND	ND	7	16
4-Jul	1	0	ND	ND	10	16
5-Jul	4	0	ND	ND	12	14
Total		5				

ND = No Data

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

Appendix 3. Kasilof River 2003 - Smolt Migration

Date	Number of Migrants
18-May-03	2,464
19-May-03	1,208
20-May-03	1,304
21-May-03	2,319
22-May-03	5,700
23-May-03	12,850
24-May-03	8,502
25-May-03	16,957
26-May-03	17,391
27-May-03	34,155
28-May-03	47,391
29-May-03	21,836
30-May-03	16,280
31-May-03	46,087
1-Jun-03	103,188
2-Jun-03	106,087
3-Jun-03	22,367
4-Jun-03	77,681
5-Jun-03	279,324
6-Jun-03	326,763
7-Jun-03	92,346
8-Jun-03	61,692
9-Jun-03	491,808
10-Jun-03	307,769
11-Jun-03	56,077
12-Jun-03	1,370,885
13-Jun-03	630,359
14-Jun-03	999,701
15-Jun-03	1,888,224
16-Jun-03	756,886
17-Jun-03	33,493
18-Jun-03	38,383
19-Jun-03	199,261
20-Jun-03	301,537
21-Jun-03	368,822
22-Jun-03	385,035
23-Jun-03	482,587
24-Jun-03	893,287
25-Jun-03	1,149,231
26-Jun-03	96,643
27-Jun-03	54,685
28-Jun-03	72,308
29-Jun-03	65,664
30-Jun-03	123,776
1-Jul-03	195,455
2-Jul-03	92,797
3-Jul-03	50,979
4-Jul-03	476,713
5-Jul-03	78,951
Total:	12,965,211

Appendix 4. Bear Creek 2003 - Adult Escapement.

Date	Upstream Count	Hatchery Broodstock Mortalities	Females	Males	Total	Daily Total	Cummulative Total	Creek Mortalities
23-Jul-03	7,300				0	7,300	7,300	
24-Jul-03	2,597				0	2,597	9,897	
25-Jul-03	2,089				0	2,089	11,986	
26-Jul-03	2,387				0	2,387	14,373	
27-Jul-03	2,513				0	2,513	16,886	
28-Jul-03	2,329				0	2,329	19,215	
29-Jul-03	2,593				0	2,593	21,808	
30-Jul-03	2,799				0	2,799	24,607	
31-Jul-03	2,245				0	2,245	26,852	
1-Aug-03	733				0	733	27,585	
2-Aug-03	761				0	761	28,346	
3-Aug-03	301				0	301	28,647	
4-Aug-03	1,119	13	125		138	1,257	29,904	12
5-Aug-03	1,806	23	125	125	273	2,079	31,983	320
6-Aug-03	334	8		125	133	467	32,450	24
7-Aug-03	345	9	275		284	629	33,079	17
8-Aug-03	466	21	275	275	571	1,037	34,116	22
9-Aug-03	323	28	275	275	578	901	35,017	36
10-Aug-03	379	8		275	283	662	35,679	12
11-Aug-03	449	10	332		342	791	36,470	12
12-Aug-03	5,000 *	19	252	332	603	5,603	42,073	
13-Aug-03	273	15	284	285	584	857	42,930	
14-Aug-03	307	0		242	242	549	43,479	
15-Aug-03	289				0	289	43,768	
16-Aug-03	262				0	262	44,030	
17-Aug-03	293	11	360		371	664	44,694	
18-Aug-03	288	15	180	360	555	843	45,537	
19-Aug-03	314	14	360	180	554	868	46,405	
20-Aug-03	506	15	360	360	735	1,241	47,646	
21-Aug-03	454	13	360	360	733	1,187	48,833	
22-Aug-03	258	1	360	360	721	979	49,812	
23-Aug-03	444	20	360	360	740	1,184	50,996	
24-Aug-03	1,218	4	360	360	724	1,942	52,938	
25-Aug-03	1,360	0		360	360	1,720	54,658	
26-Aug-03	6,000 *	4	180		184	6,184	60,842	
27-Aug-03	341	3	180	180	363	704	61,546	
28-Aug-03	6,875	0		180	180	7,055	68,601	
29-Aug-03	375				0	375	68,976	
30-Aug-03	1,028				0	1,028	70,004	
31-Aug-03	420				0	420	70,424	
1-Sep-03	230					230	70,654	
2-Sep-03	1,000				0	1,000	71,654	
	61,403	254	5,003	4,994	10,251	71,654		455

Total Return 72,109

* Estimate, wier integrity compromised

Appendix 5. Tustumena Lake 2003 - Project Update

Stocking & Misc. Activities

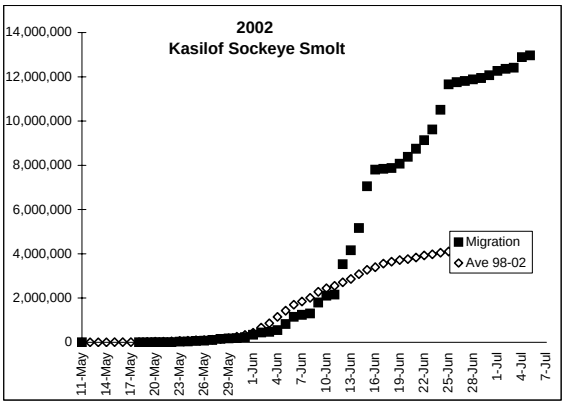
Crew on-site for fry release:	26-May to 31-May		
Crew on site for adult count:	20-Jul to 2-Sep		
Fry release:	28-May to 31-May	6,020,000	
Zooplankton sampling:	28-May to 8-Oct		

Smolt Migration

Dates:	18-May to 5-Jul			
Sockeye total migration:			12,948,000	(±2,438,000)
Age 1:	74.2%	(±16.2%)	9,606,000	(±2,099,000)
Age 2:	24.8%	(±6.4%)	3,212,000	(±835,000)
Hatchery:	18.0%	(±4.6%)	2,309,000	(±591,000)

Adult Migration

Dates:	14-Jun to 10-Aug		
Sockeye return to Cook Inlet:		996,483	
Tustumena Escapement:		358,033	36%
Commercial Harvest:		568,850	57%
Personal Use Harvest:		63,000	6%
Sport Harvest(below sonar):		5,000	1%
Sport Harvest(above sonar):		1,600	0.2%

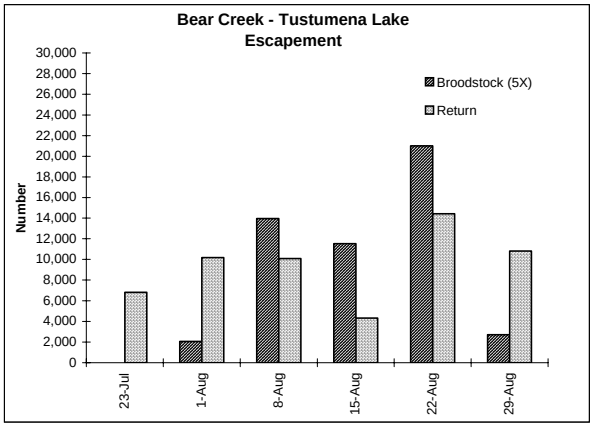


Bear Creek Escapement

Dates:	23-Jul to 2-Sep		
Sockeye total return:		72,109	
Upstream before weir installed:		7,300	
Upstream before eggtake:		28,647	
Remaining after weir removed:		1,000	
Used for eggtake:		10,251	14%
Creek mortalites		455	1%
Total upstream spawners:		61,403	85%

Egg Take

Dates:	4-Aug to 28-Aug		
Total no. fish used:		10,251	
No. of females used:		5,003	49%
No. of males used:		4,994	49%
No. of mortalities		254	2%
Green eggs:		10,936,000	
Eyed eggs:		9,600,000	
percent eyed survival		87.8%	
Fecundity:		2,186	



12/30/2003